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USE OF LPWAN IN INDIAN RAILWAYS

Hemalatha K N[1], Sumith P S[2]

[1]*Asst. Professor, Dept. of CSE, Atria Institute of Technology, Karnataka, India*
[2]*Dept. of CSE, Atria Institute of Technology, Karnataka, India*

Abstract - *The proposed idea of using LPWAN protocol in communication and safety management in Indian railways will help improve the existing systems. This paper discusses the LoRaWAN(LONG RANGE WIDE AREA NETWORK) modules designed to use less power and able to communicate small messages over a long range using the LPWAN protocol, the module designed consists of sensors to monitor the temperature, load, control panel details and the condition of the track and update the data to the receiver placed at each station wirelessly in real time along with messages about the current status of the train, all of which can be used to maintain accurate data about the train and also ensuring a safe journey of the passengers. This is done by placing the LPWAN module at a certain distance and one in each train connected to the sensors, these modules communicate among each other by passing the messages until it reaches the central station, where each node has a unique ID and contains the whole detail related to the ongoing trip which helps to prevent delay in train services and also helps in automating the signaling and track change process.*

Key Words: **LPWAN(low power wide area network), LoRaWAN(Long Range Wide Area Network), safety, communication, railways, sensors, IoT, automation.**

1. INTRODUCTION

The usage of LPWAN in communication for the railways will help in efficient and faster way to transfer messages among the different stations when compared to the existing system which uses traditional methods using copper wires, which involves a lot of maintenance and communication delays resulting in confusions and various signaling problems which causes delay in train causing discomfort to the commuters, the proposed plan uses LPWAN technology which involves placing the LoRa modules at required locations and communicate with each other until the signal reaches the necessary station, the data obtained from these signals can be used to communicate with other locomotives and automate the signals accordingly such that the traffic blocks caused due to early closings of level crossings can also be reduced to a larger extent, and can also be used for automating the track rerouting process, since the operating range of Lora is in the range of kilometers(around 11-12 km/module) it can be effectively used for long distance communication and consumes very less power so the battery used need to be replaced once in two years, all these features makes it a perfect module to be used for such an application as railway provide services throughout the country and has railway lines running through the most deserted places and monitoring the status of the tracks and maintaining the safety of the tracks and other communication modules are difficult and is not done on a regular basis all this can be solved by the above proposed idea, the temperature sensor(infrared based) and associated sensors which are used to monitor the vibration and the wear and tear of the tracks is placed in such a way on the locomotive such that the collected data is processed and an alert message is sent with the help of the LoRa module to the nearest station so that he can take necessary actions immediately instead of manually checking the track (which happens after a long time) this system helps in maintaining real time data about the track and prevents a lot of accidents caused due to lack of maintenance of the track on the required time. LoRa, having limitations in the amount of data that it can carry cannot be used to carry or send video files or any files above a particular size(50Kb per second), but I this situation we are using it to carry signals and messages which are in it's data bandwidth range making this idea the best in case of security, speed, distance and the money invested to implement this idea is worth as the maintenance cost is very less.

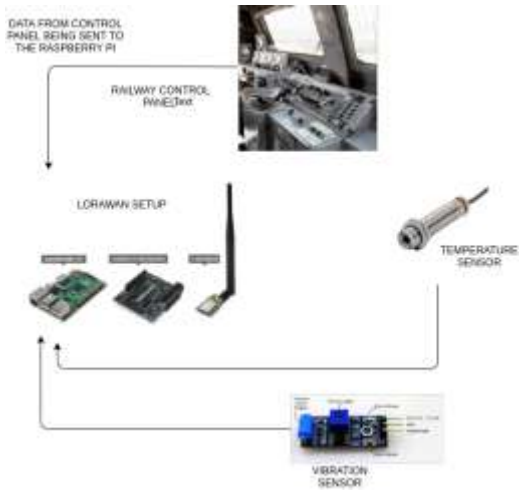

Fig -1: LoRa based safety module design

The proposed design consists of a standard LPWAN supported LoRa module which has a good antenna connected to it which helps in hassle free communication, the sensors measure the required data and sends it to a suitable micro controller (Raspberry Pi) to process all the readings and prepares it to be transported using the LoRa modules. As shown in figure-1, all sensors are connected to the Raspberry Pi where the data coming from them are analyzed and checked for any variations in the readings, if it finds out that there is a serious problem it communicates the

same with the nearest possible safety units, the message is passed on from the micro-controller /microprocessor to the LoRa module with the help of a bridge which help to connect both the devices which is then transported via the carrier modules placed at a fixed distance to form a network.

1.1 SECURITY OF DATA

LoRa provides ambient security to it's data which are being transmitted, it is designed to fit the standard LoRaWAN design criteria without affecting it's features like low power consumption, low implementation complexity, low cost and very high scalibility option, with all this intact LoRa modules offer end to end security to it's data as these modules are deployed for a long period, and this is done by mutual authentication, integrity protection and confidentiality.

[3] Mutual authentication is established between a LoRaWAN end-device and the LoRaWAN network as part of the network join procedure. This ensures that only genuine and authorized devices will be joined to authentic networks and also prevents any other devices to get connected and tamper with the integrity of the data. LoRaWAN security further implements end-to-end encryption for the payload which is being carried from the device to the other device connected. Other communication devices use various other security features, this approach is not suited in LPWAN's where additional security features add considerable additional power consumption, complexity and cost.

The security mechanisms rely on the well-tested and standardized cryptographic algorithms. These algorithms have been analysed by the cryptographic community for many years, are approved and widely adopted as a best security practice for wireless sensor based communication. Constrained nodes and Integrity protection is provided in a hop-by-hop nature one hop between the networks through the integrity protection provided by LoRaWAN protocol and the other hop between the network and application server with the help og VPN's and other suitable features.

Third party security solutions can also be used in order to provide extra security which is done by the use of IoT fingerprint technique which provides two factor authentication without affecting the battery life or the computation power thus making sensor based communication secure by using the LPWAN technology.

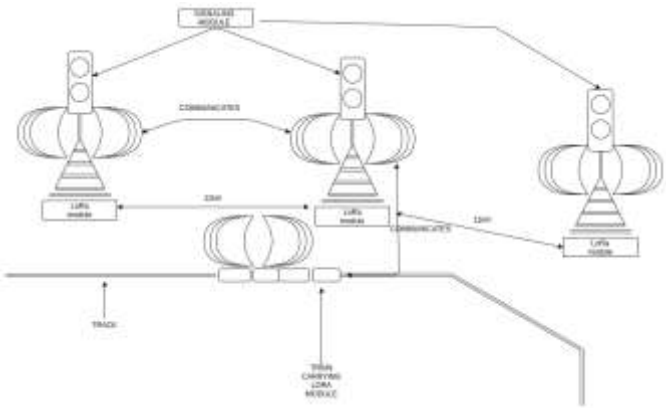

Fig -2: LoRa modules communicating

2. TRACK SAFETY MONITORING

This is that part of the module which is used to determine the safety of the tracks by checking track's wear and tear on real time basis along with it's load bearing capacity and determine the condition of the track based on the vibrations caused due to the locomotive moving on it, the track temperature and other related features are detected by the sensors, the values obtained are compared with the lower threshold values , if there are any fluctuations in the value, a message is passed to the nearby station to check and rectify the track so that no accidents are caused because of this. A minor crack in the track may result in the train derailing and other causalities which can be avoided by immediate response, the data collected can also be used to determine how long the track can survive as it is exposed to extreme climates in India causing it to rust and corrode making it unpredictable when an accident can occur.

3. AUTO SIGNALING SYSTEM

The signaling part using the LoRa module is going to be a great advantage and saves a lot of time, money and physical labour compared to the current system, with this module in place the signaling in railways is going to be automated and can save a lot of time by managing the speeds of the locomotive such that they don't have to wait in the signals for other trains to pass so that it can use the track. This will also save a lot of time delay caused in the level crossings as the gates are closed just on time before the train is passing. The LoRa modules placed at the signals will be constantly updated with the various trains taking that route and and it automatically adjusts the signaling time for each train in such a way that none of the trains have to wait for a long time, suggesting the optimized speed the loco pilot has to follow in order to reach the desired stations on time making Indian railway a reliable and trusted organization. Since our module keeps constant track of the control panel it can understand the loco pilot's movements as well as get updates about he components used, if it finds out that there has been a failure in particular system it alerts the person in-charge and also the signals such that the train can stop in that signal until necessary replacements are made, and since all the signal modules and the track interchange units are interconnected they can adjust the signals in such a way that it won't interrupt the routes of other trains and reroute it such that the trains reach the destination on time.

4. MESSAGE COMMUNICATION

The messages are communicated wirelessly from one module to another and it is passed until it reaches the required location, LoRa modules are placed at regular gaps in different locations where the tracks pass through as the communication range of the LPWAN module is in the range

of kilometers it is not necessary to place the modules close by and saves a lot of money on installing the module, the message from a locomotive is collected by the nearest LPWAN module the module checks the header for the destination address and guides it to the required destination then it is sent to the nearest node leading to the destination this process continues until the message reaches the destination, the communication happens at a faster rate and all messages can be communicated to the necessary locations as this module is widespread. A simple message update at the right time can save thousands of life, figure-3 shows the accidents in the railways in a span of 5 years from [2010 to 2015] by using advanced communication and alerting system all this can be avoided to a larger extent. As the data states around 85 percentage of the accidents are caused due to human failures due to late or no response at the required time, regular checking of tracks never happen in deserted areas which makes it vulnerable for accidents, with the help of sensors to monitor this the rate of accident can be exponentially reduced.

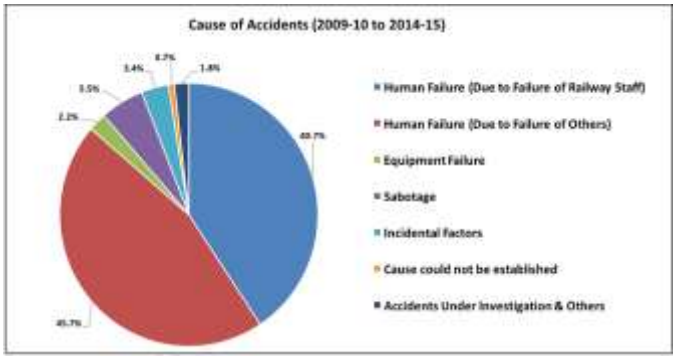

Fig -3: Accidents in railways due to various causes in a span of 5year

5. CONNECTIVITY AND MAINTENANCE

The main aim of using a LoRa module is the cost efficiency , the service range it provides and the longevity of the battery. This module can communicate with each other at a range of 11-12 kilometers distance with a good antenna, so the number of modules needed to cover a large area is less, since railway covers almost all parts of the country and has tracks laid through forests and the most deserted areas it is the perfect option for communication as this module requires less maintenance as the battery needs to be changed only after 2-3 years which is better compared to the current wired system as well as other wireless systems which needs constant monitoring and requires a lot of time to replace and repair them. The modules does or require any 3G, 4G or any GSM (Global Subscribers Module) facilities to communicate with each other, in comparison with the upcoming 5G technology the LoRa modules have a great advantage in terms of the distance covered they spread over a large area as discussed, making it a powerful tool for communication and dat transfer but one main disadvantage is the bandwidth, a LoRa module has limitations in the amount of data that it can carry, it cannot carry heavy files, but in this sector it only involves light weighted sensor data and alert signals which can be easily carried by the network making it a best solution for almost all the problem existing in the Indian railways.

All these features make LPWAN the best fit technology to be used in railways.

6. CONCLUSION

From the above mentioned idea we can conclude that the implementation of LPWAN for communication in the railways will automate almost half of the railway sector and help in effective performance of the railways by preventing delays and improving the safety of passengers and saves a lot of time and money required for maintenance of the communication lines and also prevent disasters caused due to non maintenance of the tracks. LoRa being a reliable and sustainable model, it can be placed anywhere due to it's low maintainability and scalability. For an organization like the Indian railways which has around 67368 kilometers of tracks spread along all 4 direction making it the world's fourth largest railway network an update in it's communication system using LoRa will be a breakthrough advancement.

REFERENCES

[1] R. Sinha, Y. Wei, s. Hwang, A survey on LPWAN technology:LoRa and NB-IoT, J. ICT Expr. 3(2017).

[2] "Railways in India", Wikipedia the Free Encyclopedia; https://en.wikipedis.org/?title=Indian_Railways.

[3] LoRa world coverage available in:www.lora-alliance.org/.