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Analysis of Two Routing Protocols of MANET:AODV and DSR

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Abstract: *Mobile Ad hoc Networking (MANET) is becoming increasingly important in today's world in which routing protocols are used to discover routes between nodes to facilitate communication. Though many routing protocols have been developed to provide the kind of dynamic behaviour needed for ad hoc networks, each of the protocols exhibit their least desirable beahviour and have some unique characteristics when presented with a highly dynamic interconnection topology. In case, the unique characteristics of them can be combined in one protocol, the MANET can become promising network type in future mobile applications. In this paper, we have done analysis of two of the routing protocols, namely AODV and DSR based on parameters like effects of changing node mobility, bit rates, and pause time on average end to end delay, throughput and control packet overhead.*

Keywords*: MANET, Throughput, AODV, DSR, NS-2.*

1. INTRODUCTION

A Mobile Ad Hoc Network is made of a collection of mobile nodes that can be interconnected by a multihop path and without any need of a wired infrastructure [1]. The nodes may be located in or on airplanes, ships, trucks, cars, perhaps even on people or very small devices, and there may be multiple hosts per router. Therefore, MANET can be seen as an autonomous system or a multi-hop wireless extension. As an autonomous system, it has its own routing protocols and network management mechanisms and should provide support to the various Quality-of-Service (QoS) applications that transit via the networks.

Being independent on pre-established infrastructure, mobile ad hoc networks have advantages such as rapid and ease of deployment, improved flexibility and reduced costs. Mobile ad hoc networks are appropriate for mobile applications either in hostile environments where no infrastructure is available, or temporarily established mobile applications which are cost crucial.

The routing protocols are responsible for exchanging the route information, finding a feasible path to a destination based on criteria such as hop length, minimum power required, and lifetime of wireless link, gathering information about the path breaks, mending the broken paths, expending minimum processing power and bandwidth. The major challenges which a routing protocol faces includes mobility of nodes, Location Dependant Contention**,** Bandwidth Constraint, Error-prone and shared channel, Distributed operation, Loop-Freedom, Demand-based operation, Proactive operation, Security, Unidirectional link support,

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2. EXISTING ROUTING PROTOCOLS

The routing protocols have been generally categorized as Table-driven, Source-initiated (demand-driven) and hybrid protocols. Table-driven routing protocols are proactive in the nature and aim to maintain consistent, up-to-date routing information from each node to every other node in the network. Such protocols need each node to maintain one or more tables for storing routing information, and they respond to changes in network topology by propagating updates throughout the network for maintaining a consistent network view [2]. The areas in which they differ are the number of necessary routing-related tables and the methods by which changes in network structure are broadcast. Major table-driven ad hoc routing protocols are Wireless Routing Protocol (WRP)[3], Destination Sequenced Distance Vector (DSDV) and Clustered Gateway Switch Routing [4].

The Source-initiated on Demand Routing protocols are reactive in nature and the aims to create routes only when desired by the source node. When a node requires a route to a destination, it initiates a route discovery process within the network. This process is completed once a route is found or all possible route permutations have been examined. Once a route has been established, it is maintained by a route maintenance procedure until either the destination becomes inaccessible along every path from the source or until the route is no longer desired. Major On Demand routing protocols are Ad Hoc On Demand Distance Vector Routing (AODV) [5], Dynamic Source Routing (DSR) protocol [6], Temporally Ordered Routing Algorithm [7], Signal Stability Routing (SSR) [8], Associativity Based Routing (ABR) Protocol [9].

The hybrid routing protocols combine both the proactive and reactive approaches to bring together the advantages of the two approaches. Zone Routing Protocol (ZRP) is a hybrid protocol, which divides the network into non-overlapping routing zones [10]. The hybrid protocols are proposed to reduce the control overhead of proactive routing approaches and decrease the latency caused by route search operations in reactive routing approaches. Within the zones it has a more proactive scheme and between zones it has reactive schemes.

3. DESCRIPTION OF AODV AND DSR ROUTING PROTOCOLS

3.1 Ad hoc On Demand Distance Vector Routing Protocol (AODV)

The Ad Hoc On-demand Distance Vector Routing (AODV) protocol [5] is a reactive unicast routing protocol. It maintains the routing information in routing tables at nodes about the active paths only. Every mobile node keeps a next-hop routing table, which contains the destinations to which it currently has a route. A routing table entry expires if it has not been used or reactivated for a pre-specified expiration time.

When a source node wants to send packets to the destination but no route is available, it initiates a route discovery operation. In the route discovery operation, the source broadcasts route request (RREQ) packets. A RREQ includes addresses of the source and the destination, the broadcast ID, which is used as its identifier, the last seen sequence number of the destination as well as the source node's sequence number. Sequence numbers are important to ensure loop-free and up-to-date routes. To reduce the flooding overhead, a node discards RREQs that it has seen before and the expanding ring search algorithm is used in route discovery operation.

3.2 Dynamic Source Routing (DSR) Protocol

The Dynamic Source Routing (DSR) [6] is a reactive unicast routing protocol that utilizes source routing algorithm. In source routing algorithm, each data packet contains complete routing information to reach its destination. Additionally, node uses caching technology to maintain route information that it has learnt.

There are two major phases in DSR, the route discovery phase and the route maintenance phase. When a source node wants to send a packet, it firstly consults its route cache. If the required route is available, the source node includes the routing information inside the data packet before sending it. Otherwise, the source node initiates a route discovery operation by broadcasting route request packets. A route request packet contains addresses of both the source and the destination and a unique number to identify the request. Receiving a route request packet, a node checks its route cache. If the node doesn't have routing information for the requested destination, it appends its own address to the route record field of the route request packet. Then, the request packet is forwarded to its neighbors. To limit the communication overhead of route request packets, a node processes route request packets that both it has not seen before and its address is not presented in the route record field. DSR has increased traffic overhead by containing complete routing information into each data packet, which degrades its routing performance.

4. RELATED WORK

Comparison of different routing protocols is reported in earlier works. However the present work is different from all of them in input parameters and objectives.

Ahuja *et al*. [11] have compared the performance of TCP over DSR, DSDV, AODV and SSA protocols. Their simulation was for 25 nodes and 250 scenarios. Perkins et. al. [12] has given the performance comparison of the two routing protocols AODV and DSR for fixed number of nodes. E.M. Royer *et al*. [2] have examined routing protocols for ad hoc networks and evaluated them on the basis of a given set of parameters. Broch *et al*. [13] have evaluated for ac hoc routing protocols with an earlier version of AODV (without query control optimizations) for 50 nodes with traffic loads of 4 pks/s, and 210 scenarios.

5. EXPERIMENTAL SET-UP

We have tested both the protocol the two routing protocols i.e. AODV and DSR by simulation using NS-2. Random Waypoint Model (RWM) is used to generate node position and movement, number of nodes, simulation area, and pause time of 0 to 600 seconds with increments of 50 seconds during the simulation time of 600 seconds. The simulation area used for mobile node movement is 1500m x 500m in which a node starts its journey from a random location and moves to a random destination with randomly selected speed which is distributed uniformly between 0 to 50 m/sec. On reaching the destination, another destination is selected after a pause. The sources used are Continuous Bit Rate traffic connectors with a packet size 512 bytes and in order to test various load conditions in the network the rate of packet generation is varied.

6. RESULTS

In order to compare the performance of the two routing protocols, we evaluate them with respect to following metrics:

- *Average end to end delay:* The delay packet suffers between leaving the sender application and arriving at the receiver application.
- *Throughput:* The ratio between the number of packets sent out by the sender application and the number of packets correctly received by the corresponding peer application, and
- *Control packet overhead:* Total number of routing packets transmitted.

6.1 Mobility

The effect of mobility on the throughput is shown in Fig.1. When the nodes move a very slow speed both the routing

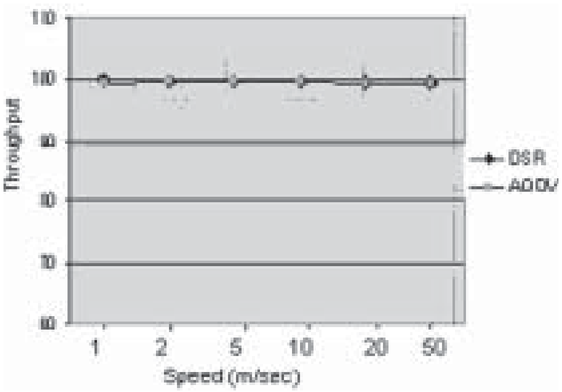


Figure 1: Effect of Mobility on Throughput

protocols (AODV and DSR) have 100 % throughput. As the speed of node increases, throughput decreases in both the routing protocols, this is due to frequent link changes and connection failures at higher speeds

The effect of mobility on control packet overhead is shown in Fig.2. The variation in control packet overhead is more in DSR as compared to AODV protocol.

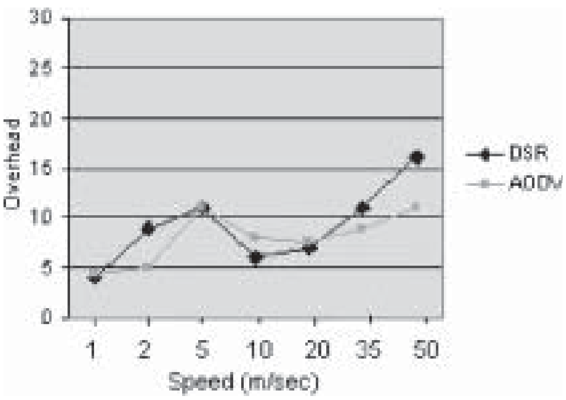


Figure 2: Effect of Mobility on Overhead

Fig.3 shows that the average end to end packet delay increases sharply in the AODV with increase in node mobility. This is because of more route discoveries with increase in node speed as AODV maintains only one routing entry per destination.

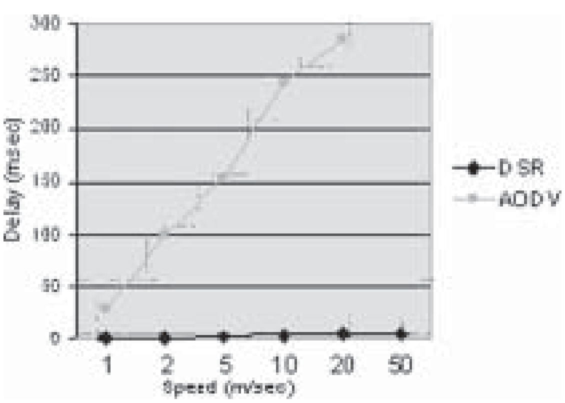


Figure 3: Effect of Node Speed on Delay

6.2 Effect of Pause Time

On reaching the destination, nodes stop for a Pause time and then move towards another destination. As the time pause time between movements increases towards the final simulation time, the shift from highly dynamic to static topologies take place. The throughput performance of the two protocols AODV and DSR as the pause time for the nodes changes is shown in Fig. 4. Both the protocols exhibit greater throughput when the pause time for the nodes is large. The throughput is 100 % when the nodes are static and on an average AODV and DSR have throughput of 97% in all the cases. The DSR performs well with larger number of nodes even with small pause time.

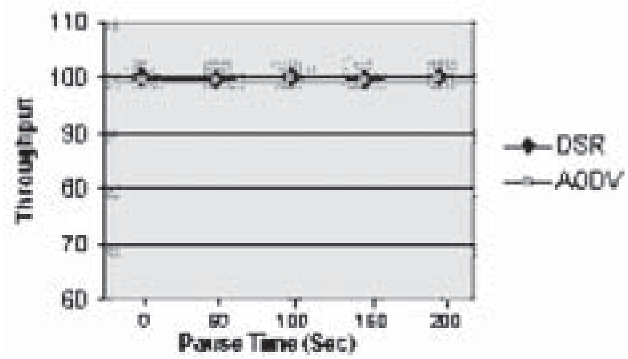


Figure 4: Effect of Pause Time on Throughput

As shown in Fig.5, DSR has the minimum Control Packet Overhead, the overhead increases slightly as the speed of nodes increase. In AODV almost the control packet overhead halves as the pause time increases as seen in the Fig. 5. This is due to the hidden cost of keeping the throughput constant. The overhead of AODV is comparable to DSR at low node speeds but the overhead increases sharply as node speed increases.

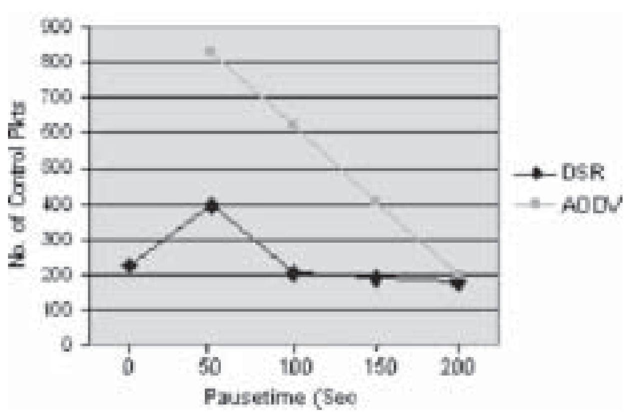


Figure 5: Effect of Pause Time on Overhead

6.3 Effect of Bit Rate

In order to examine the performance of the two protocols in terms of end-to-end delay, throughput and control packet

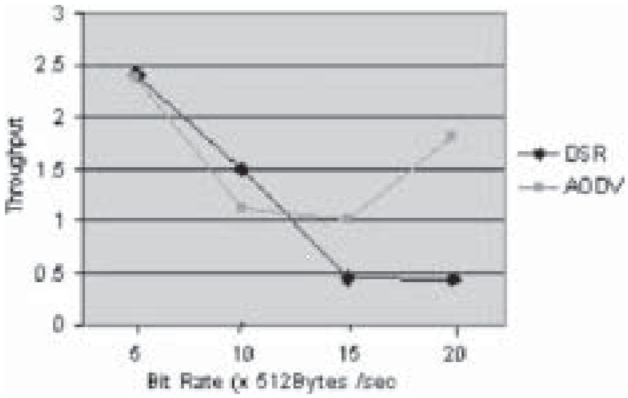


Figure 6: Effect of Bit Rate on Overhead

delay with change in the bit rate, we pumped as much data as possible from the mobile nodes. The control packet overhead decreases as the bit rate increases as seen in Fig.6, this is a deviation from our intuition and is because of increase in the number of data packets received for every packet sent as the bit rate is increased. For finding out the route for more data packets, only one route discovery packet is used. The control packet overhead in AODV increases as the bit rate increases from 10 Kbps. This puts limit on traffic handling capacity of AODV.

The average end-to-end delay increases as the bit rate is increased as seen from Fig 7. The delay increase in AODV is more as compared to the delay in DSR protocol as larger control packets are required to be sent for each packet of data sent in AODV, this results in more time of route establishment in AODV protocol.

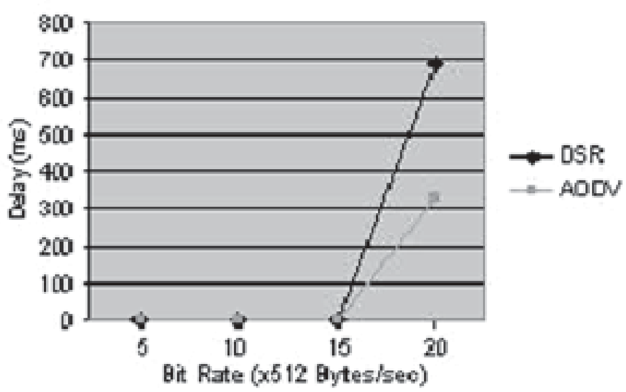
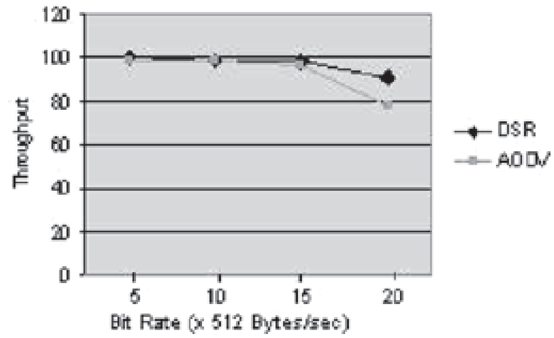


Figure 7: Effect of Bit Rate on Delay

Fig. 8 shows that the throughput decreases in AODV as well as in DSR with the increase in bit rate.

7. CONCLUSION

In this paper, we have presented the result of simulation of two on demand routing protocols AODV and DSR based on their control packet overhead, throughput and end-to-end delay in a wide range of experimental set up in which we varied the nodes speeds, bit rate, pause times and the



Figue 8: Effect of Bit Rate on Throughput

movement scenarios. DSR and AODV both use on-demand route discovery, but routing mechanisms used are different. DSR uses source routing and route caches, and is independent of any periodic or timer-based activities. DSR exploits caching aggressively and maintains multiple routes per destination. Whereas AODV makes use of routing tables, one route per destination, and destination sequence numbers, a mechanism to prevent loops and to determine freshness of routes. The performance of DSR routing protocol is observed to be better than AODV in all the conditions of the experimental set up. The AODV compromises control packet overhead and end to end packet delay with throughput.

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