Mesh networks over LoRa

Dionysis Grigoropoulos

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Who am I

- `https://f.erethon.com/mesh2023.pdf`
- dgrig/Erethon
- Infrastructure / Automation / Security / Tinkering
- email: dgrig@erethon.com
- 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

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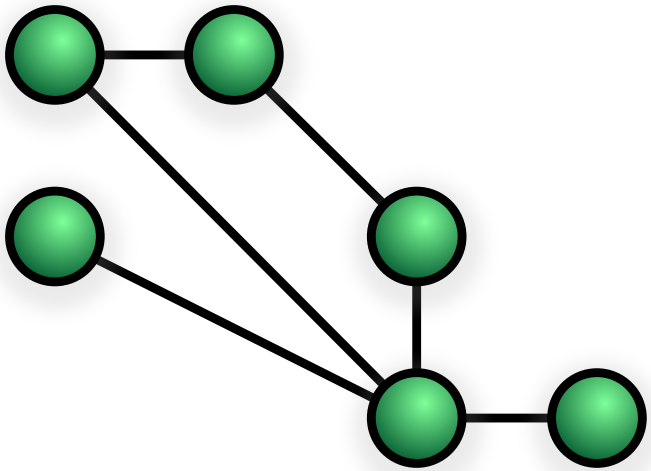

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- A thing of the past?
- Internet of Things depends on meshing

LoRa (Long Range)

LoRa vs LoRaWAN

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

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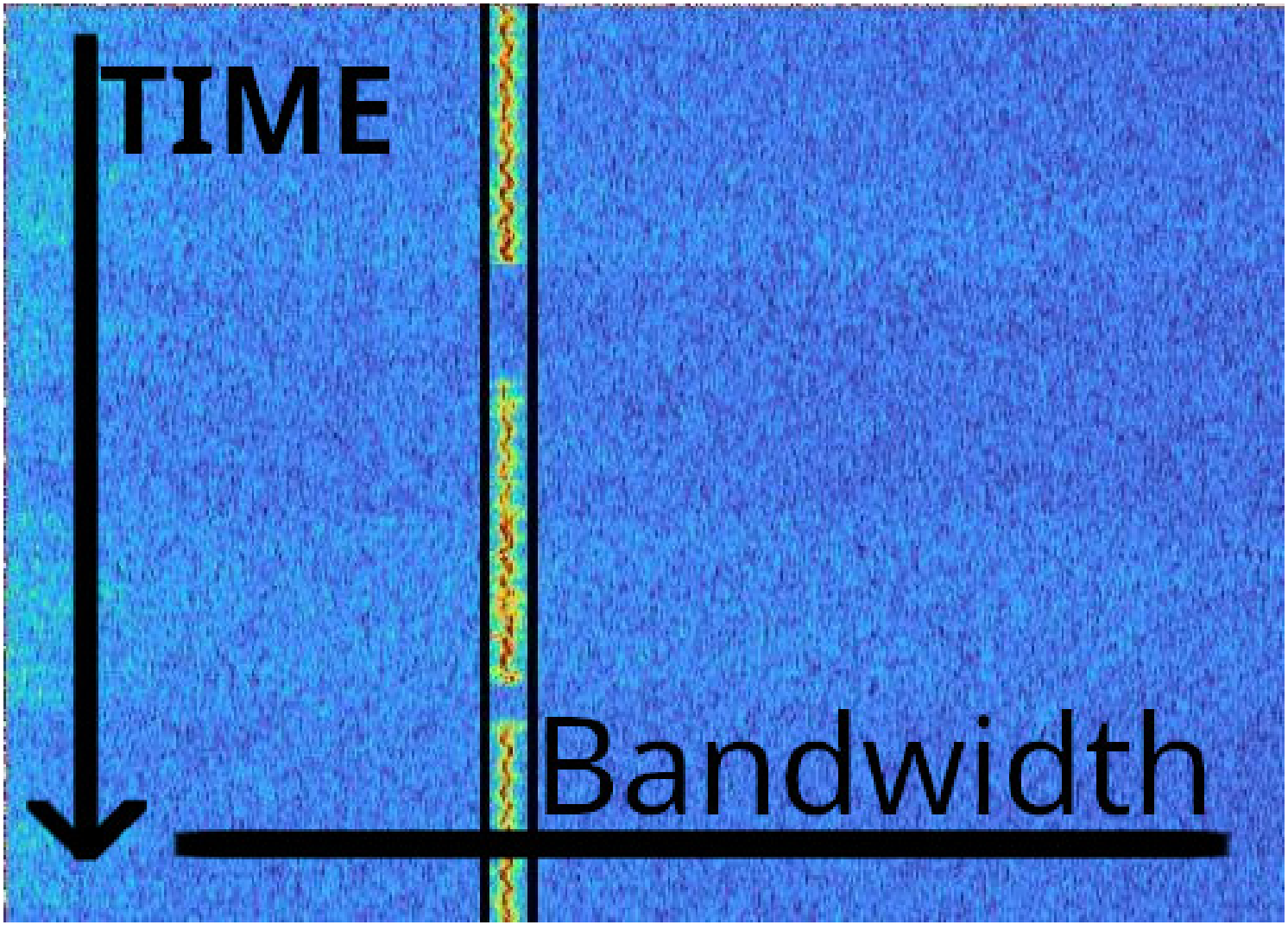

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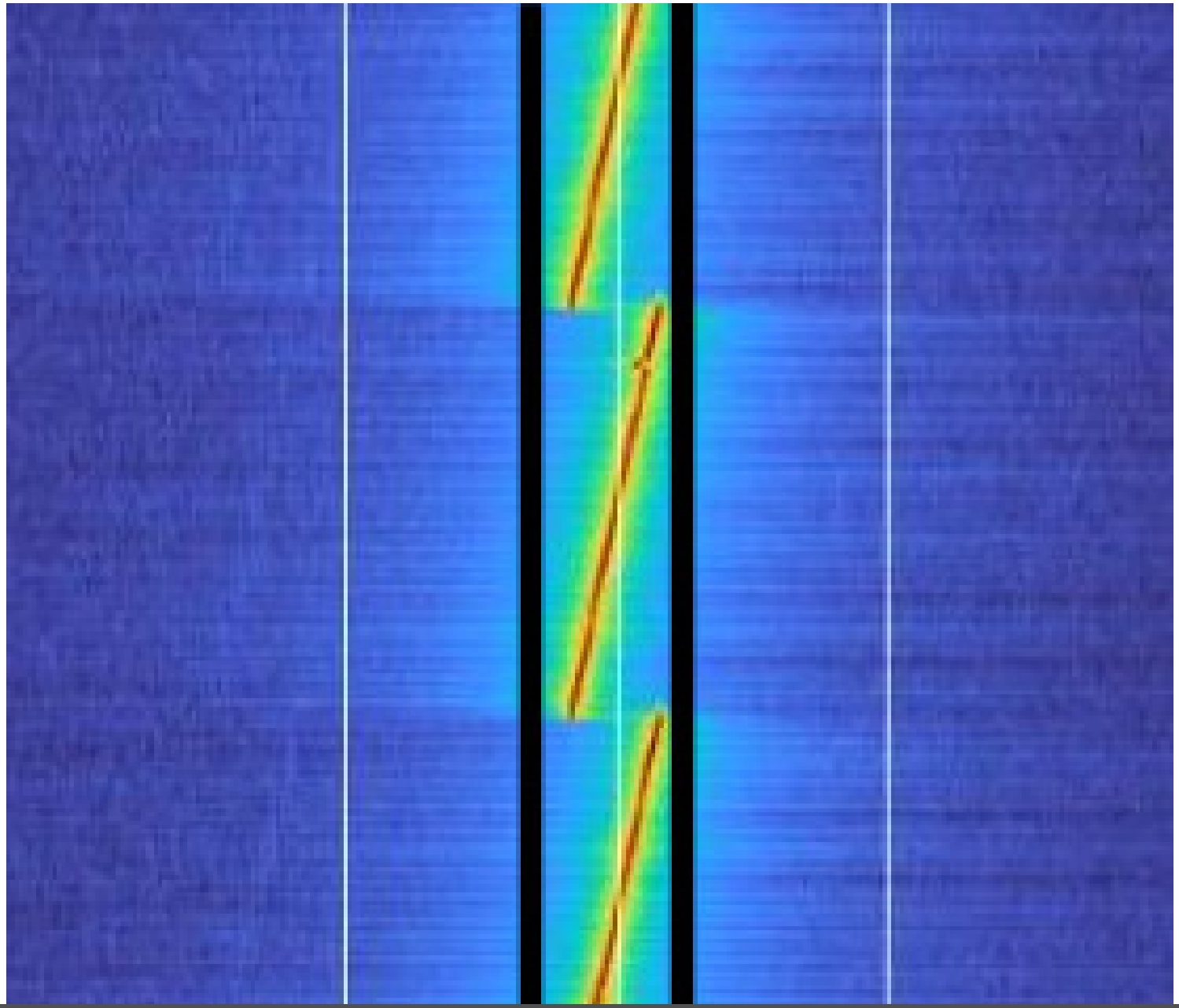

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- Data rate: 11bps to 21.88kbps

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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

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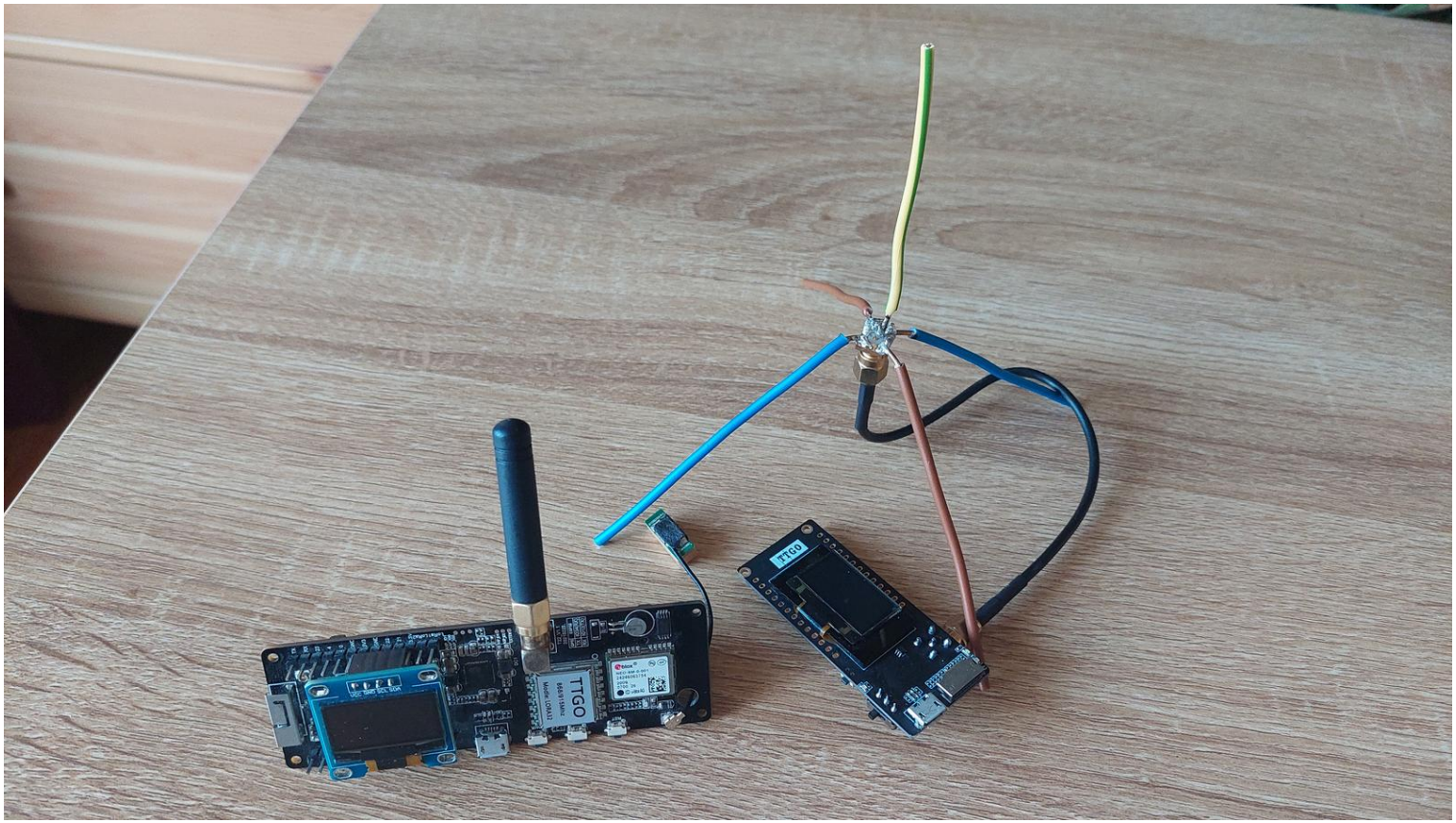
- LoRa ICs (~2$), hats, development boards
- SDR (Software Defined Radio)!

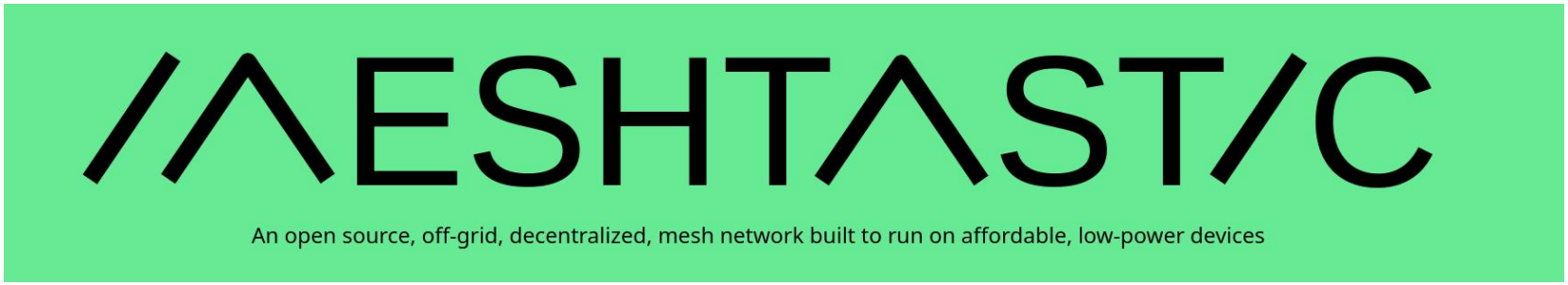
LoRa Boards


VCC GND SCL SDA
TTGO
868/915Mhz
Modle: LORA32
NEO-6M-0-001
24246063754
2009
0700 26
u-blox AG
GND
5V
RST

LoRa Boards



Meshtastic


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

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  - Allows for easy cross platform development
- Firmware
- Apps that consume these ProtoBuff definitions
  - Mobile applications
  - Python CLI
  - Web

Meshtastic - Features

- Single "channel" for all devices in a mesh
  - AES256 PSK (pre-shared key) shared between all nodes
  - Chat room with all participants
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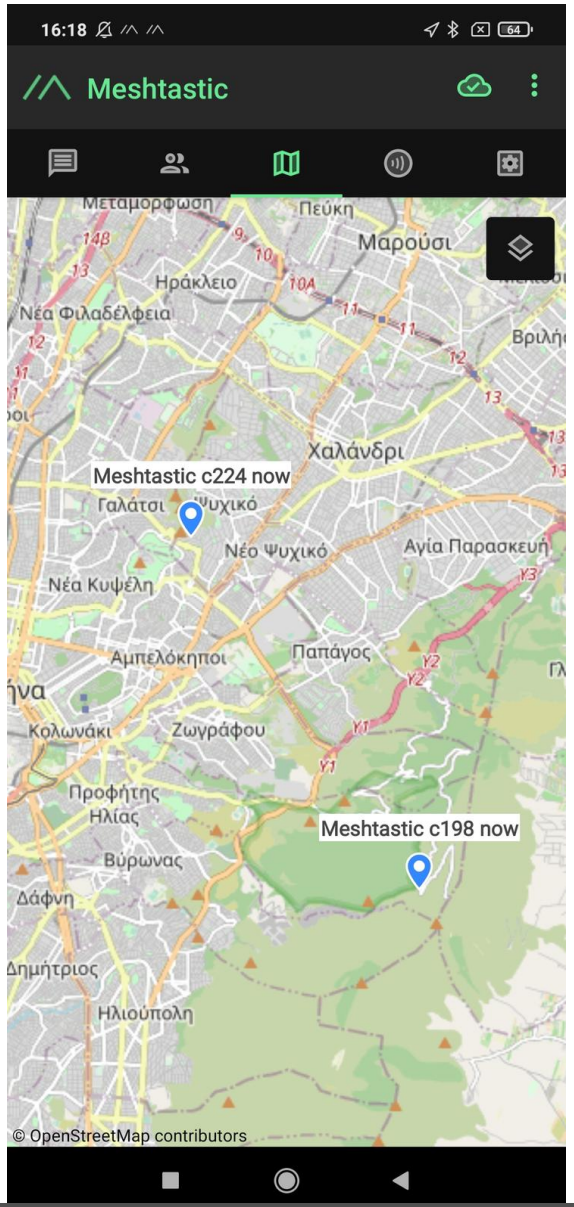
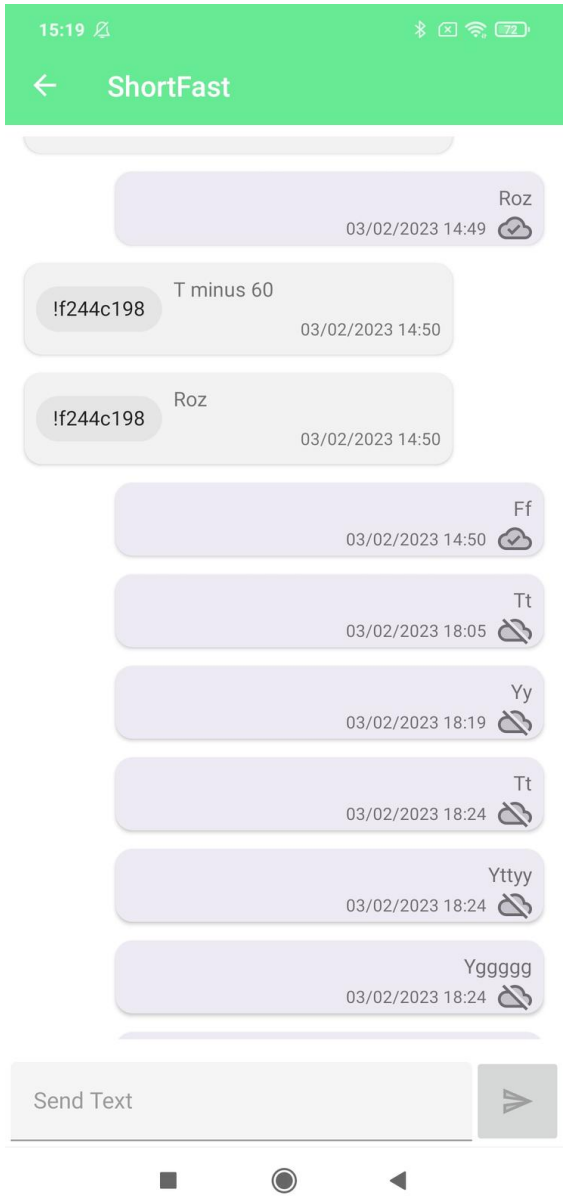
- Bridging to MQTT for "tunneling" Meshtastic over TCP/IP
- Longest range contact 254km!

Meshtastic

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

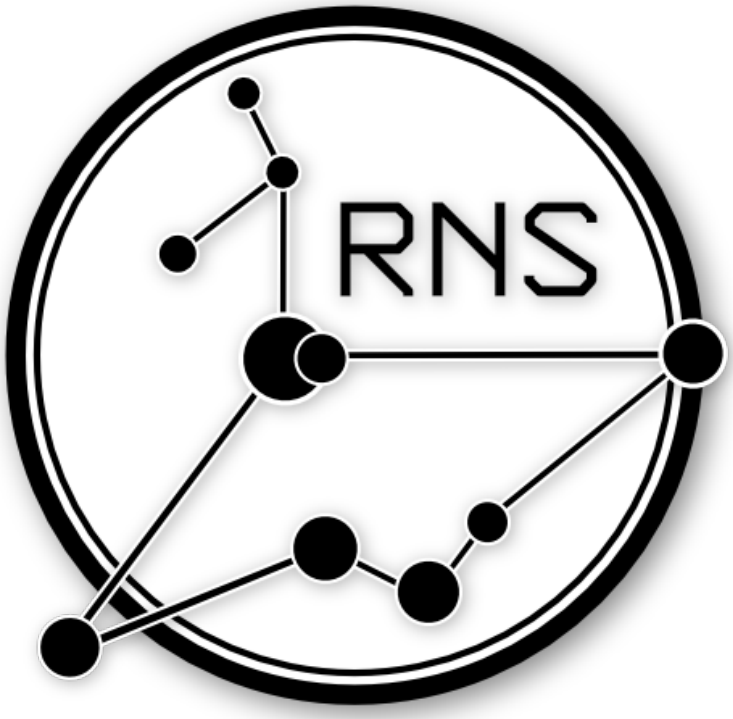
Meshtastic


16:18
Meshtastic
Μεταμόρφωση
Πεύκη
Μαρούσι
Ηράκλειο
Νέα Φιλαδέλφεια
Βριλήσ
Χαλάνδρι
Meshtastic c224 now
Γαλάτσι
Ψυχικό
Νέο Ψυχικό
Αγία Παρασκευή
Νέα Κυψέλη
Αμπελόκηποι
Παπάγος
Κολωνάκι
Ζωγράφου
Προφήτης Ηλίας
Meshtastic c198 now
Βύρωνας
Δάφνη
Δημήτριος
Ηλιούπολη
© OpenStreetMap contributors


15:19
ShortFast
Roz
03/02/2023 14:49
!f244c198
T minus 60
03/02/2023 14:50
!f244c198
Roz
03/02/2023 14:50
Ff
03/02/2023 14:50
Tt
03/02/2023 18:05
Yy
03/02/2023 18:19
Tt
03/02/2023 18:24
Yttyy
03/02/2023 18:24
Yggggg
03/02/2023 18:24
Send Text

Meshtastic

Reticulum



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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

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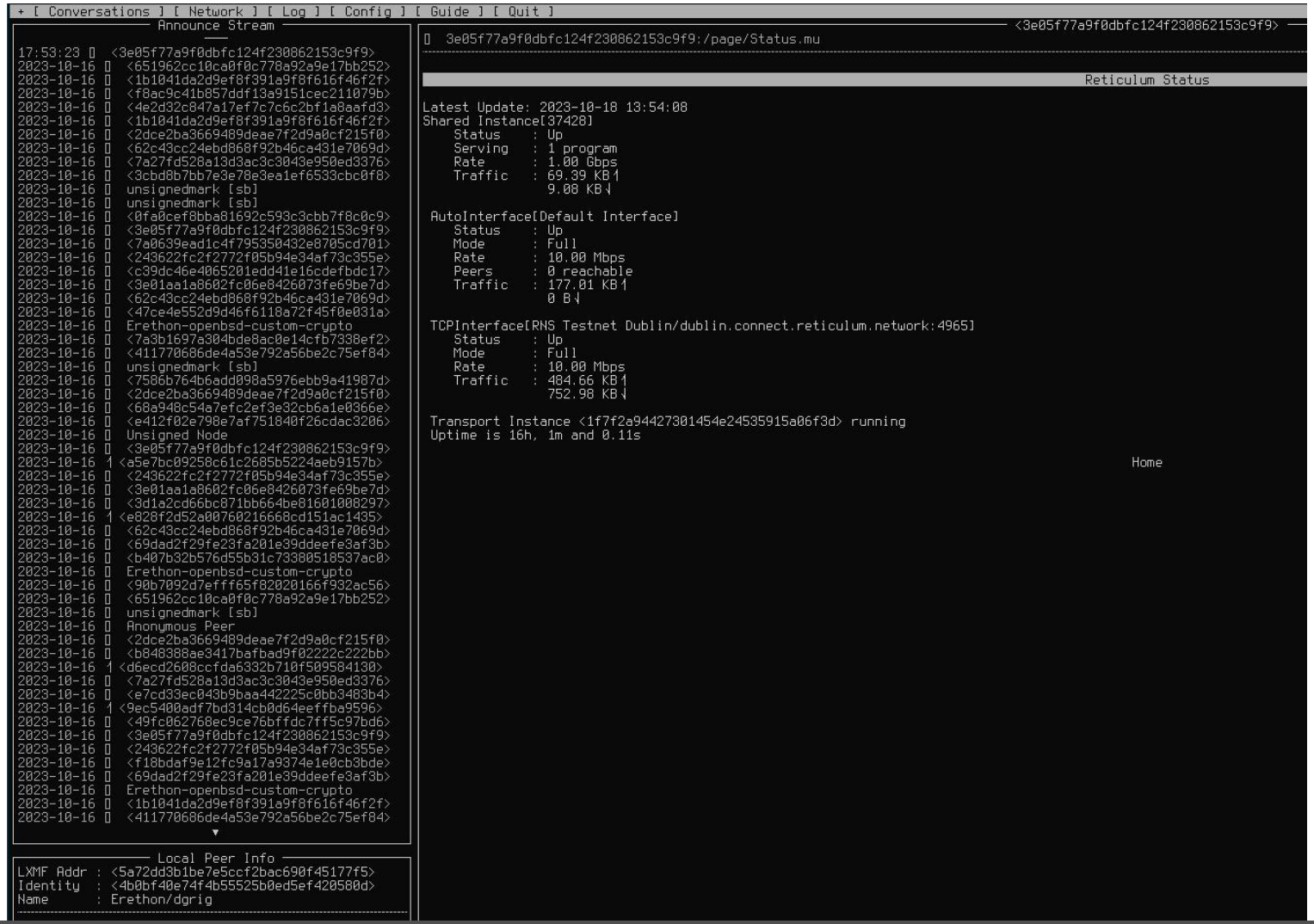

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- Mesh with nodes that have no line of sight

Reticulum software

- Rnode

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

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

Contribute!

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  - Meshtastic is more polished and has a smaller scope
- ProtoBuffs 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)

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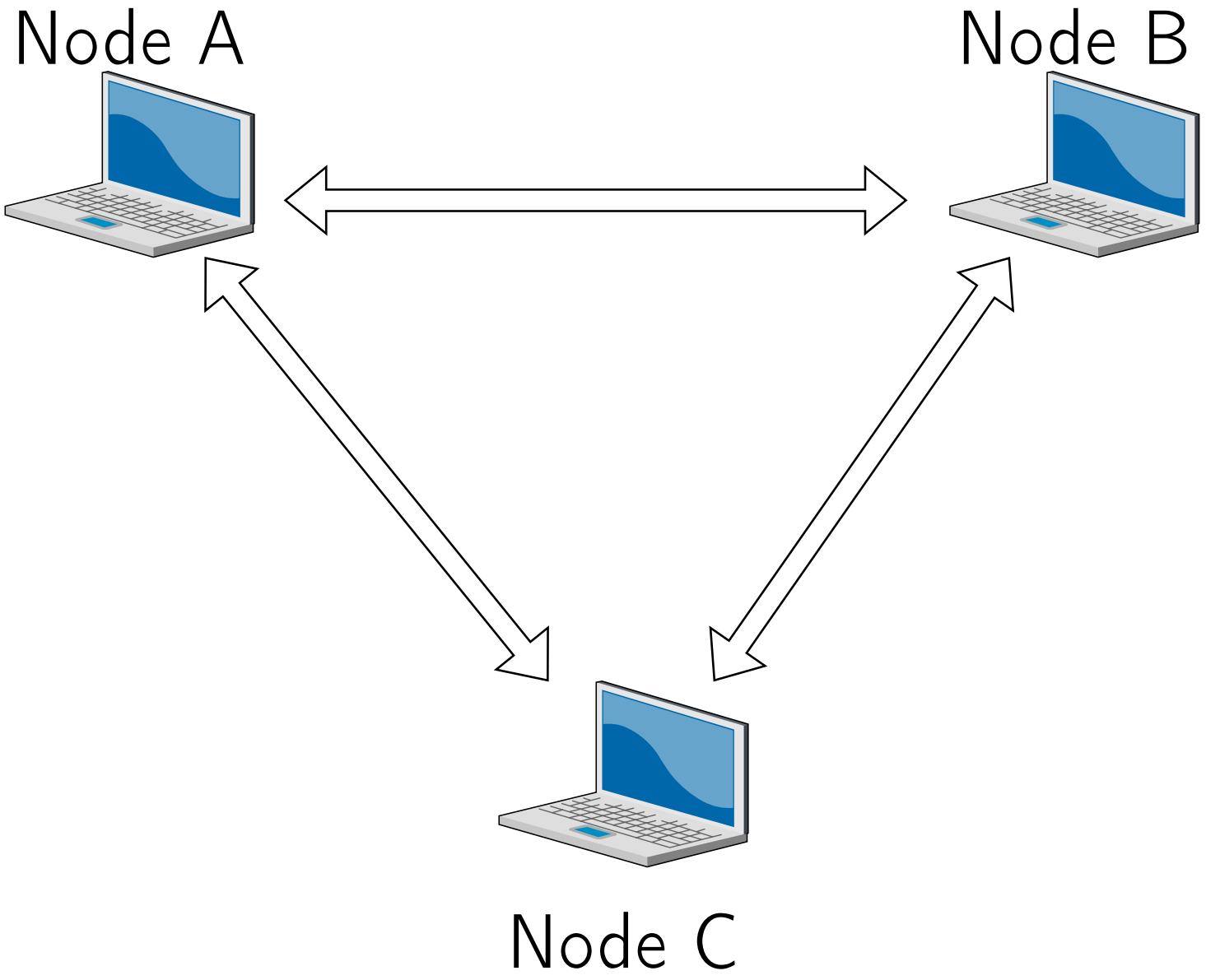
- Nodes might not be stationary

Routing loops and other issues



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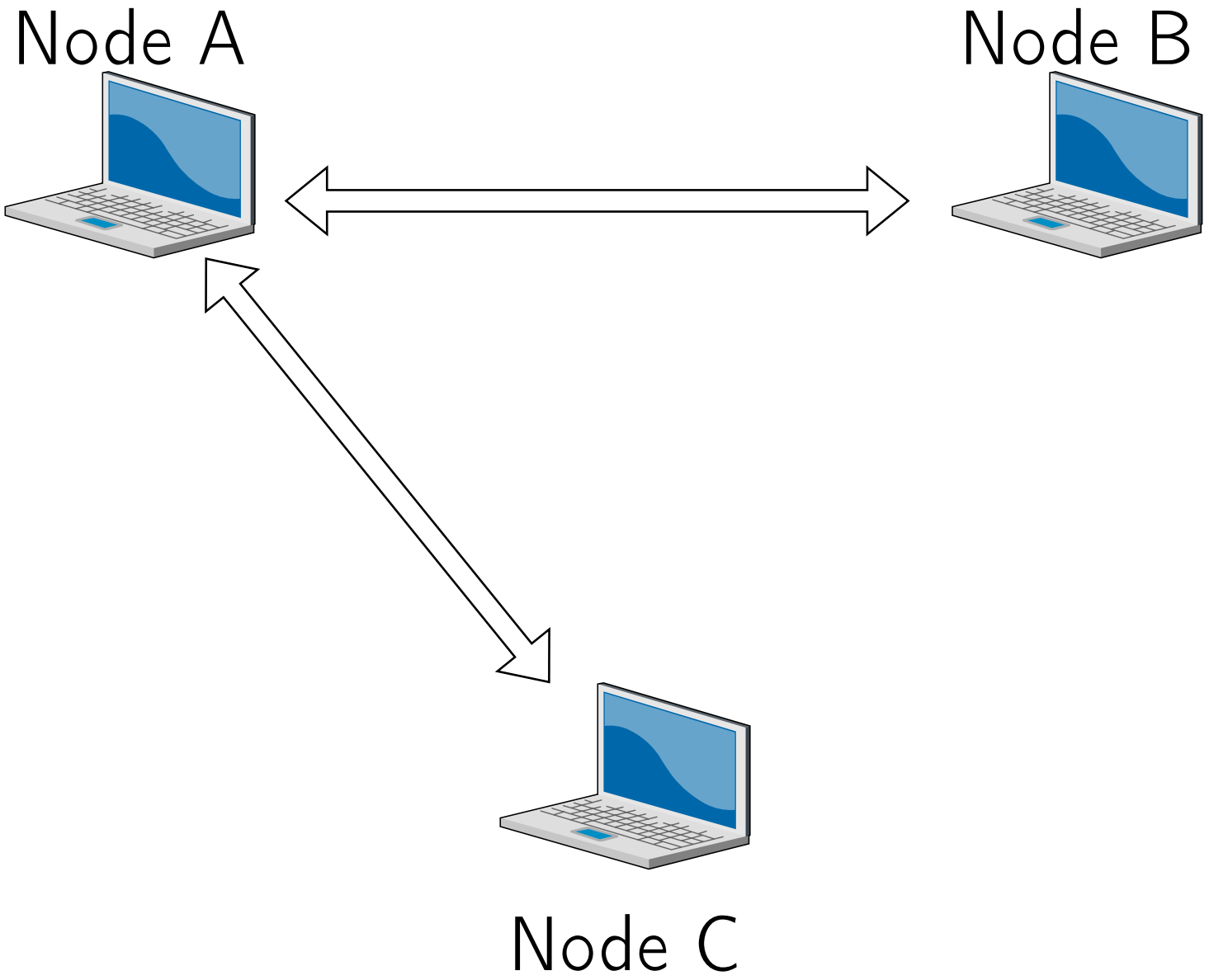

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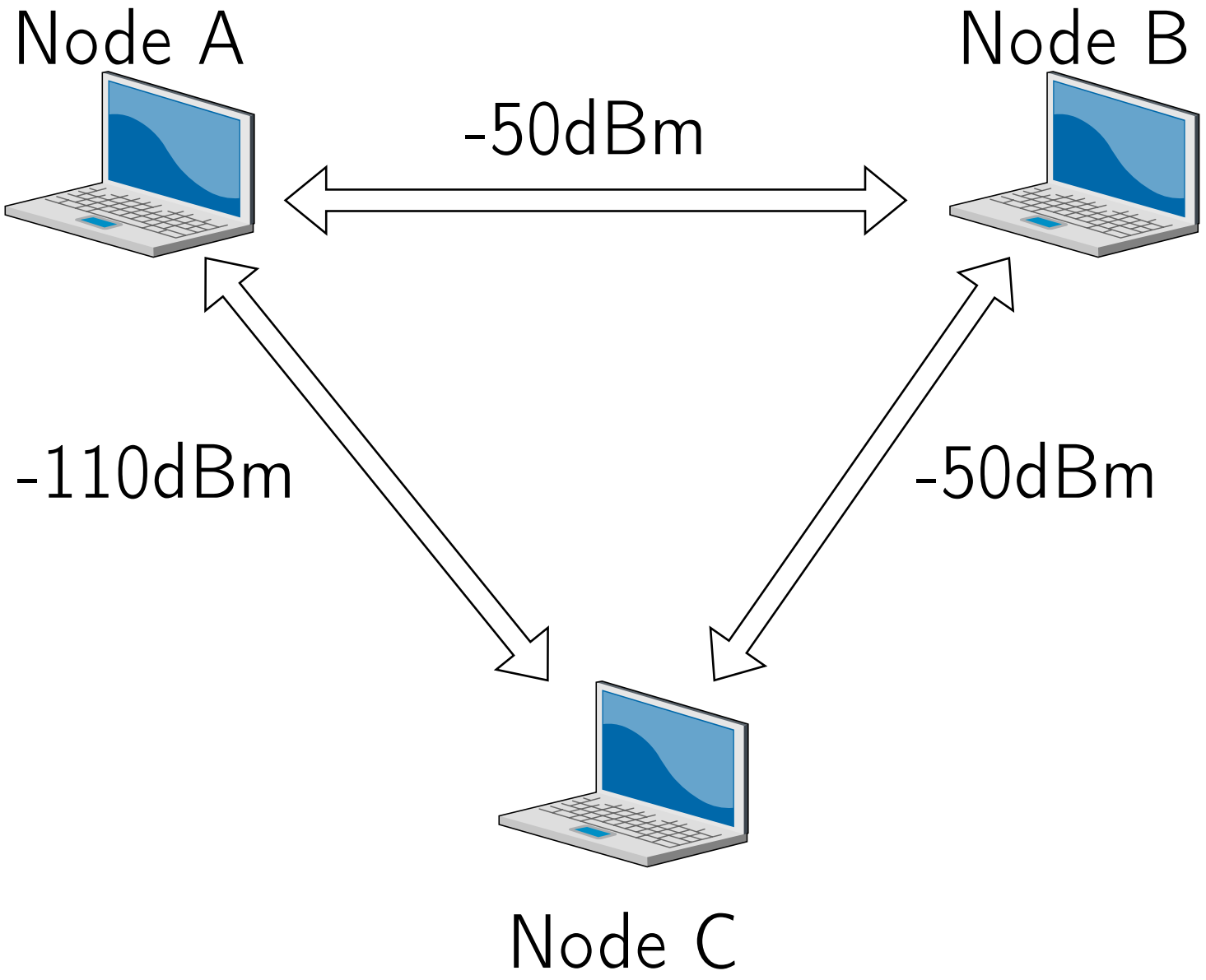

Routing on Mesh networks

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