HOW DOES 9-1-1 WORK?

INFORMATIONAL DOCUMENT #1. PREPARED BY THE METROPOLITAN EMERGENCY SERVICES BOARD (MINNEAPOLIS - ST. PAUL REGION)

The term "9-1-1 system" means different things to different people. To some it means the entire process related to the determination of the need for some form of "emergency response" to some kind of incident, encompassing the dialing of the numbers 9-1-1 on a phone, to the network and equipment over which the 9-1-1 call is transmitted and received, to the facility where the 9-1-1 call is answered, to the process of relaying information to the 9-1-1 operator/call-taker, to the process of the 9-1-1 call-taker assigning units to respond to the emergency, to the radio system used to support that dispatching or paging activity, to the ultimate response of (or non-response) and actions taken (or not taken) by those responders.

To others, the term "9-1-1 system" is more narrowly defined as the telephone network(s) via which calls dialed to 9-1-1 are routed, transmitted and electronically received at a 9-1-1 call taking center (**P**ublic **S**afety **A**nswering **P**oint or "PSAP", for short). It is this more narrow, technical definition of "9-1-1 system" that this paper will primarily deal with.

We need to draw a clear distinction between three different 9-1-1 applications. These are ***wired*** 9-1-1, ***wireless*** 9-1-1 and ***Voice over Internet*** **9-1-1** (also known as VoIP). While these three types of 9-1-1 share some issues and technologies in common, they also differ dramatically from each other. This paper deals exclusively with **wired 9-1-1**.[1]

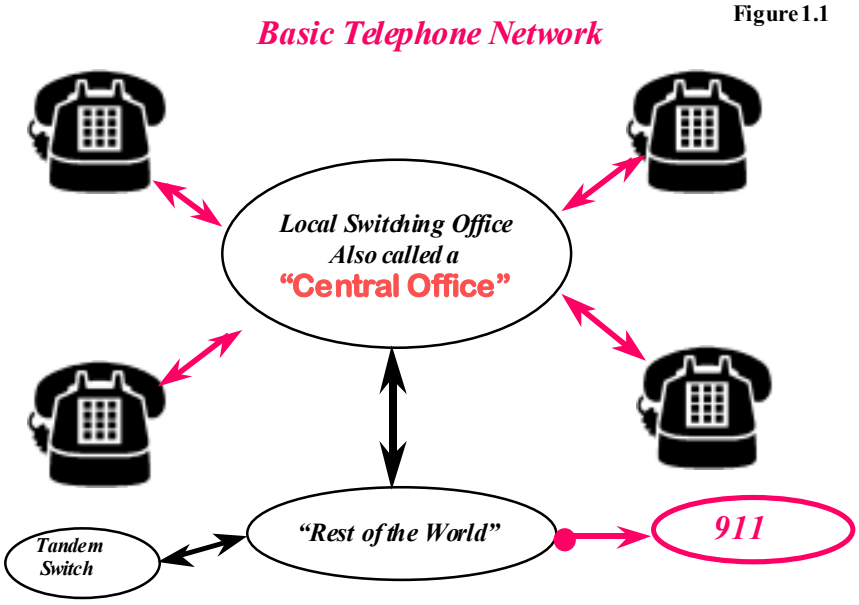
What is a wired 9-1-1 system?

In its simplest sense, a 9-1-1 system is the network over which phone calls requiring the response of public safety personnel are transported and switched in an effort to cause for that call to be answered by the public safety answering point (PSAP = a 9-1-1 dispatch center) with data being presented to the answering call-taker to facilitate determining where the call is coming from and where the need for public safety responders exists.

Wired 9-1-1 comes in two distinct "flavors"; **Basic or B-9-1-1** and **Enhanced or E-9-1-1**. This paper will deal exclusively with Enhanced 9-1-1. However, persons desiring a more in depth understanding of the technical beginnings of 9-1-1 service are referred to a Appendix A to this document on the Board's web site.

To fully understand how a wired 9-1-1 system works, a basic understanding of telephone networks is helpful. Figure 1.1 should help.

Figure 1.1



[1] Other Metropolitan Emergency Services Board informational documents dealing with Wireless 9-1-1, PBX or Multi-line Telephone Systems and 9-1-1, and Voice Over Internet 9-1-1 issues can be found at www.mn-mesb.org .

All wired phone calls leave the origination phone and first travel to a local "Local Exchange/ Switching Office" (Generally called a Central Office or "CO" [2]). The CO determines if the call is local *(meaning to another phone that is served by the same CO)*, in which case it "switches the call" out directly on the wires leading to that dialed local phone. If the CO sees that the dialed phone number is located somewhere in "the rest of the world", it switches that call out to a regional switching center called a "tandem". The term "rest of the world" means all phones that are <u>not</u> served by the local telephone switching facility. This would include neighboring communities, other states, other counties or the E9-1-1 system.

The issue of COs and the land areas they serve is important in understanding E9-1-1. Unfortunately *(at least from the perspective of 9-1-1 policy makers)* "traditional" telephone company central office service areas most often <u>do not</u> follow political jurisdictional boundaries such as County lines or city limits. In fact, they sometimes don't even follow state lines. We say "traditional" because 10+ years ago, this was the only kind of CO around. However, with the advent of "competitive local exchange carriers" (CLECs) the service areas of a given CO switch can now be an entire metro area, and even an entire small state. To illustrate the point with traditional CO service areas, we have a picture below (Figure 1.2) of the COs serving Carver County MN. In this drawing, the County boundary is not well indicated, but it is everything South and West of the straight gray line beginning above the word Watertown, running East to just below the word Excelsior, down to the Minnesota River (wiggly line) and along the river West to right by the word Sibley where it becomes straight again. The irregular gray lines surrounding the yellow, tan and light green areas are the CO boundaries (the names here refer to the CO and not only the community by the same name), and the heavy red line in the 507/952/612/763 area code boundary. The key here is to that many of the CO exchange areas cross County lines, and some even cross area code boundaries.

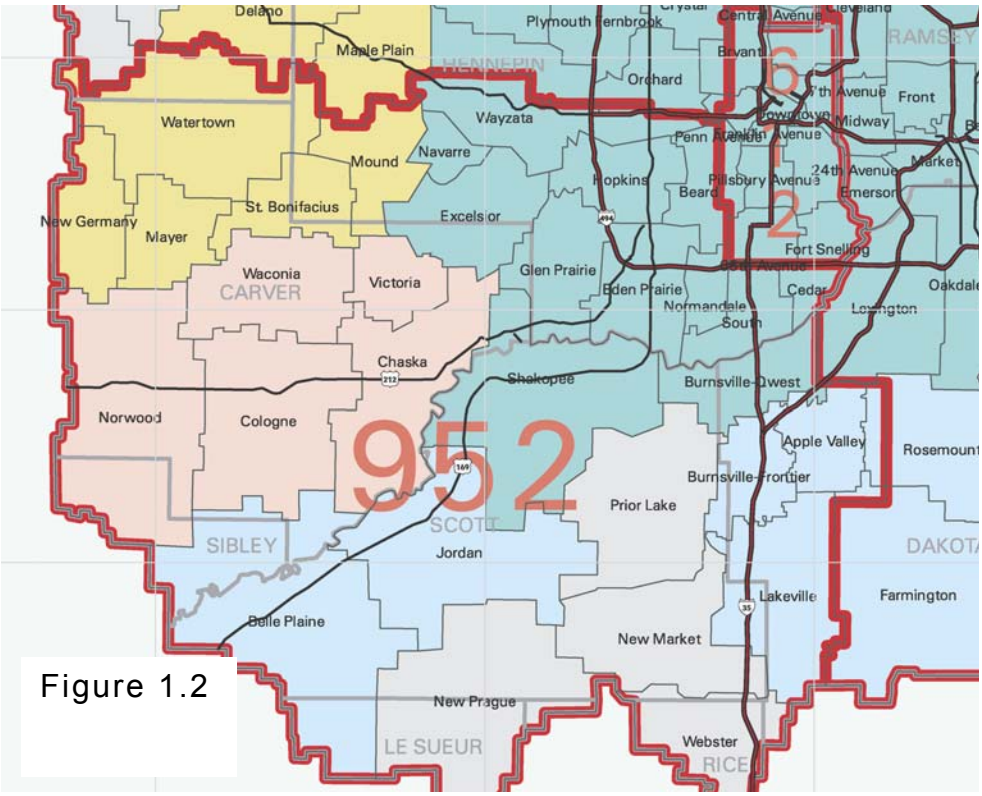


Figure 1.2

In the above diagram, note the Excelsior, Mound and St. Bonifacius exchanges in particular. All of them cross over into neighboring counties. And, in fact, all of them have their actual physical CO located in a County outside Carver County, yet they serve a number of subscribers within Carver County. It is situations like this that make the E9-1-1 feature known as "**<u>selective routing</u>**" particularly important.

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[2] *"Office" as used in this report is a telephone company term that refers to a "central office" or a "switching office" which are not really OFFICES, per se. Rather, a telephone "office" is a building within a specific area of a community to which all the phone wires from all the phones in that area are connected. Calls placed within that area are switched within that "office". That "office" is subsequently connected by another set of wires to all of the other "offices" in nearby towns, and if a call is destined for another town, it goes from the local "office" to the distant town's "office" where it is switched to the lines serving the desired party's phone.*

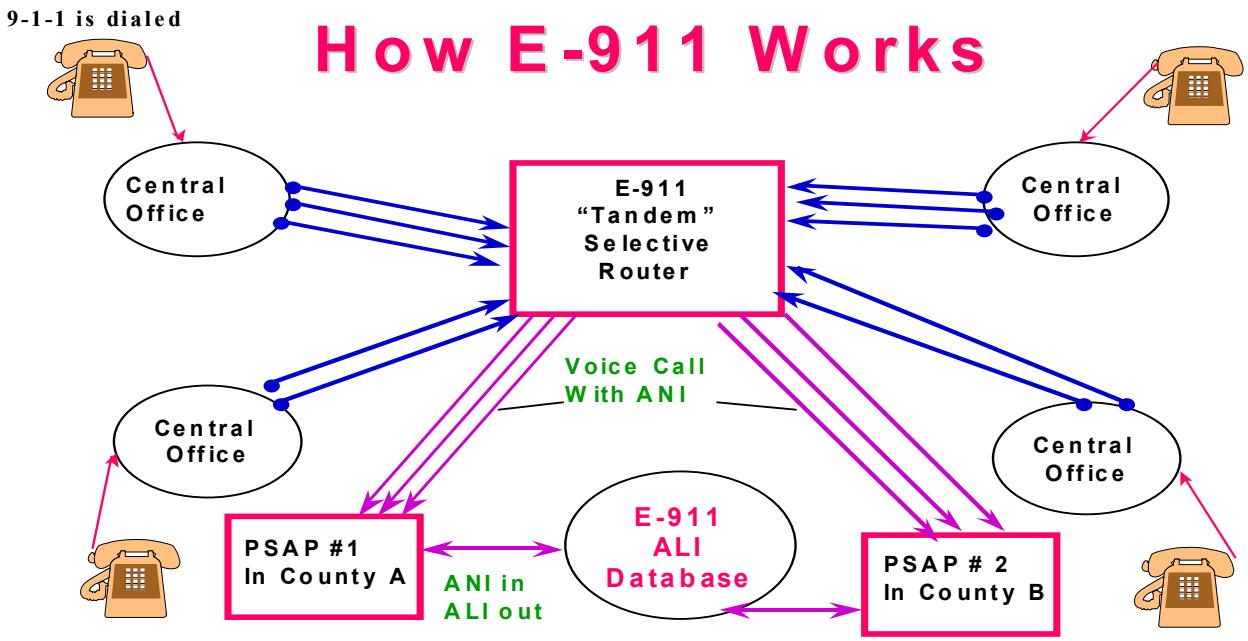

Fig 1.3

In the above diagram "ANI" stands for "**A**utomatic **N**umber **I**dentification", the 9-1-1 caller's phone number. It differs from commercially available "Caller ID" services in that the calling party CANNOT block it, and that it precedes the 9-1-1 call through the network. The term ALI refers to **A**utomatic **L**ocation **I**nformation, which is a data presented on a screen to the call-taker with the following typical information:

612-498-2410*(calling number)* **22:13** *(time/24 hr)* **01/01***(date)***QWST***(serving LEC)*
1234 Main St *(Listed ALI address)*
ANYTOWN MN *(Community name, State)* **RESD** *(Class of service-residential)*
PSAP=ACSO *(Abbreviation for destination PSAP – Anytown County Sheriff's Office)*
John Doe *(Name of phone service subscriber/customer)*
1234 Main St Apt 304 *(complete address with location identifier – Apt. # here)*
LAW = Anytown County Sheriff *(law enforcement dep't responsible for address)*
FIRE= Anytown Fire *(Fire service responsible for address)*
EMS = Speedy Ambulance EMS *(EMS service responsible for address)*

Sample ALI Screen (Figure 1.4)

Referring to the E9-1-1 diagram above (Figure 1.3), we can now see one of E-9-1-1's main attributes: ***SELECTIVE ROUTING***. In E-9-1-1 calls travel over dedicated 9-1-1 circuits to a device called the ***E-9-1-1 Tandem Selective Router*** (which we will refer to as the "router" going forward). This router would be located somewhere in the general region, but could even be a couple of hundred miles away. When the 9-1-1 call in an E-9-1-1 system reaches the router, the caller's phone number (ANI) precedes the call. This ANI number is then submitted to a "selective routing data base" (SRDB) associated with the router that answers the question:

To which of the E9-1-1 PSAPs served by that 9-1-1 router should this call be selectively routed?"

This SRDB will have been built as a direct result of having built the ***"Master Street Address Guide"*** **(MSAG)**. The process of constructing an MSAG flowed directly from the development of "locatable addresses" within the jurisdiction. The MSAG is essentially a "routing table" that identifies all street names, a range of theoretically possible house numbers for each street, and which unique set of law enforcement, fire, and emergency medical services providers are responsible for that address. For example, in an MSAG, the address for the John Doe residence at 1234 Main Street in ANYTOWN would be referenced as follows:

Name	Type	Direction	Low #	High #	Odd/Even	ESN	PSAP
Main	Street	<blank>	100	1400	Both	101	ACSO

The fields in the above MSAG table are as follows:

Name: The name of the roadway. In this case: Main
Type: What type of roadway is it? Street, Ave, Lane, Drive, etc. In this case: Street.
Direction: Is it North, South, East or West? In this case, it has no directional.
Low #: What is the lowest house number possible within this unique ESN? Here it's 100
High #: What is the highest house number possible within this unique ESN? Here it's 1400.
O/E: Does this unique ESN reflect ODD or EVEN house numbers, or both. In this case, both.
ESN#: What number will be assigned to this area which has a unique grouping of Law enforcement, fire and EMS service providers? This is the ESN#. (*Stands for Emergency Services Number or Zone; also expressed as ESZ)*
PSAP: To which of several PSAPs served by this router should 9-1-1 calls from ESN 101 be routed? In this case it's the Any County Sheriff's Office (ACSO).

This MSAG table for an area as large as the Twin Cities metro area goes on for hundreds pages, listing every roadway in the region, and for each roadway that passes through a different ESN, there is another entry. An E9-1-1 router performs the Selective Routing function based on the address associated with the caller's ANI that precedes the E-9-1-1 call.

Once the E9-1-1 call is answered at the PSAP, the ANI is sent out over dedicated data circuits to a (usually) remote computer which houses the ALI (caller location information) database. The ANI arrives at the ALI database and the database looks up its record of 612-498-2401 and immediately returns that ALI data to the PSAP display screen of the answering 9-1-1 call-taker at the PSAP and the ALI display populates as previously illustrated in figure 1.4. The ALI database is updated (and it subsequently updates the SRDB in the tandem) generally on a 24-hour turn-around basis. It needs to be updated in this fashion because every day of the week people are adding phone lines, removing phone lines, or changing the service address of an existing phone line when (for example) they move 1 mile down the road but keep their same phone number. Because there are already mechanisms in place in the "traditional phone world" for this "add, move, or change" information to be shared among telephone companies on a daily basis for purposes of business like Directory Assistance, and because telephone companies are very good at keeping track of the addresses where there services are installed *(they need to send out those monthly bills!)*, this process usually flows quite smoothly on an automatic basis. Generally, the only major maintenance work that a 9-1-1 jurisdiction has to be involved with is to update the MSAG when new streets are added or lengthened, or street names are changed or when the unique grouping of emergency service providers for a given location change. (For example, Fire Department X and Fire Department Y "swap" some service territory, or City Z annexes some portion of the County.)

As can be seen from the previous discussion, traditional E-9-1-1 systems for "wired phones" are effective in:

- Enabling the 9-1-1 call to get to the correct PSAP (Selective Router).
- Providing the answering 9-1-1 center with the caller's telephone number (ANI)
- Providing the 9-1-1 call-taker with a <u>text display</u> showing the address of where the calling phone is installed, the name of the subscriber for that line, and which unique grouping of emergency response agencies to dispatch to that address (ALI).