Amateur Radio

Lesson 1

Course Overview

- Welcome!
- Ham Radio includes 3 classes of licenses…Technician, General and Extra.
- Technician is the entry level license and what we will be teaching in this course.
- An FCC issued license is necessary before using a ham radio.
- An Amateur Radio license lasts 10 years and can be renewed free of charge.

Course Overview

- This session will include 4 Classes (1.5 Hours Each)
- The 4th Class includes Exam (Exam Fee $15)
- The Exam includes 35 multiple choice questions from a pool of 426 possible questions.

Course Overview

- Classes will cover basic concepts and hands-on topics and allow for Q&A.
- Students are recommended to take the optional online study program in tandem with this course hamtestonline.com ($15 with discount code)
- Students not wishing to take the online course can memorize the 426 questions/answers or take free online practice tests at hamstudy.org or hamtesting.com.


Let's Get Started

What is Radio?

- Radio is the practice or science of communicating over a distance by converting sounds or signals into electromagnetic waves and wirelessly transmitting these to a receiving set, which changes them back into sounds, signals, etc.

Why is Radio Important?

- Sound waves travel one mile in about five seconds while in the same time, Light travels 930,000 miles. Long distance communication using sound waves isn't practical.

Speed of Sound	Speed of Light
767 mph / 1,235 kph	671 Million mph / 1,080 Million kph
0.21 mps / 0.34 kps	186,000 mps / 299,700 kps

Why is Radio Important?

- Sound can be converted into signals that can be transmitted using electromagnetic waves which travel at the speed of light. These signals can be converted back to sound on the receiving end. This is Radio.

- Since radio is wireless, it requires less infrastructure to operate. This allows radio to continue functioning when many other forms of communication are inoperable following a disaster.

What are Radio Waves?

- Radio waves are invisible but an essential part of how we communicate in modern society.

- Radio waves are part of the electromagnetic spectrum. (Also Light and heat)

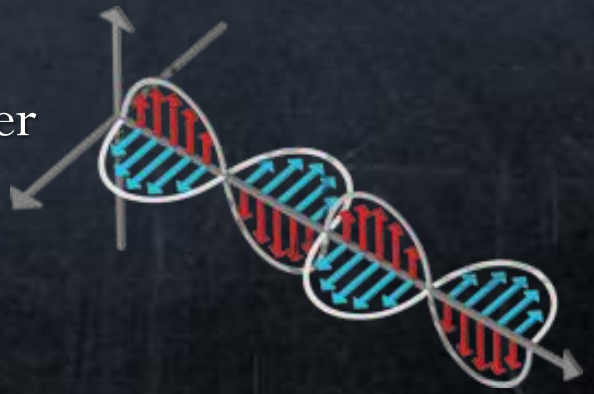
- Television, radio and mobile phones all use radio waves.

What are Radio Waves?

- Waves consist of oscillating electric and magnetic fields, the frequency of these oscillations are measured in a unit called hertz. (Hz, KHz, MHz).

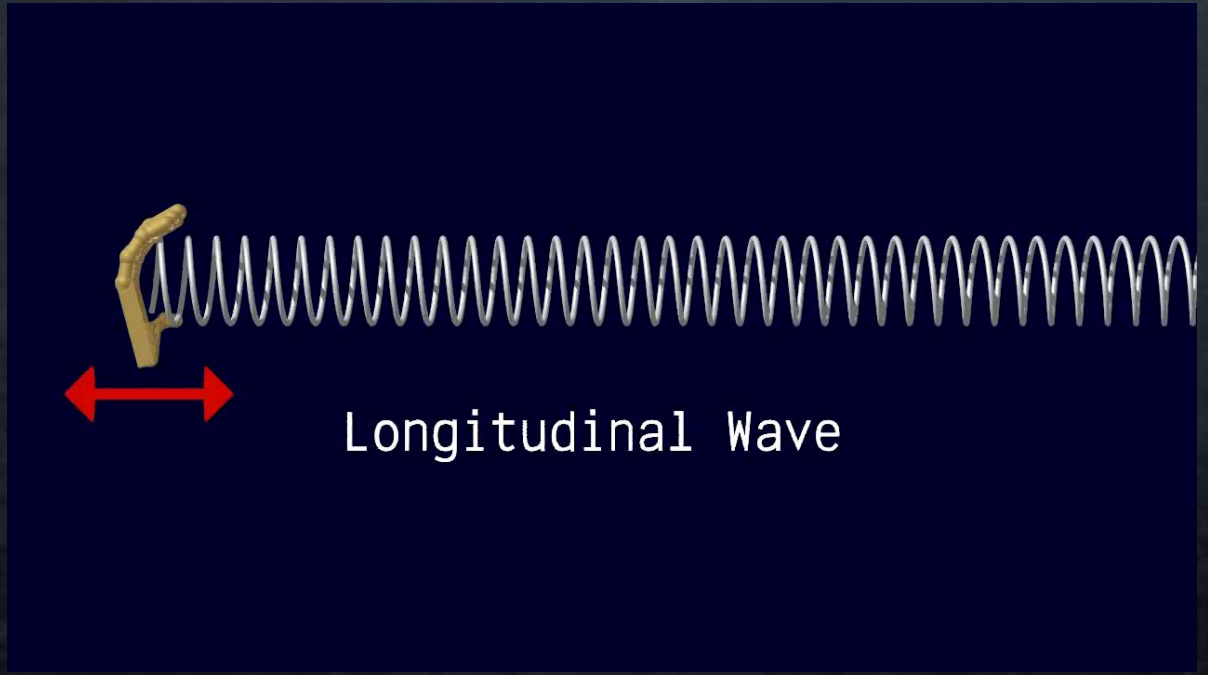
- Radio waves used for carrying radio communication are often referred to as carrier waves.

- Carrier waves are able to carry speech or computer data once the speech or data has been combined with the wave via a process called modulation.



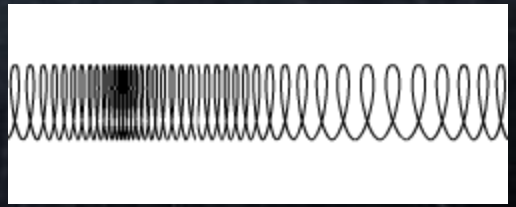
Waves

- There are two types of Waves: Longitudinal (Compression) & Transverse



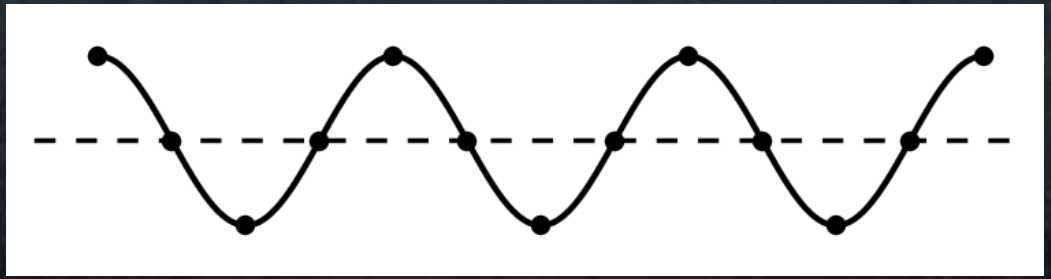
Longitudinal or Compression Waves

- Longitudinal or Compression waves are how sound travels.
- Compression waves can only transfer through a “Medium”.
- A “Medium” can be Air, Water or Earth for example.
- Particles of the medium bump into neighboring particles as a means of transferring its energy.
- Sound cannot travel in a vacuum (Space) as there is no medium to compress to allow the wave to propagate.

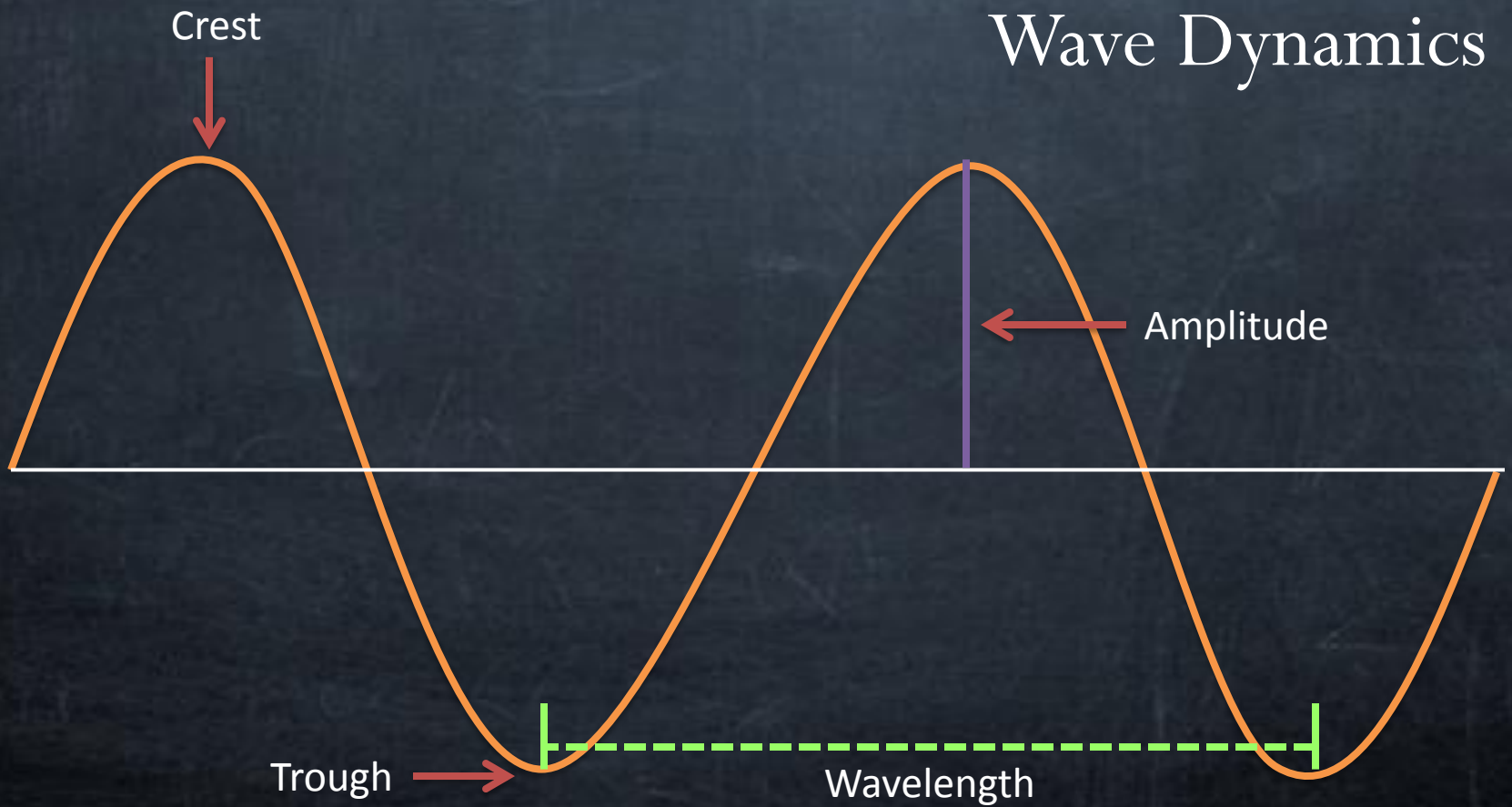


Transverse Waves

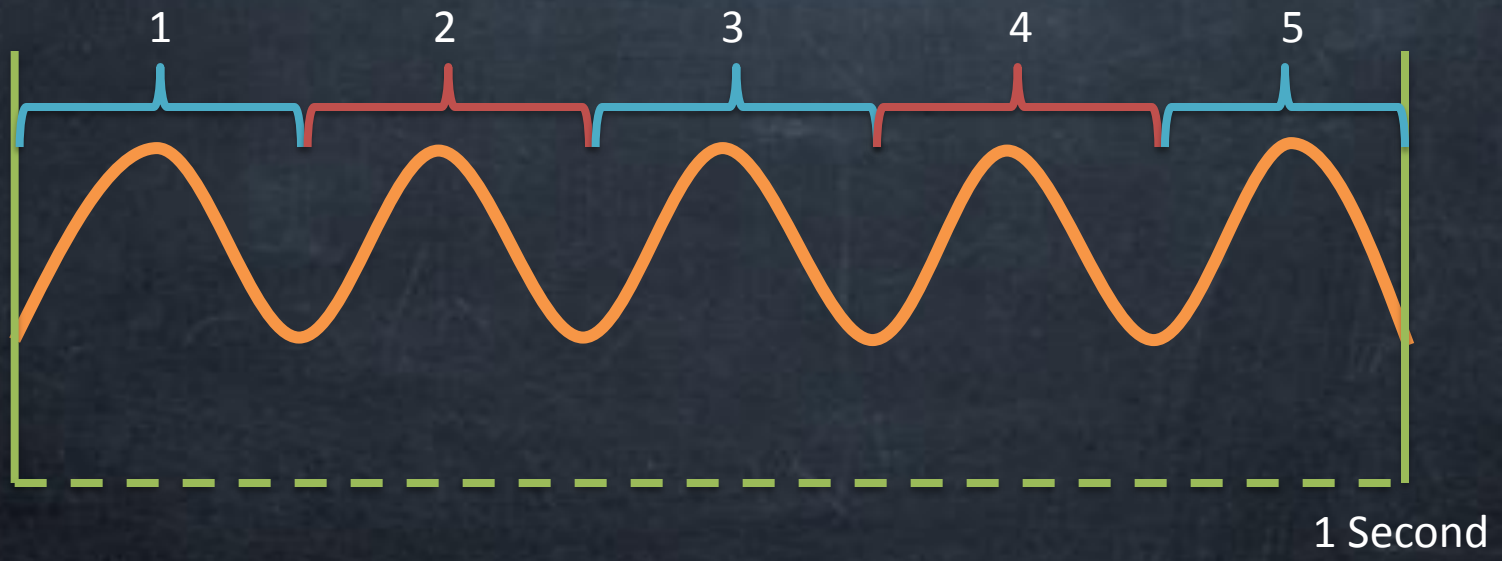
- Some examples of Transverse waves are seen in water, using a rope or light waves.
- Waves only transfer energy… not matter!



Wave Dynamics

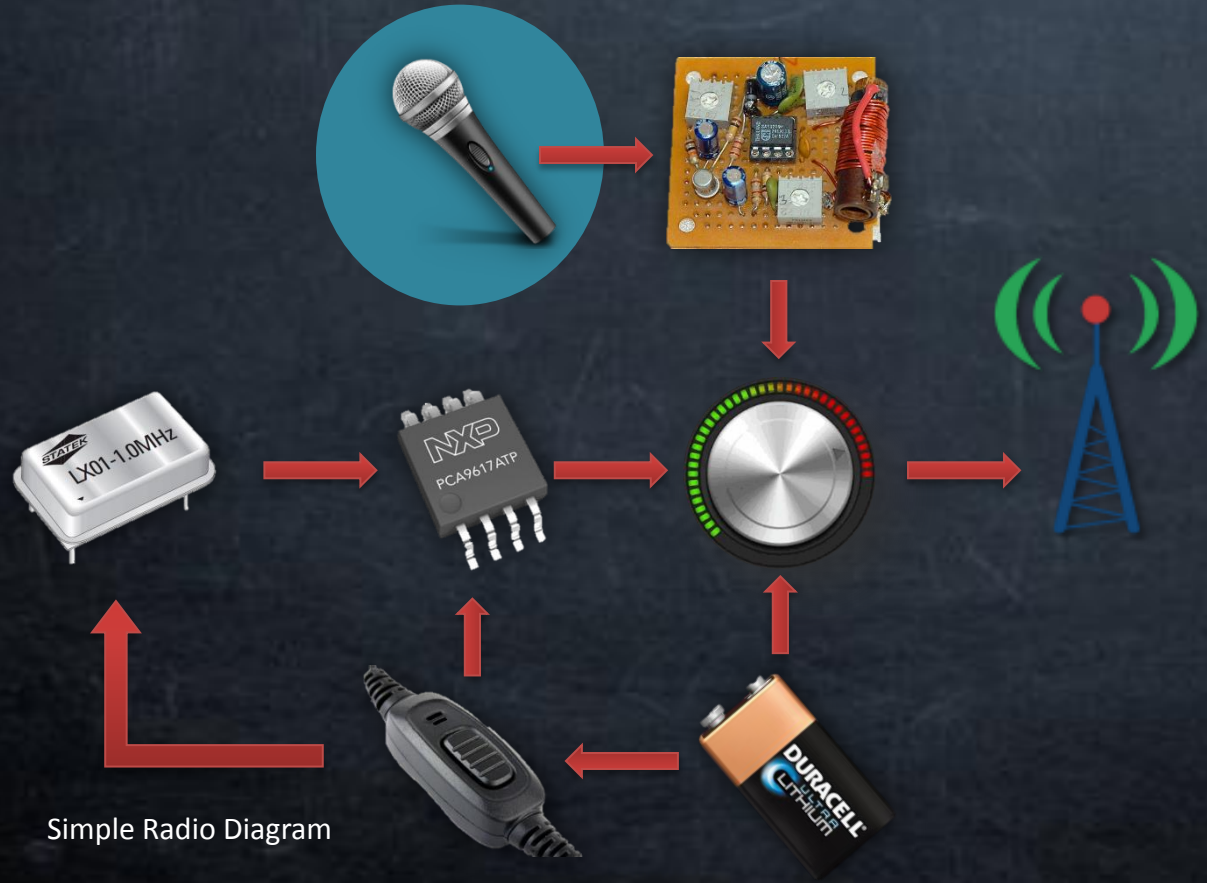


Wave Frequency



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

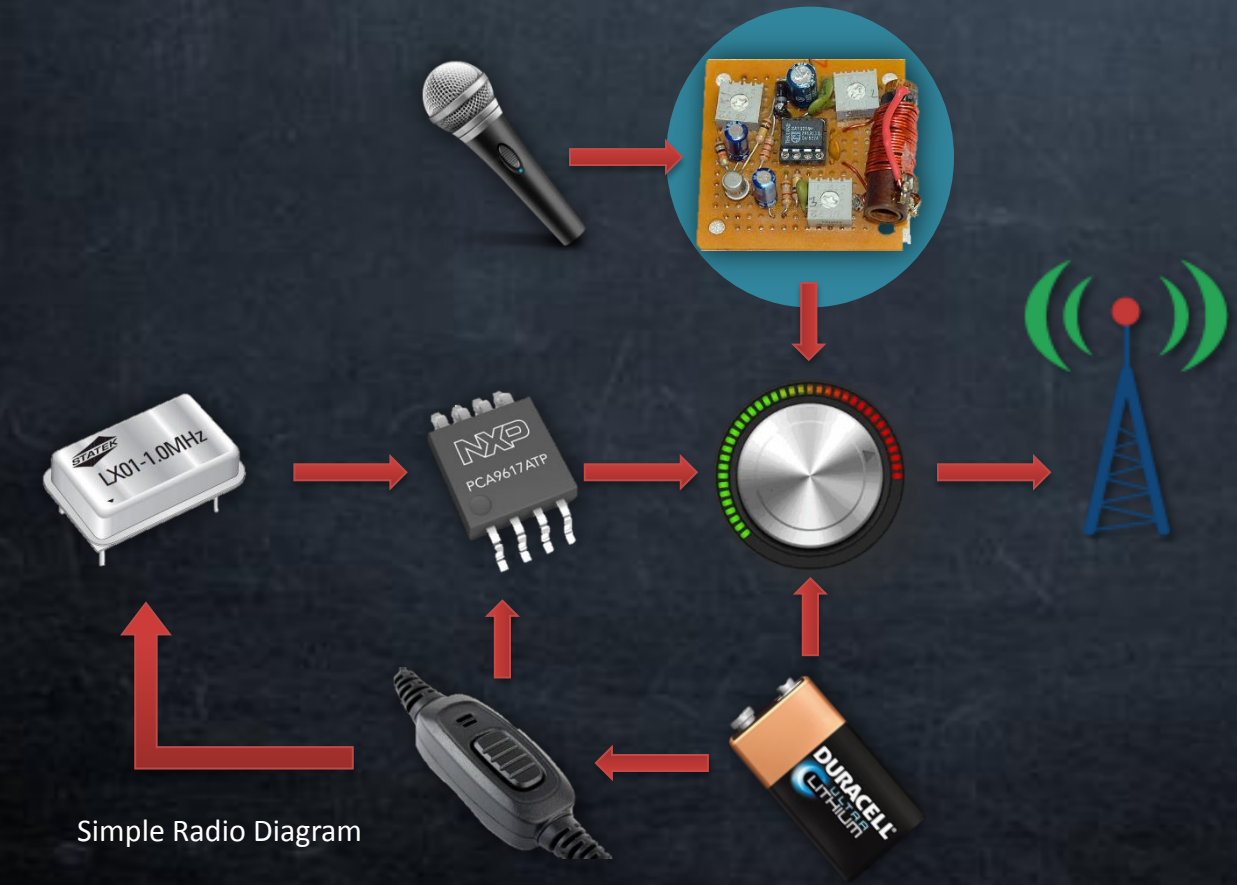
How Do Radios Transmit Messages?



Simple Radio Diagram

Microphones convert sound waves into electrical waves of the same waveform.

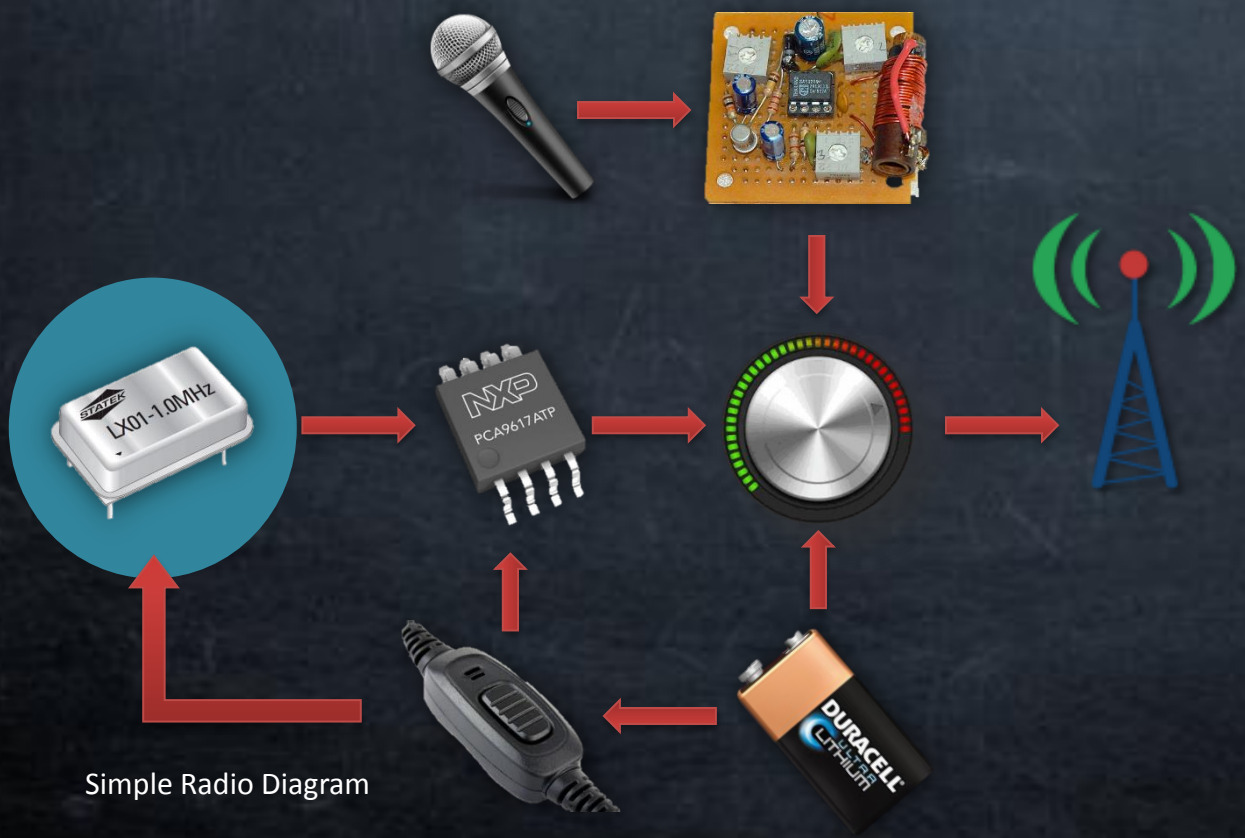
How Do Radios Transmit Messages?



Simple Radio Diagram

Modulators pair the electrical message from the microphone to an existing carrier wave produced by the Oscillator by altering the carrier wave's amplitude, frequency or phase.

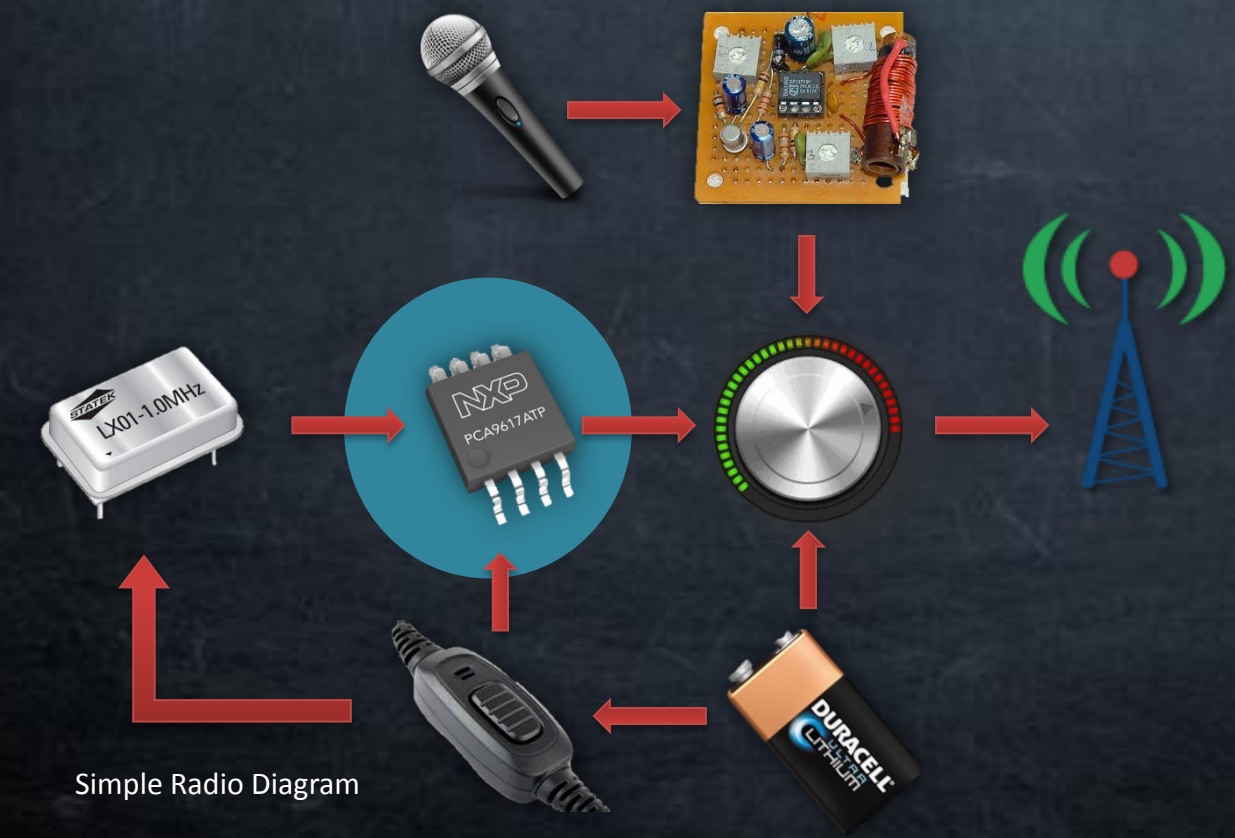
How Do Radios Transmit Messages?



Simple Radio Diagram

Oscillators rapidly change the direct electric current to alternating magnetic and electric fields by using conductors and inductors. This results in a carrier wave being created.

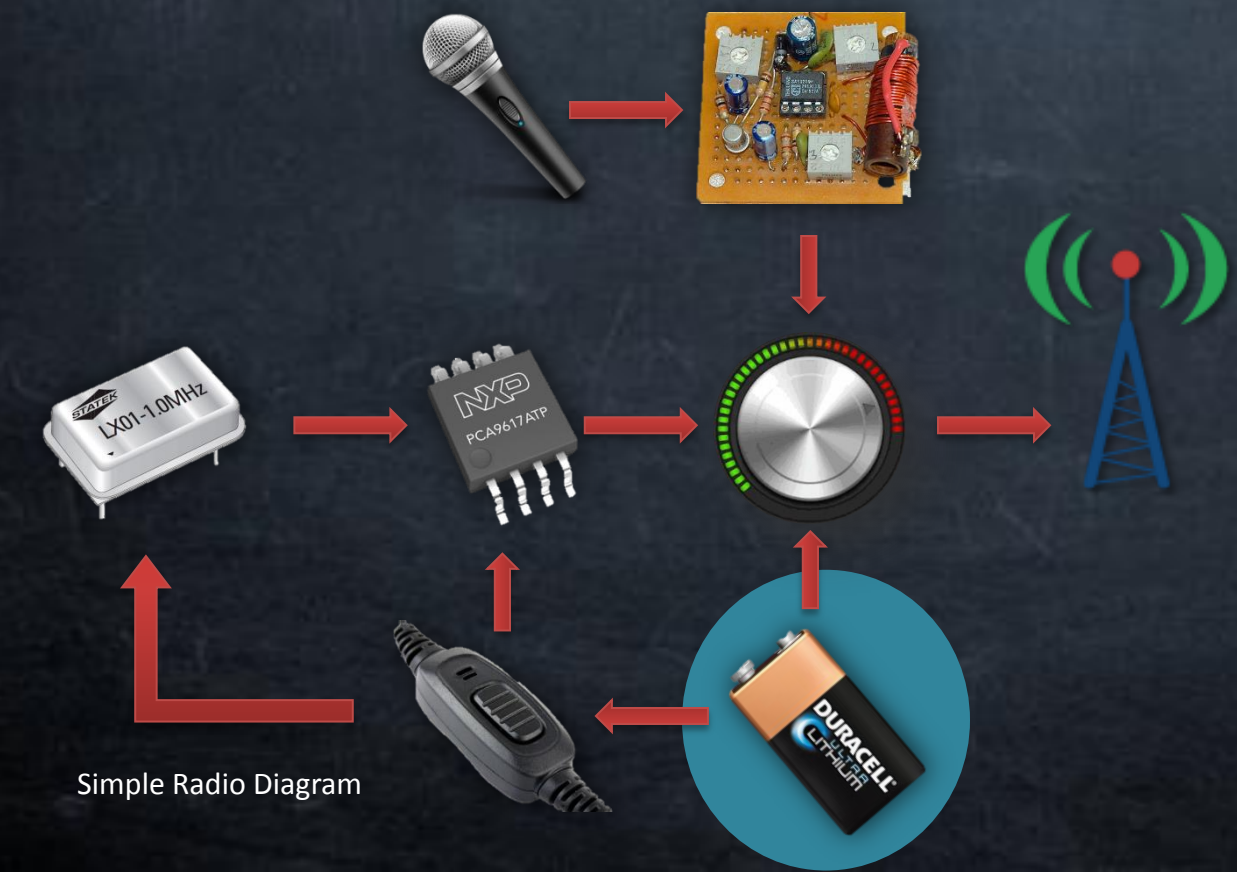
How Do Radios Transmit Messages?



Simple Radio Diagram

The Buffer isolates the Oscillator from the load or power except when you want to enable it using the key.

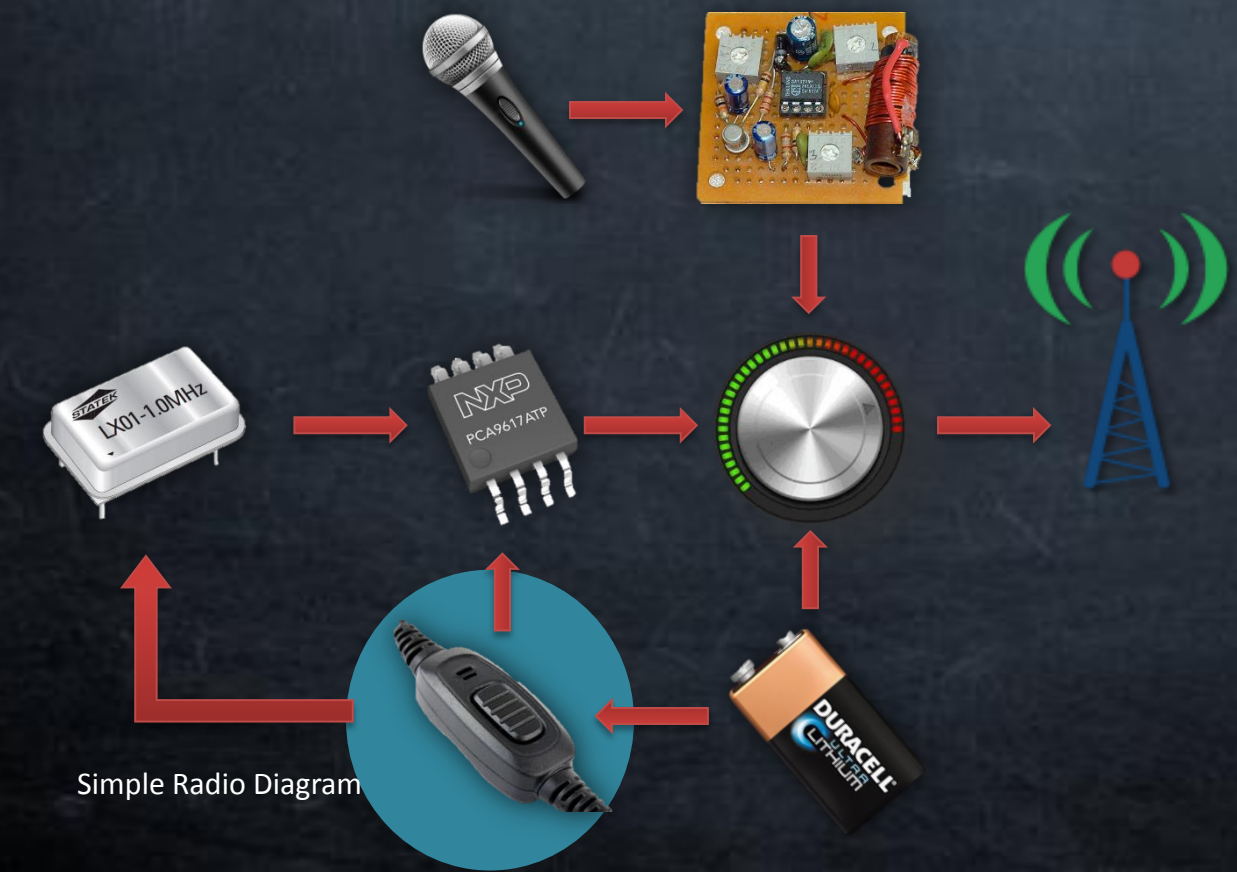
How Do Radios Transmit Messages?



Simple Radio Diagram

The Power Source provides power to the radio

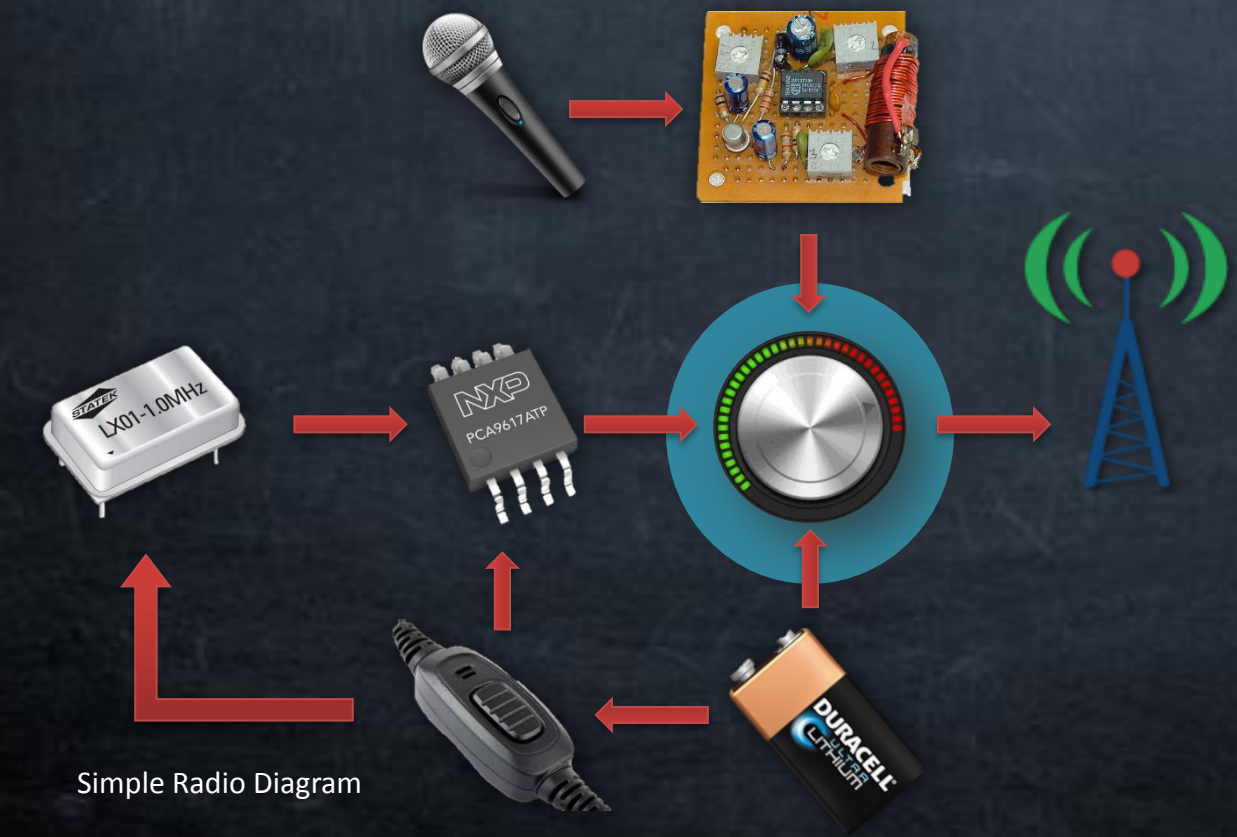
How Do Radios Transmit Messages?



Simple Radio Diagram

The Key or PTT (Push-To-Talk) button in essence runs an electric current to the oscillator so a carrier wave is created. In other words, to transmit.

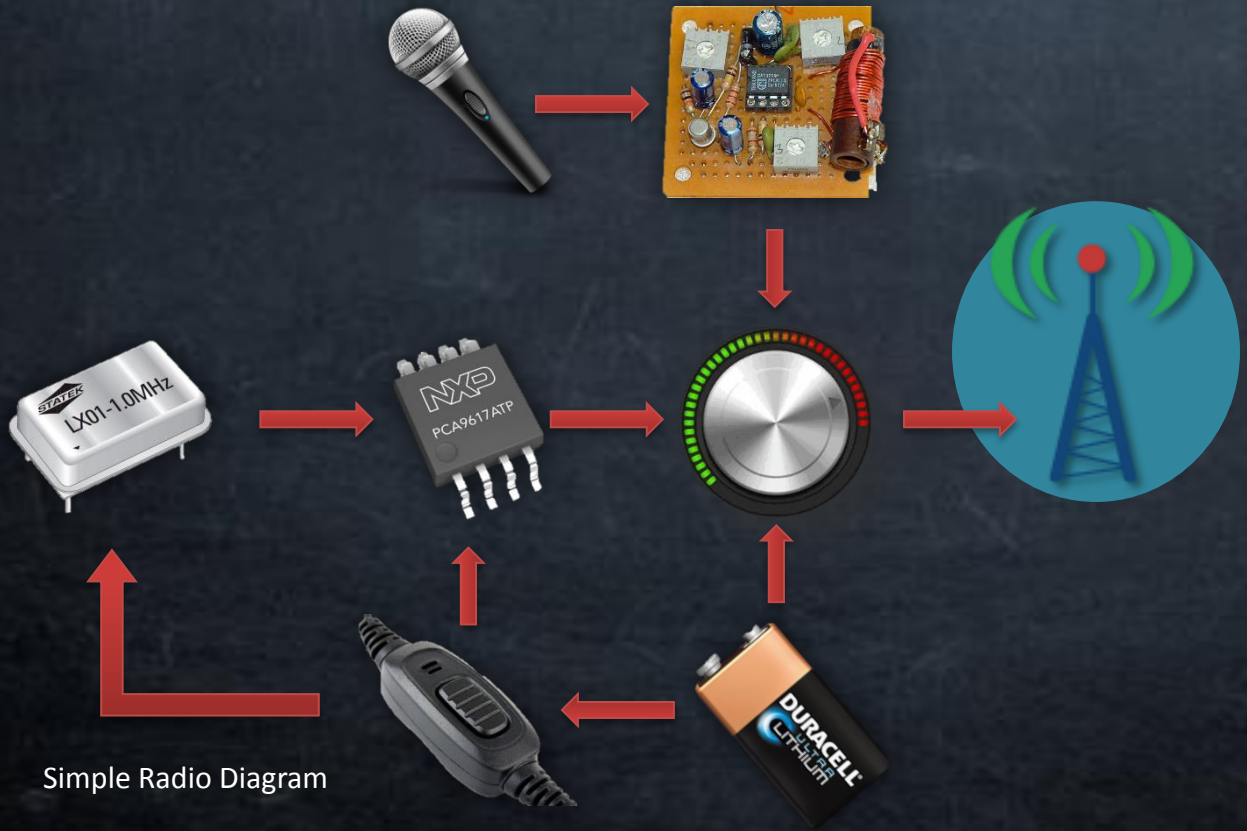
How Do Radios Transmit Messages?



Simple Radio Diagram

The Power Amplifier is where the Carrier Wave and Message Wave (Modulated Signal) are combined and amplified for transmission.

How Do Radios Transmit Messages?



Simple Radio Diagram

The Antenna broadcasts the amplified, modulated signal.

How Do Radios Receive Messages?

Carrier Wave

Antenna

Amplifier

De-Modulator

Speaker

Simple Radio Diagram

Radio Waves

- Radio waves travel at the speed of light.
- Radio Waves, Micro Waves, Visible light, and heat are all on the Electromagnetic Spectrum.
- Understanding some key characteristics of radio waves can help you choose the right one for your particular radio needs.

The Electro-Magnetic Spectrum

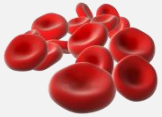
A Single Wavelength is about the size of:

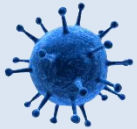

Buildings

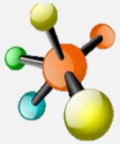

Humans


Insects


Grains of Sand


Red Blood Cells


Virus

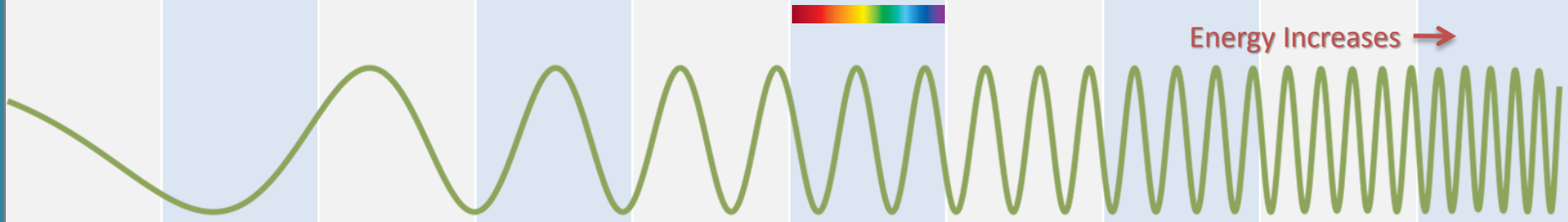

Molecule


Atom


Atomic Nuclei


Subatomic Particles

Radio | Microwave | Infrared | Visible | Ultraviolet | X-ray | Gamma-ray



Wavelength λ (m) ← Longer — Shorter →

10^{3} 10^{2} 10 1 10^{-1} 10^{-2} 10^{-3} 10^{-4} 10^{-5} 10^{-7} 10^{-6} 10^{-8} 10^{-9} 10^{-10} 10^{-11} 10^{-12}

Frequency (Hz) ← Lower — Higher →

10^{5} 10^{6} 10^{7} 10^{8} 10^{9} 10^{10} 10^{11} 10^{12} 10^{13} 10^{14} 10^{15} 10^{16} 10^{17} 10^{18} 10^{19} 10^{20} 10^{21}

The Electro-Magnetic Spectrum

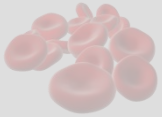
A Single Wavelength is about the size of:


Buildings

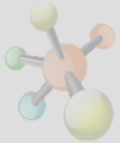

Humans


Insects

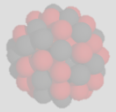

Grains of Sand


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.

The Electro-Magnetic Spectrum

A Single Wavelength is about the size of:

Buildings Sand Cells Nuclei Particles

Radio | Microwave | Infrared | Visible | Ultraviolet | X-ray | Gamma-ray

High Frequency/Short Wavelength radio waves are used for short distances.

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	

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The Electro-Magnetic Spectrum

A Single Wavelength is about the size of:

Buildings Sand Cells Nuclei Particles

Radio | Microwave | Infrared | Visible | Ultraviolet | X-ray | Gamma-ray

Low Frequency/Long Wavelength radio waves are used for long distances.

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.
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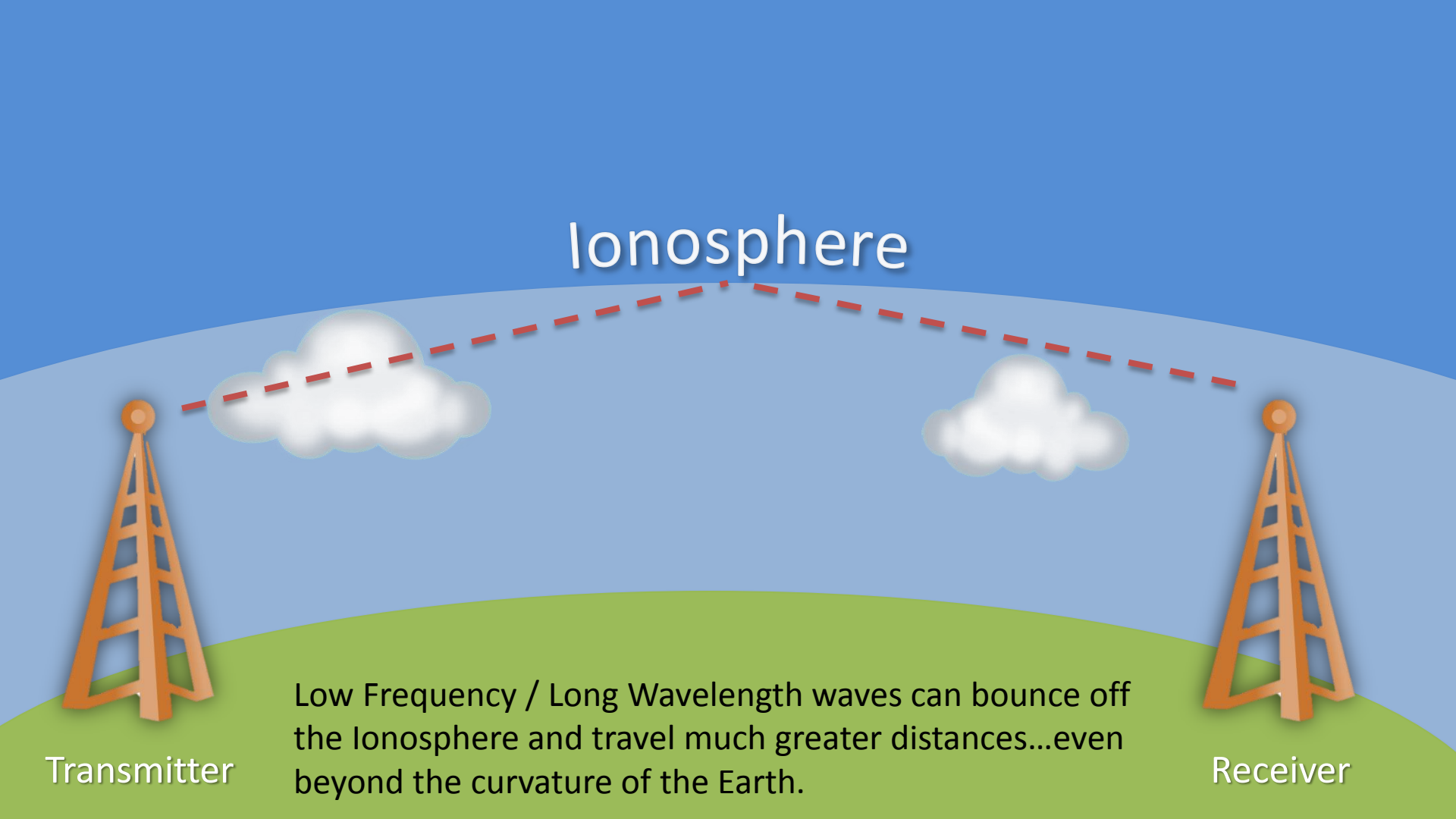


Low Frequency / Long Wavelength waves can bounce off the Ionosphere and travel much greater distances…even beyond the curvature of the Earth.

What is Amateur Radio?

- According to the FCC, Amateur or "Ham" Radio is a voluntary, non-commercial, radio communications service.
- "Amateur Radio" has nothing to do with knowledge or skills. It implies that Ham radio cannot be used for revenue generating purposes.

What is Amateur Radio?

- It allows licensed operators to improve their communications and technical skills, while providing the nation with a pool of trained radio operators and technicians who can provide essential communications during emergencies.
- Amateur radio operators generally use radio transmitters and receivers to communicate with each other in several ways such as: Voice (phone), Radio Teletype (Rtty), Morse code (CW), television, and digital modes such as Packet.

What is Amateur Radio?

- Ham Radio is also a Social Network. It allows operators to make connections with other radio operators around the world.

Levels of Amateur Radio

- There are three Levels of Ham Radio:

1. Technician: Local Communications

2. General: Local Communications + Some High Frequency Privileges for long distance communications.

3. Extra: Full access to all Ham frequencies, including many less crowded portions of the bands.

UNITED STATES FREQUENCY ALLOCATIONS

THE RADIO SPECTRUM

RADIO SERVICES COLOR LEGEND

- AERONAUTICAL MOBILE
- AERONAUTICAL MOBILE SATELLITE
- AERONAUTICAL RADIONAVIGATION
- AMATEUR
- AMATEUR SATELLITE
- BROADCASTING
- BROADCASTING SATELLITE
- EARTH EXPLORATION SATELLITE
- FIXED
- FIXED SATELLITE
- INTER-SATELLITE
- LAND MOBILE
- LAND MOBILE SATELLITE
- MARITIME MOBILE
- MARITIME MOBILE SATELLITE
- MARITIME RADIONAVIGATION
- METEOROLOGICAL
- METEOROLOGICAL SATELLITE
- MOBILE
- MOBILE SATELLITE
- RADIO ASTRONOMY
- RADIODETERMINATION SATELLITE
- RADIOLOCATION
- RADIOLOCATION SATELLITE
- RADIONAVIGATION
- RADIONAVIGATION SATELLITE
- SPACE OPERATION
- SPACE RESEARCH
- STANDARD FREQUENCY AND TIME SIGNAL
- STANDARD FREQUENCY AND TIME SIGNAL SATELLITE

ACTIVITY CODE

- GOVERNMENT EXCLUSIVE
- GOVERNMENT/NON-GOVERNMENT SHARED
- NON-GOVERNMENT EXCLUSIVE

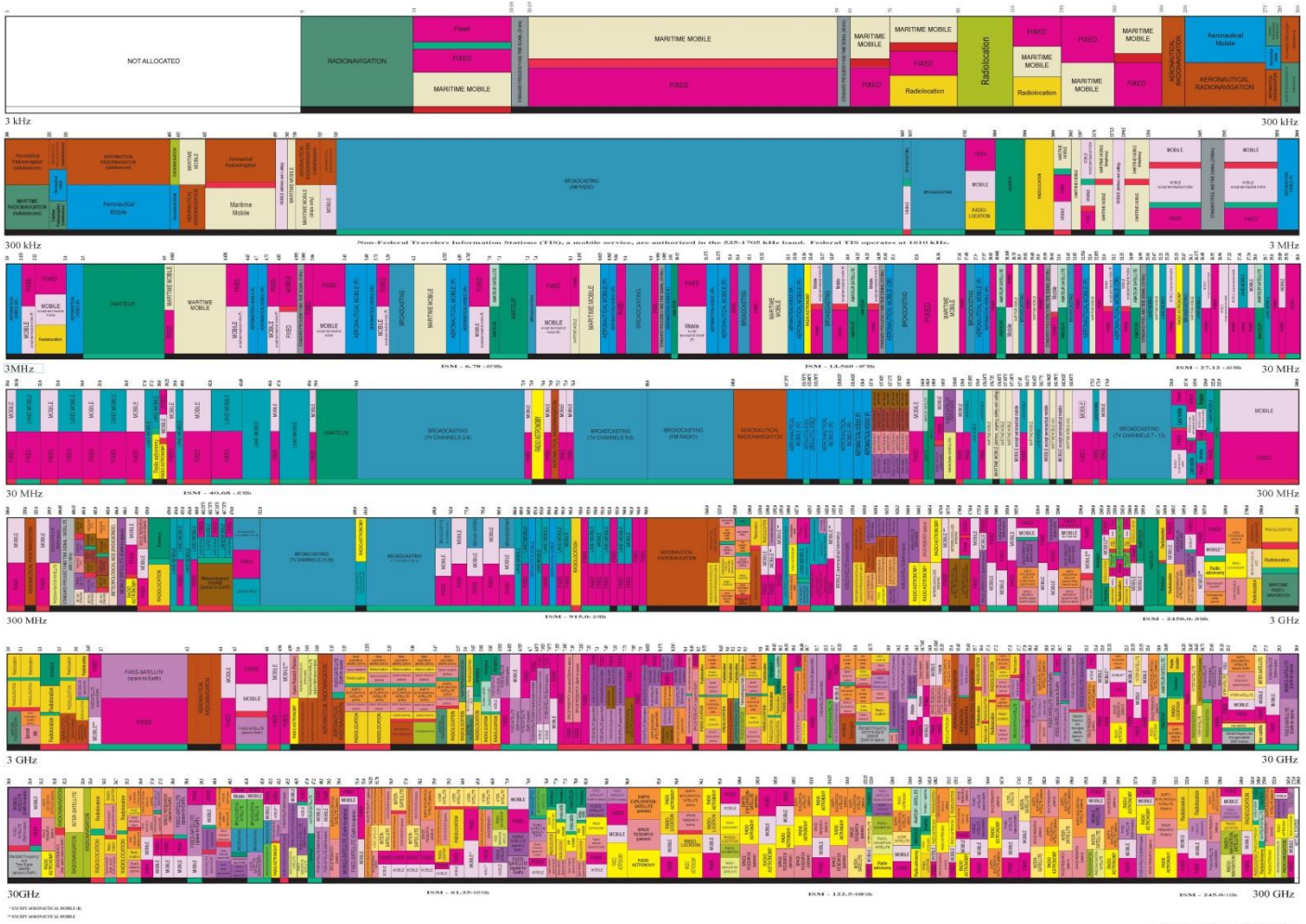
ALLOCATION USAGE DESIGNATION

SERVICE	EXAMPLE	DESCRIPTION
Primary	FIXED	Capital Letters
Secondary	Mobile	1st Capital with lower case letters

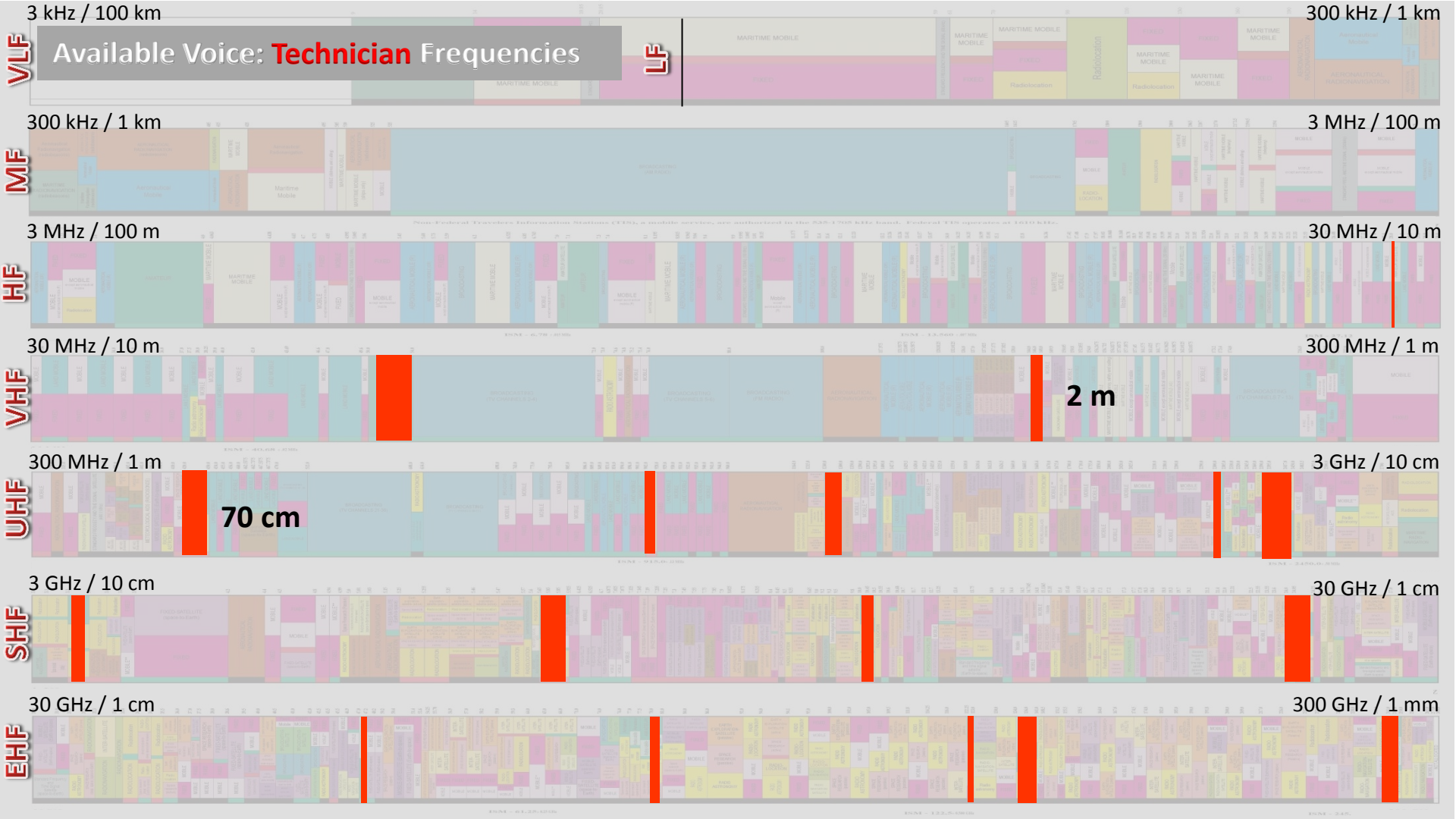
This chart is a graphic single-point-in-time portrayal of the Table of Frequency Allocations used by the FCC and NTIA. As such, it does not completely reflect all aspects, i.e. footnotes and recent changes made to the Table of Frequency Allocations. Therefore, for complete information, users should consult the Table to determine the current status of U.S. allocations.

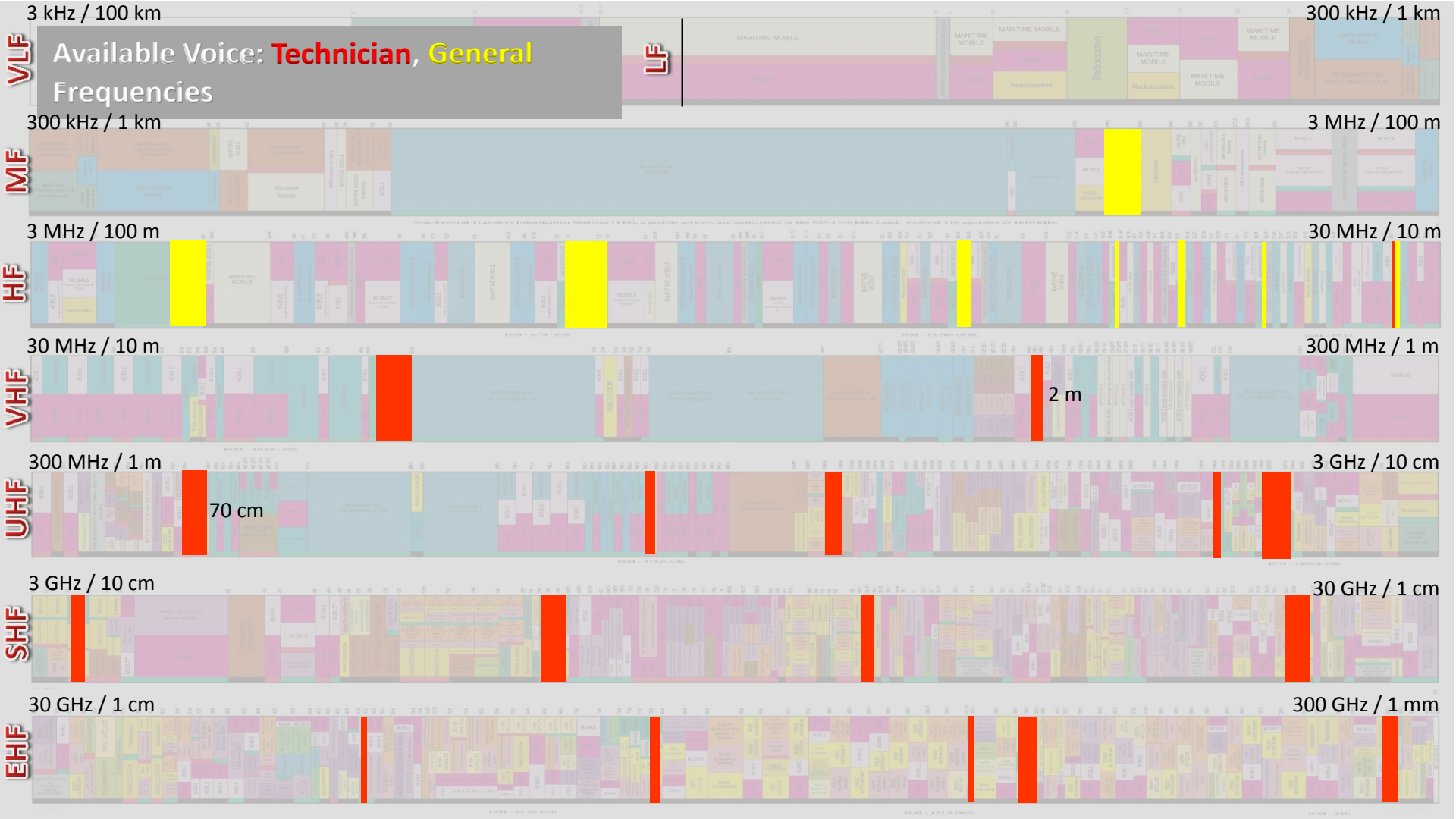
U.S. DEPARTMENT OF COMMERCE
National Telecommunications and Information Administration
Office of Spectrum Management

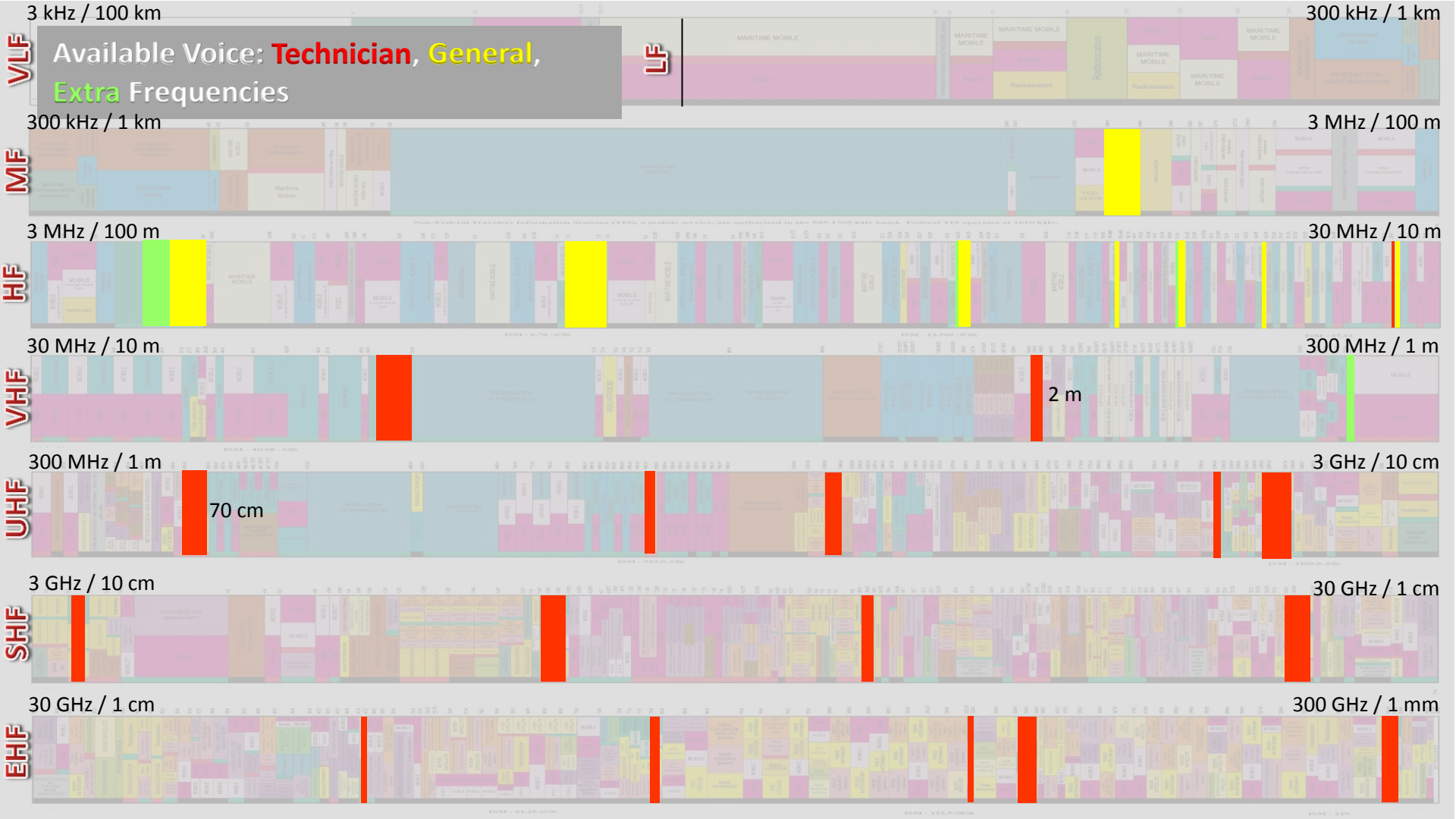
August 2011

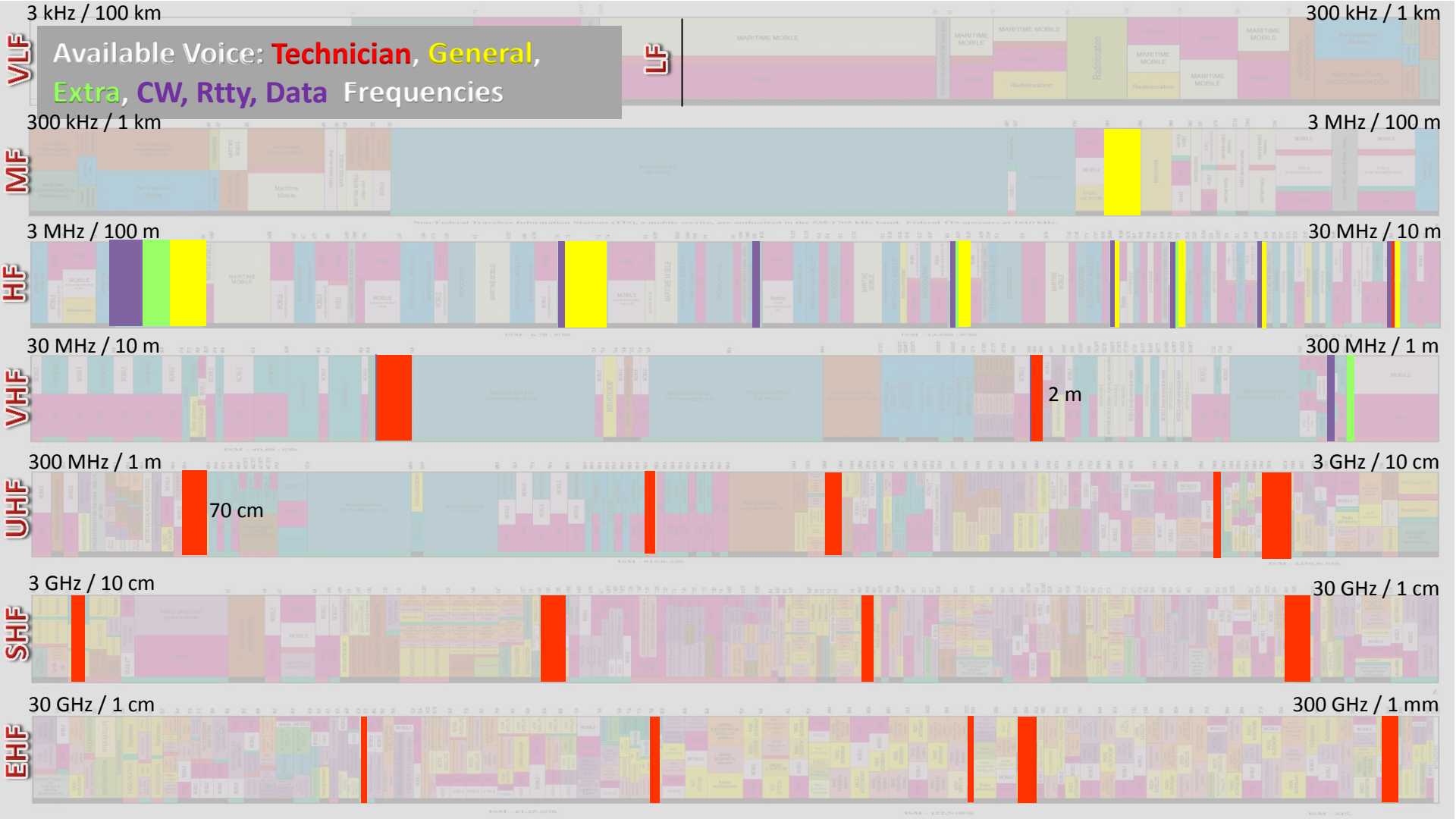


PLEASE NOTE: THE SPACING ALLOTTED HEADINGS IN THIS SPECTRUM DEPICTION DO NOT REFLECT PROPORTIONAL TO THE ACTUAL AMOUNT OF SPECTRUM ALLOTTED.


Available Voice: Technician Frequencies
3 kHz / 100 km
300 kHz / 1 km
VLF
LF
300 kHz / 1 km
3 MHz / 100 m
MF
3 MHz / 100 m
30 MHz / 10 m
HF
30 MHz / 10 m
300 MHz / 1 m
VHF
2 m
300 MHz / 1 m
3 GHz / 10 cm
UHF
70 cm
3 GHz / 10 cm
30 GHz / 1 cm
SHF
30 GHz / 1 cm
300 GHz / 1 mm
EHF


Available Voice: Technician, General
Frequencies
3 kHz / 100 km
300 kHz / 1 km
VLF
LF
300 kHz / 1 km
3 MHz / 100 m
MF
3 MHz / 100 m
30 MHz / 10 m
HF
30 MHz / 10 m
300 MHz / 1 m
VHF
2 m
300 MHz / 1 m
3 GHz / 10 cm
UHF
70 cm
3 GHz / 10 cm
30 GHz / 1 cm
SHF
30 GHz / 1 cm
300 GHz / 1 mm
EHF


3 kHz / 100 km
300 kHz / 1 km
VLF
LF
Available Voice: Technician, General,
Extra Frequencies
300 kHz / 1 km
3 MHz / 100 m
MF
3 MHz / 100 m
30 MHz / 10 m
HF
30 MHz / 10 m
300 MHz / 1 m
VHF
2 m
300 MHz / 1 m
3 GHz / 10 cm
UHF
70 cm
3 GHz / 10 cm
30 GHz / 1 cm
SHF
30 GHz / 1 cm
300 GHz / 1 mm
EHF


3 kHz / 100 km
300 kHz / 1 km
VLF
LF
Available Voice: Technician, General,
Extra, CW, Rtty, Data Frequencies
300 kHz / 1 km
3 MHz / 100 m
MF
3 MHz / 100 m
30 MHz / 10 m
HF
30 MHz / 10 m
300 MHz / 1 m
VHF
2 m
300 MHz / 1 m
3 GHz / 10 cm
UHF
70 cm
3 GHz / 10 cm
30 GHz / 1 cm
SHF
30 GHz / 1 cm
300 GHz / 1 mm
EHF

Amateur Radio in Emergencies

- Amateur Radio has consistently been the most reliable means of communications in emergencies when other systems have failed or were overloaded.

- Telephones, cell phones, Internet and satellite phones all have complicated and vulnerable networks. Even when these systems are functioning, they can be easily overwhelmed when more than 5-10% of its users attempt to make calls during an emergency.

Amateur Radio in Emergencies

- Why is Ham Radio more reliable than other forms of communications?

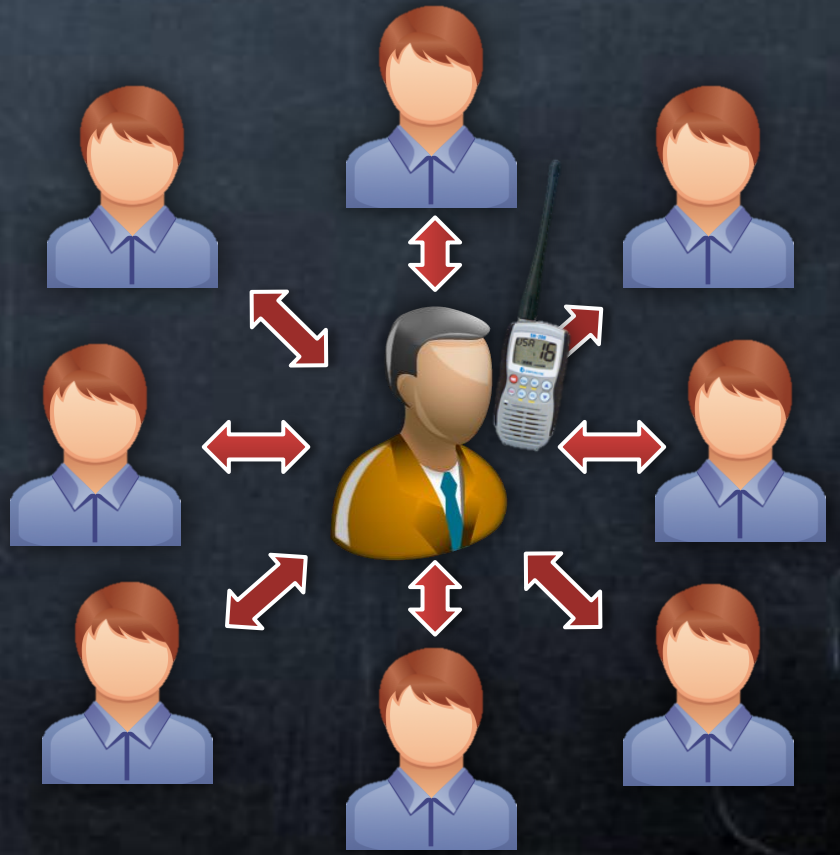
- While Hams may use the Internet or a repeater system, they do not have to. Hams can "go direct" and talk straight through to each other because each station is fully independent. Hams can operate just fine without other infrastructure. By selecting the right frequencies, Hams can talk across town or around the world.

Point-to-Point Communications

- In an emergency, who would you call if you needed something?
- For example: where can I find a generator and gas? Where is the local Red Cross Shelter and do they accept pets? Or which local Emergency Room is still accepting patients?
- Phones use point-to-point communication. You have to know who to call, then you call them directly.

Point-to-Many Communications

- Amateur Radio uses point-to-many communication.
- When you need something, you can make the request to hundreds of radio operators representing hundreds of groups or volunteers.
- This drastically decreases the time it takes to match up needs with resolutions.




GAME
TIME!

Equipment Identification

Radios (Rigs)

HT (Handy-Talkie) or
Handheld

Base Station

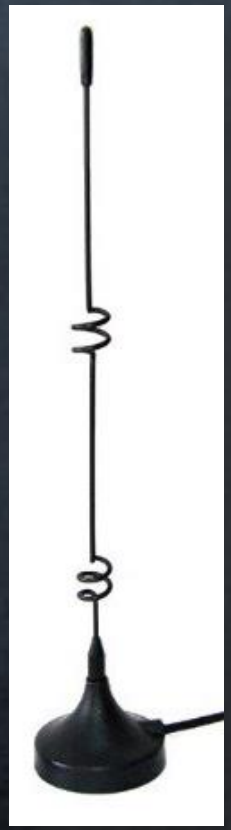
Mobile

Equipment Identification

Antennas

Rubber Ducky
(Sold With Radio)
1/8 Wave

¼ Wave

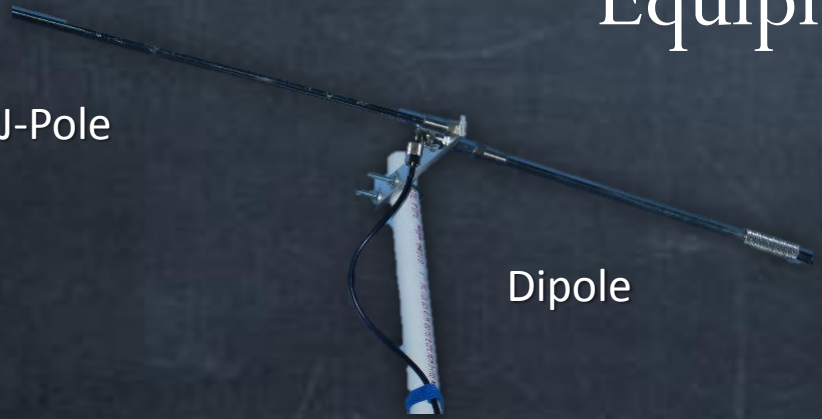


Mag Mount

Equipment Identification

Antennas

J-Pole



Dipole

Yagi

Ground Plane

Equipment Identification

Accessories

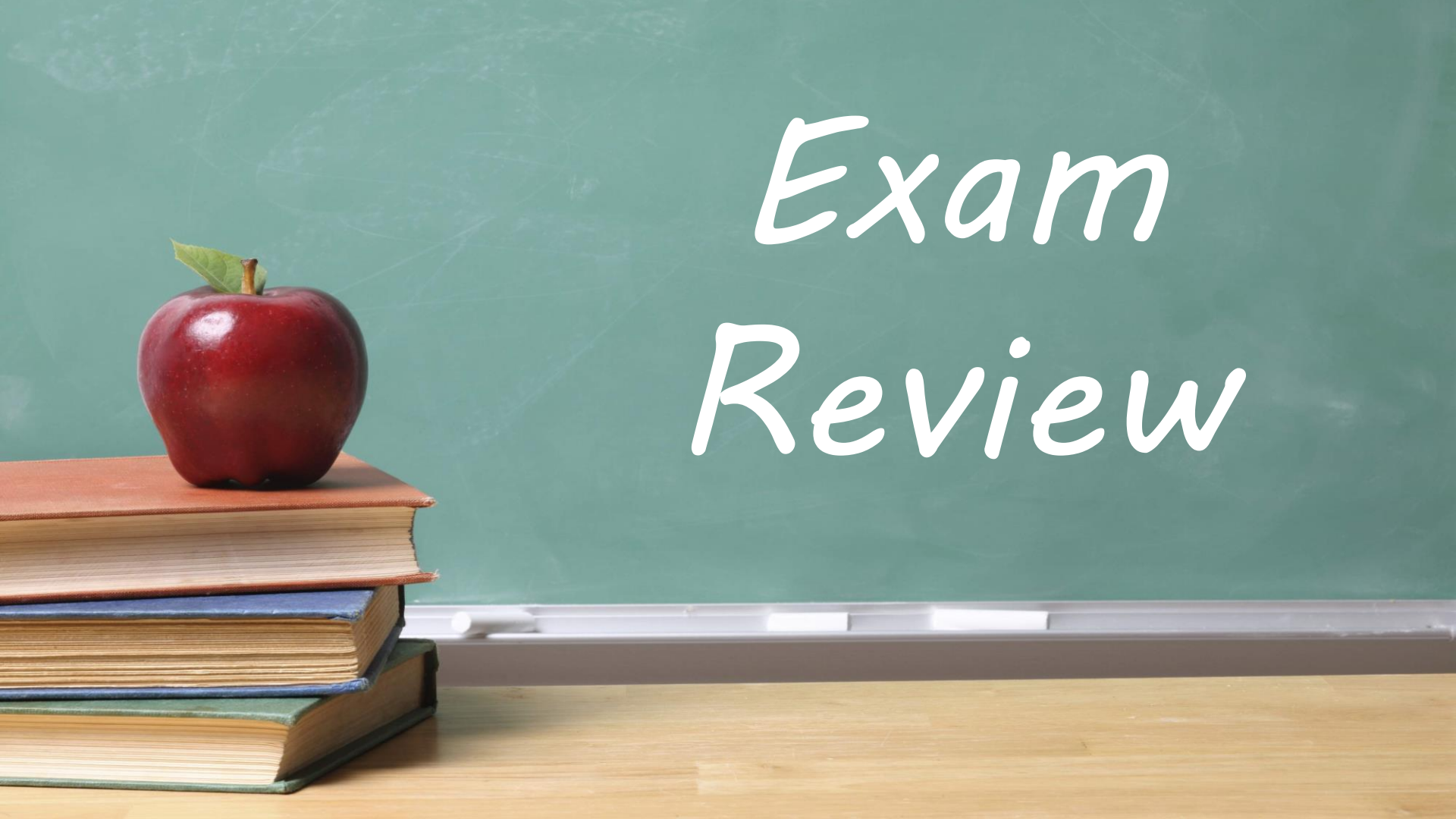
Speaker Mic

Headset

Equipment Recommendations

- See Equipment Recommendations Sheet
- Bring Radios to Class on Week 3


Questions?


Exam
Review

Next Week!

Lesson 2:

- Antenna Fundamentals
- Repeaters
- Duplex & Simplex
- Nets and Frequencies
- Cool Radio Functions
- Exam Review (Homework = Study!)


Questions?

See You Next Week

thanks for joining us