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A Survey on Role of Ethernet in Vehicles Advanced Technologies

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ABSTRACT: Automotive industries are areas which is expanding rapidly with an increasing new applications such as safety, driver assistance, infotainment devices, and safety in new vehicles. Currently vehicles use number of different protocols such as CAN, Flex ray to integrate these applications into the vehicle. The introduction of these protocols doesn't satisfy the high-bandwidth requirements which are required by the upcoming applications within the vehicle. In this paper we get idea of different topologies of Ethernet in Vehicle network and also the Ethernet frame format. This paper presents a overview of applications of using Ethernet the most popular LAN technology in computer networks in vehicles to overcome high bandwidth problem. In this paper, we explore the idea of replacing the current vehicular network with standard switched Ethernet, the most popular LAN technology in computer networks at very low cost.

KEYWORDS: Energy efficient algorithm; Manets; total transmission energy; maximum number of hops; network lifetime

I. INTRODUCTION

In Vehicle ECU controls all the operation and number of ECU's are present in the vehicle.ECU takes its input from the sensors such as speed sensors, temperature sensor, pressure sensor etc, and controlling operation is performed by the ECU based on data given by these sensors. The data needs to be exchanged among modules during the normal operations in the vehicle. This need for exchanging data quickly and reliably led to the development of the vehicle network. The vehicle network is the medium of data exchange. To exchange this information wiring complexity from one module to all other module increases. The automotive industry quickly realized the complexity of wiring between each module to every other module[4]. The industry's answer to this problem was to create a central network in the vehicle. This design was easier to manufacture, easier to maintain and provided the flexibility to add and remove options without affecting the entire vehicle's wiring architecture. Each module, a node on the vehicle network, controls specific components related to its function and communicates with the other modules as necessary, using a standard protocol, over the vehicle network[5]. In Internal communications network, the vehicle bus interconnects components of the vehicle (e.g. aircraft, bus, train, ship). This bus with the help of protocols such as Controller Area Network (CAN), Local Interconnect Network (LIN) and others provides facilities like guarantee of information delivery, less time delivery, low cost. Some of the applications of vehicles demands Vehicle communication networks for security, bandwidth, and safety. Wireless communication, infotainment system, camera-based driver assistance, infotainment system etc provides more data for the bus in the vehicle network for processing. The protocols such as CAN, LIN, do not provide high bandwidth which is required by advanced applications. Ethernet (IEEE 802.3) provides potential solution to the problem faced by the vehicle communication networks with high levels of bandwidth and security[4].

II. RELATED WORK

LIN came into existence in 1990s with the speed 20kbps and later CAN which was first developed by Bosch for vehicle network with the speed 500kbps came into existence. Flex ray existed for the components which is having high performance. Users demands keep on changing for getting more information in the vehicles, and this makes changing of protocols in the vehicle network for high bandwidth. This high bandwidth requirement made the Ethernet to use in the vehicle network for upcoming advanced application.

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III. FRAME STRUCTURE

PRB: Preamble (Start of transmission) - this field indicates the starting of the frame.
DA: Destination Address- this field indicates about destination to where the frame needs to be transmitted.
SA: Source Address- this field indicates about source from where the frame has arrived.
Payload: This field contains the information which source is send to the destination. This data field can contain minimum of 42 Byte data or maximum of 1500 Byte Data.
CRC: when data is transmitted from sender to receiver, there are chances of corrupting data, so this is identified in the field

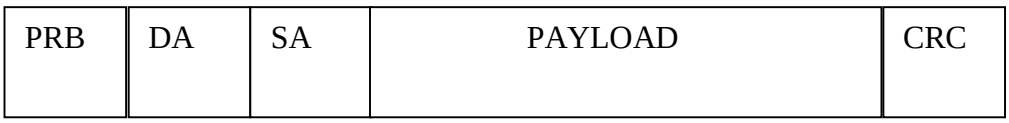

Fig.1. Ethernet Frame Structure

IV. ETHERNET TOPOLOGIES

In a vehicle, many ECU's are present, functionalities of these ECU can be grouped and this can be controlled or monitored by few ECU, thereby hardware size of the vehicle can be reduced. Decreasing number of ECUs decreases the complexity of the vehicle network structure[3]

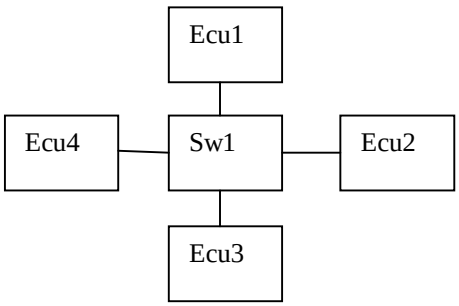

Fig.a. Star topology

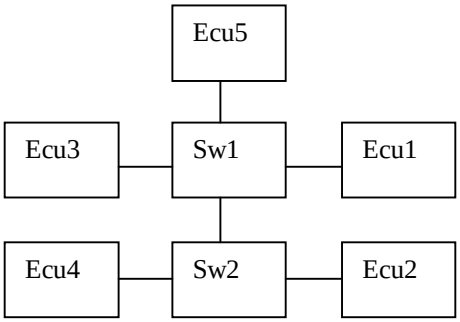

Fig.b. Double star topology

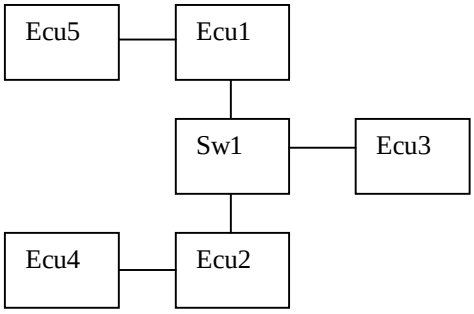

Fig.c. Line topology

Fig.2. Switched Ethernet Topologies

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There are few topologies where the ECUs can be mapped in the network. Fig.2. shows the different switched Ethernet topologies .Star topology, double star topology and line topology. In star topology ECUs are connected to single switch as shown in fig.a. .In double star topology ecus are connected to the two switches which are connected each other shown in fig,b. whereas in line topology each ECU is connected to single switch and these switches are interconnected as shown in fig.c. Basically switches have three components they are Input ports, output ports and switch fabric. Switch has many ports, all these ports serves as input as well as output ports. Input ports get the Ethernet frames from link and transfer it to fabric switch. In fabric switch based on the priority, frames are processed and transferred to the output port. Output port forwards it to Ethernet link based on the destination addresses mentioned in the frame[2] .

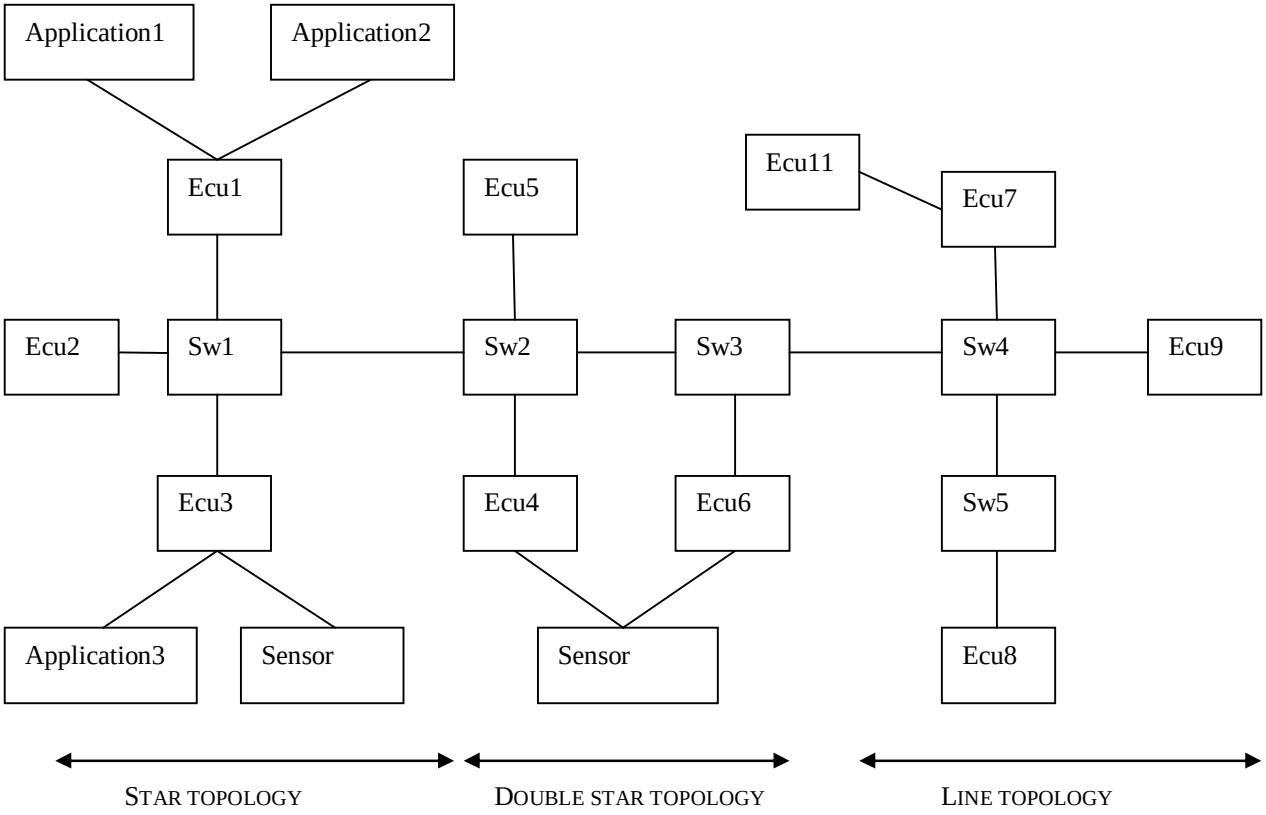

Fig.3. Combination of different topologies

Ethernet topology can be combination of different topology as shown in fig .3. ECU takes the input from the sensor, radar, etc which is connected directly to the ECU or takes input from other ECU. Each application can connect single or many ECUS based on the network and functionality as illustrated in the fig .3. To establish network between the switches, ECU and SENSORS etc for Ethernet communication, if unshielded twisted pair is used, it gives 100Mbps speed for the full and half duplex, and for 1000 Base T speed is 1000Mbps. The techniques such as NRZI, 4B5B, MLT-3, 4D-PAM5, 8B1Q4 are used for coding or decoding in the Ethernet communication[2].

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V. ETHERNET IN DIFFERENT ADVANCED TECHNOLGIES OF VEHICLE

- **Adaptive cruise control**: It is also called as **radar cruise control** or autonomous cruise control is an advanced system developed for safety of the vehicles on road . This system automatically adjusts speed of vehicle to maintain safe gap or distance from vehicles which is moving front of the particular which is with the ACC system. ACC helps the vehicle in automatic accelerations and decelerations by doing this it balances speed among the vehicles on the road thereby reducing accidents and saving precious life. This control system makes use of either sensors or radars to get information about the distance of the vehicles which is moving ahead and slowdowns the speed when distance is very less and again increases the speed when it detects less distance and less traffic on the road. To employ such systems in vehicles network bandwidth should be more because more data is captured by the sensors and radars but CAN, Flex ray and LIN provides less bandwidth. Ethernet provides data transmission rates 100 times more than other protocols. Thereby it provides required bandwidth for movement of higher data in the vehicle networks [5].
- **Driver monitoring system**: This system is capable of driver eye tracking through LED detectors based on infrared rays. If the driver is feeling drowsy especially during night times, then there are more chances for accidents and if the driver is not concentrating on the driving ,then system will give warning to the driver by some sounds or lights about the dangerous situation. ECU should get all of these data from the detectors and sensors about the situation within fraction of time. CAN and other protocol does not support these facilities like speed and bandwidth for this technology .Hence if the Ethernet is used in the vehicle network, then this facility can be utilized in the vehicle.ECU process these data and controls the actuators by warning the driver .Even after the warning, if no proper response from the driver, then vehicle automatically applies the brakes[2].
- **Collision avoidance system**: It is one the technology designed for safety purpose and to reduce the accident counts .This system uses the radar, sensor and camera to identify the crashing possibilities [1]. When the driver changes lanes or when the driver fails to identify the obstacles or other vehicles coming behind or side ways, this system detects these obstacles and distance between the vehicle and obstacles, then it gives warning to the driver to take appropriate action, even if driver fails the system itself takes action by steering or braking to avoid collision .In these critical cases using of Ethernet for vehicle networking is important than other protocols[5].

VI. CONCLUSION AND FUTURE WORK

Ethernet provide the high bandwidth based on the specification for an flexible system. By using Ethernet in vehicle network many problems like bandwidth, delay etc can be solved which is required by upcoming technologies. But the engineers have to think and face challenges about the migration of present protocols with Ethernet ,once it is done other things rare easy because hardware and software is already present ,and also hardware is cheap .By 2020 we can see 60% of the vehicles will be Ethernet based vehicle network .

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