



# TOPICS

- About the Speaker
- Why FM Contesting?
- Analysis of FM Contesting
- Link Margins / Range
- System Design
- January 2016
- Modifications for September 2016
- September 2016
- January 2017 Plans

# About the Speaker

- ▣ Dad was a Ham in the 60's: Grew up around it.
- ▣ Aerospace Engineer, S&T PM for ONR
- ▣ SWL, Motorsports, Engine Building, Rock Crawling, Fab.
- ▣ Found Amateur Logic on Roku.
  - Watched every episode and it reignited an old interest.
- ▣ General & Technicians at Dayton May 2015
  - First Radio: FT-60 HT late November 2015
- ▣ Contesting Looks Like Fun: Early December 2015

Let's go build a contest station, in 6 weeks

# Why FM Contesting?

- ▣ YouTube videos on Contesting
  - HF: You need big \$\$\$\$ , the perfect location & great skill
  - VHF/UHF Fixed Site: Location only North East and Gulf Coast.
    - ▣ N5X0 2013 UHF/VHF Contest video: How to operate
  
- ▣ VHF/UHF Rover or FM “fixed” site?
  - Studied K8GP/R & Grid Pirates ; extensive web history
    - ▣ Inspiring & Educational but far beyond me.....maybe some day
  - FM: New category, few entrants, low scores, LOS is king.
    - ▣ Almost nothing published: Room to innovate, set the standard?
    - ▣ Lack of propagation is a regional equalizer, an advantage?
    - ▣ Rochester NY dominates but they can't get winter altitude.
    - ▣ Blue Ridge gives altitude and I have the vehicle to get me there

## UNFAIR ADVANTAGE #1

Altitude in January: I can get it in VA, they can't in NY.



# Analysis of FM Contesting

Just what am I getting into?

## Rules:

### 2.4. Single Operator, FM Only (not available for the August UHF Contest)

2.4.1. All QSOs must be made using Frequency Modulation (FM).

2.4.2. Restricted to 50, 144, 222 and 440 MHz.

2.4. Power limits are 100 W on all bands.

### 4. Exchange: Maidenhead grid-square locator.

4.1. Exchange of grid square is required. Signal report is optional.

### 5. Scoring:

5.1. QSO points:

5.1.1. Count one point for each complete 50- or 144-MHz QSO.

5.1.2. Count two points for each 222- or 432-MHz QSO

Everyone has 144 & 432 MHz. 50 & 220 MHz are less common  
Focus on 2M & 70cm bands: \$, Time & Performance

# Analysis of FM Contesting

Historic Scores: What do I need to do?

Contest	Score	QSO	Mult	Call
Jan 13	1080	59	15	W2EV
June 13	360	23	12	K6TDI
Sept 13	688	34	16	W2EV
Jan 14	1218	87	14	KB0LYL
June 14	1650	54	22	W2EV
Sept 14	1157	64	13	K7NIT
<i><u>Jan 15</u></i>	<u>3080</u>	<u>103</u>	<u>22</u>	<u>W2EV</u>
	<u>2136</u>	<u>61</u>	<u>24</u>	<u>NL7CO</u>
	<u>1935</u>	<u>91</u>	<u>15</u>	<u>N2HJD</u>
June 15	3725	114	25	KK4OSG
	3612	93	28	W2EV

**January 16 Goal: Top 3 Finish , Need~100 QSO & 15 to 20 Multipliers**

# Site Selection: FM Contesting

- Many candidate sites along 1<sup>st</sup> & 2<sup>nd</sup> range of Blue Ridge
  - Evaluated sites based on LOS, grids reached in each band (multipliers), winter accessibility, overnight parking/camping.
  - Flagpole Mound at 4400 ft was the baseline for comparison:
    - 94 mile LOS to Sea Level, 125 mile LOS to 450 ft (metro DC alt.)
    - 120 mile arc covers Pittsburg- DC-Baltimore-Richmond

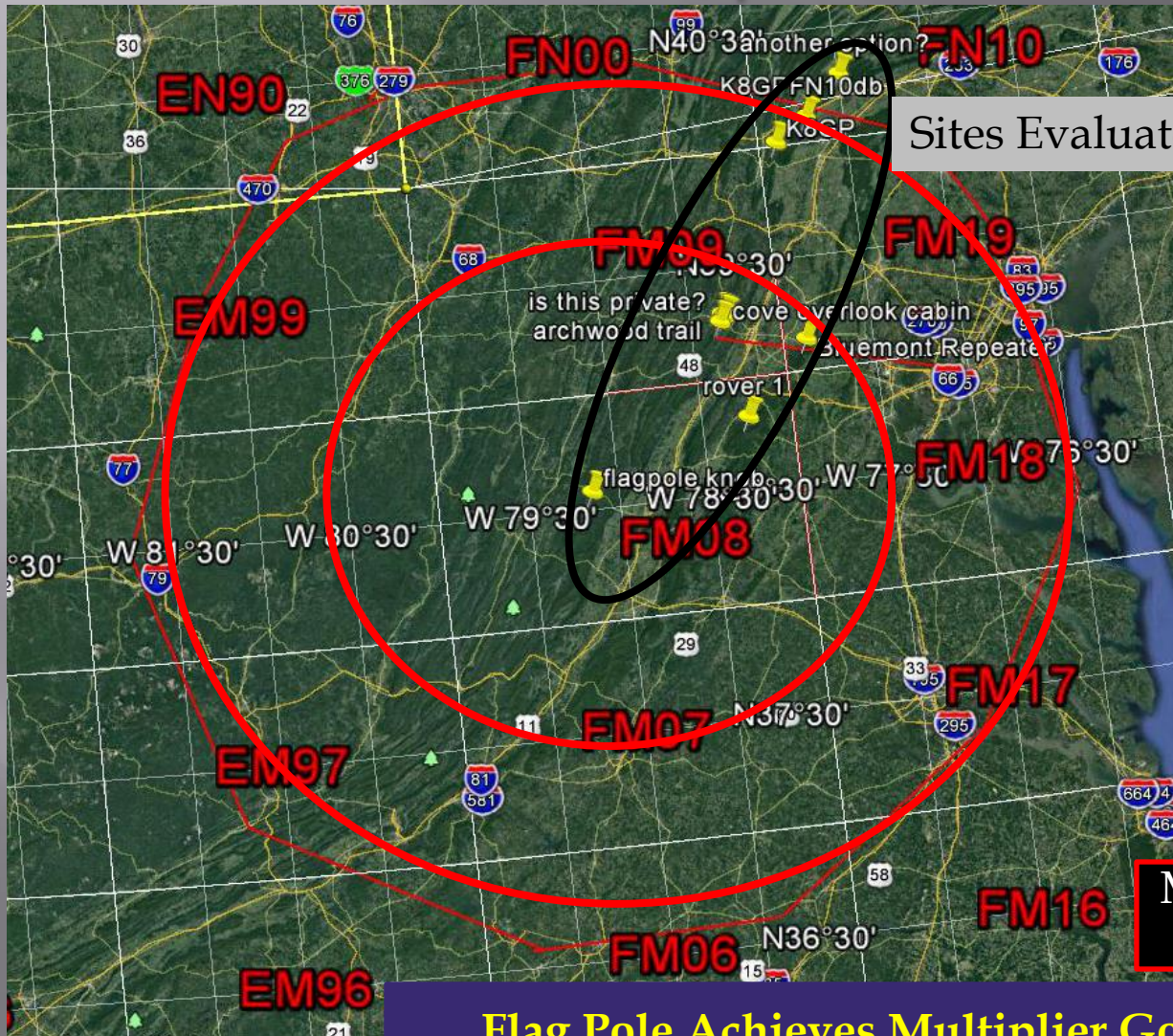
## Link Margin & Range Calculations (Pasternack web calculator)

Freq	TX pwr	Tx ant dBi	Tx Loss dB	Rx ant dBi	Rx Loss dB	Rx sens uV	Range miles
146	50W	13.2	2	3	3	0.20	125
446	25W	13.2	2	6	3	0.20	70



# Analysis of FM Contesting

Grid Squares 2M & 70cm



Sites Evaluated

70cm Grids

Five at High Confidence  
FM 07,08, 09, 18, 19

Four at Low Confidence  
terrain & population  
EM99, 98, 97 & FM 17

2 Meter Grids

Eleven at High Confidence  
FM 06, 07, 08, 09, 17, 18, 19  
EM 97, 98, 99, FN00

Four at Low Confidence  
terrain & population,  
FM16, FN10, EN90, EM96

Minimum of 16 Multipliers  
is reasonable to expect

Flag Pole Achieves Multiplier Goal of 15-20



# System Design

- Hardware Selection
  - Iterative with link margin and range calculations.
  - 12 to 15 dBi gain beam antennas
  - Receiver Sensitivity 0.20 uV @12dB SINAD or better
  - Cable & connector losses must stay under 2dB
- Radio(s) MUST be intuitive to use and easy to operate
  - Monitor 2M & 70cm simultaneously
  - Dual display and controls if dual band or two independent radios.
  - Removable face plate with all controls
- Switches, rotator handle, radio & log book must all be in easy reach and comfortable.
  - No cross body motions
  - No leaning or twisting
  - Seat should be comfortable for napping (adjustable leg room and reclining)
- Power
  - Deep cycle marine battery.
  - Charge from engine
  - Disconnect from engine unless charging.
  - Separate volt meter for deep cycle battery
  - Battery powered LED lighting
  - Manual rotator (simple, reliable, no power required)

# System Design & Layout

## Dual Band Omni

For stations out to 60 miles on 2m or at high depression angles.



## 2 M Yagi

For 60mi +  
Crucial for collecting multipliers



## 70cm Yagi

For all 70cm contacts except those at high depression angle  
Close in.



Diplexer

RF Cables run up the inside of Mast. Only 1 roof penetration  
No chance of cable tangles  
Minimizes connections

RF Switch

RF Switch & Radio Mounted to mast Inside vehicle.

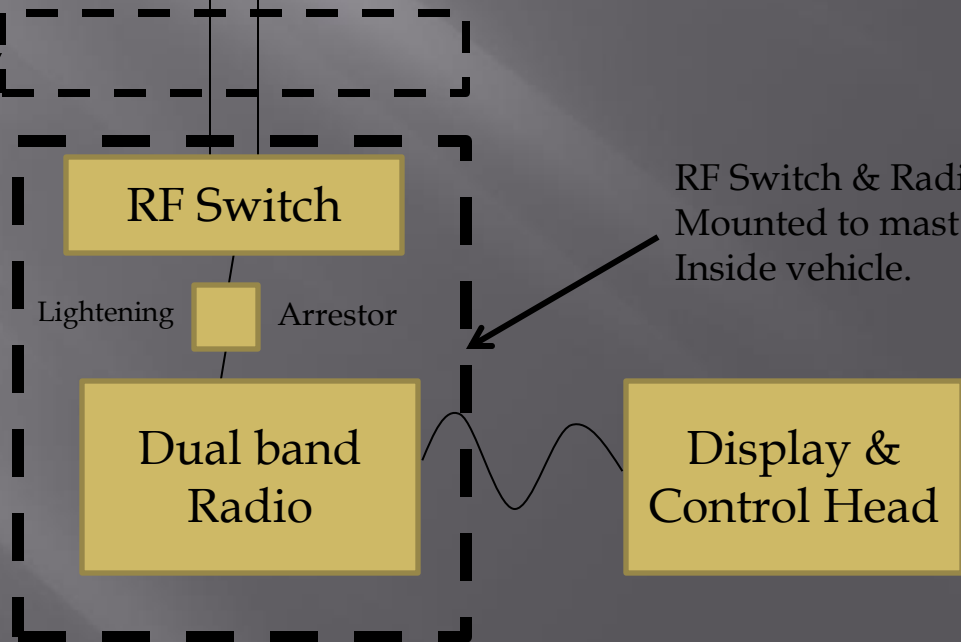
Lightening Arrestor

Dual band Radio

Display & Control Head

RF Connector ends  
Radio to Yagis 8 (0.8dB)  
Radio to Omni 6 (0.6dB)

~1.5 dB allowable cable loss.

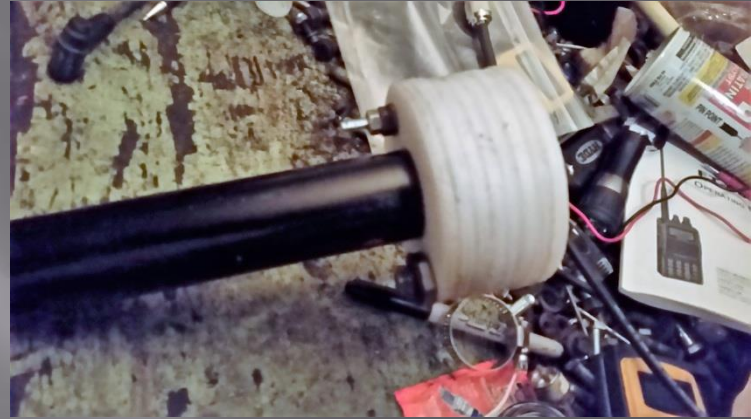


# Components Selected

- ▣ Radio
  - Yeasu FT-8800
    - ▣ Spent hours at HRO trying various radios: Yeasu “felt natural”
    - ▣ Dual Band, Dual Display, Dual Controls
    - ▣ 50W 2M, 25W 70cm
  
- ▣ Antenna's
  - Omni: Diamond X-30 Dual Band (I already had it)
  - M2 or Cushcraft ?
    - ▣ M2 more gain, better design. Higher Cost
    - ▣ Chose Cushcraft, higher M2 gain didn't appear to add any grids.
  
- ▣ Diplexer: Comet, hard connectors, lowest loss
- ▣ Switch: Diawa, internally it's better designed than Alpha-Delta
- ▣ Cable: LMR-400 with solder on PL-259's

# Building the Manual Rotator

- Mast bottom rides on HDPE disc and is located by a stack of HDPE bushings bored to a tight slip fit. Bushings made from cutting boards.



Bushing stack bolted to rotator base  
Rotator base sitting on top of base  
plate but not bolted down.



Preparing to tack weld the support  
“can” to the rotator base plate.



# Rotator Index Plate & Locking Pin

Index plate drilled every 15 degrees



Clamp on sleeve & tiller arm



Sleeve & Locking Pin.  
Spring and lifting handle added later

# Jeep Interior

Roof center line hole drilled.  
Plumb bob used to center  
base plate prior to welding



Base plate welded down, rotator installed.  
Tiller has lift plate and spring loaded pin  
installed. Preparing to bore the roof.





# Work Table & Insulation

Reclining passenger seat installed first. The table was located for best reach and comfort. Mast tiller is in easy arm's reach as are all table surfaces. Table top folds up to make room to sleep under it on the floor. Expect high winds & single digit temps at night. Tent set up takes time and will be colder than Jeep.



# Work Table & Insulation

Ceiling is covered in 3/8" double sided aluminum backed insulation for warmth and light reflection. Floor is covered in 1/2 inch closed cell medium density foam. Back board has grid map, grid range-bearing tables & frequency table



All spaces between inner & outer body panels are filled with household insulation and covered in 10 mil plastic.





# Mast

Mast is made from fence post top rail. I found a bundle of 8' sticks at the I-66 transfer station. Ends are notched and tabbed so they won't slip.



At each joint there is an internal sleeve about a foot long. This internal sleeve has the tab welded to it.

All parts are liberally coated in anti-seize. The tab also serves as a boss that can be hit with a hammer to separate the parts.



At each joint there is an external sleeve as well made from the same tube, just spread with clamping tabs and bolts. I used this same design for holding the tiller arm on the mast and for mounting other items to the mast tubing.

# Cross Arms: January

Capture Area calculation. Prevents Pattern Distortion

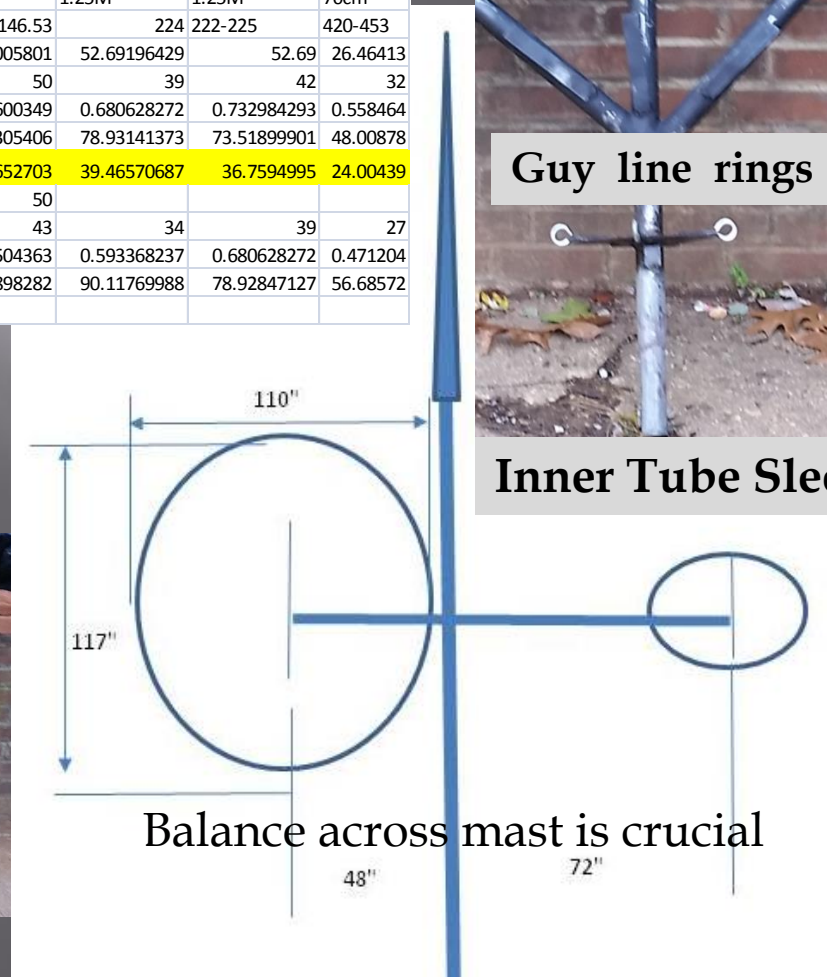
	Ant	A14810S	A44911S	2M7	222-10EZ	DSFE0222-10RS	M2440-18
	Band	2M	440	2M	1.25M	1.25M	70cm
Max interaction: $S=51/BW$	Design Freq	146.52	446	146.53	224	222-225	420-453
BW is Beam Width	lamda inches	80.55555556	26.46413	80.55005801	52.69196429	52.69	26.46413
Lamda=11803/F (inches)	H fld BW (Azimuth in V pol)	43	42	50	39	42	32
	H fld BW in radians	0.7504363	0.732984	0.872600349	0.680628272	0.732984293	0.558464
	H fld ellipse axis	109.9057825	36.92572	95.305406	78.93141373	73.51899901	48.00878
$D = W / (2 * \sin(B/2))$	V POL Tower Offset	54.95289126	18.46286	47.652703	39.46570687	36.7594995	24.00439
D & W are in same units	V Pol Azimuth Beam Width	43 DEG	42 DEG	50			
D is optimum stacking distance	E fld BW (Elev in V Pol)	40	48	43	34	39	27
W is the wave length	E fld BW in radians	0.698080279	0.837696	0.7504363	0.593368237	0.680628272	0.471204
D is the major or minor axis of capture area	E fld ellipse axis	117.7726634	32.53452	109.898282	90.11769988	78.92847127	56.68572
B is the beam width							



Guy line rings

Inner Tube Sleeve

Finished Cross Arm. Stows on roof.  
Slides into mast, located by tab, clamped with outer sleeve.



# Mast Design Criteria

- ▣ Yagis for 2m, 70cm and omni
  - Fixes weight, wind load, balance & cross arm size
- ▣ No failures below 75 mph winds
  - Bending load at roof & roof bearing geometry
  - Sets guy support geometry (must fit on Jeep)
- ▣ Stows folded over onto roof of Jeep
  - Sets maximum length/height
- ▣ Light enough to raise & lower by hand
  - Weight when stepping from hood to roof must be manageable
- ▣ Guys must rotate with mast
  - Puts peak bending loads tube at roof bearing

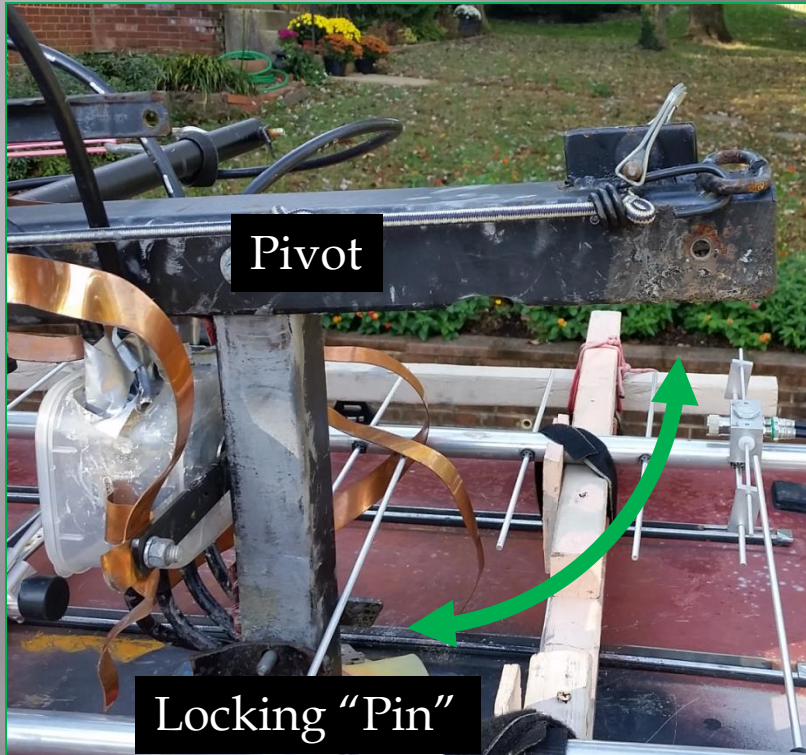


# Mast Folding





# Mast Folding & Roof Bearings



3/4 " HDPE bearing stacks and 3/16th steel plates on both sides of roof.

Mast length trimmed so box tube rests on top of upper HDPE bearing stack to minimize bending loads at bearing (mast weak point)

# Mast Folding

Mast Folded Down & Resting in Cradle





# Battery Box & Power Cables

The 3' snow caused problems now & later





# Time to Load Up & Head Out



Final Fuel Stop Before Heading Up The Mountain



# January 2016 Contest



- ❑ I started down the trail chained & locked on 35's
- ❑ Met an LS1 Samurai tube buggy on ton's & 44's who couldn't get in.
- ❑ Only the second time in 10yrs I could not get there in winter
- ❑ New site was co-altitude with front range of Blue-Ridge.

# January 2016 Contest



- 30-40 mph winds at night, single digit temps
- 6 contest QSO's in first 15 min, 2 into NC
- After that it got REAL SLOW.
- **11 contest contacts total.** Only one was 70cm.
- 5 grids: FM 06, 07, 08, 09 & 18
- **90+ QSO's but only 11 were contesting (logging)**



Everything worked great even if the location was poor.



# January 2016 Lessons Learned

- ❑ Log all QSO's. Uniques are spot checked, not discarded. 540 vs 80 pts
- ❑ Too many nuts and bolts to tighten. Fasteners & tools dropped in snow.
- ❑ The mast is heavy to raise and terrifying to lower when stepping off the roof onto the hood. Imagine doing it at night in snow, rain or ice.
- ❑ Need to carry antennas fully assembled on the roof, not disassembled inside the Jeep.
- ❑ Need to add 220 MHz, Several requests.
- ❑ Need a better 440 MHz Antenna. Several "almost had them" QSO's

I only submitted my "contesting/logging contacts." **Doom On The Newbie**

# Drinking From a Fire Hose

## VHF/UHF Super Conference

- ▣ He's that weird FM guy
  - Asked a lot "stupid questions"
  - Got a lot of great answers.
  
- ▣ Met Stu & Stu2
  - ▣ Invited to contest with W4IY in June at Flagpole
  - ▣ Best thing I ever did. A week of graduate level training
  
- ▣ Met Andy & Terry
  - ▣ Beacons of Rover UHF/VHF/uW excellence.
  - ▣ They answered more stupid questions politely over the next few months.
  - ▣ Wickedly professional on the air (worked them for W4IY)



# Preparing for September 2016

- ▣ Second deep cycle battery (very smart move)
- ▣ TGE battery booster (this would save my bacon)
- ▣ Comet CX-333 Tri-Band monopole
- ▣ Converted to “mostly” N connectors
- ▣ Replaced Cushcraft A44911S with M2 440-18
  - Additional 4 dB of gain and a cleaner pattern. Very noticeable
- ▣ M2 222-EZ Beam
- ▣ TE amplifier for 2M (100W and pre-amp)

# Remote Control Winch & Gin Pole



Key fob remote for operation while standing on roof (guide the mast)

2500 lbs capacity ATV winch

Stows on tire carrier.

Extension chord for power, quick disconnect at winch.

Jumper cable ends to attach to cab mounted battery



# Folding Cross Arms, Locking Hitch Pins

## Clearance Lights & DSE Rover Plates

Cross arm open showing 440 & 220 Yagi Directive Systems Engineering quick disconnect rover plates

Mating DSE Rover Plate on Antenna  
Insert bolt heads, rotate 45 deg and lock





# Little Things That Save a Lot of Time (and frustration) When Lightning Approaches

All nuts and bolt heads have  
“wrenching handles” welded on. No  
tools required. Easier to find if dropped



Mast is secured to “saddle” for transport  
using double sided Velcro wraps instead of  
ratchet straps over the top & down to bumper.

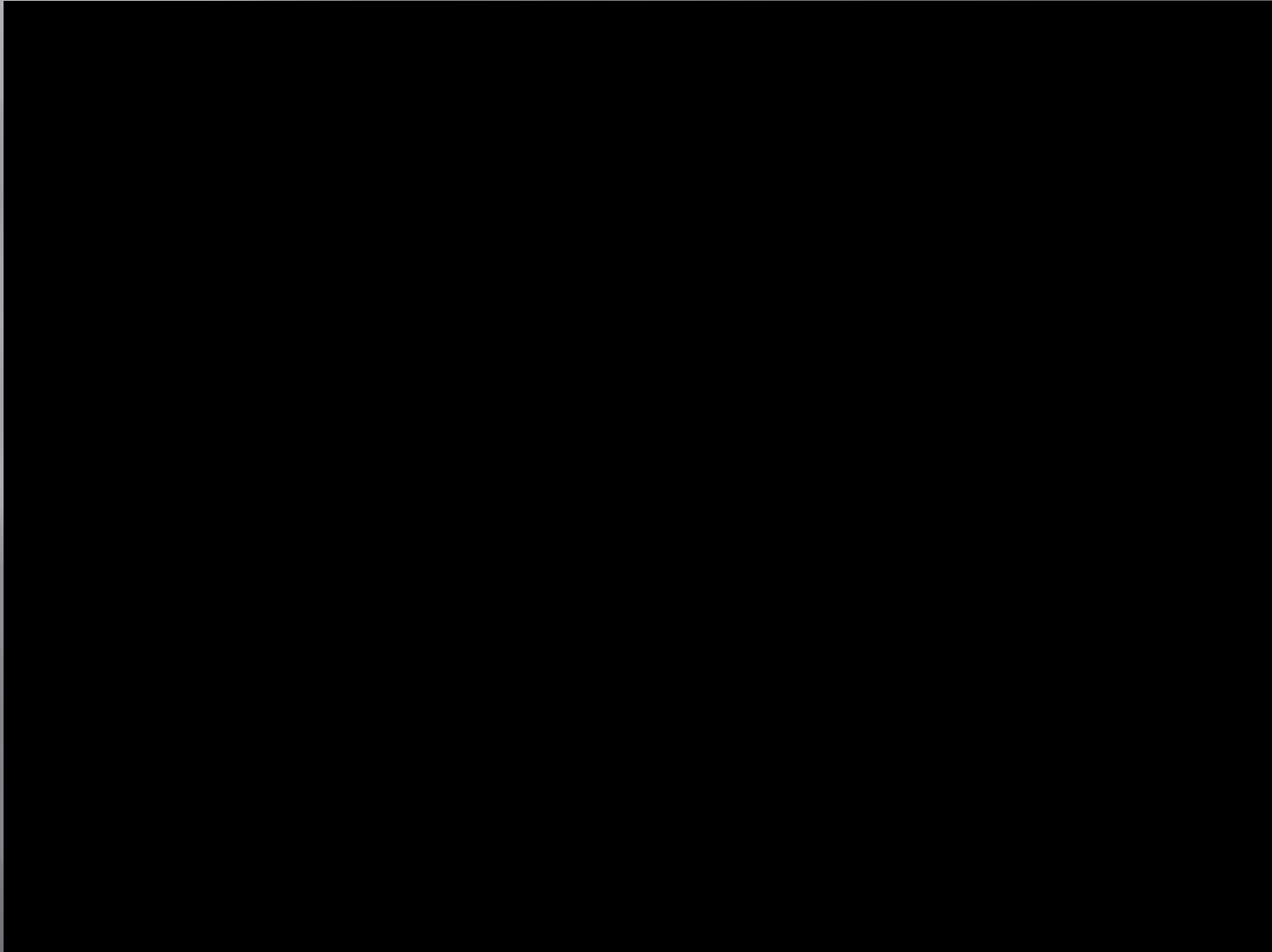
Ratchet strap hooks go into clevis plates welded  
to the support & bumper.

Easily saves 10 minutes rigging & de-rigging.



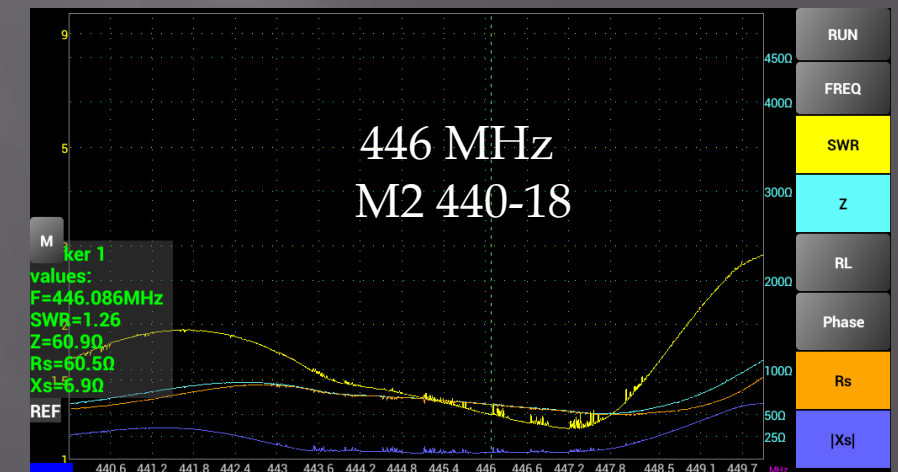
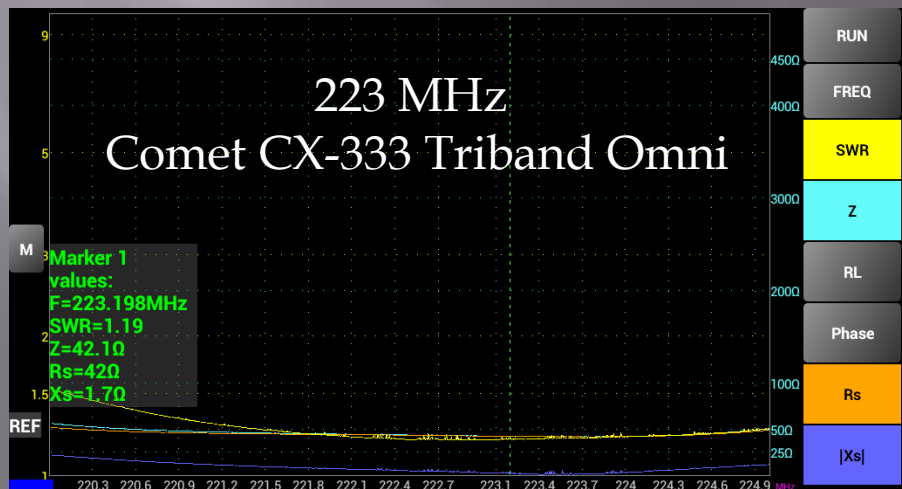
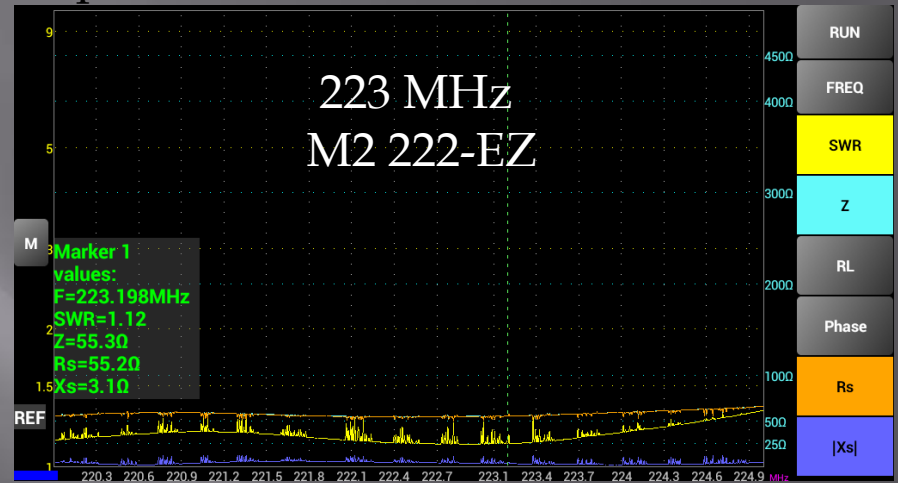
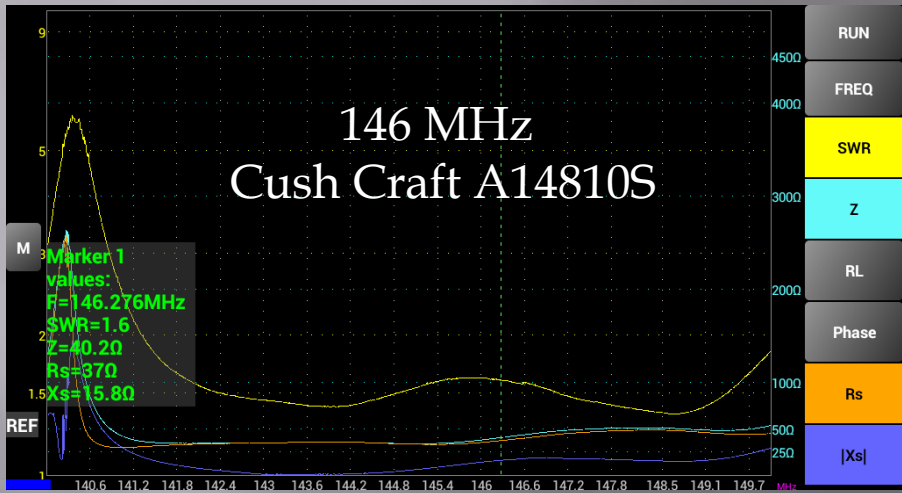
# Winching the Mast

Network Analyzer Day: Dialing it in the weekend before.



# Network Analyzer Results

Results shown: System "End to End" Radio to Antenna  
Antenna's tuned first, mast up, blue tooth link







# Generating Contacts

- ▣ FM simplex can be a desert
- ▣ Sent an email to every ham within 150 miles (QRZ listed email)
  - Checked rules on self spotting
  - Bart Jahnke ARRL Contest Branch Manager: “that’s a great idea”
- ▣ Addresses from QRZ.com pages
- ▣ Over 3,500 emails sent
  - 4 complaints. Two (HF contesters) “calling ARRL you will be disqualified”. Sent them Bart’s reply & spotting rules. Replies were actually very nice and apologetic.
- ▣ Started collecting addresses & sending emails July 5<sup>th</sup>. Finished September 8<sup>th</sup>.
  - 2-5 hrs per day and a several full weekends

I probably spent as much time on emails as I did building the XJ in 2015



# September Contest

Stowed & ready to roll

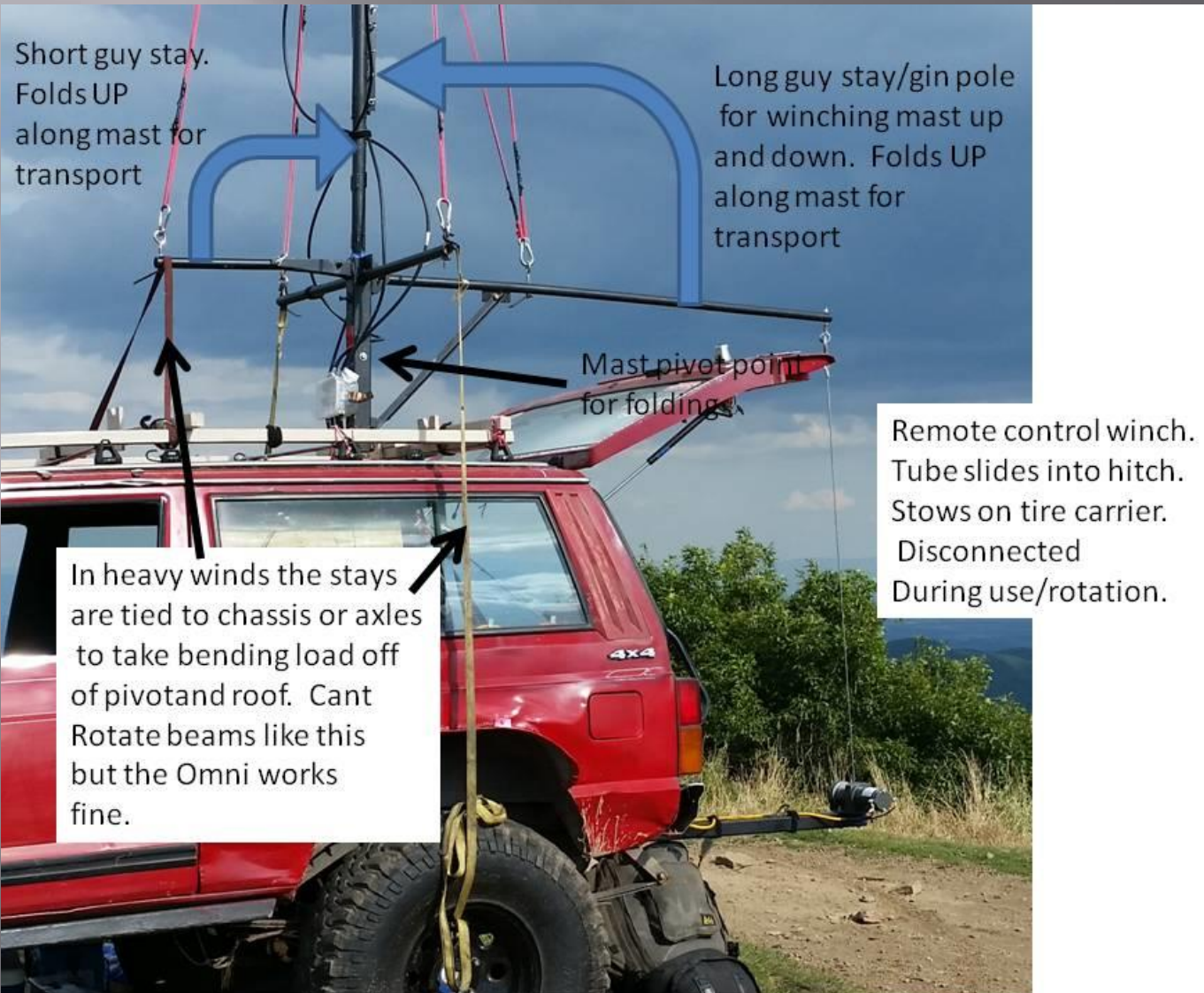


At the Trail Head





# Secured for High Morning Winds



# September Contest



Friday

Afternoon arrival

Set up & test. Perfect

Dig latrine (for me & BooBoo)

Drop mast at 10pm, lightning

Saturday

Set up by 0800

Contest start 1400

BooBoo stinks, whose boss?

Lightning threat 2300

Packed & rolling 2400

Sunday

Up at 0430 (4hrs bad sleep)

Hoping for a.m. duct

On air by 0515. Busy!!

No Duct.

1400 BooBoo Stinks BAD

1900 Rotten eggs, lungs burn

2030 blown cell. Love TGE

2145 K8GP/R FINALLY

2146 shut down pull bad battery

0030 packed, go to hotel

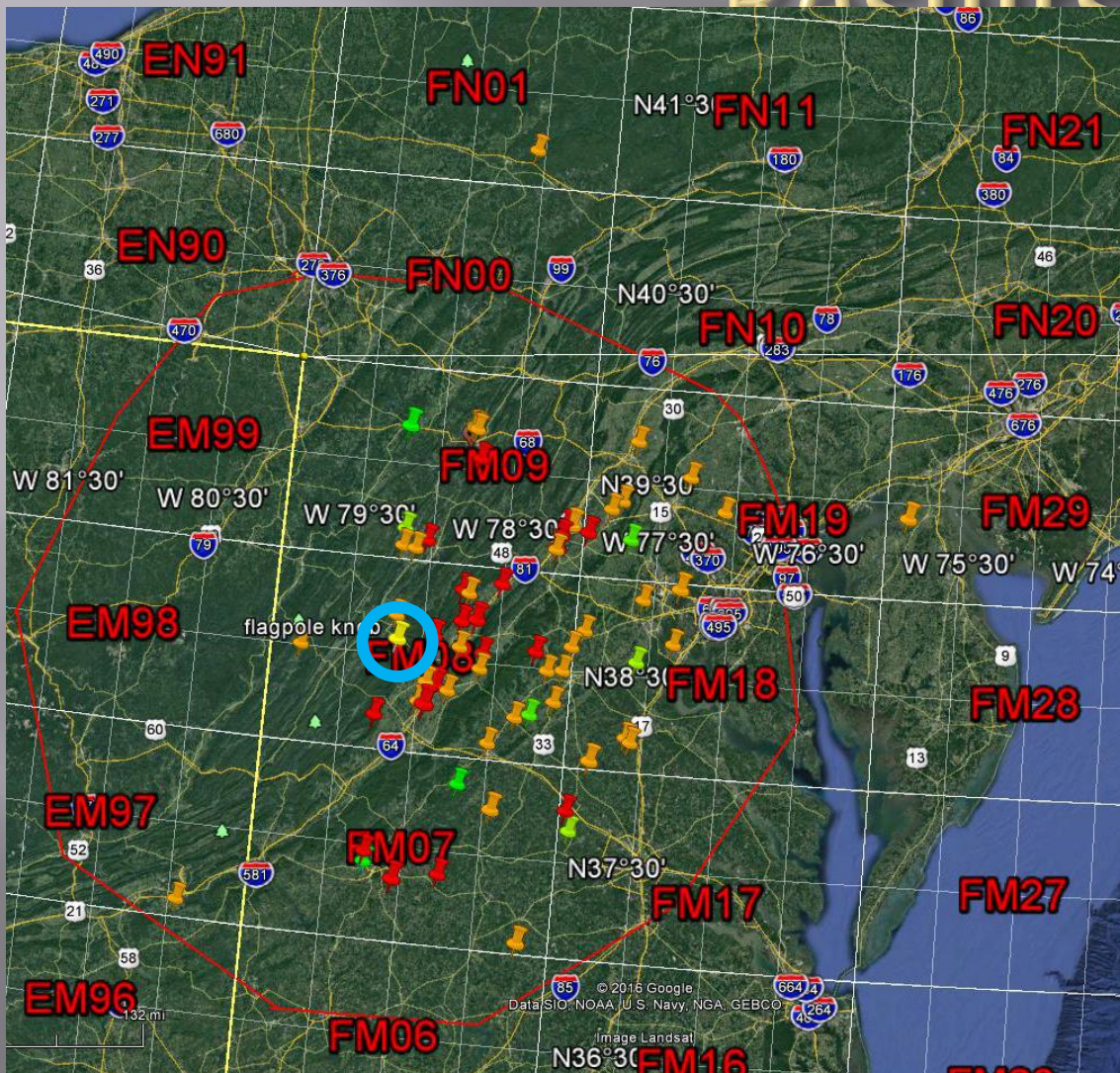
0300 H Burg Hotel

Monday: Park service call & home





# September QSO Map & Results



Band	QSOs	Multi
2 meter	92	10
222 MHz	19 (2pts)	6
432 MHz	41 (2pts)	6
Totals	212 pts	22

**Score: 4664**

EM grids were dead other than one SOTA in EM97 (email). It's the terrain

Longest Range: FM29 187mi

Next Best: FM01 183 mi. (mobile)

Most Fun: 1W HT in Rockville (email)

## Grid Results

- FM29 1
- FN01 1
- EM97 1
- FM06 1
- FM17 5
- FM19 10
- FM18 12
- FM07 23
- FM09 34
- FM08 61

**850 points of sheer luck**

45 deg polarization Sunday. Make some band noise on the waterfalls of big SSB fixed site stations. No takers. Refused my email invitations too.

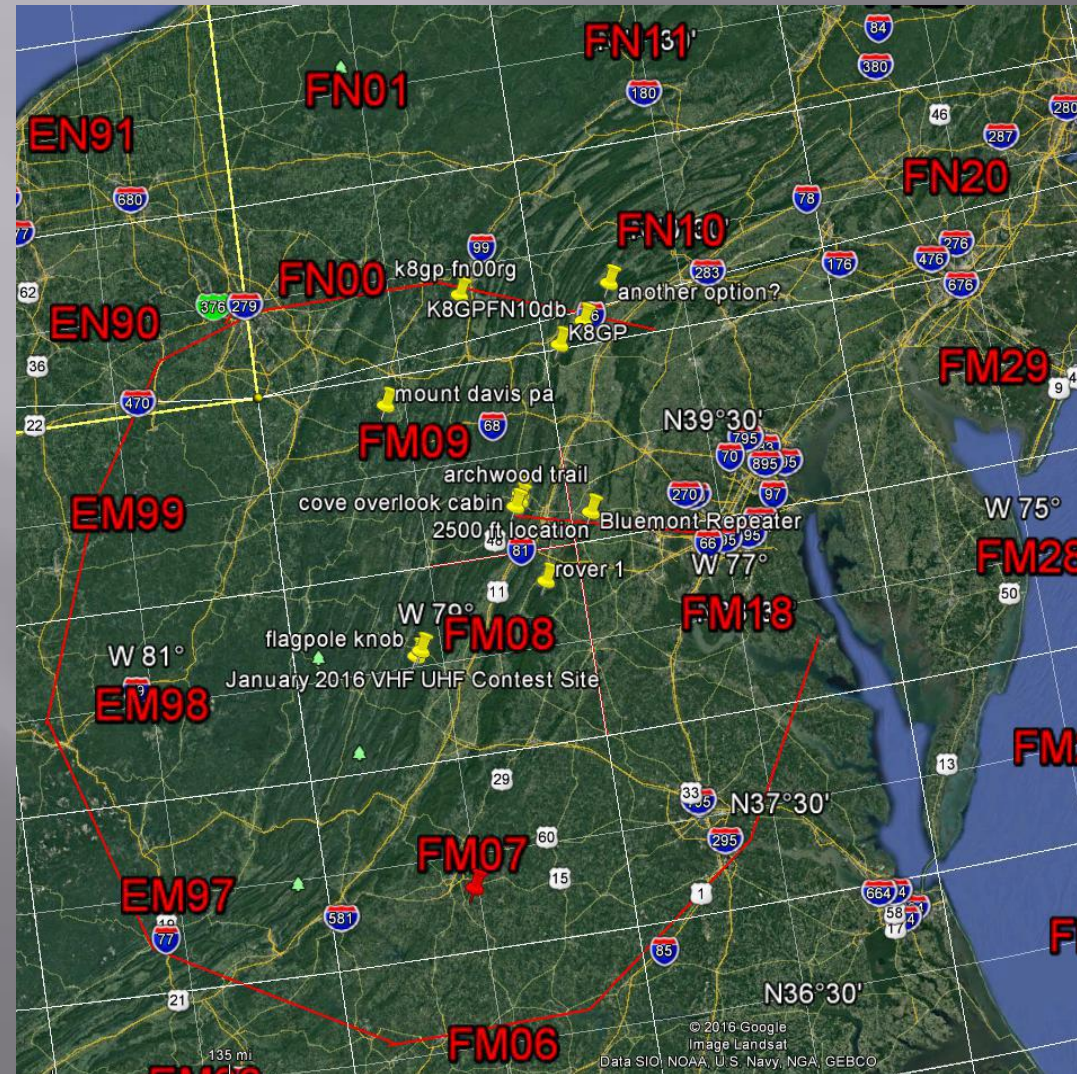




# September Lessons Learned

- ▣ Schedules didn't work: 2 of 8: LOS & my lack of discipline
- ▣ Heavy up mast "neck" where it enters roof.
  - All mast stress is centered there.
  - 45 mph a.m. winds. Strap down arms for load relief
  - Wind is worse in the winter.
- ▣ Need a better place to sleep
  - Table doesn't fold up now, very tight & cramped
  - Quick release operator seat & pallet 8'x2' not 5'x1'

# New Location for January?



FP is to far West & South  
FP reaches E & W sides of front range

Northern sites are lower. Either give up East of the front range (DC Metro) or give up the Shenandoah valley? (no clear crest knobs)

Lose highly productive FM09 & FM08 or Lose equally productive FM18 & FM19.

Move North loses FM06, FM17  
May pick up FN00, FN01, FN10, FN20.

North is closer to FM18, FM19, FM09  
Where there is huge Ham population.

Weather Mountain (all private)  
Easy access, treed, no crest knob (bad)  
Closer to a huge population



# January 2017 Plans

- ▣ Act on lessons learned & consider new site.
- ▣ Biggest change is adding 6M (suggestions?)

FT-8900 \$319



Pro's:

Familiar. Detachable Head. 6M, 2M, 70cm  
Run as 6m only. Back up radio  
0.2uV receive sensitivity (good not great)

Con's:

Minor: Only monitor 2 of 3 bands (but 70cm is a hand off)  
Major: Must add a triplexer at the radio to split out bands.  
Major: Single point failure for 3 bands if I use as multi-band.

Alinco DR-06T \$245



Pro's:

Single Band (no switching)

Con's:

Fixed head.  
0.25uV receive sensitivity.  
Japanese Designed, Chinese mfg. (reliability?)

# 6M Beam Design

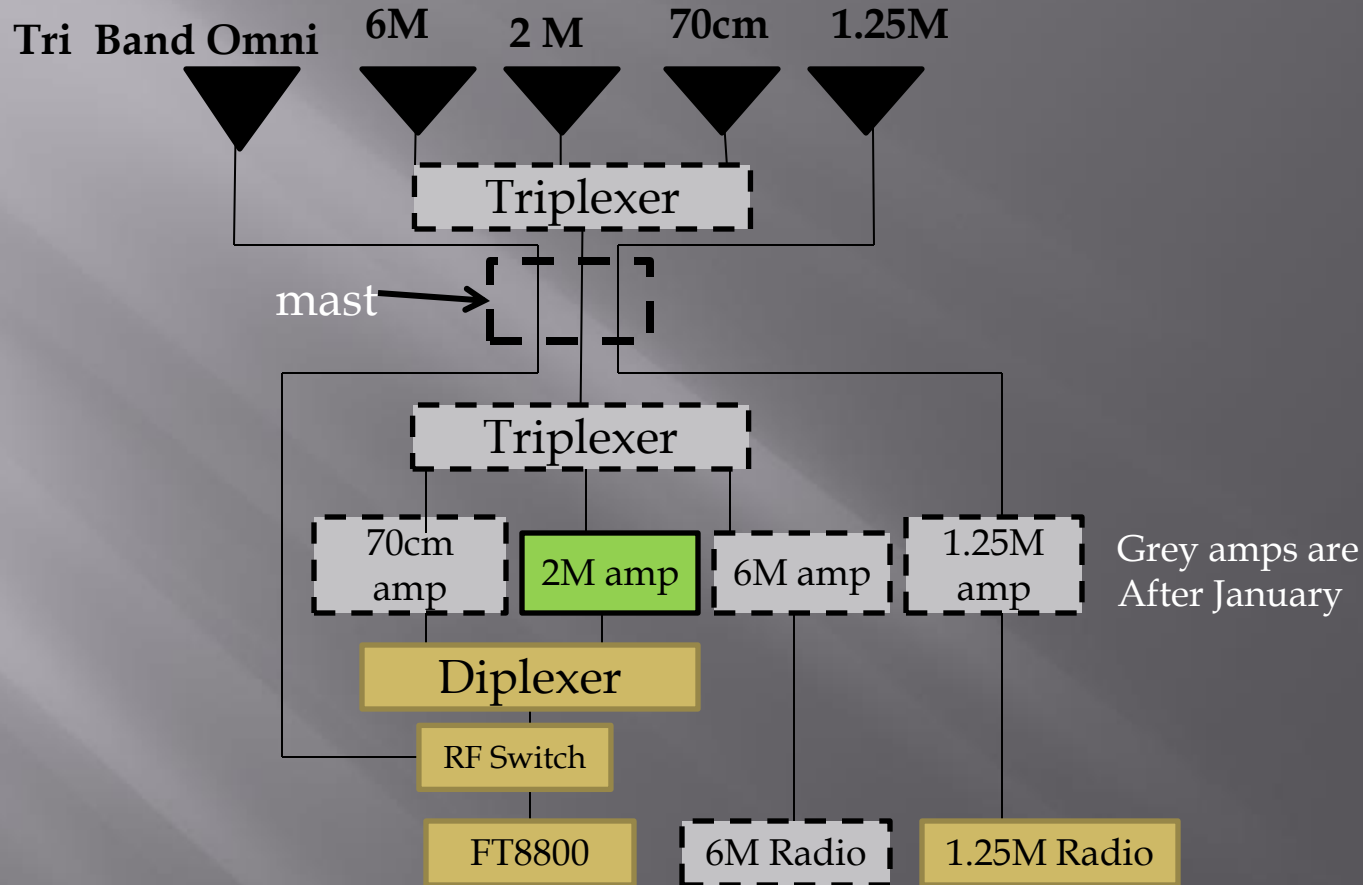
## ▣ Design considerations:

- 6ft from mount to driven end (set up with mast down)
- 15 ft max boom length on roof.
- Element width for roof carry: 5 feet
  - ▣ Folding elements or multi part elements (set up time)

## ▣ Options

- Custom Design from Directive Systems Engineering
  - ▣ Terry & Andy “understand.” Prefer working local
- **M2 6M-3SS**
  - ▣ Cut for FM. 8dBi, 6ft long (6M would be my smallest antenna)
  - ▣ 7 feet mast to antenna required (easy) Only 6 lbs.
  - ▣ 3 piece elements, designed for transportability.
  - ▣ Probably throwing away 3-4 dB over a custom design.

# Possible January Set Up



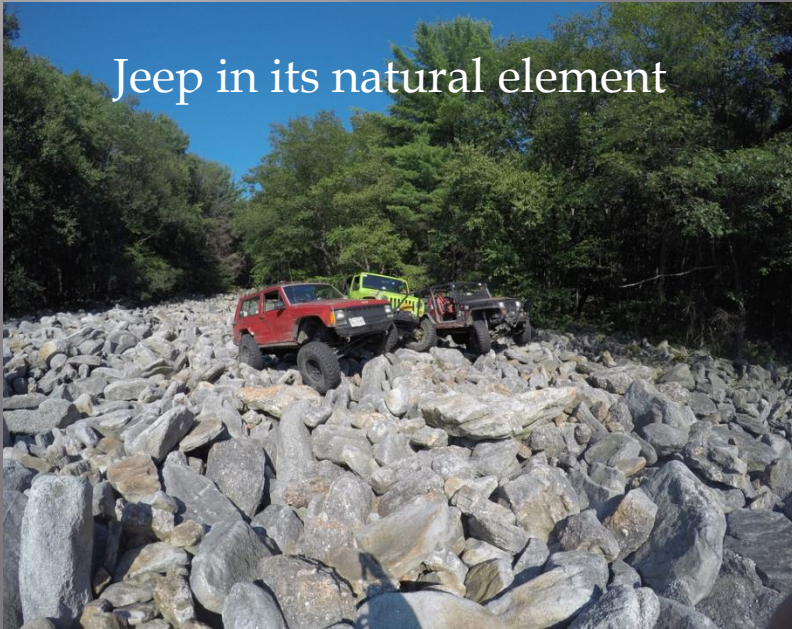
Triplexers are ONLY needed because of restrictive space inside mast for LMR-400  
LMR-240? Had ends fall of the set I bought (wrong die was used)  
Is there something better?



# Summary

- ▣ This is Fun. Especially if you are new to Ham Radio
- ▣ It's now about doing better than before, not just trying to win (though that's a real possibility)
- ▣ Suggestions & Criticism Needed
  - "Talk to me Goose"

Jeep in its natural element



END



