Amateur Radio

Lesson 2

Class Overview

- Antenna Fundamentals
- Repeaters
- Duplex and Simplex
- Nets and Frequencies
- Cool Radio Functions
- Review

Antennas

Antennas

- An antenna is a device used for converting electrical currents into electromagnetic radiation while transmitting, or the reverse while receiving.
- Antennas are resonant - that is, they respond best to a certain frequency.
- If the antenna is not precisely the right length for the frequency used, the radio waves cannot be emitted or captured efficiently.
- It should neither be too long, nor too short. A good transmitting antenna can be a good receiving antenna, and for ordinary uses, one antenna serves both functions.

Antennas

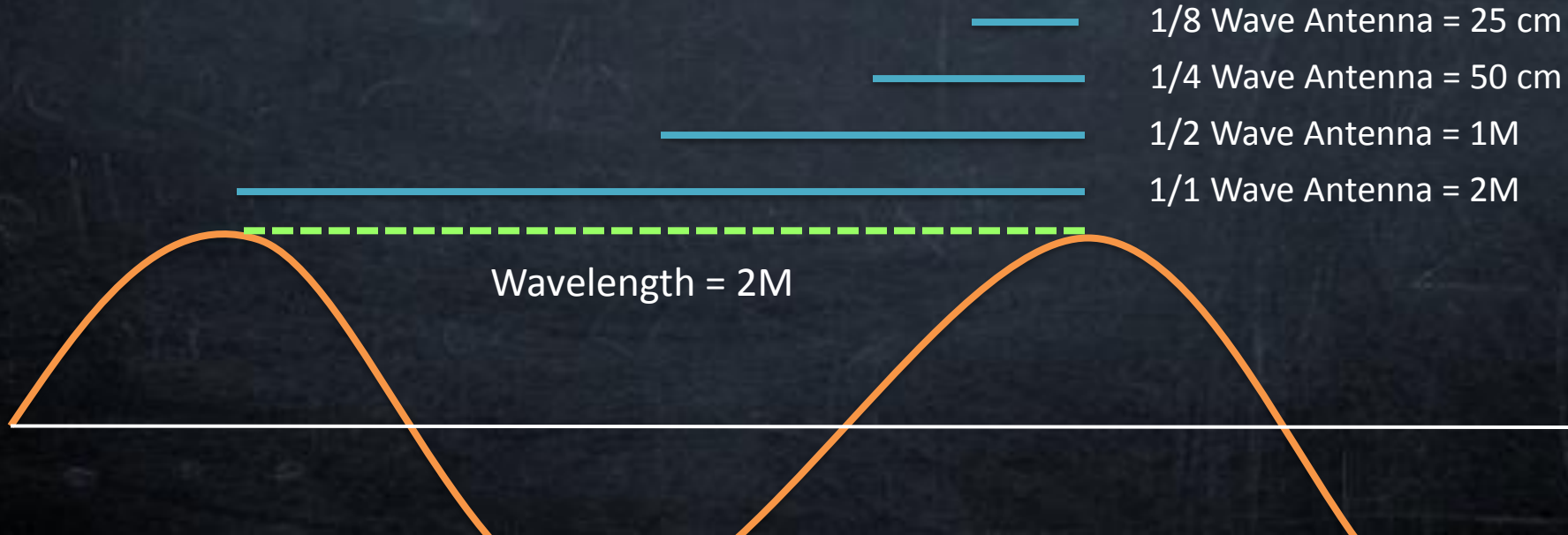
- Antennas come in all shapes an sizes depending on their intended use. Some antennas can cost thousands of dollars or free based on what you might have laying around.

Antenna Bandwidth

- Antenna Bandwidth describes the range of frequencies over which the antenna can properly radiate or receive energy.
- Antennas are designed to operate at certain frequencies. The antenna must therefore be built to match the frequency range (bandwidth) of the intended application.
- Dual band antennas are designed with two different length elements so they can be operated on multiple bandwidths.

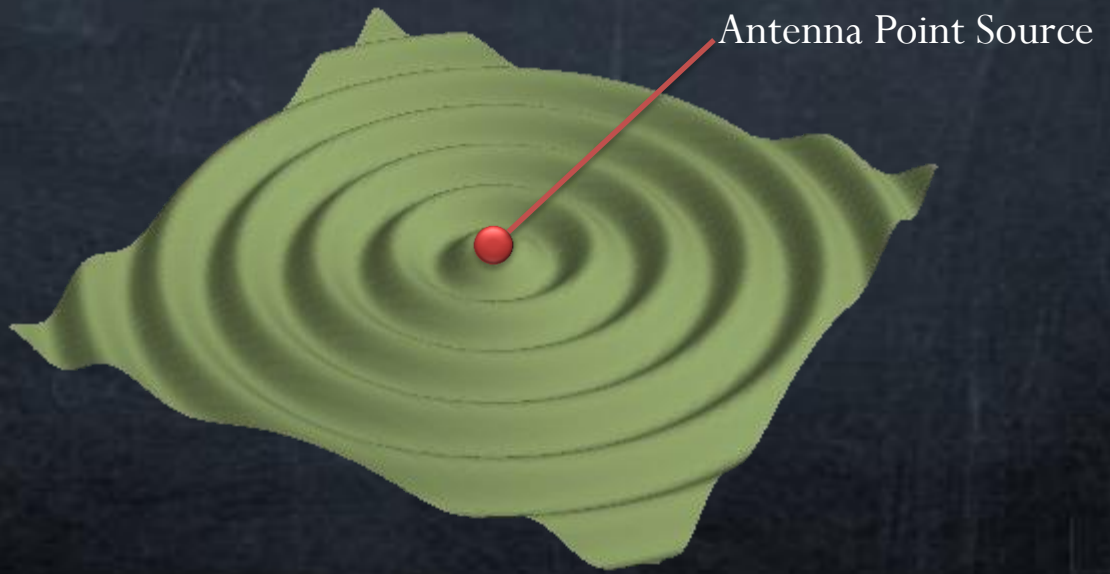
Antenna Length

- While many household items may be used as an antenna, in order for it to radiate and receive signals efficiently, its dimensions must be an appreciable fraction of the signal's wavelength.



Antennas

- A simple antenna propagates an electromagnetic wave equally in all directions.



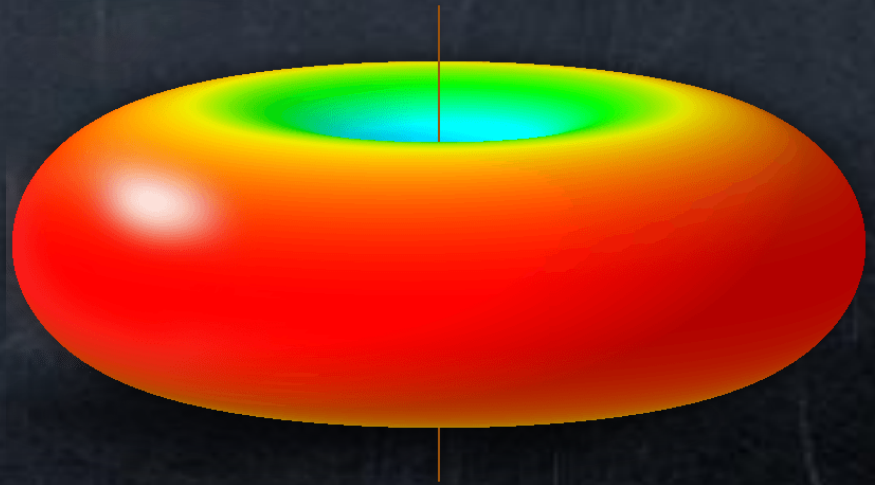
Antennas

J-Pole

Ground Plane

Dipole

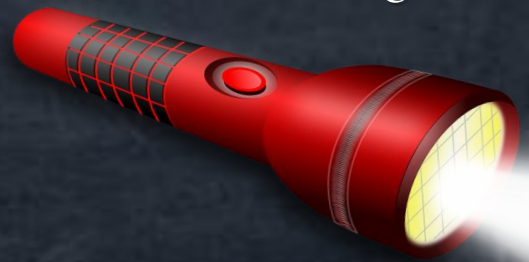
Simple Antenna Propagation Pattern



Antenna Gain

- A relative measure of an antenna's ability to direct or concentrate radio frequency energy in a particular direction or pattern.

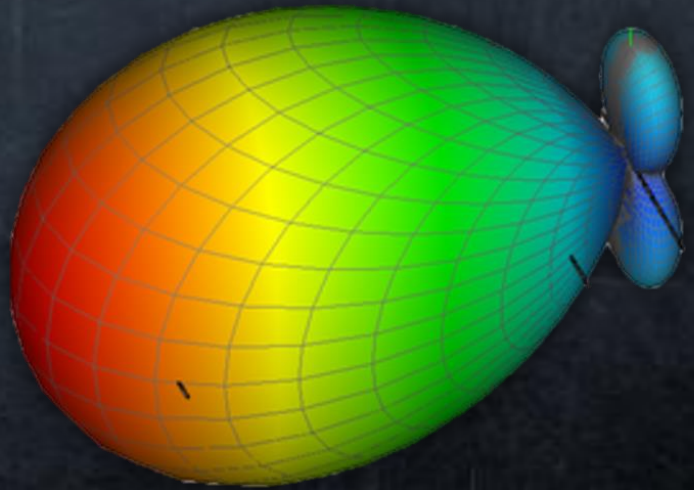
Higher Gain



Antennas

Yagi
(Directional or Gain Antenna)

Directional Antenna Propagation Pattern



Antenna Impedance

- Impedance is the loss of energy measured from its feed point to the output that emanates as RF (Radio Frequency) Radiation.

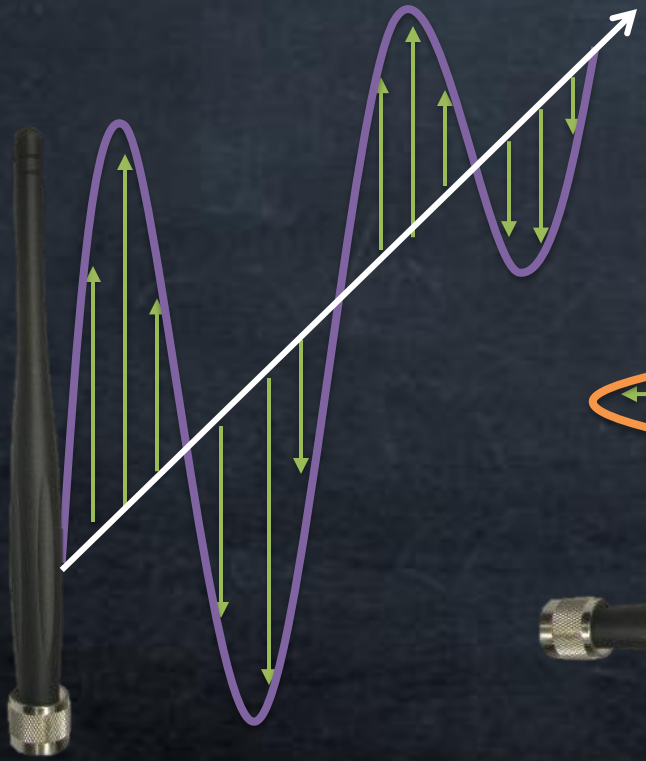
- The impedance is affected by a number of factors including the size and shape of the antenna, the frequency of operation and its environment.

Antenna Polarization

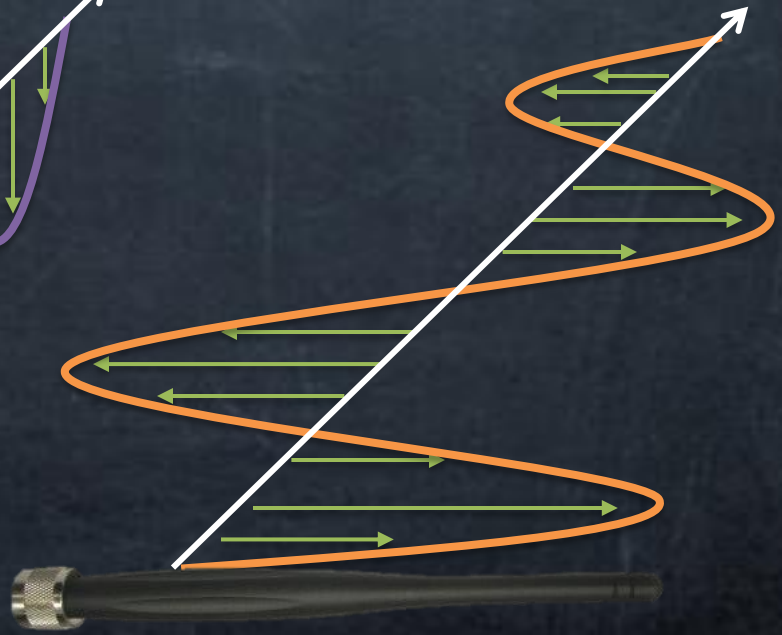
- Polarization is the orientation of the electric field of an electromagnetic wave in relation to the earth.
- Simple antennas oriented vertically emit vertically oriented waves and those oriented horizontally emit horizontally oriented waves.
- Antennas transmit and receive in the same manner so if a horizontally polarized antenna is trying to communicate with a vertically polarized antenna, there will be reduced reception.

Antenna Polarization

Vertical Polarization



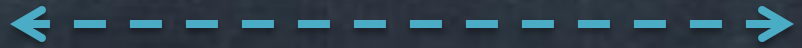
Horizontal Polarization



Repeaters

Simplex and Duplex

- Simplex: Direct radio-to-radio communication using the same frequency for both receiving and transmitting.



- Duplex: Communication using different receiving and transmitting frequencies. Duplex is used when communicating via repeaters.

What is a Repeater?

- A repeater is an electronic device that receives a radio signal and retransmits it at a higher power or onto the other side of an obstruction, so that the signal can cover longer distances.

- Multiple repeaters can be linked together so you can communicate over hundreds of miles.

- Repeaters extend the reach of less powerful handheld radios.

Repeater in Use

Input Frequency
146.920 MHz

Output Frequency
146.320 MHz

Offset:
-600 KHz

50+ Miles

Repeater Offsets

- An Offset is the separation between the input frequency and output frequency of a repeater.
- Offsets can either be Positive (+) or Negative (-).
- Certain bands (frequency ranges) in the United States have standardized offsets.

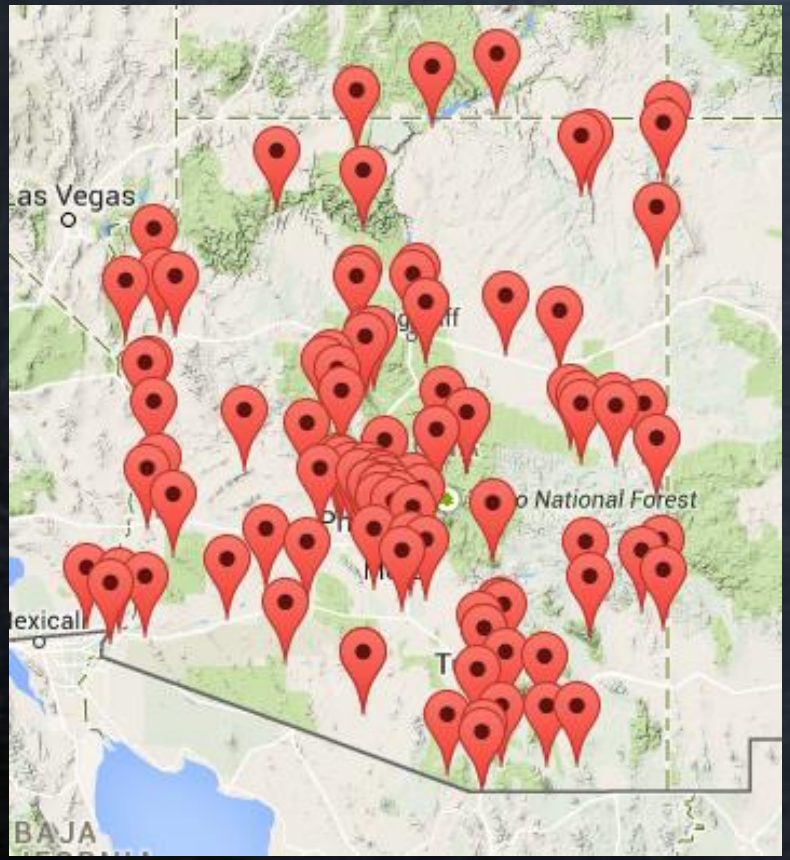
Standard Repeater Offsets

- Offset Direction for 2 Meter: <147.0 = Negative (-)
  >147.0 = Positive (+)
- Offset Value for 2 Meter [144-148 MHz]: 600 kHz
- Offset Direction for 70cm: <445.0 = Positive (+)
  >445.0 = Negative (-)
- Offset Value for 70cm [420-450 MHz]: 5 MHz

Repeater PL Tone

- Privacy Lock (PL) tones, or Continuous Tone Coded Squelch System (CTCSS) tones are sub-audible tones sent by your radio to the repeater along with your regular transmission.
- On a PL equipped repeater, it will not retransmit your signal unless the correct PL tone is received. This helps reduce noise and unwanted signals from being transmitted from the repeater.
- PL Tones range from 67.0 to 254.1 Hertz.

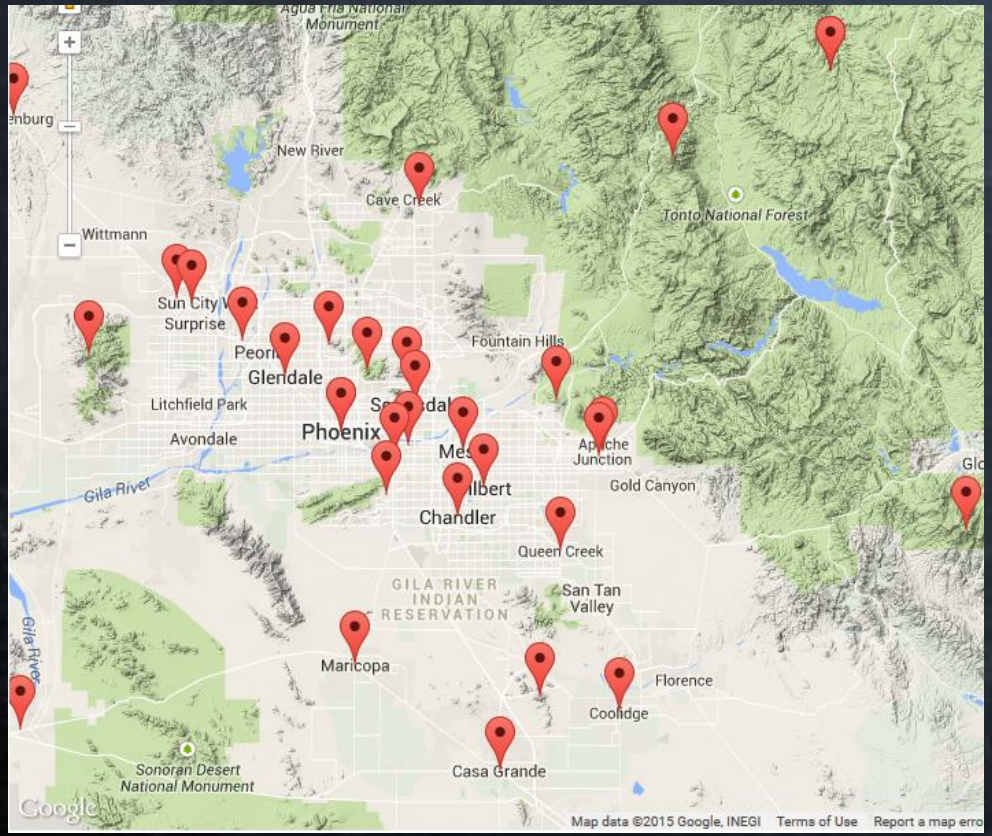
AZ 2M & 70cm Repeaters



- 332 2M and 70cm repeaters found in Arizona.

http://www.levinecentral.com/repeaters/google_mapping.php

AZ 2M & 70cm Repeaters



- East Valley Repeaters

http://www.levinecentral.com/repeaters/google_mapping.php


DEMO

Nets

- Ham Nets are gatherings of Hams on the air at a scheduled time and frequency.
- Usually they are formal or directed nets controlled by the Net Control Station (NCS).

Net Control

- Net Control acts as an "Air Traffic Controller" moving message traffic between members quickly and effectively.
- All traffic goes through Net Control during a formal or directed net.

Purpose of Ham Nets

- Learn net protocol
- Gain experience for when we have to communicate in an emergency or disaster.
- Report weather or road conditions during a storm, such as SkyWarn activation.
- Special interest such as 4x4 off-roading.

Purpose of Ham Nets

- Pass emergency or routine radio traffic during drills and disasters.
- Between family members inside and outside the disaster area.
- Shadow community, school, and church leaders to provide communications when the grid is down.

When To Use A Net

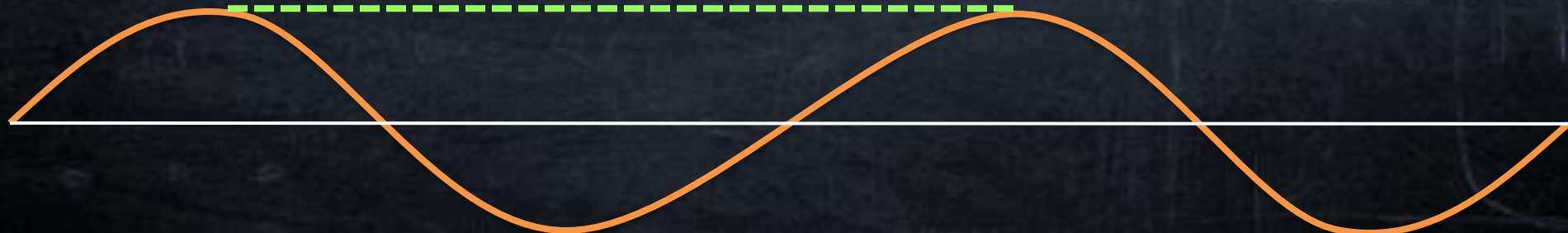
- Nets are used in actual emergencies. It allows for important messages to get through quickly and efficiently.
- Nets are also used for large events with multiple hams.
- Nets are often used for training events and less formal gatherings to allow hams more opportunities to practice Net protocols.

Net Control

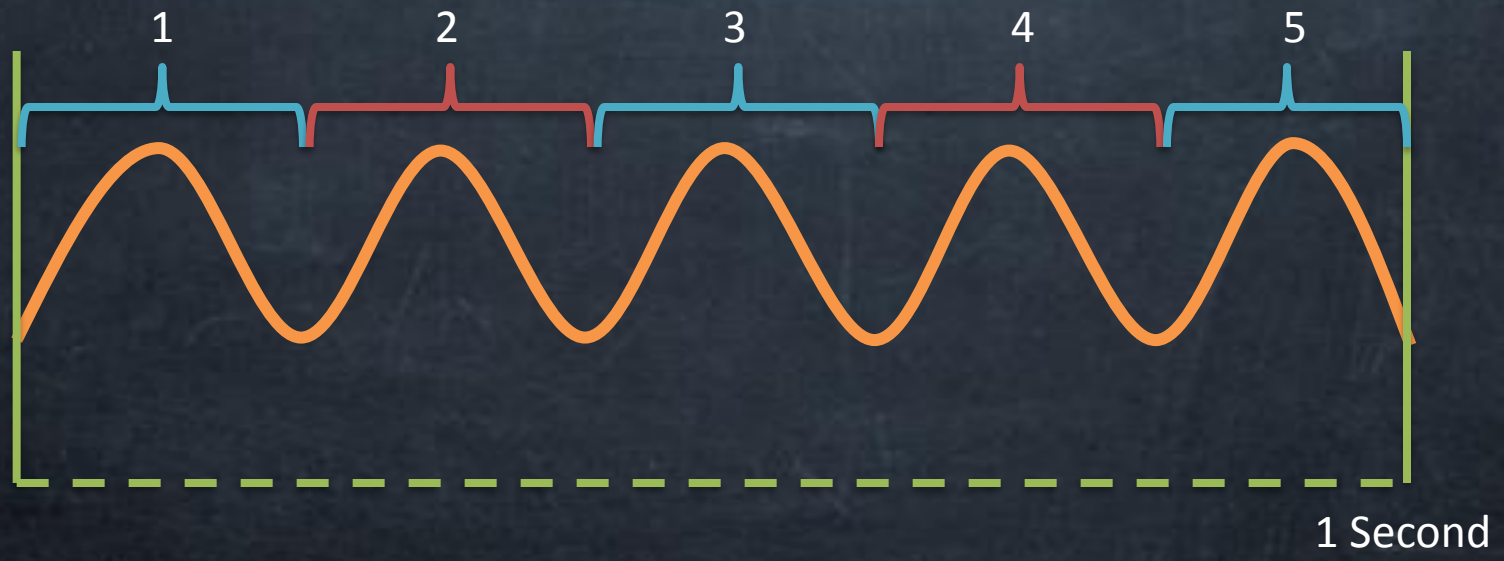
- Let's listen to an actual Net in Action!

Radio Frequency

- Wavelength and frequency are closely related. The higher the frequency, the shorter the wavelength. Because all electromagnetic waves move at the same speed (speed of light), the number of wave crests passing by a given point in one second depends on the wavelength. That number, also known as the frequency, will be larger for a short-wavelength wave than for a long-wavelength wave.



Wave Frequency



Frequency is the number of times a wavelength (cycle) passes a point per second.
In this example, Frequency = 5 Hertz (Hz).

Frequency, Wavelength and Antenna Length

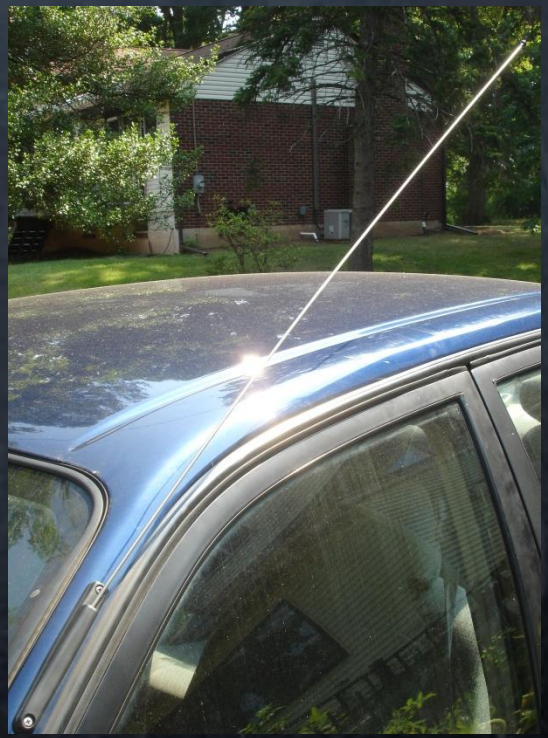
- Let's say that you are trying to build a radio Antenna for radio station 680 AM. It is transmitting a sine wave with a frequency of 680,000 hertz. In one cycle of the sine wave, the electrons will change direction four times.

Frequency, Wavelength and Antenna Length

- If the transmitter is running at 680,000 hertz, that means that every cycle completes in (1/680,000) 0.00000147 seconds. One quarter of that is 0.0000003675 seconds. At the speed of light, electrons can travel 0.0684 miles in 0.0000003675 seconds. That means the optimal antenna size for the transmitter at 680,000 hertz is about 361 feet. So AM radio stations need very tall towers. For a cell phone working at 900,000,000 (900 MHz), on the other hand, the optimum antenna size is about 3 inches.
- This is why cell phones can have such short antennas.

Frequency, Wavelength and Antenna Length

- You might have noticed that the AM radio antenna in your car is not 300 feet long … it is only about 3 feet long.
- A longer antenna would receive better, but AM stations broadcast with so much power that it doesn't really matter if your antenna is the optimal length.



The Electro-Magnetic Spectrum

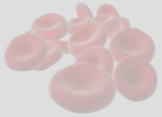
A Single Wavelength is about the size of:


Buildings

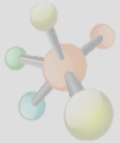

Humans


Insects

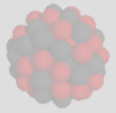

Grains of Sand


Red Blood Cells


Virus


Molecule


Atom


Atomic Nuclei


Subatomic Particles

Radio	Microwave	Infrared	Visible	Ultraviolet	X-ray	Gamma-ray

Radio Frequency Spectrum

3 kHz	30 kHz	300 kHz	3000 kHz	30 MHz	300 MHz	3000 MHz	30 GHz	300 GHz	3000 GHz
VLF	LF	MF	HF	VHF	UHF	SHF	EHF	Not Designated	

VLF: Very Low Freq.
LF: Low Freq.
MF: Medium Freq.

HF: High Freq.
VHF: Very High Freq.
UHF: Ultra High Freq.

SHF: Super High Freq.
EHF: Extremely High Freq.

Most Used Technician Frequencies

- 2 Meter:
  - 144.1-148.0 MHz
- 70 Centimeters:
  - 420.0-450.0 MHz

Band Plan

2 Meters (144-148 MHz)

144.00-144.05	EME Earth-Moon-Earth (CW) Morse Code
144.05-144.10	General CW and weak signals
144.10-144.20	EME and weak-signal SSB
144.200	National calling frequency
144.200-144.275	General SSB operation
144.275-144.300	Propagation beacons
144.30-144.50	Orbiting Satellite Carrying Amateur *Radio*
144.50-144.60	Linear translator inputs (Similar to a Repeater)
144.60-144.90	FM repeater inputs
144.90-145.10	Weak signal and FM simplex (145.01,03, 05,07,09 are widely used for packet)
145.10-145.20	Linear translator outputs

145.20-145.50	FM repeater outputs
145.50-145.80	Miscellaneous and experimental modes
145.80-146.00	Orbiting Satellite Carrying Amateur *Radio*
146.01-146.37	Repeater inputs
146.40-146.58	Simplex
146.52	National Simplex Calling Frequency
146.61-146.97	Repeater outputs
147.00-147.39	Repeater outputs
147.42-147.57	Simplex
147.60-147.99	Repeater inputs

Notes: The frequency 146.40 MHz is used in some areas as a repeater input. This band plan has been proposed by the ARRL VHF-UHF Advisory Committee.

Band Plan

70 Centimeters (420-450 MHz)

420.00-426.00	Amateur TV
426.00-432.00	Amateur TV simplex
432.00-432.07	EME (Earth-Moon-Earth)
432.07-432.10	Weak-signal CW (Morse Code)
432.10	70-cm SSB calling frequency
432.10-432.30	Mixed-mode (Simultaneous Analog and Digital) and weak-signal work
432.30-432.40	Propagation beacons
432.40-433.00	Mixed-mode and weak-signal work

433.00-435.00	Auxiliary/repeater links
435.00-438.00	Satellite only (internationally)
438.00-444.00	Amateur TV
442.00-445.00	Repeater inputs and outputs
445.00-447.00	Shared by auxiliary and control links, repeaters and simplex (local option)
446.00	National simplex calling frequency
447.00-450.00	Repeater inputs and outputs

Radio Capabilities

- Some radios can monitor/transmit on frequencies outside the allowed Ham bands, police and fire bands, FRS and GMRS for example, but we are not permitted to transmit on those frequencies.

Awesome Radio Functions

APRS

- APRS or (Automatic Position Reporting System) is simply a GPS for your Ham radio, which reports your live updating current location that can be visible to others on APRS websites.

ARISS

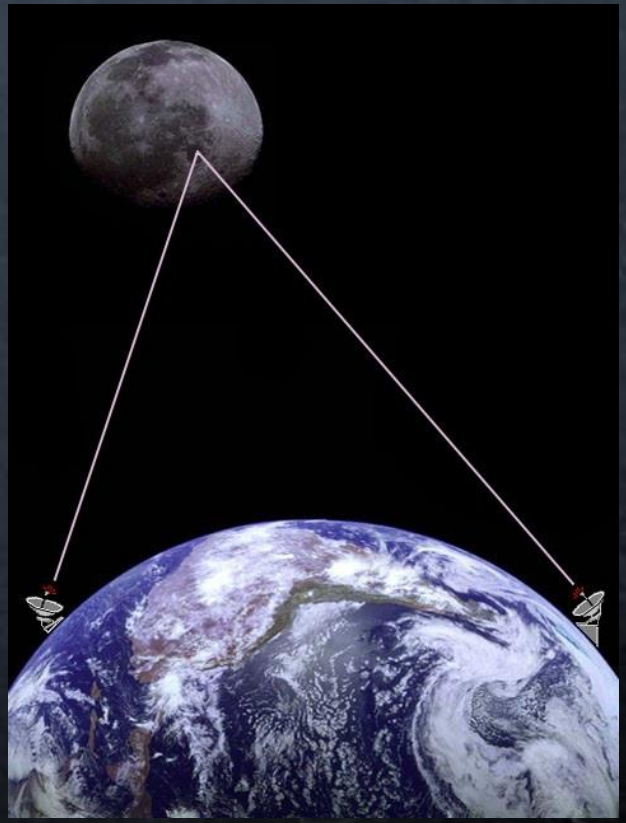
- Hams can communicate with the Astronauts on the International Space Station using various modes such as 2 Meter, Packet, Image and Amateur TV.

ARISS

Amateur Radio on the International Space Station

Moon Bounce

- Moon Bounce or Earth–Moon–Earth communication (EME), is a technique which relies on the propagation of radio waves from an Earth-based transmitter directed via reflection from the surface of the Moon back to an Earth-based receiver.



Packet Radio

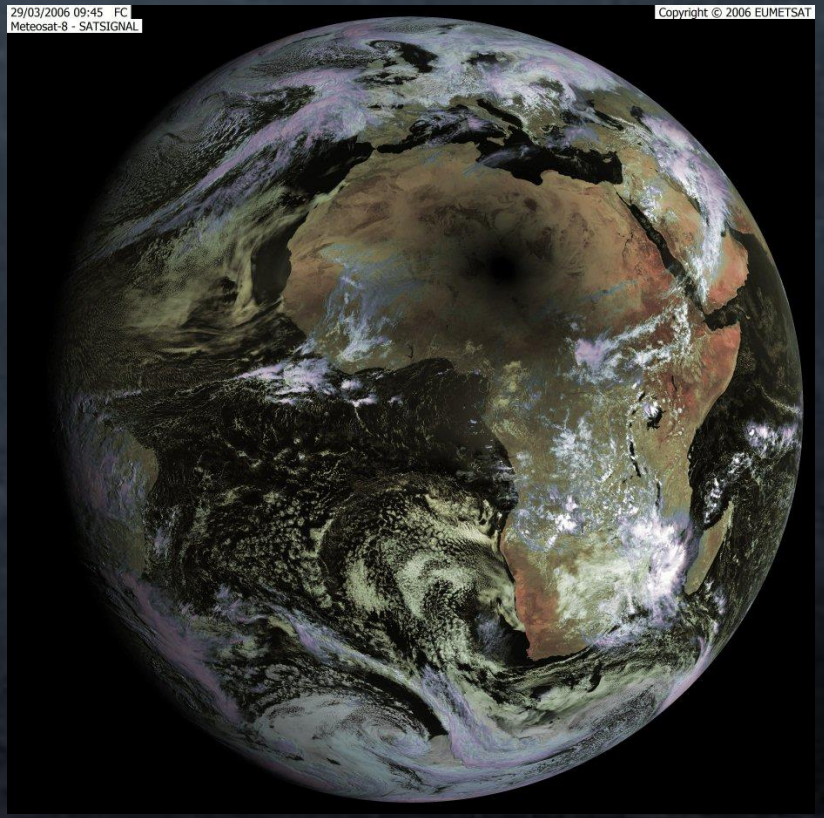
- Packet radio is a form of packet switching technology used to transmit digital data via radio.
- Programs like fldigi allow us to send text messages and large files like text documents and spreadsheets from PC to PC via Ham Radio.

Amateur TV

- Amateur television (ATV) is the transmission of Broadcast quality video and audio over the wide range of frequencies allocated for Radio amateur (Ham) use.

Satellite Direct Weather Images

- Amateur radio operators can directly capture weather images from several weather satellites orbiting the Earth.



AutoPatch

- Autopatch is a feature available on some repeaters allowing the Ham Radio operator to enter a code on their radio to activate the repeater's phone system and make a telephone call directly from their radio.

AutoPatch

- Autopatch Sequence: Key up, announce your call sign, then, without unkeying, press the * key followed by the 3-digit area code + 7-digit number. Keep the radio keyed for about half a second after entering the last digit, then, unkey.
- The repeater will announce "autopatch" and place the call. When finished, key up, announce your call sign, press the # key, and then unkey. The repeater will respond with "call complete" and the time.
- There is a 3 minute limit per call. (911 calls have a 15 minute timer.)

Some East Valley Autopatch Enabled Repeaters.

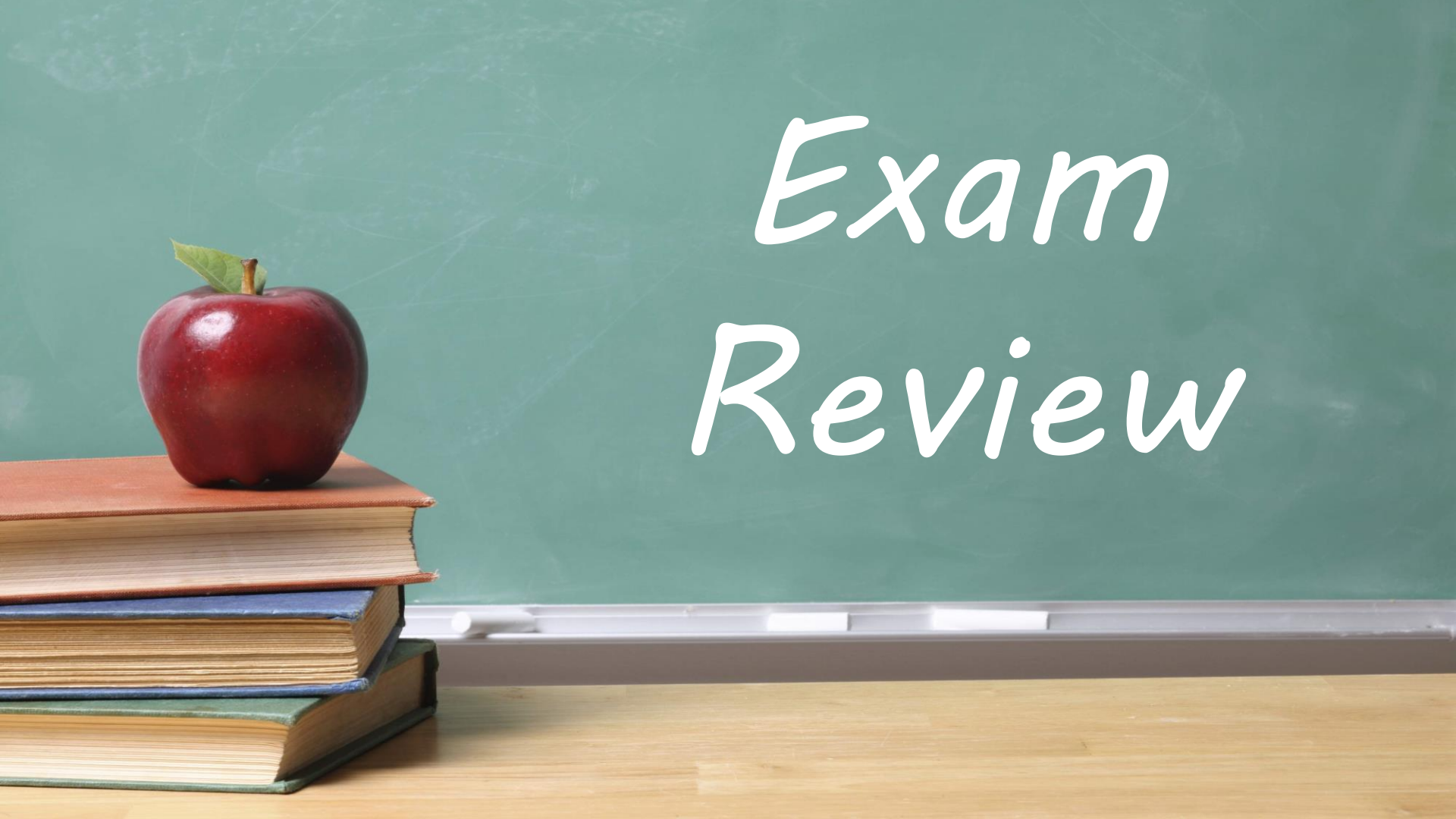
Frequency	PL	Location	Features
146.760 -	162.2	Scottsdale Airpark	Autopatch (480, 602, 623)
146.860 -	162.2	Usery Pass	Autopatch (480, 602, 623)
146.920 -	162.2	Mt. Ord	Autopatch (480, 602, 623)
147.240 +	162.2	Shaw Butte	Autopatch (480, 602, 623)
449.525 -	100.0	Shaw Butte	Autopatch (480, 602, 623)
449.625 -	100.0	Bank of America Tower	Autopatch (480, 602, 623)


Questions?

Next Week!

Lesson 3:

- Safety
- Radio Etiquette/Procedures/Traffic Handling
- Radio Go Bags
- How to Program your Radio (Bring your Radios)
- Exam Review (Homework = Study!)


Exam
Review


Questions?

See You Next Week

thanks for joining us