



More than 50 Years of Service to the
Amateur Community

The Central Ohio Radio Club, Inc.

Home of the Central Ohio Severe Weather Net

An [ARRL](#) Special Service Club



Repeater Basics

Part One of a Two Part CORC TechNet Presentation

Rick Tressler, WA3UOO



TechNet

WA3UOO

Slide 1

Tonight's Topics

- What is a Repeater?
- Repeater vs. Simplex Operation
- Types of Repeaters
- What Makes Up a Repeater?
- Frequency Band Plan for Repeaters
- Input/Output Frequency and CTCSS
- Standard Frequency Offset and Direction
- Repeater Timer
- Useful Online Resources

What is a Repeater?

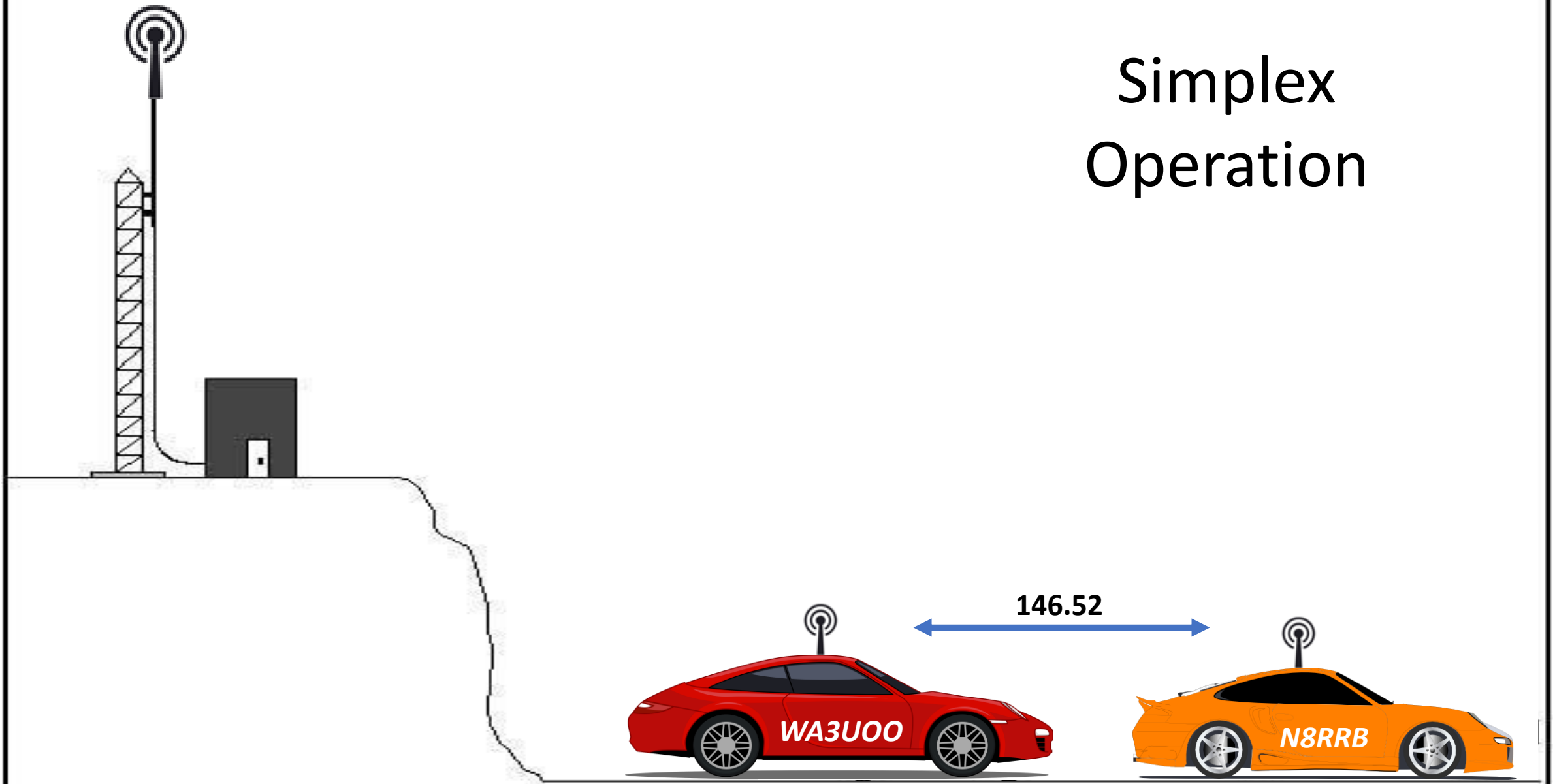
- A repeater is a radio communication system that receives a signal on one frequency and simultaneously retransmits that signal on another frequency at a higher power level to extend the available range between two or more stations.
- Tonight's discussion is limited to a single site system. More on multi site systems in Part two

Simplex vs. Repeater Operation

- **Simplex Operation**

- In simplex operation the stations are in range of each other that allows for direct station to station communication
- Terrain such as hills and mountains limit effective range between the stations as well as distance
- Another consideration is the types of antennas in use and the available RF power output limitations of the stations involved
- Communications between multiple stations on a simplex frequency may not be possible due to various locations

Simplex Operation

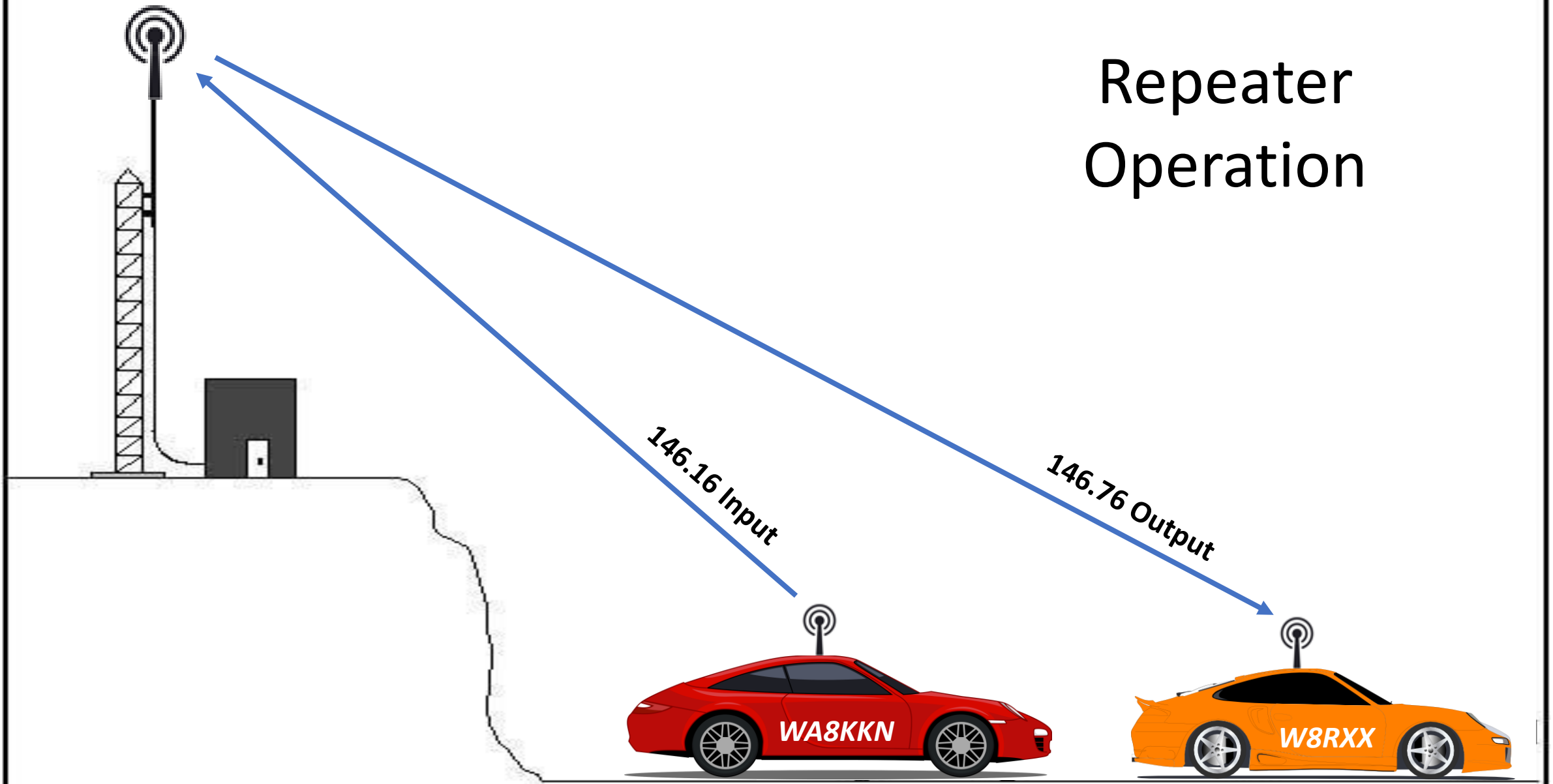


Simplex vs. Repeater Operation

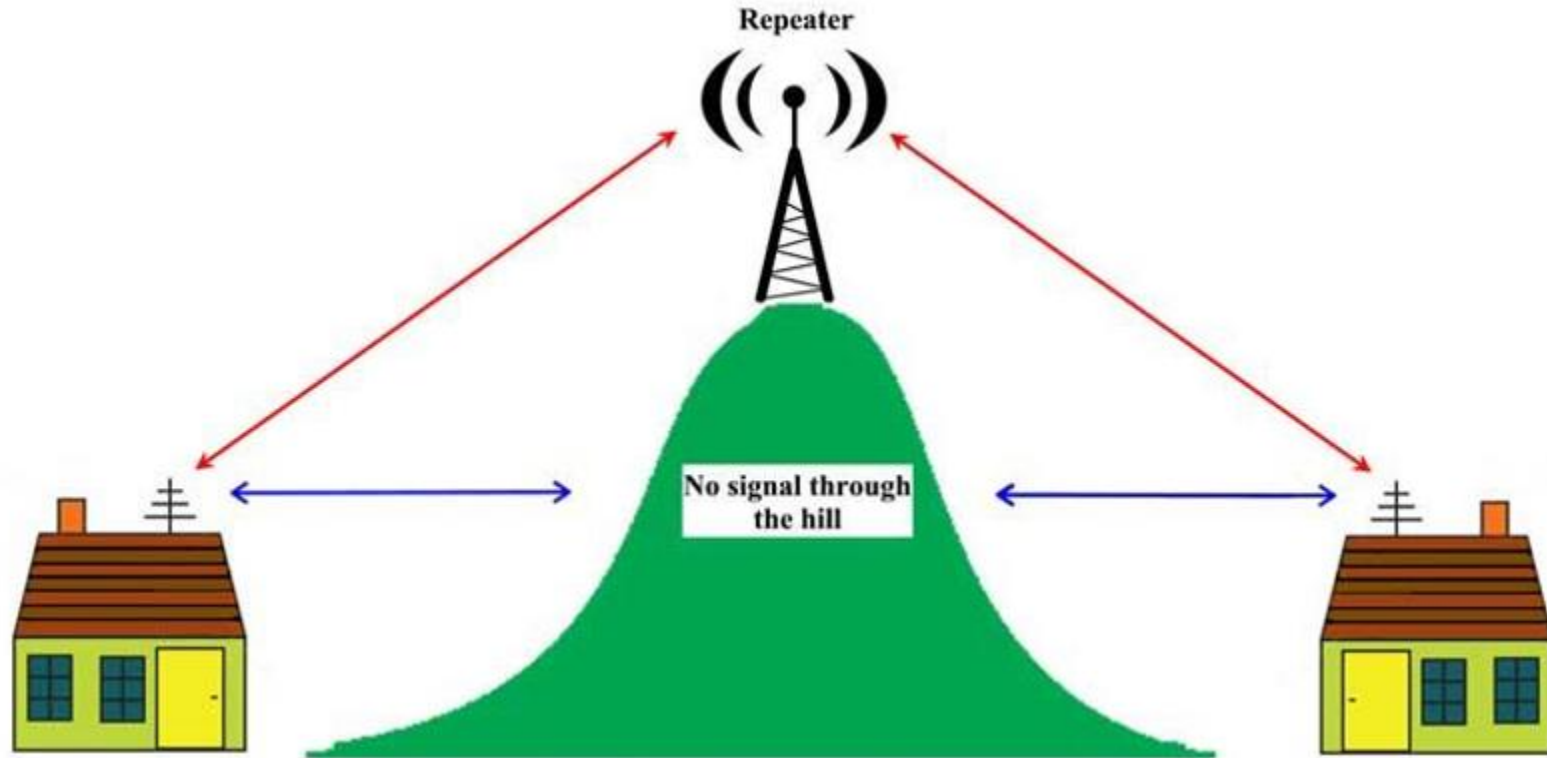
- **Repeater Operation**

- To use a repeater, all stations must be in usable range of the system and can communicate with each other over considerable distance. There are limitations, however.
- Terrain, such as hills, mountains and tall buildings can and do limit effective range between the stations as well as distance
- Whether we're discussing a base station or a portable or mobile setup, the type of antenna, its height, gain and transmit power all affect communication effectiveness

Repeater Operation



Practical Use of a Repeater



If it were not for a repeater, these two stations and many others under similar conditions would not be able to reliably communicate on a number of bands.

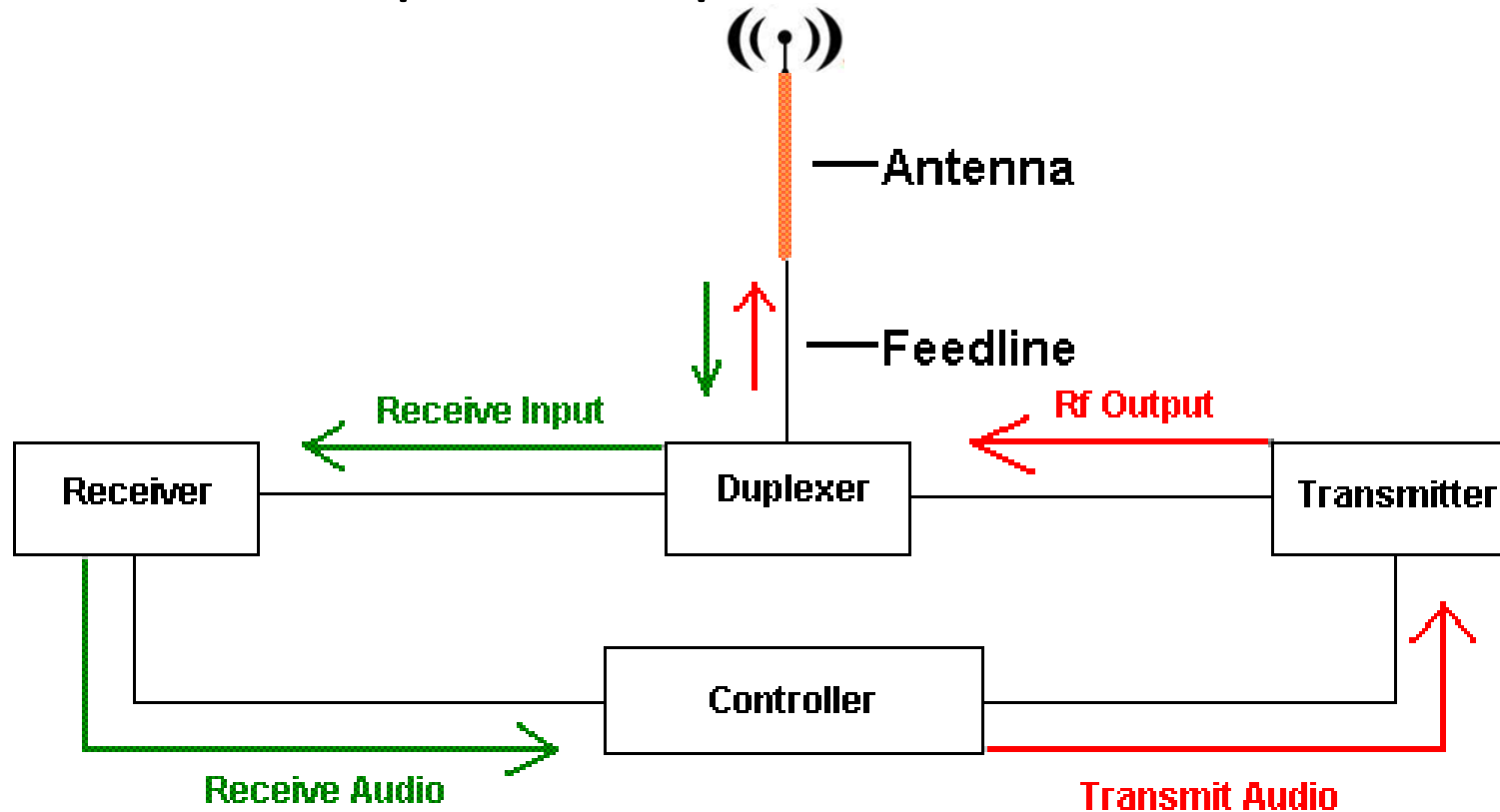
Types of Repeaters (Modes) & Capable Radios

- **FM** - most common in the U.S.
 - Seemingly endless source of FM handheld and portable radios
- **DMR** – **D**igital **M**obile **R**adio
 - Availability same as FM radios
- **C4FM** - Yaesu (System Fusion)
- **D-Star** – **D**igital **S**mart **T**echnologies for **A**mateur **R**adio
 - Icom, Kenwood, FlexRadio Systems
- **P-25** (APCO-25) – Kenwood, Harris, Motorola (commercial)
- **ATV** – amateur television – build or buy and assemble your own

What Makes Up A Repeater?

- Basic Components
 - Antenna
 - Duplexer
 - Receiver
 - Transmitter (High power RF amp may be required)
 - Controller
- For control of a repeater over the air, a control receiver is needed

What Makes Up A Repeater?



BASIC REPEATER BLOCK DIAGRAM

Bands for Repeaters

- Per ARRL Band Plan
 - 10 Meters
 - 6 Meters
 - 2 Meters
 - 1 ¼ Meters
 - 70CM
 - 33CM
 - 23CM
 - For details about specific frequencies on these bands, consult the ARRL Band Plan at <http://www.arrl.org/band-plan>

Example of the ARRL 2 Meter Band Plan

144.00-144.05	EME (CW)
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	New OSCAR subband
144.50-144.60	Linear translator inputs
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	OSCAR subband
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.

Repeater Input & Output Frequency

- In repeater operation, the frequency you transmit on is known as the ***input*** frequency
 - For example, 146.16 MHz
- The frequency you receive on is known as the ***output*** frequency
 - For example, 146.76 MHz
- Depending on the repeater you're on, you may need to program your radio with a CTCSS (aka PL) tone to access the repeater. Repeaters may also transmit the CTCSS tone to minimize received noise by a distant repeater transmitter during unusual band conditions

More on CTCSS – Continuous Tone Coded Squelch System

- CORC FM repeaters utilize CTCSS. *CORC does not use DCS.*
- **CTCSS** is one type of in-band signaling that is used to reduce the annoyance of listening to other users on a shared two-way radio communication channel. It is sometimes referred to as **tone squelch** or **PL** for Private Line, the latter being a trademark of Motorola.
- Today's radios can be easily programmed with a CTCSS tone frequency when required.
- CORC repeaters also transmit the same CTCSS tone so you can set up your radio to open its squelch **ONLY** when it hears the repeater tone.

The 50 Standard CTCSS Tones

CTCSS TONE FREQUENCY (Hz)					
67.0	69.3	71.9	74.4	77.0	79.7
82.5	85.4	88.5	91.5	94.8	97.4
100.0	103.5	107.2	110.9	114.8	118.8
123.0	127.3	131.8	136.5	141.3	146.2
151.4	156.7	159.8	162.2	165.5	167.9
171.3	173.8	177.3	179.9	183.5	186.2
189.9	192.8	196.6	199.5	203.5	206.5
210.7	218.1	225.7	229.1	233.6	241.8
250.3	254.1	–	–	–	–

Repeater Shift or Offset Frequency

- A repeater offset, also called a repeater shift, is the difference between a repeater's input and output frequency
- There is no universal offset frequency.
- The offset and direction are based on the band you're operating on.

Standard Frequency Offset by Band

- Offset and its direction is referenced to the repeater output frequency. The Columbus 16/76 repeater has a negative (-) offset of 600 kHz meaning you listen on 146.76 and transmit on 146.16
- The *direction* of the offset can be plus (+) or minus (-) within a given band

Standard Frequency Offsets for Repeaters

<u>Band</u>	<u>Offset</u>
29 MHz	100 kHz
52 MHz	1 MHz
144 MHz	600 kHz
222 MHz	1.6 MHz
440 MHz	5 MHz
902 MHz	12 MHz
1240 MHz	12 MHz

The Repeater Timer

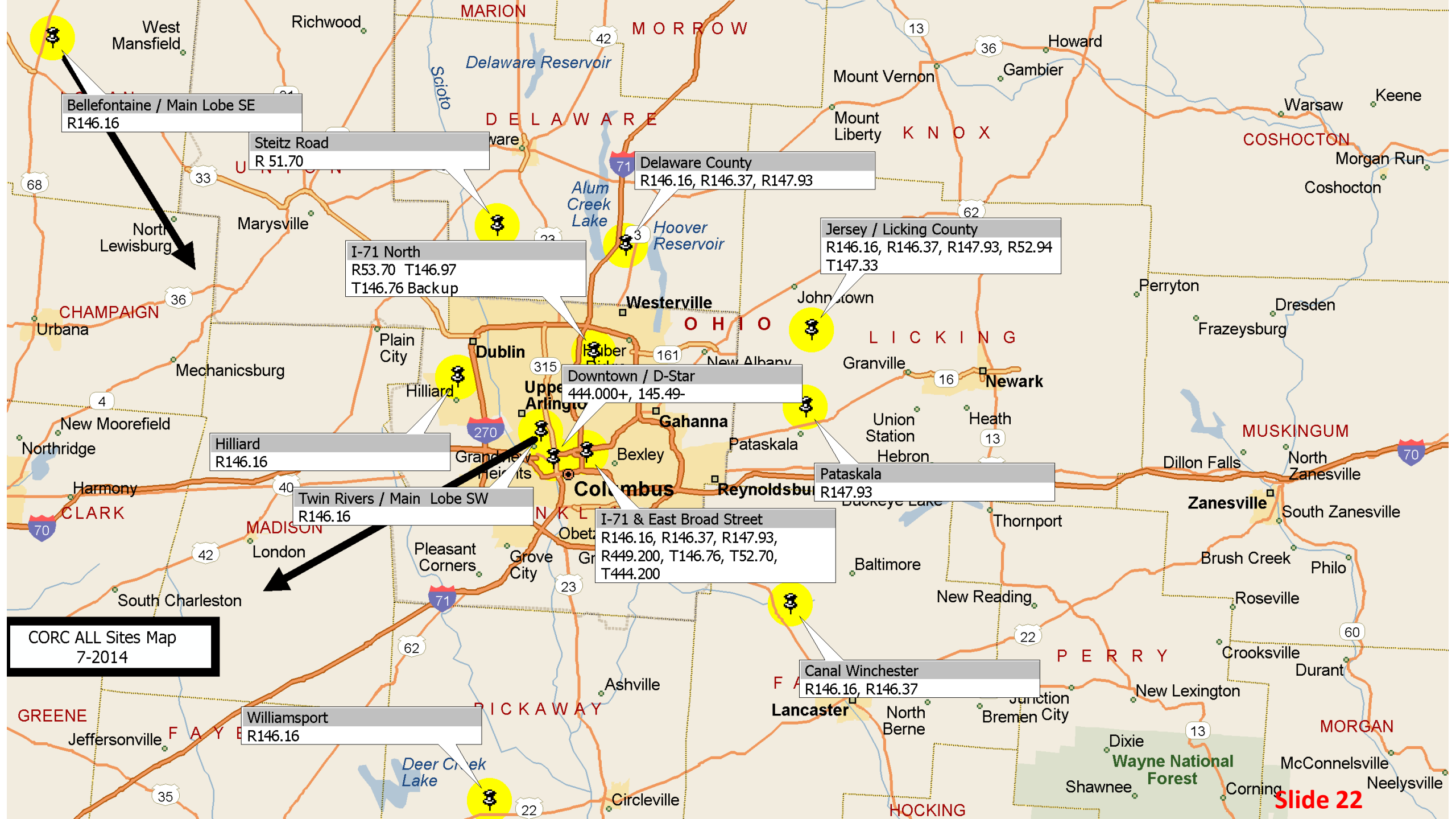
- A system timer or “timeout timer” is a common operating feature of a repeater.
- The timer can be connected to the repeater’s receiver or transmitter
 - When on the *receiver*, the operator must release the microphone PTT and wait for the reset tone which indicates the timer has been reset to zero
 - When on the *transmitter*, the operator must release the microphone PTT and wait for the transmitter to drop off the air, at which time the timer resets.
- Timers are generally set to a maximum 3 minutes and are frequently connected to the repeater’s receiver.
- Keep transmissions short. **Avoid “timing out” the repeater.**

CORC Repeaters - 2M & 70CM FM

- FM 146.76 MHz (-) 600 kHz & 123.0 PL
- FM 146.97 MHz (-) 600 kHz & 123.0 PL
- FM 147.33 MHz (+) 600 kHz & 123.0 PL
- FM 442.80 MHz (+) 5 MHz & 151.4 PL

CORC Repeaters – 6M FM & D-Star

- FM 52.7 MHz
 - 52.70 (-) 1 MHz & 123.0 PL (51.70 MHz input)
 - 52.70 (+) 240 kHz & 123.0 PL (52.94 MHz input)
 - 52.70 (+) 1 MHz & 123.0 PL (53.70 MHz input)
- D-Star 145.49 MHz (Node C) and 444.000 (Node B)
- Full details about our repeaters are found at www.corc.us



Bellefontaine / Main Lobe SE
R146.16

Steitz Road
R 51.70

Delaware County
R146.16, R146.37, R147.93

Jersey / Licking County
R146.16, R146.37, R147.93, R52.94
T147.33

I-71 North
R53.70 T146.97
T146.76 Backup

Downtown / D-Star
444.000+, 145.49-

Hilliard
R146.16

Pataskala
R147.93

Twin Rivers / Main Lobe SW
R146.16

I-71 & East Broad Street
R146.16, R146.37, R147.93,
R449.200, T146.76, T52.70,
T444.200

**CORC ALL Sites Map
7-2014**

Williamsport
R146.16

Canal Winchester
R146.16, R146.37

Useful Online Resources

- CORC Repeater Information
 - <https://www.corc.us>
- ARRL Band Plans
 - <https://www.arrl.org/band-plan>
- Ohio Area Repeater Council – Frequency coordination
 - <http://oarc.com/>
- Federal Communications Commission
 - <http://arrl.org/part-97-text>
- Repeater Builder – Extensive information resource
 - <http://repeater-builder.com/rbtip/>
- ARRL Repeater Directory
 - <http://www.arrl.org/repeaters>
- Basic Repeater Etiquette – Recommended practices
 - <http://www.gcarg.org/repeater-etiquette/>
- Repeater Book – Online directory
 - <https://www.repeaterbook.com>
 - Apps available for Android and iOS



Repeater Basics

Part One of a Two Part CORC TechNet Presentation

Next week - Part Two

Beyond the Basics

Thanks for checking in to the CORC TechNet this evening!

73 until next time!