LoRa Mesh Lab

Workshop on Communication in Extreme Environments for Science and Sustainable DevelopmentICTP 20231123Sebastian Büttrich <sebastian@itu.dk>



... and often with the



Network Startup Resource Center



LoRa Mesh Lab

Quick intro to LoRa mesh & Meshtastic (max. 20 minutes)

Only the absolute basics – we rather focus on:

Hands-on: Build a local mesh and test it in and around ICTP

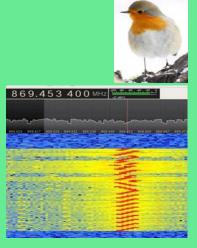
(1 hour today, more tomorrow)

And re-visit in-depth questions along the way,



LoRa Mesh Lab

LoRa – Layer 1 (physical layer) network technology Chirp Spread Spectrum (CSS) & extension LR-FHSS (frequency hopping – satellites!)



LoRaWAN – Layer 2 (MAC layer) network standard

Not limited to, but often on license-exempt / ISM frequencies EU433 MHz, EU863-870 MHz, US902-928, ... 2.4 GHz

ITU: 6 years LoRa on EU868 in Research, Education and Deployments

LoRa Mesh has been tried various times over the last years: PyMesh, LoRaMesh, etc



LoRa at ITU.dk

50- 100 km every day,

200 km on good days

THE THINGS

COPENHAGEN

Device: 0018820000021098 Time: 2019-07-26 14:46:45 RSSI DL -3 SNR DL: 0 Temperature: 40 Battery 37228 Data Graphs Region Sjælland Falsterbohaivons Gateway 1 : eui-fcc23dffe0aa402 havsområde Desc: ts-lorixone-4 / YSILO lat: 55.42452 lon: 13.82173 Coords from message, TTN meta tue 35.42451772 / 13.8217295 Distance: 173.83 km RSSI: -105 SNR -15 Gateway 2 : eui-fcc23dffe0f4044 Desc: ts-lorbone-1 / Kladdarp lat: 55.541336 lon: 13.587948 Coords from message, TTN meta has 55.54133706 / 13.58794822 Distance: 175.07 km RSSI: -111 SNR: -1.2 Gateway 3 : eui-0000024b0805024b Desc: ITU_PITLab_01_Kerlink_Roof lat: 55.65959 lon: 12.59145 Coords from measuage, TTN meta has 55.65959 / 12.59145 Distance: 162.10 km Falster RSSI: -117 SNR -15 Fehmarnbell Kieler Bucht Lubecke Natur pari Holsteinisch Schweiz

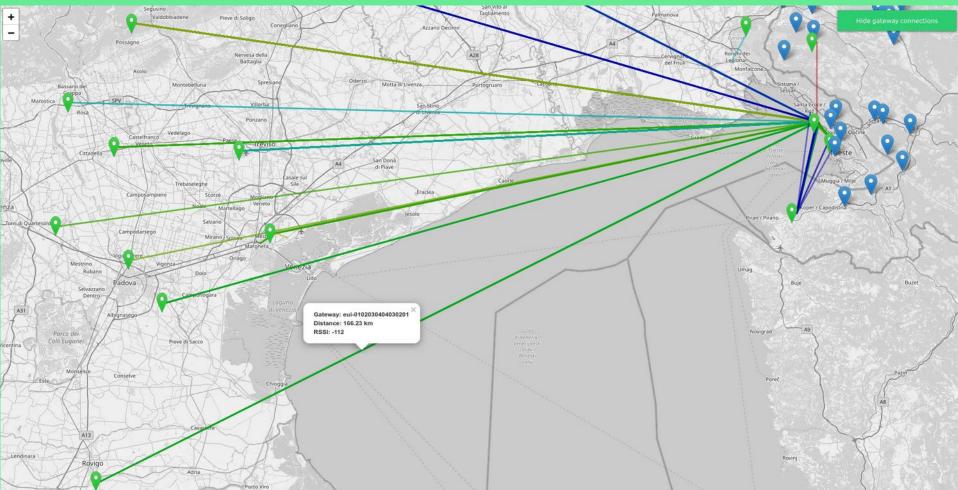


... and always happy to be back @ ICTP (thank you, ICTP people!)

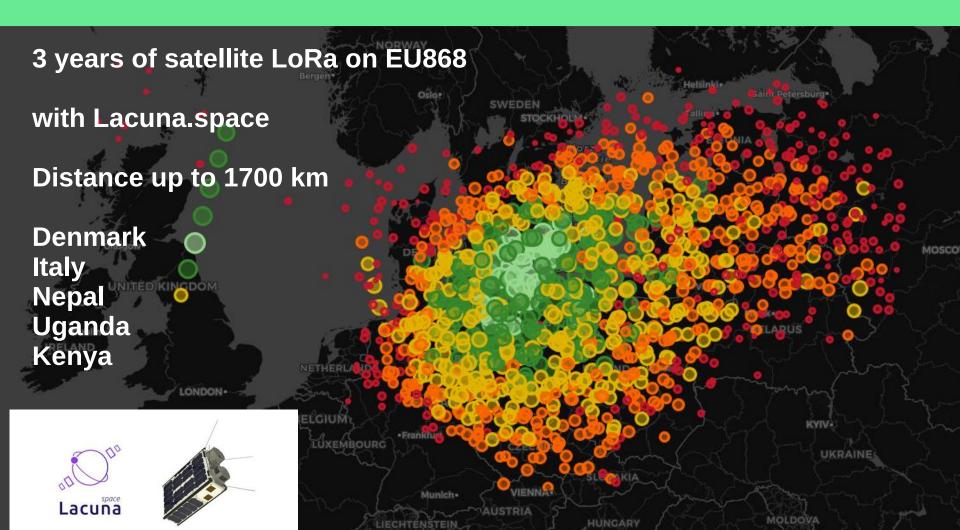


... and always happy to be back @ ICTP

(thank you, ICTP people!)



Satellite LoRaWAN at ITU



But now, just LoRa, no LoRaWAN, on earth

LoRa Mesh - general Idea & motivation:

Messaging without any central infrastructure – think: SMS without mobile provider

In areas without communications infrastructure:

Disaster situations

Rapid response

Autonomy

Privacy



Some use cases

Any situation where communications infrastructure is absent

From this workshop:

Hybrid LoRa Network for Underserved Community Internet (LUCI)

LoRa out at sea?

You get messaging with location tracking

LoRa into high mountain valleys?

Long distance meshing around obstacles

And many more



Meshtastic – who and what is it?

"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!"

https://meshtastic.org

Some characteristics:

A number of different software components – device firmware, mobile apps, web API, python API, CLI, simulators, integrations, ..



Meshtastic – who and what is it?

"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!"

The initial developers are IT professionals with an evening hobby :)

Active development community

Well-documented and communicated:

https://meshtastic.org

+ Discord + Discourse +



Mobile phone talks to

LoRa node

via Bluetooth

There are other ways to connect to the node:

Serial ----->

Web interface ----->





and the second

Then we add many users ...









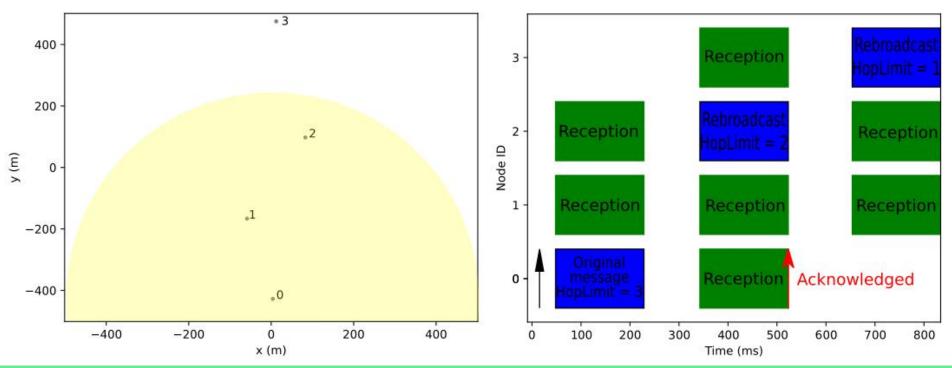
* Internet uplinks enable full integration with anything that can talk MQTT

Meshtastic – Mesh routing

Passive mesh routing - "Naive broadcast flooding":

The initial node sends out a message. The receiving node re-broadcasts anything that

- has not hit the maximum re-broadcast count yet
- it has not heard before

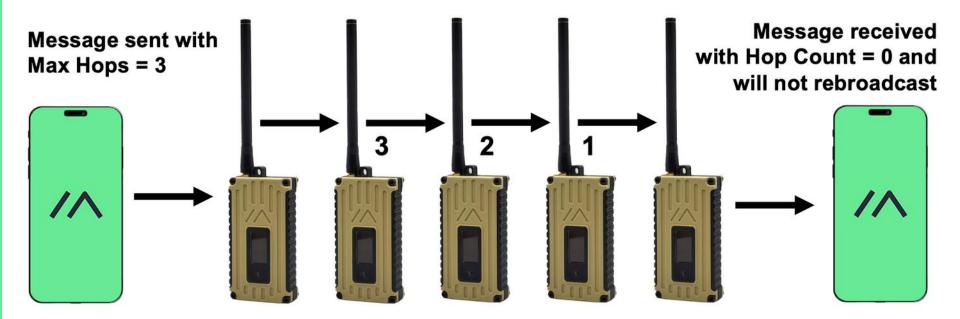


Details: https://meshtastic.org/docs/overview/mesh-algo

Meshtastic – Mesh routing

Passive mesh routing - "Naive broadcast flooding":

The algorithm favors weak signals, in order to make sure that messages from far away get re-broadcasted.



Details: https://meshtastic.org/docs/overview/mesh-algo

Meshtastic – Hardware

ESP32 based: T-Beam (\$30)

There is more, from about \$20 https://meshtastic.org/docs/hardware

nRF52 based: T-Echo (\$50)



Meshtastic - website has all info you need

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

Learn More

Get Started

Connect with us.

Getting started with Meshtastic is as easy as 1, 2, 3!

1. Purchase Supported

Hardware you will want to consider:

Hardware

Radio Battery

Case

2. Flash & Configure Node

The Meshtastic Web-Based Flasher & Clients can assist you in flashing the firmware and configuring settings.

3. Connect to Node

Applications are available for the following systems: Android iOS Mac

Meshtastic – limitations

Distance: it depends :) *... current record is 254 km

* on all the things that "normal" LoRa transmissions depend on: power, antennas(!), locations, ...

Number of nodes in one mesh network: limited to 80

What it is NOT:

It is not "Connecting the Unconnected". It is not broadband access, but of course can relay data form the internet to the users.

It is not closing any "digital gap".

It is also not a finished product or standard. It is under development.



Let us get started

We have

12 x Lilygo T-ECHO (easiest) (firmware already updated)

And some

Lilygo T-BEAM (more difficult – no screen – experts pls grab those!)

We need

The Meshtastic mobile app

(find it in the Play Store, or via https://f-droid.org/) - install it now!

Also for iPhone







Naming our devices

We each will have a long name -

please make your long name

Owner + the 4-digit Hex ID – example:

SEBA E95C

and a short name -

Please make that a name that allows us to know who you are, like

SEBA

For T-Echo: keep this image ... you need it :)







So let s get it to work

And take a walk in the park?

Up to Galileo? Maybe this evening?

Find your device ID (white sticker on the back of the T-ECHOs)

Always connect to that one device ONLY!

Else you are re-configuring your neighbour :)

ps.

All devices should have recent firmware (2.2.11 and up). If your device does not, you need to update.

Bluetooth connect to that device

You might need to find it in your Phone's Bluetooth list first and pair with it

Watch out for pairing pin codes needed!

Watch for the line that says

Connected to radio

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EU_868

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statistics and crash

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reports.

Channels:

Adding

Sharing

Joining

The terms might be confusing:

- Add = add a new channel yourself
- Scan = join a channel you are being invited to
- Send = save to device

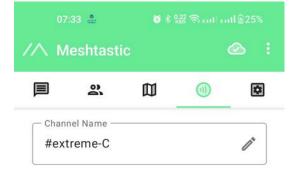
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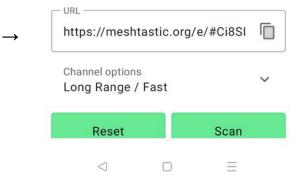
We invite you right now – to channel

"extreme"

Channels have settings that we can discuss later*





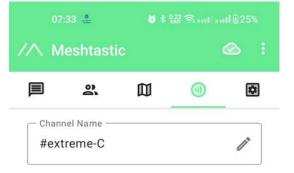


*Settings that we can discuss later:

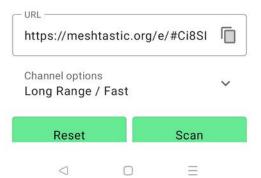
Channels can be optimized for various Ranges and speeds -

These are presets for LoRa Bandwidth, Spread Factor, and Coding Rate

Default is Long Range Fast







Channels, Chats, Messages

Here you can see

Your channels And direct chats

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Seb2		eam 6750 alking to ours ring	elves, are	16:45 we?
???	Unknow Direct ar	n Username n dich	9/3/2	3 19:06
???	Unknow Ping	n Username	8/30/2	3 07:49
Seb1	Seba 14 Qwerty	6c echo	8/29/2	3 17:09
???	Unknow Done, M	n Username r. Carlos	8/24/2	3 10:57

Inside a Channel

When you have found this

Please say hi!

And who you are!

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← e	extreme
-	
	Welcome to our new channel
Seb2	This is Seb2, the t-beam with screen 16:19
	Welcome! I am Seb1, a T-echo 16:23 📀
	It s not surprising we connect - we are 5 cm apart LOL 16:24
Seb2	True We should go a bit further soon 16:25
	Let s do some NLOS together with the good people at this workshop! 16:26
Seb2	let's try Adriatico to Galileo! 16:31
SEBASTI	ANQUICKCHAT
Send Text	≯

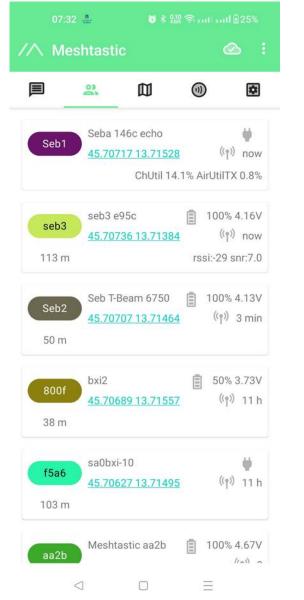
Peers

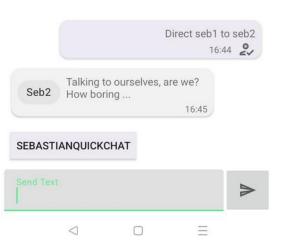
With info on

Location, Power, Last Seeen

&

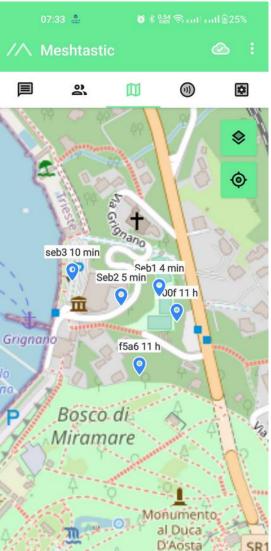
Direct messages





Seb T-Beam 6750

Map view







© OpenStreetMap contributors

SR1

Things we could talk more about

Internet integration – MQTT - Telegram integration

Configuration details

Use cases

Satellites and drones and mesh

Stay in touch via telegram group https://t.me/+CUPBrSbva-RiNTU0

or via email

sebastian@itu.dk