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Performance Evaluation of Ad-hoc On -Demand Multipath Distance Vector Routing Protocol in Wired Network

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ABSTRACT

A Mobile Ad-hoc Network or MANET is a collection of mobile nodes sharing a wireless channel without any centralized control or established communication backbone. We can classify the routing protocol as flat and hierarchal routing and flat routing protocols are classifying into reactive (source initiated) and proactive (table driven). In this paper we mainly focusing on reactive routing protocols i.e. Ad-hoc On demand Multipath Distance Vector (AOMDV) for better performance in simulation by comparing Ad-hoc On demand Distance Vector (AODV), and Dynamic Source Routing (DSR).AODV and DSR protocols are unipath routing protocols but AOMDV is multipath. The performance of three routing protocols is analyzed in terms of their Packet Delivery Fraction, Average End-to-End Delay, Routing overhead, Route Discovery Frequency. NS2 simulator is used for comparison and critical analysis of AOMDV is done to find its merits and demerits.

Keywords: AODV, AOMDV, DSR, MANETs.

1. INTRODUCTION

Mobile Ad-hoc Network (MANET) [1] concept is developed recently to convoy the increasing demand on mobile and ubiquitous access to network resources, especially the Internet. Thus, MANET is a key part in the next generation network structure in which the wireless Internet will be involved. A MANET is a collection of mobile nodes that form a dynamic topology and highly resource constrained network. Unlike Wireless LAN (WLAN) which is a single hop and an infrastructure based network, MANET is considered a multi hop and infrastructure less network which means that MANETs operate without support of any fixed infrastructure or centralised administration.

The most significant challenges [2] and factors affecting MANETs are summarised as follows:

- Application/Market penetration
- Design/Implementation
- Limited wireless transmission range
- Operational/Business-related
- Mobility
- Energy conservation

The four most important issues in MANETs are listed first in the following list and they are covered in more details later in this section.

- Routing
- QoS provisioning
- Security
- Multicasting
- Energy management

MANETs are very flexible networks and suitable for several types of applications, as they allow the establishment of temporary communication without any pre-installed infrastructure. The following is a summary of the major applications [3] in MANETs: Personal communications, (e.g. cell phones, laptops and ear phone), cooperative environments (e.g. Taxi cab network, meeting rooms, sports stadiums, boats and aircrafts), Emergency operations (e.g. policing, fire fighting and earthquake rescue), Military environments (battlefield), Conferencing (using mobile nodes), Enterprise network, Vehicle network, Home network (almost used for PANs), Hospitals (e.g. healthcare), Wireless mesh networks (very reliable networks that are closely related to MANETs, the nodes of a mesh network generally are not mobile), Wireless sensor networks (a very hot research area of Ad-hoc networking which includes fixed networks or mobile sensors), Hybrid wireless networks (which aims to cost savings, performance Improvements and enhanced resilience to failures), Collaborative and distributed computing.

2. ROUTING PROTOCOLS IN MANETS

Many routing protocols have been proposed so far for MANETs, each one offering some advantage over the other approaches. Routing protocols in MANETs are classified [4] into three types, proactive (table driven), reactive (on-demand), and hybrid protocols.

Proactive, reactive and hybrid routing protocols

Proactive protocols update periodically routing information to various nodes in the network so that a source node can find the route to the destination when ever needed. As the route is always known, forwarding packets is faster in proactive protocols. The main disadvantage of such protocols is the large over heads of route discovery process which is launched periodically. Also, more bandwidth and power are consumed for updating process in proactive protocols. Destination Sequenced Distance Vector (DSDV) and Wireless Routing Protocol (WRP) are examples of proactive routing protocols in MANETs. Proactive protocols characteristics are summarised as follows:

- No latency in route discovery
- Continuously evaluate routes
- Need a large capacity to keep network information updated
- A lot of routing information may never be used

Location-based routing protocols

In addition to proactive, reactive, and hybrid, there is a fourth type of Ad-hoc routing protocols includes location-based routing protocols which claim that no routing tables need to be maintained, and thus no overhead due to RDP and RMP is imposed. However, they need to obtain position data of their corresponding destinations either by an internal discovery process or by an independent position service (e.g. Global Positioning System - GPS), which will then impose overhead to maintain the position information either proactively or reactively. In location-based routing protocols, three location components can be used in both route discovery and packet forwarding, the position relationship between an intermediate node (a packet forwarding node) and the destination, together with the node mobility. An example of location-based routing protocols is Location-Aided Routing protocol (LAR). Based on the mechanism used for routing, most of position-based protocols can be also classified as proactive, reactive, or hybrid routing protocols (e.g. LAR is considered a reactive). Thus, the first three types are still considered the typical types of ad-hoc routing protocols.

Hierarchical routing protocols

All routing protocols mentioned above as examples of proactive and reactive routing have flat structure because they use a flat network topology. A hierarchical routing protocol is a protocol that uses a hierarchical network topology.

Single path vs. multipath protocols

Single path abstraction in routing protocols means that multiple routes can be detected due to routing discovery process and one route of them (usually the optimal) is maintained in the source node routing table. DSDV and AODV are examples of single path routing protocols. In multipath routing protocols, multiple routes can be detected due to routing discovery process and all routes are maintained in a source node routing table. All of these routes can be utilised for data transmission between the source and the destination nodes. DSR and TORA are examples of multipath routing protocols. There are several criteria can be used for comparing single path and multipath routing in MANETs.

3. AD-HOC ON-DEMAND MULTIPATH DISTANCE VECTOR

Ad hoc on demand Multipath Distance Vector (AOMDV), [5] is an extension to the AODV routing protocol. AOMDV is designed to provide efficient recovery from route failures and efficient fault tolerance. To achieve these goals, AOMDV computes multiple loop-free and link-disjoint paths. A notion of advertised hop count is used to guarantee loop freedom, and a particular property of flooding is used to achieve Link-disjointness of multiple paths. The advertised hop count of a node for a destination represents the maximum hop count of multiple paths for the destination at the node. When the AODV single path routing protocol is used, new route discovery is needed in response to every route break. This inefficiency can be avoided by having multiple paths for each destination. In this case, new route discovery is only needed when all paths are broken. The AOMDV protocol has two components: a rule to create and maintain multiple loop free paths, and a distributed protocol to find link-disjoint paths. The basic idea for finding link-disjoint paths is as follows. To consider the paths between a pair of nodes as disjoint paths, it is necessary that all but the first and last hops of those paths are distinct. AOMDV augments the AODV route discovery procedure in two ways:

1. By exploiting the routing information obtained via duplicate route request copies, alternate loop-free reverse paths are formed at the intermediate and the destination nodes.

2. The destination node generates multiple route replies that travel along multiple loop-free reverse paths to the source established during the route request phase to get multiple loop-free forward paths to the destination. As in AODV, AOMDV uses destination sequence numbers to ensure loop-freedom. Every node maintains one or more paths to a destination corresponding to the highest sequence number for that destination. Route maintenance in AOMDV is similar to that in AODV. The difference is that, in AOMDV, a node only generates or forwards a RERR packet for a destination when all paths to the destination break.

4. AD-HOC ON-DEMAND DISTANCE VECTOR

Ad hoc On-Demand Distance Vector Routing Protocol (AODV) [6] is a unicast reactive routing protocol, where the routes are constructed only when needed. AODV maintains a routing table where routing information about the active paths is stored. AODV protocol use four control packets: Hello messages, Route Requests (RREQs), Route Replies (RREPs), and Route Errors (RERRs). Each node maintains a routing table which contains: Destination, Next Hop, Number of hops (metric), Sequence number for the destination, Active neighbors for this route, and Expiration time for the route table entry. Each time a route entry is used, the timeout of the entry is reset to the current time plus active route timeout. The sequence number is used to ensure loop freedom in distance vector routing protocols. The sequence number is sent with RREQ (for source) and RREP (for destination) and stored in the routing table. The larger the sequence number the newer the route information. If a new route is offered, the sequence numbers of the new route and the existing route are compared. The route with the greater sequence number is used. If the sequence numbers are the same, then the new route is selected only if it has fewer numbers of hops. AODV is composed of two mechanisms: Route Discovery and Route Maintenance:

1. Route Discovery: When a node needs to send data to a destination, it checks its routing table if it has a valid route to that destination. If a route is found, the node starts to send the data to the next hop. Otherwise, it begins a route discovery procedure. In the route discovery procedure, a route request (RREQ) and route reply (RREP) packets are used to establish a route to the destination. RREQ is broadcast throughout the entire network. Upon receipt of RREQ, the node creates a reverse routing entry towards the source, which can be used to forward replies later. The destination or an intermediate node, which has a valid route towards the destination, answers with a RREP packet. When a node receives RREP, a reverse routing entry towards the originator of RREP is also created, the same as with the processing of RREQ. Associated with each routing entry is a so-called precursor list, which is created at the same time. The precursor list contains the upstream nodes which use the node itself towards the same destinations.

2. Route Maintenance: Each node along an active route periodically broadcasts HELLO messages to its neighbors. If the node does not receive a HELLO message or a data packet from a neighbor for a certain amount of time, the link between itself and the neighbor is considered to be broken. In case of the destination with this neighbor as the next hop is not far away (from the invalid routing entry), a local repair mechanism may be started to rebuild the route towards the destination; otherwise, a Route Error (RERR) packet is sent to the neighbors, which in turn propagates the RERR packet towards nodes whose routes may be affected by the broken link. Then, the affected source can re-initiate a route discovery process if the route is still needed.

5. DYNAMIC SOURCE ROUTING

The second reactive routing protocol is the Dynamic Source Routing Protocol (DSR) [7] [8]. It is based on the concept of source routing. Unlike other unicast routing protocols, DSR does not maintain a routing table, but uses a Route Cache to store the full paths to the known destinations. Unlike other protocols, DSR requires no periodic packets. For example, it does not use any periodic routing advertisements. The lack of periodic activity may reduce the control overhead. The protocol is composed of two mechanisms to discover and maintain the source routes: Route discovery and Route Maintenance.

1. Route discovery: When a node has a ready data packet to send, it first searches for a route to the destination in its route cache. If an active route entry towards the destination is found, it uses the found route to send the data packet. Otherwise, the source node initiates route discovery by broadcasting a Route Request (RREQ) packet. The RREQ packet contains the source node's address, the destination node's address, and a unique request id. Also, each RREQ contains a record listing the address of each intermediate node that forwarded the packet. Each intermediate node receiving the RREQ packet checks whether it has a route to the destination. If it does not have a route, it adds its own address to the route record of the packet and then broadcasts it to its neighbors. To limit the number of route requests propagation, the node only broadcasts the RREQ if it has been received for the first time. A route reply (RREP) is generated, when the RREQ is received by the destination or an intermediate node that has an unexpired route to the destination. If the receiving node is the destination, it places the route record contained in the RREQ into the RREP. If the receiving node is an intermediate node, it appends its cached route to the route record and then generates the RREP. If the responding node has a route to the RREQ initiator, the route can be used to return the RREP packet. Otherwise, if symmetric links are supported, the responding node could be reversing the route in the route save information (record). If symmetric links are not supported, the node initiates its own RD and piggybacks the RREP packet on the new route request.

2. Route maintenance: Unlike proactive routing protocols and AODV, DSR does not introduce a periodic HELLO message. Every node along the path is responsible for the validity of the downstream link connecting itself with the next hop. If a broken link is detected, route maintenance is invoked. This phase is accomplished through the use of Route Error (RERR) packets and acknowledgements. A RERR packet is generated at a node that discovers a link failure and sent to the source node. When an RERR packet is received, the hop in error is removed from the node's route cache and all routes containing the hop are truncated at that point. In addition to RERR packets, acknowledgements are used to verify the correct operation of the route links. When the source node

receives the RERR packet, it may re-initiate route discovery if an alternate route is not found.

6. SIMULATION

The simulator used here is Network Simulator [9] [10], NS, version 2.34. NS is a discrete event simulator targeted at networking research. NS provides substantial support for simulation of TCP, routing, and multicast protocols over wired and wireless (local and satellite) networks. NS is free software, publicly available under the GNU GPLv2 license for research, development, and use.

Performance metrics

End-to-End delay: It is time delay for data packet from source to destination.

Packet delivery ratio: The number of data packets successfully received by the destination.

Routing overhead: The number data packets transmitted by the source node.

Route discovery frequency: The highest number of route requests generated by all sources per second is called the route discovery frequency.

Results and Analysis

Here the traffic type is TCP by using the “setdest” command as discussed above with type being “tcp”. The parameters are calculated with varying speeds and pause times. The results are documented below:

Table 1: Simulation Parameters

Parameter Type	Value
Simulator	NS 2.34
Number of nodes	50
Simulation time	100 sec
Node speed	10 m/sec
Data rate	1 Mbps
Simulation area	1000m * 1000m
Data type	TCP

The above mentioned parameters are calculated and corresponding graphs are plotted for all the three protocols, AOMDV, AODV and DSR with varying pause times, speeds. The mobility model used here is Random Waypoint mobility model. When one of the parameters is varied, the others are kept constant. The default values for the parameters are given below:

Route discovery frequency:

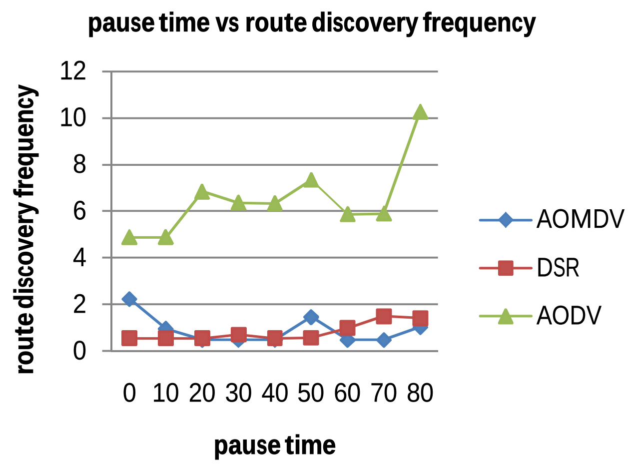

Figure 1 shows route discovery frequency with varying pause times

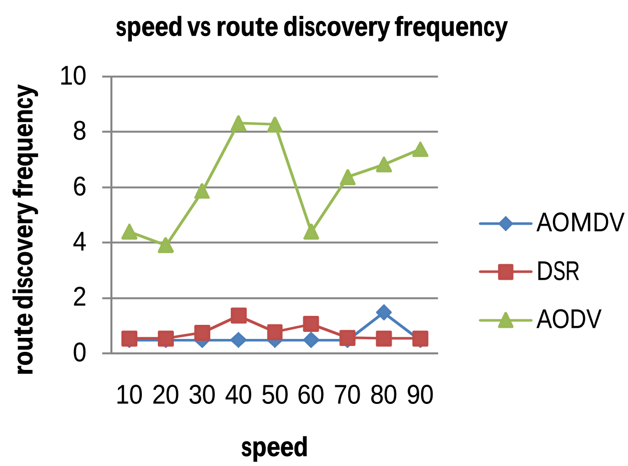

Figure 2 shows route discovery frequency with varying speeds

The route discovery frequency of AOMDV is observed to be lesser than that of AODV and DRS and it is due to the availability of alternate routes already available in the AOMDV routing table which prevents the issue of route requests on failure of a route. Whereas in the other two, new routes have to be found on a route failure and this adds to the route discovery frequency. From above graphs it is clear that AOMDV results in lesser route discovery invocations than the other two and thus have the potential to reduce delays.

End-to-end delay:

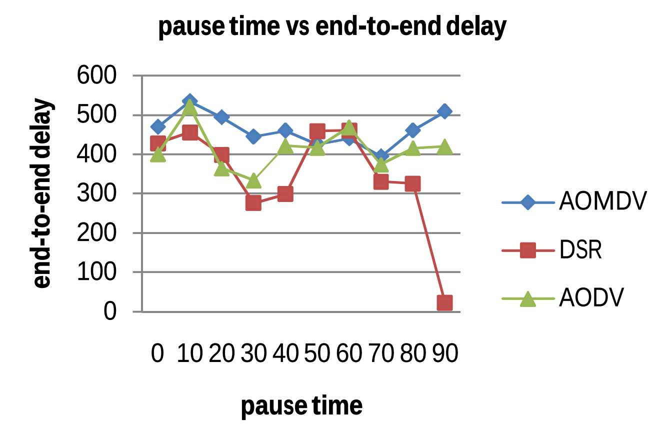

Figure 3 shows end-to-end delay with varying pause times

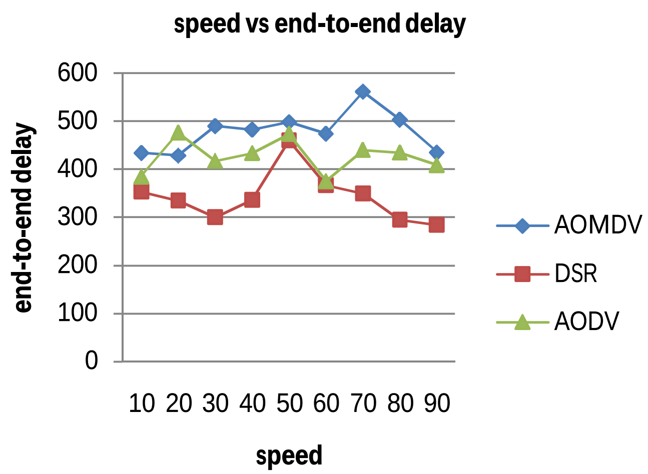

Figure 4 shows end-to-end delay with varying speeds

The end-to-end delay of AOMDV can be observed to be more than AODV and DSR and this can be attributed to the increased delay for connection establishment and other overhead associated with the TCP connection management.

Packet delivery ratio:

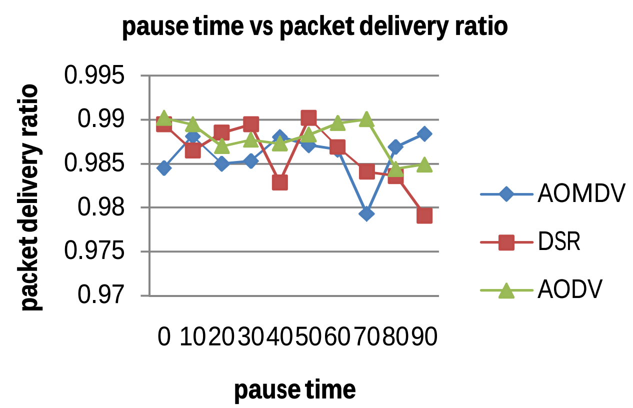

Figure 5 shows packet delivery ratio with varying pause times

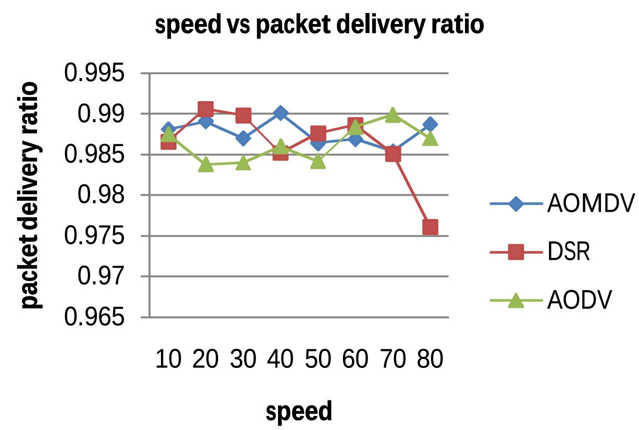

Figure 6 shows packet delivery ratio with speeds

The average packet delivery ratio of all the three protocols can be observed to be not varying much. This is because in AODV, an intermediate node drops a packet when it does not have a route to forward the packet. The source also drops packets when the buffer overflows or when it fails to get a route after several futile route discovery attempts. But in AOMDV, the availability of alternate routes at both source and intermediate nodes is made use of and hence resulted in little greater PDR.

Routing overhead:

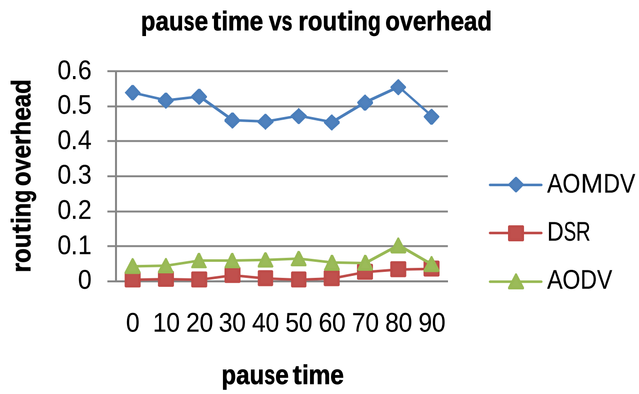

Figure 7 shows routing overhead with varying pause times

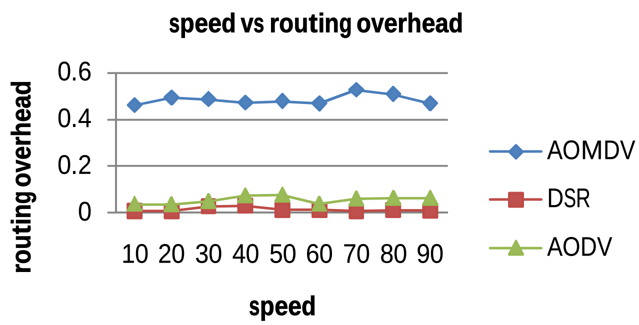

Figure 8 shows routing overhead with varying speeds

The routing overhead in AOMDV is found to be more than in AODV and DSR and this can be attributed to the flooding of route requests and transmission of route replies.

7. CONCLUSION

The performance of three popular on-demand routing protocols, AOMDV, AODV and DSR is evaluated by comparing various parameters like route discovery frequency, packet delivery ratio, end-to-end delay and routing overhead. From the results it can be concluded that AOMDV performs very well with respect to route discovery frequency and it is due to this factor that end-to-end delays are comparatively lower than AODV and DSR. However, routing overhead in AOMDV is very high than in AODV and DSR and this is due to the flooding of requests and transmission of replies. This factor drains away the battery power of the mobile nodes which is otherwise a critical factor in the survival of MANETs. Packet delivery ratio in AOMDV is comparatively better than in AODV and DSR. Hence we can conclude that AOMDV performs well in achieving better delays and in situations where routing overhead i.e. network load is of no importance. In the latter mentioned scenario, AODV performs better than AOMDV. Also we can conclude that DSR performs well in the respect of routing overhead than AODV and DSR.

REFERENCES

[1] Mobile Ad-hoc network (MANET), www.ietf.org/html.charter/manetcharter.

[2] SujataAgrawal, Dr. M.B. Daigavane, Dr.K.D.Kulat, "**Performance Evaluation Of Routing Protocols For Wireless Ad-hoc Network**", *International Journal of Advanced Engineering Technology, IJAET/Vol.III/ Issue* I/January-March, 2012/13-17.

[3] TahirSaleem, KifayatUllah, "**Performance Issues of Routing Protocols in Mobile Ad-hoc Networks**", Master of Science in Electrical Engineering, Thesis no: MEE 10:95 November, 2010.

[4] Carlos de Morais Cordeiro and Dharma P. Agrawal, "Mobile Ad-hoc networking".

[5] Mahesh K. Marina, and Samir R. Das, "**Ad-hoc on-demand multipath distance vector routing (AOMDV)**", *Published online in Wiley InterScience, Wirel. Commun. Mob. Comput.2006;* 6:969–988, DOI:10.1002/wcm.432.

[6] Charles E.Perkins, Elizabeth M.Royar, "**Ad-hoc on-demand distance vector routing (AODV)**", *Network working group, RFC 3561,* July 2003.

[7] Nikhil patearia, "**Performance analysis of DSR protocol in MANET**", *Journal of Global research in computer science, volume 2,* No.10, October 2011.

[8] David B.Johnson and David A.Maltz, "***Dynamic Source Routing in Ad-hoc wireless Networks***", in Mobile computing, edited by Tomaszimielinski and Hank korth, Chapter 5, pp.153-181, Kluwer Academic publishers, 1996.

[9] NS-2 Network simulator http://www.isi.edu/nsnam/ns.

[10] The VINT Project, "**The ns Manual (formerly ns notes and documentation**)",http://www.isi.edu/nsnam/ns/ns-documentation.html, Nov, 2011.