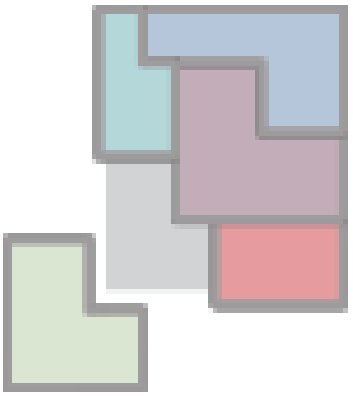
GeoComm



What You Need to Know about the Spatial Information Function

Role of a SIF in NG9-1-1

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Preface

Next Generation 9-1-1 (NG9-1-1) is a modernization of the nation's 9-1-1 system and is being carried out across the country today. While the existing 9-1-1 system has been a success story for more than 30 years, NG9-1-1 provides a more advanced system for accessing emergency care. The system leverages and supports new communications tools and technologies which have evolved into common use over the last 15 years, including text and multi-media messaging and Internet Protocol (IP) communications platforms.

The new standards for NG9-1-1 introduce fundamental architectural changes such as using Geographic Information Systems (GIS) data for 9-1-1 call routing and location validation. To integrate GIS into the core 9-1-1 functional elements of call routing and location validation, the new system includes a Spatial Information Function (SIF). This white paper specifically seeks to clarify the role of a National Emergency Number Association (NENA) i3 SIF while also presenting some practical considerations to make during procurement and implementation of a new 9-1-1 system.

Introduction

Advancements in modern communications technology have created the need for a more advanced system to access emergency services. The current 9-1-1 system has been effective for the past three decades but its limits have been stretched as technology has advanced.

Smartphone and tablet devices are being adopted at a rapid rate by the population and offer capabilities such as text and video messaging. Unfortunately, the existing 9-1-1 system was never intended to receive calls and data from these technologies. As a result, through cumbersome adaptations, Enhanced 9-1-1 (E9-1-1) is being asked to perform functions it was not designed to handle. In 2000, NENA identified the need for 9-1-1 system upgrades and subsequently published the *Future Path Plan*. In 2011, NENA issued Version 1.0 of NENA Technical Standard 08-003, *Detailed Functional and Interface Specification for the NENA i3 Solution – Stage 3* (herein referred to as NENA 08-003 v.1).

Many 9-1-1 authorities across the United States are already beginning to implement NG9-1-1 systems based on this design and similar NG9-1-1 transitional architectures. Architectural overhaul of the nation's three-digit emergency calling system is not without risk. Beyond the technology, functional elements, interfaces, redundancy, diversity, capacity, and security issues, there is a need for new databases and human process and workflow procedures. These must all be developed, modeled, and tested as well.

One important component of an NG9-1-1 system is SIF. SIF is defined in NENA 08-003 v.1 as follows:

> The SIF is a specialized form of a Geographic Information System, and may be implemented on a conventional GIS with the appropriate interfaces. The SIF itself is not standardized in i3. What is standardized is a method of replicating layers from the master SIF to external databases. The ECRF/LVF provisioning interfaces use this mechanism.

NENA 08-003 v.1 standardizes the SIF interface for provisioning GIS data from a SIF to an Emergency Call Routing Function (ECRF)/Location Validation Function (LVF) system but does not standardize the entire SIF itself. As a result, there is industry uncertainty over what a SIF is and does. Many questions are likely to emerge as 9-1-1 authorities begin to implement NG9-1-1 systems and services, but some commonly asked questions include:

- What is GIS?
- What is the role of GIS in 9-1-1 and NG9-1-1?
- What is a SIF?
- What are some expected SIF deployment approaches and industry trends?
- What does an end-to-end SIF system look like?

What is GIS?

As NENA defines a SIF as "a specialized form of a Geographic Information System" it is worthwhile to first consider the definition of GIS. A GIS is commonly defined as follows:

> GIS is a system of hardware and software used for storage, retrieval, mapping, and analysis of geographic data.

Geographic data includes digital map layers representing the real world using points, lines, and polygons, as well as aerial and satellite imagery. Digital maps provide fast and reliable computer-based display and analysis and support enhanced decision making business functions. GIS data is experienced through many free consumer services such as Google™ and Microsoft Bing™ maps.

A GIS is a system of hardware and software used for storage, retrieval, mapping, and analysis of geographic data. As a result, it is not a single software application displaying a map on a computer screen. Rather, a GIS typically:

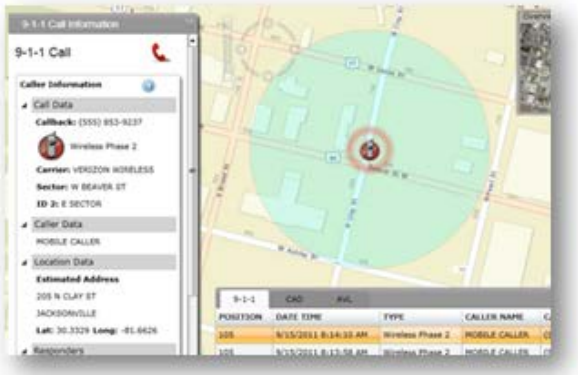
- Comprises many different applications, as well as human processes and workflows, federated within a single common system
- Provides applications and methods for authoring and maintaining geographic data over time, for performing spatial analysis and decision making calculations
- Displays maps to end users in desktop, mobile, or web based computing environments

Human processes and workflows required to operate a GIS include division of roles and responsibilities for various users of the system, identification and agreements around authority of data loaded into the system, and processes for editing and maintaining GIS data. They are required to ensure GIS provides an accurate generalization of the real world.

What is the Role of GIS in 9-1-1 and NG9-1-1?

Tactical Mapping

GIS plays many roles in 9-1-1. Since the late 1990s, GIS is most commonly used to provide tactical mapping for 9-1-1 telecommunicators, Computer Aided Dispatch (CAD) dispatchers, and emergency responders. Tactical mapping systems reduce emergency response time by identifying the location of emergency calls on a map, and compute best routes to the scene for emergency responders. Valuable supplemental "on the ground" information, not limited to fire hydrant locations and valve specifications, network camera locations, and premise information including contacts, physical structure information, and owner and tenant data, is also provided by GIS.



NG9-1-1 Call Routing

GIS plays an even more critical role in NG9-1-1 by determining which public safety answering point (PSAP) to route a 9-1-1 call to, based on the location of the calling device, and also for location validation prior to a caller making an emergency call (replacing an E9-1-1 MSAG). Geospatial call routing enables more accurate call routing than traditional E9-1-1 systems and can reduce the number of 9-1-1 call transfers due to misrouted 9-1-1 calls. This in turn can help reduce emergency response times and save more lives and property; a primary goal of emergency responders and public safety management and stakeholders.

When an NG9-1-1 call is being routed, an Emergency Services Routing Proxy (ESRP) queries an ECRF to determine which PSAP to route the call. The ECRF query contains the location of the device calling 9-1-1. This location may be a civic location (house number / street name style address) or a geodetic location (a latitude / longitude coordinate, circle, ellipse, polygon, or arc-band). Civic locations may be used for fixed location devices such as wireline or VoIP phone

services. Geodetic locations may be used for mobile devices such as cell phones. In either case, when routing a 9-1-1 call, an ESRP will query an ECRF with the location of the device and the type of service being requested (such as 9-1-1 or a selective transfer from the 9-1-1 center to a responding agency). The ECRF will intersect the location provided in the query against a map of the PSAP service area boundaries to determine the PSAP which should receive the call.

To route 9-1-1 calls based on location, an ECRF must be provisioned with GIS data depicting the PSAP service area boundaries. If the location provided in the query is a civic location, this must be converted into map coordinates to be intersected with the PSAP boundary polygon map. This conversion can be accomplished using an address point layer in the GIS, a site/structure polygon layer where each polygon is tagged with civic address location attributes, or an address ranged road centerline layer. Minimally, an ECRF needs to be provisioned with PSAP service area boundaries and one form of civic location GIS data such as address point data.

Location Validation

In addition to being used when routing 9-1-1 calls, NG9-1-1 systems use GIS data before a 9-1-1 call is placed. As Communications Service Providers (CSPs) prepare subscriber records for 9-1-1, they must confirm subscriber records have addresses usable for 9-1-1. This process is similar to checking an E9-1-1 ALI record for MSAG validation. In this case, a Location Information Server (LIS) queries an LVF with the location in question. The LVF examines its GIS database to see if the address is valid for 9-1-1. The GIS data provisioned to the LVF is identical to the GIS database provisioned to the ECRF.

9-1-1 GIS Data Maintenance

GIS data provisioned to an ECRF/LVF or PSAP mapping system must first be created, and must also be maintained over time. GIS data can be authored and maintained using a variety of different GIS software applications. The dominant provider of GIS software in state and local government is Esri (Environmental Systems Research Institute, www.esri.com). Other vendors, such as Pitney Bowes and Manifold, provide GIS software to state and local government as well. In addition, there are some open source GIS applications such as QGIS, MapServer, MapGuide, and others.

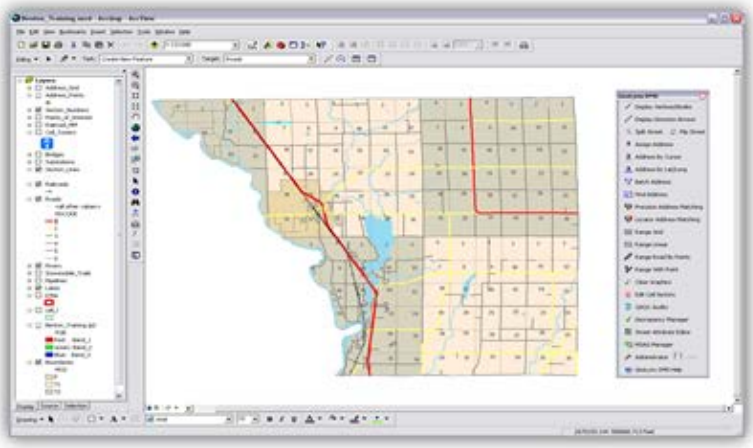
A number of 9-1-1 GIS vendors, such as Geo-Comm Inc. (GeoComm), provide 9-1-1 GIS data management applications and services on top of existing broadly horizontal GIS platforms. These platforms are used in a variety of different industries ranging from utilities, to defense, to natural resources mapping, to business analytics, and beyond. NENA has not standardized any particular end-user GIS application or platform. 9-1-1 authorities are free to pick and choose the best GIS platform, software, and vendor services for editing and maintaining GIS data for 9-1-1, based upon their own particular needs and individual enterprise requirements.

What is a SIF?

Based on the definitions of SIF and GIS described earlier, a SIF encompasses the traditional business functions of a GIS, in addition to the NG9-1-1 system-specific interfaces for provisioning GIS data to the ECRF and LVF. NENA describes a SIF as a specialized form of a GIS which may be implemented on top of a conventional GIS, so long as the appropriate NG9-1-1 interfaces are available. As a practical matter, this means 9-1-1 authorities building and maintaining GIS data systems for 9-1-1 should consider GIS data management components to be part of the SIF. In addition, they need to add interfaces to their GIS systems for provisioning GIS data and updates into NG9-1-1 ECRF/LVF i3 functional elements.

While not required in NENA standards, GeoComm recommends SIFs include quality assurance and quality control (QA/QC) mechanisms tuned for 9-1-1 GIS data, such as MSAG to GIS synchronization during NG9-1-1 transitional periods, service area boundary gap/overlap checking, and various address point and road centerline checks.

The importance of GIS data quality control mechanisms and processes cannot be overstated as routing 9-1-1 calls to the closest responding agency depends on accurate, complete, and timely high quality GIS data.



The interface for provisioning GIS data from the SIF to ECRF/LVF is standardized in section 4.7 of NENA 08-003 v.1. While the standards are continuing to evolve and subsequent versions of 08-003 are planned and in process, the current standardized mechanism in NENA 08-003 v.1 can be difficult to implement as a practical matter. The Open Geospatial Consortium (OGC) geo-synchronization standard referenced in NENA 08-003 v.1 is a public engineering report and not

a standard. GeoComm has implemented a NENA-compliant ECRF/LVF provisioning mechanism based on the documents but has found several ambiguities in the specifications. As a result, assumptions are required to proceed with the interface development. This limits the possibility of interoperable provisioning systems emerging across different vendor platforms. At the same time, existing proprietary geodatabase replication mechanisms exist from common GIS platform vendors, such as Esri. The platforms are robust, performant, and already widely in use in enterprise GIS systems across state and local government.

What are Some Expected SIF Deployment Approaches and Industry Trends?

SIFs may be deployed in different manners, and NENA does not standardize or require a single particular approach. There are two general approaches for SIF utilization by 9-1-1 authorities:

Multiple SIF Approach: In this envisioned approach, each 9-1-1 authority participating in a common Emergency Services IP Network (ESInet) operates their own SIF for building and maintaining their jurisdiction's 9-1-1 GIS data. In this scenario, individual 9-1-1 authorities provision GIS data directly to the same ECRF/LVF system using their own SIF. NENA standards around the SIF to ECRF/LVF provisioning mechanism are intended to support interoperability – each 9-1-1 authority may utilize a different SIF make and model to provision locally authoritative GIS updates to a single common ECRF/LVF system, by adhering to a common provisioning interface standard. To date, this approach has not been commonly utilized in any live NG9-1-1 systems.

Single Shared SIF Approach: In a more commonly used approach, a regional or statewide 9-1-1 authority may have GIS staff operate a SIF for NG9-1-1. Local 9-1-1 authorities typically provide GIS updates to the regional authority via a variety of modalities including file transfer, CD/DVD, or Esri geodatabase replication. The statewide or regional authority applies a data normalization service to load locally authoritative GIS data into a common regional GIS data model for NG9-1-1, as well as QA/QC services to ensure the GIS data is suitable for use in core NG9-1-1 functions of ECRF and LVF. Errors and discrepancies are transmitted back to locally authoritative sources for resolution. The regional or statewide 9-1-1 authority manages the provisioning of GIS data updates into the ECRF/LVF system. To date, this approach is used by many live NG9-1-1 implementations.

Either approach described above may utilize on premise or hosted implementations. On premise implementations are better suited for 9-1-1 authorities with strong GIS capabilities and an existing enterprise GIS system. In some cases, it may be possible to layer SIF interface software on top of the existing GIS enterprise. The existing investment in GIS staff and

technology may be leveraged for 9-1-1, decreasing the costs and time required to implement a fully functioning SIF.

In contrast, hosted SIF systems (commonly referred to as managed services) are emerging in the market and provide all elements and functions of a SIF as a professional managed service. In this case, 9-1-1 authorities provide locally authoritative GIS updates to the service bureau using a modality best suited to them. The professionally managed service bureau then performs GIS data normalization, QA/QC, error reporting and feedback, and safe and secure provisioning into NG9-1-1 ECRF/LVF systems and other third party PSAP mapping systems. NG9-1-1 Managed SIF services provide some benefits over on premises self-operated SIF systems such as:

- 24x7x365 operation (many GIS offices limit operations to normal business hours)
- NG9-1-1 GIS domain expertise (some local GIS offices specialize in tax and cadastral mapping rather than GIS for 9-1-1 purposes)
- Automated QA/QC, closed loop error reporting, and performance measurements
- Service Level Agreements guaranteeing availability and system performance
- Off-site data backups
- Often a managed SIF service can be turned on faster, and for less cost, than an on-premises system
- Management by a single GIS service provider, when there is no regional or state authority that can take on the work of managing all GIS data for all participating local 9-1-1 authorities

Regardless of which scenario is in play, stakeholders of regional and statewide SIF systems must also consider data model and geodetic system transformation considerations. Often times, locally authoritative sources of GIS data have developed their own GIS data models, and use geodetic systems (coordinate systems and projections) which conform to local GIS application requirements. These may differ from the common GIS data model and geodetic system used by the regional or state-wide NG9-1-1 system. In these cases, SIFs should have a conversion function to transform GIS data from local data models and geodetic systems into the common model for the coalesced NG9-1-1 GIS database. To avoid unintended gaps and overlaps in PSAP and other service area boundaries, and street centerlines not connecting at the edges of GIS dataset, additional care must be taken when GIS data from multiple authorities is coalesced into a single GIS database for NG9-1-1.

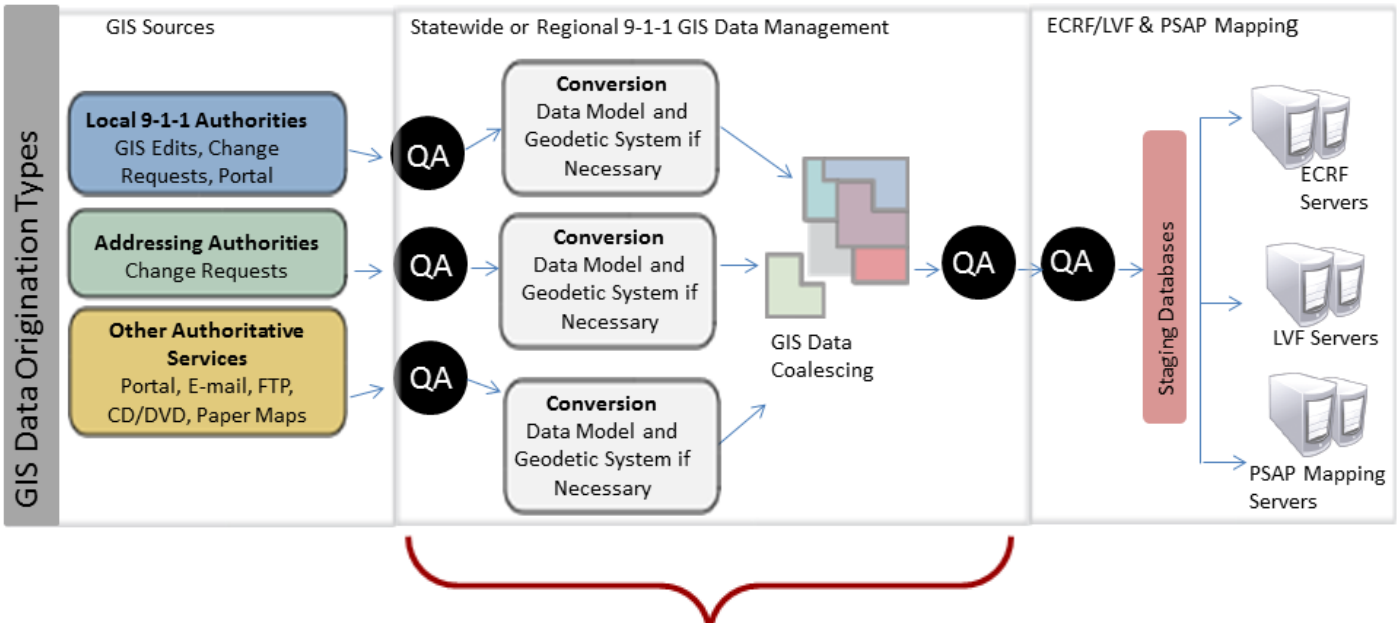
GeoComm recommends all SIF systems include QA/QC to ensure the quality of GIS data and meet GIS requirements for NG9-1-1. QA/QC checks should include a closed loop error reporting feedback mechanism. Locally authoritative sources of GIS data should receive QC check error reports after submitting GIS updates into the system, and the SIF system should track resolution of error reports. Performance measurements are necessary in order to ensure

all components of the SIF are operating as required for NG9-1-1, including human workflows and processes.

What Does an End-to-End SIF System Look Like?

Below is an end-to-end NG9-1-1 GIS data management workflow diagram depicting the commonly used shared SIF approach. The middle component labeled "Statewide or Regional 9-1-1 GIS Data Management," as well as the input and output interfaces, comprise the SIF. The arrows moving GIS data from the coalesced GIS dataset and into ECRF/LVF and PSAP mapping servers is provided by the SIF provisioning interfaces. Thus the diagram below depicts a **conventional GIS** with multiple authoritative inputs, GIS data QA/QC, transformation, coalescing, gap/overlap checking, and finally provisioning to ECRF/VLF **with the appropriate interfaces**:

NG9-1-1 GIS Provisioning System Overview



Conclusions

GIS data plays a critical role in NG9-1-1 for mapping the location of 9-1-1 calls in PSAP and responder mapping applications, pre-validating locations (replacing 9-1-1 MSAG validation), and for determining 9-1-1 call routes in real time. As a result, NENA has created a SIF element for managing GIS data for NG9-1-1. NENA's definition of a SIF is broader than only the provisioning interface between an authoritative GIS system and an ECRF/LVF system. 9-1-1 authorities should take into account the following considerations when designing, specifying, and procuring NG9-1-1 SIF systems and services:

Sending GIS updates into the NG9-1-1 system is a continual process, not a one-time event. SIF systems must support on-going daily updates similar to E9-1-1 ALI/MSAG maintenance.

- Normalizing NG9-1-1 GIS data from local authoritative sources to a common data model and geodetic system. Service boundaries and road centerlines must edge match.
- Providing 24x7x365 support for SIF processing is recommended. 9-1-1 GIS data used for 9-1-1 call routing is mission critical and must be supported outside of normal business hours.
- Leveraging existing investments and reduce SIF costs to ensure the planned procurement of an NG9-1-1 SIF can interoperate with your existing enterprise GIS.
- Planning how you will manage GIS data from multiple locally authoritative sources, including transformation and coalescing into a single SIF database.
- Implementing performance measures and GIS error reporting feedback loops within the SIF to ensure GIS errors detected in the SIF are corrected in a timely fashion.
- Identifying legacy QA/QC SIF requirements during NG9-1-1 transitions, such as MSAG to GIS on-going continual synchronization.
- Considering the necessary human factors such as processes, workflows, roles and responsibilities, and data sharing agreements for managing a SIF for multiple 9-1-1 authorities.

By considering the requirements for daily 9-1-1 GIS data management, and the holistic nature of a SIF beyond the physical ECRF/LVF provisioning interface, 9-1-1 authorities can implement rich and robust NG9-1-1 systems leveraging GIS data. These NG9-1-1 systems will route 9-1-1 calls faster and more accurately, ultimately reducing response times, saving more lives, and protecting more property.

While advancements in technology continue, public safety agencies must adapt their systems and processes to meet the need of their citizens and responders. The procurement of SIFs will be a consideration for public safety during NG9-1-1 implementation and needs to be carefully planned and executed. Overall, enabling 9-1-1 systems to receive other methods of communication via smartphones and tablet devices, while also being aware of the requirements for each NG9-1-1 component, is one step towards managing the latest in voice and data technological advancements for your agency.

About Geo-Comm, Inc.

GeoComm (www.geo-comm.com) was founded in 1995 to provide county governments with turnkey emergency 9-1-1 development services. Over the subsequent 19 years, the company has grown to serve more than 12,000 dispatchers in 800 emergency 9-1-1 call centers in the United States, helping to keep more than 84 million people safe. Today, GeoComm has a national reputation as a leading provider of geographic information and communication systems for local, regional, and state government agencies. The company's systems route emergency calls to the appropriate call center, map the caller's location on a dispatchers map, and guide emergency responders to the accident on mobile displays within police, fire, and ambulance vehicles.

GeoComm's mission is: When seconds matter, we help save lives and protect property by providing essential, innovative, location-based solutions to public safety professionals.

Contact us today to learn more about the Spatial Information Function and other NG9-1-1 related topics.

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