Trunking Basics

Trunked Radio Systems share a small pool of frequencies among a large number of users. They can do this because communications are typically less than 5 seconds long, and a particular channel might be busy less than 5% of the time. System users are assigned to "talk groups" which function as virtual channels. When a user makes a call, the radio transmits a unique radio ID number and current talk group ID and a request for a radio channel (frequency pair) to the computer which controls the trunking system.

The controller then sends out a “channel grant” specifying which frequency pair to use, and telling every other radio in that user group to also switch to that frequency pair for the duration of the transmission. When the user stops transmitting, the assigned frequency pair is released so that it is available for the next group to use, which can be any other users of the system. On a trunking radio, a “channel” is not a specific frequency pair, but instead determines the affiliation of that radio with a talk group assigned to a particular group of users on the system.

The benefit of this technology to the agencies is that many more virtual channels are available for specialized traffic than there are frequencies. For example, the Fort Worth trunked system has only 20 frequencies, but services over 400 talkgroups. All radio channels in a trunking system are repeaters, so system traffic can be widely heard.

The down side for scanner users is that, because a new frequency is assigned every time a user keys his radio, an exchange of communications can occur across several different system frequencies. If you only monitor the frequencies, you’ll get a mix of all the users on the system and have a very difficult time hearing any one particular communications exchange.

Trunk Tracking lets a scanner monitor the computer’s channel, so it can watch for the channel assignments and follow individual communications (or scan for communications of interest) on such systems.

The below goes into this in a bit more detail.

Early attempts at spectrum management [edit]

Repeaters [edit]

To understand trunking, one must first understand the concept of repeater operation. This is fairly simple if you consider the following; place a remotely controlled receiver and transmitter on a high point somewhere in the area. The repeater receives all the signals transmitted on one frequency known as the input frequency (call this channel "A") and takes what it hears and retransmits it on another frequency known as the output frequency (call this channel "B") at the same time. All mobile and base stations listen on channel "B" and transmit on channel "A."

This system allows units across a wide area to communicate with each other via the repeater (called a mobile relay by the FCC).

Tone-controlled access [edit]

The first way interference was solved was by the use of CTCSS or DCS (more commonly called PL or DPL tones). These are subaudible (and in the case of DCS, digitally encoded) signals sent out along with the radio signal carrying the voice transmission. Radio receivers are set to only open squelch when a specific CTCSS or DCS is detected. This meant, for example, that two counties near each other could use the same frequency (for example, 155.25 MHz) with different tones and would not normally interfere with each other. One organization could be using 155.25 MHz with a CTCSS tone of 114.8 Hz and in the next county over, another organization could be using 155.25 MHz with a CTCSS tone of 110.9 Hz and for the most part they would not hear each other.

Trunking [edit]

While the use of CTCSS and DCS proved to be a good solution for a while, spectrum crowding, especially in urban areas, overwhelmed such solutions, and eventually led to the development of trunked radio systems. Trunking is the use of several repeaters, on different frequencies in the same band, operating together under computer control to allow the pooling of

resources for several agencies. A presentation on the basics of trunked radios systems was done at Defcon 15 and a video of that presentation is available here.

The trunking radio, in a patrol car for example, is much more sophisticated than the simple transceiver previously used in a simplex or repeater configuration. A trunking transceiver is a microprocessor-controlled radio capable of receiving instructions from the system controller and changing frequencies on the fly. All trunked radios operate in a similar manner although the type of trunking technology used by each type of trunked radio system differs greatly.

In the trunked radio environment, each agency is assigned one or more talkgroups that the agency's communications will use. All agencies on the system will have different talkgroups but all will share the same pool of frequencies. For simplicity I will use an example of a control channel-based type of trunked radio system as an example. In this type of system, all the radios on the system (except the computer controlled set of repeaters, of course) listen to a common control channel (CC) output frequency and transmit (initially) on a common control channel input frequency, unless they are listening to a conversation on a talkgroup.

Let's say that Patrolman Bob (from Smalltown Police Department) wants to tell the dispatch office that he is now in service. The following actions take place in a very short time, much shorter than it takes you to read this. He picks up his microphone and keys the mike, his radio sends a signal on the CC input frequency, which the controlling computer understands as a request for a channel grant for the talkgroup assigned to Smalltown Police, his radio then instantly goes back into receive mode. The computer looks at the system for an empty channel pair and issues that channel grant on a specific channel pair and sends that channel grant information out on the CC output channel. This channel grant information tells all radios on the system, if you are listening (monitoring) for communications on the Smalltown Police talkgroup: change to channel pair XX on the system for a communication. All radios tuned to Smalltown Police's talkgroup, including Patrolman Bob's, then switch frequencies to that channel pair granted by the computer. Patrolman Bob's radio, after changing frequencies, goes into transmit mode and he can start to talk. As he talks, all the radios monitoring the Smalltown Police's talkgroup are now listening on the assigned repeater output channel and are ready to talk on the assigned repeater input channel. This continues until Patrolman Bob has finished his transmission. On some types of systems, further communication may be on the initially assigned channel pair or it may move to another, but the process stays the same.

A trunk-tracking scanner is designed to follow those same instructions (except, of course, it ignores the instructions relative to the input side of the repeater pair) so that it will also follow the conversations by changing frequency to the appropriate repeater output frequency. Each type of trunked radio system operates a little differently, and some cannot be monitored by current trunk-tracking scanners at all.

Please take a look at detail information in regard to the type of system that you are attempting to monitor and the instructions that come with your scanner in regard to that type of system.

Networked Systems [edit]

A trunking system that uses more than one site is either a multi-cast (sometimes referred to as simulcast) system covering a larger but restricted area, like a mid-sized city; or a networked system. A multi-cast system could also be part of a larger networked system.

Networked systems typically are made up of a trunked system that uses control channels as opposed to a LTR type system. The reason this is important to you the scanner user is that you must accommodate the use of multiple control channels in your scanner programming. For the purposes of this discussion on networking, we will only consider those systems that use control channels to manage usage (as described in the above section.) Also, in networked systems that also have multi-cast systems, consider the multi-cast system as a single site within the network.

Affiliation [edit]

An important concept to understand with networked systems is affiliation. This is the term used to describe when a real radio (subscriber) is using a specific site to communicate with the trunked system and hence causes specific talkgroup traffic to appear on a specific site. To explain this further let us consider a very large system, say a statewide system. Using our example above, let's consider that Smalltown has a local site on the statewide system. Normally all the traffic for Smalltown would probably be carried on the Smalltown site. If patrolman Bob had to take a prisoner to a detention facility in Big City then as he traveled from Smalltown toward Big City he probably would leave the range of the Smalltown site and pass into other sites' range as he travelled. Assuming he kept his radio tuned to the Smalltown Dispatch channel as he travelled, into the range of each site, his radio would automatically affiliate with the closest (or strongest) site and unaffiliate with the site he previously was on. This means that as patrolman Bob travels, he is causing the Smalltown Dispatch channel to be able to be heard on each site as he affiliates with it.

This is important to you, the scanner user, because you are using a passive device to listen to this trunking network. You cannot force traffic from a desired talkgroup to appear on the site that you can hear, because you don't actively communicate on the system. You must rely on actual subscribers to cause desired traffic to appear on the site you are listening to. This concept affects you in two ways and both are best presented by examples.

> Say you grew up in Smalltown and would like to hear it to keep up with what is going on, but you moved to Big City for a job. Unless patrolman Bob (or someone else) comes to Big City and keeps his radio tuned to Smalltown Dispatch, you will never hear it because no one in Big City has a radio affiliated with the Smalltown Dispatch talkgroup on the Big City site.
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> Say you are listening to a couple of state policeman who are doing some surveillance many miles away and they are communicating on the regular dispatch channel for the local state police station. They can be heard, even though they are not affiliated on the local site, because the local state police station's radio is affiliated with the dispatch channel. If the two state policemen (who are affiliated with some other site you can't normally hear) decide to switch channels to a

TAC (talk around channel) that no one in your area has tuned, then you will lose the conversation because it will not be carried on the local site.

These two circumstances are why you, the scanner user, should try and set up as many sites as you can hear in your scanner. And if you are traveling, program all the sites that you will come within range of on your trip. The actual programming of many sites within specific trunking systems becomes too complicated to discuss in this basic article. It depends on your scanner and the type of system you are attempting to monitor, so once again take a look at detailed information in regard to the type of system that you are attempting to monitor and the instructions that come with your scanner in regard to that type of system.

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