Performance Comparison of AODV/DSR On-demand Routing Protocols for Ad Hoc Networks in Constrained Situation

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ABSTRACT

On-demand routing protocols for Mobile Ad-hoc networks registers unexpected performance behavior when multiple data streams are sent to common destination. This scenario is common when MANET is connected to Internet through common gateways or used in similar cases. The AODV out-perform DSR in the normal situation but in the constrained situation DSR out-performs AODV, the degradation is as severe as (30%) in AODV whereas DSR degrades marginally (10%) as observed through simulation in Glomosim. This problem has been analysed in both on-demand protocols and the improvements, has been suggested in a proposed local congestion control algorithm.

Keywords- Ad hoc networks, routing protocols, mobile networks, wireless networks, simulation, performance evaluation

INTRODUCTION

Wireless mobile networks without fixed infrastructure consists of mobile hosts that move randomly in and out of each other communication range resulting in frequent connection breaks and topology varies stochastically. Traditional table-driven routing protocols cannot perform in such environment resulting in development of on-demand routing protocols for ad hoc networks. The two prominent on-demand routing protocols are AODV(Ad hoc on-demand distance vector) and DSR(Dynamic Source Routing) .

DSR(Dynamic Source Routing) is on-demand, simple and efficient routing protocol for multi-hop wireless ad hoc networks of mobile nodes. DSR uses source routing and protocol composed of two main mechanisms-'Route Discovery' and 'Route Maintenance', which works together entirely, on-demand. The protocol allows multiple routes to destination, loop-free routing, support for unidirectional links, use of only 'soft state' in routing, rapid discovery when routes in the network change, designed for mobile ad hoc networks of upto about two hundred nodes and to work well even with high rates of mobility. The DSR internet draft 10 is accepted by IETF manet working group for the release of experimental RFC.

AODV(Ad hoc on-demand distance vector) enables dynamic, self-starting, multi-hop on-demand routing for mobile wireless ad hoc networks. AODV discovers paths without source routing and maintains table instead of route cache. It is loop free using destination sequence numbers and mobile nodes to respond to link breakages, changes in network topology in a timely manner. It maintains active routes only while they are in use and delete unused routes(stale). The IETF manet working group has accepted AODV specifications as experimental RFC(3561).

The advantage of DSR is allowing it to reduce routing load by storing routing information using route caching. AODV on the other hand manages to avoid stale routing information by means of sequence numbers.

The dynamics of AODV and DSR on the route maintenance is different which shall be considered in this paper under constraint environment.

The rest of the paper is organized as follows. In the following section, we briefly review AODV and DSR protocols, related work and motivation. In next section, we present detailed observation on constrained environment and point out problem. Further section details about the analysis of problem and solutions. Finally, presents Simulation environment followed by conclusions.

REVIEW OF AODV/DSR AND RELATED WORK

AODV

This protocol performs Route Discovery using control messages route request(RREQ) and route reply(RREP) whenever node wishes to send packet to destination. To control network wide broadcasts of RREQs, the source node use an expanding ring search technique. The forward path sets up in intermediate nodes in its route table with a lifetime association using RREP. When either destination or intermediate node moves, a route error(RERR) is sent to the affected source nodes. When source node receives the (RERR), it can reinitiate route discovery if the route is still needed. Neighborhood information is obtained from broadcast Hello packet.

DSR

This protocol has two mechanisms- Route Discovery and Route Maintenance. The source route is needed when some node originates a new packet destined for some node by searching its route cache or initiating route discovery using ROUTE REQUEST and ROUTE REPLY messages. On detecting link

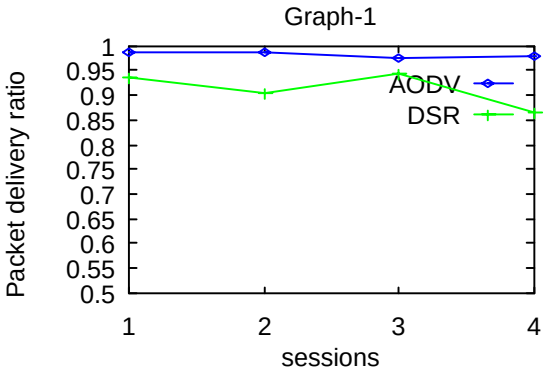
break, DSR sends ROUTE ERROR message to source for new route.

Related Work

The performance differentials are analyzed using varying network load, mobility and network size[3]. However, the aspect of scenario which was not considered important to compare the performances of AODV and DSR[2] was considered in this paper. Solutions to support Internet connectivity for a MANET have considered the ad-hoc routing protocols AODV and DSR with multiple mobile internet gateways[8,9]. MIPMANET considered internet connectivity through integration of Mobile IP and AODV[7]. The internet connectivity may frequently create scenarios of multiple sources with constant bit rate traffic leading to common destination. In this paper, the performance of AODV and DSR are compared in constrained scenarios for getting conclusions.

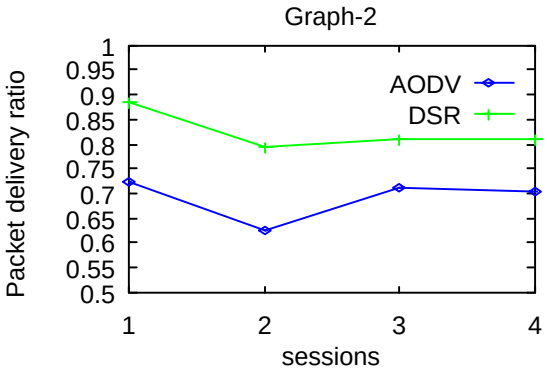
OBSERVED PROBLEM

On conducting experiment with four CBR traffic sources sessions between different to common destination using AODV and DSR. The performance metric is Average Packet delivery rate. It was observed that AODV performs better than DSR in normal case. The Graph-1 reflects the performance comparison. The details of simulation setup were given in section –V.



In another experiment four different CBR traffic sources started sessions with a common destination. The performance comparisons, as shown in graph-2, reflects that AODV suffers degradation of 30% whereas DSR suffers 10% compared to the normal situation (shown in Graph-1). On comparing their performances, it was observed that DSR performs better than AODV under the constrained situation.

The performance degradation in Average Packet Delivery ratio is due to packet drops by the routing algorithm after being failed to transfer data in the active routes. The packet drops are due to network partitioning, link break, collision and congestion in the ad hoc network. Assuming that quick link recovery through the route maintenance is desirable property of routing algorithm, there DSR has shown fast reaction in compared to AODV in the given situation which is clear from the graph-2.



ANALYSIS AND PROPOSED SOLUTION

Analysis

Assuming that problem is due to routing protocols. The reactive routing protocol triggers its operation on route break to initiate the route repair mechanism. In case of AODV, the alternative routes are limited due to fact that protocol keeps only the active routes and removes the stale ones. Therefore, unavailability of alternative routes it is referred to source node for route discovery. In the constrained situation case of multiple constant bit rate traffic sources to single destination, the congestion on routes to single destination triggers route recovery provisions of AODV in the wake of situation that intermediate nodes are unable to send the data packets, link break situation perceived by AODV sends route error of finding new route through source will result in packet drops eventually resulting in degradation of packet delivery ratio. This situation will result to localised congestion. The existing congestion control mechanism of AODV ie backoff in route request requires additional provisions for fast reactions to such congestion and route maintenance. Understanding the provisions of alternative routes in route cache in DSR, the AODV can also adopt the fast route repair locally . However, AODV keeps only active routes and do not keep alternative routes , therefore the active routes of neighbor nodes will also serve as alternative routes in local route repair mechanisms. In the situations of congestion, there is high possibility of existence of alternatives routes in the neighborhood. The proposed algorithm for local route repair in AODV exploits the by-pass route to the destination through one of the neighbor having less load. The alternative routes thus creates in the increase of the temporary capacity and diffuse the local congestion which would otherwise result in packet drops. This results to an improved performance in the packet delivery metrics.

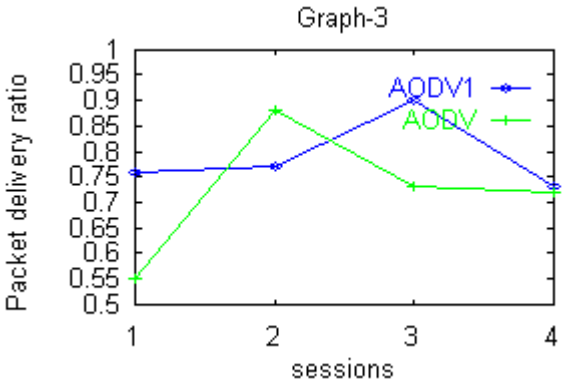
On the other hand in DSR, the route caches have more alternative routes and in the constrained environment when most of the routes are fresh, therefore the route repair is localized. Further, DSR has provision of more than one mechanism for local route repairs such as replying to Route Requests using Cached Routes, Packet Salvaging , Queued Packets Destined

over a Broken Link besides route maintenance. Thus DSR, invokes the local route repair using the alternative routes in route cache.

Solution-I Adjustment of AODV Parameters

Increase the values of following AODV parameters and values each to ensure the high availability of alternative routes and reduce rate of stale route removal process:-
Active_route_timeout, rrep_wait_time, rev_route_life,ttl_start, ttl_increment, ttl_threshold, delete_period .

The overall AODV performance can be improved to extent of 5% in the constrained situation. In the following graph it is observed that AODV1 indicates an improved performance by applying change in AODV parameters to make available more alternative routes.



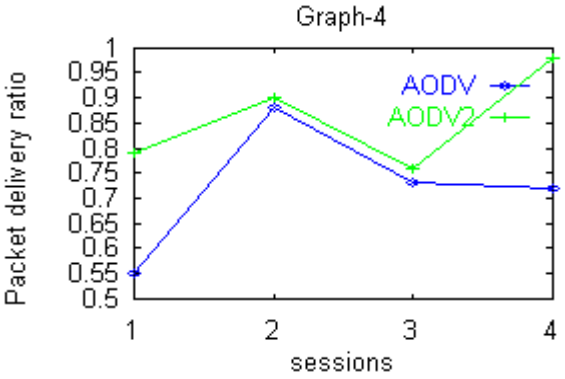
Solution-II The Algorithm

The Algorithm is invoked as the last option before the packet dropping in AODV. This mechanism will create alternative route out of neighbor's available routes .The RREQ to the neighbor will obtain the routes to destination through neighbor nodes. This will create bye-pass temporary routes for the packets considered for dropping in AODV. It will also attempt to diffuse local congestion by creating alternative routes.

The solution to improve AODV protocol due to constrained environment (congestion) :-

Local Load Balancing Congestion Control Algorithm for AODV
/* Algorithm is invoked when link failed event has occurred in data transfer while using the active route */
1 Query neighbors for route to destination
2 Select route with minimum queue length.
3 Send the data packets through alternative by-pass route
4 If no route is available then drop packet.

The performance of AODV with local congestion control algorithm is 81%(average packet delivery ratio) in the constrained environment. This improvement of 10% performance registered in AODV is almost same as the performance of DSR in the same situation. In the graph-4 AODV2 is improved using the algorithm as compared to general AODV without having considered for local route repairs.



SIMULATION ENVIRONMENT

We simulated on **GloMoSim** [6], a scalable discrete-event simulator developed by UCLA. This software provides a simulation for Mobile wireless communication with detailed propagation, radio and MAC layers.Table1 describes the detailed setup for our simulation.

Routing	AODV, DSR
MAC Layer	802.11
Bandwidth	11Mb/s
TERRAIN	1000m, 1000m
Nodes	50
Node placement	Uniform
Simulation time	500 Sec
Mobility Model	RWP(pause 3 Sec,speed 0-10m/s)
Data traffic	CBR

Table 1. Simulation settings

In our evaluation, we compare the performance of two different routing algorithms: AODV [2], DSR [1].In our evaluation, we present the set of results: end-to-end packet delivery ratio under two different scenarios, The experiments were repeated 10 times with different random seeds.

CONCLUSION

The performance of reactive routing protocol depends upon the scenario. In normal cases AODV performs better than DSR using various performance metrics. In this paper we observed DSR working better than AODV in constrained situation of several CBR traffic sources leading to same destination in the mobile communicating nodes. In the earlier works, local route repairs were not considered as important[2] for performance comparison of ad-hoc routing protocols, but importance of local route repairs was highlighted in this work. To improve the AODV performance it needs to trigger the local corrective mechanisms which are quick reactive to local route repairs to

overcome from the local congestion situation ie in constrained conditions. This paper has proposed improvements using mechanism for local congestion control in AODV.

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