

Performance Comparison of MANET Routing Protocol based on RandomWaypoint Mobility Model

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Performance Comparison of MANET Routing Protocol based on RandomWaypoint Mobility Model

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ABSTRACT

Today, the use of Mobile Ad Hoc Network (MANET) is becoming increasingly popular due to its flexibility and ease of use wherever and whenever. MANET is able to adapt to many applications, such as disaster management and military operations. The MANET routing protocol consists of two types, namely Proactive Routing Protocols and On Demand Routing Protocols. Destination-Sequence Distance-Vector (DSDV) is an example of a protocol that includes Proactive Routing Protocols. Meanwhile, Ad Hoc on-Demand Distance Vector Routing (AODV) and Dynamic Source Routing (DSR) are examples of protocols that include On Demand Routing Protocols or Reactive Routing Protocols. Because routing protocols greatly affect MANET performance significantly, it is necessary to study the performance of routing protocols. This paper discusses the performance comparison of MANET routing protocol based on RandomWaypoint mobility model. The experiment was carried out by applying the MANET routing protocol to the RandomWaypoint mobility model. Routing protocols used are AODV, DSDV and DSR. The simulation is done using NS-2 software. The total of nodes used in simulations is 100, 150, 200 and 250 nodes respectively. Length of simulation time 900 s. The simulation area take place in urban residential areas. Performance evaluation is performed on variable packet delivery ratio (PDR), throughput, average end to end delay, packet loss and normalized routing load (NRL).

CCS Concepts

Networks → Network performance evaluation → Network simulations

Keywords

MANET; AODV; DSDV; DSR.

1. INTRODUCTION

In general, wireless networks are divided into two types, namely infrastructure-based and infrastructure-less. In infrastructure-based wireless network required a device that serves to connect between nodes in the network, the access point. This infrastructure-based wireless network is adapted from cellular

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networks. In an infrastructure-less network, each node establishes the network itself without any other fixed devices. All nodes on the infrastructure-less network work together with each other to forward packets [1], which are limited to the coverage of the wireless network interface transmission of each node. Mobile Ad Hoc Network is one type of infrastructure-less wireless network.

Today, the use of Mobile Ad Hoc Network (MANET) is becoming increasingly popular due to its flexibility and ease of use wherever and whenever. MANET is able to adapt to many applications, such as disaster management and military operations. MANET enables end-to-end connectivity [2]. Communications lines can be established instantaneously requiring minimal human intervention during path establishment. In general, data is transmitted over a mobile node-based pathway that works together, carrying packets through multi-hop networking. Each node can forward packets unrelated to its use, therefore nodes become routers for other nodes [3]. Each node on the MANET is independent to move in any way and hence the node can change the connection to other devices frequently.

Mobile Ad Hoc Network is differed by dynamic topologies, limited wireless bandwidth, no fixed infrastructure, rapid network forming and creation [4]. The development of routing protocols became one of the main challenges to ad hoc networks. Unpredictable topologies have a significant impact on MANET performance. Therefore, routing protocols play an important role in mobile ad hoc network (MANET). A protocol consists of a set of communicable, formal messages and how to react to these messages [5].

The MANET routing protocol consists of two types, namely Proactive Routing Protocols and On Demand Routing Protocols. Destination-Sequence Distance-Vector (DSDV) is an example of a protocol that includes Proactive Routing Protocols. Meanwhile, Ad Hoc on-Demand Distance Vector Routing (AODV) and Dynamic Source Routing (DSR) are examples of protocols that include On Demand Routing Protocols or Reactive Routing Protocols. In general, the difference of all types of protocols is how protocols mapped the network [5]. Some protocols store all destination routes completely, while others store only partial information.

Because routing protocols greatly affect MANET performance significantly, it is necessary to study the performance of routing protocols. This paper comparing of MANET routing protocol based on RandomWaypoint mobility model. Routing protocols used in this experiment are DSDV, AODV, and DSR. The comparison parameters include Packet Delivery Ratio (PDR), Throughput, Average End to End Delay, Packet Loss and Normalize Routing Load.

The paper is structured as follows, section 2 discusses MANET. Section 3 deals with the MANET routing protocol. Section 4 deals with experimental methods. Section 5 Discusses experimental results and discussion. And section 6 deals with conclusions.

2. MANET

MANET is dynamically built by mobile nodes connected via a wireless link without the utilize of existing network infrastructure or centralized administration [6]. MANET is decentralized where there is no single main station or access point that governs the flow of network traffic [7]. MANET is governed by the rule of the 802.11a/b/g/n physical layer protocol, all nodes in the same time send and receive wireless data and forward the traffic to other nodes. Every node acts as a node and as a router at the same time and make a multi-hop wireless network.

Nodes that are within range of other nodes, can exchange packets between devices without the help of other entities. To send a remote packet, the node between the source and the destination forwards the packet from one to another, as in the conventional router until it reaches the destination, shown in Figure 1.

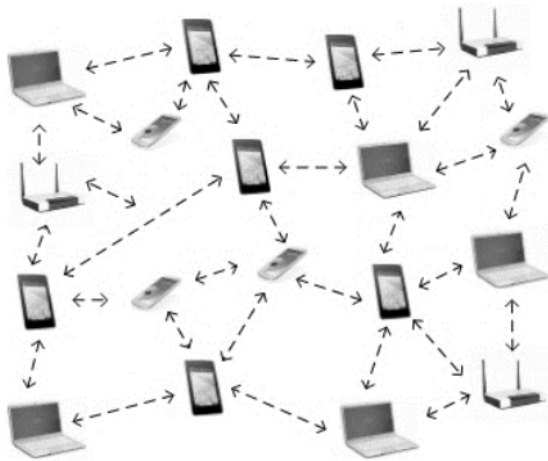


Figure 1. MANET Topology [2].

MANET's main advantage over wireless infrastructure-based networks is decentralized, which means afford to self-manage. Another advantage, does not need the installation of special infrastructure and flexibility as a mobile network. MANET is widely used in disaster management, military operations, instant infrastructure, remote areas and cost-effectiveness in an area with no wireless infrastructure-based network.

MANET is marked with the following criteria:

- **Dynamic topology;** nodes independent to move anywhere, network topology can change randomly and quickly at unpredictable times [8].
- **Limited bandwidth and fluctuating relationship capacity;** wireless networks have lower capacity compared with cable networks.
- **Low resources;** Mobile nodes typically use batteries as power sources that have limited capacity.
- **Limited physical security;** compared with cable network, MANET more susceptible to physical security threats. For example, there is an increased likelihood of spoofing, denial

of service and eavesdropping attacks that need to be carefully calculated.

- **Decentralized network control;** each node requires extra resistance compared to a centralized network.

3. ROUTING PROTOCOL IN MANET

There are several different routing protocols developed for ad hoc networks over the years. This protocol is basically divided into 2 categories [7]. There are several protocols that combine these two categories and benefit from both categories.

- **Proactive or Table Driven Routing Protocols -** In this category, the routing protocol maintains some neighboring tables or routing information on each node for all nodes in the network. Each at the specified time sends a small packet and through this small packet keeps neighbor records. When the network topology changes, the node propagate the update messages to the entire network and has the latest network topology information. DSDV is one of these routing protocol types.
- **Reactive or On Demand Routing Protocols -** Unlike Proactive Routing Protocols, each node does not store the current route of the entire network. Route created when package needs to be sent. When the source wants to send packets to the destination, the routing protocol initiates the route discovery process to get the path to destination. The route remains valid when the new packet is created for the purpose and removed from routing table if it is not used after a certain period of time. AODV and DSR are the types of routing protocols.

3.1 AODV

AODV uses a conventional routing table, one record on every destination. Differ with DSR, which maintain several route cache for every destination. AODV depend on routing table records to distribute RREP back to source, hereafter, to forward packets to destination. AODV utilize the serial number kept at every destination to decide the freshness of routing information and to avoid routing loops. Entire routing packet carry this serial number. Preservation of a timer-based condition in every node is necessary attribute of AODV, in connection with the use of individual routing table record. The routing table record expired when it was not used lately. Predecessor nodes is conserved for every routing table record, which indicate the neighboring nodes that utilize the record to route the data packets. This node is informed with the RERR packet if the subsequent hop link stops. Every precursor node, in its turn, through RERR to its own predecessor circuit, successfully removing entire routes by using broken links. Differ with the DSR, the RERR package in AODV is meant to advise entire sources utilizing links if a failure happen. AODV error disputation route could be conceptually visualized as a tree whose a node at the point of failure is root and all as a leaves is sources that utilized a failed link.

Advantages of AODV:

- Very powerful on highly dynamic networks
- Require less storage space compared to other reactive routing protocols
- Supports multicasting

Weakness of AODV:

- Has no efficient route maintenance techniques because routing information is always obtained on request.

- Suffer from high route discovery latency
- Large overhead is imposed on the routing protocol because of the overhead of control. This is required to send route reply messages for single route requests

3.2 DSDV

Distance-Vector Destination-Sequenced Distance (VDS) routing algorithm is a classic Bellman-Ford routing algorithm advancement. The principal think is that every mobile node keep a routing table comprising all available destinations, the number of hops convenient to that goal and the series number specified by destination node. Serial numbers are utilized to differentiate stale routes from new ones and thus prevent loop establishment. Thus, updates are done both time-based and event-driven. The routing table can be renewed either by a full dump or by conventional updates. A full dump transmits the whole routing table to a neighbor. Accordingly, many packages may be exposed in such an update mode. On the other hand, only records that have metric changes since the latest update are announce. So, the update must match the package. The record can be included in which the series number changed when space in the incremental update available. Incremental updates are transmitted to prevent additional traffic and full dumps are comparatively rare when the network comparatively stable. Incremental packets can get larger in a fastchanging network so that full dumps will be more frequent.

Advantages of DSDV:

- No loop guarantee
- Ensure the freshness of routing information in the routing table by using serial numbers.
- Avoid extra traffic by using extra updates.
- Keep the 1st paths for just about each destination. Therefore, the routing table space is reduced.

Weakness of DSDV:

- Periodic update messages require large bandwidths.
- Does not support multipath routing.
- Waste bandwidth because advertising does not require routing information even though there is no change in the network topology.

3.3 DSR

Dynamic Source Routing (DSR) is a routing protocol for Ad Hoc network primary source-based routing theory and not table-based. Its a initiated resource. It is especially designed for utilize in ad hoc networks of multi-hop wireless networks. DSR does not require existing network infrastructure. This protocol allows the network to fully self-organize and configure itself. Route finging and route keeping are two necessary parts to this protocol. Every node keep a cache to save the recently discovered path. If a node needs to transmit a packet to another, it verify its record in the cache. Then he utilizes the path to send the packet if available. Additionally, it append the source address to the packets. If the record is not cached, or expired (because it has been idle for a long time), the sender sends a route request packet to all the neighbors request for a way to the destination. The sender will await until the route is found. During the awaiting time, the sender can execute other job such as send/forward other packets. Once the route request packets achieve one of the neighboring nodes, the latter search destinations in the appropriate cache. When the route to destination information is known, the neighboring node sends back the route reply packet to the sender node; If the same route request packet is not broadcast. When a route is found, the

sender starts the delivery on the found route. Also, records are made in the corresponding cache. Furthermore, the node keep the age-entry information to decide cache is new or not. Intermediate node first examine the packet, whether the packet is for its or not. If the data packet for itself, the packet is received (intermediate node is the destination). Alternatively, the same packet is forwarded utilizing the path added to the data packet. Any links may collaps at any time on the Ad hoc network.

Therefore, the route preservation process continues to monitor network status. A notification is sent to the relevant node in case of a failure on the road. Thus, nodes change their route cache entries.

Advantages of DSR:

- With using cache, route discovery overhead decrease.
- Support Multipath routing
- No need periodic beaconing or hello message exchange.

Weakness of DSR:

- Not effective for large networks
- In consequence of source routing, package size continues to increase along with route length.
- Suffer from high route discovery latency

4. EXPERIMENT METHOD

In this experiment use ns-2 as software simulator. Three MANET routing protocols are implemented in simulations, ie AODV, DSDV and DSR. MANET simulation using RandomWaypoint mobility model that generated using Bonnmotion software [9]. The simulation parameters are shown in Table 1. The distance coverage of simulation activity is 1.000 m².

Table 1. Simulation Parameter

Simulation parameter	Value/description
Chanel type	Channel/Wireless Channel
MAC type	MAC/802_11
Number of node	100/150/200/250
Traffic Pattern	Constant Bit Rate (CBR)
Network size	1000 x 1000
Simulation time	900 s
Protocol routing	AODV, DSDV, DSR
Mobility model	RandomWaypoint

After the simulation perform, then evaluated the performance of each routing protocol. The evaluation is done on variable packet delivery ratio (PDR), throughput, average end to end delay, packet loss and normalized routing load (NRL).

Packet Delivery Ratio (PDR) is the ratio between packets sent to destination and the total number of packets.

Throughput is the ratio between the number of successfully transmitted and the total simulation time.

Average End to End Delay is the average time required by packets to move from source to destination.

Packet Loss is the total of packets dropped in the router.

Normalized Routing Load is the ratio of the total packet routing that was successfully sent and the number of data packets.

5. RESULT AND DISCUSSION

The experiment was carried out by applying the MANET routing protocol to the RandomWaypoint mobility model. Routing protocols used are AODV, DSDV and DSR. The simulation was performed using NS-2 software which stands for Network Simulator Version 2. NS-2 was chosen because it provides simulation and research support for wired and wireless networks using TCP, UDP, IP and CBR communication patterns [10]. The number of nodes used in the simulation is successive, 100, 150, 200 and 250 nodes respectively. Length of simulation time 900 s.

The packet delivery ratio (PDR) measurement results are shown in Figure 2. As the number of node 100 AODV protocols has the highest PDR while DSDV has the lowest PDR value. The greater the number of nodes of PDR values in the AODV and DSR protocols tend to be constant, whereas the DSDV fluctuates at the number of nodes 200. The DRD protocols DDR value is the lowest when the number of nodes 200, but again increases as the number of nodes 250.

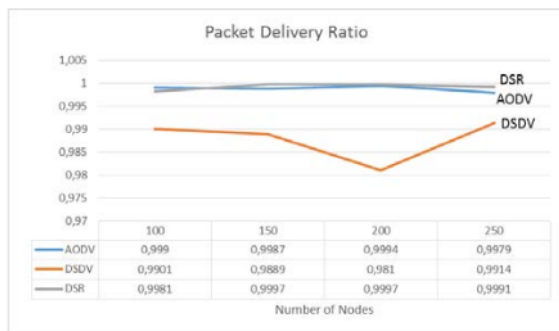


Figure 2. Packet Delivery Ratio (PDR) Measurement.

As shown in Figure 2, the difference between PDR values between routing protocols is not so far. DSDV has the lowest PDR value compared to the other two routing protocols, AODV and DSR. This indicates that the reactive routing protocol has a better PDR value compared to the proactive routing protocol.

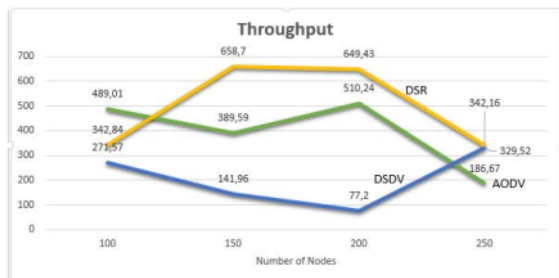


Figure 3. Throughput Measurement.

The throughput measurement results are shown in Figure 3. As the number of nodes 100, the largest throughput value is achieved by the AODV protocol. The largest throughput value is achieved by the DSR protocol at the number of nodes 150. Of the three routing protocols, the DSDV has the lowest throughput value at the node number 100, 150 and 200. But at the node number 250, the DSDV throughput value is better than the AODV throughput value.

Overall throughput value of reactive routing protocol is better than proactive routing protocol.

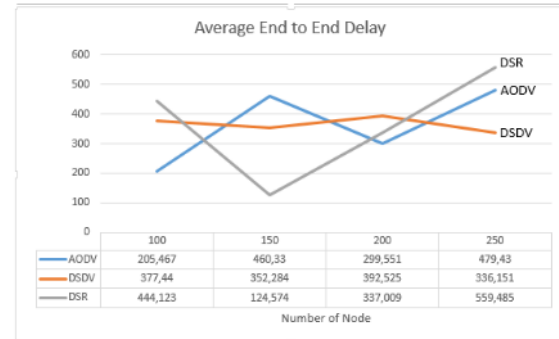


Figure 4. Average end to end delay.

The average end to end delay values for the three protocols are shown in Figure 4. The average end to end delay DSDV tends to be constant when there are additional nodes, whereas for AODV and DSR fluctuates. This is because on DSDV each node will maintain the overall routing table. While on AODV and DSR routing lines are determined when needed to forward packets. The addition of number of nodes resulted in the average value of end to end delay of AODV and DSR increase. This is indicated when the number of nodes increases to 250 nodes. From the average end to end delay the proactive routing protocol is better than the reactive routing protocol.

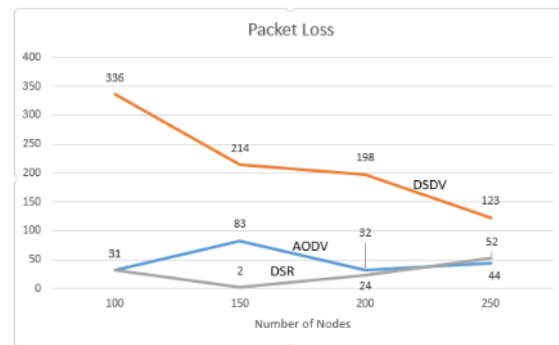


Figure 5. Packet Loss.

Packet loss measurements are shown in Figure 5. Based on these images the largest packet loss is owned by DSDV for all nodes. At the node number 100, 150 and 200, the lowest packet loss is achieved by DSR. But at the time of the node 250 the lowest number of packet loss was achieved by AODV. The value of the packet loss recipes routing protocol is better than the proactive routing protocol.

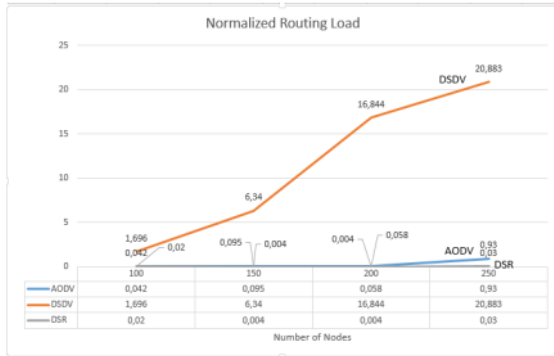


Figure 6. Normalized Routing Load.

The normalized routing load (NRL) values for the three routing protocols are shown in Figure 6. Based on those images the lowest NRL is achieved by DSR followed by AODV and DSDV. This indicates that the reactive routing protocol has NRL better than the proactive routing protocol.

The simulation results are in line with [1] that shows that the DSR protocol has the best performance compared to other protocols.

6. CONCLUSION

This paper discusses the comparison of the performance of the MANET routing protocol based on RandomWaypoint mobility model. Routing protocol performance is measured by packet delivery ratio (PDR), throughput, average end to end delay, packet loss and normalized routing load (NRL). Based on experimental results obtained that DSDV protocol has the best value for average end to end delay, while for PDR value, throughput, packet loss and NRL, DSR protocol is best followed by AODV. Overall it can be concluded that reactive routing protocol is better than proactive routing protocol. In this case the reactive routing protocol is represented by AODV and DSR while the proactive routing protocol is represented by DSDV. Further research can apply the MANET routing protocol to specific activities, such as post-disaster handling.

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