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Appendage of CAN Segments with IEEE 802.11 WLAN

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Abstract
The controlled Area Networks (CAN) is mainly employed in distributed real-time control application. Increasing use of several CAN networks in modern industrial plants results in need for interworking between CAN networks as well as between CAN and other major public/private networks. There may be certain difficulties in some in some industrial scenarios where a traditional wired backbone is deployed to provide this type of required interconnection functions. Instead having a wireless backbone as alternatives in such environments to interconnect CAN networks would be exceptionally valuable. One wireless network which currently provides the features needed in an industrial control environment, that is, easy integration with several communication system and capability to ensure critical time constraints, is the IEEE 802.11 standards.This project will presents sample design and implementation of CAN/WLAN/CAN interworking units (WIU) that is capable of connecting remote CAN 2.0 nodes over IEEE 802.11b WLAN. It will provide straightforward solution to extend size of distributed area of CAN networks & enables CAN networks to communicate with other LANs utilizing a low cost technology with high data rate.

Keywords: CAN, WIU, WLAN

1. Introduction
The Controller Area Network (CAN) is mainly employed in distributed real–time control applications. Increasing use of several CAN networks in modern industrial plants results in need for interworking between CAN networks as well as between CAN and other major public/private networks [1-4]. There may be certain difficulties in some industrial scenarios where a traditional wired backbone is deployed to provide this type of required interconnection functions. Instead, having a wireless backbone as an alternative in such environments to interconnect CAN networks would be exceptionally valuable [1-3]. One wireless network which currently provides the features needed in an industrial control environment, that is, easy integration with several communication systems and capability to ensure critical time constraints, is the IEEE 802.11 standard. This work presented includes a sample design and implementation of a CAN/WLAN/CAN interworking system utilising Wireless Interworking Units (WIU) proposed in [2, 3]. The organization of this paper is as follows. Section 2 briefly introduces CAN and IEEE 802.11b WLAN. Section 3 describes block diagram of the WIU and its structure employed in interconnection of the CAN segments using IEEE 802.11b WLAN. The CAN/IEEE802.11b/CAN algorithm is presented in Section 4.

1.1 Original System
Today's system have different nodes of the system mounted far away from each other in two groups, see Fig 1. The main group handles all of the data and computation and the other group which is mounted far away is a group of sensors which handles a lot of important information. Therefore do they have a long cable installed between the main group and the sensor group. Installing the cable costs a lot of money, at least in their case; they have to bury it in the ground.

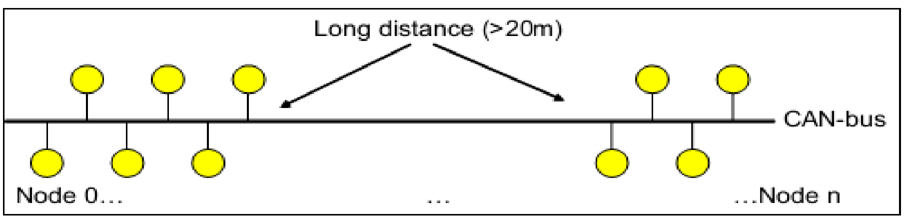

Fig 1:

The data transferred on the CAN-bus is controlling the complete system but the CAN data from the sensor group is mostly directed to the main group, but the upcoming radio communication concerning the data transfer two way with just an ACK from the both direction.

1.2 New System

The solution for the cable problem is easy to solve, just add a WLAN to replace the cable between the two groupsand then the problem would be solved, see Fig.2.the bus that's in use is a CAN-bus which is widely used in industrial and automotive applications. The CAN-bus is one of the most reliable and robust data busses and if it is split up to two busses and node between these two split networks communicate with two ways via wireless interworking unit (WIU).

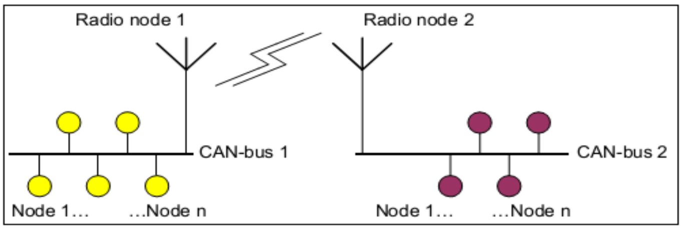

Fig 2: New CAN System with WIU Radio Communication

2. Background of CAN and IEEE 802.11 WLAN

[5] and [6] supply a detailed overview of the CAN features that can be summarized as high speed serial interface, low cost physical medium, short data lengths, fast reaction times and high level of error detection and correction. CAN utilises the Carrier Sense Multiple Access with Collision Detection (CSMA/CD) as the arbitration mechanism to enable its attached nodes to have access to the bus. As CAN employs a priority based bus arbitration process, the node with the highest priority will continue to transmit without any interruption. There are two versions of CAN exist and they only differ in the size of identifier. The identifier field serves two purposes: assigning a priority for the transmission and allowing message filtering upon reception. Figure 1 shows the CAN 2.0B message format utilised in the WIU.

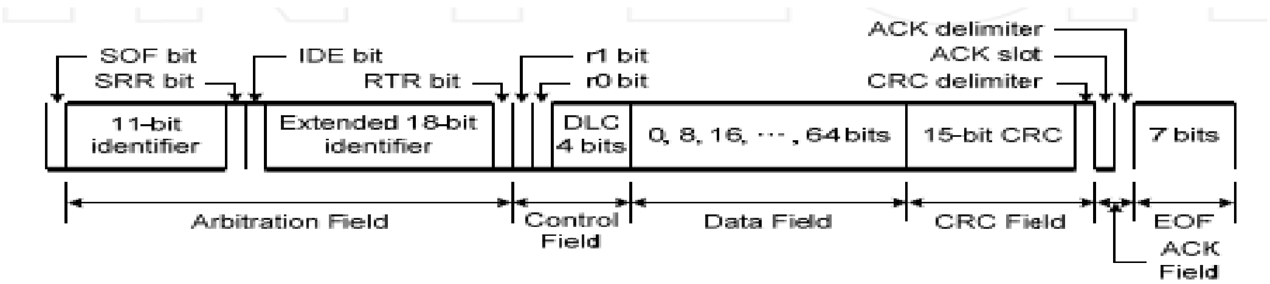

Fig3: CAN 2.0B Message Telegram

IEEE 802.11 WLAN is a local area network implemented without wires. The main advantages of WLAN are mobility and cost saving installation. Any WLAN aims to offer all the features and benefits of traditional LAN technologies (e.g., Ethernet and Token Ring) but without the limitations of being tethered to a cable [7-8]. IEEE 802.11 employs Carrier Sense Multiple Access/ Collision Avoidance (CSMA/CA) as the channel access method and operates in the 2.4 GHz unlicensed ISM (Industrial, Scientific and Medical) band. Figure 2 shows IEEE 802.11b frame that consists of a PLCP preamble, PLCP header, and MAC Protocol Data Unit (MPDU), utilised also in the WIU[7].

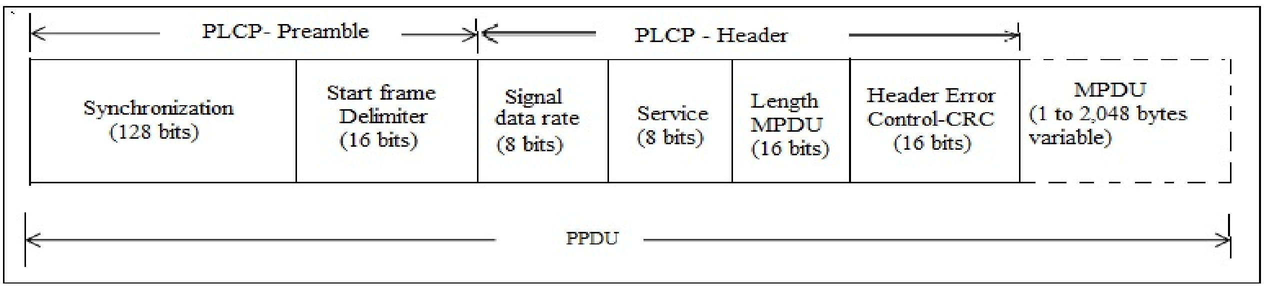

Fig 4: IEEE 802.11b DSSS PCLP packet format

3. Design of CAN/IEEE 802.11b/CAN WIU Prototype

The Wireless Internetworking Unit (WIU) interconnects two CAN2.0B networks communicating through IEEE 802.11b. The WIU has two ports. Each port of WIU has a different protocol, frame/message format, and frame reception/ transmission mechanism. Thus, the processes to be performed at each port of the WIU are different. Fig 5 and 6 shows the two CAN network which communicate through WLAN. This provides a straightforward solution to extend the size of distributed area of CAN networks and enables the CAN networks to communicate with other LANs utilising a low cost technology with high data rates. Generalized block diagram gives idea about how to design the hardware and clear idea about implementation flow. Network 1 has node one & two in which node two also act as WIU for remote communication. Similarly network 2 has node three & four. Node three also act act WIU for remote communication.

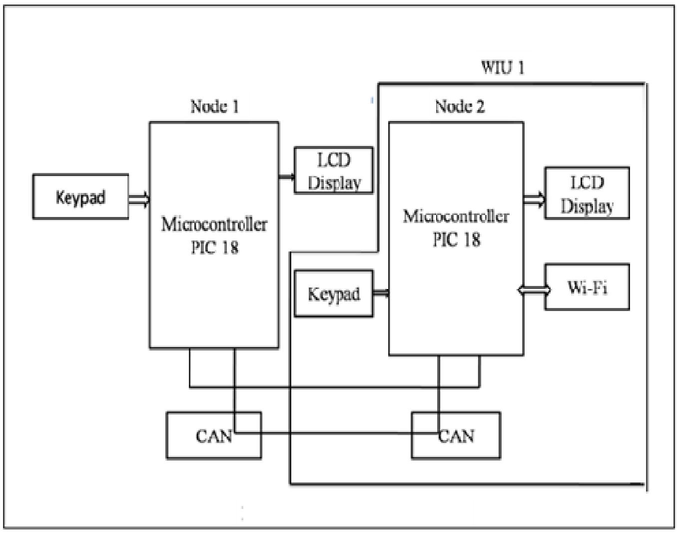

Fig 5: CAN Network 1 with WIU

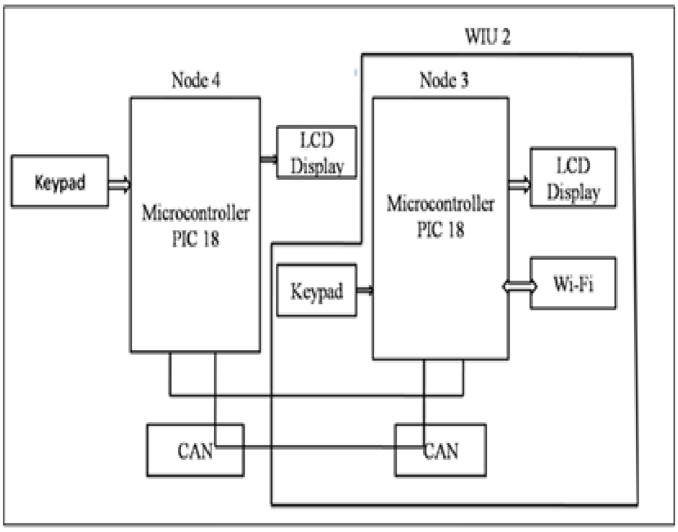

Fig 6: CAN Network 2 with WIU

Communication between same network nodes referred as 'Local message Communication' whereas between different network nodes referred as 'Remote message Communication'. Main function of the Wireless Internetworking Unit is that the Protocol Data Units (PDU) of the CAN messages are encapsulated within those of the IEEE 802.11b DSSS frames to be carried over wireless channels. Since a CAN 2.0B message easily be fitted into one IEEE 802.11b frame MPDU (Figure 7). Thus, neither segmentation / reassembly of CAN messages nor data compression is necessary for carrying a CAN message in one IEEE 802.11 frame. At the destination WIU, preamble and header parts of the IEEE 802.11b frames are stripped off, and the CAN messages extracted from the IEEE 802.11b MPDUs can be processed.

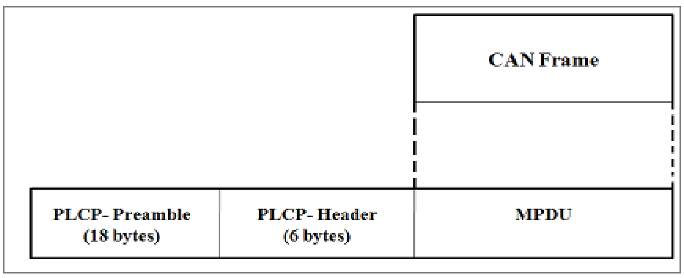

Fig 7: Encapsulation of CAN 2.0B message into an IEEE 802.11b Frame

4. Project Flow Algorithm

Project Flow algorithm gives idea about how CAN frames are transmitted in local and remote transmission. Local transmission of frame is in same CAN Network. Remote transmission of frame means from one CAN Network to other via WLAN which includes CAN/WLAN/CAN conversion of Frame. Fig. 5 and 6 shows two CAN networks, communication between these two networks is in two ways. First is CAN to CAN communication and other is CAN to Wi-Fi and Wi-Fi to CAN communication. Below shown algorithm are implemented communication scheme between these twonetworks. These two networks are having four nodes as shown in fig 4.1 and 4.2.Algorithm for node 1 and 3 shown in fig.7 (a & b) and for node 2 and 4 shows in Fig.8 (a,b,c,d,& e).

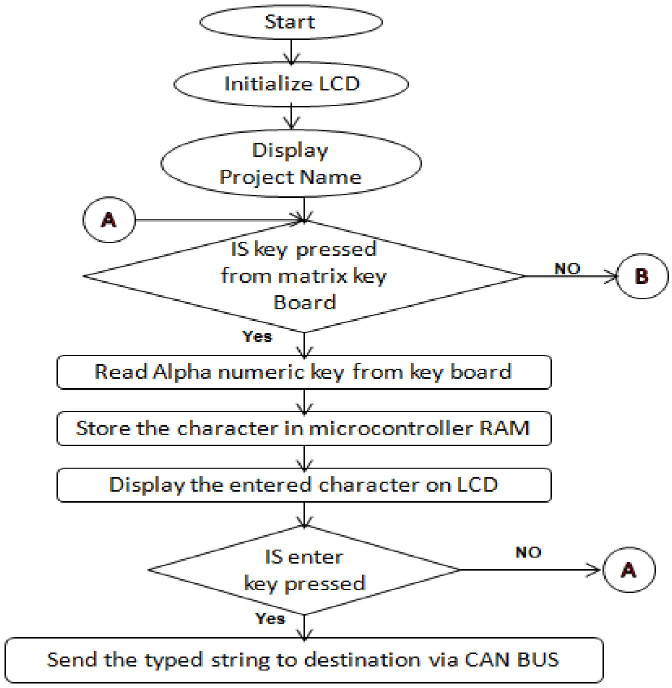

Fig 7: (a)algorithm for node 1 or 3

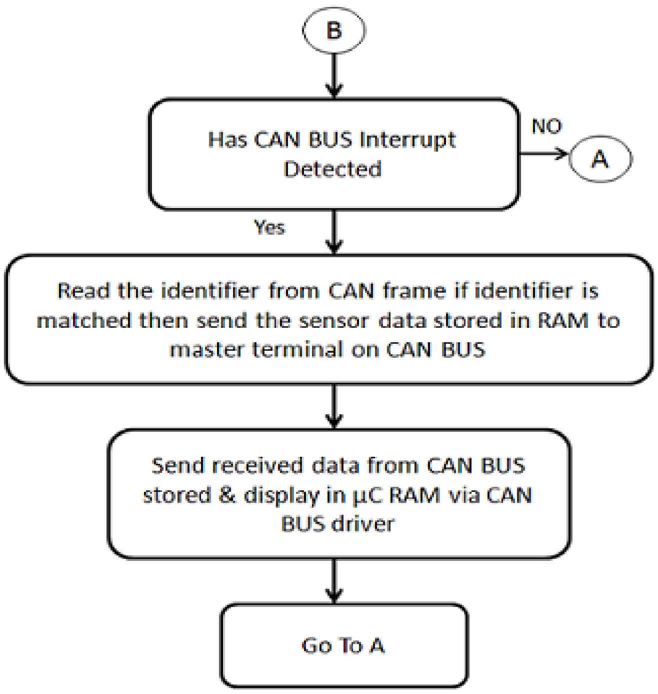

Fig 7: (b)algorithm for node 1 or 3

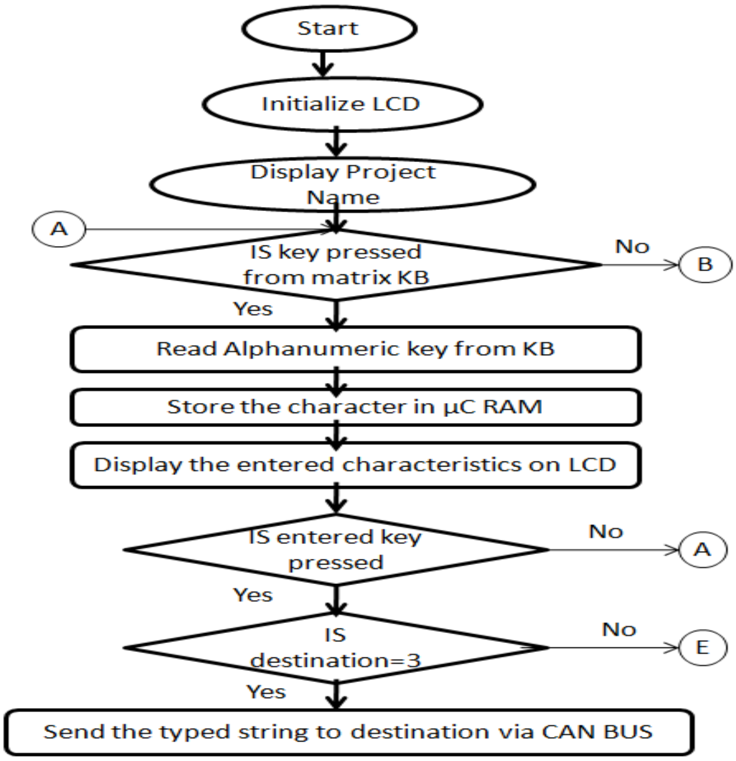

Fig 8: (a)algorithm for node 2 or 4

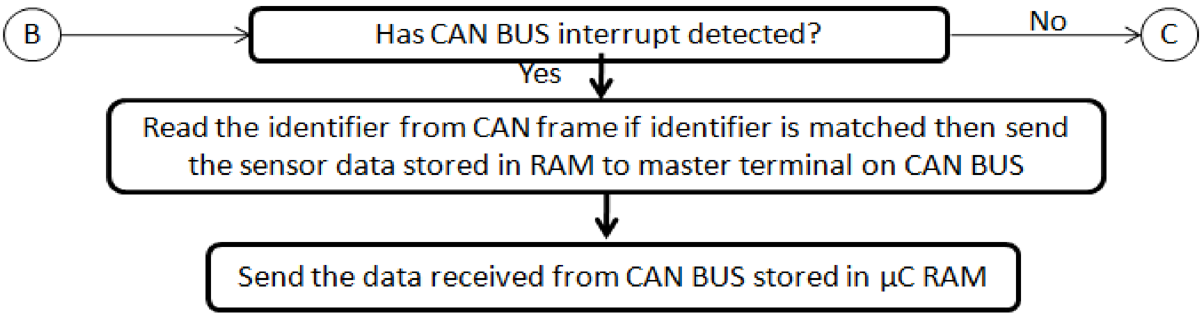

Fig 8: (b) algorithm for node 2 or 4

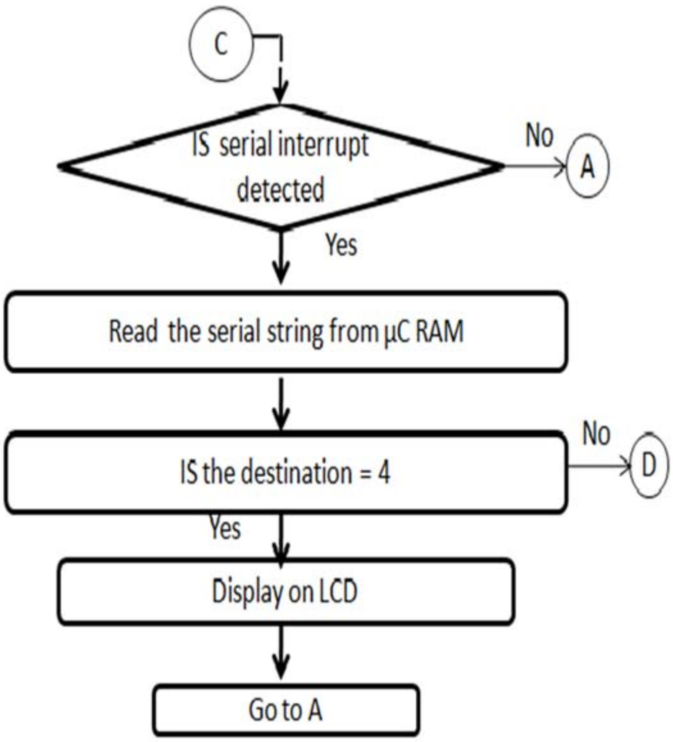

Fig 8: (c) algorithm for node 2 or 4

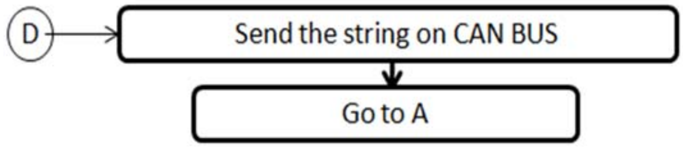

Fig 8:(d) algorithm for node 2 or 4

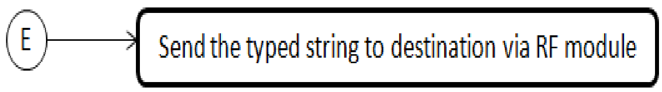

Fig 8: (e) algorithm for node 2 or 4

5. Implementation Results

Block diagram Fig.6 and 7 and a picture of the CAN/IEEE802.11b/CAN internetworking application prototype Fig. 9, respectively. The system designed and implemented consists of two independent CAN segments each with two CAN nodes and a WIU. Every CAN node produces a remote CAN message and a local CAN message carrying data entered using the keypad. The local message is destined to the other CAN node in the same CAN segment while the remote message is destined to a CAN node in the other CAN segment. The CAN messages used in this sample application are given in Table 1. The flowchart of operation of the WIUs and flowchart of operation of the CAN nodes in this application prototype network are defined in above section4 are also justified by implemented design.

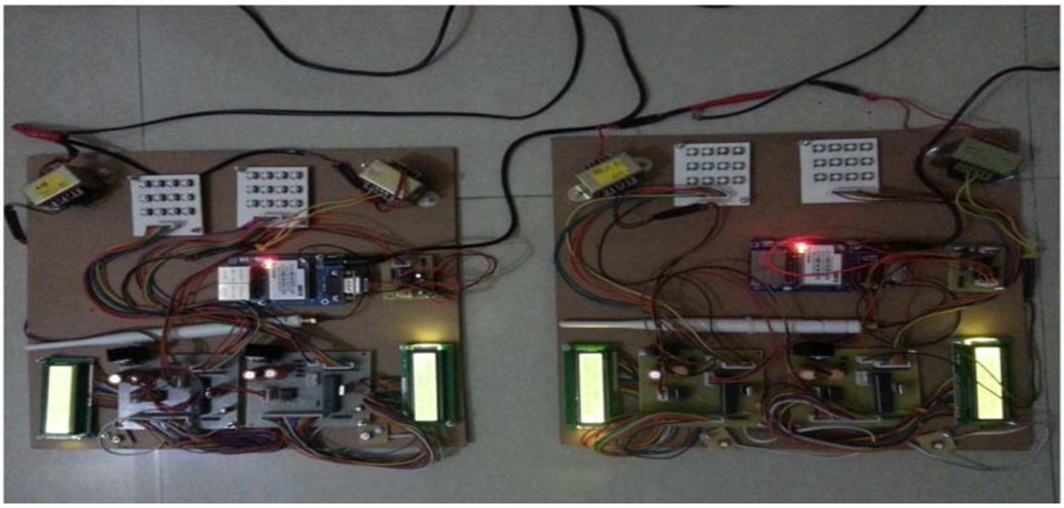

Fig 9: Picture of CAN/WLAN/CAN interworking application prototype

Table 1: CAN message used in implemented sample application prototype.

	Source Node	Message Type	Data (Bytes)	Destination Node
Segment 1	1	Remote	8	3 or 4
		Local	8	2
	2	Remote	8	3 or 4
		Local	8	1
Segment 2	3	Remote	8	1 or 2
		Local	8	4
	4	Remote	8	1 or 2
		Local	8	3

This sample design shows that easy and widespread usable CAN network in industrial area with Wireless interworking will increase the flexibility for industrial applications. Sample design implemented is having two types of communication i.e. remote and local. Below table gives idea about communication between nodes of two networks implemented in Fig 9 picture.

6. Conclusion

TheaimofthisworkhastodesignaWIU that providesaservicetoachieve thewireless interconnection oftwoCAN2.0BsegmentsusinganIEEE802.l1b WLAN. Consideringtheir easy usageinmanyindustrial areas,CANnodesemergeinevitablytoneedthistypeof wirelessinterworkingforgreaterflexibilityfortheir applicationstobecontrolledand/orprogrammed remotely. In summary, the model of the designed CAN/IEEE 802.11b WLAN Will includes four phases of operation.First,itreceivesaCANmessageoraWLAN framefrom one of its ports, i.e. theCAN side or theIEEE 802.11bside,respectively.Second, it decides whether or not to forward the message/frame.Third,the message /frameisreformattedintotherequiredtype to be, lastly,transmittedtotheother system.

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