



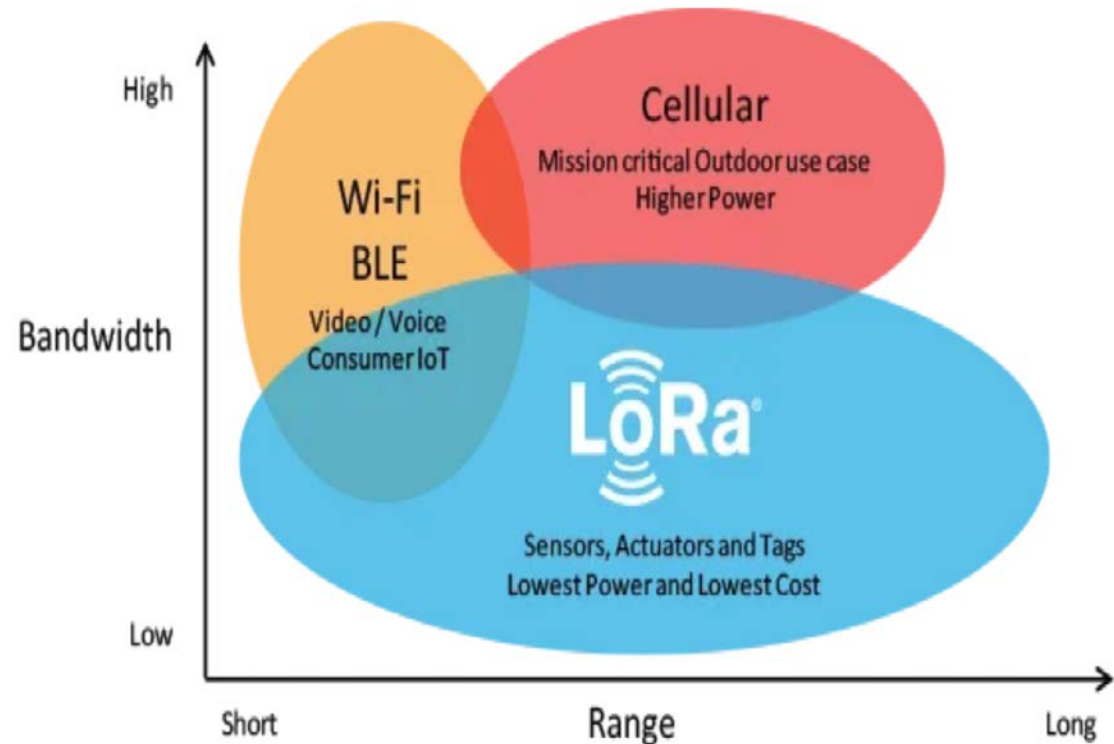
Tulsa Meshtastic Presentation
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February 2025

What is Meshtastic?

- Meshtastic® is a project that enables you to use inexpensive LoRa radios as a long range off-grid communication platform in areas without existing or reliable communications infrastructure. This project is 100% community driven and open source!
- Source: <https://meshtastic.org/docs/introduction/>

What are LoRa and LoRaWAN?

- **LoRa** is a wireless modulation technique derived from **Chirp Spread Spectrum (CSS)** technology. It encodes information on radio waves using chirp pulses - similar to the way dolphins and bats communicate! LoRa modulated transmission is robust against disturbances and can be received across great distances.
- **LoRaWAN** is a Media Access Control (MAC) layer protocol built on top of LoRa modulation. It is a software layer which defines how devices use the LoRa hardware, for example when they transmit, and the format of messages.
- Source:
<https://www.thethingsnetwork.org/docs/lorawan/what-is-lorawan/>



How does Meshtastic work?

- Meshtastic utilizes LoRa, a long-range radio protocol, which is widely accessible in most regions without the need for additional licenses or certifications, unlike HAM radio operations.
- These radios are designed to rebroadcast messages they receive, forming a mesh network. This setup ensures that every group member, including those at the furthest distance, can receive messages.
- Additionally, Meshtastic radios can be paired with a single phone, allowing friends and family to send messages directly to your specific radio. It's important to note that each device is capable of supporting a connection from only one user at a time.
- When you send a message on your Meshtastic companion app, it is relayed to the radio using Bluetooth, Wi-Fi/Ethernet or serial connection. That message is then broadcasted by the radio. If it hasn't received confirmation from any other device after a certain timeout, it will retransmit the message up to three times.
- When a receiving radio captures a packet, it checks to see if it has heard that message before. If it has it ignores the message. If it hasn't heard the message, it will rebroadcast it.
- For each message a radio rebroadcasts, it marks the "hop limit" down by one. When a radio receives a packet with a hop limit of zero, it will not rebroadcast the message.

Meshtastic Frequency Bands

1. Europe Frequency Bands

A. 433 MHz

- The maximum power allowed for Europe is +10 dBm ERP (Effective Radiated Power 0.1 Watts).
 - <https://meshtastic.org/docs/overview/radio-settings/#:~:text=433%20MHz%E2%80%8BThe%20maximum%20power>
- The band range is from 433 to 434 MHz.

B. 868 MHz

- The maximum power allowed for Europe is +27 dBm ERP (Effective Radiated Power 0.5 Watts).
- The band range is from 869.40 to 869.65 MHz.

2. North America Frequency Bands

A. 433 MHz

- The maximum power allowed for North America is +40 dBm ERP (Effective Radiated Power 10 Watts).
- The band range is from 433 to 434 MHz. Requires an Amateur Radio License

B. 915 MHz (ISM Band)

- The maximum output power for North America is +30 dBm ERP (Effective Radiated Power 1 Watt).
- The band range is from 902 to 928 MHz.

Pros and Cons to using 915 MHz vs. 433 MHz in the USA

Item	915 MHz	433 MHz
Amateur Radio License Required	No	Yes
Encryption Allowed	Yes	No
Transmission Power	1Watt	10Watt
Station must identify every 10 minutes	No	Yes

Data Rates

- There are eight LoRa radio presets. These are the most common settings and have been proven to work well:

Channel setting	Alt Channel Name	Data-Rate	SF / Symbols	Coding Rate	Bandwidth	Link Budget
Short Range / Turbo	Short Turbo	21.88 kbps	7 / 128	4/5	500 kHz ¹	140dB
Short Range / Fast	Short Fast	10.94 kbps	7 / 128	4/5	250 kHz	143dB
Short Range / Slow	Short Slow	6.25 kbps	8 / 256	4/5	250 kHz	145.5dB
Medium Range / Fast	Medium Fast	3.52 kbps	9 / 512	4/5	250 kHz	148dB
Medium Range / Slow	Medium Slow	1.95 kbps	10 / 1024	4/5	250 kHz	150.5dB
Long Range / Fast	Long Fast	1.07 kbps	11 / 2048	4/5	250 kHz	153dB
Long Range / Moderate	Long Moderate	0.34 kbps	11 / 2048	4/8	125 kHz	156dB
Long Range / Slow	Long Slow	0.18 kbps	12 / 4096	4/8	125 kHz	158.5dB
Very Long Range / Slow	Very Long Slow	0.09 kbps	12 / 4096	4/8	62.5 kHz	161.5dB

Hardware Recommendations

- There are several Meshtastic nodes to choose from. The listed below is just a few examples:
 1. Heltec V3
 2. T-Echo, T-Beam, T-Deck
 3. RAK Wishmesh Pocket
 4. RAK Meshtastic Starter Kit
 5. Refer to <https://www.tulsa-meshtastic.com/gadgets> to learn more about which unit might be the right one for your needs.

Hardware Setup Notes

- **Once you have purchased your hardware, please read these notes carefully before proceeding.**
1. Attach the antenna to the Meshtastic unit BEFORE connecting a power source. Failure to do so will result in a damaged transmitter.
 2. Verify the polarity on the power source before connecting it to the Meshtastic unit. If the plus and minus leads are reversed and you connect the power source, it will damage the entire board and render it unusable.
 3. Look for the plus and minus stamped on the circuit board and ensure that the battery cable polarity is oriented correctly.
 4. You will need a USB data cable. Depending on the computer that you are going to use to flash the Meshtastic firmware you will likely need a USB-A to either USB-C or microUSB depending on the model of Meshtastic unit that you purchase.
 5. The Meshtastic unit has a built-in interface chip in it. You will need to install the device driver on your computer prior to connecting the Meshtastic unit to your computer.
<https://meshtastic.org/docs/getting-started/serial-drivers/>
 6. Once the Meshtastic device is connected to your computer, you will need to look at device manager and determine which COM port the computer assigned to your device and make note of it.

Hardware Setup Notes continued

- **Once you have purchased your hardware, please read these notes carefully before proceeding.**
7. As with any RF communications device, the higher that you can mount the antenna with more clear line of sight and less obstructions the more effective your transmissions will be.
 8. You do not want to use a long amount of feedline between the antenna and the Meshtastic unit, because the loss in the feed line will decrease the effective power of the transmission.
 9. If your unit is mounted outside, the extreme weather conditions will have an impact on battery life.
 10. Depending on the battery type, the batteries effectiveness can be permanently affected if attempt to charge the battery in extreme cold or heat.

Flashing the Firmware

1. Once you have all of this information, use a web browser and go to the following URL: <https://flasher.meshtastic.org/>



2. You will need to select your device by clicking on the button circled in red and scrolling through the list to select it.
3. Then you will need to select what firmware you want to install by clicking on the button circled in yellow. It is recommended that you select the most recent stable version.
4. Then lastly you will need to click on Flash circled in green.
5. A progress window will show up at the bottom of the screen.
6. Do yourself a favor and do NOT interrupt this process. Wait until it tells you that it has been completed successfully.
7. The next step will be to perform the configuration on your Meshtastic unit. This can be done from the computer and a serial connection to the unit, or you can download the Meshtastic app from the Apple store for IOS devices or from the Google Play store for Android devices.

Hardware Configuration

1. Configuration of the device can be done using the Meshtastic App for IOS or Android device. It can also be done using a web interface and connecting to the node.
2. The steps provided here are for the IOS version of the app.
3. Start by opening the Meshtastic app.
4. Click Bluetooth at the bottom of the app.
5. Find your radio in the list and click on it.
6. Enter the PIN onscreen, or 123456 if your node doesn't have a screen.
7. The first time connecting to your node after flashing the firmware you will see UNSET (region).
8. Click on it and select "United States" (the device will reboot)

Settings -> LoRa

1. Region United States
2. Use Preset: on
3. Presets: Long Range – Fast
4. Ignore MQTT: off
5. OK to MQTT: on
6. Transmit Enabled: on
7. Number of Hops: 4
8. Frequency Slot: 0
9. Frequency override: 0
10. Transmit power: 30dBm (1 Watt)
11. Click Save

Settings -> Channels

1. By scanning one of these codes from the same device that has the Meshtastic app on it, it will add or replace the channels in the Meshtastic app.
2. Adding Channels
3. <https://meshtastic.org/e/?add=true#CgcSAQE6AggOChASAEaCVR1bHNhTWVzaDoAEg8IATgBQARIAVAeaAHIBgE>

Generate QR Code

The current LoRa configuration will also be shared.

Primary	<input checked="" type="checkbox"/>
TulsaMesh	<input checked="" type="checkbox"/>
Channel: 2	<input type="checkbox"/>
Channel: 3	<input type="checkbox"/>
Channel: 4	<input type="checkbox"/>
Channel: 5	<input type="checkbox"/>
Channel: 6	<input type="checkbox"/>
Channel: 7	<input type="checkbox"/>



Add Channels

Replace Channels

Sharable
URL

<https://meshtastic.org/e/?add=true#CgcSAQE6AggOChASAEaCVR1bHNhTWVzaDoAEg8IATgBQARIAVAeaAHIBgE>

4. Or Replacing Channels

5. <https://meshtastic.org/e/#CgcSAQE6AggOC hASAEaCVR1bHNhTWVzaDoAEg8IATgBQARI AVAeaAHIBgE>

Generate QR Code

The current LoRa configuration will also be shared.

Primary	<input checked="" type="checkbox"/>
TulsaMesh	<input checked="" type="checkbox"/>
Channel: 2	<input type="checkbox"/>
Channel: 3	<input type="checkbox"/>
Channel: 4	<input type="checkbox"/>
Channel: 5	<input type="checkbox"/>
Channel: 6	<input type="checkbox"/>
Channel: 7	<input type="checkbox"/>



Add Channels

Replace Channels

Sharable
URL

<https://meshtastic.org/e/#CgcSAQE6AggOC hASAEaCVR1bHNhTWVzaDoAEg8IATgBQARI AVAeaAHIBgE>

Settings -> Channels

- **This slide is included in the event that you were unable to scan the QR code to add in the channels.**
1. Click on Primary Channel
 2. Do not modify channel details
 3. Positions Enabled: on
 4. Approximate Location: 0.9mi
 5. Click Save
 6. Click Add Channel
 7. Name: TulsaMesh (no space, case sensitive!)
 8. Key Size: Default
 9. Key: AQ== (this should be automatically entered when you select "Default" under "Key Size")
 10. Channel Role: Secondary
 11. Allow Position Requests: Off
 12. Click Save

Settings -> User

1. Long name: name of your node (up to 36 characters, shown on node list)
2. Shortname: Short name for your node (up to 4 characters)
3. License Operator (HAM mode): Off
4. Click Save
5. The Tulsa Meshtastic group has a naming standard that we are encouraging folks to participate in.
6. This is not required to participate in the Tulsa Meshtastic project, but it is suggested.
7. Please refer to the next slide for instructions.

Tulsa Meshtastic Naming Convention

1. The Tulsa Meshtastic group has a naming standard that we are encouraging folks to participate in. Use the following URL to register your node:
<https://www.tulsa-meshtastic.com/meshtastic-node-list-1>
2. Select the airport code for the closest airport.
3. Select the Node Type Fixed or Portable.
4. Enter the Latitude and Longitude with a maximum of 5 decimals.
5. Owner's email address.
6. Click Submit.
7. You will receive an email back from the Tulsa Meshtastic system giving you're the short name and long name to input into your node configuration under Settings > User.
8. When the name changes are applied to your node, you will need to save and reboot your device.

Settings -> Device

1. Device Role:
 - A. If you have a mobile/pocket/edc node: Client Mute
 - B. If you have a stationary node that is poorly placed (ie: inside a house): Client Mute
 - C. If you have a stationary node that is well placed (2nd floor window, roof, attic): Client
 - D. If you have multiple nodes for camping/poor cell service/in woods/etc: Client
2. Rebroadcast Mode: All
3. Node Info Broadcast Interval: One Hour
4. All other options can usually be left at their defaults
5. Click Save

Device Roles

Here is a completed list of device roles as a technical reference.

Device Role	Description	Best Uses
CLIENT	App connected or stand alone messaging device. Rebroadcasts packets when no other node has done so.	General use for individuals needing to communicate over the Meshtastic network with support for client applications.
CLIENT_MUTE	Device that does not forward packets from other devices.	Situations where a device needs to participate in the network without assisting in packet routing, reducing network load.
CLIENT_HIDDEN	Device that only broadcasts as needed for stealth or power savings.	Use in stealth/hidden deployments or to reduce airtime/power consumption while still participating in the network.
TRACKER	Broadcasts GPS position packets as priority.	Tracking the location of individuals or assets, especially in scenarios where timely and efficient location updates are critical.
LOST_AND_FOUND	Broadcasts location as message to default channel regularly for to assist with device recovery.	Used for recovery efforts of a lost device.
SENSOR	Broadcasts telemetry packets as priority.	Deploying in scenarios where gathering environmental or other sensor data is crucial, with efficient power usage and frequent updates.
TAK	Optimized for ATAK system communication, reduces routine broadcasts.	Integration with ATAK systems (via the Meshtastic ATAK Plugin) for communication in tactical or coordinated operations.
TAK_TRACKER	Enables automatic TAK PLI broadcasts and reduces routine broadcasts.	Standalone PLI integration with ATAK systems for communication in tactical or coordinated operations.
REPEATER	Infrastructure node for extending network coverage by always rebroadcasting packets once with minimal overhead. Not visible in Nodes list.	Best positioned in strategic locations to maximize the network's overall coverage. Device is not shown in topology.
ROUTER	Infrastructure node for extending network coverage by always rebroadcasting packets once. Visible in Nodes list.	Best positioned in strategic locations to maximize the network's overall coverage. Device is shown in topology.
ROUTER_LATE	Infrastructure node that always rebroadcasts packets once but only after all other modes, ensuring additional coverage for local clusters. Visible in Nodes list.	Ideal for covering dead spots or ensuring reliability for a cluster of nodes where placement doesn't benefit the broader mesh. Device is shown in topology.

Settings -> Position

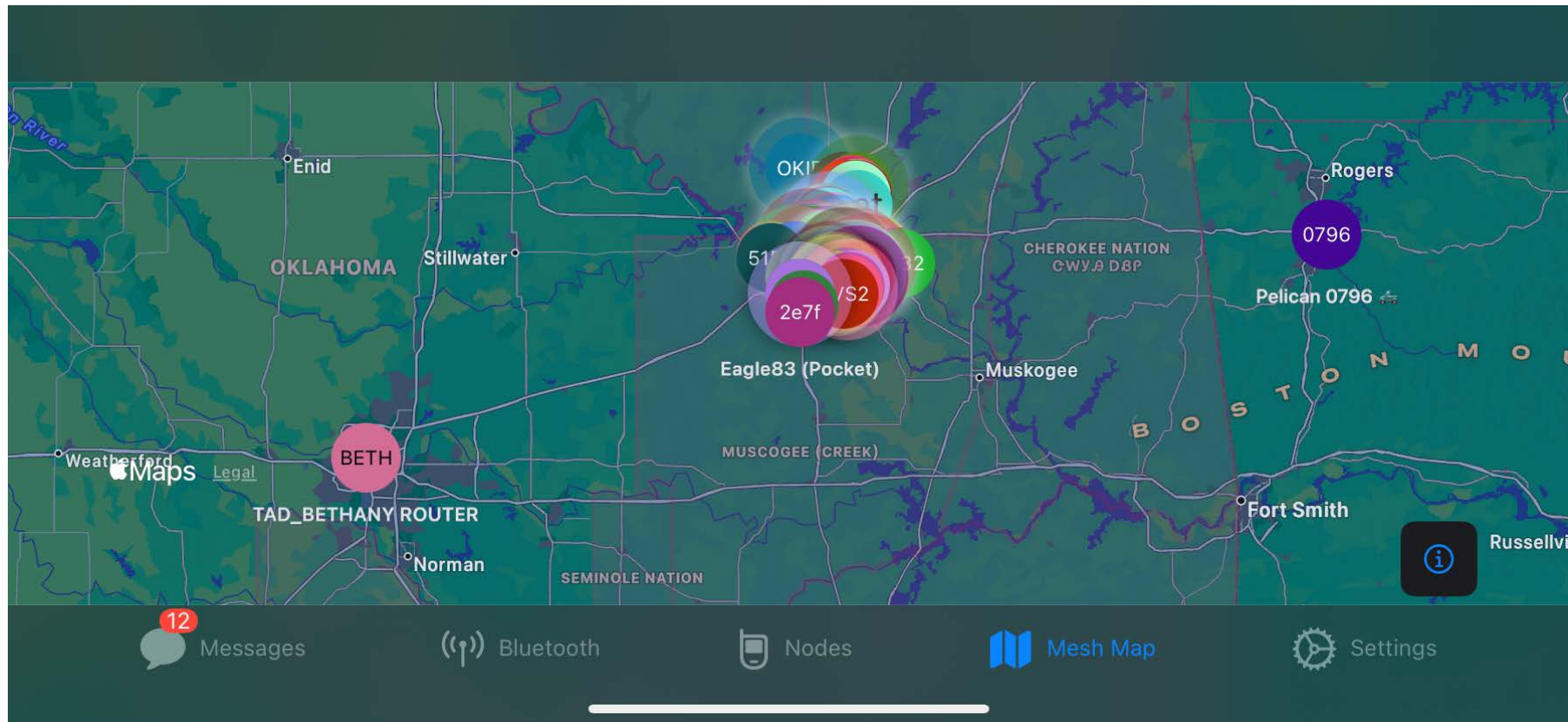
1. Broadcast Interval: 60 minutes
2. Smart Position: on
3. Minimum Interval: 30 Minutes
4. Minimum Distance: 100
5. Device GPS: Enabled if your device has GPS, Not Present if your device does not have GPS
6. Update Interval: 30 Minutes
7. Position Flags: Only enable metrics you need. Suggest enabling altitude, satellites, and timestamp only.
8. All other options can usually be left at their defaults
9. Click Save

Send a Message

1. Say Hi!
 - A. Open the app
 - B. Click the message bubble at the bottom left
 - C. Click on Primary Channel or TulsaMesh
 - D. Type a message!

Is Anyone Out There

- Here is a recent map of Meshtastic nodes around the Tulsa, Oklahoma area.

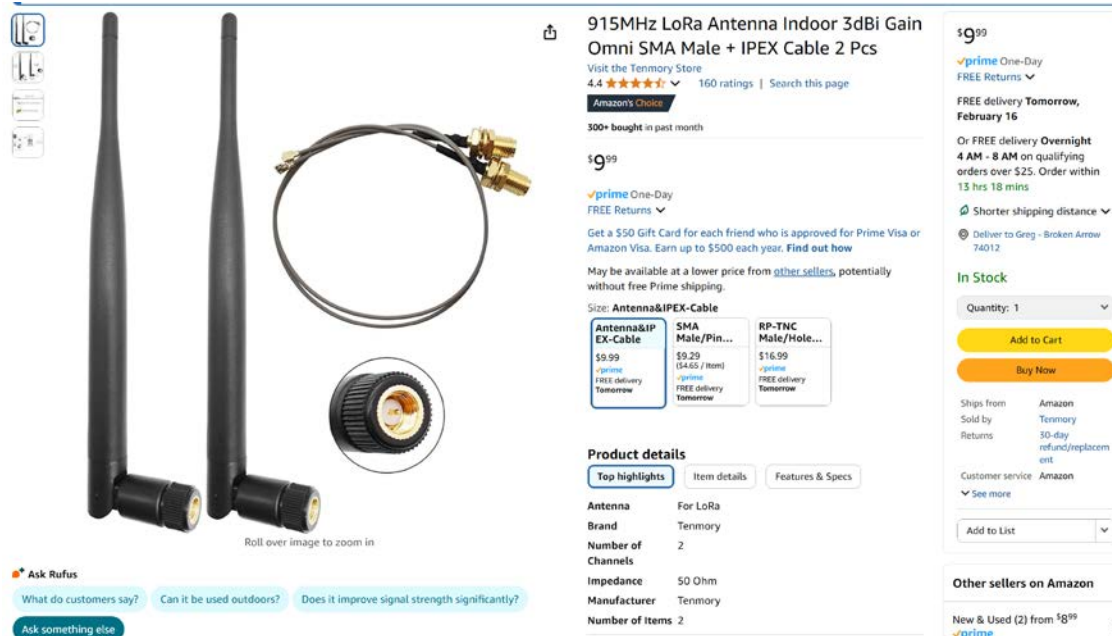


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How Can I Increase My Range?

- Range can be increased by buying antennas with additional gain such as this one from Amazon for the smaller portable units.







Gain in dBi	Meaning
-10 dBi	One tenth or 10 % (loss)
-6 dBi	One quarter or 25 % (loss)
-3 dBi	One half or 50% (loss)
0 dBi	Same or 100% (no gain/loss)
+1 dBi	12% higher or x 1.12
+2 dBi	58% higher or x 1.58
+3 dBi	100% higher or double
+6 dBi	4x higher or quadruple
+9 dBi	8x higher
+10 dBi	10x higher
+13 dBi	20x higher
+20 dBi	100x higher

- <https://amzn.to/4b0Gug2>
- Antenna dBi reference:
- <https://antennatestlab.com/antenna-education-tutorials/what-is-antenna-gain-dbi-scale>

How Can I Increase My Range? continued

- Range can be increased by buying antennas with additional gain for outdoor setup.

			
Add to Cart	Add to Cart	Add to Cart	Add to Cart
5.8 dBi N-Male Omni Outdoor Helium 915 MHz Antenna for RAK Miner Hotspots & Meshtastic	6 dBi Low Profile N-Female Omni Outdoor 915 MHz Antenna for Helium RAK Miner Bobcat & Meshtastic	8 dBi Low Profile N-Female Omni Outdoor 915 MHz Antenna for Helium RAK Miner 2 Nebra Indoor SyncroB.it & Bobcat	8.5 dBi N-Male Omni Outdoor Helium 915 MHz Antenna (Large Profile 40") for RAK Miner 2 Nebra SenseCap M1 & Bobcat Hotspots
\$39.97	\$29.97	\$34.97	\$44.97

- <https://store.rokland.com/collections/802-11ah-wi-fi-halow>

External Antenna Feedline

- If you are planning to use a outdoor antenna, you will also need to purchase feedline.
- Based on the output power and feedline loss, you will want to keep this cable the shorter the better.
- This is achieved by mounting the Meshtastic node within a few feet of the antenna.

Feedline	Freq. MHz	Length, ft.	Input	Output	Approx \$/ft
RG-8X	915	2	1W	0.94W	\$2.00
RG-8X	915	5	1W	0.85W	\$2.00
RG-8X	915	10	1W	0.72W	\$2.00
Heliax 7/8"	915	10	1W	0.97W	\$\$
Heliax 7/8"	915	25	1W	0.93W	\$\$
Heliax 7/8"	915	50	1W	0.86W	\$\$
Heliax 1.25"	915	10	1W	0.98W	\$\$\$
Heliax 1.25"	915	25	1W	0.95w	\$\$\$
Heliax 1.25"	915	50	1W	0.90w	\$\$\$
https://kv5r.com/ham-radio/coax-loss-calculator/					

Feedline	Freq. MHz	Length, ft.	Input	Output	Approx \$/ft
RG-8X	433	2	10W	9.61W	\$2.00
RG-8X	433	5	10W	9.05W	\$2.00
RG-8X	433	10	10W	8.20W	\$2.00
Heliax 7/8"	433	10	10W	9.81W	\$\$
Heliax 7/8"	433	25	10W	9.52W	\$\$
Heliax 7/8"	433	50	10W	9.07W	\$\$
Heliax 1.25"	433	10	10W	9.87W	\$\$\$
Heliax 1.25"	433	25	10W	9.66W	\$\$\$
Heliax 1.25"	433	50	10W	9.33W	\$\$\$
https://kv5r.com/ham-radio/coax-loss-calculator/					

Resources

- Here are some locations that can provide you with more information.
 1. Tulsa Meshtastic <https://www.tulsa-meshtastic.com/>
 2. Tulsa Meshtastic Google Group
<https://groups.google.com/g/meshtastic-tulsa-network>
 3. Meshtastic <https://meshtastic.org/>
 4. Austin Meshtastic <https://www.austinmesh.org/>
- Instructional video on YouTube on Meshtastic unit setup:
 - <https://youtu.be/tFOCV8sCRnA>
- Dr. Greg Meador AI5HV, gcmeador@outlook.com
- Jeff Scoville AE5ME, ae5me@yahoo.com

Resources continued

- For those of you who are amateur radio operators:
 1. Please check out the VOIP Net on Monday evenings at 7:15 PM
 2. Statewide VOIP Net 444.35 Repeater
 3. 444.35 Repeater | Wires-X 28292 | YSF US-OklahomaLink | DMR TGIF 31403 | DMR Brandmeister 3140122 | P25 31403 | NXDN 31403 | DSTAR XLXOKL Module "B" | M17-OKL Module "A"
 4. 147.09 Repeater | Allstar 49562 | Echolink N5XQK-R
 5. Net that covers the aspects of digital voice and data in amateur radio. This net is the newest addition, starting in 2012 as a Dstar/EchoLink cross-mode net, it has now expanded into many, many other modes, including both analog and digital.

Questions ?