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Survey on Vehicular Ad hoc Routing Protocols

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Abstract: ***Vehicular ad hoc network is a special form of MANET (Mobile ad hoc networks) which is a vehicle to vehicle wireless communication network. It is an autonomous and self-organizing wireless communication network which involves the exchange and sharing of information between two mobile devices. Due to the new technology in ad hoc routing there is a huge attention from government, academy and industry to handle the dynamism of the network intelligently. The primary objectives of VANET routing protocols are to maximize network throughput, energy efficiency, network lifetime and to minimize delay. The issues of routing protocols such as packet overhead, packet delivery ratio and an average delay in multi-hop wireless networks of mobile nodes are examined. This paper considers different methods of optimization of selected algorithms. The performance evaluation for the protocols DSR, AODV, and TORA in terms of the metrics: Throughput, Average power consumed, Constant Bit Rate (CBR), Control Overhead are analysed. The aim is to develop an efficient routing protocol, which finds the minimum possible path length between the source and destination involving minimum nodes to transmit data.***

Keywords: VANET, DSR, DSR-SRR, AODV, TORA

1. INTRODUCTION

Vehicular Ad hoc Network (VANET) is appeared to be a new technology to integrate the susceptibility of vastly employed wireless networks to vehicles [1]. Wireless technologies use a shared communication medium; this causes interference which degrades network performance when multiple nodes attempt to transmit simultaneously [2]. An ad-hoc routing protocol is a convention, or standard, that it improves the scalability of wireless networks compared to infrastructure based wireless networks because of its decentralized nature [3]. Ad-hoc network have the attributes such as wireless connection, continuously changing topology, distributed operation and ease of deployment [4].VANET is a collection of communication vehicles to broadcast desired information [5]. The vehicles in VANETs are termed as nodes and are characterized by high speed. Therefore, the network users cannot rely upon the infrastructure for communication – it could be either too expensive to setup or should be assumed to be not at all existing. An effective and cheaper solution is to involve the various nodes in the network to act as communication means and contribute equally to enhance speed for transfer of packets. The network architecture of VANET can be classified into three categories: Pure cellular/WLAN, Pure ad hoc, and hybrid. There are many research projects around the world which are related with VANET such as COMCAR, DRIVE, Fleet Net and NOW (Network on wheels) and Carnet. The VANET applications are Vehicle collision warning, Security distance warning, Driver assistance, Co-operative driving, Internet access, Map location, Automatic parking and Driverless vehicles.

Inter-vehicular communication provides communication through wireless physical media and eliminates the need of a central network administrator to control the communication channel between the various nodes [12]. Inter-vehicular communication involves the exchange of data between two mobile devices in an ad hoc network [13]. Due to the wide network topology and devices are not stationary, the passage of messages between a source and destination node involves various intermediate nodes that act as links between the two. The more the number of nodes involved in a network at a time, the more is the power consumed by them, thereby adding to the

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average power consumption of the network and the transmission time. Vehicular ad hoc network are characterized by unplanned, spontaneous and generally short duration connections which does not give one the chance of setting up an infrastructure, unlike in the case of infrastructure based system such as cellular network [15]. Each node in the network must be capable of forwarding the data packets to the other nodes. High degrees of dynamism of the network demand the route to the destination to be established as and when required through the process of routing [18]. Every node can then communicate with its immediate peer which is at most a radio range away or with a distant node which may be many hops away. In such a case, the path is made up of a chain of nodes where the intermediate node acts as repeaters. In ad hoc wireless network, two types of routing mechanism are relevant – Proactive routing and reactive routing.

A. Table-driven (proactive) routing: Proactive protocols rely upon maintaining routing tables of known destinations, this reduces the amount of control traffic overhead [2]. In table-driven protocols, a well-defined table containing the information about the accessible nodes is maintained for each and every node in the network. At regular intervals, the node transmits hello packets to the nodes in its vicinity to inform them about its presence. The nodes receiving these beacons update their neighbor tables to keep track of dynamically changing topologies. This protocol is difficult to implement and uses more power, memory and bandwidth. However, it offers good network survivability. Table-driven approach has less connection delay time as compared to on-demand routing. The major advantage of a table-driven protocol is that the route from a source to a destination is always available. Here, the end-to-end delay is less as compared to on-demand routing protocols where route is discovered only when data packet is to be forwarded. Examples of this category of protocols include destination-sequenced distance vector, global state routing and life cycle assessment.

B. On-demand (reactive) routing: Reactive Protocols use a route discovery process to flood the network with route query requests when a packet needs to be routed using source routing [2]. In this category of routing protocols, route is discovered only when required. It does not maintain any table for storing routes, thereby saving memory. The route to the destination node is established as and when required by broadcasting route request (RREQ) packets till the destination node retraces the path back to the originator. This type of protocols suffers from the connection delays, as route from source to destination is not known in advance and is power-inefficient. Every time a route is established, it is saved in the route cache of the node for further use. But these routes are never verified for their validity when used later and also there is no method available to repair any broken links in the route. Dynamic source routing (DSR), ad hoc on-demand distance vector, temporally ordered routing algorithm, location aided routing, relative distance micro discovery ad hoc routing, zone routing protocol, and so on are examples of reactive routing protocols.

2. OBJECTIVE

The idea of the VANET routing protocols are to improve the performance metrics such as throughput, power consumption, total traffic and control of packets.

A. Throughput: It is the number of data packets transferred over a period of time. It is usually measured in bits per second.

B. Average power consumed: It is the amount of power measured over a time interval by the node in sending the control packets as well as in the transmission of data. The amount of power used is assumed to be directly proportional to the size of the packet to be transmitted.

C. Total traffic: It is the constant bit rate (CBR) at which the data is sent.

D. Control packets: It is the total number of control packets sent by a node. Control packets include RREQ, RREP and RERR messages.

3. DESCRIPTION OF EXISTING ON-DEMAND PROTOCOLS:

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A. Dynamic Source Routing Protocol (DSR)

The Dynamic source routing protocol is a source-routed on-demand routing protocol [19]. DSR is an efficient and a simple protocol that enables communication between two mobile nodes. It uses a multi hop approach to transmit data from the source node to the destination. It is superior to the table-driven protocols in the sense that its bandwidth consumption is low. These are designed to restrict the bandwidth consumed by control packets in ad hoc wireless networks by eliminating the periodic table update messages. It is a beacon-less and does not require periodic hello packet transmissions. The two major phases of the protocol are: route discovery and route maintenance [4]. Basic approach is to establish a route by flooding Route Request packets in the network. Destination node responds by sending a Route Reply packet back to the source. Each Route Request carries a sequence number generated by the source node and the path it has traversed. A node checks the sequence number on the packet before forwarding it. The packet is forwarded only if it is not a duplicate Route Request. The sequence number on the packet is used to prevent loop formations and to avoid multiple transmissions, thus, all nodes except the destination forward a Route Request packet during the route construction phase. Advantages are: It uses a reactive approach which eliminates the need to periodically flood the network with table update messages. Route is established only when required. Reduce control overhead. Disadvantages are: The route maintenance mechanism does not locally repair a broken link. Stale route cache information could result in inconsistencies during route construction phase. Connection set up delay is higher. Performance degrades rapidly with increasing mobility. Routing overhead is more & directly proportional to path length.

Drawbacks

- One of the major drawbacks of DSR is that it does not repair a broken link. As a result, the cache gets piled up with stale routes.
- DSR just picks up the route from the cache if available, without checking for its existence that introduces inconsistency in the packet forwarding mechanism increasing the error rate.
- For every message to be transmitted the route discovery procedure is initiated separately, therefore the connection set-up delay is appreciable.
- In highly mobile scenarios the protocol's performance degrades gradually.
- There is no mechanism to remove stale routes from the cache

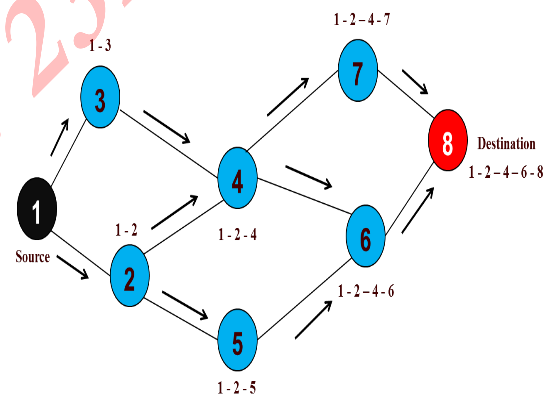

Figure 1 Topology of DSR

B. DSR with stale routes removed

DSR-SRR checks the validity of the routes available in the cache prior to using them in route discovery [11]. Each and every route that gets added to the cache has a timestamp attached to it. Whenever a route is to be retrieved from cache, the current time and the timestamp of the route are compared. Based on this comparison and the relative traffic density, the validity of the route is checked. This time based route expiry enables the network to dispose of with the stale routes in advance, thereby decreasing the probability of packet loss. However, sometimes even the valid routes are marked stale

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because of the expiry of the timestamp. This leads to the initiation of route discovery from the ground level and hence increases the total time taken to discover the route and hence deliver the packet. This mechanism is effective when the traffic is of dynamic nature and hence the routes become stale in relatively shorter time span.

*C. Ad Hoc On-Demand Distance Vector Routing Protocol (AODV)*AODV combines some properties of both DSR and DSDV routing protocols with significant differences [17]. AODV utilizes sequence numbers and routing beacons from DSDV but performs route discovery using on-demand route requests (RREQ); the same process as the DSR protocol [16]. In AODV when a node sends a packet to the destination then data packets only contains destination address. On the other hand in DSR when a node sends a packet to the destination the full routing information is carried by data packets which causes more routing overhead than AODV. The AODV establishes a route when a node requires sending data packets i.e. on-demand [14]. For finding path from source to destination node in AODV algorithm the source node sends a route request packet to its neighbors and this process is repeat till the destination node path is not found. The sequence number of packet is check at every intermediate node to produce a loop free path. If a node finds that number in its routing table, then node discard the route request packet otherwise store record in its table. It has the ability of unicast & multicast routing and uses routing tables for maintaining route information. It doesn't need to maintain routes to nodes that are not communicating.

AODV use only symmetric links between neighboring nodes because the route reply packet follow the reverse path of the route request packet [20]. If one of the intermediate node realize path broken than it send information to its upstream neighbor and this process is execute until source node not get this message and after it again source node transmit the route request packet to neighbors node for finding new path. The AODV has the advantage of establishing on-demand route in between source and destination. Route is established only when it is required by a source node for transmitting data packets. It employs destination sequence numbers to identify the most recent path. Source node and intermediate nodes store the next hop information corresponding to each flow for data packet transmission. It uses DestSeqNum to determine an up-to-date path to the destination. A Route Request carries the source identifier, the destination identifier, the source sequence number, the destination sequence number, the broadcast identifier and the time to live field. DestSeqNum indicates the freshness of the route that is accepted by the source. When an intermediate node receives a Route Request, it either forwards it or prepares a Route Reply if it has a valid route to the destination. The validity of the intermediate node is determined by comparing the sequence numbers. If a Route Request is received multiple times, then duplicate copies are discarded. Every intermediate node enters the previous node address and the BroadcastID. A timer is used to delete this entry in case a Route Reply packet is not received. AODV does not repair a broken path locally. When a link breaks, the end nodes are notified. Source node re-establishes the route to the destination if required. Advantages are: The routes are established on demand and DestSeqNum are used to find latest route to the destination. Connection setup delay is less. Disadvantages are: The intermediate nodes can lead to inconsistent routes if the source sequence number is very old. Multiple Route Reply packets to single Route Request packet can lead to heavy control overhead. Periodic beaconing leads to unnecessary bandwidth consumption.

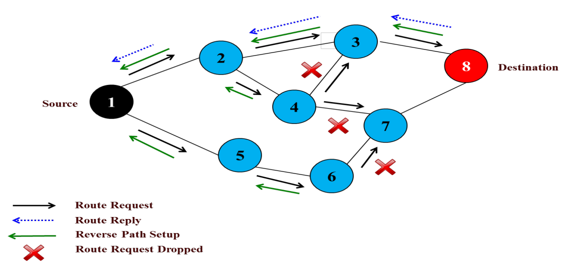

Figure 2 Topology of AODV

D. Temporally Ordered Routing Algorithm (TORA)

TORA is a source-initiated on-demand routing protocol. TORA uses a link reversal algorithm and Provides loop free multi path routes to the destination [8]. Each node maintains its one-loop local topology information and has capability to detect partitions. Unique property is limiting the

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control packets to a small region during the reconfiguration process initiated by a path break. TORA has three main functions: establishing, maintaining and erasing routes. The route establishment function is performed only when a node requires a path to a destination but does not have any directed link. This process establishes a destination-oriented directed acyclic graph using a query/update mechanism. Once the path to the destination is obtained, it is considered to exist as long as the path is available, irrespective of the path length changes due to the re-configurations that may take place during the course of data transfer session. If the node detects a partition, it originated a clear message, which erases the existing path information in that partition related to the destination. Advantages are: Incurred less control overhead, concurrent detection of partitions and Subsequent deletion of routes. Disadvantages are: Temporary oscillations and transient loops, local reconfiguration of paths result in non-optimal routes.

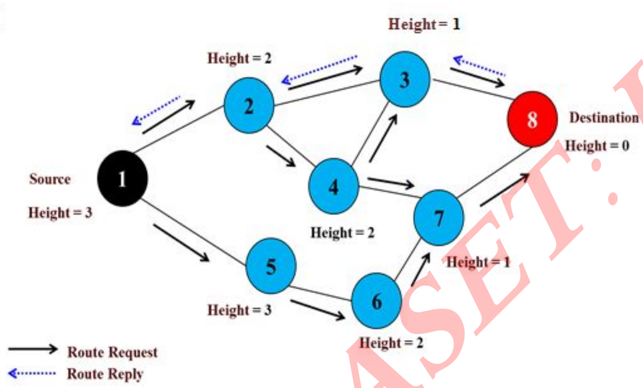

Figure 3 Topology of TORA

4. COMPARISON TABLE

The following comparison table gives the performance evaluation in terms of the metrics; Throughput, Average power consumed, Constant Bit Rate (CBR), Control Overhead for the protocols DSR, AODV, and TORA.

Table 1 Performance parameters

Protocol	Throughput	Power Consumption	CBR	Control Overhead
DSR	Low	High	Low	Low
AODV	High	Low	High	High
TORA	Low	High	Low	Low

5. CONCLUSION

This paper deals with the performance analysis of the reactive protocols DSR, AODV and TORA so that the protocol could be used successfully as a VANET protocol by incorporating power efficiency and better throughput during transmission. DSR and TORA involve circulating lesser number of control packets than AODV, thereby reducing packet overhead. DSR maintains multiple routes to destination and performs well in terms of packet delivery ratio. AODV establishes single route on demand and performs well in terms of average delay. Minimizing the total number of nodes involved during transmission lowers the overall power consumption rate and improves the throughput. The reactive protocols are adaptable for the changes in the network topology and this makes the protocol more suitable for VANET. Therefore reactive protocols perform well in high mobility conditions than proactive protocols.

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