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## What is a repeater.....

and why should you care? In terms of radio telephone communications, a repeater can be a very important part of the efficient operation of your system and for that reason we have prepared this information to help you better understand what a *repeater* is and what it does.

There are seven basic types of repeaters:

- 1) Mobile in band UHF repeaters
- 2) Mobile VHF/UHF cross band repeaters
- 3) Single site duplex base station repeaters
- 4) Multi-site base station repeaters
- 5) Single site bypass repeaters
- 6) Satellite receiver voting systems
- 7) Trunking VHF or UHF real time repeaters

If you are planning to upgrade an existing radio system or planning a new system, we think it would be to your benefit to review the current alternatives and select the one that is right for your individual needs.

Regardless of your choice, there are three primary recommendations that would apply for most users. They are:

- 1) Purchase only equipment capable of both 12.5 and 25 KHz operation
- 2) If you are considering paging, limit your selections to VHF or UHF
- 3) Choose LTR trunking compatible equipment whenever possible.

The information contained herein is not meant to be used for budgetary purposes. When you are ready for an price quotation on the system and equipment of your choice, just let us know. We'll take it from there!

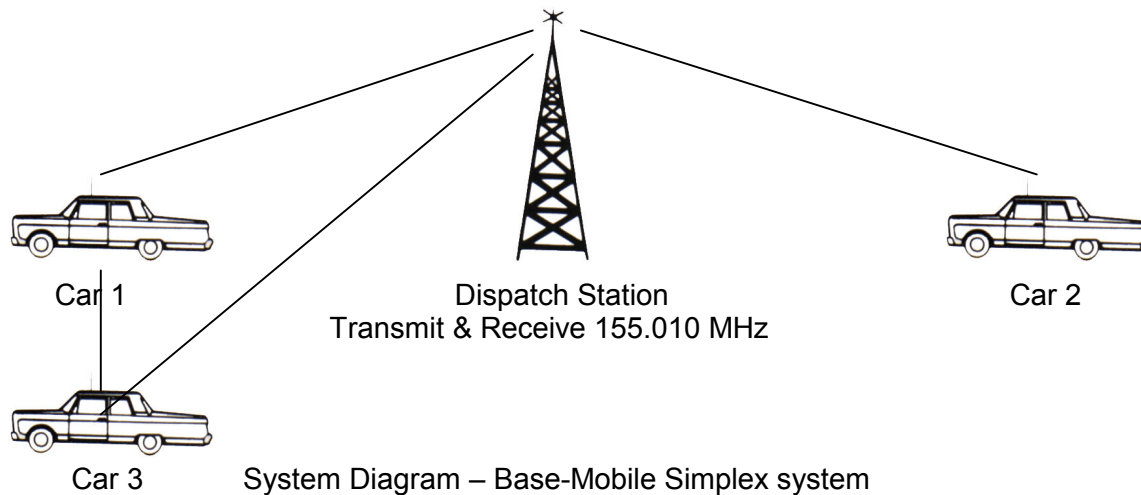
Thank you for your consideration of our company and our products.

The Falcon Team  
*At your service!*

# Long Range System Planning

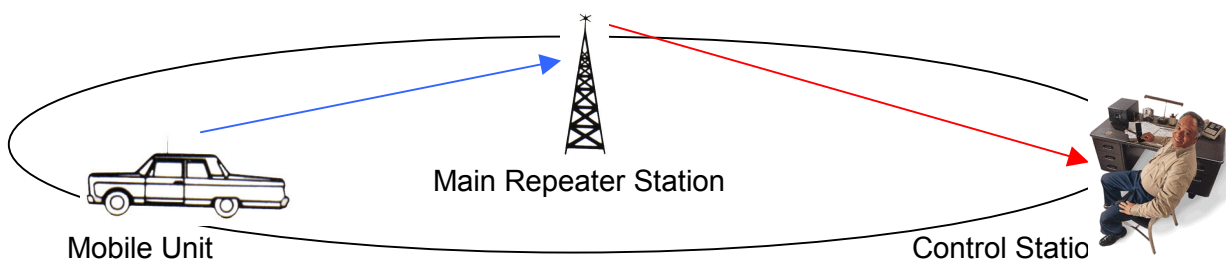
## HISTORICAL OVERVIEW

In general, all radio systems started in a simplex mobile operational mode. In simple terms, there was a base station with the ability of providing municipal or county wide coverage as applicable. The majority of these systems are either VHF or UHF with a few 800 MHz systems operated in larger metropolitan areas. The diagram below more graphically represents how these systems work.



Assuming a distance of 20 miles between the station and each car, this system provides adequate coverage to and from all mobiles. In addition, Cars 1 & 3 which are within 5 miles of each other can also communicate, but car 2 which is almost 40 miles away from cars 1 and 2 cannot communicate with either car.

The first improvement was to convert the dispatch station to repeater operation. Several benefits resulted. First, the main station could be moved to an area of higher elevation such as a mountain top to water tank to provide greater range. It was no longer called a *dispatch station*. Now it was called a *repeater station* and the associated dispatch station was called a *control station*. Instead of using a single frequency, a repeater uses two frequencies – one for transmitting and the other for receiving. The repeater transmits F1 and receives F2. The control station and mobile use these same frequencies in reverse order as is shown in the diagram below.

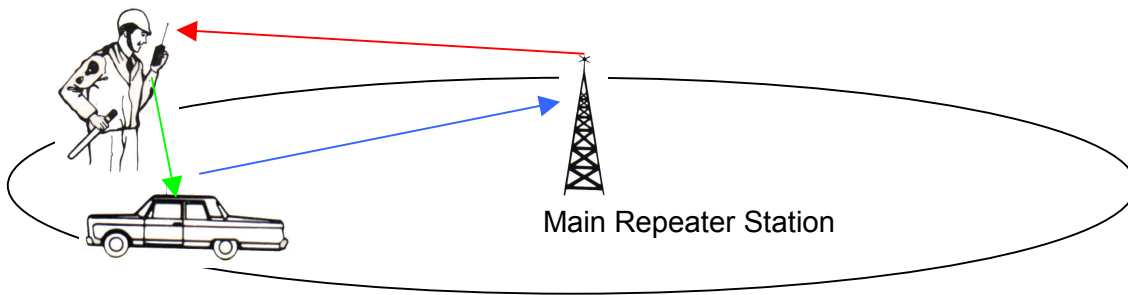


**Frequency 1** – Transmitted by Main Repeater station. Received by mobile and control station

**Frequency 2** - Main Repeater station receive frequency. Can be heard directly from mobile, or from control station. Control station can talk to mobile through repeater. Mobiles can also talk to each other through the repeater.

System design has not changed appreciably over the past forty years. Most systems are either simplex systems as we saw in our first example, or repeater systems as we saw in our last example. The problem is that portable (handheld) radios were introduced in the seventies that have continued to improve in performance as size and price has come down. That's great, but a five watt handheld will never talk as well as a 40 watt mobile – repeater or no repeater!

This brings us to one of the issues that must be addressed in system planning – to make handhelds perform to meet the users needs. There are several ways to address this requirement. One of the more common is to use a mobile repeater that allows the mobile to pick up the transmissions from the handheld and *repeat* the call through the mobile. The diagram below shows how this works.

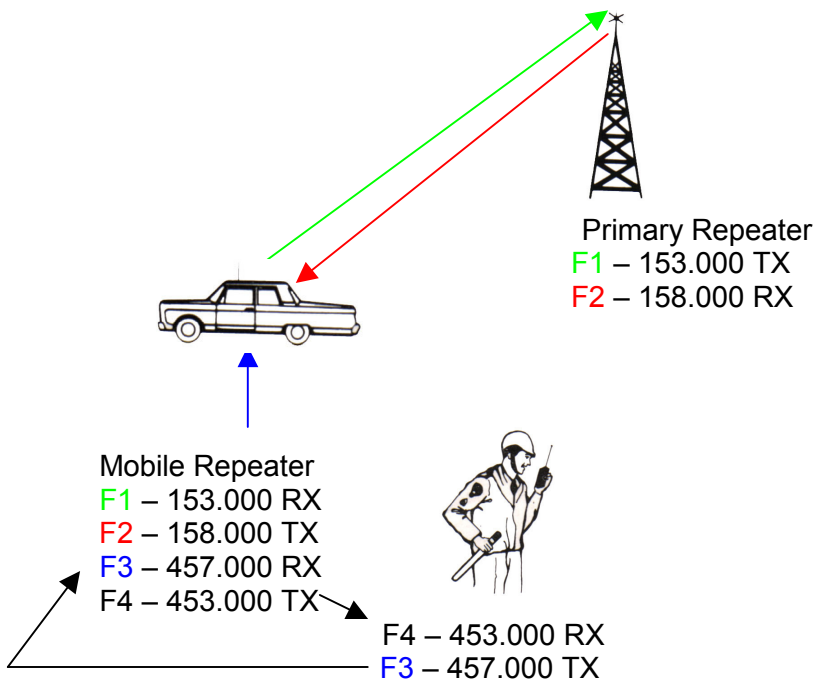


**Frequency 1** – Transmitted by Main Repeater station. Received by mobile and handheld

**Frequency 2** - Main Repeater station receive frequency. Can be heard directly from mobile, but not from handheld due to talk-back range limitations of handheld.

**Frequency 3** – Cross-link transmit frequency from handheld. Received by mobile and retransmitted on the mobile transmit frequency to Main Repeater Station.

This application works very well with UHF systems. On VHF systems, it is necessary to use a cross band repeater in association with a UHF handheld as is shown in the diagram below.

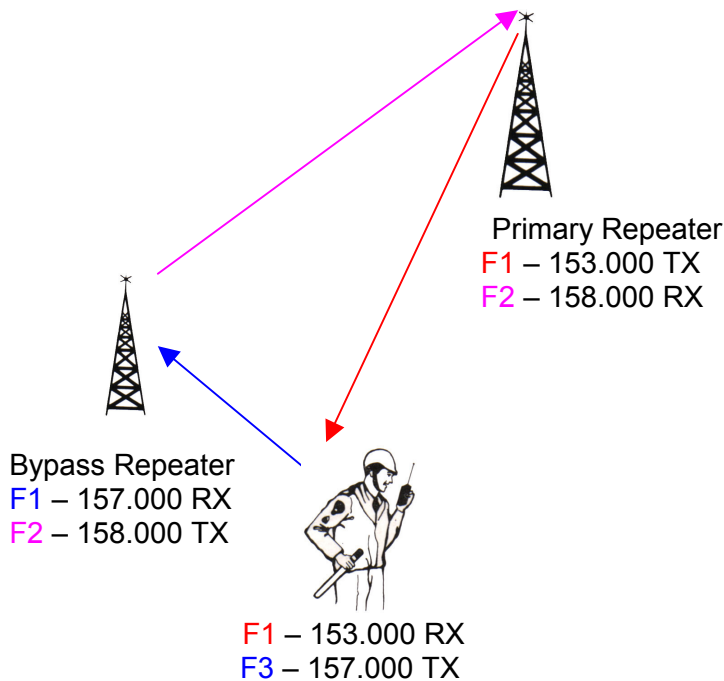


Mobile Cross band repeater VHF mobile – UHF handheld

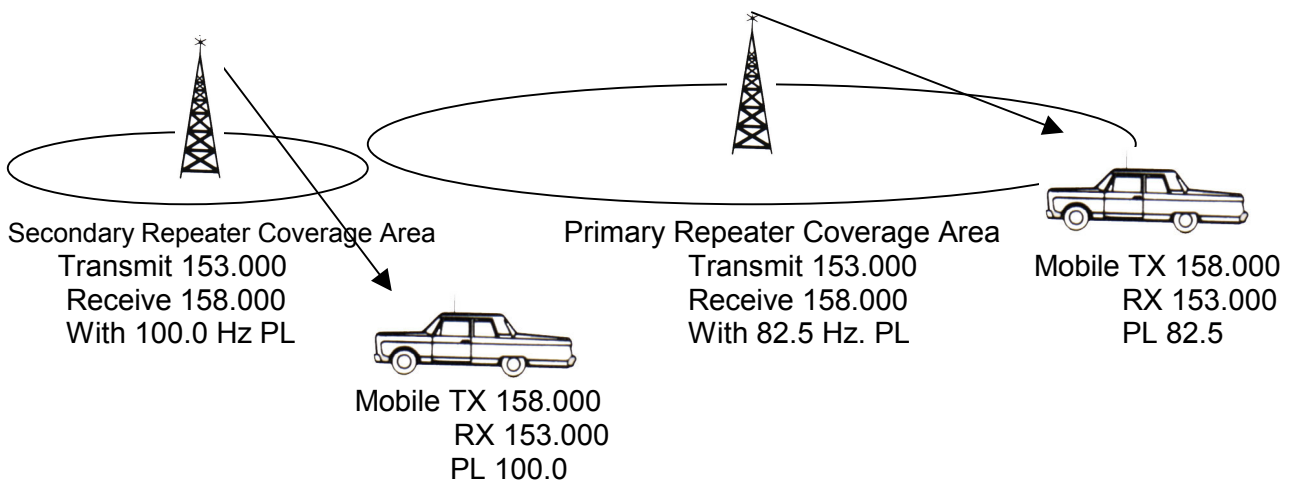
## THE BETTER SOLUTION

The repeater was a great improvement. Mobile repeaters can sometimes be used by smaller departments where only a few vehicle are involved. However, the better solution generally is to add a repeater. There are several ways to do this.

If the handheld radios can hear, but can't get back, a common solution is to use a *bypass repeater*. This involves using a second repeater that is within range of both the handheld radio and the main repeater. The diagram below shows the use of the two existing frequencies already used by the primary repeater and the third frequency used by the by the *bypass repeater* may better explain how this system extends coverage.

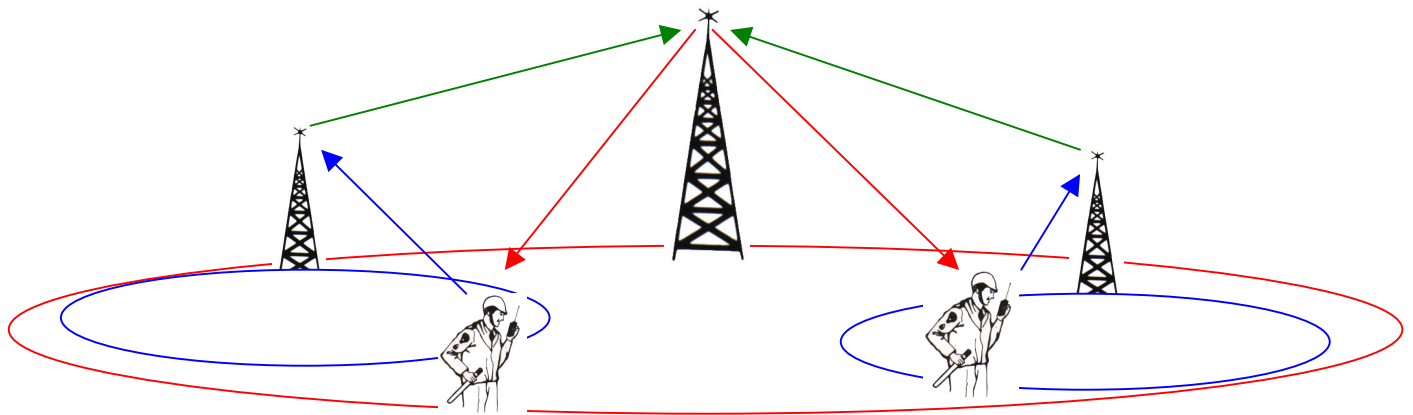


The second method of providing additional coverage applies when the handheld radio is NOT within range of the primary repeater. This involves adding a *zone repeater*. As you will note from the diagram below, the secondary coverage area is outside the range of the primary repeater.



As you will note from the diagram above, a mobile can access either repeater since both repeaters operate on the same frequency. The only difference is the access tone (82.5 Hz Private Line Code for Primary Repeater, or 100.0 Hz for the secondary repeater). Zone repeaters are very popular in counties where more that one repeater is required to provide adequate coverage.

One of the more affordable and efficient alternatives is the use of a satellite receiver voting system as shown in the diagram below.



**Satellite Receiver System**

The red circle represents the original coverage of the 2-way radio system designed for mobile radio use. Within this area handheld radios can generally receive but not talk back due to power limitations. By adding satellite receivers in areas where talkback range is limited, we can provide talkback performance comparable to the talk-out range of the base station. This technology was widely used in the 1970's but generally fell out of favor as the idea of multiple receivers was proposed as a better alternative. There are some who would not agree with this conclusion, but in general, the majority rules. This is particularly true when large manufacturers and their distribution channel partners who are rewarded to participate in the technology advancement by promoting more expensive products.

The fact is that satellite receiver voting systems are very cost effective since the satellite (or remote, if you prefer) transmitters are nothing more than low cost 50 watt mobile type transceivers with AC power supplies and a low cost link between the satellite(s) and the host base station. Additional information on this technology is available at <http://www.info4u.us/Satellite Receiver System.pdf>

## TRUNKING, THE ULTIMATE SOLUTION

Most people associate the term *trunking* with 800 MHz. In general, the term is also associated with high cost, poor range, and incompatibility with paging. That is true of 800 MHz. It is NOT true of the true definition of trunking.

There are several different trunking system standards including G-MARK (originated by General Electric), CMS (originated by Midland), and others of lesser significance. Suffice it to say that the defacto standard is LTR (Logic Trunked Radio) developed by E.F. Johnson and later adopted by most major manufacturers including Motorola.

Trunking is the concept of combining two or more repeaters such as the Motorola GR1225 to function together for dynamic channel assignment. This is a fancy way of saying that the Police Department is not limited to just one repeater. They could have automatic access to the Fire Department and Street Department repeaters depending on which one was available when they wanted to communicate. Each radio in the system has a coded ID with scanning capability. When a user wishes to make a call, the ID code is sent when they push the transmit button. They are then connected to the first available repeater station which in turn connects them to their dispatch fleet or group (i.e. fire, police, DPW etc.)

Trunking is available in the VHF 150-174 MHz, UHF 450-470 MHz, 220 MHz, 700 MHz, and the 800 MHz band. For most users, the VHF and UHF band are the most desirable since frequencies are often already available. There is one caveat to consider before planning for trunking. You **MUST** use the new narrow band 12.5 KHz channels for the system to perform to expectations. If you are applying for new

FCC licenses, they will automatically be issued with 12.5 KHz channel spacing. For any future planning, do NOT plan on the use of 25 KHz channel spacing.

A trunking system requires one antenna for all connected transmitter stations and one antenna for all station receivers. All transmitters are fed through a device called a *Combiner* and all receivers fed through a *Multicoupler*. These devices allow multiple transmitters or receivers to share a common antenna. Each repeater also requires a device known as a *Controller*.



The Controller mounts externally to each repeater station. This item adds **\$1,295** to the cost of each GR1225 repeater. In essence, this device is a computerized interface to network each station.

The price of combiners and multicouplers will vary depending on the number of repeater station associated with the trunked network. For budgetary considerations assume \$2,500 per station.

Standard radios can be used on a trunked radio system but the full benefits in instant channel availability, user ID and privacy would not be applicable. If you are considering a trunked radio system, it is generally advisable to plan for new hand held radio and/or mobile radio equipment.

Trunking of three or more channels can be used at a single site, assigned to zones, or connected between zones through the use of connector circuits (Canopy is well suited for this purpose). It is possible to *roam* from one system to another using a technology called *Passport* developed by Trident and later adopted by Motorola and other major manufacturers.

The bottom line is that if you are purchasing new equipment, either handheld or mobile, you should plan two things for sure. First, that your equipment is narrow band 12.5 KHz compatible and second, that it is adaptable for use in both the conventional (standard) mode as well as LTR trunking. If you have any questions, we are as near as your telephone – local at 205.854.2611 or toll free 1.800.489.2611.

Repeater reply.new 04/2006

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