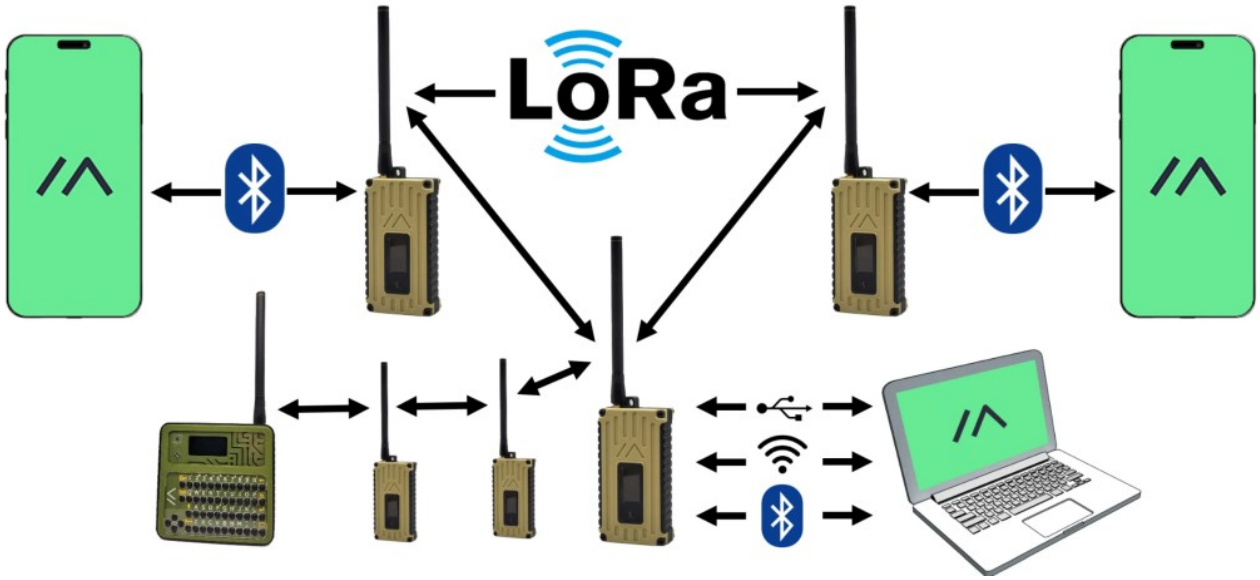
Meshtastic Network Deployment Considerations



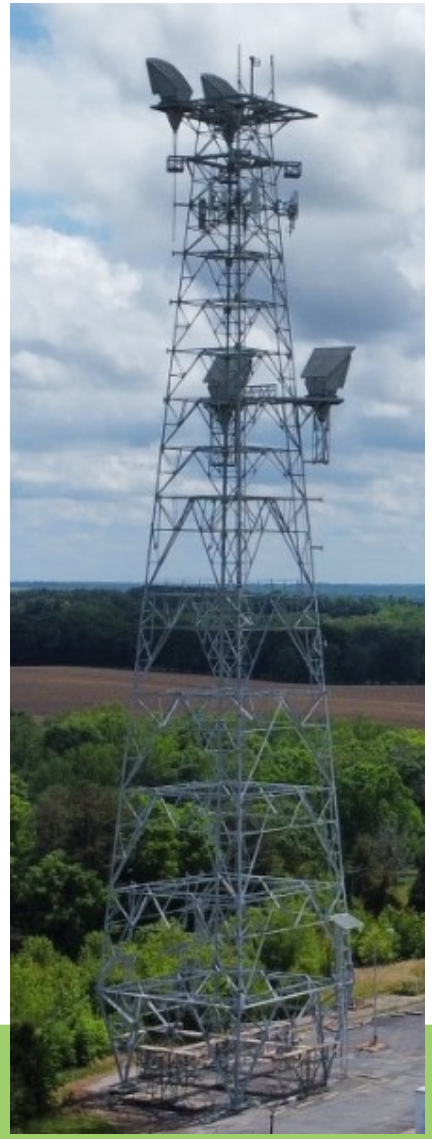
Why Meshtastic?

- Well supported and documented LoRa meshing technology
- Automated self healing, highly available network
- Widely available affordable hardware selection and peripherals
- AES256 encrypted communication
- Enterprise grade security and remote management features
- Easy to use app for iPhone, Android, Computers

Mesh Networks of the Past

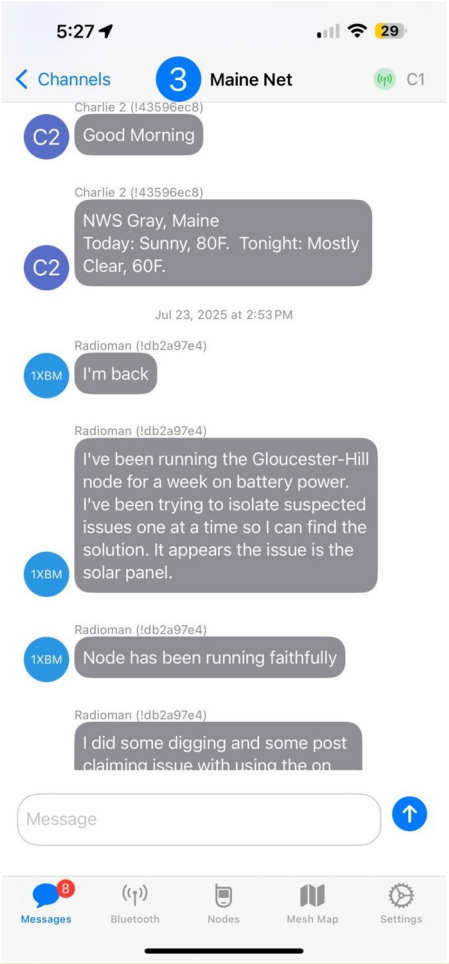
AMERICAN TELEPHONE & TELEGRAPH CO.
BELL SYSTEM
LONG LINES DEPARTMENT

Directional Horns
C & KU Bands
5-20 Watts Output
Avg 50-100 Miles Apart

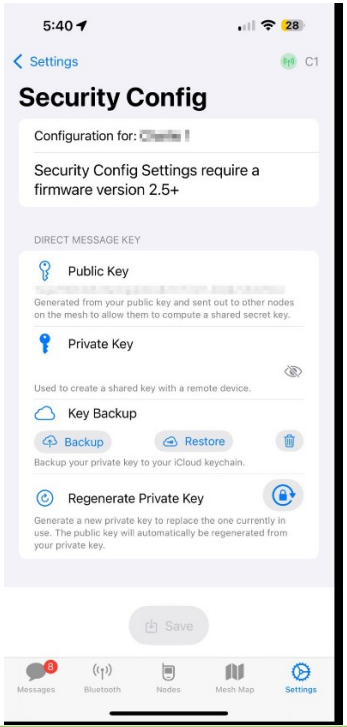


What is it for?

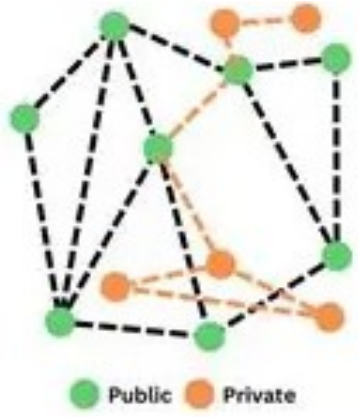
Secure Messaging



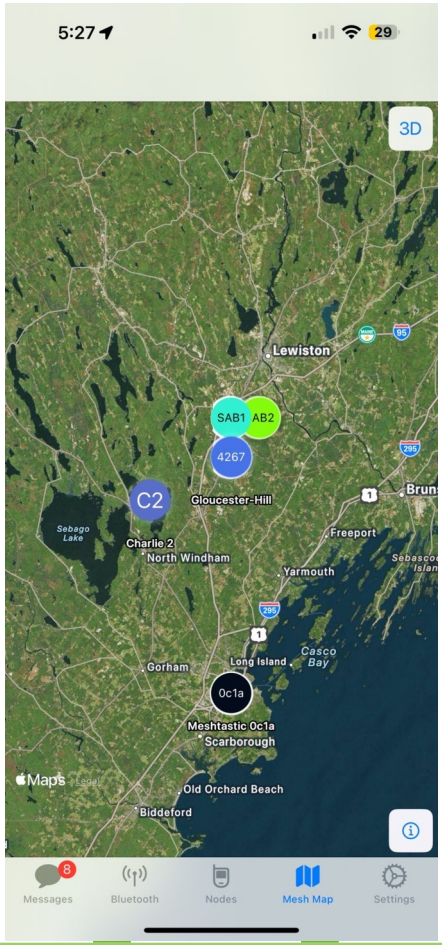
PKI Encryption



Off-Grid Network



Location Sharing



Mobile Hardware Selection

RAK

- Low power consumption
- On-board solar charger
- Modular inputs
- Small footprint
- Best for remote node

Heltec

- Med power consumption
- Easy setup
- Small footprint
- Best for personal node

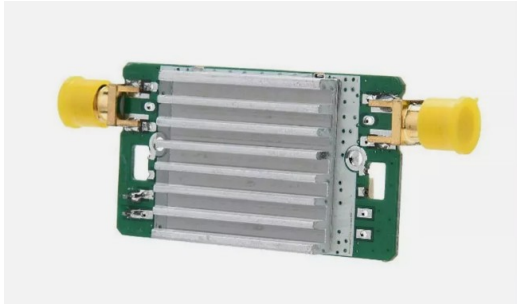
LillyGo
T-Beam

- High power consumption
- Feature rich (Wi-Fi, GPS)
- Many inputs (soldering)
- Med footprint, fragile
- Best for powered base station/car

Base Station Hardware Selection

Station G2

Signal Amplifiers*



High Gain Antennas

- High transmit power (4.8 watts)*
- Low-noise receiver
- ESP32-S3 processor
- Flexible power input (USB C PD, DC 9V-19V)
- GPS and sensor ports (Grove I²C , Qwiic, Stemma)

*Unlicensed operators may only transmit up to 1 watt

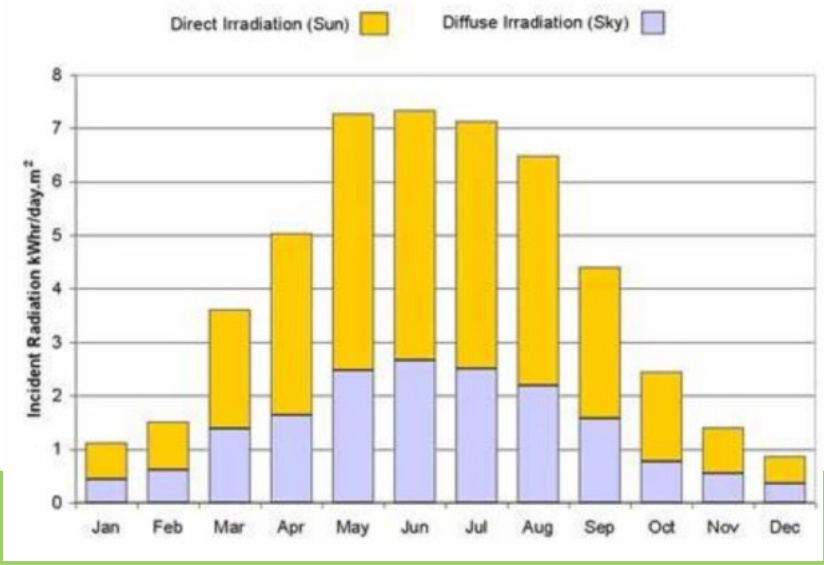
Power

Batteries:
RAK node average power consumption = 4-6mA hour

x1 18650 battery = 2500mA hour

Each 18650 battery can power a RAK node up to an average of 20 days dependent on usage.

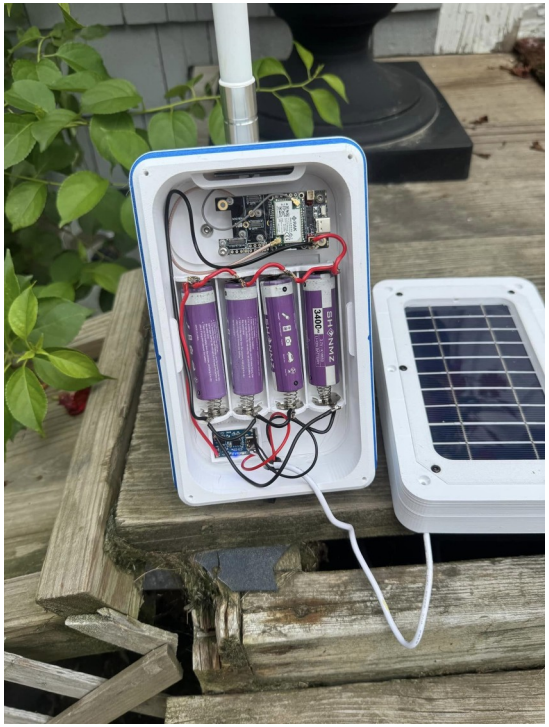
Solar:
Using a small .5 watt solar panel (6”x3”), it would take 12 hours to charge an 18650 in full sun. This time will extend based on the season.



USB Power:

Version	Maximum Power	Voltage	Maximum Current
USB 2.0	2.5 W	5 V	500 mA
USB 3.1	4.5 W	5 V	900 mA
USB BC 1.2	7.5 W	5 V	1.5 A
USB Type-C 1.2	15 W	5 V	3 A
USB PD	100 W	5/9/15/20 V	5 A

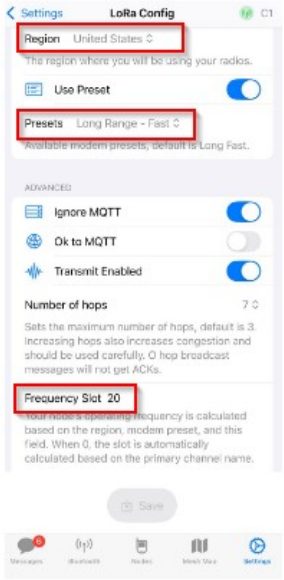
Remote Node Deployment Examples

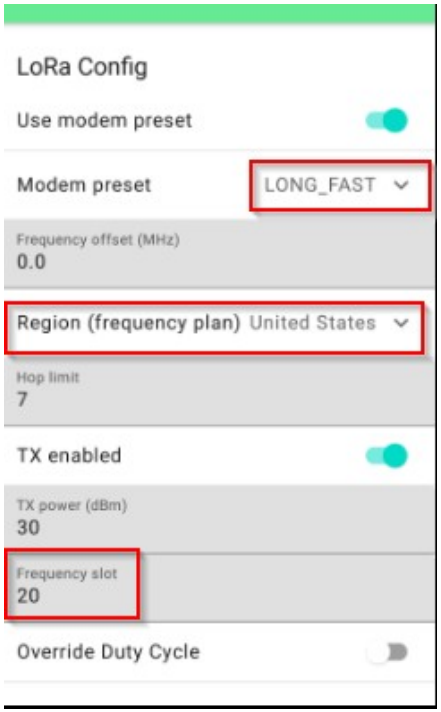


Device Roles

Role	Description	Routes Messages	Telemetry	Power Behavior	Strategic Placement?	Ideal Use Cases
Client	Default general-purpose role. Sends, receives, **and** intelligently routes messages.	✅ Yes (smart delay)	✅ Sends normally	Moderate power; sleeps when possible	❌ No	Most handheld or mobile devices. Great for general users.
Client_Mute	Like Client, but **does not** route others' messages. Minimizes congestion in dense networks.	❌ No	✅ Sends normally	Lowest power; no routing activity	❌ No	Use on personal devices near a main CLIENT or ROUTER node.
Router	Always routes others' packets. Prioritized in routing decisions. Sends less telemetry to save power.	✅ Yes (always)	⚠️ Reduced frequency	Sleeps between relays; no user messages	✅ Yes – crucial	Line-of-sight fixed stations: mountaintops, towers, strategic high points.
Repeater	Like Router, but **never sends telemetry or user messages.** Pure rebroadcast node.	✅ Yes (always)	❌ None	Always on; only responds to others	✅ Yes – very critical	Bridging gaps across valleys, ridgelines, or isolated terrain.
Sensor	Gathers and transmits sensor data (e.g. weather, air quality). Prioritizes its own telemetry.	✅ Yes	✅ High-priority telemetry	Sleeps between environmental reporting intervals	❌ Not required	Remote environmental monitors, weather stations, field sensors.
Tracker	Broadcasts GPS coordinates regularly. Prioritizes position packets over mesh congestion.	✅ Yes (when a)	✅ High-priority GPS	Sleeps between location broadcasts	❌ Not required	GPS tracking of people, vehicles, pets, or assets.

LoRa Settings





Preset	Frequency (MHz)	Modem Settings	Range	Use Case
LONG_FAST	~915	SF7, 250kHz	Medium	General use
LONG_SLOW	~915	SF12, 20.8kHz	Long	Maximum range
VERY_LONG	~915	SF12, 31.25kHz	Very Long	Remote sensors

Slot Index	Frequency (MHz)
0	903.08
1	904.28
2	905.48
3	906.68
4	907.88

Meshtastic as a ham

Most commonly deployed in normal “unlicensed mode” there is Licensed mode for hams. Licensed mode changes the following

- Removes encryption keys
- Allows additional power on limited boards
- Can be used on 433 MHZ

Feeds and Speeds

Radio Preset	Alt Preset Name	Data-Rate	SF / Symbols	Coding Rate	Bandwidth	Link Budget
Short Range / Turbo	Short Turbo	21.88 kbps	7 / 128	04/05/25	500 kHz1	140dB
Short Range / Fast	Short Fast	10.94 kbps	7 / 128	04/05/25	250 kHz	143dB
Medium Range / Fast	Medium Fast	3.52 kbps	9 / 512	04/05/25	250 kHz	148dB
Long Range / Fast	Long Fast	1.07 kbps	11 / 2048	04/05/25	250 kHz	153dB
Long Range / Moderate	Long Moderate	0.34 kbps	11 / 2048	04/08/25	125 kHz	156dB
Long Range / Slow	Long Slow	0.18 kbps	12 / 4096	04/08/25	125 kHz	158.5dB

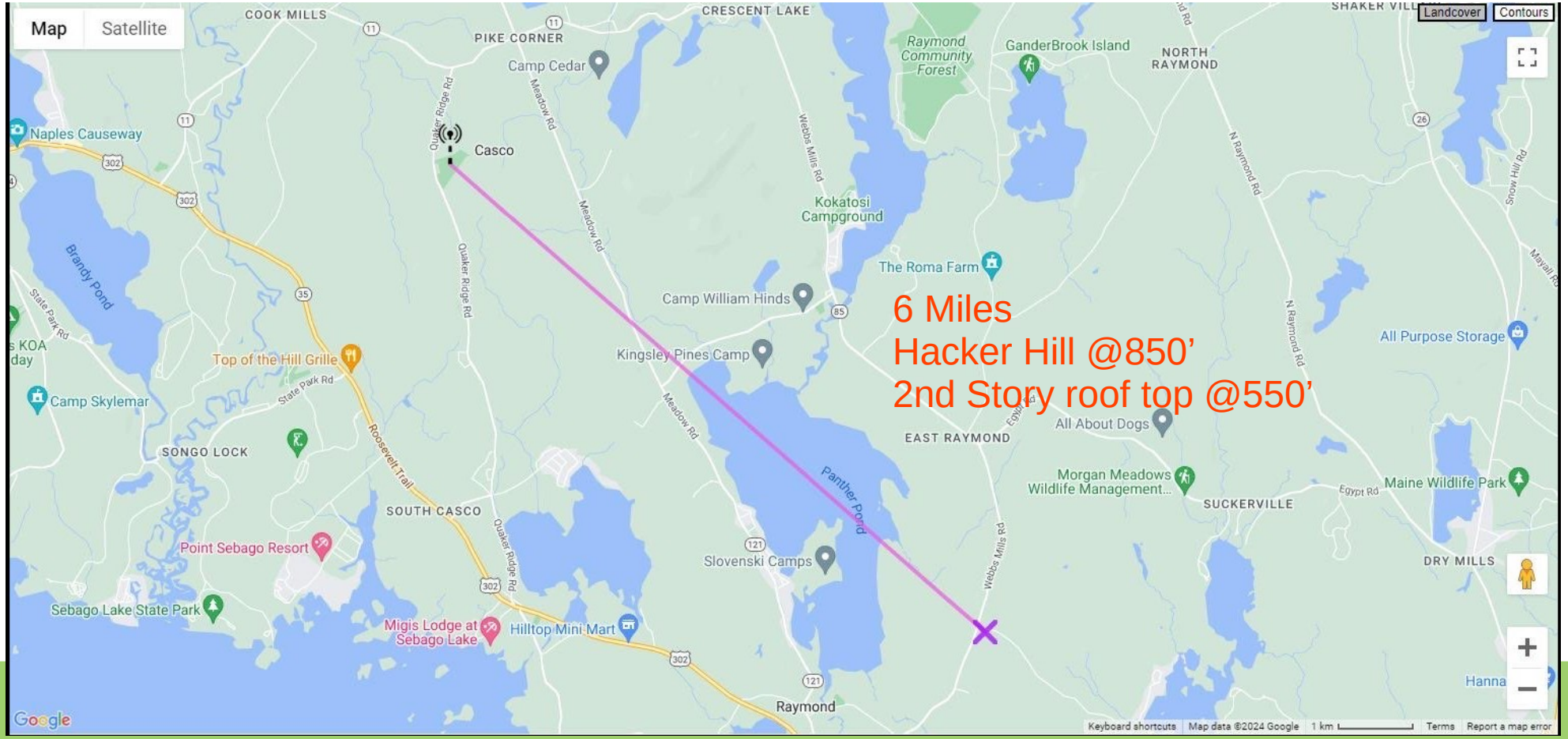
Remote Node Security Best Practices

- Physical access to device allows access to encryption key(s)
- Encryption keys should only be shared in person
- Rebroadcast Mode “all” allows forwarding of packets without keys
- Use PKI admin for remote management over LoRa
- Use “Managed” mode to disable local device management
- Disable LED lights
- Properly camouflage node enclosure and antenna

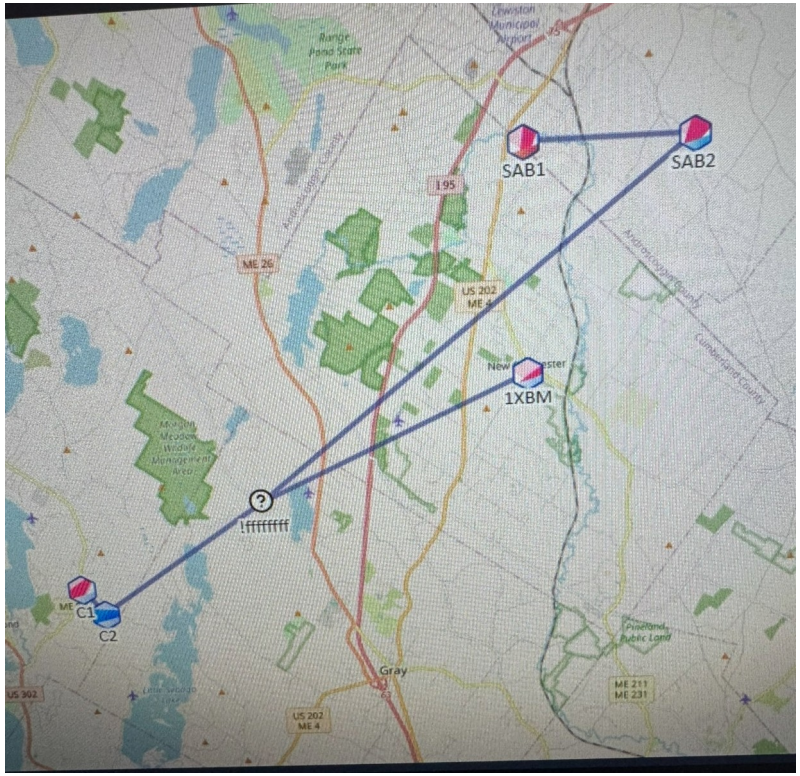
Real World Range

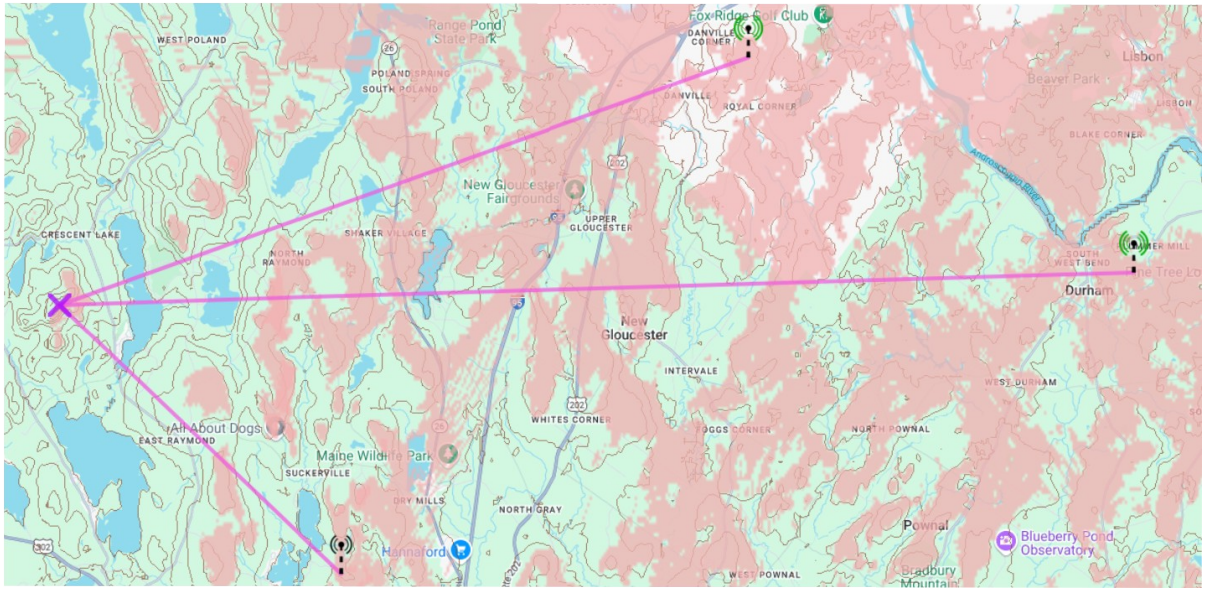
- Meshtastic is a line of sight radio technology (UHF)
- The higher the node, the better the range. Height is Might!
- ¼ mile when line of sight is obstructed (trees, buildings, etc)
- 15+ miles when line of sight is strong
- Using an external antenna when in car or building is important
- Flying a node on a drone or balloon extends range significantly

Range Test: Roof Top

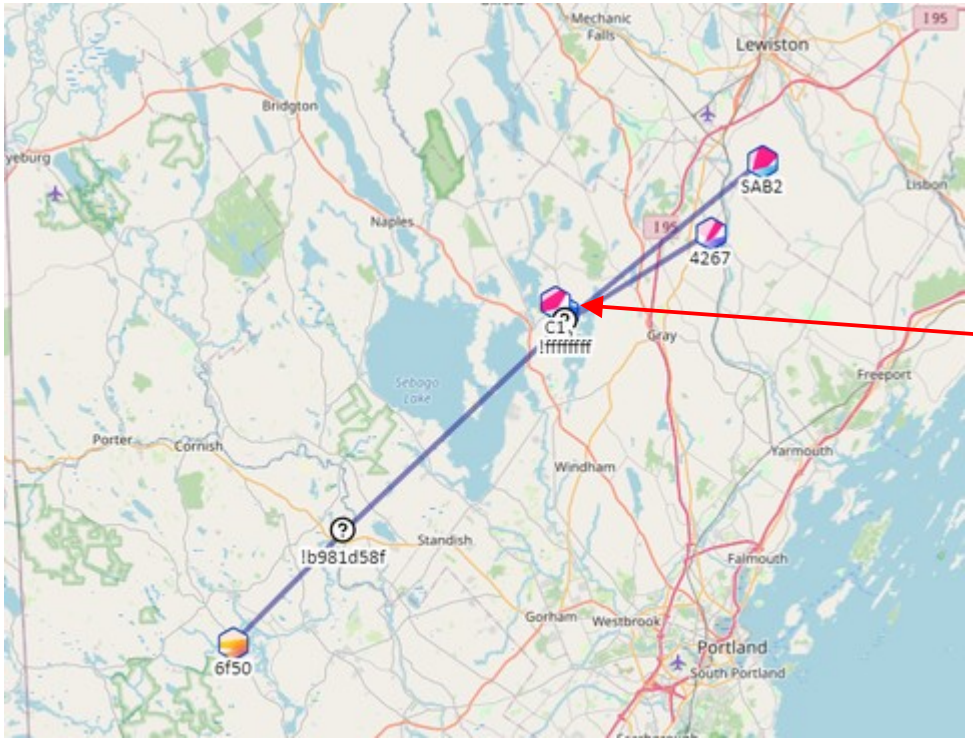


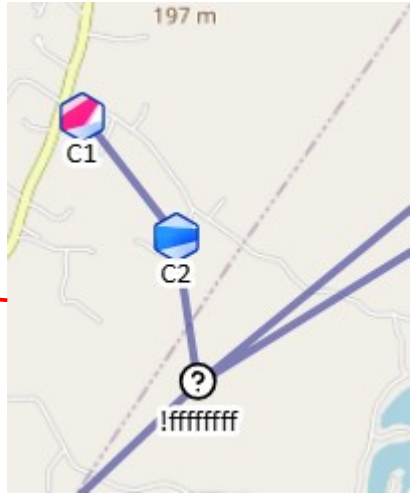
Range Test: Router at Altitude





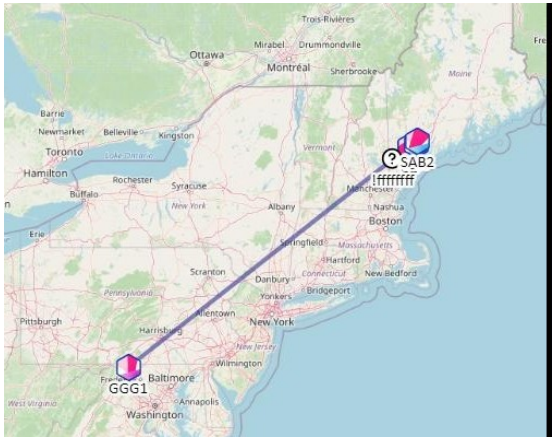
Range Test: Drone Lift



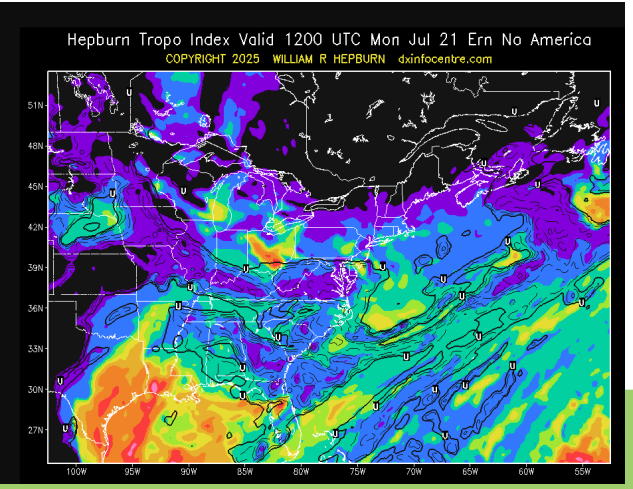


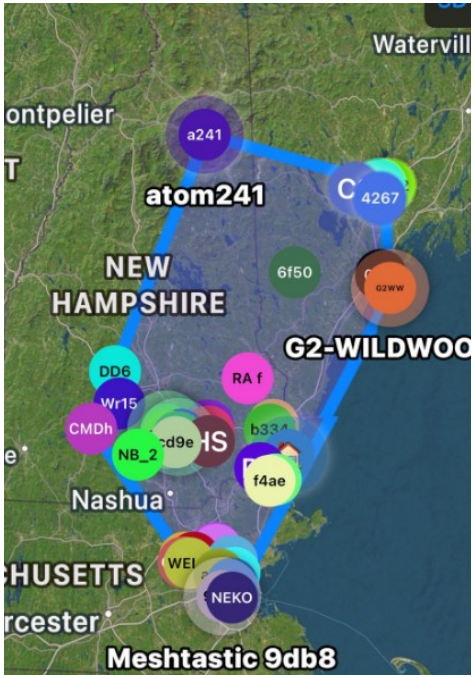
Tropospheric Ducting

Where did all these nodes come from?



- During the day, the sun heats the earth’s surface, causing warm air to rise and mix with cooler air aloft. This breaks up any stable layers and limits long-distance radio propagation.
- At night, the ground cools quickly, and cooler air gets trapped near the surface under a layer of warmer air aloft.
- This "inversion layer" refracts radio waves back toward the ground, forming a duct that can carry signals hundreds of miles.





But also sometimes...

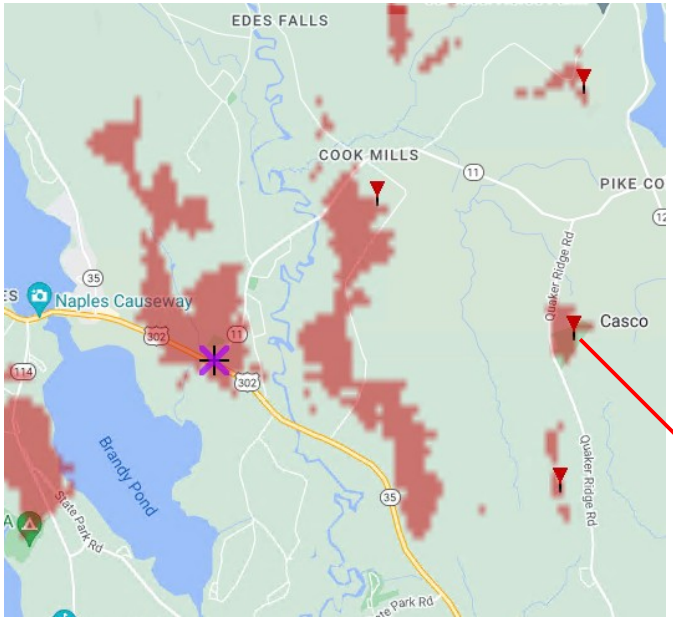
RF Propagation Mapping Tools

- Panorama = What can I see from a point/height (line of sight)
  https://heywhatsthat.com/
- WISP Tools = Generate Meshtastic coverage maps
  https://wisp.heywhatsthat.com/
- RF Line of Sight = Generate detailed line of sight report
  https://www.scadacore.com/tools/rf-path/rf-line-of-sight/
- Radio Mobile Online
  https://Ve2dbe.com

Node Site Selection Step 1: Panorama

Locate high point between locations you want to connect

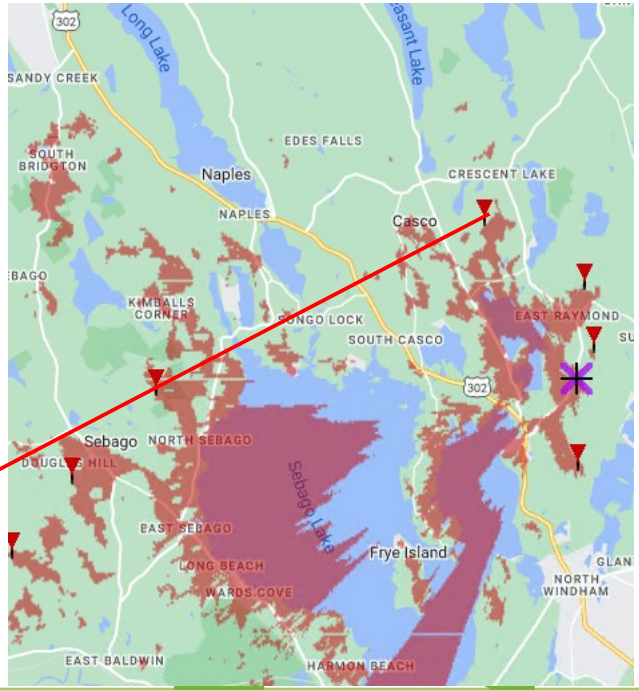
Dodge Oil, Naples

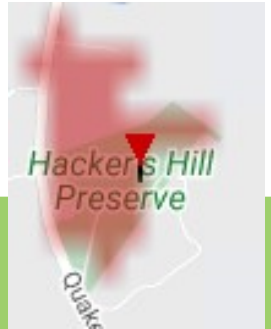


Generate panorama for each location and find overlapping areas.

1. New panorama button
2. Enter address
3. Enter antenna elevation
4. Name and submit

Brown Rd, Raymond





= Coverage

Node Site Selection Step 2: Coverage Map

WISP Tools:

1. Enter address of node site

2. Enter elevation

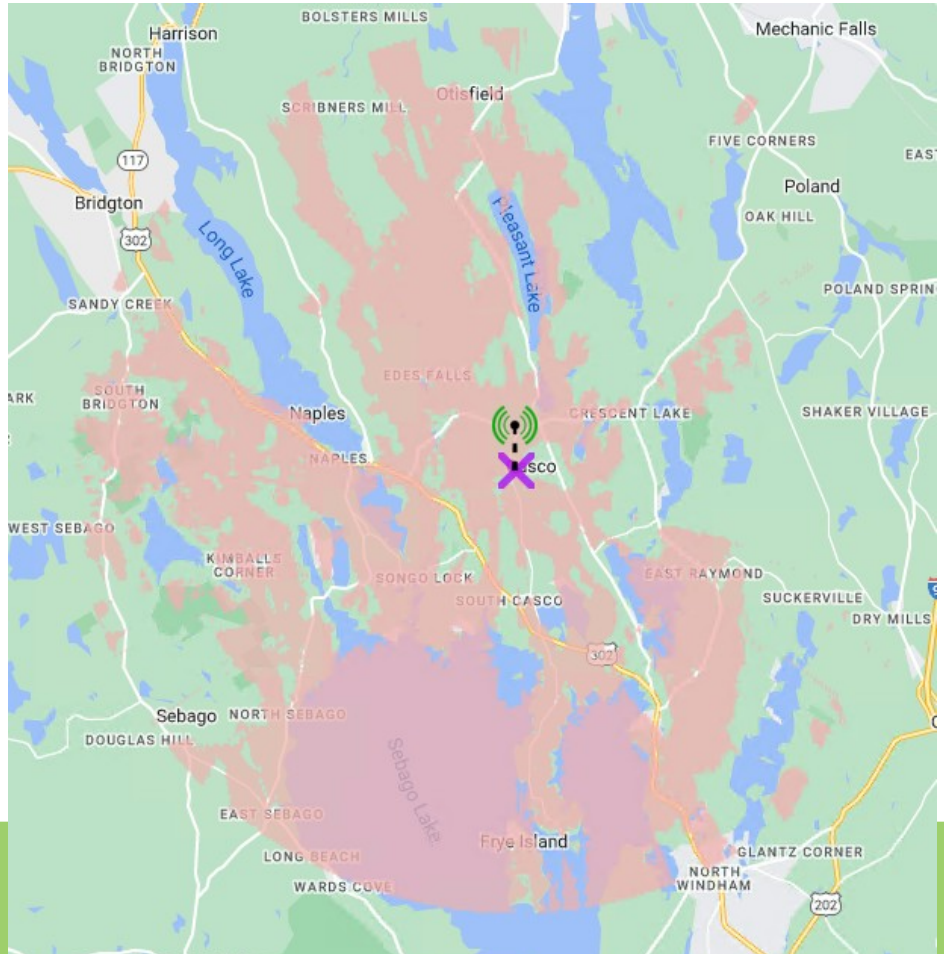
3. Set freq to 900MHz

4. Click “Create Tower”

5. Tower tab, name, change range to 15

6. Remove examples, “Refresh”

7. View shed tab, check box for your tower



Now you can see theoretical coverage area of proposed node site.

Note: Node height and placement within coverage area is critical.

= Coverage

Node Site Selection Step 3: Verify Line Of Sight

RF Line of Sight Tool:

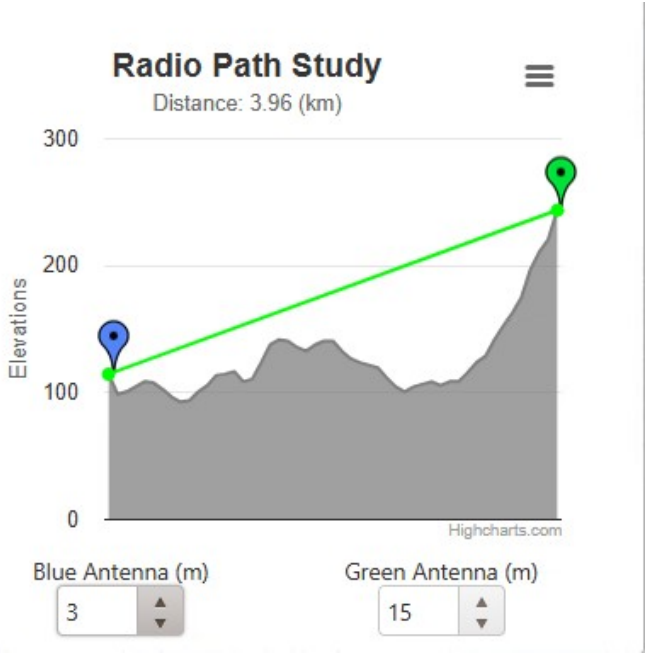
1. Drag and drop between points

2. Enter elevation

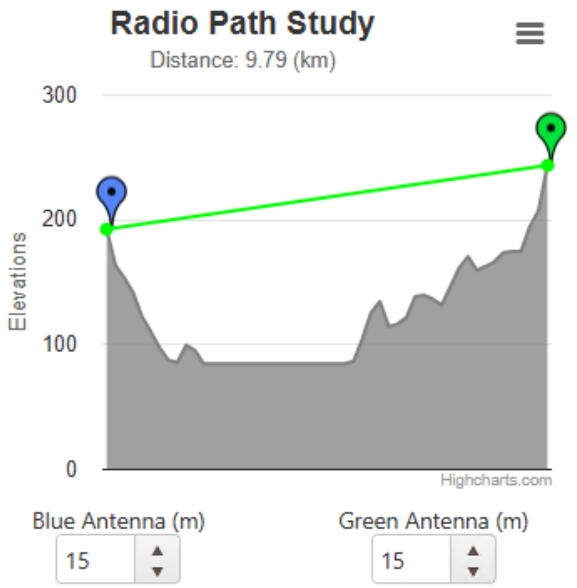
3. Radio path is generated

4. Use a topo map to locate obstructions if present

Dodge Oil –> Hacker Hill



Hacker Hill –> Brown Rd



Node Site Selection Step 4: Access and Physical Security

- Nodes should be mounted as high as possible
- Permission should be obtained for placement
- Node should be placed in an area that cannot be easily accessed by the public to prevent tampering
- Node should be retrievable in case of failure*

*Nodes tend to fail after several months in the field due to firmware/device bugs

Node Site Selection Step 5: Connect Routers (Expand Network)

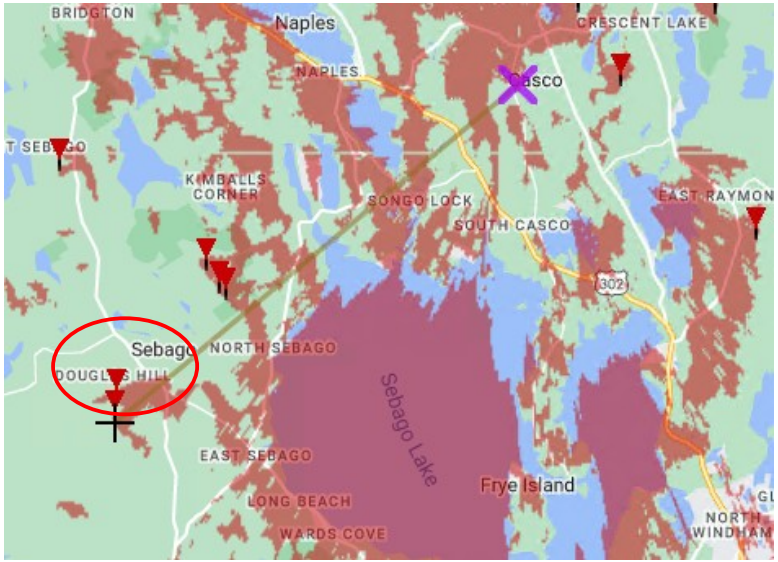
WISP Tools:

1. Using your coverage map/Panorama locate another high point that overlaps with the next area you want to cover

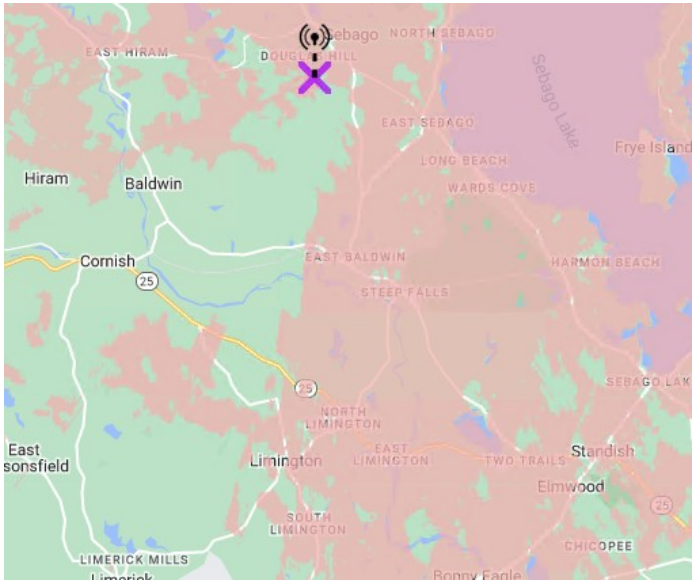
2. Generate new coverage map for next hop node location

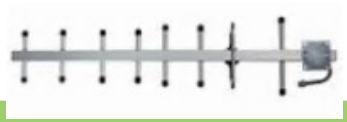
3. A directional antenna can be used to interconnect further away nodes

Hacker Hill Router Site



Douglas Mountain Router Site





= Coverage

Why is my mesh not working as expected?

Limited Bandwidth: LoRa is optimized for range, not throughput—only small packets can be transmitted, causing delays or incomplete data propagation.

Network Latency and Congestion: Nodes may queue or drop messages during periods of high traffic or poor link quality.

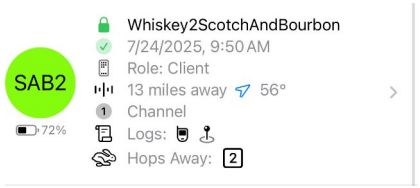
Unreliable Node Discovery: Nodes don’t maintain a centralized view of the network; route information is shared opportunistically and may be outdated or incomplete.

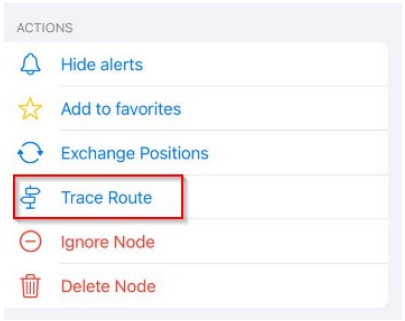
Device Variability: Differences in firmware versions, antenna quality, and power levels can impact node visibility and performance.

Environmental Interference: Physical obstructions, weather, and RF noise can all degrade signal quality, leading to inconsistent behavior.

Overall, Meshtastic prioritizes resilience and range over real-time precision, which can result in unexpected or delayed behavior in dynamic environments.

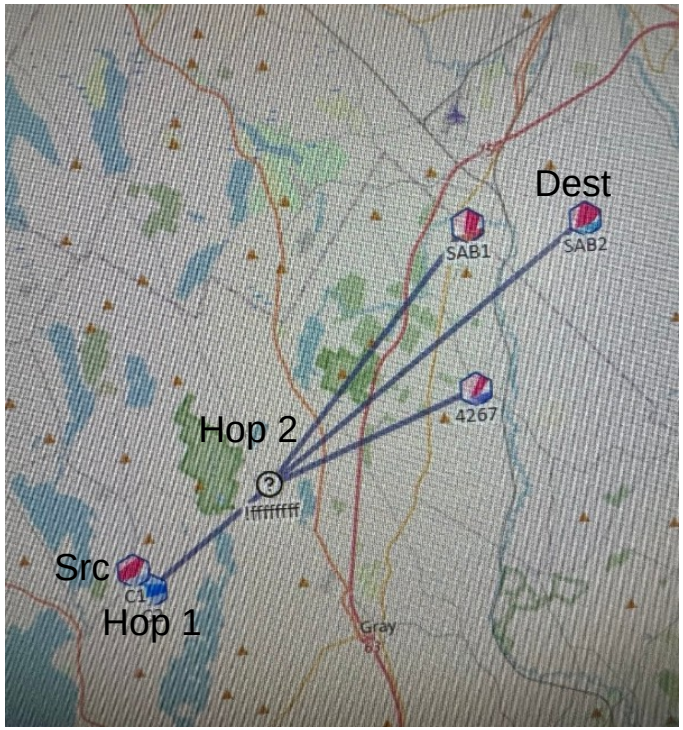
Trace Routes



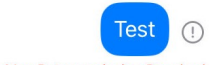


Route: Charlie 1 --> Repeater (unknown dB) --> Repeater (unknown dB) --> Whiskey2ScotchAndBourbon !7d85fc0e (-3.0dB)

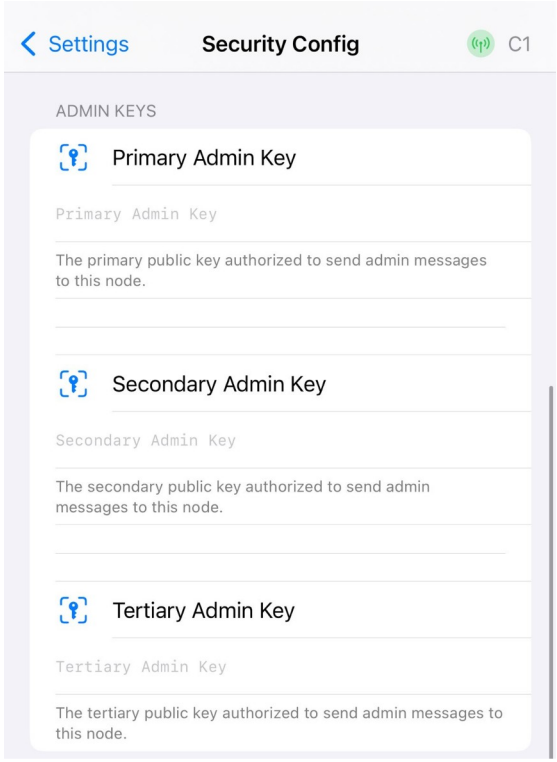
Route Back: Whiskey2ScotchAndBourbon ! 7d85fc0e --> Repeater (unknown dB) --> Repeater (unknown dB) --> Charlie 1 (12.0dB)

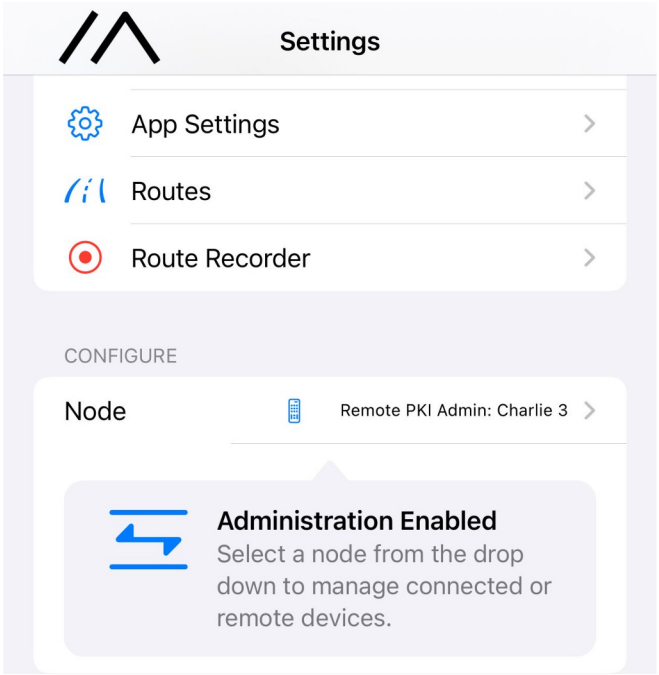


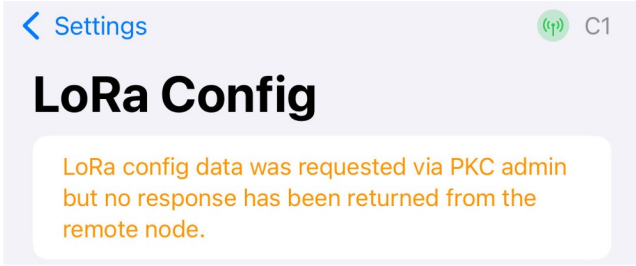
Meshtastic Network Troubleshooting

Nodes not talking at close range. 	Verify the channel and LORA configurations match.
Nodes not talking at long range. 	Verify line of sight, antenna, connectors, LORA configuration. Use second device to verify connectivity at close range.
Node not reachable via Bluetooth. 	Verify node is powered on, within Bluetooth range, active on the mesh.
Node is not functioning properly or responding.	Verify all of the above, if still not working re-flash and re-configure.

Remote Node Administration





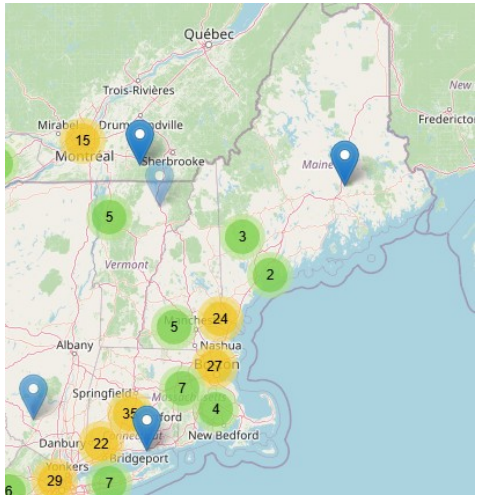


You can also use Python commands:
https://meshtastic.org/docs/software/python/cli/

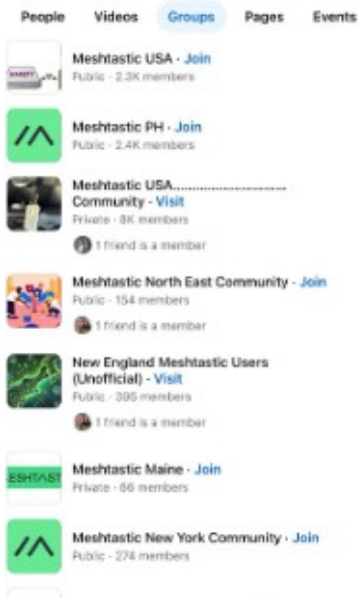
Additional Tools

Mesh Sense

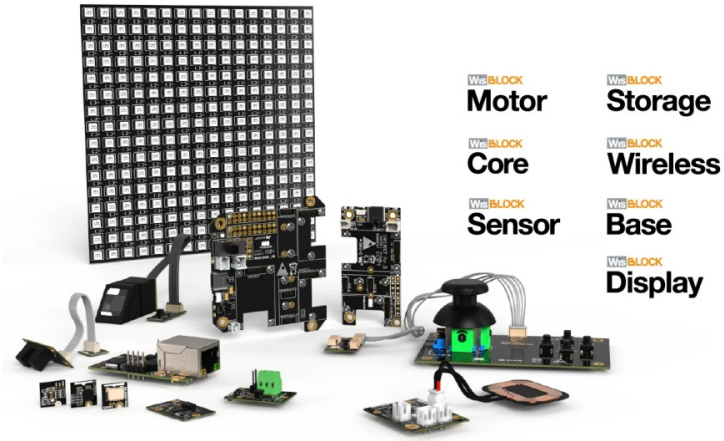
Meshmap.org



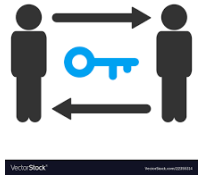
Social Media

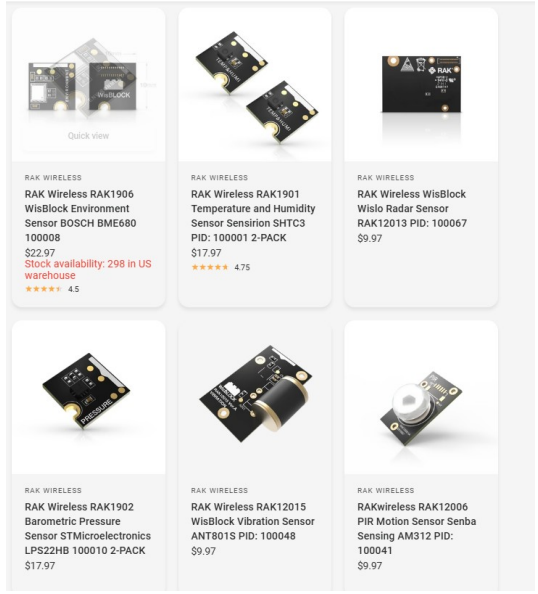


Other Ideas



WisBlock Motor
WisBlock Storage
WisBlock Extra
WisBlock Core
WisBlock Wireless
WisBlock Enclosures
WisBlock Sensor
WisBlock Base
WisBlock Power
WisBlock Display
WisBlock Interface





RAK WIRELESS
RAK Wireless RAK1906 WisBlock Environment Sensor BOSCH BME680 100008
$22.97
Stock availability: 298 in US warehouse
4.5

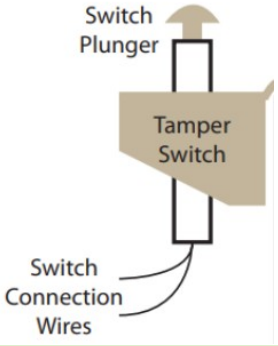
RAK WIRELESS
RAK Wireless RAK1901 Temperature and Humidity Sensor Sensirion SHTC3 PID: 100001 2-PACK
$17.97
4.75

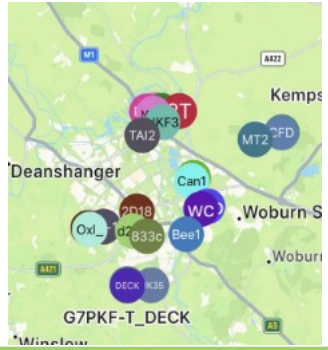
RAK WIRELESS
RAK Wireless WisBlock Wislo Radar Sensor RAK12013 PID: 100067
$9.97

RAK WIRELESS
RAK Wireless RAK1902 Barometric Pressure Sensor STMicroelectronics LPS22HB 100010 2-PACK
$17.97

RAK WIRELESS
RAK Wireless RAK12015 WisBlock Vibration Sensor ANT801S PID: 100048
$9.97

RAK WIRELESS
RAKwireless RAK12006 PIR Motion Sensor Senba Sensing AM312 PID: 100041
$9.97





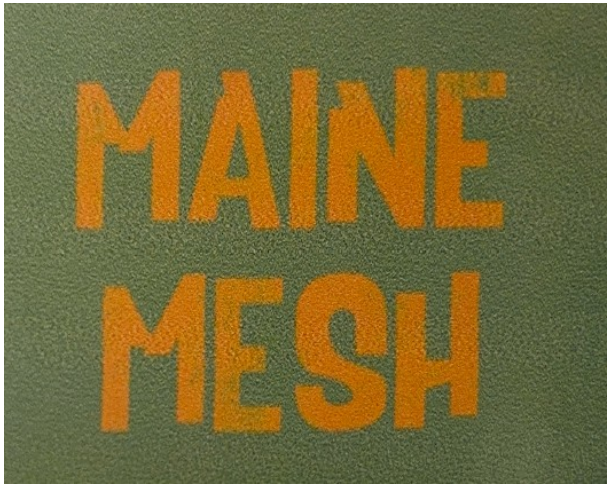
Every family needs a PACE Plan

Primary	**Monitored continuously** - cell phone, land line
Alternate	**Monitored nearly continuously.** Uses, but does not require cell phones. - Email, Facebook messenger-type messaging or land line - need non-cordless phone if no power - Sometimes texts can get through when phone calls can't
Contingency	**Rarely monitored when not in emergency.** Not as fast, easy or convenient as the first two methods, but capable of accomplishing the task. - Using GMRS, FRS or amateur (Ham) radios on a frequency/channel plan previously agreed on, i.e., rotating channel/frequency every 15 minutes in an emergency until contact is made. Every hour starting at 7 am, monitor your chosen channel or frequency for five minutes If you have a message to share, transmit during this five-minute window This helps maintain your battery and be more effective in brokering communication
Emergency	**Only monitored when other means fail.** Used as a last resort. Typically has significant delays. - a hand-written note left at a known trusted location (think geocaching or dead drop) - face-to-face communication (walking or biking around ward boundaries)

Additional Resources

https://www.youtube.com/@The_Comms_Channel
https://www.youtube.com/@HamRadioCrashCourse
https://meshtastic.org/
https://store.rokland.com/
https://www.facebook.com/groups/730536684339042

Meshtastic Maine Net



https://github.com/JFRHorton/MaineMesh