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Wagon Next Point Routing Protocol (WNPRP) in VANET

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Abstract VANET (Vehicular Ad hoc Network) is an emerging technique which is very challenging. It has attracted the attention of numerous researchers. Characteristics of the VANET network such as the dynamically changing topology, partitioned network and high mobility of modes makes is more challenging. There are so many routing protocols has been suggested to bring out the best communication. In order to ensure a reliable, continuous and unified communication in the presence of speeding vehicles, a novel routing protocol has been has been proposed and implemented. The wagon next point routing protocol (WNPRP) has been proposed. The topology of the VANET has also been discussed. The WNPRP outperforms the existing routing protocols. A better packet delivery ratio along with less link failures while upholding a sensible routing control overhead and lowest average end to end delay is obtained. The simulator NS2 is used to implement the proposed technique and evaluate the proposed technique.

Keywords VANET · Routing protocol · Wagon · Next point routing protocol · AODV

1 Introduction

One of the special kinds of mobile ad hoc networks is the vehicular ad hoc networks (VANETs). They are formed between the moving vehicles on an as-needed basis. VANET is an evolving technology. It allows an extensive range of applications that includes

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intelligent transportation, road safety and passenger convenience. They help the passengers and the drivers on road to travel safely by providing the information about the road conditions and traffic scenario. VANET provides the real-time information such as the mobile e-commerce, weather information, road traffic, transit systems and other multimedia applications [1]. These applications are related to the safety of the users. Some of the applications that are used in the highways are automated and some of the vehicles are independent of the driver, even though such applications have not yet developed in real [2].

The MANETs gives out some of its self-organizing behaviour to the VANETs. There are some of the characteristics that are unique and are possessed by them such as the high mobility of nodes, time varying density of nodes, frequent disconnections, highly partitioned network and dynamically changing topology [3]. These unique characteristics make them more challenging. It has been a difficult task to construct networks between the vehicles that are on road moving from place to place. It also becomes important to maintain a secure communication, reliability among the various vehicles that are connected in a network [4, 5]. A proposer routing in VANET is a very important issue that has been widely discussed upon. This paper focuses the issue related to the VANET routing. The rest of the paper is organised as follows. Section 2 discusses related work. Section 3 discusses the routing issues in VANET. Section 4 presents taxonomy on VANET. Section 5 give the detailed explanation about the wagon next route point routing protocol. Section 6 discusses about the simulation results and the graphs and finally Sect. 7 concludes with a discussion.

2 Related Work

The communication in a vehicular Ad hoc Network is generally classified as the Vehicle to Infrastructures (V2I) and Vehicle to Vehicle (V2V). Both the classifications use a dedicated short range communication (DSRC) method between two or more vehicles or between a vehicle and an infrastructure having the facility that is present at the road side. On any roads of the country, the traffic causes chaos and sometimes accidents too [6]. This can be monitored and controlled by the VANET. However, the safety measures are the first and foremost priority researchers of the VANET. It would be good to increase the efficient use of such applications that can reduce or rather eradicate the mishaps such as the fatal accidents and help in an comfortable, cleaner and safer travel on roads [7]. It is practically not possible to predict the conditions on roads in advance, hence with help of the sensors it becomes easy for computing by the wireless devices that are used for communication. The speed of the vehicles coming in the opposite directions can also be predicted using the equipped devices. One way is to send a warning alert every particular time period in the form of messages in order to predict the speed of the vehicle for preventing the occurrence of accidents [8, 9].

Owing to the routing issue in the VANET, it is vital to concentrate on the efficiency of the networks performance. Hence it becomes mandatory to propose and implement an efficient routing protocol that will accomplish the task of delivering packets to their destinations in a more secure and realistic method [10, 11]. The manuscript proposes a novel method in VANET to overcome the limitation that has been discussed so far. Wagon next point routing protocol (WNPRP) is the novel routing protocol that has been suggested to find the current position of the node along with the current direction and the speed. The WNPRP also will provide whether there is going to be any change in the direction of the node in mere future. The best and efficient next hop node with respect to network connectivity and stability of the route can be chosen by the knowledge about the direction of the node towards which it is going to proceed. The contribution of this paper includes the study of the different routing issues along with the various routing protocol in VANET. A novel WNPRP has been proposed an implemented and the simulation results have been evaluated.

Research on the designing a suitable routing protocol in VANET has been highly focussed upon. It has also been the area of interest for interest researches. Their target is to overcome the problems of high node mobility and some of the restricted movement such as the connectivity, latency and unnecessary overhead [12, 13]. Vehicle-assisted data delivery routing protocol (VADD) has been proposed earlier by Zhao and Cao. VADD tackles the problems of packet delivery ratio, overhead and data packet latency. Connectivity-aware routing protocol (CAR) has been proposed by Naumov and Gross [14]. This CAR protocol upkeeps the vehicular network within the city and highway environments. Motion vector routing algorithm (MVRA) was introduced by Lebrun and Chuah. The MVRA has been intended to deliver a message to a static destination present in a sparse environment from a static or moving vehicle. The MVRA also it emphases on forecasting which vehicle from its neighbourhood will travel towards the fixed destination. This is done by exploiting the needed information from the knowledge of its neighbouring vehicles [15].

3 Routing Issues in VANET

The nodes in VANETs can be mobile or immobile. Hence, they can leave the network as and when they wish. This leads to the disruption of the path in a network. The vehicle also varies with time; this causes rapid change in the topology of the network. Due to the rapid change in the topology, it becomes difficult to preserve the route [16, 17]. This in turn leads to a reduced throughput and the routing overhead increases. The performances in VANETs are reduced by the hidden terminal problem. This causes the less number of packets to be received. The tall buildings that surround the environment cause a high inference. They lead to the routing loops and forward the signals in a wrong direction [18]. This causes delay in receiving the signals by the devices that work works with the VANET. The occurrence of temporary network fragmentation and also the broadcast storm leads in the design complication of the VANET routing protocols [19]. It becomes mandatory, that the routing protocol of the VANET should be proficient enough to establish the routes dynamically and preserving the entire route during the communication process [20]. The routing protocol should be able to suggest the alternate routes in a faster manner in the course of losing a path.

The VANET works in real time application. The time delay should be correctly monitored. A small delay may lead to a big disaster. The safety related applications should also be looked upon during the communication process [20] [21, 22]. The design of any routing protocol should be such that they should take into consideration the optimal path in order to reduce the routing [23]. It is suggested that the multiple routes should be avoided within a network to reduce congestion. The chief challenge is to plan out a routing protocol that would overcome all the difficulties face by the routing protocols that exists. Also the designed protocol gives out minimum delay along with minimum overhead. A self-organizing and self-managing network is formed by the

VANET in a distributed manner. They do not have any centralised authority or a server that dictates the communication process. All the VANET applications only depend on the various routing protocols that exist. Better models or patterns in the routing algorithms that lead to distribution of information with the precise time is taken into consideration.

4 Taxonomy of VANET

The Taxonomy of VANET consists of environments in VANET, the different protocols that are used in VANET, the techniques that are applied and the QoS parameters. The environments are further classified as the types of communication, network architecture, and application support. The communication can take place between two vehicles, between a vehicle and a nearby structure. The network architecture is further classified into single

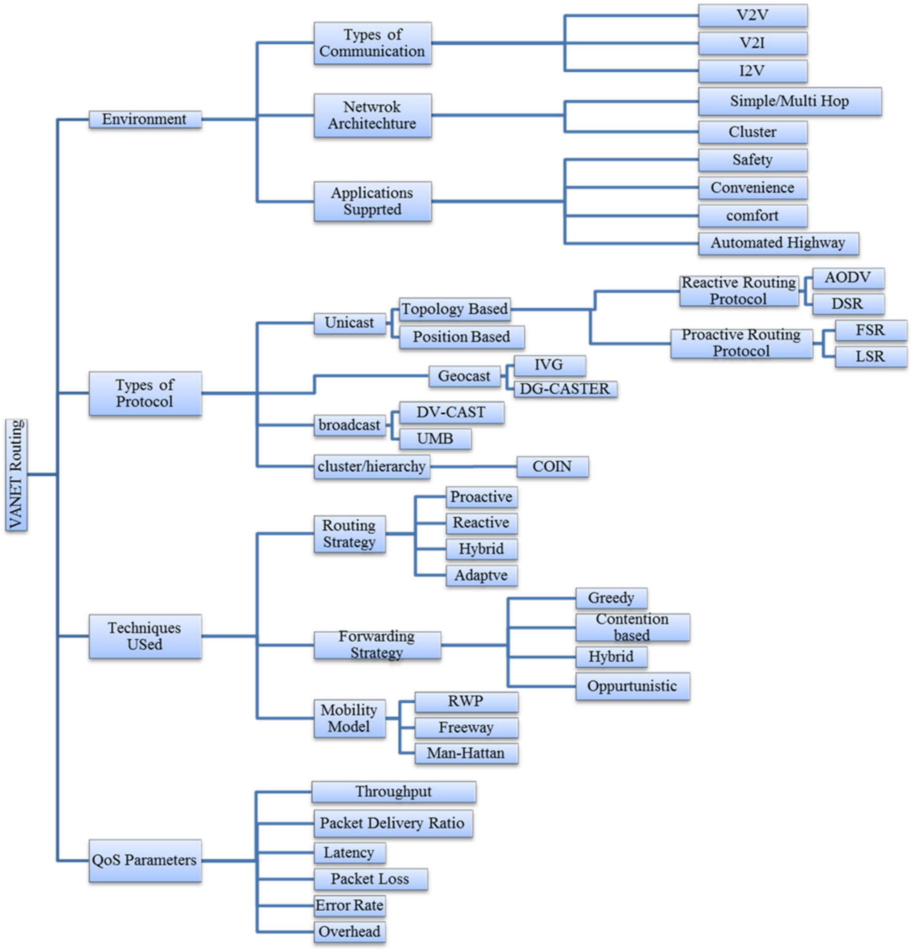

Fig. 1 Taxonomy of VANET

hop, multi hop and cluster based architecture. The applications of VANET should support safety, convenience, comfort and it should also provide automated highway. The manuscript focuses more on the routing protocol in VANET. In the taxonomy the different types of routing that are supported are unicast, geocast, broadcast and cluster. The geocast is also called as the multicast type of protocol. The unicast type routing is further classified into topology based and position based. That is depending upon the topology of a network the routing can vary. The routing Strategy is further divided into reactive routing protocol, proactive routing protocol and Hybrid routing protocol [24]. Similarly the forwarding strategy is the method by which the information is forwarded from the device to the vehicle are classified as greedy, contention based, hybrid and opportunistic. The QoS parameters that are focused are throughput, packet delivery ratio, latency, error rate and overhead. The taxonomy is shown in Fig. 1.

Selecting a best path that is selected in a network along which a message can be sent is often called as routing. The routing helps in sending information from source to sink. Each midway entity achieves routing by passing along the information to next node over network. The network contains routing tables that are used to analyse the best path from the source to destination. Proactive and reactive routing protocols have been discussed [25]. A routing that takes place by having the necessary information for routing stored in the background is called as the proactive routing. The data packets are continuously broadcasted to all the nearby nodes in order to maintain the path and the routing table that is required to get the information about the next hop towards destination. Types of the proactive routing protocols are Fisheye state routing (FSR) and link state routing (LSR). In the FSR, the information regarding the route is collected from the neighbouring nodes in the network and maintained, whereas in the LSR link of the routes are collected and maintained [26]. The FSR helps in reducing the routing overhead. The routing table is maintained even though there is a failure of a link in the network.

The reactive routing protocols are also called as the demand routing protocol. The routes are not always opened. The routes are only opened when necessary for communication by a node. The route consists of the discovery phase. In order to update the routing table, the flooding is used. One of its disadvantages is that the excess of flooding causes the network disruption. Also the latency is high for finding the exact route. The ad hoc on demand distance vector (AODV) establishes route only when a node is required to send data. Both unicast and multicast type of communication is used by AODV. Because of its on demand nature, the memory consumption is less and also the route redundancy is reduced. The cluster based routing is mainly used for safety applications. It is used for applications such as the traffic, emergency, road conditions, weather report among the vehicles and distributing the advertisement. In the broadcasting, the very same message is sent to all the vehicles in the network. While considering a cluster based network, cluster based routing. In the cluster network, a node is chosen as cluster head and the cluster head will broadcast the message to all the nodes that comes in that cluster in a network.

5 Proposed Wagon Next Point Routing Protocol (WNPRP)

This section describes the proposed WNPRP. The Wagons are nothing but a vehicle that is used for transporting. The WNPRP works assuming that the range of a Wagon in the network is around 500 m. Also each Wagon in the network should be able to gain sufficient knowledge about the nearby nodes. This is done by sending ‘Hello Message’ periodically

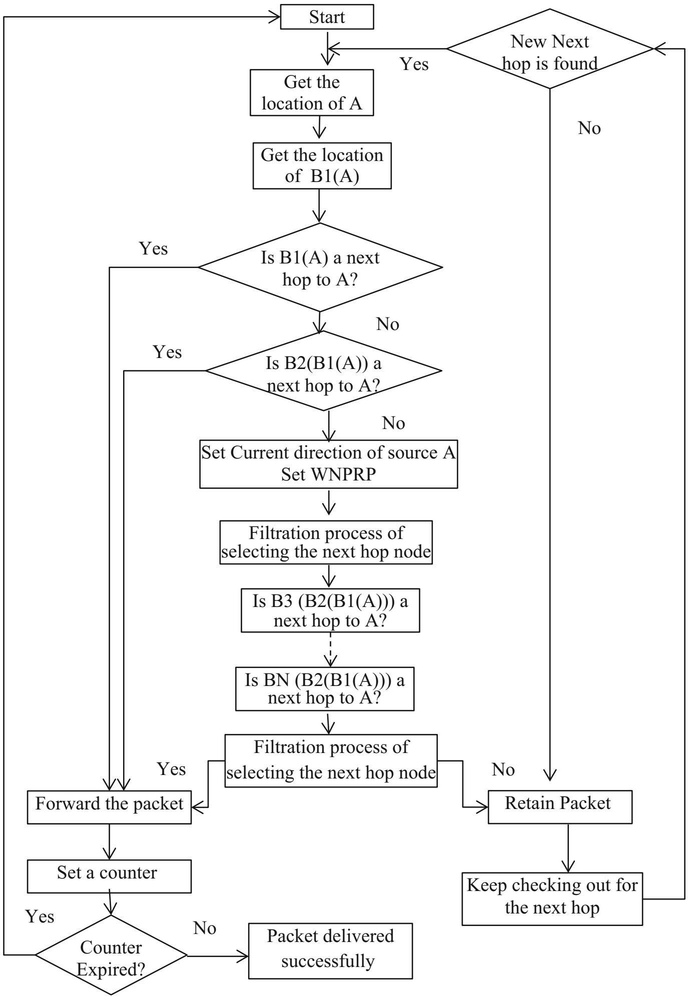

Fig. 2 Algorithm of WNPRP

with the nearby Wagons. This help is in gaining the information such as the position of Wagon, speed and direction at which the Wagon is moving. In the proposed work, each and every Wagon is provided by a GPS device and an automotive navigation system so that the tracking of the Wagon becomes possible. The wagons are equipped with the devices that already have the map of the places. Therefore it is assumed that the Wagon knows its current location along with the direction that is obtained by the GPS that is fixed in the wagon. The source from where the Wagon starts and the destination point is marked with the help of GPS.

The proposed method has used the GPS and the navigation system that already exist. The wagon gains the information about its position. Also the Wagon which is the vehicle gets the information about the surrounding vehicle or about the nearby places. The proposed protocol aims at providing a robust and best and uninterrupted route between a source and destination. The steps are suggested in the WNPRP in order to select the next hop node making sure that the data packets reach a proper place. Consider a vehicle or Wagon ‘A’ is travelling on a route which is intended to deliver a packet to a Wagon ‘B’. Wagon B is assumed to at the end of the Route. In case of a heavy traffic, if a wagon wants to send a data, in prefers to send data via WNPRP to get the best and timely approach. The forwarding wagon selects the next vehicle which runs on same route in which the packets are travelled. This avoids diversion of packets from one route to another or from one vehicle to another. Thus the number of messages that are sending will reach the destination at correct time. The WNPRP initially does the packet sending process, next it filters select the next vehicle form various other vehicle on the same route. Finally the packet delivery is confirmed.

Initially a packet is made to send from a defined source ‘A’ to a destination ‘B’. The destination node is the next hop in the network. The next hop is checked in the routing table. If the next hop is found in the routing table then the packet is forwarded. If the next hop is not found in the routing table, then the packet gets discarded. Once the destination is noted, the packet is sent from ‘A’ to ‘B’. In some cases multiple appropriate next hops will be available. In such cases the, filtering process takes place. This is done for selecting the best next hop for the packet.

5.1 Algorithm of WNPRP

The flow of the algorithm WNPRP is shown in Fig. 2. Initially the wagon has a packet ready to deliver it to the destination. The location ‘A’ is obtained. It is insufficient to have only the information and the position of the source node. It is the WNPRP that plays a vital role in deciding the next hop node.

Next the location ‘B1’ from the source ‘A’ is obtained, which is denoted as ‘B1(A)’. ‘B1’ is the next hop in the network. Once the ‘B1’ is detected, it is made sure that the ‘B1’ is the next hop of A. If ‘yes’, then the packets are forwarded or else the second next hop ‘B2’ from the source is checked. After which the second next hop to the source that is the ‘B2’ is checked. This is written as ‘B2(B1(A))’. If ‘yes’, then the packets are forwarded or else the current direction of source A is set with the help of WNPRP.

Once the current direction of the source ‘A’ is set then the filtration process takes place for selecting the next hop. This is done to make sure that the malicious node does not interfere. This goes on till the final next hop is selected. The final next hop to the source node is represented by ‘BN’. Once again the filtration process of selecting the next hop node is done. If the filtering is correct, then the packet is forwarded. If not, then the packets are retained at the source itself. If a wagon has WNPRP that leads to another route before reaching the destination, the flag 1 will be set making sure that wagon will divert its route in the next point. If the flag is set to 0, then the wagon will not divert its route. Position knowledge stage, current detection knowledge stage, wagon next route knowledge stage and speed knowledge stage are some of the stages in the filtration process.

When a packet is forwarded to another node which is an intermediate node, the source node makes sure that the packet is delivered to the designation node in a VANET. Hence once the packet is forwarded, the acknowledgement is sent to the source node. A counter is used in this process. The time counter is established at the same moment of sending the packet. When any nodes plan to forward the packet, it sets the time counter to a particular value known as the threshold value. The values in the time counter decrements for each forwarding node. If the time is over and done then the packet is dropped or discarded if no

Table 1 Simulation parameters

Parameters	Values
Network simulator	NS2-version 2.34
Simulation time	2 mins
Configures area	500 × 500
Source/destination	Random
Total nodes	25
Speed of vehicles	25 km
Channel type	Wireless
Routing protocol implemented	WNPRP
Threshold value	60 m/s
Movement	Random way point

confirmation message is received on time. The message reaches the destination successfully based on the WNPRP.

6 Simulation and Graphical Representation

Umpteen number of network simulators are available of different types of Network in VANET. The proposed work has been carried out in NS-2 simulator version 2.34. The NS2 is an open source simulator tool which is available with its latest version. The output obtained is NAM file and a Trace file. The NAM file is the Network Animator file that shows the animation of the output that has been obtained. Also the trace files show the route taken by the packets, time taken, energy consumed.

The simulator can also generate X-graphs and AWK scripts. The simulations that are executed are stored in various places in NS2 in the form of trace files. The proposed routing protocol has been evaluated using the simulator and if has been found that the proposed WNR routing protocol proves more efficient when compare to others. 500 × 500 m is the grid size chosen for simulation. For simulation purpose nearly 25 nodes are taken into consideration. For communication purpose, AODV, DSR, WNPRP routing protocols have been considered for different occasions. The malicious nodes are created in NS2 by creating an agent in WNPRP. Simulation parameters has been summarised in Table 1.

VANET is deployed with fixed and mobile nodes known as the vehicles or wagon. Here, an identification number has been assigned to each node at the time of their registration in order to move freely on roads. A node is picked up randomly and configured as the malicious node. Here node 9 is the malicious node. Communication is initiated between node 0 and node 3, where the node 9 acts as a forwarder node. The network deployment is shown in Fig. 3.

The packet delivery ratio is the ration of number of packets that are received to the number of packets that are sent. The Average packet delivery Ratio is given in Fig. 4. This clearly shows that the packet delivery of the proposed routing protocol remains the best throughout the evaluation. The loss rate can be defined by the formula:

$$\text{Packet Delivery Ratio} = [100 - (\text{Packet Received})/(\text{Packet Sent}) * 100] \qquad (1)$$

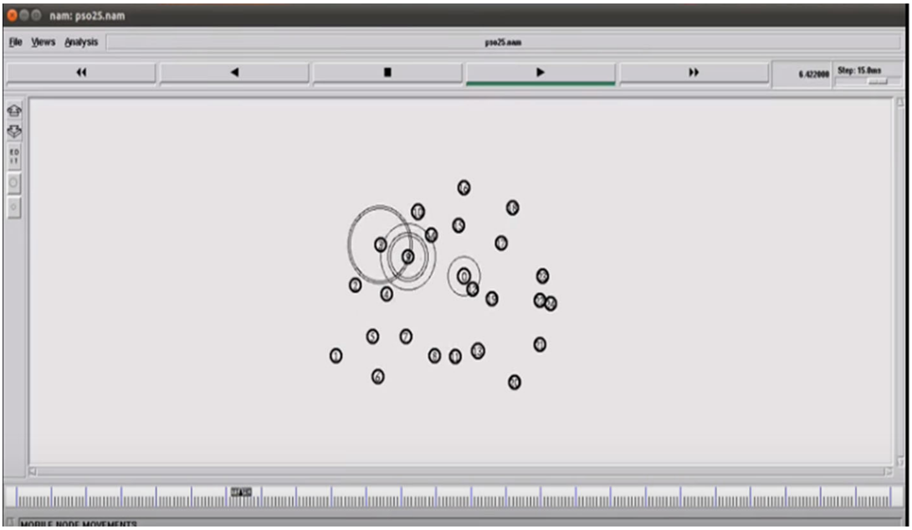

Fig. 3 Network deployment in VANET

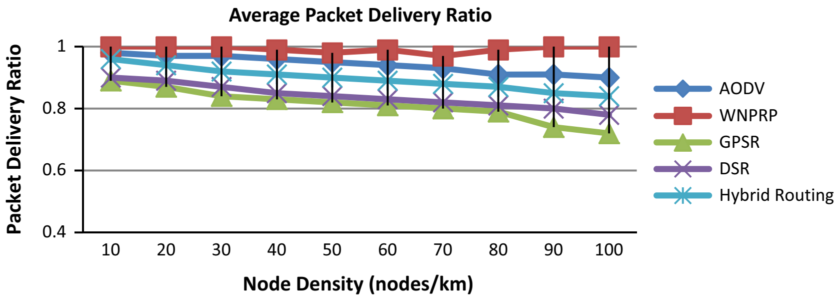

Fig. 4 Average packet delivery ratio

The latency of the packets are said to be the interval between the time taken for simulation to the response time. The Average latency of the packets is shown in Fig. 5. A low latency was maintained in the network during the usage of the proposed WNPRP. AODV shows a less latency when compare to the other techniques. The latency is calculated by the formula

$$\mathrm{Latency} = \mathrm{RTT}/2 \tag{2}$$

The average overhead of the packets is shown in Fig. 6. The overhead of the packet is the time taken for a packet to be transmitted over a packet switched network. The overhead of the packets for the proposed WNPRP is less when compared to the other routing protocols. This proves that the WNPRP is one of the reliable and scalable protocols.

The end to end delay is the average time taken by a data packet in a network to reach in the destination. The Average end to end delay of the packets in the network is shown in

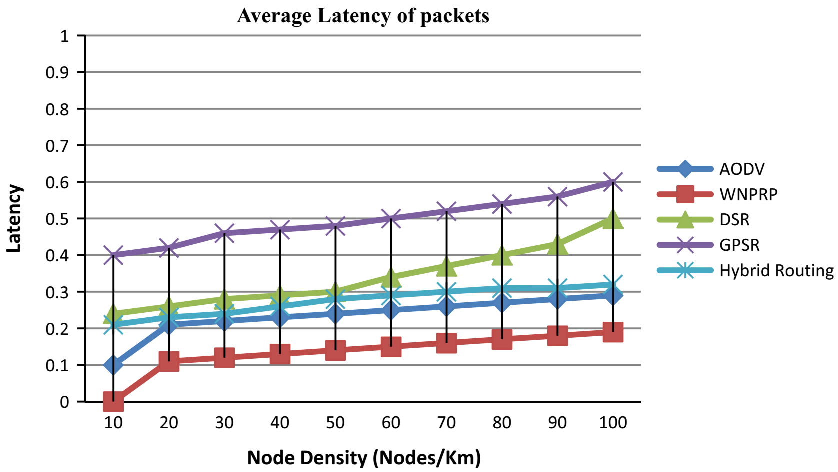

Fig. 5 Average latency of packets

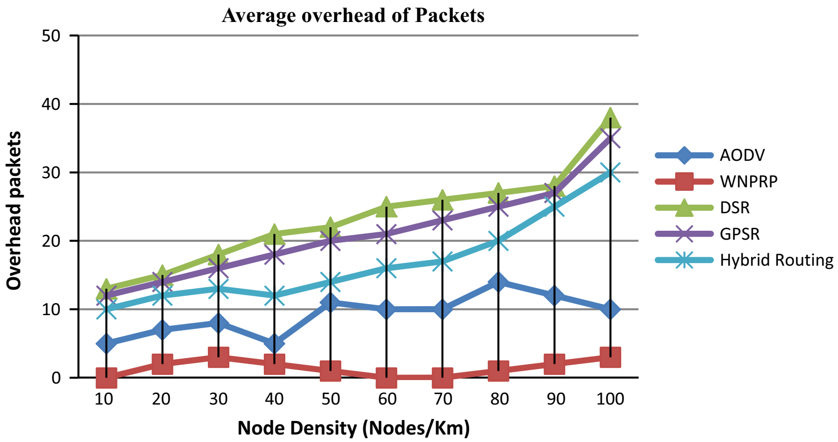

Fig. 6 Average overhead of packet

Fig. 7. It have been found out that the end to end delay is minimum when the proposed WNPRP is used. It varies for other routing protocol. The packet arriving time and the sent time should be monitored in order to maintain a low end to end delay. The End to End Delay can be defined by the formula:

$$\text{End to End Delay } = (\text{Timestamp}_{(\text{pkt\_-rcvd})}) + \left(\text{Timestamp}_{(\text{pkt\_sent})}\right). \tag{3}$$

The network throughput is well defined as the rate of positive message transfer of the packet over a wireless communication channel. The analysis of throughput is shown in Fig. 8. The throughput is high for WNPRP. The throughput varies for all the routing protocol. The main aim of the research is to make sure that the packets are delivered at

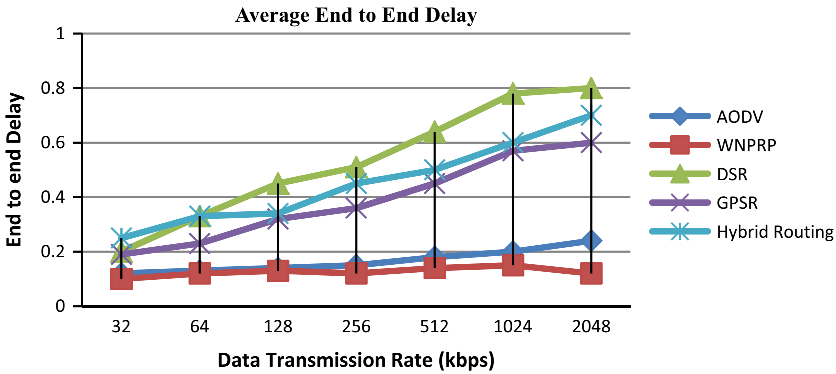

Fig. 7 Average end to end delay

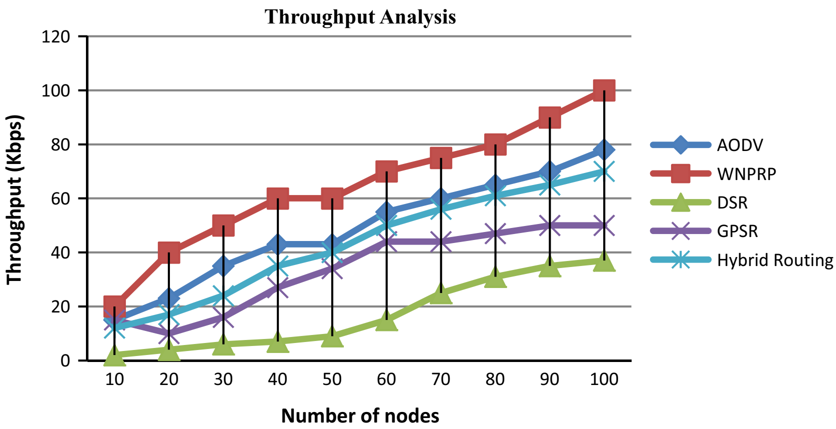

Fig. 8 Throughout analysis

correct time. Hence the proposed routing protocol seems to play a better role when compared to others. The throughput is calculated by the following formulae

$$\text{AvgThroughput} = (\text{Data Size} * \text{No. of times transmitted})/(\text{AverageRTT}). \tag{4}$$

7 Conclusion

A novel routing technique in VANET, WNPRP has been proposed and implemented in this paper. The novel routing protocol focuses on the perfect delivery of the packets to their destination. Also a constant stability and connectivity is maintained between the source and the destination. The safety applications have been much focussed on to reduce the risks that are associated with fatal accidents. The behaviour of the WNPRP is examined in a simulator and has been compared with other routing protocols in VANET. It has been concluded that there is a better packet delivery ratio when compared to others along with less link failures which plays a vital role in upholding a sensible routing control overhead and lowest average end to end delay. The simulator network simulator2 has been used to implement the proposed technique and evaluate the proposed technique.

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