Next-Generation 9-1-1
And
Local GIS Services

An introduction to the technology, and discussion of challenges and opportunities for GIS service providers

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Who am I?

For the past 10 years, I was Chief Technologist for Contact One, now a subsidiary of Intrado.

I was architect, designer, and primary developer of MapSAG, Contact One's flagship GIS data maintenance software for 9-1-1.

I also was 100% responsible for QuickPoint, Contact One's dispatch mapping system, and a variety of other software products.

I now am working as Jerry Steenson GIS.

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A brief introduction.

The basic technologies behind our national 9-1-1 infrastructure were developed in the late 1960's and early 1970's.

These technologies were high-tech at that time, which, remember, was *40 years ago*.

Most technologies that were considered high-tech at that time have been replaced or, at least, significantly upgraded.

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A brief introduction.

The National Emergency Number Association (NENA) has been working since the early 2000's on standards for Next-Generation 9-1-1, and has begun releasing those standards.

To get an idea of how this may impact GIS, see *Detailed Functional and Interface Specification for the NENA I3 Solution* (NENA 08-003, June 14, 2011).

Go to www.NENA.org* for more information. Also, check in on the FGDC addressing standards.

*Don't go to www.NENA.com, which gets you to the web site for 80's German pop ban NENA:

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Why changes need to happen.

Existing 9-1-1 technologies are substantially obsolete, for a variety of reasons. Here are two key ones:

9-1-1 calls are routed over regular phone lines, similar to the way a modem or fax works. This is slow, somewhat unreliable, and expensive, while restricting the kinds and amounts of data that can be transmitted.

The system was designed to locate people calling on land lines. Today, most 9-1-1 calls (perhaps 75% at this time) come from cell phones, and that percentage is rapidly increasing.

Changes are coming.

Next-Gen 9-1-1 makes two major changes to address the issues mentioned on the previous slide:

1) 9-1-1 communications will be done over what will ultimately be a nationwide IP network for this purpose.

2) The routing of 9-1-1 calls, which includes determining where the call came from, which Public Safety Answering Point (PSAP) will answer the call, and even which agencies (police, fire, ambulance, or dog catcher) will answer the call will be done using GIS data.

GIS is currently used in most PSAPs.*

The typical computer arrangement in many 9-1-1 centers looks like this:

GIS is currently used somewhat infrequently, but is sometimes critical in locating callers, especially cell phone callers.

*Public Safety Answering Point
**Computer-Aided Dispatch (not Drafting)
***National Crime Information Center
****Automatic Location Information
9-1-1 *loves* its acronyms

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Here are some current uses of GIS in 9-1-1.

Real-Time

- Determining the location of callers, especially cell phone callers
- Giving directions to responders regarding where an incident is occurring
- Tracking location and availability of responders in CAD
- Locating the proximity of responders to incidents
- Routing of responders to incidents
- Using ortho and oblique imagery to determine building configurations
- Incident response planning, including tracking officer locations
- Hazardous materials response, or plume modeling

Not Real-Time

- Crime mapping
- Pre-planning for raids and arrests
- Siting studies for new police or fire stations
- Determining response boundaries by calculating fastest response times

Here are two other spatial components used in 9-1-1.

The Master Street Address Guide (MSAG) is a table of allowable address ranges and response configurations, and is explicitly spatial, though lacking coordinates.

Dir	Street Name	Low	High	OEB*	ESN**	Community	County	State
	Main St	1	899	B	222	Fort Collins	Larimer	CO
W	County Rd 34	49002	50000	E	223	Nunn	Larimer	CO

The MSAG is used when a customer applies for phone service, to make sure they have a valid address, and also when a call comes in, to determine which agency or agencies should respond, using the ESN.

*Odd, Even, or Both, usually as a single character.
**Emergency Service Number, a 3 to 5 character code linked to data on which police, fire, and ambulance should respond.

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Here are two other spatial components used in 9-1-1.

The Automatic Location Information (ALI) database is a table or set of related tables with 1 record for each telephone number.

HN	HN Suffix	Dir	Street Name	Community	State	County	Location
234	A	W	Main St	Fort Collins	CO	Larimer	2nd Floor
132			County Rd 34	Nunn	CO	Larimer	

The ALI database is maintained by the telephone company, and is validated against the MSAG.

If you have parcels or address points with addresses, the ALI database will be a subset of the records in whichever of those layers you have.

*Odd, Even, or Both, usually as a single character.
**Emergency Service Number

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Next-Gen changes the use of GIS in 9-1-1.

If GIS is not tightly integrated into 9-1-1 in your jurisdiction yet, it almost certainly will be within a very short time.

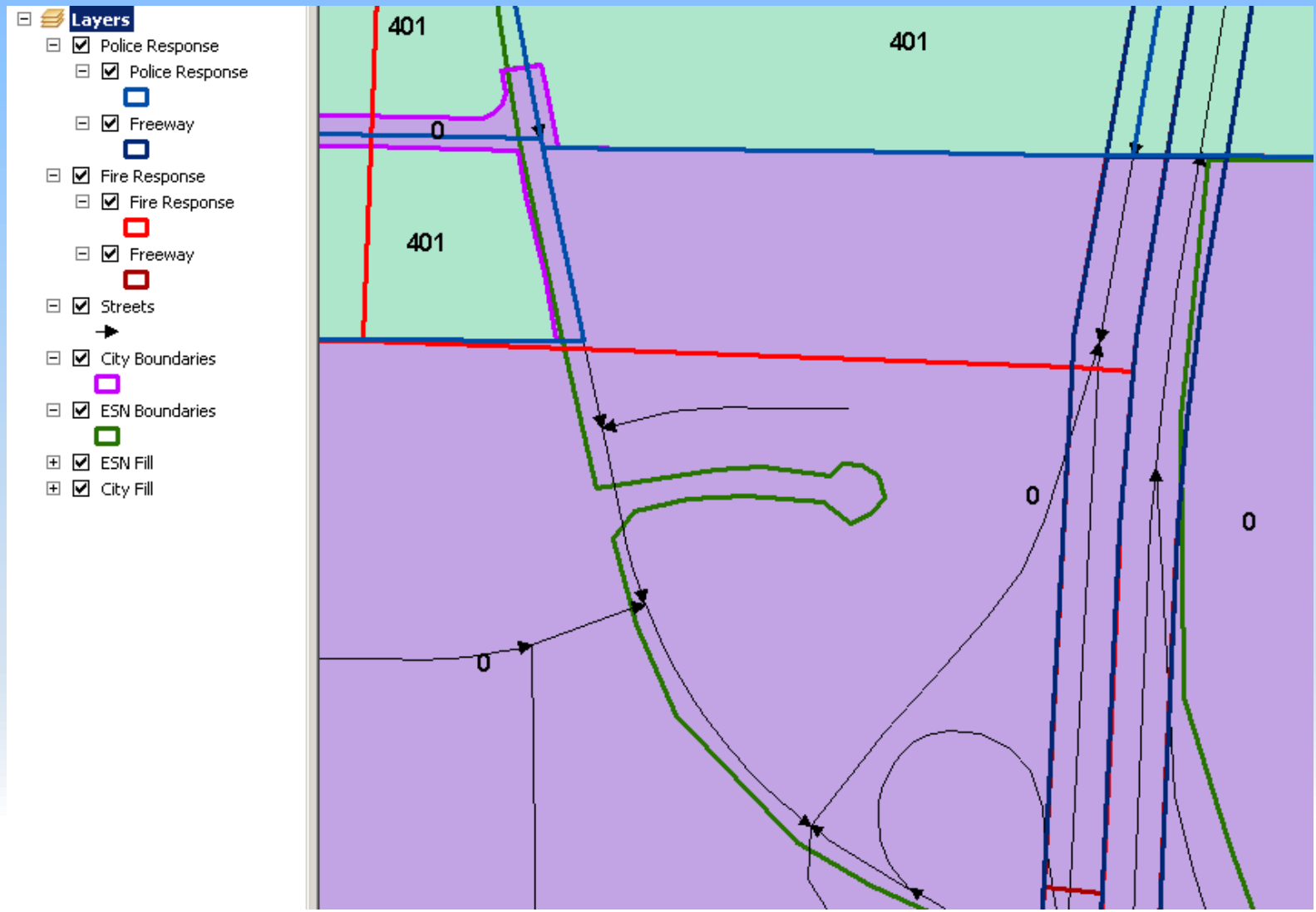
The biggest change will be that GIS data will be used for real-time routing of 9-1-1 calls, and determination of responders.

This will significantly change how agencies manage their GIS data, particularly in terms of the completeness of the data and the timeliness of data updates.

Data accuracy, especially attribute accuracy, will become more important than it has been. Spatial accuracy is still not considered all that important, however.

Next-Gen changes the use of GIS in 9-1-1.

Spatial accuracy isn't *all* that important, but…



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Next-Gen changes the use of GIS in 9-1-1.

Polygon data layers that have not been created, or that have been neglected, will need to be managed much more carefully. Examples of these layers include:

- Emergency Services Boundary – This is the most critical layer
- Municipal Boundary – This is nearly as critical as the ESB layer
- Unincorporated Community Boundary
- Neighborhood Boundary

Additional layers that are, or will become quite useful:

- Address points or parcels, if you don't already have them
- Building footprints
- Apartment complexes – with detail
- Business location, with detail such as hazmat information
- Mile markers, intersections (not just roads), place names
- All kinds of imagery, plus LIDAR, building photos, floor plans, etc.

Next-Gen changes the use of GIS in 9-1-1.

Zip codes and postal communities need to be maintained on centerlines and address points or parcels (if used). This is problematic, especially on centerlines.

Some data, especially Emergency Service Boundaries, County Boundaries, and Municipal Boundaries, may need to be redundantly managed as polygon attributes, and also as attributes on centerlines, address points, or parcels.

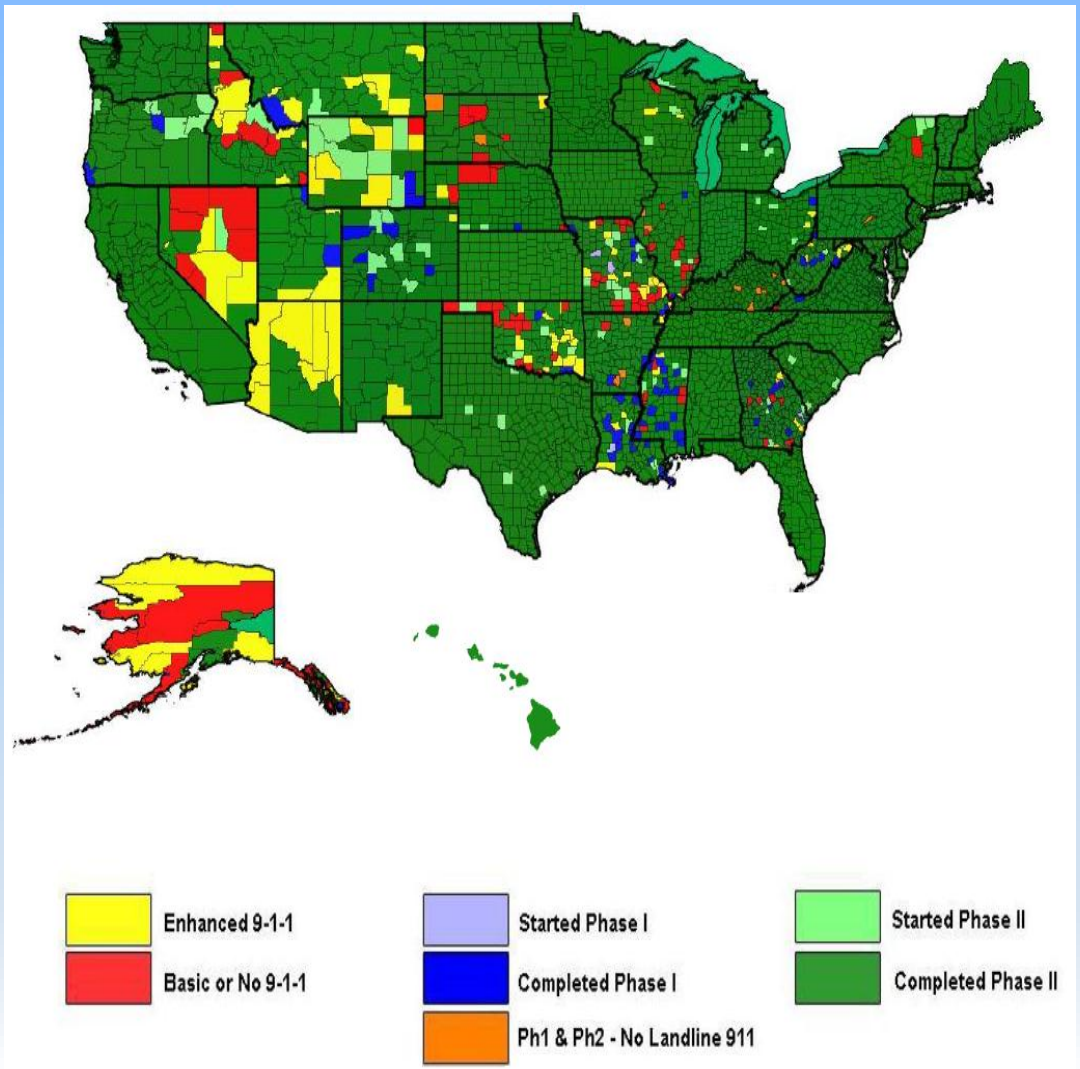
This spatial de-normalization will need attention. Whether de-normalization is required may depend on what specific vendor solution is chosen for the new 9-1-1 system chosen by your jurisdiction(s).

The transition to Next-Gen is beginning.

Here is a map of where we are at nationally in 9-1-1 implementation.

*Wireless Phase I – You receive the location of the cell tower that received the call, and can route the call to the most likely Public Safety Answering Point (PSAP) based on that location.

*Wireless Phase II – You receive the actual caller location, either by GPS coordinates from the phone, or by triangulation among multiple towers.



From NENA, as of 9/6/11

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Issues to be addressed for Next-Gen 9-1-1.

The GIS data used in Next-Gen goes by names like LVF* and ECRF***. They're called 'Functions', but are GIS databases. In fact, these two will likely be the same database, or replicas.

These database will have a standard schema (see NENA 08-003), which might change, but will be the same nationwide for exchange.

9-1-1 equipment vendors will drive many of these decisions locally.

You will either need to change your schema for all your data, which is unlikely, or find a solution to easily and automatically transmit changes to this system. Changes will be transmitted using WFS and/or GeoRSS.

*Location Validation Function
**Emergency Call Routing Function

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Issues to be addressed for Next-Gen 9-1-1.

All that new IP bandwidth opens opportunities to feed 9-1-1 mapping with exotic new data, such as ground-based LIDAR or real-time camera feeds. Be pro-active in working with the 9-1-1 data consumers to help them identify these opportunities.

Other more detailed ground information can be very useful. Building footprints, for example, could help identify which apartment a cell call is coming from.

If routable data is desired, you will need to coordinate with all your neighboring GIS managers as well, to ensure your data will be routable over jurisdictional boundaries.

Meshing GIS data with the MSAG and ALI.

In most jurisdictions, the MSAG and ALI will transitionally remain, but the new Next-Gen GIS 'functions' will need to be supported as well. To make this work, the following guidelines should be met:

1) The MSAG should match the GIS centerline data as closely as possible. This means that each MSAG range should match the range from 1 or more centerlines.
2) The ALI data should be entirely contained in the MSAG ranges.
3) If there is address point data, or parcel data, each ALI record should match 1 (and sometimes more) of those points or parcels.

NENA has some ideas about this in 'NENA-71-501-v1'.

Meshing GIS data with the MSAG and ALI.

In working with synchronization of many GIS databases with their corresponding MSAG and ALI databases, we have always found that many more errors are to be found in the MSAG than in the GIS.

This is less true with ALI databases, though the error rates in the MSAG make it possible for incorrect records to creep into the ALI as well.

For all cases where the GIS data is locally maintained, and there is reasonable confidence in the quality of the addressing in that data, I advise completely replacing the MSAG with similar data derived from the GIS in one of these forms on the next two slides.

Meshing GIS data with a Virtual MSAG.

First conversion option: A new MSAG with 1 entry for each street segment. Original MSAG row:

Dir	Street Name	Low	High	OEB*	ESN**	Community	County	State
	Main St	1	499	B	222	Fort Collins	Larimer	CO

Replaced by these MSAG rows – 1 for each segment:

Dir	Street Name	Low	High	OEB*	ESN**	Community	County	State
	Main St	1	99	B	222	Fort Collins	Larimer	CO
	Main St	100	199	B	222	Fort Collins	Larimer	CO
	Main St	300	399	B	222	Fort Collins	Larimer	CO
	Main St	400	499	B	222	Fort Collins	Larimer	CO

This creates an MSAG that has a 1 to 1 correspondence with the GIS, making maintenance of the MSAG a reasonably simple matter.

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Meshing GIS data with a Virtual MSAG.

Second conversion option: A new MSAG with 1 entry for each address. Original MSAG row:

Dir	Street Name	Low	High	OEB*	ESN**	Community	County	State
	Main St	1	499	B	222	Fort Collins	Larimer	CO

Replaced by these MSAG rows – 1 row for each actual address:

Dir	Street Name	Low	High	OEB*	ESN**	Community	County	State
	Main St	10	10	E	222	Fort Collins	Larimer	CO
	Main St	23	23	O	222	Fort Collins	Larimer	CO
	Main St	28	28	E	222	Fort Collins	Larimer	CO
	Multiple	Rows	…	…	…	…	…	…
	Main St	485	485	B	222	Fort Collins	Larimer	CO

This creates an MSAG that has a 1 to 1 correspondence with the points or parcels, reducing the possibility of invalid addresses.

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Meshing GIS data with the MSAG and ALI.

The term Virtual MSAG means that the MSAG is not directly maintained, but is a derived artifact of the GIS.

Using a Virtual MSAG doesn't keep you from using other means such as your service provider's maintenance tools, to do so, but it does mean that there is only 1 valid address range in use in both databases.

In the examples provided, note that there is a strict one-to-one correspondence between the source GIS layer and the destination MSAG database.

Wrapping up.

Now is the time for you as a GIS professional to take a proactive stance relative to coming changes in 9-1-1. Your knowledge, if offered early in the process, can be of huge help in optimizing implementation strategies.

Be prepared for the ways in which 9-1-1's needs will alter how you do your work, and this all will go a lot easier.

Next-Gen's potential needs offer an opportunity to expand the horizons of what your GIS organization does and what it provides back to the community, including significantly enhancing public safety efforts.

Questions or Comments?

For further information, please check these:

www.jerrysteensongis.com/upload/PDFs/Implementing_a_Virtual_MSAG.pdf
www.jerrysteensongis.com/upload/PDFs/GISStaffing-NextGen911.pdf

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