Comparative Analysis of MTP and DSDV Routing Protocols in VANET

Tsvetan Marinov[1], Maria Nenova[2] and Georgi Iliev[3]

Abstract –**Nowadays we are witnessing the rapid development of telecommunication technologies. The transmission speed is constantly increasing and the routing protocols are improved. Intelligent Transport Systems are also part of this development. Vehicular ad-hoc network - VANET belongs to them. It is expected to solve serious problems such as road accidents, congestions and harmful air emissions. This report presents a comparative analysis between two protocols - Message Transmission Protocol - MTP and Destination-Sequenced Distance-Vector Routing - DSDV.**

Keywords –**ITS, VANET, routing protocols, MTP, DSDV**

I. Introduction

The number of cars around the world is increasing every day. Road accidents are constantly occurring. Congestions are a common part of everyday life. The air is getting polluted. As a result, many people get sick. All these problems require the development of VANET. It is subclass of MANET (mobile ad hoc network) network. Originally MANET was developed for military purposes. The basic idea is that moving devices can communicate with each other. The main purpose of VANET is the same but here the communication will be between cars. If vehicles can exchange information among themselves, mentioned problems will be solved.

VANET differs from all known networks. This difference is determined by the movement of vehicles. As a result, the network has a dynamic topology. Architecture is varied and depends on the geographical area. Figure 1 shows the architecture of VANET. In general, the architecture may include all communication equipment.

The communication is divided into four types:

The first type is In-vehicle communication. Here each controller or computer in a vehicle can communicate with each other following the driver and vehicle behavior.

The second is Vehicle to Vehicle communications (V2V). The main idea is that cars can exchange information with each other. This is a new technology that is developed for VANET. In this area, a lot of research has been done to make the links between cars as reliable as possible.

The third communications is Vehicle to road infrastructure (V2I). In these types of communications vehicles can communicate with road infrastructure as traffic lights, base stations and so on.

The last type of communications is Vehicle-to-broadband cloud (V2B). This allows wireless communication of automobiles over broadband connections such as 3G/4G. The broadband cloud has a great resource and may include more traffic information. It is also possible to use it for entertainment. This way the trip will be more pleasant.

Next section describes MTP and DSDV protocols. These protocols are selected because of their presence in the NS2-35 simulator (The MTP protocol is a modified version of Ad-hoc On-Demand Distance Vector (AODV). NS2-35 is open source code and allows modifying different types of protocols. This makes it suitable for the research.

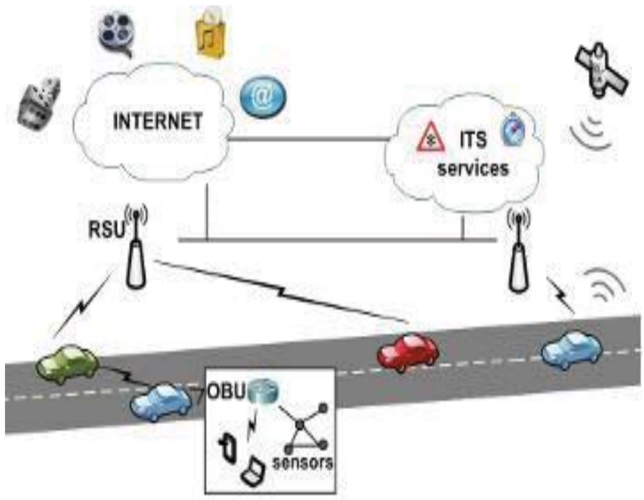


Fig. 1. Architecture of VANET

II. Description of MTP and DSDV routing protocols

A. Description of Message Transmission Protocol - MTP

This section describes shortly Message Transmission Protocol. Detailed description is provided in [1]. The proposed MTP restricts unreliable connections in VANET formed because of the high mobility of the network. During the route detection phase, cars send routing packets. When neighboring car accepts these packages, the speed of the vehicle is determined in order to form a reliable route of the package. If the vehicle moves too quickly, the neighbor refuses to give it the message. The new algorithm of the protocol helps to eliminate high speed vehicles, thus reducing unreliable links and saving bandwidth [1].

[1]Tsvetan Marinov is with the Faculty of Telecommunications at Technical University of Sofia, 8 Kl. Ohridski Blvd, Sofia 1000, Bulgaria, E-mail: ts_marinov@abv.bg

[2]Maria Nenova is with the Faculty of Telecommunications at Technical University of Sofia, 8 Kl. Ohridski Blvd, Sofia 1000, Bulgaria, E-mail: mariamnenova@gmail.com

[2]Georgi Iliev is with the Faculty of Telecommunications at Technical University of Sofia, 8 Kl. Ohridski Blvd, Sofia 1000, Bulgaria, E-mail: gli@tu-sofia.bg

Decision making under this protocol depends on the duration of the link connection. In this research, the duration of the link is measured quantitatively from the time when two cars are connected without interruption. This amount is called LT (link time). The link time (LT) between two automobiles can be defined as a predicted time for connection between nodes [2]. In other words, this is the predicted time when two nodes have an active connection without interruption. LT is calculated using the GPS system of the nodes [3]. LT is defined by the following formula:

$$LT = \frac{-(ab+cd)+\sqrt{(a^2+c^2)r^2-(ad-bc)^2}}{a^2+c^2} \quad (1)$$

Parameter "a" is the relative speed of the receiving vehicle with respect to the sending vehicle by axis X.

Parameter "b" is used to determine the distance between the receiving vehicle from the sender along the X axis.

Parameter "c" is the speed of the receiving vehicle with respect to the sending vehicle by axis Y.

Parameter "d" is the distance between the receiving vehicle and the sender.

The MTP protocol is a modified version of Ad-hoc On-Demand Distance Vector (AODV). The algorithm is added to the MAC layer in NS-2.35 (Network Simulator) and calculates LT. Pseudo-code of the algorithm is given in [1].

A. Description of Destination-Sequenced Distance Vector routing-DSDV

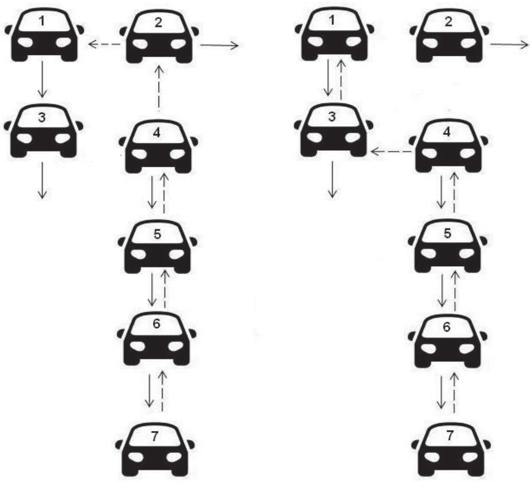
Destination-Sequenced Distance-Vector Routing - DSDV is a table-driven routing scheme for ad-hoc mobile networks based on the Bellman–Ford algorithm. It was developed by C. Perkins and P. Bhagwat in 1994 [3]. It is one of the basic protocols in mobile networks. The routing algorithm of the DSDV solves the routing loop problem. Routing information is recorded in a table. The table is arranged according to the sequence number of the data received. The number is generated by the destination node, and the transmitter needs to send out the next update with this number. Routing information is distributed between cars by sending full dumps infrequently and smaller incremental updates more frequently.

Upon receiving a new message, the cars use the most recent route number. A major advantage of the DSDV is the rapid creation of a route. The protocol is not suitable for dense networks. If the network has a large number of cars, the messages will be delayed due to the update of the routing table. Nowadays DSDV is not one of the most used protocols. In this study, the protocol was chosen for comparison because of its presence in the NS-2.35 simulator.

III. SIMULATIONS RESEARCH OF THE PROTOCOLS

A. The Scenario

Figure 2a shows link formation under the DSDV protocol. Figure 2b shows link formation under MTP. Car seven will send a data and car one should receive it. Dashed lines show the active link and the direction of motion of the vehicles. The selected speed is 20m/s. The speed is carefully selected to ensure the reliability of the connection. Car 7 should send a message to car 1. DSDV forms a road through cars 7-6-5-4-2-1. If cars are moving in the same direction, the message will get to car 1 without any problems. But car 2 will change its direction of movement. As a result, the connection will be interrupted. The DSDV will try to restore the link but without result. After a certain time, a link will be formed through 7-6-5-4-3-1. As a consequence of all this will get a delay in the delivery of the message. It is also possible to lose packets. High traffic will be generated and collisions may occur.



a. b.

Fig. 2. a. Link formation under the DSDV protocol b. Link formation under the MTP protocol

MTP offers a solution to this problem. If the link time - LT is calculated and compared with the time it takes for the message to be delivered, it will be known whether it is possible to reach the final destination. MTP calculates the LT of the scenarios given in the study and establishes that a reliable connection through vehicle 2 will not exist. As a result, a route is formed through cars 7-6-5-4-3-1.

For the research done in this work NS-2.35 is used. A TCL file has been created for the execution of the given scenario. Initially, the file is compiled under the DSDV protocol and then recompiled under MTP. The simulator then creates two protocols analysis files. The channel parameters are given in Figure 3. The IEEE 802.11p standard is used. The scenario under consideration has a simple network topology because cars are few in number.

The network size is 700mX700m. The vehicles are selected to be seven in number. The Traffic Model is generated with CBR (constant bit rate). CBR is a feature set in the NS-2.35 simulator. In this research, the sending vehicle must transmit 512 bytes per second. The average data transmission rate is 256 kbps. The transport protocol used is TCP (Transmission Control Protocol). The cars have initial coordinates - car 0 (300, 700), car 1 (400, 700), car 2 (300, 600), car 3 (400, 600) car 4 (400, 500), car 5 (400, 400), car 6 (400, 300). They are set to move continuously.

Gt_	1
Gr_	1
L_	1.0
freq_	2.472e9
bandwidth_	11Mb
Pt_	0.031622777
CPThresh_	10.0
CSThresh_	5.011872e-12
RXThresh_	5.82587e-09
dataRate_	11Mb
basicRate_	1Mb

Fig. 3. The channel parameters

Where:
L - System Loss Factor
Freq – Channel frequency
Bandwidth – Channel bandwidth
Pt – Transmission power
CPThresh - Collision Threshold
CSThresh- Carrier Sense Power
RXThresh- Receive Power Threshold

B. Research parameters

The parameters tested for the two protocols are Packet Delivery Ratio, Normalized MAC Load and End-to-End Delay. After analyzing the results, we can see that the new protocol is doing well. This is achieved by the fact that there is no disconnection.

The Packet Delivery Ratio represents the ratio of the data packets delivered to the destination to those generated by the CBR sources. The PDR is calculates by following formula:

$$PDR = \frac{\text{Data packet delivered to all sources}}{\text{Data packet send by all sources}} \quad (2)$$

Figure 4 shows the Packet Delivery Ratio. The figure shows that MTP performs well with the DSDV for the given scenario.

The Normalized MAC Load is defined as the fraction of all control packets (routing control packets, Clear-To-Send (CTS), Request-To-Send (RTS), Address Resolution Protocol (ARP) requests and replies, and MAC ACKs) over the total number of successfully received data packets. This is the metric for evaluating the effective utilization of the wireless medium for data traffic. The NML is calculates by following formula:

$$NML = \frac{\text{Number of routing packets sent}}{\text{Number of data packets delivered}} \quad (3)$$

Figure 5 shows Normalized MAC load. MPT has a greater NML than DSDV. The main reason for the better performance of MTP is that the original route will be through 7-6-5-4-3-1 cars. There will be an interruption in the DSDV because the initial road is through 7-6-5-4-2-1.

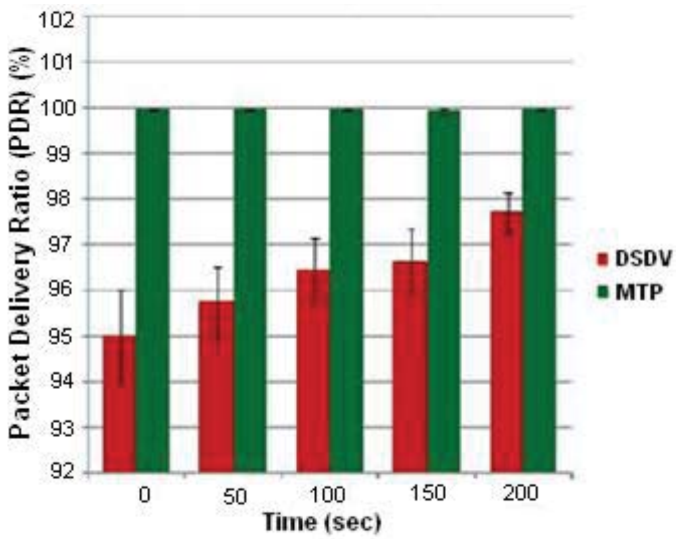


Fig.4 Packet delivery Ratio

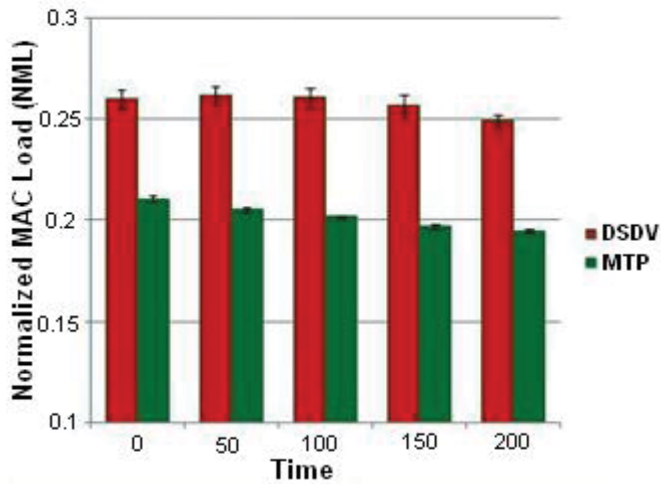


Fig. 5 Normalized MAC Load

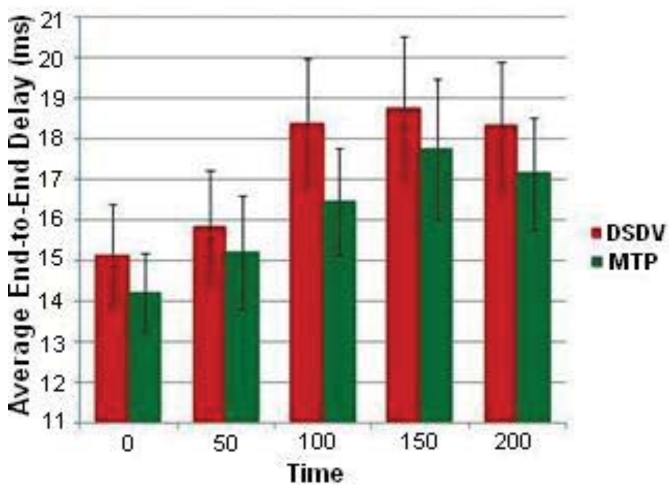


Fig. 6 End-to-End Delay

The average End-to-End Delay of data packets includes all possible delays caused by buffering during routing discovery, queuing at the interface queue, retransmission at MAC layer, propagation, and transfer time. The End-to-End Delay is calculates by following formula:

$$\text{Delay} = \frac{\Sigma(\text{Packet received time} - \text{packet sent time})}{\Sigma(\text{packets received by destinations})} \quad (4)$$

Figure 6 shows End-to-End Delay. MTP performs better than DSDV. The figure shows that the delay is different in time. This is because every car is delaying the network.

IV. Conclusion

In this paper Message Transmission Protocol and Description of Destination-Sequenced Distance Vector routing protocol are described and compared. Most protocols have a problem with the formation of a proper route due to the high mobility of vehicles. As a result, the links are in a continuous process of connecting and disconnecting. MTP algorithm reduces unreliable links in VANET. The protocols are compared using the following three parameters - Packet Delivery Ratio, Normalized MAC Load and End-to-End Delay. The study shows that the MTP performs better than the DSDV.

In the scenario under consideration the cars are seven in number. These are a few vehicles. The topology of the network is simple. As a future work, the protocol should be tested with more vehicles. It is possible for a large number of vehicles and a densely populated network to get a long delay from the LT calculation. An attempt will also be made to improve some of the protocol parameters in selecting next hops during route discovery phase.

References

[1] Tsvetan Marinov, Maria Nenova and Georgi Iliev “Message Transmission Protocol in VANET” Proc. X National Conference with International Participation Conference "Electronica 2019", May 16 - 17, 2019, Sofia, Bulgaria.

[2] R. Oliveira, M. Luis, L. Bernardo, R. Dinis, R. Pinto, P. Pinto. "Impact of Node‟s mobility on Link-Detection Based on Routing Hello Messages." WirelessCommunications and Networking Conference (WCNC10). 2010.

[3] C. E. Perkins and P. Bhagwat, “Highly dynamic Destination-Sequenced Distance-Vector routing (DSDV) for mobile computers,” ACM SIGCOMM Computer Communication Review, vol. 24, no. 4, pp. 234–244, Oct. 1994.

[4] M. Zhang and R. S. Wol_. Routing Protocols for Vehicular Ad Hoc Networks in Rural Areas. IEEE Communication Magazine, 46(11):126{131, 2008.

[5] Tsvetan Marinov, Maria Nenova and Georgi Iliev “Comparative analysis of broadcasting protocols in VANET” Proc. IX National Conference with International Participation Conference "Electronica 2018", May 17 - 18, 2018, Sofia, Bulgaria.

[6] H. Moustafa and Y. Zhang. Vehicular networks: techniques, standards, and applications. CRC Press, 2009.

[7] S. Youse_, M. S. Mousavi, and M. Fathy. Vehicular Ad Hoc Networks (VANETs): challenges and Perspectives. In proceedings of 6th Interma-tional Coference on ITS Telecommunications, pp. 761-766, 2006.

[8] W. Chen, R. K. Guha, T. J. Kwon, J. Lee, and I. Y. Hsu. A survey and challenges in routing and data dissemination in vehicular ad hoc networks. In Proceedings of the 2008 IEEE International Conference on Vehicular Electronics and Safety, pp. 328-333, 2008.

[9] M. M. Al-Doori, F. Siewe, and A. H. Al-Bayatti. VSHDRP: Vehicle second heading directional routing protocol in VANET. In proceeding of 4th IEEE International Conference on Computer Science and Information Technology (ICCSIT2011), Chengdu, China, 2011.

[10] D. A. Maltz, J. Broch, J. Jetcheva, and D. B. Johnson. The effects of on-demand behavior in routing protocols for multi-hop wireless ad hoc networks. IEEE Journal on Selected Areas in Communications, 17:1439-1453, 1999.

[11] A. Festag, A. Hessler, R. Baldessari, L. Le, W. Zhang, and D. Westhoff. Vehicle-to-Vehicle and road-side sensor communications for enhanced road safety, 2009.