

# Mesh networks over LoRa

Dionysis Grigoropoulos

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# Who am I

- <https://f.erethon.com/mesh2023.pdf>
- dgrig/Erathon
- Infrastructure / Automation / Security / Tinkering
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- matrix: @dgrig:erethon.com

# We're gonna speedrun over these topics

- Mesh networks
- LoRa and modulation schemes
- LoRa over "cheap" ESP32 based boards
- Software to create mesh networks over LoRa
  - Meshtastic
  - Reticulum

# Mesh Networks

## Mesh Networks

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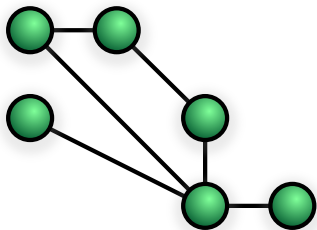
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- A thing of the past?
- Internet of Things depends on meshing

# LoRa

LoRa (Long Range)

# LoRa vs LoRaWAN

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- These two together define the low power wide area network (LPWAN) LoRa

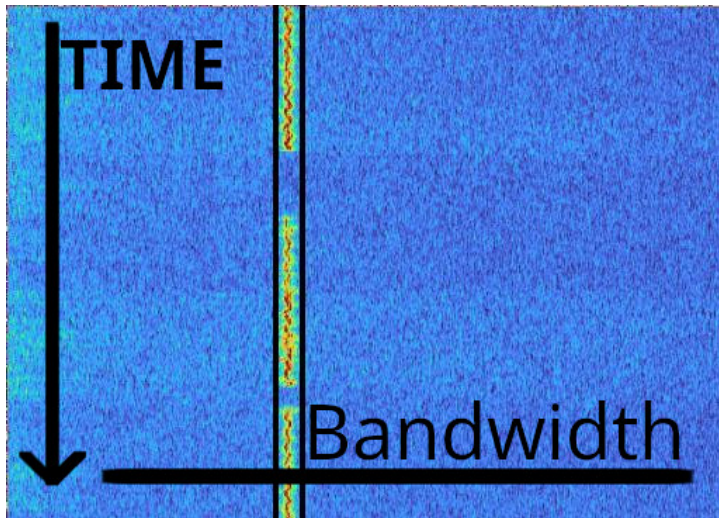


# LoRa Basics

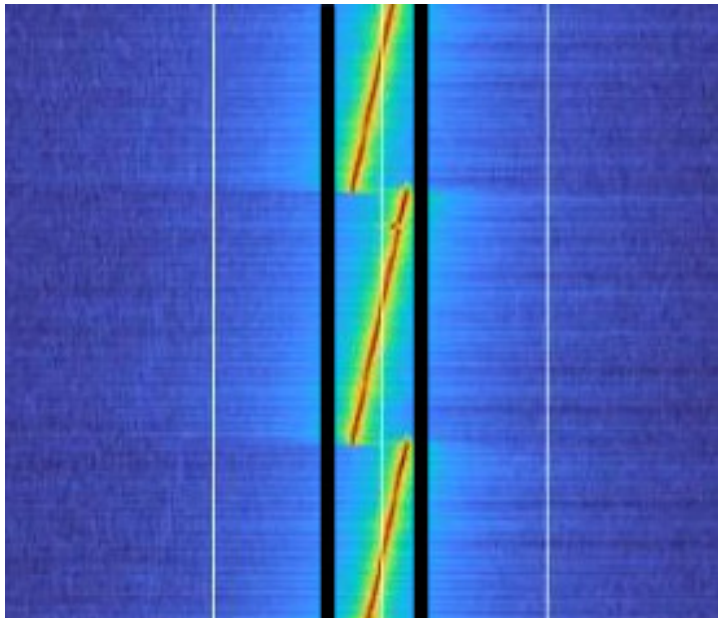
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- Data rate: 11bps to 21.88kbps

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- Legislation is a bit weird (power, duty cycle)

# Video

# Video

# How to transmit/receive LoRa

- LoRa ICs (~2\$), hats, development boards

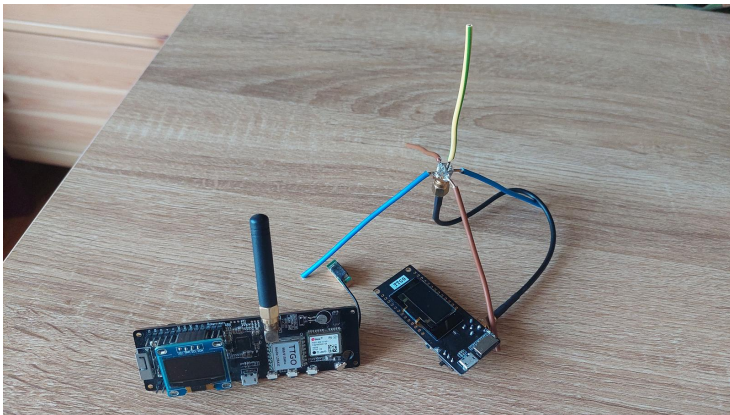
# How to transmit/receive LoRa

- LoRa ICs (~2\$), hats, development boards
- SDR (Software Defined Radio)!

# LoRa Boards



# LoRa Boards



# Meshtastic

The logo for Meshtastic, featuring the text "/^ESHT^ST/C" in a bold, black, sans-serif font. The characters are stylized, with the forward slashes and carets acting as part of the wordmark. The logo is centered within a light green rectangular background.

**/^ESHT^ST/C**

An open source, off-grid, decentralized, mesh network built to run on affordable, low-power devices



# Meshtastic

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- Firmware
- Apps that consume these ProtoBuff definitions
  - Mobile applications
  - Python CLI
  - Web

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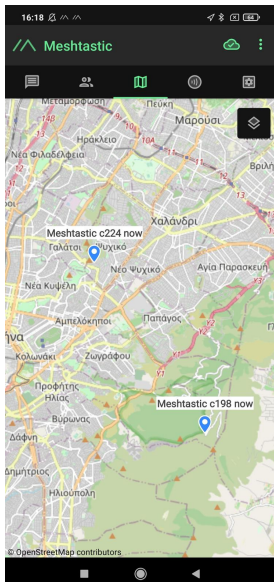
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Meshtastic over TCP/IP
- Longest range contact 254km!



# Meshtastic

- Networks
  - Canadian Network
  - Austin Mesh
- Map of nodes (1540 entries)
- Simple routing protocol, 3 hops by default
- GitHub & Discord

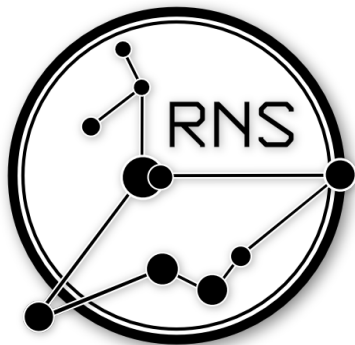
# Meshtastic



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# Reticulum



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- It works over Ethernet / WiFi / TCP/IP / I2P / LoRa
- MIT Licensed

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- Bandwidth aware interfaces

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- It's not based on TCP/IP, it's using its own lower-bw protocol. Lightweight Extensible Message Format (LXMF) based on msgpack
- Docs are amazing

# Reticulum software

- NomadNet, browser + messaging
  - Pages use a custom Markdown



# Reticulum software

- NomadNet, browser + messaging
  - Pages use a custom Markdown

```
Conversations | Network | Log | Config | Guide | Quit
Announce Stream
17:53:23.0 <3e05f77e9f0dbfc124f230862153c9f9>
2023-10-16 <651962cc18ca0f0c778a92a9e17bb252>
2023-10-16 <1b1041d429e16f91e9f0f616f46f2f>
2023-10-16 <f0ac4c3e1d00f13a1515cc211879b>
2023-10-16 <4e2d32c847a17ef7c7c6c2b1fa8aaf3d>
2023-10-16 <1b1041d429e16f91e9f0f616f46f2f>
2023-10-16 <2f0c39a3e599d9e772d9abf725f4b>
2023-10-16 <62c43cc24ebd860f92b46ca431e7069d>
2023-10-16 <7a27f052b13d3ac3c3043e950ed3376>
2023-10-16 <3cbdb0b1a7e307deae1ef6533c0bf6>
2023-10-16 unsignedchark (sb1)
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2023-10-16 <0f4eef81b0bd16f92c5593c3bb7f8c0c9>
2023-10-16 <3e05f77e9f0dbfc124f230862153c9f9>
2023-10-16 <7a6639e6d1c47395358432e5705cd781>
2023-10-16 <249c22cf27277f059a3e34af73c355e>
2023-10-16 <3c9d46e4065201edd4d1e16cde7bdc17>
2023-10-16 <3e81a01866d2fcd0e6426073fe9b7d>
2023-10-16 <62c43cc24ebd860f92b46ca431e7069d>
2023-10-16 <47ce4552d946f611ba75745f6e801a>
2023-10-16 Erethon-opersbd-custom-crypto
2023-10-16 <7a30107b304de8a0c9f4c0f7338ef2>
2023-10-16 <41177086e4d53e792c56a2c73ef84>
2023-10-16 unsignedchark (sb1)
2023-10-16 <75667674b6ad098a5976eb0b0a1987d>
2023-10-16 <2f0c39a3e599d9e772d9abf725f4b>
2023-10-16 <68e940c547efcf2f3e32cb5e1e0366e>
2023-10-16 <e412f02e790ef751640f26cdac3206>
2023-10-16 Unigned Node
2023-10-16 <3e05f77e9f0dbfc124f230862153c9f9>
2023-10-16 <1e5a7bc092593c1c26b5b224aeb9157b>
2023-10-16 <249c22cf27277f059a3e34af73c355e>
2023-10-16 <3e81a01866d2fcd0e6426073fe9b7d>
2023-10-16 <3d1a2cd6b0c71b0b54aeb1610b0237>
2023-10-16 <1e8f9f2c20077d21e66d0d151ac139>
2023-10-16 <62c43cc24ebd860f92b46ca431e7069d>
2023-10-16 <69aad2729fec23fa201e39d0eef93ef3b>
2023-10-16 <4070302576d5b31c73089510557ac0>
2023-10-16 Erethon-opersbd-custom-crypto
2023-10-16 <90b709207eff165f020c20166f932ac56>
2023-10-16 <651962cc18ca0f0c778a92a9e17bb252>
2023-10-16 unsignedchark (sb1)
2023-10-16 Anonymous Peer
2023-10-16 <2f0c39a3e599d9e772d9abf725f4b>
2023-10-16 <b84388a9417bfba09f10222c2220b>
2023-10-16 <1c66cd268cfcda332b710f509504130>
2023-10-16 <7a27f052b13d3ac3c3043e950ed3376>
2023-10-16 <e7cd33ec043b9baa44225c80b3483e4>
2023-10-16 <19cc5480aef7bd314cbdd54eeff5e9536>
2023-10-16 <4070302576d5b31c73089510557ac0>
2023-10-16 <3e05f77e9f0dbfc124f230862153c9f9>
2023-10-16 <249c22cf27277f059a3e34af73c355e>
2023-10-16 <f18a0ef9e1f6c91e7a974e1e6c0b3de>
2023-10-16 <69aad2729fec23fa201e39d0eef93ef3b>
2023-10-16 Erethon-opersbd-custom-crypto
2023-10-16 <1b1041d429e16f91e9f0f616f46f2f>
2023-10-16 <41177086e4d53e792c56a2c73ef84>
Local Peer Info
LXMF Addr: <5a72dd3b1e7e5ccf2bac690f45177f5>
Identity: <4b0bf40e74f4b55525b0ed5ef420598d>
Name: Erethon.dgrig

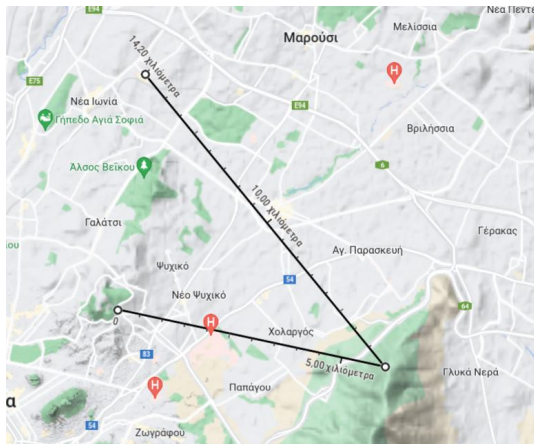
Reticulum Status
Latest Update: 2023-10-18 13:54:00
Shared Instance(37420)
Status: Up
Serving: 1 program
Rate: 1.00 Gbps
Traffic: 69.39 KB/s
9.00 KB/s
AutoInterface(Default Interface)
Status: Up
Mode: Full
Rate: 10.00 Mbps
Peers: 0 reachable
Traffic: 177.01 KB/s
0.04
TCPInterface(RHS Testnet Dublin/dublin.connect.reticulum.network:4965)
Status: Up
Mode: Full
Rate: 10.00 Mbps
Traffic: 484.66 KB/s
752.98 KB/s
Transport Instance (<177f2e64427301454e2453591a0e6f3d> running
Uptime is 16h, 1m and 0.1s
Home
```

# Reticulum software

- RNSH, for spawning shells over Reticulum
  - 11.2km shell session!

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  - 11.2km shell session!
- Mesh with nodes that have no line of sight



# Reticulum software

- Rnode

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- Rnode
- tncattach, allows one to attach KISS TNC devices as network interfaces

# Reticulum Community

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- There's also a Public Testnet over TCP/IP and I2P for running experiments

# Contribute!

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# Reticulum vs Meshtastic

- Different end goals
  - Reticulum is more open-ended and powerful
  - Meshtastic is more polished and has a smaller scope

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- Different end goals
  - Reticulum is more open-ended and powerful
  - Meshtastic is more polished and has a smaller scope
- ProtoBufs make it easy to update the protocol and extend it, also porting to new devices

# Other meshes over LoRa?

- Ripple

# Questions?

- Feel free to ask me in the corridor sessions ;)

# Links

- <https://unsigned.io/understanding-lora-parameters/>
- <https://wirelesspi.com/understanding-lora-phy-long-range-phys>
- <https://github.com/GUVWAF/Meshtasticator>
- <https://meshtastic.org/>

# Links

- `https://reticulum.network/`
- `https://github.com/markqvist/RNode\_Firmware`
- `https://github.com/markqvist/tncattach`

# Bonus Slides

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# Notable mesh networks

- AWMN
- Freifunk (~1750 routers, ~4k clients)
- guifi.net (~38k nodes)
- AREDNet (~7k nodes)



# Routing on Mesh networks

- It's a mess ;), more than 70 schemes

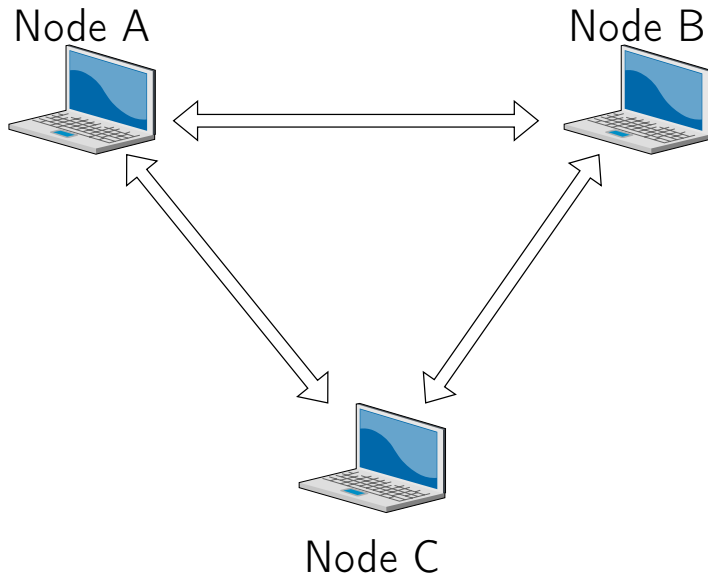
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  - Complex & Resource intensive
  - Power hungry as well

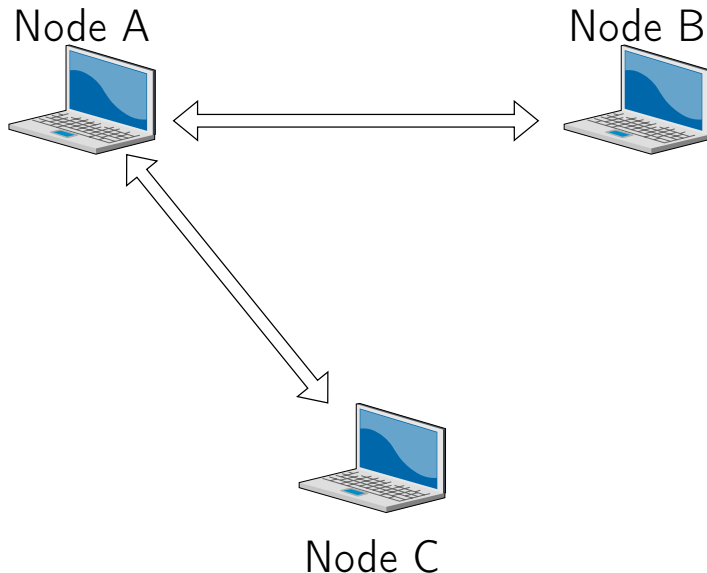
# Routing on Mesh networks

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  - Power hungry as well
- Nodes might not be stationary

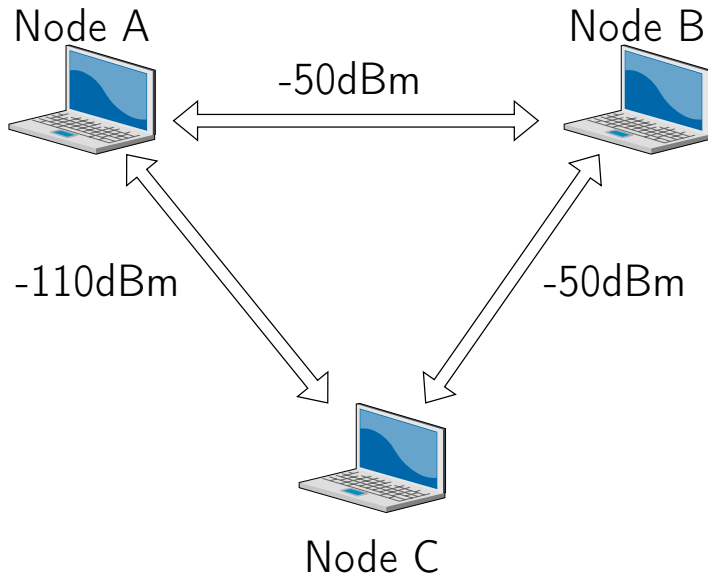
# Routing loops and other issues



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# Routing on Mesh networks

- Routing schemes:
  - DVR (Distance (hops) Vector Routing)
  - DSDV (Destination Sequenced Distance-Vector Routing)
  - DSR (Dynamic Source Routing)