

# Repeater operation

By Karl Shoemaker

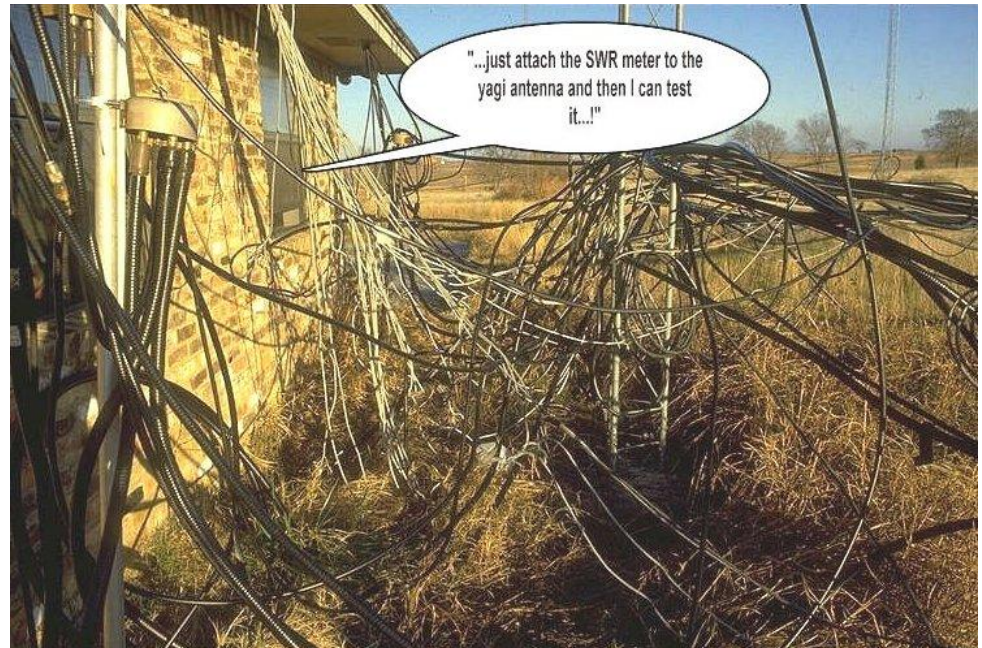
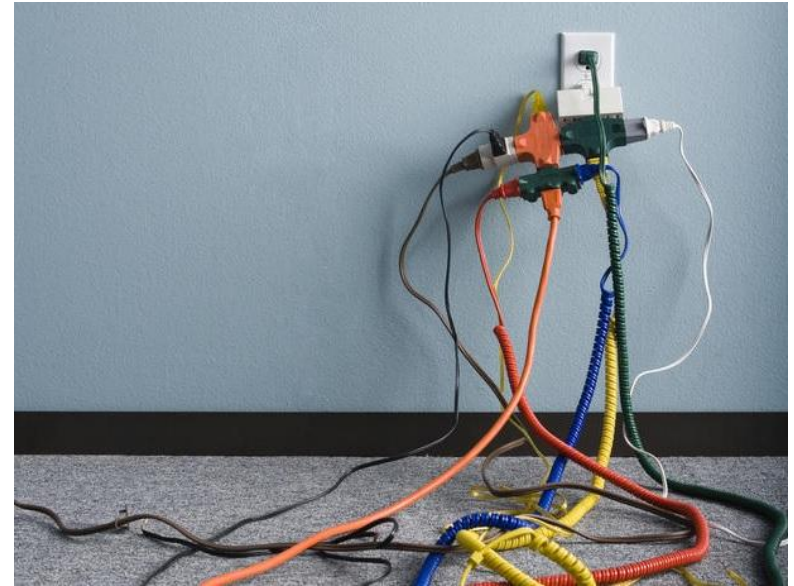
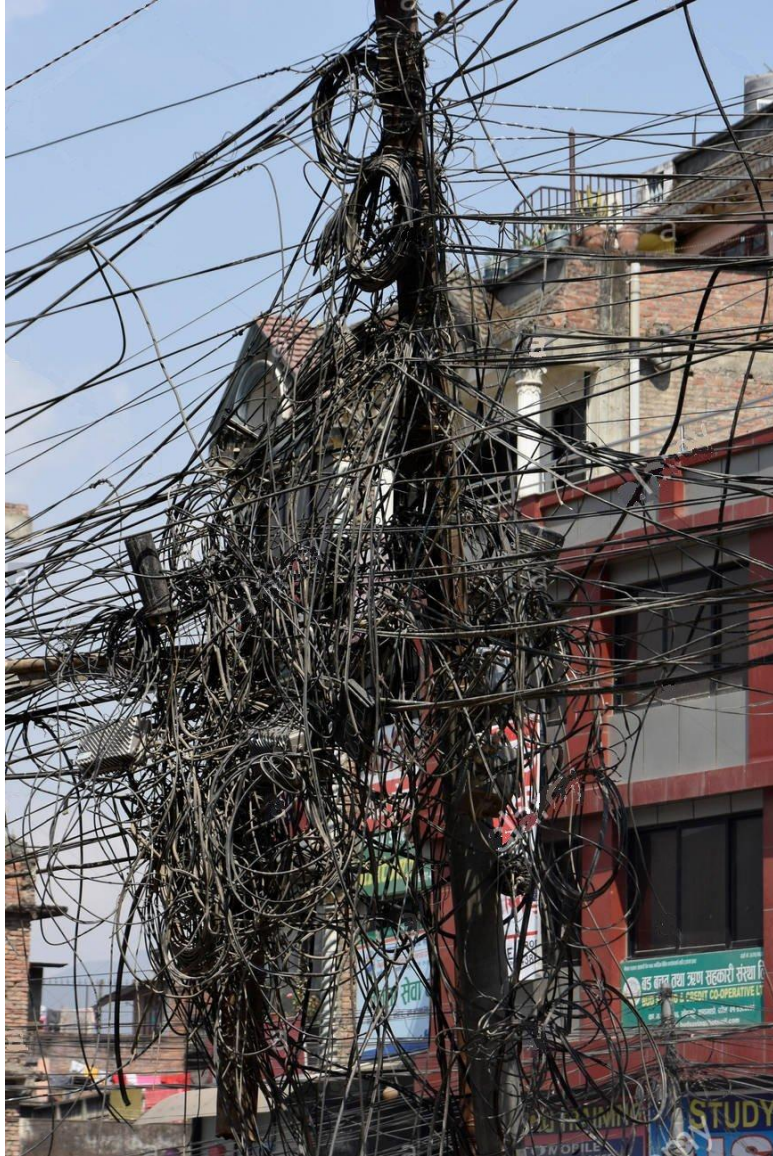
# Repeater basics; components

What makes up a repeater ( project ) ?

- Some money. Perhaps a “club” or organization to obtain funds.
- Site acquirement; MOU / Lease / other arraignments with the owner. Sometimes this is dealing with a large company.
- RFI study and research; Frequency coordination.
- Equipment; receiver, controller, transmitter, duplexer, feed line and antenna.
- Other RFI management; RF filters(s), isolator, etc.
- Rack or cabinet to house the equipment.
- Tower or other structure for antennae.
- Power supply / heat considerations and design.
- Notes, Documentation and other “paper work”.

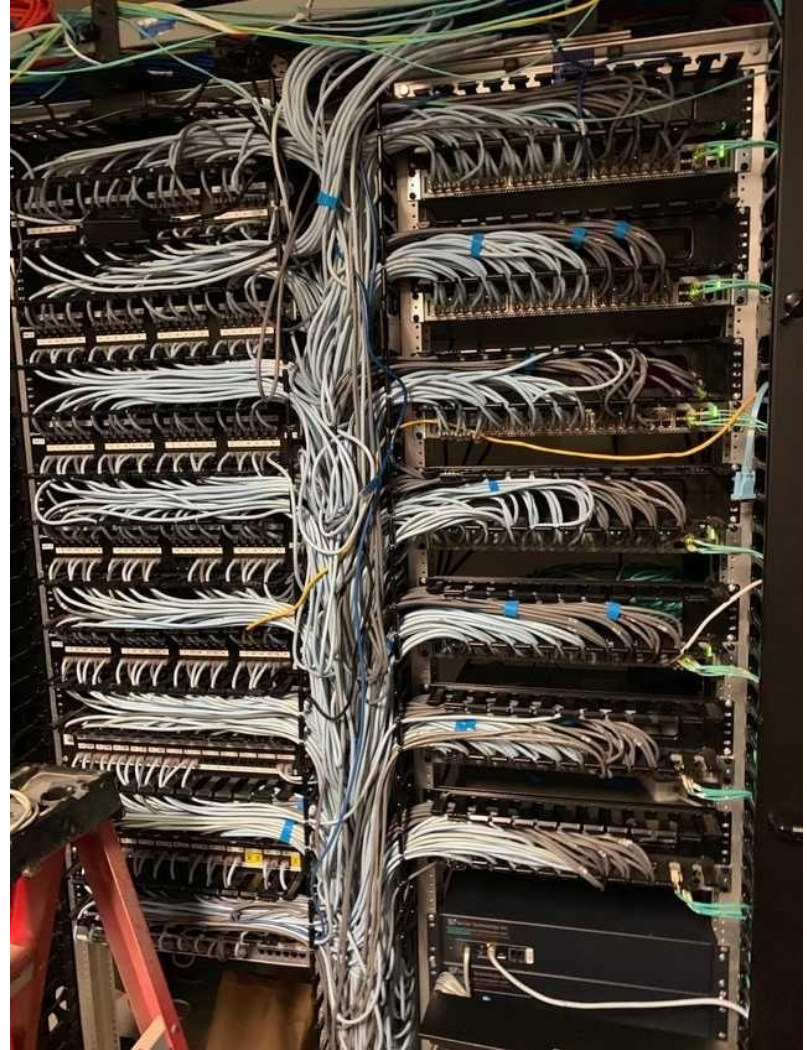
## Construction practices

## Bad wiring





## Good wiring



# Documentation

Good

FROM THE MAKERS OF THE BLOGOSPHERE,  
BLOGOCUBE, AND BLOGODROME COMES

the Blogofractal

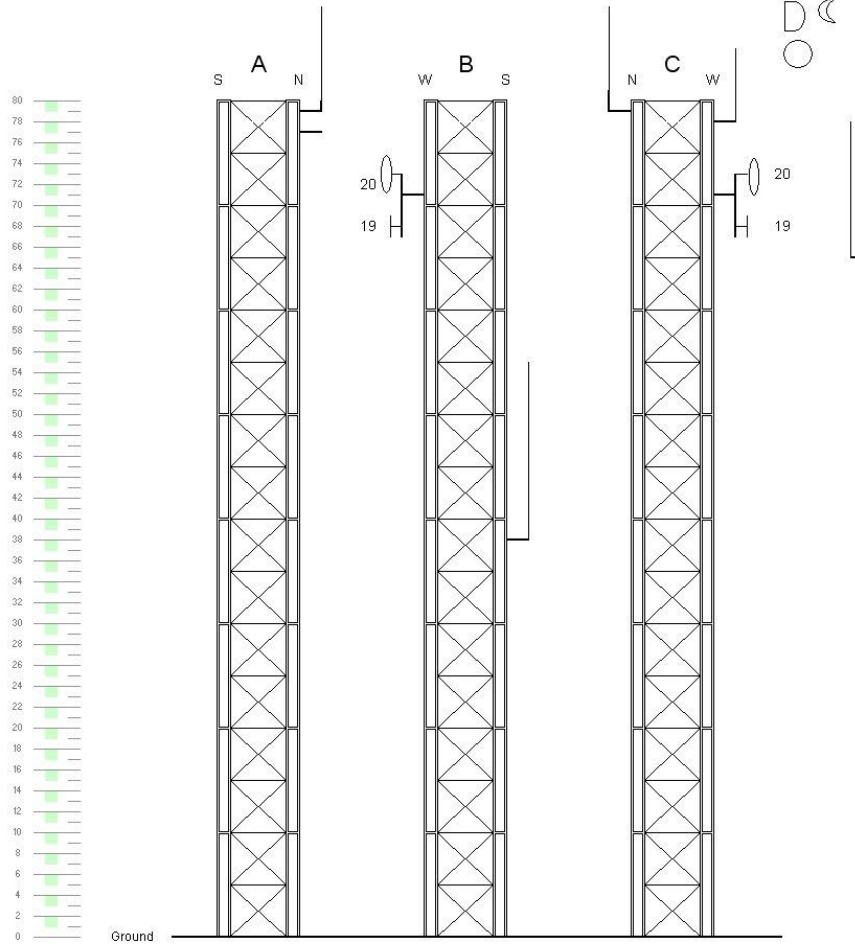
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Task	Status	Comments:
Site acquirement, admin, relations, building, land, etc.	Done	
Lease / LOA / MOU /other admin considerations		
Offer to help out with the site general maintenance		
Access procedures to site (key, comb, call-in at site, etc.	Done	
Transportation to and from site; motel arrangements, etc	N / A	
Coordination for station frequencies, station license, etc	Done	
Site directions, pictures, station manual	Done	
Neighbors/other building considerations		
FR/IRF interfacing, RF compatibilites, other		
Mounts, brackets for antennas and lines	Done	
Coax (lines)	Done	
Coax terminations	Done	
Location(s) for antennae	Done	
Antennas (main, link, etc)	Done	
Sealing for lines and entry points		
Conduit / cat walk /line entry parts-plans, etc.	Done	
Grounding		
AC power provider / account / billing etc.	N / A	
Power supply /12v /off grid sources, etc.	Done	
Cabinet/rack/mounting cans/other panels, etc	Done	
Station radio (Tx, Rx, duplexer, controller, IDer, etc	Done	



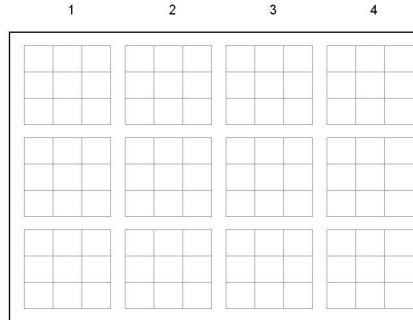
# Antenna placements

## Inventory



Entry panel  
4 x 6 type

Drawing by Karl Shoemaker April 8, 2020 8:40 AM

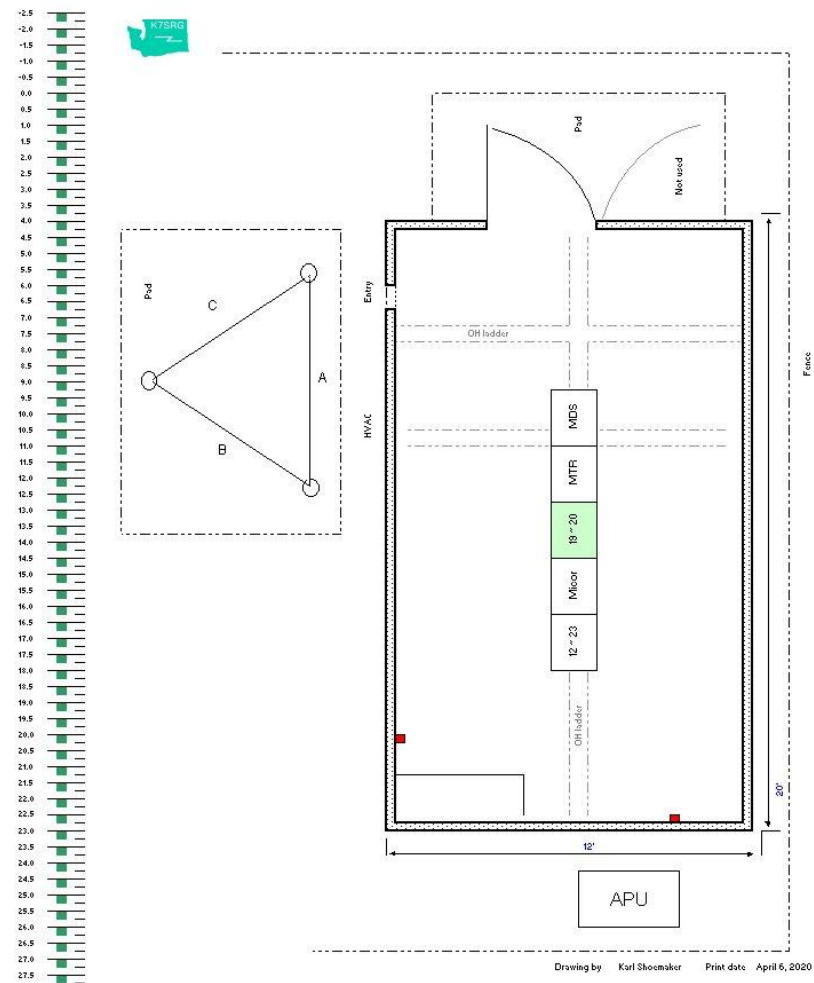


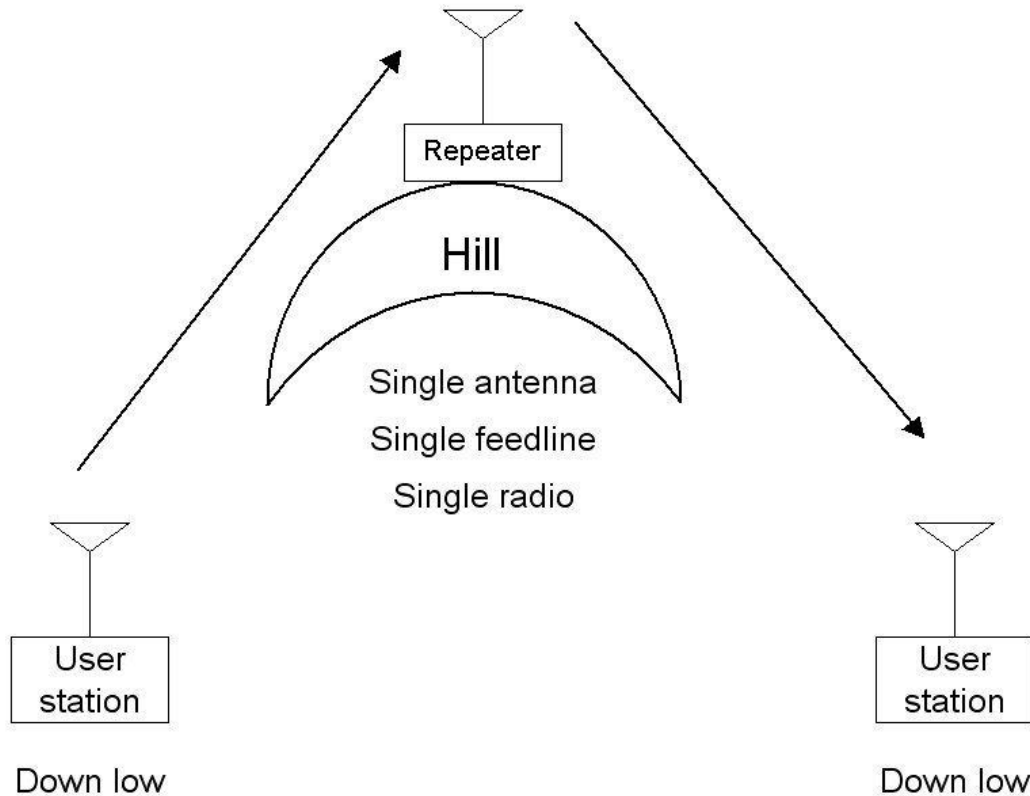
A  
B  
C

ID	Company or Organization	Station license & Class	Frequency & Tone		Transmission line		Antenna type	Polarization	Site: Your site				Near	Spokane	Wa
			Input	Output	Type	Terminations			Level	ID	Coordinates	ASL			
1	Tennent one	Gov		460.xxx			Stick	V	True						
2	Tennent two	Gov	xxx,xxxx	xxx,xxxx			Yagi	V	+ 57						
3	Person of Contact (509) xxx-xxxx							RO							
4															
5															
6															
7															
8															
9															
10															
11															
12															
13															
14															
15															
16															
17															
18															
19	Spokane Repeater Group	Amateur	TO	xxx,xxxx	LMR-400-WHT		Dipole			55					
	Karl Shoemaker (509) xxx-xxxx		Passive		UHF-M UHF-M				+ 28						
20	Spokane Repeater Group	Amateur	RO	xxx,xxxx	LMR-400-WHT		Loop	V	Omni	60					
	Karl Shoemaker (509) xxx-xxxx		CS		N-Female N-Male				+ RO						

Version: Jun 2018  
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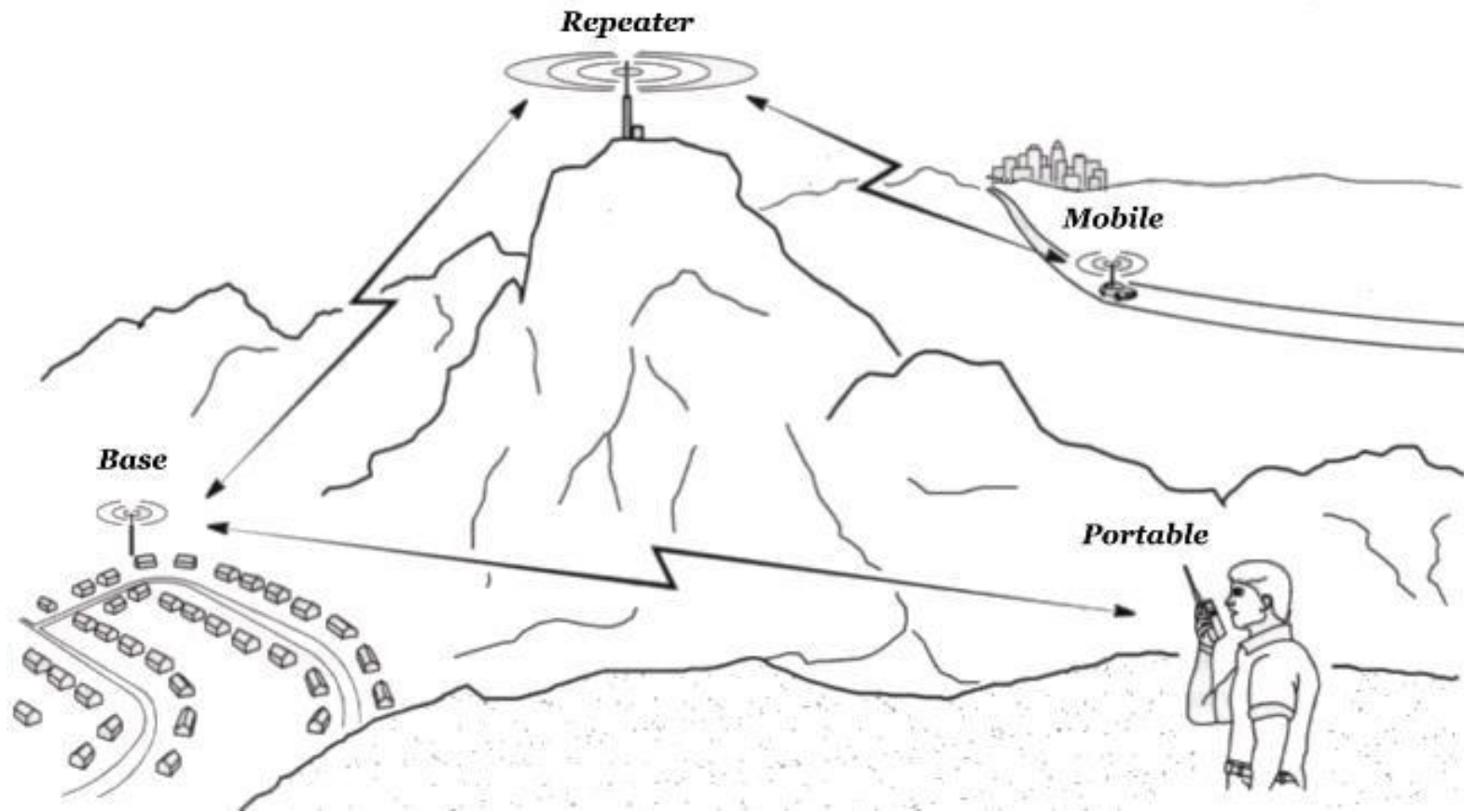
NOTES:





Simple, conventional repeater. VHF radio communication is generally line-of-sight. Users are blocked by hills in many cases. A repeater will receive user #1 and pass it on to user #2 and vice-versa





Mixed operation  
diagram.

# Equipment:

- The repeater can be commercially made and purchased. Normally, it has one receiver and one transmitter in the unit. Sometimes it includes the power supply.
- A repeater receives and transmits on the same antenna on different frequencies.
- Most duplexers can be commercially made and purchased. Use the appropriate design for the site conditions. In many cases populated sites require band-pass or band-pass/ reject modes of a duplexer (no band-reject only).

# More on the duplexer:

- Primary purpose is to protect the repeater's receiver. The secondary purpose is to protect your "neighbors" (other stations at the site).
- Several RF resonant cavities make up one duplexer (singular term).
- Normally it's made up of four or six cavities. Each of these are connected to together with a cable "harness" to work together.
- Normally, one side of the string of cavities is for the repeater's receiver. The other side is for the repeater's transmitter.
- The receiver side cavities are tuned to filter out the repeater's RF transmitter energy. Vice-versa; the transmitter side cavities are tuned to filter out energy on the repeater's receiver frequency.



# Why is a duplexer important?

- The repeater transmitter typically puts out +50 dbm of RF energy.
- The repeater receiver needs to hear a signal -110 dbm of RF level.
- That's a 160 db difference between the transmitter and receiver

That is huge !

- Why is this important to understand ?
- Let's explore a little theory.

# “ Old school thinking “

- For “old school” folks use linear measurements:
- “Watts”
- “Microvolts”

## A better way of thinking

- Logarithmic scale is a better way to see the “big picture”.
- It’s good to determine subtle system gains or losses.
- Also good for establishing bench marks.
- Good for RF path analysis.

( Log (bel) based 10 (dbm)

RF level	Typical use
+ 100 dbm	Radar; can be lethal
+ 90 dbm	Radar; can be lethal
+ 80 dbm	Radar; can be lethal
+ 70 dbm	High power broadcast stations; dangerous
+ 60 dbm	Medium power broadcast stations
+ 50 dbm	High power LMR stations / repeaters
+ 40 dbm	Medium power LMR stations, mobile radios
+ 30 dbm	Low power LMR stations, portable radios
+ 20 dbm	Low power LMR stations, portable radios
+ 10 dbm	High power signal generator / test equipment
0 dbm	High power signal generator / test equipment
- 10 dbm	Normal signal generator / test equipment
- 20 dbm	Normal signal generator / test equipment
- 30 dbm	Normal signal generator / test equipment
- 40 dbm	Very strong user or station signal level
- 50 dbm	Very strong user or station signal level
- 60 dbm	Medium strong user or station signal level
- 70 dbm	Medium strong user or station signal level
- 80 dbm	Medium strong user or station signal level
- 90 dbm	Medium strong user or station signal level
- 100 dbm	Weak user or station signal level
- 110 dbm	Very weak user or station signal level
- 120 dbm	Extremely weak user or station signal level
- 130 dbm	Laboratory test and measurement level
- 140 dbm	Laboratory test and measurement level
- 150 dbm	Experimental operation
- 160 dbm	Laboratory test and measurement level
- 170 dbm	Laboratory test and measurement level
- 180 dbm	Laboratory test and measurement level
- 190 dbm	Laboratory test and measurement level
- 200 dbm	Laboratory test and measurement level
- 210 dbm	Laboratory test and measurement level
- 220 dbm	Laboratory test and measurement level
- 230 dbm	Laboratory test and measurement level
- 240 dbm	Typical Earth to Moon RF level from a station.
- 250 dbm	Typical Earth to Moon RF level from a station.

Most amateur &  
commercial  
repeater  
operational levels



# Other site RF management considerations

- Proper antenna placement.
- Your neighbors.
- Is an isolator needed? What is an isolator?
- There's a good article on this subject by Scott Grimmer, who holds a degree in Science and Electrical Engineering. The document is on SRG's web site.

# Repeater bands for amateur radio:

Repeaters can be operated on several amateur radio bands:

(these are generalized for this presentation)

- 10-meters (28 ~ 30 MHz )
- 6-meters (50 ~ 54 MHz )
- 2-meters (144 ~ 148 MHz) (most common 145~147)
- 1.25-meters (222 ~ 225 MHz)
- 70-centimeter (420 ~ 450 MHz) (most common 440~450)
- 33-centimeter (902 ~ 928 MHz)
- 23-centimeter (1240 ~ 1300 MHz)
- Higher, specialized amateur bands, including laser / light.
- 2-meter band is by far the most popular band to operate.

# Other considerations:

- People population in major cities and other towns.
- Stations - population on mountain top sites.
- Less frequencies are available (repeater pairs).
- Alternate bands from 2-meters.
- There are many repeaters around the Spokane area.
- Several have “links”; IRLP, Echo-link, DMR / IP, etc.
- Several are analog voice.
- Does everyone “need” to have his/her own repeater?
- What about group efforts, communication and cooperation?



More information can be found  
on SRG's web site of:  
<http://www.srgclub.org>

Or you can search on line:

- The Club's call sign of K7SRG
- The Author's call sign of AK2O



## Chances of a Man Winning an Argument



Questions ?