

Repeaters To Go... Wild

Steve Sergeant, KC6ZKT

Repeaters To Go... Wild

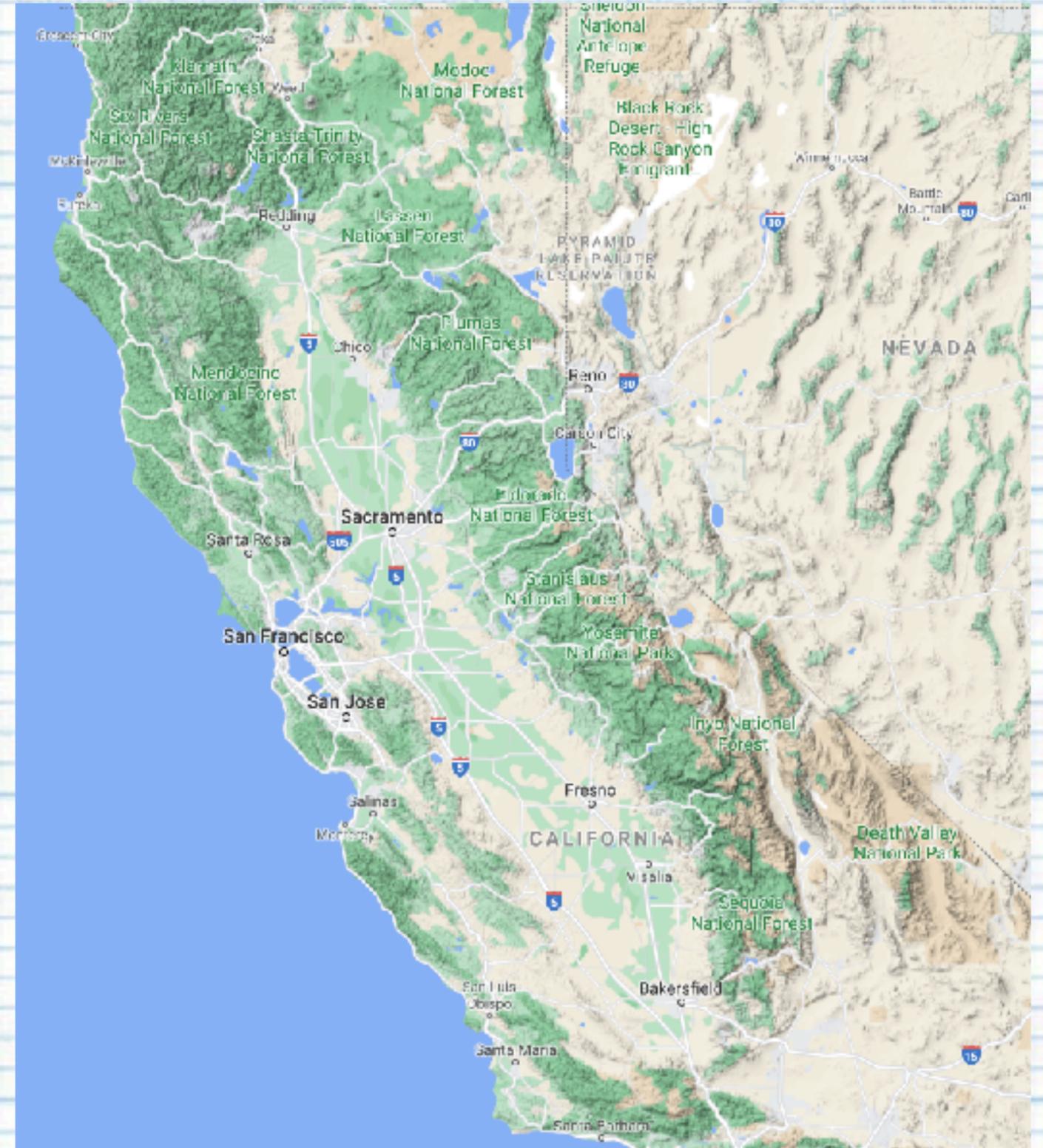
Presentation Outline

- ▶ **The Problem—Why would we need a portable repeater?**
- ▶ **Requirements—Criteria for design.**
- ▶ **Applications—Experiments and field operations.**
- ▶ **Live demonstration.**

The Problem

Why would we need a portable repeater?

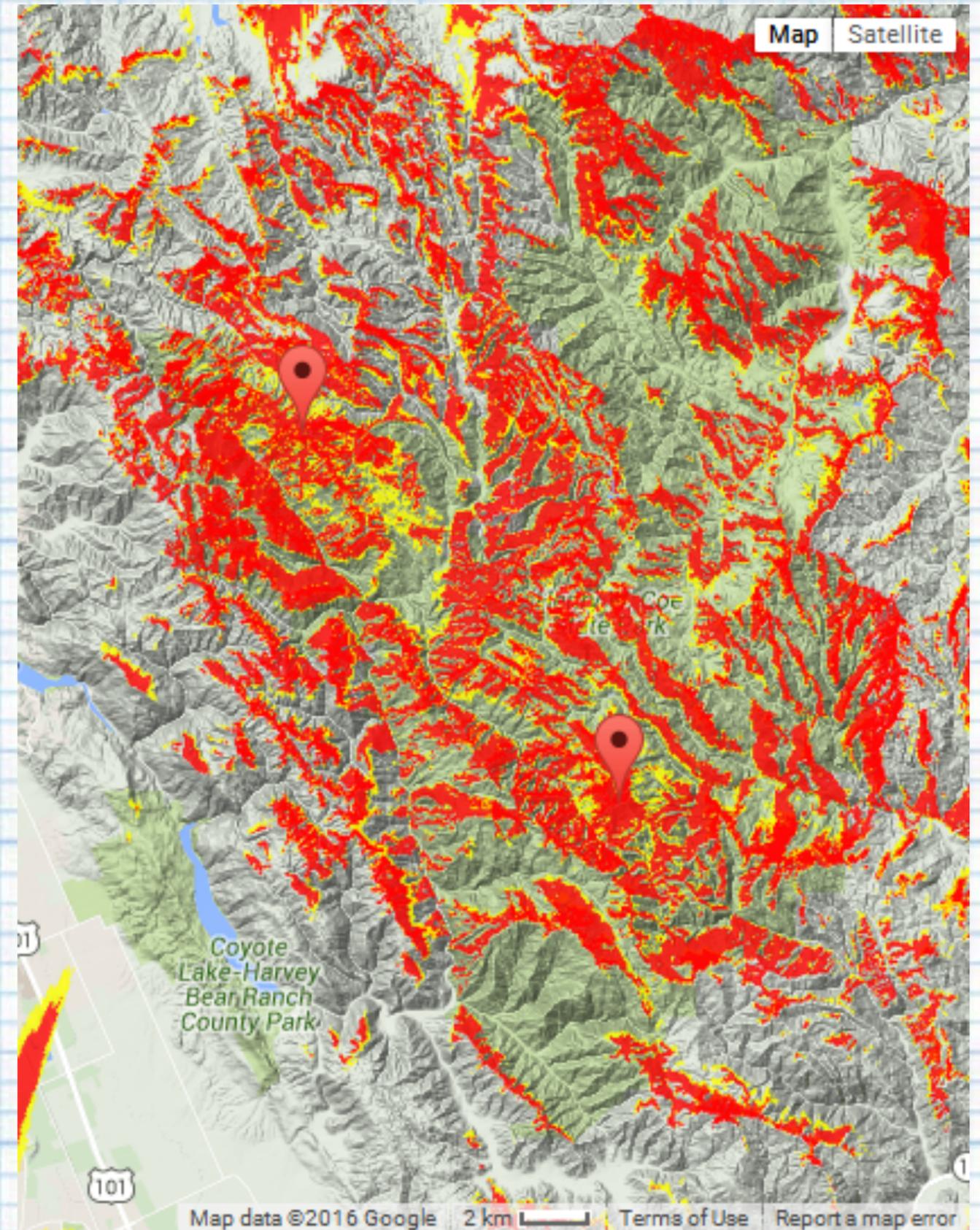
- **Terrain:** California has mountains which isolate valleys and canyons.
- **Policy:** Areas of public land prohibit (or complicate) permanent installations, leaving areas uncovered.
- **Access:** Optimum radio sites for backcountry events are often not vehicle-accessible.



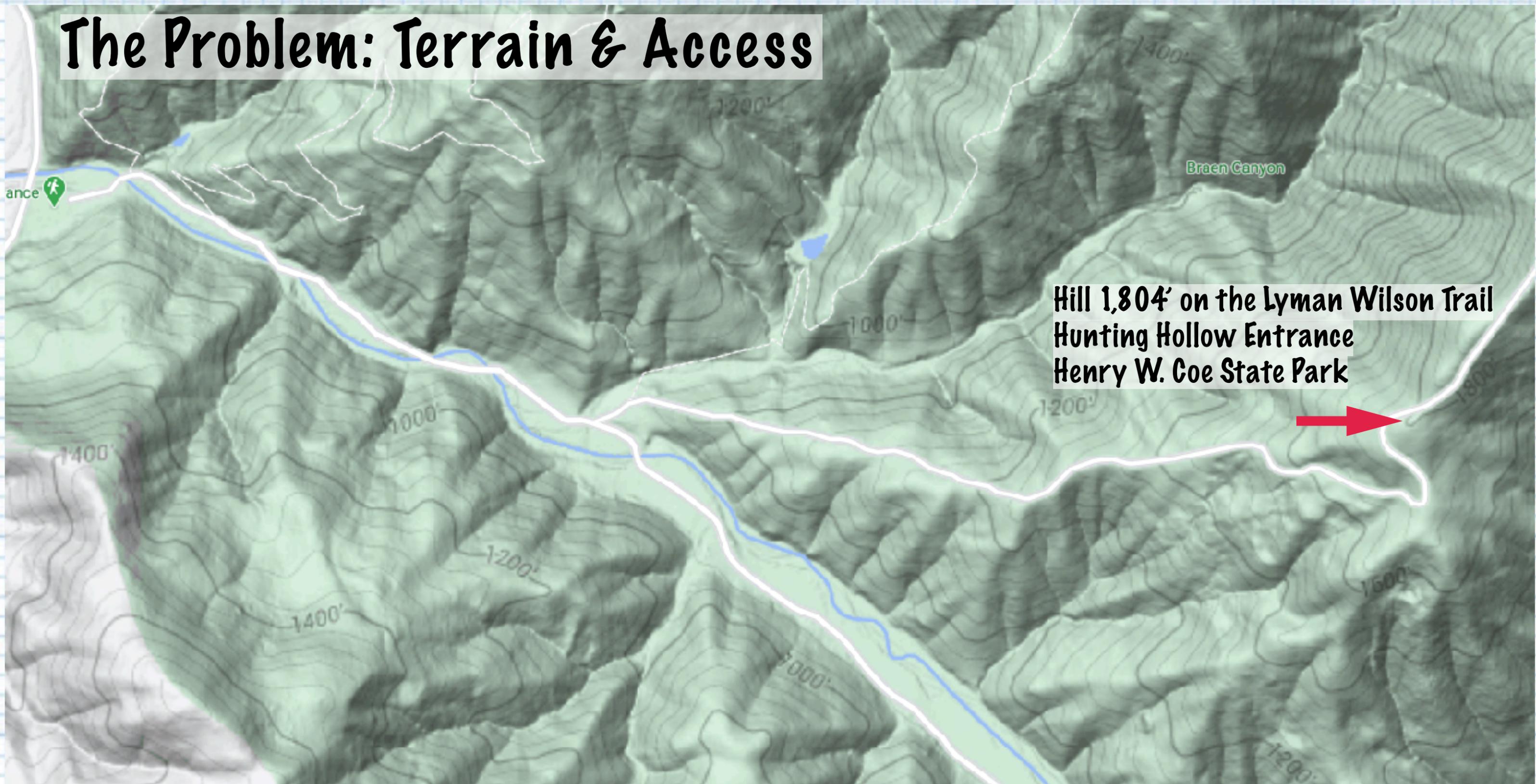
The Problem

Poor coverage by fixed stations

- Example: Coverage of fixed, state-operated, 800 MHz repeaters in Henry W. Coe State Park.
- Pins mark two repeater sites.
- Red is 95% reliability, yellow is marginal.
- See any gaps?



The Problem: Terrain & Access



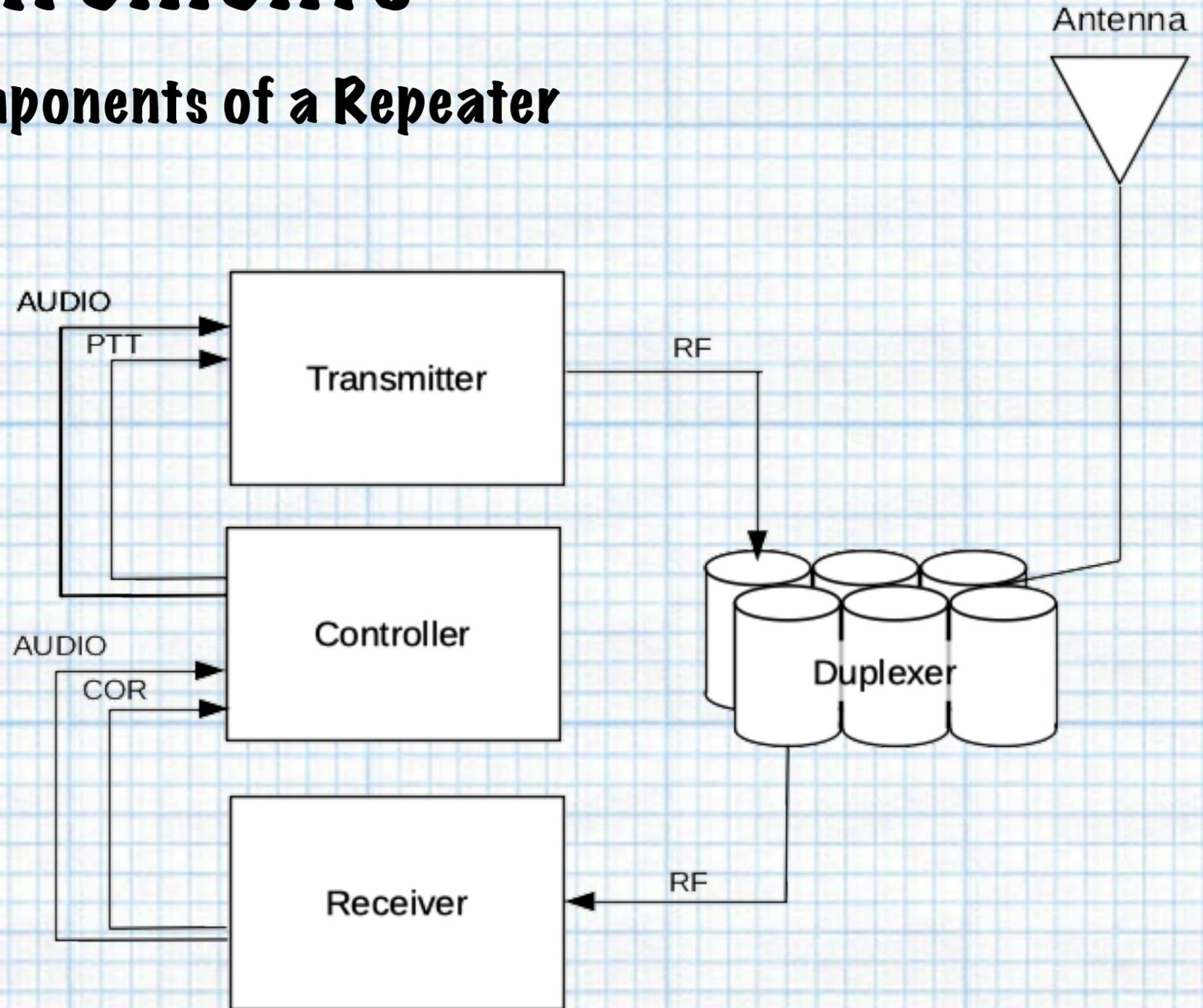
Requirements

(Or... How do we cover these areas?)

Requirements

Review the Components of a Repeater

- **Transmitter**—tuned to output
- **Controller**
 - Manages audio, courtesy beeps, ID's, timeouts, etc.
- **Receiver**—tuned to input
- **Duplexer**
 - Protects receiver from transmitter
- **Antenna**
- **Power supply (not shown)**



**A Typical
installed
repeater looks
like this:**

**Do you want to backpack
that up a mountain?**



Requirements

Criteria for portable repeater design

- Minimum weight, < 50 pounds w/everything
- Standard frequency offsets
 - Or else tuning is too difficult for users
- Off-grid solar-powered
 - Battery for 20+ hours @ 10% duty
 - Solar panel to recharge in <8 hours
- Package sized to fit in a backpack
 - Including all electronic components
 - Protected from weather/elements
- Controller with CW ID & timeouts
- Hobbyist-priced components
- Performance?
 - At least as good as a traffic relay op. using an HT at the same location!
- Did I say lightweight?
- Did I say minimum power requirements?

Requirements

Research on Prior Art

- Searched for commercial products
 - Public service “tactical” systems:
Expensive!
 - Amateur products from China:
Too little documentation
- Web searched for ham how-tos
 - Most were not impressive
- Talked to repeater Elmers
 - Most said I was naive and dismissed the idea
 - “Performance would be dismal”

 **MOTOROLA SOLUTIONS**



RETCVIS



**“Eighty percent of success
is showing up.”**

Woody Allen

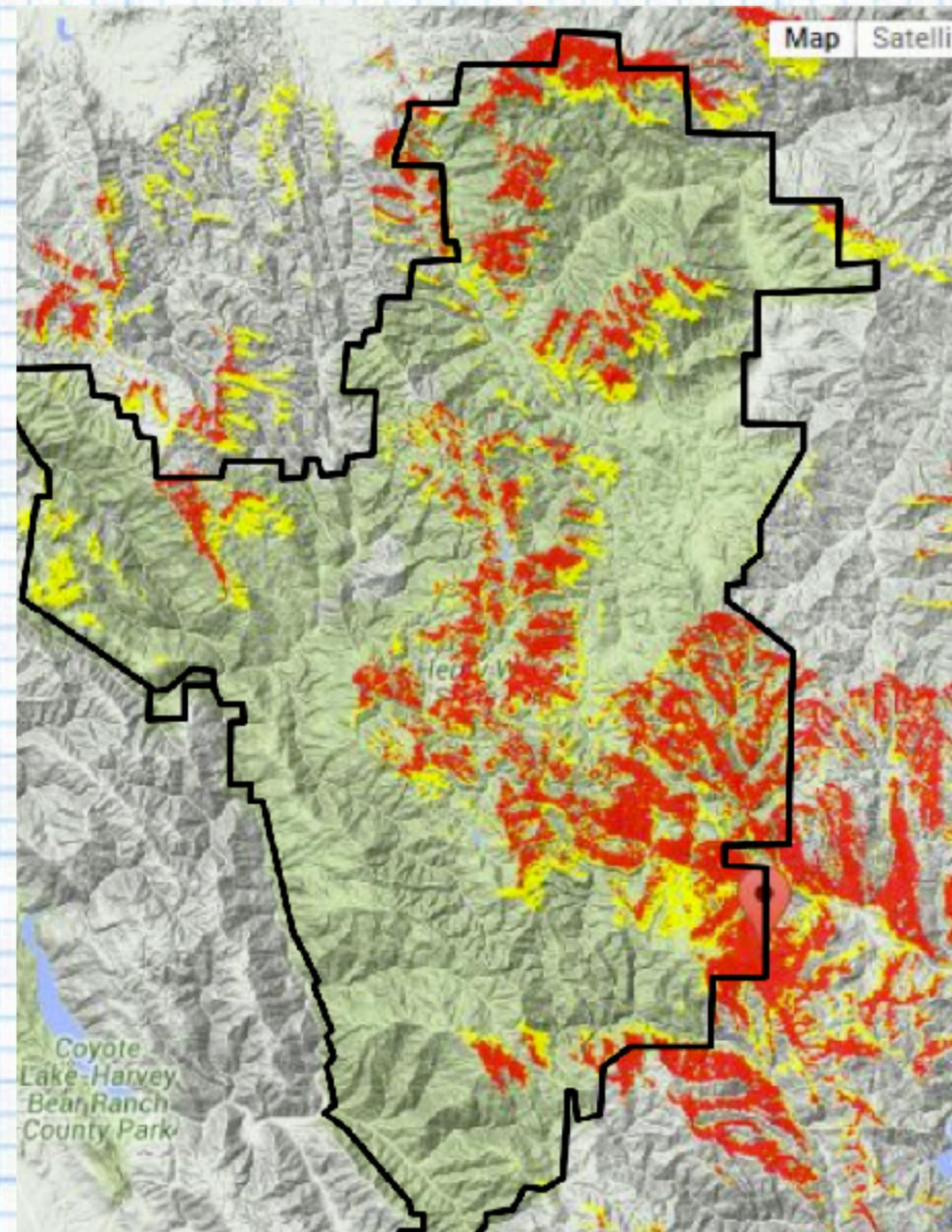
Experiments & Applications

(Or... Lessons eventually learned.)

Applications

Backcountry Weekend Henry W. Coe State Park

- Loaner 70cm repeater for the past 20 years complimented the 800 MHz state system
- Only covered the park entrance
- Barely reached the net control site
- It didn't reach the backcountry

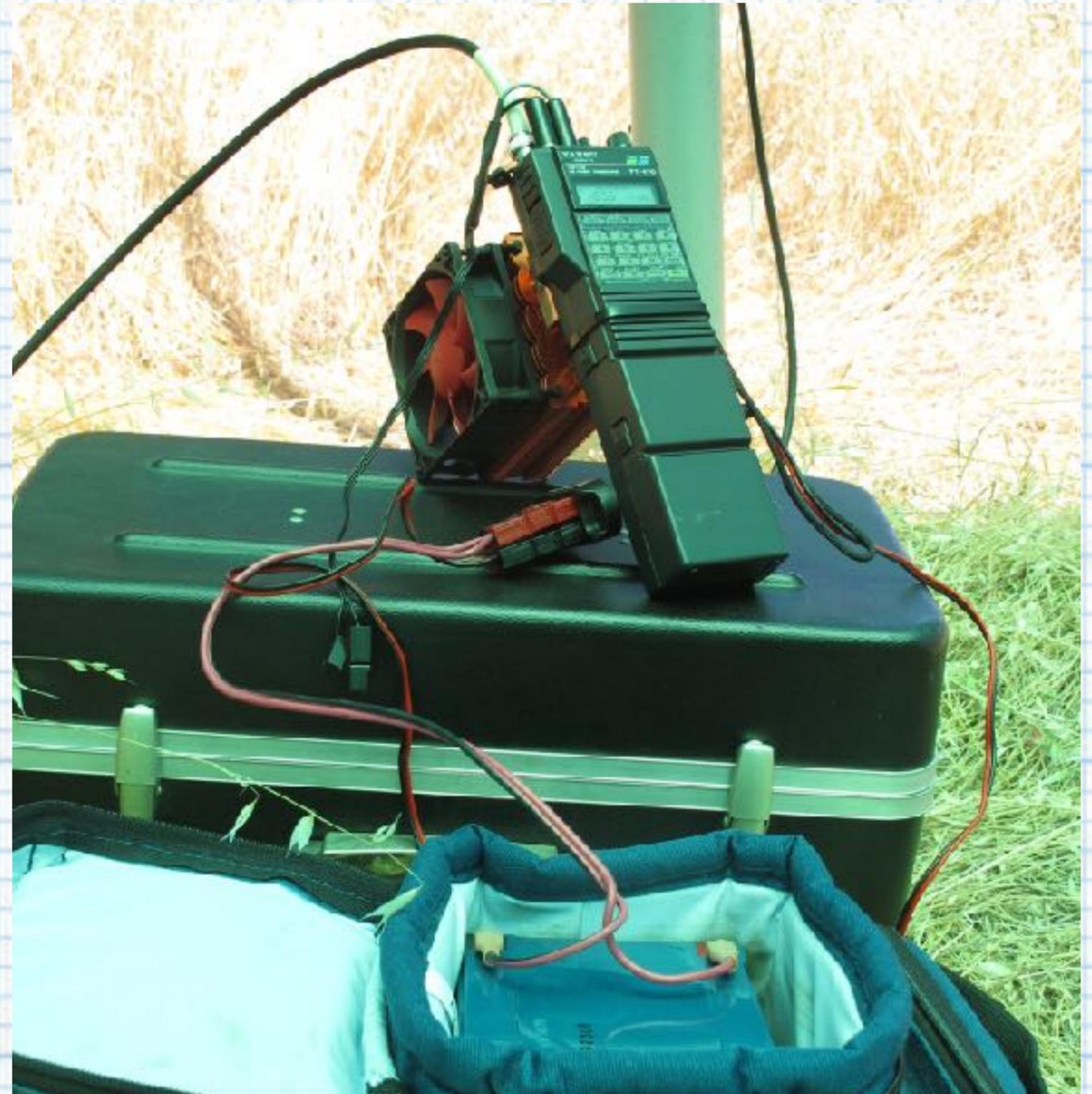


Coverage calculated by K6OIK

Experiments

**Cross-band HT Repeater
2016 Backcountry Weekend
Henry W Coe State Park**

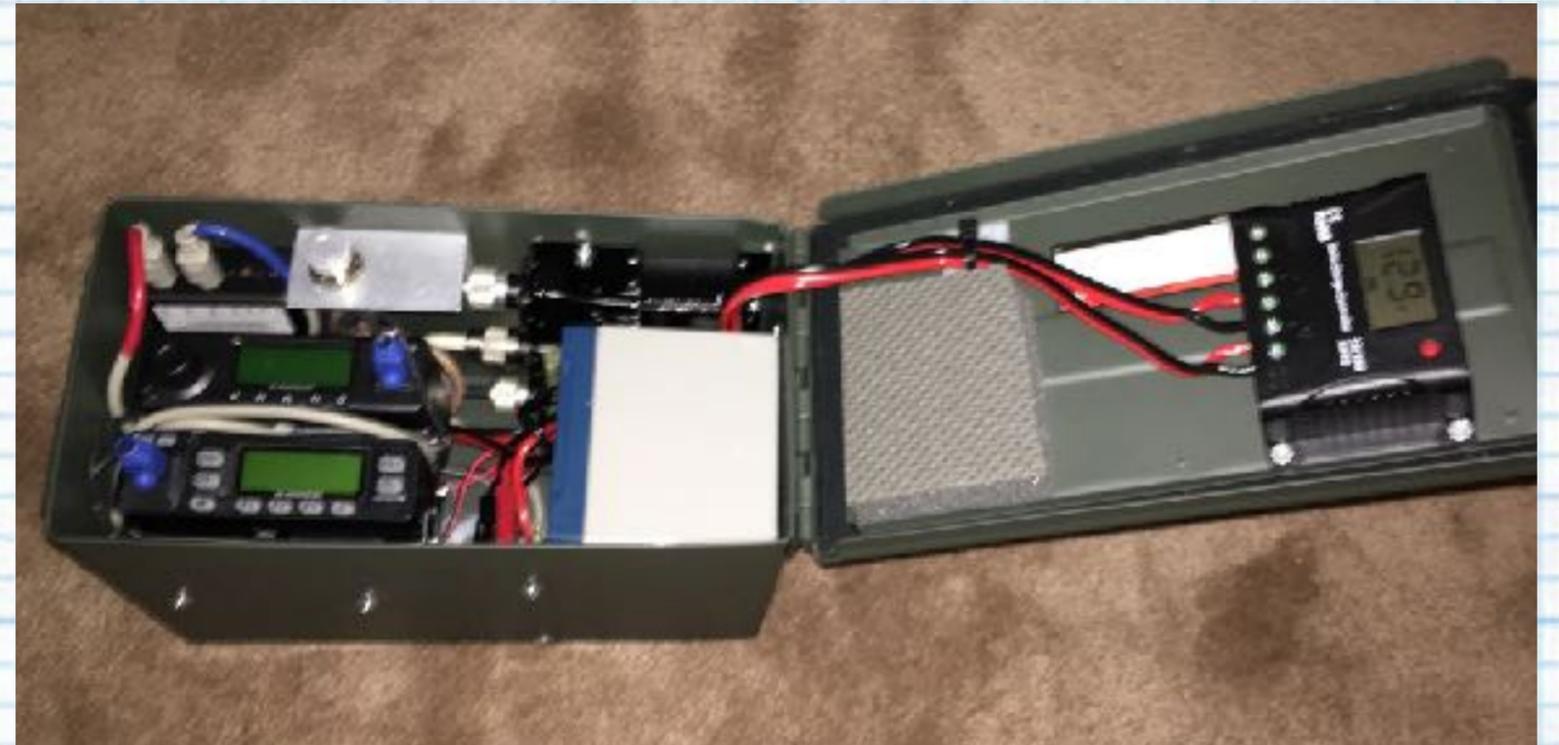
- Yaesu FT-470 HT hacked to cross-band repeat at full power
- Note the mods:
 - heat sink & battery
- The system expanded the 70cm repeater's coverage on 2m simplex
- Confusing for operators
 - Users on 2m simplex couldn't hear each other



Experiments

A first real™ repeater

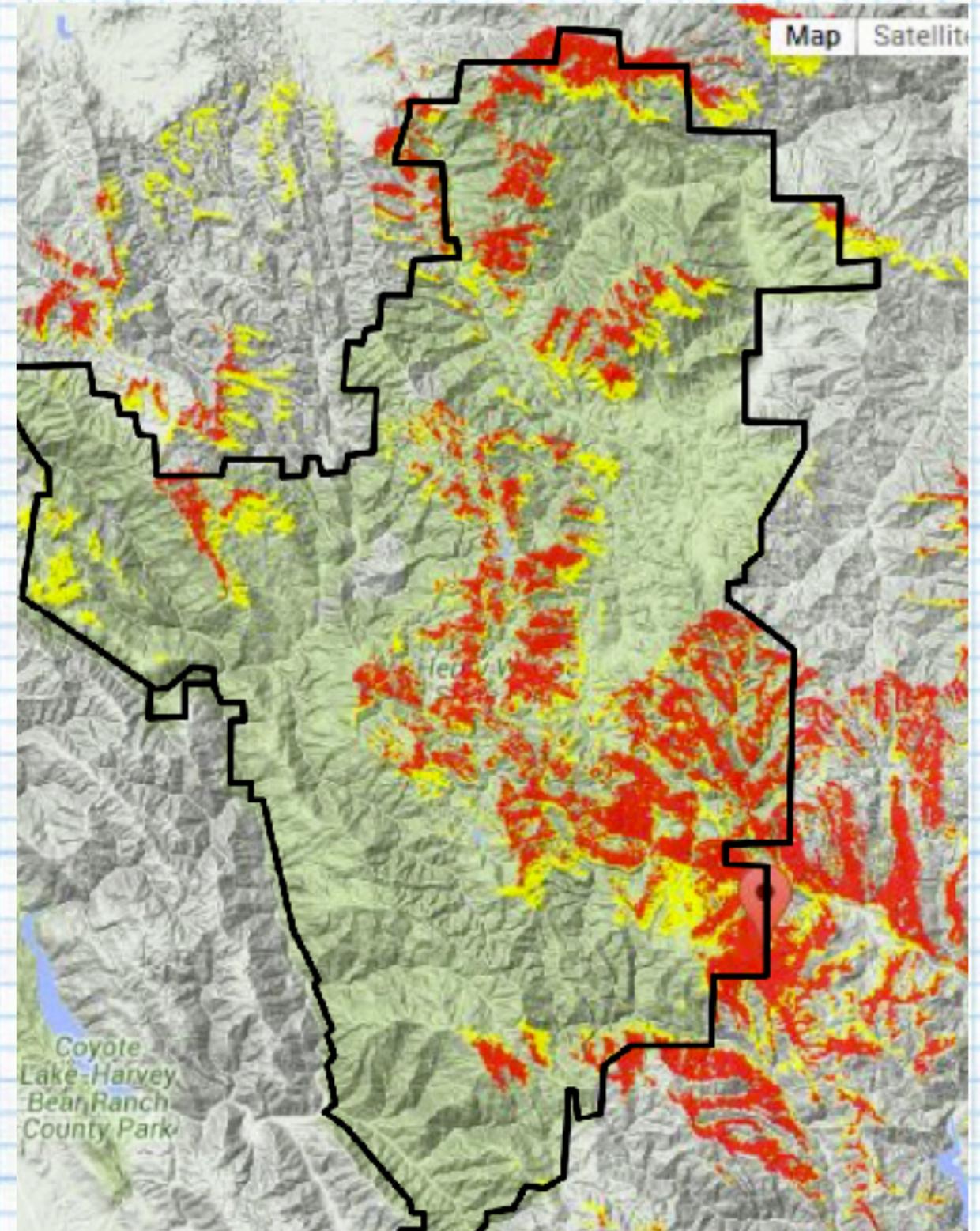
1. Buy cheap parts on Ebay...
 - Duplexer, 2 mobile radios, repeater controller, 12 Ah battery, & charge controller
2. Build into 50-cal ammo case
3. Discover inadequate performance
4. Replace receiver
5. Discover adequate performance



Applications

2017 Backcountry Weekend Henry W. Coe State Park

- We knew there were problems with the 70cm repeater's coverage
- K6OIK performed a coverage study

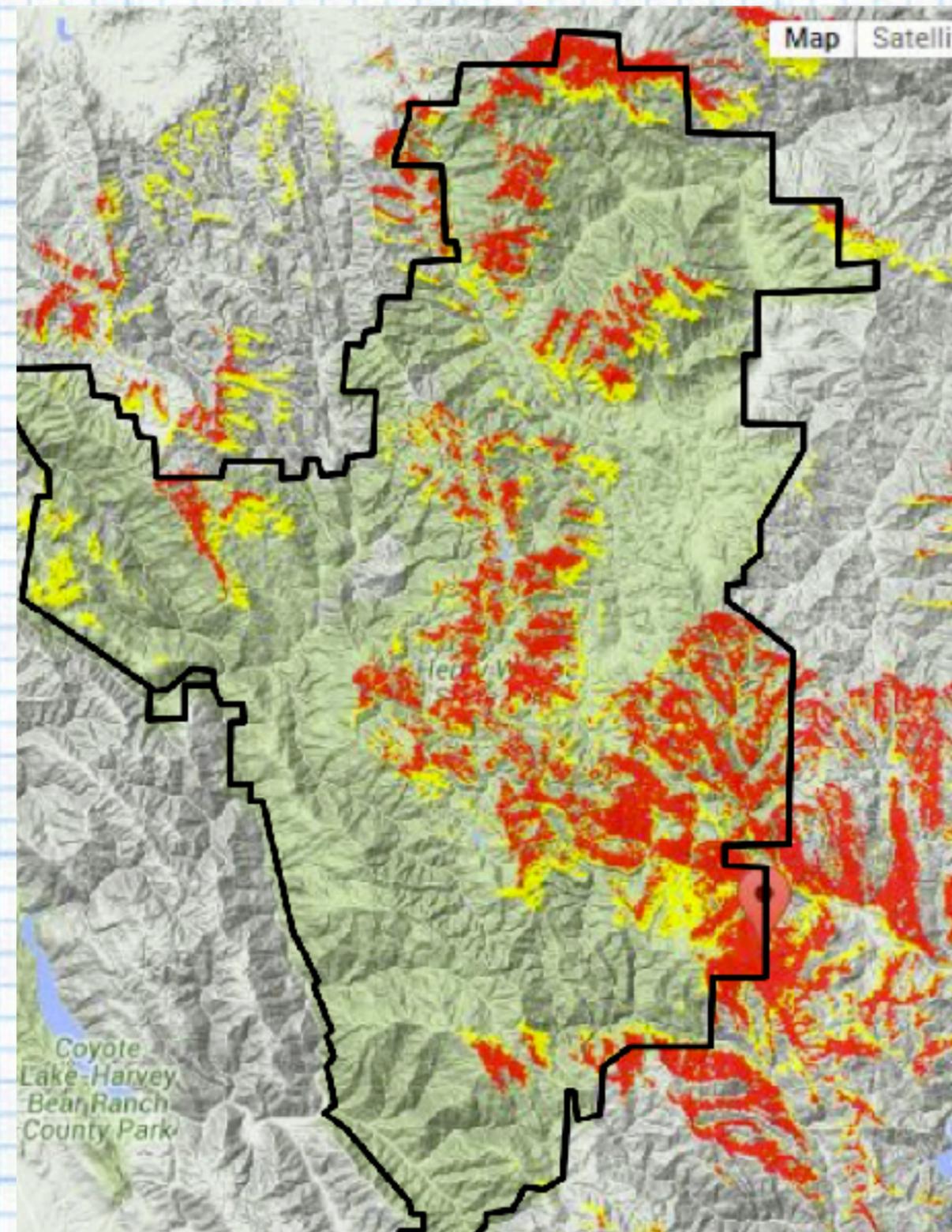


Coverage calculated by K6OIK

Applications

2017 Backcountry Weekend Henry W. Coe State Park

- We knew there were problems with the 70cm repeater's coverage
- K6OIK performed a coverage study
- Two additional sites were proposed
- We saw how coverage in the deep backcountry could be improved
- But one site was hard to get to...

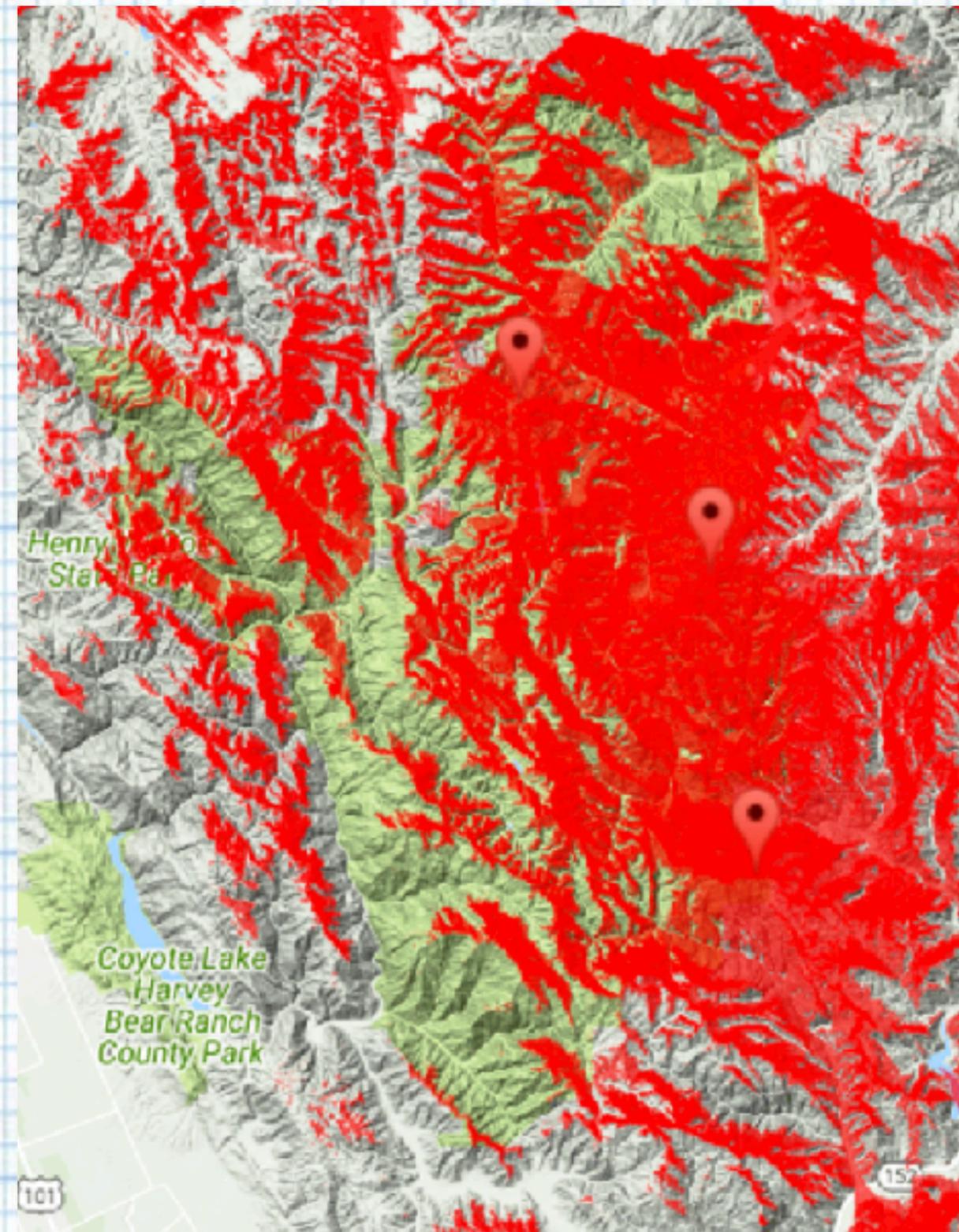


Coverage calculated by K6OIK

Applications

2017 Backcountry Weekend Henry W. Coe State Park

- We knew there were problems with the 70cm repeater's coverage
- K6OIK performed a coverage study
- Two additional sites were proposed
- We saw how coverage in the deep backcountry could be improved
- But one site was hard to get to...



Coverage calculated by K6OIK



Applications

2017 Backcountry Weekend, Henry W. Coe State Park

- Other repeater ops planned a linked system—without telling me
- And... That's not what I built
- They depended on vehicle access to their sites
- So I used my old cross-band repeater HT to link to their network
 - RFI susceptibility
 - Kerchunk oscillations

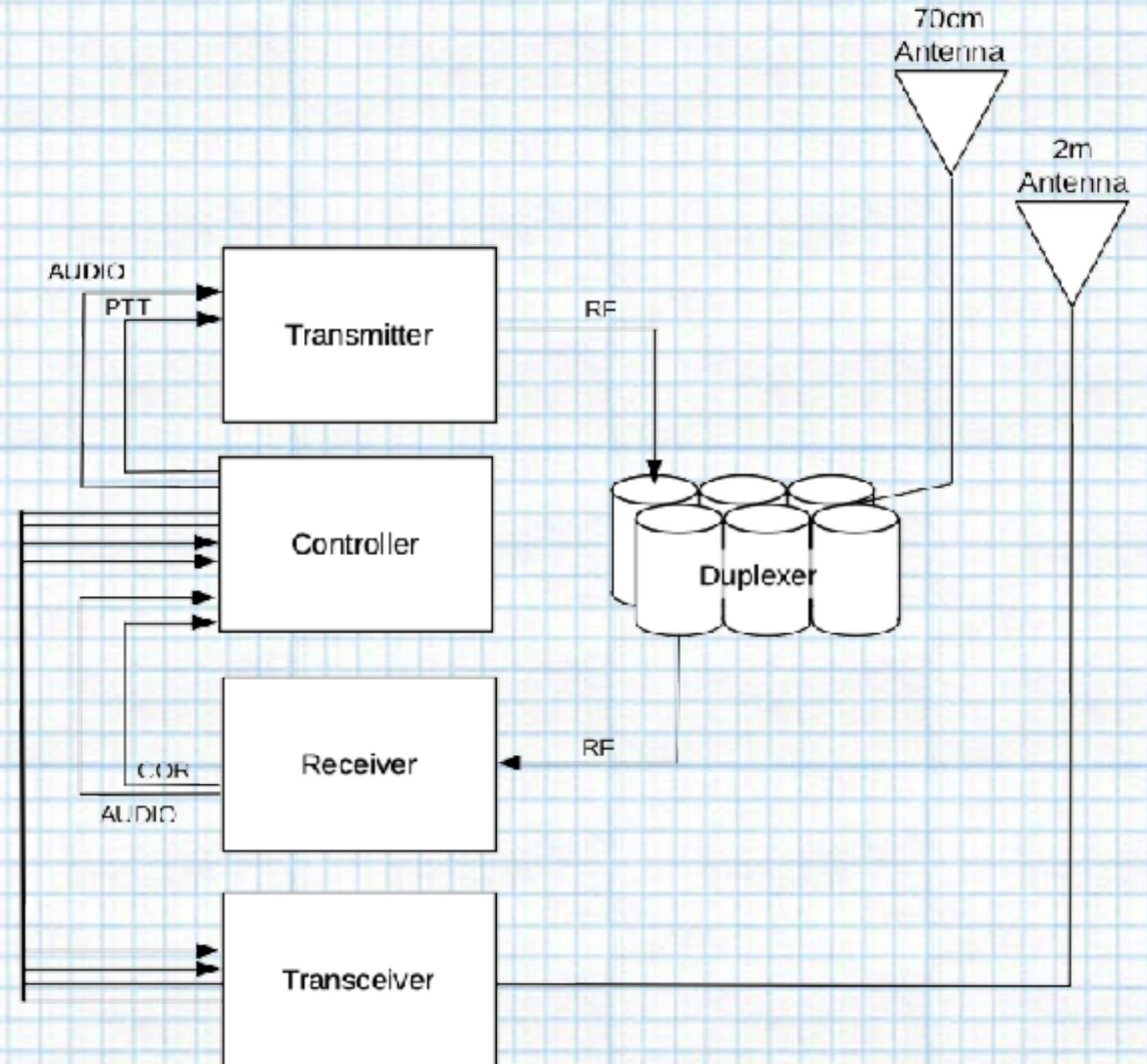




Applications

Next project: Build a linking repeater

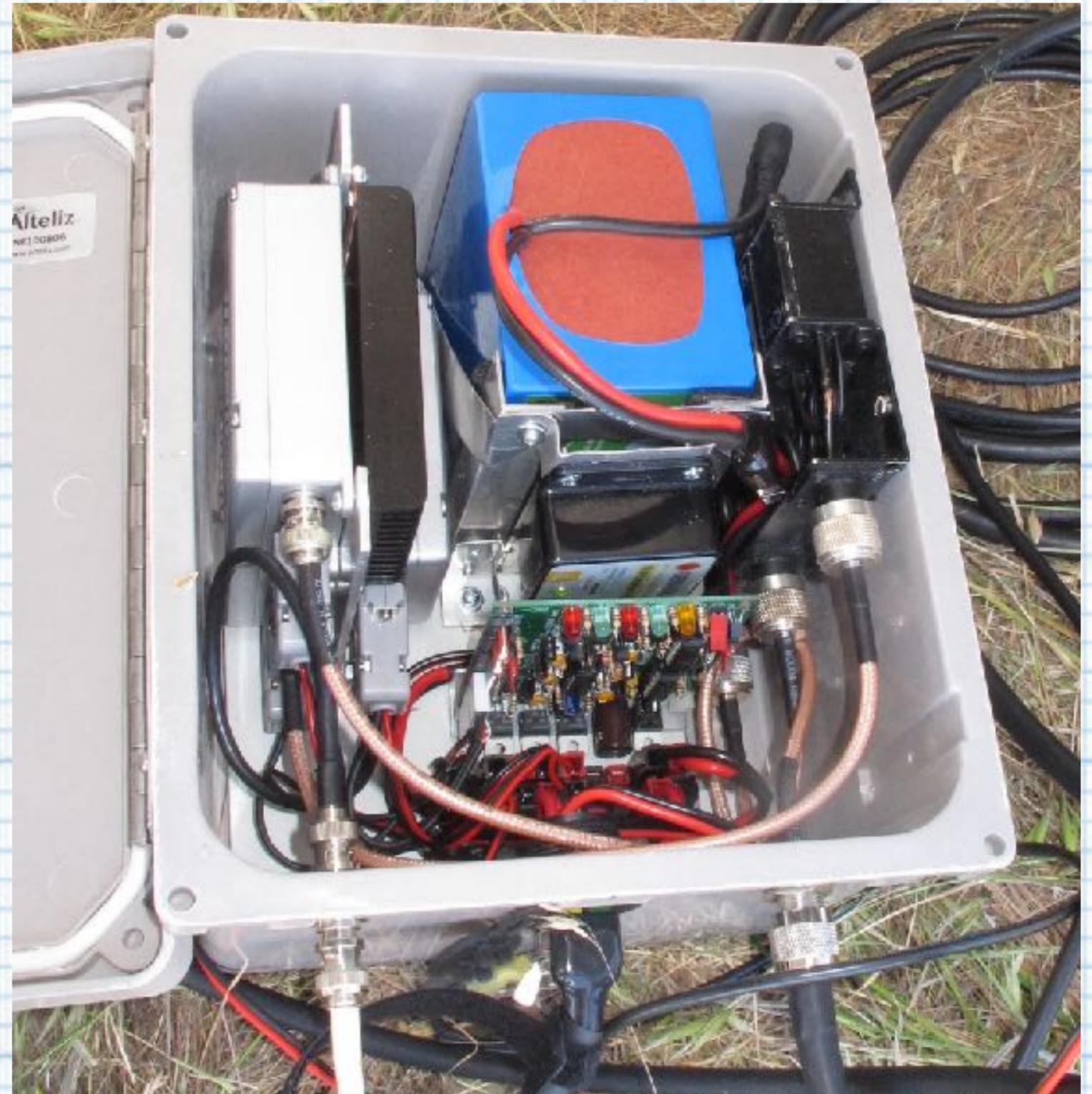
- In 2017, the BCW team linked the systems using a 2m simplex frequency
- So I built a new repeater to do that for 2018
- This box contains
 - Three 5W radios:
2-440 MHz, 1-146 Mhz
 - Linking controller
 - Duplexer
 - 20 Ah battery & solar charger



Applications

Next project: Build a linking repeater

- In 2017, the BCW team linked the systems using a 2m simplex frequency
- So I built a new repeater to do that for 2018
- This box contains
 - Three 5W radios:
2-440 MHz, 1-146 Mhz
 - Linking controller
 - Duplexer
 - 20 Ah battery & solar charger



Applications

2018 Backcountry Weekend, Henry W. Coe State Park

- Let's make it more complicated!
 - Decision was made to link sites with Allstar and Point-to-point WiFi
- Not surprisingly, that required a lot more hardware and more solar power
- Allstar interface wasn't tested before we climbed the mountain. It didn't work on my system
- Fell back to the 2m link—it worked fine
 - Ask those who were there: K60IK, KN6QI, others?





The good news! We didn't have to carry this up the mountain.

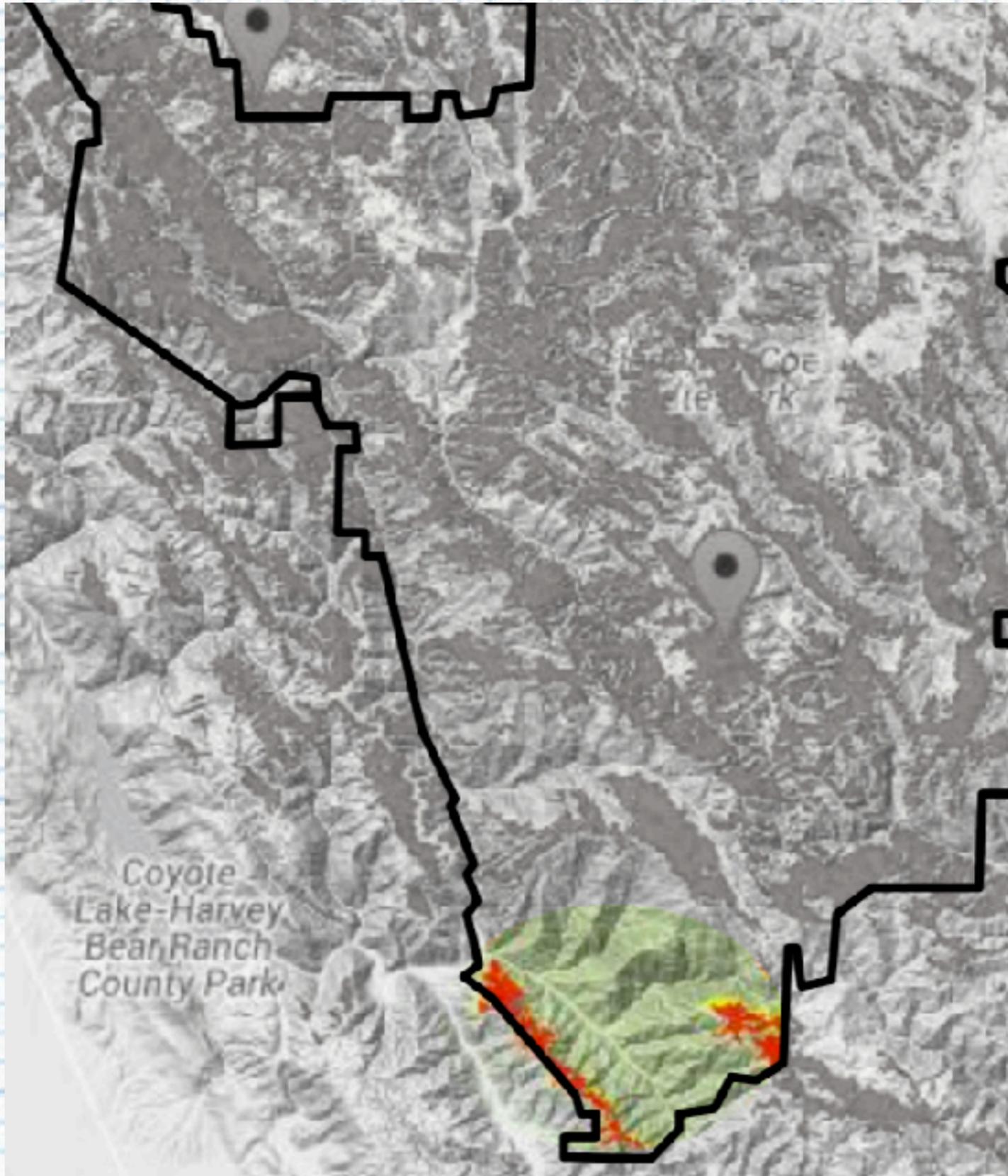


Applications

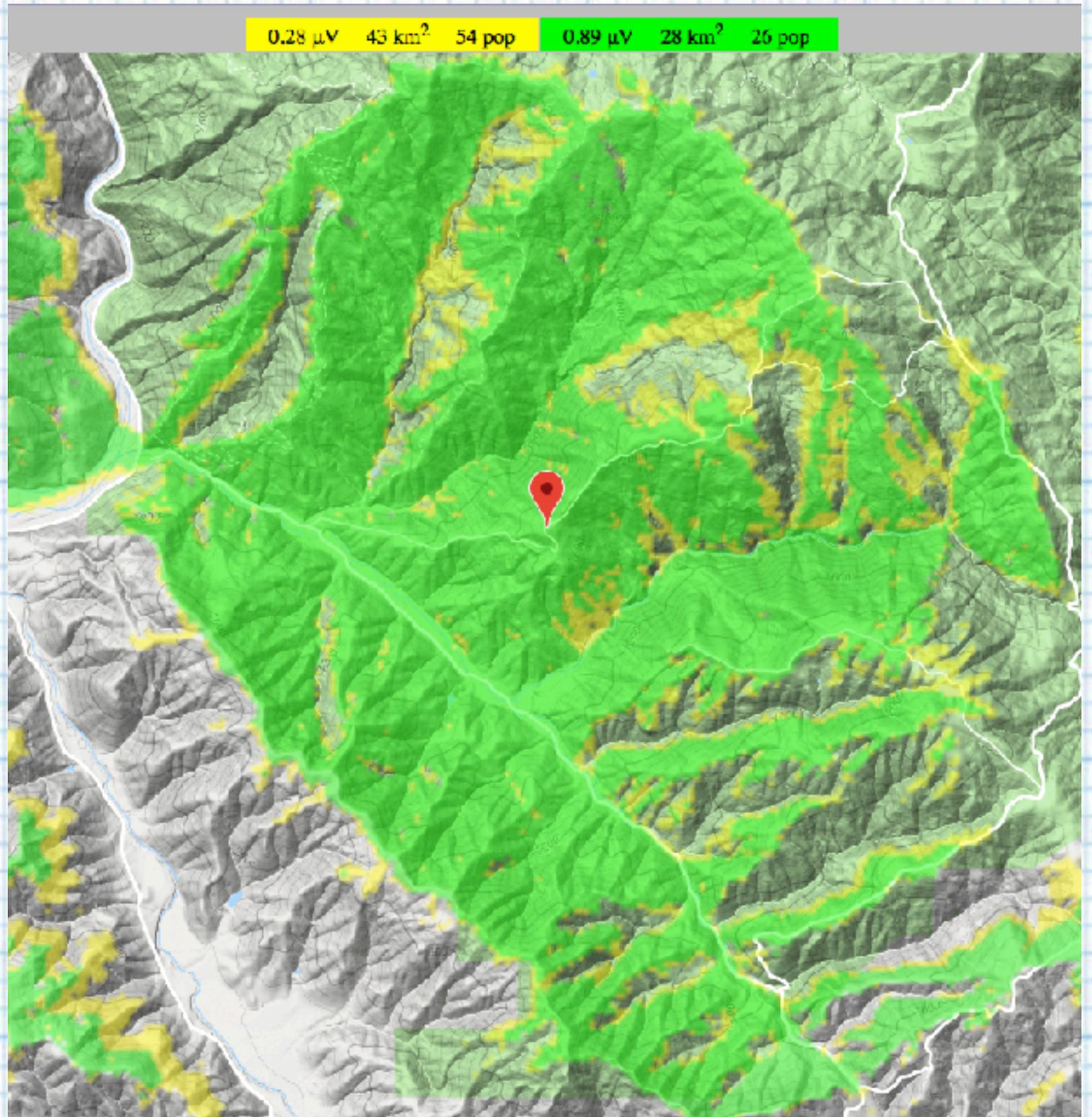
2017 Hunting Hollow 5k/10k Run Henry W. Coe State Park

- Hunting Hollow is a canyon.
- It's RF isolated from all normal services:
 - No state 800 MHz coverage
 - No fixed ham repeater coverage
 - No cellular coverage
 - No land lines nearby
- 2m simplex kinda-works





Coverage calculated by K60IK



Coverage calculated by KC6ZKT



Applications

Lessons (Eventually) Learned

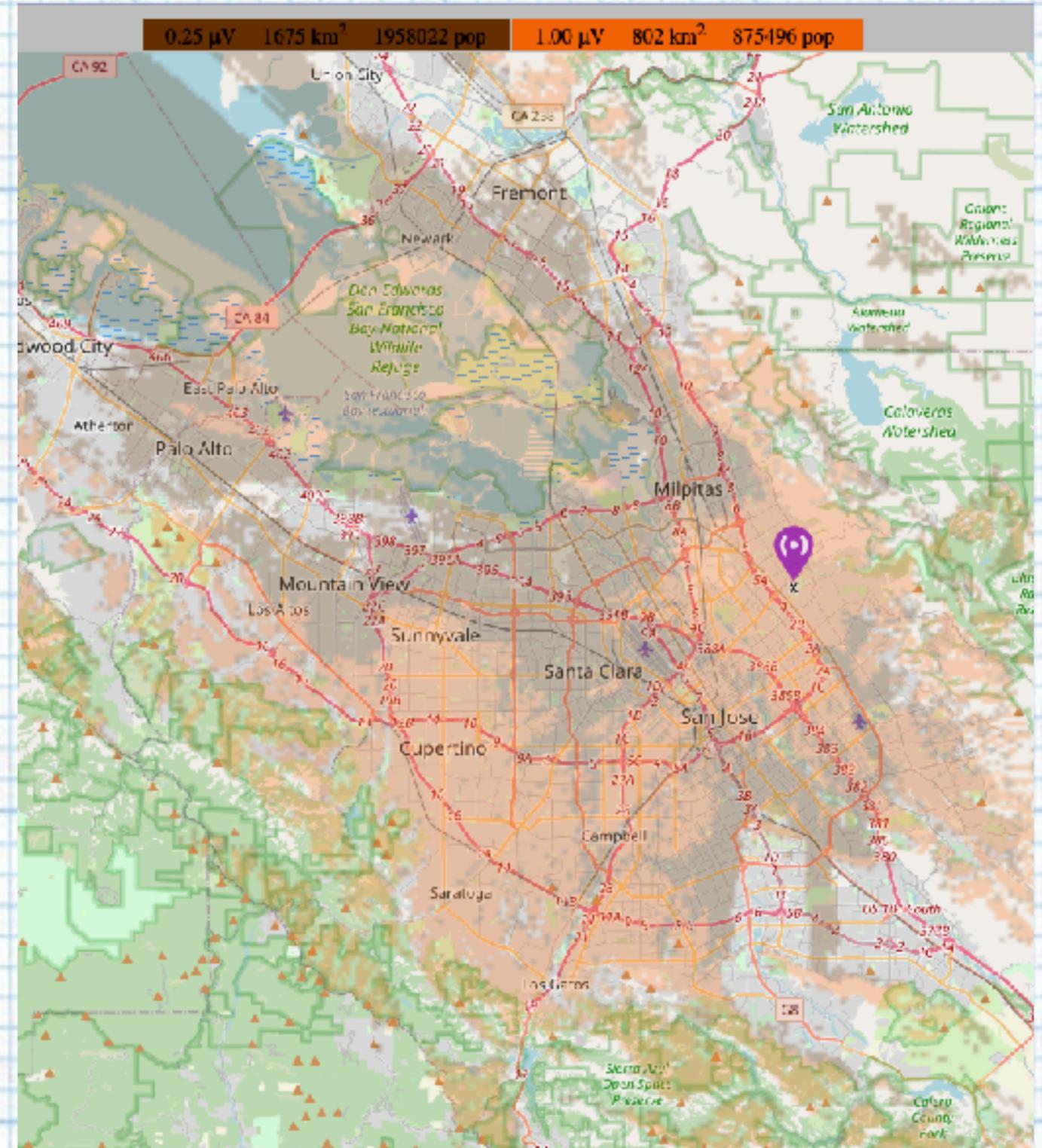
- A portable backpack-able repeater is useful for remote wilderness applications.
- There is little to no gear off-the-shelf that's ideal for this application.
 - Admittedly, it's a pretty small niche.
 - A lot of different components can be made to work.
- Receivers matter most in any repeater system design.
- It helps to have all of the right tools and test equipment (service monitors, etc.) to do the job right—but they're not necessary to build something that works.
- Event organizers frequently present late-breaking changes in requirements.
 - When you've custom-built something, you might find you needed something else.

Demonstration

Antenna is a 7 dBi colinear on a 25' mast, at 160' elevation in northeast San Jose.

System #1: 443.500+ PL203.5Hz

System #2: 441.200+ PL203.5Hz



Questions?

Repeaters To Go... Wild

Steve Sergeant, KC6ZKT (email available on QRZ.com)



Function	Description/brand	Model#	lbs.	oz.	Weight	Amps idle	Amps full	Ah for 24hr	Cost
Rcv radio	Maxon	SD-174EXU	0	9.4	0.59	0.06	0.07	1.46	\$125.00
Xmt radio	Leixen	VV-898	2	2	2.13	0.07	2.40	7.16	\$59.00
Controller	Arrow	uController	0	6	0.38	0.01	0.01	0.29	\$110.00
Duplexer	Jiesai	20Q-450N	1	13	1.81	0.00	0.00	0.00	\$64.00
Coax jumpers	BNC/N 1'x2, N/N 1'	RG-400u	0	5	0.31	0.00	0.00	0.00	\$17.00
Battery	PowerSonic	PD-12140	8	6	8.38	0.00	0.00	0.00	\$39.00
Power block	4-pole	Anderson	0	5	0.31	0.00	0.00	0.00	\$21.00
Power cables	10ga, 1', qty 5	custom Anderson	0	4	0.25	0.00	0.00	0.00	\$7.00
Charger	Genasun	GV-4	0	5	0.31	0.02	0.02	0.48	\$68.00
Enclosure	Harbor Freight	50mm ammo case	5	12	5.75	0.00	0.00	0.00	\$16.00
Repeater Subtotal					20.21			9.40	\$526.00
Guy stakes	20D nails, (qty 4)	generic	0	20	1.25	0.00	0.00	0.00	\$1.60
Guy ropes	3mm paracord	35' ea, Qty 3	0	12	0.75	0.00	0.00	0.00	\$6.00
Feed line	28'	RG-214/U	4	6	4.38	0.00	0.00	0.00	\$72.80
Mast	MFJ 18'	1919EX	9	12	9.75	0.00	0.00	0.00	\$159.00
Antenna	Ed's Antennas	DBJ-UHF	2	9	2.56	0.00	0.00	0.00	\$45.00
Solar panel	Eco-Worthy	20W	1	7	1.44	0.00	0.00	0.00	\$28.00
Solar cables	15' 10ga, Qty 2	DIY	1	14	1.88	0.00	0.00	0.00	\$12.00
Solar panel mount	3mm paracord + tent stakes	24'	0	5.5	0.34	0.00	0.00	0.00	\$1.00
Velcro cable ties	8" x 0.5", Qty 12	various	0	3	0.19	0.00	0.00	0.00	\$4.00
Tarp	Harbor Frieght	5'x7' silver	1	4	1.25			0.00	\$6.00
					0.00			0.00	
Total Weight in pounds					43.99	Total Power req. in Ah		9.40	
Duty cycle	10.00%	Battery Ah	14			Bat. Power Budget		67.1%	
Solar panel output A		1.43	Sunlight Hrs.	8		Daily recharge %		121.63%	
								Total cost:	\$861.40