Geospatial Considerations for Emergency Call-Taking, Computer-Aided Dispatch, and Record Management Systems

An Esri® White Paper
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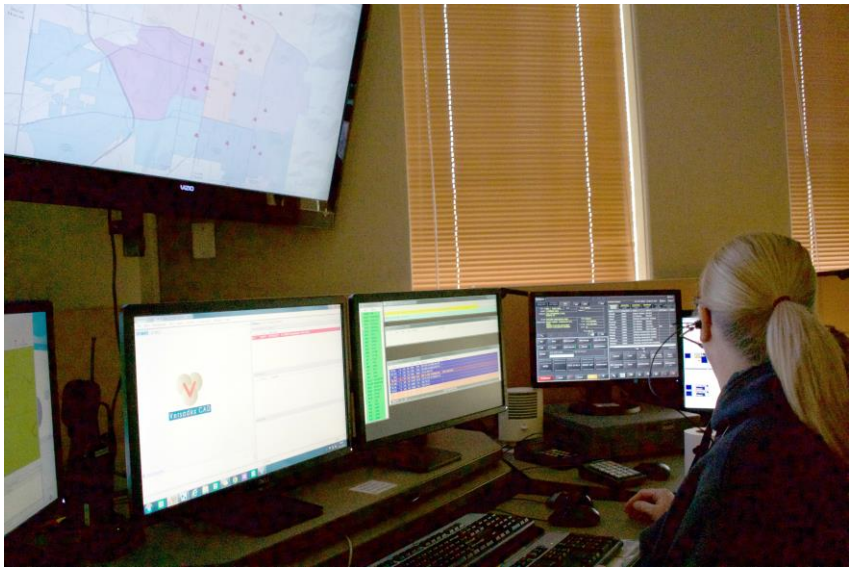
Geospatial Considerations for Emergency Call-Taking, Computer-Aided Dispatch, and Record Management Systems

Executive Summary

The primary mission of public safety is to ensure that our communities are safe and secure. This responsibility drives decision making and compels us to better understand our environment and the factors that influence it. These elements affect our response to emergency events and are often the result of our aging infrastructures and technology, as well as unforeseen hazards created by industrial accidents; criminal events; or proximity to natural risks such as wildfires, earthquakes, floods, and severe weather.

When someone calls for help from land-based or cellular telephones, regardless of the nature of the event or problem, the call is automatically analyzed and routed to the appropriate Public Safety Answering Point (PSAP), where dispatchers classify and prioritize the call before sending first responders to assist.



The responders rely on sophisticated, computerized systems to manage large volumes of information including the data necessary to accurately locate the caller, dispatch resources, and manage the historic record of the call for service.

Emergency call-taking systems are composed of several technologies, and terminology is used differently in many organizations and PSAPs. Agencies in the United States and Canada refer to the evolving technologies as *Next Generation 9-1-1* (also referred to as *NexGen9-1-1* or *NG9-1-1*) and *computer-aided dispatch* (CAD) solutions. In most

circumstances, these solutions include the capability to export the CAD information into a record management system (RMS), where the call information is stored and becomes part of a larger volume of record about the event. In other countries, most agencies are using a three-digit code for emergency calling systems, such as 112, 119, and so forth.

The term *911* (often referred to as *nine–eleven*) is not used in the United States and Canada because of the terrorist event on September 11, 2001—referred as *9-11*. Thus, emergency numbers have a hyphen (-) between the letters to clearly identify it as the emergency number 9-1-1.

Current emergency numbers, (e.g., 9-1-1 or E9-1-1/Enhanced 9-1-1) are evolving to Next Generation 9-1-1, and the information that is received in PSAPs will include the physical location of the caller or device (eventually including indoors, even for mobile phones) and in situations where the device is unexpectedly disconnected. This location information will become more accurate and will eventually include a z-coordinate, or third-dimensional coordinate, of elevation, in addition to an indoor dispatchable address.

Those who receive the incoming emergency call for service are often referred to as *telecommunicators*. In most PSAPs, those who assign the call to a first responder are referred to as *dispatchers*. Titles and terminology differ throughout the industry at the PSAP and association level. For purposes of this document, we will refer to all who participate in the call-taking and dispatch process as *dispatchers*.

Computer-aided dispatch systems ingest the emergency information and automatically create a response case number and file. Simultaneously, the appropriate type of emergency response provider is identified (e.g., police, fire, medical), and dispatchers assign the call for service. The caller is connected to a live dispatcher who gathers further information before assigning the call.

Throughout the call-taking, dispatch, response, and transitional record-keeping process, geographic information system (GIS) technology is used to analyze location data, identify the coordinates, and store and analyze spatially referenced intelligence. Most CAD solutions require a geographic database (addresses, street information, points of interest, and/or parcel information) to accurately locate emergency calls. GIS technology enhances NG9-1-1 and CAD functionality through advanced analytics and data visualization.

In response to the increased use of wireless phones to call 9-1-1, especially from indoors where traditional 9-1-1 technologies often fail, the Federal Communications Commission (FCC) worked with the largest telecom providers in the United States to develop more accurate location information on cellular devices. In the agreement, the telecom providers were given several years to improve location accuracy using "clear and measureable timelines for wireless providers to meet indoor location accuracy benchmarks, both for horizontal and vertical location information." Recognizing that no single technological approach would solve the challenge of indoor location and no solution could be implemented overnight, the rules allow sufficient time for development of applicable standards, establishment of testing mechanisms, and deployment of new location technology. (See FCC PS Docket No. 07-114, Wireless E911 Location Accuracy Requirements, January 29, 2015.)

As cellular providers and PSAPs embrace the rules, these systems will be able to more accurately identify x-, y-, and eventually z-coordinate location and elevation and indoor dispatchable addresses that include subaddress elements such as floor and room designations. This white paper discusses the value GIS provides to emergency call-taking, dispatch, and record management systems in the public safety environment.

The purpose of this paper is to focus on the geographic components of call taking, dispatch, and record keeping. As this industry evolves, updates will be available at esri.com/industries/public-safety.

Introduction

Esri does not design or build emergency call-taking, computer-aided dispatch, or record management system solutions. However, GIS integration within NG9-1-1, CAD, and RMS is valuable and increasingly identified as a solution element and requirement. As PSAPs and solution providers migrate toward NG9-1-1, they will undoubtedly rely on GIS to provide address location validation, call routing, resource allocation, and analysis.

For more than 40 years, the public has relied on the 9-1-1 system (USA and Canada) during emergencies. As technology improves, location intelligence increasingly appears as an integral component of everything we do. Every unit of data has a geographic component. The public has come to rely on maps on their mobile devices, home computers, and vehicle navigation systems, and today's citizens are demanding faster and more flexible, resilient, and scalable ways to communicate in emergency situations. In fact, the National Emergency Number Association (NENA) publicly promotes the statement, "Emergency Help. Anytime, anywhere, any device."

Industry-leading CAD providers are configuring and adapting their solutions to operate within the next generation of service, coined *NG-CAD* (or the evolution and redesign that CAD is going through). New and improved system architectures support common services and standards and enable better interfaces with enterprise systems, including systems operating within or between other CAD solutions.

Government agencies are regularly using GIS to identify streets, boundaries, tax information, and so on. GIS usage among law enforcement agencies includes the management of geographic patrol areas, crime analysis, infrastructure protection, and call routing (see Esri Technology for Law Enforcement). Fire departments are using GIS to catalog the locations of fire hydrants and assess vulnerability or deployment planning (see Esri GIS for the Fire Service), while emergency medical services use GIS to respond to calls for service, define service areas, and so forth. All these agencies are typically staffed with personnel who maintain the geographic data in the system to ensure planning, analysis, and response accuracy.

A GIS-integrated CAD solution provides more actionable information and capability than simply displaying an incident on a dispatch monitor. CAD solutions that incorporate a platform GIS provide more relevant and actionable information to the call taker, the first responder, or the supervising commander, all of whom can now interface with the data from a number of different sources. These sources can be dynamically updated and analyzed and, when properly configured, provide officials with reliable information such as available fire apparatus or patrol units, their location, and any conditions that may impact a safe and timely response.

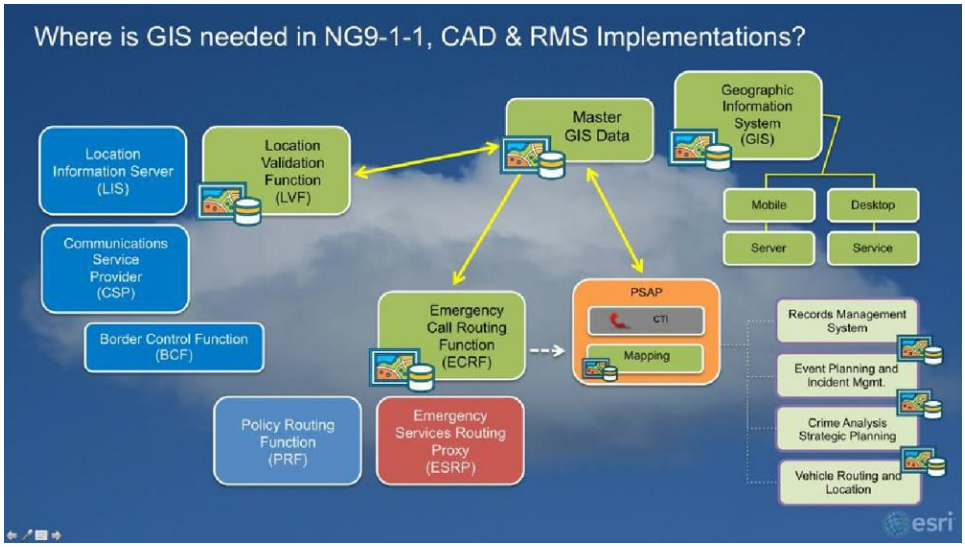
Emergency Call-Taking, Dispatch, and Record Management Systems Design Overview

To better understand the benefits of GIS inclusion in emergency call-taking, CAD, and RMS solutions, one must understand the basic design and workflow used within the NG9-1-1 call-taking environment. Most call-taking solutions rely on the primary components generally described below, with more information on the pages that follow:

- **Next Generation 9-1-1** solutions receive information from the telephone/cellular providers, including the caller's 10-digit phone number and address location, as well as some other information. The NG9-1-1 solution relies on GIS to validate the caller's address and route the incoming call to the appropriate PSAP.

- **Computer-aided dispatch** systems receive caller and location information from the NG9-1-1 solution, ultimately connecting the caller with a professional emergency call taker who gathers the additional information needed to assess the type of call and the seriousness of the event. This communication occurs through computer telephony integration (CTI), allowing the dispatcher to exchange information with the caller. The call taker then prioritizes the call and assigns the appropriate first responder (e.g., fire, police, or medical services). The CAD becomes a system of record for the call for service (CFS), and the stored intelligence can be exported to an RMS for further case management and analysis.

- **Record management systems** can consume CAD information and create a case management file for further analysis or historic record keeping. In most cases, this transfer of CAD information to the RMS is seamless and instantaneous. Data fields used in the CAD (location of event, time, date, and so on) can be automatically populated into relevant fields within the RMS to minimize data entry and maintain consistency in addressing and other records. These agency-wide management systems provide an ecosystem where additional information can be entered, stored, retrieved, interrogated, and analyzed.



Emergency Call-Taking, CAD, and RMS Data and Workflows Highlighting a GIS Foundation for the Utilization of Geoprocessed Data in Dispatching and Operational Business Logic Functions

A Closer Examination of Next-Generation 9-1-1, CAD, and RMS

Next-Generation 9-1-1

NG9-1-1 relies on a number of services and capabilities to accurately route emergency calls to the appropriate call center. When a caller dials the localized emergency number, such as 9- 1-1, the communications service provider (CSP) relies on GIS to accurately identify and validate the call location. Once validated, the call is routed through a process called the *Emergency Call Routing Function* (ECRF) to the PSAP (or dispatch call center). The PSAP relies on GIS to accurately display the geographic location of the call, and functionality within the CAD identifies the type of emergency services available within the boundary where the call originates.

The CAD system, using the NG9-1-1 data, connects the caller with a live dispatcher who can obtain further information, including address verification and the elements of the service request. This combined intelligence is then used to validate the location accuracy and assign first responders to the CFS. In cases where a call may be received by the wrong PSAP, the dispatcher relies on GIS to identify the correct PSAP and transfers the call, further validating the need for continual address validation and correction.

NENA recommends regular maintenance on the addressing database, stating, "The 9-1-1 Authority will always be the responsible party for the data…" NENA counsels the 9-1-1 Authority to implement strategies to keep the Master Street Address Guide (MSAG), Automatic Location Identification (ALI), and GIS databases in harmony with each other and up-to-date. As organizations migrate from the tabular databases (MSAG) to geographic databases, such as those created in the ArcGIS® platform, well-defined processes and procedures need to be followed. One such set of guidelines can be found in the NENA publication "NENA Information Document for Synchronizing Geographic Information System Databases with MSAG & ALI."

As the CFS is concluded, the information stored in the CAD can be exported to an RMS for further interrogation, historic analysis, and so on. Most CAD systems export the stored data automatically to the RMS seamlessly and instantaneously.

Computer-Aided Dispatch Systems

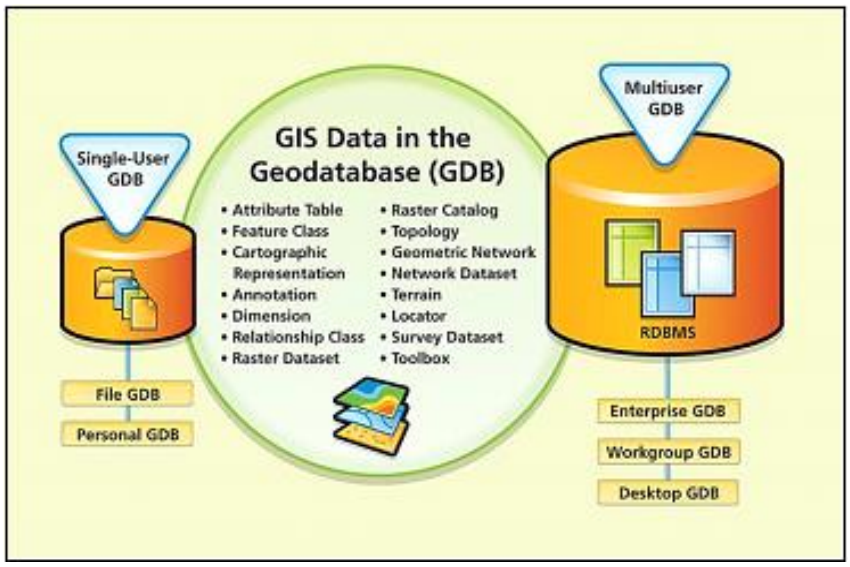
CAD systems are uniquely designed to provide a logical process of managing information based on client workflows and needs through customizable software configurations. These workflows are computed through the software's Business Logic Engine (BLE). Esri's ArcGIS platform interacts with the solution's BLE to efficiently and effectively consume and analyze geoprocessed data such as call type, location, first responder category (e.g., police, fire, or medical), response area or asset, and so on.

While CAD workflows appear simplistic (a call is received, and a first responder is dispatched), the actual process is much more complex. Emergency calls for service require analysis to determine the type of response needed—police, fire, or medical. In some cases, the response may involve assigning several types of responders, such as in the case of an injury traffic accident where fuel is leaking from damaged vehicles. In this example, the response requires police, fire, and medical personnel. GIS identifies the location of the event and the availability and proximity of appropriate first responders

and can be used to provide operational understanding of risks associated with the call or possible routing hazards such as flooded roadways, damaged bridges, and so forth.

The call-taking, dispatch, and records process relies on several geographic databases in most cases. While they are independent in many cases, they should be validated and regularly synced to ensure the most current and accurate information. Each database contains similar information, requiring careful maintenance and support. While a carefully prepared architecture of a single geodatabase is optimal, this replication of data and services is often unavoidable. Speed and performance, leaning on industry data standards, should be the pursued goal of every agency.

Geodatabases are collections of geographic datasets that are held in a common file system folder; a Microsoft Access database; or a multiuser relational database such as Oracle, Microsoft SQL Server, PostgreSQL, Informix, or IBM DB2. These datasets are the primary mechanism used to organize and use geographic information and consist of three primary datasets: feature classes, raster datasets, and tables.



To ensure the highest probability of data availability, a localized PSAP may choose to use a local geofile rather than the MSAG (which was probably built for a larger region). As the National Emergency Address Database (NEAD)becomes a reality over the next six years, agencies will have a reliable additional option. Until then, agencies must deal with the challenge of data reliability, updates, and local data governance, as well as data update schedules, processor loads, and so on. Regardless of the database choice, each PSAP should continually evaluate and correct the data and work tirelessly toward improving accuracy at the call origination point and dispatchable location.

Relying on a GIS-centric MSAG and CAD geofile ensures higher-quality address verification and reduces the need for multiple street and address data sources. In addition, GIS/CAD-centric systems equipped with good editing tools provide PSAPs with the ability to update files dynamically. Commitment to data quality and location accuracy provides the end user with a single authoritative source for street and address data.

The computer-aided dispatch user screen is where dispatchers 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.

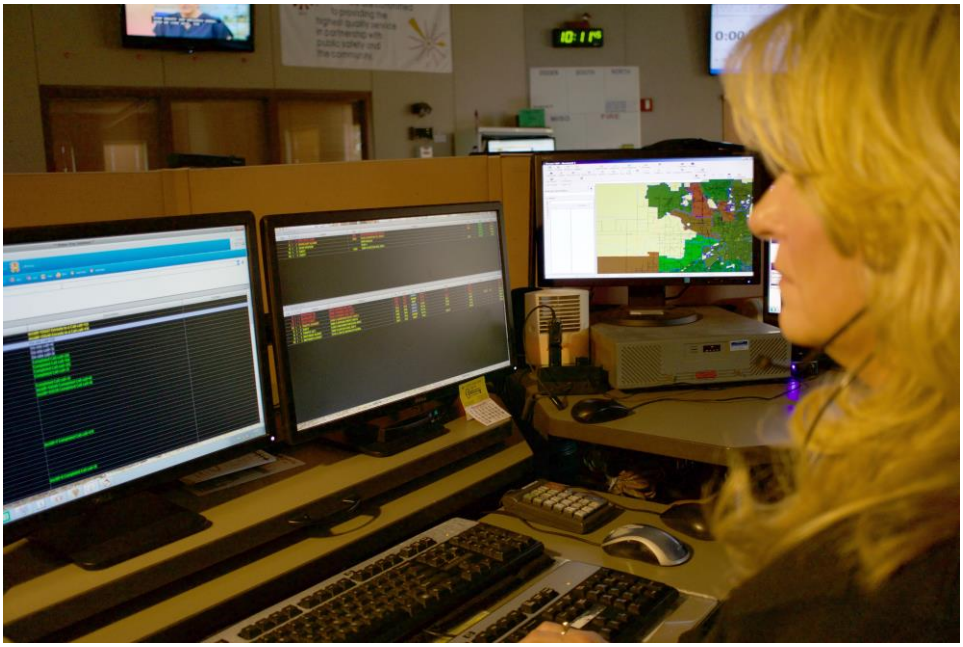
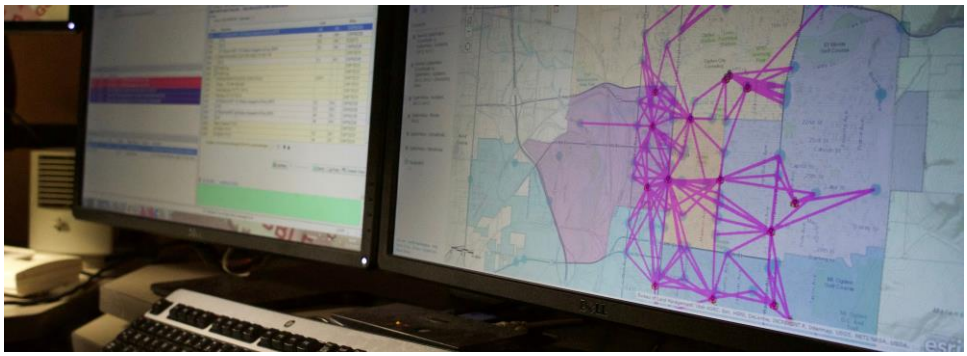


Photo of a CAD User Interface Displayed on Monitors Showing Call Intake, Dispatch Status, and Dynamic Maps

The CAD system then interprets the shorthand codes and populates the appropriate tabular fields with full-length, detailed information. Typical CAD configurations appear on several monitors including primary workspace (where the incident details are displayed and interacted with), mapping, and so on.

Record Management System Interface

A record management system is a repository for incident data that is most often acquired directly from the CAD or through a user interface. The RMS provides functionality for case management; supplemental reporting; and case-specific information such as vehicle description, victimology, and suspect and associate data. Users can access RMS data and information remotely using a mobile data terminal, mobile device, or desktop computer. GIS can correlate spatially referenced RMS records with new CAD incident data to provide intelligence for real-time response; overall situational awareness; or analysis for administrative, strategic, or tactical purposes. Both CAD and RMS data should be managed in a way that allows it to be interrogated for real-time response and investigative and administrative follow-up.



Many agencies analyze data stored in both the CAD and RMS in fusion, intelligence, and real-time crime centers (RTCC). Crime analysts rely on the data collected to complete administrative, strategic, and tactical responses to crime. An excellent resource—white paper 2014-02, "Definition and Types of Crime Analysis"—is available through the International Association of Crime Analysts (IACA).

Emergency call taking, CAD and record management systems all benefit from GIS capability. Agencies that access GIS through a platform provide more up-to-date intelligence more quickly across each of these disciplines. Esri's Portal for ArcGIS helps organize and share information throughout the organization with relevant data, maps, and apps. It provides a framework to easily manage and secure geographic assets within the organization to enable better decision making.

Just about every problem and situation handled by a PSAP has a location aspect. Agencies using ArcGIS unlock the power of location and stay on top of key performance indicators and more effectively analyze trends and spatial connections. ArcGIS can analyze performance, provide real-time and spot location-related analysis, and make map building seamless and easy.

Using existing and developing policies and procedures, integrated ArcGIS systems maintain data integrity on-premises or in the cloud.

Portal for ArcGIS for Emergency Call Taking, CAD, and RMS

With Portal for ArcGIS (which is included with ArcGIS for Server Standard and Advanced), users experience the same capabilities found in ArcGIS Online, but it stays within the agency infrastructure (on-premises or in the cloud). Users can create, organize, secure, and manage geographic assets and connect end users with useful apps, maps, and geographic data.

Portal for ArcGIS includes many apps to distribute geospatial data and tasks in simple, focused interfaces, and Web AppBuilder for ArcGIS provides powerful tools to quickly build web apps. It also links with apps such as Esri® Maps for Office, Collector for ArcGIS, and Operations Dashboard for ArcGIS.

Web maps allow users to mash up ArcGIS services and define how the map behaves. Once authored, web maps can be used repeatedly in everything from web browsers to mobile devices and embedded within websites. Web maps reduce the time it takes to get maps in the hands of people who need them, allowing access to relevant information while protecting sensitive information. Portal for ArcGIS acts as a central node of the ArcGIS platform, controlling access to items across all ArcGIS clients.

With a unique, secure identity for ArcGIS, you can unlock maps and apps that can be used on any device, anywhere. Personal identity opens the door to ArcGIS so that users can join groups, access resources, and share geographic information with other people. Identity in ArcGIS lets users own something and share it with others. They can save items under their name and access them later; have favorites, special privileges, or full administrative privileges; and keep items private until they are ready to share them with another person or group or the public.

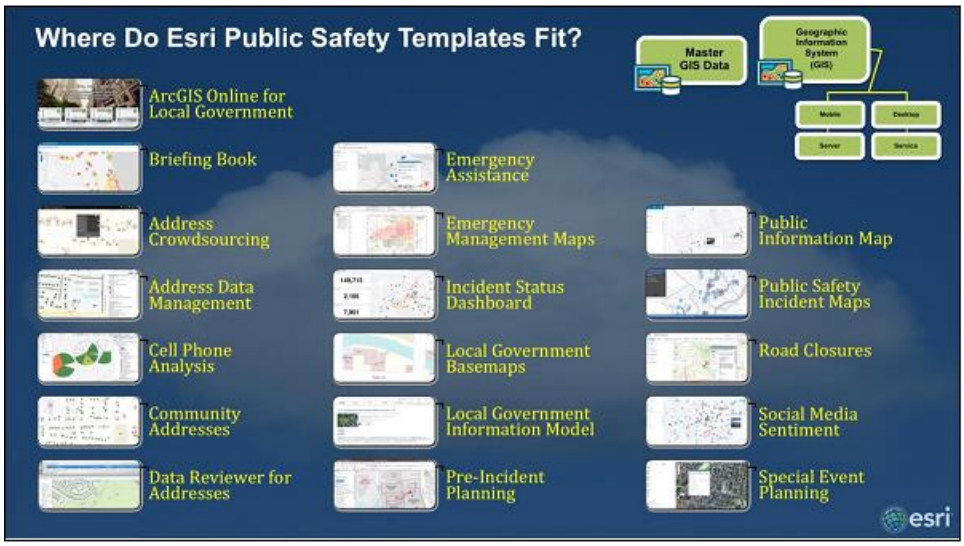
A user's identity (named user credential) associates them with ArcGIS privileges. These users can log in to any app, on any device, anytime, and have access to all the maps, apps, data, and analysis they're entitled to. This is similar to how identity works with other familiar solutions such as Salesforce, SharePoint, and SAP.

With an identity, users can access a growing list of standard and premium capabilities such as Collector for ArcGIS, Operations Dashboard for ArcGIS, ArcGIS Open Data (for publishing), Web AppBuilder for ArcGIS (for building apps), Esri Maps for Office, Esri

Maps for Salesforce, and ArcGIS Pro (if entitled to do so). These improved administrative capabilities provide an efficient, flexible licensing method that can be applied across the entire organization; a means of gathering user-level reporting and metrics on usage; the ability to ensure that users have the software and privileges they need; a way to identify authoritative users and their content; and oversight of how named users interact with the platform, forums, and staff.

Esri has developed a large (and growing) library of templates for the public safety industry. If a user wants to quickly make a web map that shows change over time or a map that shows elevation changes in a specific area, they can make and share interesting maps by selecting from a variety of configurable web mapping templates.

ArcGIS web application templates and Esri Story Map templates are designed so a user can download and publish apps on their own site or host them on ArcGIS Online℠. Plus, they don't have to spend a lot of time on coding or configuring the app. Some examples of key templates that may prove beneficial in the CAD/RMS environment are shown below.



Conclusion

Every call-taking solution, CAD, or RMS requires a geographic database or geofile to ensure that the right resources are directed to the right location. This white paper focuses on the various geographic data sources utilized in the emergency call-taking, dispatch, and record management processes and includes exploration into generic CAD system overviews and data flows; the advantage of a geospatial CAD; and the value GIS provides to overall call management, storage, and analysis.

Emergency dispatching and response are inherently spatial. Obtaining an accurate location of a caller is essential whether the call originates through a landline or wireless device. Dispatching resources that are closest to the incident requires geographic understanding of the location for the call for service. GIS technology can improve location accuracy and resource allocation. The result is reduced response times and increased response effectiveness through enhanced operational understanding.

The use of proprietary call-taking, CAD, and RMS mapping systems poses challenges in maintaining and reusing GIS data, analyzing spatial intelligence, or managing geofiles. The ArcGIS platform improves data management and analytic capability, resulting in improved emergency response and operational understanding.

PSAPs must remain vigilant in solving current and emerging challenges like solutions with maps that stop at a jurisdictional boundary. This approach to maps that end at a jurisdictional boundary create frustration for call takers who must somehow determine where a call should be routed if it is outside a PSAP's area of service. Most PSAP maps are based on an outline of a service area, with authoritative custom GIS data loaded in. Adding Esri basemaps gives a PSAP "borderless boundaries"—instant, high-quality maps that reach beyond boundary lines and can be national or global.

Many PSAPs have invested in high-quality GIS maps and apps, but those resources remain locked inside PSAP vaults, used by a limited number of people. Sadly, most of the first-responder agencies served by these PSAPs are relying on other, less authoritative maps for day-to-day operations. Industry and government leaders across the United States, including the Integrated Justice Information System (IJIS) Institute, the United States Department of Homeland Security, and the White House, are promoting initiatives to improve this situation.

Millions of dollars are spent annually in the creation of statewide and regional authoritative GIS datasets, which require daily updates and management for PSAPs and in-call routing facilities. Esri portals and apps are beneficial in unlocking rich GIS data, exposing users inside and outside the PSAP to capabilities that can move them closer to meeting their objective of reducing response times and saving lives and property.

For information on features and functionality in the CAD/RMS environment, refer to the January 2016 Esri white paper "Geospatial Features and Functionality for Emergency Call-Taking, Computer-Aided Dispatch, and Record Management Systems."

Esri inspires and enables people to positively impact their future through a deeper, geographic understanding of the changing world around them.

Governments, industry leaders, academics, and nongovernmental organizations trust us to connect them with the analytic knowledge they need to make the critical decisions that shape the planet. For more than 40 years, Esri has cultivated collaborative relationships with partners who share our commitment to solving earth's most pressing challenges with geographic expertise and rational resolve. Today, we believe that geography is at the heart of a more resilient and sustainable future. Creating responsible products and solutions drives our passion for improving quality of life everywhere.

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