Design Approach for VANET Routing Using Real Time Vehicular Traffic Information

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Abstract—In order to meet performance goals, it is widely agreed that Vehicular ad hoc networks (VANETs) must rely heavily on Vehicle to Vehicle communication (V2VC), Vehicle to Infrastructure communication (V2IC) and Infrastructure to Vehicle communication (I2VC). The vehicles are to be taken as node and they are having the sensors and switches. Driver using the keypad can allow access to transmit the data to base station from the node. In the same way driver can press buttons depending on the situation and the message (traffic jam, emergency, accident) is transmitted to others and hence this can help and assist the drivers in the process. The system is required to transmit real time data accurately in the intelligent transportation system. In our approach ZigBee is used as wireless technology which has an important impact on the future development of information technology because of its low cost, low power consumption, automatic network protocol flexibility and convenient applications and by using this, traffic problems can be communicated to all other drives in that vicinity.

Index Terms—Infrastructure to Vehicle communication (I2VC),Inter Vehicular Communication (IVC),Mobile Node,PIC Microcontroller, Vehicular Ad Hoc Network (VANET),Vehicle to Vehicle communication V2VC,Vehicle to Infrastructure communication (V2IC) ,ZigBee.

1 Introduction

Each year traffic accidents have been taking thousands of lives. Studies show that 60% road ways collision could be avoided if the operator of the vehicle provided warning at least half second prior to collision.

Human drivers suffer from perception limitation on roadway emergency events, resulting in large delay in propagating emergency warnings.

In our approach we are suggesting a commercial model through which Inter Vehicular Communication (IVC) can be considered as a future application, adding extra value to the vehicle industry. Taking into consideration the constant growth of automotive market and the increasing demand for vehicle safety, also driven by regulatory domain, the potential of V2V connectivity is immense. Application area of such system should be suitable for a wide spectrum, including traffic and fleet control, issues concerning architectures, security and routing performances. Key Points of our design approach is standardization of the VANET modeling. It is to be considered that the protocols should be carefully planned to ensure interoperability as vehicles hails from different vendors and that must communicate smoothly .The need of the scenario is that a common system must be deployed and finally a strategic deployment is proposed, as application would become functional.

As we are working on a VANET technology, that uses moving cars as nodes to create a mobile network. VANET turns every participating car into a wireless router or node, allowing cars approximately 100 to 300 meters of each other to communicate and in turn, create a network with a wide range.As cars fall out of the signal range and drop out of the network, other cars can join in, connecting vehicles to one another so that a mobile VANET is created. It is estimated that the first systems that will integrate this technology are police and fire vehicles to communicate with each other for safety purposes.

In VANET, or Intelligent Vehicular Ad-Hoc Networking, defines an intelligent way of using Vehicular Networking.VANET integrates multiple ad-hoc networking technologies such as Wi-Fi IEEE 802.11p [11], WiMAX IEEE 802.16 [11], Bluetooth, IRA and ZigBee [7] for easy, accurate, effective and simple communication between vehicles on dynamic mobility [4].Effective measures such as media communication between vehicles can be enabled as well as methods to track the automotive vehicles.

The rest of this article is organized as follows: The next section briefly explains the architectural model and in section 3 we have discussed about the components used in the model and related working specification of the respective components.

2 Design Approach

Let us consider 2 vehicles as node – 1 and node – 2. Both these nodes have a built in sensor, in our case we are using the sensor for a possible accident and the driver has 2 emergency buttons for traffic jam and Road block (that could have occurred due to other reasons). Let's assume that in case if node -1 is involved in an accident the data is sent to the node-2 with information about the accident. Now the driver using the keypad can allow access to transmit the data to the base station from node – 2.

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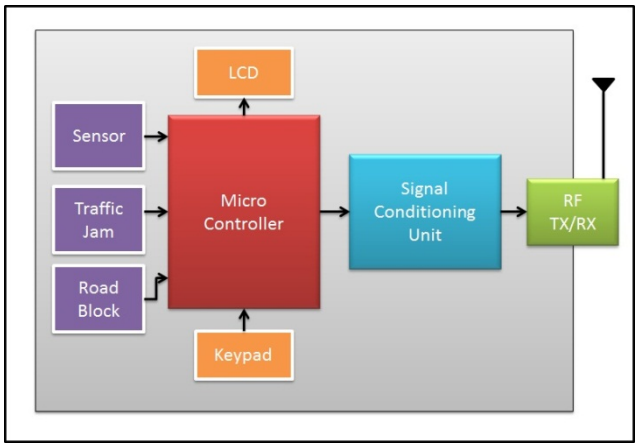

Fig. 1 Architecture of node consists of Sensor, Traffic Jam and Road Block connected to PIC Microcontroller.The node is connected with radio frequency transmittor and reciver

Let's assume that the base station is far away from the car involved in the accident. The data from the node – 2 is then received at the base station- 1 or the tower – 1 and the station officer will get to know from which node the data has been received.

He can transmit the message to all the other vehicles using the ZigBee and at the same time send the data to the other base stations, for example for base station -2 or tower -2 using the internet only.Now the base station-2 can do the same work as done by the base station-1. In the same way the driver can press any button depending on the situation and the message is transmitted to others and hence this can help and assist the drivers in the process. In our model we are only showing the base station-2 is getting the message from the base station-1 but it is not retransmitting messages to any other vehicle. Thus we can see that if it's done for 2 nodes, it can be done for any number of cars. In our project we have taken the node-1 and node-2 as vehicles which work on wired power. As our main focus is on VANET and not the vehicle or how it's powered.

At the time of implementation we used Metal Sensor, PIC Microcontroller, ZigBee and power source to these devices and Embedded C and JAVA is used to implement this model.

At the base station side we need to develop the software using java on the windows platform and also communicate to the Microcontroller which is connected to the USB port or serial port of the base station pc.

In this model there are three types of behaviors in message passing from node to node or node to base station. In first case if button '1' is pressed then it displays and sends message of traffic jam through ZigBee to next vehicle. In second case if button '2' is pressed then it displays and sends message of emergency with current position of vehicle. While in third case if button '3' is pressed then it displays and sends message of accident with current position of vehicle. However in case of receiving end (vehicles) the behavior of model is that it only receives and displays the message according to message number and also forwards it to nearest base station.

Behavior of base station with ZigBee and PC is to receive the message sent by vehicle and according to message type and area, display the message and again send that message with location to another base station or vehicle.

3 Working of Components

To make this model functional we need to divide the whole model into two parts, first one is hardware and second one is software comprising of embedded C and Java.

Knowledge of each component plays a vital role in the working of model, so it is very important part to know all the technical knowhow of the components. In this section we are going to explain all the specification of the components.

1. PIC Microcontroller as Controlling Unit
2. ZigBee as Communication Device

3.1 PIC Microcontroller as Controlling Unit

PIC microcontrollers (Programmable Interface controllers) are electronic circuits that can be programmed to carry out a vast range of tasks. They can be programmed to be timers or to control a production line and much more. They are found in most electronic devices such as alarm systems, computer control systems, phones, in fact almost any electronic device.

In our model we are using PIC18FXXX microcontroller instead of simple microcontroller because of its own advantages like analog to digital converter is inbuilt in it, C-Language friendly architecture, supporting two-stage instruction pipelining etc.

In this model we are using PIC18F458 microcontroller, it is a 40-bit microcontroller.We have five ports port A, port B, port C, port D and port E, different port for different purposes like port B for display output, port C for serial communication (for data transfer between ZigBee and microcontroller), port D for LCD (for display message) and we can use port A, port E for general purpose.But if we have analog input than we must have to use port A because port A has specific feature to convert analog to digital.

3.2 ZigBee as Communication Device

ZigBee is an IEEE 802.15.4 standard for data communications with business and consumer devices.. It is designed around low-power consumption allowing batteries to essentially last forever. The ZigBee standard provides network security, and application support services. It employs a suite of technologies to enable scalable, self-organizing, self-healing networks that can manage various data traffic patterns.

It is a low-cost, low-power, wireless mesh networking standard. The low cost allows the technology to be widely deployed in wireless control and monitoring applications, the low power-usage allows longer life with smaller batteries, and the mesh networking provides high reliability and larger range. ZigBee has been developed to meet the growing demand for capable wireless networking between numerous low power devices. It can operate in Industrial, scientific and medical (ISM) radio bands.

Features of ZigBee:

1. Power supply voltage (Vcc): 3.3 to 3.6 V.
2. Operating frequency: ISM 2.4 GHz.
3. Indoor/Urban range: Up to 30 meters with antenna.

4. Outdoor range: Up to 100 to 150 meters with high gain antennas.
5. RF Data rate: 250 kbps.
6. Often used in mesh network form to transmit data over longer distances so it is flexible.
7. Low power Consumption and low cost. Battery life is for several years.
8. Provides high security and simplicity.
9. ZigBee forms ad hoc, with no centralized control.

The basic architecture of ZigBee is shown on next page. This architecture is ZigBee protocol stack. As shown in the ZigBee protocol stack there are three basic levels.

3.2.1 Physical layer

The Physical/Data Link level is concerned with low-level network operation such as addressing and message transmission/reception. It is based on the IEEE 802.15.4 standard and comprises the following two layer first MAC (Media Access Control) sub-layer secondly PHY (Physical) layer.

3.2.2 Network layer

The network layer provides the glue between the applications and the Physical layers. It consists of stack layers concerned with network structure, routing and security (encryption, key management and authentication).

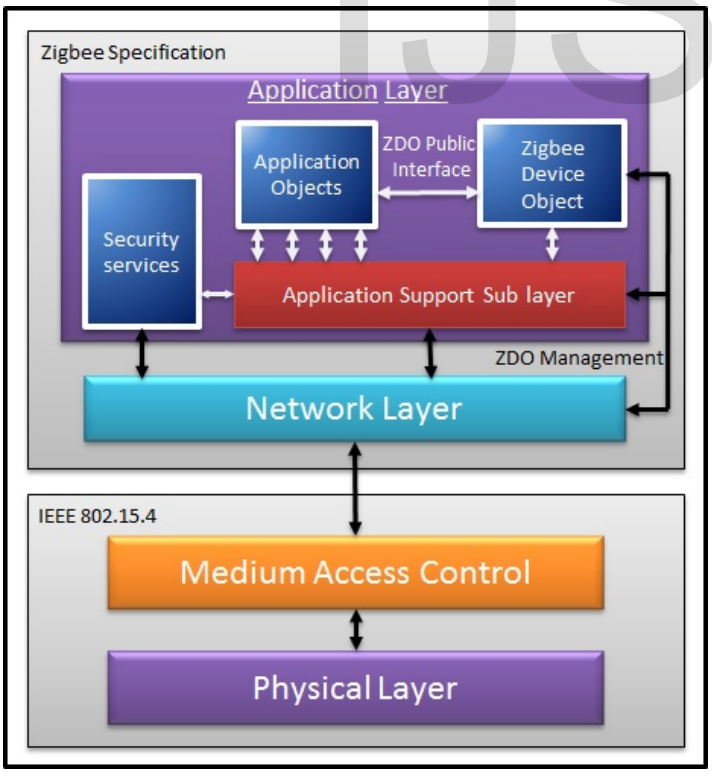

Fig. 2 Zigbee Protocol Stack

3.2.3 Application Layer

The Application level contains the applications that run on the network node. These give the device its functionality - essentially an application converts input into digital data, and/or converts digital data into output.

3.2.4 Zigbee Implementation

In model we are going to multicast the message. We are using ZigBee in the nodes and base stations. When any accident occurs or emergency message has to be send or receive for that purpose ZigBee is used.

Suppose an emergency message has to be send to other nodes and base station then through ZigBee message will be multicast to nearby nodes. From the nearby nodes that message will be transfer to the base station via ZigBee.

ZigBee is a low cost and low power consuming device than other devices such as Bluetooth or wifi. Also it works in ISM band and has range up to 100 meters that is why we used ZigBee in our project.

In our project we are using 2.4 GHz (ISM) bandwidth with 16 channels which is worldwide used. It has data rate of 250 kbps. As it has such high speed, message can be transmitted to many nearby nodes. Thus it handles many number of nearby nodes in the area of a ZigBee device. This is useful in the situation of traffic jam.

In our project, security of data is done in Mac layer like encryption of data, duplicate rejection and access control. ZigBee Mac layer provides security services such as,

1. Access control – the device maintains a list of trusted devices within the network.
2. Data encryption is done by using 128 bit advanced encryption standard.
3. Data is protected from being modified by unauthorized parties.

Network startup, device configuration, topology specific routing and security are performed by network layer of ZigBee protocol stack. Route calculation, neighbor discovery and reception control is also done in network layer. The routing protocol used by network layer is AODV.

The application layer in the ZigBee protocol stack defines effective interface to its end users. It consists of two main components ZigBee device object (ZDO) and application support sub layer (APS). ZDO defines the device as either a coordinator between other devices or as an end device. It also discovers new devices on the network.

It helps in establishing secure links with external devices. The APS offers well defined interface and control services. It acts as bridge between network layer and application layer. It keeps updated information regarding devices in order to find the appropriate device.

Thus, using ZigBee our project provides secure and fast data transmission.

4 BASE STATION IMPLEMENTATION THROUGH JVM

In our model communication between vehicle to vehicle, vehicle to RSU (Road Side Unit), RSU to vehicle is handled by ZigBee in addition to that if message is needed to pass in a distance greater than 100m which is range of any single ZigBee module from the originator of message then RSU is able to send respective message via internet to a far RSU thus passing message across any distance is possible with the use of internet.

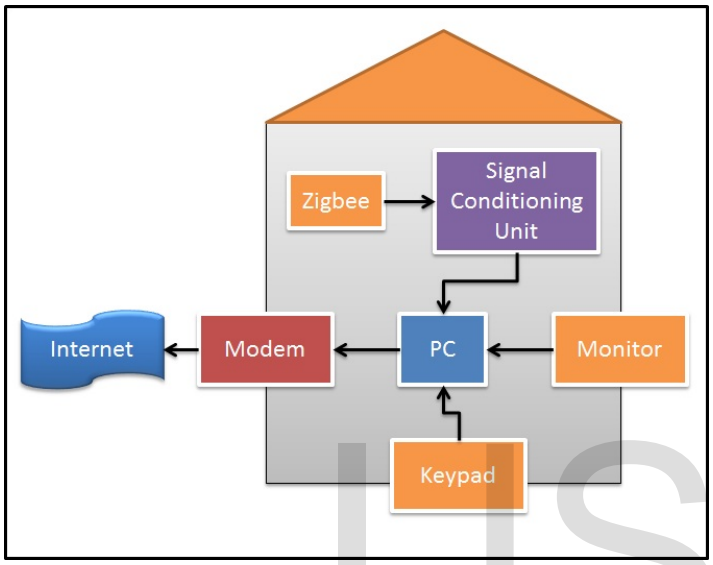

Fig. 3 Architecture of base station consists of zigbee module connected with PC which sends email through Internet to other Road Side Units

Our proposed model also include ZigBee module at each Road side unit to receive message from vehicle and sending message to vehicle and the interfacing of ZigBee with RSU is with the use of RS232 and hardware reader module.

The java code can interface the ZigBee and convert the message from received vehicles into emails which are to be sent via internet across a large area where ZigBee is insufficient to send message.

The Gmail authenticator and send mail module are able to authenticate and the message through internet to the other road side units for message transfer across a large portion of streets.The session creation and handling for transferring the mail is handled by these modules.

The SMTP protocol is used to send the mails using port no "587" .Simple mail transfer protocol is used most often used for sending simple mails.

These modules create the MIME i.e. Multipurpose Internet Mail Extensions which are an Internet standard that extends the format of email to support:

1. Text in character sets other than ASCII
2. Non-text attachments
3. Message bodies with multiple parts
4. Header information in non-ASCII character sets

All this information can be send via mail using MIME messages.The JDBC connection module is used to store and maintain the database of vehicles having node installed in them and information like vehicle no and driver details.

The Hardware reader module interfaces the ZigBee attached on communication port and it reads the data receiving from ZigBee and chooses the course of actions to be taken on respective arrival of message from nodes.

It takes decision to send the message to nearby vehicles or to other RSU via internet.

5 CONCLUSIONS

Using this technology we can ease the traffic problems on the road which is cost effective and time efficient in its operation. Any problems on the road can be informed to all the other vehicles in that vicinity. In case of emergency like fire, ambulances, police etc, data can be sent to all the drivers in that road.

We implemented Zigbee technology to communicate in between vehicles which allowed us to make a cost effectivecommercial model and increasing the limits of range up to 150 meters with data rates up to 250kbps.So Zigbee has made this model a low cost, reliable and fully controlled Ad hoc network in vehicles and RSU. RSU and vehicles ensure that message is spread in all of area to ensure the flow of message across the network.

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