Analysis on LoRa RSSI in Urban, Suburban, and Rural Area for Handover Signal Strength-Based Algorithm.

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Abstract. This paper focuses on analysis on Long Range (LoRa) handover session was conducted in urban, suburban, and rural area in Perlis state, Malaysia. The experiment will consists of observation and analyzed on three area using LoRa communication modules. These three areas were collected on its Received Signal Strength Indicator (RSSI) to know the signal strength over the distance from base station and the differences physical object appear in Line of Sight (LoS) during the transmitting and receiving its signal from LoRa Transmitter to LoRa Receiver. The result at three area of different location have shown various pattern in term of RSSI where the each of the location give the distance that signal of LoRa could reach whilst the motion of vehicle is constant. From this experiment, certain level of RSSI value will be chosen to set as minimum boundary switcher for handover process state indicator and be used handover process algorithm in network switcher.

1. Introduction

Internet of Thing (IoT) comes with several of technique to receive data and send it to the cloud storage [1-7]. LoRa in IoT platform is a new Industrial, Scientific, and Medical (ISM) band wireless technology designed for low power, unlicensed, and Long-Range operation[8]. The frequency of LoRa has given access to the area of the country that could perceive and usable to simultaneously sending and receiving process. The sensor that is installed in modern vehicle currently can be optimized using the latest technology such as On-Board-Diagnostic (OBD-II) system. In the past, people communicate either with each other or with machines. However, with the arrival of the IoT, physical objects have the ability to communicate with each other without human intervention[9]. Thus, the previous non-cellular module being install in all around the smart cities or metropolitan but have their pros and cons in their respective coverage area network.

2. Existing Studies

In past literature, a study regarding the cellular network was executed in the country of India. N. Rakesh and S. K. Srivatsa [10], explain that different radio propagation model was used to determine the suitable method to calculate path loss in three different area. N. Alam, et. al. [11], mentioned radio raging
technique such as RSSI is very popular due to lower cost and its simplicity compared to other method. Although there are many models viable to analyze the path loss model, not all of them could use in certain unique environments[11].

3. Experimental Setup
To test the reliability and credibility of LoRa network in the communication link layer, communication node hardware was developed using two devices; Arduino Uno, and LoRa module with antenna to communicate between the moving vehicle and a base station as shown in Figure 1.

The LoRa device is divided into two communication nodes which is the receiver node and sender node. The placement or the height base for sender node was set to 20m from the ground and the receive node with the height of 1.6m from the ground would take far from the sender node to establish the communication signal. The area that had mention were: (i) rural area, (ii) suburban area and last (iii) urban area. The settings of LoRa was set that to send and receive the RSSI and with that analyze the signal strength with suitable path loss algorithm to ascertain the results. The system build using a microcontroller Arduino Uno, Dorji drf 1276 LoRa and GPS antenna. The RSSI value would be transmitted into and kept in the independent database to process the result and set the coverage that need to handover when transition from mobile station away from base station.

![Figure 1. Experimental setup for signal strength](image)

![Figure 2. Location selected for experimental setup](image)
In Figure 2, the location selected in rural area was Jalan Arau – Changlun which consists trees and uneven hills. For the suburban area taken was from Jalan Pekan Pauh until the city of Arau. The selected location was suitable because half of them were covered in trees, while the other half are building. As for the urban area, the chosen sites were the capital city of Perlis, Kangar due many of buildings and houses.

4. Experimental Result and Discussion
The result obtained from RSSI value from these three significant areas show differently in term of their communicated to other nodes due interference on infrastructure, vehicle noise and etc. From the data RSSI value need to transform into a graphical result which could see in line graph in Figure 3.

![RSSI OVER DISTANCE (RURAL)](image1)

![RSSI OVER DISTANCE (SUBURBAN)](image2)
In Figure 3, the RSSI value in rural tested in different location were compare the differences of RSSI which there been involvement of LoS along the communication. The different location of rural area gives the different distance for the maximum RSSI value of LoRa Sender could send and maximum recorded from one of the location is 9.7km. Moreover, the suburban and urban area also used the outcome getting the RSSI value as rural area. The locations involve in suburban area had different distances that the signal strength of LoRa compare in the rural area. The maximum distance that RSSI value from one of the locations that had been recorded was 6.9km where beyond that distance, the signal was not sent any indicator or the strength of signal had no power to thrust the infrastructure between the base station and mobile station. Lastly, for the urban area, five location were tested to compare the maximum distance that the signal strength can received by LoRa receiver. The maximum distance that had recorded in one of the locations in urban area was 4.6km where most of the signals LoRa send to the receiver were diminished when faced the building that past which the height of 38m high. The signal indicator in urban was mostly disrupted by the interference of building height and the motor noise that occurred the recorded RSSI value.

5. Conclusion
In this paper, the analysis on LoRa handover session was determined by the boundary that was set using RSSI value and its connectivity strength during the transition from one base station to another base station. This also include the consideration of the path loss on three area stated and the coverage with the interference in three area while the hand over session perform on multiple base station. From the result show, that condition on using antenna could give a different setting value for the boundary for hand over the communication nodes. However, further analysis is necessary to improve the understanding of the communication link in urban, suburban, rural areas before any conclusions could reached.
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