Next Generation in Vehicle Networking

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Abstract **–**The paper proposed the use of wireless network to facilitate communication between different Electronic Control Units (ECU) in the vehicle more specifically for Body Control Module (BCM) in bus platform. In typical bus platform the main constrain is wiring harness as it involves many critical issues as weight, complex design and many more. To tackle down this issue the wireless network modules in vehicle play important role as it significantly reduced wiring harness. Weuse the IEEE 801.15.4 standard for communication between different wireless network modules in vehicle.

IndexTerms—*Wireless Network, In vehicle Networking (IVN), Electronic Control Unit (ECU), Body Control Module (BCM)*

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I. INTRODUCTION

The electrical circuits and their electronic control units are essential for good performance of vehicle and communication between them. At the beginnings of the 1980s, the engineers of the automobile manufacturers assessed the existing field bus systems for their use in vehicles as requirements are continuously changing so lots of research activities and innovation gets involved in automotive segment. Intra vehicle to vehicle communication, Vehicle to road infrastructure communication, Communication between different parts within vehicle such as trailer and dispatchers are getting connected and able to gather and distribute data, which could be used to enable better operations. If we broadly consider any communication possible by physical hard wired point to point connection, second is use of inter ECU communication protocol and third one is wireless communication medium. Till date above both physical point to point hard wired connections for communication and proprietary hard wired serial communication protocol is used but even though wireless sensor networks are having potential to be used in many vehicle applications it is not being actively used or not on focus for further research. They came to the conclusion that none of protocols fulfilled completely their requirements. It supposes the beginning of the development for new field bus protocols use of same in vehicle. With the increased number of electronic control unit system and its complexity it is impossible to implement this exchange of information through point to point links because it would suppose a disproportionate length of cable, an increase of cost and production time, reliability problems, and other drawbacks. To overcome this scenario of using more than one protocol in vehicle, to reduce wiring harness reduction and better scalability wireless sensor network (WSN) can play important role. In this IEEE 802.15.4 protocol based Zigbee transceivers module are used to make the wireless sensor network. The node will acquire and internally store data periodically. Starting times as well as the time intervals for can be freely programmed over the network system. As soon as a proper network is detected in its proximity the node will automatically transfer data. Optionally sensor data can be delivered on demand. When in its idle state the node remains in power-down mode in order to minimize power consumption. These multiplexed network modules installed in the vehicle to provide an important reduction of the wiring that involves a reduction in costs, less breakdown risks, and easier scalability. Also, the maintenance tasks can be enhanced.

II. PROPOSAL

The in-vehicle network architecture can be partitioned into different domains mainly safety critical or non-safety critical function.Safety critical functions are the functions which are introduced in the system to prevent or stop accident or critical situation occurrence. If this critical safety function is malfunction then there may be chance of accident. Non-safety critical functions are the function those does not affect main system if it gets failed due to some reason but if these functions are present in the system then it enhanced overall system. From bus platform view it includes user oriented features in vehicle like park light, buzzer, Internal Lights, front and rear side of lamp etc. In this paper non safety critical functions are consider for implementation as a first step toward wireless in-vehicle networking. Later on can able to move towards complete wireless in-vehicle networking architecture.

III. OBJECTIVE AND SCOPE

The main objective is to integrate and implement wireless sensor networks in prototype vehicle also to evaluate and get alternative solution from using more than one protocol for communication. The technology chosen for the wireless network is Zigbee, after successful implementation of concept on prototype communication protocol can be easily upgrade. Another important point is weight reduction. In vehicle there are different parts of wiring harness such as front panel, dashboard, Engine, Body control, Chassis, Tail wiring harness and total weight is more than 130kg in trucks and buses. If total length we consider then it is more than 8km of copper wire and cost is huge so even if consider and manage 30% reduction in

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wiring harness it will create significant difference in terms of both cost and weight.

IV. SYSTEM OVERVIEW

The evolutionary development of vehicle electronic systems has rapidly increased the number of wires in the vehicle. The conventional wiring harness is not able to provide solutions for problems such as bunch of wire size and weight in addition to meeting cost and reliability objectives. The conventional vehicle architecture is as shown in figure 1.

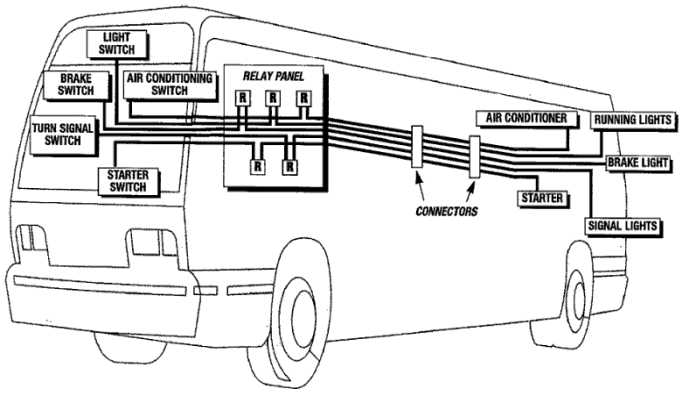

Fig.1. Conventional Vehicle Architecture

In conventional 40-ft bus architecture the vast amount of equipment increases electrical system complexity and bus weight. In point to point wire connection loss of continuity can occur because of corrosion, poor crimping, or loose terminals or connectors, it must be traced step-by-step back to the faulty connection. Additionally, specific features requested by each agency require a different configuration of wires and relays, which adds production time and cost to each bus order. According to bus manufacturer, the electrical system can consume up to one half the engineering time to design, and up to 15 percent of the vehicle production time to build, install and troubleshoot. Adecentralized architecture provides good solution for these problemsas each electronic control unit handle its local sensor signals.

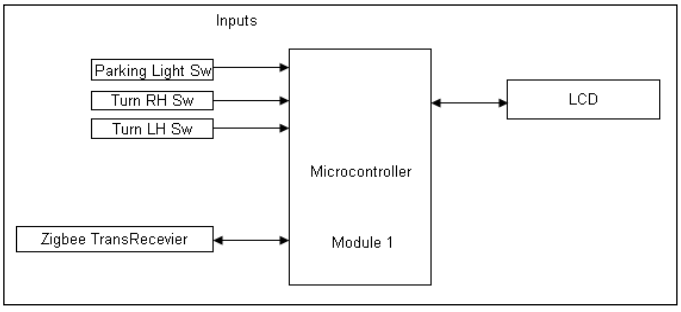

Fig.2. Block Diagram of Node

As shown in figure 2 in proposed vehicle architecture modules which is called as nodes, will be placed in vehicle at appropriate location such that source of signal or output that need to be derived from node is very nearby place this will help to reduce wiring harness.First node will be placed in front side driver cabin compartment, as all front combi switch inputs, dashboard switch inputs will be easily accessible. Input from combi switch such as turning light input, parking light input is given to node one, it will transmit wireless data to both second node and third node. Second node will be placed in middle of vehicle as side blinker lamps will cover in this module and engine related sensor input given to second module. When data received from first node it will turn on side blinker lights. Third module will be at rear side of vehicle and rear loads of vehicle will be connected to this module. The sensor input such as air pressure, Engine oil pressure will be given to node and it will transmit data to first node, it will receive data from respective node and display on LCD module. Each sensor node contains a computational module (a programmable unit) which provides computation ability, storage, and bidirectional communication with other nodes in the system. The main two advantages are they can be re-task in the field and easily communicate with the rest of the network.

The major blocks of the proposed system are given below, the block describes about the components and modules used in the systems. The major blocks are,

- ZigBee Trans receiver (2.4 GHz)
- Microcontroller
- Software

A. ZigBee Trans receiver

ZigBee is a wireless communication protocol standard based on the IEEE 802.15.4. Zigbee is a low-cost, low-power, wireless mesh network standard. The low cost allows the technology to be widely deployed in wireless control and monitoring applications. Low power usage allows longer life with smaller batteries. Different networking topology provides high reliability and more extensive range and also very flexible network. ZigBee nodes can go from sleep to active mode in 30 ms or less, the latency can be low and devices can be responsive, particularly compared to Bluetooth wake-up delays, which are typically around three seconds. Because ZigBee nodes can sleep most of the time, average power consumption can be low, resulting in long battery life.Wireless nodes consist of side-marker lights and sensors that create an electronic fence around the trailer and can detect if an unauthorized person is trying to access the truck's cargo, steal its fuel or anything else from the vehicle. The network is composed by the lamps and sensors, which is the Zigbee coordinator and has the intelligence to process the messages from the lamps and identify and alarm situation. The concept is shown in below figure 3.

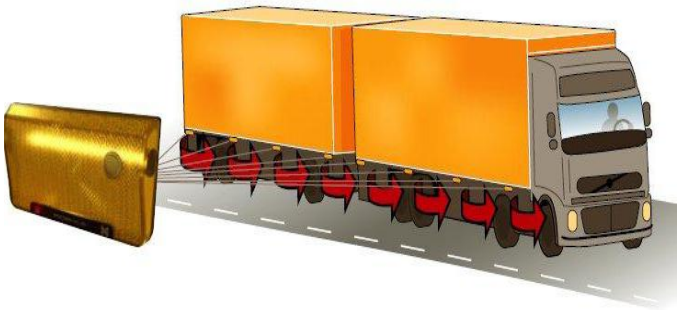

Fig.3. Concept of use of wireless node in trailer

The IEEE 802.15.4 low-rate Wireless Personal Area Network (WPAN) works in three different frequency bands. Some basic data can be found in below Table 1. For one particular RF front-end design, the F Transceiver, some numbers on power dissipation are available. With a supply voltage of 3.3 V, the transmit mode draws a current of 22.7 mA, whereas in the receive mode, 25.2 mA current are drawn, In the sleep mode, only 12 μA are drawn. In the 868 MHz band, only a single channel with a data rate of 20 kbps is available, in the 915 MHz band ten channels of 40kbps each and in the 2.4 GHz band 16 channels of 250 kbps are available.

Table 1
Frequency band in IEEE 802.15.4

Band	**868MHz**	**915Mhz**	**2.4 GHz**
Frequency (MHz)	868-868.6	902-928	2400-2483.5
Chip rate (kchips/s)	300	600	2000
No of Channels	1	10	16
Data Rate (kb/s)	20	40	250
Symbol rate	20	40	62.5

For a practical wireless use, in RF-based system, the carrier frequency need to carefully choose since a single frequency does not provide any capacity, for communication purposes always a finite portion of the electromagnetic spectrum, called a frequency band is used.

B. Microcontroller

The Microcontroller used in the proposed system is general purpose PIC18F46K22 controller with serial UART (Universal Asynchronous Receiver and Transmitter).The UARTis connected to ZigBee transceiver module for serial communication. The vehicle chassis unique number and module node ID is saved in the NVM (Non Volatile Memory) of controller while final programming this is required to identify and to authenticate appropriate node and vehicle platform.

C. Software

MPLAB Integrated Development Environment (IDE) is a free, integrated toolset for the development of embedded applications employing Microchip's PIC8bit, 16bit and 32bit microcontrollers. MPLAB IDE tool is easy to use and includes software components for fast application development and debugging. PICPgm is a PC-Software to program PIC microcontrollers using external programmer hardware connected to the PC. It allows

- flashing program a HEX file into a PIC microcontroller
- Read the content of a PIC microcontroller and save it to a HEX file
- Erase a PIC microcontroller
- Check if a PIC microcontroller is empty, i.e. not programmed (Blank Check)

The PICPgm Development Programmer Software is Freeware. It is available with a Graphical User Interface (GUI) and a Command Line interface.

V. NETWORK TOPOLOGY

A communication network is composed of nodes, each of which has computing power and can transmit and receive messages over communication links. The basic network topologies are star, ring, fully connected, mesh type topology as shown below figure 3. Each network topology is having its advantage and disadvantage but for this project initially start type network is preferred then can be switch to mesh type or fully connected network for more reliability. The main advantages of this topology are that it is possible to reconfigure the network to skip broken nodes and it is possible to choose the shortest path to a certain destination.

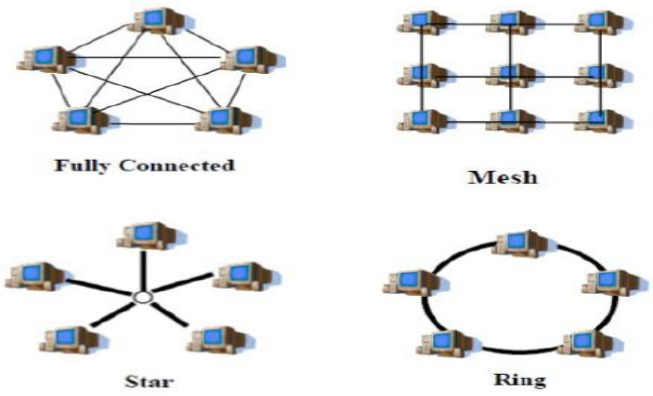

Fig.3. Different Network Topology

VI. CONCLUSION

Based on study and document experience it is observed that today introduction of new function in the vehicle is limited by expensive installation and wiring harness but which could be enhance by introduction of wireless sensor network so we explored the potential of using wireless network in vehicle for monitoring, control and communication between components. The main outcome is significant reduction in complexity, weight and cost of the wiring harness.The challenge at the main time is to transform the capabilities of sensor network in to useful services for the vehicle application.

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