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LORAWAN NETWORKS TEST ASPECTS OF CRITICAL INFRASTRUCTURES

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Introduction

IoT technologies are increasingly being used for critical infrastructures as well. One of the most frequently used IoT communication technology is LoRaWAN. The technology provides opportunities for developing long-range, low-power systems. Due to the robustness of communication, this is specifically suitable for providing stable communication with extreme terrain and environmental parameters. Our research aims to determine the data transmission distance for different LoRaWAN communication modules and gateways. In addition, our goals include the examination of communication parameters. Based on the measurement results, we improve the cases where LoRaWAN technology can be used in the critical infrastructure aspect.

Experimental study

The following measurements compared different gateways in terms of signal propagation over a large built-up area. The purpose of the measurements was to compare some commercially-available gateways in terms of sensitivity and signal-to-noise ratio. Three gateways—two indoor and one outdoor—were used for the measurements.

The three gateways were operated simultaneously while taking the measurements, and the packets received by them could be identified based on their standard parameters. The two indoor passages were placed about 8m high in a window facing the street. The outdoor gateway was placed on a balcony overlooking the inner courtyard of the same house.

Parameters of used gateways for measurement:

- *Tracknet TBGW100*
  - Indoor gateway
  - Antenna: internal PCB antenna
  - Maximum receive sensitivity: -140 dB SF12
- *Kerlink WirnetTM iFemtoCell*
  - Indoor gateway
  - Antenna: LoRa® swivel antenna, 3 dBi
  - Maximum receive sensitivity: -140 dB SF12
- *Microtik wAP + R11e-LR8 LoRa Gateway module*
  - Outdoor gateway
  - Antenna: Collinear antenna, 10 dBi
  - Maximum reception sensitivity: -137 dB SF12

During the measurements, a *Micromite LoRaWAN* (Microchip RN2483 module) GPS tracker was used as the end-node and continuously moved away from the gateways. The results of the measurements were represented in two ways, one of which was the heat map representation (Fig. 1.), in which the colour of the layer drawn on the map depends on the received signal strength and the density of the signals received in the given area.

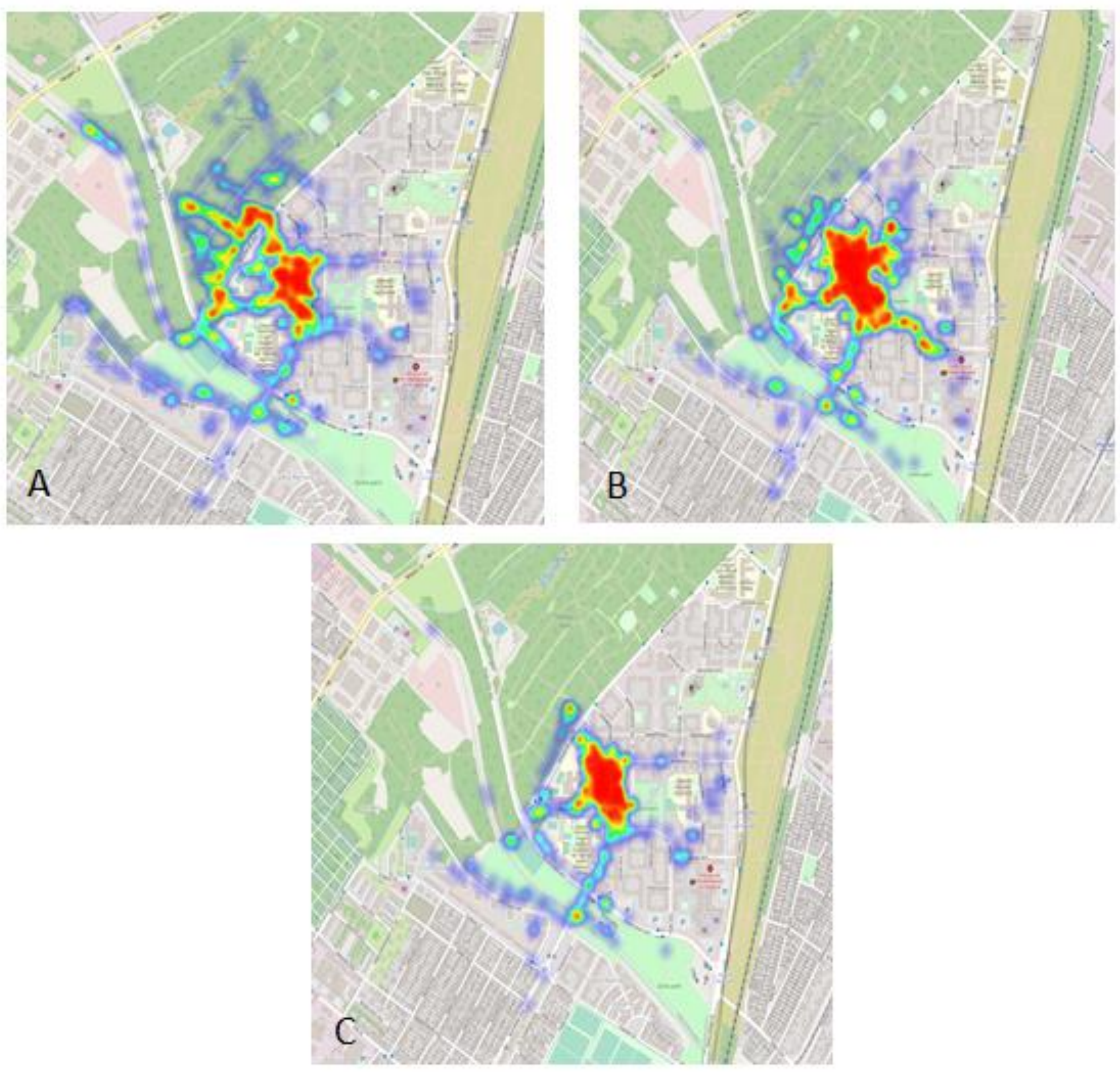

Fig. 1. *Mikrotik Gateway (A), Tracknet Gateway (B) and Kerlink Gateway (C) RSSI heat map*

The other representation method was the graph of the signal strength and signal-to-noise ratio of the received packets as a distance function (Fig. 2.). This representation no longer includes duplications.

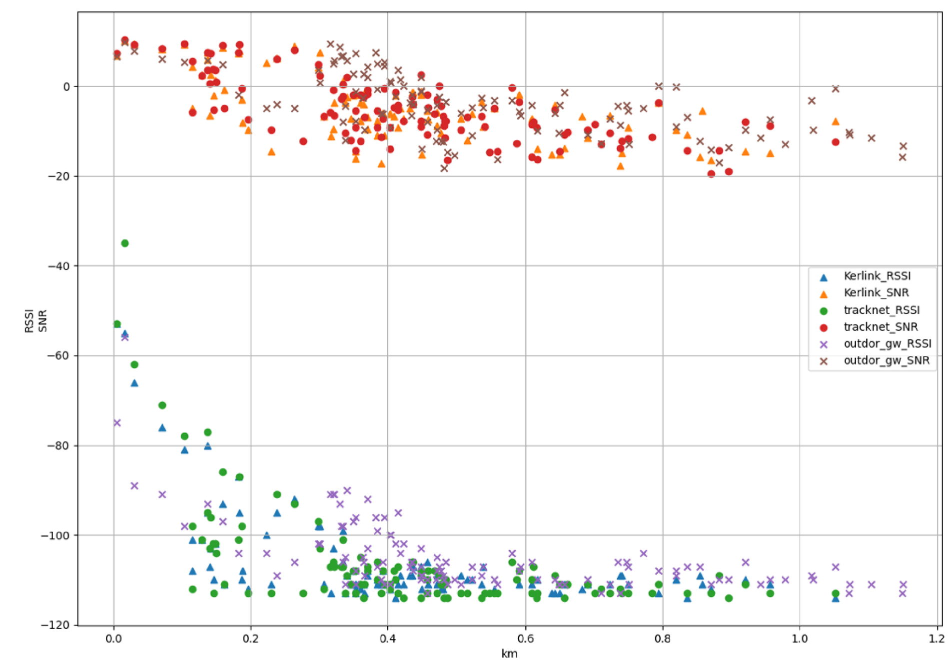

Fig 2. *Representation of RSSI and SNR values per gateway as a function of distance*

The other group of our measurements dealt with the examination of the network of a Hungarian service provider. In connection with the application of the technology, a data-transmission distance of a few kilometres within a city is typically displayed. In a less built environment, it is typically around 10 km. In the case of LoRaWAN technology, it is also possible to set up private networks, but service providers have also appeared on the market.

The purpose of the measurement is to examine the data-transmission distance using a service provider network. The end-node used was an *ACSIP EK-S76GXB EVK LoRa + GPS* device. Among our measurements, the most significant data-transmission distance was measured between Abasár and Debrecen (Fig.3.). This corresponds to a data-transmission distance of 125 km.

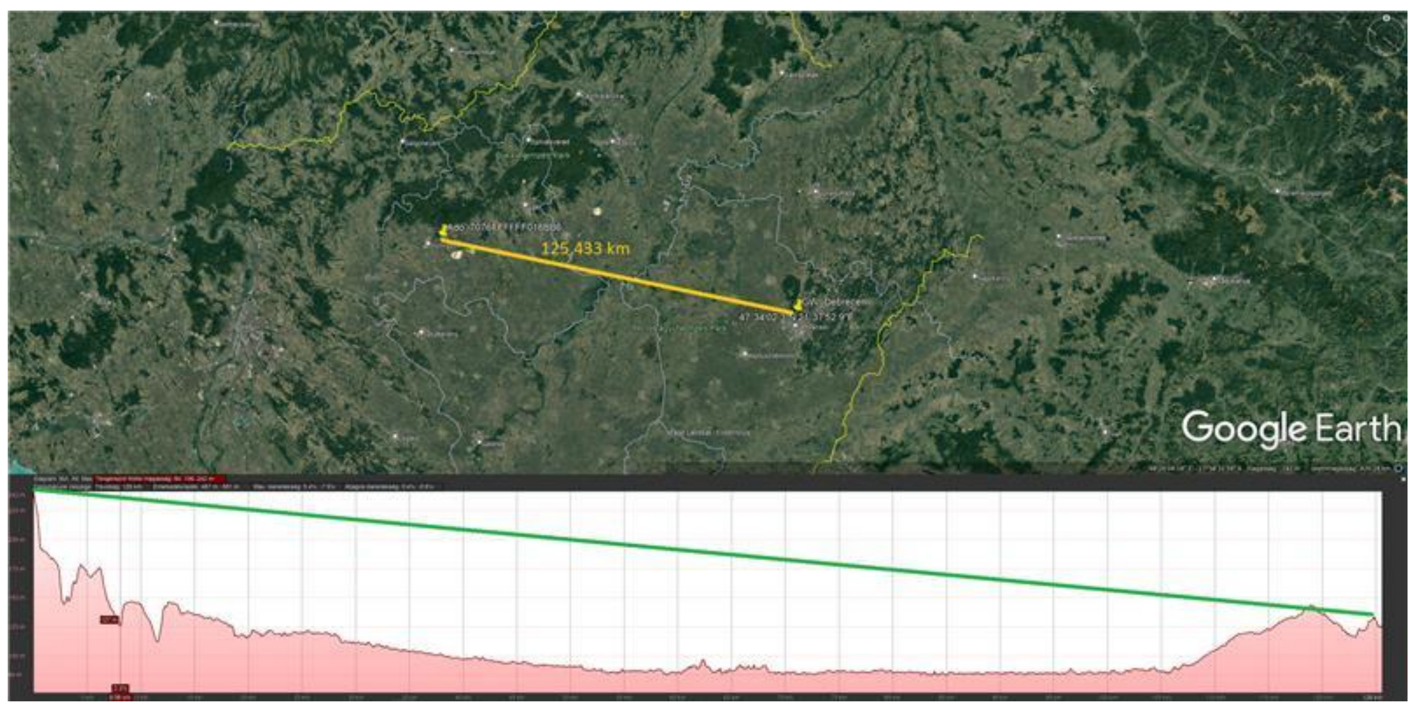

Fig 3. *125 km data transmission distance on the Hungarian LoRaWAN service provider network*

Conclusion

The gateway test measurements (Fig. 1.) show that the coverage of the outdoor gateway is higher in the direction of the forest, while the coverage of the indoor gateway is higher in the opposite direction. The difference is that the inner courtyard in which the outdoor gateway is located is towards the forest, and the indoor gateways are opposite to the forest. The three heat maps are a great illustration of the potential of LoRaWAN communication. Each gateway is located in a built-up area in which there is a block 2–3 blocks higher than their position in their immediate vicinity (10–20 m). Thus, signal propagation is realised almost exclusively through reflection and reinforced concrete prefabricated panel houses. Fig. 2. shows that the outdoor gateway received packets on average with better signal strength and signal-to-noise ratio due to the high-gain antenna, even though it is located in an inner courtyard. Furthermore, the two indoor gateways received packets with almost identical results. The first measurements indicate that coverage that can be used in built-in areas can be achieved using LoRaWAN technology, unlike virtually any other known wireless technology. Compared to the gateways used, much more robust designs are available on the market, but even with these measurements, it has been proven that the LoRaWAN technology can be used with extreme environmental parameters or critical infrastructure protection.

The data-transmission distance of 125 km (Fig. 3.) achieved by the second measurement team is an outstanding result. We worked with an antenna with much better radio parameters than the factory LoRa antenna of the ACSIP product to achieve this result.