

## **Trunked Radio Systems**

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***ICK! I Hate Technical Stuff!***

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One of the latest developments in the two way radio world is something called TRUNKED RADIO or TRUNKING. For some reason, trunked radio has been a difficult concept for lots of folks to get their hands around. We'll try here to explain the basic concepts of trunked radio in a fashion that (we hope) will make you able to be conversant about a topic that is almost certain to impact your system in the next 10-20 years, if it hasn't already.

First of all, **trunking in itself, does not necessarily mean 800 MHz.** The fact is that trunking is a methodology of efficiently using and re-using several radio channels that could be done (at least in theory) in any of the bands discussed above. Yes, you could even use trunking on the 40 good old CB radio channels! However, the reality is that for a trunked system to work properly, it needs at least a handful (usually 5 or more) of relatively adjacent **pairs of radio frequencies**. We say "pairs of radio frequencies" because a trunked system is always "repeated". Repeated means that the talk path goes to and through a device called a REPEATER (much more on this later) and it needs one frequency for the transmissions headed to the repeater and another frequency for the transmissions coming out of the repeater. Therefore, each CHANNEL consists of two FREQUENCIES, one inbound and one outbound from the repeater. So, to repeat (no pun intended), a trunked system needs several pairs of frequencies (channels) and about the only place in the usable spectrum left where you can find relatively clean (free of interference) pairs of frequencies is in the 800 MHz. band, to include the NPSPAC channels. That's why almost all of the trunked systems you'll hear about for the foreseeable future will be at 800 MHz. *(Yes, Virginia, it is true that there are UHF (400 MHz.) trunked systems in use. One place is by the Navy for shipboard trunked radio systems on aircraft carriers).*

Now that we've established that "trunked" doesn't *necessarily* mean 800 MHz, but that almost all trunked systems are 800 MHz trunked systems (have we got you confused, yet?), lets try and get a handle on how trunking works. The best way I've found to understand this is to make a comparison between simple two way radio (non-trunked) and simple telephone systems. On day one, when Alexander Graham Bell invented telephone, he ran one pair of copper wires from Place A to Place B. Over these two wires he sent voltage which turned into voice at the other end. This is a "talk path". On day two, he ran another pair of wires from Place C to Place D. This is another talk path. If the telephone world would have followed this basic concept, each of us today would have as many pairs of wires running from the phone at our house to as many other different places as

we could imagine we would ever want to talk to. This would definitely be lots of wires and a real mess. Every time we wanted to talk to somebody, we'd have to go into that pile of wire "spaghetti" and find the pair of wires that went to the place we wanted to call and connect them to our phone. Then we'd have to hope that the party we were calling had also found the pair of wires that came from our house and connected them to their phone. If they had, we could send a ring down those wires, they'd pick up and we could talk.

Needless to say, old Alex figured this problem out real fast. What he did was invent "telephone exchanges". That meant that from every house there was just one pair of wires running to a central place. At that central place (you've all seen pictures of old telephone company switchboards and operators), the we'd ring the operator who would plug into our pair of wires and ask us who we wanted to talk to. We'd tell her (they were always "hers" back then). We'd tell her and then she'd run a "patch cord" from our the plug representing our pair of wires to the plug representing the pair of wires that went to the place we were calling. Then she'd put a ring on those wires and the phone would ring at the desired place. If somebody answered, we'd talk. When we were done, we'd hang up and the operator would get an indication of that and remove that patch cord and free up that temporary connection between the two of us.

***OK, here's how the analogy works:*** The first example of a pair of wires running everywhere we might want to call is exactly like simple non-trunked two way radio. The only difference is that instead of dealing with wires we are dealing with specific radio frequencies or pairs of frequencies that make up radio channels. Imagine CB radio. If you want to talk to me on CB Channel 14, both you and I have to have CB radios. They must both be turned on. They must both be switched to the same "pair of wires" (channel). Then when you call me, you are the only person who can be talking on Channel 14 at that instant and if I hear you, I answer you. Nobody else in our geographic area (say 10 miles in diameter) can be using that channel at the same time. If they do, we end up in a party line sort of situation, which is what CB is. Now jump to public safety radio. Let's say your agency has a 4 channel radio system with 4 channel radios in all the cars and trucks. If the dispatcher wants to talk to Car 54, the dispatcher must know which channel (pair of wires) Car 54 is tuned to, wait until nobody else is talking on that channel and then call for Car 54.

You all know what radio scanners are. Imagine you are in TV station's "assignment desk" room in a major metro area. They might have 10 of these scanners mounted on the wall, all humming away. Let's say each scanner has 1 channel. That means they are monitoring 10 channels continuously. Not all the channels are all talking at the same time (usually). Each channel in each scanner is assigned to a different agency in the same unit of government (1 police, one fire, one street dept. etc.). All of a sudden, there is a big deal going down in Agency #1 and their channel gets real busy.

At the same time, however, none of the other 9 are busy at all. The folks at Agency 1 are dying. Their channel is all tied up and they are having a hard time getting any air time for all the important things they need to say, while the other nine are dead silent. If only some of the folks from Agency 1 knew that channel 5 (the sanitation department) was dead silent, they could switch to it, if they even had that channel in their radios.

***This is what trunked radio is all about.***

Let's take the same unit of government and give them a 10 channel trunked radio system. What we do is take all 10 channels and control them by a computer. Then we put all 10 channels in all of the mobile and portable radios of that unit of government. Now, we no longer think in terms of "**channels**". Instead, we think of terms of "**talk paths**", or in trunked radio language, "**talk groups**". A typical assignment of talk groups to a unit of government (a city, for example) might look like this:

<b><i>Talk Group Designation</i></b>	<b><i>Assigned to</i></b>
Police North Patrol	Police
Police South Patrol	Police
Police Tactical	Police
Police Investigative	Police
Police Traffic/Radar	Police
Police surveillance	Police
Police Car to Car	Police
Police Administration	Police
Police Common	Police
Fire Dispatch	Fire
Fire Command	Fire
Fire truck to truck	Fire
Fire Ground Tactical 1	Fire
Fire Ground Tactical 2	Fire
Fire administrative	Fire
Fire Common	Fire
Sanitation 1	Sanitation
Sanitation 2	Sanitation
Park Maintenance	Park
Park Operations	Park
Sewer Mtce. 1	Sewer
Sewer Mtce. 2	Sewer
Street Mtce. 1	Streets
Street Mtce. 2	Streets
Public Works Common	Public Works
City administration 1	City Manager
City administration 2	City Manager
Inspections 1	Building Inspections
Inspections 2	Building Inspections
City Wide Common 1	City wide
City Wide Common 2	City Wide
Statewide VHF Emergency (155.475)	Hard patch to 155.475 (always up)

Each of the radios owned by the separate agencies are programmed to be able to access only the talk groups for their agency, plus some or all of the "common" talk groups (Like city common). That way, you don't have sewer workers listening in on police surveillances, etc. Now, in a city that used to have only 10 channels, we now have 32 separate talk groups.

In reality, in a trunked system, all of the radios are actually remote computers first and radios second. Lets take a look at one simple transmission and see how this all works:

- Police Car 1 wants to talk to Police Car #2. He knows 2 is monitoring the North Patrol Talk Group.
- Police 1 selects (via a knob like a channel selector) North Patrol and calls for #2.
- Police 1's radio (computer) sends a split second command to the central system computer saying:
  - I am Police 1
  - I am authorized to access the North Patrol talk group
  - I want to talk on the North Patrol talk group
  - Please take a channel (pair of frequencies) from your set of 10 stored channels and set it up to support the following communication between me and everyone else on North Patrol.
- The central computer hears all of this and picks one of the 10 channels in its bank (6) and then:
  - Sends a command out to all radios monitoring the North Patrol Talk Group
  - Tells all those radios to tune to channel # 6 from the 10 channels the system has.
  - Sends a signal back to Car 1 which tells car one it is OK to talk. (\*)
- Car 1 talks and everyone monitoring the North Patrol Talk Group hears Car 1, especially Car 2.
- Car 2 goes to answer, and the whole process is repeated.

*(\*) Car 1 isn't actually told that it is OK to talk. In reality, Car 1 always assumes that it is OK to talk unless the computer tells her radio that no channels are available on which to set up a talk path for that talk group at that instant. In that case, Car 1's radio would beep when she pressed the talk button, with the beep indicating that no talk path is available. This is great, because it means that several users will no longer be permitted to talk at the exact same instant (You'll never again have to say, "Two cars calling, try again!"). Further, no user will think they got through when they didn't actually get through. Another neat side benefit of trunked systems is that (in order to work and be able to identify each user's radio) each radio is assigned its own ID number. This is really just like ANI (Automatic Number Identification) in an E9-1-1 system. It means that every time a radio talks, its ID number can be displayed for the dispatcher and the other receiving radios. That ID number can be listed in a database and can automatically cause for a plain English display to be shown saying not "RADIO 123344", but "CHIEF SMITH" when the Chief talks. This could be the end to those occasionally gross and inappropriate (but unidentified) comments (or other noises) that some*

*of our fine and professional field personnel find it necessary to make now and then. Further, it also creates the ability to establish a "private call" whereby a properly equipped radio (one with a touch tone pad on it like a phone) can "dial up" the radio number of the party she wants to talk to and then establish a private talk path between her and the other party for the duration of that chat. This would seem to be ideal for Supervisors to use to communicate with an errant subordinate or one needing guidance, without risking everyone else hearing the counseling or other advise being given.*

*A final neat benefit of trunked systems is that they are, by definition, much harder to listen to from scanners. In a conventional radio system, if two detectives on a surveillance are saying some really juicy stuff, all on one channel all the time, the scanner buff (or bad guy or "newsie") need only lock in that one channel and (provided they are within range) listen to their heart's content. In a plain (non digital) trunked system, that same buff would have to listen to all 10 channels of our 10 channel trunked system all of the time in hopes of picking up snatches of what the two detectives are saying, because every time they are talking, the computer is assigning them a different one of the 10 channels for their talk path. So, in order to hope to hear them, they'd have to monitor all 10. But, in so doing, they'd have to listen to and wade through all of the other talk going on in the system and, by doing this to pick out our detectives, they'd certainly miss much of what the detectives are saying.*

In trunked system design, the key is to have enough channels (pairs of frequencies) serving the trunked system users (regardless how many talk groups there may be) so that there are very few, if any, occasions where the user's radio beeps to indicate inability to provide a talk path to that user. It is often the case that the number of channels necessary to support a given agency's communications on a trunked system can be as few as 25% or less than they would need for the same level of communications in a conventional, non-trunked environment. The author is aware of a planned large metro wide trunked system which will support 25,000 end user radios which are now using over 300 conventional VHF, UHF and 800 MHz. channels and it will do it with 96 NPSPAC 821 MHz. channels. Further, through this system, every single user will have coverage throughout the entire 2,500 square mile metro region and have the ability to inter-communicate with any other user from any other agency or type of agency. **Now that's INTER-OPERABILITY, folks!**

To sum up trunked radio, the technology came into being as a mechanism for getting better efficiency and utilization out of a very limited number of available radio channels in urban areas. In fact, the FCC now requires that any agency that has more than 5 806 MHz. channels must

implement a trunked radio system, and all NPSPAC channels will likely be used in trunked systems.

 **SPECIAL NOTE AND CAUTION:**

There are several vendors of trunked radio systems. In general, these systems are not inclined to be able to talk to each other in a trunked mode. Each vendor uses proprietary computer protocols (just like an IBM PC trying to work with an Apple MAC PC) so that (for example) a Motorola trunked radio cannot be used in a trunked mode on an Ericsson GE trunked radio system, and vice versa.

Perhaps you have heard of something called **APCO PROJECT 25**. This is a user based standard setting effort which is intended to force the radio manufacturers to make radios that will all work to the same minimum standard of trunking protocols so that a radio from one vendor will, in fact, work on a trunked system from another vendor, in a trunked mode. This is being done for the obvious reason of ensuring greater inter-system inter-operability, but also for the important reason of ensuring that a unit of government that buys Vendor A's trunked system on day one, can gain the advantage of competitive bidding for the end user radios by getting bids from more than one vendor as time goes on.

**PROJECT 25** has been very controversial and a slow process. In early 1996, it is nearing completion and several vendors have agreed to the protocol standards in it. Unfortunately, (as of this writing) one of the major vendors has not agreed to the standards and the battle goes on.