Realistic Simulation, Analysis and Result for VANET Using ZigBee Technology

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Abstract—One emerging, new type of ad-hoc network i the Vehicular Ad-Hoc Network (VANET), in which vehicles constitute the mobile nodes in the network. Due to the prohibitive cost of deploying and implementing such a system in real world, most research in VANET relies on simulations for evaluation. A key component for VANET simulations is a realistic vehicular mobility model that ensures conclusions drawn from simulation experiments will carry through to real deployments. Vehicular Ad Hoc Network (VANET) is a form of Mobile Ad Hoc Networks (MANET). The field of VANETs started gaining attention in 1980s and has now been an active field of research and development. VANETs provide us with the infrastructure for developing new systems to enhance drivers' and passengers' safety and comfort. There are many routing protocols that have been proposed and assessed to improve the efficiency of VANET. Simulator tool has been preferred over outdoor experiment because it is simple, easy and cheap. In this paper, simulation of one of the routing protocols i.e. AODV which belong to ZigBee technology is done on simulators which allow users to generate real world mobility models for VANET simulations. The tools used for this purpose are SUMO, MOVE and NS2. MOVE tool is built on top of SUMO which is an open source micro-traffic simulator. Output of MOVE is a real world mobility model and can be used by network simulator NS-2. Then graphs were plotted using Tracegraph for evaluation. Based on the simulation results obtained, the performance of AODV is analyzed and compared in three different node density i.e. 4, 10 and 25 nodes with respect to various parameters like Throughput, Packet size, Packet drops, End to End delay etc.

Keywords- ZigBee, AODV, MOVE, NS2, SUMO, VANET.

I. INTRODUCTION

Recent advances in wireless networks have led to the introduction of a new type of networks called Vehicular Ad Hoc Networks (VANETs).VANETs [1] is the subclass of Mobile Ad Hoc Networks (MANETs). It deploys the concept of continuously varying vehicular motion. VANETs provide us with the infrastructure for developing new systems to enhance drivers' and passengers' safety and comfort. In after month of accident, it can be vital to maintain communication with trapped miners and rescuers ,and to establish and track their position VANETs are distributed self organizing networks formed between moving vehicles equipped with wireless communication devices. But the WSN has its own limitation, such as not having enough bands to communicate and transfer image data efficiently so, how to overcome the limitation and provide one communication with wide band is concerned. [9] VANETs possess a few distinguishing characteristics from MANETs. These are:

1 Highly dynamic topology.

2 Patterned Mobility.

3 Propagation Model.

4 Unlimited Battery Power and Storage.

5 On-board Sensors.

There are many routing protocols that have been proposed and assessed to improve the efficiency of VANET. In this paper, I discus the choice of working frequency for wireless system and node deployment then I introduce the wireless system that invent using ZigBee technology which is called the ZigBee standard use two routing protocol in routing layer in order to establish the network and transfer the data among sensor node thus routing protocol are Ad Hoc on-demand distance vector (AODE) [10] So, I are trying to analyze the performance of one of the routing protocols AODV with respect to various parameters like Throughput, Packet size, Packet drops, End to End delay etc in three different scenarios of node density. The performance of the proposed protocol has been studied using simulation tools mainly Network Simulator (NS) and MOVE (MObility model generator for VEhicular networks) over SUMO (Simulation of Urban Mobility). The paper is organized in five sections. The next section describes

VANET routing protocols in which AODV is described in detail. In section III we discuss research methodology used for carrying out the experiment. Section IV shows the results and analysis made and last section covers the conclusion part.

II ZigBee OVERVIEW

A group of companies called the zigbee alliance has introduce anew technology called zigbee is standard for low cost ,low power ,and low data rate WSNs based on the IEEE 802.15.4 physical(PHY) and medium access control (MAC) layer specification as shown in fig 2 the ZigBee standard has added three layer extract to the MAC and the PHY layers of the IEEE 802.15.4 standard in fig.2, NLDE is the network layer data entity, MLDE is the MAC layer data entity ,NLME is the network layer management entity ,and SAP is the service access point and of these are only interfaces between the layer .these layer are the network layer ,the application layer .the network layer support three network topology star, tree, and mesh topologies. The network layer is also responsible for the network establishment, maintenance and network routing protocol.

Each ZigBee network should have coordinator this coordinator must be an IEEE 802.15.4 full function device FFD).this coordinator is engaged in coordinating and disconnecting nodes to the WSN. Moreover the ZigBee coordinator is responsible for establishing the network and providing secure and stable link between the network device.

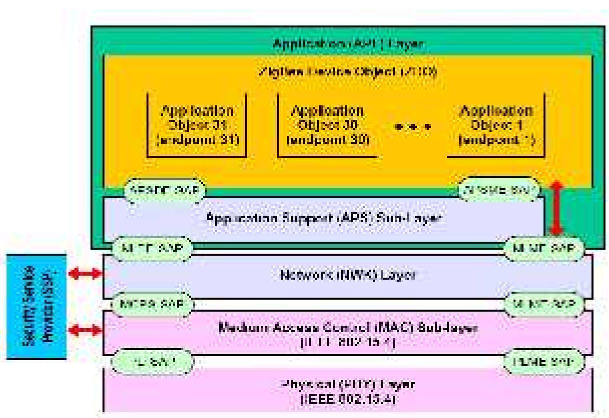

Fig 1 : Stack of ZigBee

The ZigBee network could have some devices acting as ZigBee router. these router are other FFDs in the network, which are not the ZigBee coordinator .the router participate in the routing presses and supporting association in the network IEEE 802.15.4 reduce the function devices (RFDs) may participate in the ZigBee network acting as end device. These end device sense the surrounding phenomena, and they send the data back to coordinator directly or through other router devices. These end device are optional, but they can perform very low power operation. [18]

When using ZigBee technology, the BS is FFD and CH, and the sensors and ID cards are RFD and CN. The sensor and ID card only send signals to the BS and the BS read these data by poll method. The base station also has backup power that can sustain more than 2 hours. The sensor and ID card use battery. The battery life T can be calculated as follows:

$$T = C \times (T1 + T2 + T3) / (T1 \times I1 + T2 \times I2 + T3 \times I3)$$

In this formula, T1: data sending time, I1: working current, T2: waiting time, I2: waiting current, T3: active time, I3: active current. C: battery capacity. Take ID card as an example, we use the battery CR2450, its capacity is 550mAh. T1 is 450μs, I1 is 12.5mA, T2 is 500ms, I2 is 1μA, T3 is 600μs, I3 is 1.5 mA, so we can calculate T= 39149.8 h, that is about 4.5 years. Considering real factors, we can confirm that the ID cards can normal work for 3 years. [9]

ZigBee standard use a combination technique of two routing protocols in its routing table; the cluster tree and ADOV routing protocols .these routing protocols cooperate in order to establish the network and send data among the wireless sensor device in the network. [10]

III. ROUTING PROTOCOLS

A routing protocol governs the way of exchanging information in two communication entities; it includes the procedure in establishing a route, decision in forwarding, and action in maintaining the route or recovering from routing failure. Fig. 2 illustrates the taxonomy of these VANET routing protocols which can be classified as topology-based and geographic (position-based) in VANET.

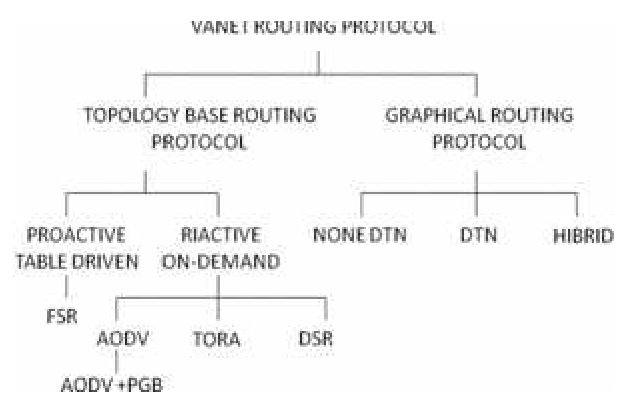

Fig. 2: Taxonomy of Various Routing Protocols in VANET

The routing protocols can be divided into topology based routing and geographic routing.[13] Topology based routing protocols use links information to forward the packet whereas geographic routing uses the information about the location of destination to forward the packet. Topology based routing can again be reactive or proactive. Proactive routing uses the routing table for propagation of message whereas reactive routing builds the route only when it is required. We have used AODV protocol for the analysis which is reactive routing protocol. [13]

A. AODV

As in VANET, nodes (vehicles) have high mobility and moves with high speed. Proactive based routing is not suitable for it. Proactive based routing protocols may fail in VANET due to consumption of more bandwidth and large table information. AODV is a reactive routing protocol, which operates on hop-by-hop pattern. The Ad hoc On-Demand Distance Vector (AODV) [10] algorithm enables dynamic, self-starting, multi hop routing between participating mobile nodes wishing to establish and maintain an ad hoc network. AODV allows mobile nodes to obtain routes quickly for new destinations, and does not require nodes to maintain routes to destinations that are not in active communication. Route Requests (RREQs), Route Replies (RREPs), and Route Errors (RERRs) are the message types defined by AODV. In AODV routing, upon receipt of a broadcast query (RREQ), nodes record the address of the node sending the query in their routing table (Fig. 3a). This procedure of recording its previous hop is called backward learning. Upon arriving at the destination, a reply packet (RREP) is then sent through the complete path obtained from backward learning to the source (Fig. 3b). At each stop of the path, the node would record its previous hop, thus establishing the forward path from the source. The flooding of query and sending of reply establish a full duplex path. After the path has been established, it is as maintained long as the source uses it. A link failure will be reported recursively to the source and will in turn trigger another query-response procedure to find a new route.

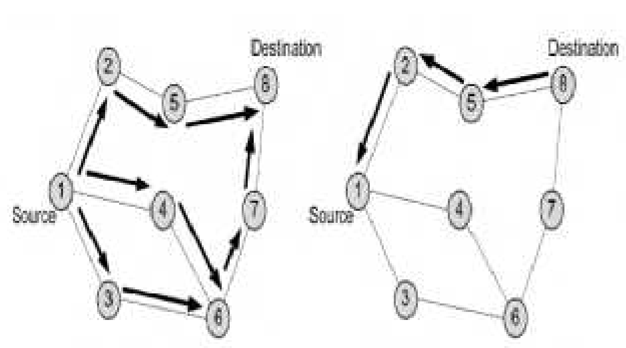

Fig. 3: AODV route discovery

IV. RESEARCH METHODOLOGY USED

To carry out the experiments those simulations tools are used which can produce realistic mobility model. The various tools used for simulation, simulation configuration, performance metrics used for making various comparisons are discussed in this section.

A. Simulation tools

The simulation module created using TCL makes use of two tools to simulate the implementation and evaluate its performance:

NS2: The Network Simulator (ns2) [16] is a discrete event driven simulator developed at UC Berkeley. We are using Network Simulator NS2 for simulations of protocols. It provides substantial support for simulation of TCP, routing and multicast protocols over wired and wireless networks. Ns- 2 code is written either in C++ and OTCL and is kept in a separate file that is executed by OTCL interpreter, thus generating an output file for NAM (Network animator) [17]. It then plots the nodes in a position defined by the code script and exhibits the output of the nodes communicating with each other. It consists of two simulation tools. The network simulator (ns) contains all commonly used IP protocols. The network animator (NAM) is use to visualize the simulations. shown in Fig 4.

Fig 4: NS2 Simulation For VANET

B. *Simulation configuration*

The following are the configurations set as per the assumed simulation context:

TABLE I: SIMULATION SETUP

Parameter	Value
Channel Type	Wireless
Network Interface type	Physical Wireless
Routing Protocol	AODV (NS2 default)
Interface queue type	Priority queue
Queue Length	50 packets
Number of nodes in topography	10, 25

X and Y Dimensions in topography	500 * 500 sq m
Time of Simulation end	100 simulation seconds
Traffic Type	TCP
Number of Road Lanes	2
Speed	40 m/s
Radio Propogation Model	Two Ray Ground
MAC protocol	IEEE 802.15.5

C. *Simulation Parameters*

Various parameters used for performance evaluation are:

1) Throughput:

It is the amount of data per time unit that is delivered from one node to another via a communication link. The throughput is measured in Packets per unit TIL or bits per TIL. TIL is Time Interval Length. More is the throughput of sending and receiving packets better is the performance. Lesser is the throughput of dropping packets better is the performance.

2) Average throughput:

It is the average of total throughput. It is also measured in Packets per unit TIL or bits per TIL.

3) Packet Drop:

It shows total number of data packets that could not reach destination successfully. The reason for packet drop may arise due to congestion, faulty hardware and queue overflow etc. Lower packet drop rate shows higher protocol performance.

4) Packet size:

Size of packets in bytes.

5) Average simulation End to End delay (End2End delay):

This metric gives the overall delay, from packet transmission by the application agent at the source node till packet reception by the application agent at the destination node. Lower delay shows higher protocol performance. The following equation is used to calculate the average end-to-end delay, Average End to End Delay = (T_DataR – T_DataS), Where T_DataR = Time data packets received at destination node T_DataS = Time data packets sent from source node. The end to end delay is important metrics because VANET needs a small latency to deliver quick messages. It shows the suitability of the protocol for the VANET.

6) Simulation time:

Total time taken for simulation. It is measured in seconds.

V. RESULTS AND ANALYSIS

Experiment has been carried out for three different numbers of nodes under various cases and results are drawn and evaluated. The numbers of nodes used are:

I. 10 nodes II. 25 nodes Results are compared for following cases:

CASE 1: Throughput of sending packets.
CASE 2: Throughput of receiving packets.
CASE 3: Throughput of dropping packets.

A. CASE 1: Throughput of sending packets.

The graph is plotted for the throughput of sending packets against the simulation time. Throughput is the number of packets sent per unit TIL. TIL is the Time Interval Length. Simulation time is measured in seconds.

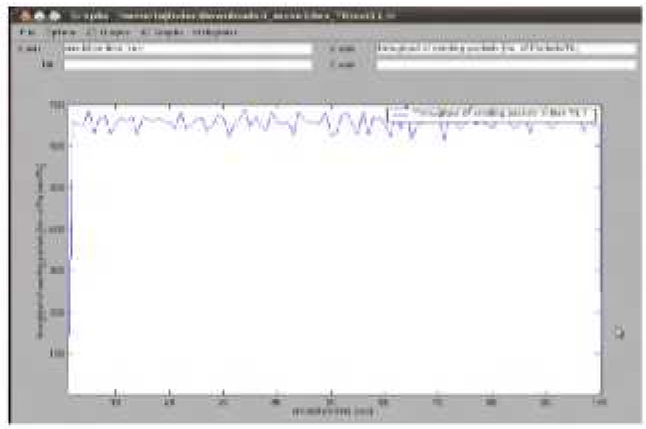

Fig. 5: Throughput of sending packets for 10 nodes

1) INFERENCE FOR FIG. 5: This graph is showing that throughput increases to 650 packets/TIL in just 1 sec in the beginning and then it keeps on giving an average throughput of 650 packets/TIL with little variation for rest of the simultaion time. Here total simulation time is 100 secs.

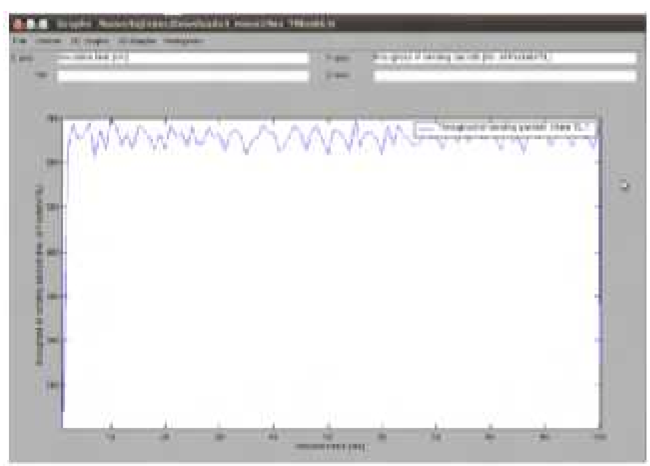

Fig. 6: Throughput of sending packets for 25 nodes

2) INFERENCE FOR FIG. 6: This graph is also showing that throughput increases to 650 packets/TIL in just 1 sec in the beginning and then it remains in range 600-700 packets/TIL for rest of the simultaion time. So, graphs for 10 and 25 nodes are more uniform then for 4 nodes.

B. CASE 2: Throughput of receiving packets

The graph is plotted for the throughput of receiving packets against the simulation time.

1) INFERENCE FOR FIG. 7:

This graph is showing that throughput increases to 560 packets/TIL within 2 sec in the beginning and then it remains in the range 550-600 packets/TIL for 10 secs and then it rises suddenly to 650 packets/TIL then it keeps on giving throughput in the range of 620-680 packets/TIL for rest of the simultaion time.

2) INFERENCE FOR FIG. 8: This is a more uniform graph then for 4 nodes and 10 nodes. Here throughput rises to 580 packets/TIL in 3 secs then it remains in range of 500-600 packets/TIL for 10 secs approx.and then it rises above to 630 packets/TIL in 2 secs and then it remains in the range of 610- 690 packets/TIL uniformly for rest of the simulation time.

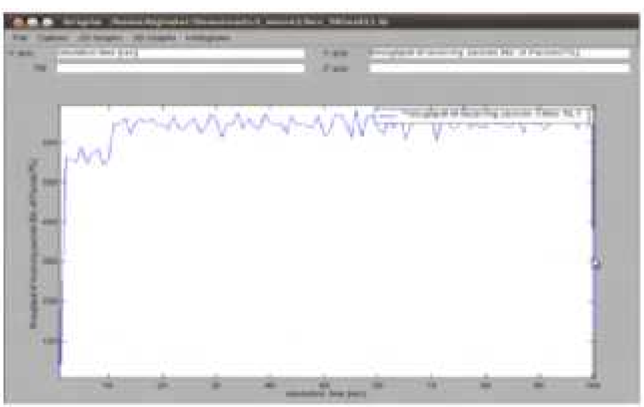

Fig. 7: Throughput of receiving packets for 10 nodes

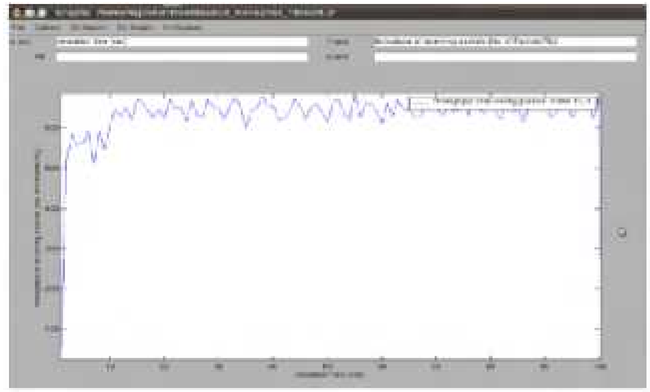

Fig. 8: Throughput of receiving packets for 25 nodes

C. CASE 3: Throughput of dropping packets

The graph is plotted for the throughput of dropping packets against the simulation time.

1) INFERENCE FOR FIG. 9: Here from this graph it can be easily analyzed that number of packets dropped has increased constantly to 18 packets/TIL in just 0.016secs (10.038-10.054secs).

2) INFERENCE FOR FIG. 10: This graphs shows that throughput of drooping packets has increased to 350 packets/TIL in first 2 secs and then dropped to zero in next one sec. Then number of packets dropped per unit time remains to be at zero for about 7 secs. After which it again rises to 200 packets/TIL.

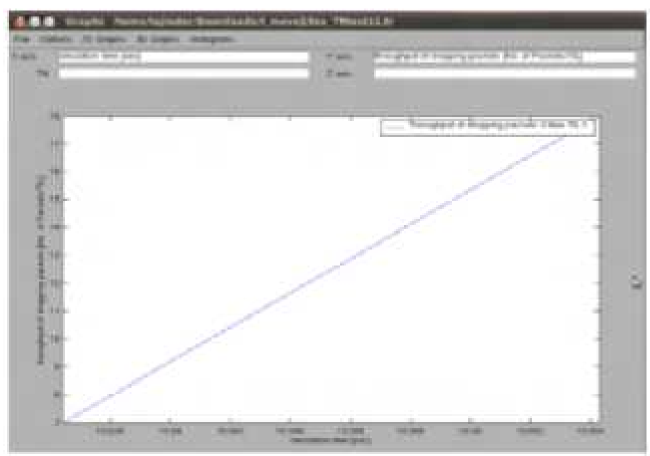

Fig. 9: Throughput of dropping packets for 10 nodes

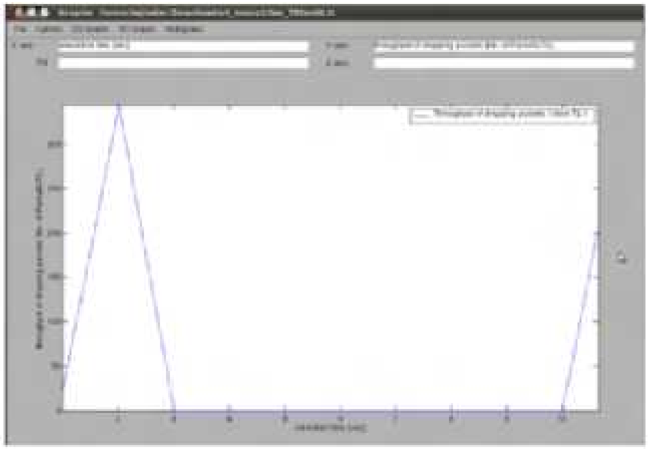

Fig. 10: Throughput of dropping packets for 25 nodes

VI. CONCLUSION & FUTURE SCOPE

In this thesis, AODV is simulated with realistic mobility model. For this MOVE is used along with NS2 and SUMO. Then graphs are plotted using Tracegraph for evaluation. AODV's performance is analysed for three different number of nodes i.e. 4, 10 and 25 nodes with respect to various parameters like throughput, packet size, packet drops, delay time etc. The simulation results for various cases can be summarized as below:

CASE 1: Throughput of sending packets: Results shows that for lesser no. of nodes i.e. 4 nodes, throughout drops with time in steps, but for more nodes like 10 and 25 ,throughput of sending packets is almost uniform.

CASE 2: Throughput of receiving packets: Results shows that throughput of receiving packets becomes more uniform with increase in number of nodes.

CASE 3: Throughput of dropping packets: Results shows that number of packets dropped in intial few secs is more in a network where number of nodes are more like in case of 25 ,it has reached to 350. While for fewer nodes like 4, it is quite less (less then 5 approox.) This might be because there are very few nodes in the network to communicate well with each other. In future, it can be simulated and analyzed for higher number of nodes like 50 and 100. It would be interesting to see how AODV performs in high node density network. Here it has been implemented for single mobility model and manually generated maps. In future performance can be compared for different mobility models. And also its performance can be analyzed for random maps, spider topology and maps imported from TIGER database [19].

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