A Review on LoRa Transmission

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***Abstract*—The concept of Internet of Things(IoT) has evolved over the past years, connecting systems to the internet to make life easier or simply to improve quality of life. LoRa is a low power RF transmission technology working on Chirp spread spectrum . LoRa is long range low data rate transmission technique having an effective range upto five kilometers.The major advantage of this technology is low power consumption along with large area coverage .This paper focuses on the LoRa module working, its behavior, scalability.**

Keywords—LoRa, Spreading Factor,Data Rate , LoRaWAN.

I. INTRODUCTION

Communication systems have evolved with time from wired to wireless from kilobytes speed to Gigabytes. The IoT [8], which interconnects systems with one another, requires efficient communication. LoRa is a such communication model which transmit data efficiently to long distance with low power consumption. It suits most IoT applications as it can transmit information to long distances. But it comes with a disadvantage of less data speed. So it will be time consuming for transmission of large data packets. It is having its scope in agriculture, tourism, internet of things and more as it provides data transmission over long areas without much error for milliWatts of power.

LORA TECHNOLOGY :

LoRa is an innovative wireless technology which works on chirp spread spectrum(CSS). This technology is designed for transmission of data over longer distances, so the technology is named as LoRa which abbreviates Long Range.The another advantage of the module is low battery usage, which is the result of less data rate of the module. LoRa module has a maximum speed of 50kbps and minimum varies with distance. It is operated at 433MHz, 868MHz and 915MHz at different locations.

Chirp spread spectrum [9] is a spread spectrum technique that uses wideband linear frequency modulated chirp pulses to encode information.A chirp is a sinusoidal signal whose frequency increases or decreases over time.

This technology is owned by Semtech Corporation which has created a space for collaborative working on the technology namely LoRa alliance. The main parameter governing the LoRa transmission is Spreading factor. It governs the data rate, range and other factors as shown in below equation.

$$\text{Symbol Rate} = \frac{\text{Bandwidth}}{2^{SF}}$$

Where SF is Spreading Factor.

Fig.1. LoRa technology with other technologies

II. LITERATURE REVIEW

[1] explains LoRaWAN architecture that takes physical and MAC layers in detail, and also explains applications of LoRa in different fields. It compares the technology with other technologies such as NB-IoT, Sigfox, Zigbee etc. Also shows the result of LoRa transmission over different distances and success rate of frame transmission. [2] the performance and coverage result of the LoRa indoor and outdoor deployment is presented using a selected combination of Spreading Factor and Bandwidth setting. The SNR, packet Loss rate and RSSI etc. are derived and analyzed. [3] allows connection of multiple sensors to the LoRa transceivers, and enables data collection from various units within a microgrid. The scheme can be employed to transfer measured data such as voltage, current, frequency and other parameters between the local controllers of DG units and the central controller of microgrids at the secondary level of control and communication. [4] gives the basics of LoRa and LoRaWAN along with an OSI model of it. Also explains frame transmission in LoRa technology and its network elements. It explains the variation of data rate w.r.to. spreading factor in both uplink and downlink. Also elaborates on Discrete spread spectrum in LoRa technology and advantages of LoRa over others. [5] analyzed the performance of LoRa, based on its three basic parameters: code rate, spreading factor and bandwidth. Explaining different connecting technologies, it describes the data transmission model of LoRa. The LoRaWAN network architecture elements (end devices, gateways, network server, application servers) are explained, the 3 basic classes of end devices are elaborated by the authors. [6] speaks about the power distribution in the LoRa cell and spreading factor allocation. The author is proposing an algorithm to reduce and control the path loss and error rate using power and spreading factor. Using a simulation he showed a 42% reduction in loss.

III. LORA MODULES IN INDIA

The LoRa module is available in different forms of different companies.So , a survey is found necessary to be conducted to

find the best module out of them . We found the existence of 6 LoRa modules in the Indian market by different vendors. The LoRa technology was built by SemTech company which is providing the technology license to others. These 6 modules have similar functionalities and differ little bit with each other. So, the comparison was done between different modules and the comparison table is shown below.

Table .1. Hardware components comparison-1

	RA 02	**RN2903**	**LoRa E5**
Spreading factor	6-12	6-12	6-12
Price	₹595	₹931	₹931
Interfaces	SPI	I²C, SPI, UART	I²C, SPI, UART, ADC,NRST.
Data rate	300kbps-FSK	300 kbps-FSK 12500 bps-LoRa	300 kbps - FSK 10990 bps - LoRa
Frequency	410-525 MHz	902.00 MHz to 928.00 MHz	both 434MHz and 868 MHz

Table .2. Hardware components comparison-2

	CMWX1ZZABZ-078	**SX1279**	**RFM95/96/97/98(W)**
Spreading factor	12	6- 12	6-12
Price	₹ 1,196.04	₹540	₹565
Interfaces	I²C, SPI, UART, USB	SPI	UART
Data rate	100kbps - FSK 4.8Kbps - LoRa	0.018-40kbps	0.018 - 37.5 kbps
Frequency	868MHz, 915MHz	137 - 960MHz	433/470MHz

So, most of the modules are having the same features and differ mostly in cost and data rate which are the main factors to be considered. Here SX-1276,77,78,79 series (SX-127x) is manufactured by SemTech, parent company of LoRaWAN. And most modules embedded this chip to provide LoRa transmission.

IV. IMPLEMENTATION

Team has practically designed communication system and tried to analyse the process. Two LoRa modules with NodeMCU had placed at different end; one servicing as transmitter and another as receiver. As shown in figure 2 the circuit is implemented with two NodeMCU, two LoRa modules (Ra02 from AiThinker), two Antennas .Since LoRa module's antenna has ipex male pin an ipex female to SMA male connector is used for antenna connections . The power supply of 3.3V is provided to LoRa by the NodeMCU 3v3 pin.Here serial communication is established and out of six data pins D0 is used for data transfer.

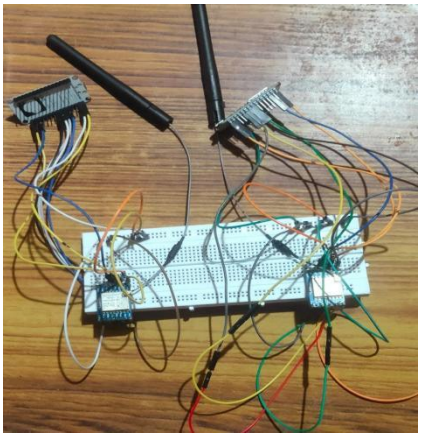

Figure .2. Module setup for small distance

The transmission of numeric data was performed where random numbers are generated and transmitted over the connection . Both the NodeMCUs were sending data at 115200 symbols/sec to the modules .it was found that packet were transferred with a delay of approximately 400-450ms .i.e. with average delay of 430 ms.The delay is a lot more compared other wireless modules.

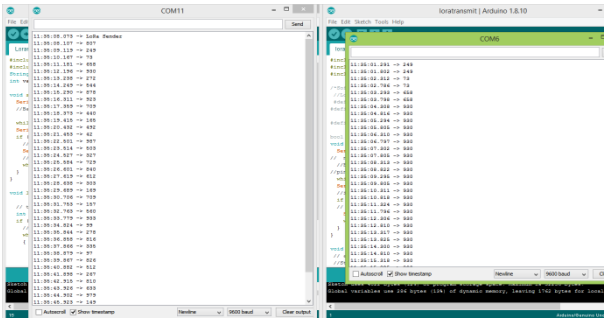

Figure .3. LoRa transmission with packet drop and high delay

From the implementation we also come to know about the issue of preambling in LoRa .i.e. repeating of last value for the next set of instances. The pattern of sending was after four correct transmission the fourth value was repeat random times. This might because of error data reception or asynchronous data reception.

Disadvantages of LoRa

LoRa technology has some disadvantages along sides the great advantages which includes

1. Delay : The transmission delay in LoRa modules is too high which makes it not so suitable for real time application .Ra02(AiThinker) LoRa module has a delay of range 400-450 ms between transmission and reception .The typical value of the delay is 430ms . A wireless module of such high delay is not suited in many industrial works.A conventional wireless module should have delay less than 200 ms in industry standard . (We on trial over the NodeMCU module obtained a delay of 130 ms).

2. Data Rate : As mentioned before LoRa module has a maximum data rate of 50 Kbps. It is done to complement the power consumption . But this is a road breaker for many applications to imply it.

3. Packet Drop : While transmitting numeric data, it was found that the LoRa module drops some data packets between transmission , which might make the information loss during real time usage which is crucial to be known . It was found that a pattern of receiving happens in the module where a middle packet is sent but not received .

4. Error Rate : LoRa uses UDP for transmitting frame which does not include Error control or flow control or congestion control algorithms . So LoRa transmission will contain error in data.

V. FUTURE SCOPE

In this paper we have shown the result found on transmitting numeric data between modules.The effect while transmitting large data can be analyzed and presented. LoRa transmission between multiple devices can be tried to implement and the analysis for the same can be performed. The increment of the data rate without affecting power consumption could be a possible improvement in the technology.

VI. CONCLUSION

LoRa technology has its own purpose of designing. So it incoperates different advantages and disadvantages.It has vast field of applications which can be explored. It has major application in IoT data transmission. It is cost effective and also covers wide area. So it has application in home automation , security systems , sensor connectivity etc.

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