

TRUNKING TECHNOLOGY OVERVIEW

The idea for wireless trunked radio systems came about to address the need for more efficient and *more efficiently managed* voice communications. Radio channels have become a scarce and expensive commodity, and customers were looking to maximize their channel resources as per the directives of the FCC. Customers, particularly public safety customers, had also expressed the need to adhere to a public safety standard and utilize systems that could easily adapt to their changing communications needs.

In response to these needs and requirements, Motorola developed Trunking for three important reasons:

- For more efficiently managed and flexible communications
- To meet the FCC's mandate for spectral efficiency
- To satisfy APCO 25 requirements for public safety communications

In addition, Trunking provides the following three advantages over a conventional system:

- Ease of Use
- Increased privacy
- Better designed for efficient operation during peak usage

Trunking systems are modeled, in concept, on the telephone trunking idea. Through advancements in electronic microcomputer technology, radio systems were able to truly incorporate the advantages of the trunking concept into wireless communications. Thus, trunking systems provide an efficient method for large groups of radio users to share a limited number of RF channels. These features are fully explained in the following section.

BASIC FEATURES

Even with all the advantages trunking has to offer, a Trunking radio is still easy to use. That is because the user only has to press the PTT button on the radio and, if a channel is available, begin speaking. If all the channels are busy, the user just waits for the go-ahead tone and begins speaking. It is that simple. The user does not have to monitor the channel before transmitting. Simple operation is important to ensure that users easily understand and correctly use new technologies. Trunking provides many new advanced system features such as:

- Emergency Call
- Multiple Priority Levels
- Talkgroup Call
- Dispatch Console Talkgroup Merge
- Multi-Group Call
- Dual Mode (Trunked/Conventional) Operation & Conventional Talkaround
- Selective Calling (Call Alert/Private Call)
- Compliance with APCO 25 Requirements

Emergency Call

An emergency call/alarm is initiated from a portable or mobile by depressing a button which is solely devoted to emergency signaling. Once the button is depressed, the mobile or portable transmits a burst of data over the control channel. The dispatcher is immediately notified of the emergency status by an audible alert and visual display of the emergency caller's ID at the console, or by a display of the unit alias on the system management terminal. This sequence will take place even if all voice channels are temporarily busy, thus guaranteeing immediate notification of the emergency situation at the dispatch area, even before a voice transmission takes place.

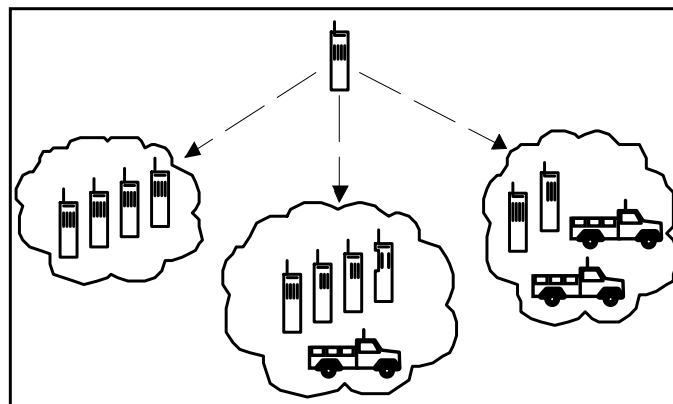
Multiple Priority Levels

In addition to Emergency Call Processing, Trunking systems provide multiple levels of priority to allow faster system access to the most critical users during busy periods. Users are assigned a particular priority level, and in the event of a busy signal, channel requests are processed according to those priority levels.

Talkgroup Call

Trunking places users into groups where only those users assigned to a particular group will be involved in that conversation. In a conventional radio system, everyone can listen to everyone else's conversations. But, when your department does not want other departments to listen, you have to get your own conventional system and restrict other departments from using your frequency. If that is done, coordinated communications are not possible between departments.

In a trunked system, departments are able to form communication groups called "talkgroups." Only those radios that are programmed to use a particular talkgroup can participate or listen to that talkgroup's conversation. Trunked radios are capable of being programmed with multiple talkgroups. This enables a radio user to maintain "partitioned" communications within their departmental talkgroup and still be able



to communicate with other departments by selecting different talkgroups.

Talkgroups. A trunked radio can be programmed with multiple talkgroups.
This allows many groups of users to set up private conversations.

DISPATCH CONSOLE TALKGROUP MERGE

Talkgroup merge is a dispatch function which allows multiple talkgroups to be patched together on one voice channel for the duration of a call, at which time the dispatcher can disengage the merged talkgroups. This function can only be executed by a trunked console and is a standard feature of CENTRACOM series consoles. A major benefit of this feature is channel efficiency, since only one voice resource is used by all the merged talkgroups.

MULTI-GROUP CALL

Multi-group call is used to make a simultaneous call to multiple talkgroups. This feature can operate in one of two ways:

- 1) The user waits for all requested talkgroups to finish their calls.
- 2) When a user initiates a multi-group call, that call immediately interrupts other conversations in progress without waiting for other users to dekey. Those radio users who are transmitting on a voice channel will not hear the call until they dekey. They will then join the call if it is still in progress.

Everyone in a multi-group call is message trunked, which allows all units to have talk back capability.

SELECTIVE CALLING OPTIONS

TRUNKING offers users several types of calling options, described below.

Call Alert

The Call Alert option allows a dispatcher or radio user to selectively alert an individual's radio so they know that someone is trying to reach them. The signaling is done over the control channel and does not affect the efficiency of the voice channels. The Call Alert produces an audible and visual alert on the receiving party's radio. Receipt of the Call Alert is acknowledged by indicators on the initiating caller's radio. If the receiving unit is a display style mobile, it will display and store the calling unit's ID. Also, an optional horn or light activation is available for a user that may be away from a vehicle. This feature can be accessed through properly equipped subscriber units.

To verify system access, simplify radio operation, and limit operator involvement, the TRUNKING System has many advanced access features:

FASTER SYSTEM ACCESS

Access time is defined as the time delay from initiation of a call (PTT) to the point at which a talkgroup call voice path is actually established. Motorola's TRUNKING trunked systems have an access time of less than 500 milliseconds. The only time that the trunked system would exceed the 500-millisecond access time is when all channels in the system are busy.

TALK PROHIBIT TONES

Although trunked systems are considerably more efficient than conventional systems, there occasionally may be times when all the channels are busy. A user depressing the PTT while all the system channels are in use will be given a "telephone type" busy signal until either a channel is assigned the PTT is released.



OUT-OF-RANGE INDICATION

When traveling outside the systems coverage area, the radio can signal the user with an audio and/or visual alert. The TRUNKING trunked radios are programmable to indicate an out-of-range tone whenever the radio cannot immediately access the system because it is out of range or the system is out of service. Similarly, the display (if available) can indicate an out of range condition.

BUSY QUEUING AND CALL BACK

Users requesting system access when all voice channels are in use are placed into a queue and are assigned a channel via pre-assigned priority levels, then on a FIFO (First-In-First-Out) basis. When a channel becomes available, the System Central Controller notifies the first radio in the queue by “calling him back”. This call back consists of a short series of beeping tones heard over the operator's radio. This feature makes it unnecessary for the radio operator to waste valuable time repetitively keying his radio in an effort to gain channel access.

AUTOMATIC RETRY

If a channel request issued by a field unit is not received by the Central Controller because of poor signaling conditions or interference. The individual radio unit retransmits a PTT request until the central controller acknowledges the request, or until a total of 16 automatic retries (which occur within 4 seconds) has exhausted sending channel requests. This "automatic retry" feature eliminates the need for the operator to continually key and dekey his radio or to keep his radio keyed in an effort to gain system access. Once the automatic retry process begins, it will continue to its conclusion automatically even though the operator has released the PTT. As an added feature to ensure system access, the automatic retry timing is at random intervals to eliminate the possibility of contention on the control channel.

RECENT USER PRIORITY

To ensure uninterrupted communications, a recent radio user priority provides those users who have been assigned a voice channel priority over the other system users. Recent user priority ensures that a talkgroup engaged in a conversation receives priority system access for up to 10 seconds between transmissions.

Automatic Unit Registration

When TRUNKING subscriber units are turned on, switched to another talkgroup via their selector switch or button, or with every push to talk, the radios will transmit their individual unit ID to the system controller. This process enables the dispatcher to locate which talkgroup a particular radio has currently selected and to maintain an updated working knowledge of which talkgroup each radio has selected.

Unit ID Display

Push-to-Talk (PTT) unit ID display allows a dispatcher to view the IDs on a CENTRACOM series console. The unit ID's can be made up of alias names for ease of identification by the dispatcher. The dispatcher can view the ID's on the CRT dispatch console or on the system management terminal. The ID's can be displayed in a customer defined alias format.

Dynamic Regrouping

In special situations, individuals from different talkgroups may need to be brought together to communicate. Dynamic Regrouping allows the system supervisor-dispatcher to change the talkgroup

assignment of an individual radio to quickly accommodate changes in communication needs. The dispatcher, or system supervisor, accomplishes regrouping by entering commands that are transmitted over the air on a system management terminal, requiring no action on the part of the field operator.

Secure Conversation Capability

There are many instances where secure communications are of the utmost importance. Encryption is an option that can be added to a TRUNKING system that will provide the highest level of voice security that is commercially available. Encryption can add to a few channels or the entire system. Encryption provides radio system security through a sophisticated coding algorithm and encryption technique that is virtually impossible to break

Selective Radio Inhibit

Selective radio inhibit allows the system supervisor/dispatcher to selectively deny an individual radio (i.e., lost or stolen) access to the trunked radio system through commands sent over the air via a system management terminal. Once inhibited, the radio becomes inoperable until the dispatcher reactivates the radio.

Console Interface

The TRUNKING fixed end can be interfaced to a dispatch console system. These consoles can be designed to virtually any size or configuration depending upon the specific needs. MCC7500 Gold Series® consoles allow monitoring of talkgroup traffic, logging recorder interface and access to advanced features.

Failsoft

In the event that all subsystem controllers at a site are rendered inoperative, an additional level of back up has been incorporated into the TRUNKING system. Under such circumstances, the mobiles/portables automatically revert to pre-assigned failsoft channels (system voice channels) where they are capable of conventional repeater operation.

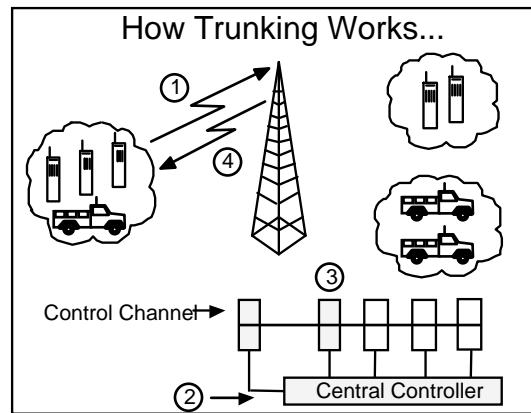
BASIC TRUNKING OPERATION

As stated in the overview, TRUNKING basically consists of a central controller computer and radio repeaters. One of these repeaters is dedicated as a digital control channel and is not available for voice calls. The control channel sends and receives digital information allowing all the radios to be in constant communication with the central controller.

In a typical call sequence, all the radios are already communicating on the control channel with the central controller by sending and receiving digital information. This is how the central controller knows which radios are turned on and which group each user wants to communicate with. This ensures that desired communications are not missed. At this point no one is talking, so all the radios are muted while the digital communication is taking place with the central controller. So far, the user has not taken any action to initiate a conversation.

When a user wants to talk, that person presses the push-to-talk (PTT) button. The radio sends a signal over the control channel into the central controller. The central controller processes the call request and

assigns a repeater for the user to use. The central controller now sends a signal back over the control channel instructing all the radios in that group to switch automatically to the assigned repeaters frequency.



How Trunking Works. When a user initiates a call, the radio sends a signal over the control channel to the central controller (1,2). The central controller assigns a repeater (3) and sends that information back to the caller over the control channel (4). All radios in the caller's group automatically switch to the correct repeater frequency. This process is automatic and takes a fraction of a second to complete.

When the conversation is done, this user group switches back to the control channel frequency and the assigned repeater is freed up for another call.

TRUNKING operates by assigning radio channels to user-groups only during the time a call is actually taking place. When a group is not involved in an active transmission, all users in that group will be monitoring the system control channel. This control channel is a single RF channel that is continually transmitting channel assignment data to all of the system users. The control channel ensures that all users are able to monitor conversations intended for them while providing conversation privacy. TRUNKING's controller and trunking capabilities allow users to access the system efficiently, even during peak usage hours.

BASIC TRUNKING ADVANTAGES

Improved Channel Efficiency

Public Safety users need access to available channels even during periods of heavy system use. A trunking system handles large numbers of users better than a conventional system. This increased efficiency means more radios and departments can use the trunked system and have quicker access to a free channel. Trunking achieves this efficiency because, unlike a conventional system, a radio is not dedicated to a repeater. When a user attempts to access the trunked system, he will not have to wait if a repeater is available. Therefore, all the repeaters are being used at maximum efficiency.

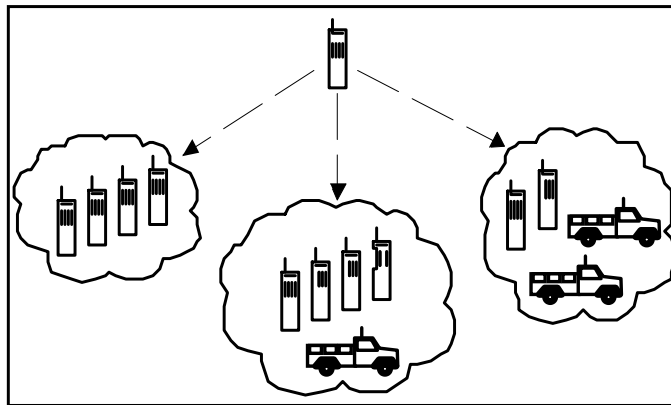
In a crisis or emergency, having access to your communication system becomes even more important. Unfortunately, it is during these situations when the system is heavily used. Because of the inherent efficiency of trunking, more users are able to operate on the system without causing the system to become busy. If the system does become busy, users will access the system in an orderly-prioritized manner instead of continually competing with other users for an available repeater. With TRUNKING, communication is possible when it is needed the most.

User-Friendly Operation

Even with all the advantages trunking has to offer, a trunked radio is still easy to use. The user only has to press the PTT button on the radio and, if a channel is available, begin speaking. If all the channels are busy, the user just waits for the go-ahead tone and then begins speaking. It is that simple. The user does not have to monitor the channel before transmitting. Simple operation is important to ensure that users easily understand and correctly use new technologies.

Private Talkgroup Capability

In a trunked system, departments are able to form communication groups called “talkgroups.” Only those users that are assigned access by the system manager to a particular talkgroup can participate or listen to that talkgroup's conversation. Trunked radios are capable of being programmed with multiple talkgroups. This enables a radio user to maintain “private” communications within their departmental talkgroup and



still be able to communicate with other departments by selecting different talkgroups.

TRUNKING Talkgroups. A trunked radio can be programmed with multiple talkgroups. This allows many groups of users to setup private conversations.

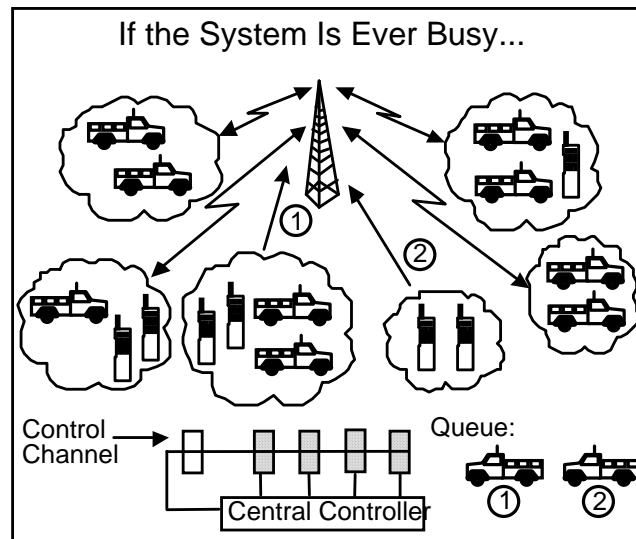
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Orderly Access on a Busy System

On the infrequent instance that a TRUNKING system is busy, your users will not have to continually monitor the channel to determine when a channel is free to use. The central controller can still handle call

requests on the control channel. Each user's call request that occurs while all the channels are busy is placed in a queue and the user is notified by a tone. The queue is organized by first using the user's priority level and then a first-in first-out basis. As soon as one of the voice channels becomes available, the first user in the queue with the highest priority level will be assigned the channel. The central controller will notify that user that a channel has been granted. A short beep will be heard and that user will know to begin speaking.

If multiple users attempt to access a busy system, they too will be placed in the queue to await an available channel. By having a system that incorporates busy queuing and calling back when a channel is



available, your users have an orderly and efficient means of obtaining a channel on a busy system.

Orderly Access. *In the unlikely event of a busy system, users are placed in a queue and TRUNKING grants channel access according to a preprogrammed priority list.*

System Flexibility

To preserve your investment, a TRUNKING system can adapt to the changing needs of your organization. As your organization expands, your system can have additional radios and repeater channels added without affecting any of the existing radios. Therefore, your radios do not require expensive and time-consuming reprogramming. TRUNKING radios even have the capability of adding future features without replacing the existing radios. This is possible with Motorola's Over the air programming OTAP.

Coordination, Management, and Control of System Activity

With a TRUNKING system, your dispatcher and system manager will have greater control over the system than is possible on a conventional system. This is because Motorola has a variety of dispatching products available. To coordinate system activity effectively, a console can become the centralized point of communications. In addition, your dispatcher or system manager can manage system activity and effectively control system use from a centralized location.