

Fun with LoRa and Ham Radio

Who am I?

- Ben Jackson, N1WBV
- Licensed since 1995
- Salty digital operator since 1998
- Been playing with LoRa and Meshtastic since 2024
- Active with APRS and LoRA since 2025

Agenda

- What is LoRa?
- The Hardware
- The Platforms
- Call to Action

Understanding LoRa

What the heck is LoRa?

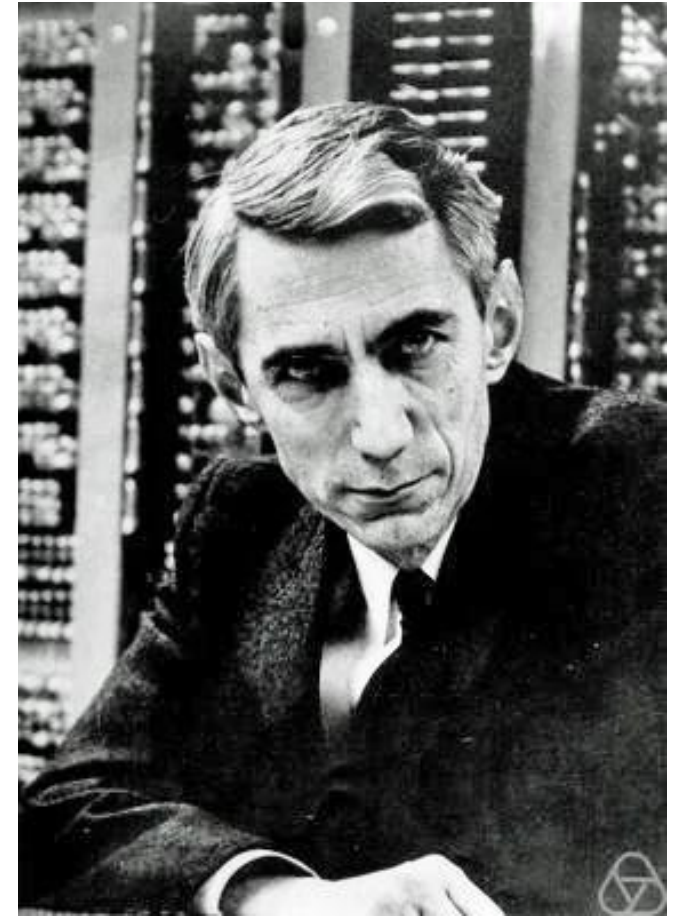
- LoRa ("Long Range") is a spread-spectrum radio modulation technique
- Developed in 2009 by a French semiconductor startup
 - Now controlled by a company called SemTech
- Designed for Internet of Things (IoT) devices
 - Low power output
 - Low power consumption
 - Low data rates
- 1-3 mile range
 - In urban environments

Frequencies and Bands

- 915 MHz (Americas)
 - Most common LoRa band in the US
 - Unlicensed 902–928 MHz ISM allocation
 - Hey! Also our 33cm band!
- 433 MHz (Europe & elsewhere)
 - European ISM band
 - Hey! Also our 70cm band!
- Also other bands (868MHz, etc)
- Most devices are stuck to a band
 - Watch out

Why does LoRa work so well?

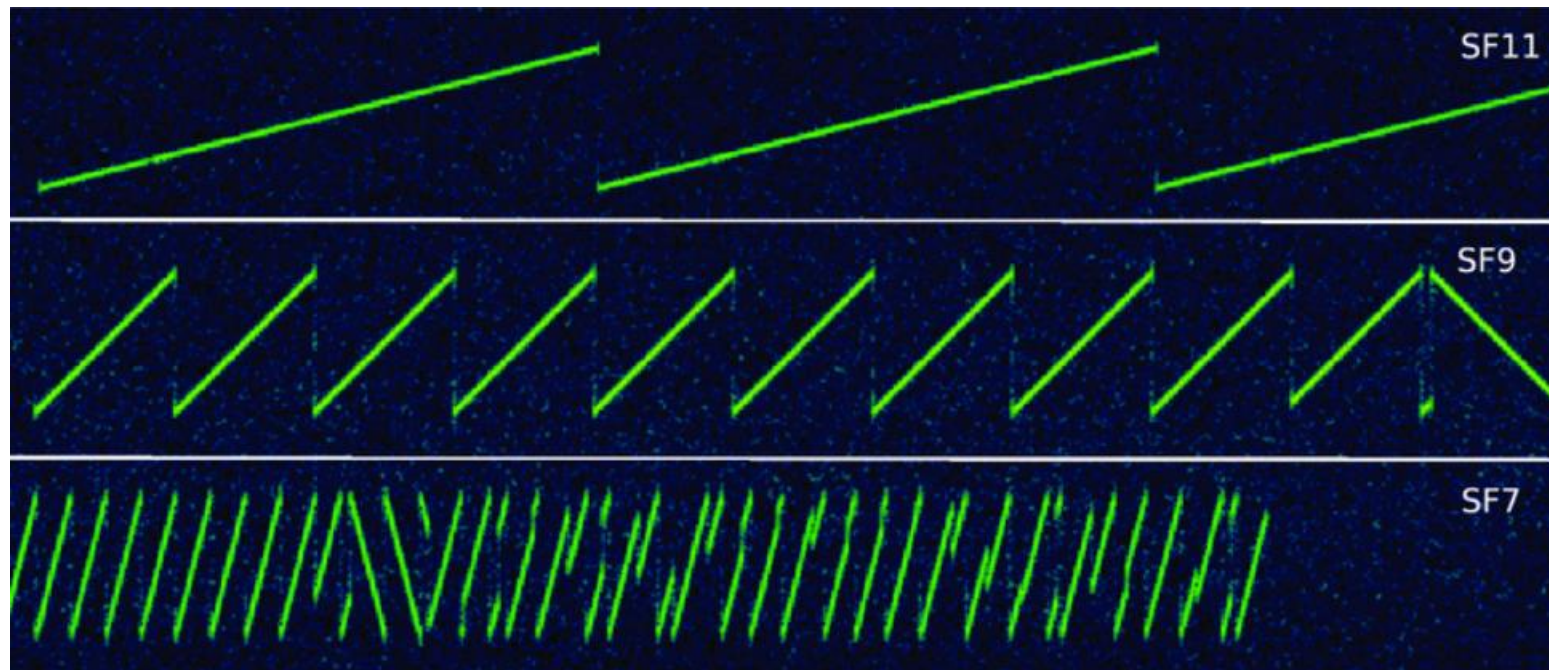
- Claude Shannon & Information Theory
- You can fit a certain amount of information in a certain amount of bandwidth over a certain amount of time over a certain distance
- More information?
 - More bandwidth
 - More time
 - Less distance



Spreading Factor

- LoRa uses “Chirp Spread Spectrum”
- Every LoRa configuration is a balance between how far a signal reaches and how much data it carries.
- SF7 — Fast, Shorter Range
 - Highest data rate, quickest airtime
- SF9–10 — Balanced
 - Common middle ground
- SF12 — Slow, Longest Range
 - Maximum sensitivity and reach
 - Very low throughput and longer airtime per packet

Spread 'Em



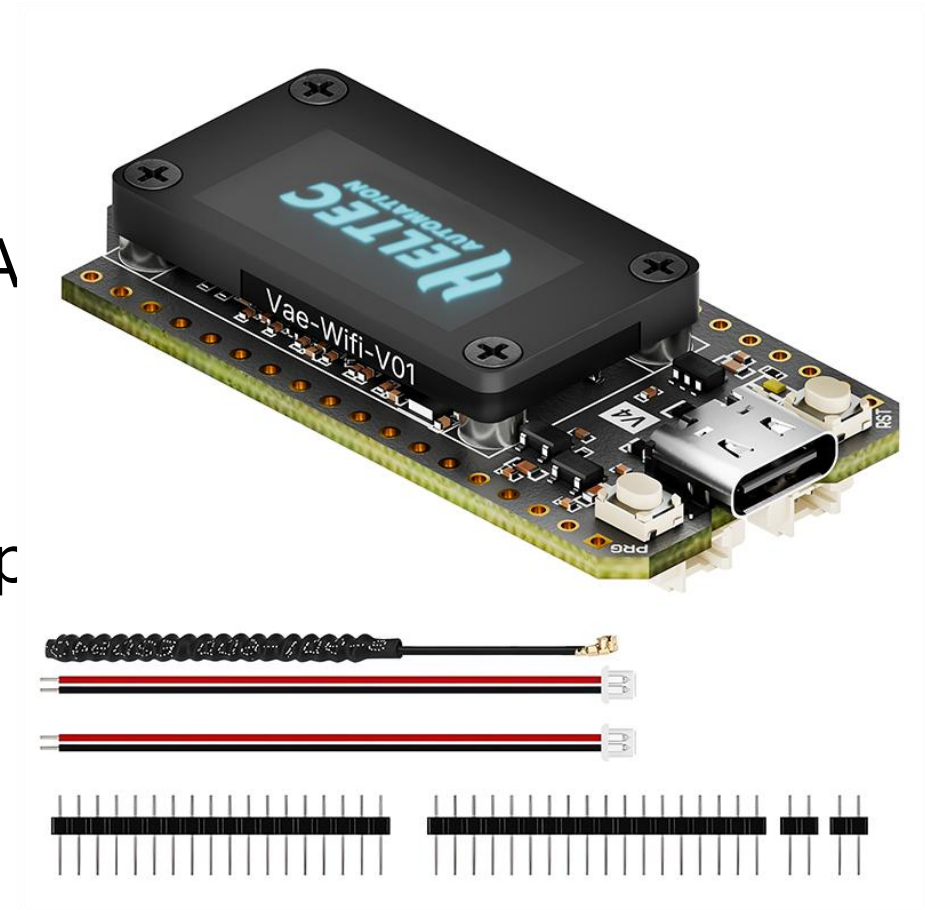
LoRa Data Rates

- In a word: Slow
- Maximum Data Rate: 12.5Kbps
- Average Data Rate: 1.7Kbps-5.4Kbps
- For comparison:
 - AX.25: 1.2Kbps
 - 802.11ah HaLow: 150-500Kbps
 - WiFi 802.11ac: 3500000+ Kbps

The Hardware

Heltec v4

- 915MHz Only
- \$30-\$40
- Simplest way to way to go into LoRA
- Solder headers, plug in antenna, flash firmware, and go
- ESP32 processor, SX1262 LoRa chip
 - Power hungry



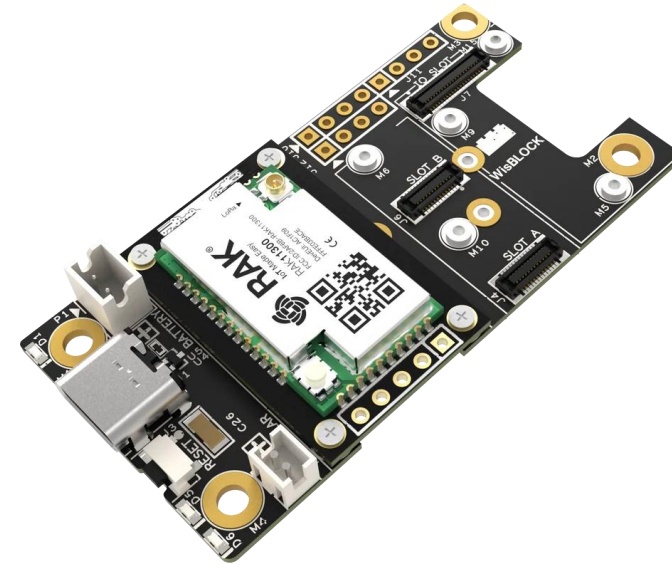
Heltec T114

- 915MHz/433MHz
- \$35-\$50
- Successor to the v4
- nRF52840 processor, SX1262 LoRa chip
 - Lower power consumption than an ESP32
- Very good general purpose unit



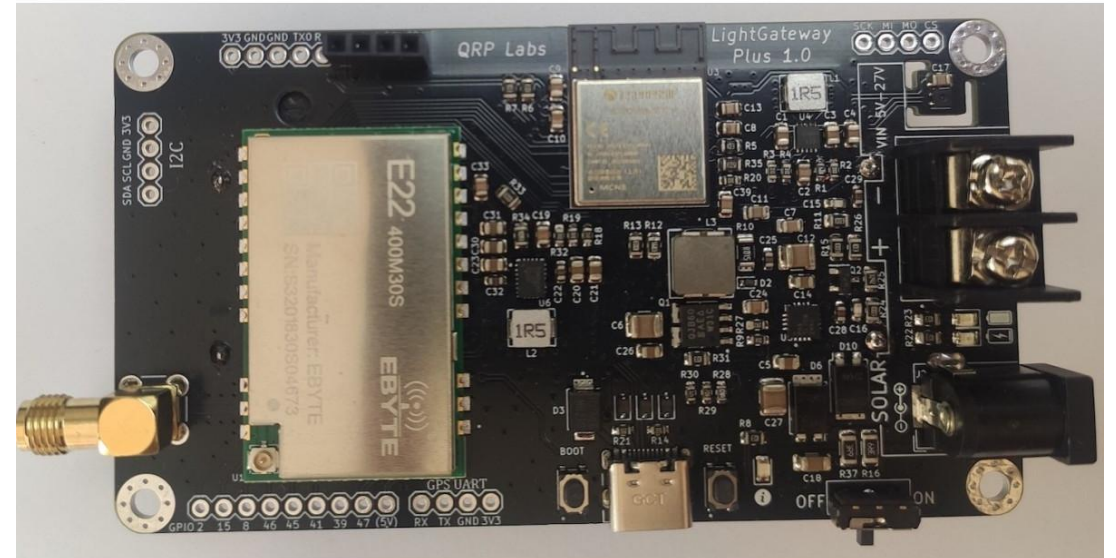
RAK Wisblock (RAK19007+RAK4631)

- 915MHz/433MHz
- \$35-\$50
- nRF52840 processor, SX1262 LoRa chip
- Modular setup
 - Teeny... tiny... modules
 - Barometer, Temperature, WiFi
- Frighteningly low power consumption
- Perfect for unattended solar installations



QRP Labs Light Gateway / Light Gateway Plus

- 433MHz Only
- \$45-\$130
- ESP32 based
- Designed to be an APRS Digipeater/iGate
- Open source hardware
- 1W Transmitter options



Lilygo T-Beam Supreme

- 915MHz/433MHz
- \$50-\$70
- ESP32 processor, SX1262 LoRa chip
- Integrated 18650 cell holder
- Integrated GPS
- Perfect for a car tracker/transceiver



Lilygo T-Deck Plus

- 915MHz/433MHz
- \$80-\$100
- ESP32 processor, SX1262 LoRa chip
- Integrated battery
- Integrated GPS
- Full screen and QWERTY keyboard
- T-Deck = No case



RPC Electronics ESP32 LoRA-Pi Modem

- 433MHz Only
- \$65
- ESP32 based
- Designed for APRS
- KISS Modem capability
- 1W Transmitter
- Easy to integrate!



Easy to integrate!

- Bought the device
- Plugged it in
- Reconfigured my aprsx on my Raspberry Pi
 - May not be as easy for everyone
- Instant cross band repeat



Antennas

- Don't use the stock antennas
- Not only are they monopoles, they're often terrible
- Plenty of homebrew antennas for 33cm and 70cm
- Meshtastic also keeps a good list of “buy these ones and not these ones”

Power

- These are not high power devices
- Therefore low power consumption
- Most boards have integrated charging capabilities
- Some have solar capabilities
- ESP32 devices draw much more power than NRF devices



Finally, your phone

- Most of these devices have a tiny screen that can provide some data
- Does not scale well
- Your phone most often runs the software that you use to configure and interface with these devices, via Bluetooth
- Some devices have WiFi interfaces as well

The Platforms

Quick Detour – Mesh Networks

- Mesh Network
 - No central hub - every node can help relay traffic for its neighbors
- Peer-to-peer by design
 - Nodes communicate directly with nearby peers rather than routing everything through a single base station.
- Multi-hop relaying
 - A message can travel node to node across many hops, extending coverage well beyond any single radio's range.
- No single point of failure
 - Because the network is decentralized, the loss of any one node rarely takes down the whole system.

Another Quick Detour - Routing

- Flood routing
 - Every node rebroadcasts a message to all its neighbors
 - Simple and robust, but less efficient on busy networks
 - Sometimes called Store-and-forward
 - Meshtastic and MeshCom do this
- Managed / routed mesh
 - Nodes build routing tables and forward traffic along known paths
 - Reduces redundant airtime and collisions
 - MeshCore and APRS do this

Commonalities across platforms

- All the systems have a number of commonalities
- Telemetry
 - Weather
 - Location
 - System Health (voltage, etc)
- Messaging

Meshtastic

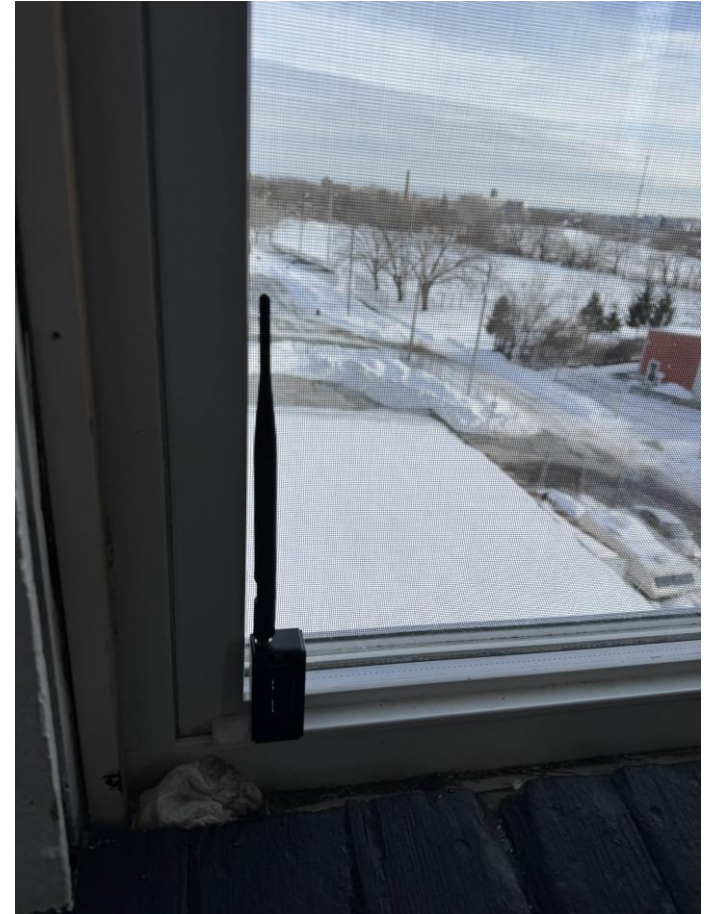
- Created by Kevin Hester in early 2020
- Solution for communication during hobbies where reliable internet access is unavailable
- Flood routing
- Really took off around 2024-2025
- Currently the “most popular” mesh network
 - By way of node count
- Popularity ebbing due to MeshCore

Meshtastic

- The best option to start your LoRa journey
- \$50, an amazon order, some firmware, and you're in business
- This is easiest way to go online and find someone to talk to
 - Buy, flash, run
- If you are in Boston, Worcester, or other dense urban area, may not be the best
- Again, flood routing

Why flood routing?

- Super simple to create a mesh, even if by accident
- As I did this past winter
- Accidentally bridged two 100K+ cites together while at soccer practice



Meshtastic Bottom Line

- Great for tactical networking with no fixed infrastructure
- The best choice for finding someone in your area to talk
 - Again, the most popular
- Flood networking causes issues in dense environments
 - Like cities... and conventions like HamX
 - This is not a repeat from 2001 with APRS
- Limited in hop distance when compared to other solutions
- iOS and Android clients very different from each other

MeshCore

- Developed in 2024 by Scott Powell
- Alternative to Meshtastic
 - Implemented after attempts to change Meshtastic away from flood routing
- Not as popular as Meshtastic, but gaining popularity
 - Especially in dense cities
- Designed to fix the shortcomings of flood networking

MeshCore

- Uses managed routing to better handle dense networks
- Devices have roles
 - Companions – Phones and other devices that are used by users
 - Repeaters – Devices that route the packets
 - Rooms servers – Bulletin Board Systems that store and forward messages
- Because not everything floods blindly, collisions have a lower probability

MeshCore Bottom Line

- People love MeshCore
- It still has not achieved critical mass
 - Yet...
- MeshCore is having some internal political struggles
 - Yay
 - Not affecting the underlying hardware or software

MeshCom

- Ham Specific Meshtastic Alternative
 - Developed in Austria primarily by Kurt Baumann, OE1KBC
 - Explicitly designed around ham operation
- Flood routing
- Integration with existing amateur radio stacks
- Started in Austria, grew to Germany, now going across Europe
 - United States? Not so much
- Meshcom designed for 70cm, can be grafted on to 33cm
 - Not for the faint of heart

Meshcom

- “Native” APRS compatibility
 - Via APRS-IS
- Position and message traffic can flow into APRS-IS
 - You show up on APRS.fi, etc
- No messaging integration
- No telemetry capabilities
- Option for integrated LoRA APRS capabilities
 - Tracker only

Meshcom Map



Meshcom Bottom Line

- Ham mesh made by hams
- There are pros and cons to having a mesh made by hams
 - Ham integration, ham ingenuity... and ham coding
- Rapid development often with limited testing
 - Bugs and feature requests rapidly deployed
 - A bit more stable over the past months

APRS

- APRS stack can be pushed to LoRA easily
- APRS does not care about the medium it's transmitted on
- CA2RXU has a great pieces of firmware for multiple devices
 - Trackers
 - iGates
 - Digipeaters

APRS Bottom Line

- Every fiber of my being hates this idea
 - It's 40 years old for cryin' out loud
- But, it works
 - Really, really well
- There is some advantage in that we have figured this stuff out over the life of APRS

Call to Action

Saddle up, folks!

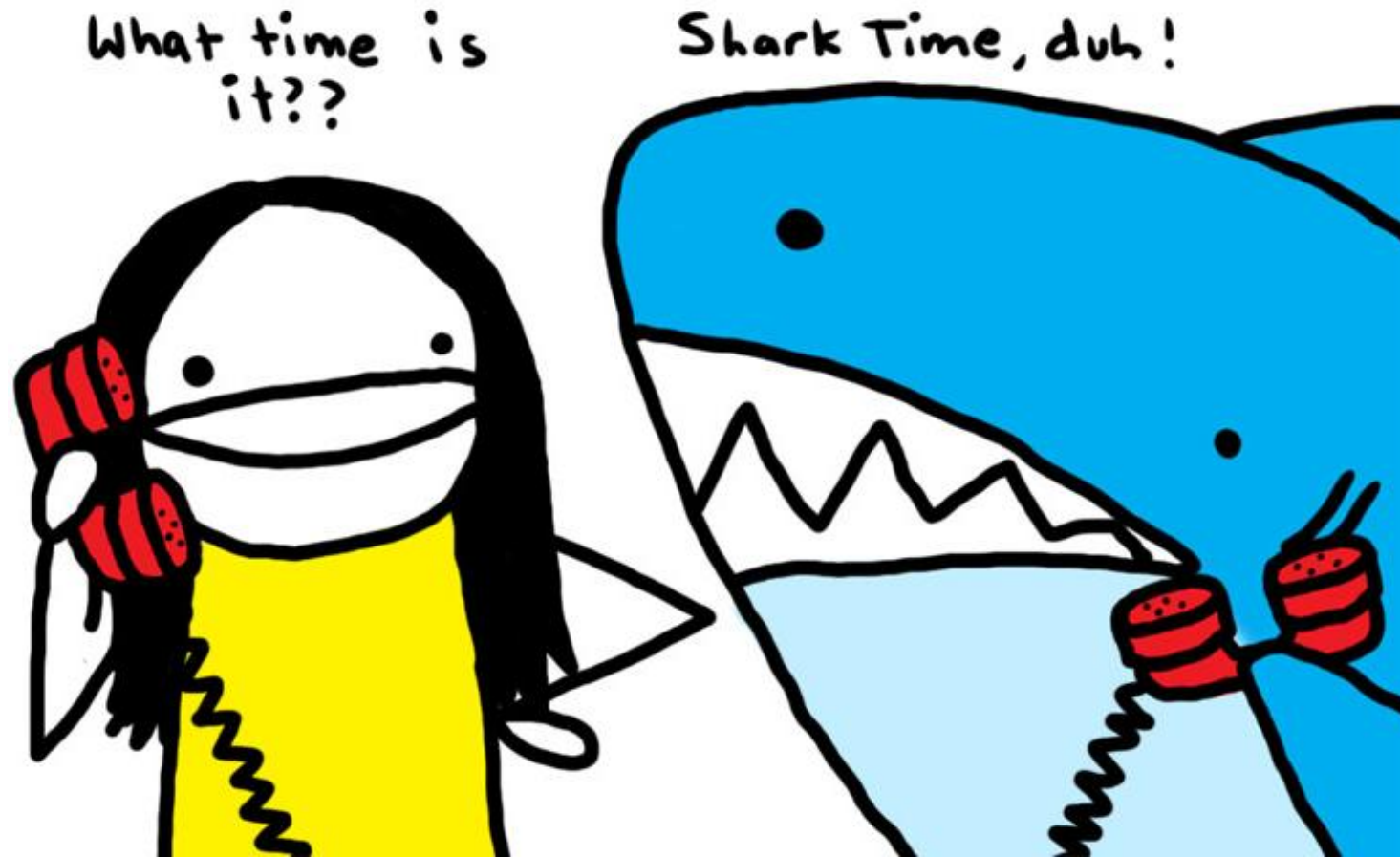
- We, as a community, need to start experimenting with this
- At least learn to play with unlicensed Meshtastic
 - Get a feel for the platforms
- This is not new technology, and as a hobby we are supposed to be cutting edge
- We, as amateurs, can take advantage of the 70cm allocation overlap with European bands
 - Lets put a less popular band to better use!

“OK Ben, how?”

- How many of you have a 2M/70cm antenna you are not using the 70cm being unused?
- How many of you have a 2M repeater or APRS digipeater with the 70cm portion being unused?
- Why not put in a diplexer and a LoRA on the 70cm side?
 - It doesn't matter what you use, lets start generating RF
- More activity = Less chance it will be taken away
- Side note – We are fending off a threat to 33cm!

Demo time!

Questions?



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