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# Unit 5: Frequency Regulations and Usage

STUDENT GUIDE

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**Objectives**

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By the end of this unit, students will be able to:

- Identify methods and standards relating to frequency regulations and usage.
- Identify the factors influencing frequency coordination efforts.
- Understand local use agreements and special temporary authorizations.
- Identify and describe considerations in recognizing and preventing interference.
- Identify modes of typical types of radio systems in use today.
- Describe the Public Safety Spectrum Bands.
- Identify RF safety issues.

**Methodology**

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This unit uses lecture, discussion based activities, and exercises.

The purpose of this unit is to provide students with an orientation to methods and standards related to frequency regulations and usage.

The purpose of Exercise 5 is to provide the participants with an opportunity to identify how to address frequency issues and explain their solutions to address these challenges.

Knowledge of unit content will be evaluated through administration of the final exam (to be administered upon completion of the course). Instructors will evaluate students' initial understanding through facilitation of Exercises 5.

**Time Plan**

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A suggested time plan for this unit is shown below. More or less time may be required, based on the experience level of the group.

<b>Topic</b>	<b>Time</b>
Lesson (first part, day 1)	30 minutes
Lesson (second part, day 2)	2 hours, 30 minutes
Exercise 5	20 minutes
<b>Total Time</b>	<b>3 hours, 20 minutes</b>

**Reference Materials**

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- Projector & other equipment as necessary for PowerPoint presentation
- Easel chart/Easel pad
- Marking pens
- Exercise 5: Frequency Usage

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**Topic**

Unit Title Slide

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**Key Points**

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**Topic****Unit Terminal Objective**

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**Unit Terminal Objective**

**At the end of this unit, students will be able to identify methods and standards relating to frequency regulations and use.**

Unit 5:  
Frequency Regulations and Usage

Visual 5-2

**Key Points**

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**Unit Terminal Objective:**

- At the end of this unit, students will be able to identify methods and standards relating to frequency regulations and use.

**Unit Enabling Objectives:**

- Identify the factors influencing frequency coordination efforts.
- Understand local use agreements and special temporary authorizations.
- Identify and describe considerations in recognizing and preventing interference.
- Identify modes of typical types of radio systems in use today.
- Describe the Public Safety Spectrum Bands.
- Identify RF safety issues.

**Topic** Terminology and Conventions of Use

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**Terminology and Conventions of Use**

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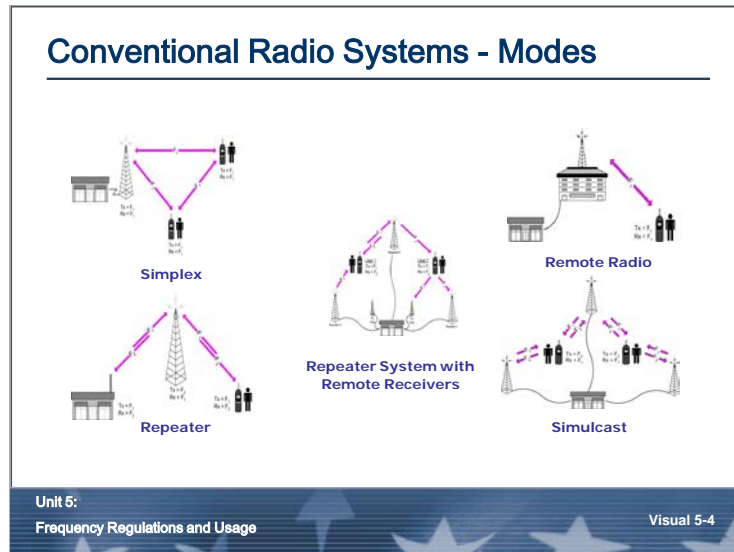
- A *frequency* is a defined unit of electromagnetic spectrum
- A *channel* is a talk path and may utilize one or two frequencies
- A *talkgroup* is a virtual channel within a group of frequencies
- Frequencies are written as four places past the decimal and should be identified as “wide” or “narrow”
  - Example: 155.4750 W
  - All frequency references on an ICS Form 205 represent mobile and portable frequencies

Unit 5:  
Frequency Regulations and Usage

Visual 5-3

**Key Points**

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**Topic** Conventional Radio Systems Modes**Key Points**

Overview of Radio Frequency (RF) Systems: Conventional or Trunked

Conventional radio system modes

- Simplex
- Repeated
- Simulcast

Trunked radio system modes

- Repeated
- Simulcast

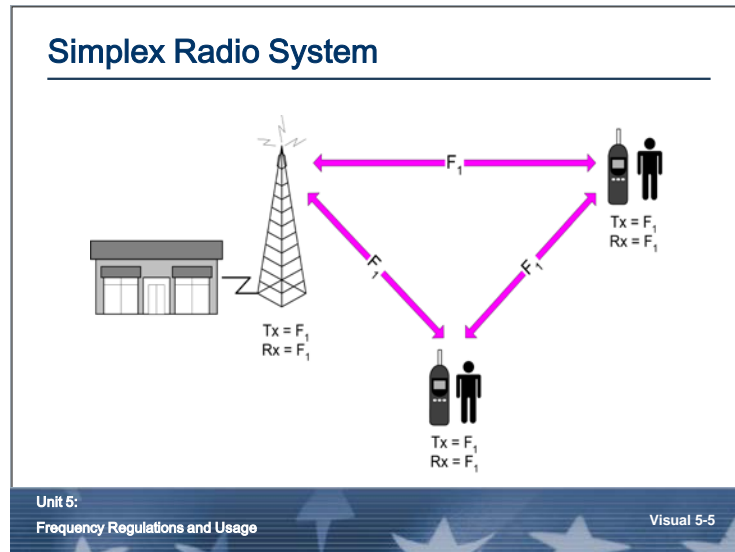
How does a Multicast network differ from a Simulcast?

Multicast systems are similar to simulcast systems with exception of the radio channels transmitted. While a simulcast system transmits on the same RF channels simultaneously from each base station/repeater, multicast systems use different RF channels at each site.



## Topic

## Simplex Radio System



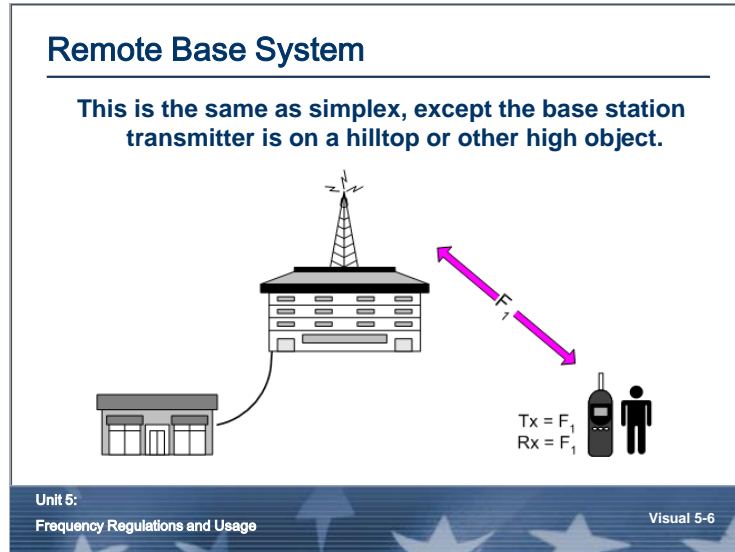
## Key Points

What is a Simplex network?: In Simplex operation, one radio of the system transmits while the other radio(s) receives. Simultaneous transmission and reception at a radio is not possible with Simplex operation. The Simplex dispatching system consists of a base station, mobile/portable units, all operating on a single frequency. Simplex operation is generally limited to a line-of-sight. Simplex requires no additional external equipment, infrastructure or systems to work. Simplex mode remains a valuable tool within all system types, and is commonly used in tactical environments.

“Car-to-car” or “direct” are common terms for this.

## Topic

## Remote Base System

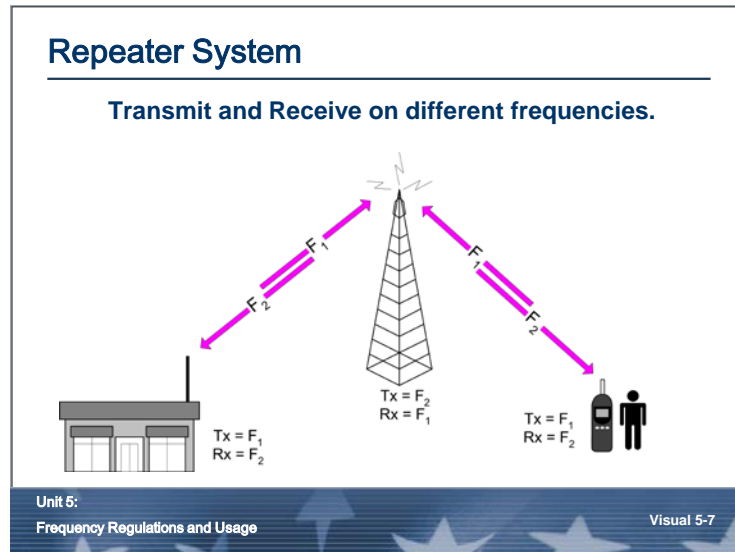


## Key Points

What is the limiting factor on remote base system's usable transmit range?: The base transmitter in a Land Mobile Radio (LMR) system typically has much more power than mobiles or portable radios. The base antenna is typically at a much higher elevation than mobile or portable radio antennas. For these reasons, mobiles and portables communications are limited by their talk-back capability.

## Topic

## Repeater System



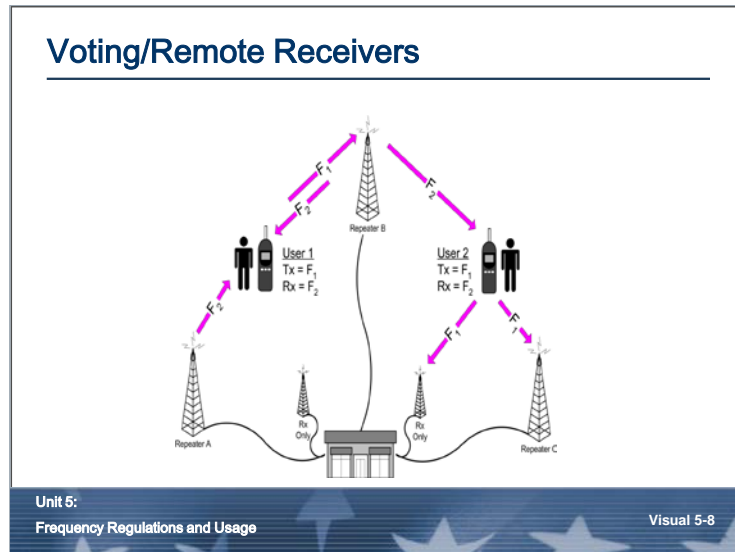
## Key Points

What is a Half Duplex/Repeated network?: A repeater is an electronic device that receives a weak or low level radio signal and retransmits it to overcome obstacles and increase range. In repeated systems, a channel is made up of two different frequencies. The repeater transmits on the mobile's receive frequency and vice versa. Repeated systems are deployed to overcome "line-of-sight" obstacles presented by terrain, obstructions, or distance.

These systems are used to extend range, but only one person can speak at a time.

## Topic

## Voting/Remote Receivers



## Key Points

Why would you use voting/remote receivers?

- To improve the talkback capability.

How do voting/remote receivers work?

- A number of radio receivers located in strategic areas receive the RF signal from a mobile or portable unit. Receive-only sites act as “listening-only” base stations that receive the lower power signals of mobiles and portables and relay them back to a base station or repeater, usually via dedicated telephone or microwave links. By using one or more receive-only sites in conjunction with a high-power base station or repeater transceiver, the overall system talk back coverage can be expanded.

**Topic**Voting/Remote Receivers

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**Voting/Remote Receivers (cont'd)**

- Remote or satellite receivers are used in addition to regular repeater base station or trunk 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

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Visual 5-9

**Key Points**

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How are remote or satellite receivers used?: Remote/satellite receivers act as “listening-only” base stations that receive the lower power signals of mobiles and portables and relay them back to a base station or repeater, usually via dedicated telephone or microwave links.

**Topic**Voting/Remote Receivers

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**Voting/Remote Receivers (cont'd)**

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- 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

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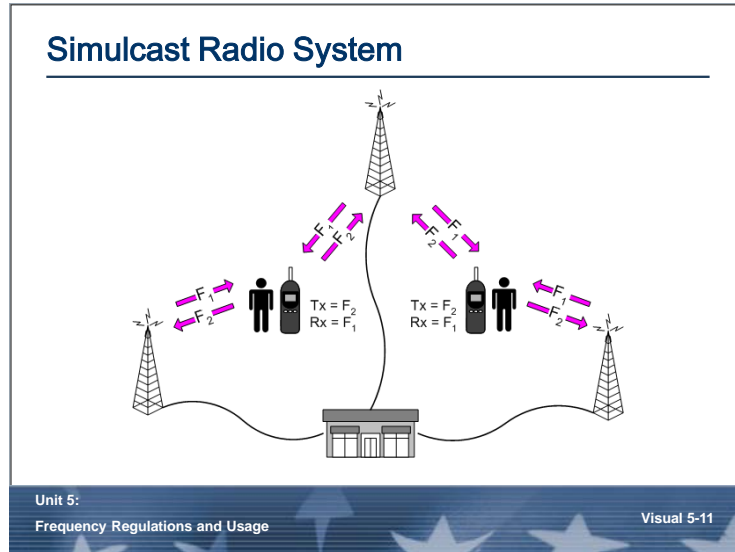
Visual 5-10

**Key Points**

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## Topic

## Simulcast Radio System



## Key Points

What is a Simulcast network?

Simulcast systems use several geographically separated base stations/repeaters that transmit on the same frequencies simultaneously. Through this type of a system deployment, a single radio channel can be radiated over a wider region than with a single-site transmitter. These networks require a timing system to synchronize each transmitter on the network to assure that transmissions on the same frequency are in phase thus reducing heterodyne interference.

Systems are complex to engineer and require thoughtful design. Simulcast systems do not increase capacity; in fact, they add to system loading.

**Topic****The Radio Spectrum**

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**The Radio Spectrum**

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- Radio frequencies are the products of resonance or vibration
- These vibrations can be used for effective communication at a number of frequencies
- As the speed of the resonance increases, physical properties change
- Frequencies range from the audible to the production of light
- As frequencies pass above the audio range, the waves begin to travel through air and become radio frequencies

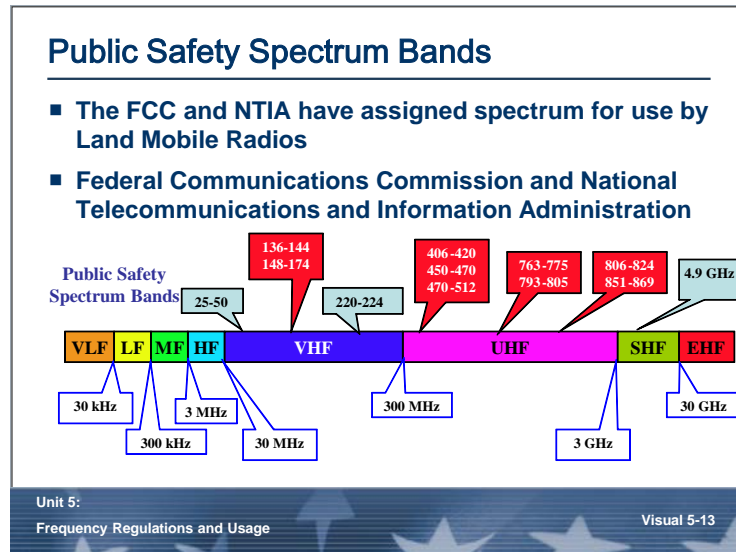
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Visual 5-12

**Key Points**

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**Topic** Public Safety Spectrum Bands**Key Points**

Who assigns state and local (non-federal) frequency assignments? The Federal Communications Commission (FCC)

Who assigns the federal frequency assignments? National Telecommunications & Information Administration (NTIA). Bands allocated for public safety use (as indicated on the chart) are small segments of the overall spectrum

What are the primary frequency bands being used for public safety today? (FCC & NTIA)

- VHF low band (30 - 50 MHz)
- VHF high band (136-174 MHz)
- UHF (421-512 MHz)
- 700 (769-775 and 799-805 MHz)
- 800 band (806-824 and 851-869 MHz; 806-816 and 851-861 MHz after rebanding)
- 4.9 GHz (4.940 – 4.990 GHz)

**Topic**VHF Low Band

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**VHF Low Band**

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- **Lowest effective frequency used by Public Safety**
- **30 MHz to 50 MHz**
- **Performs very well in mountainous terrain, primarily because the radio waves conform to the terrain well**
- **Susceptible to long distance “skip”, solar interference, and “industrial generated” noise**

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Visual 5-14

**Key Points**

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- Low band is still in use in many States. Very few manufacturers still make low band equipment.
- Susceptible to background noise, which has increased greatly due to other proliferation of other technologies.
- Caution should be used in placing low band channels in gateways due to potential interference which could disrupt the

## Topic

VHF High Band

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**VHF High Band**

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- Widely mixed use – most commonly used public safety band
  - 108-136 MHz – Exclusive to aviation (AM modulation)
  - 138-144 MHz – Exclusive to Federal (military)
  - 144-148 MHz – Amateur radio
  - 148-150 MHz – Shared mobile and satellite
  - 150-162 MHz – State & local public and private
  - 156-174 MHz – Marine band
  - 162-174 MHz – Primarily Federal
- Frequency pairings are random
- Extensive Federal use
- Good long-range propagation

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Visual 5-15

**Key Points**

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- Most commonly used frequency band in public safety (50% of licensed systems).
- No standard frequency pairings for repeaters.
- Most federal law enforcement and federal land management (fire) is on VHF.

**Topic**UHF Band

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**UHF Band**

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- Duplex use
  - 406-420 MHz – Federal Use
  - 420-450 MHz – Amateur radio and radio-location
  - 450-470 MHz – Non-Federal public and private
  - 470-512 MHz – Non-Federal public and private (T-band)
- Standard frequency pairings

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Visual 5-16

**Key Points**

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- “T-Band” came from reallocated television channels 14-20; public safety occupies this spectrum in large population areas and some coastal areas of the U.S. New T-Band systems are in planning.
- Note Federal UHF spectrum is at the bottom end of the UHF band and is generally not compatible with standard Public Safety radios.

**Topic** UHF Paired Frequencies

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**UHF Paired Frequencies**

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- Paired splits
  - The standard split for 406 to 420 MHz is 9 MHz
  - The standard split for 420 to 470 MHz is 5 MHz
  - The standard split for 470 to 512 MHz is 3 MHz
- VHF has no designated pairs
  - Inconsistent use (high side/low side)
  - Inconsistent TX/RX splits
  - 175 kHz minimum

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Visual 5-17

**Key Points**

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## UHF Paired Frequencies

- UHF is allocated in pairs
- 9 MHz separation – Federal allocations
- Bandwidth between TX and RX pair
- 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)

## VHF has no designated pairing

- Odd combinations and inconsistent assignment (licensing)
- 175 kHz typical minimum usable separation

**Topic**800 MHz

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**800 MHz****800 MHz - Upper part of UHF band**

- 806-824 MHz/851-869 MHz
- Paired channels – 45 MHz
- Trunked and conventional
  - Trunking requirements for certain capacity limits
- 5 dedicated interoperability channels
- General channels
- Rebanding (NEXTEL interference)

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Visual 5-18

**Key Points**

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- Upper UHF band
- Primarily trunked operations
- Frequencies allocated by Regional Planning Committee (RPC) plans
- Some general pool frequencies not allocated by RPCs
- Good building penetration, but reduced range compared to VHF and UHF

## Topic

700 MHz

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**700 MHz****700 MHz**

- 763-775 MHz (Old TV band channels 62 and 63)
- 793-805 MHz (Old TV band channels 68 and 69)
- All 700 assignments are narrowband
- Mandated digital emissions
- Dedicated Interoperability channels
  - Mandated P25 Common Air Interface (CAI)
- 6.25 kHz equivalency (Frequency-Division Multiple Access [FDMA] versus Time-Division Multiple Access [TDMA])
  - Temporary 12.5 kHz authorization until about 2017

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Visual 5-19

**Key Points**

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- Adjacent to 800 MHz public safety band
- Regional Planning Committee frequency block allocations
- State-licensed – large system frequencies
- Digital requirement
- Dedicated interoperability channels (P25 CAI required)
- Original channelization shifted to address changes to 700 Broadband Rule changes
- Performance similar to 800 MHz

## Topic

4.9 MHz

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Key Points

A portion of the 4.9 GHz Band (50 MHz) was made available through FCC rules for Public Safety use. These uses include: Mesh type networks where multiple nodes operate as an area-wide network. Point-to-Point Microwave links. Point-to-Point links are frequently used on an itinerant basis to make data connections to mobile communications vehicles, video links to public safety aircraft and other incident related support.



## Topic

Aviation Radio

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**Aviation Radio**

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- Exclusive use for aircraft
  - 108 MHz – 136 MHz
  - 225 MHz – 380 MHz (military)
  - AM modulation
- Extreme caution must be used in frequency use
- Must coordinate with Aviation management



Unit 5:  
Frequency Regulations and Usage

Visual 5-21

**Key Points**

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Air-to-air and air-to-flight control facilities

- 108 MHz – 136 MHz (civil and military aviation)
- 225 MHz – 380 MHz (military aviation)
- AM modulation

Most emergency services aircraft include conventional FM public safety LMR channels appropriate to their area of operation.

Protection of AIR-TO-GROUND channels is critical to safe air Operations.

- Selection of FM frequency (LMR) is critical due to interference with adjacent systems (altitude of airplanes).

## Topic

Aviation Radio

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**Aviation Radio (cont'd)**

- With appropriate licensing, may be used by ground mobile units for air-ground communications

*Air-to-ground operations should be on public safety FM channels*



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Frequency Regulations and Usage

Visual 5-22

**Key Points**

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Air-to-air and air-to-flight control facilities

- 108 MHz – 136 MHz (civil and military aviation)
- 225 MHz – 380 MHz (military aviation)
- AM modulation

Most emergency services aircraft include conventional FM public safety LMR channels appropriate to their area of operation.

Protection of AIR-TO-GROUND channels is critical to safe air Operations.

- Selection of FM frequency (LMR) is critical due to interference with adjacent systems (altitude of airplanes).
- Do not patch AM aviation frequencies without express approval of aviation management.

**Topic**      Analog vs. Digital Radio

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**Analog Versus Digital Radio**

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- Analog radios use Frequency Modulation (FM) for Land Mobile Radio applications
- Susceptible to noise and sometimes noise can override intended traffic
- Usually users will know there is someone calling
- Gradual decay of signal quality versus distance

Unit 5:  
Frequency Regulations and Usage

Visual 5-23

**Key Points**

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Analog (FM modulation) is the mainstay of historical public safety radio systems.

- Most established systems use analog
- Susceptible to noise – worse at low band, less at upper UHF
- Usually has some minimal indication of a transmission
- Gradual decay of signal in fringe areas of operation

**Topic** Analog vs. Digital Radio

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**Analog Versus Digital Radio (cont'd)**

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- Digital radio uses a vocoder to convert human voice into digital symbols for compression purposes
- Digital users either hear clear traffic or hear nothing
  - Sharp fringe area drop-off
  - Several studies have questioned the reliability of digital in high noise environments, such as fire ground operations (IAFC report link)  
<http://www.iafc.org/displaycommon.cfm?an=1&subarticlenbr=719>
- Signal blocking by unintended third party transmission in conventional digital usage



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Frequency Regulations and Usage

Visual 5-24

**Key Points**

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- Digital vocoder converts analog audio to digital format.
- Consistent quality out to fringe with rapid drop of signal Bit error rate.
- High ambient noise environments may tend to “confuse” the vocoder and cause poor performance in areas such as fire ground operations
- IAFC Report on Fire Ground Noise link:
- <http://www.iafc.org/displaycommon.cfm?an=1&subarticlenbr=719>
- May drop a desired signal in the presence of a “hidden” third-party transmitter where an alternate transmitter (on channel) keys up.

## Topic

Trunking

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**Trunking**

- Trunked radio systems differ from conventional
- Trunked systems have a number of frequencies pooled into one system
- Primary difference is the use of “talkgroups” instead of discrete frequencies
- Each transmission is between talkgroups and is moved between frequencies as frequencies are available
  - Dynamic frequency assignments
  - Channel loading is based on probability

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Frequency Regulations and Usage

Visual 5-25

**Key Points**

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Typically 800 MHz (700 MHz). UHF and VHF high band trunking is growing

Dissimilar vendor systems are often incompatible due to proprietary features. Theory of trunking:

- Greater number of potential talk paths than available frequencies due to the statistical probability length of given radio calls and the statistical availability of frequencies
- Number of simultaneous calls limited to the total number of talkpaths available on a given trunked site
- Quality usually indicated by the number of “busy” indications
- Systems are typically scaled for very few “busies”
- Interoperability talkgroups should be pre-defined in local/regional systems and part of system pre-planned fleet mapping
- Trunking is based on the theory of probability. There is no guarantee of access in congested time periods.

How long has trunking existed?: Trunking has been used in the telephone systems since 1923 to share a limited number of lines. Telephone company interoffice lines were referred to as “trunk lines.”

How does a trunked talkgroup work?

User A wants to contact all of the units in his/her talkgroup. The Push-to-Talk (PTT) is keyed, which causes the radio to send a short burst of data to the control channel repeater. This data identifies the caller attributes and enters a channel request to the system controller. User A's radio then switches to receive mode to await a data response from the controller. Upon receipt of the request, the system controller attempts to select an available voice channel. If a voice channel is available, the system controller sends a data message over the control channel switching all units in User A's talkgroup to the available voice channel. Only units in this particular talkgroup are automatically switched to the assigned channel. When User A starts talking, all the members of the talkgroup will hear the conversation. This preempts any other use of that assigned channel for the duration of the call.

**Topic**Trunking

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**Trunking (cont'd)**

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- When was trunking invented?
- Talkgroups capacity enhanced by probability of channel availability
  - Instantaneous capacity is limited to the actual frequency capacity
- Fleet mapping should include interoperability talkgroups

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Visual 5-26

**Key Points**

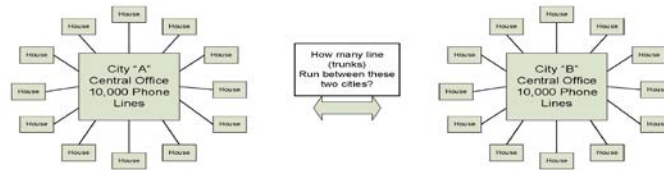
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## Topic

## How Many Lines Run Between the 2 Cities?

### How Many Lines Run Between the 2 Cities?

- The answer is very few, possibly as few as 20. This is based upon the probability that a very small percentage of the City "A" population will want to talk to the City "B" population at the same time (Erlang Theory)
- This is the exact same theory used in Trunked radio, a large number of users sharing a small number of trunked channels, making the utilization very efficient

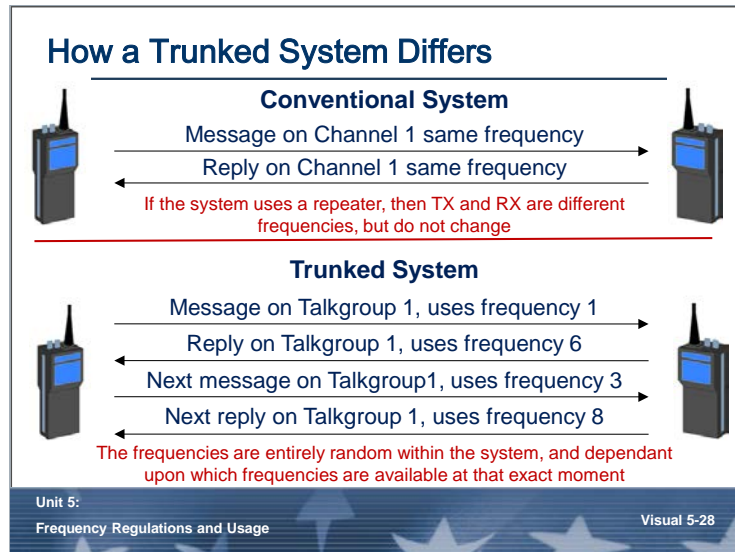


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Visual 5-27

### Key Points

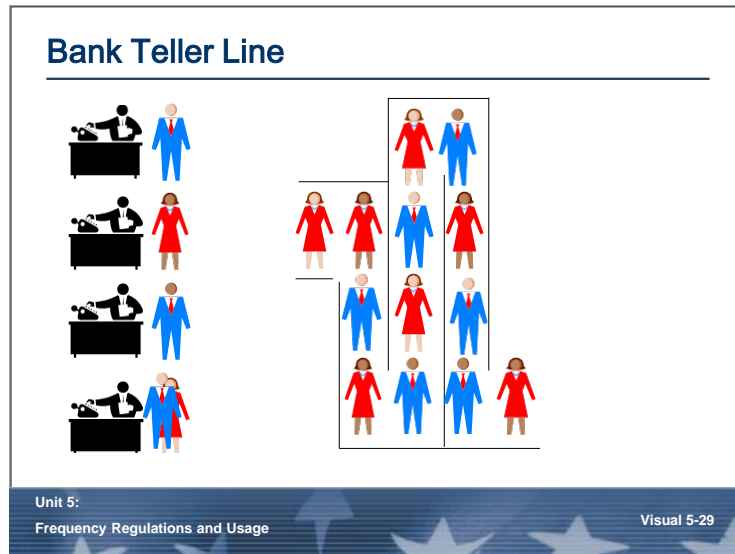


**Topic** How a Trunked System Differs**Key Points**

## Topic

Bank Teller Trunking Analogy

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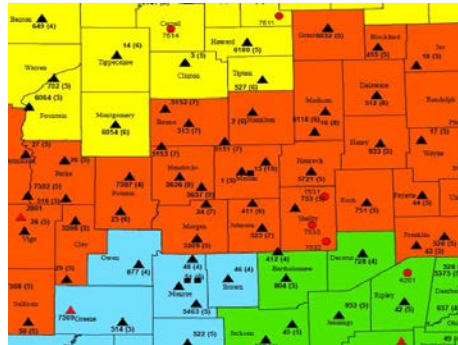
Key Points

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## Topic

## Trunked System Capacity

## Trunked System Capacity



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Frequency Regulations and Usage

Visual 5-30

## Key Points

Talkgroups do not equal talkpaths. A given site will contain a fixed number of available talkpaths. A COML should understand system architecture in order not to overload a site. This diagram depicts site locations followed by the number of talkpaths available in parentheses. Shared channels are good but scanning can be a mess. To avoid these problems it can be recommended not to allow scanning.

**Topic** Narrowband – VHF/UHF

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**Narrowband – VHF/UHF**

**Federal Communications Commission (FCC) Deadline:**  
*December 31, 2012*

- 150-174 MHz and 421-512 MHz

<http://www.imsasafety.org/PDFs/Narrowbanding%20V2%20R2.pdf>

**Convert from...**

- 25 kHz bandwidth channels to 12.5 kHz bandwidth channels, or equivalent voice talk paths – one per 12.5 kHz)

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Visual 5-31

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**Key Points**

Discussion regarding the FCC mandate to reduce bandwidth of transmissions in order to create additional channels and greater spectrum efficiency.

FCC Deadline – December 31, 2012 (with the exception of marine VHF and two VHF paging channels)

- 150-174 MHz and 421-512 MHz
- Convert from 25 kHz bandwidth channels to 12.5 kHz bandwidth channels (Or equivalent voice talk paths – one per 12.5 kHz)
- Radios purchased in last 10 years are narrowband-capable
  - Check specific models for full compliance on all available channels
  - Regional coordinated conversion conflicts
  - Including designated mutual aid channels

IAFC Narrowbanding Guide: <http://npstc.org/documents/NarrowbandingV2R2.pdf>

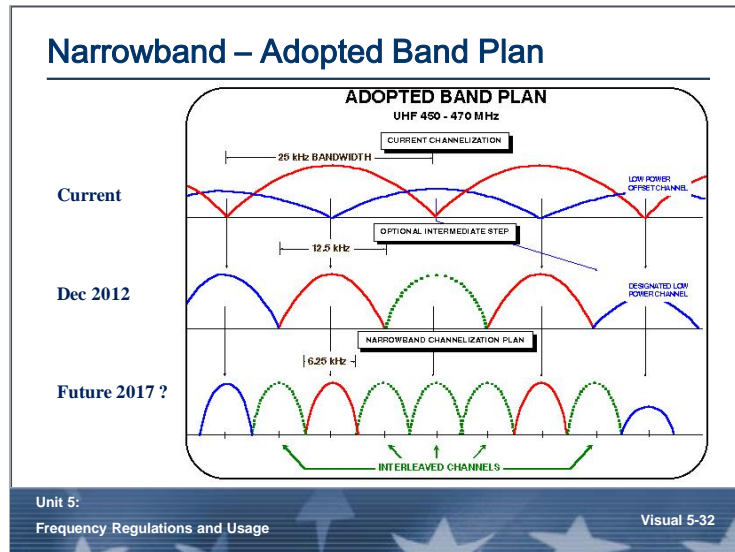
Further narrowbanding to 6.25 kHz channel centers while mentioned by the FCC, have no determined dates as yet.

700 MHz is already channelized to 6.25 kHz with a temporary general waiver for 12.5 kHz.

During the narrowband transition ending in December 2012, COMLs must be careful not to mix bandwidth on any given channel. Mixing bandwidths has dangerous consequences.

**Topic**      Narrowband – Adopted Band Plan

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**Key Points**

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## Topic

Interference

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### Interference

This issue becomes bigger every day

- Mechanical interference – rusty bolts, bad grounds
- Broadband noise
- Inter-modulation (transmitter mixes)
- Co-channel – on frequency
- Adjacent channel – near frequency
  - Try to identify the offending station by monitoring; listen for call signs or geographical information to assist in locating the station



**Be aggressive in eliminating interference. It can get worse at exactly the wrong time and compromise operations**

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Visual 5-33

### Key Points

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Interference: How does interference affect radio communications?

- Congestion causes increased interference
- Licensed spectrum users
- Ambient commercial and industrial noise sources
  - Computers
  - Industrial systems (RF gluing, computer control)
- High power transmitters – near field overload
- Intermodulation (Intermod) – mixing of various frequencies
  - Direct frequency mixes in transmitters
  - Rusty bolts, fences
- Bi-directional amplifiers (BDAs)
- Digital TV over-the-air antenna amplifiers
  - Self-oscillation

- Co-channel (same frequency-different user)
- Adjacent channel – near frequency

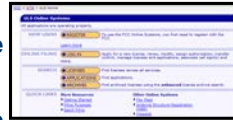


## Topic

## Interference

### Interference (cont'd)

- First choice may be to contact the agency or licensee directly, and try to find out if they changed something recently, such as antennas or power output
- Most public safety agencies will cooperate to rectify interference
- The FCC may also be of assistance finding the offending station
- Make contact; operator information can be obtained via the FCC Universal Licensing System (ULS) database



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

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Visual 5-34

### Key Points

Interference: Actions that can be taken to identify and eliminate interference:

- Direct “on frequency” interference
  - Attempt to contact licensees directly
- In extreme cases, the FCC may be able to assist in identifying dedicated interference sources
- Proper installation practices can help prevent interference
- FCC database may help to identify sources

With the exception of licensed trunked systems, the FCC classifies all other frequencies as “shared” without legal recourse to exclusivity.

**Topic**Willful Interference

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**Willful Interference**

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- This is a criminal act; involve the FCC and law enforcement early on in the process
- 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, radio shops, and amateur radio operators may all be of assistance solving this problem

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Visual 5-35

**Key Points**

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This is a criminal act; involve the FCC and law enforcement early on in the process. 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, radio shops, and amateur radio operators may all be of assistance solving this problem.

**Topic**                      Tone-Coded Squelch

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**Tone-Coded Squelch**

- **Continuous Tone-Coded Squelch System**
  - Analog sub-audible frequency tone continuously transmitted
  - 38 standard tones ranging from 67.0 Hz to 250.3 Hz
  - Provides protection from errant on-frequency RF signals
    - Radio will not open audio without the presence of the required tone
    - Particularly required for repeater operations to control repeat function
- **DCS – Digital-Coded Squelch**
  - Equivalent action as analog using digitally encoded 134.4 Hz sub-audible tone
- The P25 Network Access Code (NAC) performs a similar function to CTCSS

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Visual 5-36

**Key Points**

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**CTCSS - Continuous Tone-Coded Squelch System**

- Analog sub-audible frequency tone continuously transmitted
- 38 standard tones ranging from 67.0 Hz to 250.3 Hz
- Provides protection from errant on-frequency RF signals
  - Radio will not open audio without the presence of the required tone
  - Particularly required for repeater operations to control repeat function
- Private Line “PL,” Channel Guard “CG,” Quiet Talk “QT,” Quiet Channel “QC,” Tone Guard “TG,” and Tone Lock “TL,” are all manufacturer-specific names for the CTCSS function

**DCS – Digital-Coded Squelch**

- Equivalent action as analog using digitally encoded 134.4 Hz sub-audible tone

P25 uses a digital equivalent of tone code squelch

**Topic** Radio Programming

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**Radio Programming**

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- Laptop – Radio Interface Box (RIB)
- Cloning cables
- Logistics considerations
- De-programming radio



Unit 5:  
Frequency Regulations and Usage

Visual 5-37

**Key Points**

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Radio Programming—requirements for programming modern radios:

Virtually all modern radios are software-controlled to some degree.

Programming requires:

- Laptop with a Radio Interface Box (RIB)
- Cloning cables: Duplicate a similar make/model radio by directly loading configuration data from a master unit to a slave unit

Logistic considerations:

- Training of users (what channel, where)
- Obtain system managers authorization to alter radio programming
- Logging program parameters
- De-programming radios as required at the end of the incident
  - Retain copy of original program

Ensure programming software versions are the same. Programming a radio with a newer version of software than what is currently on the radio may prevent the radio from being re-programmed with the older version.

## Topic

Portable Repeaters

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### Portable Repeaters

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- Transportable
  - Repeat mode
  - Relay mode



Unit 5:  
Frequency Regulations and Usage

Visual 5-38

### Key Points

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Basic transportable repeaters:

- Mobile - Vehicle-mounted
- Transportable - Hand-carry (for example, helicopter, boat transport)

**Topic**NIFOG - Resource

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**NIFOG - Resource**

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- **National Interoperability Field Operations Guide**
- **Common interoperability channel lists**
- **Technical reference for the Communications Unit**



Unit 5:  
Frequency Regulations and Usage

Visual 5-39

**Key Points**

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Contents of the National Interoperability Field Operations Guide (NIFOG):

- Common interoperability channel lists
- Common used frequency lists
- Miscellaneous technical references
- Contact numbers
- FCC & NTIA rules

## Topic

NIFOG

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**Key Points**

Designed to meet the needs of an all hazard incident COML and emergency communications planners.

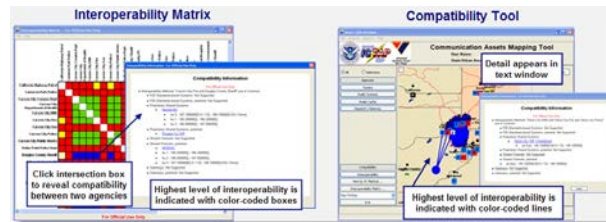
Introduce interoperability principles, regulations, technologies, communications planning tools, and templates.

Used to solve real-world interoperability problems.

## CASM

### CASM: Assets Survey and Mapping Tool

- Displays communication interoperability on a regional basis
- Available by contacting the Local Area Manager for CASM



Unit 5:  
Frequency Regulations and Usage

Visual 5-41

## Key Points

CASM was designed as a strategic planning tool but may have tactical applications. It requires real-time connectivity. Password access may be obtained through the State CASM Administrator.



## Topic

Communications Interoperability

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**Communications Interoperability**

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



Unit 5:  
Frequency Regulations and Usage

Visual 5-42

**Key Points**

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Communications Interoperability is the ability of public safety service and support providers to communicate with staff from other responding agencies, to exchange voice and/or data communications as required, on demand, and in real-time, as authorized.

Communications Interoperability is not a party-line. Common mission, common area. Interoperability might or might not be a priority. Keep it simple. Complex fixes increase risks and vulnerabilities.

**Topic**Interoperability Channels

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**Interoperability Channels**

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- **National Interoperability Channels:**
  - **VHF: 1 Calling, 4 Tactical, and 6 Tactical Repeater**
    - **Calling: VCALL10**
    - **Tactical: VTAC11, VTAC12, VTAC13, VTAC14**
    - **Tactical Repeater: VTAC33, VTAC34, VTAC35**
    - **Tactical Repeater: VTAC36, VTAC37, VTAC38**
  - **UHF: 1 Calling and 3 Tactical**
    - **Calling: UCALL40**
    - **Tactical: UTAC41, UTAC42, UTAC43**

Unit 5:  
Frequency Regulations and Usage

Visual 5-43

**Key Points**

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VCALL and VTACs, UCALL and UTACs are narrowband assignments. There are wideband interoperability channels available.

**Topic**

## Interoperability Channels (cont'd)

**Interoperability Channels (cont'd)**

- **National Interoperability Channels:**
  - **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**

Unit 5:  
Frequency Regulations and Usage

Visual 5-44

**Key Points**

VCALL and VTACs, UCALL and UTACs are narrowband assignments. There are wideband interoperability channels available.

## Topic

Local Use Agreements

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### Local Use Agreements

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- 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



Unit 5:  
Frequency Regulations and Usage

Visual 5-45

### Key Points

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You can only agree to the terms of your license, especially related to your licensed area of operation. You cannot authorize use outside of the terms of your FCC license. These should be written agreements. Agreements do not need to be complex.

**Topic** Special Temporary Authorizations

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**Special Temporary Authorizations**

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- It is possible to receive a Special Temporary Authorization to use a frequency under the Code of Federal Regulations 47 CFR Ch. I (10-1-06 Edition)
- These are obtained from the FCC
- This is not to be used in lieu of normal licensing procedures
- More information at:  
<http://www.fcc.gov/pshs/services/sta.html>

Unit 5:  
Frequency Regulations and Usage

Visual 5-46

**Key Points**

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When do you want to do this?

These are used generally for fixed systems during system failures, not typically used for planned events or exercises.

- They are allowed for emergencies involving danger to life and property
- Informal application may be used
- Grants are typically for 6 months

If you do need one, they are not difficult to get. Generally you can do this online. Be prepared to provide name and address of the applicant agency, the location of the proposed installation or area of operations, and the nature of the emergency

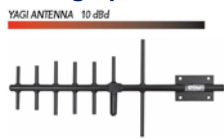
## Topic

RF Exposure

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### RF Exposure

- RF Exposure can harm human tissue
- Typically not an issue with the relatively low power and relatively low frequency equipment used in Public Safety
- RF hazards analysis required for FCC license applications and OSHA workplace safety
- Can be an issue with high-power base stations



Unit 5:  
Frequency Regulations and Usage

Visual 5-47

### Key Points

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High power broadcast and military and aviation radar facilities. Higher frequency emissions are the cause of more damage, typically to soft tissue such as the eyes.

Directional antennas such as dishes and Yagi antennas produce more focused energy.

Consult with radio engineering professionals for Maximum Permissible Exposure (MPE) evaluations for fixed high-power stations.

Exposure level drops by 75% or more each time the distance from the transmitter is doubled.

FCC Office of Engineering and Technology (OET) Bulletin No. 65 – Evaluating Compliance with FCC Guidelines for Human Exposure to Radiofrequency Electromagnetic Fields (August 1997) Reference:  
<http://www.fcc.gov/oet/info/documents/bulletins/#65>

**RF Exposure (cont'd)**

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- Best shield is distance; RF exposure drops off very quickly
- High power broadcast (AM, FM, or TV) and radar antennas are the most hazardous
- If in doubt, get an engineer to evaluate your situation



Unit 5:  
Frequency Regulations and Usage

Visual 5-48

**Key Points**

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## Topic

Exercise 5

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Key Points

**Exercise:** The purpose of the exercise is to provide the students with an opportunity to identify how to address frequency issues and explain their solutions to address these challenges. The exercise will be an instructor led discussion of frequency issues. Ask the participants of their experiences using local, regional, state, and national interoperable channels.



## Topic

Objectives Review

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**Objectives Review**

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1. *What are the factors influencing frequency coordination efforts?*
2. *Describe local use agreements and special temporary authorizations.*
3. *What are considerations in recognizing and preventing interference?*
4. *What are the modes of typical types of radio systems in use today?*
5. *Describe the Public Safety Spectrum Bands.*
6. *Identify issues related to RF safety.*

Unit 5:  
Frequency Regulations and Usage

Visual 5-50

**Key Points**

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## Unit Terminal Objective:

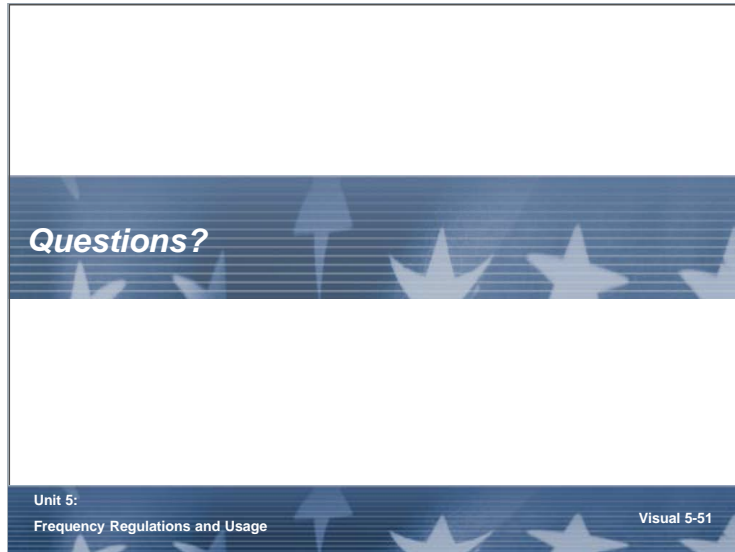
- At the end of this unit, students will be able to identify methods and standards relating to frequency regulations and use.

## Unit Enabling Objectives:

- Identify the factors influencing frequency coordination efforts.
- Understand local use agreements and special temporary authorizations.
- Identify and describe considerations in recognizing and preventing interference.
- Identify modes of typical types of radio systems in use today.
- Describe the Public Safety Spectrum Bands.
- Identify RF safety issues.

**Topic****Questions**

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**Key Points**

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