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Emergency network in Aveiro:

Integration with ATCLL

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TOC

Overview

The objective of the project is to establish an emergency network infrastructure in Aveiro by integrating the current infrastructure of the Aveiro Tech City Living Lab (ATCLL) using the street poles and drones to expand the ad-hoc network. Additionally, the project intends to offer the population an emergency 5G network utilizing 5G modules on the posts, which will subsequently be complemented by drones.

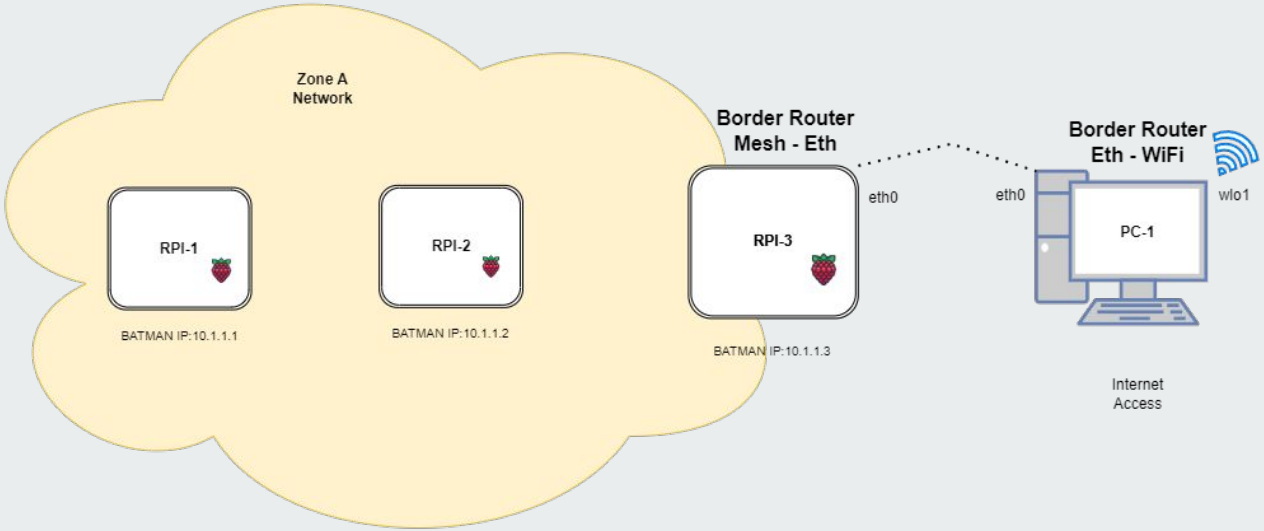
Project objectives

1. Use the ATCLL infrastructure to create an ad-hoc network and expanding its range among emergency entities (firefighters, police, etc...).

2. Whenever possible, provide a 5G network that will be strong near the infrastructure and weaker near the areas covered by drones. The 5G modules will be activated upon detection of disasters or network failures.

3. Use drones to extend the network's range (5G and Ad-hoc) by connecting the street poles and devices that are not close to each other, establishing connections between areas that are difficult to access or have a lack of connectivity.

Final Architecture

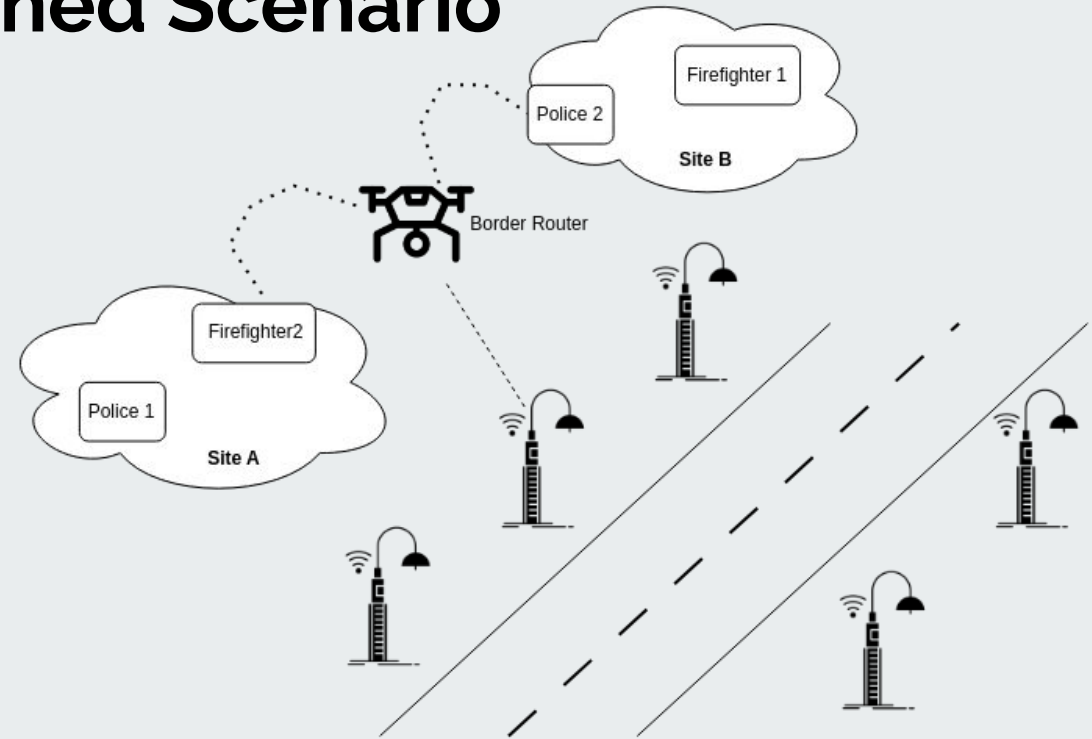


Devices with static IP and static default route to RPI-3

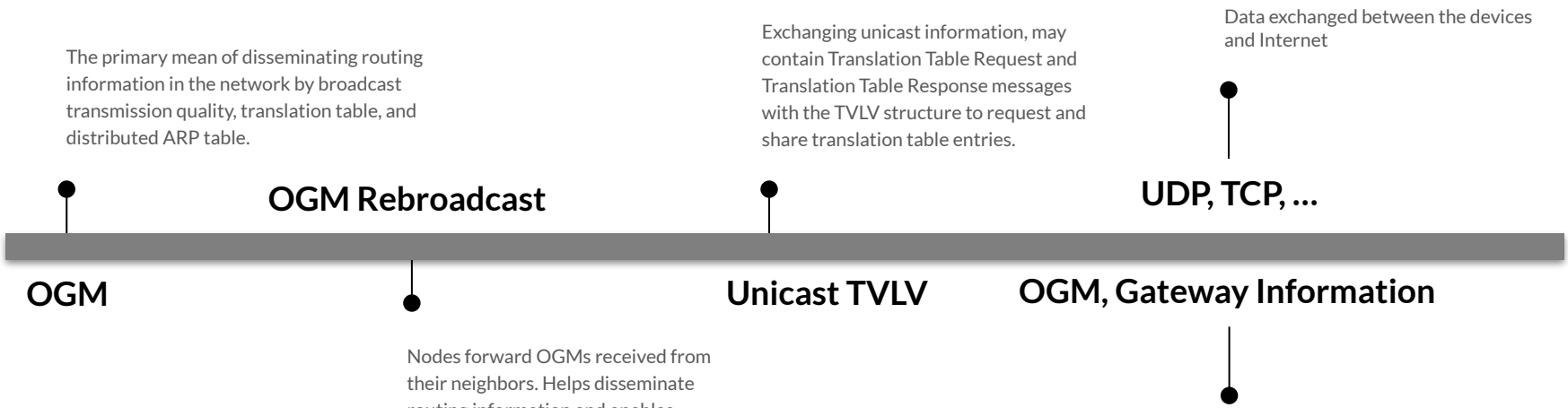
Messages exchanged:

- OGM
- Unicast TVLV
- OGM, Gateway Information (by the BR)

Envisioned Scenario



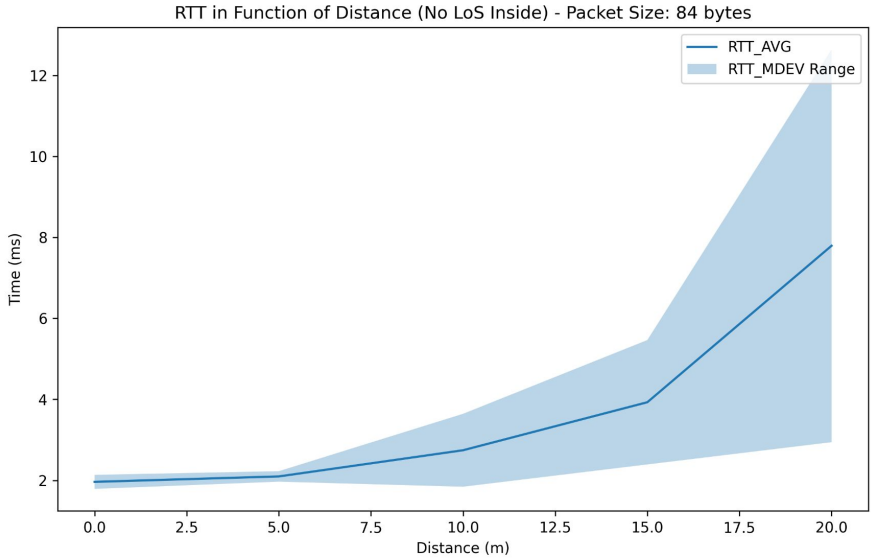
Messages Timeline



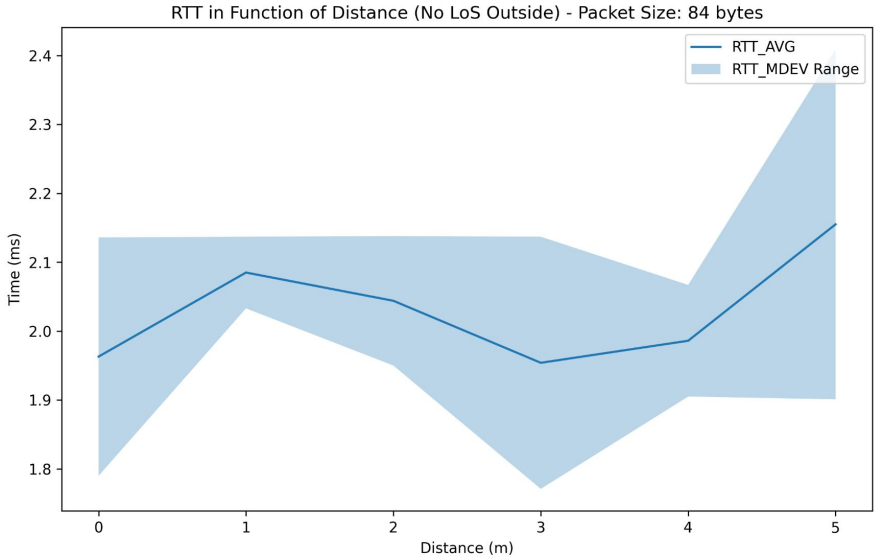
Test Methodology

We conducted experiments on device communication at a height of approximately 1.5 meters. To determine the distance between the devices, we relied on the smartphone's GPS and calculated the coordinates-based distance. Although our measuring equipment lacks precision, we can guarantee a certain degree of consistency in our tests.

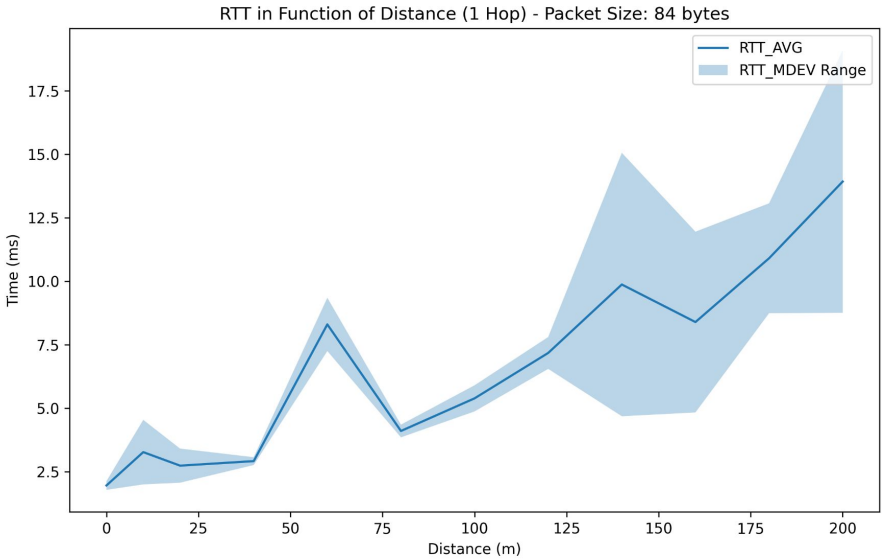
RTT Results


RTT in Function of Distance (No LoS Inside) - Packet Size: 84 bytes
RTT_AVG
RTT_MDEV Range
Time (ms)
Distance (m)
2
4
6
8
10
12
0.0
2.5
5.0
7.5
10.0
12.5
15.0
17.5
20.0

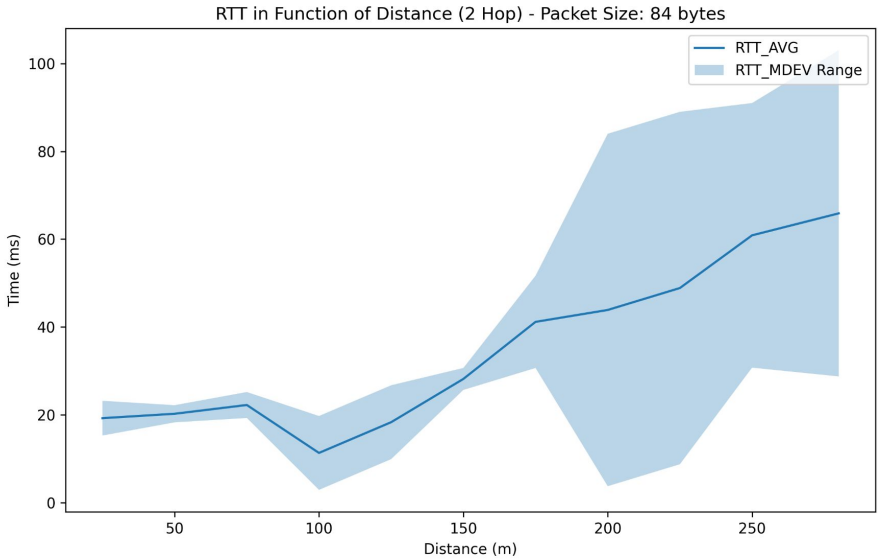
RTT Results


RTT in Function of Distance (No LoS Outside) - Packet Size: 84 bytes
RTT_AVG
RTT_MDEV Range
Time (ms)
2.4
2.3
2.2
2.1
2.0
1.9
1.8
0
1
2
3
4
5
Distance (m)

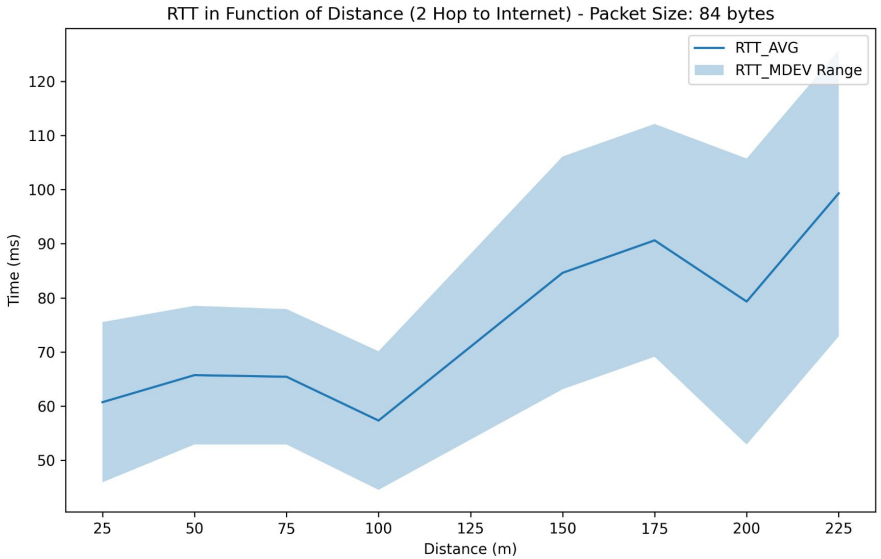
RTT Results


RTT in Function of Distance (1 Hop) - Packet Size: 84 bytes
RTT_AVG
RTT_MDEV Range
Time (ms)
17.5
15.0
12.5
10.0
7.5
5.0
2.5
0
25
50
75
100
125
150
175
200
Distance (m)

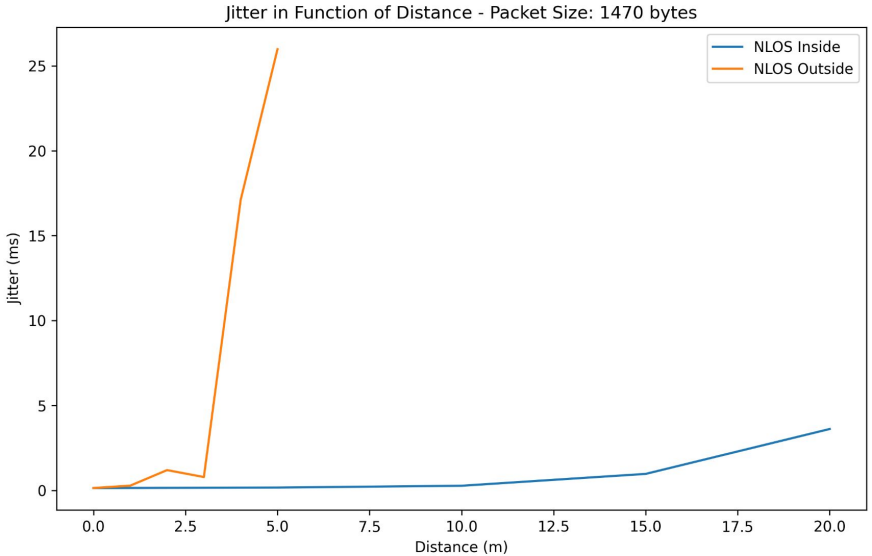
RTT Results


RTT in Function of Distance (2 Hop) - Packet Size: 84 bytes
RTT_AVG
RTT_MDEV Range
Time (ms)
Distance (m)
0
20
40
60
80
100
50
100
150
200
250

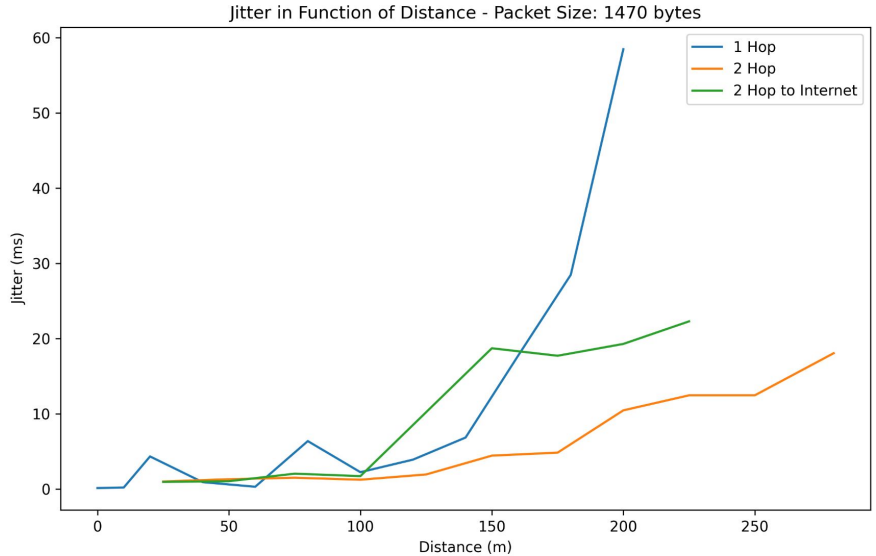
RTT Results


RTT in Function of Distance (2 Hop to Internet) - Packet Size: 84 bytes
RTT_AVG
RTT_MDEV Range
Time (ms)
120
110
100
90
80
70
60
50
25
50
75
100
125
150
175
200
225
Distance (m)

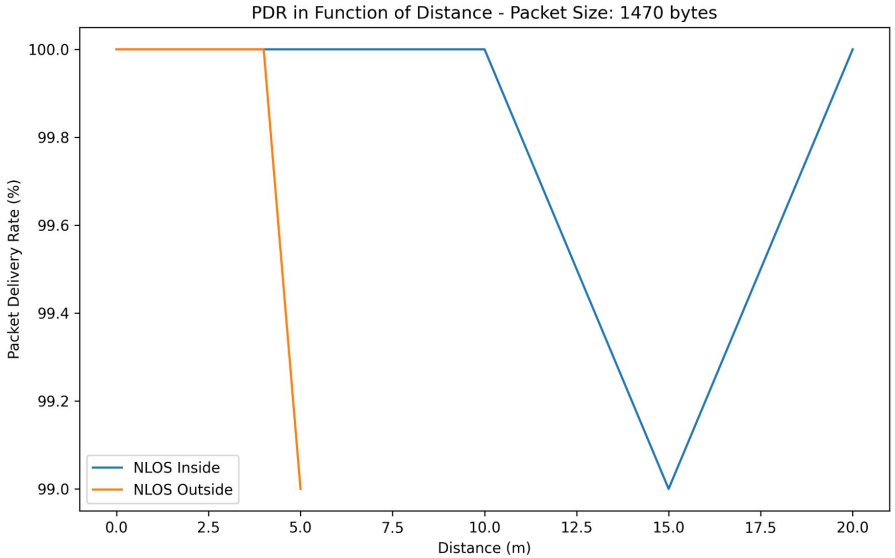
Jitter Results



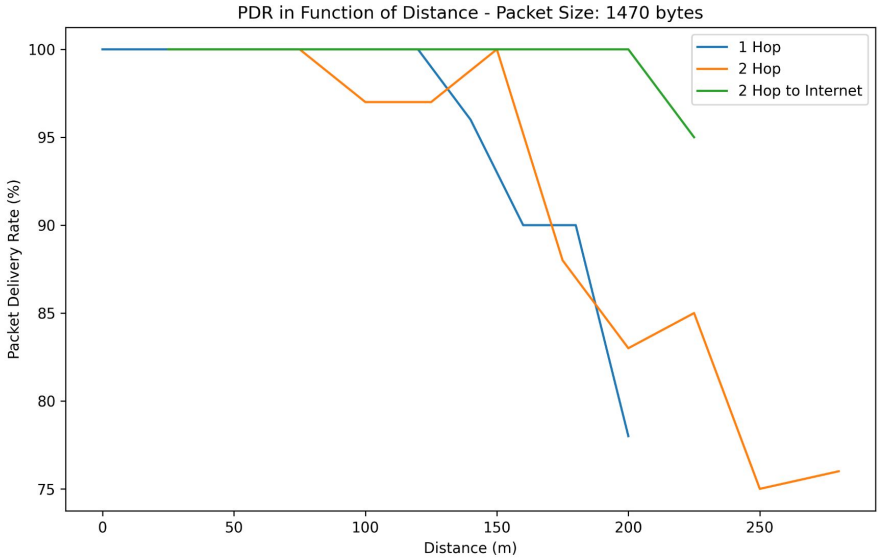
Jitter Results



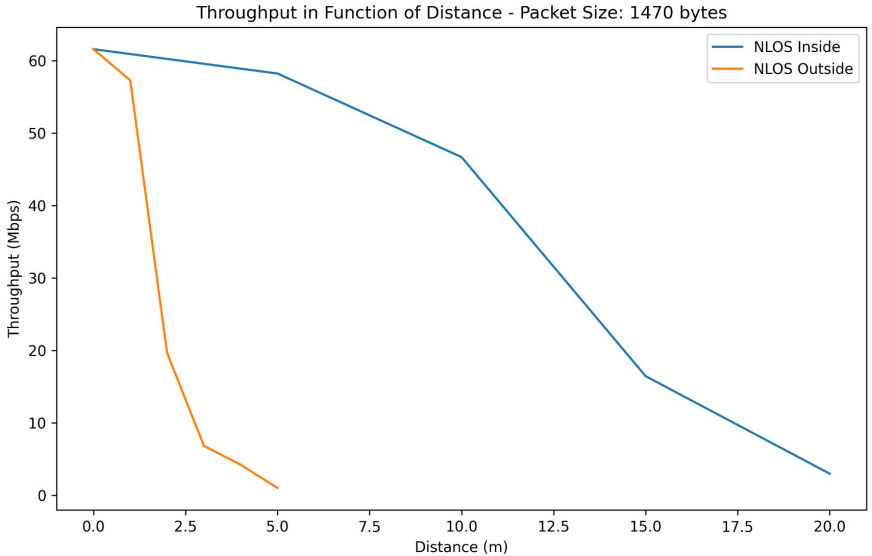
PDR Results


PDR in Function of Distance - Packet Size: 1470 bytes
Packet Delivery Rate (%)
100.0
99.8
99.6
99.4
99.2
99.0
0.0
2.5
5.0
7.5
10.0
12.5
15.0
17.5
20.0
Distance (m)
NLOS Inside
NLOS Outside

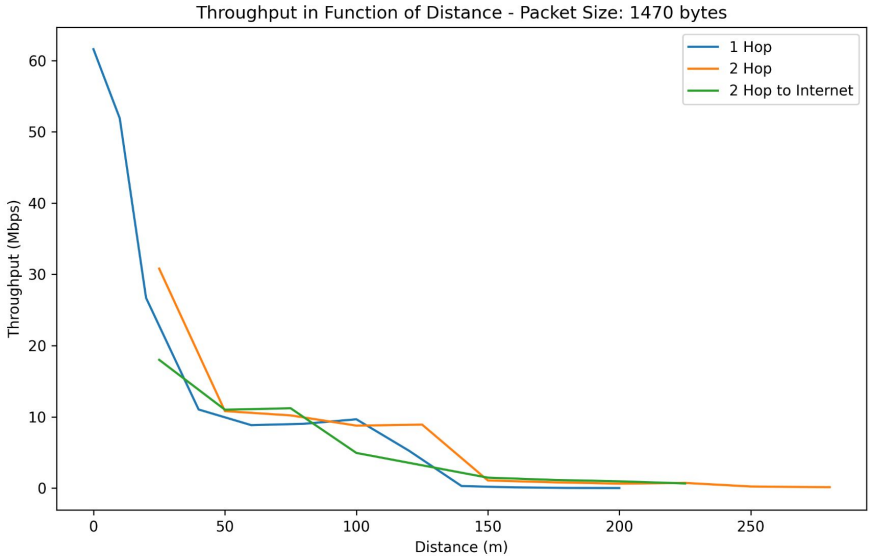
PDR Results


PDR in Function of Distance - Packet Size: 1470 bytes
Packet Delivery Rate (%)
Distance (m)
1 Hop
2 Hop
2 Hop to Internet
100
95
90
85
80
75
0
50
100
150
200
250

Throughput Results



Throughput Results

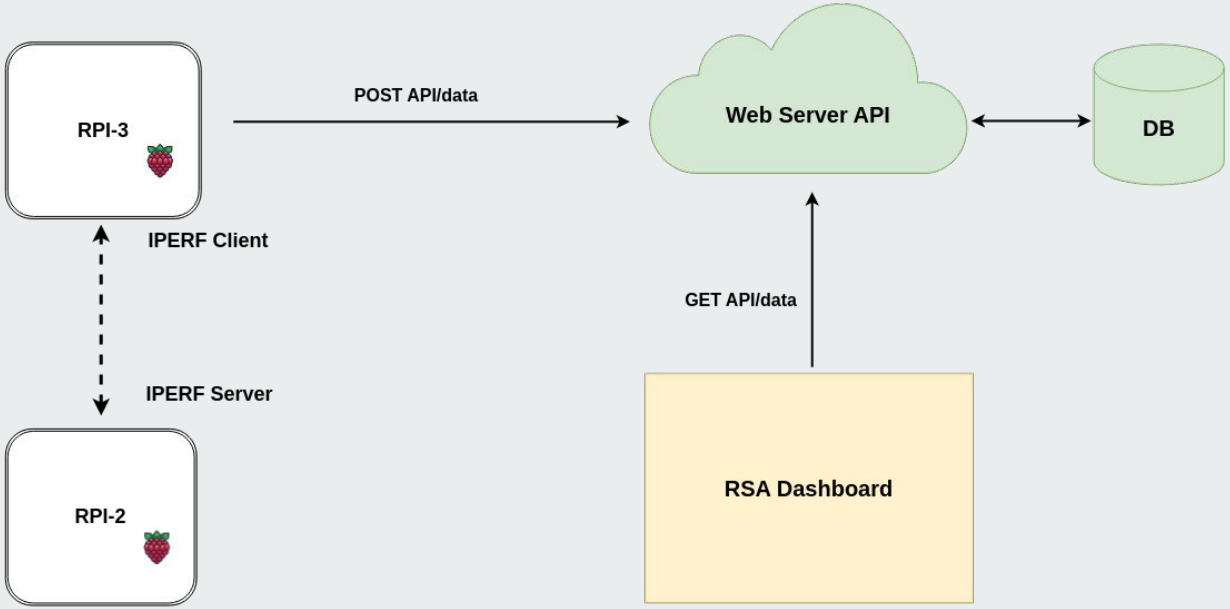


Test Conclusions

Based on our results, we determine that this technology would be very useful for the envisioned scenario. We observed a correlation between device height and achieved distance, indicating that if we used the city street poles and a drone, we could easily exceed 500 meters in LoS and with multi hops.

Furthermore, the devices we utilized had small network cards with no antennas, and they were enclosed, exacerbating the degradation of the signal.

Demo Architecture



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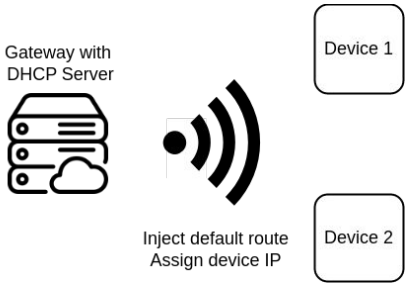
Demo Preview

Future Work

Add DHCP Server to the Gateway



New network card to get RSSI

Add 5G module to the gateway

Conclusions

We constructed a scenario in this project that closely resembles the intended use case. Additionally, we conducted thorough testing of our implementation through a diverse range of tests, which ultimately confirmed the effectiveness of our network in a real-life scenario and its ability to meet the user's demands.
As an additional feature, we incorporated a service called "toxcore" into our project, which emulates a social chatting platform and facilitates seamless communication among users across devices within an ad-hoc network.