Samarra Journal of Pure and Applied Science

www.sjpas.com

p ISSN: 2663-7405
e ISSN: 2789-6838

AODV, DSDV, and DSR Protocols of Routing: A Comparative Study in VANETs Using Network Simulator-2

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https://doi.org/10.54153/sjpas.2024.v6i1.662

Article Information

Received: 08/08/2023
Revised: 05/10/2023
Accepted: 09/10/2023
Published: 30/03/2024

Keywords:

MANETs, VANETs, Routing protocols, Simulation, NS-2 simulator.

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Abstract

Mobile Ad-Hoc Networks (MANETs) are a group or a collection of wireless moving nodes (mobile-nodes) that spontaneously forms a network and functions with-out a central controller or coordinator. Mobile Ad Hoc Networks include the subset known as Vehicle Ad Hoc Networks (VANETs). The unpredictability of the multi-hop network design is further compounded by the fact that in MANET and VANET, nodes move around at their whim. Many well-known routing methods have been proposed to facilitate data flow between the different nodes of a wireless network. The NS-2 simulation in this research paper compares the performance of the protocols (reactive and proactive) of AODV, DSR, and DSDV across a variety of metrics, including "throughput, control overhead, packet delivery ratio, and average end-to-end latency". Simulations showed that different routing protocols may optimize the (VANET) connectivity and throughout. Moreover, the evaluations also illustrates the impact of sizes for the network and routing protocols on "packet loss, packet delivery ratio, average end-to-end delay and overhead transmission".

Introduction

The fields of mobile systems, local area networks (WLANs), and widespread (ever-present) computing have all seen particularly rapid expansion in recent years, largely thanks to the proliferation of mobile communication. The flexibility afforded to end users, the accessibility of information from anywhere, the ease of deployment, and the user-friendliness of mobile communication are the primary reasons for its meteoric rise. Spontaneous ad-hoc networks are made up of mobile terminals that are positioned near together and communicate with one another, exchanging supports, resources, or time of computing for a short amount of time and in a kind of small area. Users shouldn't notice any changes made to the network. Such networks have simple access for both new and seasoned users, as well as centralized management that is completely separate from the network itself. Establishing and sustaining the ad hoc network using routing protocols is an active area of study in MANET. To implement and develop a good and capable protocol of routing for VANETs, a rigorous search of popular existing VANETs routing protocols is always necessary [1].

Despite the abundance of available routing protocols, this study compares only three of them: AODV, DSR, and DSDV in terms of performance. The simulation results obtained using the NS-2 simulator are presented, together with an analysis of the various routing protocols with respect to key metrics including "control overhead, throughput, packet delivery ratio, and average end-to-end time". In particular, DSDV, AODV, and DSR, three well-known routing protocols, are briefly discussed along with their classification and functionality. The later part provides a summary of routing protocols. We then compare the three aforementioned routing protocols using simulation data and examine their relative performance. Changing the number of nodes and their speeds in the simulation is covered in the subsequent section, along with two examples. In the last section, in order to determine which protocol is best, we assess the overall performance of AODV, DSR, and DSDV based on "throughput, control overhead, packet delivery ratio, and average end-to-end latency"[2].

The main contribution of this paper includes the following: A study on the routing protocols in VANETs. Analysis of the impact of routing protocol on throughput of VANETs network. Finally, a number of simulations had been designed and performed to evaluate the overall performance parameters such as delay and overhead transmission of VANETs using different network sizes and routing protocols. Simulation results showed that AODV is a practical option for use in VANETs and PLATOONs.

Routing

The primary responsibility of the network layer is the routing of data packets or the process by which information is transmitted from its origin to its final destination. The routing algorithm is the primary factor in determining how this path is created. Routing is a critical problem in both stationary and mobile networks, and many protocols are available to address this challenge [3].

Virtual autonomous network environments (VANETs) are a subset of ad hoc networks. VANET is distinct from MANET due to its more mobile nature and its dynamic topology. Standard ad hoc routing protocols are initially examined in mobile ad hoc networks (MANETs) before being implemented in a vehicular ad hoc network (VANET). The means by which different parts and objects of a network communicate the information they need in a reasonable amount of time is called a routing protocol, and it is closely monitored.

The general order in which we can classify VANET routing protocols as protocols for directing network traffic depending on location (geographic).

This is a topology-based routing protocol.

- A routing mechanism based on broadcast messages.
- A cluster routing protocol that relies on a distributed hash table.
- A technique for routing data packets based on their location in space.

Routing protocols in mobile ad-hoc networks

Classifications of the protocols

Below (in Figure 1), we classify MANET routing protocols according to how they deal with the packets as they are being sent from the source to the destination. Reactive protocols, proactive protocols, and hybrid protocols are the three main categories of routing protocols based on their respective purposes [4].

Proactive Protocols

Table-driven routing protocols are these include in the requisite route data is stored in a table. Packets are sent over-through the network according to a specific path they take in the routing table. Due to the need to identify all routes before sending data and control packets, this approach results in faster packet forwarding at the expense of increased routing overhead. Since all routes are kept in sync at all times, table-driven protocols experience less downtime. Protocols like DSDV and OLSR are good examples (Optimized Link State Routing).

Reactive Protocols

When just a small fraction of all possible routes is in use at any given moment, this network only keeps up with the routes that are really being used. When routes aren't predefined, these protocols are sometimes referred to as "On Demand Routing Protocols." When a transmission is required, the source-node initiates the route-discovery process to find a new path. The flooding method underpins this route discovery approach by having a node only broadcast the packet to all of its close neighbors of it, with intermediate nodes merely forwarding the packet to neighboring nodes. The method involves repeating the same steps until the desired result is achieved. On-demand methods increase latency but reduce routing overheads.

Example Protocols: AODV, DSR (Fig.1).

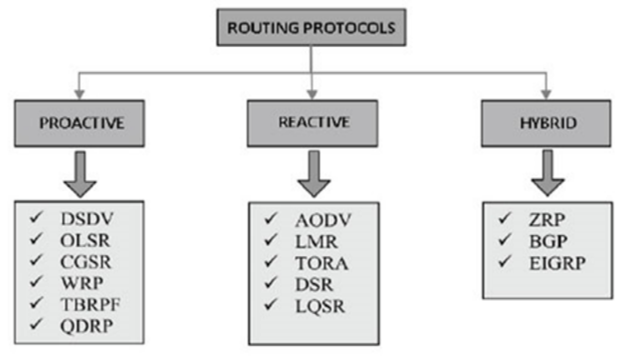

Fig. 1: *Routing protocols in MANETs [5]*

Hybrid Protocols

Rapid route discovery in the routing domain is made possible by hybrid protocols, which combine some advantages of reactive and proactive methods. For instance, consider the ZRP protocol (Zone Routing Protocol.).

An Overview of the Routing Protocols

In the following part, a brief review of the routing operations executed by the DSDV, AODV and DSR protocols is been discussed [4].

(DSDV) protocol: "Destination Sequenced Distance Vector"

DSDV is a Bellman-ford algorithm-based table-driven routing strategy for mobile ad hoc networks. By employing sequence numbers, the Bellman-Ford method was enhanced so that routing table loops were eliminated. Every node functions as a router, maintaining a routing table and periodically exchanging routing updates, even if the routes are superfluous. Each possible path to the destination is given a unique sequence number to avoid routing loops. Routing updates are always being communicated between nodes, even when the network is not actively being used. Therefore, extremely dynamic networks are not ideal for this.

Each mobile node has its recent sequence number and the following information for each new route will be [2]:

-The IP address of the destination,

-The number of intermediate nodes,

-The sequence number of the information received on the destination as initially designated by the destination are all stored in the memory of each mobile node, together with the updated sequence number.

(AODV) protocol: "Ad-hoc On-Demand Distance Vector Routing"

An On-Demand routing system that combines DSDV and DSR, AODV is a hybrid of these two approaches. Like with DSR, the route is determined dynamically in response to user input. In contrast to the DSR's practice of keeping numerous entries for each target in its route cache, AODV only keeps track of a single entry per destination in its routing table. While AODV can fix broken links and provide loop-free routes, DSDV doesn't need periodic global routing advertising.

AODV defines control messages for use during route discovery and upkeep. The following are some of the definitions of the various control messages.

-RREQ When one node needs to contact another; it sends out a route request message (RREQ) to its neighbors. These intermediary nodes will continue to relay the message until it reaches its final destination. Data such as the RREQ id, destination IP address, destination sequence number, originating IP address, and originating sequence number are all contained within a single RREQ packet.

-RREP If the intermediate node determines that the source is a valid destination or if it has a route to the destination, then it will unicast route the reply (RREP) message back to the source. The hop-count, destination-sequence-number, destination IP-address, and source IP-address are all included in RREP packets [1].

When a link failure occurs, the AODV system (Fig. 2) sends out a route error message (RERR) to invalidate the route. Information such as the Unreachable Destination IP Address and the Unreachable Destination Sequence Number can be found in an RERR.

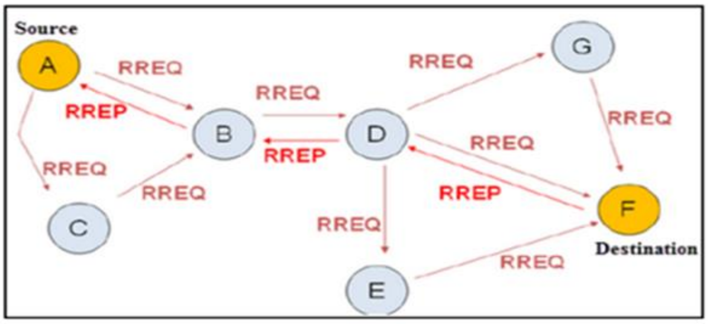

Fig. 2: *Structure of AODV Protocol [6]*

(DSR) protocol: "Dynamic Source Routing"

Pure On-Demand routing protocols, like Dynamic Source Routing, only compute the route when it's actually needed. Multi-hop ad hoc networks with mobile nodes are its intended environment. DSR enables autonomous networks to self-configure and self-organize without the need for human network administrators. Unlike AODV, it does not send periodic routing messages, which saves on both battery life and network resources while transferring large amounts of data. Source routing, in which the entire route is carried as an overhead, requires only the work of the MAC layer to detect connection failures. In DSR, the entire route is sent along with the message as an overhead, but in AODV, the routing table is kept so that only the portion of the route that has changed needs to be sent [2, 3].

Protocols (DSDV, DSR, AODV) Challenges

The DSDV protocol is a mobile network routing protocol based on exchanging routing tables, events, and a schedule to keep the route up and running. As a result of using this protocol, integration will be completed more quickly, but at a higher cost for now. The aforementioned protocol works well in settings with modest levels of human movement. Path variations and false alarms are two examples of DSDV flaws that lead to unnecessary bandwidth use. Another is the difficulty in determining the optimal value for parameters like the maximum waiting time for a particular, very complicated destination. Periodic updates used by both the DSDV routing protocol and its active upgrades which lead to un-necessary data transfer and higher communication costs. In order to update its routing table entries for each destination, a DSDV node must first wait for the next route update driven by the destination. Unfortunately, DSDV is not a multi-path routing and multicasting technology. Bandwidth waste is a greater problem for the DSDV protocol as well. The Data-Sensitive Routing (DSR) protocol was developed for short-lived, dynamic wireless networks with many path-ways. The DSR protocol, in contrast to other short-term network protocols, does not need the transmission of periodic routing messages. Therefore, it does not depend on the intermediary node's routing information. The fundamental flaw of the protocol is that it is un-fit for a big network with high mobility since present routing costs are dependent on route length and damaged connections in the network do not need local repair in the path maintenance process. [1, 3].

When a mobile node wants to deliver some data packets, it will build a route using the AODV protocol, which combines certain features of the DSDV and DSR protocols. The routing tables used by this protocol do not include information about the nodes in the network that are not actively exchanging data with one another. In comparison to the other two procedures(Table 1), AODV is the safest. Delays in route formation, along with a lack of support for the identification and maintenance of several multi-paths between each source and destination pair, are among the most significant issues with this protocol.

Table 1: *Comparison of protocols (DSDV, DSR, and AODV)*

Protocol's Name	Package Delivery Rate Criterion	Average Delay	Overhead	Security	Scalability	Operation Capacity
DSDV	High	Average	Depending on the amount of data traffic	Average	Average	Average
DSR	Average	Low	Low	Depending on the size of the network	Average	High
AODV	High	High	Average	High	High	Average

Simulations and Analysis

In the world of ad hoc networking, Network Simulator 2 is a popular tool. Whether you're looking to compare how well your current network protocols perform to something new, or you just want to see how well they line up against the competition, this open-source program will do the job [7]. Many IP network configurations have been simulated using the ns2 simulator. Four below parameter metrics were used to compare the various routing systems.

Packet delivery Ratio:

The Packet Delivery Ratio (PDR) measures how well packets are delivered from a traffic source to its destination. It is a metric for the accuracy and efficiency of ad hoc routing protocols that evaluates the loss rate from the perspective of transport protocols. Every network would benefit from having a high percentage of packets successfully delivered [2].

PDR =Total no. of packets received /Total no. of transmit packets ………………..(1)

Average End-to-End delay:

The time it takes for a packet to move from one end of a network to the other is known as the End-to-End delay. In this context, latency refers to the amount of time in seconds it takes for a packet to travel from its originator's point of origin all the way to the application layer at its intended recipient's endpoint. As a result, it takes into account not only the time it takes for data to travel across the network, but also the time it takes for other processes, such as MAC control exchanges and other routing activities [2].

Average EED =Average time for delivered packet / Total no. of packet delivered ……….…(2)

Throughput:

The definition of throughput is the quantity of data sent by a sender to a receiver divided by the period pf time the takes for that receiver to receive the final packet [2].

Link Through-put (Mbps)=Total transmitted Bytes / Time for Simulation (μ-sec) ………..……..(3)

Control overhead:

The time taken for sending data via a wireless packet-switched network is the overhead. Assembly and disassembly of packets, in addition to the additional bytes required for format information provided in a packet header, slow down the speed of transmission for raw data [2].

Control H =Total no. for overhead messages / Total data packet transmit……………………..(4)

Major assumption

Using the (setdest) command in the ns-2 tool, the RWM (Random Waypoint Mobility) layout generates a new mobility scene every time of it is run. In order to do comparisons of the effects of the various tweaks, we utilize the identical mobility scenario for all of them. Both scenarios for evaluating wireless routing protocol performance using the random way point model may be considered simultaneously. Lastly, by setting the number of nodes to: (30,40 and 50) and then also by changing the speed to: (5ms,10ms and 20ms) for the nodes then after to compute the parameter values such as throughput, control overhead, average end to end latency and packet delivery ratio [8].

Simulation

Before beginning the simulation, we may prepare three sample TCL scripts for our batch files to utilize in simulating situations by using of Mobility scene which is provided through the use of "setdest" toolset. It employs "4" (four-Batch files) involved in this process: one by running simulations based on the (test scenarios' varying speed and number of nodes; another to copy the test scenarios into the template (TCL script); another is to run the (awk script) and a final batch file to archive the network animator window, trace, and mobility scenarios in a particular folder. The values for the on parameters from simulations are as shown below in table 2. The collection (same) of mobility use cases is used for changing the speed of individual nodes, the number of nodes, and the routing protocol [9].

Case (1) "By changing the number of nodes": The parameters, including control overhead, normalized routing overhead, latency, packet delivery ratio, throughput, and jitter, may be measured by varying the number of nodes (Table 2) while keeping the speed of the node constant.

Table 2: Parameters for simulation

Topology-area	500x500 .m	Maxim-speed	20ms
Pauze-time	10s	UDP-traffic	3 conn

Case (2) "By changing the speed of the nodes": Parameters like packet delivery ratio, control overhead, normalized routing overhead, latency, throughput and the jitter may be evaluated in this scenario by changing the speed of individual nodes (5ms, 10ms and 20ms) while keeping the total number of nodes (40-nodes) fixed (Table 3).

Table 3: Parameters for simulation

Topology-area	500x500 m	Number of nodes	40
Pauze-time	10s	UDP-traffic	3 conn

Results from the Simulations

The simulations are run first while changing the total number of nodes by holding the node speed constant (20ms), and then changing the node speed while keeping the total number of nodes fixed (40-nodes). Each change was accomplished by using a different routing protocol (AODV, DSR, and DSDV, in that order). So to isolate the effect, we also experimented with increasing the number of mobile nodes in each comparison starting from 30 to 40 to 50.

All scenarios were compared using the following performance metrics: "Packet Delivery Ratio, Control Overhead, End-to-End Latency, and Throughput" as in the below tables [4], [5].

Table 4: Simulation parameter-values by changing the number of nodes

Parameter measured	30 Nodes			40 Nodes			50 Nodes		
	AODV	*DSR*	*DSDV*	*AODV*	*DSR*	*DSDV*	*AODV*	*DSR*	*DSDV*
No. of packets send	557	560	578	573	572	555	568	558	562
No. of packets received	549	557	351	567	571	390	565	558	497
Packet delivery ratio	98.56	99.46	60.72	98.95	99.82	70.27	99.47	100	88.43
Control Overhead	399	88	444	285	107	585	253	46	780
Normalizing routing Overhead	0.7263	0.1579	1.2649	0.5026	0.1873	1.502	0.4477	0.0082	1.5694
Delay	0.03299	0.01291	0.01044	0.01011	0.01204	0.00762	0.00929	0.0090	0.0074
Throughput	23984	23425	15377	24766	24034	17057	24691	23479	21741
Jitter	0.1742	0.1748	0.2465	0.01718	0.1705	0.2256	0.1726	0.1747	0.1961
No. of packets dropped	8	3	227	6	1	165	3	0	65

Table 5: Simulation parameter-values by changing the speed for mobile nodes

Parameter measured	30 Nodes			40 Nodes			50 Nodes		
	AODV	*DSR*	*DSDV*	*AODV*	*DSR*	*DSDV*	*AODV*	*DSR*	*DSDV*
No. of packets send	579	567	558	570	554	561	557	561	559
No. of packets received	576	568	494	566	553	347	550	556	367
Packet delivery ratio	99.481	100.176	88.530	99.298	99.811	61.851	98.742	99.10	65.651
Control Overhead	242	50	590	324	61	607	525	92	624
Normalizing routing Overhead	0.42013	0.08803	1.19433	0.57243	0.1103	1.7492	0.9545	0.1634	1.7003
Delay	0.01163	0.01003	0.00886	0.01432	0.0142	0.00968	0.01969	0.0103	0.00651
Throughput	25170.1	23903.7	21607	24728	23247	15172	24067	23376	16038
Jitter	0.16933	0.17164	0.19737	0.17232	0.1764	0.28131	0.17710	0.1755	0.2657
No. of packets dropped	3	-1	64	4	1	214	7	5	192

Packet Delivery Ratio based comparison (Fig. 3 & Fig.4)

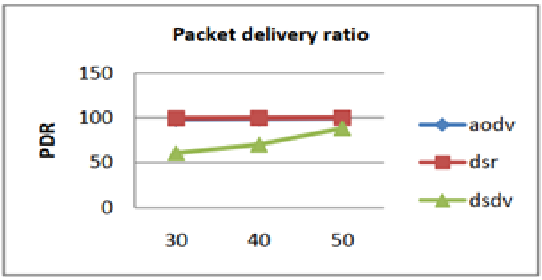

Fig.3. By changing the number of nodes

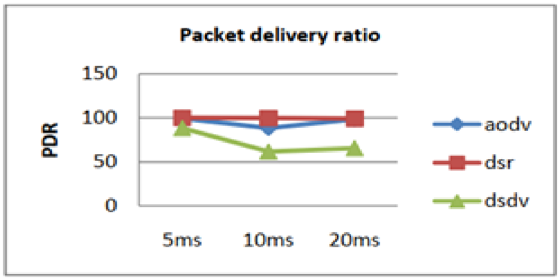

Fig.4. By changing the speed for the nodes

Control overhead based comparison (Fig. 5 & Fig.6)

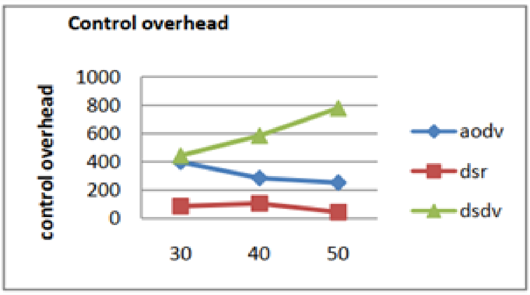

Fig.5. By changing the number of nodes

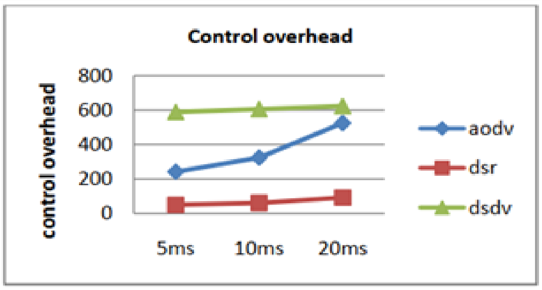

Fig.6. By changing the speed for the nodes

The findings showed that changing the node count and node speed both affect the control overhead. It is evident from Fig.5 and 6 that DSDV has a substantial control overhead due to its frequent changes of the network's routing tables. AODV protocol has a little less control overhead than DSDV and DSR routing protocols [12, 13].

Throughput based comparison (Fig. 7 & Fig.8)

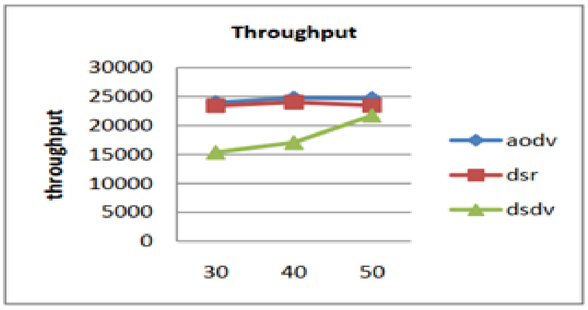

Fig.7. By changing the number of the nodes

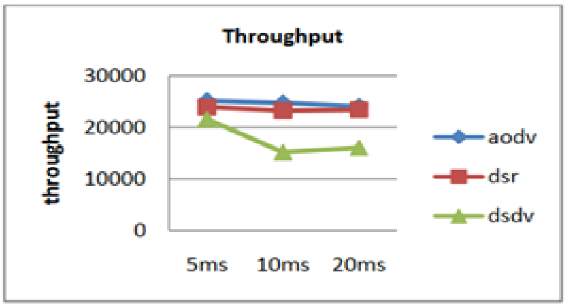

Fig.8. By changing the speed for the nodes

In Fig. 7, we saw what would happen if we changed the number of nodes from 30 to 40 to 50. AODV has better throughput than DSR and DSDV when measured at the destination node throughout the course of the full path. As AODV prioritizes avoiding loops and using up-to-date routes, it generates much more routing packets than DSR. When compared to two other routing protocols during a high-mobility simulation timeframe, its throughput is superior [6]. The AODV routing protocol has been shown to be capable of obtaining simulation results and predicted throughput. The throughput of DSR is somewhat lower than that of AODV, but it is still the best of the three routing protocols. As can be seen in Figures 7 and 8, the DSDV has a lower throughput than other routing methods [2, 14].

End to End delay based comparison (Fig. 9 & Fig.10)

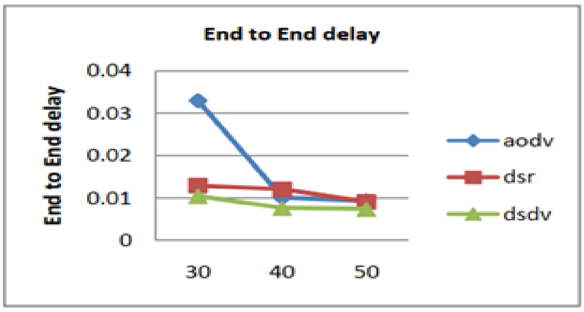

Fig.9. By changing the number of nodes

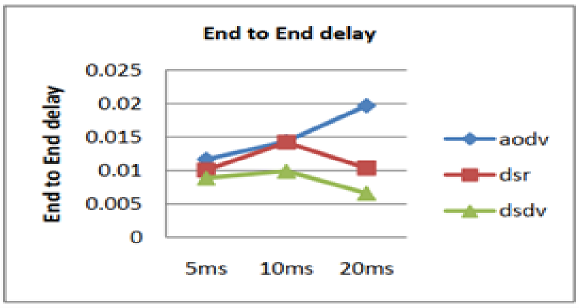

Fig.10. By changing the speed for the nodes

The above simulation demonstrates that AODV has the longest end-to-end delay, followed by the DSR and DSDV, which achieves the most consistent and lowest End-to-End Delay in the mobility. The end-to-end latency in AODV may be decreased by increasing the density of nodes in a given region, while it can be increased by increasing the node's speed. We see a little shorter delay with DSR and DSDV compared to AODV [6, 15-17].

While almost all the researches of this area are about routing protocols and security, connectivity is also an important part of this field for the future studies [18]. Algorithms can be used to design and implement a selection of a protocol based on previously chosen criteria. The process of selecting an algorithm involves providing a portfolio of algorithms to select from based on the performance of the protocol and the evaluation [19].

Conclusions

Our simulations show how effective the AODV, DSR, and DSDV routing protocols are. In this paper, we examine how different routing systems fare in a high-mobility setting, accounting for factors like network density. On a set (500*500) meter topography, we experiment with densities ranging from: "30 (low-density) to: 50 (high-density)" nodes. Moreover, the research generates node mobility using the Random Waypoint Mobility Model. Performance is shown to be highly dependent on the number of nodes and the pace of their movement. When the ability to stay connected via regular data exchanges is factored in, AODV has the greatest performance. Throughput-wise, DSR &AODV both are more effective than DSDV even in highly-dispersed networks with many nodes. Our simulation results suggest that AODV thrives in networks with many nodes, whereas DSR excels in networks with few.

DSDV has the lowest average end-to-end delay regardless of the number of nodes in use. As a result, we conclude that AODV is a practical option for use in VANETs and PLATOONs. In this study, we thoroughly examine all facets of these three routing methods. The next step for us is to examine AODV's security flaws.

Acknowledgment

The Department of Computer Science, College of Computer Science & Information Technology, University of Anbar, Anbar, Iraq, is acknowledged for the support of the work.

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p ISSN: 2663-7405
e ISSN: 2789-6838

بروتوكولات التوجيه: AODV, DSDV and DSR
دراسة مقارنة في شبكات المركبات (الفانيت) باستخدام محاكي الشبكات (أن أس-2)

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معلومات البحث:

تأريخ الاستلام: 2023/08/08
تاريخ التعديل: 2023/10/05
تأريخ القبـول: 2023/10/09
تاريخ الـنشر: 2024/03/30

الكلمات المفتاحية:

شبكات المحمول المخصصة، شبكات المركبات المخصصة، بروتوكولات التوجيه، المحاكاة، محاكي الشبكات-2.

معلومات المؤلف

الايميل:
الموبايل:

الخلاصة:

شبكات المحمول اللاسلكية المخصصة (MANETs) هي مجموعة من العقد المتحركة اللاسلكية (العقد المتنقلة) التي تشكل تلقائيًا شبكة وتعمل بدون وحدة تحكم ثابتة أو منسق مركزي. تشمل الشبكات المخصصة للأجهزة المحمولة المجموعة الفرعية المعروفة باسم شبكات مخصصة للمركبات (VANETs). تتفاقم مشكلة عدم القدرة على التنبؤ بتصميم الشبكة متعددة القفزات بسبب حقيقة أن العقد في MANET وVANET تتحرك من مكانها حسب رغبتها. تم اقتراح العديد من طرق التوجيه المعروفة لتسهيل تدفق البيانات بين العقد المختلفة للشبكة اللاسلكية. تقارن المحاكاة باستخدام الـ NS-2 في ورقة البحث هذه أداء البروتوكولات (التفاعلية والاستباقية) لـ: AODV وDSR وDSDV عبر مجموعة متنوعة من المقاييس، بما في ذلك "الإنتاجية والتحكم الزائد ونسبة تسليم الحزمة ومتوسط النهاية إلى- وقت الاستجابة ". وكذلك أظهرت الدراسة أن بروتوكولات التوجيه المختلفة قد تعمل على تحسين اتصال (VANET) طوال الوقت. علاوة على ذلك، توضح التقييمات أيضًا تأثير حجم الشبكة وبروتوكولات التوجيه على "فقدان الحزمة، ونسبة التسليم ومتوسط التأخير من طرف إلى طرف، والنقل العلوي.