Journal of Engineering Technology and Sciences
Volume 02, Issue 02, February 2025 *ISSN:3048-913X*
www.jets.org.in *DOI: https://doi.org/10.5281/zenodo.14874040*

Shadowing Impact on LoRa LPWAN Radio Links

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To Cite this Article
Sasidhar, "Shadowing Impact on LoRa LPWAN Radio Links", Journal of Engineering Technology and Science, Vol. 02, Issue 02, February 2025, pp: 05-08

***Abstract**: LoRaWAN is expected to be one of the key elements of the Internet of Things using long range, low power wireless telecommunications. LoRaWAN enables end appliances to communicate within a single hop through a gateway to the Internet. These gateways serve to unify two end devices with a central network server which is the transparent pathway of messages from the end devices. This technology, which combines long range, low battery consumption and secure data transmission is proving to be very popular in Internet of Things networks that wireless network carriers are introducing. However, the public inventory of the technology is not as through an assessment. The main purpose of this paper is to study the influence of shadowing over LoRaWAN networks and determine the performance in terms of packet loss ratio for different physical layer configurations. This shows that the intended performance has significant performance variances that are sufficiently disruptive when shadowing is taken into consideration.*

***Keywords**: Long range, wireless communication, low power wide area network, Internet of things*

I. Introduction

The transfer of power or information from one or more locations to another location that is not connected by an electrical connection is referred to as wireless communication. Radio is the most popular wireless technologies. It is also used to shorten distances, for example, a small amount of meters for television, thousands or millions or even kilometres of metres. It consists of a variety of stationary, mobile and portable application. Other ways of providing wireless communications include use of different electromagnetic wireless technologies, using other electromagnetic wireless technologies, such as light, magnetic, or electric fields; or sound. Wireless operations make long distance communications and other services, that are not possible or that would be impossible to provide by using wires. LoRa is one type of a low power wide area wireless network.

LoRa is referred to Long Range Radio. This is a unique technology created by Semtech Corporation and is mainly geared for M2M and IoT networks. This technology was expected to facilitate the bringing together with public or multi-tenant networks different applications that are part of the same network in order to reach the ones of achieving smart cities [3]. It allows low power consumption (up to 10 years battery power while maintaining a large network capacity (up to 1.4 million nodes), reliable communication, long range communication (more than 10 miles), localisation capabilities and the use of spread spectrum modulation in the Sub-GHz band to happen.

Microchip Technology Inc., a leading provider of microcontroller, mixed-signal, analogue and Flash-IP solutions, announced on April 10, 2018 the earliest of a series of modules for the LoRa (long range) wireless networking standard. LoRa standard allows wireless machines to talk to the Internet of Things (IoTs) through its capabilities of range of over 8 miles, battery life of over 10 years, and connectivity of millions of wireless sensor nodes to LoRa technology gateways. An example of the LoRaWANTM network protocol is the LoRaWAN specification published by the LoRa Alliance on June 16th, 2015 in version 3.0. Low Power Wide Area Network (LPWAN) refers to the specification of LoRaWANTM which describes LoRaWANTM wireless devices used in national or local networks or in large networks around the globe by batteries. The choice of benchmarks will be to enable smooth interoperability among smart devices without the need for annoying local installations and restoring user, developer, company autonomy, allowing for the expansion of the Internet of Things [4].

It is a type of long distance wireless telecommunication network network with ability to send data at a low bit rate or sending mass data which could be very less, between very simple and energy saving devices i.e.; connected objects, could be battery operated sensor. The structure of this document is given as follows. An explanation of the LoRa architecture is given. Section 3 demonstrates the research methodologies. It is shown and analysed. An ending to the paper and a summary of the opportunities are offered.

II. LORA Technology

Basically, LoRa wireless network in general can provide coverage far more than what cell networks do now. To enable the Internet of Things, LPWAN standardization will be implemented by LoRa across the world. LoRa technology provides many of its features as well as a dynamic architecture. In the first, this chapter shows how LoRa works, and in the second, how the Lora comm unit is limited in its transmission.

Architecture: As a LoRaWAN network has a star-of-stars topology, the gateway is simply a transparent link relaying messages passing end points to the LoRaWAN backend. End devices are inherently single hop wirelessly connected to one or many gateways whereas gateways themselves connect to the network server by standard IP connections. All of endpoint connection is bi-directional and they also provide multicast, which is a means to send software update over the air or any other mass distribution message to decrease the spent on air communication [4].

Spread spectrum modulation technique used in LoRa is wideband linear frequency modulated pulses switching the frequency from one level to another in a given period. The spread spectrum modulation used is chirp spread spectrum. Low powered, multipath resistant, Doppler resistant, with increased resilience, and long range are LoRa's most notable features. These days, a LoRa transceiver can operate in the licensed band as well since it can operate between 137MHz and 1020MHz. However, they are seen in ISM bands (UK 250MHz and 1080MHz, EU 511MHz and 750MHz) and the same chip rate (chip per second per Hz) and chip-per-second per Hertz can be 250, 350, or 800 kHz. Moreover, a spreading factor for a LoRa link can vary considerably depending on the communication.

Transmission Constraints: A few of these parameters are available to configure LoRa. For example: Bandwidth, Coding Rate, Transmission Power, Carrier Frequency, and Spreading Factor. In the LoRa evaluation, these parameters will be used. According to the SF principle, every byte of information should be encoded as several chips. Secondly, in LoRa modulation, bit and chip rate relationship is that the chip rate is equal to 2sf × bit rate [5]. The spacing factor is observed as directly related to the length of a LoRa packet as it is related to one single chip. However, SF can be one of the 6 to 12; but only 6 and 12 will be used here.

Carrier Frequency: The broadcasting of a predetermined frequency with a modified frequency conveying data which is presented in Hertz (cycles per second). In this case the carrier frequency used is 868MHz. Power Transmission: Power transfer is the movement of power from its source to be used on a place to provide tasks with benefit. In the case of LoRa radio, the range is between -4dBm and 20dBm. It may also range from 2dBm to 20dBm [6] depending on the gear. Bandwidth (BW) is the range of frequencies contained within a single band, in particular, the band used for signal transmission. The spreading factor should be chosen with supervision as a function of the BW. You can select a narrow BW which increases time on and sensitivity.

Gearbox can be speeded up as well as sensitivity lowered, especially at higher BW. LoRa modulation is used to drive the data stream on a chip at rate equal to the set bandwidth in chips per second per Hz. Therefore, the bandwidth of 125 kHz is the same as 125 kcps chip rate. The SX1276 offers bandwidths of up to 500 KHz to as small as 7.8 KHz depending on the tuning curve, the SX1272 has programmed rates of bandwidth of 500 KHz, 250 KHz, and 125 KHz.

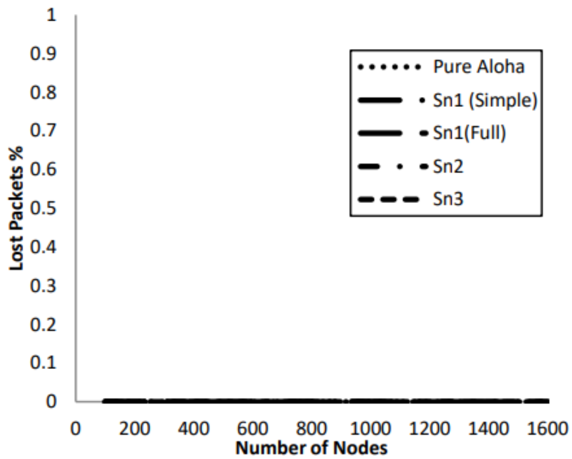
Coding Rate: :This is truly necessary in the case when bursts of interference may appear in the radio line. A higher CR results in improved time on air. CR can have the options of 5/6, 5/7, 5/8 and 8/9.

III. Research Method

As part of its assessment of LoRa technology, the author created the simulator platform in [6]. It is a simple Python implementation of the LoRa WAN air interface for Windows. To research a different aspect of LoRa WAN technology, we change the source code to fulfill our research, but also highlight the limitations of the LoRa WAN air interface design and optimize performance on a basis of the presetted standard specification. This method is by far the best for assessment of LoRa technology for the reason that it allows to present the results and compare the behaviour of a number of technological participants. We repeated the same studies to draw out the shadowing issue, as it is common to us to use the work in [6] as reference to compare our work with.

IV. Simulation Results and Analysis

In the beginner experiments, we evaluate the average capacity of LoRa by using a simple setup with N nodes to be broadcast to a single sink. In these studies, the standardised transmitter configuration set SN will be used, i.e. SN = {SF, CF, TP, BW, CR}. The nodes are indiscriminately placed in the sink vicinity in such a way that all nodes reach the sink with the predetermined SN setting. Table 2 lists the three transmitter configurations (SN1, SN2, and SN3). Under all settings a 20 byte packet is transmitted by every node 16.7 minutes apart. For SN1, the strong transmitter settings allow broadcasting the maximum possible air time.



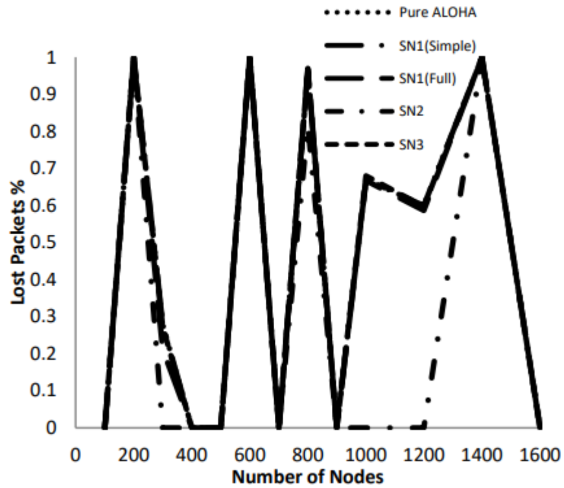
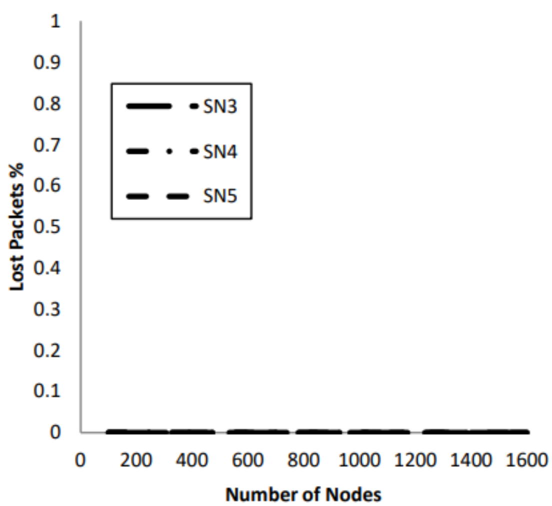


Fig 1: Packets Lost (without shadowing effect) as a percentage Fig 2: Lost Packets Percentage (with shadowing)



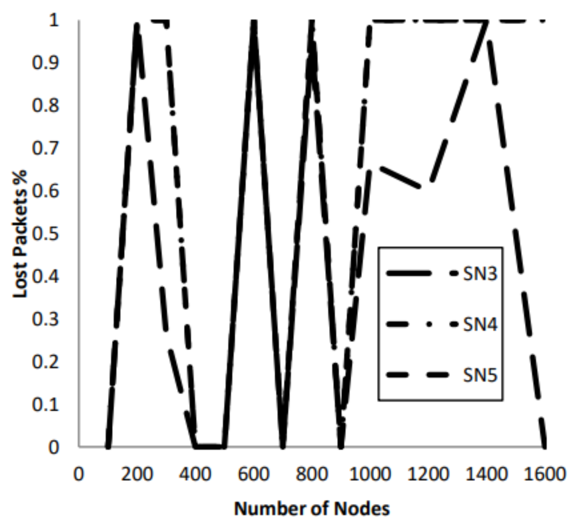


Fig 3: Packets Lost (without shadowing effect) as a percentage Fig 4: Lost Packets Percentage (with shadowing)

IV. Conclusion

The conclusions of the paper make sense – LoRa LPWAN should not work well when the shadowing effects are added. The current world cannot allow such thing in future IoT deployments. Results also show that even when very many sinks are used and the transmission parameter is selected dynamically, LoRa networks are not able to scale sufficiently. More practical findings can be produced in the near future due to the further research in these stages, as rules for the employment of functional sinks as well as procedures for the selection of dynamic transmission parameters must be formed.

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