LTR (Logic Trunked Radio) FAQs

Contents

1. INTRODUCTION TO TRUNKING

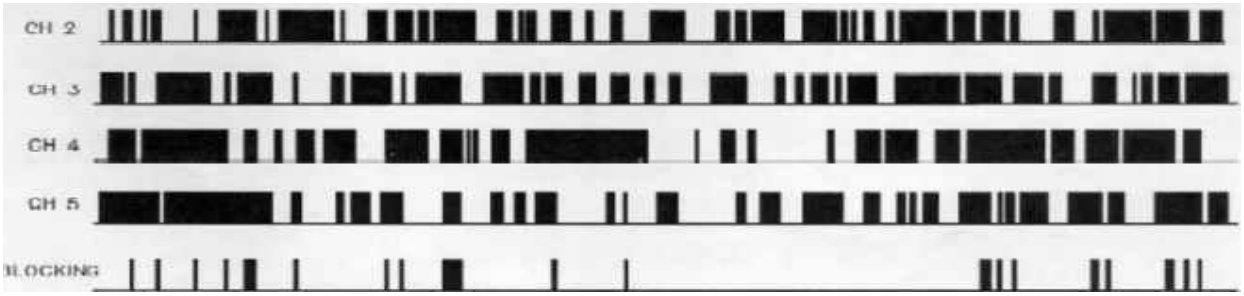
LTR radio systems utilize a control concept called trunking. As it applies to radio, trunking is the automatic sharing of channels in a multiple repeater system. Advantages of trunking include less waiting to access the system and increased channel capacity for a given quality of service. Since the probability of all channels being busy at the same instant is low (especially in larger systems), the chance of being blocked is much less than when only one channel can be accessed.

Trunking concepts are based on the presumption that individual subscribers use the system only a small percentage of the time, and a large number of users do not use the system at the same time. Figure 1 represents typical traffic on a five-channel trunked system. The channels shown are approximately 50% loaded, which means that they are occupied by a carrier 50% of the time. The dark areas in the top 5 lines indicate when the repeater is in use, and the dark areas in the bottom line indicate when all five channels are busy.

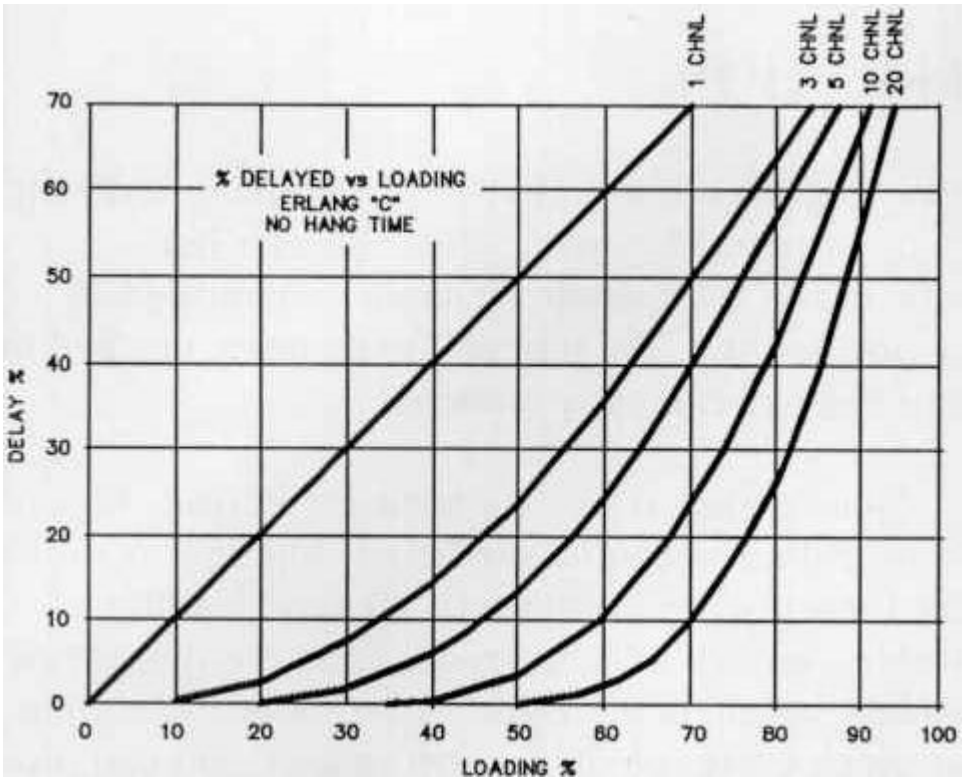
It can be seen from this chart that if the channels are not trunked and only one channel is available to the user (as with a community repeater), there is a much lower chance of obtaining a channel at any instant. However, when the user has automatic access to multiple channels as indicated by the bottom line, the probability of being blocked or denied access is greatly reduced.

Since typical traffic patterns are known, blocking probabilities can be predicted. Figure 2 shows that for a given percentage of airtime loading, blocking probabilities are reduced as the number of trunked repeaters increases. A ten-repeater system has much better blocking performance and can provide a higher quality of service than ten independent channels that are utilized by manual switching means (represented by the "1 CHNL" line. Note that "loading" as referred to here pertains to percentage of available transmission time and not a certain number of mobiles per channel.

A repeater is held for only the duration of the transmission with dispatch calls. This means that an entire conversation consisting of several transmissions may occur on several channels. This is called transmission trunking and it provides maximum system efficiency because the time between transmissions can be used by others. Some special calls, such as telephone calls, hold the repeater for the duration of the call. This is called message trunking.



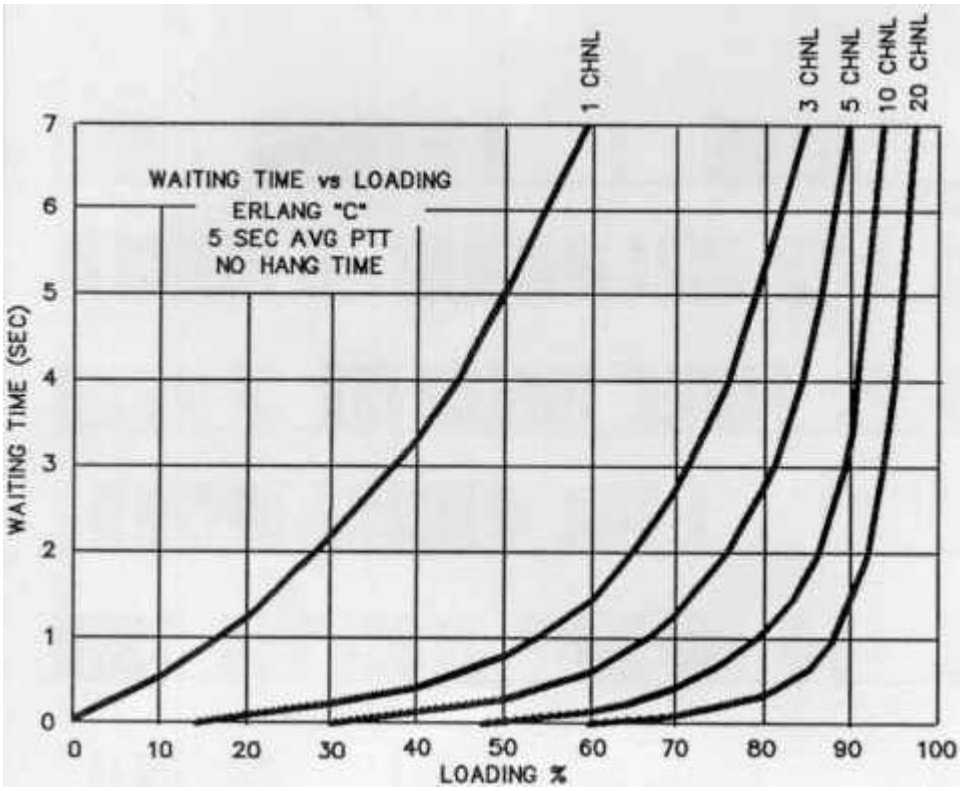
BLOCKING PROBABILITY
Figure 1



PERCENTAGE OF CALLS DELAYED
Figure 2

Trunked systems are also often characterized in terms of delay in gaining channel access. Delay probabilities can be calculated if assumptions are made for average transmission length and statistical distribution of transmission lengths. Statistics gathered by the Stanford Research Institute under FCC contract RC 10056 support 5 seconds as a reasonable transmission length and exponential distribution, access delays can be calculated and plotted as shown in Figure 3. LTR systems can have up to 20 channels (repeaters).

ACCESS DELAY TIMES
Figure 3



2. TRUNKING METHOD COMPARISON

2.1 DISTRIBUTED VERSUS CONTROL CHANNEL CONTROL

There are two different methods currently being used to control trunking systems. One is distributed control used by LTR, and the other is dedicated control channel used by Motorola and some other systems.

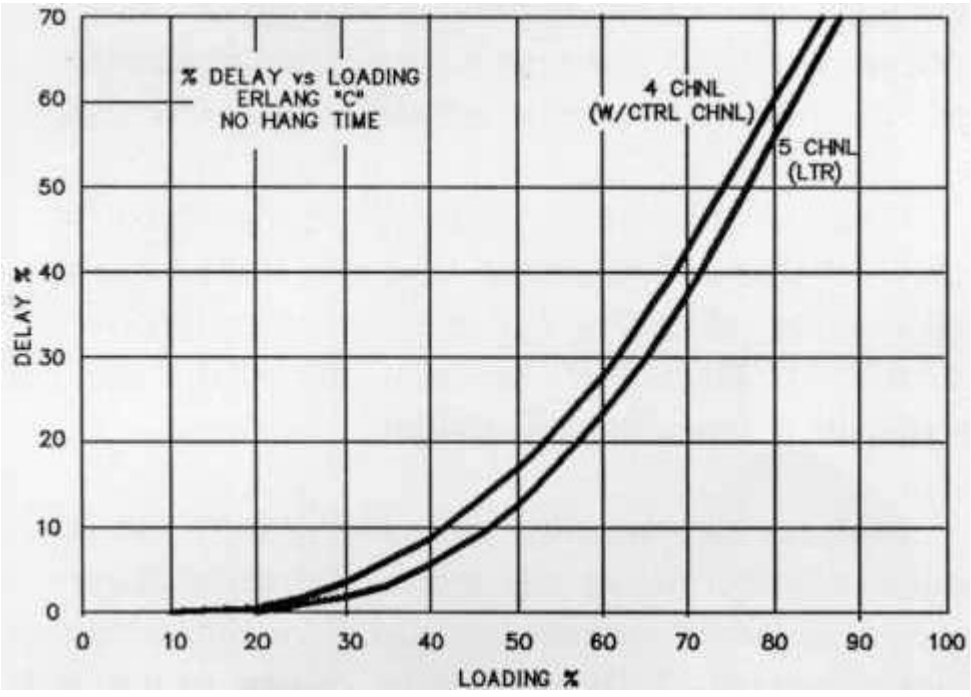
The dedicated method has several disadvantages over the distributed method. One disadvantage may be throughput constraint. When a dedicated control channel is used, all access must be made through the control channel. Therefore, some method must be used to avoid collisions. Most systems use a modified version of slotted (aloha) access control. The characteristics of this system are well documented in other literature. The maximum throughput of slotted access control is approximately 37%. This results in throughput constraint even though the control channel packets are typically short in duration. Other disadvantages are that a control channel system must process all calls in sequential order, and as loading increases and fewer channels are available, accesses rise exponentially and mobiles must compete with each other on only one channel.

One advantage of the distributed method used in LTR systems is that access can be made on any channel that is idle. Each repeater determines which channels are idle and transmits this information in a data stream that coexists with voice information. This means that each repeater maintains its own data stream and handles all accesses on its channel. Collision avoidance is handled by the mobiles. This provides full parallel processing of calls.

Another advantage of the distributed method is that it uses all channels for voice communications. With a control channel system, the control channel typically cannot be used for voice communications. In Figure 4, the blocking rates of five-channel systems are compared to those of a four-channel system (one channel used for control). It can be seen that there is significantly less blocking for the five-channel system. For example, at 57% loading, the five-channel system is delayed (blocked) 20% of the time compared to 25% for the four-channel system.

Once a call is blocked, the waiting time is directly related to the blocking rate and the traffic loading. Therefore, a five-channel (distributed) system also has less waiting time. As shown in Figure 5, the waiting time for the five-channel system with a traffic load of 57% is 0.45 seconds compared to 0.71 seconds for the four-channel system using a control channel.

BLOCKING PERCENTAGE COMPARISON
Figure 4

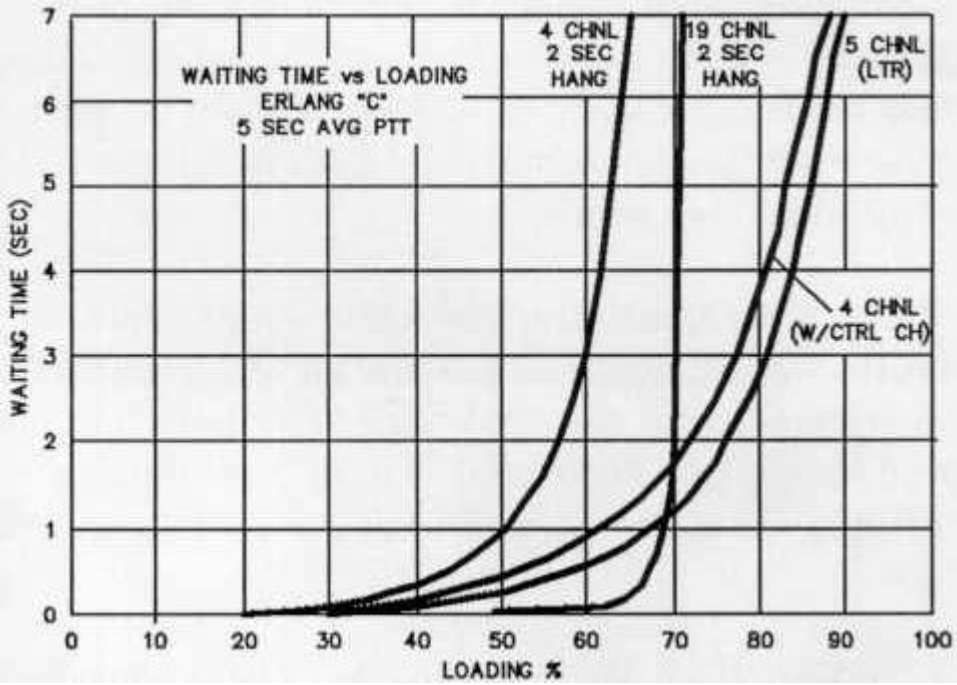


2.2 **HANG TIME**

With LTR radio systems, hang time is not used for dispatch (mobile-to-mobile) calls. A channel is held for only the length of the transmission so that the time between transmissions can be used by others making calls. The only time that hang time is used with LTR trunking is when making telephone calls.

Some other trunking methods do use hang time with dispatch calls during heavy loading periods. This allows a called party to almost always respond to a call without being blocked. However, the disadvantages of hang time usage at the system level are significant because it adds directly to the average transmission time which increases blocking and waiting times for others.

As indicated in Figure 5, the waiting time with a traffic load of 57% for LTR trunking ("5 CHNL" line) is 0.45 seconds compared to 2.1 seconds for the control channel method using 2 seconds of hang time ("4 CHNL, 2 Sec Hang" line). Notice that the waiting time of the 20 channel system using dedicated control channel and 2 second hang time approaches infinity at 70% effective loading. However, Figure 3 shows that an LTR (distributed) system has only about 0.1 seconds waiting time under the same conditions.



DELAY COMPARISON
Figure 5

2.3 ACCESS PRIORITY

Access priority determines who gains access to a busy system. The method used by most systems with a dedicated control channel is to allow all mobiles to attempt access to the system but deny access to lower priority mobiles by not providing a channel to use. This means that lower priority mobiles still busy up the system with their access attempts even though they are not given a channel for voice communications.

With distributed (LTR) systems, no mobiles can even attempt to access the system until a channel is available. The mobile that then acquires the channel is the one that makes the first access attempt. This is a first-come-first-served method of access. All mobiles have equal access priority.

3. MOBILE AND REPEATER DESCRIPTION

3.1 GENERAL MOBILE INFORMATION

The mobile transceivers used in an LTR system must be programmed for LTR signaling and also be of the correct frequency range (800 or 900 MHz).

Operation of an LTR transceiver is even simpler than with conventional operation. The reason is that many functions normally performed by the user are performed by the control logic such as channel selection and monitoring before transmitting. All the user has to do to make a call is select the desired system (and group if applicable) and press the push-to-talk switch. If a busy signal or out-of-range condition is not indicated by special tones or warning messages in some displays, the path is complete and speaking can begin.

The basic transceiver controls include power on-off, volume control and system select. Most transceivers also have a group select switch. There is no squelch control because the squelch is internally preset.

3.2 GENERAL REPEATER INFORMATION

Repeaters operate on a single frequency, so one repeater is required for each channel. A controller card in each repeater performs all control and signaling functions on that channel. Information is exchanged between repeaters via a high-speed data bus. A separate system controller is not required. Optional accessories such as Telephone Interconnect Card and ID Validator may be used.

3.3 HOME REPEATERS

All mobiles have one of the site repeaters assigned as its "home" repeater. This is the repeater from which it receives most of its control information. When a mobile is not placing or receiving a call, it is always monitoring its home repeater to determine which channel is free and if it is being called by another mobile.

The home repeater is always used to make a call unless it is busy. If the home repeater is busy, any other repeater in the site may be used. Up to 250 ID codes are assigned to each repeater. An ID code and home repeater number are the "address" of mobiles in the system. Therefore, up to 1250 separate addresses can be assigned in a five-repeater system and up to 5000 can be assigned in a twenty-repeater system. An ID code may be assigned to an individual mobile or group of mobiles as required.

4. MOBILE-REPEATER DATA SIGNALING

4.1 GENERAL

System control is accomplished by the exchange of data messages between the mobile and repeater. This data signaling occurs continuously with voice at the subaudible frequency of 150 Hz. This eliminates the need for a dedicated control channel and all channels can be used for voice communications for maximum system efficiency. If a repeater should fail, the rest of the repeaters remain operational.

Constant update messages are transmitted by repeaters that are in use so that if a transceiver is just coming into service, a message in progress is not missed. These messages also inform the mobiles as to which repeater is available.

Mobiles can transmit and receive only the ID codes programmed by the system operator. Therefore, other users cannot eavesdrop on the conversations of others. Although traffic can be monitored by a non-LTR transceiver, even that may be difficult because a complete conversation may occur on several channels as described in section 4.3.

4.2 DATA HANDSHAKE

When a mobile makes a call, a data "handshake" occurs with the repeater. The mobile transmits a service request to the repeater and when the repeater detects that message, it transmits a message back to the mobile that tells the mobile that it has successfully accessed the system. The total time that is required to complete the handshake is less than 0.03 seconds. Other advantages of this handshake are that it insures that the handshake is not occurring on the wrong channel because of intermodulation, and it prevents a mobile with a stronger signal from capturing a channel already in use.

4.3 TRANSMISSION TRUNKING

With standard mobile-to-mobile calls, a repeater is held for only the duration of a transmission. This type of trunking is called transmission trunking. With RIC (Interconnect) calls, the repeater is held for the duration of the call so that a call is not interrupted. Transmission trunking provides maximum system efficiency because others can use the time between transmissions. Refer to section 2.2 for more information on this type of trunking.

4.4 DATA MESSAGE FORMAT

Data messages are continuously transmitted to the repeater by the calling mobile while a conversation is in progress. The repeater is also continuously transmitting messages to the called mobile and al other mobiles monitoring that channel. The specific information contained in the data messages depends on whether it is repeater or mobile transmitted. The width of each data bit is 3.33 milliseconds and the data rate is 300 bits per second. A complete data message is transmitted in about 130 milliseconds.

The information contained in the various data messages is shown in Figure 6. The information that follows describes the various parts of these messages.

SYNC = The first two bits of a data message initialize the receive data circuitry. The other sync bits are used to detect the arrival of the data message and establish bit synchronization.

AREA = With mobile transmitted messages, this is the area programmed into the mobile; with repeater transmitted messages, it s the area programmed by the programming switch in the logic drawer. If the area of the transmitted message does not agree with the programmed area, the message is ignored and the call attempt is unsuccessful. This bit is usually coded "0" unless there are two LTR systems close enough to interfere with each other. It is then coded "0" in one system and "1" in the other.

Mobile-to-Repeater Data Message

Sync	Area	Repeater In use	Home Repeater of Called Unit	ID code of called unit	Pass Character	Error Check bits

Mobile-to-Repeater Data Message (Repeater Busy)

Sync	Area	Go-To Repeater for called unit	Home Repeater of Called Unit	ID Code of Called Unit	Free Repeater	Error Check bits

Mobile-to-Repeater Data Message (Repeater Idle)

Sync	Area	Repeater Number	Repeater Number	255	Repeater Number	Error Check bits

DATA MESSAGE FORMAT

Figure 6

IN USE or GO-TO-REPEATER- In a mobile to repeater data message, this slot contains the number of the repeater to which the message is being transmitted. If these bits are not the same as the number assigned to the repeater, the message is appearing on the wrong channel because of intermodulation and is ignored.

When the PTT switch is released, the transmitter remains on for a short time and the turn-off code (31) is sent in this slot. The code is retransmitted by the repeater and when it is detected by the receiving mobiles, they squelch and resume monitoring the home channel. This prevents a "squelch tail" (noise burst) when the transmitting mobile unkeys.

With repeater-to-mobile messages, the specific information in this slot depends on whether or not the repeater is busy. If it is busy, separate messages are transmitted to the mobile using the repeater and also to other mobiles that may be trunked out to other repeaters. In the message to the mobile using the channel, this slot contains the repeater number. In messages to mobiles trunked out to other repeaters, it contains the repeater to switch to in order to receive the call. If the repeater is not busy, a message is transmitted every 10 seconds to keep the mobiles updated and this slot contains the number of the repeater.

HOME REPEATER = In a repeater-to-mobile data message, this slot contains the home repeater number of the mobile being called. This is always the home repeater number programmed into the selected system of the mobile making the call.

In a repeater-to-mobile data message, this slot contains the same repeater number received in the data message from the mobile. If the repeater is not busy, it transmits its number in this slot.

ID CODE = In a mobile too repeater data message, this slot contains the ID code (1-250) of the mobile or group of mobiles being called. In a repeater to mobile data message, this is the ID code of the mobile or group of mobiles being called on that channel.

If other mobiles assigned to that repeater have been trunked to other repeaters to receive a call, additional messages are transmitted containing the ID codes of these mobiles. The repeater gets this information from the repeater data bus. The GO-TO information described earlier tells these mobiles which repeater to switch to.

FREE CHANNEL = In a mobile to repeater data message, this slot contains (31) which is a pass code. In a repeater to mobile data message, this slot contains the number of a repeater that is not busy and available for service. This tells mobiles assigned to that repeater which repeater to use to make the call. The free repeater is chosen in a random manner as described in section 5.3. If a repeater is not busy, this slot contains its number. If all repeaters are busy, this slot contains "0".

ERROR CHECK BITS = These bits are used to check for errors in a data message. If an error is detected, the message is ignored.

5. REPEATER BUS SIGNALING

5.1 GENERAL

A single line serial bus interconnects Main Controller Cards of all LTR repeaters at the site. There are 21 time slots on the data bas with 1-20 used for repeater reporting and 21 used by the ID Validator (see section 5.4). The time slot used by a repeater is determined by the number assigned to that repeater by programming. Repeater 1 uses time slot 1; repeater 5 uses time slot 5 and so on. The data rate on the repeater data bus is 18,750 bits per second.

In its time slot, each repeater places information on the bus indicating its status. If a repeater is not busy, only start bits appear in its slot. If a repeater is busy, it places in its slot the home repeater and ID code of

the mobile receiving the call on that repeater. If a repeater number is unassigned, nothing appears in that time slot.

5.2 MOBILE DATA MESSAGE ORDER

Each repeater monitors all the time slots on the repeater data bus. If it detects its number in another time slot, it begins transmitting an additional data message to its mobiles. This message tells mobiles programmed to detect that ID code to go to that repeater to receive a call. This additional message continues for as long as the mobile is transmitting on the other repeater.

The sequence of data messages transmitted on a home repeater is as follows: Every third message is to the mobile currently receiving a call on that repeater. Then alternating between these messages are messages to its mobiles that have been trunked to other repeaters. For example, assume that five different mobiles on a five-repeater system are making calls. If all have repeater 1 as their home channel (not very likely in actual practice), the data message on repeater 1 is as follows: 123145123 and so on.

5.3 FREE REPEATER DETERMINATION

Each home repeater determines which repeater is free by monitoring the information in the twenty time slots. Each slot is monitored in order and if a slot contains only start bits, that repeater is detected as idle. If information in a slot indicates no repeater or a busy repeater, the free repeater does not change and is the last repeater detected as idle. The free repeater transmitted in a data message is then the free repeater being detected at the instant the message is composed. For example, assume a five-repeater system with repeaters assigned 1,5,9,13 and 17. If repeaters 5 and 13 are busy, the free repeater changes as follows as the twenty time slots are monitored:

1 1 1 1 1 1 1 1 9 9 9 9 9 9 9 9 17 17 17 17

It can be seen with this scheme that when less than twenty repeaters are used, the numbers should be assigned so that the gaps between numbers are as equal as possible. For example, if five repeaters were numbered 1-5, the last repeater detected as idle would be the idle repeater for time slots 6-20.

5.4 ID VALIDATOR OPERATION

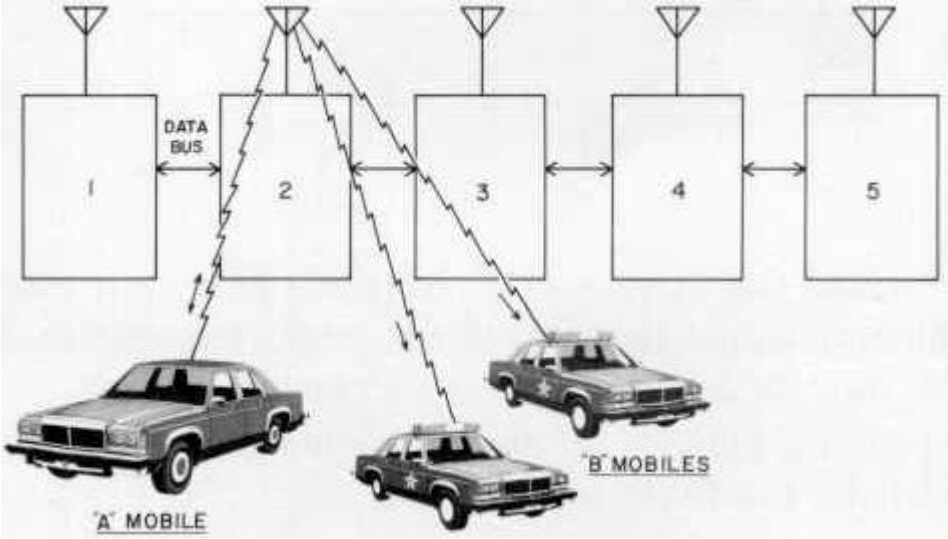
If the ID Validator is used, it is programmed with the status of up to all 5000 home repeater/ID code combinations possible with a twenty-channel system. Each combination is programmed as either valid or invalid. Information in the twenty time slots on the repeater data bus is monitored. If an invalid home repeater/ID code combination is detected, the ID Validator places in time slot 21 the number of the repeater being used by the invalid mobile and also the ID code. When a repeater detects its number in slot 21, it transmits the turn off code (31) to the mobile receiving the call. That mobile then squelches and resumes monitoring its home channel. This effectively disables the invalid mobile because it cannot talk to anyone. When the turn off code is sent, the repeater places "21" in the repeater position of its time slot to indicate to the ID Validator that turn-off has occurred.

6. SYSTEM ACQUISITION EXAMPLE

6.1 INTRODUCTION

When a mobile is turned on but not in use, it is always monitoring the data messages from its home repeater. It checks these messages to determine if it is being called by another mobile and also which repeater is free if a call is to be placed. If the PTT switch is pressed, the transceiver switches to the repeater appearing in the FREE slot and transmits a data message. The FREE repeater is always the home repeater unless it is busy. The following information describes the information contained in the data messages transmitted when a call is made.

CALL WITH HOME REPEATER FREE
Figure 7



6.2 MAKING A CALL WHEN HOME REPEATER IS FREE

Assume that mobile "A" is calling "B" mobiles which are programmed to decode ID code 212 (see figure 7). The home repeater of all these mobiles is 2 and the area bit is 0. This call proceeds as follows:

Repeater 2, which is not busy, has been transmitting the following message every 10 seconds:

Go To Home ID Free

Area Repeater Repeater Code Repeater

Sync	0	2	2	255	2	Check Bits

The "A" mobile receives and decodes this message and checks the FREE REPEATER bits to determine which repeater is available. When the PTT switch of the "A" mobile is pressed, it transmits the following data message:

Repeater Home ID Pass

Area In Use Repeater Code Character

Sync	0	2	2	212	31	Check Bits

After the message is transmitted, the logic of the "A" mobile turns off the transmitter and waits for a response from the repeater. Repeater 2 checks AREA and REPEATER IN USE bits to make sure the mobile is from the correct LTR system and transmitting on the correct channel. Repeater then places the following information in slot 2 on the repeater data bus:

				2	212	

TIME SLOT TIME SLOT

Until this time, slot 2 contained only start bits, which indicated that it was not busy. The information in slot 2 tells the other repeaters that Repeater 2 is busy. At the same time, Repeater 2 transmits the following data message:

Go To Home ID

Area Repeater Repeater Code Repeater

Sync	0	2	2	212	3	Check Bits

When the "A" mobile receives this message, it compares the AREA, HOME REPEATER and ID CODE bits to those transmitted and checks if the GO TO repeater number is the same as the channel it is on. If this data is correct, the transmitter is enabled and the handshake is complete.

When the "B" mobiles decode this message, the AREA, HOME REPEATER and ID CODE bits are checked. Since the ID code corresponds to the programmed decode ID code; the logic unsquelches the receiver. It remains on the same channel because the GO TO bits indicate Repeater 2. This completes the RF path between the "A" mobile and the "B" mobiles.

All mobiles with Repeater 2 as a home repeater also decode the preceding data message, which is transmitted continuously when the repeater is busy. If a mobile "B" just now comes into service, it immediately unsquelches and receives the message. Other mobiles with repeater 2 as a home channel monitor the data message and use the repeater in the FREE REPEATER slot if they make a call.

The free repeater number appearing in a repeater to mobile data message (of a busy repeater) is chosen randomly as described in section 5.3. For this example, Repeater 3 is the free repeater. When the "A" mobile finishes the transmission, the PTT switch is released and the following data message is sent before the transmitter turns off:

Repeater Home ID Pass

Area In Use Repeater Code Character

Sync	0	31	2	212	31	Check Bits

The "A" mobile then resumes monitoring Repeater 2. When Repeater 2 sees the turn-off code (31) in the REPEATER IN USE slot, it disables the transmit audio signal and removes the home repeater/ID code information from its slot on the repeater data bus. This informs the other repeaters that it is no longer busy. Repeater 2 also transmits the following data message:

Go To Home ID Free

Area Repeater Repeater Code Repeater

Sync	0	31	2	212	2	Check Bits

After transmitting this message, Repeater 2 resumes transmitting the idle data message shown at the beginning of this example every 10 seconds. When the "B" mobiles decode the turn-off code in the GO TO REPEATER slot, they squelch and resume monitoring Repeater 2.

Note: Since the repeater is released after each transmission, this sequence of events is repeated from the beginning when one of the """ mobiles responds to this call (see section 4.3).

6.3 MAKING A CALL WHEN HOME REPEATER IS BUSY

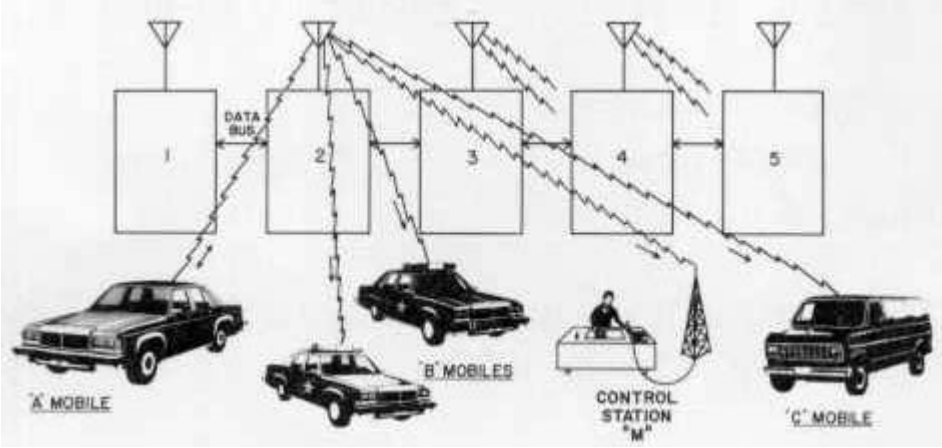
Assume Control Station "M" wants to call Mobile "C" while the call described in the preceding section is in progress. Figure 8 shows the system before the control station trunks to another repeater and Figure 9 shows the system after it trunks to another repeater. This is a five-channel system and repeaters 3 and 4 are busy with other traffic. Mobile "C" can decode ID code 91 and all mobiles have repeater 2 as their home repeater.

Control Station "M" receives the following message being continuously transmitted by Repeater 2:

Go To Home ID Free

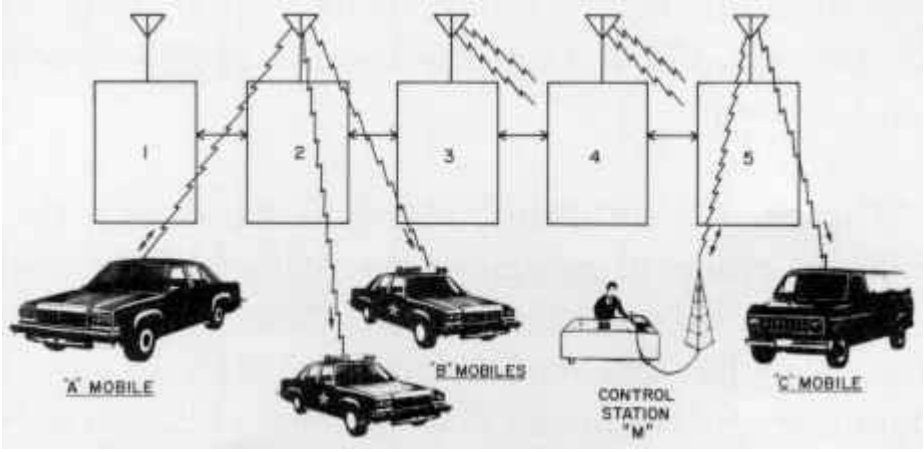
Area Repeater Repeater Code Repeater

Sync	0	2	2	212	5	Check Bits



SYSTEM BEFORE TRUNKING
Figure 8

SYSTEM AFTER TRUNKING
Figure 9



Since repeaters 3 and 4 are busy, the FREE REPEATER slot contains repeater 5, which is chosen at random between repeaters 1 and 5. If all repeaters were busy, the FREE REPEATER slot would be "0". Control Station "M" decodes this message and knows that its home repeater is busy and an available repeater is 5. When the PTT is pressed, it switches to repeater 5 and transmits the following data message:

Repeater Home ID Pass

Area In Use Repeater Code Character

Sync	0	5	2	91	31	Check Bits

After this message is transmitted, the transmitter turns off and waits for a response to begin (normally a few milliseconds). The repeater logic checks the message to make sure that the area and channel are correct as described in the preceding section and then places the following information in time slot 5:

		2	212	3	21	4	242	2	91

TIME SLOT TIME SLOT TIME SLOT TIME SLOT TIME SLOT

1 2 3 4 5

Repeater 5 also begins transmitting the following data message continuously. This message tells all its mobiles that it is busy and Repeater 1 is an available repeater.

Go To Home ID Free

Area Repeater Repeater Code Repeater

Sync	0	5	2	91	1	Check Bits

Control Station "M" also decodes this message; the transmitter turns on again because the AREA, HOME REPEATER and ID CODE information agrees with what it transmitted. When Repeater 2 sees its number in time slot 5, it begins to transmit an additional data message. The two data messages it is transmitting are as follows:

Go To Home ID Free

Area Repeater Repeater Code Repeater

Sync	0	2	2	212	1	Check Bits

Go To Home ID Free

Area Repeater Repeater Code Repeater

Sync	1	5	2	91	1	Check Bits

The first message continuously updates Repeater 2 mobiles as to which repeater is free and if any other mobiles come on line that decode ID code 212, they immediately receive the message. The second message also provides updates as to which repeater is free. Since the "C" mobile is programmed to decode ID 91, it looks at the GO TO slot, switches to repeater 5, and receives the message. This completes the RF path between Control Station "M" and mobile "C".

6.4 ATTEMPTING A CALL WHEN ALL REPEATERS ARE BUSY

When all repeaters are busy, the FREE REPEATER slot of the repeater-to-mobile data message contains 0. If a call is attempt is then made, the transmitter does not turn on when the PTT is pressed. This busy condition is indicated to the user by a busy tone. This tone continues sounding until a repeater is available or the PTT switch is released. (If the PTT switch is held down, the call proceeds when a repeater is available).

All LTR Transceivers have a Proceed (Clear-to-talk) feature that can be enabled. This feature sounds a short tone when the repeater has been successfully accessed. Refer to section 7.6 for more information.

6.5 ATTEMPTING A CALL WHEN OUT-OF-RANGE

When a mobile is out of range of the repeater system, it is usually the repeater that cannot decode the data message from the mobile. When this occurs, no response is made to the mobile message, so the mobile makes repeated attempts to get a response. After several attempts are made and no response is received, the intercept tone sounds (alternating high and low tones) and no more attempts are made. The PTT switch must then be released and pressed again to make more attempts.

7. LTR OPERATING FEATURES

7.1 SELECTABLE SYSTEMS AND GROUPS

A transceiver can be programmed with ten or more systems, depending on model. Each selectable system can be programmed with a unique set of operating parameters including LTR (trunked) or sometimes conventional (non-trunked) operation.

When a selectable system is programmed for LTR operation, system parameters may include home repeater, all encode and decode ID codes, call indicator and horn alert operation. The ID codes can be fixed, selectable and block types as follows. Any combination of codes can be programmed and all codes can be different.

Decode (Receive) Encode (Transmit)

2 fixed priority ----------

10 Selectable 10 Selectable

Block of up to 250 ----------

Note: *Selectable ID codes are available only if the transceiver* has a group select switch

Groups

If the transceiver has a group select switch, each group switch position selects one of the selectable decode and encode codes. If the transceiver does not have a group select switch, only one selectable decode and encode code is programmable in each system.

The encode (transmit) ID code determines the mobile or group of mobiles being called. Only one ID code can be transmitted. The decode codes determine what calls can be received. Group scan programming determines if all or only the selected group ID is detected. With group scanning, all are detected; without group scanning, only the selected ID is detected (see section 7.5)

The fixed and block decode codes are always decoded regardless of which group is selected or group scan programming (as long as the system is selected or scanned). Generally, when a fixed priority ID code is detected (see next section), the selectable groups are checked to see if any are programmed with the priority ID code. If one is the same, the display changes to that group. Otherwise, the display does not change. Programming a block of codes allows a group of contiguous codes to be decoded, for example, 204-219. The display does not change when a block ID code is decoded.

7.2 RECEIVE PRIORITY ID CODES

With standard mobile-to-mobile calls, the fixed, selectable and blocked ID decode codes have a priority order so that an incoming call with a higher priority ID code can interrupt a lower priority call in progress. One use of receive priority is to allow a dispatcher to interrupt calls in progress with an important "all call" message. If the transceiver detects a call with a higher priority ID than the one it is receiving, it immediately drops that call and switches to another repeater to receive the higher priority call. Telephone calls are not interrupted by higher priority calls.

The priority order of the decode ID codes is as follows:

Fixed ID Code 1

Fixed ID code 2

Selected ID code

Other selectable ID codes (with group scan)

Block ID codes

For example, if a call is being received on selectable group 4 and a call is detected on priority ID 2, the call on group 4 is immediately dropped and the transceiver switches to the call on priority ID2.

Since incoming call information is received only while monitoring the home repeater, priority calls are not detected when trunked out to some other repeater or while transmitting. To reach trunked out mobiles in this case, the priority caller can press the PTT and then not start talking for a few seconds. This should allow trunked out mobiles to return to their home repeater and detect the call. However, this may not reach mobiles making telephone calls because with those calls, the repeater is held for the duration of the call (see section 4.3).

7.3 RIC REPEATER INTERCONNECT ID CODES

If the transceiver is to be used to place and receive LTR Telephone calls, it can be programmed with a block of RIC ID codes. This block may include up to all 250 ID codes assignable on a home repeater. When an ID code within the block is decoded or selected to be transmitted, the transceiver goes into the RIC operating mode.

7.4 SYSTEM SCAN

General

The system scan feature is standard with most LTR transceivers. When scanning is enabled, all programmed systems are scanned in sequence. When a call is detected (that the transceiver is programmed to receive), scanning stops and the call is received. Shortly after the call is completed, scanning resumes. If both LTR and conventional systems are programmed, both are scanned. Some LTR transceivers have a user-programmable scan list. The user can then select which systems are to be scanned.

System Scan Rate

When system scanning, the home repeater of a system is monitored for only 60 ms if no carrier is detected. If a carrier is detected, the method of monitoring varies with the model of transceiver. With some transceivers, the home repeater is monitored only as long as necessary to detect any call that it is programmed to receive. With other transceivers, the home repeater is monitored for three data messages or approximately 400 ms.

Since some messages could then be missed if the system is very busy, these transceivers can be programmed so that the revert (selected) system is scanned longer. The scan time can be increased in multiples of three data messages up to eight using the scan weighting parameter. For example, if 2 is programmed, the scan time is 2 X 3 or 6 data messages. More information on data messages is located in section 5.2. In the example in that section, the maximum number of messages before repeating is six. Therefore, programming 2 in that case would ensure that no messages are missed. If information in the data messages indicates that no mobiles are being trunked out to other repeaters, only two data messages are monitored even if additional scan time is programmed.

7.5 GROUP SCAN

If a system has more than one selectable group, group scanning can be programmed. Calls are then detected on all selectable groups. Within group scanning, calls are detected on only the selected group. There is no separate switch that allows the user to turn group scan on and off. If it is programmed, it is enabled whenever the system is selected. (The microphone must be on-hook if applicable).

7.6 PROCEED (CLEAR-TO-TALK) TONE

This feature sounds a short tone when the PTT switch is pressed to indicate when speaking can begin. This tone sounds when the radio system has been successfully accessed (handshake completed). If it is busy when the PTT is pressed, the busy tone sounds. If an out of range or other error condition occurs when the PTT is pressed, the intercept tone is sounded. With most transceivers, the proceed tone can be enabled or disabled by the user. With others, it is controlled by programming.

7.7 TRANSMIT INHIBIT

The transmit inhibit feature prevents the transmitter from being keyed if an ID code in the transmit inhibit block has been detected within 5 seconds of when the PTT switch is pressed. The transmit inhibit block of ID codes can include up to all 250 codes programmable on a repeater. When the transmitter is disabled by this feature, the intercept tone also sounds. The PTT switch must be released to make another attempt.

This feature can be used to prevent interruption of a call in progress. This could happen when the other transmitting party unkeys, or if an ID code with a higher priority is transmitted by your transceiver. Another use of this feature is to provide an audible indication that the party being called is busy with another call. All LTR transceivers can be programmed with this feature.

7.8 FREE SYSTEM RINGBACK

If a radio system is busy when placing a telephone call, this feature can be selected to automatically signal the user when the system becomes available. If the busy tone sounds when the PTT is pressed, this feature is selected automatically or it is selected by pressing a button. A beep sounds when the PTT switch is released to confirm that Free System Ringback is selected. Then when the system becomes available, a "ringing" tone sounds. The call can then be placed if desired. This feature is available on most LTR transceivers. It does not function on mobile-to-mobile calls.

7.9 BUSY QUEUING

This feature replaces the Free System Ringback in some radios. It places telephone calls in a queue if the radio system is bust when the call is placed. Then when the system becomes available, the call is automatically placed. Dispatch (mobile-to-mobile) calls are not queued by this feature.

When busy queuing has been programmed, the queuing mode is entered automatically when the bust tone stops sounding or the PTT switch is released (if it is used). This queue mode is indicated by "In Queue" in the display. Then when the radio system becomes available, the radio waits a random time before attempting access. This random delay prevents all transceivers in queue from attempting access at the same time. If an attempt is unsuccessful, another is made after another random delay. When the access is successful, a beep and landside ringing is heard.

Calls are being received normally while in queue mode and group scanning continues if programmed. However, system scanning is disabled so that calls are not received on other selectable systems.

7.10 SYSTEM SEARCH

This feature automatically searches for other systems if the selected system cannot be accessed because of an out of range condition or other reasons. If the intercept tone sounds shortly after the PTT switch is pressed (procedures for selection differ from radio to radio) and then a beep sounds when the PTT is released to confirm that it is selected.

Only systems with a last-selected group programmed for telephone calls are accessed. As each system is accessed, a beep sounds and the system number is displayed. If a system is successfully accessed, the number of that system is displayed and the call can be placed. If none could be accessed, the intercept tone sounds. Only one access attempt is made on each system. This feature does not function on standard mobile-to-mobile calls, and is not available with some LTR transceivers.

7.11 TRANSPOND

The transpond feature provides an indication to the person making the call that the mobile being called is in service. Each of the selectable ID codes can be programmed for this feature. If the ID code on which a call is received is programmed for transpond, the transceiver will wait until the calling mobile unkeys. It then automatically transmits two data messages with the second containing the turn-off code. This causes the calling mobile to briefly unsquelch. If that transceiver is equipped with a call indicator programmed to turn on when that ID code is detected (see next section), that indicator also turns on. This feature is not available with some LTR transceivers.

7.12 CALL INDICATOR

The purpose of the call indicator is to show when a call was received while the user was away from the transceiver or vehicle. The call indicator can be programmed to turn on only when calls are received on specified ID codes. Each of the selectable and fixed priority ID codes can be programmed for a call indicator. This indicator can also be programmed to turn on when calls are received on conventional channels.

7.13 HORN ALERT

The horn alert feature sounds the vehicle's horn or some other type of alert when a call is received. This feature can be programmed like the call indicator to turn on when certain calls are received. When the proper call is received, the alert sounds once per second for 3 seconds and then goes back to he disabled state. This feature is available with most LTR mobile transceivers.

7.14 TIME-OUT TIMER

The time-out timer automatically disables the transmitter if it is keyed continuously for longer than the programmed time. A warning tone sounds when the transmitter is disabled by this feature. The timer is reset by releasing the PTT switch. One use of this feature is to prevent possible transmitter damage caused by transmitting for extended periods. Another use is to prevent channels from being blocked by accidentally keyed transmitters.

8. GLOSSARY

DEFINITIONS OF LTR TERMS

All Call – An ID code that is programmed to be decoded by all users in a group. This allows a dispatcher, for example, to communicate with all users in a group at once.

Code Block – A group of consecutive ID codes that can be any size up to all 250.

Conventional Operation – This type of radio system operates on only a single channel. Trunking is not used and the radio channel is selected manually

Dispatch Calls – Standard mobile-to-mobile or mobile-to-base calls that do not use the Public Switch Telephone Network (PSTN).

Fixed ID Codes – Receive ID codes that are always decoded by the transceiver regardless of the group selected by the group select switch.

Group Call – A call to a group of mobiles.

Group Select Switch – This switch allows up to ten different ID codes per system to be selected for transmitting and receiving.

Home Repeater – All LTR mobile transceivers have one of the site repeaters assigned as their "Home" repeater. This repeater is monitored to receive calls and also for the information needed to place calls such as which repeaters are free. In addition, the home repeater/ID code number identifies the mobile or group of mobiles being called. Each selectable LTR system can be programmed with a different home repeater.

Interconnect – This is a telephone interface between a repeater or control station and the Public Switched Telephone Network (PSTN). This allows telephone calls to be placed and received from a mobile transceiver.

Logic Trunked Radio – Logic Trunked Radio (LTR) systems utilize a concept called trunking. This method of channel management gives all users of the system automatic access to all channels. This results in minimum waiting to make a call and the most efficient use of the available channels. Trunking is controlled by logic circuitry in the mobile transceivers and the repeaters. This circuitry continually monitors the system and generates data messages which update the mobiles and repeaters as to which repeaters are free.

Mobile – This term refers to a transceiver mounted in a vehicle but can also be applied to other types of transceivers such as handhelds and control stations because they all operate basically the same. A control station is basically a mobile transceiver at a stationary location such as an office site.

Selectable System – This normally applies to the systems selectable by the transceiver system select switch. Each system can be programmed with almost an entirely different set of transceiver operating parameters including home repeater, receive and transmit ID codes, and repeater channel numbers. Systems can either be the LTR (trunked) format or (sometimes) conventional (non-trunked) type.

Selective Call – The ability to selectively call individual mobiles or control stations. The system or group select switch can be programmed to perform this function.

Site – A group of repeaters that are connected to the same high-speed data bus. Up to 20 LTR repeaters can be connected together in this way.