



LoRaMesher for LoRa mesh networks

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What are multi-hop LoRa mesh networks?



Needs for multi-hop LoRa mesh network?

As a connectivity solution?

Strengths

- **affordable (hardware & operation)**
- **fast-to-deploy**
- **no deep technical knowledge needed**
- geographically flexible
- low-energy consumption
- no network operator contract
- off-the-shelf microcontroller-based hardware
- support “light-weight” applications

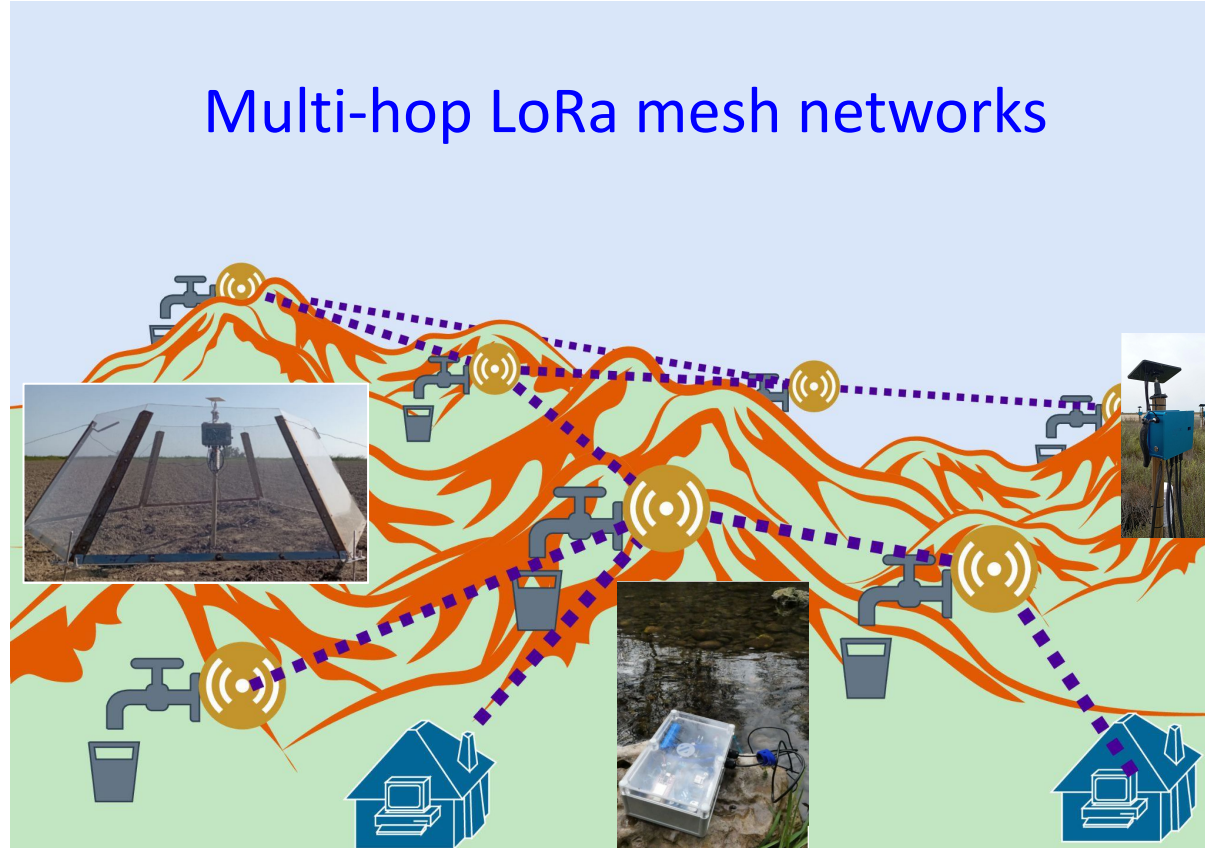
Potential issues

- **not providing high data rates**
- **lack of standardization**
- not providing real-time communication
- only few implementations
 - community-based
 - Meshtastic
 - LoRaMesher
 - commercial

Technology: LoRaMesher library

- A library for multi-hop LoRa mesh networks
- Node-to-node communication
- Distance vector routing
- Going beyond LoRaWAN
- Developed at since 2021
- Open-source
- git repository:

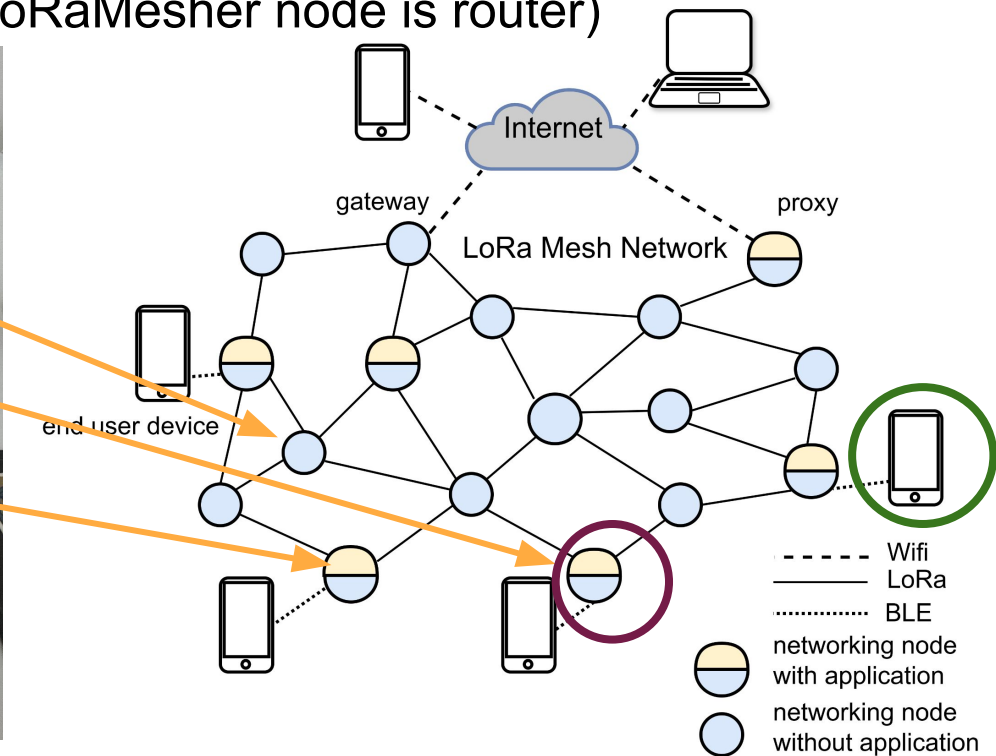
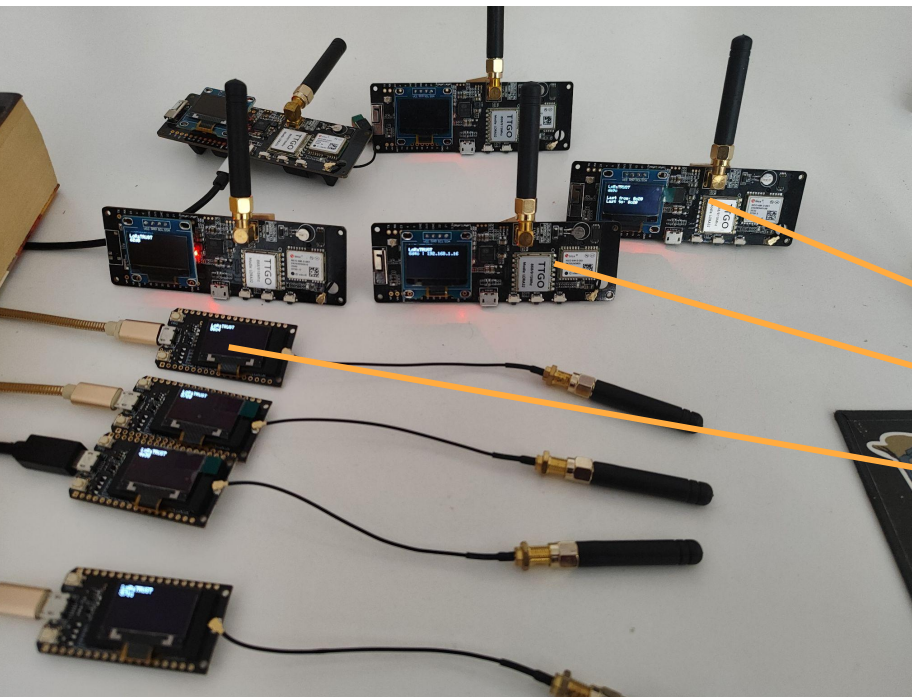
Multi-hop LoRa mesh networks



<https://github.com/LoRaMesher/LoRaMesher>

Usage scenario

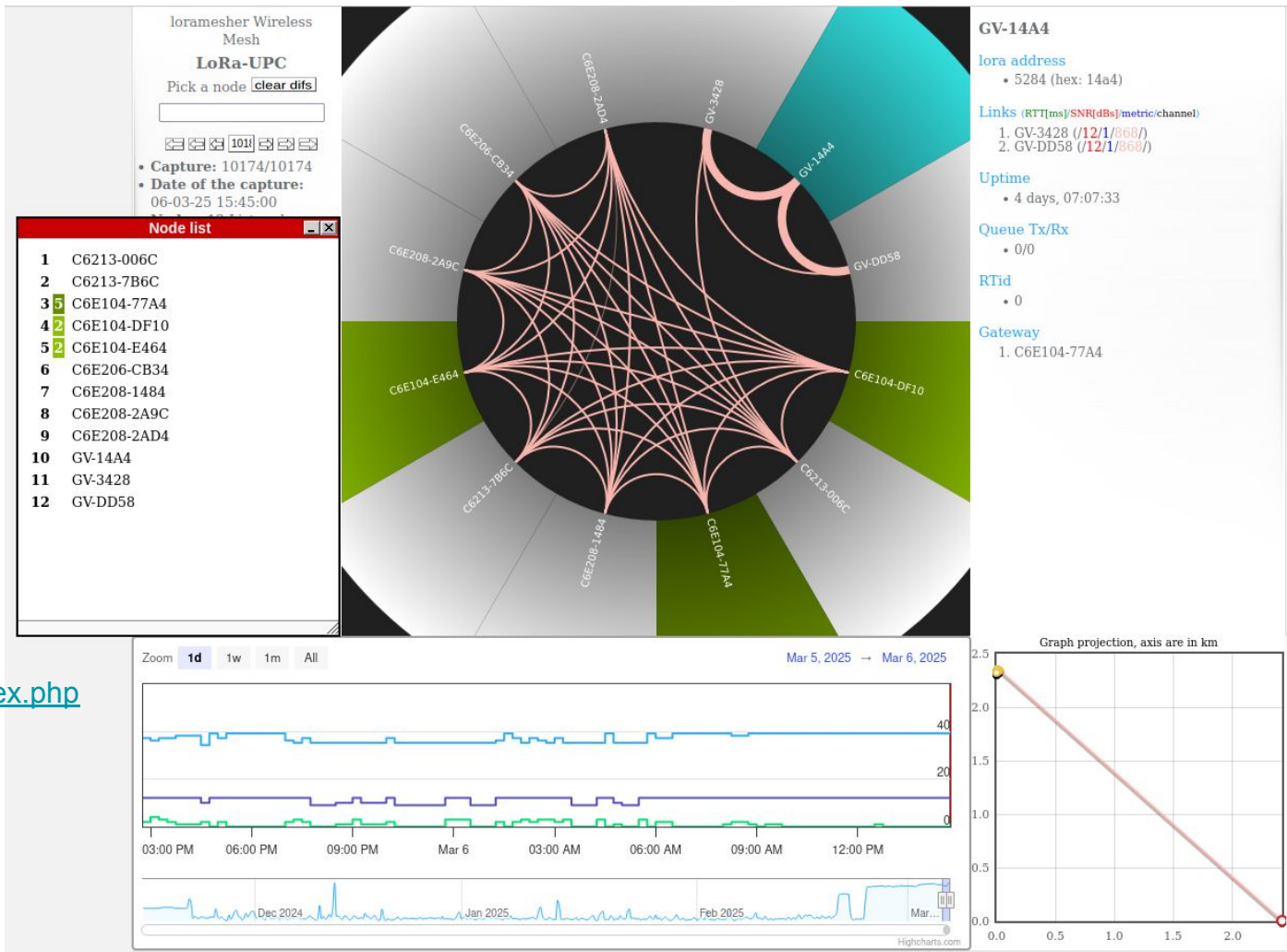
1. Applications on **IoT boards** (LoRaMesher node with application code)
2. Applications on **end user devices** (LoRaMesher node is router)



Scalability experience (so far)

Permanent deployment of LoRaMesher nodes at UPC campus:

<https://tomir.ac.upc.edu/loraupc/index.php>



Technical readiness

Routing table of a node.

```
I (6377488) LoRaMesher: Current routing table:  
I (6377492) LoRaMesher: 0 - 142C via 142C metric 1 Role 0  
I (6377499) LoRaMesher: 1 - 3188 via 3188 metric 1 Role 1  
I (6377505) LoRaMesher: 2 - C6C4 via C6C4 metric 1 Role 1  
I (6377511) LoRaMesher: 3 - 1428 via 1428 metric 1 Role 0  
I (6377517) LoRaMesher: 4 - 7AFC via 7AFC metric 1 Role 0  
I (6377523) LoRaMesher: 5 - E7A8 via E7A8 metric 1 Role 1  
I (6377529) LoRaMesher: 6 - 1DB8 via 1DB8 metric 1 Role 0  
I (6377535) LoRaMesher: 7 - 2598 via 2598 metric 1 Role 0  
I (6377541) LoRaMesher: 8 - 50B8 via 50B8 metric 1 Role 0  
I (6377547) LoRaMesher: 9 - 869C via 869C metric 1 Role 0  
I (6377553) LoRaMesher: 10 - 148C via 148C metric 1 Role 0  
I (6377559) LoRaMesher: 11 - 66DC via 66DC metric 1 Role 0  
I (6377566) LoRaMesher: 12 - 7984 via 7984 metric 1 Role 0
```

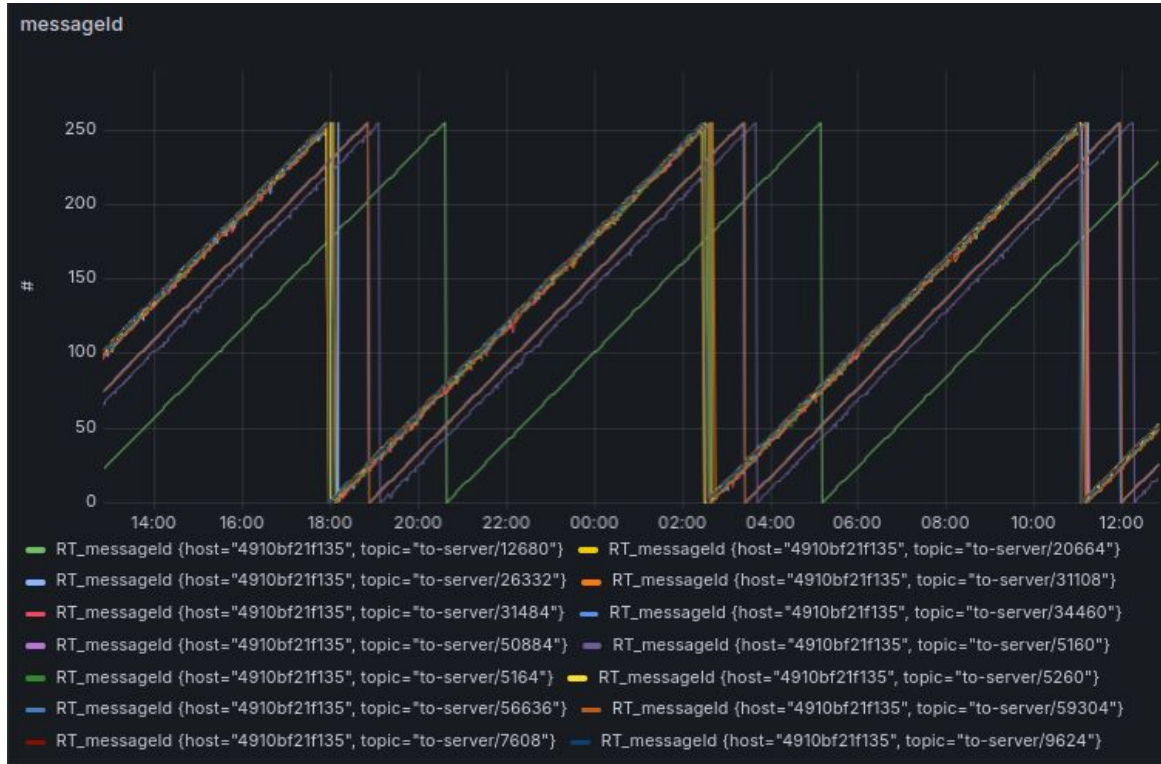
Technical readiness

Large messages of 1014 bytes are sent from three nodes in the LoRa mesh network (id 46300, 50884, 59304) during 24-hours to a gateway node (id 56636)



Technical readiness

Evolution of the value of the MessageId field along a 24-hour experiment with 14 nodes



How to develop with LoRaMesher?

- Hardware: ESP32 microcontroller board, e.g., T-Beam
- Code in open git repository

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How to develop with LoRaMesher?

LoRaMesher / src /

<https://github.com/LoRaMesher/LoRaMesher>

- 1) Take an example
- 1) Integrate library

LoRaMesher / examples /

Jaimi5 fix: Changed examples for LoRaMesher

Name
..
Counter
CounterAndDisplay
LargePayload
SX1262

EXAMPLES

```
main.cpp

#include "LoraMesher.h"
...
LoraMesher& radio = LoraMesher::getInstance();
...

void setup() {
  ...
  setupLoraMesher();
  createSendMessages();
}

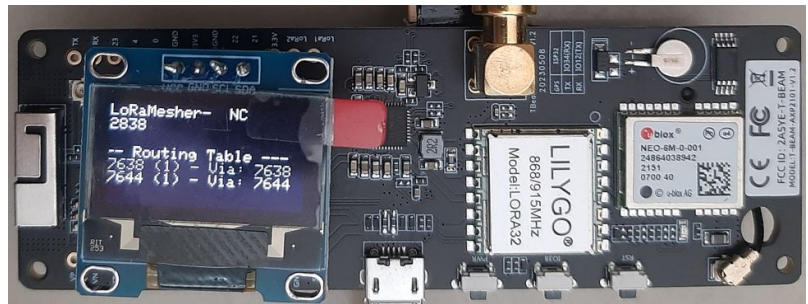
void loop() {
  ...
}
```

PTT3108 update pin for sx128x

Name
..
entities
modules
services
utilities
BuildOptions.cpp
BuildOptions.h
EspHal.cpp
EspHal.h
LoraMesher.cpp
LoraMesher.h

LIBRARY

How to develop with LoRaMesher?



Log messages from serial port

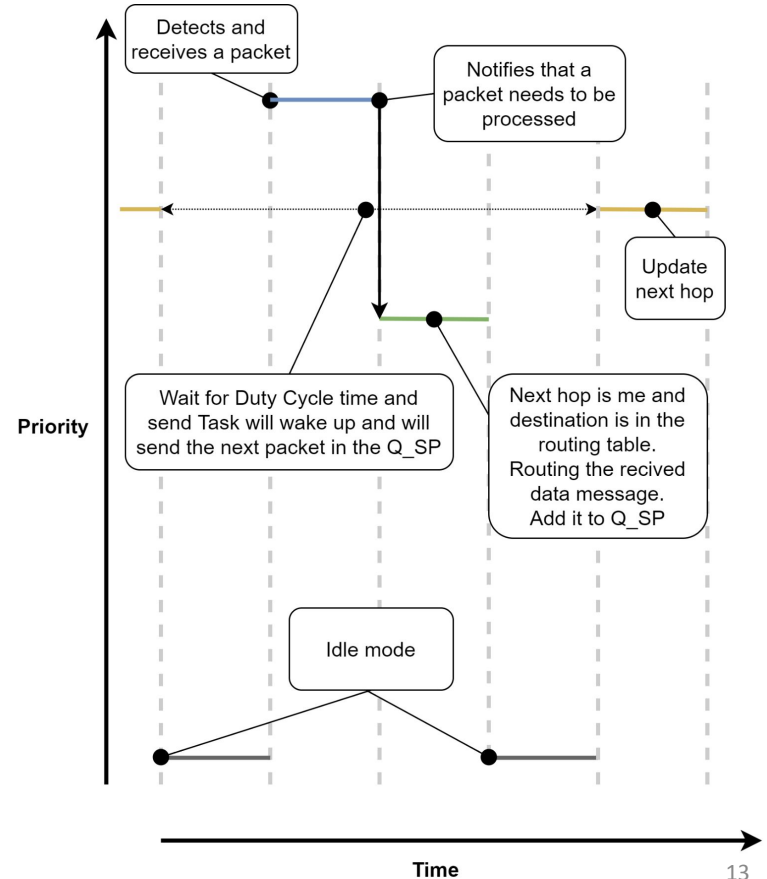
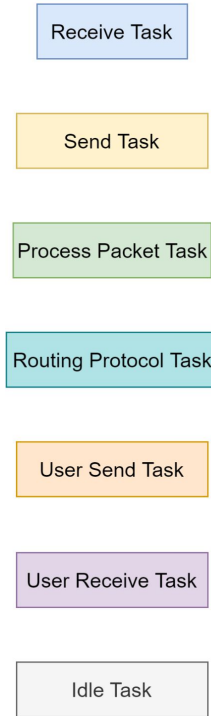
```
[262846][I][PacketService.cpp:12] createEmptyPacket(): [LoRaMesher] Packet created with 12 bytes
[262855][I][LoraMesher.cpp:392] receivingRoutine(): [LoRaMesher] Receiving LoRa packet: Size: 12 bytes RSSI: -27 SNR: 9
[262866][V][LoraMesher.cpp:647] processPackets(): [LoRaMesher] Size of Received Packets Queue: 1
[262875][V][LoraMesher.cpp:754] printHeaderPacket(): [LoRaMesher] Packet received -- Size: 12 Src: B4DC Dst: FFFF Id: 204
Type: 4 Via: 0 Seq_Id: 0 Num: 0
[262888][I][RoutingTableService.cpp:77] processRoute(): [LoRaMesher] Route packet from B4DC with size 1
[262898][I][RoutingTableService.cpp:99] resetReceiveSNRRRoutePacket(): [LoRaMesher] Reset Receive SNR from B4DC: 9
[262908][I][RoutingTableService.cpp:192] printRoutingTable(): [LoRaMesher] Current routing table:
[262916][I][RoutingTableService.cpp:206] printRoutingTable(): [LoRaMesher] 0 - B4DC via B4DC metric 1 Role 0
[262916][I][RoutingTableService.cpp:206] printRoutingTable(): [LoRaMesher] 1 - DD3C via DD3C metric 1 Role 0
[262916][I][RoutingTableService.cpp:206] printRoutingTable(): [LoRaMesher] Deleting packet
[262916][I][RoutingTableService.cpp:206] printRoutingTable(): [LoRaMesher] Deleting packet queue
[262916][I][RoutingTableService.cpp:206] printRoutingTable(): [LoRaMesher] Time unused after entering the task: 2212
[262916][I][RoutingTableService.cpp:206] printRoutingTable(): [LoRaMesher] 300968
[262916][I][RoutingTableService.cpp:206] printRoutingTable(): [LoRaMesher] Detected while waiting 2
[275795][V][LoraMesher.cpp:754] printHeaderPacket(): [LoRaMesher] Packet send -- Size: 16 Src: F020 Dst: FFFF Id: 8 Type: 4
Via: 0 Seq_Id: 0 Num: 0
[277393][V][LoraMesher.cpp:575] sendPackets(): [LoRaMesher] TimeOnAir 1582 ms, next message in 0 ms
```

Routing table at startup

```
0 - B4DC via B4DC metric 1 Role 0
1 - DD3C via B4DC metric 2 Role 0
```

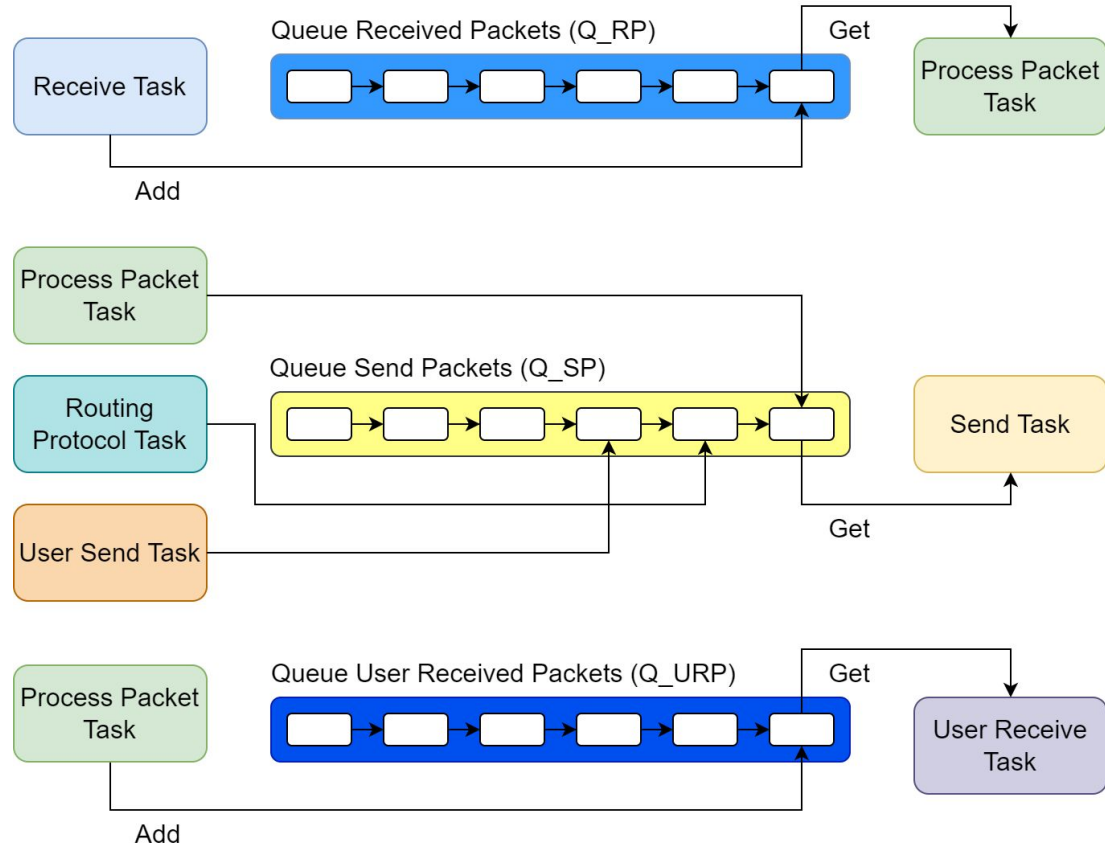
Technical details: Tasks in LoRaMesher

- Task-based execution
- Uses FreeRTOS
- Example: Routing a received data packet



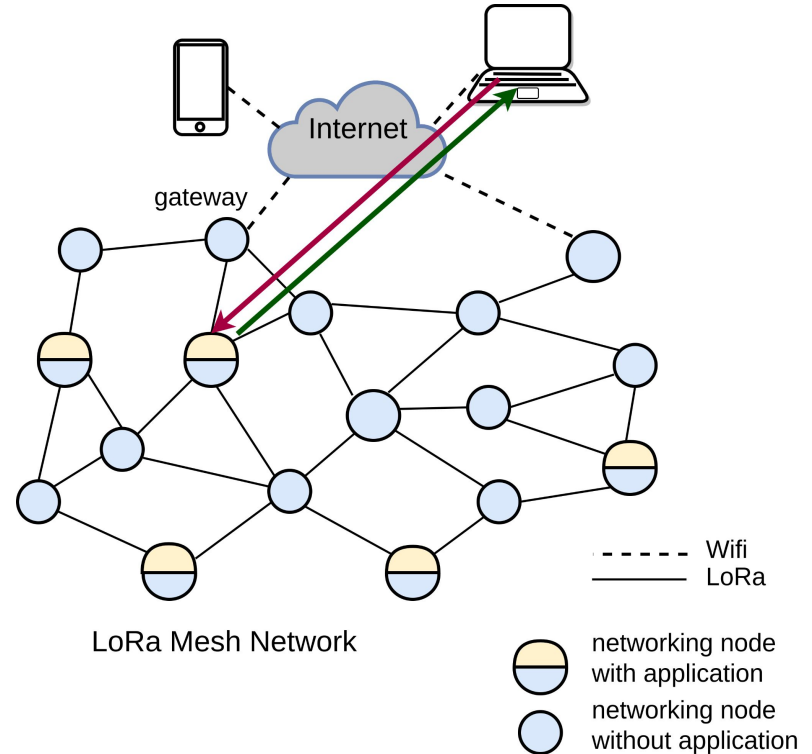
Technical details: Queues in LoRaMesher

- Received_Packet_Queue
- Send_Packets Queue
- User Received Packets Queue



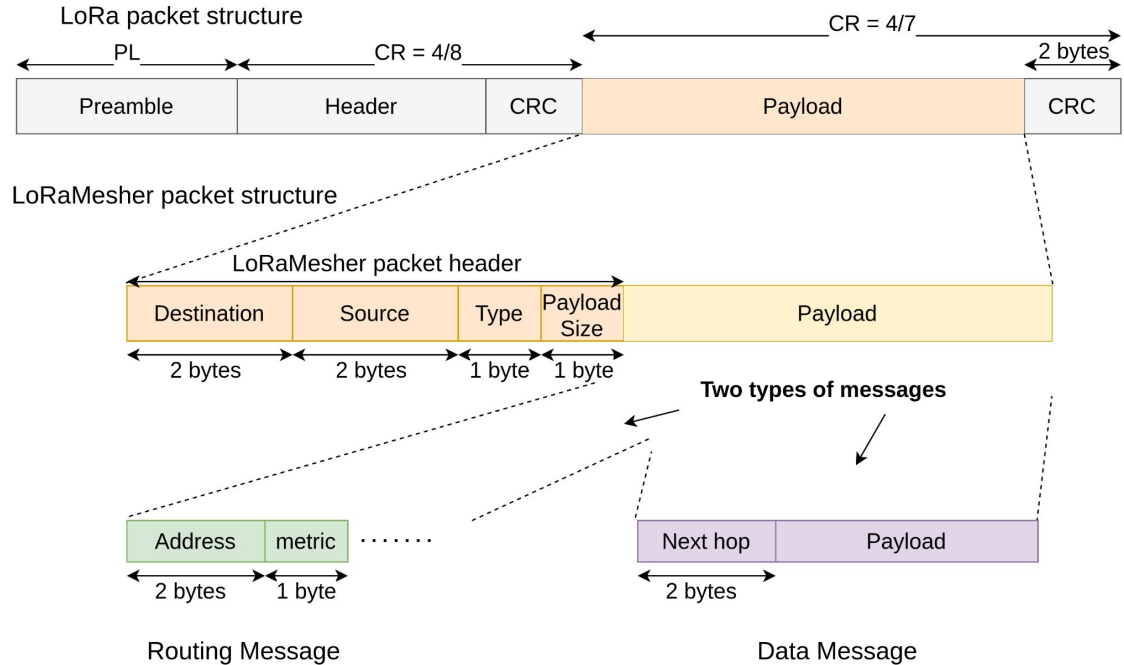
Diverse considerations

- Opportunity of bidirectional communication with the Internet
- Standardization
- Tragedy of the commons
- LoRaMesher community (developers & users)
- Community networks



Discussion

- LoRa mesh network deployments
 - Performance
 - Costs
 - Deployment time
 - Ad-hoc networking capacity
 - Technical knowledge





Thank you for your attention!

Git repository: <https://github.com/LoRaMesher/LoRaMesher>

[Discord](#)

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