Geospatial Computer-Aided Dispatch

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Executive Summary

The primary mission of public safety is to respond to emergency events to protect life and property. Many communities are growing in terms of population and geographic area. Many are also exposed to increased hazards associated with industry, crime, and proximity to natural risks such as wildfires, earthquakes, flooding, and severe weather. Increased exposure means emergency response requests are more frequent, complex, and dangerous.

The complex demands for public safety require sophisticated, computerized systems to manage the volume of information needed for a safe and effective response by our law enforcement officers, firefighters, and emergency medical personnel. Today, a person requiring help dials 911 and describes what help is needed, and within minutes emergency response teams will arrive.

A 911 emergency call system is composed of two technologies: enhanced 911 (E-911) and computer-aided dispatch (CAD). E-911 is a feature provided by the telephone company that allows the emergency dispatcher to identify the location of a caller whether the call is from a landline or wireless. E-911 provides the ability to identify a caller's location even if the call becomes disconnected.

CAD is a system that identifies the most appropriate and available resource required to respond to the 911 call. In addition, a CAD system manages resource status and interfaces with a records management system to capture and retain incident data.

Geographic information system (GIS) technology is used to store and analyze spatially referenced data. Most CAD applications require a database containing addresses and street information to accurately locate a 911 call. GIS technology can enhance CAD functionality through advanced analytics and data visualization.

This white paper will discuss the value GIS provides to both E-911 and CAD systems, emphasizing the CAD portion of 911 response handling.

Introduction

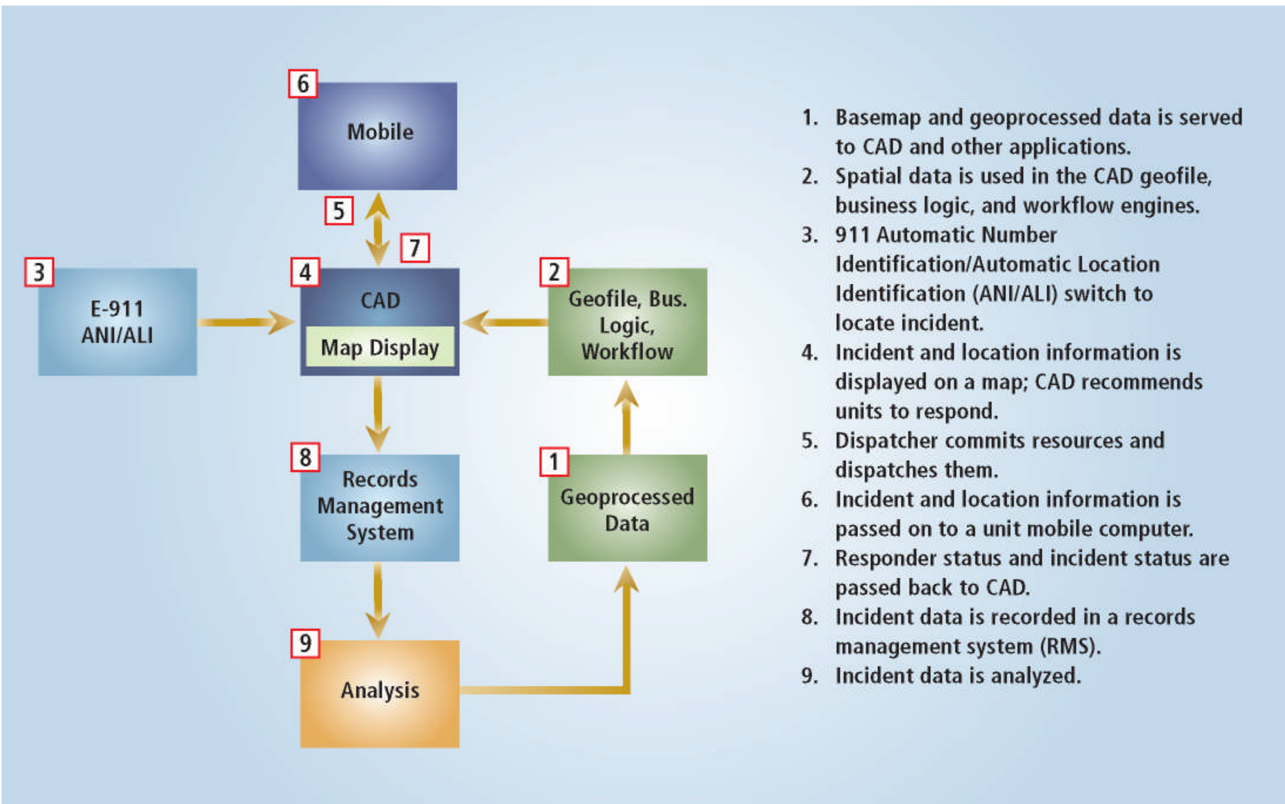
ESRI does not design or build CAD solutions. However, GIS integration with CAD is certainly a value-added functionality that is increasingly becoming part of some CAD solution architectures. Many CAD providers in the market are building what has been coined as the next generation CAD (NGCAD). Typically, NGCAD refers to a redesign of CAD complete with a new architecture to support common services and standard interfaces with other enterprise systems or between CAD applications.

Today, many local and county governments use GIS to identify streets, boundaries, tax information, and so forth. They are typically staffed with personnel who maintain the data in the system to ensure accuracy. More than a typical map display on the dispatch console, a GIS integrated CAD system provides greater efficiency in maintaining street and address data by interfacing and leveraging existing data. The mapping capabilities of

GIS provide dispatchers with the ability to visualize the location of incidents and of emergency and law enforcement units when an automatic vehicle location (AVL) solution is utilized. Dispatcher insight into the location of incidents and resources provides greater efficiency in assigning the right resource to the right incident to reduce response times.

CAD Design and Architecture Overview

To better understand how GIS adds value to a CAD solution, we must first review the basic design and information flow of a CAD system. At the highest level, every CAD solution has these primary system components: an E-911 interface, a server-based business logic engine, a server-based workflow engine, a geofile and provisioning database, a user-client interface, and a records management interface.



The above diagram provides a generic CAD dataflow using a GIS foundation for the utilization of geoprocessed data in dispatching workflow and operational (business) logic functions.

E-911 Interface

E-911 routes call traffic to the public safety dispatch center responsible for the geographic area where the call originated. E-911 provides CAD with location data so that the emergency dispatcher knows where to send resources without having to ask the caller for the information. However, address verification is still required because the call may be coming from a nearby location rather than the location of the emergency itself.

Business Logic Engine

Each CAD system is uniquely designed. However, each provides some sort of systematic processing of information based on a client-configurable or -specified algorithm, often referred to as a business logic engine. GIS server technology can interface with a CAD business logic engine to consume geoprocessed data variables such as unit type, call type, beat, or response area parameters to handle specialized tasks, providing the dispatcher with a unit recommendation to assign the most appropriate resource response.

Workflow Engine

A CAD workflow appears fairly simple; a call comes in and a unit must be assigned to respond. However, CAD workflows are much more complicated. Every response unit has an associated status based on its availability and location. Each CAD customer requires a configurable set of unit statuses within a CAD system. The more common ones are In Service (Available), En Route, On the Scene, Out of Service, En Route to Hospital, or In Pursuit. A GIS server technology interfaced with a CAD workflow engine helps dispatchers manage unit assignments and availability when new emergency calls are received by graphically displaying unit status on a map.

CAD Geofile

Today, there are up to three geofiles in the 911 call process: the Master Street Address Guide (MSAG), CAD geofile, and a local or county GIS system. Each requires maintenance and support of essentially the same data, which is an inefficient use of resources.

Processing speed and performance is paramount in the world of emergency dispatching. Knowing and verifying the location of an emergency are absolutely essential to ensure law enforcement or fire/rescue personnel arrive at the correct destination. Rather than using an MSAG, which is typically used to determine the 911 call location to route it to the appropriate public safety answering point (PSAP), many CAD providers utilize a proprietary geofile to ensure a Five-9 high-availability operation rating and a one-second response cycle. (A Five-9 availability rating means that a system is only allowed approximately 5 minutes of downtime per year.) However, a proprietary geofile also poses some unique problems, including database updates as new streets and addresses are added, with the community resulting in increased market pressure for CAD to utilize existing local or county GIS files that are more frequently maintained.

A GIS-centric MSAG and CAD geofile would ensure consistency and reduce the need for multiple street and address data sources. In addition, a GIS/CAD-centric system with good editing tools would provide the ability to update files more frequently, ensuring greater location accuracy as well as providing a single authoritative source for street and address data accessible to authorized users.

Provisioning Database

The provisioning database warehouses law enforcement and fire/rescue personnel rosters, dispatcher user details, fire apparatus, and police unit information as well as other resource details.

User Interface

The user interface (UI) is simply the method dispatchers use to enter data and interact with the CAD system. Most CAD user interfaces utilize a command line, which is a field within the CAD UI where dispatchers essentially record information in shorthand. The CAD system then interprets the shorthand codes and populates the appropriate tabular fields with full-length or detailed information. The typical CAD UI functions on two or three separate monitors. The left monitor is often used for a map display or for looking up information. The center monitor is often used as the primary workspace, where incident and call details are displayed. The center monitor is also where the command line is

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typically found. The right monitor is often used to display the call work queue and unit status information.

The above photo depicts a CAD user interface using two monitors. The left screen is workspace designed to allow dispatchers to enter incident data, verify unit status, identify available resources, and coordinate incident assignments. The right screen is the map interface, designed to provide dispatchers with a visual reference of incident and resource locations.

Records Management System Interface

A records management system is a repository for incident data acquired directly from CAD or through a user interface. The records management system provides functionality to query transactions for analysis and historical information. Users can access RMS data and information remotely using a mobile data terminal. GIS can correlate spatially referenced RMS records with new CAD incident data to provide situational awareness to response personnel. Information regarding premises with a history of repetitive incidents can prepare responders to better manage the current situation they are about to enter.

Geospatial CAD Features and Functionality

This section is intended to provide insight into some key features CAD customers are looking for in a geospatial CAD. Each of these features is written as a marketing requirements statement, with the intention that they can be shared with either a CAD provider or customer to provide or enhance a vision for a geospatial CAD. The features and functions discussed here are not an inclusive list and do not represent all aspects of a geospatial CAD.

- **Entity Name Map**

  For example, if the street centerline features are stored in a table called STREETS, and the street name is stored in a column named FULLNAME, a configuration tool will need to allow you to specify these names without having to change entity names to match hard-coded names in the GIS system.

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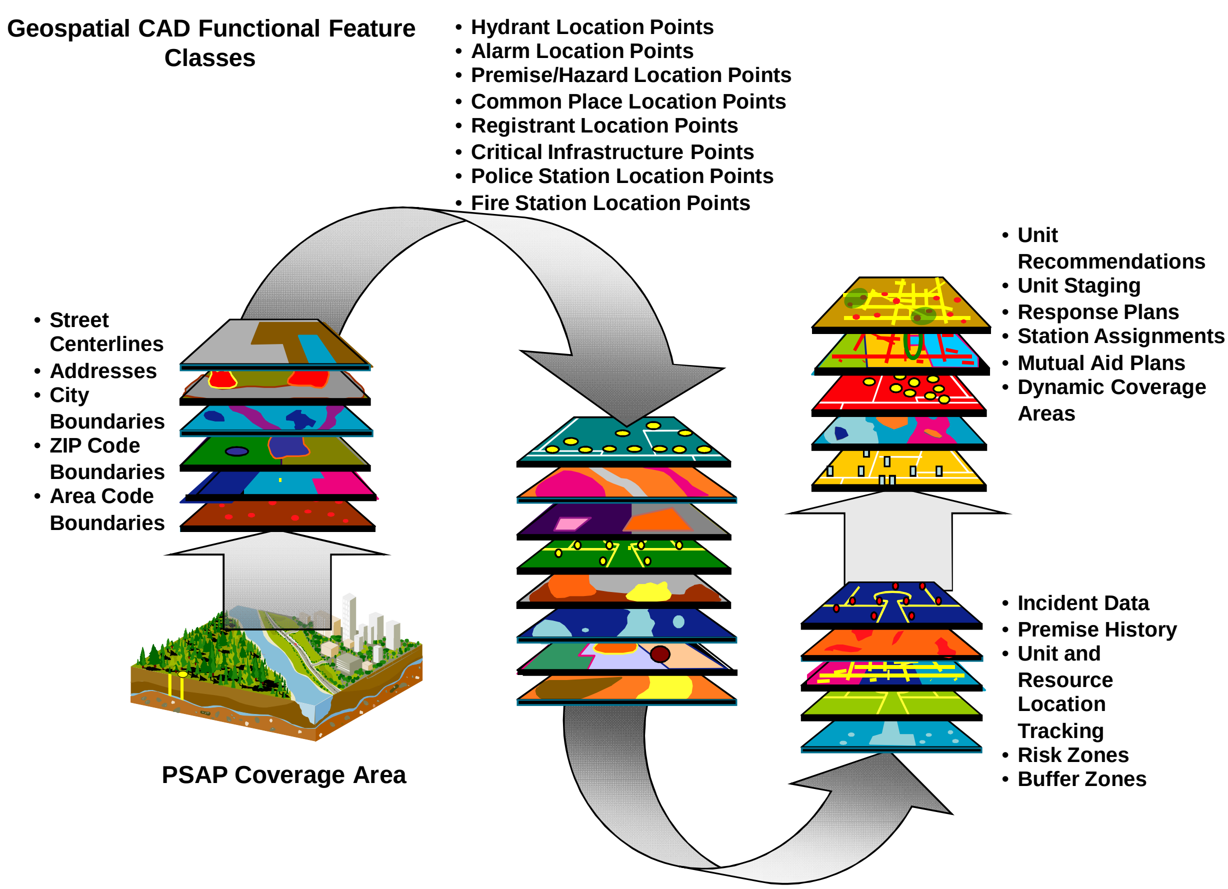
■ Functional Feature Classes

A features class (spatial layer) is a collection of geographic features with the same geometry type (such as point, line, or polygon), the same attributes, and the same spatial reference.

A functional feature class is a feature class that has specific business logic developed to consume data from it. For example, applications that need to perform address matching services will need to require the presence of a street centerline and/or address point feature class in the geodatabase. Some feature classes are never required and only support specific functionality if present. For example, the GIS service will need to support the existence of a hydrant feature class and allow clients to search for a nearby, in-service fire hydrant. While this feature class is not required for basic dispatching, it may be used to supplement dispatch functionality.



The above diagram provides an illustration of applying various functional GIS feature classes within a CAD business logic and workflow engine. Geographic data provides the ability to create new rules and automation for dispatching and emergency response.

■ Nonfunctional Feature Classes

A nonfunctional feature class is a feature class that exists in the geodatabase and must be displayed as a layer on a map client application. However, it is not required to have any business logic associated with it in the GIS system.

Examples of nonfunctional feature classes are as follows:

- Water boundaries
- Forestry boundaries
- Orthophotography
- Any other feature class not specifically listed

Feature Class Attributes

Each feature class will need to have certain attributes providing the ability for the feature class to be consumed as a data variable in a business logic process.

For example, a Street Centerline feature class must contain attributes for house number values and the name of the street. There may also be attributes that are not required but which will need to be used if present (functional).

■ Hierarchical Address Matching Model

A geospatial CAD system will need to support a hierarchical approach to street address matching. Address matching will need to be supported against both point (address point) and line (street centerline) feature classes.

If an address point feature class is available, it will need to be queried first for a street address match. If no match is found, or if an address point feature class is not available, the street centerline feature class will need to be queried. It is recommended that, even if an address point feature class is available, a street centerline feature class should exist to support address matching of street intersections.

A geospatial CAD system will need to support address point feature classes with attributes consisting of a house number and a street name. The address point feature class will need to optionally support building and unit numbers/names to accurately depict the location of residences or businesses that share the same house number and street name (for example, mobile home parks or shopping centers).

If the GIS system can still not find a match, it will need to return the nearest match.

For example, if 705 MAIN ST is entered, but no segment of MAIN ST contains this house number, the GIS system may return a segment of MAIN ST with a house number range of 601–699 and designate it as a near match.

The user will need to be able to geocode an address using a nearby segment if the actual segment does not exist in the GIS.

- **Numeric, Alphanumeric, and Hyphenated House Numbering**

A geospatial CAD system will need to support numeric, alphanumeric, and hyphenated house numbers as specified in the United States Postal Service Postal Address Standards. However, to support geocoding of addresses using an address range, a segment side must use the same house number type for the low and high house number, and it is expected that all houses within the range adhere to the same house number type.

For example, the following situations do not need to be supported:

- Mixed types in the low/high address attributes
  - Left low address = 12001
  - Left high address = 23N899
- Mixed types within the segment
  - Left low address = 12001
  - Left high address = 12998
- Actual house number along this segment = 23-101

- **"In Front of Address"**

A geospatial CAD will need to provide a way to geocode a location for an incident that occurs in the street using a parcel address. For example, "In front of 1990 Cherry Circle" would be geocoded to a coordinate on the street segment directly in front of the parcel at 1990 Cherry Circle.

- **Street Names**

Some data sources may have street names stored as a single attribute, while others are parsed into as many as five attributes (prefix direction, prefix type, name, suffix type, and suffix direction).

A geospatial CAD system will need to handle any combination of attributes in between. However, because of how the Soundex and address matching algorithms work, it is desired that prefix attributes be stored in attribute fields separate from the street name. Prefix types are typically considered part of the street name. They are used almost exclusively in foreign language street names such as Calle Valdes and Rue Bourbon.

However, by storing them in the same field as the street name, the system will need to produce several Soundex and address match results when only "Calle" or "Rue" is provided as input. Prefix directions create the same problem.

- **Cross Street Determination**

  A geospatial CAD system will need to provide a service to determine the cross streets of any given street segment. This service will not only need to support the ability of a user to get the cross streets for a particular segment but can also be used to get a list of streets that intersect a particular street.

- **Street and Pseudo Intersections**

  A geospatial CAD system will need to support location matching using the names of two streets that intersect without the use of a junction or intersection feature class. A geospatial CAD will need to also support "pseudo" intersections, where two streets do not actually meet but where the addressing schema aligns with block numbering.

- **Block Numbers**

  A geospatial CAD system will need to support address matching and geocoding of locations entered as block numbers (for example, 100 BLK MAIN ST). A geospatial CAD system will need to geocode this address similar to how it would a house number (100 MAIN ST) but without the XY offsets applied to the segment ends and sides.

- **Common Place Matching**

  A geospatial CAD system will need to support matching point locations that have address information associated with them (for example, common places such as businesses, schools, and other government buildings) by both name and address (reverse place matching).

- **Geocoding**

  A geospatial CAD system will need to support translating a verified location (street address, intersection, named feature point) to a geographic coordinate. Reverse geocoding, or translating a coordinate to a street address, intersection, or named feature point, will need to also be supported.

- **Feature Attribute Queries**

  A geospatial CAD system will need to support querying features in any functional feature class by any functional attribute(s).

- **Feature Aliases**

  Most functional feature classes (such as street centerline and common place) will need to support the use of Alternate Name Tables, allowing aliases to be defined on a per feature basis.

- **Spatial Queries**

  A geospatial CAD system will need to support querying features from functional feature classes within a specified radius of a specified coordinate. This feature will need to be used for such things as previous incident searches, premise/hazard searches, and determining the responding agency/beat/station.

- **Transportation Network Services**

  A geospatial CAD system will need to provide a service to calculate the shortest or quickest path between two or more points using the street network dataset. Driving directions will need to be included as part of the response as will estimated travel time. Custom evaluators, such as peak and nonpeak travel costs; restrictions based on vehicle length, height, and weight; illegal turn restrictions; and turn penalties, can be defined in the network dataset and taken into account while solving. Network elements can be closed or opened in real time or at scheduled times. A geospatial CAD system will also need to be designed in such a way as to support intelligent traffic systems so that real-time traffic data can be used to assess network travel costs.

- **Complex Routing Support**

  A geospatial CAD system will need to provide the user with complex navigation routing information to be displayed in a map client application.

- **Turn Penalty Modeling Support**

  A geospatial CAD system will need to provide the user with the ability to model turn penalties associated with a particular route and display it in a map client application.

- **Sensory Data Interface Support**

  A geospatial CAD will need to support an open API-like interface with sensory devices to collect the following data:

  - Vehicle data
    - Speed
    - Vehicle in motion
    - Warning systems (lights and sirens) activation
  - Personal data
    - Self-contained breathing apparatus air levels
    - Biostatistics

- Devices
    - Heat sensors
    - Toxic gas sensors
    - Video surveillance sensors

- **Meteorologics Support**

  Users often need to understand how weather may be impacting an incident. There are several situations beyond catastrophic weather situations warranting this feature. For example, weather has an effect on wildfires, the direction and speed of toxic gas clouds, and the usability of bridges/roadways that become dangerous at certain wind speeds. A geospatial CAD will need to support an open, API-like interface with meteorologics applications to import weather data for a specific location and overlay it on a map.

- **Layer Management within Dynamic Map Client**

  A geospatial CAD will need to support an open, API-like interface to provide any map client with data associated with spatial layers contained within the geodatabase. A geospatial CAD will need to also support the ability to define those layers and switch between the views to prevent screen clutter.

- **Overlapping Jurisdictional Support**

  Many agencies have overlapping jurisdiction, where more than one agency may be required to respond to a location for an incident. In addition, an agency may have overlapping jurisdictions within itself. For example, university campus police may be the first to respond to a burglary on a college campus, but local police may also be required to respond if an arrest were to occur. As such, a geospatial CAD will need to support the ability to have overlapping jurisdictions and to allow a dispatching application to notify all responsible agencies.

- **Time-Dependent Polygons**

  Overlapping jurisdictions may also have a time element associated with them. For example, park police may be responsible for a community park or beach between the hours of 6:00 a.m. and 6:00 p.m., whereas local police are responsible for the other 12 hours. As such, a geospatial CAD will need to support the ability to establish time-dependent geopolygons.

- **X,Y Coordinate Projection Exposure**

  A geospatial CAD will need to support an API-like interface to expose x,y coordinate projections to be used by any application.

- **Incident Location Data Store and Query**

  A geospatial CAD will need to support the ability to store and query incident data associated with a specific location in a records management system except where bandwidth limitations exist in a mobile operating environment.

Dynamic Map Client Functionality

A dynamic map client is required to graphically display location data, as well as data corresponding to locations, to the user. A dynamic map client could be a plug-and-play module and provide an API-like interface, providing the ability to share location data with a host application.

- **Host CAD Application Interactions**

  The dynamic map client will need to be able to share data by populating the host application's data entry forms and unique user interfaces such as Active Paper and dispatch command lines.

  - The user will need to be able to point, click, or touch a point on the map client, and data associated with the location will need to be populated in the host application user interface based on the host application's call for the data.

  - The map client will need to support the ability for the host application to populate new data associated with a location on the map through an API-like interface.

  - Host applications performance will need to be free of adverse effects caused by interacting with the dynamic map client.

- **Client User Interactions**

  The dynamic map client will need to support the ability for users to interact with the system through the use of a mouse, touch screen, key commands on a handheld device, voice activation, or pen-based technologies.

- **User-Selected Location Data Views**

  Geographic data is typically displayed as a digitized map or as an orthophotography image. The dynamic map client will need to provide users with the ability to select, deselect, or change their desired view of location data. View selections are meant for a later release of the solution but will need to include the following actions:

  - Switch from a digitized map to an orthophotography (including oblique) view of the same location.

  - Switch from an orthophotography view back to a digitized map view.

  - Minimize the digitized map view to a smaller perspective and display hosted application data associated with a location in a secondary panel.

- Apply either a static or dynamic dispatch command line interface on top of the map for data input and provide the ability to close out of the command line when completed.

- When data that is spatially displayed is selected, a "halo" window will appear with base information including hyperlinks to the full data view.

■ **Location Data Acquisition**

Users require the ability to access location data through a map interface. The acquired location data is to be used by a host application for specific processes. The dynamic map client will need to provide the ability for a user to access location data through the utilization of the following drawing tools:

- Single point access
- Multiple point access (ctrl + [Click])
- Select by layer
- Point-to-point line
- Polygons
- Circles
- Ovals
- Measured distance from a given point or current location
- Measured radius from a given point or current location

■ **Location Data Viewing**

The dynamic map client will need to provide the ability to view and select data associated with a location through the following methods: mouse-over movement, point and click, pen devices, and touch screen access.

Situational Awareness Functionality

The dispatcher or first responder is a person who will be interfacing with the map client to complete a specific task for a specific location or set of locations.

The dispatcher or first responder uses the map to obtain an awareness of response boundaries and assigned areas, where they are located in a geographic area, where units from their agency or another agency are located within an area, where incident or response calls are occurring, automatic directions to those calls, detailed information relating to the calls, or detailed information relating to a specific location.

■ **Single and Multiple Vehicle/Person Display**

Geospatial CAD users will want to know their relative position and the position of other users on a map. This would include direction of travel and where they have gone. The dynamic map client will need to provide the user with a flight following awareness by displaying a solid arrow indicating direction of travel and a dashed line indicating previous route.

- **Vehicle/Person Display Toggles**

  The geospatial CAD user and supervisors will want the ability to toggle on and off whether or not their location is displayed and viewable by others. They may also want the ability to restrict the overall operational view to supervisor level and above. The map solution will need to provide a means to grant authority to specific users for this feature.

- **Vehicle/Person Type Indicators**

  The geospatial CAD will need to support customization of icons and/or shapes to represent different types of conveyance including vehicle, motorcycle, bicycle, walking, and mounted as required, and it will be based on the vehicle class of the resource.

- **Incoming Unit Flight Following**

  The geospatial CAD user will want to know the location of other vehicles responding to the same location. As such, the dynamic map client will need to provide the ability to identify incoming units that are off the map by an indication pointing to the incident they are responding to. The indication will need to support a user-defined color variant correlating to the distance from the incident.

- **Routing Indicators**

  The geospatial CAD user will need to be provided with the ability to apply individual icons for each of the following:

  - Start of route
  - End of route
  - Location icon
  - Incident
  - Caller location
  - "Barriers" and "Via" (intermediate) route points

- **Point-to-Point Directions**

  The geospatial CAD user will want the ability to search for and receive point-to-point directions. The dynamic map client will need to support the ability for the user to enter a starting location and ending location. The map client will need to then determine the route to take and provide the user with both textual information and graphical information pertaining to route, estimated time of arrival, and distance.

- **Address Lookup**

  The geospatial CAD user will want the ability to search for and receive location information for a given address or range of addresses. The dynamic map client will need to support the ability for the user to enter an address or block of addresses. The map client will need to then determine the location of the address and center the map on that location.

- **Common Place Searching**

  The geospatial CAD user will want the ability to search for and receive location information for a common place. The dynamic map client will need to support the ability for the user to enter a common place. The map client will need to then determine the location of the common place and center the map on that location.

- **Incident Display**

  The geospatial CAD user will want detailed information regarding the location, as well as incident data, associated with a given location. The user will most commonly want to know address data, street name, premise history, and incident detail (incident type, how many people are involved, when it was received, and hazardous conditions). The dynamic map client will need to support a host application interface to present nongeographic data on a map.

- **Traffic Volume Impact (traffic impact on response times)**

  The geospatial CAD user will want to be made aware of unique travel conditions that may impede a response. The dynamic map client will need to support an interface to alert the user to the impact traffic volumes may have on a route.

- **Environmental Response Factors**

  The geospatial CAD user will want to be made aware of unique weather conditions that may impede a response. The dynamic map client will need to support an interface to alert the user to the impact weather may have on a route.

- **Wind Direction and Plume Modeling**

  An awareness of environmental factors is also essential in hazardous material and wildfire incidents. The dynamic map client will need to support an interface that a host application capable of providing meteorological information can utilize to present the impact weather may have on an incident. A geospatial CAD will need to provide an automatic Wind Direction and Plume Notification feature.

- **Utility Company Availability**

  The geospatial CAD user often has to interact with utility companies as well as other services such as street or water departments. The dynamic map client will need to support an interface that a host application capable of providing location tracking information from an outside source can use.

- **Location Send**

  A geospatial CAD user is often busy with handling the demands of an incident and therefore would gain an advantage by having the ability to send location information to another user such as a person with a map-enabled handheld device, a vehicle equipped with a map client, or aircraft such as helicopters. The following are potential situations:

- Location-specific concerns
- Staging area
- Command post identification
- Mutual aid response (data share geodata for incidents)
- Sending GPS coordinates to aviation units (fire and police)

■ **Photo Attaching**

A geospatial CAD user wants the ability to attach a photo and/or video file with the location information. A geospatial CAD will need to support the ability to attach a digital photo with corresponding location information for the purpose of sending an e-mail or message. The map is not required to use the location data.

■ **Accident Sketching and Investigation**

A geospatial CAD user wants to leverage location information in day-to-day operations such as

- Leveraging GPS technology within vehicle accident investigations

- Accident sketching using existing geospatial data

    - ♦ Using map graphics as well as aerial photography
    - ♦ Using GPS technology to take measurements of the accident scene

A mobile client would make a request to the dynamic map client for an exported image of the current map extent to support the ability for a user to incorporate location information into a host field-based reporting application.

■ **Crime Analysis Support**

A crime investigator has the need to view information on a map to better investigate and solve crimes. For example, a field investigator responding to a murder scene understands that the suspect is not out in the community being a model citizen. Therefore, the field investigator will want to be made aware of other incidents occurring in close proximity to the scene he or she is working. Location information will also need to be included such as providing premise history of selected locations, a map populated with registered offenders, locations of parolees, and known locations of previous suspects.

The dynamic map client will need to support an interface with a records management system for the following activities:

- Ability to view other agency incidents and/or investigations

    - ♦ Automated data sharing

- Crime analysis and correlation to dates aerial photos were taken

    - ♦ Possible concealment locations

- Seasonal view of the location
- Crime analysis units
    - Requires access to the data
    - What-if analysis
    - Web-based density analysis
- Administrative
    - Geodashboard (static and dynamic views)
    - Use of Crystal Reports® to create the data

Real-Time Location Tracking

The geospatial CAD location tracking system will need to supply the dynamic map client with real-time movement of vehicles, persons, or assets. The reporting system will also need to provide real-time location tracking of stationary devices such as sensory and image capturing devices at street intersections and places of interest.

- **Discrete I/O Reporting**

  The geospatial CAD location tracking system will need to support discrete I/Os to provide telemetry tracking such as door-open status, rifle latch status, and lights/siren status.

- **Vehicle/Person ID**

  The geospatial CAD location tracking system will need to extend services to provide a host application with the unit ID, vehicle type, and the unit's GPS location to a map client monitoring the geographic area/boundary to which the ID is assigned.

- **Vehicle/Person Status Message**

  The geospatial CAD location tracking system will need to provide the active/inactive status of a vehicle/personal device.

- **Poll On Demand**

  The geospatial CAD location tracking system will need to receive Poll On Demand requests from the host application and send a location report response back to the host application.

- **Status Change Monitoring**

  When tracking a resource, the resources, whether a vehicle or person, will have an associated status as determined by the work activity they are performing. For example, a resource may be en route, at a location, available, out of service, and so forth. The geospatial CAD location tracking system will need to support receiving a resources status change based on the host application status types. A geospatial CAD will need to provide the information to the host application.

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Boundary Assignments

The geospatial CAD location tracking system will need to extend to a host application the ability to determine a geographic boundary and/or limit of all registered vehicular or personal devices.

Response Assignment Tracking

The geospatial CAD location system will need to support the ability for the host application to apply response assignment associations to an individual or group of vehicles/persons.

Location Display

The geospatial CAD location tracking system will need to support the following displays:

- Single Vehicle/Person: Display information pertaining to an individual vehicle/person to include location identification, speed, and direction of travel

- Multi-Vehicle/Person: Display information for multiple vehicles/persons within a user-defined group or entire system to include individual location identification, speed, and direction of travel

- GPS Status: Display for identification as to whether or not an active GPS signal is being captured as determined by a configurable length of time from the last tracking report (This will need to also include a time stamp of the last recorded location report.)

Location Tracking Data Formats

The geospatial CAD location tracking system will need to provide the following data within the dynamic map client as a tabular halo field attached to the respective vehicle/person location.

- Date/Time
- ID/Status
- Call Sign
- Incident/Assignment ID
- Latitude/Longitude
- Associated Address
- Speed/Heading/Altitude
- GPS Time (UTC)
- Satellite Count
- Reporting Source

- **Location Tracking Administration**

  The geospatial CAD location tracking system will need to provide the ability for a system administrator to modify vehicle and person attributes remotely to eliminate the need for the device to be brought back to a central location.

- **Administrator User Interface**

  The geospatial CAD location tracking system will need to support both thick and thin client administration user interfaces.

- **Vehicular/Personal Devices Registration**

  The geospatial CAD location tracking system will need to support the access of a host application vehicular/personal device registration file or provide a generic file within the system in the event a host file does not exist. The generic file will need to include data fields required to support the location tracking capabilities outlined in this section.

- **Vehicle/Person Location Cloaking**

  The geospatial CAD location tracking system will need to support a system administrator's ability to determine vehicles/persons that will not be sent/displayed on the dynamic map client or host application. A geospatial CAD will only need to provide authorized users with the ability to view cloaked locations.

- **Vehicle/Person Location Grouping**

  The geospatial CAD location tracking administration will need to support grouping resources in the following configurations to be used in application functions like messaging and chat:

  - Team of selected vehicles/persons
  - Jurisdictional boundaries
  - Unit/Person role (e.g., patrol, detective, supervisor)
  - Unit status (en route, in service, in staging, on standby, out of service)
  - Individual unit

- **Location Tracking Data Repository**

  Location tracking data will need to be retained within a records management system and will need to contain location key indices to a centralized GIS service.

- **Route History**

  The geospatial CAD location tracking system will need to support the ability to play back a route of travel for registered devices within the following time intervals:

  - Route playback—Determine route traveled within user-specified time increments.

- Boundary comparison—Determine when the vehicle/person left an assigned boundary and when they returned.

- Distance traveled—Determine the distance traveled in terms of feet/miles (meters/kilometers) within a user-defined time frame.

- Rate and speed of travel—Determine the rate/speed of the vehicle/person in terms of miles per hour (kilometers/hour) for vehicular application and feet/minute (meters/minute) for personal application.

■ **Location Tracking Alerts**

The geospatial CAD location tracking system will need to support the providing of location alerts to be displayed in the dynamic map client or to a host application. Style, method, and configuration of alerts will need to be determined by the application receiving the data.

■ **GPS Failure (device dependent)**

The geospatial CAD location tracking system will need to store and provide reports for any device's failure recognition capabilities.

■ **Vehicle/Person Location Violations**

The geospatial CAD location tracking system will need to provide the ability to detect and determine if a vehicle or person has violated either standard or user-configured location violation parameters and provide the alert to the dynamic map client or host application:

- Standard parameters

  - ♦ Speeding (maximum speed by vehicle type)
  - ♦ Assigned beat/boundary crossing
  - ♦ Device disabling

■ **Violation Logging**

The geospatial CAD location tracking system will need to support violation logging within a centralized records management system.

Conclusion

Every CAD system requires a geographic database or geofile to ensure the right resources are directed to the right location. This white paper discussed the various geographic data sources utilized in the 911 dispatching process, a generic CAD system overview and dataflow, the geographic advantage of a spatial CAD, and the value GIS provides to emergency call management.

Emergency dispatching and response are inherently spatial. Obtaining an accurate location of a caller is essential whether the call originated through a landline or wirelessly. Dispatching resources that are closest to the incident requires knowing where the resources are located in relation to the emergency. GIS technology provides CAD applications with the ability to more accurately determine the location of E-911 calls in relation to resources using AVL to reduce response times, increase responder safety, and enhance situational awareness.

Proprietary CAD mapping systems pose challenges in maintaining and reusing GIS data. In addition, spatial analytical functions using proprietary geofiles are limited. GIS technology provides tools that improve data maintenance functions as well as analytical capabilities to enhance emergency dispatching workflows. Data visualization in the context of a map provides dispatchers with a more intuitive view of what is happening in the community.

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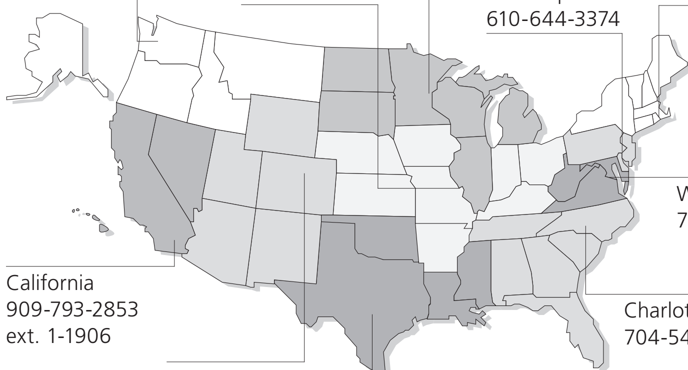

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