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What is a repeater…….

and why should you care? In terms of 2-way radios 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 four 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) Single site bypass repeaters
5) Multi-site base station repeaters
6) 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 being upgraded to digital operation and 6.25 kHz channel spacing if at all possible
2) If you are considering paging, limit your selections to VHF or UHF
3) Choose equipment suitable for being upgraded to trunking at a later date

The information contained to be used for budgetary purposes. When you are ready for a price quotation on the system and equipment of your choice, just let us know. We'll take it from there!

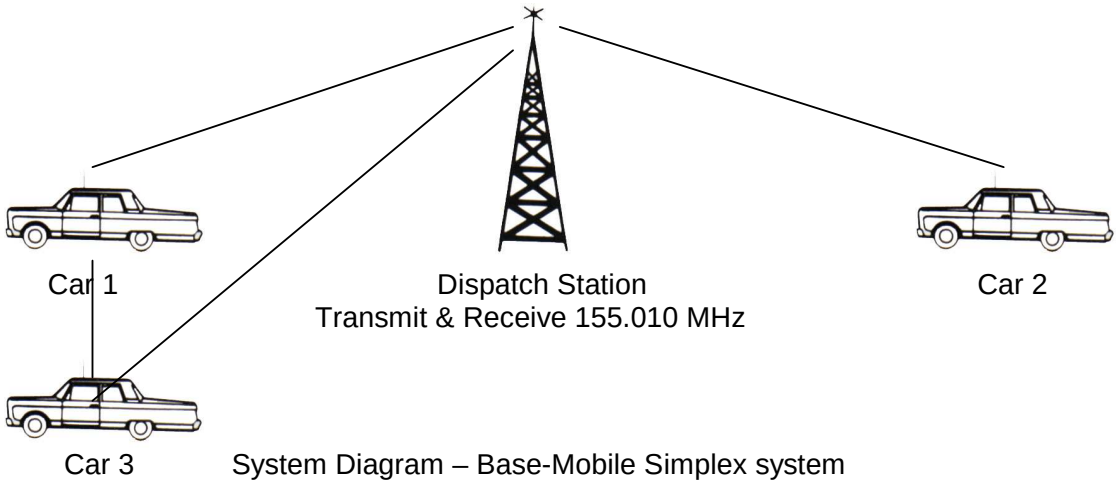
Thank you for your consideration of our company and our products.

The Falcon Team
At your service!

Long Range System Planning

HISTORICAL OVERVIEW

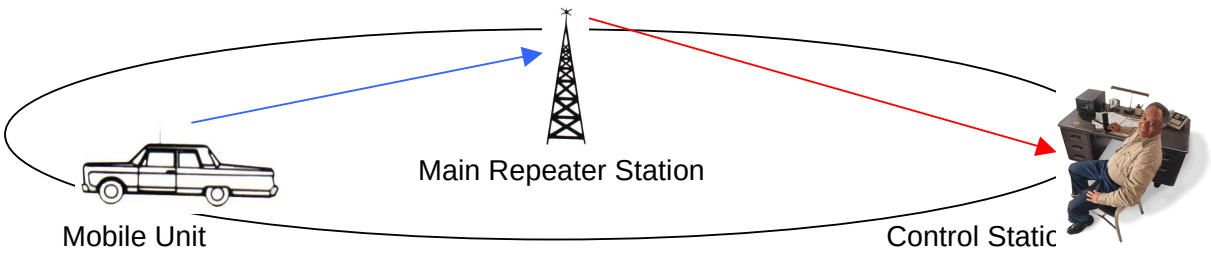
In general, all radio systems started in a simplex mobile operational mode. In simple terms, there was a base station with the ability of providing municipal or county wide coverage as applicable. The majority of these systems are either VHF or UHF with a few 800 MHz systems operated in larger metropolitan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



System Diagram – Base-Mobile Simplex system

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.

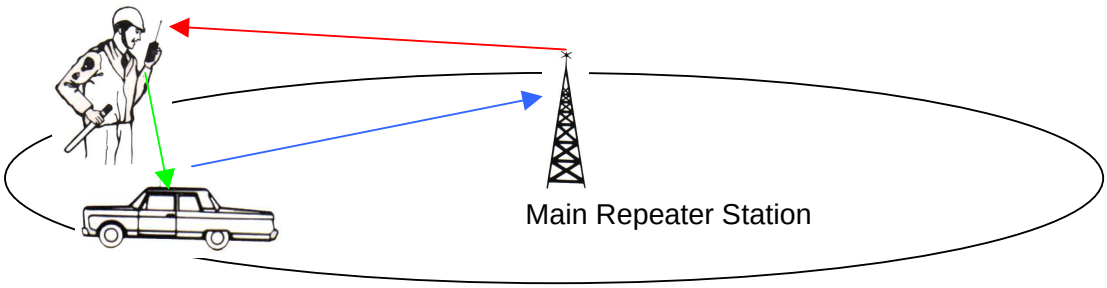


Frequency 1 – Transmitted by Main Repeater station. Received by mobile and control station

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.

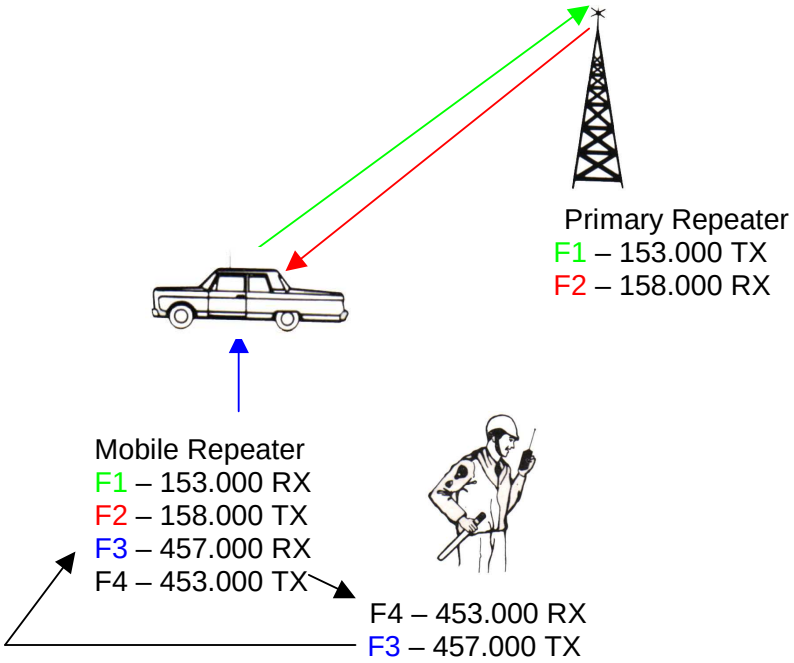


Frequency 1 – Transmitted by Main Repeater station. Received by mobile and handheld

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.

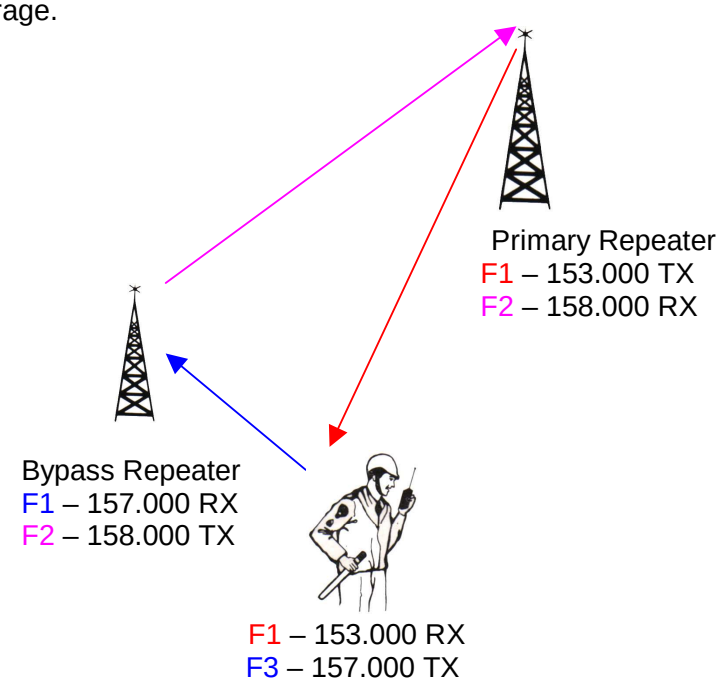


Mobile Cross band repeater VHF mobile – UHF handheld

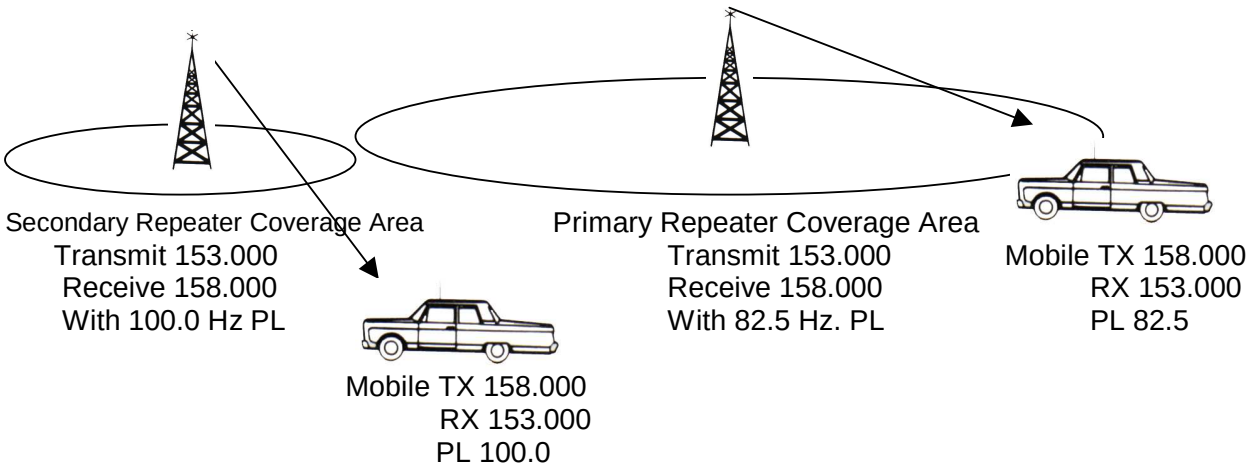
Extending Repeater Coverage

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.

Planning an in-band repeater system

As previously noted, your planning will normally involve selection of a proper antenna site. If your office is suitably located, your repeater can be placed on your desk and function both as a repeater and as a dispatch station (optional desk microphone required).

Your next step is to choose your equipment, antenna system, and antenna support structure (tower, water tank etc.). Next, you apply to the Federal Communications Commission for a license (or modification of your existing license) and within a few months, you should be in operation.

Here is an estimate on the cost of setting up a typical VHF Repeater.

FCC License – New locations/control frequency	-	$950
Analog Repeater with internal duplexer	-	1,843
Station antenna – 3 db (2X) gain for use with Bypass repeaters	-	285
Station antenna – 5.25 db (4X) gain – Recommended standard repeaters	-	799
Low loss transmission cable plus connector kit	-	$3 per foot $55
Lightning protection (AC Line and transmission cable)	-	99

Tower and installation – Cost can vary depending on geographic area. We normally use the Rohn #25 tower for new tower installations. On average, an installed Tower will cost $500 for each ten feet in height (i.e. a 100’ tower installed Would have an estimated cost of $5,000). Installation on water tanks or existing structures will average $75 for each 10 feet in height (i.e. installing an antenna on a 120’ water tank would average $900 plus a mounting bracket at a typical cost of $250.

Bypass repeaters are generally installed at fire stations or other existing structures with a 50 foot tower and 3 dB VHF antenna. This saves a lot of money on towers or mounting on water tanks and/or payment for site rental charges. This is a great solution IF the received signal from a central dispatch station is adequate. This system has the added advantage of not requiring any changes at the dispatch center. Total estimated cost - $4,992 plus applicable FCC license cost. A standard repeater using a 5.25 dB gain antenna and a 100' tower would cost $8,246 or using an existing 120' water tank would be $4,396. The FCC licensing cost can vary depending on number of locations, frequencies used, and other factors. For budgetary purposes, $950 is a good estimate.

Prices assume a 50 watt repeater. The probability of getting FCC approval for more than 50 watts for new stations locations located near large metropolitan areas (such as Memphis, TN) are somewhere between zero and unlikely. However, if you are approved for 100 watts and you wish to use a higher powered station (which has no improvement in talk back range of portables or mobiles), add $2,000 to the prices above.

Our brand of preference for repeater stations is the Hytera RDR model since if has the ability to be upgraded to DMR digital when desired and it is covered by a five year factory warranty. No other manufacturer has this capability at anywhere near the cost. See www.info4u.us/RD982.pdf for more info.