



# *Wireless And Mobile Propagation*

## *Project*

Prof. Michele D'Amico

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# Radio Mobile Project (PMR) Network Design for Shahr-e Bābak City

## *Team Members*



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# *Introduction*

In Shahr-e Bābak City, Iran, we provide a strong and dependable Private Mobile Radio (PMR) network for digital voice and data transmission. The network covers a square area of 100 km by 100 km, with Shahr-e Bābak City located at its center. For network planning and analysis, we use Radio Mobile.



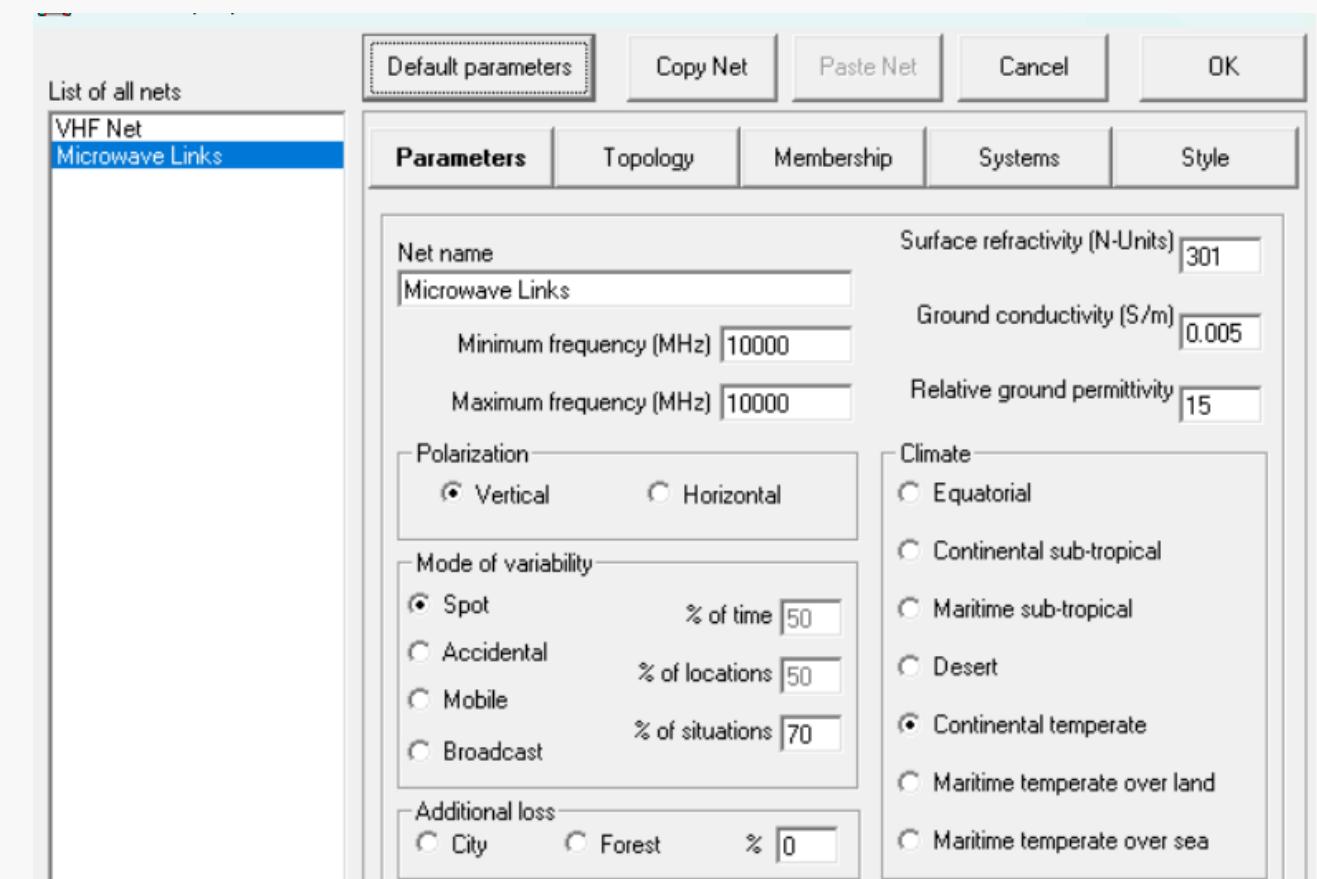
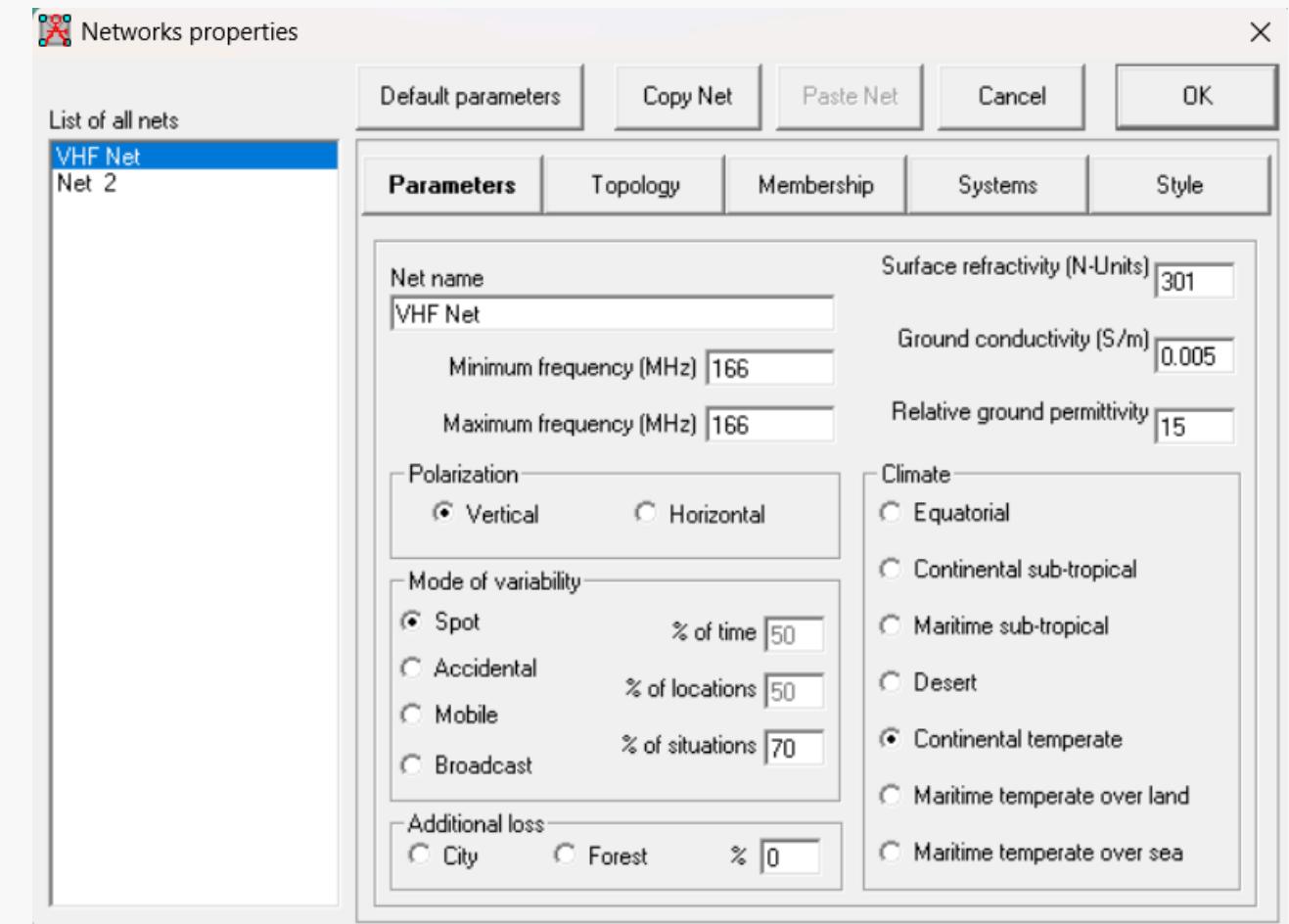
— Center of the area of interest

# Network Design

After reaching a user's signal to the nearest repeater, this signal is transmitted via microwave links to every other repeater.

The signal is then retransmitted by all repeaters on the user access frequency (VHF), enabling simultaneous listening by the Operations Center and all users.

In this project, mobile users connect to the nearest repeater at **166 MHz** and connect all repeaters at **10 GHz**.

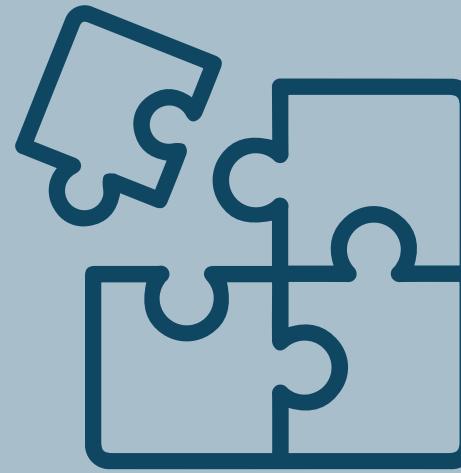


The VHF and Microwave Links Configuration

# Network Design: VHF



- Operation Frequency: **166 MHz**
- Modulation Type: ETSI Digital Mobile Radio (DMR)



## Mobile Unit Configuration

- Motorola DM4000e vehicular terminals.
- Transmit Power: **40 W.**
- Sensitivity: **0.18  $\mu$ V.**
- Antenna Gain: Assumed as **0 dBi**

Networks properties

List of all systems

Mobile Radio	System 2
	System 3
	System 4
	System 5
	System 6
	System 7
	System 8
	System 9
	System 10
	System 11
	System 12
	System 13
	System 14
	System 15
	System 16
	System 17
	System 18
	System 19
	System 20
	System 21
	System 22
	System 23
	System 24
	System 25

Default parameters    Copy Net    Paste Net    Cancel    OK

Parameters    Topology    Membership    **Systems**    Style

00    Select from VHF ... UHF ...

System name: Mobile Radio

Transmit power (Watt) 40    (dBm) 46

Receiver threshold ( $\mu$ V) 0.2    (dBm) -121

Line loss (dB) 0.5    (Cable+cavities+connectors)

Antenna type: omni.ant    View

Antenna gain (dBi) 0    (dBd) -2.15

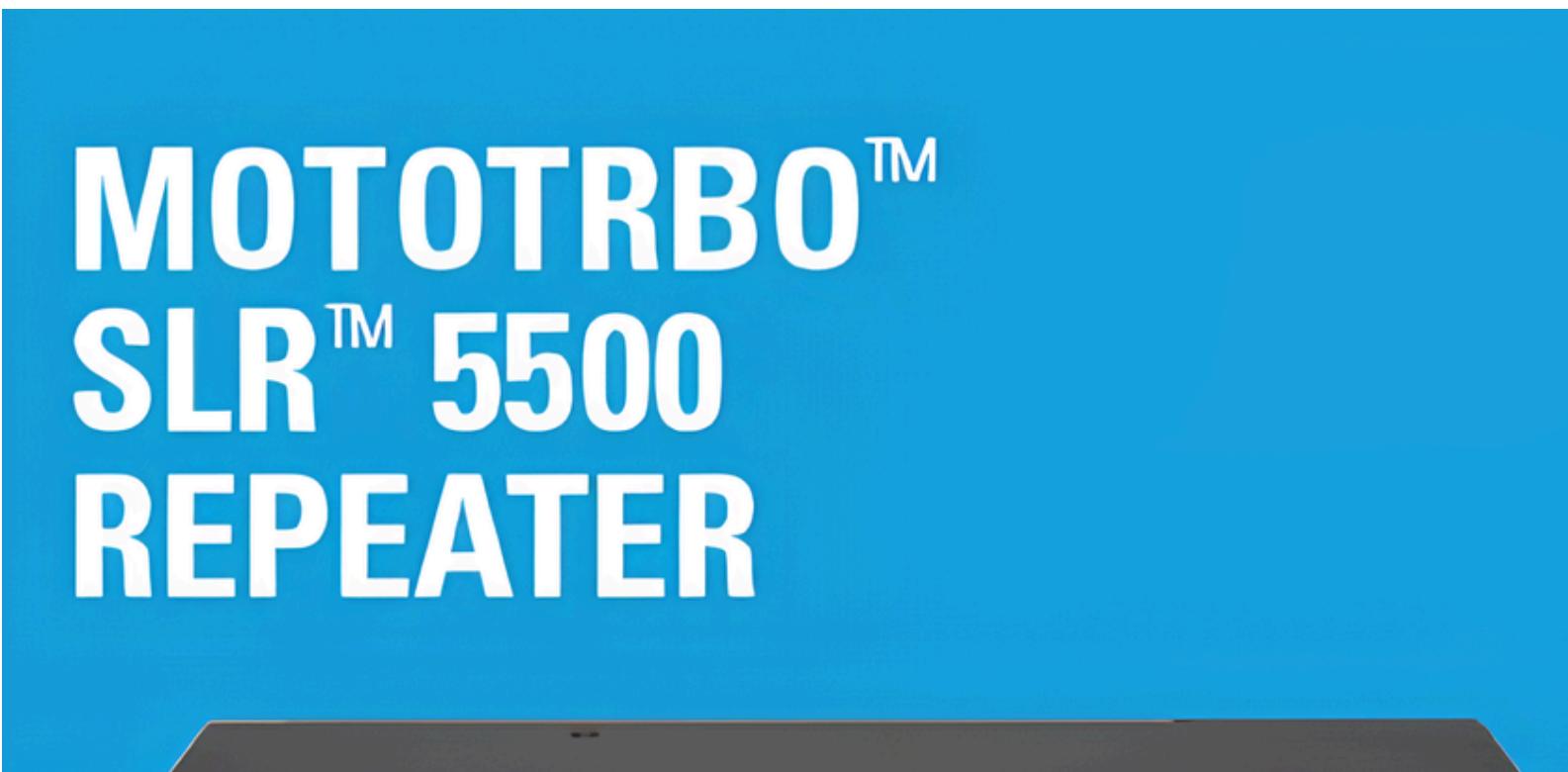
Antenna height (m) 2    (Above ground)

Additional cable loss (dB/m) 0    (If antenna height differs)

Add to Radiosys.dat    Remove from Radiosys.dat

— Mobile Unit Configuration —

# Network Design: VHF



- **Repeater:** Motorola SLR5500 (DMR)
- **Power Output:** 50 W
- **Sensitivity:** 0.22  $\mu$ V.
- **Signal Gain:** 5 dBi.
- **Antenna Height:** 10 m
- **Coaxial Cable (VHF):** RT 50/20 low-loss cable
- **Loss:** ~0.6 dB for 10-meter run at 166 MHz

Networks properties

Mobile Radio  
Repeater

List of all systems

System 3  
System 4  
System 5  
System 6  
System 7  
System 8  
System 9  
System 10  
System 11  
System 12  
System 13  
System 14  
System 15  
System 16  
System 17  
System 18  
System 19  
System 20  
System 21  
System 22  
System 23  
System 24  
System 25

Default parameters Copy Net Paste Net Cancel OK

Parameters Topology Membership Systems Style

00 Select from VHF ... UHF ...

System name Repeater

Transmit power (Watt) 50 (dBm) 47

Receiver threshold ( $\mu$ V) 0.25 (dBm) -119

Line loss (dB) 1 (Cable+cavities+connectors)

Antenna type omni.ant View

Antenna gain (dBi) 5 (dBd) 2.85

Antenna height (m) 10 (Above ground)

Additional cable loss (dB/m) 0 (If antenna height differs)

Add to Radiosys.dat Remove from Radiosys.dat

— Repeater Configuration —

# *Network Design: Microwave Net*



— PTP 820S Microwave Radio —

To provide dependable routing, every repeater needs to see at least **two** other repeaters.

- **Operation of the Frequency:**
- **Urban (< 5 km): 32 or 38 GHz**
- **Short Haul (0-10 km): 18 or 23 GHz**
- **Mid Haul (10-25 km): 13 or 15 GHz**
- **Long Haul (25-70 km): 7 or 10 GHz**

Networks properties

List of all systems		Default parameters	Copy Net	Paste Net	Cancel	OK
Mobile Radio	Repeater	Parameters	Topology	Membership	Systems	Style
Microwave Radios		00 Select from VHF ... UHF ...				
System 4		System name	Microwave Radios			
System 5		Transmit power (Watt)	0.5011872	(dBm)	27	
System 6		Receiver threshold ( $\mu$ V)	3.7584	(dBm)	-95.5	
System 7		Line loss (dB)	0.5	(Cable+cavities+connectors)		
System 8		Antenna type	omni.ant	View		
System 9		Antenna gain (dBi)	36.7	(dBd)	34.55	
System 10		Antenna height (m)	10	(Above ground)		
System 11		Additional cable loss (dB/m)	0	(If antenna height differs)		
System 12		Add to Radiosys.dat		Remove from Radiosys.dat		
System 13						
System 14						
System 15						
System 16						
System 17						
System 18						
System 19						
System 20						
System 21						
System 22						
System 23						
System 24						
System 25						

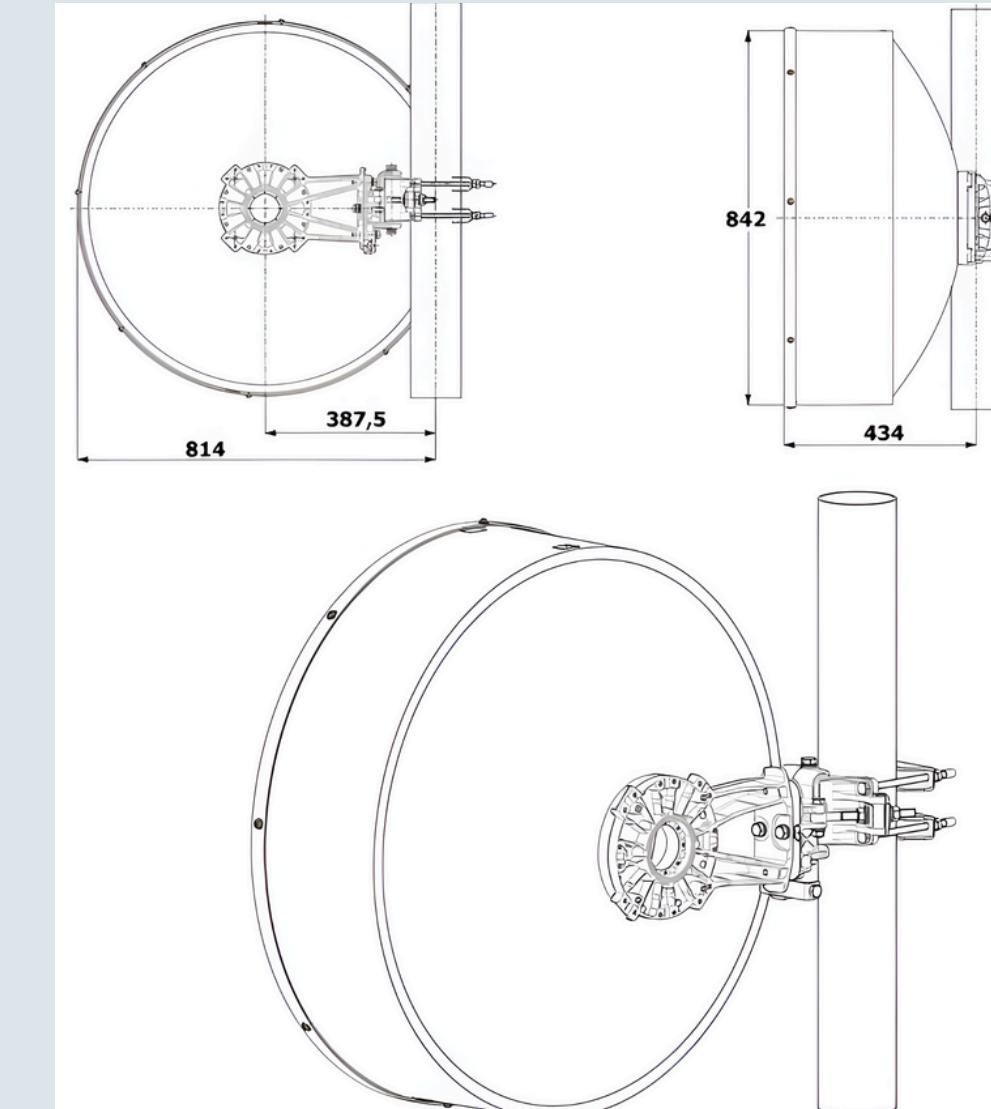
— Microwave Radio Configuration —

# *Network Design: Microwave Antenna*



THP 08 100 D WB Microwave Antenna

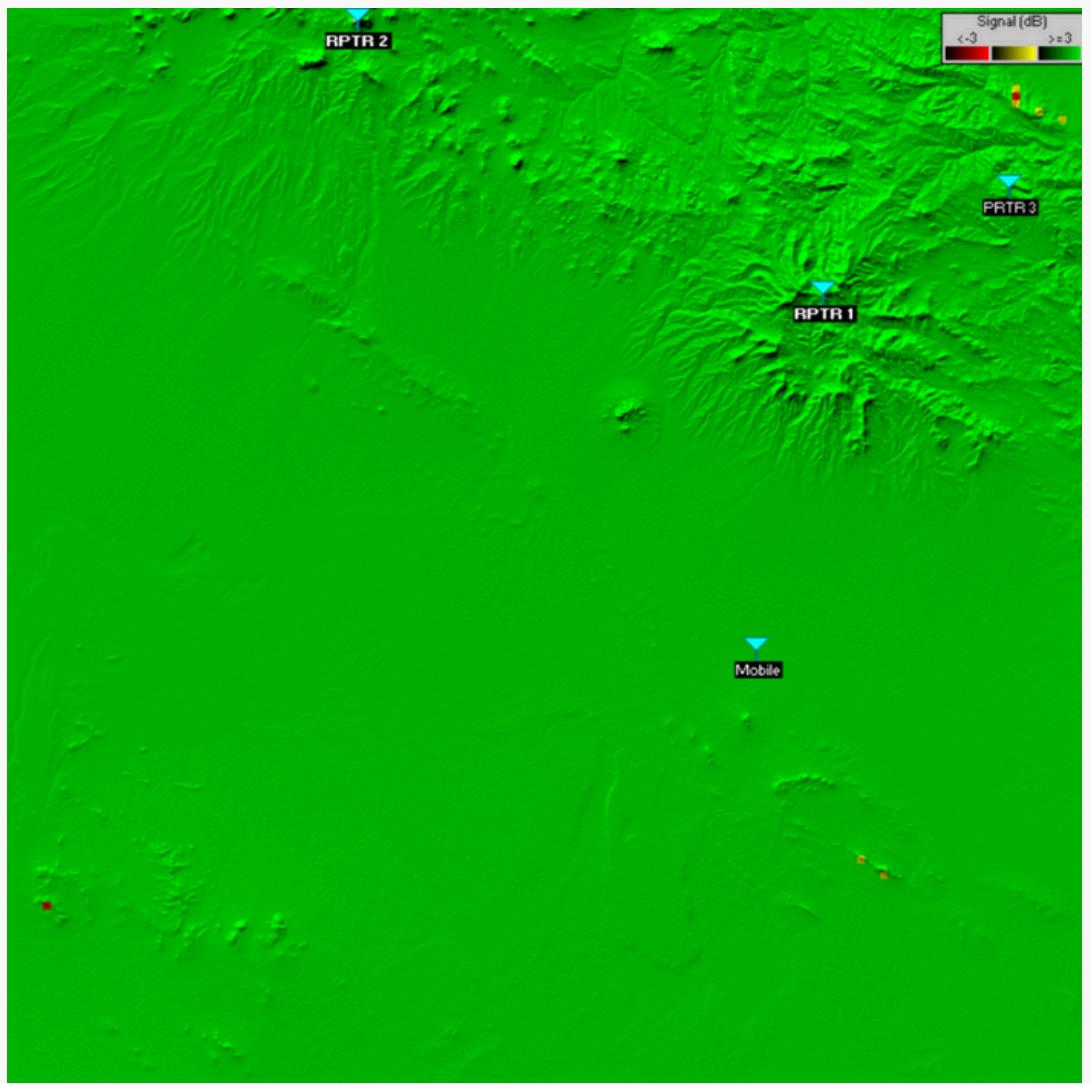
- **Microwave Antenna Characteristic:**
- **Diameter:** 0.8m
- **Frequency Range:** 10 or 11.7 GHz
- **Gain of Midband:** 36.7 dBi
- **Wind velocity operational:** 30 m/s
- **Antenna Dimensions:** 842 mm height, 814 mm width, and 434 mm depth.
- **Construction:** Wind-resistant, industrial-grade, and appropriate for installations in mountains.



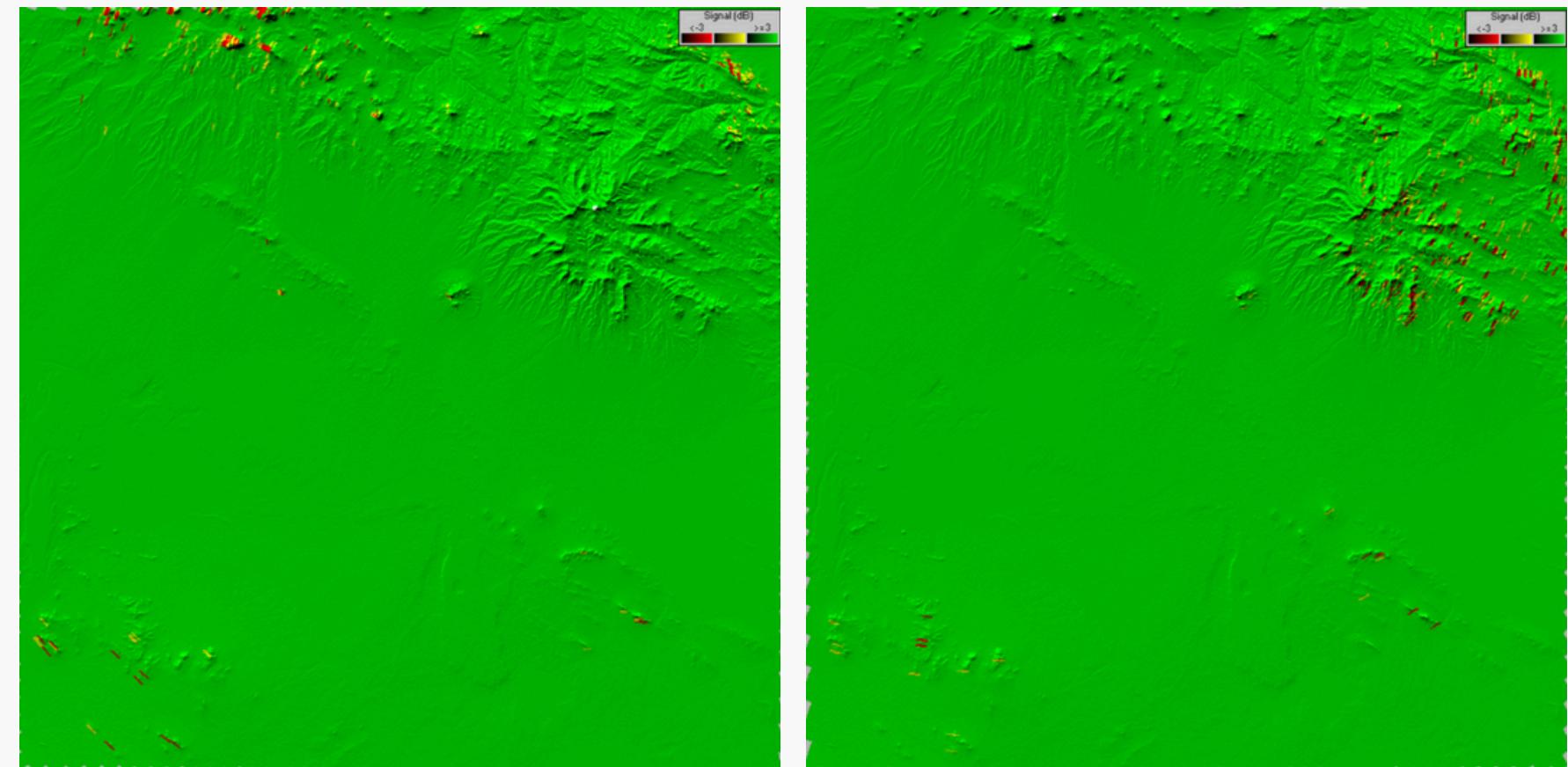
— Antenna Dimensions —

# Results

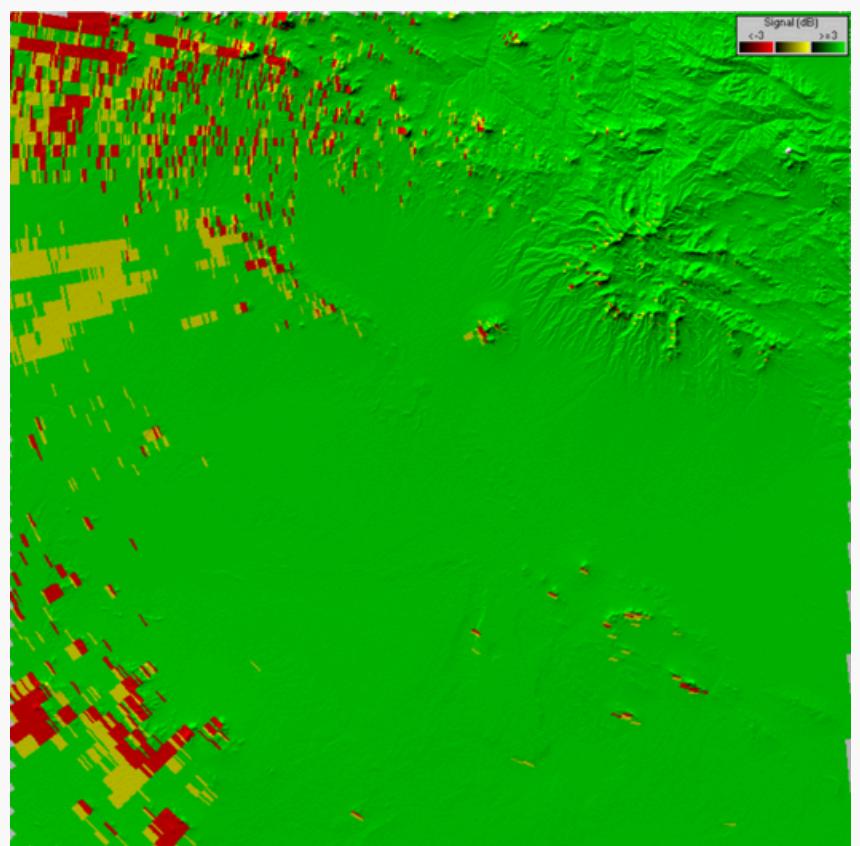
To ensure wide-area radio coverage with optimal efficiency, **three** repeater sites were strategically installed at elevated locations. Site selection was driven by terrain elevation and line-of-sight advantages to reduce signal blockage from natural obstacles. Each repeater was configured to maximize surface coverage.



Repeater positions

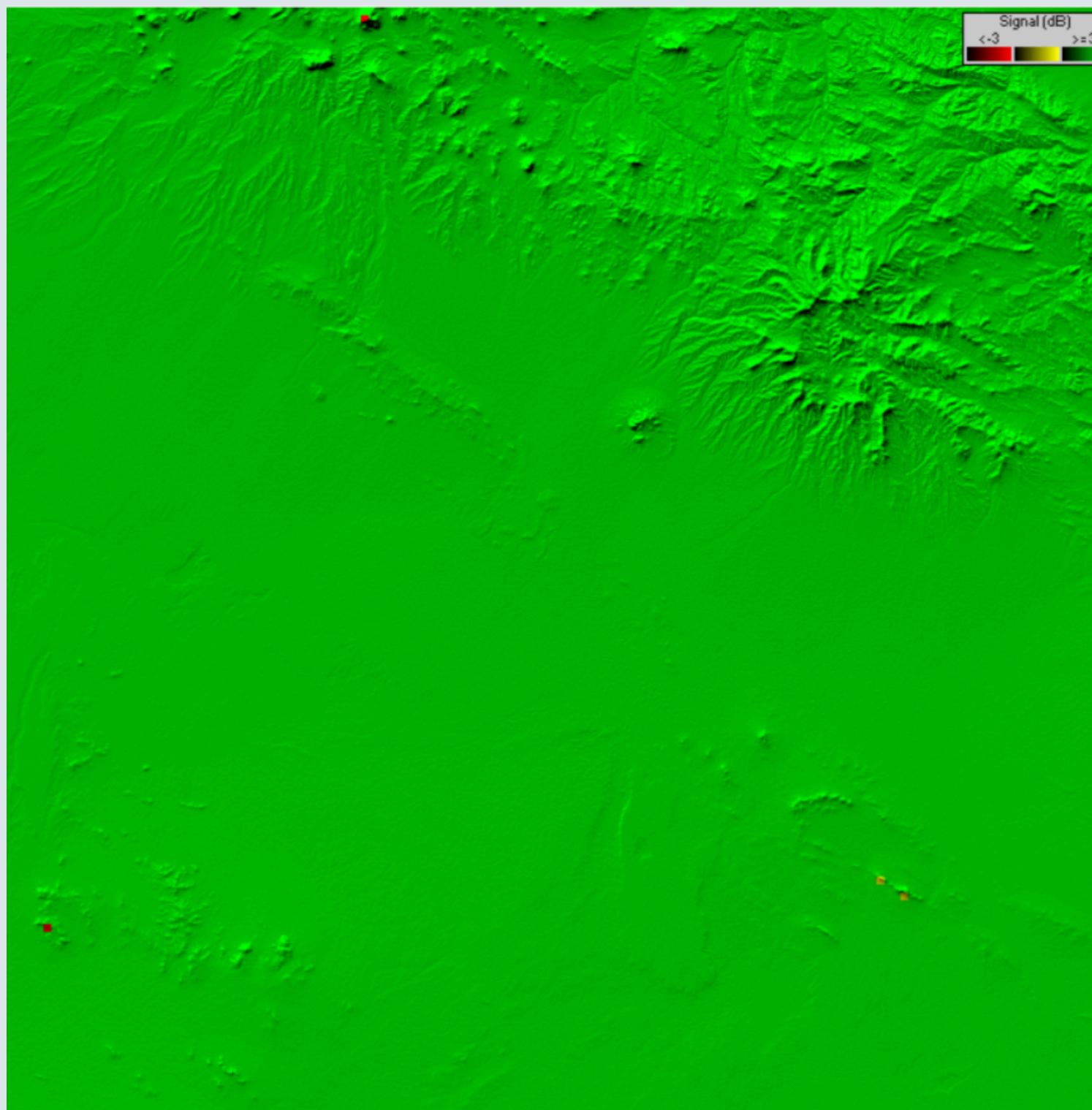


Coverage of Repeater 1      Coverage of Repeater 2



Coverage of Repeater 3

# Results



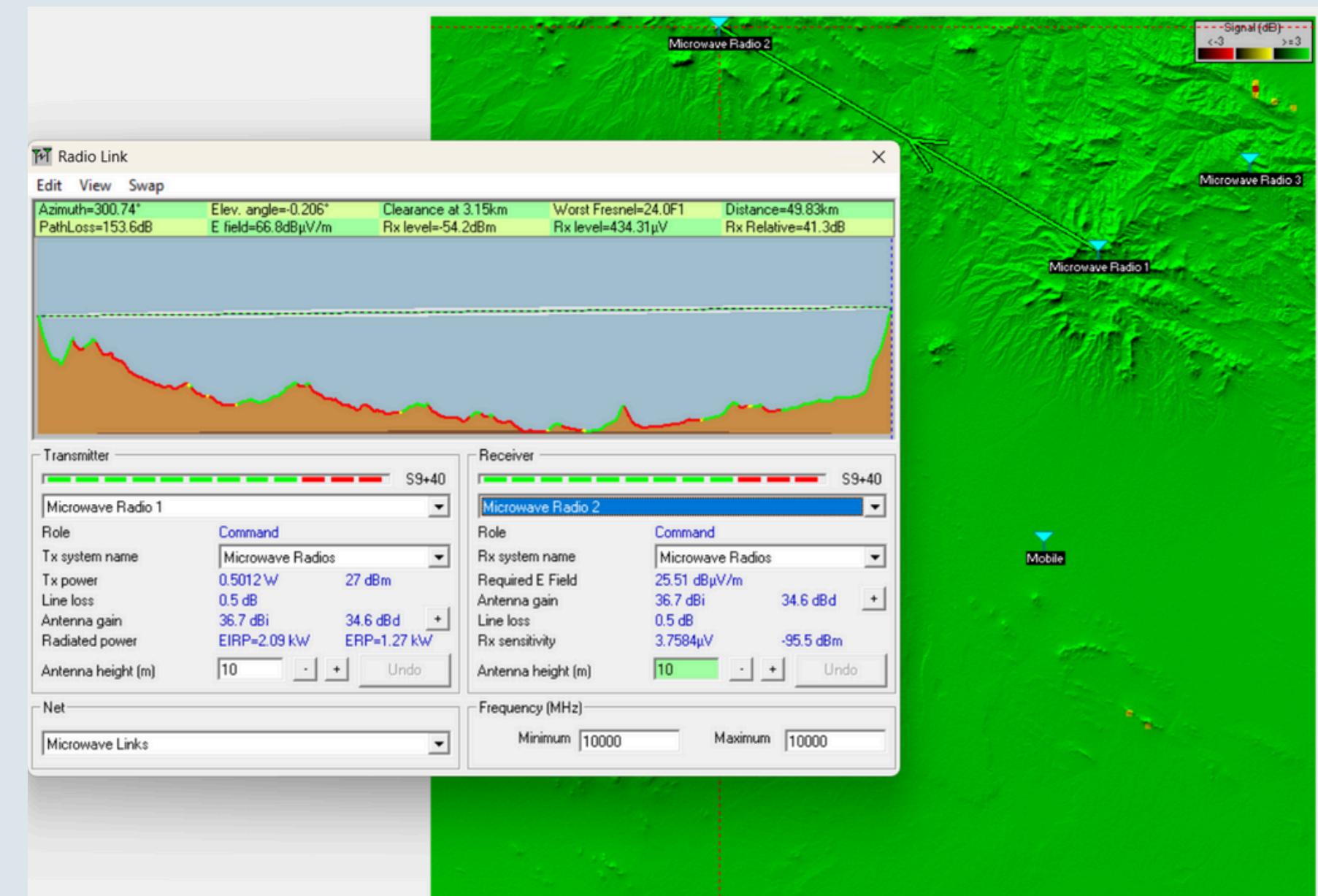
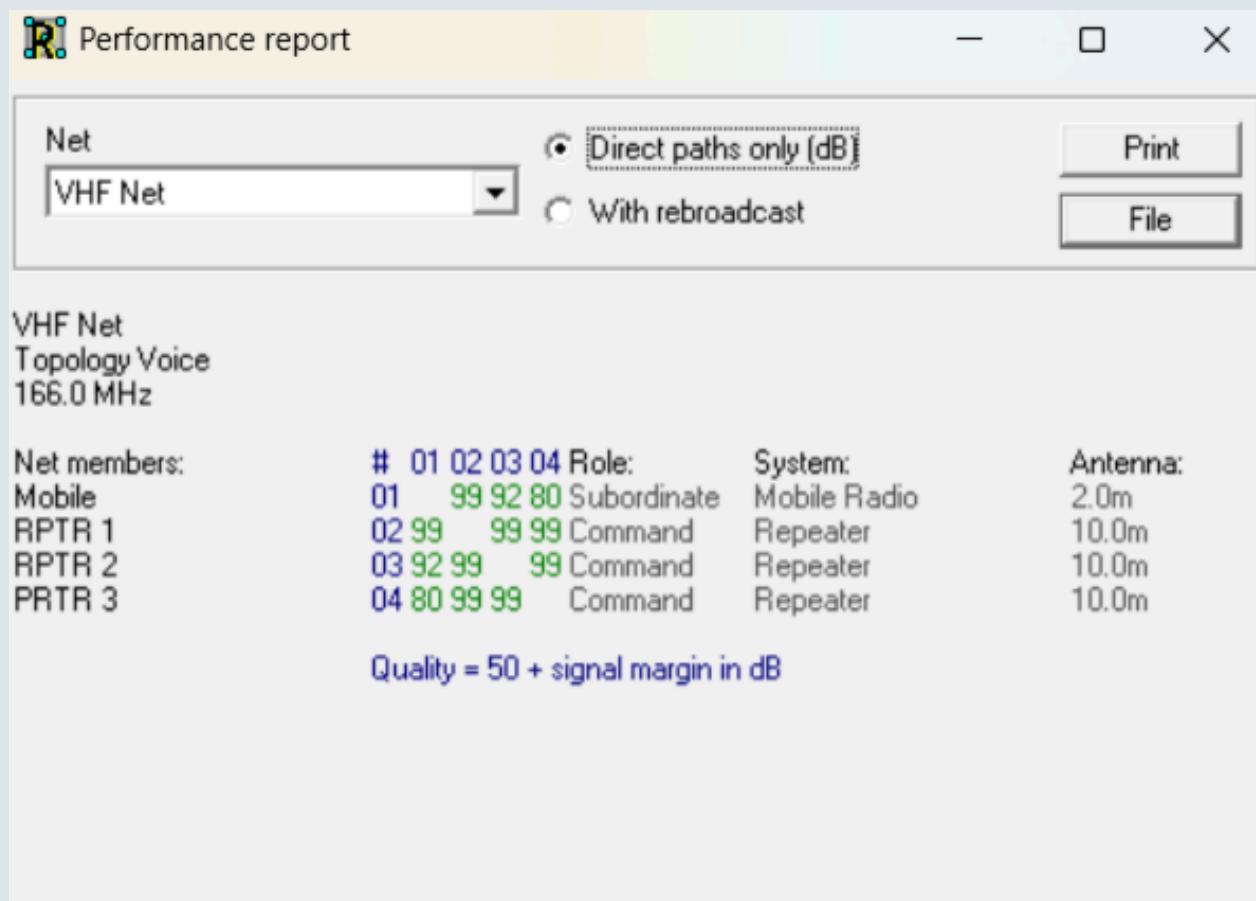
— Coverage of the whole area —

The designated region of 100 km x 100 km is fully covered by the network configuration, confirming reliable end-user connectivity.

- Total Area Covered: ~**9978 km<sup>2</sup>** (**99.78 %** of the area)

# Results

- All links are built with at least a 10 dB safety margin above the modulation threshold.
- In order to maintain network integrity, each repeater uses microwave links to connect to at least two other repeaters.
- The link between the microwave radios is green, and it means there is no blockage between them.



Connection between microwave radio 1 and microwave radio 2

# Conclusion

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The final system implementation successfully delivers a robust, wide-area PMR network with:

- Full coverage of the area,
- Exceptionally high signal integrity throughout,
- Minimal infrastructure deployment (just 3 repeaters),

This setup strikes an excellent balance between performance, cost, and scalability, making it suitable for future expansion or deployment in similar geographic conditions.





*Thank you*

