

- Deploying a multi-site DMR system for the Total Eclipse of the Sun
- Presenters
 - Mike Pappas W9CN, RF Resource Coordinator
 - John Spainhower, N0JPS, IT Engineering
 - Dave Lanning, KD0SEM, Balloon Fill (AKA Gas Passer)



- Colorado Non-profit Corporation 501(c)(3)
- Charter:
 - Promoting Science and Education through Amateur Radio and High Altitude Balloons
- Provide Student Groups with Firsthand Experience with Science and Technology to the Edge of Space
- Funded by Donations, Fees and 60+ members



- An ARRL-affiliated club
- FAA Part 101 Waiver allows flying “heavy's” to 30+ lbs.
- Flying Educational Balloons and Experiments since 1990, 28 years
- Three Balloons per Deployment, Sometimes Six
- Over 75,000 Students Directly or Indirectly
- Several dozen have become Hams as a result
- 278 Launches, 278 Recoveries

U.S. DEPARTMENT OF TRANSPORTATION
FEDERAL AVIATION ADMINISTRATION

CERTIFICATE OF WAIVER OR AUTHORIZATION

ISSUED TO

Edge of Space Sciences, Inc. (EOSS) / Russell B. Chadwick, Vice President

ADDRESS

4371 North 63rd Street, Boulder, CO 80301 / 303-530-0228 / russell.b.chadwick@gmail.com and @noaa.gov

This certificate is issued for the operations specifically described hereinafter. No person shall conduct an operation pursuant to the authority of this certificate except in accordance with the standard and special provisions contained in this certificate, and such other requirements of the Federal Aviation Regulations not specifically waived by this certificate.

OPERATIONS AUTHORIZED

Activity: Up to 14 unmanned free balloon launches IAW 14 CFR, Part 101; this Certificate; and Special Provisions.
Max. Altitude: 115,000 feet Mean Sea Level (MSL)
Location: Five (5) potential launch sites – see special provisions and attached map/table of launch sites
Time: Official sunrise to sunset applicable to launch site (daylight hours only)
Date/s: 2/17/2018 - 12/31/2018

COA: WSA-1802-BAL

(cc: Prescott AFSS, ZDV, D01)

LIST OF WAIVED REGULATIONS BY SECTION AND TITLE

14 CFR 101.35 Equipment and marking requirements (a)(3) radar reflective devices

STANDARD PROVISIONS

1. A copy of the application made for this certificate shall be attached to and become a part hereof.
2. This certificate shall be presented for inspection upon the request of any authorized representative of the Administrator of the Federal Aviation Administration, or of any State or municipal official charged with the duty of enforcing local laws or regulations.
3. The holder of this certificate shall be responsible for the strict observance of the terms and provisions contained herein.



EOSS Upcoming Flights

- [Fall STEM Flight](#)
10/13/2018 (All day)
- [Metro State Intro to Space](#)
11/03/2018 (All day)
- [CU Boulder Gateway to Space and DemoSats](#)
11/10/2018 (All day)
- [NDIA STEM Flight](#)
03/16/2019 (All day)
- [Metro State Intro to Space](#)
03/30/2019 (All day)
- [CU Boulder Gateway to Space and DemoSats](#)
04/06/2019 (All day)
- [Spring STEM Flight](#)
05/04/2019 (All day)
- [Colorado Space Grant Consortium Summer Flight](#)
07/27/2019 (All day)
- [Metro State Intro to Space](#)
11/02/2019 (All day)

[more](#)

EOSS-278 CU Science Discovery - Recap



Submitted by Tom Londrigan (... on Fri, 08/10/2018 - 15:52

EOSS-278 was launched out of Genoa, Colorado on 8/11/18 at 08:03 and achieved an altitude of 93,912 feet at 09:31. The flight string landed at 10:15 in a pasture. All payloads were recovered approximately 3.6 miles northwest of Peyton, Colorado.

Original Announcement

Launch Site has been changed to GENOA RV Park (click for directions). 205 5th Street, Genoa Colorado. We may park on the lot north of the RV park building, or along the side of 5th street. The town of Genoa and the owner of the RV park will be our gracious hosts to allow us to use their facilities.

Predictions are available here. On that page, look for the Genoa launch site and click on the "GIF" link to see the predicted flight path.

UPDATE! All payloads plan on being onsite no later that 7:00 am for weigh in and stringing.

Look at this link: <http://wxqa.com/eoss278.html> for all sorts of links for tracking the balloon during flight and information on the track after the flight.

One 1500g balloon carrying payloads developed by:

- CU Science Discovery program student workshop
- Space Mail
- Science Girls

Total Eclipse Experience

- Eclipse August 21st, 2017
- NASA Sponsored
- Designed by Montana State University
- Supported by Colorado Space Grant Consortium
- Approximately 300 local students
- Two balloons with video streaming



NASA Eclipse Ballooning Project

- Coordinate with totality, be at altitude during totality
- Target 85,000 foot ASL
- Raspberry PI 2 computers
- 5.8 GHz modem for video
- 900 MHz modem for images

ECLIPSE BALLOONING PROJECT

NASA Space Grant
2017
 Eclipse Ballooning Project

IRIDIUM SATELLITES, IN COMBINATION WITH GPS SATELLITES, COMMUNICATE THE LOCATION OF EACH BALLOON.

THE PROJECT CONSISTS OF 57 HIGH ALTITUDE BALLOONING TEAMS OF STUDENTS AT UNIVERSITIES AND HIGH SCHOOLS FROM AROUND THE COUNTRY.

THE BALLOONS WILL ASCEND TO 100,000 FEET ABOVE THE EARTH AND WILL BURST SHORTLY AFTER THE CONCLUSION OF THE ECLIPSE

VIA THE IRIDIUM SATELLITE DATA THE FEDERAL AVIATION ADMINISTRATION (FAA) WILL BE ABLE TO TRACK ALL PROJECT BALLOONS SIMULTANEOUSLY

ON BOARD THE BALLOONS ARE A 5.8GHz MODEM FOR TRANSMITTING VIDEO AND A 900MHz MODEM FOR TRANSMITTING IMAGES, BOTH OF WHICH ARE RUN BY RASPBERRY PI 2 COMPUTERS

WATCH THE 2017 SOLAR ECLIPSE FROM THE EDGE OF SPACE LIVE AT **STREAMECLIPSE.LIVE**

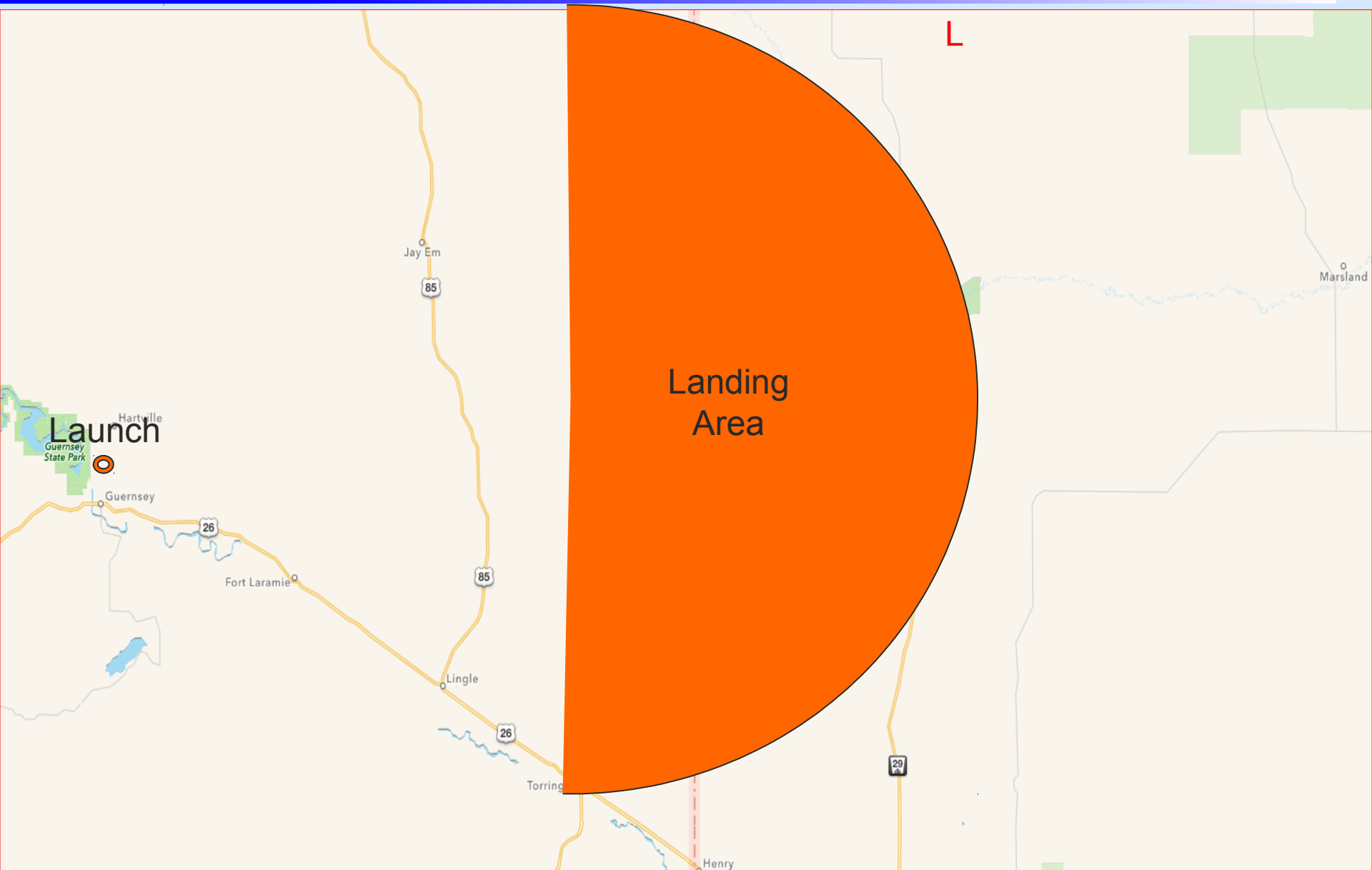
THE RASPBERRY PI 2 COMPUTERS PAIR WITH THE GROUND STATION COMPUTER AND TRANSMIT VIDEO AND IMAGES FROM THE BALLOON TO GROUND STATION THROUGH RADIO WAVES

THE VIDEO AND IMAGES TRANSMITTED TO THE GROUND STATION COMPUTERS ARE DIRECTLY STREAMED ONLINE WHERE THE FOOTAGE CAN BE ACCESSED BY ANY DEVICE, MAKING THE SOLAR ECLIPSE VISIBLE FROM THE EDGE OF SPACE TO ANYBODY WITH INTERNET ACCESS

BE SURE TO WATCH THE ECLIPSE LIVE FROM THE EDGE OF SPACE AT STREAMECLIPSE.LIVE!
 SPECIAL THANKS TO THE NASA SCIENCE MISSION DIRECTORATE, NASA SPACE GRANT COLLEGE AND FELLOWSHIP PROGRAM, AND THE TEAMS PARTICIPATING IN THE PROJECT.

Problem: Recover Eclipse Balloons

- Balloon Launch Site: Camp Guernsey Army Airfield, Guernsey, WY
 - Only one 2M amateur repeater (WA7SNU Located at Cherry Knoll outside of Wheatland, WY)
 - Assume repeater will be useless for tracking operations
 - It didn't cover the predicted landing area (Southeastern Wyoming/Southwestern Nebraska)
 - Potentially there would be hundreds of users on it during the eclipse (which is what happened!)



Camp Guernsey, Launch Site



Problem: Recover Eclipse Balloons

- Marginal to no cell coverage in most locations outside of the cities in Wyoming
- Need to assume whatever cell coverage will be “jammed” during the event
- LTE data support? LOL! We crashed Verizon LTE in Torrington every time we stress tested it!
- 700,000 visitors expected for the Eclipse in a State with a Population of 579,000 = No Cell, No LTE, No Fuel, No Food?
- Must have reliable communications for track and recovery teams

Problem: Communications for the flight?

- VHF or UHF?
 - EOSS APRS and DF beacons are on 2M
 - APRS beacons are 50 mW (from 95,000 foot up)
 - DF beacons are 100 mW
 - De-sense/interference is a major problem if we use VHF
 - EOSS moved to UHF for track and recovery communications many years back for these reasons

Problem: Communications for the flight?

- How About Using Multi-site Analog FM?
- Pros:
 - Everyone has analog FM radios and knows how to program and use them
 - They are familiar with the audio quality of FM

Problem: Communications for the flight?

- Multi-site analog FM?
- Cons:
 - Users would have to know where they were and what repeater they should select “Failure = Out of Touch”
 - Unfamiliar with Wyoming making correct site selection difficult
 - One more thing to deal with while tracking/recovering
 - Security: Anyone with a scanner can listen in
 - Analog linking has latency issues requiring long pauses between transmissions to allow the system to drop and allow others to join the conversation

Problem: Communications for the flight?

- What about DMR?
 - Pros:
 - Easy to link sites via Motorola IP Site Connect
 - Site “Ping” & Tier 3 DMR Radios support Roaming list
 - Make site selection automatic
 - We could rent gear economically
 - Some EOSS members had DMR gear/experience
 - We get two channels/timeslots on one frequency

Problem: Communications for the flight?

- What about DMR?
 - Cons:
 - We would need to make system “user friendly”
 - Had to work with minimal training
 - Had to manage expectations on digital audio quality
 - Not as “crisp” as analog
 - Older EOSS members with degraded hearing might have issues

Problem: Communications for the flight?

- What about DMR?
 - Cons:
 - We would need to rent gear
 - \$
 - Sunny Communications in Lakewood. CO had mobiles & repeaters
 - XPR 4550 for \$25 a week

- We floated (pun intended) the idea of running DMR during an eclipse test flight and see what the EOSS team thinks of it. EOSS management approved
 - EOSS Comms team organized
 - Stephen Meer, K0SCC
 - Parker Meer, KE0BMV
 - Dave Lanning, KD0SEM
 - Chris Krengel, KB0YRZ
 - Shaun Bryant, N0SPB
 - Miles Pappas, KD0JIT
 - John Spainhower, N0JPS
 - Mike Pappas, W9CN

- DMR Test flight one year before the event
 - Need to find repeater sites
 - Run propagation studies based upon flight and landing prediction

- Need Coordinated Frequencies
 - The Wyoming Frequency Coordination (WRCG) was handled by Leonard Pearce, W7QQA
 - We asked for 5 pairs of UHF narrowband digital Emergency/Special Event (ESE) Frequency pairs with a minimum of 100 kHz spacing between pairs
 - The 100 kHz spacing was for de-sense in situations where users were proximal to each other yet were “Roamed” into different sites

	Input	Output	Location	
x	440.0125	445.0125	yours	Wheatland, WY
	440.0250	445.0250		
	440.0375	445.0375		
	440.0500	445.0500	USED	USED
	440.0625	445.0625		
	440.0750	445.0750		
	440.0875	445.0875		
	440.1000	445.1000		
	440.1125	445.1125		
	440.1250	445.1250	Add	Lay Ranch, WY
440.1375	445.1375			
440.1500	445.1500			
440.1625	445.1625			
440.1750	445.1750			
440.1875	445.1875			
440.2000	445.2000			
440.2125	445.2125	yours	K7STM John Patrick	
440.2250	445.2250			
440.2375	445.2375			
440.2500	445.2500			
440.2625	445.2625			
440.2750	445.2750			
440.2875	445.2875	Spare	SPARE	
441.7250	446.7250			
441.7375	446.7375			
441.7500	446.7500			
441.7625	446.7625			
441.7750	446.7750			
441.7875	446.7875			
441.8000	446.8000	yours	Torrington, WY	

- DMR System
 - We would need to build a system that utilized “ping” on the repeaters and “roam lists” on the radios to automate the site selection
 - Ping was set at 30 sec intervals (1/2 mile @ 60 MPH)
 - RSSI was set “empirically” at -108 dBm

- DMR System
 - We needed to make the system “simple to use”
 - Few EOSS personnel had any DMR experience
 - We didn’t want to have to train all of the users
 - Radios needed to be user friendly
 - Turn them on, adjust RX volume knob and hit the PTT to talk

- Local Support was invaluable!
 - We reached out to the WA7SNU 2M repeater folks (site located at Cherry Knoll east of Wheatland, Wyoming).
 - Terry Meier, WA7SNU Trustee and their technical guru Jim Andersen, AE7AF
 - We tested the WA7SNU on our R&S and HP gear and it was in superb shape
 - They connected us to the Cherry Knoll site owner Christine Knittle, KC7MJI
 - Christine was “all in” letting us use the site for both the test flight and the event.

Eclipse Network: Wheatland Site

- 5300 Ft. Elevation
- Site of the WA7SNU 146.88 repeater
- 180 ft. tower



Eclipse Network: Wheatland

- Motorola XPR 8300 Repeater
- Master for whole system
- Celwave duplexer, 6-cavity
- Used existing 6-bay omni antenna on the top tower
- Cambium Networks PTP 650 Microwave 5.8 GHz 20 MHz channels
- Cradlepoint LTE Modem
- Coverage started at I-25 MM 14
- Wheatland is at MM 78
- Thanks to WA7SNU,
& Christine Knittle, KC7MJI



- Local Support was invaluable!
 - We needed a site north of Torrington Wyoming that would have coverage into Southeastern Wyoming and Southwestern Nebraska
 - Needed to have a clear microwave shot to Cherry Knoll
 - We ran into Kraig Murphy, KD7JNQ, who lives in Torrington, WY and is a dispatcher for the Goshen County Sheriff two years prior to the event
 - We called Kraig and asked him if he knew of a site north of Torrington
 - Little did we know what we were getting into!

- Local Support was invaluable!
 - Kraig called me back a couple of days later with a name and number for a site north of Torrington.
 - Gene Lay @ Lay Ranch
 - 9000 acres of cattle and pure breed horses
 - The Lay family settled the ranch in 1843!
 - They have a VHF Radio site located on top of a massive butte



- We got the Lat-Long and height from Gene and ran pattern studies and microwave path studies
 - Microwave shot to Cherry Knoll was 38 miles and “good”

Eclipse Network: Lay Ranch

Equipment

Region and Equipment Selection

Band: 5.8 GHz | Product: PTP650 | Capacity: Full (Up to 450 Mbps) | Regulation: United States | Precise Network Timing: Disabled

PTP650 Configuration

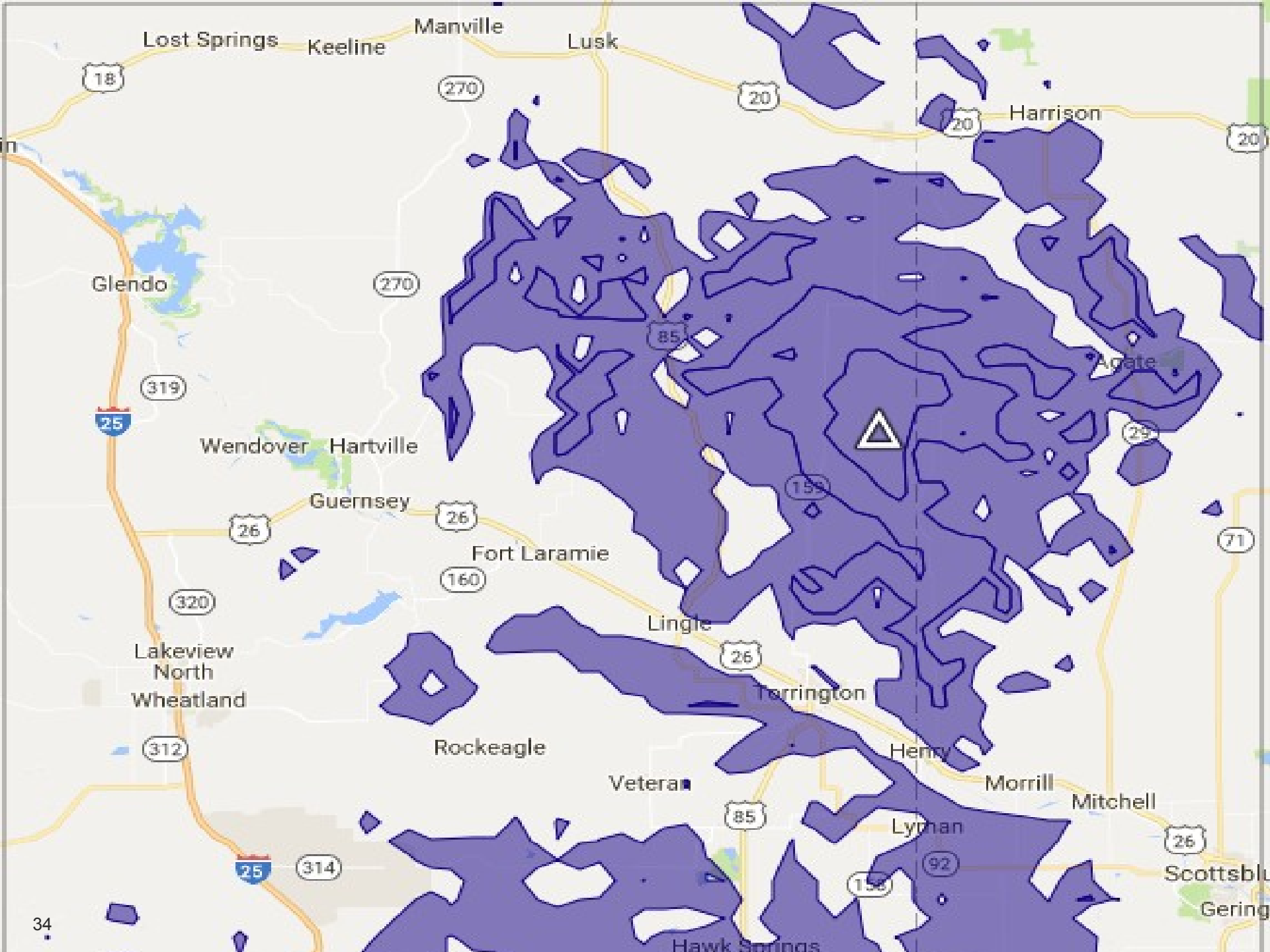
Bandwidth: 20 MHz | E1/T1: None | Optimization: IP | Sync: PTP-SYNC | Symmetry: Symmetric | Dual Payload: Enabled | Highest Mod Mode: 256QAM 0.81 | Lowest Ethernet Mode: BPSK 0.63 Sngl | Master: Wheatland

TDD Synchronization

Burst Duration: 1088 μs | Frame Duration: 2747 μs | Slave RX TX Gap: 85 μs | Phase 1 End: Wheatland (Master) | TDD Frame Offset (Master): 0 μs



- We ran UHF pattern studies using the Canadian Research Council Longley-Rice Radio Coverage Prediction website (since discontinued)
 - We used worst-case receiver sensitivity numbers and underestimated transmitter antenna height and ERP. Our target was 45 $\mu\text{V}/\text{M}$ or higher RF density
 - Site looked outstanding for coverage



- Just a couple of issues with the Lay Ranch Site
 - It was a 45 minute 4X4 “adventure” to get to the site once we left the dirt trail off from Gene’s place.
 - 45 minutes to go 5.5 miles
 - Broken rocks, steep drop offs, high clearance vehicles and spotters needed to guide through some areas
 - Not your everyday site run!
 - Over the course of the project we damaged two trucks getting in and out of the site



- We failed to realize that the “tower” consisted of a phone pole with a NEMA box screwed onto it for Gene’s VHF repeater until we got there!
- Woops!
- We didn’t have any way to mount the antenna
- And there wasn’t a “shack” for the repeater!
- We “jury rigged” an antenna mount
- We put the repeater in a cardboard box wrapped in a trash bag!





- Microwave was installed, had signal and was aimed but it didn't "connect"
 - "ack timing" had to be configured on both ends for the length of the path.
 - Its path length settings were in km and we were in miles and we had 38 of them! Which is 61 km.
 - So we dispatched a team back to Cherry Knoll to adjust the microwave. 90 minutes from the site
 - Microwave gets sorted out and the IPSite Connect (IPSC) comes up and its happy!
 - We underestimated the simplicity of IPSC out of the box
 - Yay!

- John Spainhower puts the XPR8300 repeater in cardboard box and a large black garbage bag
- We head down from the Butte which was just as hair raising as going up was
- We can't get into the Lay Ranch site from the backside of the Butte when we get to the dirt road
- We were hitting Cherry Knoll on the way down and didn't realize the Lay Site was off the air!
- Oh NO!

- John Spainhower determines that he didn't power the repeater back up when he put it in the cardboard box.
- He was almost murdered on the spot!
- Spainhower hurriedly heads to Cherry Knoll for some settings that need to be adjusted on the microwave
 - And to get away from the “**Enraged Comms Team**” who had to be restrained from dispensing Cowboy Justice
- He bought the first, second & third round at the bar as Penance that evening

- Myself and Chris Kregel, KB0YRZ head back up
- We get back to the site 45 minutes later only slightly worse for wear and find the repeater power is turned off!
- While Spainhower is tweaking the microwave we have connected a PC up to the network and had Pandora playing on the Butte!
- Site comes up perfectly

Eclipse Network: Lay Ranch

- Elevation 4900 ft.
- Motorola SLR 5700 repeater
- Celwave duplexer, 6-cavity
- Telewave ANT450 D3 antenna set for cardioid pattern (6dBd gain)
- Microwave link to Wheatland, 38 miles via Cambium Network PTP-650
- Shack added after test flight





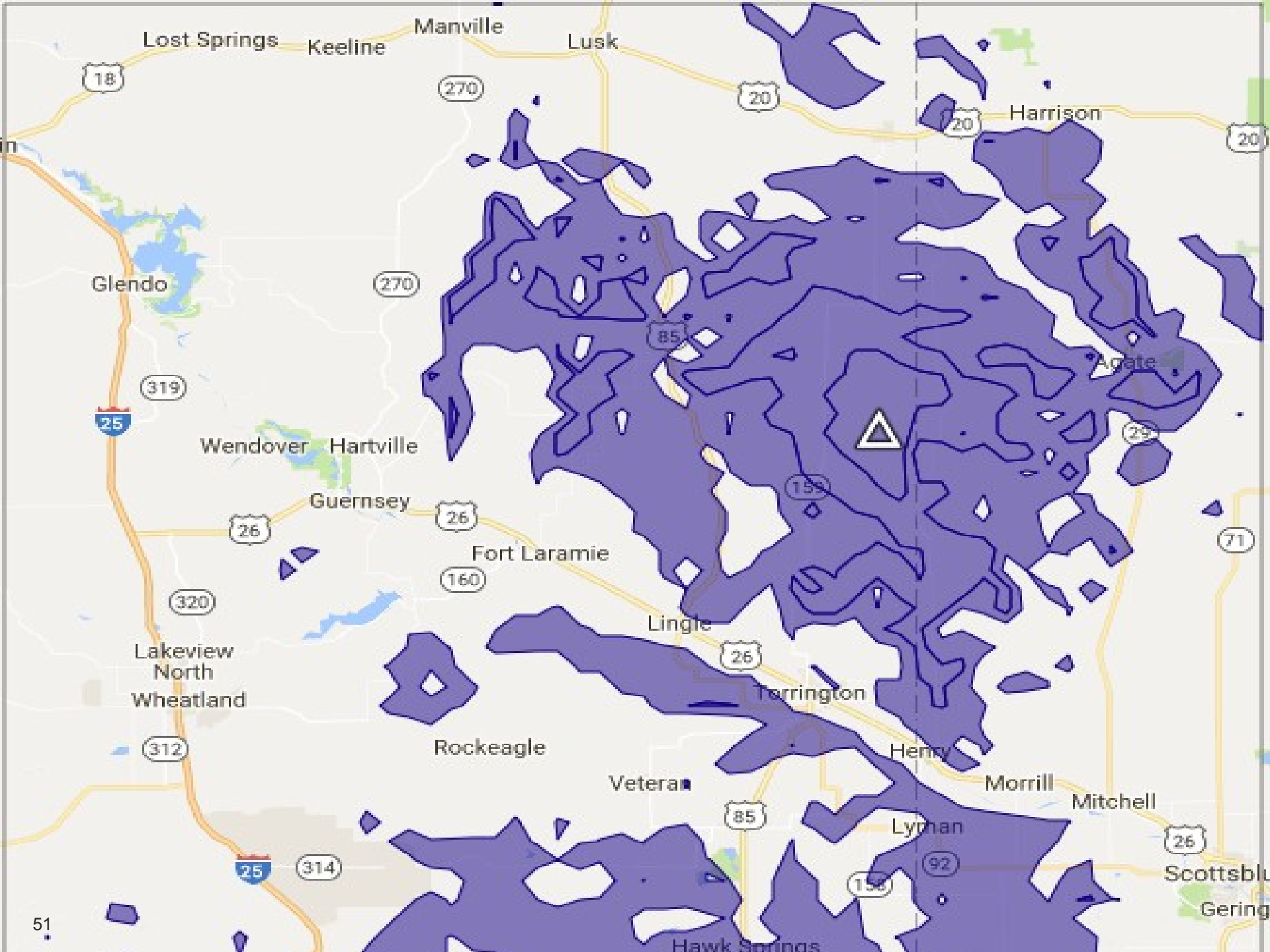




- DMR Test Flight
 - We rented Motorola XPR 4550 mobiles and programed them up
 - Distributed them to the EOSS team
 - Off we went
 - Test balloon flight goes way, way north
 - Lands north of Lusk, Wyoming
 - Longley-Rice shows no coverage north of Lusk
 - But it worked!
 - Way conservative on the coverage studies

- DMR Test Flight Post Mortem
 - Everyone was very happy with using DMR
 - Roaming worked perfectly
 - DMR audio quality got rave reviews with the younger Hams “No noise” of digital was a hit
 - Some complaints from the Guys who were 70 and/or had degraded hearing
 - “Not crisp”
 - “Couldn’t ID who it was by their voice”
 - But they said it was 100% intelligible

- We needed better coverage in Torrington.
 - We couldn't hit Lay Ranch or Cherry Knoll reliably from inside the Holiday Inn Express or the Broncho Bar & Grill in Torrington!
 - Or inside the Sheriff Dept. Dispatch Center
 - For the Eclipse Kraig Murphy, KD7JNQ was going to be on the second time slot 2, talk group "911" with a XPR6550
 - Only "admin" radios had this configuration
 - Backup incase we need to contact Sheriff Dept.
 - Fill in the shadowing along Hwy 26 from Lingle Colorado to Mitchell, Nebraska

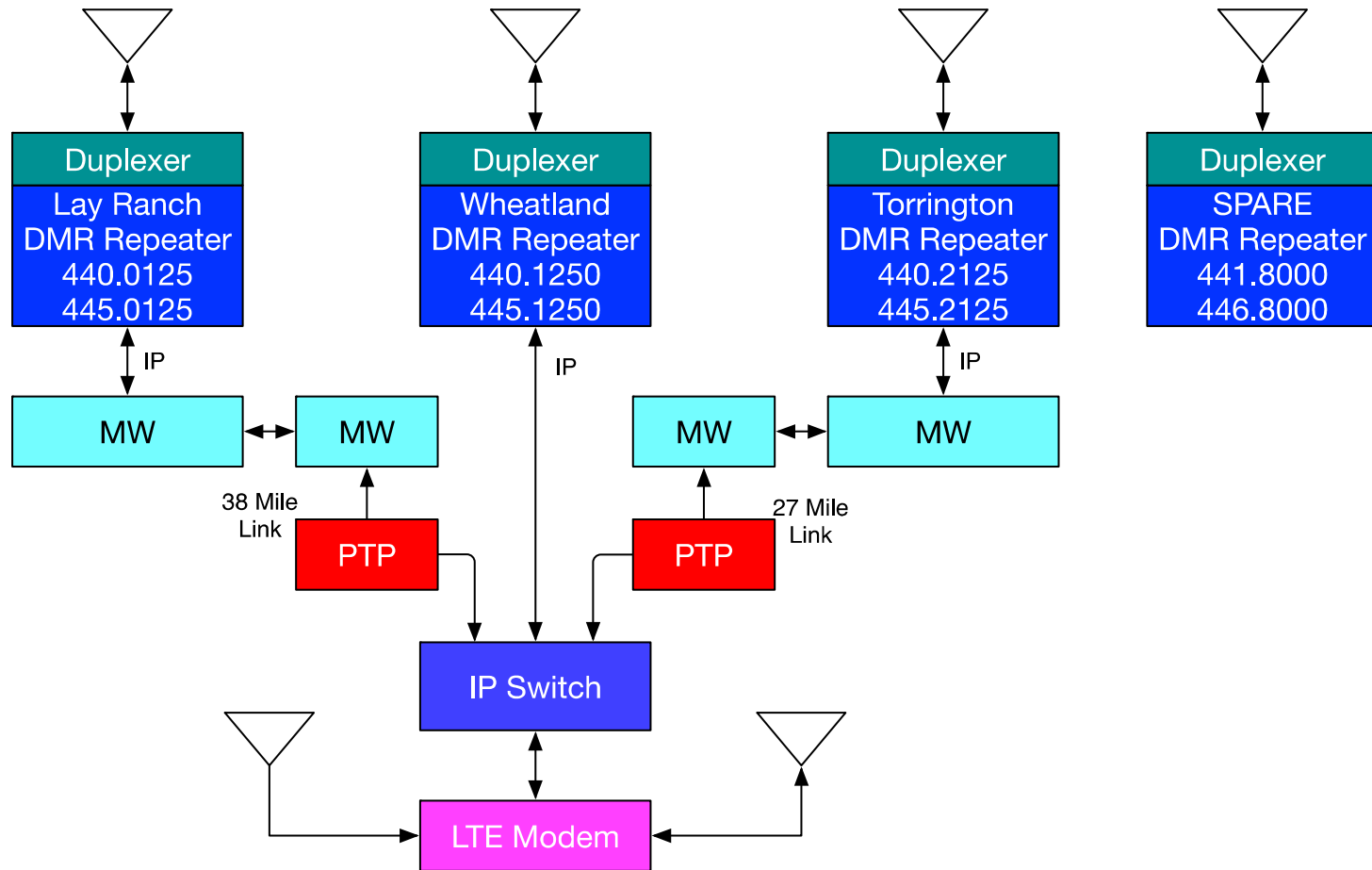


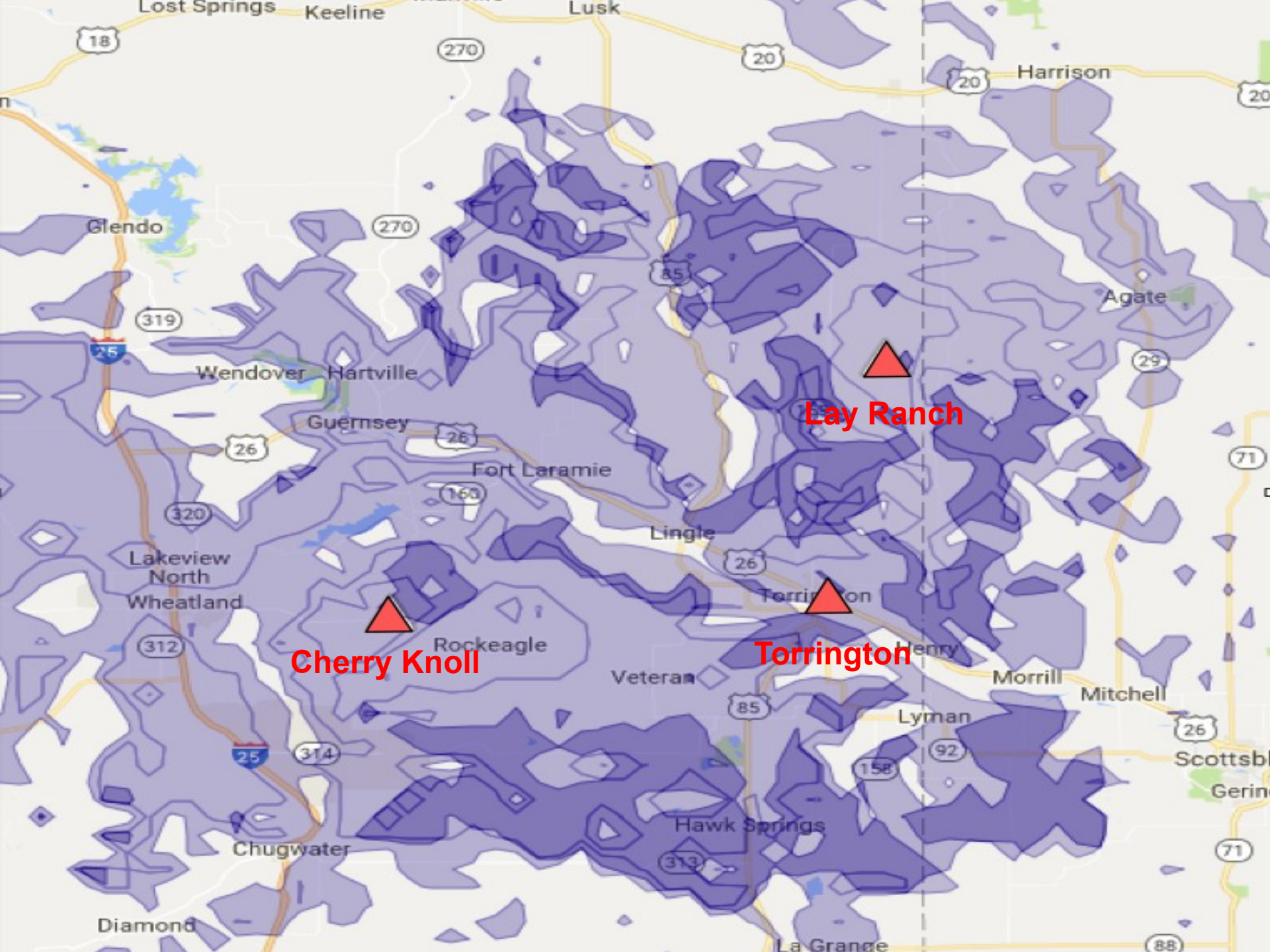
- We had concerns that we might have shadowing issues on Hwy 86 from Lingle, WY to Lusk, WY.
 - Hwy 86 is one of the main North/South highways and our tracking teams were going to be using it during the eclipse
 - During the test flight we had multiple users drive Hwy 86 and found the coverage to be solid
 - We dropped the fourth site

- The Eclipse Flight
 - We would build the system the weekend before the event

EOSS Eclipse Wyoming Network

EOSS NASA Total Eclipse of the Sun Flight 21AUG17





Cherry Knoll

Lay Ranch

Torrington

- We prebuilt and tested all three sets of repeaters and a backup repeater
 - We purchased two used XPR 8300 a new SLR 5700 and we had an XPR 8300
 - We tested the used '8300s
 - Found one with a bad power supply fan and the other had a bad main cooling fan
 - Both had the tach line cut on the main fan which causes the fan to run at full speed
 - Units were chock full of dirt as a result
 - We swapped the bad fans and restored the tach line, cleaned & tested

- UPS were MinuteMan enterprise class double conversion with 45 minute runtime on internal batteries
 - Cherry Knoll and Lay Ranch had additional battery packs extending UPS runtime to two+ hours
 - Torrington Water Tower had genset backup

Eclipse Flight: Repeater Builds

- Repeater/Duplexer performance was tested using an HP8920A with the repeaters in “analog” mode
 - Amtronix Instruments, Richard Bowman, KB2YG in Lakewood, NY services and calibrates our HP8920A
 - Target for receive sensitivity was -120 dBm to 12 dB SINAD @ 3.0 kHz deviation with a 1 kHz tone



Eclipse Flight: Repeater Builds

Input	Output	Location	Duplexer	Duplexer	Repeater	TXPO	TXPO dBm	Duplexer TX	Dup dBm	TX dB Loss	RX 12dB SINAD
440.0125	445.0125	Lay Ranch, WY	Tuned	Celwave 6 cav	5700	50	47	40	46	1	-121
440.1250	445.1250	Wheatland, WY	Tuned	Celwave 6 cav	8300	40	46	29.7	44.73	1.27	-120
440.2125	445.2125	Torrington, WY	Tuned	Wacom 4 Cav	8300	40	46	32	45.05	0.95	-121
440.2875	445.2875	SPARE									
441.8000	446.8000	K7STM John Patrick	Tuned	Small Mobile	8300						

- We purchased 2 used Celwave 6 cavity duplexers to use with our Wacom 4 cavity duplexer and our cheap Chinese 6 cavity mobile style duplexer (spare)
- We tuned all of the duplexers ourselves using our R&S FSH4 VNA and FSL6
 - We haven't found a Two Way Shop who can properly tune a duplexer in the field
 - Ordered tuned from manufacturer are typically spot on
 - We want 90 dB of notch



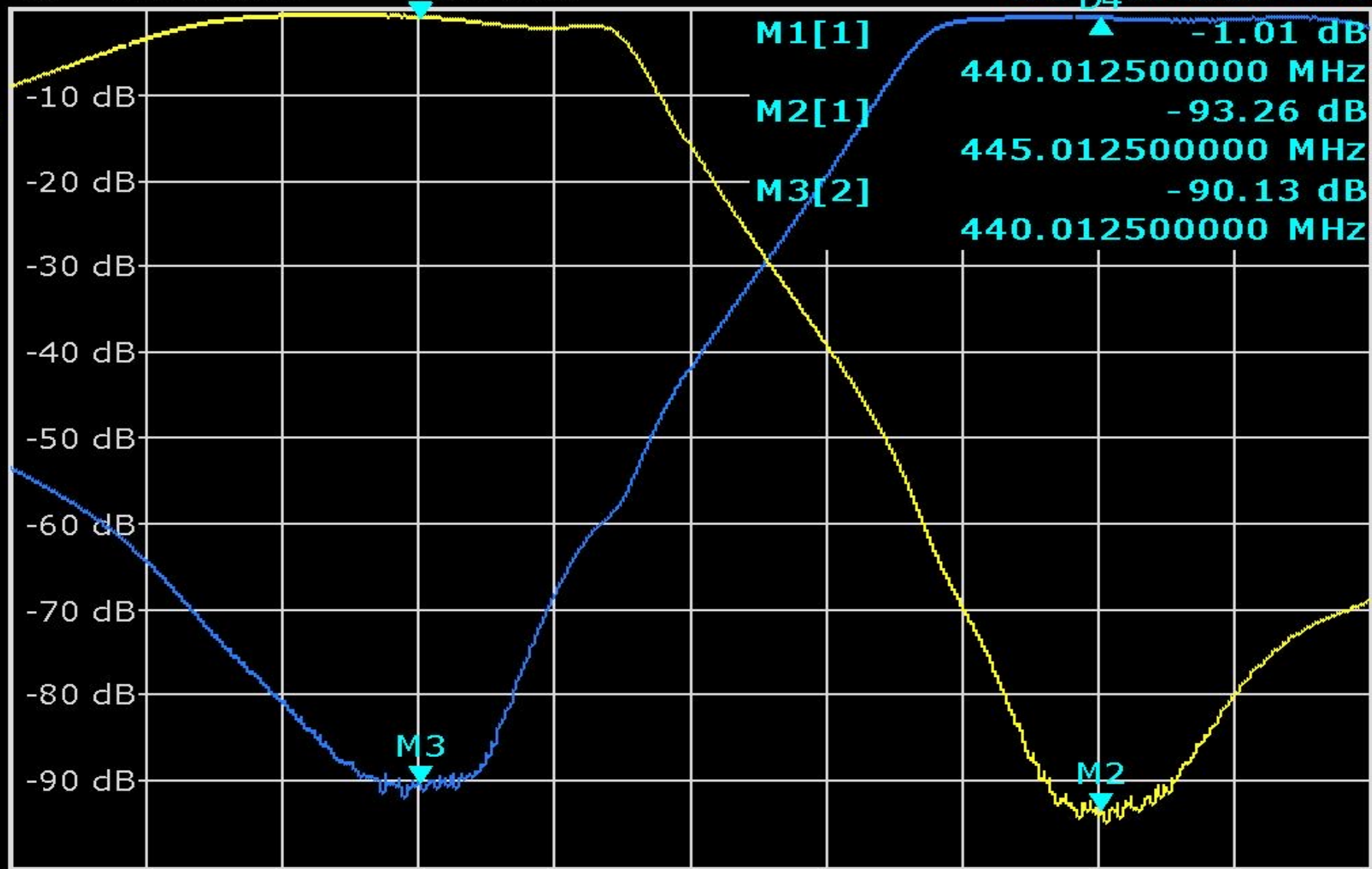
* Att 0 dB
Ref -10.00 dBm
* RBW 1 kHz
VBW 3 kHz
SWT 9.8s

D4[2] -0.15 dB
5.00000000 MHz

1Sa
View
2Sa
Clrw

M1[1] -1.01 dB
440.01250000 MHz
M2[1] -93.26 dB
445.01250000 MHz
M3[2] -90.13 dB
440.01250000 MHz

APX



CF 442.0 MHz

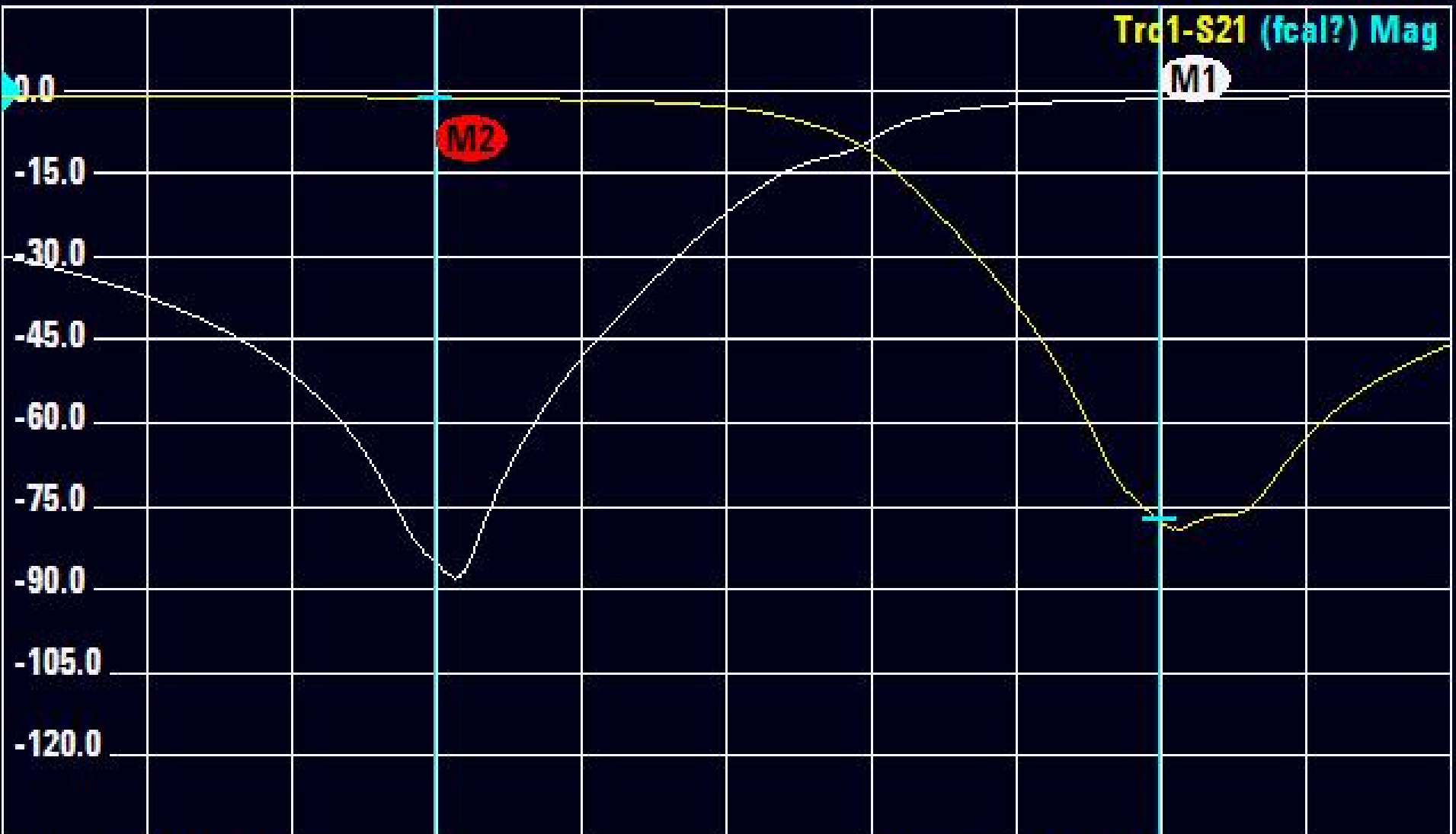
Span 10.0 MHz

- WyomingDMR (WYDMR) asked us to retune the duplexer they have at Cherry Knoll
 - We improved it by 15 dB
 - John Spainhower's perspective on 15 dB
 - The difference between Helen Keller and Stevie Wonder
- WYDMR has a state wide linked 6 site DMR system
 - We swapped code plugs with them for use if the world came to an end and programmed up a couple of our radios with theirs



Ref: 0.0 dB RBW: 100 Hz SWT: Auto Trace: Clear/Write
Att: 0 dB TG Att: 0 dB Suppr: Off

M1 446.988 MHz -77.52 dB M2 441.988 MHz -1.41 dB





Ref: 0.0 dB RBW: 100 Hz SWT: Auto Trace: Clear/Write
Att: 0 dB TG Att: 0 dB Suppr: Off

M1 446.988 MHz -1.61 dB M2 441.988 MHz -92.31 dB



Center: 445 MHz

Center: 445 MHz

Span: 7.5 MHz

- Torrington Site
 - We need a site in Torrington that would cover the city and help fill in the shadowing along Hwy 26 from Lingle, WY to Mitchell, NE
 - Needed to have a clear microwave shot to Cherry Knoll site
 - Kraig, KD7JNQ, called the Mayor of Torrington at 6:30 PM on a Friday night and got permission for us to use the water tower starting the next day at 7:45 AM
 - We ran the microwave path study and it was “good” at 28 miles

Eclipse Network: Torrington

Equipment

Region and Equipment Selection

Band: 5.8 GHz | Product: PTP650 | Capacity: Full (Up to 450 Mbps) | Regulation: United States | Precise Network Timing: Disabled

PTP650 Configuration

Bandwidth: 20 MHz | E1/T1: None | Optimization: IP | Sync: PTP-SYNC | Symmetry: Symmetric | Dual Payload: Enabled | Highest Mod Mode: 256QAM 0.81 | Lowest Ethernet Mode: BPSK 0.63 Sngl | Master: Wheatland

TDD Synchronization

Burst Duration: 1088 μs | Frame Duration: 2747 μs | Slave RX TX Gap: 136 μs | Phase 1 End: Wheatland (Master) | TDD Frame Offset (Master): 0 μs

Profile: 27.9 miles, Line-of-Sight



Eclipse Network: Torrington



Stephen, KØSCC

Eclipse Network: Torrington

- Motorola XPR 8300 Repeater
- Wacomn duplexer, 4-cavity
- Procom 5 dB omni antenna
- 28 Mile microwave link to Wheatland
- Notebook tipped for weary, tired technicians
- Double Conversion UPS (site has genset backup)
- Used outdoor enclosure purchased from Sunny Communications



- Torrington Site
 - We needed to “sync” both of the Cambium microwave systems at Cherry Knoll to sync their transmit cycles and avoid interference between the systems
 - PTP Sync system didn’t ship with power supplies!
 - Doesn’t use standard PoE! 55 VDC @ 0.5 A
 - Spainhower found the needed power supplies in his truck
 - TX Timing latency has to be set for the longest path round trip (Lay Ranch 38 miles one way 76 mile round trip: 406.948 microsecond)

- We had concerns about fueling
 - Kraig hooked us up with a local rancher who had 6,000 gallons of ‘regular’ and 9,000 gallons of diesel if we needed it
- And just when we thought it was going so well
 - Disaster!
 - Lay Ranch hit with an F3 tornado!
 - We made plans to help them

Lay Ranch: Hit By Tornado



- June 12, 2017 F3 Tornado
- Destroyed barn
- Severely damaged home
- Destroyed farm equipment



Lay Ranch: Helped by Amateurs

- 4th of July weekend helping Gene Lay rebuild
- Mike Pappas, W9CN
- John Spainhower, NØJPS
- Teresa Pappas



- Monday August 21st Eclipse Day!
 - Sun Ready to Eclipse!
 - Launch team ready to go!
 - Payloads ready to go!
 - DMR network ready to go
 - Drive tested the Saturday before with 4 teams of Launch and T&R volunteers to confirm coverage and programming
 - Inspired confidence with the users
 - Refreshed everyone's auditory memory and managed expectation on DMR audio
 - We could monitor the system using RDAC

We ran a XPR 5550e and XPR 4550 in the truck
One on TS-1 (main T&R) and the other on TS-2 (911
Dispatch) Because of the packet nature of DMR No de-
sense!







Making New Wyoming Friends

“... and Mr. Chris Kregel – if that is your real name, stop beaconing your APRS location every 30 seconds. That’s how we caught you! KBØYRZ-6, blah, blah, blah”



Eclipse: Camping at Camp Guernsey



- Track and Recovery Meeting August 21, 8 A.M. Holiday Inn Express Torrington, WY
- Ready to track two balloons, EOSS 260 and EOSS 261
- No beers for breakfast, serious stuff



Eclipse: Traffic Jam

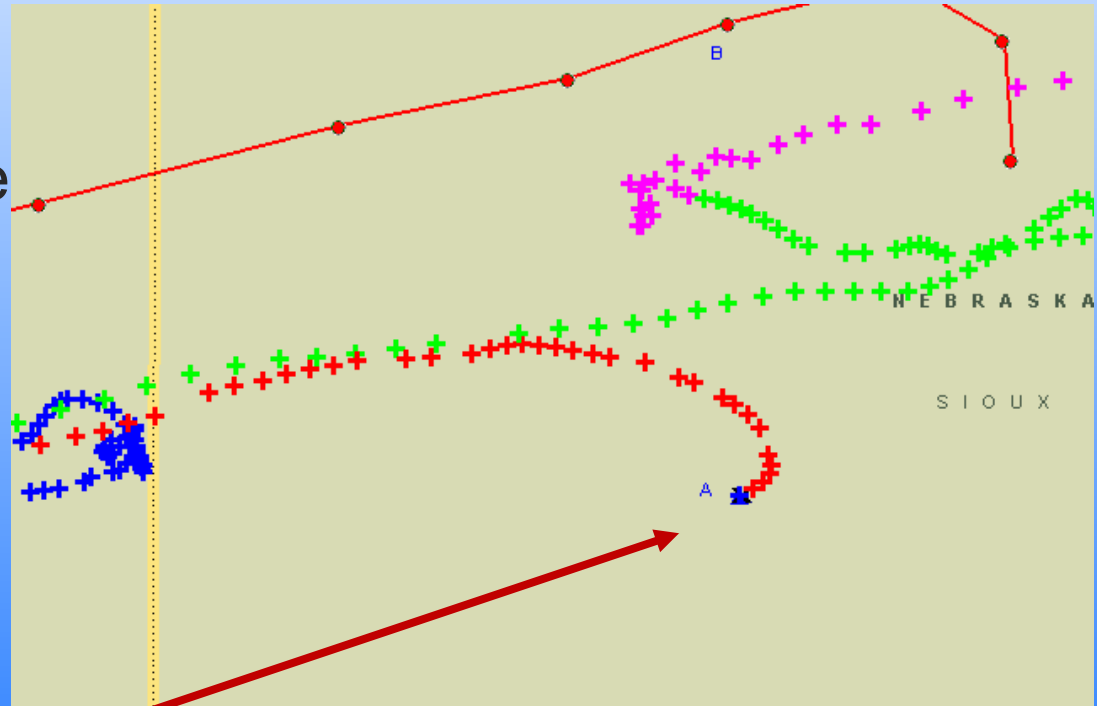


Eclipse Flight: Chasing Both Balloons



Eclipse Flight: EOSS 260 Recovery

- Landing: N 42° 24.683', W 103° 54.316'
- 43 miles from launch site
- 2 hours, 17 minutes
- 19 mi SSW of Harrison, NE
- Spectacular video of eclipse, burst and moon shadow on earth
- Location with "Alpha" 200 yards west
- EOSS 261 shown green (ascent) and purple (descent)



Eclipse Flight: EOSS 260 Recovery

Jim, KØLOB
returns with
EOSS 260
payloads



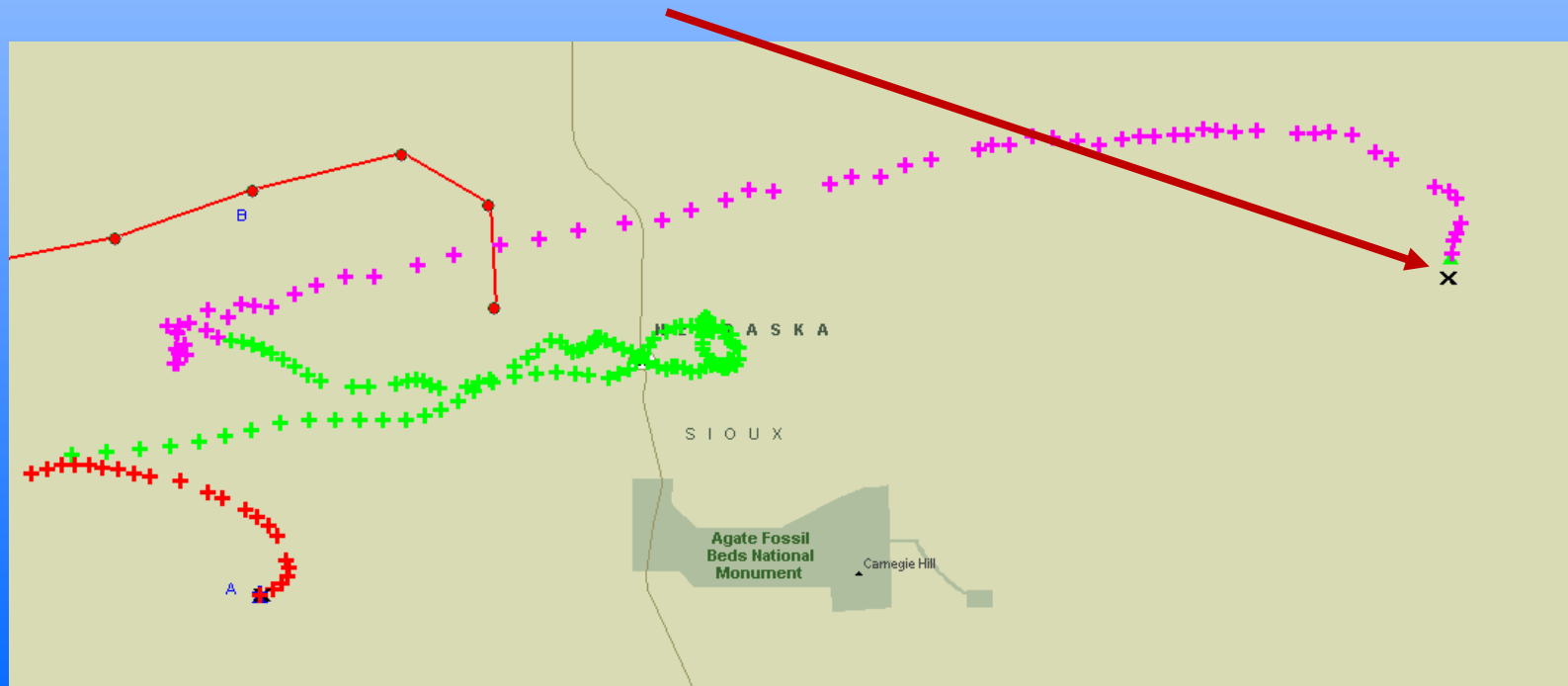
Eclipse Flight: EOSS 260 Recovery

- Jim, KØLOB
- Mark, KCØD
- Marty, WAØGEH
- John, NØJPS
- Shaun, NØSPB
- Not Pictured, Jim, KCØRPS, stuck in massive traffic jam
- Not Pictured, Mike, W9CN, camera man



Eclipse Flight: EOSS 261 Recovery

- Landing: N 42° 28.775', W 103° 33.448'
- 61.2 miles from launch site
- 2 hours, 49 minutes, 4.8 miles WSW of Pine Ridge, NE
- EOSS 261 shown green (ascent) and purple (descent)
- Recovered by John, KCØD and Dave, KDØSEM



- Photos by Mike Pappas, W9CN
- Nikon D800E
- Nikon 800 mm F/5.6 super telephoto with 1.25 X teleconverter (1000 mm)
- 1/640 of second at F/7.2
- During partial, used Orion 07723 7.17-inch ID Full Aperture Glass Telescope Solar Filter
- Removed filter during totality for corona shots









Eclipse Flight: What did we learn?

- Start Early
 - We started 2 years in advance of the event
- Contact State Frequency Coordinator Early
 - Explain what you need, why and for how long
 - We coordinated an ESE Pair for the TAPR event!
 - NMFCC
 - Thanks Bill W5YEJ for hooking us up!
 - TX 444.4000/ RX 449.400 TS1/TS2 CC1 XLR5700

Eclipse Flight: What did we learn?

TX 444.400 RX 449.400
TS1/TS2 CC1 XLR5700



Eclipse Flight: What did we learn?

- Enlist local “boots on the ground” for support
 - Who has existing sites and reach out to them
 - Use the ARRL repeater directory
 - How can you help them?
 - Why should they help you?
 - And make sure you return the favor that they are extending to you
 - We tuned a raft of duplexers for WYDMR (4) and Kraig (2)
 - And we got pretty good at it

Eclipse Flight: What did we learn?

- Understand the use case and the system users capabilities
 - Get everyone's “buy in”.
 - Simplified user experience was the key
 - Must be KISS (Roaming for auto site selection)
 - Manage DMR audio expectations
 - Understand older users with hearing loss concerns
 - The “kids” will love it
- Have a Plan B & Plan C
 - Be able to toss out the Plans if you need to
 - Its going to take longer than you expect!

Eclipse Flight: What did we learn?

- Run conservative coverage studies using Longley-Rice
 - Optimistic studies are not beneficial
 - Better coverage than predicted is a “great thing”
 - We had better radio coverage than the Goshen County Sheriff had
 - They were knocked out that we had comms in areas they didn’t
 - We were on a handheld (XPR7550) in Harrison, Nebraska talking to Kraig in Sheriff dispatch (911 TS-2)
 - Their 100 W mobile radios didn’t work there

Eclipse Flight: What did we learn?

- Over design the system and cover the unexpected (UPS)
 - Test every aspect of the system
 - Do not rely on any supplied gear (duplexers come to mind)
 - And document everything
 - You might want to do it again!
- Several weeks later, once the smoke cleared, over multiple adult beverages, looking at all of the effort the project took, Spainhower and myself came to the conclusion we might have had a significant lapse of sanity!!

We are looking for our next DMR Comms challenge

- **DMR Trunking? Wide Area? Impossible to do?**
- **You Name it!**
- **Have anything interesting going on?**
- **See us!**
 - **We will be at the bar!!!**

Thank You!