Technician Licensing Class Introduction

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Special thanks to K3DIO

The Plano Amateur Radio Klub (TX)

Some of this material comes from them

How to Operate a HAM Radio

- Definitions
- Radio Controls
- Bands and Frequencies
- Communicating over ham radio
- Simplex and Repeaters
- Emergency Communications

Definitions

- Transmitter: Transmits radio signals
  - Just like a FM radio station
- Receiver: Receives radio signals
  - Just like a FM radio in your car
- Transceiver: Does Both

Definitions

- Microphone: Converts sounds to electric signals
- Speaker: Converts electric signals to sounds
- Headphones: Speakers for your ears!
  - Really really useful in noisy areas

Audio Definitions

- Audio Feedback:
  - A microphone picks up speaker output
  - That high pitched noise at a presentation!
- Sound Card
  - Computer interface for sending/receiving
  - Can be connected to a transceiver

Audio Definitions

- Microphone
  - Some connectors include **Push-to-Talk and voltage** to power the microphone
  - If gain is too high: **distortion can occur**
    - **"Overdeviating"**
    - Can be corrected (also) by **talking farther from the microphone**

*Definitions

- AC: Alternating Current
- DC: Direct Current
- Power supply:
  - Converts AC power to DC power
- Regulated power supply:
  - Its regulator ensures output is consistent
    - EG: even if the input changes, output is 12V
    - **Prevents voltage fluctuations**
  - Many radios require 12V supplies

Ham radios vs others

- You're probably used to:
  - CBs
  - Walkie-Talks
  - CERT Radios
  - i.e. radios with “channel numbers”
- Ham radios are different
  - You set the exact frequency to use
  - There is a LOT of space in the spectrum
  - Most radios let YOU pick memory channels for your favorite frequencies if you want

Ham radios vs others

- Ham radios also:
  - Let you change the antenna
    - You can build your own antenna easily!
  - Have much higher power levels
    - Walkie-talkies: .5 watts
    - Ham radio hand-helds: 5 Watts
    - Base and mobile radios: 50 Watts and higher

Radio Controls

- Change operating frequency
  - Using the keypad (if there is one)
  - Using the VFO knob (changes freq)
  - Many microphones have up/down buttons
- All modern radios store “memories”
  - Transmit and Receive Frequency
  - CTCS Tones Frequencies and DTS codes
  - Transmit Power Level
  - …

Radio Controls: frequency

- "Shift" control separates receive/transmit frequencies
- "Step" menu changes size of up/down
  - EG: .005 vs .015MHz
  - Different area band plans

    have different FM channel steps like .015 vs .020MHz apart.

Radio Controls

- **Receiver Incremental Tuning** (RIT)
  - Fine control over frequency
  - Voice pitch in SSB seems **too high or low**
- **Carrier Squelch**
  - Quiets the radio when no signal is present

Definitions

- Filter: Removes portions of signals
  - Notch: Removes a middle segment
  - Band Pass: Leaves just the middle
  - High Pass: Removes lower frequencies
  - Low Pass: Removes higher frequencies
  - Noise Blanker: Special processing to remove repeating noise

Filters – Live Audio Demo

Definitions

- Filters can be used:
  - Input: To filter incoming signals
    - Example: Notch filter can be used to remove RF overload from a 2m signal to a TV
  - Output: Reduce “harmonic emissions”
    - Install between **transmitter and antenna**
    - If a transmitter is producing signals it shouldn't

Radio Controls: Others

- Noise blanker:
  - Useful to remove “repeating” noises
  - Useful to remove car ignition noise
    - (Spark plugs make noise when they fire)

Unit Prefixes

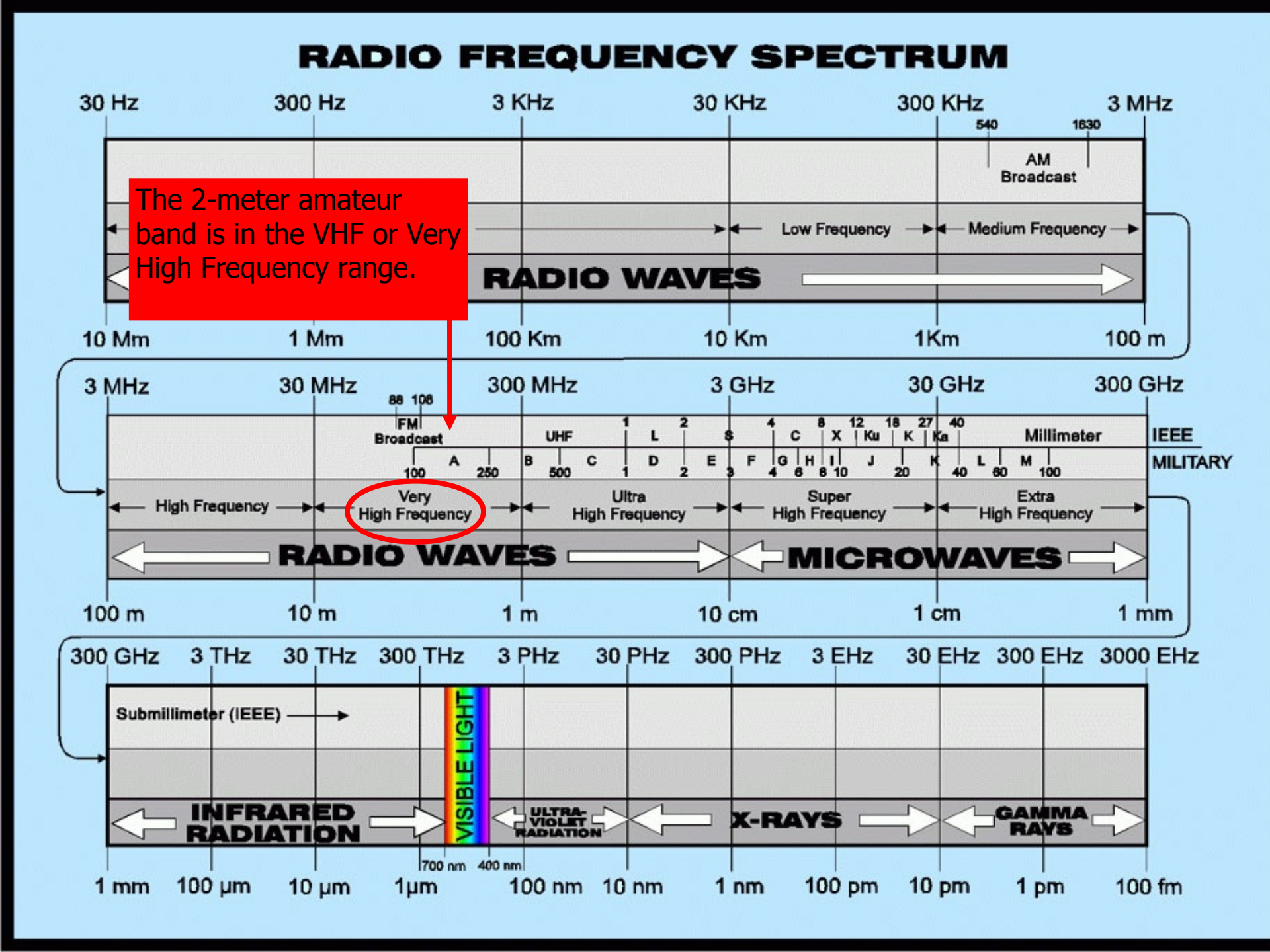
Prefix	Meaning
G (giga)	1,000,000,000
M (mega)	1,000,000
k (Kilo)	1,000
m (milli)	1/1000
u (micro)	1/1,000,000
n (nano)	1/1,000,000,000
p (pico)	1/1,000,000,000,000

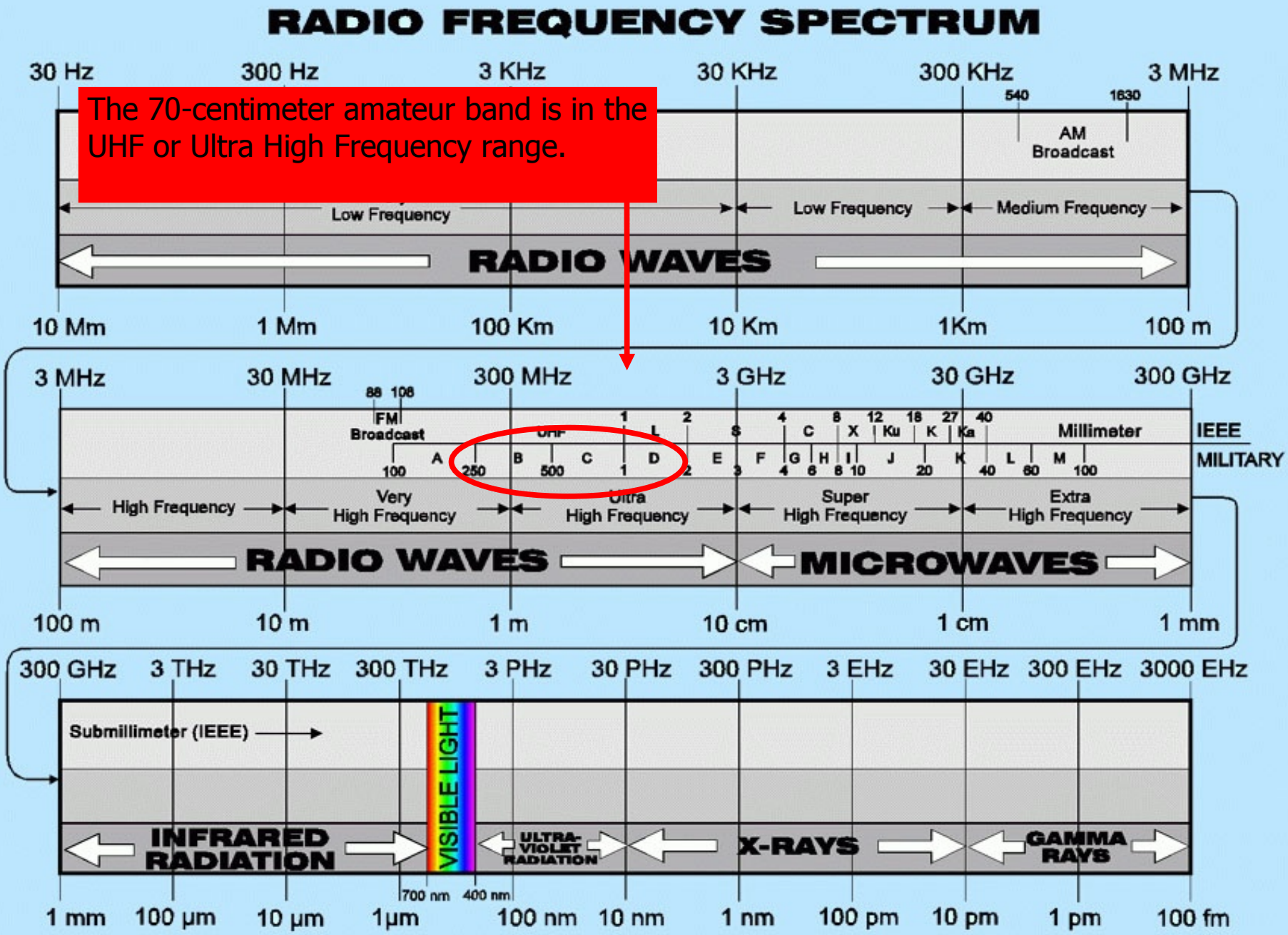
Examples:

1500 kHz	= 1,500,000 Hertz
1 kV	= 1000 Volts
1 uV	= 1 millionth of a Volt
1500 mA	= 1.5 Amperes
1 kDavisites	= 1000 Davisites – prefixes are generic!

Bandwidth Control

- Some radios have multiple bandwidth choices
  - e.g. narrow FM vs wide FM
  - **Can reduce noise and interference**
    - "Narrow" lets less in, and broadcasts less
- Good receive filters
  - SSB: **2400 Hz** (2.4kHz)
  - CW: **500 Hz**


RADIO FREQUENCY SPECTRUM
30 Hz
300 Hz
3 KHz
30 KHz
300 KHz
3 MHz
540
1630
AM Broadcast
Low Frequency
Medium Frequency
RADIO WAVES
The 2-meter amateur band is in the VHF or Very High Frequency range.
10 Mm
1 Mm
100 Km
10 Km
1Km
100 m
3 MHz
30 MHz
300 MHz
3 GHz
30 GHz
300 GHz
88 108
FM Broadcast
UHF
L
S
C
X
Ku
K
Ka
Millimeter
IEEE
MILITARY
A
B
C
D
E
F
G
H
I
J
K
L
M
High Frequency
Very High Frequency
Ultra High Frequency
Super High Frequency
Extra High Frequency
RADIO WAVES
MICROWAVES
100 m
10 m
1 m
10 cm
1 cm
1 mm
300 GHz
3 THz
30 THz
300 THz
3 PHz
30 PHz
300 PHz
3 EHz
30 EHz
300 EHz
3000 EHz
Submillimeter (IEEE)
INFRARED RADIATION
VISIBLE LIGHT
ULTRA-VIOLET RADIATION
X-RAYS
GAMMA RAYS
700 nm
400 nm
1 mm
100 µm
10 µm
1µm
100 nm
10 nm
1 nm
100 pm
10 pm
1 pm
100 fm


RADIO FREQUENCY SPECTRUM
The 70-centimeter amateur band is in the UHF or Ultra High Frequency range.
30 Hz
300 Hz
3 KHz
30 KHz
300 KHz
3 MHz
540
1630
AM Broadcast
Low Frequency
Low Frequency
Medium Frequency
RADIO WAVES
10 Mm
1 Mm
100 Km
10 Km
1Km
100 m
3 MHz
30 MHz
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3 GHz
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FM Broadcast
UHF
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100
250
500
1
2
3
4
6
8
10
20
40
60
100
High Frequency
Very High Frequency
Ultra High Frequency
Super High Frequency
Extra High Frequency
RADIO WAVES
MICROWAVES
100 m
10 m
1 m
10 cm
1 cm
1 mm
300 GHz
3 THz
30 THz
300 THz
3 PHz
30 PHz
300 PHz
3 EHz
30 EHz
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3000 EHz
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INFRARED RADIATION
VISIBLE LIGHT
ULTRA-VIOLET RADIATION
X-RAYS
GAMMA RAYS
700 nm
400 nm
1 mm
100 µm
10 µm
1µm
100 nm
10 nm
1 nm
100 pm
10 pm
1 pm
100 fm

Technician Bands and Frequencies

(there are test questions about these; * = secondary user)

- 10 meters 28.0 to 28.5 MHz
- 6 meters 50 to 54 MHz
- 2 meters 144 to 148 MHz
- 1.25 meters (“220”) 222 to 225 MHz
  219 to 220 MHz secondary use **only for data!**
- 70 centimeters (“440”)* 420 to 450 MHz
  no usage from 420 to 430 MHz north of line A (just south of Canada.)
- 33 centimeters (“900”)* 902 to 928 MHz
- 23 centimeters (“1.2GHz”)* 1240 to 1300 MHz
- Plus higher and also morse code on some lower

Technician Bands and Frequencies

- 10 meters
- 6 meters
- 2 meters
- 1.25 meters (“220”)
- 70 centimeters (“440”)
- 33 centimeters (“900”)
- 23 centimeters (“1.2GHz”)

Can talk across the U.S. and farther!

The most popular for local traffic; LOTS of repeaters

Great for line of site

Great for control and high-bandwidth needs; **Shorter wavelengths penetrate walls better!**

- National calling frequencies:
  - **70Cm – 446.000MHz**
  - 2m – 156.520

Mode restrictions

- The 6-meter, 2-meter, and 1-1/4-meter bands available to Technician class licensees have restrictions:
  - 6M: 50.0-50.1 Only CW (Morse Code)
  - 2m: 144.0-144.1 Only CW (Morse Code)
  - 1.25m: Only CW and data in restricted portion

FCC assigns Frequencies

- The FCC designates frequency ranges
  - Amateurs self-coordinate inside that

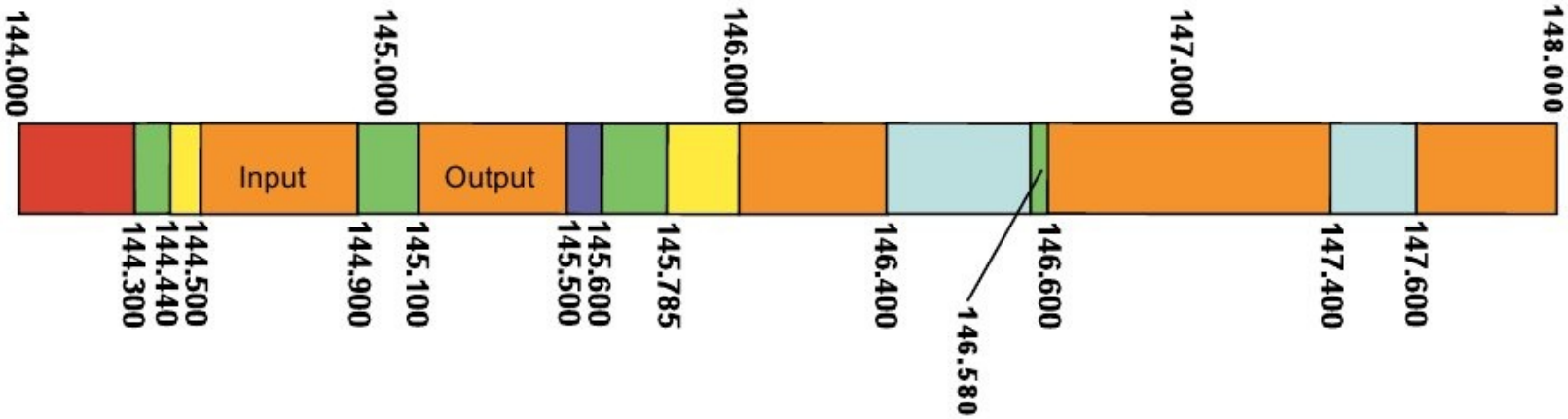
Frequency Cordinators

- NOT appointed by the FCC
  - The FCC gives us a "band"
  - We create "**Frequency Coordinators**"
    - **Recommends transmit/receive channels**
    - **Selected by National Council of Independent Frequency Coordinators**
- Frequency Coordinators:
  - Create band plans
  - **Select transmit/receive frequencies for repeater and auxiliary stations**

Band Plans

- Band Plans break down FCC frequency ranges into sub-ranges
  - Simplex vs Repeaters vs Digitial vs ...
  - Promotes “efficient use of the spectrum”
  - Regional differences (we're in “NorCal”)
  - Repeater frequencies are also coordinated

Northern California 2 Meter Band Plan



Legend

- Satellite
- Digital
- Experimental
- Simplex
- Weak Signal
- FM Repeaters

For Repeater coordination in Northern California contact NARCC
www.narcc.org

For weak signal info see the Western States Weak Signal Society
http://www.wswss.org/

For satellite information see Amsat
www.amsat.org

Specific Frequency info
FM Channel spacing
20 kHz below 146.00
15 kHz above 146.00

144.000-144.100 CW only
144.200 SSB calling
144.390 APRS
146.58 Digital
145.51 SSTV
146.52 Nationwide FM calling.
FM Simplex frequencies:
146.415, 146.430,146.445, 146.460,146.475, 146.490, 146.505, 146.520, 146.535, 146.550, 146.565, 146.595, 147.405, 147.420, 147.435, 147.450, 147.465, 147.480, 147.495, 147.510, 147.525, 147.540, 147.555, 146.570,147.585

"national calling frequency"

Communicating

- Chose a frequency
- Listen for a while
  - Ensure it's not being used
  - Frequently you can only hear one side of a conversation
- Calling someone you know:
  - Just like a phone: Hey Joe, this is Wes
  - Ham radio: KK6ABC this is WS6Z

    Optionally: Are you on frequency Joe?
  - Responding: Hi WS6Z, this is KK6ABC

    The only real rule: You must say YOUR callsign

Communicating

- Calling CQ “seek you”
  - Indicates you want to talk to anyone
  - “**Calling any station**”
  - On a repeater, often just **saying your callsign** is the same or “is monitoring”
  - More common on HF bands than 2m
    - But I've done it and it's fun!

Communicating

- Two (main) types of communication
  - Direct or “simplex”
    - Nothing in between you and the other station
    - **Transmitting and receiving on the same frequency**
  - Through a repeater
    - Useful for communicating over longer distances
    - Enables wide-area communication for grops

Communicating: Direct / Simplex

- Direct communication between stations
- Should be used instead of repeaters when possible to avoid tying up a repeater
- No one has exclusive use of a frequency except in emergencies
- “More fun”

Communicating: Repeaters

- Extends range of portable devices
- Pause briefly during conversations
  - Lets anyone else jump in if they need to
- "Courtesy tones" often trail repeater transmissions indicating completion

Communicating: Repeaters

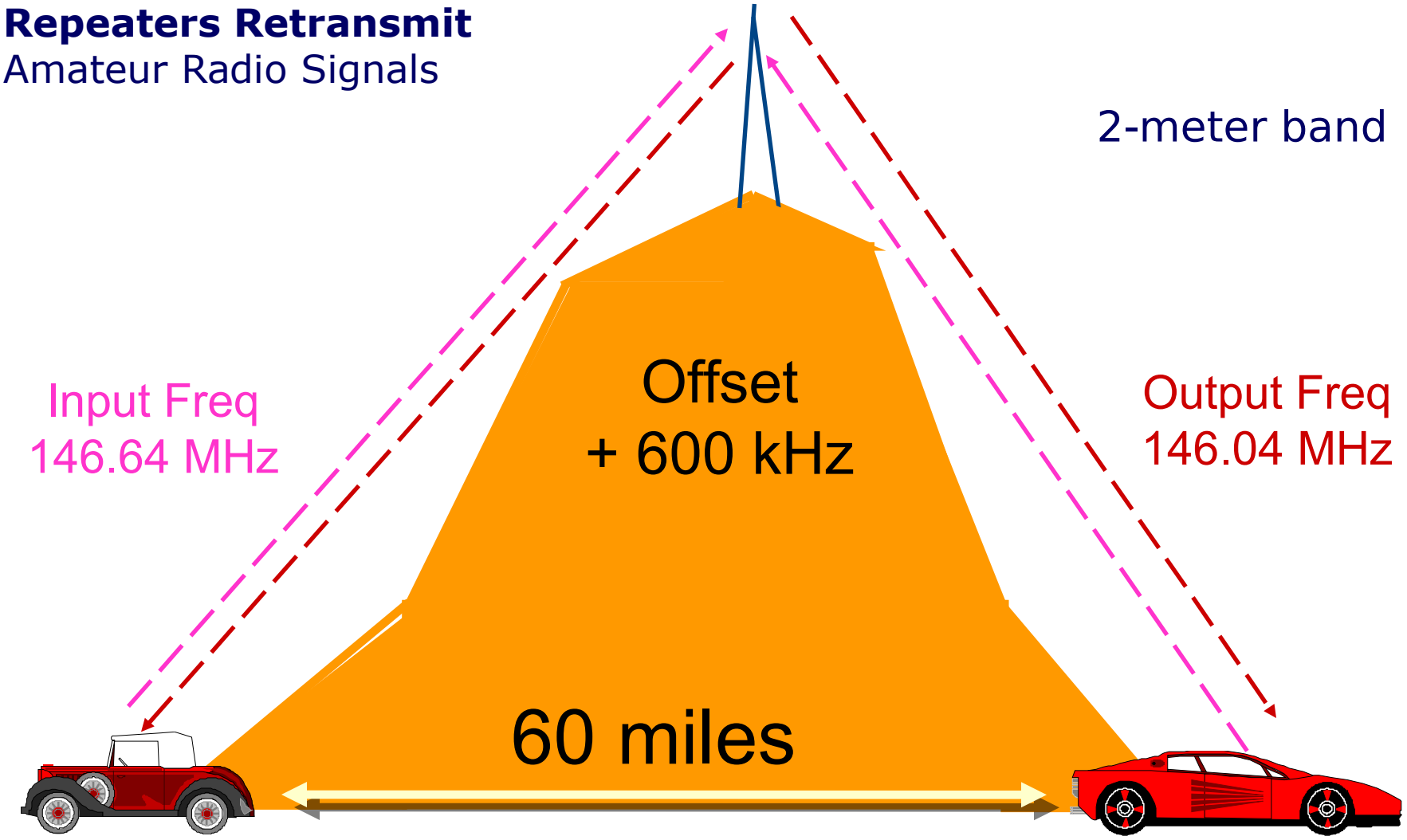
- Linked repeaters can connect multiple repeaters together
  - Radio linking – repeater to repeater
  - Internet linking: IRLP, EchoLink
- Repeater access may be restricted
  - ("Closed" to a group or club)
- **Auxiliary stations receive input and transmit them to the main repeater**
  - i.e. multiple listening antennas
  - Extends the range of a repeater
- Almost always **FM** mode

Communicating: Simplex or Repeater

- What to use?
  - Simplex when close
  - Repeaters for large groups
  - You listen to the input frequency to see if you can hear some directly
    - Some radios have a “reverse” button for this
- What is used?
  - Simplex for fun – how far can you talk?
  - Repeaters for events, nets and chit-chat

Repeaters: 2-meter band

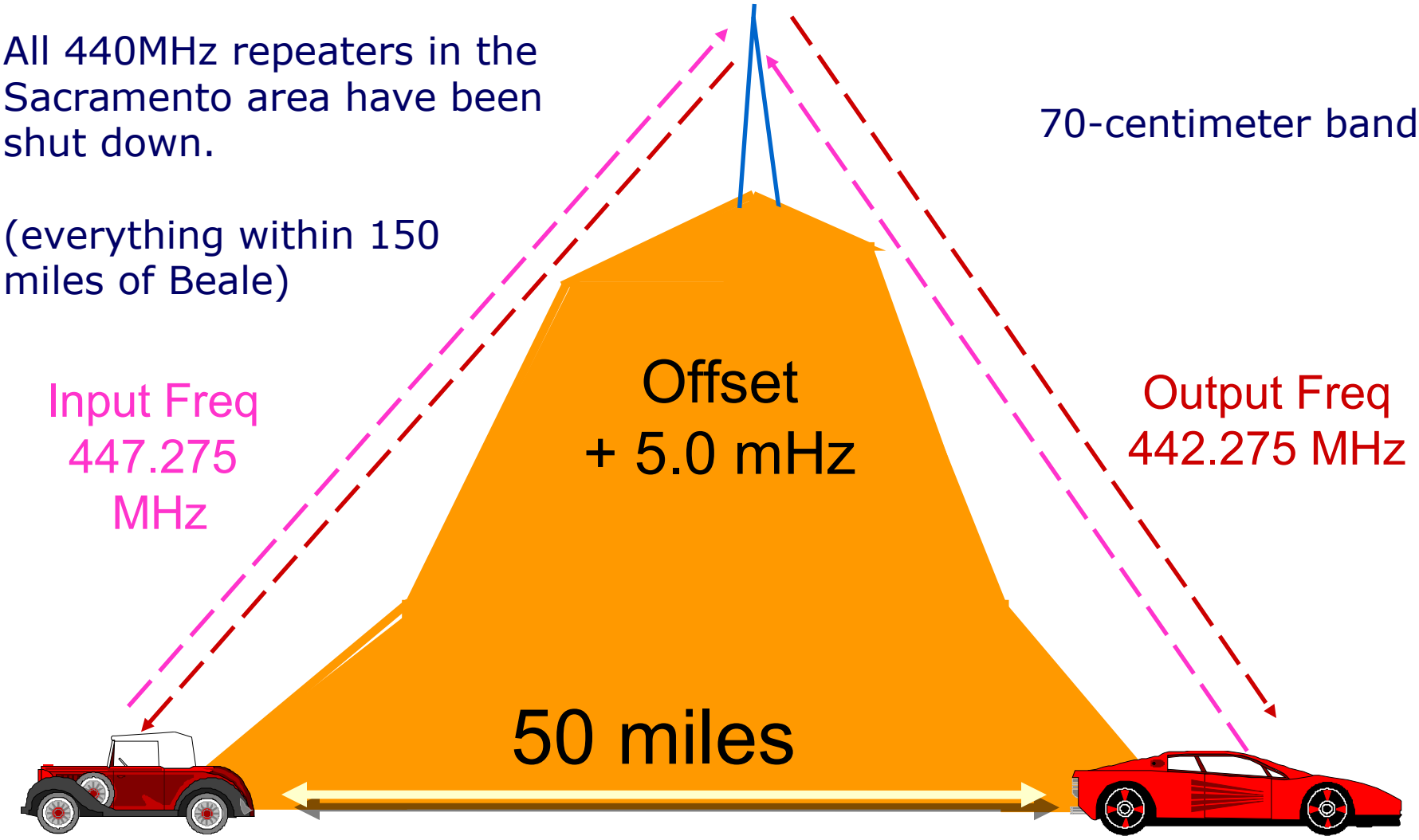
Repeaters Retransmit
Amateur Radio Signals



Repeaters: 440MHz

All 440MHz repeaters in the Sacramento area have been shut down.

(everything within 150 miles of Beale)



Repeaters: Offsets

- Repeaters **listen on one frequency and transmit on another.**
  - **"Repeater Offset"**
  - Offsets are standardized on each band
  - 2m repeaters: +/- **600 kHz**
  - 70cm repeaters: +/- **5MHz**
- Terms
  - Input frequency: Repeater listens to
  - Output Frequency: Repeater transmits on
    - (usually listed by this number)

Repeaters: Tones and DTS Codes

- Most repeaters listen for special codes
  - They implement selective hearing
    - Repeaters only retransmit signals with codes
    - Important with neighboring repeaters
  - CTCSS Tones (aka “PL Tones”)
    - A low frequency (“**sub-audible”)** tone
    - Many repeaters remove it when retransmitting
  - DTS Codes
    - Modern digital equivalent
    - Less common than CTCSS still
  - **Repeaters won't hear you w/o them**

Cross Band Repeaters

- Link two different ham bands together
  - Cheapest way to create a repeater
  - Some radios have built-in cross band ability
  - Typically:
    - You leave the crossband radio in your car
    - Set it up to listen to you on 440
    - It re-broadcasts on 2m to a repeater
- See me about the legalities of using it
  - FCC rules pseudo-prohibit them
  - Station ID requirements not fully met

Calling other people

- Say their callsign followed by yours
  - Also when responding to a CQ
- Avoid using cute phrases
  - Not easily understood by some operators
  - Use ITU phonetics instead
- ITU Phonetics
  - Internationally standardized

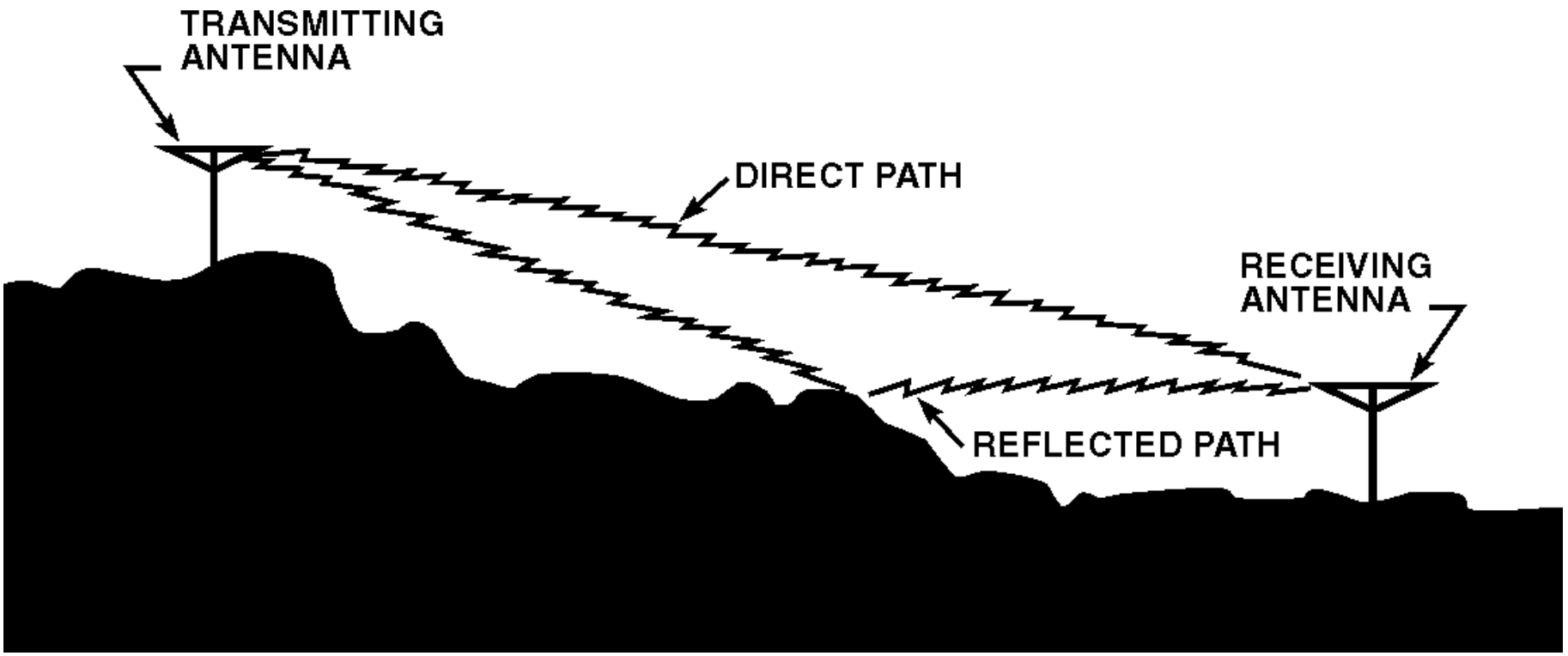
Interruptions and Conflicts

- Interrupting A Conversation
  - Wait for a pause and say your callsign
  - Similarly, when holding a conversation
    - Leave pauses!
    - Especially on repeaters
- Conflicts
  - If you accidentally transmit on a frequency in use by other hams
    - Say “sorry”
    - **ID and move to another frequency**

Operational Problems

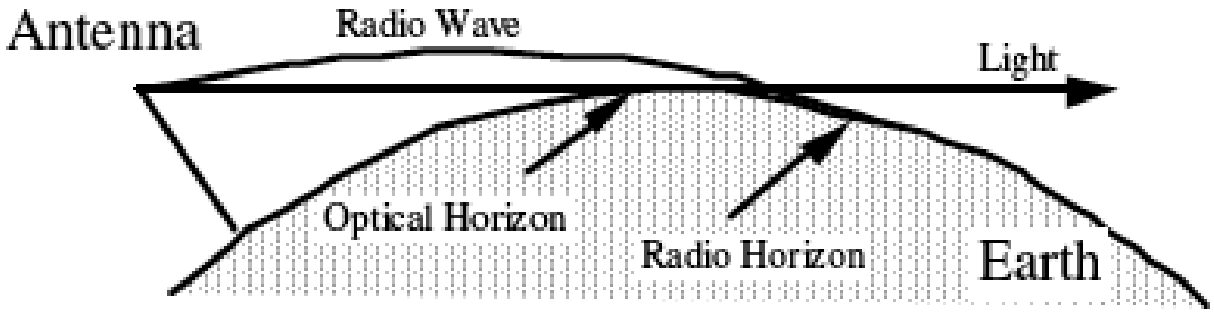
- Radio signals
  - Don't go through objects well
    - "Picket Fencing" – **rapid fluttering** heard from mobile stations – in and out of houses, e.g.
  - Bounce off of objects actually
    - People intentionally bounce signals off of planes, the moon and even comets
  - Sometimes have "multi-path"
    - e.g., a direct path and a bounce paths
- Voice signals sound worse
- Data signals have **higher error rates**

Multi-path


TRANSMITTING
ANTENNA
DIRECT PATH
RECEIVING
ANTENNA
REFLECTED PATH

Radio Horizon

- Radio signals actually go farther than line of sight

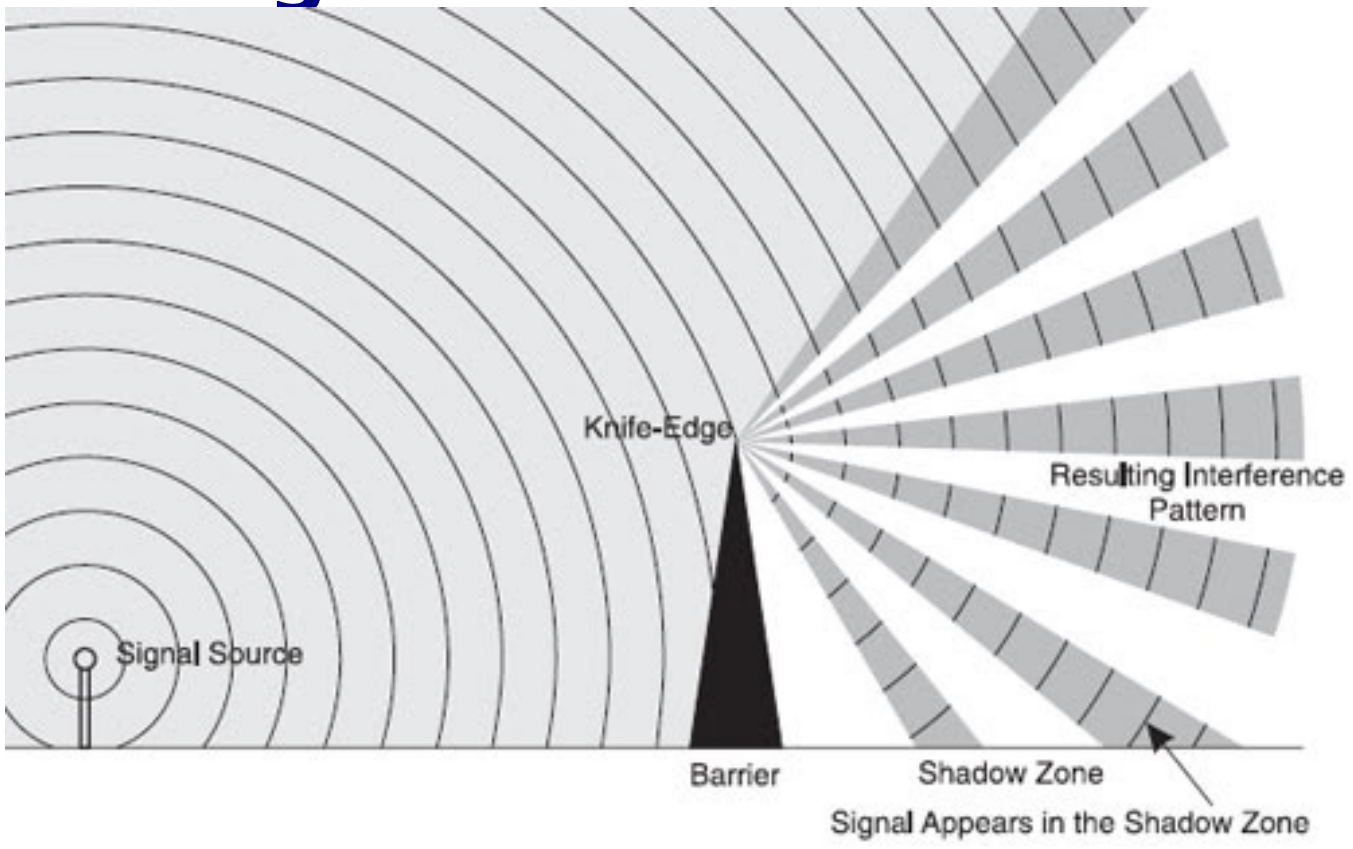


The distance at which radio signals between two points are effectively blocked by the curvature of the Earth

The earth seems "less curved" to radio waves than light

Knife Edging of Signals

- Signals going over mountains "**knife-edge**" because of waves "**partially refracting**"

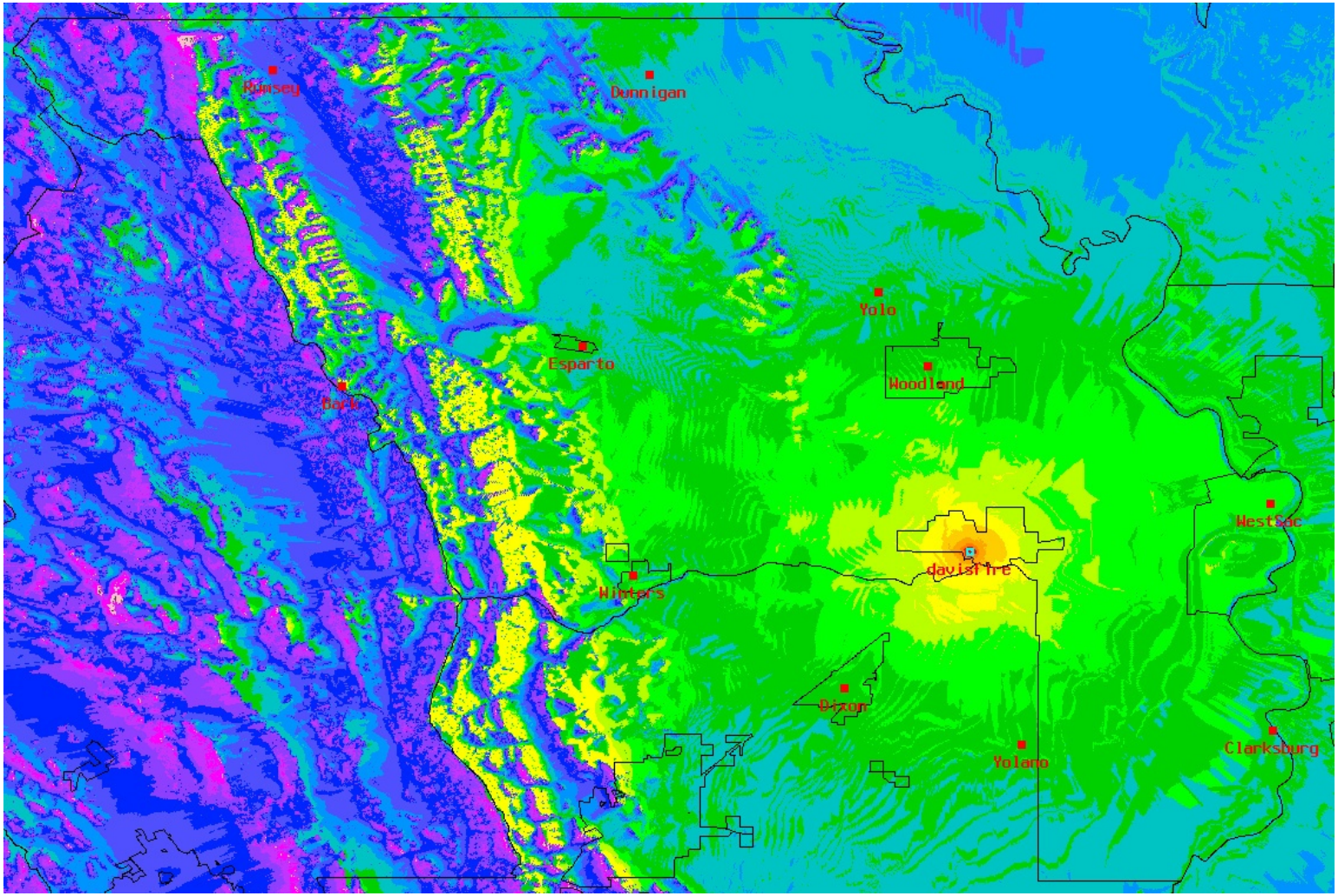


Operational Solutions

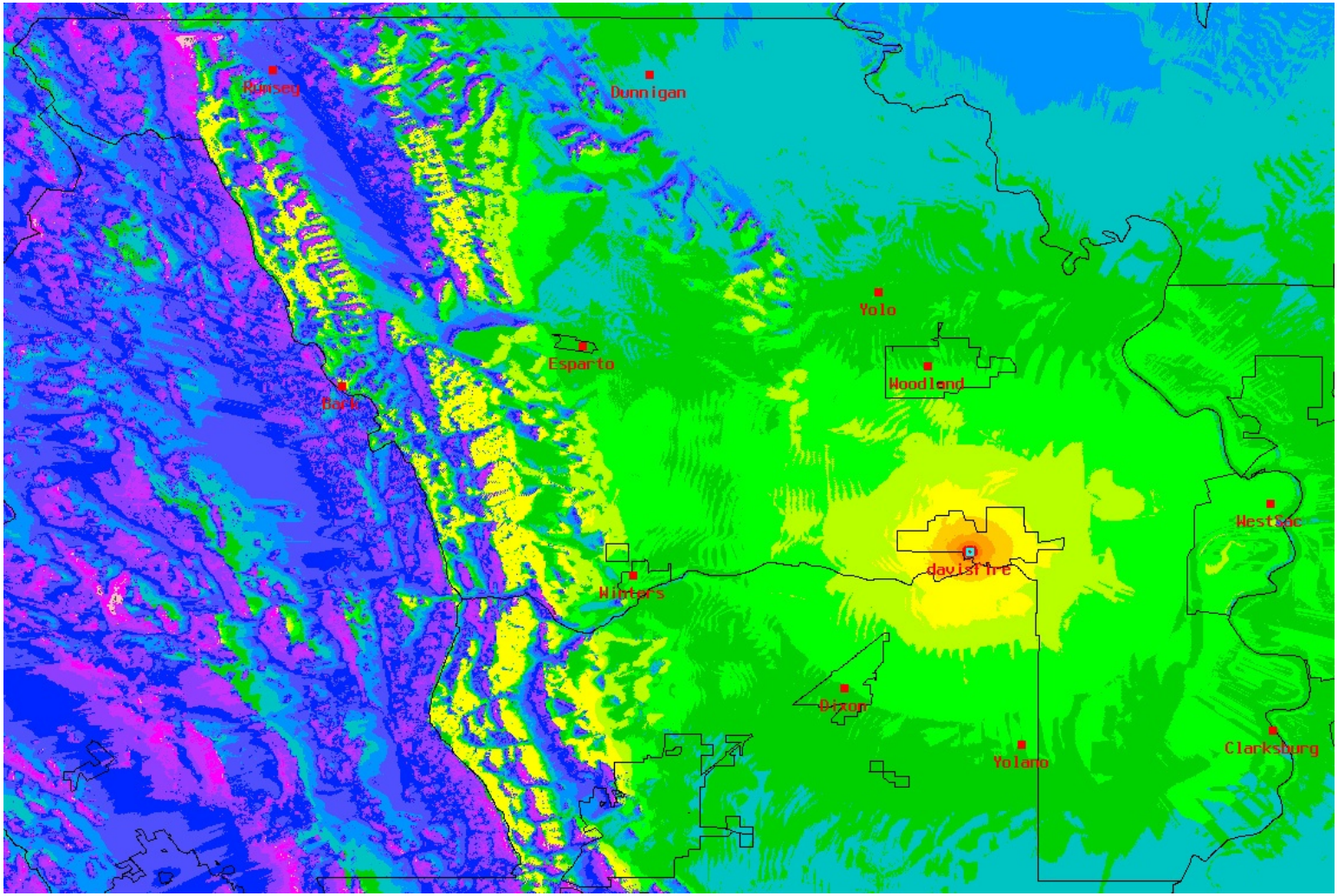
(useful for just about any radio type, not just ham radios)

- If your signal isn't getting out well
  - Move a few feed sideways!
    - **Fixes some multi-path issues**
  - Raise it up in the air – height matters!
  - If using a directional antenna, try **aiming it at a building** to bounce the signal!
- Line of sight is best
  - Especially for UHF (440+), **signals bounce less off the atmosphere** and objects

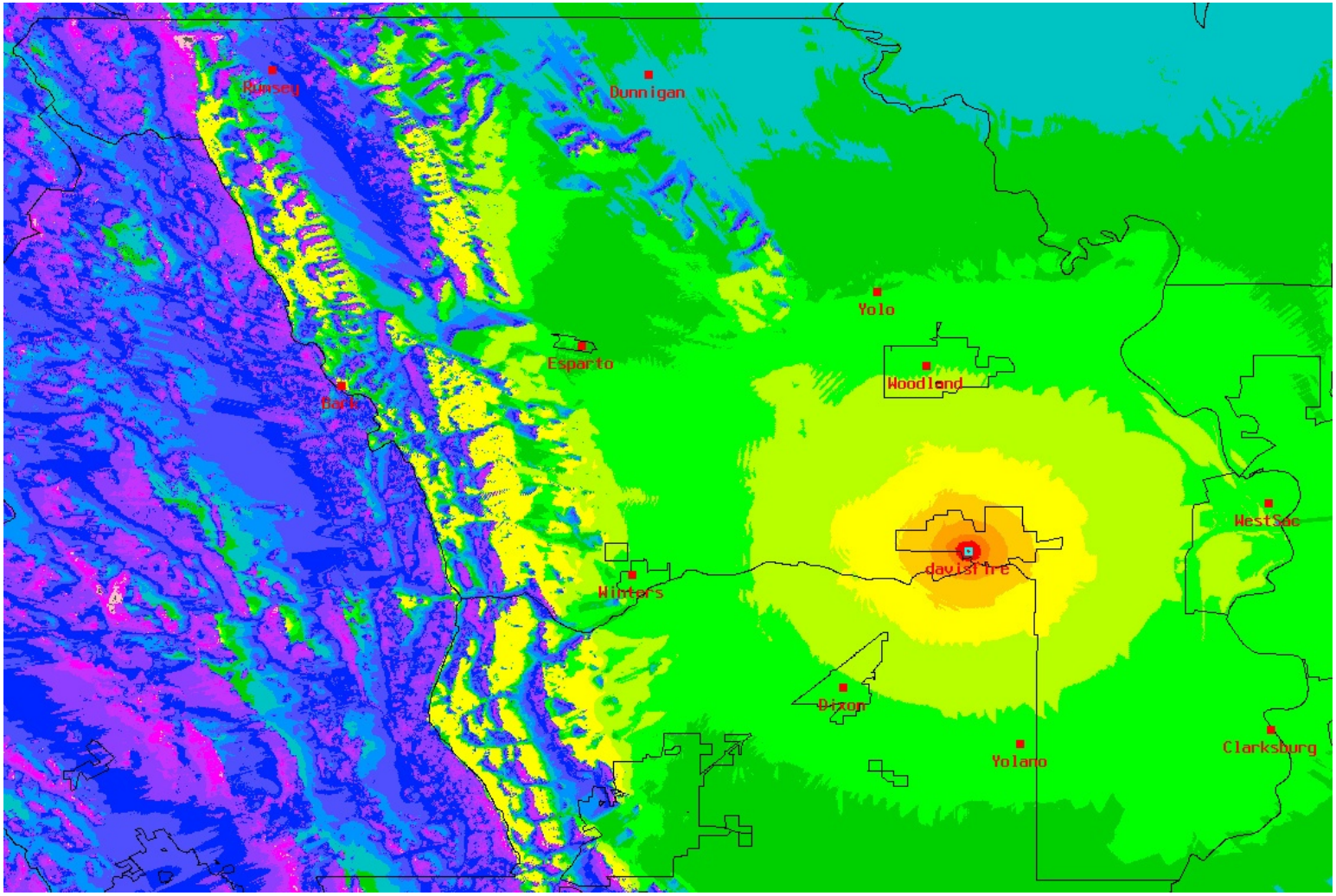
Davis Fire Department @ 2.5ft receive



Davis Fire Department @ 5ft receive



Davis Fire Department @ 15ft receive



ITU Phonetic Alphabet

A Alpha	H Hotel	O Oscar	V Victor
B Bravo	I India	P Papa	W Whiskey
C Charlie	J Juliet	Q Quebec	X X-ray
D Delta	K Kilo	R Romeo	Y Yankee
E Echo	L Lima	S Sierra	Z Zulu
F Foxtrot	M Mike	T Tango	
G Golf	N November	U Uniform	

Not required for the test; learn it anyway!!

Emergency Usage

- Emergency
  - Immediate threat to life or property
- If you hear an emergency call
  - Drop all other conversation until it is clear
  - Assume all emergencies are real
- Placing emergency calls
  - “Mayday Mayday Mayday”
  - “Any station come in please” and identify
  - In an emergency: anything goes
    - Any frequency (including fire and other services)
    - Including non-HAMs

Emergency Restrictions

- Don't transmit personal information
  - Avoid names, addresses, etc
  - To help protect sensitive information use
    - Morse code
    - Digitial modes
  - Ham-radio users can't encrypt!
- In a life or death situation, anything goes (generally)
  - **When normal means are not available**

Emergency Support and Drills

- Using Tactical Call Signs
  - Examples:
    - "**Race Headquarters**"
    - "CERT Team 2"
  - They're more efficient
  - Better coordination with emergency staff
  - ID with callsign at the end of communication
- Participating in drills to test your ability!
- Don't use "idle chit chat"
  - (It interferes with important traffic)

Net Control – similar to “dispatch”

- Check into net control
  - Then **don't transmit unless called**
  - Emergency traffic takes priority
- In a large scale emergency:
  - If no net control exists
    - Start one and ask for checkins

Net Control – similar to “dispatch”

- Running Net Controls
  - A strong clear signal is primary concern
  - If someone breaks in with emergency traffic, stop other net traffic till handled
  - Pass messages **exactly as written!**
    - Even if you see mistakes in it
- Emegencies
  - **Begin with “Priority” or “Emergency” and then your callsign**

Davis CERT Net!

- Every Sunday at 8:30PM
  - On the K6JRB (at UCD) Repeater
- A time to:
  - Check in
  - Say hi
  - Get better aquanted with radios
  - Rotate net-control so everyone learns
  - Talk about CERT and the City of Davis
- If you get a radio, we'll get you set up!

Emergency Preperation

- Emergency response equipment
  - Check it twice a year
  - Make sure you have an alternate power source if the power goes out
    - 12V Batteries
    - Solar Panel
    - Battery from a Car or Truck
      - If in the car, connect the radio's negative power connector to **any metal part of the vehicle**
    - Bicycle Generator
    - ....

False Emergency Penalties

- You could have your license revoked
- You could be fined a large sum of money
- You could be sent to prison

Declared Emergencies

- The FCC can declare “a communication emergency”
  - Will include emergency-only frequencies
    - They're legally required to restrict frequencies
    - Don't use them unless you're participating
  - May include special conditions and rules
- You **may not** transmit news for a reporter
  - **Except for helping immediate safety of human life or protection of property**

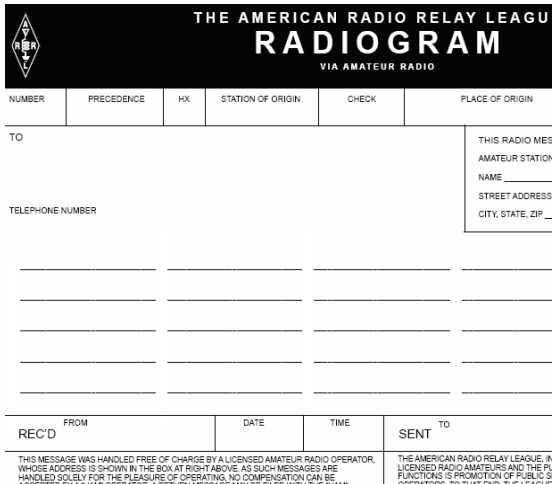
Emergency Organizations

- RACES
  - Restricted to serving local, state, and federal government emergency management agencies
  - **Emergency management or civil defense communications**

- ARES
  - Supports agencies like the Red Cross, Salvation Army, and National Weather Service
  - Must have an Amateur License

Message Handling

- Heavily used by ARES groups
  - Transmit messages for other organizations
  - EG, Davis FD, Red Cross, OES, ...
- Pre-amble
  - Track **information as it passes through**
  - Name of the originating person
  - **"Check": Number of words**
- Body guideline:
  - Use less than 25 words


THE AMERICAN RADIO RELAY LEAGU
RADIOGRAM
VIA AMATEUR RADIO
NUMBER
PRECEDENCE
HX
STATION OF ORIGIN
CHECK
PLACE OF ORIGIN
TO
TELEPHONE NUMBER
THIS RADIO MES
AMATEUR STATION
NAME
STREET ADDRESS
CITY, STATE, ZIP
FROM
REC'D
DATE
TIME
TO
SENT
THIS MESSAGE WAS HANDLED FREE OF CHARGE BY A LICENSED AMATEUR RADIO OPERATOR, WHOSE ADDRESS IS SHOWN IN THE BOX AT RIGHT ABOVE. AS SUCH MESSAGES ARE HANDLED SOLELY FOR THE PLEASURE OF OPERATING, NO COMPENSATION CAN BE
THE AMERICAN RADIO RELAY LEAGUE, I
LICENSED RADIO AMATEURS AND THE P
FUNCTIONS IS PROMOTION OF PUBLIC S

Emergency Organizations

- Both RACES and ARES
  - Provide communication during emergencies
- FCC Rules still apply when using amateur radio
  - At the request of emergency services
  - On scene of an emergency

Questions?

?

(We're just getting going!)