A Comparative Study between AODV and DSDV Routing Protocols in Mobile Ad Hoc Networks using Network Simulator NS2

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Abstract— **Mobile Ad hoc Networks (MANET's) have become increasingly popular in infrastructure-less mobile wireless communication system. Nodes of these kinds of networks function as a router which discovers and maintains the route to the other nodes in the networks. Route discovery and packet forwarding operations need an efficient routing protocol. Ad-Hoc on Demand Distance Vector Routing Protocol (AODV) and Destination Sequenced Distance Vector Routing protocol (DSDV) are counted as widely used routing protocols in MANET. To this end, in this paper we compare and evaluate the functionality of AODV and DSDV routing protocols. Simulation is conducted in NS2.34 and performance evaluation is based on parameters such as packet delivery ratio (PDR), Throughput and end-to-end delay using network simulator on Linux Fedora. Simulation results show that AODV protocol is always superior in terms of packet delivery ratio, average delay and throughput as compared to DSDV protocol when number of node and scenario are changed.**

Keywords: MANET, Routing Protocol, AODV, DSDV, Comparative Study.

I. Introduction

A Mobile Ad-hoc Network (MANET) is a collection of wireless nodes that can be deployed anytime anywhere without using any pre-existing network infrastructure. It is an autonomous system in which mobile nodes connected by wireless links are free to move randomly and often act as routers at the same time. The topology of such networks is highly dynamic because each node can freely move and no pre-installed base stations exist **[1]**. Due to the limited wireless transmission range of each node, data packets then may be forwarded along multi-hops. Route discovery and packet forwarding should be implemented with minimum of overhead and bandwidth consumption.

AODV is considered as the most well-known routing protocol for MANET, which is a hop-by-hop reactive (On demand) source routing protocol **[2]**. AODV creates a routing table like DSDV, It offers quick adaptation to dynamic link conditions, low processing and memory overhead, low network utilization, and determines unicast routes to destinations within the Ad-hoc network. On the other hand, Destination-Sequenced Distance Vector (DSDV) routing protocol is a typical routing protocol for MANETs. In DSDV, each route is tagged with a sequence number which is originated by destination, indicating how old the route is. All nodes try to find all paths to possible destinations nodes in a network and the number of hops to each destination and save them in their routing table. New route broadcasts contain the address of destination, the number of hops to reach the destination, the sequence number of the information receive regarding the destination, as well as a new unique sequence number for the new route broadcast. Wireless networking is an emerging technology that allows users to access information and services electronically, regardless of their geographic position.

II. Routing protocols in mobile ad-hoc network (MANET)

Many routing protocols available today in Mobile Ad-Hoc Network can be divided into two categories: Table driven (or Proactive) and on-demand (Reactive). In this paper we focus on the comparison between AODV and DSDV routing protocol. This is because these protocols are very popular in the research field of MANET routing solutions.

A. On –Demand Routing Routing (Reactie)

This type of routing protocols creates a route between the source and destination node only when the source node require a route to the destination node. It initiates a route discovery process within the network. It is a reactive or on-demand routing protocol. This type of protocols finds a route on demand by flooding the network with Route Request packets and Replay with a unicast Route Request packet [3]. AODV, DSR, CBRP, TORA and ABR are some examples of need-base protocols.

1) Ad-hoc on-demand Distance Vectore (AODV)

Route discovery process in AODV starts when a source node does not have routing information for a node to be communicated with. When a node wants to send a packet to some destination node and does not locate a valid route in its routing table for that destination, it initiates a route discovery process. In the Figure 1 denotes that the source node creates a request (RREQ) packet and broadcasts it to its immediate neighbors, each node when received the packet will forward the request to their neighbors until the request reaches either an intermediate node with the a route to the destination or the destination node itself. This route request packet contains the IP address of the source node, current sequence number, IP address of the destination and the sequence number known last. An intermediate node can reply to the route request if they have a destination sequence number that is greater than or equal to the number contained in the route request packet header. When intermediate nodes forward route request to their neighbors, they record in their route table the address of the neighbor from which first packet of the broadcast is received. This recorded information will use later for the route reply (RREP). A source node may receive multiple RREP messages with different routes. It then updates its routing entries if and only if the RREP has a greater sequence number, i.e. fresh information.

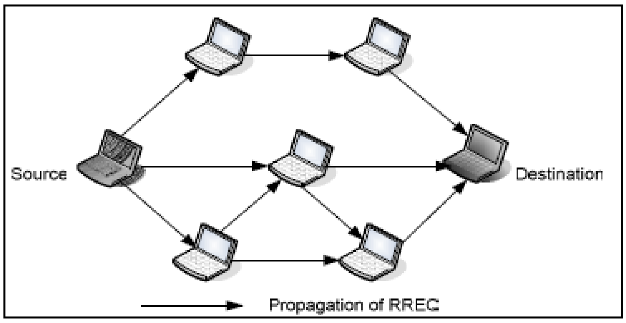

Figure 1: route discovery

To control network-wide broadcasts of RREQ packets, the source node use an expanding ring search technique. In this technique, source node starts searching the destination using some initial time to live (TTL) value [4]. If no reply is received within the discovery period, TTL value incremented by an increment value. This process will continue until the threshold value is reached. When an intermediate node forwards the RREQ, it records the address of the neighbor from which first packet of the broadcast is received, thereby establishing a reverse path. Figure 2 denotes that the RREP is routed back along the reverse path, intermediate nodes along this path set up forward path entries to the destination in its route table and when the RREP reaches the source node the figure 2 shows that RREP from the destination to the source will be unicat then a route from source to the destination established. If the same REEQ packets arrive later on, they are discarded. When the route reply packet arrive from the destination or the intermediate node, the nodes forward it along the established reverse path and store the forward route entry in their route table. When the source or the intermediate node moves away the route maintenance packet should send. If a source node become unreachable will result reinitiates route discovery process.

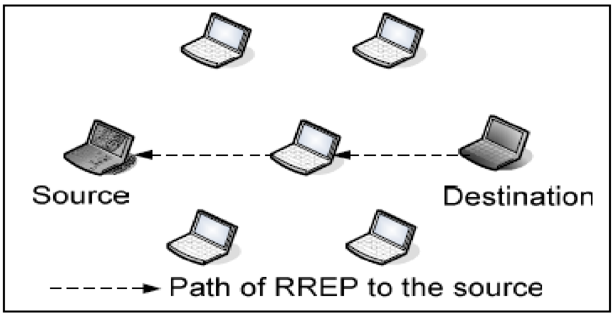

Figure 2: route reply

a) Advantage of AODV

- Unicast , Broadcast, and Multicast communication.
- On-demand route establishment with small delay.
- Multicast trees connecting group members maintained for lifetime of multicast group.
- Link breakages in active routes efficiently repaired.
- All routes are loop-free through use of sequence numbers.
- Use of Sequence numbers to track accuracy of information.
- Only keeps track of next hop for a route instead of the entire route.
- Use of periodic HELLO messages to track neighbors.

b) Limitations of AODV

- Overhead on the bandwidth: Overhead on bandwidth will be occurred when an RREQ travels from node to node in the process of discovering the route information on demand, it sets up the reverse path in itself with the addresses of all the nodes through which it is passing and it carries all this info all its way.
- No reuse of routing info: AODV lacks an efficient route maintenance technique. The routing info is always obtained on demand, including for common case traffic.
- It is vulnerable to misuse: The messages can be misused for insider attacks including route disruption, route invasion, node isolation, and resource consumption.
- AODV lacks support for high throughput routing metrics: AODV is designed to support the shortest hop count metric. This metric favors long, low bandwidth links over short, high-bandwidth links.
- High route discovery latency: AODV is a reactive routing protocol. This means that AODV does not discover a route until a flow is initiated. This route discovery latency result can be high in large-scale mesh networks.

2) Dynamic Source Routing (DSR)

DSR is one of the widely referred routing protocols in MANET, which is an on-demand routing algorithm or source route and it has route discovery and route maintenance phases.

Route discovery have route request and route reply messages. When a node wants to send a packet, it will broadcast a route request packet (RREQ) to its connected nodes. Each node when received the packet will add it's node id to the message and resend the packet to the neighbors and the process will continue until the packet reached either the destination or to a node that have a route to the destination node. Every node when receiving the packet will maintain a route cache, if a node has a path to the destination in its route cache, then the node will send route reply packet to the source node otherwise will forward the packet (RREQ) further. First packet reached the destination node will have the entire path to the source. DSR will establish the route reply to the source node [5].

Two packets are used in route maintenance, route error and acknowledgments. Based on the (ACK) packet that is received from the connected nodes DSR will ensure that the existing route is active. When a node didn't receive an (ACK) packet, route error will send to the source node in order to resend a new route discovery.

B. Table Driven Routing protocols (Proactvie)

In this category routing protocol in Mobile Ad-Hoc Network, each node keeps one or more tables containing routing information to other nodes of the network. Table driven ad hoc routing protocols maintain at all times routing information regarding the connectivity of every node to all other nodes that participate in the network. Also known as proactive, these protocols allow every node to have a clear and consistent view of the network topology by propagating periodic updates. Therefore, all nodes are able to make immediate decisions regarding the forwarding of a specific packet [6]. DSDV, OLSR, GSR, WAR, ZHLS and CGSR are some example of table-based protocols.

1) Destination sequence vector routing (DSDV)

The mechanism of routing discovery in DSDV is different compare with AODV. DSDV protocol requires each node to advertise its routing table to the current neighbors. The entries in this list may change dynamically over time, so the advertisement must be made often enough to ensure that every node in the network can always locate every other node. DSDV requires a regular update of its routing tables, which uses up battery power and a small amount of bandwidth even when the network is idle [7][8].

The information that is broadcasted by each node will contain new sequence number and the following information for each new route

- The destination's address.
- The number of hops required to reach the destination.
- The sequence number of the information received regarding that destination, as originally stamped by the destination.

a) Advantage of DSDV

- DSDV protocol guarantees loop free paths.
- Count to infinity problem is reduced in DSDV.
- We can avoid extra traffic with incremental updates instead of full dump updates.
- Path Selection: DSDV maintains only the best path instead of maintaining multiple paths to every destination. With this, the amount of space in routing table is reduced.

b) Limitations of DSDV

Wastage of bandwidth due to unnecessary advertising of routing information even if there is no change in the network topology.

- DSDV doesn't support Multi path Routing.
- It is difficult to determine a time delay for the advertisement of routes.
- It is difficult to maintain the routing table's advertisement for larger network. Each and every host in the network should maintain a routing table for advertising. But for larger network this would lead to overhead, which consumes more bandwidth.

2) Optimized Link State Routing (OLSR)

OLSR optimizes a pure link state and this algorithm differ from the previous one by reduces the size of information sent in each message and minimizing the number of retransmission flooding in the network. It uses a multipoint relaying technique to flood the control message in a network in an efficient manner.

Each node selects a set of one-hop neighbors or connectors nodes which called multipoint Relays (MPR) for the node. The nodes which are not (MPR) process the packet but do not forward them since only the MPRs forward the packet and the node forwards any of the broadcast messages to these MPR nodes [9].

The range of multipoint relay should cover all the two-hop neighbors. The MPR of node N should be such that every two-hop neighbor of node N has bidirectional link with the nodes in the MPR set of N. by using HELLO packet which contain the information about all neighbors and their link status. the route from source node to the destination through the MPR within the network. The source node does not know the entire route to the destination only know the next hop information to forward the packet.

III. SIMULATION MODEL

The NS-2 network simulator has gained an enormous popularity among participants of the research community, mainly because of its simplicity and modularity [10]. It allows simulation scripts, also called simulation scenarios, to be easily written in a script-like programming language, OTcl. More complex functionality relies on C++ code that either comes with ns-2 or is supplied by the user. This flexibility makes it easy to enhance the simulation environment as needed, although most common parts are already built-in, such as wired nodes, mobile nodes, links, queues, protocols (e.g., routing algorithms, TCP, UDP) and application can be done using NS2 [11].

To investigate network performance like end-to-end delay, packet delivery ratio, and throughput between the routing protocols in MANET researchers can simply use an easy-to-use scripting language to configure a network, and observe results generated by NS2.

Figure 3 shows the basic architecture of NS2. NS2 provides users with executable command ns which take on input argument, the name of a Tcl simulation scripting file. Users are feeding the name of a Tcl simulation script (which sets up a simulation) as an input argument of an NS2 executable command ns. After executing TCL file by writing the "ns filename.tcl" in shell executable command we will obtain the trace file. Through the NAM we can show the proposed scenario as animation and Xgraph for showing the ratio of the End-to-End, Packet delivery ration and throughput [12].

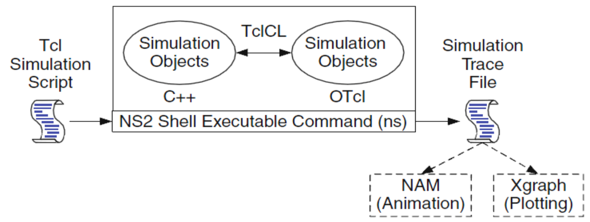

Figure 3: Basic architecture of NS-2.

A. Simulation Result

We present experiments that study the performance comparison of the DSDV and AODV in various conditions when.

a) Number of the Nodes vs. End-to-end delay

This is the average delay for a packet to traverse from a source end to a destination end. It is measured as the time elapsed from the time when a data packet is originated from a source and it is successfully received by receiver.

Simulation environment:

- Simulation time = 150 s.
- Number of nodes are (2, 4, 6, 8, 10) nodes.
- Area size is set to 500 x 500 flat areas.
- Random Way Point mobility model is used.

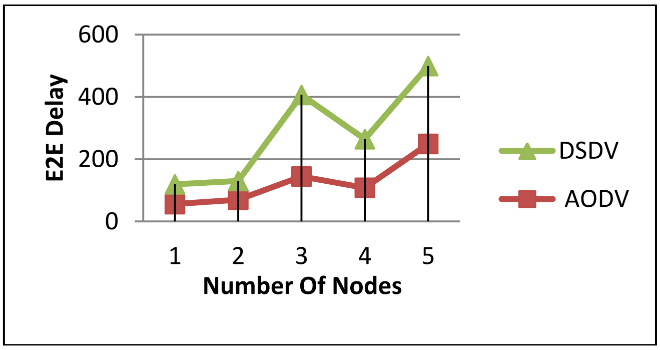

Figure 4: Average End-To-End Delay

In figure 4 took number of nodes on X-axis and end-to-end delay in Y-axis to compare the delay. Each experiment was running for 150 ms of simulation time, which is enough for stable results. Average end-to-end delay of control packets includes all possible delays caused by buffering during route discovery, queuing delay at the interface, retransmission delays, propagation and transfer times. The performance of AODV is slight better than DSDV especially when the number of nodes increased.

b) Throughput

The metric that have been used for performance evaluation are aggregate network throughput and the total data rate supported by the network. Aggregate network throughput is the sum of end-to-end throughput of all the flow in the network. The total data rate supported by the network is a measure of number of bytes switched by the network per second.

Simulation environment:

- Simulation time = 150 s.
- Number of flows is (1, 2, 3, 4, 5) respectively .
- Area size is set to 500 x 500 flat areas
- Random Way Point mobility model is used

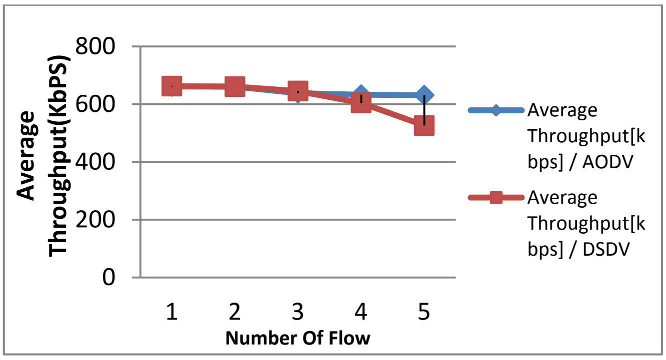

Figure 5: Throughput

The Figure 5 shows the throughput that take the total flow load on X-axis and throughput in Y-axis. We observe that the throughput of AODV is more stable than DSDV even when the number of flows increased.

c) Packet Delivery Ratio

Defines as a percentage of data packets delivered at receiver end to that of no. of data packets sent for that node. PDR is used to measure the reliability, effectiveness and efficiency of routing protocols.

Simulation environment:

- Simulation time = 150 s.
- Number of flows is (1, 2, 3, 4, 5) respectively .
- Area size is set to 500 x 500 flat areas
- Random Way Point mobility model is used

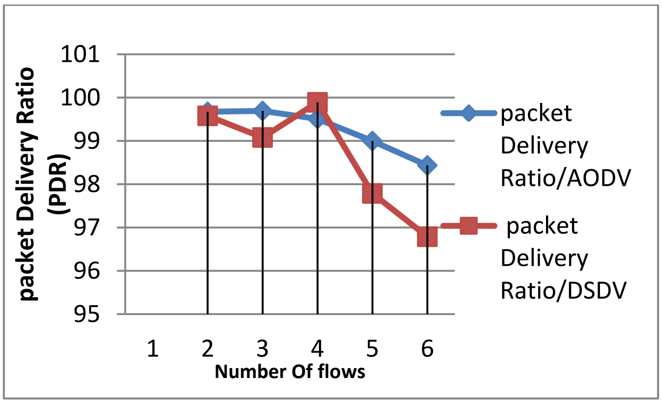

Figure 6: Packet Delivery Ratio

Figure 6 shows that AODV perform better than DSDV when the loads Increases because nodes become more stationary will lead to more stable path from source to destination, DSDV performance dropped as number of flows increase because more packets dropped due to link breaks.

B. Conclusion and Future Work

The performance of all the routing protocol were measured with respect to metrics like Packet Delivery, End to End Delay and Throughput in three different scenarios: time, no of node, number of flows and packet delivery ratio. The results indicate that the performance of AODV is superior to DSDV. It is also observed that the performance is better especially when the number of nodes and number of the flows in the network is increased, also the packet delivery ratio in AODV is better than DSDV in case of dropping packets .It is concludes that DSDV improved but still perform lower performance compared to AODV. Our Suggestion to extending this work to add some other parameters such as connectivity (Topology based), error rates could help making trace-based simulations more realistic, interference and adding multiple radios, multiple channels to the nodes.

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