



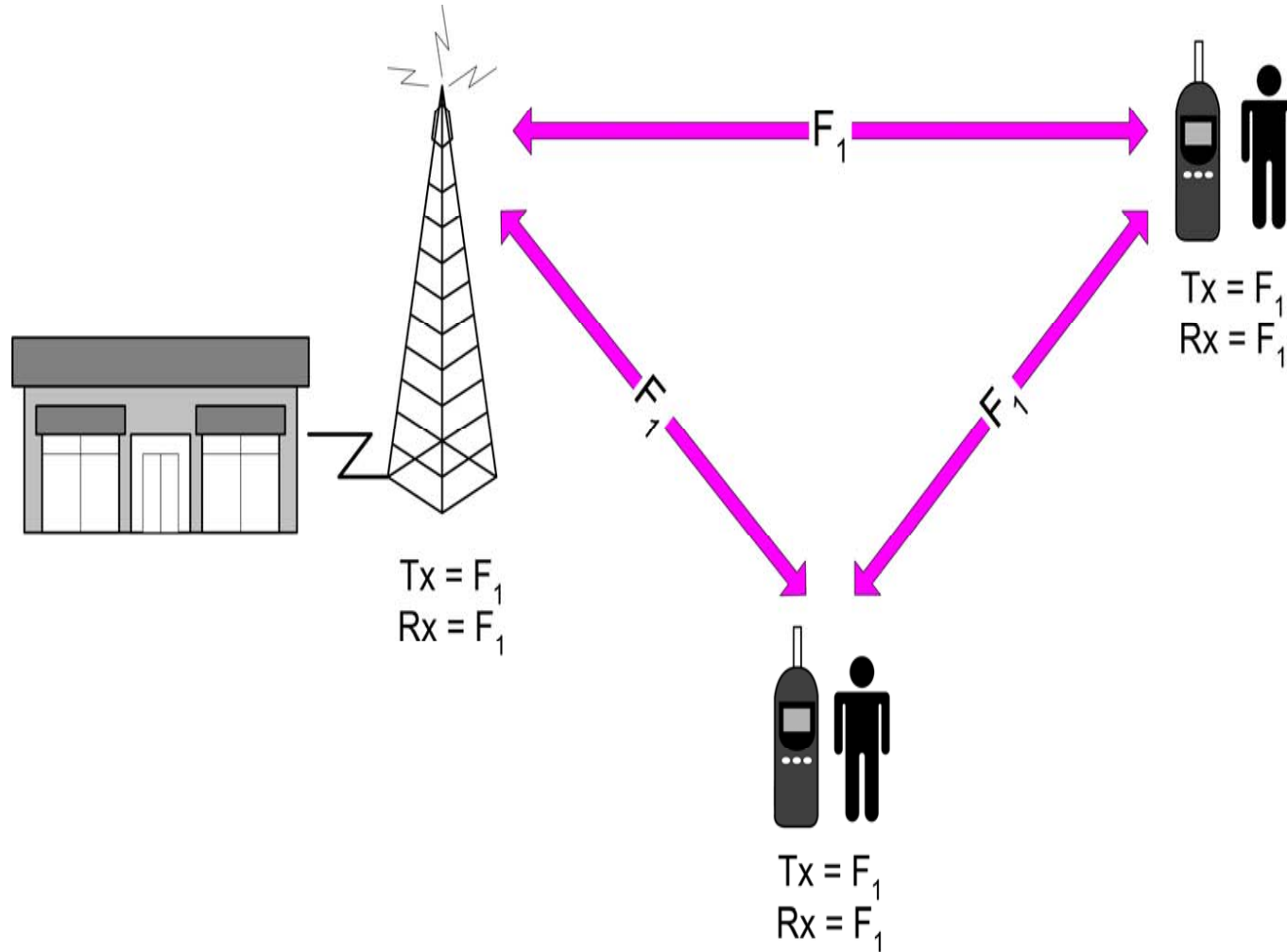
**Homeland
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Unit Objective

Confirm knowledge of the different radio systems in use today, multiple frequency bands utilized, licensing and frequency coordination responsibilities and resolving interference issues



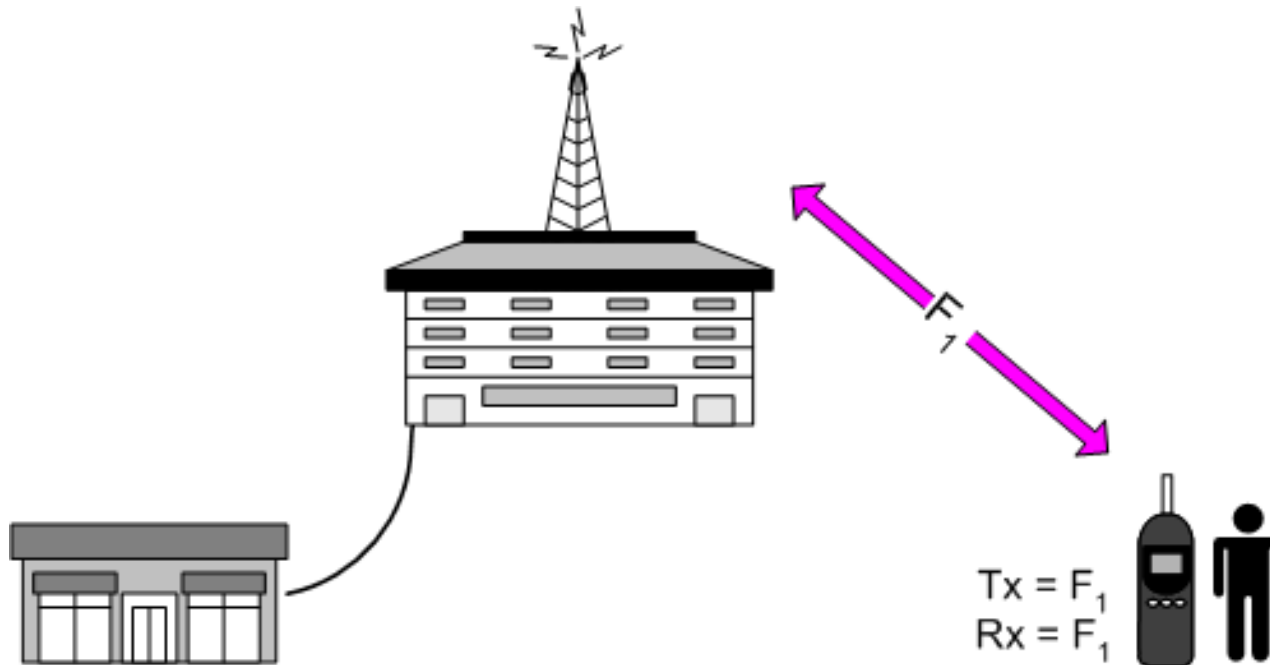
Simplex Radio System





Remote Base System

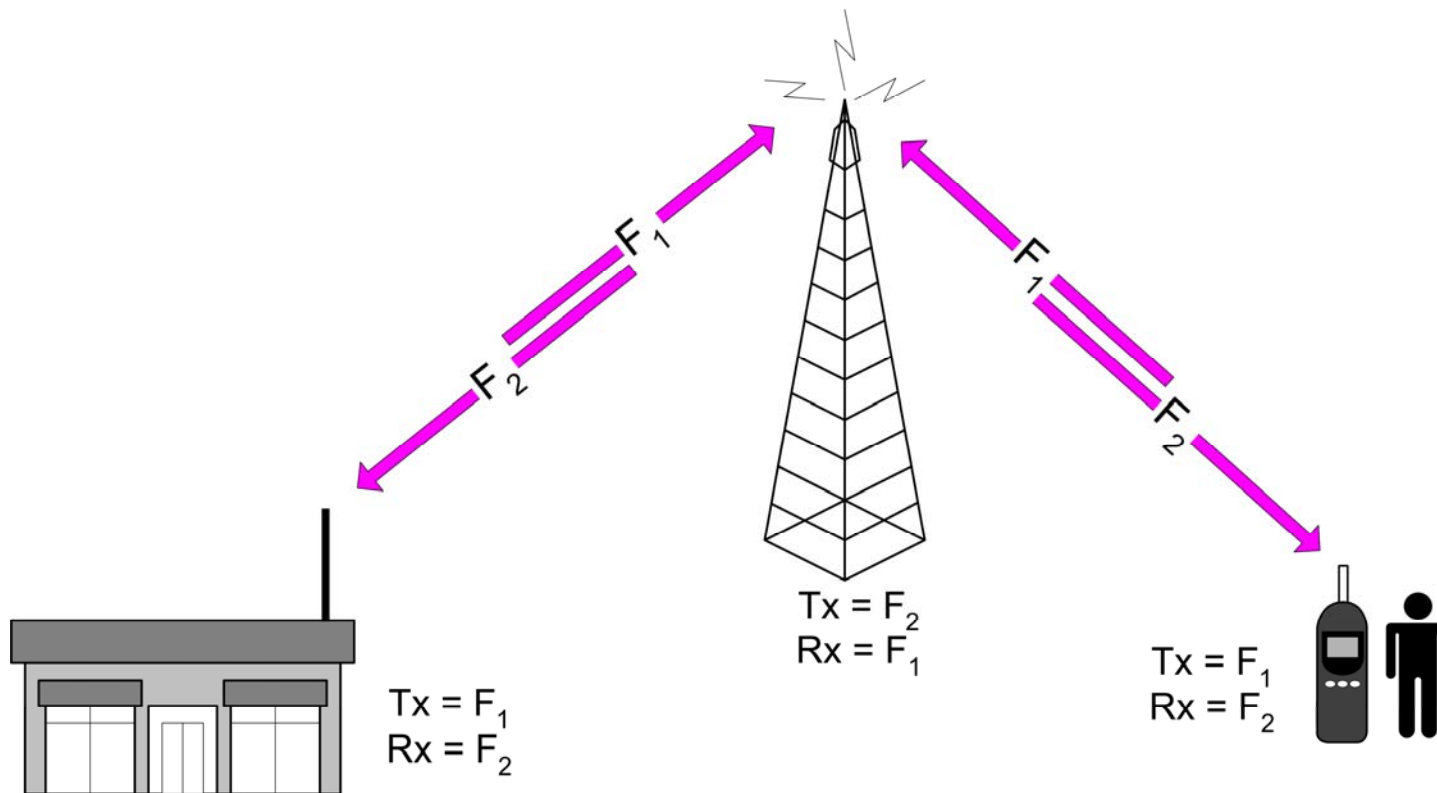
- This is the same as Simplex, except the transmitter is on a hilltop or other high object





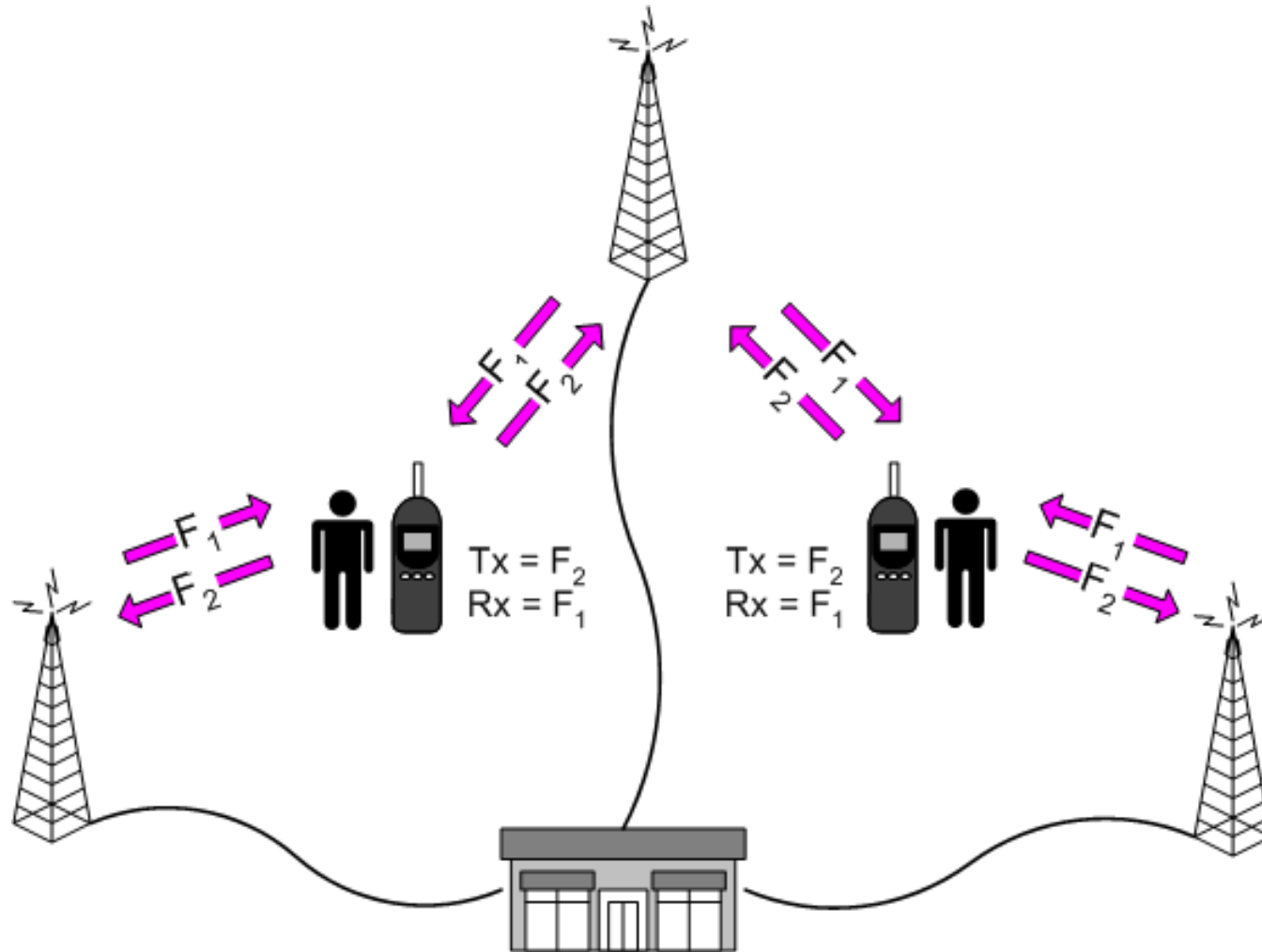
Repeater System

- Transmit and Receive on different frequencies



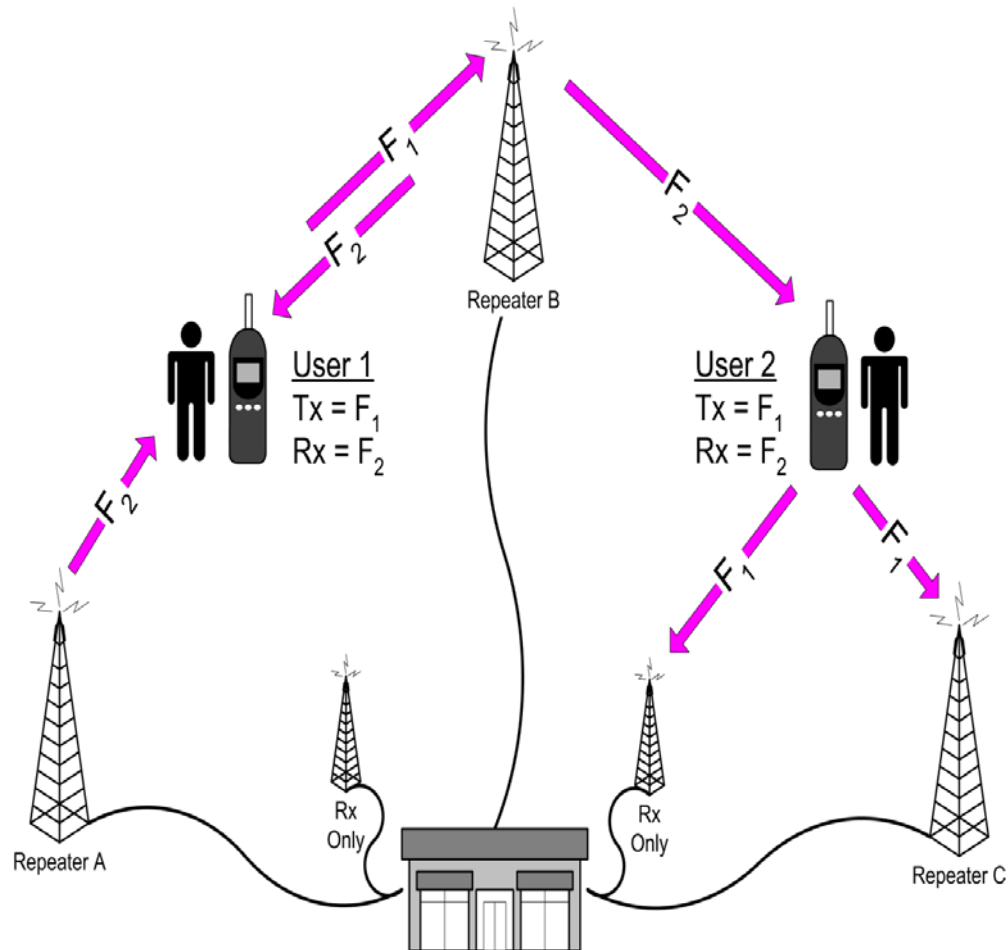


Simulcast Radio System





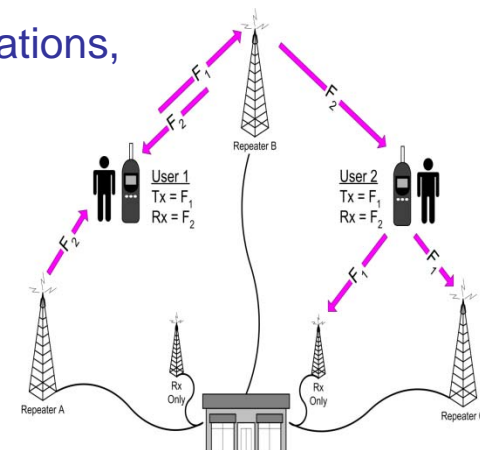
Simulcast with Voting/Remote Receivers





Remote Receivers & Voting

- Remote or satellite receivers are used in addition to regular repeater receivers to pick up relatively weak portable and mobile signals
- Audio from these receivers is routed to a central voting comparator or voter where the best received audio is selected
- The strongest signal is not always selected; that with the highest signal-to-noise ratio is typically best
- Selected audio may come from multiple receivers during a single transmission
- Some systems are configured to lock onto a single receiver, once chosen, for a transmission
- Selected audio is routed to the ultimate receiving locations, such as consoles or repeaters for retransmission

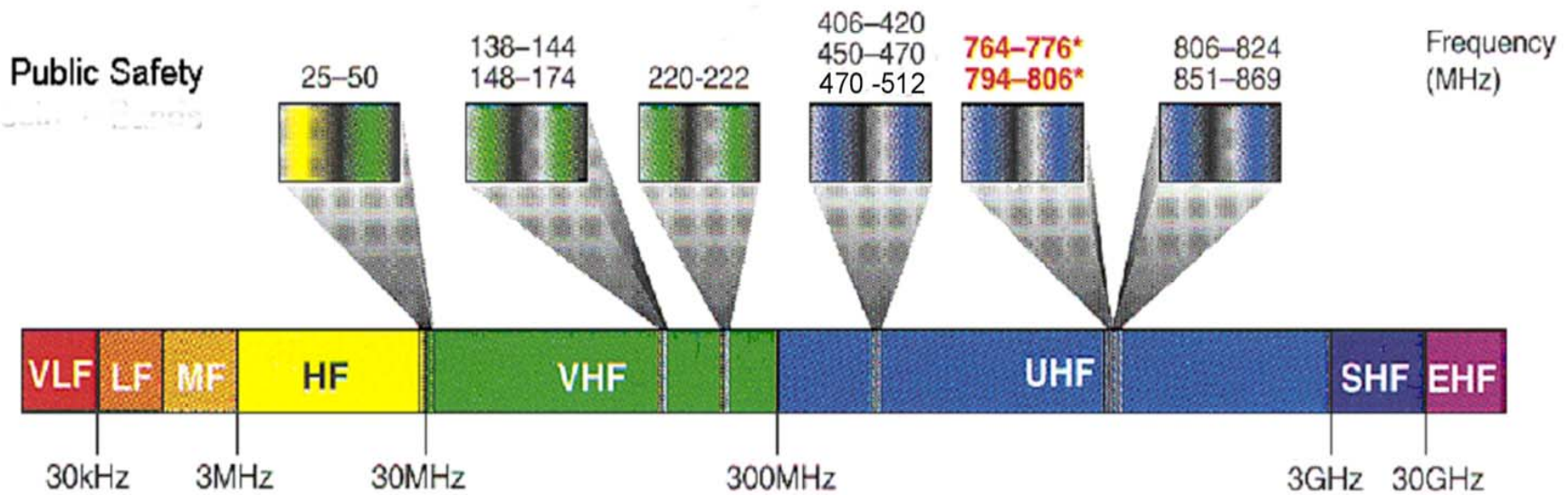




The Radio Spectrum

- Radio frequency energy is emitted from most objects in the world
- These emissions can be used for effective communication at a number of frequencies
- The FCC and NTIA* have set aside certain spectrum for use by Land Mobile radios

* Federal Communications Commission and National Telecommunications and Information Administration



* Additional spectrum bands (764 to 776 MHz and 794 to 806 MHz) allocated for public safety use as part of the Balanced Budget Act of 1997.



Bands used by Public Safety

- The lowest effective frequency used by Public Safety is VHF Low Band
- This is 30 MHz to 50 MHz
- This band performs very well in mountainous terrain, primarily because the radio waves conform to the terrain well
- This band is susceptible to long distance “skip”



Bands used by Public Safety

- The next band available is VHF High Band
- It has widely mixed use
 - 138-144 MHz – Exclusive federal
 - 144-148 MHz – Amateur radio
 - 148-150 MHz – Shared mobile and satellite
 - 150-162 – Non-federal public & private
 - 162-174 MHz – Primarily federal
- Frequency pairings for repeaters are irregular
- Throughout North America, the largest number of licensees use this band
- Cross-border coordination with Canada and Mexico is difficult
- Lots of interference, particularly within the southern parts of the United States



Bands used by Public Safety

- UHF (Ultra High Frequency) has mixed use
 - 406-420 MHz – Primarily federal
 - 420-450 MHz – Amateur radio and radiolocation
 - 450-470 MHz – Non-federal public & private
 - 470-512 MHz – Non-federal public & private
 - Also known as “T-Band” because television channels 14-20 occupy this spectrum in some areas of the US
- Repeater splits
 - Federal agencies use a 9 MHz separation between receive and transmit frequencies in this band
 - The standard split for 420 to 470 MHz is 5 MHz
 - The standard split for 470 to 512 MHz is 3 MHz, corresponding to half of a TV channel (6MHz)
- This band has improved in-building coverage versus lower bands
- This band does not work as well in rough terrain and is more line-of-sight than VHF



Analog vs. Digital Radio

- Analog uses Frequency Modulation (FM) for most Land Mobile Radio uses
- Susceptible to noise and sometimes noise can override intended traffic
- Usually users will know there is someone calling



Analog vs. Digital Radio

- Digital Modulation uses a Vocoder to convert human voice into 1's & 0's
- Digital users either hear traffic or hear nothing
- Several studies have questioned the reliability of Digital in high-noise environments, such as fireground operations



Wideband vs. Narrowband

- For many years, 25 KHz has been the standard bandwidth
- FCC mandates by 2013 all users below 512 MHz to move to 12.5 KHz bandwidth
- Very dangerous to mix wide and narrowband radios on the same channel



Bands used by Public Safety

- 800 MHz – These systems are deployed primarily in more urban areas
- Splits usually 45 MHz
- Bi-Directional Amplifiers effective to improve coverage
- Very short range; requires infrastructure to be effective
- Often used in a “trunked” environment



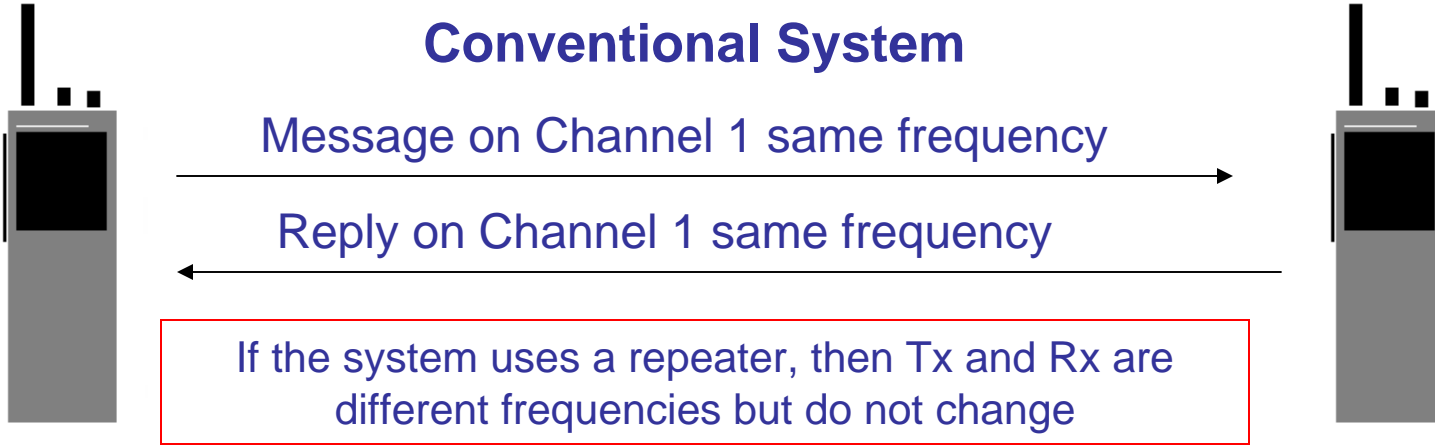
Trunking

- Trunked radio systems differ from conventional
- Trunked systems have a number of channels pooled into one system
- Primary difference is the use of “talk groups” instead of channels
- Each transmission is between talk groups and is moved between channels as they are available

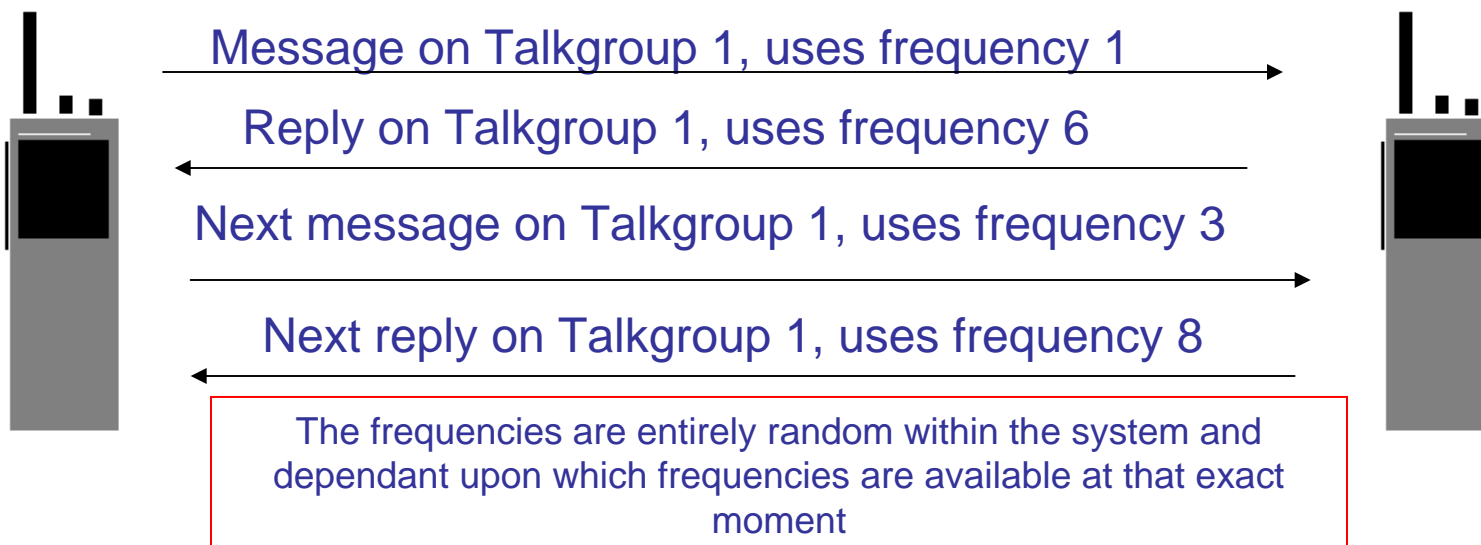


How a Trunked System Differs

Conventional System



Trunked System





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Interoperability

- One of the most misunderstood terms
- Does not mean everyone speaking to everyone else
- Must be carefully managed to avoid mass confusion
- Extremely easy to overload a system



Interoperability Channels

- National Interoperability Channels:
 - VHF: 1 Calling and 4 Tactical
 - Calling: VCALL10
 - Tactical: VTAC11, VTAC12, VTAC13, VTAC14
 - UHF: 1 Calling and 3 Tactical
 - Calling: UCALL40
 - Tactical: UTAC41, UTAC42, and UTAC43
 - 800 MHz: 1 Calling and 4 Tactical
 - Calling: 8CALL90
 - Tactical: 8TAC91, 8TAC92, 8TAC93, 8TAC94
 - 700 MHz Band are yet to be determined due to pending FCC action
- Naming these channels has proved troublesome, but the National Public Safety Telecommunications Council (NPSTC) adopted a standard that will be implemented over the new few years



Local Use Agreements

- These are agreements for one agency to use another agency's system for a specific purpose
- These agreements are limited, are not in lieu of licensing, and are usually associated with mutual aid, use of gateways or other special uses



Interference

- This issue becomes bigger every day
- Try to identify the offending station by monitoring; listen for call signs or geographical information to assist in locating the station
- Make contact; operator information can be obtained via the FCC ULS database

<http://wireless.fcc.gov/uls/index.htm?job=home>



Interference

- First choice may be to contact the agency directly, and try to find out if they changed something recently, such as antennas, power output, etc.
- Most Public Safety agencies will cooperate in trying to rectify interference
- The FCC may also be of assistance finding the offending station



Willful Interference

- Willful interference can be a more pervasive problem, depending upon the motive of the perpetrator and their skill level
- The station may be moved to prevent easy detection
- They may or may not identify themselves
- The FCC, radios shops, and amateur radio operators may all be of assistance solving this crime