J. Appl. Environ. Biol. Sci., 4(7S)487-494, 2014

ISSN: 2090-4274
Journal of Applied Environmental
and Biological Sciences
www.textroad.com

A Novel Survey on: Mobility Based Routing in Vehicular Ad-Hoc Networks (Vanets)

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Received: September 1, 2014
Accepted: November 13, 2014

ABSTRACT

Vehicular Ad-hoc Network (VANETs) is a derived version of Mobile Ad-hoc Network (MANETs). They are on its own conFigure. d infrastructure-less network. They provide communication facility between vehicle to vehicle (V-V) and vehicle to infrastructure (V-I). Vehicles follow different mobility patterns due to variations in speed. As vehicles have high mobility and dynamic topology; the tendency of change in mobility pattern is always a critical issue for VANETs. Many protocols have been proposed for solving mobility problems in VANETs. The proposed protocols have some merits and demerits on the basis of mobility and quality of service parameters. In a scenario one protocol outperforms than the other but the same protocol is not efficient in the other scenarios. In this paper a qualitative outlook of the protocols commonly used are shown and discussed.
KEYWORDS: Ad-hoc Networks, VANETs, Wireless Networks, Mobility.

1. INTRODUCTION

Vehicular Ad-hoc network is a derived form of MANETs. It may be vehicle to vehicle (V-V) and vehicle to infrastructure (V-I) wireless communication network[4]. It is self-configuring and autonomous wireless network. Currently, there are many research projects [5] around the world which are under the domain of VANETs. Communication in VANETs contains information flow from vehicle to vehicle (V-V) or vehicle to road side fixed access point (V-I). There are various applications [16], [26] such as driver assistance, map location, automatic parking, driverless (autonomous) vehicles etc.

For the wireless access in vehicular environments (WAVE) IEEE 802.11p standard is defined by IEEE 802 committee. 75 MHz of the bandwidth has been assigned to vehicle to vehicle (V-V) for short range communication while 5.9 GHz for vehicle to infrastructure (V-I) communication respectively. Dedicated short range communication (DSRC) is also used by VANETs [9]. DSRC is suitable for 1km range used both by (V-V) and (V-I) [32].

As in Figure. .1,VANETs, have vehicles which tends to move with high speed. Causing the topology to change frequently. The expected mobility in VANETs have some characteristics which make it different from MANETs. Mobility may lead to topology changes, link failure, Quality of service degradation, overhead, and latency [20].

This paper will focus on mobility problem of nodes and provides a qualitative outlook of the unicast routing protocols commonly used in VANETs and also the parameters of those protocols like Quality of service, performance, link failure, overhead, latency [20]etc. The rest of the paper is organized as follows. Section 2 presents routing protocols whereas section 3 defines related work. In section 4 selected routing protocols and there critical study is discussed. Section 5 contains discussion and results and section 6 presents comparison table and finally this paper is concluded in section 7.

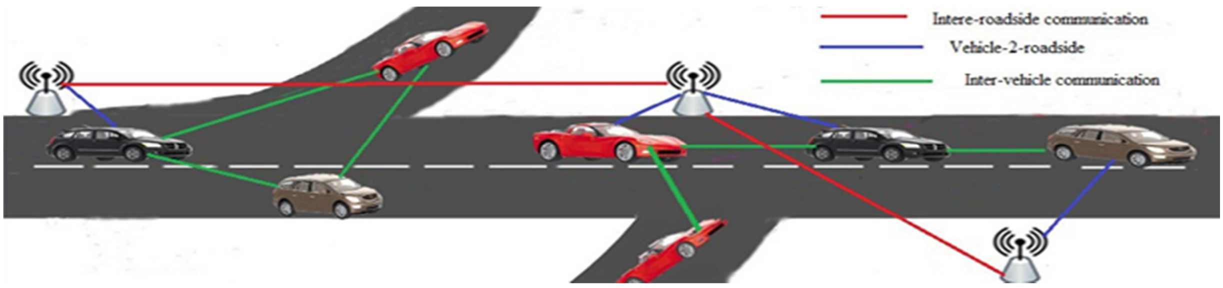

Figure. 1. Mobility/ Topology in VANETs (Speed)

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2. Routing Protocols

This paper gives details on routing protocols used in VANETs and how these protocols work. Different authors' research work will be considered and how they use these protocols to solve the problems related with mobility and there future works.

2.1 Routing protocols Classification

Routing protocols can be categorized into three main groups.

- Proactive(Table-Driven)
- Reactive(On-Demand)
- Hybrid(combination of Proactive & Reactive)

2.1.1Proactive Routing Protocol

Proactive protocols also called as Table-driven routing protocols. In proactive routing every node maintains routing table [6]. The nodes send update messages periodically, in this way all the nodes update their routing tables. Protocols in this group do not have route discovery delay because routes are already maintained. But these protocols consume lot of bandwidth due to periodic update messages [13].

2.1.2Reactive Routing Protocol

Reactive protocols are also known as on-demand routing protocols. In these protocols, nodes having no routing information in case of no data transferring. When a node wants to communicate with another node then these protocols are invoked [6] by sending route request message (RREQ). Protocols in this category have low overhead because links are only maintained during data transfer. But these protocols having high delay because initially nodes does not have routing information[17]. Protocols present in this category are DSR, AODV (may be any cast [1] or unicast or broadcast), and TORA etc.

2.1.3Hybrid Routing Protocol

Hybrid protocols combine the best features of both proactive and reactive routing protocols [17]. Its main purpose is to condense the route discovery delay in reactive scheme and routing overhead in proactive scheme. In this scheme network is divided into zones. Intra zone (inside the zone) use proactive mechanism and inter zone (between zone to zone) use reactive mechanism [21].

Hybrid routing protocol (HRP) includes some protocols like ZRP, HARP and CBDRP.

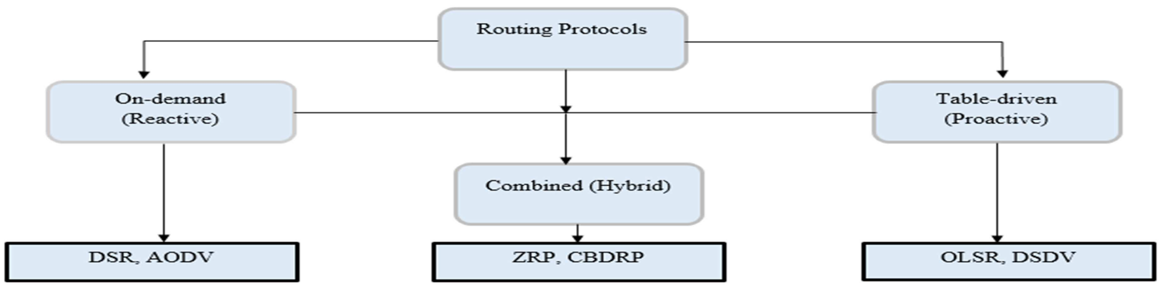

Figure. 2 Classification of Routing protocols

3. Related Work

In recent years, researchers have more focus on VANETs due to their several applications [5, 14, 16]. VANETs provide internet facility, important information and weather condition etc.Due to high mobility of vehicles and quick topology alterations, routing in VANETs is a challenging task. Many protocols proposed [32], [36], [37] in recent years to solve the problems related with mobility.

In research papers [4], [5],[13], [30], [31] the protocols are compared according to some parameters in order to find out an adaptive protocol for VANETs.

In this paper we compared the unicast (some have multicast capability) routing protocols for VANETs by selecting 2 parameters (overhead and latency) related with vehicles mobility.

3.1 Quality of Service Parameters

3.1.1 Latency

In VANETs, the term latency refers to the quantity of time a data packet takes while transferring from one node (vehicle) to another node (vehicle), so latency refers to time interval or delay [15], [29]. The network latency is low if it having small interval/delay times and high if large delay/interval times.

3.1.2Throughput
The amount of data packets transferred from one node (vehicle) to another node (vehicle) successfully in a unit time [7]. The greater the throughput will give result in faster data delivery.

3.1.3 Overhead
The overhead [26] in the VANETs refers to the amount of extra resource utilization like bandwidth, battery life etc. Network performance is degraded when the overhead is greater and vice versa.

3.1.4 Link failure
Link failure is the failure or break down of the connected link through which the data is sent. Link failure is due to mobility, node fails, fault etc. [10]. For the detection of link failure nodes send small messages.

3.1.5 Jitter
Jitter refers to the variations between the times of incoming packets [27]. Jittering is caused by network overhead and transmission link changes.

3.2Mobility Models
Mobility models determine the movement pattern of nodes (vehicles), and also describe how the acceleration, velocity and the position of nodes (vehicles) change with respect to time [23]. These models estimate the future position of nodes and they are used for the simulation of protocols. To conclude the performance of protocol mobility patterns plays a key role. Various mobility models are proposed for wireless ad-hoc networks like Random way point model [28], Random walk model, Manhattan mobility model. The selection of specific model affects the results of simulated protocol [11]. That's why it is important to select a suitable model.

4. Selected Routing Protocols

4.1 Optimized Link State Routing Protocol (OLSR)
The OLSR routing protocol is designed for ad-hoc wireless networks [24]. This protocol is table driven (proactive) and optimized form of link state protocol for ad-hoc networks. Every node (vehicle) in this protocol maintains routing table which contains routes information to all others nodes (vehicles). For routes information this protocol periodically exchange update messages. Proactive nature of this protocol provides immediate route whenever the route is needed. This protocol uses reduced control packet size and also reduces flooding of control packets by using selected nodes only. In reaction to link failure this protocol does not produce any extra control traffic. This protocol does not depend upon any central node and works in distributed fashion.

4.2 Destination Sequenced Distance Vector Routing Protocol (DSDV)
DSDV is a table driven routing protocol for ad-hoc networks that works the distance vector approach [38]. Each node (vehicle) transmits update messages to its neighbors periodically in order to maintain routes. DSDV update message contains three things

a) Destination address
b) Hop Count
c) Sequence Number.

Every entry in the routing table must contain sequence number generated by destination node. Sequence number may be even or odd, even sequence number means link is present. When the link has been broken odd sequence number is assigned. The protocol uses shortest path to implement only one route with less number of hopes to the destination and also this protocol provides loop free routes. The distribution of route information could be sent in 2-ways.

a. Incremental updates (transmitted more frequently when small changes occur).
b. Full dumps updates (the whole routing table is sent infrequently to its neighbors when no movement is occurs).

New sequence numbers are generated when the topology of the network is changed. Periodic update messages are consuming small bandwidth when there is no data transmission.

4.3 Dynamic Source Routing Protocol (DSR)
DSR is an On-Demand (Reactive) routing protocol designed to eliminate the bandwidth consumption in table driven approach by control packet [35]. In DSR the source specifies the whole optimum path to the destination in the packet header, that's why it's called source routing protocol that refers to route discovery. Each node contains a route cache in which routes are stored. No route discovery is performed if route is already in routing table. If a route

cache has many paths to the destination then choose optimum path according to some criteria that refers to route maintenance. Path is invalidated and error message is sent to the source when link failure occur.

4.4 Ad-hoc On-demand Distance Vector Routing Protocol (AODV)

It is an on-demand (Reactive) source initiated routing protocol, source sends RREQ (Route Request) message to its neighbors. By receiving the route RREQ message the destination sends RREP (Route Reply) to the source [22].

This protocol is designed to overcome routing overhead because node having information about next hop [12], unlike DSR in which the source specifies the whole path to the destination. AODV use sequence number to offer loop free paths, also it recognizes the latest path on the basis of that sequence number. This protocol have larger delay as compare to table driven protocols.

Intermediate nodes having information only about its neighbor which can lead to inconsistent path (Hidden terminal problem). In case of node failure on active route RERR (Route Error) is generated by its neighbor. When link is failed new route RREQ is initiated which leads to extra delays and causing overhead.

4.5 Zone Routing Protocol (ZRP)

In this protocol [25], the overall network is partitioned into intersecting zones. ZRP is a hybrid routing protocol which combines the best functionalities of table-driven and on-demand routing protocols. This protocol use reactive mechanism for inter-zone (zone to zone) communication when destination node and source node are not in the same zone, while for intra-zone (same zone) use proactive mechanism when both destination & source nodes are in the same zone. The benefit of this protocol is to reduce overhead among different zones by using reactive approach and proactive approach used to reduce delay with in the same zone. The maintenance of routing information is easier in intra-zone because the number of nodes are limited.

4.6 Cluster Based Directional Routing Protocol (CBDRP)

CBDRP is a hybrid routing protocol designed for ad-hoc networks [36]. In this protocol nodes (vehicles) are divided into clusters having same traveling direction. In every cluster there is a cluster head which is responsible for exchanging of routing information. Cluster heads of different clusters communicate with each other. In CBDRP source node forwards its message to the header of its own cluster. If destination is in the same cluster then the cluster head forward message directly to the destination, if destination is not in the same cluster then the header forwards the message to the cluster head having the destination node, then cluster head deliver message to the destination node. In CBDRP links are maintained when there is one cluster head in in-between clusters. Unlike other protocols overhead is less because the cluster head are responsible for exchanging of routing information. And overhead depends on the number of clusters not on individual nodes.

5. Discussion and Results

In this section, performance evaluation of selected routing protocols: OLSR, DSDV, DSR, AODV, ZRP and CBRP for CBR (UDP) traffic connection is achieved using two basic parameters of performance i.e., throughput and delay while speed is varying [3],[8], [18]. We analyze these protocols in two different scenarios where number nodes are different.

5.1 Scenario A

In scenario A, the selected protocols are analyzed for nodes in the range of 1 to 10 where packet size is 512 bytes and rate of transmission is 5 Packet/Sec. Variation in speed occurs and is changed from 0 m/s to 30 m/s. Results are collected from [3],[18],[19], [34].

5.1.1 Throughput

In Figure. .3, comparison of nodes in terms of throughput is shown. It is observed that ZRP gives lower throughput as compared to other protocols. In all selected protocols, in scenario A, DSDV and AODV throughput in the given speed variation is comparatively high.

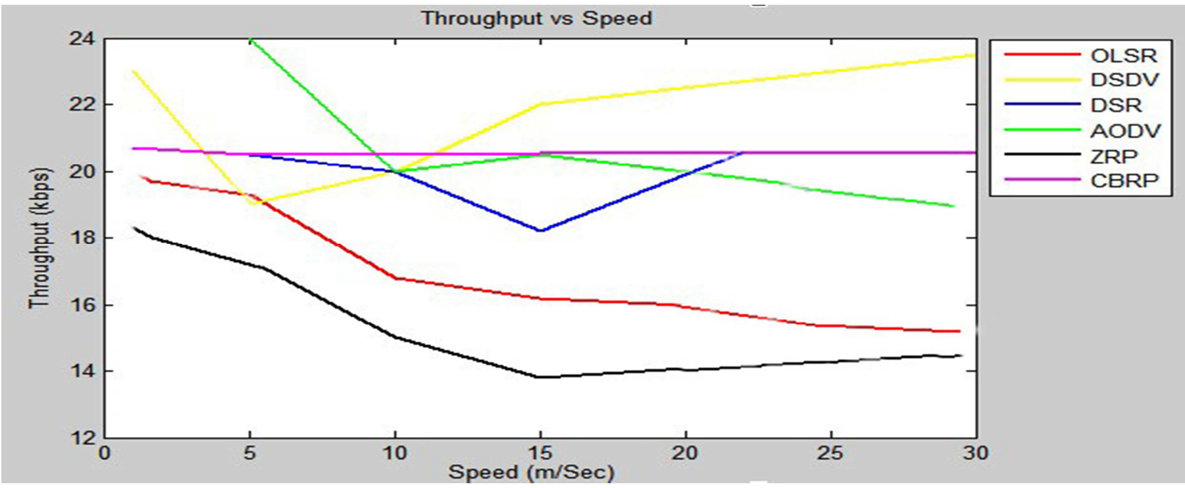

Figure. 3

5.1.2Delay

In Figure. .4,comparison of nodes in terms of latency is shown. It is noted that the DSR protocol has fluctuating delay. In all selected protocols, in scenario A, ZRP delay in the given speed variation is comparatively low,while the delay of CBRP is comparatively high.

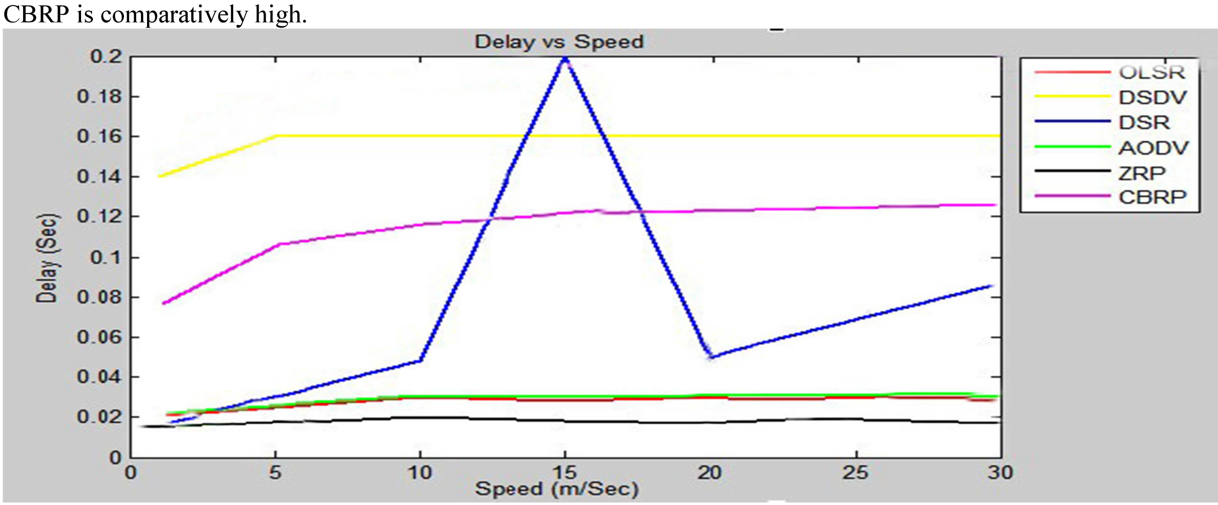

Figure. 4

5.2 Scenario B

In scenario B, selected protocols analyzed for nodes in the range of 40 to 50 where transmission rate is 1Mb/s and packet size is 512 bytes. Speed is changing from 0 m/Sec to 60 m/Sec. Results are collected from [2], [8], [18], [33], [34] as shown in Figure. 5 and Figure. 6.

5.2.1 Throughput

In Figure. .5, comparison of nodes in terms of throughput is shown. It is pointed out that the throughput of AODV is higher as compared to other selected protocols. In all selected protocols, in Scenario B, DSDV throughput in the given speed variation is comparatively low.

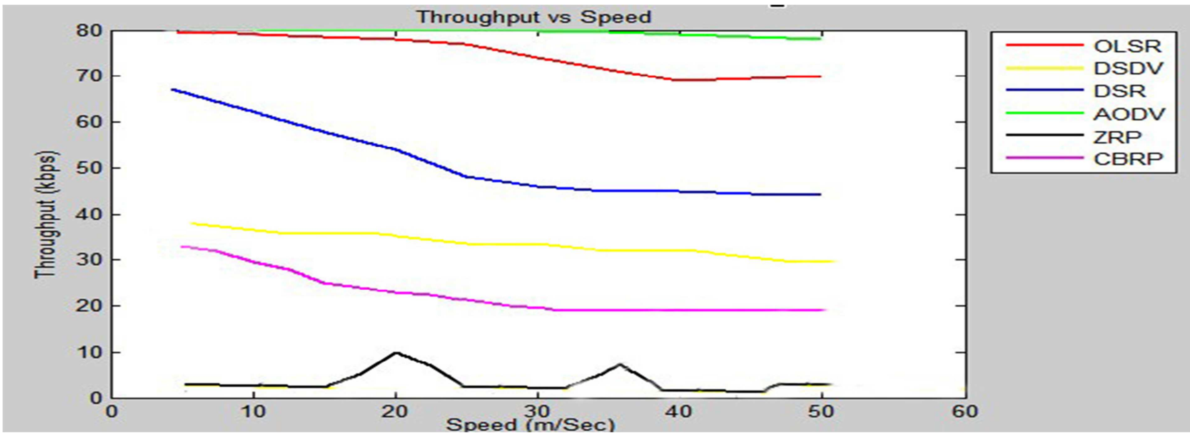

Figure. 5

5.2.2 Delay

In Figure. .6, comparison of nodes in terms of delay is shown. It is observed that the Delay of DSR is higher than other protocols, while the delay of AODV is lower than DSR. In all selected protocols, in scenario B, ZRP delay in the given speed variation is comparatively low.

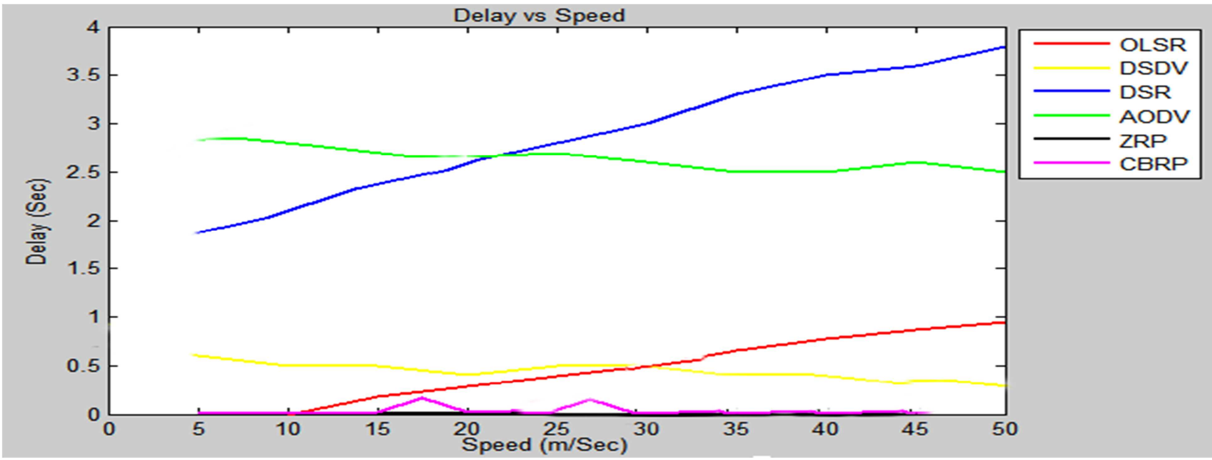

Figure. 6

6. COMPARISON OF SELECTED ROUTING PROTOCOL

Table 1. Comparison of different R. Protocols

Protocols / Parameters	OLSR	DSDV	DSR	AODV	ZRP	CBDRP
Delay	Low	Average	High	Average	Low	Average
Throughput	Average	Average	High	High	Low	Average

7. CONCLUSIONS

In VANETs routing is an essential parameter. This paper has presented a survey of existing routing protocols and their critical study. We have selected certain parameters associated with mobility and compared routing protocols such as OLSR, DSDV, DSR, AODV, ZRP and CBDRP according to those parameters.

In scenario A, one protocol outperforms than the other but the same protocol is not efficient in the other scenarios. Also one QoS parameter have good value for one routing protocol and other QoSparameter have good value for the other protocol. That's why one protocol is not fit to meet all traffic scenarios. Therefore protocol should be designed according to the environment. This research paper will be helpful for the researchers and students interested in the field of VANETs. Also, it will facilitate them in having brief and concise information provided.

Future work may include implementation of all protocols in particular scenario in term of environment irrespective of number of nodes. Analyze protocol performance, for other QoS parameters like link failure, jitter.

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