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Performance Analysis of Non-Realistic Routing Protocol using Random Waypoint Model in MANET

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***Abstract*— A mobile ad hoc network (MANET) is a collection of wireless nodes connected via wireless networks and has no set structure. MANETs feature a self-organized routing topology in which mobile nodes are free to move, making it difficult and crucial to construct a stable and reliable network. Thus, failure of the route is also regarded as a prime factor affecting the efficiency of any MANET routing protocol. The breaking of the connection between two routes or more nodes will cause the failure of the route specifically in the non-realistic routing protocol. In a network of mobile nodes, the link break is mainly based on the mobility of individual nodes. Therefore, the objective of this research is to investigate the performance of proactive DSDV and reactive AODV routing protocol using the Random Waypoint(RWP) mobility model in MANET. NS-2 network simulator is used to simulate the MANET environment and BonnMotion is to create a movement of mobile nodes that integrate with the routing protocol. The network performance metrics used are throughput, packet delivery ratio, and average end-to-end delay. In addition, three simulation scenarios have been conducted to compare AODV and DSDV routing protocols with varying numbers of nodes, a comparison of AODV and DSDV routing protocols with varying pause time, and a comparison of AODV and DSDV routing protocols with varying mobility speed. The result from the three scenarios analysed and concluded that the RWP mobility model with AODV gives a better performance of throughput with 869.69 kbps and Packet Delivery Ratio (PDR) with 83.00% meanwhile, RWP with DSDV is better for the average end-to-end delay(EED) with 212.970 bps.**

***Index Terms*—AODV, DSDV, MANET, Routing Protocol**

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I. Introduction

Mobile Ad Hoc Network (MANET) is a wireless ad-hoc network connection that connects devices for communication purposes. It consists of a combination of mobile nodes connected to a wireless network without a fixed infrastructure and self-configured. Nodes in MANET function as sources, destinations or routers in a network and communicate with each other using the defined routing protocol. In wireless networks, two types of routing protocols are commonly used, namely proactive routing protocol and reactive routing protocol [1].

Reactive or on-demand routing protocols, such as Ad hoc On-Demand Distance Vector Routing(AODV), only maintain routes where there is a demand in the network. AODV maintains a routing table that includes the following hop needed to get there. After some time, a path will time out if no packets are sent down it. Retransferring the data frames could take longer because it only contains data about its nearby nodes. In contrast, every node in the Destination-Sequenced Distance Vector Routing (DSDV) routing table will keep a table of all the other nodes it has come into contact with, either directly or via some neighbours. The routing table only has a single entry for each node. The record will provide the node's IP address, the latest known sequence number, and the number of hops required to get there. Along with these details, the table also records the timestamp of the most recent update received for the target node and the next hop neighbour needed to reach there.

Each protocol has benefits and drawbacks depending on where the routing is utilized. A route failure has a chance of happening in both routing systems since most wireless networks, more notably MANET routes, have many hops. On a multi-hop path, if one node is beyond either of two nearby nodes, the entire route will fail, and the nodes will cease to be able to communicate. Route failure is thus seen as another critical issue that impacts the effectiveness of all MANET routing methods. The route will fail if the connection between two route nodes is severed. It is also possible to assert that the overhead of the route is precisely proportional to the connection failure. Author [2] claim that the routing failure caused by individual node mobility and extensive research into the effects of routing protocols on wireless networks that lead to network performance degradation is the main cause of link breaks. However, based on the literature, there are limited studies conducted using the performance of the mobility model simulated over a network layer specifically focused on the non-realistic routing protocol [3]. This information is important due to the nodes in MANET are mobile and dynamic. Table 1 presented the comparison of AODV and DSDV routing protocol that implemented in MANET.

TABLE 1
SUMMARY OF AODV AND DSDV ROUTING PROTOCOL

AODV	DSDV
Proactive Routing Protocol	Reactive Routing Protocol
Attempt to maintain consistent, up to date routing information from each node to every node in the network	A route is built only required
It performs as dynamic source routing but requires transmission overhead of many packets	It delivers virtually all packets at low mobility
It performs better for few number of nodes	It performs better for larger number of nodes
It is not preferred	For real time traffic, AODV is preferred

The goal of the research is to evaluate the non-realistic mobility model's performance using the AODV and DSDV routing protocols to deal with failure connection difficulties in MANET. In this research, reactive routing protocols AODV and proactive routing protocols DSDV are selected for comparison. To simulate real-world circumstances at the network layer, the Random Waypoint (RWP) mobility model's performance is also set up and examined with a chosen speed. Additionally, the Network Simulator 2 (NS-2) is recommended as a simulation tool and is nearly like a testbed. Statistical configuration will include three different performance statistic types: throughput, average end-to-end delay, and packet delivery ratio.

II. RELATED WORK

Proactive protocols i.e., AODV and reactive protocols i.e., DSDV are developed to maintain the network topology information within routing by broadcasting periodic routing updates through the network layer. Each node in DSDV maintains its routing tables consistently and is up-to-date holding routing information about every node in the network. Consequently, the research discovered that each node in the network finds or maintains a path connecting source and destination based on demand. It is demonstrated that when compared to the reactive routing protocol, DSDV exceeded the AODV protocol in terms of average end-to-end delay and routing overhead. Therefore, author [6] simulated the performance of reactive routing protocol (DSDV) concerning various random and group mobility models. Two simulation scenarios were conducted over four mobility models, specifically the Random Waypoint (RWP), Random Direction (RD), Nomadic Community (NC), and the Reference Point Group Model (RPGM) consider a low as well as high random range mobility of the nodes. The performance of the DSDV protocol over different mobility models is evaluated based on latency, routing overhead, and packet loss ratio metrics. As a result, a network's DSDV performance degrades as node mobility increases from low to high degrees. For various mobility types, the performance deterioration differs. The DSDV protocol performs well under nomadic and RWP at both low and high node mobility, according to the analysis of the result. However, [7] studied the MANET network and its protocols, focusing on the reactive routing protocol (AODV). The work contains a comparison of the AODV and AODV-ETX protocols. The simulation results show that the proposed protocol has better efficiency compared to the AODV protocol, but with a larger number of nodes over 20, these properties approach the AODV protocol. As conclusion, DSDV routing protocol performs better performance in term of node mobility with different model of node movement.

Author [8] measures the performance of several routing protocols like AODV, Dynamic Source Routing (DSR), and DSDV predicated on throughput, delay, packet delivery ratio (PDR), and packet loss ratio (PLR). The authors analyzed an experiment that shows DSR and AODV have much better performance with regards to throughput, packet delivery ratio, the packet loss ratio for network load scenarios. The scenarios were tested without any mobility model or using static node. The result showed that DSDV performed better throughput, packet delivery ratio, and packet loss ratio related to the network size scenario. In addition, a similar experiment conducted by [9] and presented the result of several routing protocols (AODV, Dynamic MANET On-demand (DYMO), DSR, and Location-Aided Routing (LAR)) for ad-hoc networks. Authors have measured unicast throughput obtained (bps), average end-to-end delay, average jitter, energy consumed in transmit mode and energy consumed in receive mode as QoS performance metrics. The result presented that the DSR and DSDV routing protocol is certainly not suited to certain network sizes and mobility speeds when considering performance metrics compared to proactive routing protocol like AODV, DYMO, and LAR. Additionally, all network sizes and mobility rates, including AODV and DYMO, show stable performance.

The research focused more on speed and node density on the performance of AODV and, DSDV routing protocols, which were evaluated under RPGM (Random Propagation Group Model) Model [4]. Two varying results showed that first the performance of routing protocols at a density from low to high, network performance vary differently based on the network condition. As being observed, due to an increase in mobile nodes, it leads to an increase in PDR which makes communication more effective compared to nodes in small scale networks. Secondly, aside from large-scale networks, the experiment showed that speed has an associated cost where results showed that AODV has better performance, in terms of both large-scale networks and faster speed. Considering DSDV which was a protocol that fits end-to-end delay, which seems to have less performance.

Table 2 displays the study of the performance metrics and issues discovered from literature.

TABLE 2
SUMMARY OF PERFORMANCE METRIC AND ROUTING PROTOCOL IN MANET

Author	*Performance Metric*	*Issues*
[4]	PDR	Increase in mobile nodes in DSDV, it leads to an increase in PDR which makes communication more effective compared to nodes in small scale networks
[5]	Latency, Packet Loss Ratio	An increase in node mobility from low to high degree leads to the degradation of AODV network performance in the network
[6]	Packet Loss Ratio, Round Trip Time (RTT)	Many control packets are generated during a link break occurs and this increases the congestion level in the active route that case the network jammed.
[7]	Throughput, End to End Delay, Packet Delivery Ratio, Packet Loss Ratio	The routing overhead of AODV outperforms while DSDV performs best in networks where nodes were less note mobility and densely populated.

III. METHODOLOGY

The main objective of the research is to compare the network performance of reactive and proactive routing protocols which is AODV and DSDV in Mobile ad hoc wireless networks in terms of throughput, end-to-end delay and packet delivery ratio while varying the network size and nodes mobility. The selected Wireless Network IEEE 802.11g at the MAC layer is configured closely to match with the MAC layer of ad hoc networks and the two-ray ground reflection model. The project is simulated by using Network Simulator version 2 (NS-2) as shown in Table 3.

TABLE 3
SIMULATION PARAMETER

Parameters	*Attributes*
Routing protocol	AODV, DSDV
Simulator	NS-2
Simulation time(s)	150
Simulation area	500m x 500m wide
Maximum speed(m/s)	20
Minimum speed(m/s)	5
Pause time(s)	10
Packet size	512 bytes
Number of mobile nodes	10, 20, 30, 40,50
Mobility model	RWP
Performance metrics	Throughput, PDR, Average End-to-End Delay

Figure 1 displays the simulation scenarios of the AODV and DSDV routing protocol in the NS-2 simulation tool. It presented the movement of nodes together with the packet transmitted during the simulation.

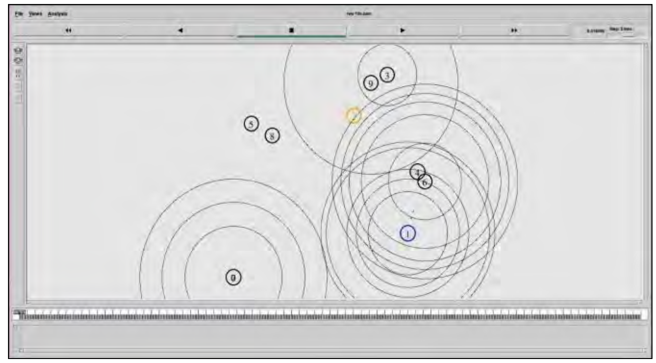


Fig. 1. Simulation Scenario Using NS-2

The computer hardware as well as the processes for installing Workstation Pro (Ubuntu), NS2, and Bonn Motion, which are used to create simulation scenarios for evaluating network performance on a mobility model are the most important part to acquire a good result. Random Waypoint (RWP) is the nodes mobility model of choice, and AODV and DSDV are the chosen routing protocols. Three scenarios were included in the simulation: comparing AODV and DSDV routing protocols with varying node counts, comparing AODV and DSDV routing protocols with varying stop times, and comparing AODV and DSDV routing protocols with varying mobility speeds. The following three-parameter metrics were used to compare the routing protocols.

A) Packet delivery Ratio (PDR):

PDR is the ratio between the number of packets transmitted by a traffic source and the number of packets received by a traffic destination. It measures the loss rate as seen by transport protocols and as specific to both the correctness and efficiency of ad hoc routing protocols. A great packet delivery ratio is desired in any network.

B) Average End-to-End Delay (EED):

The packet EED is the average time that a packet takes to travel the network. This is the time from the generation of the packet in the sender up to its reception at the destination's application layer and it is measured in seconds. Therefore, includes all the delays in the network such as transmission times, buffer queues and delays induced by routing activities and MAC control exchanges.

C) Throughput:

Throughput is defined as the ratio of the total amount of data that reaches a receiver from a sender to the time it takes for the receiver to get the last packet.

IV. RESULT AND ANALYSIS

From Figure 2, it can be shown that 10 nodes simulating the RWP mobility model with the AODV routing protocol achieved the maximum throughput rate at 869.69 Kbps. Nevertheless, as the number of mobile nodes increased to 20, 30, 40, and 50, the throughput rate substantially decreased, dropping by around 1% to 860.85 Kbps. However, as the number of nodes increases to 50, the AODV routing protocol's performance continuously drops to 854.06Kps, 5851.71Kps, and 848.64Kps. The pattern of decreasing throughput is quite like the DSDV routing protocol but not too drastically as compared to AODV. Simulated throughput at 10 nodes showed that the RWP mobility model with DSDV achieved a throughput of 841.92 Kbps and constantly decreased to 392.63, 837.28, and 831.26 with an increasing number of mobile nodes. The insignificant performance of throughput for both routing protocols is in line with an increasing number of nodes that cause many links to break while data is forwarded from one node to another and jeopardizing the maintenance of the routing table. This finding is synchronous with [8] while simulating proactive and reactive routing protocols in the control environment. In conclusion, DSDV and AODV routing protocol with RWP mobility model performs better throughput performance with a smaller number of nodes, However, it shows that AODV performed better throughput performance than DSDV with an average of 76%.

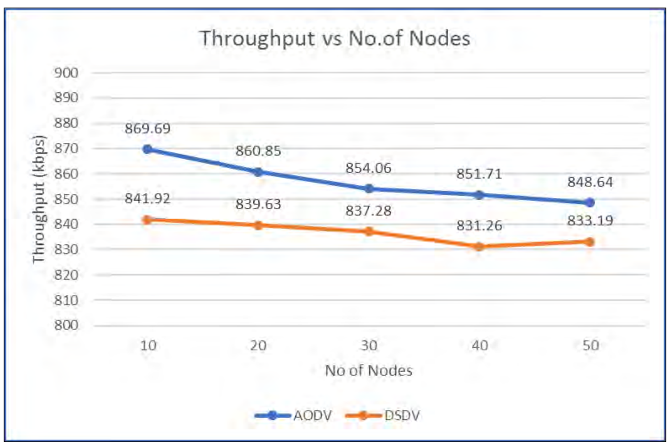
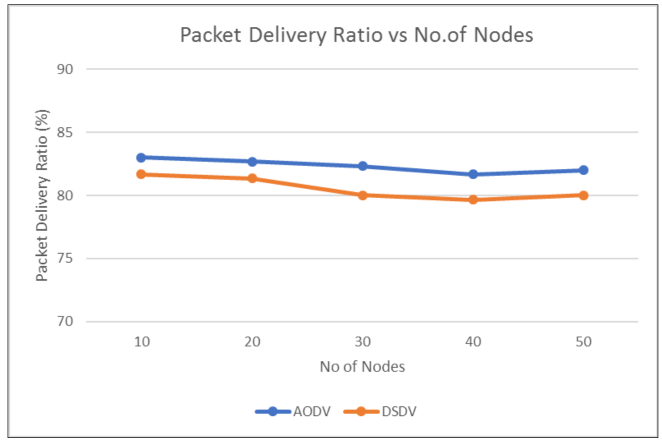


Fig. 2. Throughput vs Number of Nodes for AODV and DSDV

As shown in Figure 3, PDR vs number of nodes tested against AODV and DSDV routing protocol. The PDR value of RWP simulated with AODV decreases to 81.67% when the number of nodes is increasing from 10 to 40 nodes and then the value remained constant at 82% when reached 50 nodes. The same pattern showed when parameter PDR was tested against RWP with DSDV. The PDR performance decreases from 81.67% to 80.00% when using mobile nodes increased from 10 to 50. Therefore, if the PDR value is less than 100%, some packets may have dropped or collided. Due to this, nodes with high PDR (around 100%) ought to be able to make up for lost packets. In the ideal scenario, the value would be 100%, meaning that both transmitted and received packets are identical. If the value is higher than 100%, the received packet is higher than the packet sent, which may happen because some packets are retransmitted to the destination. Thus, in terms of the percentage of PDR, AODV presented the best network performance against DSDV with the highest percentage of 83%.

Fig. 3. Packet Delivery Ratio vs No of Nodes for AODV and DSDV



As shown in Figure 4, the RWP mobility model with both AODV and DSDV performed low average end-to-end delay of is at 220.710 m/s and 212.970 m/s when operating with 10 nodes. The end-to-end delay in RWP with AODV keeps increasing to 222.775 m/s when nodes are added to 20 nodes. The delay of routing protocol AODV showed the highest value increased rapidly from 230.602 m/s to 238.023 m/s when mobility nodes increased from 30 to 50. This is due to link breaks that may increase the average end-to-end delay for the packets to transmit data from source to destination.

With 40 nodes, the RWP with DSDV delay dropped to 223.353 m/s. Once the number of mobile nodes reaches 50, the speed gradually rises to 227.296 m/s. Considering it has a lower average end-to-end delay than AODV, RWP with DSDV performs differently from AODV. DSDV is a proactive protocol with a routing table that automatically establishes a new route and transmits packets when a connection fails at one route, according to [9]–[11] mentioned that the lower the average end-to-end delay, the better the performance of the routing protocol as the number of nodes increases. Thus, RWP in DSDV shows the best performance as it clocked the lowest average end-to-end delay.

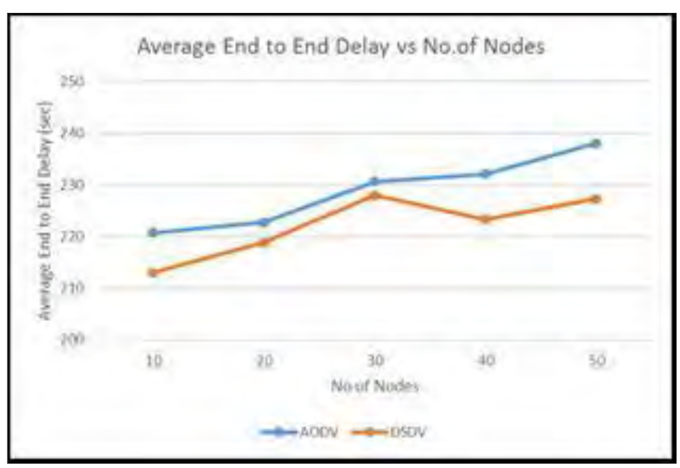


Fig. 4. Average End-to-End Delay vs Number of Nodes for DSDV and AODV

V. CONCLUSION

In mobile ad hoc networks, due to the ad hoc nature of the network and the type of applications, there is a high chance for node mobility. In some applications where node deployment is not fixed, node mobility can be high due to small-sized nodes scattered in the field for example, node deployment for monitoring seismic activities or environmental monitoring in far-off places. The impact of node mobility is an important consideration for ad hoc network routing protocols and observe this impact.

The proactive routing protocol like DSDV operates a routing path before sending data where the network maintains a single or multiple table routing tables that are regularly updated. It is also regarded as an on-demand routing protocol that is evaluated during simulation. The second type is a reactive routing protocol such as AODV that sets a routing table on demand, which retains active routes only. A bandwidth-efficient on-demand routing protocol is also called the Reactive Routing Protocol (RRP). It is necessary to send the data packet to the target node in this protocol, the route search method is initiated with the receiver node. The originator node starts a route search procedure whenever it wants to send data packets to the target node of this protocol.

The testing and analysis found that the proactive routing protocol DSDV performance is better than reactive routing protocol AODV when it is tested by increasing the number of nodes. The comparable performance result against (Arega et al., 2020) shows almost similar data while tested using RWP mobility mode. In contrast with DSDV, the result showed it is not suitable when applied to a large network topology with a huge number of nodes which is more than 30 nodes. The analysis found that proactive routing protocol DSDV node mobility has little effect on end-to-end delay with increases with node mobility. AODV gives the best performance and in this case, AODV is suitable for applications where end-to-end delay is an important consideration as compared to PDR. It concludes that when mobility is high, AODV comes next while DSDV produces less performance.

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