



Rocky Mountain Ham Radio (RMHR) 5-GHz Microwave IP Amateur Radio Network

Brian Mileschosky N5ZGT

President, Rocky Mountain Ham Radio (New Mexico)

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Vice President, Rocky Mountain Ham Radio (New Mexico)

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RMHR-NM Background

Mission and Purpose of Rocky Mountain Ham Radio, New Mexico (RMHR-NM)

- To encourage and improve the amateur service through training and education for advancing skills in both the communication and technical phases of the art;
- To contribute to the advancement of the radio art through operating and technical experimentation;
- To further the exchange of information and cooperation among the members of the amateur radio community and the public;
- To enhance the value of the amateur service to the public by providing communications assistance to governmental, charitable, and other qualified organizations; and
- To promote radio knowledge and fraternalism and to advance the interest and welfare of amateur radio in the community

RMHR-NM Background

RMHR-NM is...

- An ARRL-affiliated amateur radio club composed of active hams around New Mexico
- A registered New Mexico volunteer non-profit corporation
- A 501(c)(3) tax exempt public charity (EIN# 47-2014845)
- Closely partnered and mission-aligned with its 80 member sister organization, Rocky Mountain Ham Radio (Colorado)

RMHR-NM Background

Leadership

- Brian Mileschosky N5ZGT (President)
- Ed James KA8JMW (Vice President)
- Chris Aas NB5T (Secretary)
- Phil Darling KF5LEF (Treasurer)

RMHR-NM Background

cent/Ongoing Projects

- Organizer of annual New Mexico TechFest, a formal conference of 80+ amateur radio operators from across New Mexico and surrounding states for the purpose of education, collaboration, and demonstration of amateur radio's latest and relevant technical topics and techniques
- Constructed a trailer-mounted Will-Burt 50-foot pneumatic locking mast for use as a field-ready antenna support resource
- Designed, installed, and operates the Albuquerque/Santa Fe area's first amateur radio DMR/MotoTRBO repeater
 - Sandia Crest, 442.90 MHz
 - Linked into RMHR's multi-state DMR network (for more information, visit <http://www.rmham.org/wordpress/mototrbo-radio-site-information>)

RMHR-NM Background

cent/Ongoing Projects

- Provides D-STAR repeater system administration and technical support for several amateur radio organizations around New Mexico
- Has assisted hamfests around New Mexico with special event station equipment and operator support
- Sponsoring organization of the 2015 New Mexico QSO Party
- Is helping sponsor and host the 2015 Central States VHF Conference, the national premier VHF and above amateur radio conference
 - July 23-26 in Denver, Colorado
 - Details at <http://2015.csvhfs.org>

RMHR-NM Background

cent/Ongoing Projects

- RMHR conducts half-day *RMHAM University* classes designed to provide the amateur radio community educational deep-dives into specific ham related technical topics (e.g. Raspberry Pi, analog and digital repeater system building blocks and construction, RF measurements, microwave IP, etc.)
 - *Planning for RMHAM University* class offerings in New Mexico underway



RMHR 5-GHz Microwave IP Network

RMHR Microwave IP Network Background

Multi-megabit IP-based microwave amateur radio backbone and network

An infrastructure to facilitate and enable partnering amateur radio clubs and groups to create or expand their own capabilities for the benefit of the amateur radio community

Developed, operated, and managed by Rocky Mountain Ham Radio

Operates on FCC Part 97 microwave spectrum

- Predominantly 5-GHz; other microwave bands used as needed
- 100% Ham Radio

RMHR Microwave IP Network Background

Network is tied to actual internet for network management; however network is *not* dependent on presence of internet to function

- *If a partnering club/group requires public internet bandwidth for its specific application(s), they will need to facilitate it; RMHR will work with them to integrate it into the network.*

Average throughput anywhere along entire network: 25 Mbit/sec

Automated diagnostic tools monitor network state of health and performance 24x7

Wireless access to network (WAN capability) built into key locations and can be activated for use during emergencies, public service events, etc

RMHR Microwave IP Network Background

First segment of RMHR network installed in 2010

Today's RMHR microwave network spans from southern Wyoming border to northern New Mexico border

RMHR-NM is presently extending the network southward into central New Mexico in 2015

Ultimate objective: extend the network all the way down to El Paso, Texas

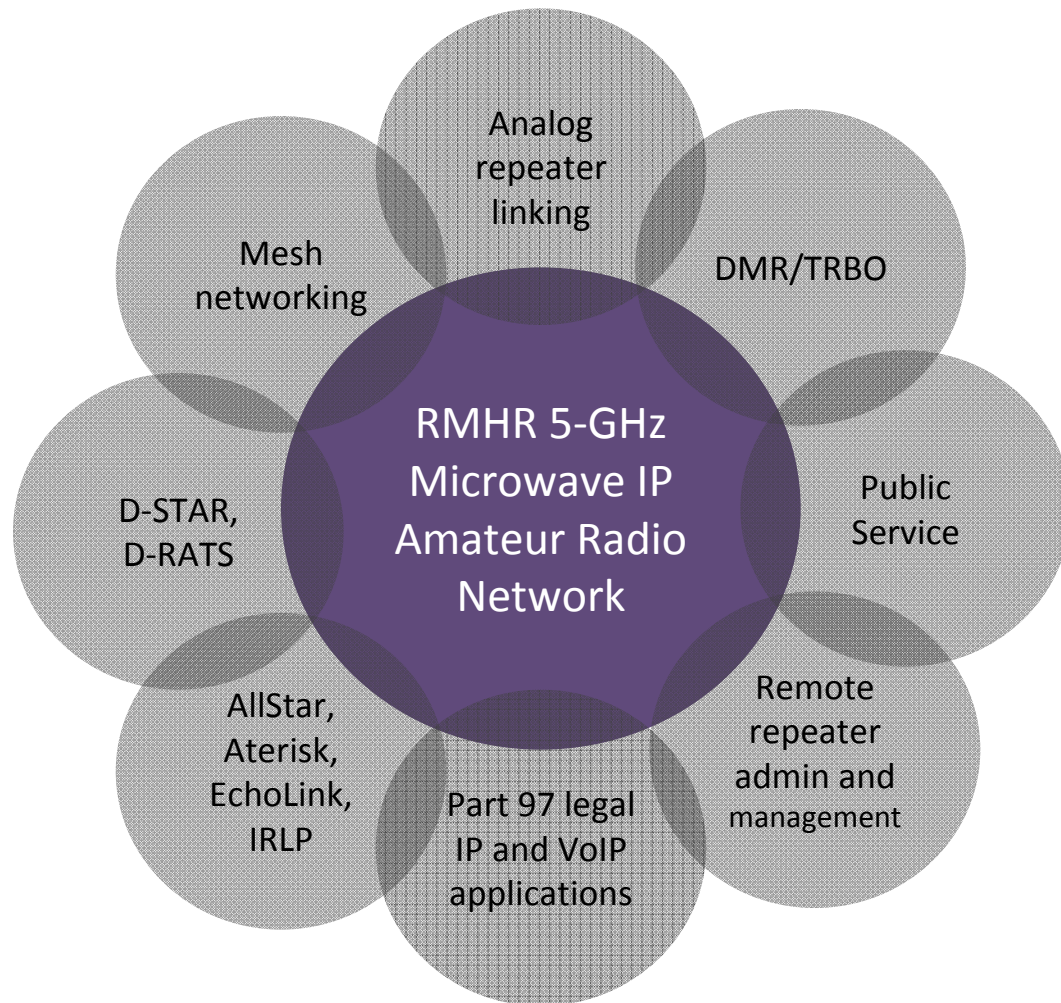
RMHR Microwave Network at a Glance



Yellow markers depict currently operational RMHR microwave network spans.

Blue markers depict future RMHR microwave network spans.

Applications that can be supported across RMHR Microwave Network



RMHR Network Extension Thrusts

From southern Colorado border to Sandia Crest (Albuquerque, NM)

Up U.S. Highway 550 towards Durango, Colorado

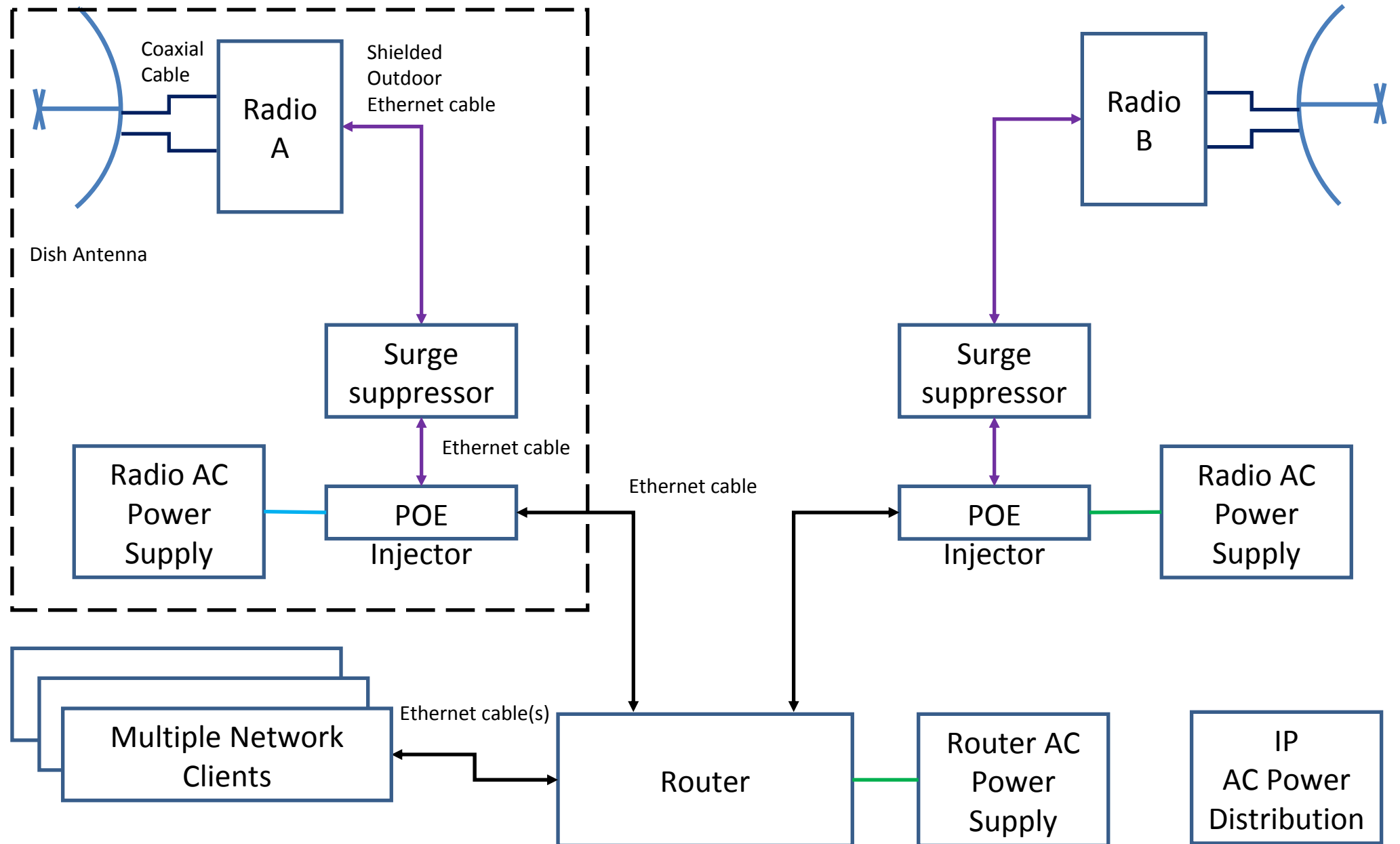
Southward from Sandia Crest along Interstate 25 corridor towards El Paso, Texas

Scope out additional sites



A Slightly Deeper Dive

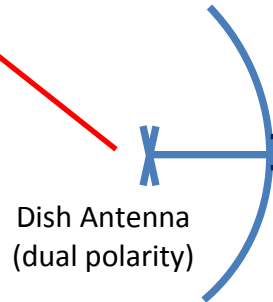
Typical Point to Point Link Site



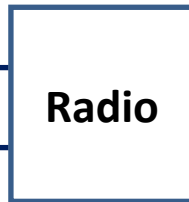
Typical Link Hardware



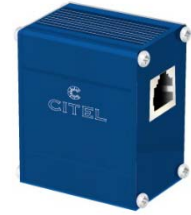
Ubiquiti
RD-5G34
3' dia.



Coaxial
Cable



Shielded
Outdoor
Ethernet cable



Citel
MJ8-POE-B

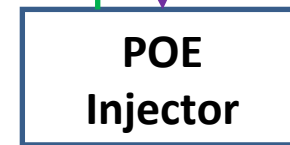
MikroTik
RB2011UiAS-RM



MikroTik
2UAGS-5HPacD-NM



Ethernet cable



Ethernet cable



Pictures not to scale dimensionally

MikroTik NetMetal 5

802.11a/n/ac
 40MHz Channel Bandwidth
 5.15 - 6100 MHz Operating Range
 US amateur radio band is between 5650 and 5925 MHz.
 20MHz or 25MHz wide band
 Gigabit Ethernet (POE)
 SFP cage (fiber)
 Input Voltage 8-30VDC
 Power Consumption: 17W
 2x RP-SMA connectors for external antenna
 MiniPCIe slot (for an optional third RF chain)
 2x USB 2.0 port
 -40°C to +70°C
 Aluminum Enclosure
 10.5" x 9.7" x 1.8"
 Weight 2lbs

Wireless Specification (5GHz)		
Data Rate	TX dBm	RX dBm
6Mbit/s	33 (2W)	-96
54MBit/s	29 (800mW)	-81
MCS0 BPSK	32 (1.6W)	-96
MCS7 QAM	29 (800mW)	-77
MCS9 QPSK	24 (250mW)	-72



Site Development Costs

	Initial Link	Subsequent Links
ProTik Net Metal 5	\$137	\$137
Antenna Ubiquiti RD-5G34	\$313 + Freight	\$313 + Freight
Home	\$100 + Freight	\$100 + Freight
Router MikroTik RB2011UiAS	\$115	
Power Supply I MJ8-POE-B	\$30	\$30
Ethernet Cables (Shielded, Outdoor)	\$50	\$50
AC Power Switch	\$235	
Total	\$980	\$630



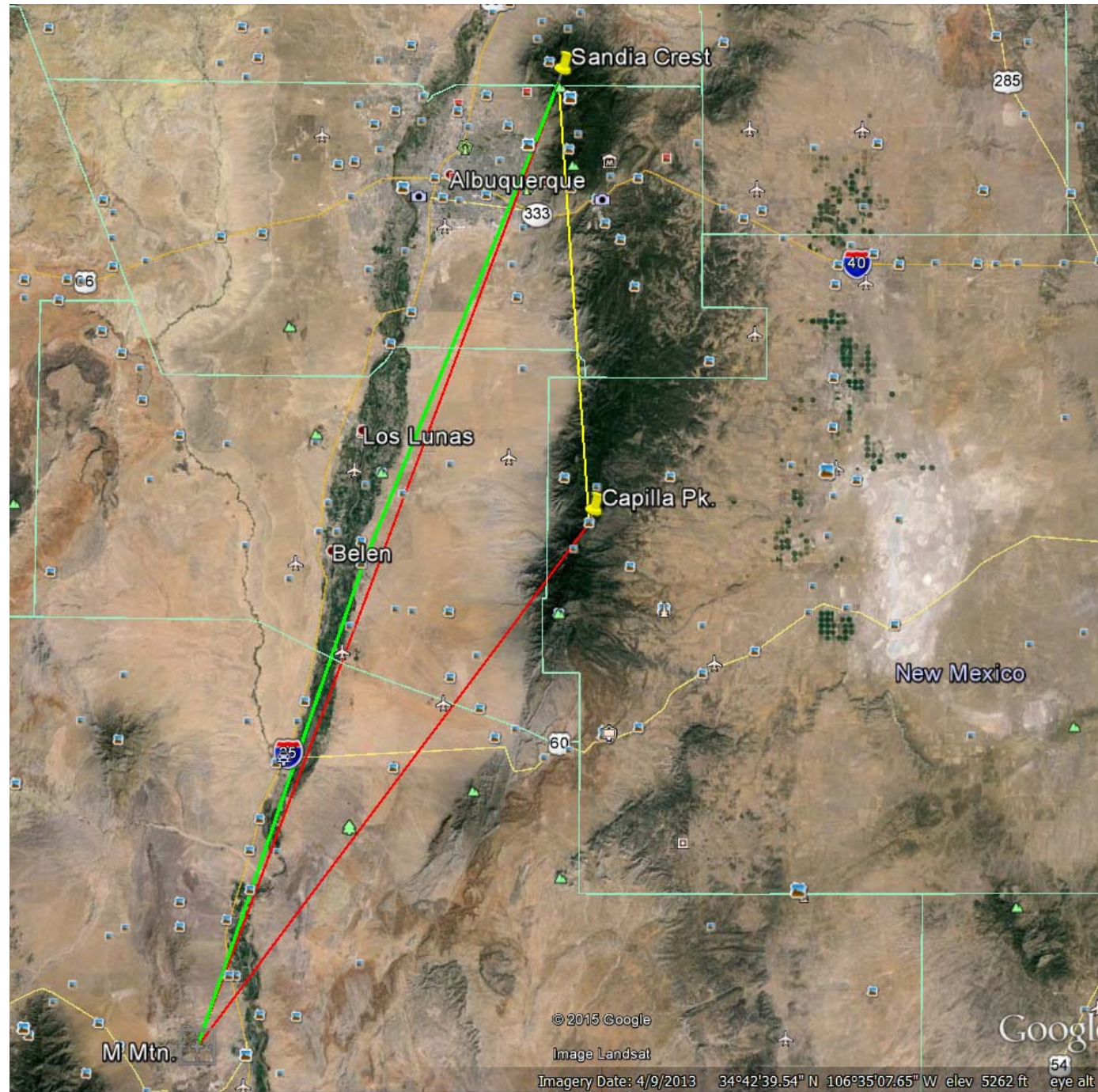
RMHR-NM's latest delivery



Expanding Southward

Getting from Sandia Crest to M Mountain

A Simple Path Analysis



RF Path and Link Margin Analysis

Radio Mobile Online used to conduct path and link margin analysis

- Uses Longley-Rice (a.k.a. Irregular Terrain) model

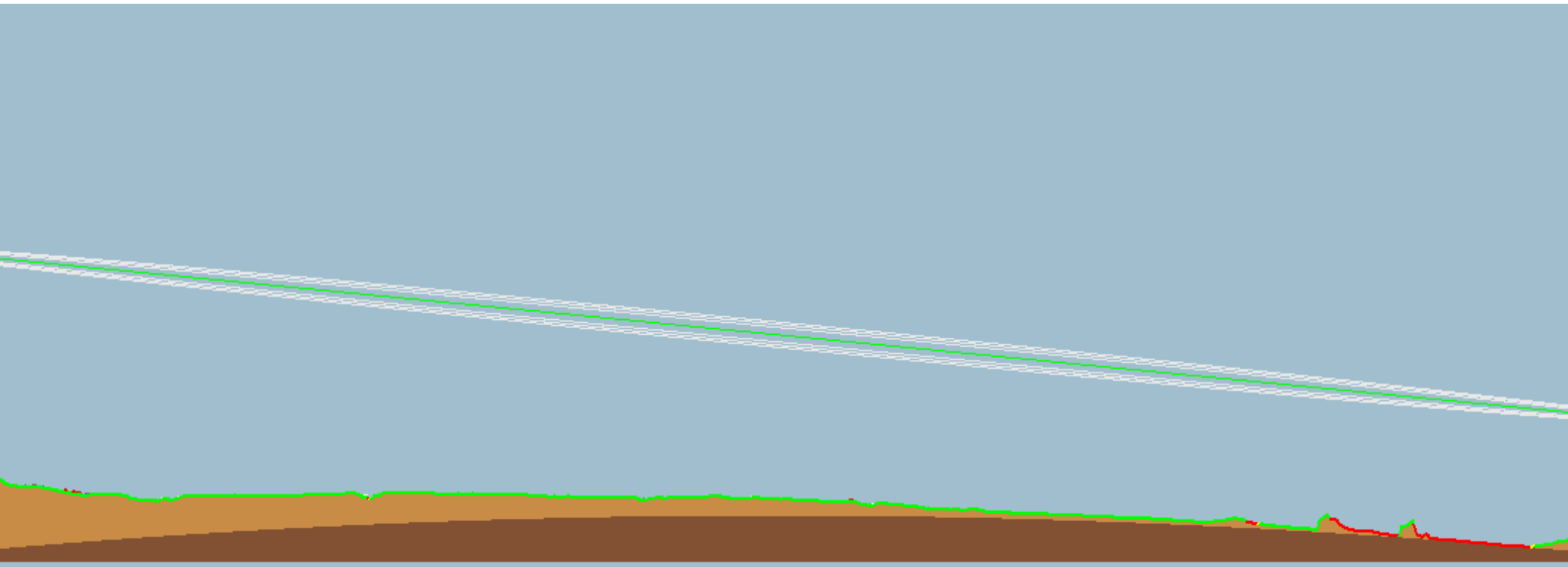
Analysis assumptions (initial nominal values):

- Antenna height above ground: 40 feet (at both TX and RX sites)
- TX power output: +31.14 dBm (1.3 watts)
- RX sensitivity: -73 dBm (5 uV)
- Antenna gain: +34 dBi (at both TX and RX sites)
- Feedline loss: 0.5 dB (at both TX and RX sites)

From Sandia Crest to M Mountain

est

M M



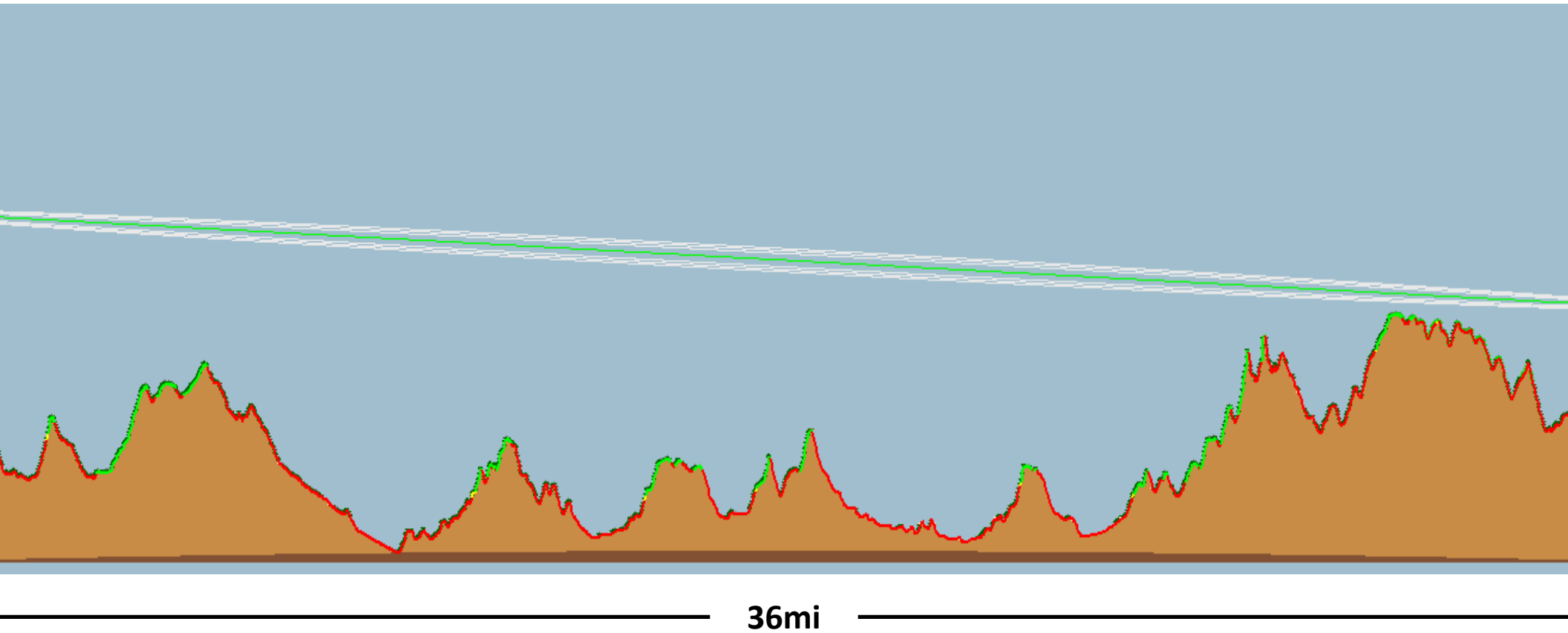
84mi

Clear shot, but path loss is higher than desired (160 dB)
More link margin = more reliable link

Sandia Crest to Capilla Peak

est

Capilla

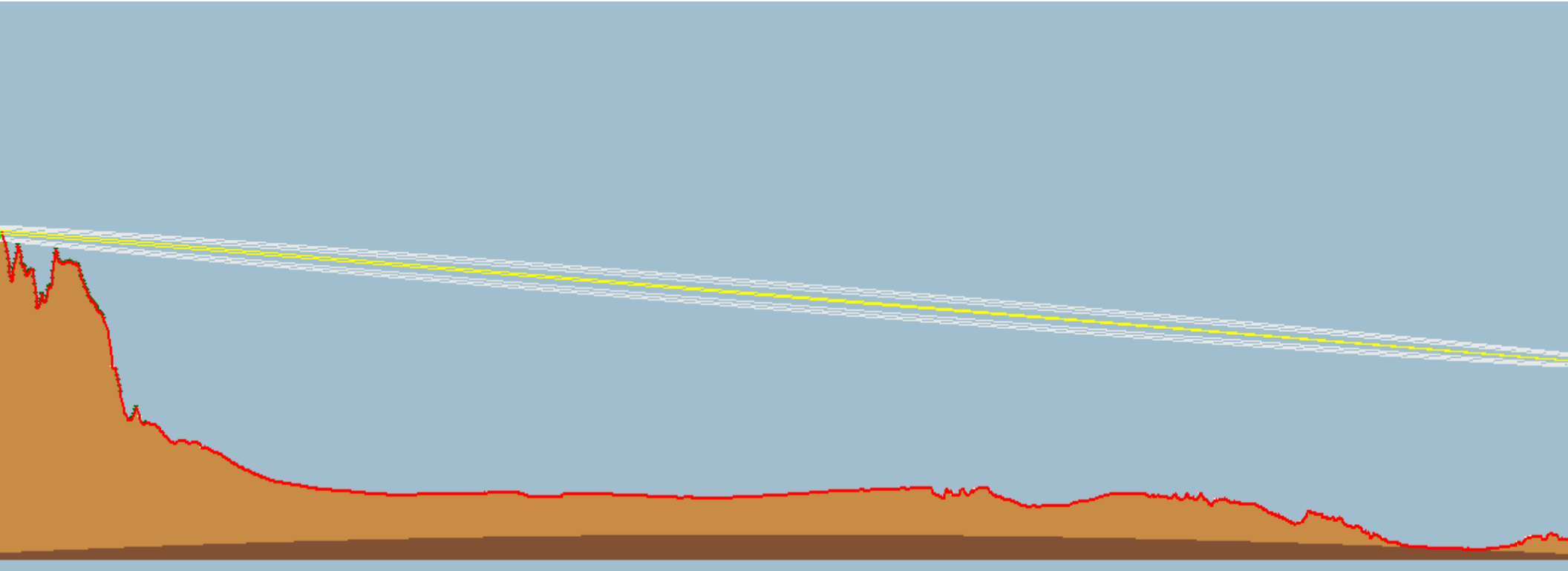


**Path appears clear, but reality shot may need to look through numerous towers along Sandia Crest
(Possible attenuation + very likely high RF noise floor)**

Capilla Peak to M Mountain

ak

M M

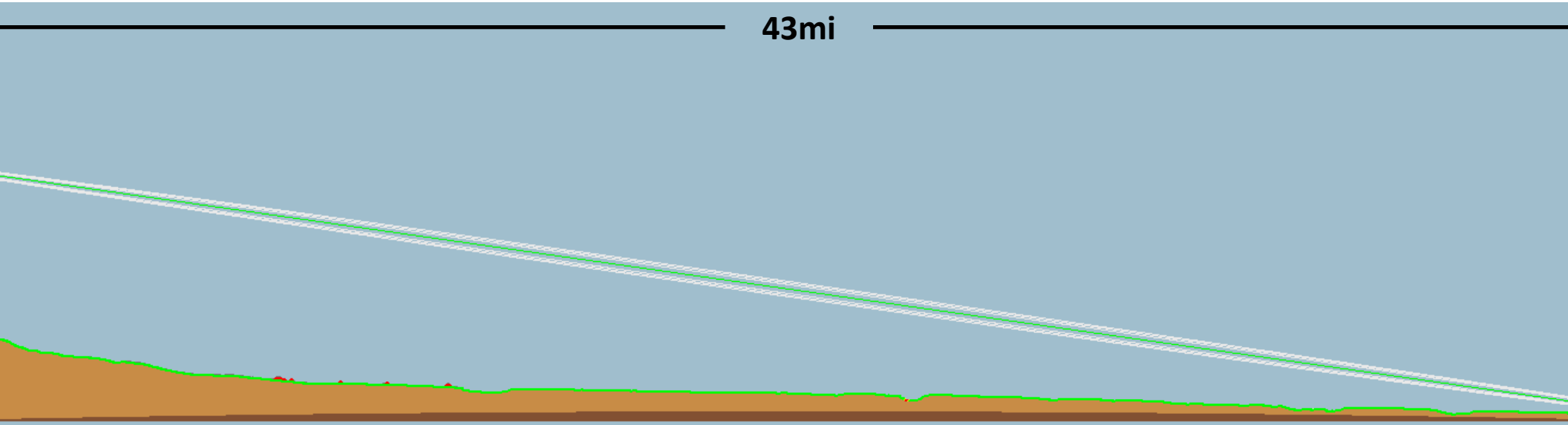


54mi

**Path Obstructed by Terrain
(Not feasible.)**

crest

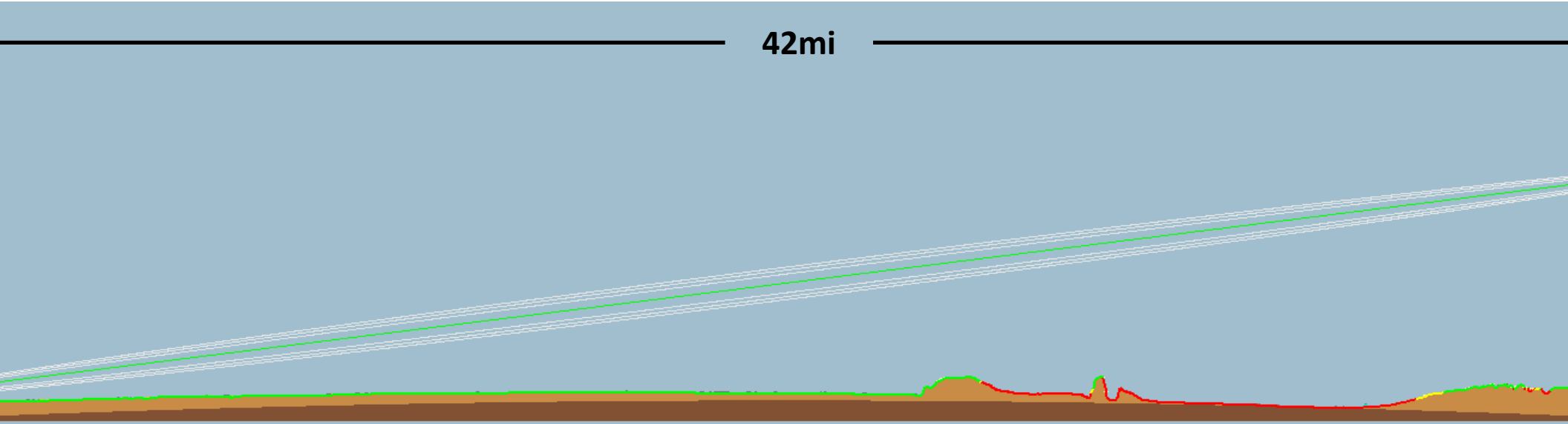
43mi



151 dB path loss; 39.4 dB link margin

M M

42mi



149 dB path loss; 41.7 dB link margin



Opportunities to Help

Opportunities to Help

RMHR's microwave network was built from scratch into what it is today *entirely* through out-of-pocket member funds and voluntary contributions from across the amateur radio community

RMHR-NM is a 501(c)(3) tax-exempt, non-profit public charity (EIN# 47-2014845)

Every dollar of every financial contribution, no matter how small or large, will directly support the network's continued expansion and maintenance

- i.e., purchase of new microwave radios, antennas, routers, tower hardware, etc.

Opportunities to Help

Contributions towards this innovative amateur community-focused project are greatly appreciated

- ...via PayPal to newmexico@rmham.org
- ...by check payable to “**Rocky Mountain Ham Radio, New Mexico**” and mailed to:

RMHR-NM

c/o Phil Darling

PO Box 3125

Corrales, NM 87048

Every contribution is tax-deductible to the extent permitted by law

- *RMHR-NM will provide a receipt for tax purposes*

Want to Learn More?

Web:

- www.rmham.org/wordpress

Reach base via email:

- Brian Mileschosky N5ZGT (President, RMHR-NM)
 - brian@rmham.org
- Ed James KA8JMW (Vice President, RMHR-NM)
 - ed@rmham.org

