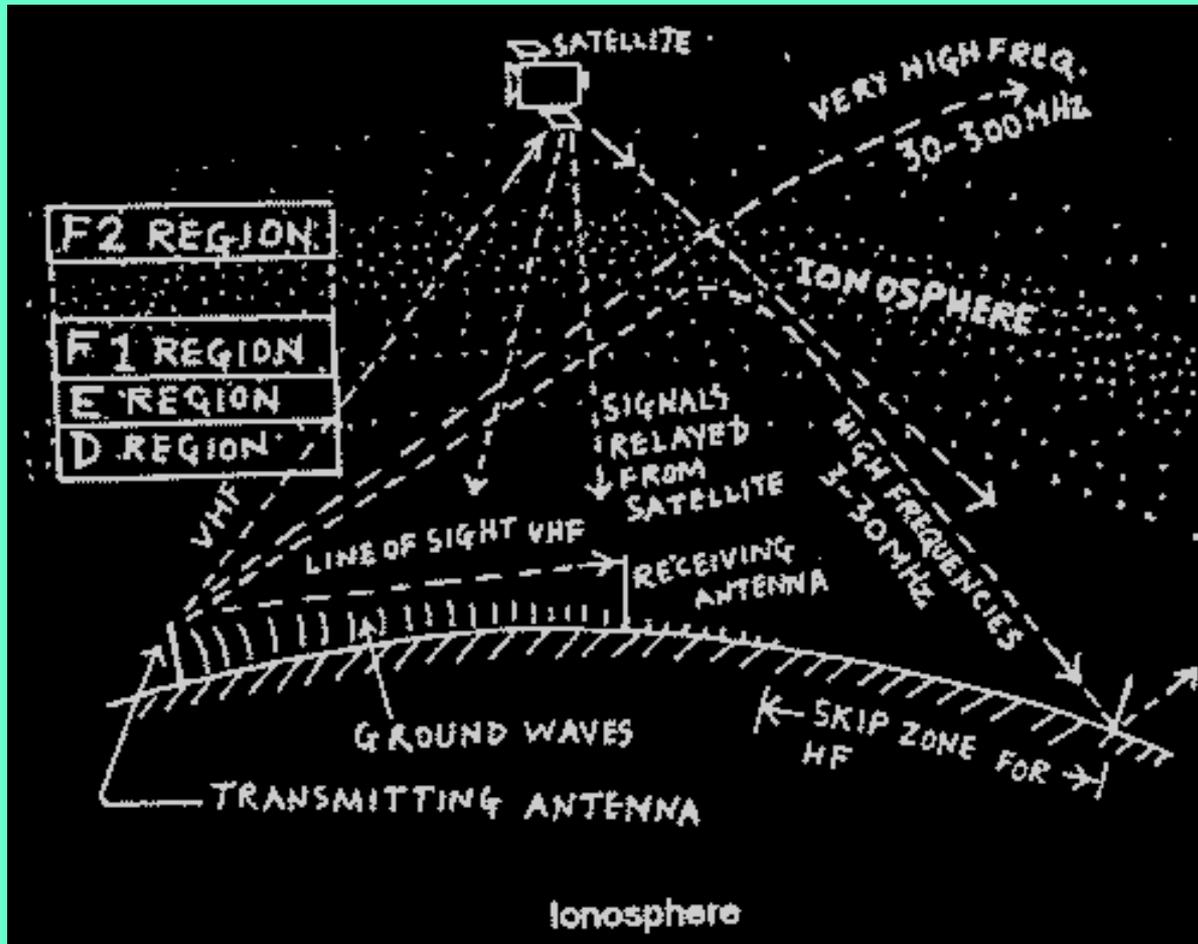


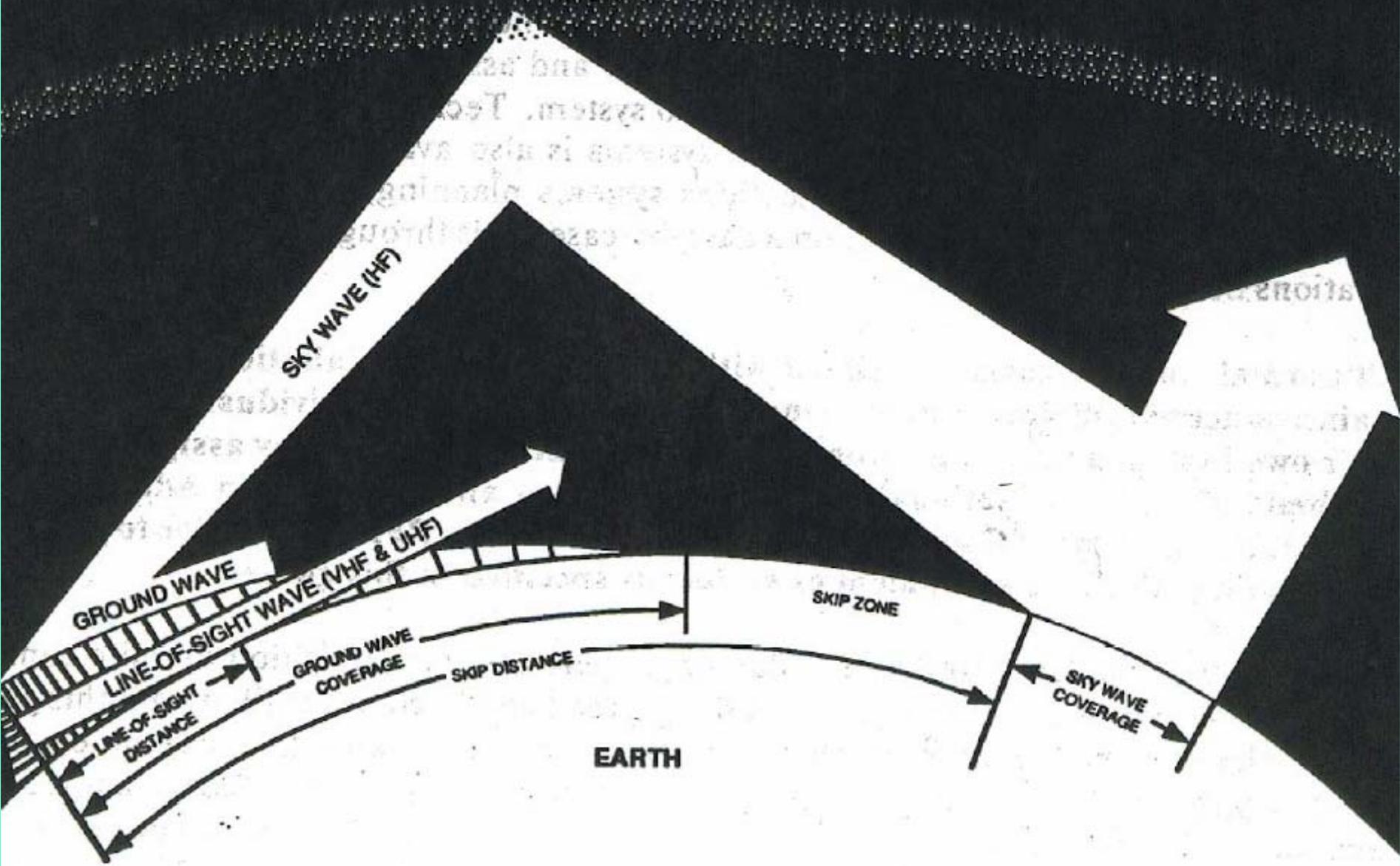
# Radio Theory The Basics



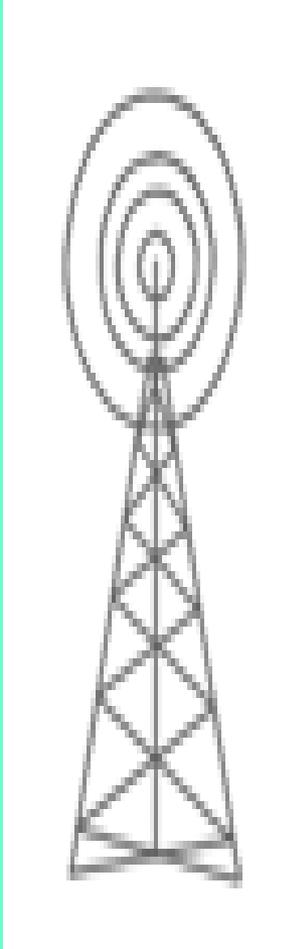
# Radio Wave Propagation



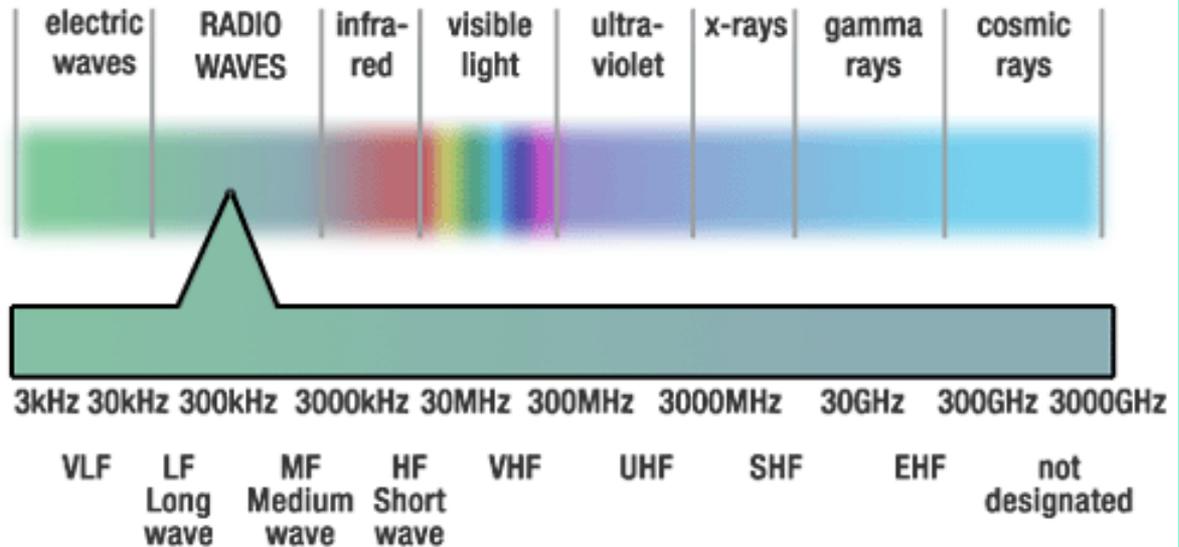
# IONOSPHERE



# Electromagnetic Spectrum



**Electromagnetic Spectrum**  
Showing the Radio Frequency Spectrum



VLF: Very Low Frequency, LF: Low Frequency, MF: Medium Frequency,  
HF: High Frequency, VHF: Very High Frequency, UHF: Ultra High Frequency,  
SHF: Super High Frequency, EHF: Extremely High Frequency



# Radio Theory The Basics

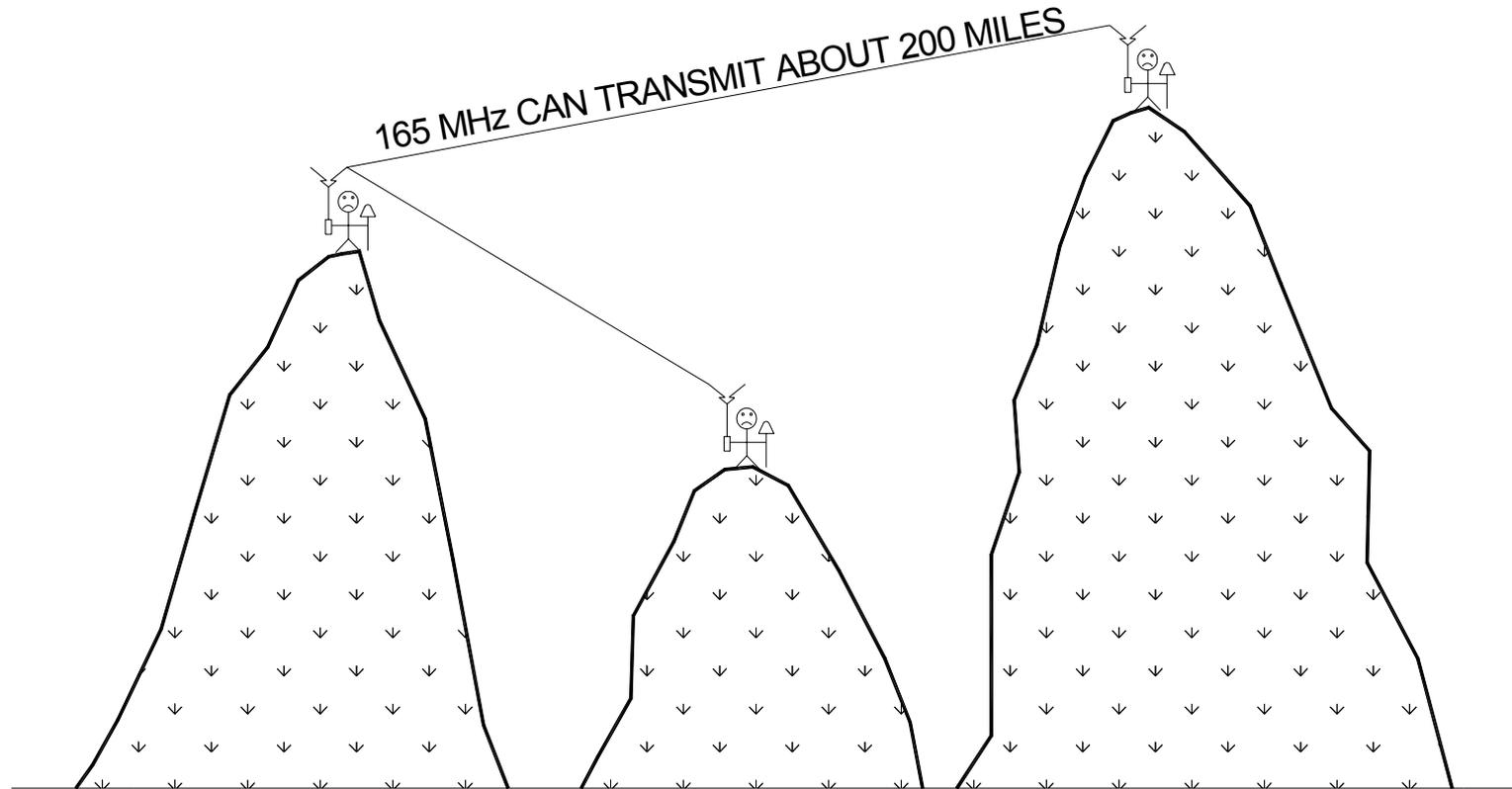
- Differences between Very High Frequency (VHF) and Ultra High Frequency (UHF).
- Difference between Amplitude Modulation (AM) and Frequency Modulation (FM).
- Interference and the best methods to reduce it.
- The purpose of a repeater and when it would be necessary.

# VHF - Very High Frequency

- Range: 30 MHz - 300 MHz
- Government and public service operate primarily at 150 MHz to 174 MHz for incidents
- 150 MHz to 174 MHz used extensively in NIFC communications equipment
- VHF has the advantage of being able to pass through bushes and trees
- VHF has the disadvantage of not reliably passing through buildings
- 2 watt VHF hand-held radio is capable of transmitting understandably up to 30 miles, line-of-sight

# VHF

## ABSOLUTE MAXIMUM RANGE OF LINE-OF-SITE PORTABLE RADIO COMMUNICATIONS



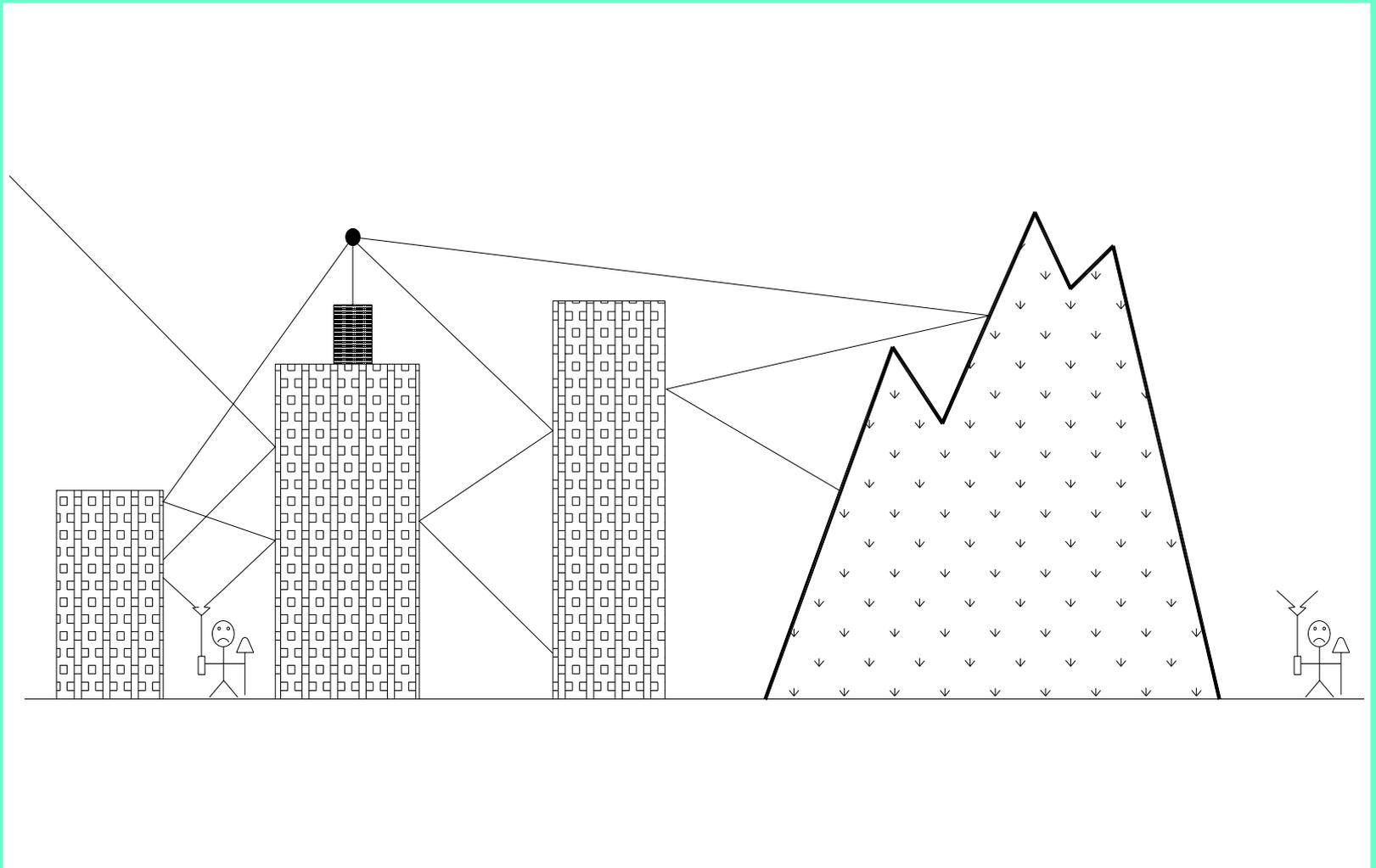
# UHF - Ultra High Frequency

- 300 MHz - 3,000 MHz
- Government and public safety operate primarily at 400 MHz to 470 MHz for incidents

# UHF - Ultra High Frequency

- 400 MHz to 420 MHz used in NIFC equipment primarily for logistical communications and linking
- Advantage of being able to transmit great distances (2 watt UHF hand-held can transmit 50 miles maximum...line-of-sight in ideal conditions)
- UHF signals tend to “bounce” off of buildings and objects, making them effective for incidents in urban areas

# UHF



# AM - Amplitude Modulation

- Government and public safety that operate primarily 118 MHz to 138 MHz use amplitude modulation for air operations
- Major disadvantages are that AM is extremely susceptible to “noisy” interference from static, lightning, and other disturbances the propagation properties also limit the effective distance
- Referred to as “victor” frequencies by the aviation community

# FM - Frequency Modulation

- Used extensively in land-mobile radio and on incidents for command and logistical nets
- Advantage: not easily accessible to atmospheric and manmade interference - very little noise

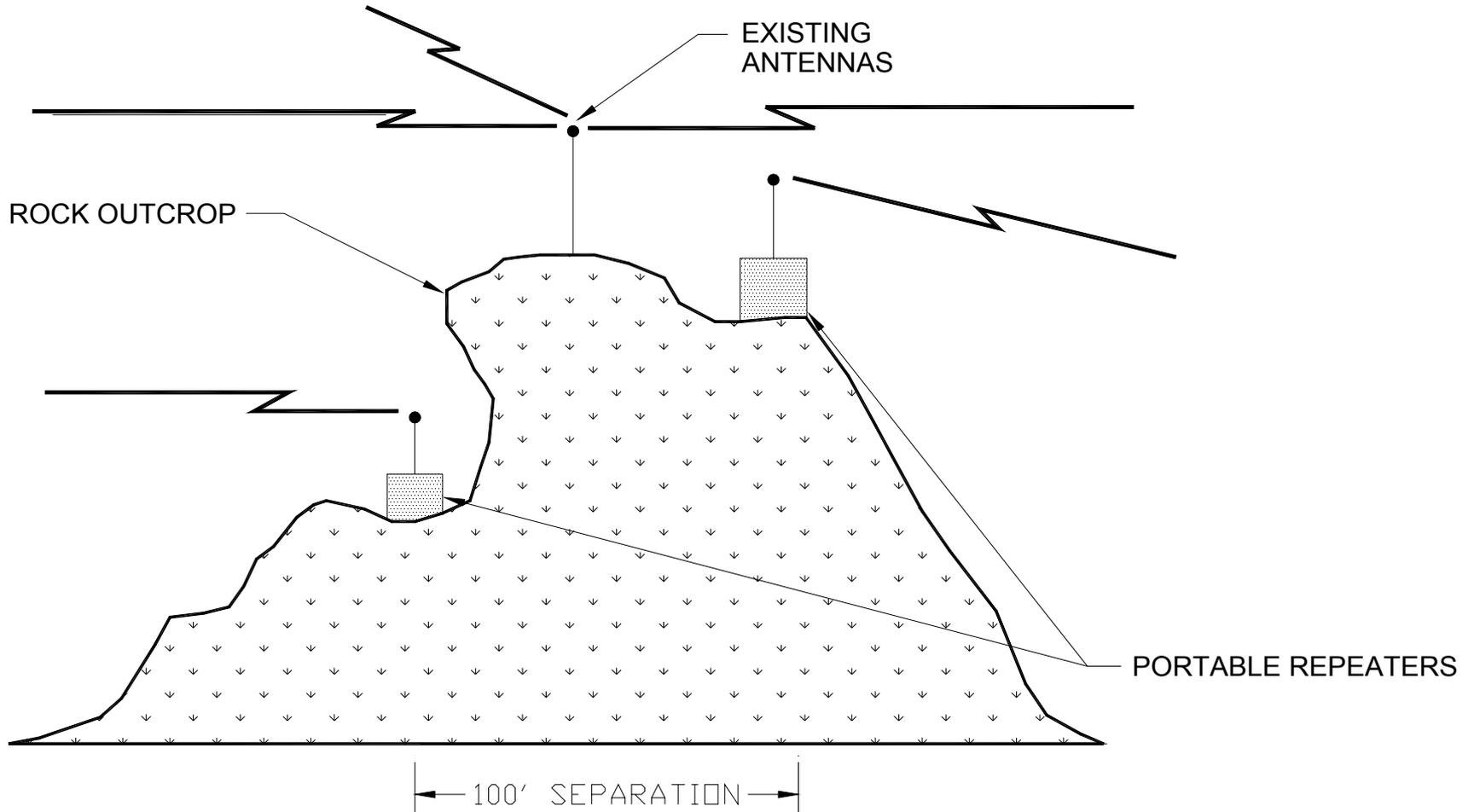
# Interference

- Primarily caused by other radio equipment operating on, or close to the same frequencies
- Reduce interference by physically separating the radio equipment

# Interference & Repeaters

- VHF repeaters should be placed several hundred yards apart or should be shielded from each other by the terrain
- VHF and UHF repeaters on the same site
  - At least 10 yards separation
  - Directional antennas will help reduce interference even more
- Vertical separation vs. Horizontal separation

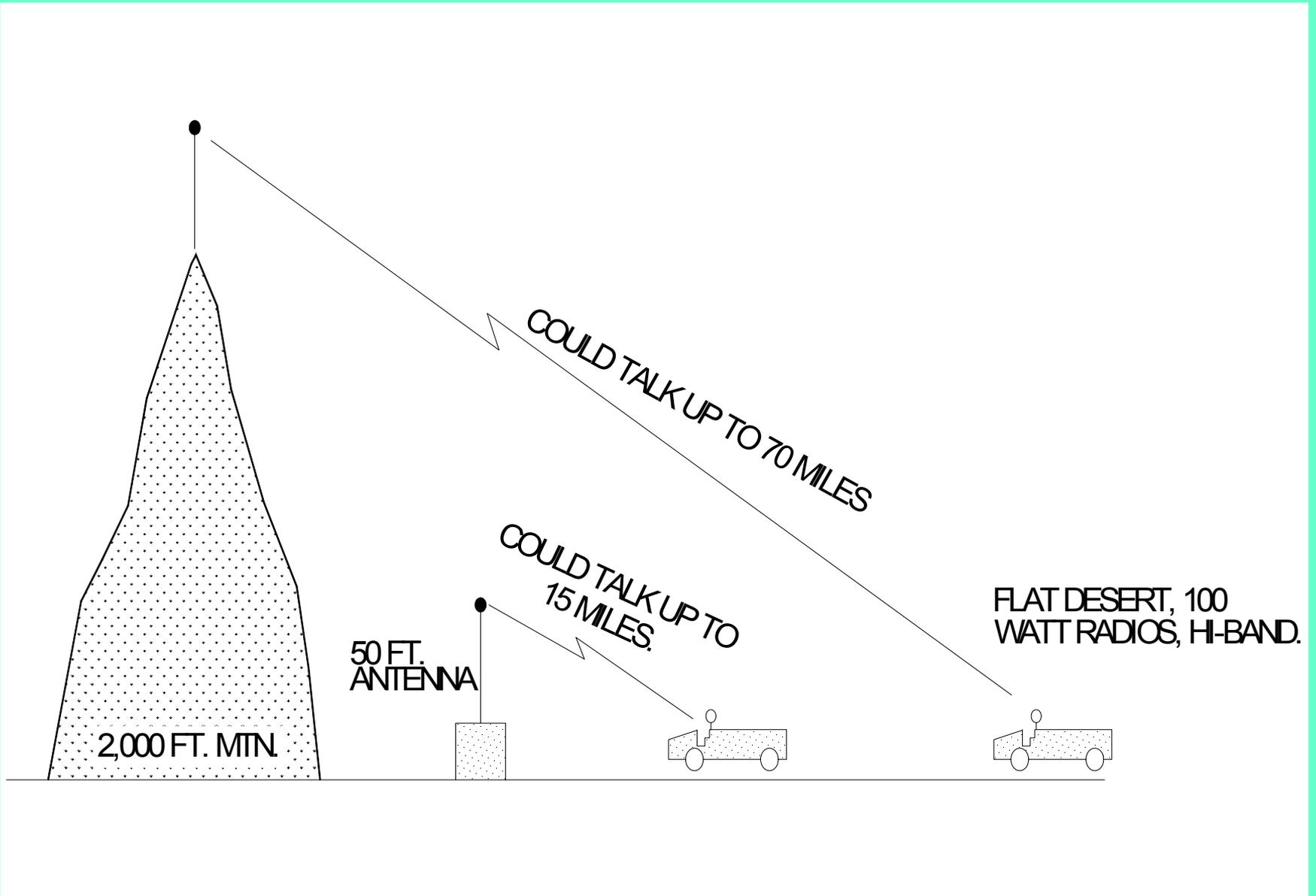
# Shielding Equipment



# Antenna Orientation

- Critical for the proper operation of the antenna
  - A hand-held radio lying on a vehicle seat is less effective than holding the hand-held upright
- The higher the antenna is above the surrounding terrain, the farther the signal will travel

# Radio Theory The Basics



# Directional Antennas

- Radiate and receive the majority of the radio signal in one direction
- The signal from directional antennas travel farther by concentrating or reflecting it in one direction
- Directional antennas provide isolation from interference by limiting receiving signals to a concentrated area
- The higher the signal is above the surrounding terrain, the farther the signal will travel



# Repeaters - VHF and UHF

- Repeats the signal by receiving on one frequency and re-transmitting on a different frequency. For example, a repeater receives the radio signals on frequency 170.450, and then transmits the signal on 168.100
- Used to cover greater distances when line-of-sight is not possible to cover the terrain

# Repeaters



# Troubleshooting Problems

- Can't hear repeater
- Rpt. Signal choppy/intermittent
- Unintelligible audio
- Low audio
- Rpt. Squelches
- Rpt. Locks Up
- No Tx or Rx
- Equipment automatically blows fuses
- Hearing adjacent traffic
- Rpt. Quits at specific times of day
- Remote does not work
- Aircraft radio link does not work
- Handheld radio does not work

# Troubleshooting Causes

- Dead battery
- Loss of coverage
- Wiring shortage
- Transmitter failure
- Receiver failure
- Antenna installation failure
- Low or no modulation
- Low battery voltage
- Incorrect frequency
- Radio not operating properly
- Incorrect Channel
- Damage in transport
- Heat / Weather
- Batteries incorrectly wired
- Transmit switch in OFF position
- Theft of Equipment
- Animal Damage
- Interference
- Intermodulation
- Keyed radio (hot mic)
- Audio levels not set correctly

# Radio Use and Incident Safety



# Incident Safety Concerns

- Lightning
- Driving hazards
- High voltage transmission lines
- Electromagnetic Radiation

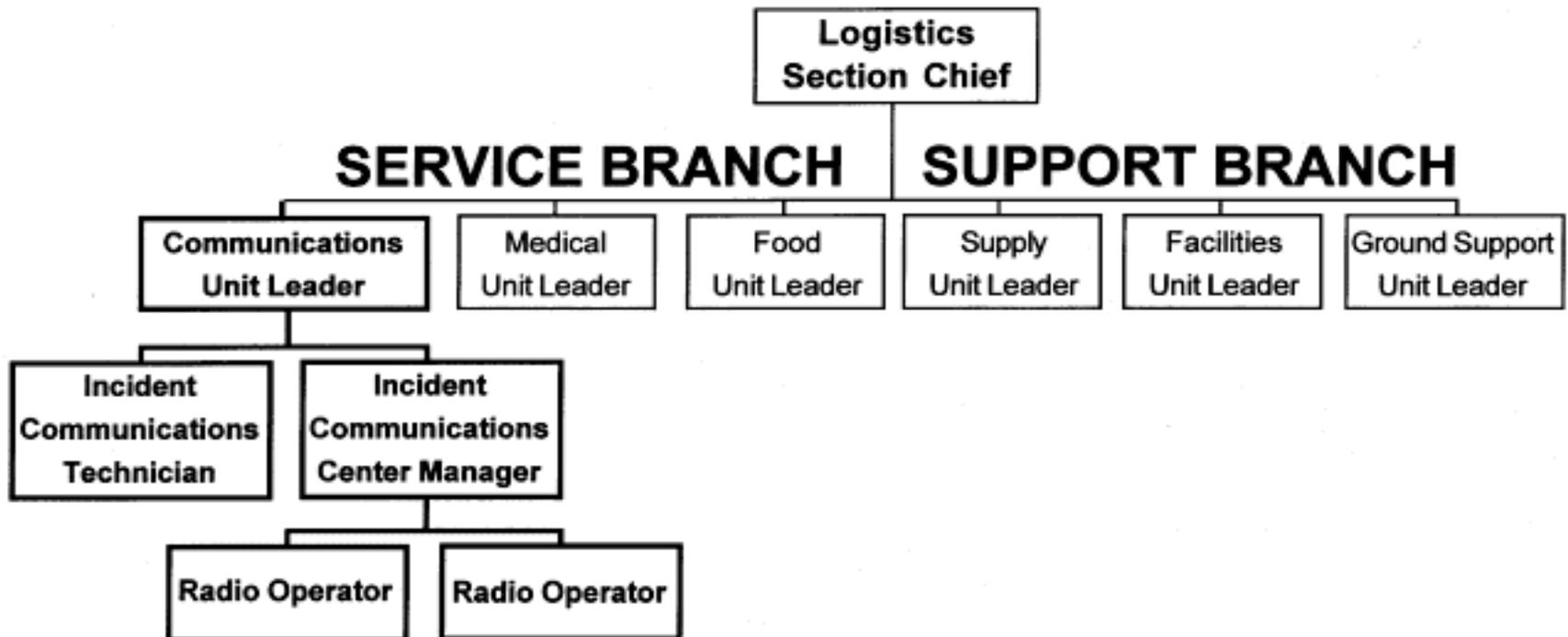


# Incident Safety Concerns

- PPE
- Hazards
- Basic and site specific hazards
- Heavy equipment



# RADIO Communications & ICS



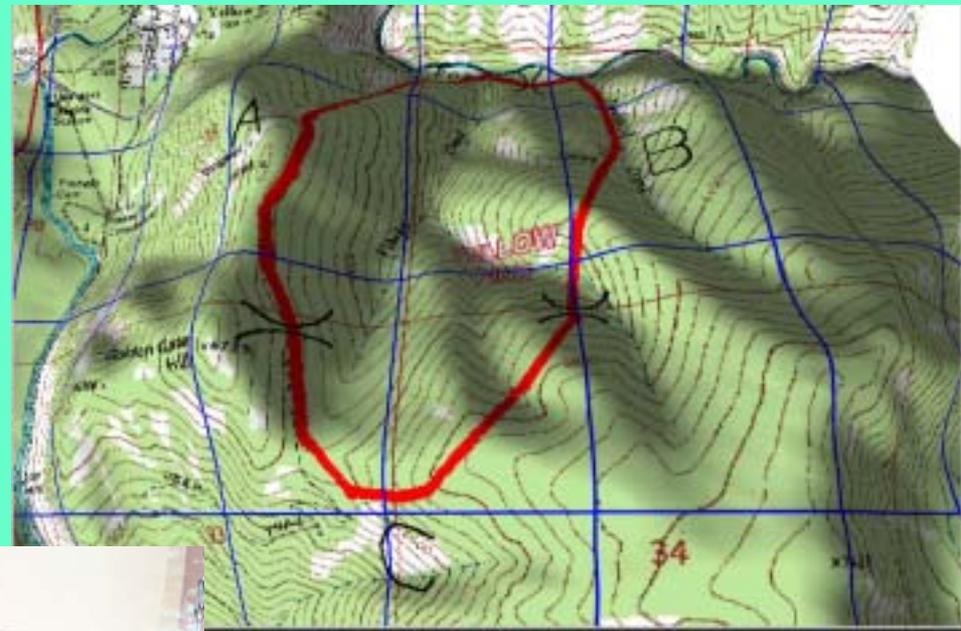
# Radio Communications Plan

## ICS 205

1. Incident Name Big Spill 1		2. Operational Period (Date / Time) From: 0600, 11/16/04 To: 0600, 11/17		<b>INCIDENT RADIO COMMUNICATIONS PLAN</b> <b>ICS 205-05</b>	
3. BASIC RADIO CHANNEL UTILIZATION					
RADIO TYPE	CHANNEL	FUNCTION	FREQUENCY	ASSIGNMENT	REMARKS
Motorola XTS 5000	2	Command Simplex	164.4500	Command	
HT 1250	5	Tactical	166.4500	Entry/Decon	
Visar	3	Tactical	162.7000	Logistics Support	
HT 1250	9	Tactical	165.4125Tx	Recon.	Repeater Freq 173.9125 Rx
4. Prepared by (Communications Unit)			Date / Time		
<b>INCIDENT RADIO COMMUNICATIONS PLAN</b>			<b>ICS 205-05</b>		
NOVA 1259					

## OTHER ISSUES:

- APCO
- Encryption
- NTIA



# QUESTIONS?