



Meshtastic

A high level presentation -
SnyderMesh | [BuffaLoRa.org](https://buffalora.org)

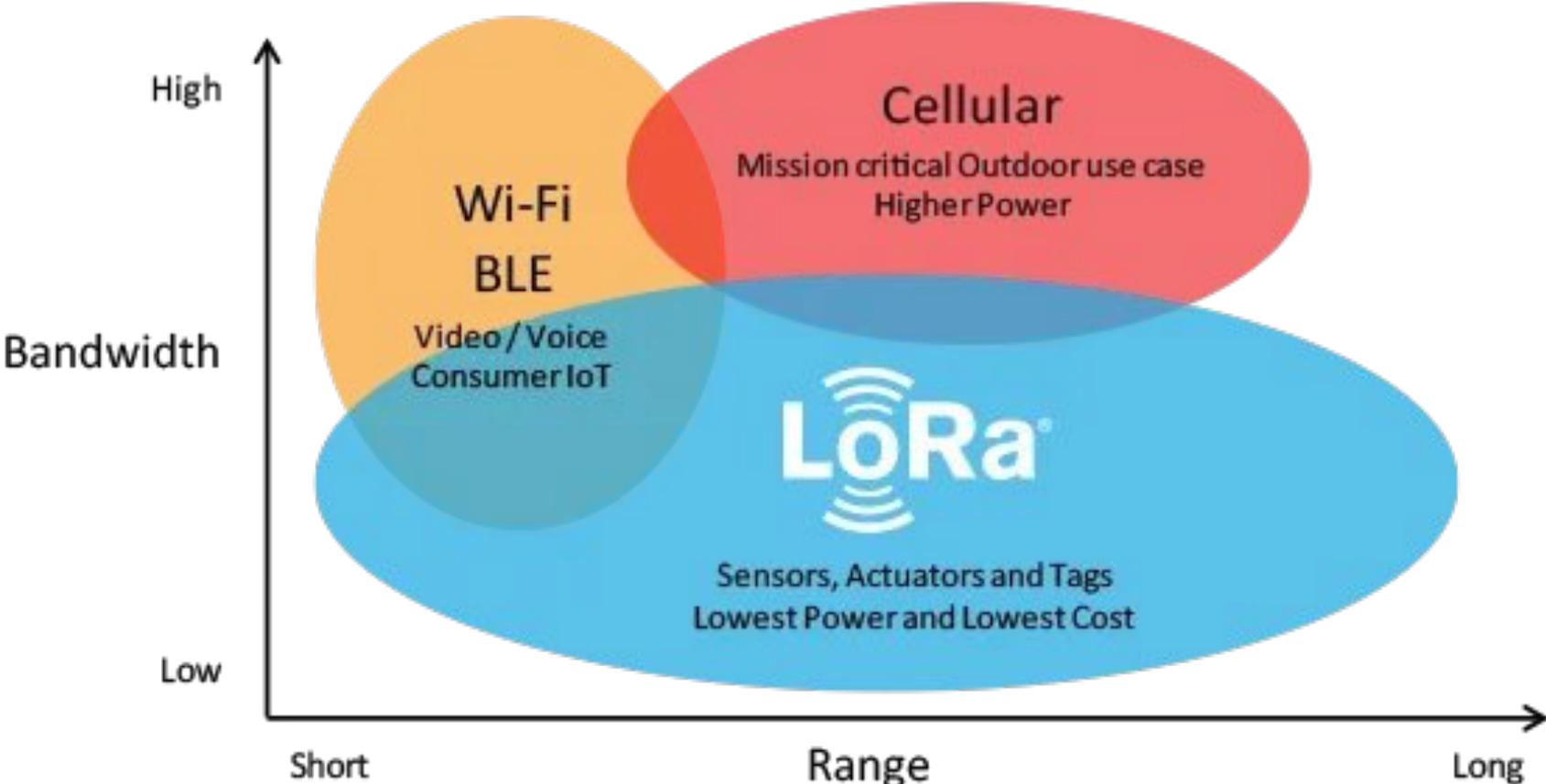
Just what the heck is Meshtastic?



Its a open network for building decentralized communications



Its a low power, low data, long range protocol



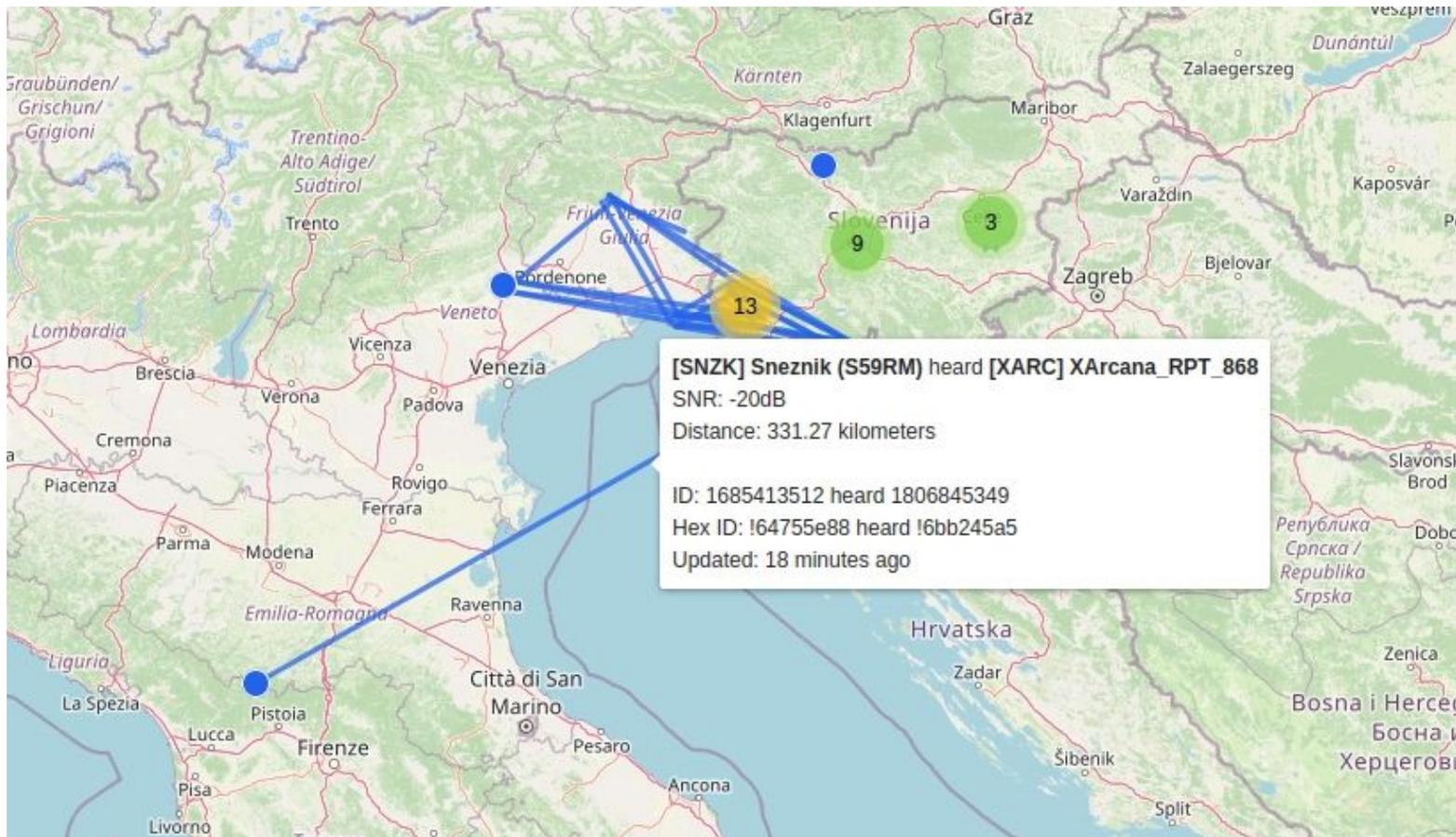


It's a mesh network that can reach vast distances with multiple hops!

It can go really far!

The current record is 331 km in a single hop!

Or just over 200 miles



It works when most other solutions won't

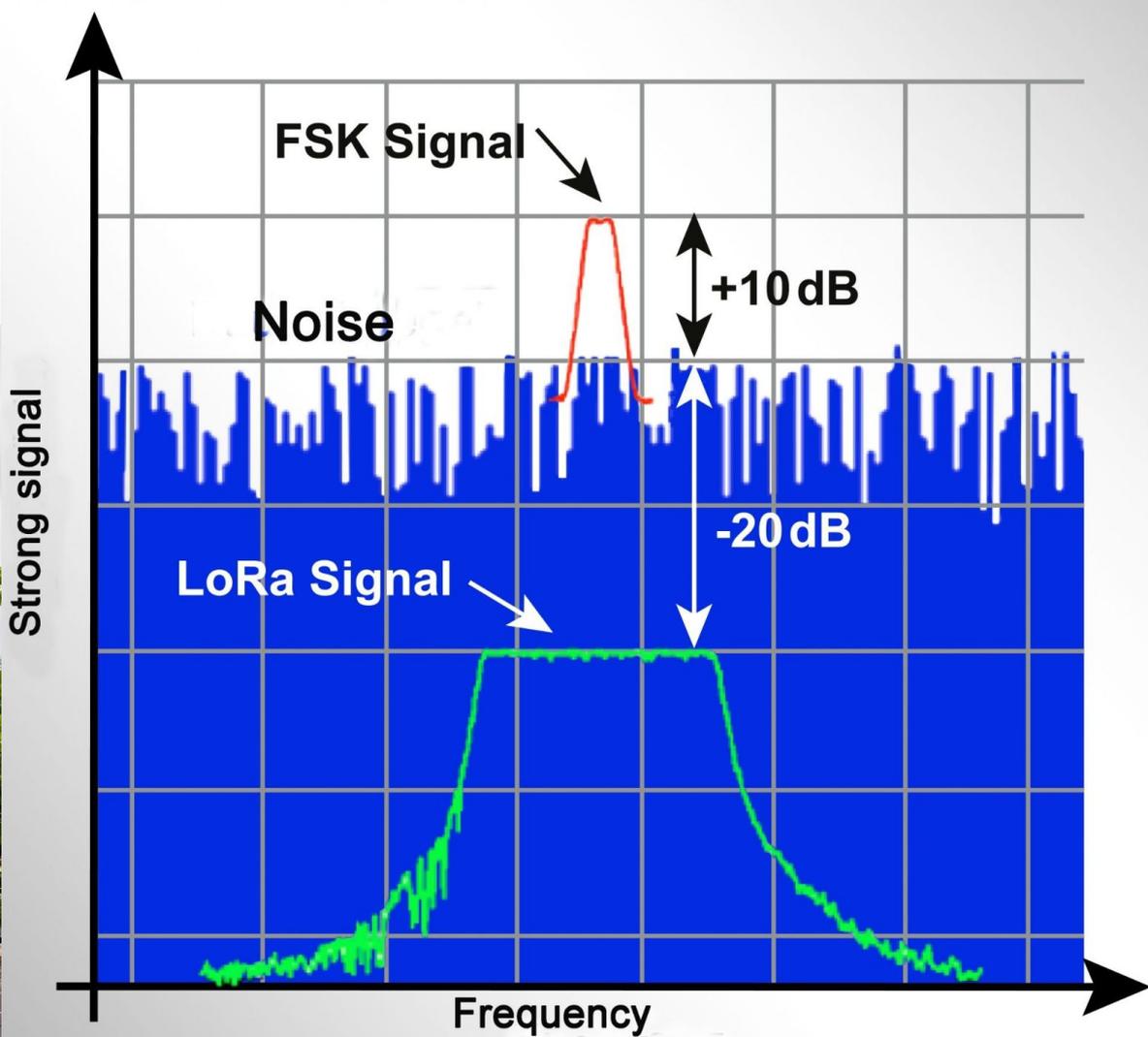
NATURAL DISASTERS

GRID OUTAGES

**BACKCOUNTRY
COMMUNICATIONS**



It works in
noisy
environments



It's Encrypted



Older versions user per channel

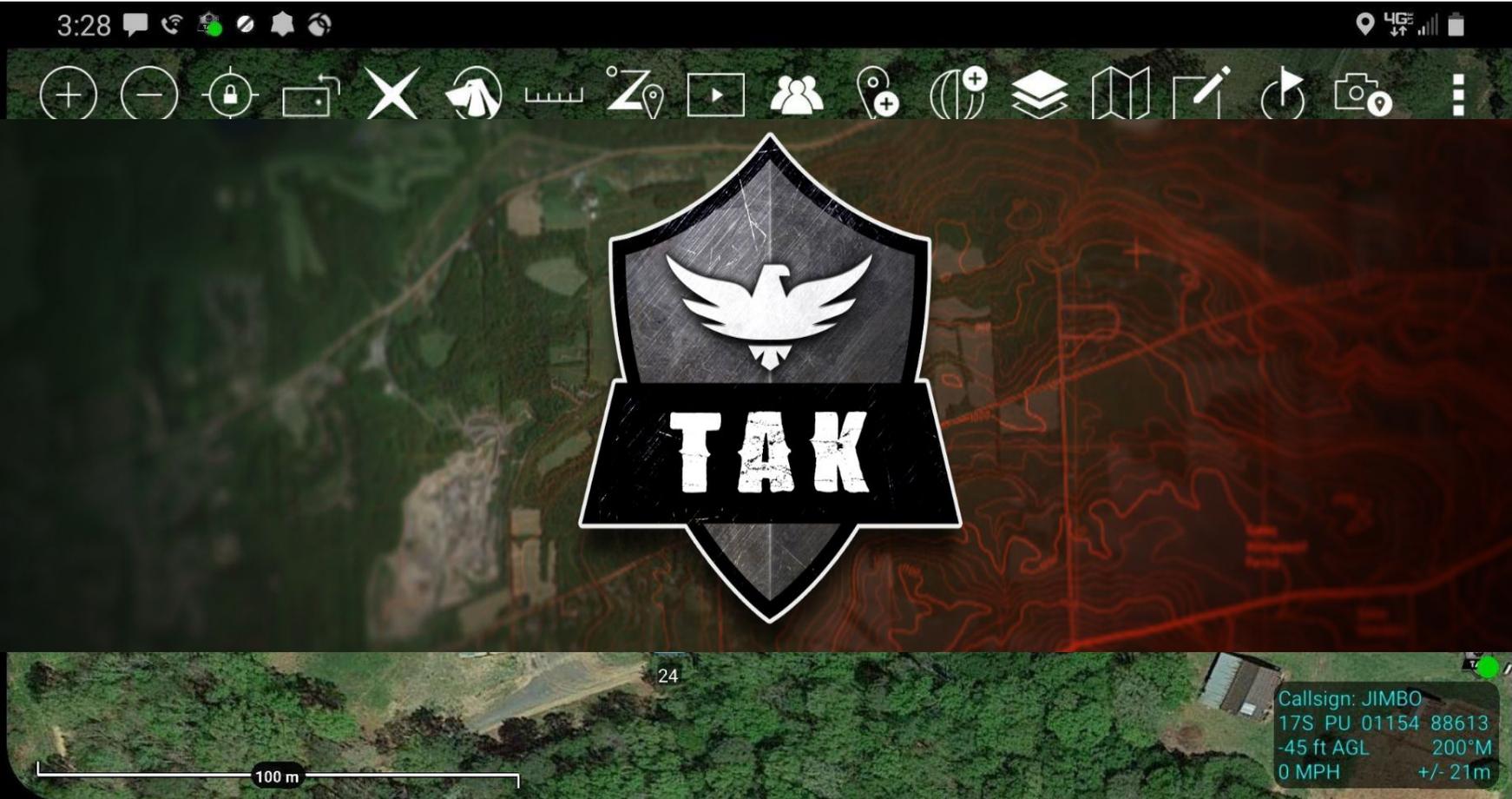
Pre Shared Keys

Newer firmware now has

Full AES 256 PKI per node
encryption...

Making messages more
secure.

It can be TAKtical



Are you excited yet!!!

It's offline texting... That's pretty much what it does....

Meshtastic can send text and VERY small data packets like GPS coordinates and sensor data.

Its relatively cheap, completely open, and the LoRa protocol is pretty amazing.

It has one job but it does it really well...

So it can send text messages and data chunks what's the big deal... We have cell phones and WiFi!?

Well LoRa and Meshtastic do those text messages REALLY well with no help from anything else like cell towers, internet, no dependencies.

- No cell service?
- No wifi?
- No line of sight?
- No power grid?
- Lots of noise?

No Problem!



Technical Overview

An open source data network that rides on the existing LoRa IoT protocol

- It's a full mesh network up to 7 hops deep (3 is normal)
- In North America it uses the license free 900 MHz ISM band 902 to 928 MHz using 104 frequency slots for data using up to +30DBm ERP at 1 Watt
 - +10DBm ERP at 10 Watts for Amateur Licensed Operators
 - Different rules for Amateur radio and Civilian use
- Default LongFast mode yields about 1 kbps of data
- Range is from 1 to 200+ miles

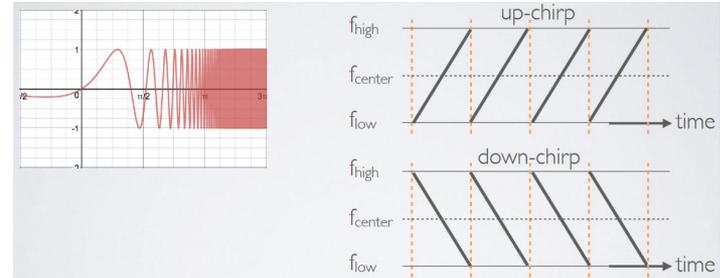
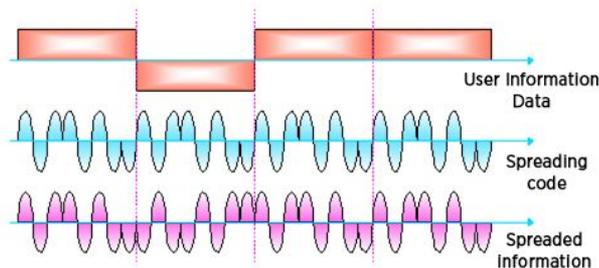
What is LoRa?

LoRa (from "**Long Range**") is a physical proprietary **radio communication** technique. It is based on **spread spectrum** modulation techniques derived from **chirp spread spectrum** (CSS) technology.

LoRaWAN (Long Range **Wide Area Network**) defines the communication protocol and system architecture. LoRaWAN is an official standard of the **International Telecommunication Union** (ITU), ITU-T Y.4480.

Together, LoRa and LoRaWAN define a **low-power, wide-area** (LPWA) networking protocol designed to wirelessly connect battery operated devices to the Internet in regional, national or global networks, and targets key **Internet of things** (IoT) requirements, such as **bi-directional communication**, end-to-end security, mobility and localization services.

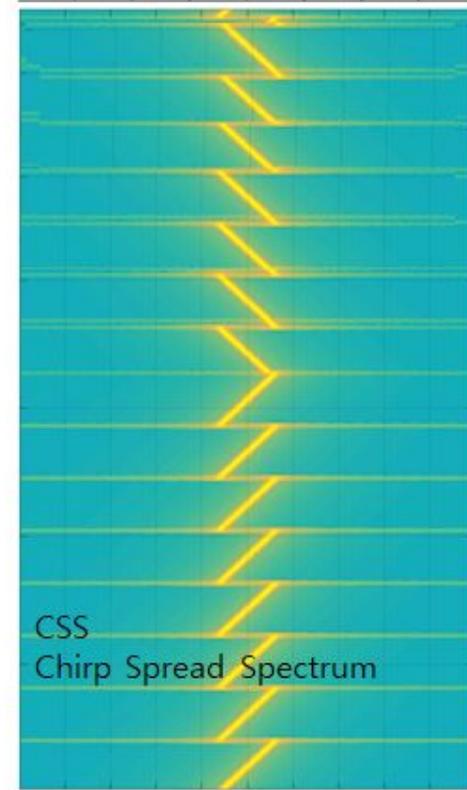
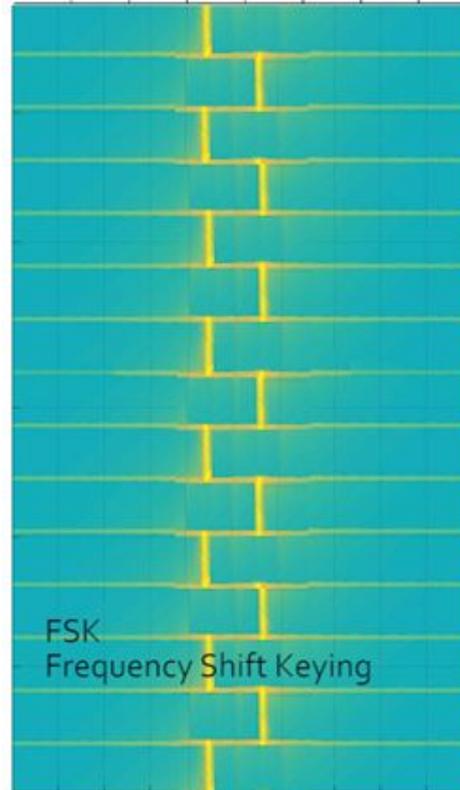
Meshtastic uses LoRa P2P (Peer to Peer), not LoRaWAN.



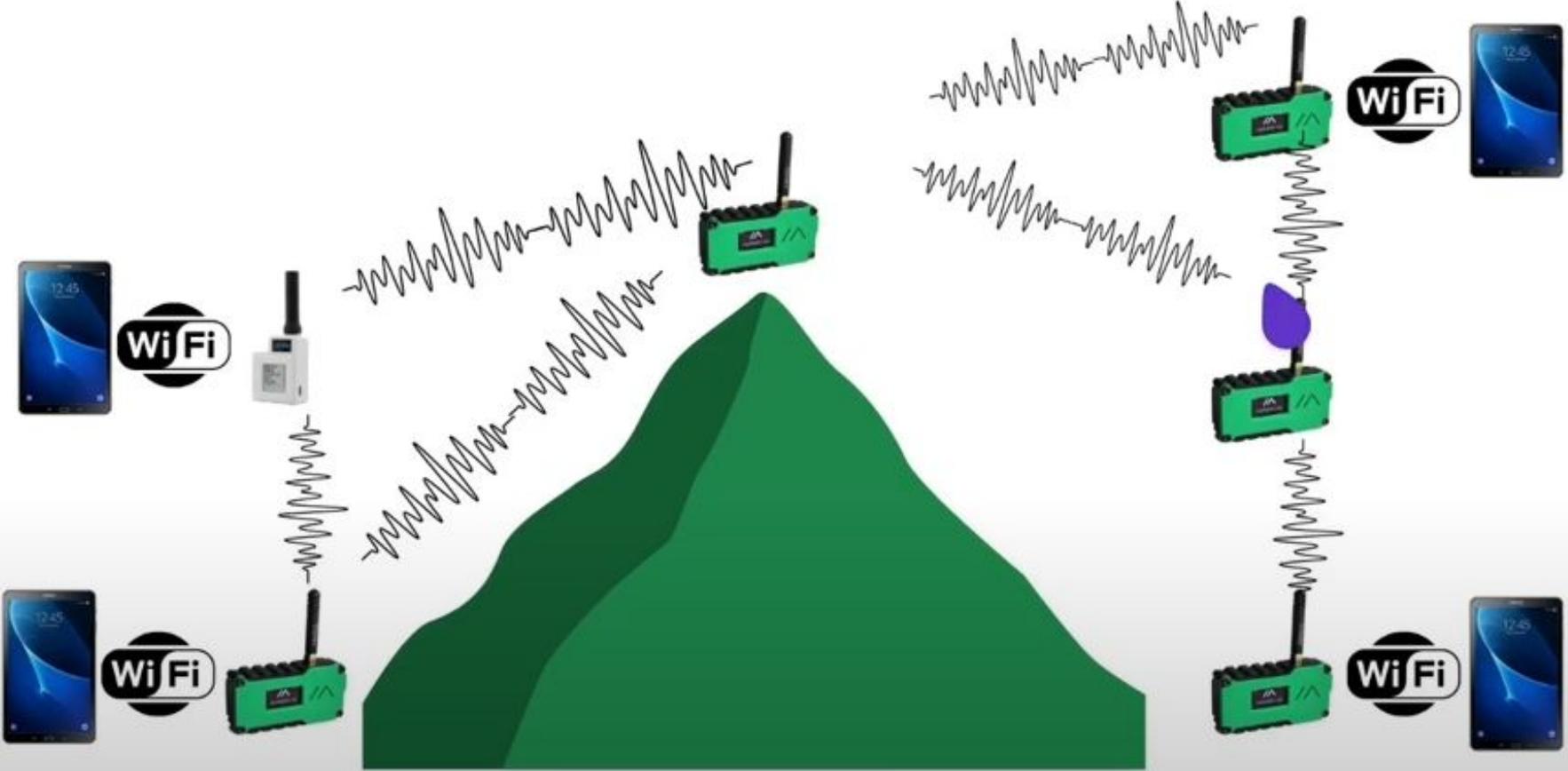
Why LoRa?

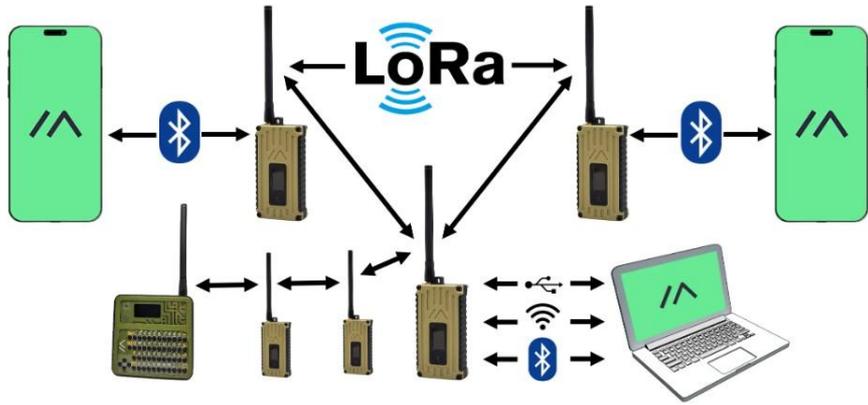
LoRa is the magic that is behind Meshtastic and other systems like it.

CSS is the secret sauce that allows LoRa to maintain data transmissions up to 20dB below the noise floor. Far beyond most other solutions. This also makes LoRa very hard to block or jam.



Mesh? What's that?





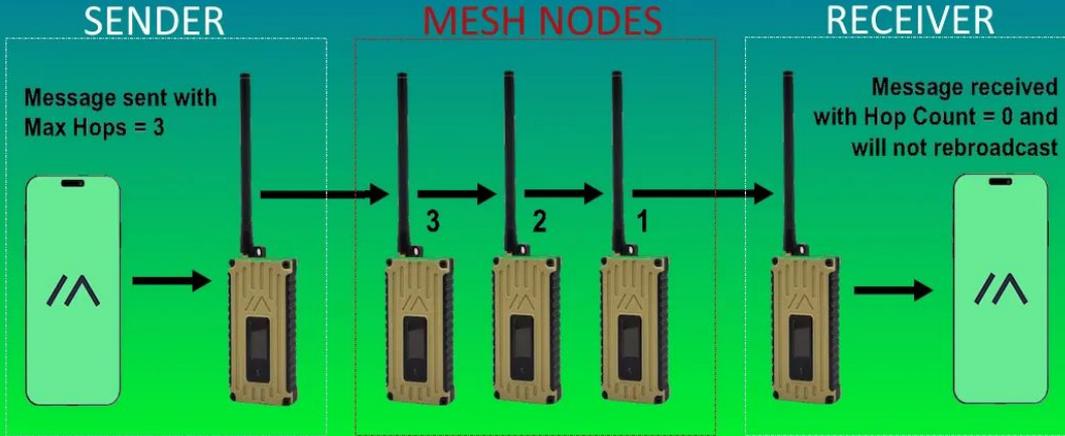
When you send a message on your Meshtastic companion app, it is relayed to the radio using Bluetooth, Wi-Fi/Ethernet or serial connection.

That message is then broadcasted by the radio. If it hasn't received a confirmation from any other device after a certain timeout, it will retransmit the message up to three times.



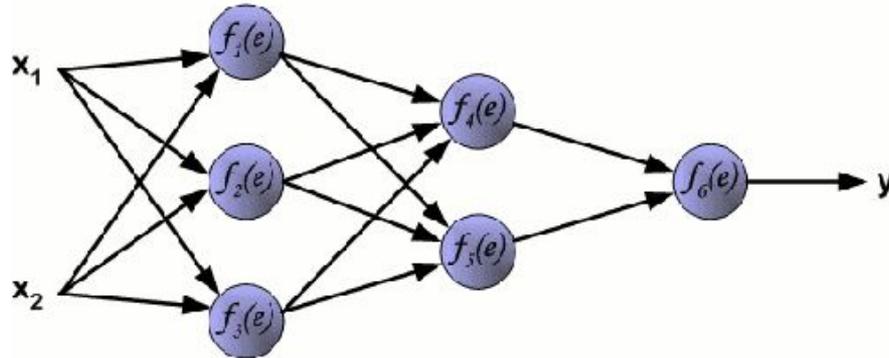
When a receiving radio captures a packet, it checks to see if it has heard that message before. If it has it ignores the message. If it hasn't heard the message, it will rebroadcast it.

MESHTASTIC HOPS



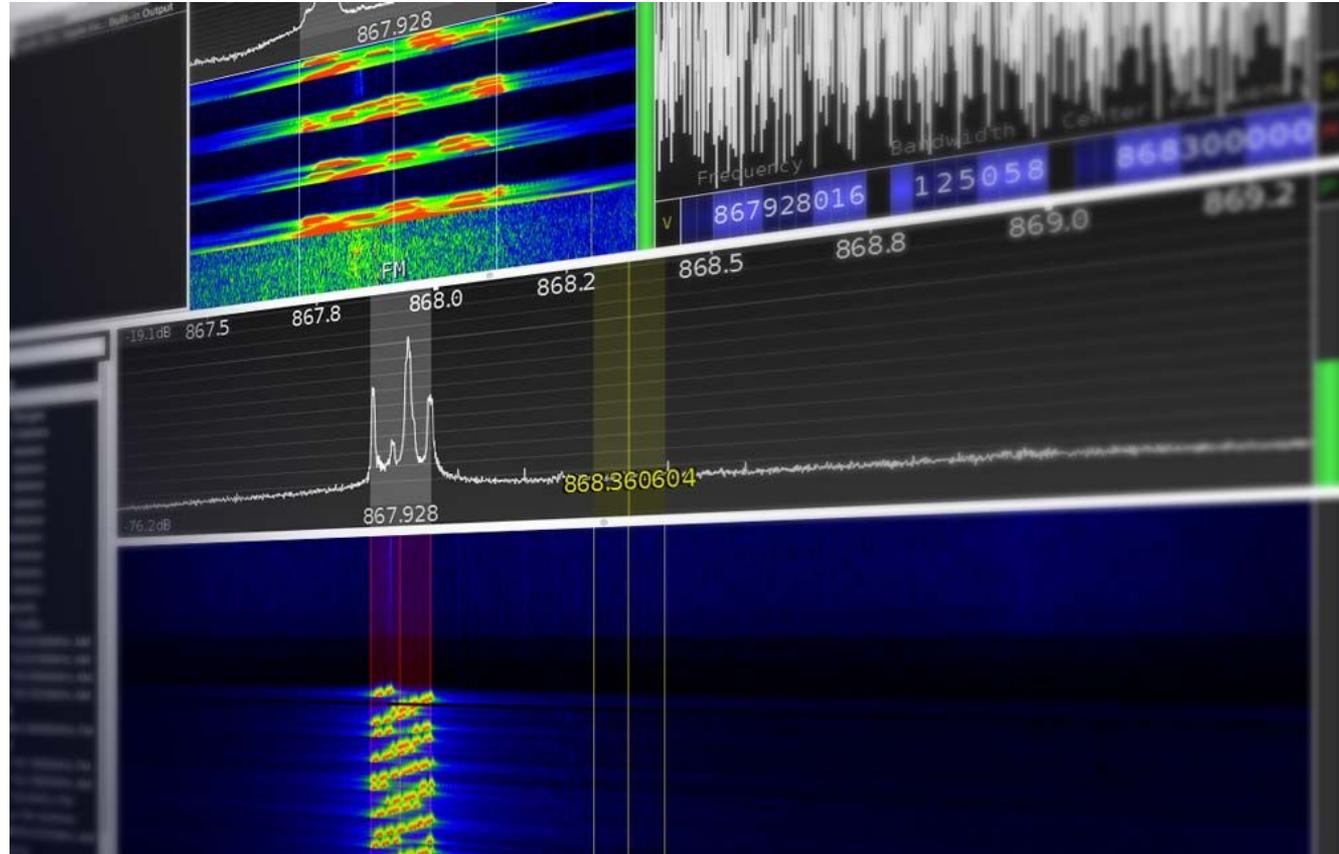
For each message a radio rebroadcasts, it marks the "hop limit" down by one. When a radio receives a packet with a hop limit of zero, it will not rebroadcast the message.

The radio will store a small amount of packets (around 30) in its memory for when it's not connected to a client app. If it's full, it will replace the oldest packets with newly incoming text messages only.



Frequency Usage

There are 104 frequency slots defined in the 900 MHz band for the US. After factory reset the radio will be set to frequency slot 20 with a center frequency of 906.875 MHz. (For the USA)



Frequency Usage

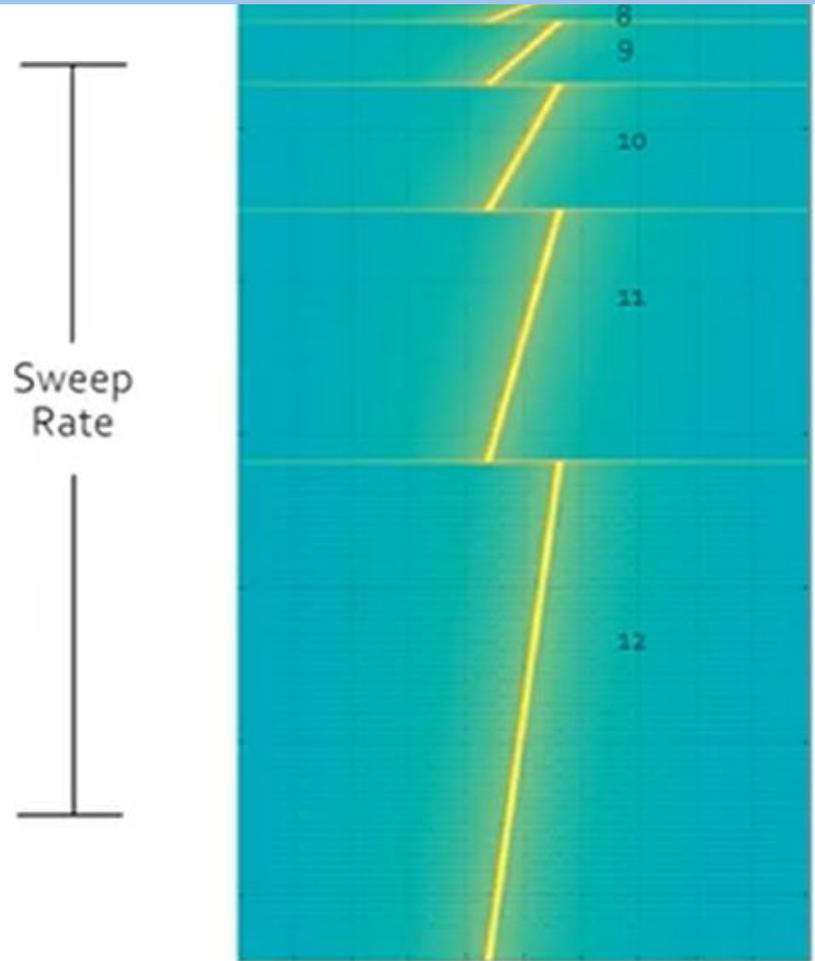
Various data-rate options are available when configuring a frequency slot and are inversely proportional to the theoretical range of the devices.

Spreading Factor (SF) - How much we "spread" our data over time.

- Each step up in Spreading Factor doubles the airtime to transmit.
- Each step up in Spreading Factor adds about 2.5db extra link budget.

Bandwidth - How big of a slice of the spectrum we use.

- Each doubling of the bandwidth is almost 3db less link budget.

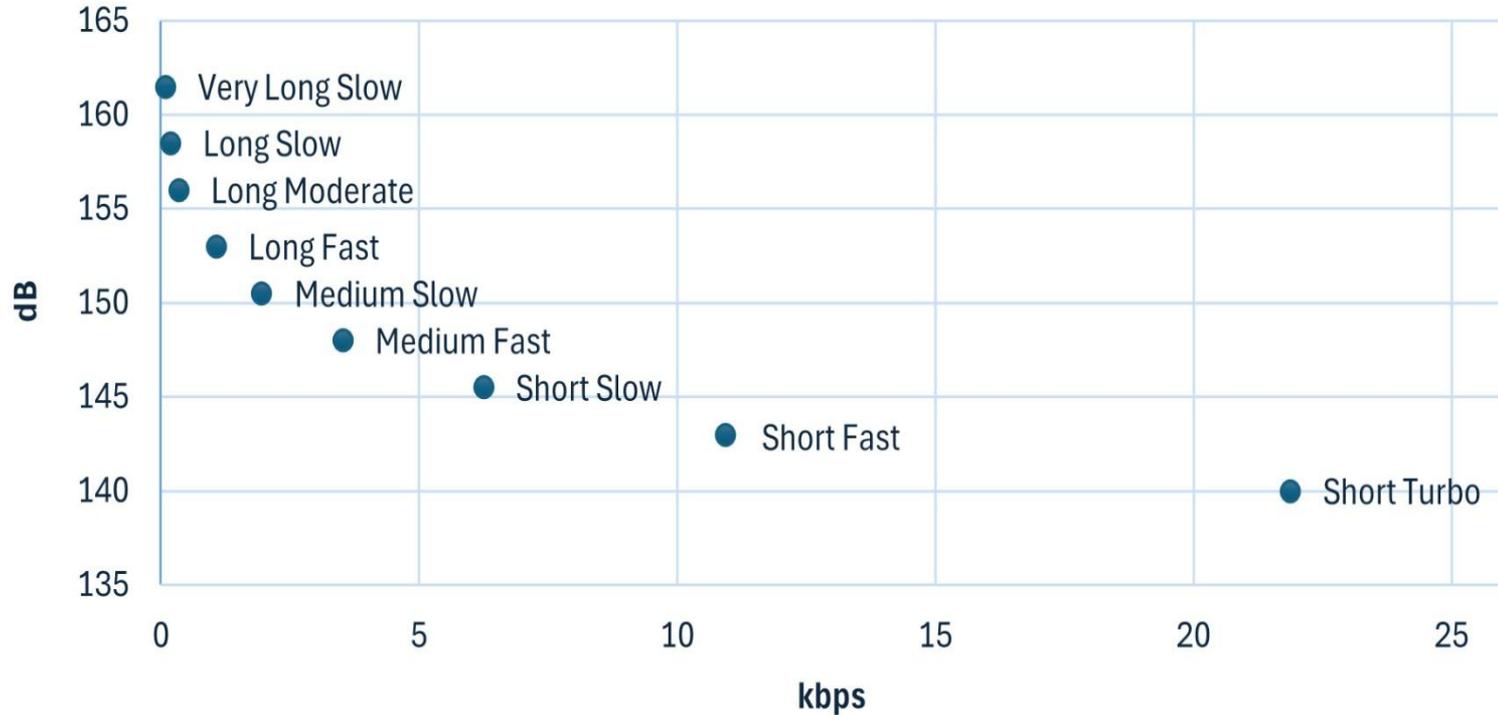


Meshtastic LoRa modes

Meshtastic has several modes that vary bandwidth vs speed.

Faster means a lower link budget. The default is LongFast

Link budget VS data rate

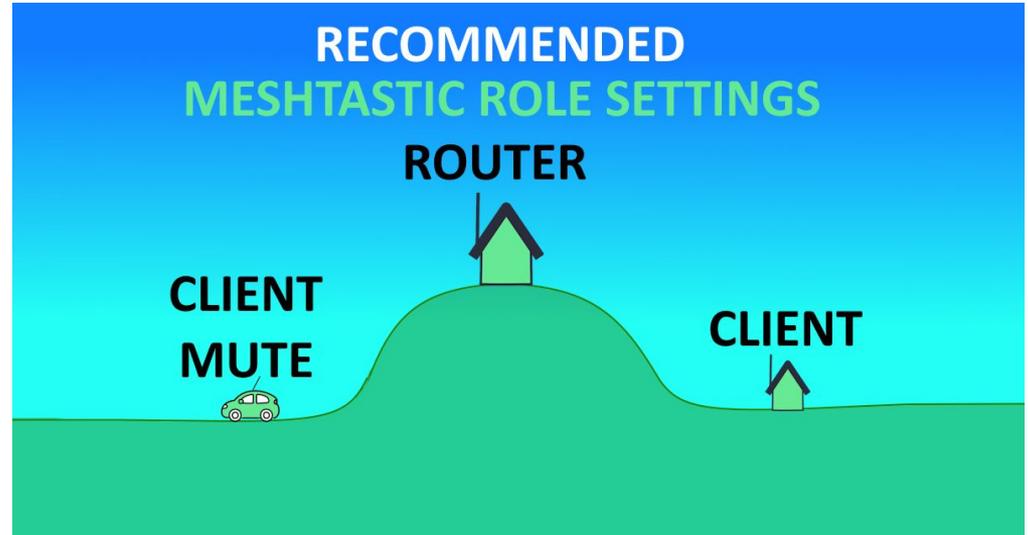


Node Operating Modes

Meshtastic nodes have different roles for operation.

Most of the time you will use CLIENT mode as it will relay messages and allow you to send and receive messages.

There are a few special modes we will talk about here.



Node Operating Modes

- CLIENT
- CLIENT MUTE
- SENSOR
- ROUTER
- CLIENT BASE

- **Client Node**

App connected or stand alone messaging device.

General use for individuals needing to communicate over a dynamic Meshtastic network with support for client applications.

Send, Receive, Relay.



Node Operating Modes

- CLIENT
- CLIENT MUTE
- SENSOR
- ROUTER
- CLIENT BASE

- Client Mute Node

App connected or stand alone messaging device.

For individuals communicating over a robust Meshtastic network with better positioned nodes close by.

Send, Receive.



Node Operating Modes

- CLIENT
- CLIENT MUTE
- **SENSOR**
- ROUTER
- CLIENT BASE

- **Sensor Node**

Broadcasts telemetry packets as priority.

Deployed where gathering environmental or other sensor data is crucial, with efficient power usage and frequent updates.

Send. Receive and Relay when Awake

T-Echo 915MHz BME280 Kit Brown



Node Operating Modes

- CLIENT
- CLIENT MUTE
- SENSOR
- **ROUTER**
- CLIENT BASE

- **Router Node**

Infrastructure node for extending network coverage by relaying messages.

Best positioned in strategic locations to maximize the network's overall coverage.

Relay with priority.



Node Operating Modes

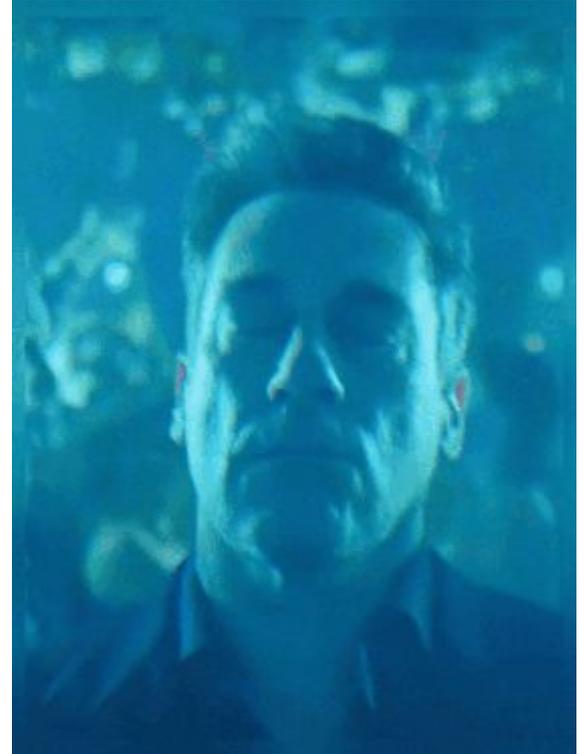
- CLIENT
- CLIENT MUTE
- SENSOR
- ROUTER
- CLIENT BASE

- **Client Base Node**

Behaves like a Router for favorited nodes (Attic Node).

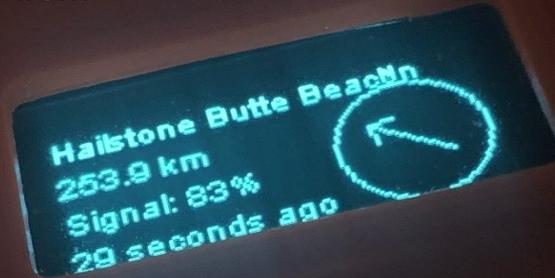
Treated like a Client by the greater mesh!

Send, Receive, Relay.
Relay with priority for Favorites.



What kind of range can I expect?

Typical stock range node to node is from
0.5 to 2 miles on the ground.



Height is might!

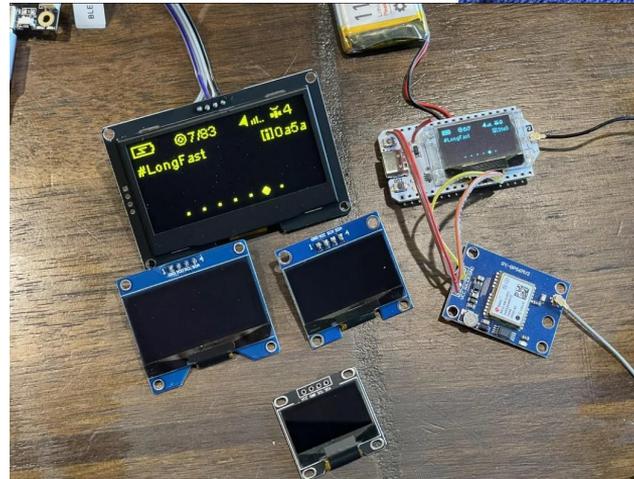
With good line of sight nodes can reach much further with single hop connections hitting well over 10 miles. As part of a mesh, 3 radios could easily reach 15-30 miles on 100mw and stock antennas.

Today, BuffaLoRa.org achieves a stable LoRa Mesh from Orchard Park to North Tonawanda, often temporarily connecting to Niagara Falls, Rochester, and Toronto by LoRa.

How does it work?

Meshtastic needs 3 things to work.

1. A Meshtastic node!
2. A phone or hardware like the T-DECK that combines the node and an interface to create and receive messages.
3. Someone to talk to!

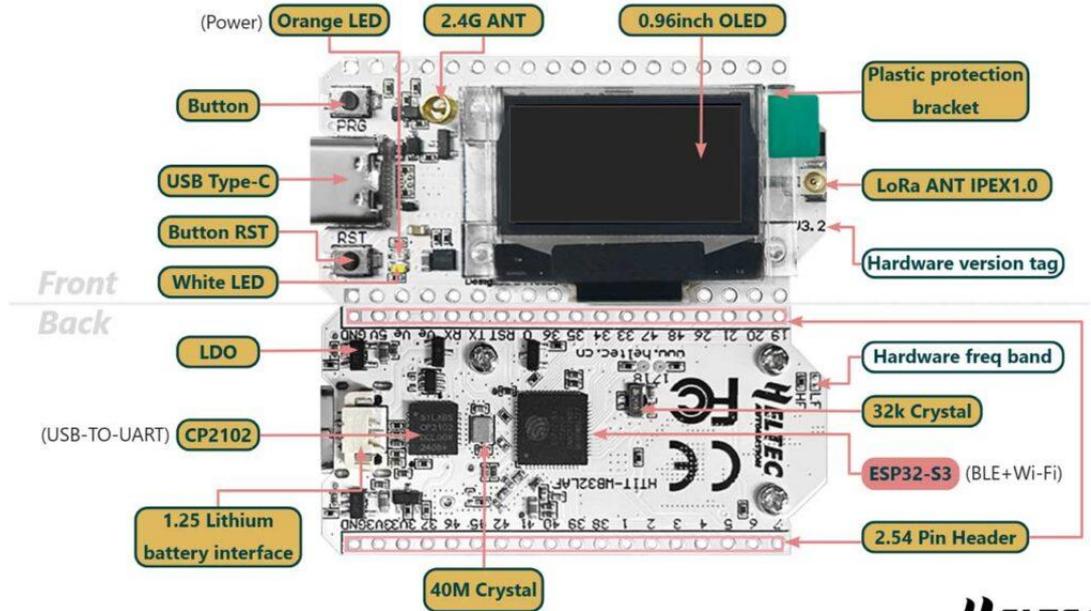


Hardware Components

What is a Meshtastic node?

This is essentially a microcontroller with a LoRA radio generally an SX1276 or SX1262 transceiver paired with an ESP32 or NRF52x MCU

WiFi LoRa 32 V3



Hardware Key Differences

ESP32 based units offer WiFi and Bluetooth as well as tons of I/O and Fast dual core 240 MHz MCU. This allows cool features like a fancy GUI but at the expense of battery usage, typically around 140~240ma.

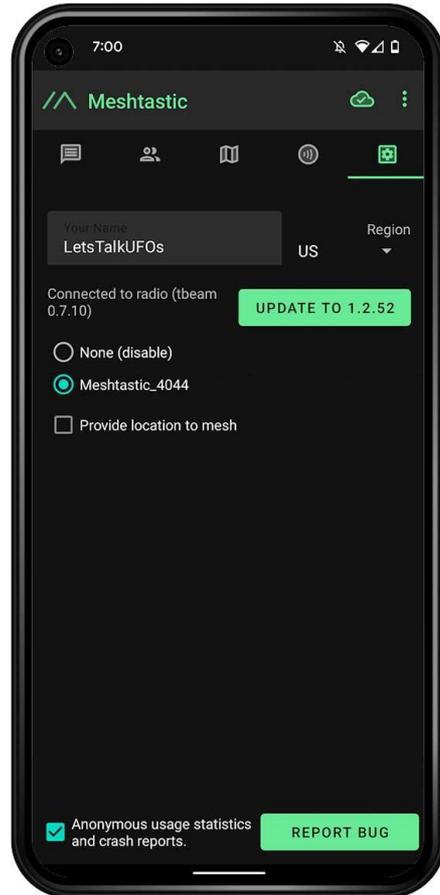
Nordic N52840 Based units offer only Bluetooth and a single core 64 MHz MCU but consume much less power typically around 80~200ma so it may be a better choice for remote battery operated and solar powered nodes.



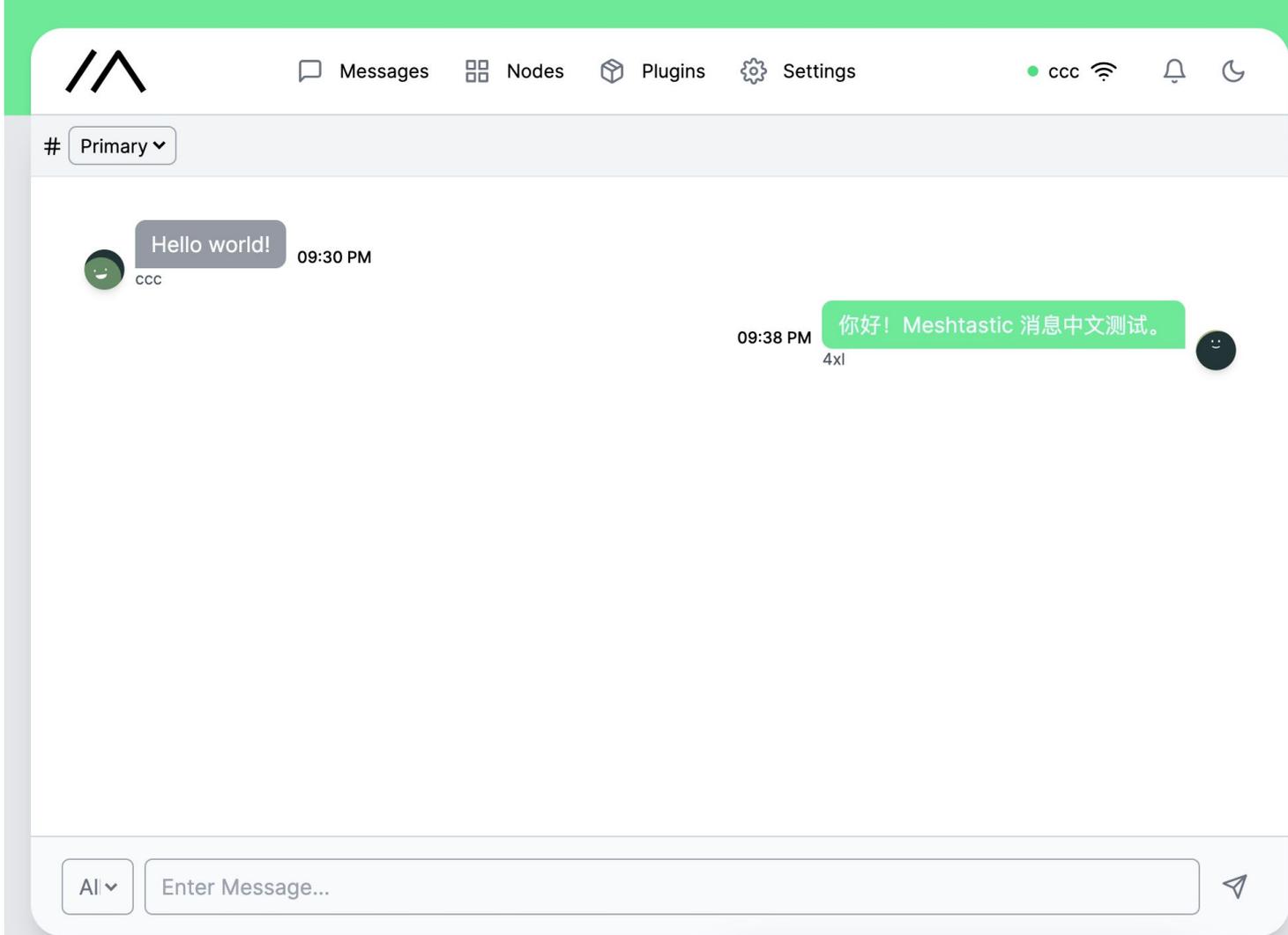
Communications

Meshtastic firmware provides up to 3 ways to connect to the node

1. Serial when plugged into a pc or phone the device will act as a serial port and you can send serial commands to it.
1. Bluetooth it will show up as a bluetooth device and allow you to pair with a code.
1. WiFi devices on the same network can connect to and use the app or web interface.



Once connected you can start chatting or using plugin applications that communicate over the Meshtastic network.



Node Options - Everyday Carry ~\$50



SenseCAP
T1000-E for
Meshtastic
★★★★★

DPCVXJER
(Seed)

IP65

10%

[Seed*](#)
[Amazon**](#)



WisMesh
Tag
★★★★★

IP67

Free
Shipping
with Prime



Wio Tracker L1
Pro & L1 E-ink for
Meshtastic

54E2V9ZK

8%

[Seed*](#)



PocketMesh
★★★★★

Qi Phone
Battery

Free
Shipping
with Prime

Node Options - Infrastructure ~\$50-200



Solar Node P1
Series for
Meshtastic
★★★★★

5%

LAT9VDTV
(Seed)

[Seed](#)*

[Amazon](#)**



Beacon Solar
Meshtastic Node
- Preconfigured

[Atlavox](#)*



T-Beam 1W

[LilyGo](#)*



Station G2

★★★★★

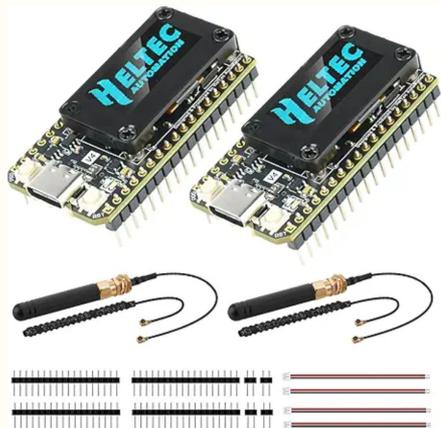
Node Options - DIY ~\$14-35



WisBlock
Mini
Meshtastic
Starter Kit
US915
★★★★☆

Free
Shipping
with Prime

[Amazon](#)**



ESP32 LoRa
v4
★★★★☆

Free
Shipping
with Prime

[Amazon](#)**



XIAO Series
★★★★☆

2%

L77ZLW26

[Seeed](#)*



[Inexpensive Homemade
Outdoor Solar Node –
BuffaLoRa](#)

Let's get started!

So you bought a thingy...



Programming!

After assembly we can see that our device is does not appear to be running Meshtastic.... Oh no!

Not to worry let's flash its brain to get Meshtastic on it.



Programming!

So just how do we do that?

The engineers that made these microcontrollers made that easy! They have built in serial ports and will check them on boot! Lucky for us these boards almost always include a USB to serial chip for easy of use.

So let's just plug it in!



Programming!

On connecting it to USB on your PC you should see it show up as a USB device like this in device manager.



Most PC's will install it automatically

<https://www.silabs.com/developer-tools/usb-to-uart-bridge-vcp-drivers> if you need drivers (linux+mac as well)



Programming!

https://flasher.meshtastic.org

FLASHER



Select Target Device

Device

Plug in your device via USB. Please ensure the cable is not a power-only one.



Select Firmware

Firmware

Choose from the release options or upload a release zip downloaded from Github.



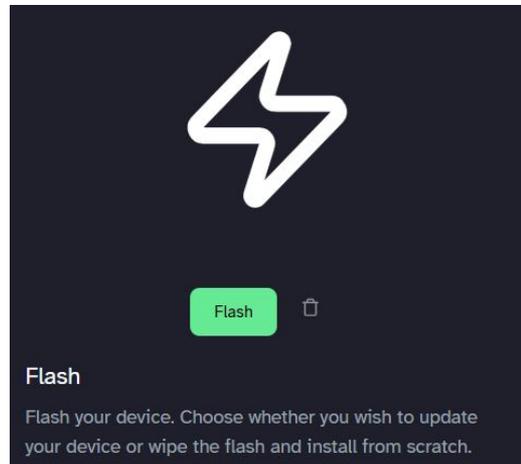
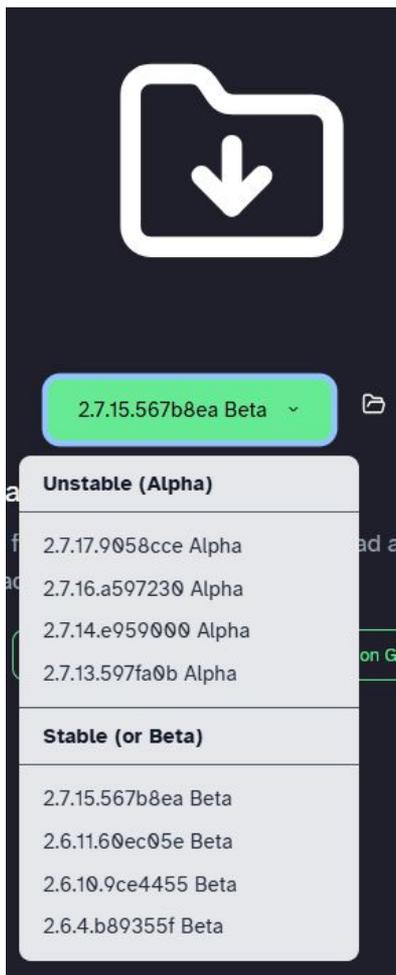
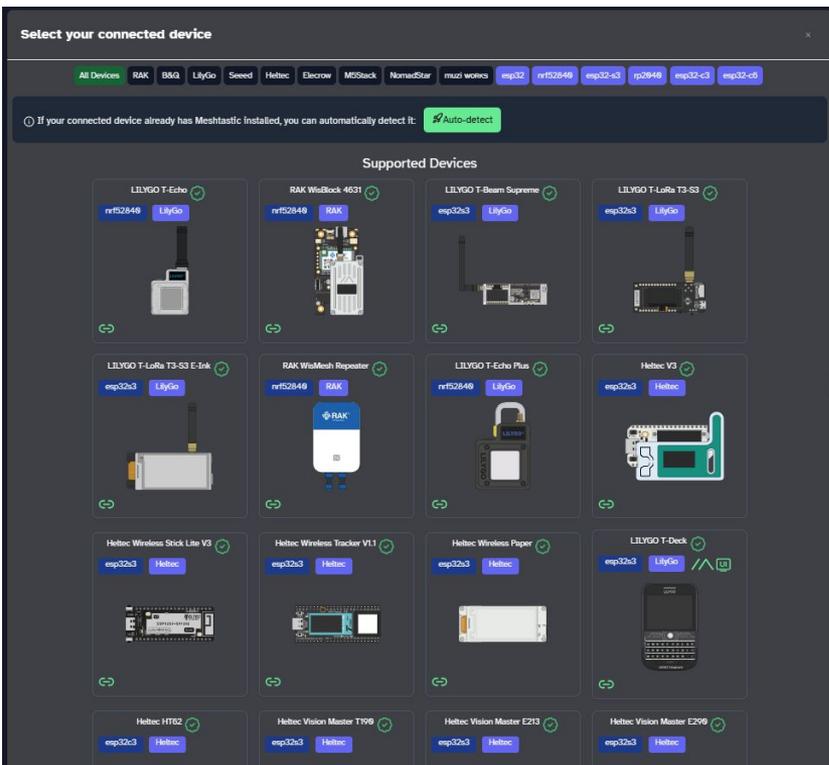
Flash

Flash

Flash your device. Choose whether you wish to update your device or wipe the flash and install from scratch.

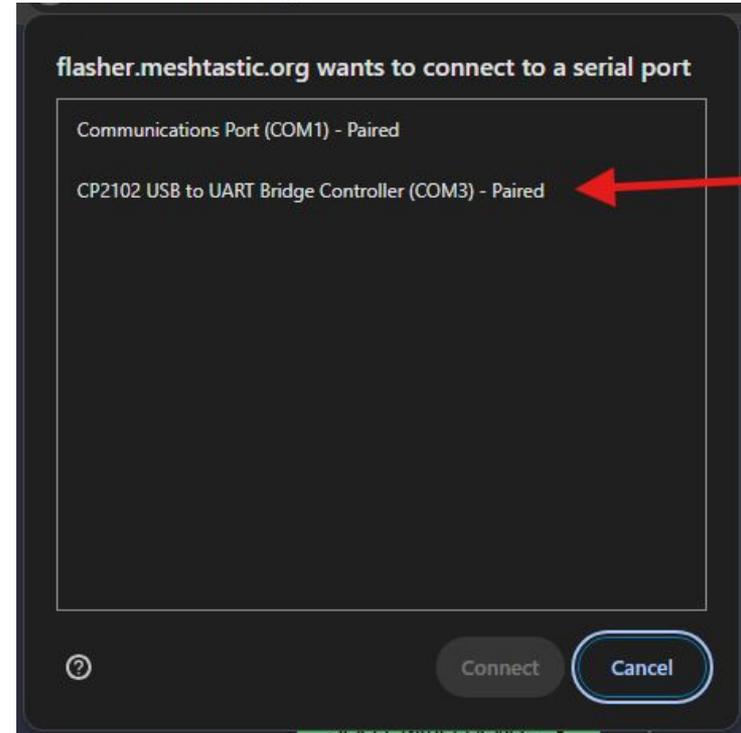
[Open Serial Monitor](#) [Meshtastic Docs](#) [Contribute on GitHub](#) [us Language](#)

Programming!



Programming!

When you hit flash or program you might get a prompt from chrome or firefox on what serial port to let the website use. Click the one that showed up when you connected the Meshtastic node.



Channels

Role

Each channel is assigned one of 2 roles:

0-7 Channels are available

PRIMARY

This is the first channel that is created for you on initial setup.

Only one primary channel can exist and can not be disabled.

Periodic broadcasts like position and telemetry are only sent over this channel.

SECONDARY

Can modify the encryption key (PSK).

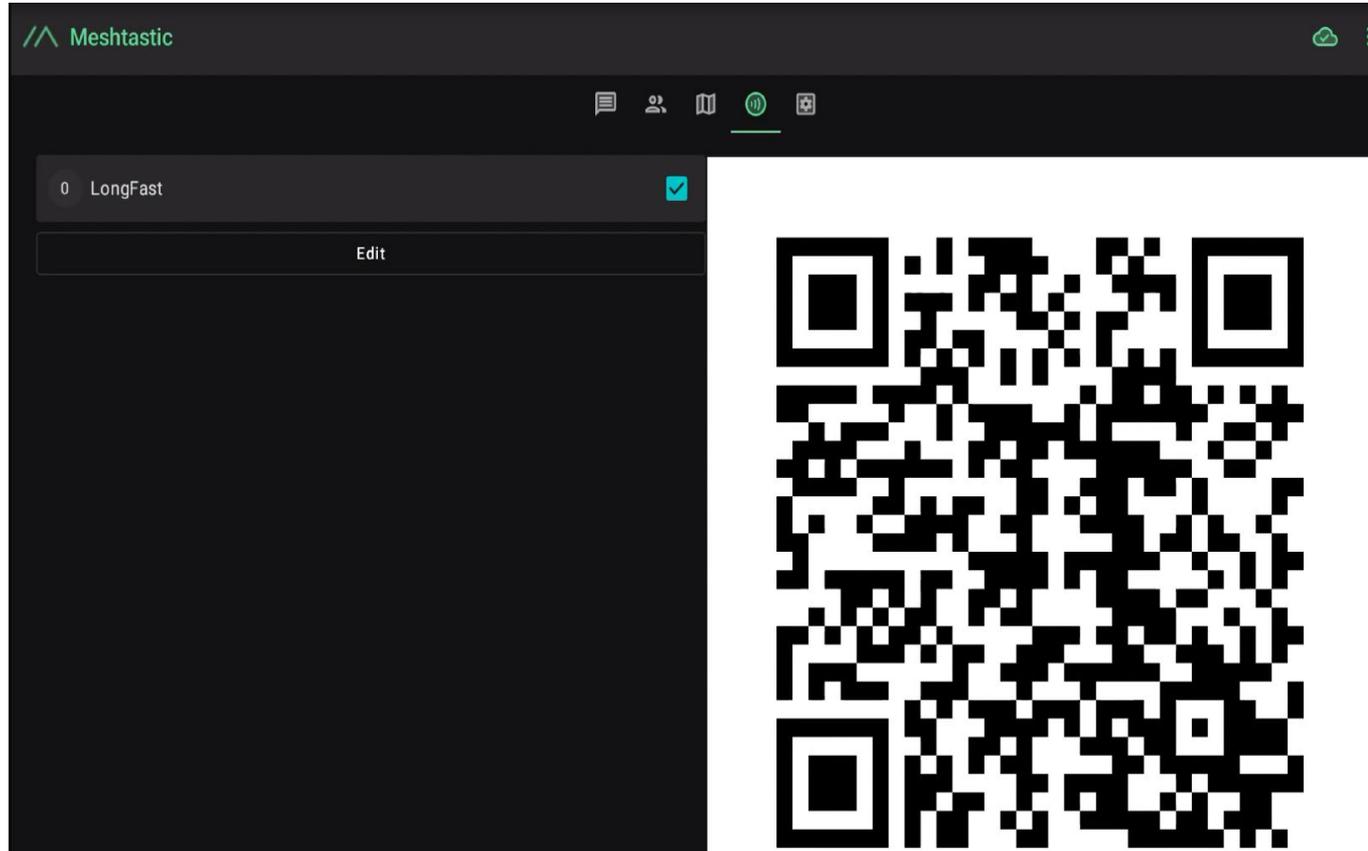
Secondary Channels are mostly for private group chats.

Index	Channel	Default Role	Purpose
0	1	PRIMARY	Used as default channel
1	2	DISABLED	User defined
2	3	DISABLED	User defined
3	4	DISABLED	User defined
4	5	DISABLED	User defined
5	6	DISABLED	User defined
6	7	DISABLED	User defined
7	8	DISABLED	User defined

Channels

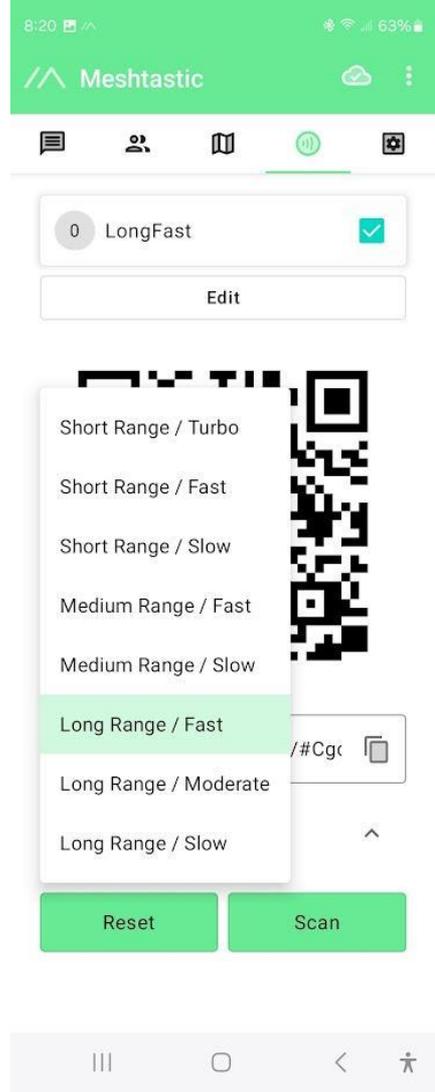
The default Channel is LongFast and has a predefined key. As you might guess it uses the LongFast radio preset setting and speed.

You can easily make a custom channel to chat privately with friends and family, and share the channel details using a QR Code.



Radio Presets

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

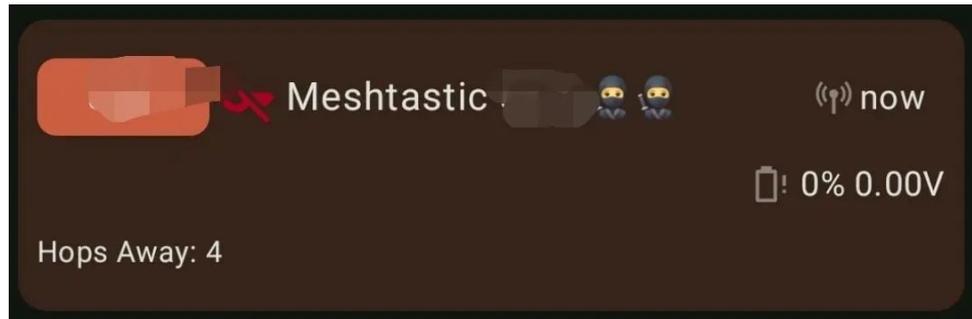


...That one time at DEF CON!

... a researcher demonstrated a way to forge node information under certain conditions, causing downstream issues in channel messaging.

Encrypted DMs and private keys were not compromised.

The specific issue has already been patched, and the event highlighted areas for future improvements, including user experience, identity verification, and message signing.



<https://app.intigriti.com/programs/meshtastic/meshtastic/detail>

Latest improvements in Firmware 2.6+ and 2.7+

Radio Utilization

- Next-Hop Routing for DMs (reduces utilization)
- Meshtastic over LAN via UDP (Mesh Bridging across presets without hop cost)
- Zero-Cost Hops between Favorited Infrastructure Nodes (Enables larger meshes)
- Telemetry disabled by default (reduces utilization)
- Deprecate Repeater Device Role - Clearer topology

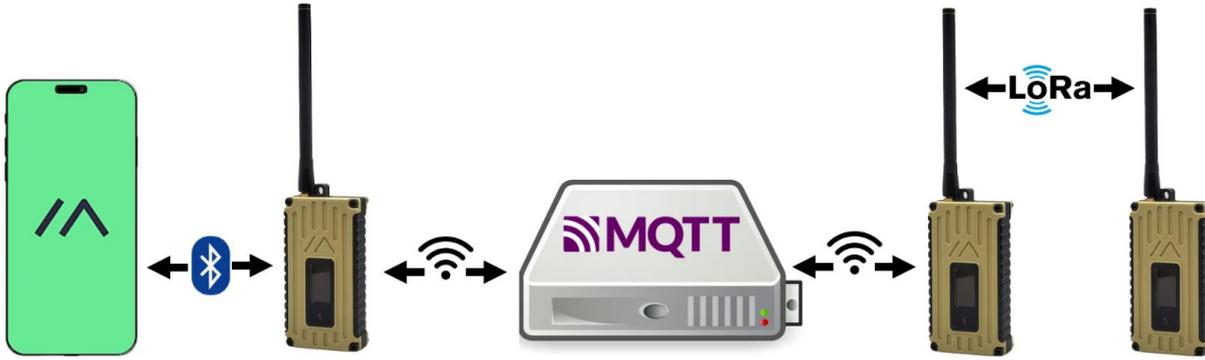
User Experience

- Meshtastic UI (MUI): Standalone device GUI
- inkHUD: Low power always on e-Ink devices
- BaseUI: Improved and unified on-device OLED and TFT experience
- Author messages on single button devices!
- UI Switching between MUI or BaseUI (Bluetooth mode)

Security Improvements / Fixes

- Manual Key Verification
- Low Entropy Key Errors and Automatic Update
- Duplicate Public Key Messages
- DEF CON Spoof and Flood Fix
- Block DMs with non-PKI nodes
- Favorited Nodes retained when clearing stale nodes

What else can we do with Meshtastic and LoRa?



```
user@TC2:~$  
user@TC2:~$  
user@TC2:~$ cd TC2-BBS-mesh  
user@TC2:~/TC2-BBS-mesh$ ls  
bulletins.db      config.ini        db_operations.py  fortunes.txt      mesh-bbs_service  
command_handlers.py  config_init.py  docker            LICHTOR           message_processor.py  
user@TC2:~/TC2-BBS-mesh$ python3 -m venv venv  
user@TC2:~/TC2-BBS-mesh$ source venv/bin/activate  
(venv) user@TC2:~/TC2-BBS-mesh$ python server.py
```

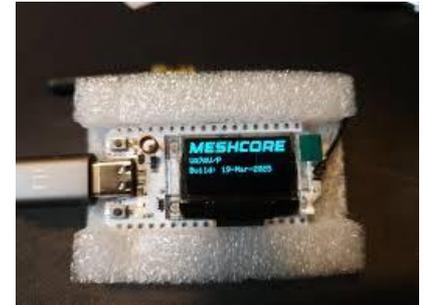
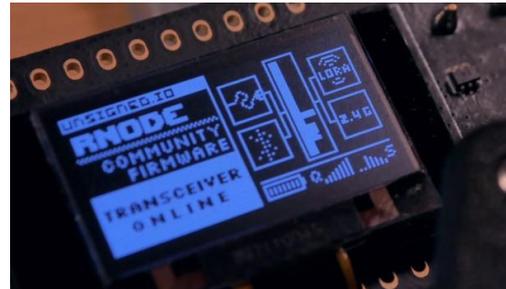
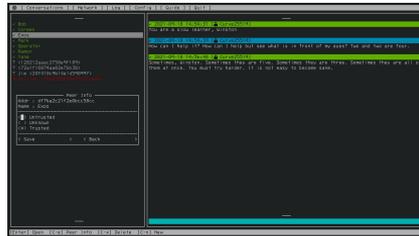
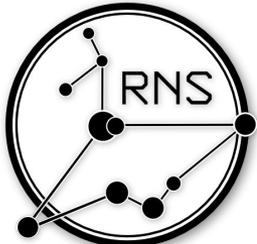
TC2-BBS
Meshtastic Version
2024-06-30 21:52:14,272 - INFO - TC2-BBS is running on serial interface...
Database schema initialized.

Reticulum

Nomad Network

RNODE

MeshCore



What is BuffaLoRa?

Started as SnyderMesh, we grew across the Buffalo area from 4-5 Nodes to 200+ since Feb of '25

<https://BuffaLoRa.org>

 Info about the Mesh in WNY

 July 17 Monthly Meetups

 Connect on Discord

 News & Updates

 Build Guides & Walkthroughs

 Device Ratings & Deals

 Contact us

BuffaLoRa

Keeping WNY Connected, One Message at a Time

[Home](#) [Blog](#) [Devices](#) [Partner with us](#) [About](#)

Volunteer-powered, community-driven Meshtastic network

BuffaLoRa is focused on serving the city of Buffalo, NY and surrounding neighborhoods. Using low-power radio devices, BuffaLoRa offers a free, resilient, and decentralized way to send text messages and share location data – no cell service or Wi-Fi required.

Whether you're hiking in the woods, prepping for emergencies, or just chatting across the block, BuffaLoRa connects neighbors through a mesh of LoRa radios that relay messages from one node to another. Each participant strengthens the network, extending its range and reliability.

Meshtastic

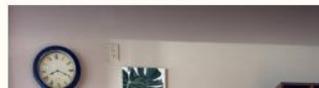
Partnerships

Snyder, NY

Buffalo, NY

Discord

What We Offer



Any Questions?



Who can help get a node deployed?

Special thanks to KC9MNE who originally created this presentation material and allowed for its usage and modification