Study of LoRaWAN for EV Standardization Techniques in India

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Abstract— **As vehicles are evolving from basic transport medium to luxurious way of roaming and making life effortless, there is a need for standardization. This should not only include constructional and power consumption standards as already defined but also functional standards. LoRaWAN can be powerful IoT amongst all to be transceiver of huge information. Which can be used for EV standardization and hence for development. In this paper study of Standardization and techniques to improve them is the aim and standardization aspects are focused on. While compared with Wifi, BT, and the fastest LTE, LoRaWAN has some unique pros to perform a vital role in the process such as 80% more working range, power requirement, and hence cost-effectiveness. In this paper, the objective is to put up the study of the LoRaWAN technique to use for the standardization of EVs in India and how it can also be improvised with the use of LoRaWAN. Also, the model study and test cases are proposed. For the model actual CV car data and EV, model data is used from project work including CAN, LIN, and IoT data transfer medium. Communication between vehicle to grid, Vehicle to the user, and Vehicle to charging station are strained.**

Keywords— ***LoRa, LoRaWAN, LTE, Cloud, IoT, transceiver***

I. INTRODUCTION

The adoption of advanced electronics in automobiles prompts safety factors for electric as well as combustion vehicles. These electronics and intelligent systems can improve not only vehicle safety but the overall safety of transport systems on road. Now Electric vehicles are going popular because of enhancing efficiency, comfort functions, reduction in direct carbon emissions. Electric Vehicles come with variants having wired or wireless charging, supercapacitor, flywheel, hybrid energy container, front /rear driver assist, and cross-traffic alert combinations. Though Combustion vehicles in India have several regulations for design, manufacturing, and functionalities, Electric Vehicles still need to have a set of regulations adding to existing ones to improve safety parameters, improve linear manufacturing, and availability to the base user of basic troubleshooting which is the first question comes to end-user. It is also affected by varying driving styles and the charging habits of users. So to implement such functions and systems with the versatility of giving grid management, standardization model, and troubleshooting, a combination of electronics with high communication capability. This system should have communication management between Vehicle to Vehicle, Vehicle to Grid, Vehicle to User, or Vehicle to various devices, for that, we use the term V2X. To achieve this there is a need for a controlling server that will be monitoring data transfer and what type of data should transfer to which platform. This server ultimately develops the EV web platform. The data sets on this will be helpful to develop features. Energy handling will be smooth because of Vehicle grid communication for exchanging data on energy requirements and the nearest available source. This will assure driver or user comfort driving without worrying about power availability as this system also will provide information about the status of the vehicle if it is safe and ready to drive or not. However, it will toss the capability to support multiple automobile services further.

The potential of this LoRaWAN service can be described in multiple areas such as; the management of the shot he rests path among needy vehicles and charging stations, optimizing those stations to serve high quality services. It can help to find geographic points with real-time time information on availability. Considering business services, pricing information statistics could help to understand usual peak crowd hours and customers can get benefits of visiting nonpeak timings. Above all the concept of data for standardization may have to face data privacy issues till it is developed into a data sorting system that takes care of data security. As every bit of data cannot be shared with all the devices in communication and sources may object to the sharing of data; it is a must to sort and make flannel groups on gateways.

II. LITURATURE REVIEW

The Indian Government, India has the ministry of Surface Transport (MOST)and it brought up Automotive Industry Standards Committee which is responsible for standards prepared for Electric vehicles that are further approved by ARAI. This standard includes requirements of Electric Vehicles' functional safety, powertrain construction, Electrical energy consumption measurement in Wh/Km for various categories, method to measure working ranges, motor speed function and power at full load, maximum 30 min electric drive power and rules for CMV (Central Motor Vehicles Rules). For this work by MOST, assistance has been taken by UNECE (United Nations Economic Commission for Europe). Most of the regulations and standardizations are based on European standards in India. In this paper, functional safety is focused on, and AIS 038 is referred to. In AIS 38, tests for protection against electric shocks, protection against direct contact, service disconnect, markings to identify and follow precautions while working, protection against indirect contact, and protection against excessive current, gas accumulation, washing, and flood conditions.

The idea for the research is with all these regulations studies of cloud data to improve safety requirements of vehicles based on actual incidents and reasons behind it. In 2018 and around Car sale become high and vision of front electric plants will be covered by 85% industries and market till 2030 as by 2020 overall growth rate increased rate of 28.12% [1]. Electric Vehicles Market and development scenario in India : First electric vehicle Reva Mahindra launched in 2001 with basic features had a sale of minimal sales unit introduced, then the Toyota hybrid was launched in 2010, and in 2013 it was the Camry Hybrid. [2].

TABLE I. AIS STANDARDS AND SIGNIFICANCE

Standards	Sub-System/Function
AIS-038 (Rev-1) 2015	Electric Power Train Vehicles- Construction and Functional Safety Requirements
AIS-039 (Rec-1) 2015	Electric Power Train Vehicles– Measurement of Electrical Energy Consumption
AIS-040 (Rev-1) 2015	Electric Power Train Vehicles - Method of Measuring the Range
AIS-041 (Rev-1) 2015	Electric Power Train Vehicles Measurement of Net Power and The Maximum 30 Minute Power
AIS-049 (Rev-1) 2016; Ref: IS 11852	Electric Power Train Vehicles - CMVR Type Approval for Electric Power Train Vehicles (Revision 1)
AIS-102 (Part 1) 2009: Amendment No.216 May 2014	CMVR Type Approval for Hybrid Electric Vehicles
AIS-102 (Part 2)	CMVR Type Approval for Hybrid Electric Vehicles of M and N category with GVW>3500 Kg
AIS 123	CMVR Type approval of Electric Propulsion Kit Intended for Conversion of vehicles for pure Electric Operation
AIS-137 (Part5)	Test Method, Testing Equipment, and related. Procedures for Electric Drive Trains intended for the Propulsion of Motor Vehicles of Categories L, M, and N with regards to the Measurement of Net Power of Electric Drive Trains
AIS-138 (Part 1)	Electric Vehicle Conductive AC Charging System
AIS -138 (Part 2)	Electric Vehicle Conductive DC Charging System

Bangalore Municipal Transport Corporation recently introduced electric transport in a crowded city corridor. A survey was conducted in the city of Ludhiana, which showed that 36% of existing cars and two-wheel drive owners were interested in switching to an electric car [4]. The Telangana District Government is also promoting the use of EVs and has announced that EV owners will not pay any road taxes. In 2018, the Telangana State Electricity Regulatory Commission (TSERC) approved the INR 6 EV charging tax. TSERC also adjusted the cost of the entire regional service to INR 6.04 / kWh [2]. The Hyderabad municipal railway line has also signed a partnership with Power Grid Corporation of India Ltd to provide EV charging stations at municipal stations. Hyderabad railway line will be the first railway line in the country to have EV charging stations that will be monitored and operated by an electric grid and the Hyderabad Government is considering replacing electric cars with diesel-powered vehicles. In 2021 the New Delhi Govt. has obtained permission to set 131 numbers of public charging stations in the capital [7]. November 2018, Delhi Govt. issued a policy framework aimed at converting 25 percent of their vehicles into EVs by providing various compensation and setting up tolling infrastructure for both residential and non-residential properties. This policy is intended to improve the 3-kilometer charging station by providing 100% subsidy (up to INR 30,000) as well as tax rebates, parking costs, and EV bEVs2023 registration fees [10]. In Mumbai-Pune highway, a private company called Magenta Power is also working to set up EV charging infrastructure [6]. The main challenge now is coup up with all the regulations and the Indian environment to not fulfil the existing standards requirement but develop improved safer EV transport as per Indian scenarios. To attempt it there are some challenges for Electric Vehicles in India to focus on or consider running successfully on market. Those barriers are:

- After market servicing; when the vehicle gets an into a technical problem
- Higher capital costs due to expensive system and spares
- Despite the growing range in the market for cars with a wide range of electric vehicles, the choice to buy an electric car is limited. Surveys are showing that less awareness of information related to Government schemes provision, and monitory advantages are affecting on direct sale and market of Electric Vehicle adoption on home level.
- The materials used for EVs batteries include lithium, nickel, phosphate and manganese, graphite, and cobalt, which are rare earthy materials. Lithium-ion batteries alone consume 5 million tons / year of nickel, which could lead to 10-20 times more use of lithium and cobalt in the future. [9].
- Battery life, as EVs batteries designed for long life, wear out over time. Currently, most manufacturers offer an eight-year / 100,000-mile warranty for their batteries. [9].
- Driving ranges with full capacity
- Charging time and knowledge of source availability
- Environmental impact and Safety requirements
- Government policies and infrastructural requirements
- All the above-studied barriers for Electric Vehicles in India can be partially solved by a system of communication between vehicles to various devices

and coordination for power source, safety, and services availability knowledge. The vehicle to Grid concept is already in discussion and supported by many industries and government bodies but not for standardization. For a vehicle to multiple device system, higher speed of vehicles, the density of vehicles on road, infrastructural development play an important role. Data transfer and receive have those parameters effect. Real-time data handover and sorting speed should be higher than the vehicle level. So that, when the ammo is sorted according to incidents observed. For that incidents background like the time, geographical place, environmental conditions, in an infrastructural situation will bunt of data stored, considered and a solution in form of the standard can be developed.

III. RESEARCH ANALYSIS

For establishing a system of Vehicle to Grid, Vehicle to User, Vehicle to the Main server through Cloud, a communication model is developed on an experiment base within a 30Km area range. This work is done using Motec hardware and software due to the high capability of data logging and analysis. C185 with T2 function, GSM modem for RS232 communication to PC used as hardware with basic sensors setup including Current, Voltage, Battery, Steering angle, wheel speed, GPS, temperature, diagnostics error, CAN errors, G-forces.

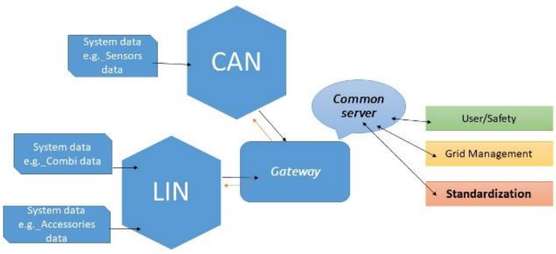

Fig 1. *System overlook*

Channels added are assigned according to the filter over signals from sensors connected to the system. CAN have voltage, temperature, GPS data, wheel speed data transfer assignment, and LIN has steering angle, current, and G-forces on it. It can be selected according to data priority. CAN has 1Mbps capability while LIN has 19200 Bps speed capability. Though LoRaWAN is flexible to increase and decrease data speed as per frequency and environment, it is focused to collect data and observe it from the perspective of real-time transport study in standardization improvement.

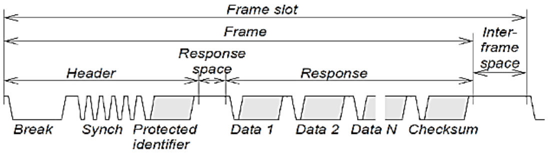

Fig 2. *CAN message structure*

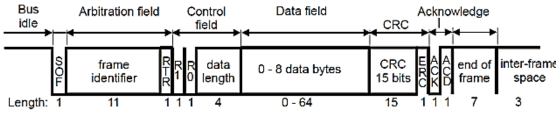

Fig 3. *LIN message structure*

In LIN data multicast transmission. transmitted data frames simultaneously received by an arbitrary number of nodes which has defined IDs. This structure has network commands for sleep mode (ID = 0x3C, length 8), active mode (ID = 0x3C, length 8), and wake up pulse (log.0 pulse of 250 μs - 5 ms (detected from 150 μs)). In CAN IDE bit is dominant in a standard frame, contains bus idle, SOF (Start of Frame), arbitration field (with RTR), data field, control field, CRC, acknowledge and end of the frame. A standard frame with the same first 11 bits of identifier has higher priority.

In V2X with LoRaWAN, real-time data is shared through different levels of data transmission such as Sensors to Gateway through CAN and LIN. From Gateway to the server, and then the server to interface devices, that the user, to grid management, to service centres. There is a challenge to be tackled to control parameters to be shared with these points because of possible data privacy concerns by the manufacturing brand. Also, it comes with time latency, data security, and criticality of data concerns which are possible to solve by sorting data channels according to need and application. OBU-on board unit in V2X with LoRaWAN can provide a reliable architecture of communication to address those obstacles. Board-carrying vehicles collect the required data through the integrated vehicle sensors and transfer the data to the OBU processing unit. Refined also makes the data packets more accurate. Vehicle infrastructure receives this predefined data from the communication system. Further Receiver takes triggers and warns, and suggests driver or user act on that. Moving on the road and sending the data is challenging due to the necessity of a high-speed network affecting a density of vehicles and data monitoring system capability. Constantly data monitoring system will sort accident incidents and background environments to provide solutions to accident avoidance.

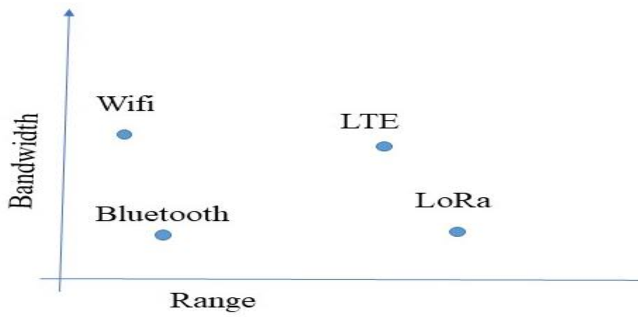

Fig 4. *comparison of communication mediums*

The establishment of V2X requires the prioritization of reliable architecture with minimum filters to sensor values. In this study, we calibrated sensors to standard vehicle ranges.

And start log trigger is KL15. In this particular test, false value is generated in system which further acted to the get vehicle into safe mode. But beyond that, this data set is logged into the server on real-time base. with heavy rain conditions with 50% visibility. The steering wheel showed up with a false value which is 3276 deg. Which acted upon a vehicle with instant speed reduction and current supply. The main idea is, functional tests are done in every manufacturing plant also tests with error reproduction are done in development stages. Existing standards are followed such as functional and safety standards, most of the time when it does not comply either terminology changed or the way of representation changed. It takes to underestimate the standards, which are referred from European standards, let us consider the below situation, Weather has 25^0 Celsius where actual road conditions are unmatched. This study

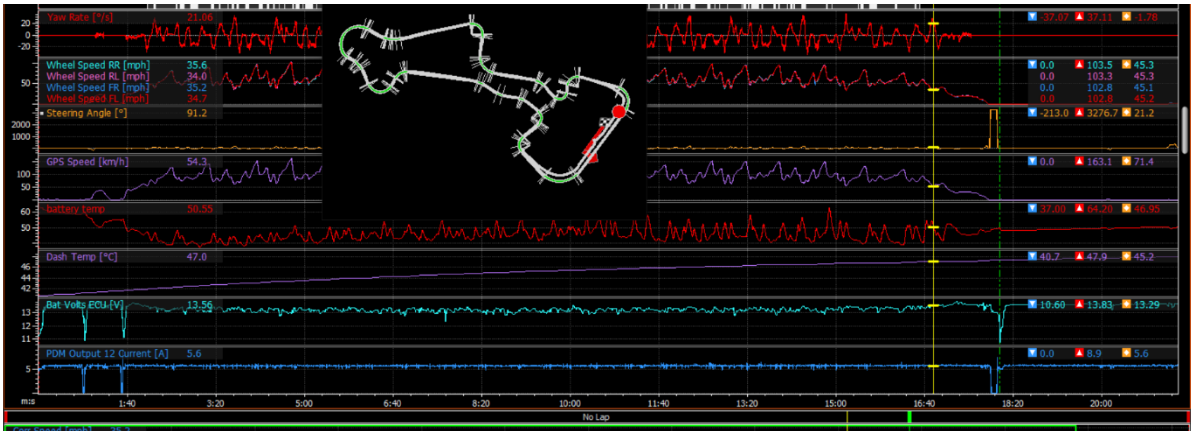

Fig 5. *Incident of steering failure (A)*

It monitors data sets, and the data studied which is logged and transferred to the server. Case study: Input parameters for the system are sensor data including all-wheel speeds, dash temperature, battery temperature, steering angle, LV battery

attempts to put the idea of using data from actual EVs on road to implement restrictions on design and functional parameters which compromise over safety. voltage, Power distribution, GPS speed, yaw rate. We can code the autosave function every x seconds. Our study is 120 sec time duration.

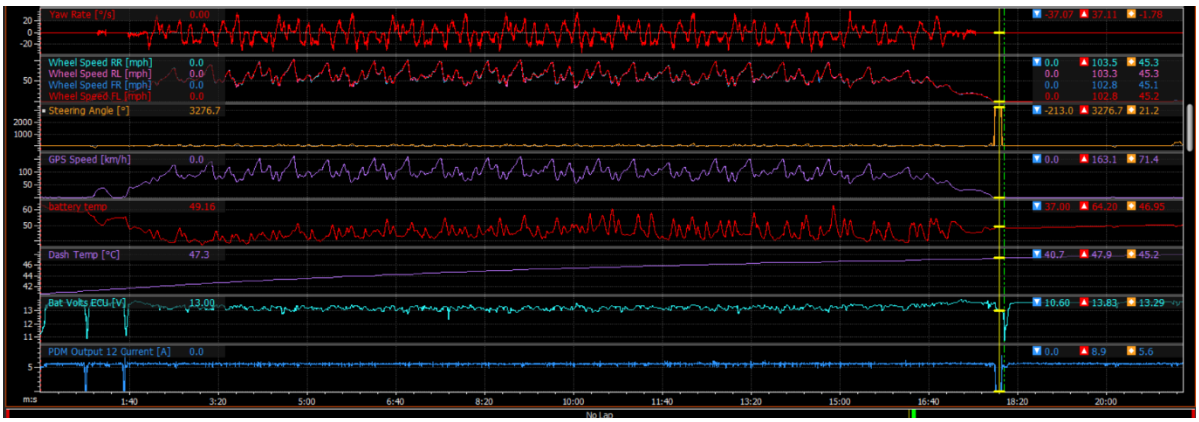

Fig 6. *Incident of steering failure (B)*

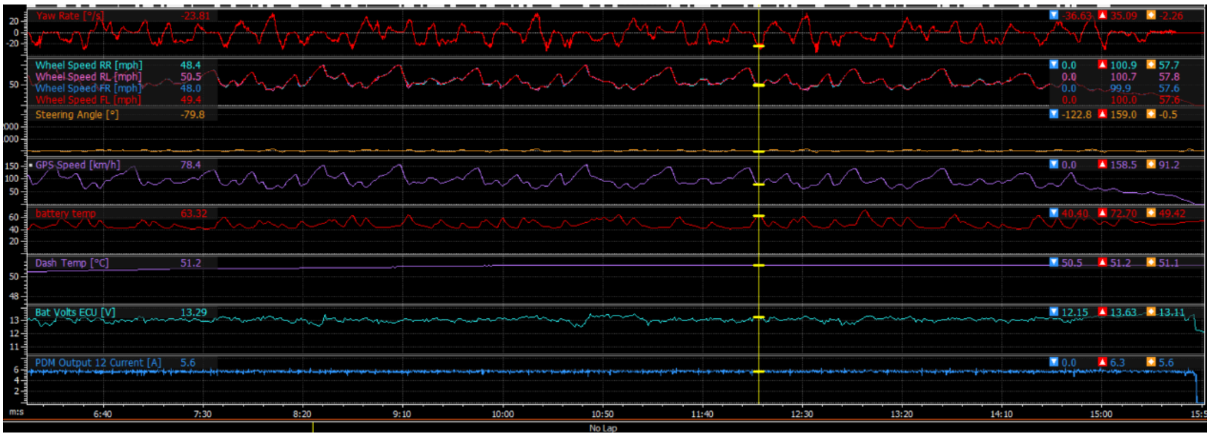

Fig 7. *Incident of High temperature*

And start log trigger is KL15. In this particular test, false value is generated in system which further acted to the get vehicle into safe mode. But beyond that, this data set is logged into the server on real-time base. Let us consider the below situation, Weather has 25^0 Celsius with heavy rain conditions with 50% visibility. The steering wheel showed up with a false value which is 3276 deg. Which acted upon a vehicle with instant speed reduction and current supply. The main idea is, functional tests are done in every manufacturing plant also tests with error reproduction are done in development stages. Existing standards are followed such as functional and safety standards, most of the time when it does not complies either terminology changed or the way of representation changed. It takes to underestimate the standards, which are referred from European standards, where actual road conditions are unmatched. This study attempts to put the idea of using data from actual EVs on road to implement restrictions on design and functional parameters which compromise over safety.

TABLE II. AVAILABLE DATA TRANSMISSION SYSTEM COMPARISON

Parameters	Wi-Fi	LR-PAN	Bluetooth	Lora
Frequency Band	5-60GHz	868/915MHz,2.4GHz	2.4GHz	868/900MHz
Data rate	1-6.75Gb/s	40-250Kb/s	1-24Mb/s	0.3-50Kb/s
Transmission range	20-100m	10-20m	8-10m	Less than 30Km
Energy Consumption	High	Low	Medium	Very Low

In Case two is observed increase in I battery temperature is higher by a system which is logged after giving this information by the sensor. So further it will be stored with other parameters such as usual outside temperature, GPS coordinates for location, timing of the incidents, and how many cars has this issue with the same standard configuration. When it is happening with multiple cases cooling standards need to be improved. In both cases, it seems very normal for the single vehicle but when collective data will be studied a group of information pallets will be generated by the system and very effective outcomes are expected.

IV. CONCLUSION

TABLE III. SYSTEMS COMBINED TO ACHIEVE LORAWAN

Parameters	Lora	LTE
Modulation	CSS(Chirp Spread Spectrum)	FDMA(Frequency Division Multiple Access)
Data Rate	50 Kbps	10Mbps
Link Budget	154Dbm	130Dbm
Power required	very low	moderate
Advantages	Long-range	long Range
Disadvantage	data limit depends on brand specs	data limit depends on brand specs

To achieve an effective V2X system for various purposes such as Grid management, Improvise standardization in the initial stages of EVs in India, troubleshooting, user management, Vehicle architecture should have embedded circuitry in Body Electronics and Smart user interface. This is possible to incorporate LoRa and LTE together to increase the range of data transceiving. It is found that multiple issues can be detected in the early stage of damage if there is data available. This data can be sorted and limited to respective requirements like grid management, Improvisation of standards implemented in India but tested for European markets, Troubleshooting purposes, and user interface. For example, it will be very convenient for users to have information about that steering have a fault , or the nearest battery charging source, its availability, and how much time it will take to reach there. Data security and copyright protection is the main challenge to implement this concept in

Indian markets. As there are numerous startups and well-known brands are putting their knowledge and efforts to occupy the market with their development; parallel many incidents are happening with EVs in India concern to safety. Extensive research has been done on the suitability of various wireless technology for mid-range and long-distance wireless long-distance networks such as long-distance communication (LoRa), ZigBee, BLE, and WIFI [7] On the other hand, researchers have embraced it. wireless technology such as Third Generation Partnership Project (3GPP) LTE and new 5G radio.This study tried to understand and develop a lab car communication system for data transceiving and understand standards from a safety perspective and India oriented.

ACKNOWLEDGEMENT

Taking into account the process of this research, I would like to express my sincere gratitude to my institution and my guide "*Prof. Shashank Gawade*" for their valuable guidance, constructive feedback, and unwavering support. Their support proved to be of enormous help for the research. The support and guidance proved to be vital for the execution of this research. Furthermore, I would like to express my gratitude towards my industrial guide "*Mr. Sirish Vissa*" (HOD of VW Motorsport), and the management of MIT School of Engineering because they provided me with a rich environment for experimentation and learning which resulted in my personal growth, refinement of knowledge, and boosting confidence. I would also like to express my gratitude to *"Prof. Dr. Sudarshan Sanap"* (Professor & Head of Mechanical Engineering) of the college for providing the opportunity and resources to plan and execute this research. Expressing my regards to the *"Mechanical Engineering (Electric Vehicles)"* department of MIT School of Engineering for constant support throughout this work.

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