Feasibility Study and Performance Evaluation of Popular Routing Protocols AODV and DSR in Wireless Mesh Networks

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Summary
Wireless mesh networks are part of ad hoc networks that have potential to deliver internet broadband access, wireless local area network coverage and network connectivity for stationary or mobile host at low cost. The technique involves a network of wireless routers relaying each others packets in a multi-hop fashion. In this paper, we evaluate the performance of the Dynamic Source Routing (DSR) and Ad-hoc On-demand Distance Vector (AODV) protocols for hybrid WMNs, which are a special type of wireless mesh network that are comprised of both static infrastructure nodes as well as mobile client devices, depending on certain performance metrics like Packet Delivery Ratio, Routing Overhead, Latency, Dropped Packets etc. While existing works on performance evaluation of ad hoc and WMN routing protocols are typically performed either via simulations or via experiments on test-beds, comparisons of results from simulation method is provided.
Keywords:
WMNs, DSR, AODV, ROUTE-REQUEST, ROUTE-REPLY

I. INTRODUCTION

Wireless communication is without a doubt a very desirable service as emphasized by the tremendous growth in cellular and wireless local area networks. But the cellular networks offer a wide area coverage, but the service is relatively expensive and offer low data rates, on the other hand, the WLANs have rather limited coverage. Wireless Metropolitan area networks(WMNs) partially bridges this gap ,offering high data rates with guaranteed quality of service. The main draw back of WMNs is their lack of mobility support and line of sight requirement.
Wireless mesh networks have the potential to eliminate many of these disadvantages by offering low cost , wireless broadband internet access both for fixed and mobile users.
WMNs are self organized wireless network in which component parts can connect each other with multiple hops. In WMN nodes comprised of mesh routers and mesh clients. There exists three main types of architectures of WMNs. these include infrastructure/backbone WMNs, client WMNs and Hybrid WMNs. In infrastructure WMNs, the mesh routers form a high band width connectivity to mesh clients. In these networks, mesh clients communicate with each other via the mesh router, but never they have to do perform the routing or forwarding function. Client WMNs are another name for the mobile adhoc network. Hybrid WMN is the combination of infrastructure and client meshing. The use of adhoc routing protocols provides WMNs with a number of positive feature such as ability to self configure, self heal and self optimize. As the Internet constantly expands, the amount of available on-line information expands correspondingly. The issue of how to efficiently find, gather and retrieve this information has led to the research and development of systems and tools that attempt to provide a solution to this problem. These systems and tools are based on the use of MA (Mobile agents) technology.

II. RELATED WORK

In [1], AODV-CGA, a reactive hop by hop routing protocol based on AODV is been discussed, but it exhibits limited scalability and because of high route set up time, the packet delivery ratio is low. FBR, proactive field based routing protocol has better performance, but it is not scalable to the network size. GSR, Gateway Source Routing protocol is scalable to size and has no route set up delay. OLSR[2] is a proactive routing protocol ,which uses multipoint relays concept. The idea of MPR is to reduce flooding of broadcast packets by reducing the no of packets to be retransmitted.

III. AODV protocol

AODV is an on-demand protocol, since it finds routes only when required. AODV makes use of the route establishment and maintenance mechanism from DSR protocol and hop by hop routing from Destination Sequenced Distance Vector protocol. To avoid the problem of routing loops AODV makes use of sequence numbers in control packets. When a source node

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communicates with a destination node whose route is unknown ,it broadcasts a route request packet. When an intermediate node forwards RREQ, it records the address of neighbor from which first packet of the broadcast is received, there by establishing a reverse path, when the RREQ reaches a node that is the destination ,replies by unicasting the route reply towards the source node. If the destination or some intermediate node moves ,RERR message will be propagated. The source node may then choose to either stop ending data or reinitiate route discovery.

IV. DSR protocol

DSR uses IP source routing. All data packets that are sent using the DSR protocol contain the complete list of nodes that the packet has to traverse. DSR uses three different types of control packets i.e ROUTE-REQUEST,ROUTE-REPLY AND ROUTE-ERROR. During route-discovery, the source node broadcasts a ROUTE-REQUEST packet with a unique identification number. The route-request packet contains the address of the destination node. In order to control the spread of ROUTE-REQUEST packets, the broadcasting is done in non-propagating manner. The recipient node creates a ROUTE-REPLY packet, which contain the complete list of nodes that the route-request packet has traversed. The destination node may respond to one or more incoming ROUTE-REQUEST packets. Similarly, the source node may accept one or more ROUTE-REPLY packets for a single target node.

V. SIMULATION

NS2 is a discrete event simulator which is extensively used for network simulation experiments. We used NS2 version 2.29 for our experiments. The following table 1.1 lists the parameters are considered in the simulation.

Table 1.1 Simulation Parameters.

Simulator	NS2
Simulation Area	1000 X 1000
Simulation time	900s
Transmission range	250 m
Mesh client Speed	5,10,15,20 m/s
Packet Size	512 bytes
Transmission rate	0.064,0.128,0.256,0.5
Traffic type	CBR
Mobility models	Random Way Point

For the purpose of performance evaluation of 2 protocols - AODV and DSR, a network with 4 mesh routers and 6 mesh clients have been created. Mesh routers are placed statically so that it helps the mesh clients in establishing reliable connection to the network. Initially mesh routers are fixed at their respective positions. During simulation, the mesh clients move and connect the different mesh routers. Two CBR connections –MC1 to MC6 and MC2 to MC5 are established. The simulations are carried out for the following performance metrics. Packet delivery ratio: ratio between the number of packets successfully received at the destination and the total number of packets sent by the same. Routing overhead: The ratio of total number of control packets generated to the total number of data packets. Latency: time taken by the packets to reach their respective destinations.

VI. RESULTS AND DISCUSSIONS

The performance analysis was conducted in the simulation layout to evaluate the performance of AODV and DSR protocol in Hybrid WMN by varying the client speed and transmission rate (traffic load).

(i) Transmission Rate In the first test we vary the Mesh Client speed from 0.064,0.128,0.256 and 0.512 Mbps. keeping the speed fixed at 20 m/s. The results for the first test are shown in Fig 1. The results obtained shows Packet Delivery Ratio vs transmission rate. The packet delivery ratio is 100% to 25% for AODV and 80% to 10% for DSR for the client transmission rate 64 kbps to 512 kbps. PDR is high when transmission rate is 64 kbps for AODV and DSR.

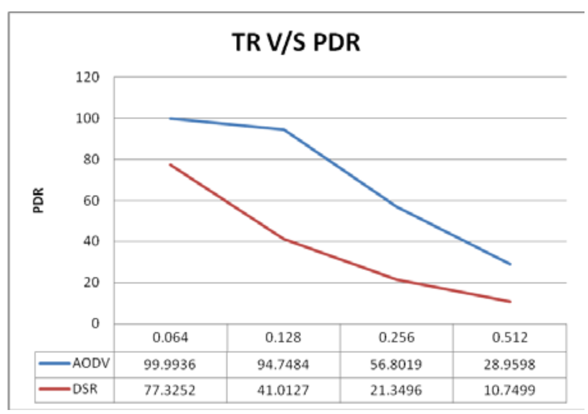

Fig.1. Packet Delivery Ratio vs. Transmission Rate

But AODV outperforms DSR in the initial stage. It shows to be winner throughout and also keep the PDR 94% at 128 kbps and drops to 56% for 256 kbps. This is because AODV does not maintain stale routes in it and takes more time establish connection during mobility of the mesh clients. The movement of mesh client at 256 kbps posses a great in packet delivery. But DSR degrades drastically with a very low rate of 10% when transmission rate is 512 kbps.

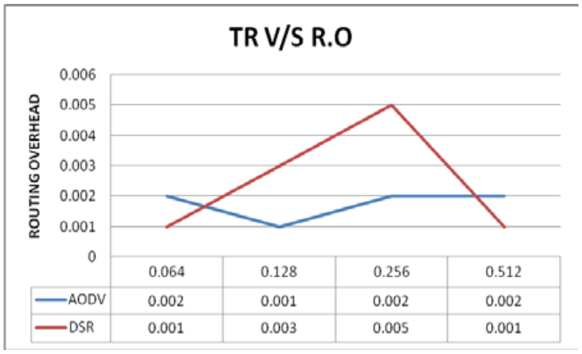

Fig 2. Transmission rate vs routing overhead

Fig.2 shows the performance of AODV and DSR protocol on the basis of routing overhead by varying transmission rate from 63 kbps to 512 kbps. The best result was on routing overhead is at 128 kbps with client speed of 20 m/s. The evaluation does not produce expected result for AODV for routing overhead at transmission at 256 kbps. Once the routes get established both the protocols start behaving decently and use less routing overhead packets.

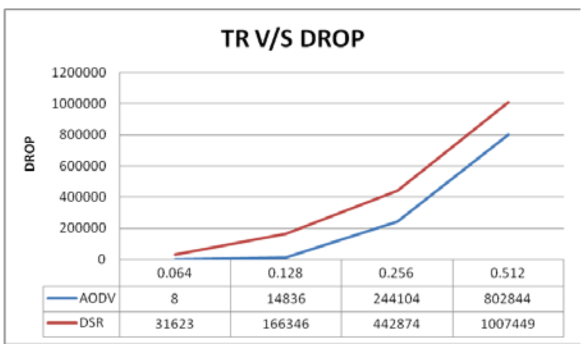

Fig. 3 Drop vs Transmission rate

The drop is very minimum for AODV and high for DSR for the client transmission rate 64 kbps to 512 kbps which is depicted in Figure 3. Drop is high when transmission rate is 512 kbps for DSR and less for AODV.

But AODV outperforms DSR in the initial stage. It shows to be winner throughout and also Keep the drop 89% less compared to DSR at 128kbps and drops to 55% less for 256kbps. This is because AODV does maintain proper routes in it and takes less time establish connection during mobility of the mesh clients. The movement of mesh client at 512 kbps posses a great loss in drop of packets. But DSR degrades drastically with a very high rate of drop when transmission rate is 512 kbps. Thus the acceptable value of 15% packet is dropped, above which the values are unacceptable. The ideal range for reducing the dropped packets is from the transmission rate of 64 kbps to 256 kbps for client speed kept 20 m/s as constant.

(ii) Speed The packet delivery ratio is 100% to 25% for AODV and 80% to 10% for DSR for the client transmission rate 5 to 20 m/s. PDR is constant for varying speed for AODV and DSR.

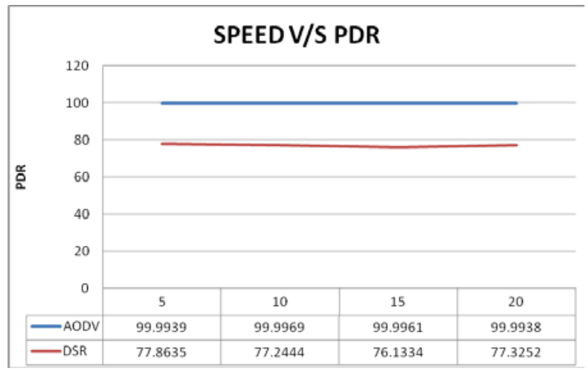

Fig 4. Speed vs Packet Delivery Ratio

But AODV outperforms DSR at every stage. It shows to be winner throughout and also keep the PDR approximately 100% with varying speed. This is because AODV keep sending hello packets continuously with varying speed and does not takes more time establish connection during mobility of the mesh clients. But DSR maintains 77-76% throughout varying speed takes more time for initial route setup and maintains stale routes as well.

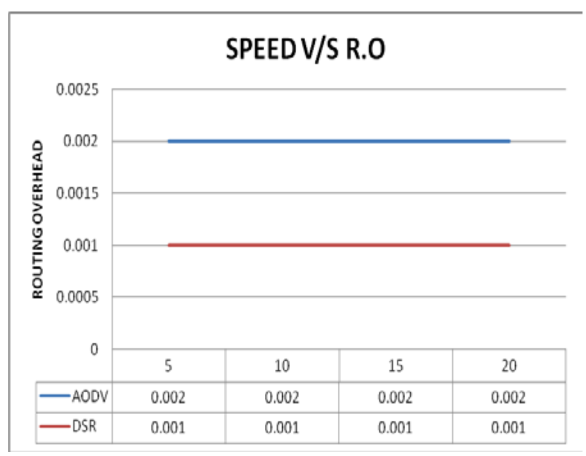

Fig 5. Speed vs Routing overhead

Fig.5 shows the performance of AODV and DSR protocol on the basis of routing overhead by varying transmission rate from 5 m/s to 20 m/s. The best result is for DSR which takes 50% less routing overhead than AODV.

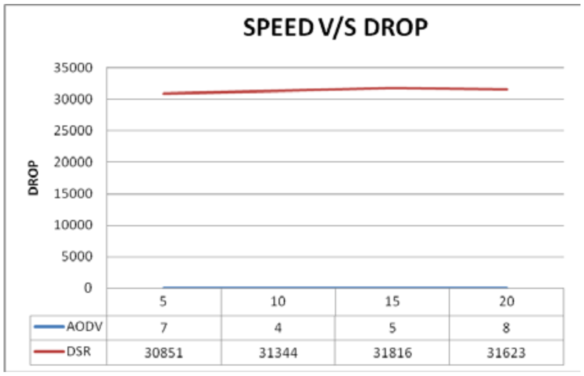

Fig. 6 Speed vs Drop

The drop is very minimum (almost zero) for AODV and high for DSR for the client transmission rate 5 to 20 m/s which is depicted in figure 6. The drop rate is almost same for varying speed intervals. But AODV outperforms DSR in the all the stages. It shows to be winner throughout and also keep the drop 100% less compared to DSR at varying speed. This is because AODV does maintain proper routes in it and takes less time establish connection during mobility of the mesh clients. The movements of mesh client with respect to DSR shows or posses a great loss in drop of packets. But DSR maintain drop rate through constantly which tells that speed does not have the effect on correct connections once the routes are established properly.

VI. CONCLUSION

Hybrid Wireless Mesh Network represents a combination of mobile ad hoc network and an infrastructure mesh network. These networks support a different ways and means of communication nodes, where routes can be established using either or both Mesh Routers and Clients. The two popular reactive protocols are currently used in our experimental simulations. However, the protocol's potential has not been fully exploited and by far and large its application has been to restricted to MANETs. In this paper we have used the AODV and DSR protocol in hybrid wireless mesh networks and evaluate its performance under varying speeds and traffic loads. In order to obtain the proper results of the performance of the routing protocols we have carried out tests for transmission rate and speed (mobility) of the mesh client. The performance of AODV and DSR protocol in Hybrid Mesh Networks are carried out by considering the performance metrics of packet delivery ratio, routing overhead and dropped packets in varying transmission rate with client speed has been evaluated. The results has been observed and analyzed from the graph depicts that AODV provides 80-100% of packet delivery ratio for both transmission rate and speed. The DSR has minimum routing head over AODV and also AODV has minimum number of dropped packets as compared to DSR. Thus, it shows that even though AODV has high routing overhead, but it outperforms DSR in PDR and packet drop. AODV has to be declared as clear winner over DSR.

As a future work, the performance evaluation of TORA and other WMN suitable routing protocols can be evaluated for mesh network. The evaluation may be carried out exclusively new performance metrics which are derived for Mesh Network along with varying various parameters which affect the network performance.

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