
# GIS Integration with Public Safety Applications

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## An ESRI White Paper

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## Executive Summary

To create an end-to-end framework for homeland security, it is essential to understand how software applications are utilized by public safety agencies to respond to everyday emergencies and incidents at state and local levels.

Every event or situation is associated with a physical location; understanding the intersection of these points can mean the difference in knowing if the situation is localized or is something much bigger. Geographic information system (GIS) technology provides the capability to understand how events relate to each other and their potential impact on infrastructure. The security and safety of citizens create the necessity for GIS to be integrated in an overall IT infrastructure plan.

Emergency events are typically reported to the authorities via a 911 call using a landline or cellular phone. Calls to 911 are typically received by a dispatch center equipped with computer-aided dispatch (CAD) software. The CAD application is where all the information and data relative to the emergency are captured including the location of the incident.

The typical first responder (law enforcement, fire/rescue, or emergency medical services [EMS]) is provided with incident data by verbal radio communication or through a mobile data client interface to a portable laptop mounted in a vehicle.

Ultimately, incident details and outcomes are captured within a records management system (RMS) for historical purposes.

This paper will explain the value of GIS integration with public safety applications such as computer-aided dispatch, mobile data clients, and records management systems.

## Introduction

This paper will illustrate how GIS can be applied as part of a comprehensive public safety application integration strategy. This paper is not intended to provide technical specifications or specific implementation recommendations but, rather, a general perspective of technical considerations.

Similar to homeland security, public safety involves the coordination of many disciplines such as law enforcement, intelligence, fire/rescue, health care, critical infrastructure protection, and public works. No matter the incident type, any time the severity of a situation escalates, the need increases for complex systems to manage the demands. As such, there is an increasing need for CAD, mobile, and RMS solutions to be more sophisticated and include GIS features/functionality.

GIS integration with public safety applications provides decision makers with spatial awareness of risks and exposures associated with an incident as well as the incident's scale and magnitude. This new knowledge affords decision makers with a better opportunity to deploy resources more effectively to mitigate further incident escalation.

Homeland security essentially begins with personnel responding to an event, arriving on the scene as well as in the dispatch center. Therefore, it is important to understand how public safety applications intersect homeland security's six essential topics:

- Strategic planning
- Common operating picture
- Critical infrastructure protection
- Emergency Operations Centers
- Data fusion
- Response exercises

## Public Safety Application Integration Fundamentals

The business of public safety has been computerized for some time now. Tactical applications, such as CAD, and mobile data computers have revolutionized how emergency calls are received by a dispatch center and how incidents are responded to by personnel in the field.

In addition, many agencies also use an RMS to warehouse data acquired from CAD and/or mobile solutions. The RMS is the master repository for a large portion of the public safety data. This repository of data is often used in criminal investigations by utilizing querying tools, providing the officer in the field with historical information such as suspect records, previous incidents and/or violations, and so forth. Historical data pertaining to a specific location or premise is also obtained from the RMS through a CAD or mobile data client (MDC) interface.

Many public safety agencies, particularly those with internal GIS departments, are seeking to leverage their investment in a GIS infrastructure. Integrating GIS with other applications is a good way of providing additional investment value.

There is also increasing demand for public safety application geocentricity. Geocentricity is best defined as an application's ability to consume spatially oriented data within the application's business logic or workflow processing engines. A data model that is spatially oriented provides the application user with the ability to view data as a geographic point on a map. This new perspective on data provides situational awareness by answering such questions as

- What are the jurisdictional boundaries?
- Where is the incident located?
- Who is responding to the incident?
- Where are units/apparatus and other assets located?
- What is the history of the location or premise?
- What are the statistical attributes of the location such as demographics, crime density, risks, and hazard locations?

### *Sample Uses for GIS Integration with Public Safety Applications*

There are numerous use cases requiring the integration of GIS functionality within public safety applications. Some of the most notable are as follows:

- Command and control decision making
- Crime analysis and density reporting
- Displaying jurisdictional geofencing for police beats and fire response districts
- Providing real-time road closure information to emergency response units
- Precise incident location in multitenant buildings such as offices, residential apartments, condos, or townhome complexes
- Strategic maps and building plans for tactical operations
- Utilization of geodata in the coordination of reverse 911
- Proximity alerting for everyone within *x* miles of an incident
- Predictive risk modeling based on historical and real-time data
- Emergency response collision avoidance utilizing vehicular location tracking
- Geoenabled video surveillance
- Mitigation planning

## Computer-Aided Dispatch

Nearly every public safety agency in the United States uses some type of computer-aided dispatch system to manage and process emergency 911 calls. CAD is the entry point to many information needs within the homeland security mission. As a public safety solution, CAD is instrumental in providing critical incident information that can be used in a common operating picture. In addition, many CAD providers are building solutions to support Emergency Operations Centers (EOCs). A geocentric CAD can be programmed to recognize whether a new incident falls within the boundaries of a defined disaster area being managed by an EOC. A 911 call can be easily routed past the dispatch center to the EOC for handling based on the location of the call.

Dispatch centers are often segregated between law enforcement and fire/rescue with each discipline having its own dedicated dispatchers. However, as CAD applications have become more complex and expensive, the trend is to move toward consolidating to a single CAD operation for both police and fire. While the dispatch needs are similar between police and fire, the need for location information differs significantly.

Most CAD systems are composed of a business logic engine, a workflow engine, and a graphical user interface (GUI). In addition, the typical CAD application interfaces to a telephone and radio network for 911 calls and dispatches, respectively. Enhanced 911 systems provide dispatchers with the ability to know the location a call is coming from via a landline or cellular phone using a Phase II wireless protocol.

GIS integration with dispatch applications has typically been limited to address verification and incident plotting on a map. Today, GIS integration can create additional value in providing both the dispatchers and field personnel with situational awareness. Situational awareness is enabled by consuming geoprocessed data within the dispatch application's business logic or workflow engine.

The CAD business logic engine processes variable data against a set of business rules and presents the user with an output result for decision making. The workflow engine manages and tracks the flow of information within the CAD. The combination of business logic and workflow helps dispatchers manage tasks such as who should be dispatched, who was dispatched, what step in the response the unit is in (en route, on scene, available, etc.), what type of incident the unit is responding to, and what additional resources are needed based on incident type and preplanning models.

Because location is often a critical data variable in both the business logic and workflow engines, it is important to have a robust GIS interface into the CAD. Many CAD providers offer an optional mapping application with their solution packages. The mapping interface usually provides the dispatcher with visual reference of the 911 call's location.

When incident mapping is used in conjunction with an automatic vehicle location (AVL) system, the dispatcher will have an improved ability to know which unit is closest for incident response. AVL also enhances dispatcher decision-making capabilities through analyzing road closures or real-time traffic data factors. AVL integrated with CAD workflow can automatically recognize that a vehicle is on scene, saving the need for radio traffic by alerting the dispatcher electronically.

Many CAD applications use a proprietary geofile containing address, street, centerline, common place, and boundary data. The utilization of a proprietary geofile in CAD has historically been more of a performance issue than a technical one. A proprietary geofile provides consistency across multiple system releases and is organized specifically to the CAD operating systems. However, there are limitations with the proprietary geofile design including the need to maintain a master GIS as well as the CAD geofile. This redundant maintenance can cause data inaccuracies and inefficiencies. In addition, the proprietary data model is not conducive to data sharing and exchanging. Hence, there is difficulty in extending or integrating CAD applications with other systems relying on location data.

The solution is to design service-oriented architecture (SOA) where a GIS server can provide a dispatch application with GIS data through an interface. Another possibility would be to replicate GIS data directly from a central source. Either solution provides locationcentric enhancements that public safety agencies are now demanding such as the following.

### *Premise History Data*

Premise history is an important element of situational awareness. Whether the incident is law enforcement or fire/rescue related, having knowledge of what has previously taken place at a specific location can better prepare response personnel to handle the incident. For example: When responding to a domestic violence call, it is beneficial for the officer to know that a shooting also occurred at the same address six months ago. Armed with this information, the officer would approach the residence more cautiously.

Similarly, fire departments benefit from knowing historical information about a particular premise. Knowing that a meth lab was discovered two months ago at the same location that is now involved in a structure fire could prepare the firefighters to suspect hazardous material involvement.

### *Resource Tracking*

Many agencies are finding value in AVL simply from a personnel safety aspect; they can track not only the location of the vehicle but also the individual after leaving the vehicle. This form of accountability is essential for safety whether the need is tracking a police foot pursuit or finding a firefighter who is trapped in a collapsed structure.

In response to the new demand for personnel tracking functionality, device manufacturers are beginning to include GPS chips to track the device. The general assumption is that the device will always be in a person's possession. Many device tracking capabilities are limited to x,y coordinates or two-dimensional tracking. However, the device manufacturers are also developing ways of providing indoor and z-coordinate (three-dimensional) tracking functionality.

Indoor and z-coordinates are usually determined through using static wireless access nodes to determine location, a process typically called bread crumbing. As a person enters a building, they place a wireless access node device on the floor and communicate to incident command where the device is located. The location of the access node is entered into a database, and as it identifies that a device being worn or carried by a person is in close proximity of the node, it sends a signal to a server on the wireless network. The server then provides the location data to an application being used by incident command.

Combining personnel skills or capabilities data with personnel tracking capabilities of a device and network, incident commanders can better position personnel at the scene of an incident.

## Mobile Data Computer

Many CAD providers either offer or integrate with an MDC. The mobile data client is merely an extension of CAD services on a portable laptop for in-vehicle use. The MDC provides the mobile user with the capability of receiving incident data (caller name, address, incident type, etc.), sending messages to other mobile users and dispatchers, and requesting and querying external databases such as the Department of Motor Vehicles records or agency RMS repositories, and it usually includes some type of mapping application.

The need for situational awareness is most evident in the mobile environment. GIS integration with mobile applications provides personnel in the field with the situational awareness needed to remain safe. After a 911 call is received, the dispatcher can query an RMS repository to obtain any premise history information. The premise history record is then attached to the new incident and is passed to the mobile data client. Because the data has spatial reference, the mobile users can point and click to view the historical data directly from the map.

The mobile map application also provides situational awareness through location tracking solutions. Some AVL solution interfaces provide the capability of alerting users to potential known whereabouts of criminal suspects or something less urgent such as addresses where warrants need to be served.

In addition, locating tracking applications can provide maps to mobile users with the current whereabouts of their colleagues. Should fellow officers find themselves in trouble and unable to communicate their positions, the device or GPS unit will lead help right to them.

There are numerous other use cases that could be discussed; however, the main point is that GIS integration is required to provide situational awareness in the mobile environment.

## Service Dispatch Applications

Service dispatch applications are often associated with 311 calls or nonemergency requests from a public safety agency. Similar to its cousin the CAD, service dispatch applications rely on GIS to provide location data of the caller and/or place requiring service. The biggest difference is the urgency of the request.

Many municipalities are beginning to realize the value of 311 services, simply in terms of lightening the workload on dispatchers and freeing up the emergency phone lines. As these applications become more sophisticated, the process of providing the community with the service is also becoming sophisticated. As a result, communities may want to begin equipping their service vehicles with mobile data clients to automate workflows for greater efficiencies.

## Dashboard Applications

Dashboard applications have very diverse feature functionality. It is virtually up to the developer to decide what information will be displayed within the application window. The applications are called dashboards because they provide multiple information windows, much like the gauge cluster on an automobile.

The dashboard-type application is often needed by high-ranking officers or community officials to gain a general sense of the events and actions occurring in their community. While possible, it is not the intention of the dashboard-style application to provide tactical manipulation of data.

The user personas for dashboard applications can be divided into two categories: the strategic and the tactical user.

The *strategic user* is typically a person with authoritative or decision-making responsibilities. This person is responsible for determining or influencing public safety response plans. This person generally has a long tenure with the agency and a significant amount of process knowledge.

The *tactical user*, on the other hand, is typically the frontline user of applications to gain a general sense of things that are occurring. This person interfaces with a dashboard application at a more intimate level, as it is necessary in their daily job responsibilities. They will want to dive into the details the dashboard is presenting. This person is either found in a dispatch/communication center, responding to incidents in a police/fire/rescue vehicle, or working in a crime analysis or investigation unit. This person is usually working a specified shift and shares equipment with other users.

GIS and mapping provide the user with a unique perspective through information visualization in the context of the boundaries of their community. GIS spatial layering enables the user to visualize many different data types on a single map ranging from a single reference point to areas of concentration.

Agency officials can use information obtained from geocentric dashboard applications to identify weaknesses in their emergency responses, then improve emergency preparedness by creating effective training and exercise drills. Incident scenarios can be constructed using GIS to model different responses without having to incur the expense of deploying physical assets.

## Intelligence and Analytics

Homeland security is driving a need to acquire more intelligence data and a need for analytical systems at all levels of government. These endeavors are often associated with data fusion projects. There are a few local agencies funding their own intelligence and analytical initiatives. Some have also been exploring solutions with predictive modeling and risk concentration analysis. Their main focus is better community protection from occurrences such as wildfires, floods, pandemics, and crime through better resource deployment planning.

Many public safety agencies use records management systems as their repository for intelligence data. The local RMS is a good source of crime and incident activity; it is considered authoritative because the information contained in the repository is often used in court cases to prosecute offenders. Some RMS providers are building solutions that automatically geocode the RMS record. The RMS geocoding capabilities will be valuable as RMS repositories become part of state-level data fusion center strategies.

While the local endeavors do not exactly meet the needs of federal homeland security intelligence gathering and analysis, the basic models the local agencies are developing can certainly be modified to meet federal needs.

Similar to dashboard applications, there are several products on the market that provide predictive or cause-and-effect modeling solutions. Many of these are already integrated with GIS and mapping interfaces as well as interfaces with various database technologies.

## Video Surveillance Integration

The nation's critical infrastructure is spread across a very large geographic area, making it virtually impossible to provide security with the 24/7 physical presence of a person. The private sector, which owns 80 percent of the infrastructure in the United States, has turned to using video surveillance systems to monitor key areas to prevent or respond to threats such as intrusion into sensitive areas. With video surveillance, a person in a central location can monitor multiple areas without being physically present. Should an abnormality occur on the video monitor, security personnel can respond accordingly. The video could even be relayed to a dispatch center for improved law enforcement response.

However, until now, video surveillance only provided a visual image of what the camera captures. Interpretation of the image, as well as what is occurring in the video, is dependent on camera location and location familiarity on the part of the person watching the video. Location unfamiliarity and poor situational awareness could potentially lead to an ineffective, delayed response.

Advancements in video surveillance have included GIS integration, which improves surveillance effectiveness with situational awareness. GIS provides the user with the precise location of the camera and knowledge of which direction the camera is pointed. In addition, some camera systems have object detection intelligence. Objects coming into the field of view of the camera are highlighted or emphasized to allow quick and easy recognition of intrusions or threats. Object detection combined with GIS also provides tracking of the object until it is no longer a threat or is out of view of the camera. GIS

enables point-and-click control of video cameras; security personnel can easily control camera movement such as pan, tilt, and zoom by pointing and clicking on a map.

GIS-enabled video surveillance provides security or law enforcement personnel with live video as well as the spatial knowledge to best respond to any threat.

## Conclusion

For many years, GIS was seen as a tool strictly used by people who take care of street or community planning; GIS within public safety was merely thought of as "my map, a means of finding my way." However, today GIS is increasingly becoming part of an overall IT strategy for information authoring, publishing, and consuming.

When time is of the essence, the importance of having and sharing information is critical to ensure a safe and effective emergency response. Whether you are a dispatcher, incident commander, or first responder, having a keen awareness of the situation can contribute to a safe and effective operation. Geoprocessing using ArcGIS® Server enhances the common operating picture through providing spatial data associated with an incident's location. No other operating system can do that. Incident commanders can assess risks and dangers to a community and publish detailed maps on a wireless handheld device using ArcWeb℠ Services so field resources can coordinate evacuations and create on-the-fly response plans.

GIS in the mobile environment provides field personnel with the ability to capture new information, geocode it, and send it back so that incident command can visualize incident progress. As such, it is strategically important that GIS become an integral part of any common operating picture IT infrastructure.

GIS functionality in Emergency Operations Centers enables distant agencies, unfamiliar with an area, to have the same knowledge as if they were locals. The ability to visualize information in the context of a map, such as premise history, stored preplans, and known risks and hazards, ensures any agency can function effectively and safely.

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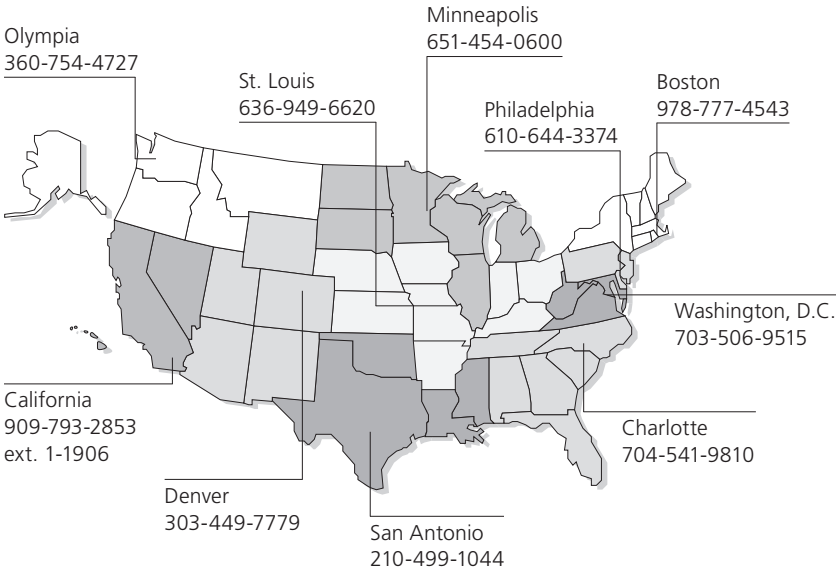


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