CDE #65174

INSIDE THE CONSOLE:

GETTING THE MESSAGE TO THE FIELD

A radio network's technical specifications depend on its size and reach.

By Donald Root

ROBERT LEVY PHOTOGRAPHY

We know that public safety telecommunicators are the individuals behind the console, serving as the initial point of contact for the public whenever there is a need for assistance. Likewise, public safety employees (law, fire and EMS) on the street are the first responders handling the public's calls for service. These are the visible segments of the public safety operating picture. What is not visible is the pathway(s) between the console and the radios on the street, AKA "inside the console."

In addition to the states, there are nearly 3,300 counties/county-equivalent entities in the United States and its territories. Each of these entities is served by at least one primary emergency communications center (ECC), providing initial screening of 9-1-1 calls for service and communicating with response personnel in the field. These ECCs serve environments ranging from the wide-open spaces of rural America to the high-density metropolitan areas around our major cities.

You probably know that most public safety agencies use two-way radios to communicate between field personnel and dispatch personnel. Radios deliver instant, "one to many" group-based voice communications — an essential and permanently useful form of human interaction, especially for first responders.

There are three types of radios commonly used for public safety communications:

- Portable radios are low-power (2- 6 watts) typically used by an individual first responder and worn on their body. These radios generally have a limited range.
- Mobile radios are higher-power (25-100 watts) typically mounted in a vehicle with a vehicle-mounted antenna to provide an extended communications range.
- Base stations (or repeaters) are high-power (50-100 watts) fixed radios installed in sites with high-performance antennas to provide maximum communications range.

These radios are the building blocks of a radio system.

Just as there are multiple types of ECCs, there are diverse modes of radio systems to support agencies. The primary modes are direct (or simplex) mode, conventional repeater mode and trunked mode. Let's take a high-level look at each mode.

Figure 1 shows a basic direct (simplex) radio network design. The ECC has one or more consoles connected to the radio equipment in this design. The ECC is connected to each radio site through house cable to the equipment room (in the case of a co-located radio site) or through remote circuits to each radio site. These remote circuits may be in the form of a local control station radio, dedicated telephone lines or a microwave circuit. A base station is used at each radio site to communicate with the mobile and portable radios assigned to field units. All communications are conducted on the same individual radio frequency for receive (R1) and transmit (T1). This frequency is considered a "direct" or "simplex" operation.

Base stations at the radio sites are designed to provide the maximum radio coverage within the agency›s operating area. Depending on the size or terrain of that operating area, more than one radio site may be required.

Note that this operating mode is also used for communications between units at the scene of an incident, frequently on a tactical or fireground frequency that does not have a dispatch center with the ability to monitor/communicate with units on scene.

Figure 2 shows a basic conventional repeater radio network design. The difference between this design and the basic direct (simplex) network design shown in Figure 1 is that two radio frequencies are used.

A repeater station is used at each radio site to communicate with the mobile and portable radios assigned to field units.

In this mode, mobile and portable units transmit on frequency 1 to the repeater,

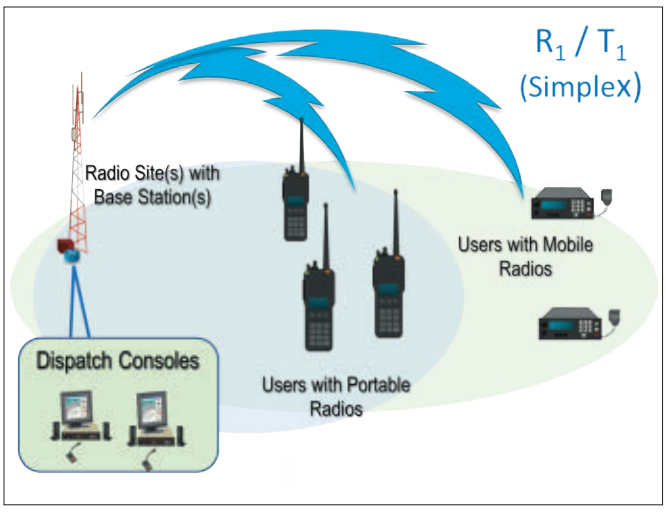

Figure 1: Basic Direct (Simplex) Network

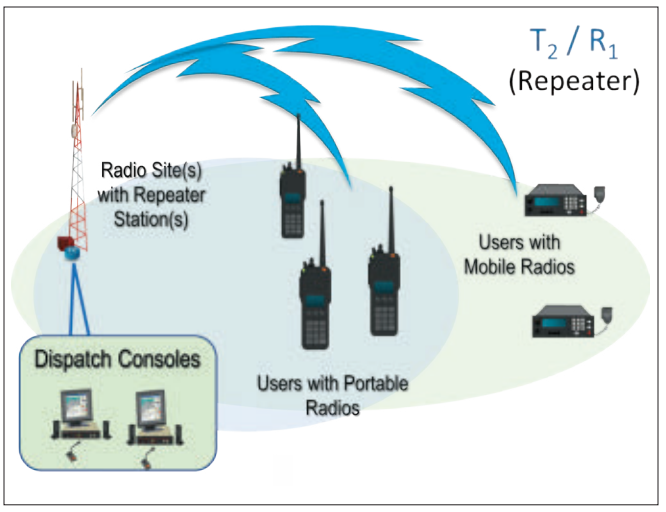

Figure 2: Basic conventional repeater network

which then repeats the communications out on frequency 2 to the users and public safety telecommunicator. This mode allows all users and the telecommunicator to hear each user in the network.

In some systems, the mobile and portable radios are configured to allow the users to talk around the repeater station (in direct mode) by shifting their transmitters to frequency 2. This capability allows the users to communicate among themselves while also hearing radio traffic on the repeater.

Many jurisdictions need multiple conventional repeater systems (law enforcement, fire, EMS, public utilities, etc.) plus conventional simplex channels. Both conventional modes use discrete frequencies. In an area with multiple jurisdictions with similar requirements, you often find it difficult to obtain enough discrete frequencies.

SPECTRUM CONGESTION

Over the last 60 years or so population growth has driven an increase in public safety agencies adopting radio for their primary communications. This growth has made the radio spectrum available for public safety use increasingly crowded. By the late 1960s, radio frequencies to meet basic public safety agency needs in the larger metropolitan areas were very hard to find. During the 1970s, 1980s and 1990s, the Federal Communications Commission (FCC) allocated additional spectrum for public safety use and required efficiency standards to increase use of the available spectrum. To ensure that users from one agency could communicate with users from another agency, the public safety community wanted to ensure emerging technologies were developed under user-driven, interoperable and open standards that would meet their needs and the FCC requirements. These requirements have resulted in emerging technologies such as trunking and digital emissions.

In September 1989, an initial meeting of major public safety associations and federal agencies resulted in an agreement among APCO International, the National Association of State Technology Directors (NASTD) and agencies of the federal government. To implement this agreement, APCO established the following sequentially available project number, Project 25 (P25). Memorandums of understanding were signed with the Telecommunications Industry Association (TIA), an ANSI-accredited standards development organization, to lead the development of vendor-driven open standards. Today, the P25 standards are the public safety radio systems benchmark.

TRUNKED MODE

Trunking allows multiple groups of radio system users to share a pool of discrete frequencies. In many places, agencies and discrete public safety radio systems have partnered to develop consolidated trunked radio systems to provide a cost-effective and spectrum-efficient infrastructure for most or all of the agencies in a given area (or even an entire state).

Figure 3 shows a sample trunked radio network. The network consists of multiple radio sites around the service area to provide jurisdiction-wide coverage. Unlike conventional networks, the trunked network has a system core computer (depicted here as the cloud) connected to a site controller computer at each radio site. Each radio site is equipped with several base repeaters (BR) operated by the site controller. The site controller uses one of the site's base repeaters to serve as the control channel (CCH).

Computers are also incorporated into user mobile and portable radios. Instead of having a discrete radio channel, these computers are programmed to assign each user group a talkgroup (TG) as a virtual talk path for each channel the user has assigned for their use. When the user radio is powered on, it continuously communicates with the system core via the control channel, so the core knows the user is affiliated with the network, which TG the user is operating on and which radio site area the user is working within.

When a unit on the City PD Law talkgroup wants to speak with the telecommunicator or another unit, that unit pushes the push-to-talk button on their radio. The radio sends a data signal through the site controller to the system core, requesting to speak. In under one-quarter of a second, the system core (continually keeping track of all active City PD Law talkgroup network user locations) instructs the site controllers at the relevant sites to assign a base repeater to the talkgroup. This then sends a command to all active users of the City PD Law talkgroup to switch to that base repeater and unmute and provides the original requesting unit a "talk permit" tone to tell the user to proceed. All members of the talkgroup can hear and participate in the conversation.

If one or more remote sites do not have a base repeater available to assign to that request, the system core sends the original requesting unit a busy tone. It places the request in a queue until every involved radio site has an available base repeater. Then the system core completes the assignment process and sends the original requesting unit the talk permit tone.

As field units move around the network, the individual radios detect that they have moved into another radio site's operating area and re-affiliate with the system core on the new radio site. If a radio cannot find another radio site to affiliate with, it informs the user that it is out of range.

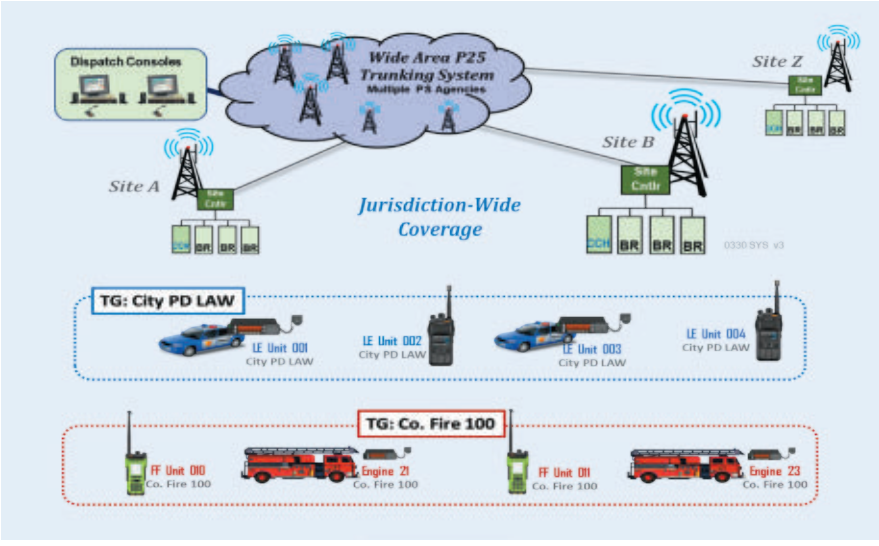

Figure 3: Typical trunked radio network

In addition to the daily operations of law enforcement, fire and EMS, many systems have public service users (public works, road maintenance, etc.) on the network to facilitate coordinated operations in a disaster or major incident. Many systems provide common talkgroups to all users of the network to facilitate these disaster or major event operations.

A well-designed trunked radio system will be configured to support the maximum traffic load at the busiest hours in a given network area and allow for a significant incident to occur simultaneously.

As a telecommunicator, you are on the front line daily. Understanding what is inside the console between you and the field units you are communicating with can assist you when a component of your agency's network becomes impaired or stops working. If your agency does not have a plan for dealing with potential technical malfunctions, consider talking with management about including the technical aspects in your center's continuity/recovery plans. ●

Donald Root *is a retired Communications System Manager. He retired after more than 40 years of experience in public safety and emergency management communications at the state and local level in California, including the management of more than 50 site trunked radio networks. He now works as APCO's Project 25 Program Manager and can be reached at rootd@apcointl.org.*

CDE EXAM #65174

1. How many diverse modes of radio systems are there?
   a. 1
   b. 2
   c. 12
   d. 3
   e. 5

2. Where are sites typically located?
   a. Co-located with the emergency communications center.
   b. At the local Starbucks.
   c. At a location or locations designed to provide the best coverage of the jurisdiction.
   d. A. and C.

3. A basic direct (simplex) network uses how many individual radio frequencies?
   a. 5
   b. 4
   c. 2
   d. 1

4. What APCO project developed the benchmark standards for modern public safety radio systems?
   a. Project 36
   b. Project 14
   c. Project 25
   d. Project 4

5. How long does a trunked system core take to set up a talkgroup call?
   a. Less than 0.25 seconds
   b. ¾ of one second
   c. When all activity on the system has ceased
   d. Instantly

6. Talk around allows a user to communicate on the input frequency of a conventional repeater.
   a. True
   b. False

7. A control channel is used to:
   a. Turn off the TV in the ECC.
   b. Provide a voice talk path for a talkgroup.
   c. Communicate with mobile and portable radios in the field.
   d. Turn off a remote radio site.

8. Base repeaters are used in trunked radio networks.
   a. True
   b. False

9. How many county or county-equivalent entities are there in the United States and its territories?
   a. More than 8,000
   b. Six per state or territory
   c. Nearly 3,300
   d. 5,280

10. A repeater station is used in a conventional direct (simplex) radio network.
    a. True
    b. False

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