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COMPARISON OF PERFORMANCE ANALYSIS OF AD-HOC ROUTING PROTOCOL

Sweta Verma* & Dr. Vivek Kumar**

A mobile ad hoc network (MANET) is a collection of wireless mobile nodes communicating with each other using multihop wireless links without any existing network infrastructure or centralized administration. To decide Routing protocols for ad-hoc networks is a great challenge. Network throughput delay and packet delivery ratio are three important parameters in the design and evaluation of mobile ad hoc networks. In recent years, a variety of routing protocols targeted specifically where Pause time was constant. In this work, we make a comparison of three prominent protocols AODV, DSR and DSDV for mobile ad hoc network by varying pause time and simulating them on NS2 [1]. Various types of scenarios are generated and each of the protocol is simulated on each of these, then their parameters like throughput, packet delivery ratio and delay will be compared. The performance differentials are analyzed using varying pause time, constant nodes and dynamic topology. Based on the observations, we make valuable conclusions about which protocol performs better in which condition.

Keywords : Destination Sequenced Distance Vector, Dynamic Source Routing, Ad-hoc On-Demand Distance Vector Routing.

I. INTRODUCTION

ALL nodes in an ad hoc network communicate with each other using multi hop wireless links. There is no stationary infrastructure; for instance, there are no base stations. And each node in the network acts as a router and it forwards data packets for other nodes. Routing in an ad-hoc network is nontrivial as they posses few characteristics [2]. Which make them different from wired networks. They are High probability of errors due to various transmission impairments, Low Transmission range to conserve energy, Frequent link breakages due to mobility, Sleep period of operation of nodes and unidirectional links, Unfavorable environmental conditions by virtue of applications of ad-hoc networks, Looping problem due to mobility, No proper Addressing scheme etc.

Routing in ad-hoc networks [3] started with the two most successful routing algorithms of wired networks: Distance Vector and Link State. Compared to Link state method, Distance vector is computationally more efficient, easier to implement and requires much less storage space. However, it is well known that this algorithm can cause the formation of both short-lived and long-lived loops (Count-to-Infinity). Almost all proposed modifications to this algorithm eliminate the looping problem by forcing all nodes in the network to participate in some form of inter nodal coordination protocol.

Such inter nodal coordination mechanisms might be effective when topological changes are rare. However, within an ad-hoc mobile environment enforcing any such inter nodal coordination mechanism will be difficult due to rapidly changing topology. Furthermore, the techniques split horizon and poisoned reverse are not useful within the wireless environment due to the broadcast nature of the transmission medium.

Link state algorithms are free of Count-to-infinity problem. However, they need to maintain the up-to-date version of the entire network topology at every node, which may constitute excessive storage and communication overhead in a highly dynamic network. Besides, Link-state algorithms proposed or implemented to-date does not eliminate the creation of temporary routing loops. Some of the link costs in a node's view can be incorrect because of long propagation delays, partitioned network, etc. Such inconsistent views of network topologies might lead to formation of routing loops. These loops, however, are short lived because they disappear in the time it takes a message to traverse the diameter of the network.

Wired networks are usually explicitly configured to have a link connecting two nodes, but there are no explicit links in ad-hoc network, and all communication is by broadcast transmission. The redundant paths in a wireless environment unnecessarily increase the size of routing updates that must be sent over the network, and increase the CPU overhead required to process each update and to compute new routes.

In this paper, we present a performance comparison of three important routing protocols for ad hoc networks by varying pause time. In particular, the main goal is the evaluation of the throughput and delay of the routing protocols by focusing on pause time. We will show that, in

* Research Scholar, Shobhit University
E-mail: sweta_verma@yahoo.com
** Prof. Galgotia College of Engineering & Technology, Greater Noida

some scenarios, proactive protocols can outperform reactive ones and vise versa. To compare the protocol behaviors, simulation results performed with NS2.

The paper is structured as in the following: in Section II, a brief description of routing protocols is discussed. In Section III the parameters of simulation and the scenario are shown, in Section IV the simulation results are plotted and argued, in Section V some conclusions are discussed.

II. ROUTING PROTOCOLS

1. DSDV: The Destination-Sequenced Distance-Vector

DSDV [4] Routing protocol is based on the idea of the classical Bellman-Ford Routing Algorithm with certain improvements such as making it loop-free. The main contribution of the algorithm was to solve the routing loop problem. Each entry in the routing table contains a sequence number, the sequence numbers are generally even if a link is present; else, an odd number is used. The number is generated by the destination, and the emitter needs to send out the next update with this number. Routing information is distributed between nodes by sending full dumps infrequently and smaller incremental updates more frequently. The DSDV is the foundation of many other distance vector routing protocols such as AODV that is addressed later.

2. AODV: Ad-hoc On-Demand Distance Vector Routing

AODV [5] [6] Is an improvement of the DSDV algorithm, which creates routes minimizes the number of broadcasts by creating routes on-demand as opposed to DSDV that maintains the list of all the routes. When a source node needs a path to a destination, it initiates a Route Discovery process by generating a broadcast packet, called Route Request (RREQ). If a node receives a not yet received RREQ, it rebroadcasts the packet. If the node receiving a RREQ is the destination or it has routing information about that destination, it replies with a Route Reply (RREP) packet which is routed back to the source by using the information stored in the nodes when RREQs are received. Each node maintains in the routing table one entry per destination (no multiple paths are stored or available).

3. DSR: Dynamic Source Routing

The key feature of DSR [7] [8] is the use of source routing, which means the sender knows the complete hop-by-hop route to the destination. The node maintains route caches containing the source routes that it is aware of. Each node updates entries in the route cache as and when it learns about new routes. The data packets carry the source route in the packet headers. The delay and throughput penalties of DSR are mainly attributed to aggressive use of caching and lack of any mechanism to detect expired stale routes or to determine the freshness of routes when multiple choices are available. Aggressive caching, however, helps DSR at low loads and also keeps its routing load down. Several additional optimizations have been proposed and evaluated to be very effective [9]. These improvements include:

- **Salvaging:** An intermediate node can replace a failed route in the data packet with route information in its own cache.
- **Gratuitous Route Repair:** Source node notifies the neighbors the error found in its packet, in order to clean up similar error in the caches of its neighbours.
- **Promiscuous Listening:** A node can update its own source routes in cache by overhearing a packet not addressed to it. The node also checks if the packet could be routed via it to gain a shorter path.

III. (1) SIMULATION PARAMETERS

Our protocol evaluations are based on the simulation of 50 wireless nodes forming an ad hoc network, moving about over a rectangular (1500 m $\times$ 300 m) flat space for 200 seconds of simulated time. We chose a rectangular space in order to force the use of longer routes between nodes than would occur in a square space with equal node density.

In order to enable direct, fair comparisons between the protocols, it was critical to challenge the protocols with identical loads and environmental conditions. Each run of the simulator accepts as input a *scenario file* that describes the exact motion of each node and the exact sequence of packets originated by each node, together with the exact time at which each change in motion or packet origination is to occur. We pre-generated 9 different scenario files with varying movement patterns and traffic loads, and then ran all three routing protocols against each of these scenario files. Since each protocol was challenged in an identical fashion, we can directly compare the performance results of the protocols.

(2) Movement Model

Nodes in the simulation move according to a model that we call the “random waypoint” model. The movement scenario files we used for each simulation are characterized by a pause time. Each node begins the simulation by remaining stationary for *pause time* seconds. It then selects a random destination in the 1500 m $\times$ 300 m space and moves to that destination at a speed distributed uniformly between 0 and some maximum speed. Upon reaching the destination, the node pauses again for *pause time* seconds, selects another destination, and proceeds there as previously described, repeating this behavior for the duration of the simulation. Each simulation ran for 200 seconds of simulated time.

We ran our simulations with movement patterns generated for 9 different pause times: 2, 10, 15, 25, 35, 50, 75, 85, 100 seconds. A pause time of 0 seconds corresponds to continuous motion, and a pause time of 200 (the length of the simulation) corresponds to no motion. Hence reducing pause time increases mobility. In this way we put our protocols in networks of varying mobility.

Because the performance of the protocols is very sensitive to movement pattern, we generated scenario files with 9 different pause times. All routing protocols were run on the same 9 scenario files. We report in this paper data from simulations using a maximum node speed of 20 meters per second (average speed 10 meters per second).

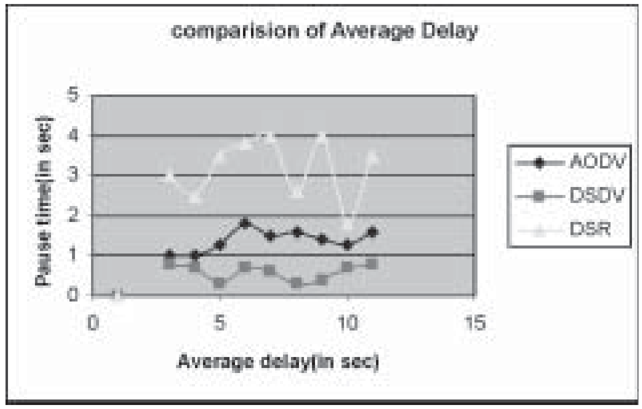

Figure 1: Average End To End Delay

(3) Communication Model

As the goal of our simulation was to compare the performance of each routing protocol, we chose our traffic sources to be constant bit rate (CBR) sources. When defining the parameters of the communication model, we experimented with sending rates of 3 packets per second, networks containing maximum connection of 35, and packet sizes of 512 bytes.

All communication patterns were peer-to-peer, and connections were started at times uniformly distributed between 0 and 180 seconds. The 9 different scenario files for maximum node movement speed (20 m/s) moving in a random waypoint model with which we compared the routing protocols.

(4) Performance Indices

In order to compare routing protocols, the following performance metrics are considered:

- **Throughput:** a dimensional parameter which gives the fraction of the channel capacity used for useful transmission selects a destination at the beginning of the simulation and (*i.e.*, data packets correctly delivered to the destinations).
- **Average End to End Delay**: the average end-to-end delay of data packets, *i.e.* the interval between the data packet generation time and the time when the last bit arrives at the destination.
- **Packet Delivery Ratio**: the ratio between the number of packets received by the TCP sink at the final destination and the number of packets originated by the "application layer" sources. It is a measure of efficiency of the protocol.

SIMULATION RESULTS AND OBSERVATIONS

DSDV which is a table driven proactive routing protocol completely wins over the on demand reactive routing protocols AODV and DSR. Since DSDV proactively keeps the routes to all destination in its table it does not have to initiate the route request process as frequently as in AODV and DSR while sending packets. Hence on average DSDV clearly has less delay. Now we can easily observe that DSR is the worst protocol in terms of delay. At high mobility and more network load (512 byte packets at 3 packets/sec) aggressive route caching strategy of DSR fails. In these stressful condition links break very often leading to invalidation of routes cached. Hence in these conditions, picking up of staled cached routes occur leading to consumption of additional network bandwidth and interface queue slots even though the packet is eventually dropped, leading to more delay.

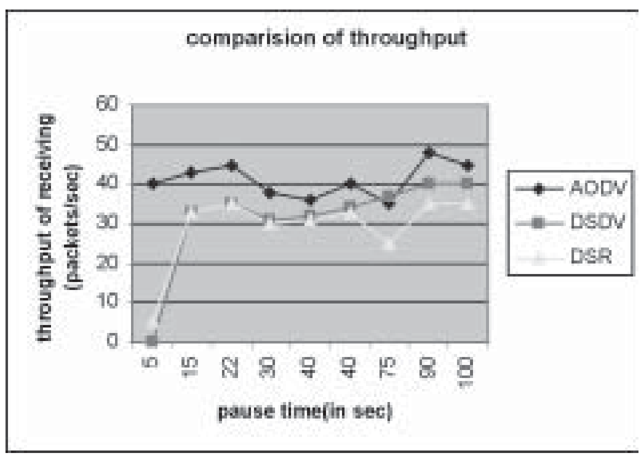

Figure 2: Throughput of Receiving Packets

DSR performed poorly in our metrics (PDR and Throughput) in these "stressful" situations (higher mobility, more network load). The reason of these phenomena is the aggressive use of route caching in DSR. In our observation, such caching provides a significant benefit up to a certain extent. With higher loads the extent of caching is deemed too large to benefit performance. Often, stale routes are chosen since route length (and not any freshness criterion) is the only metric used to pick routes from the cache when faced with multiple choices. Picking stale routes causes two problems:

- Consumption of additional network bandwidth and interface queue slots even though the packet is eventually dropped or delayed.
- Possible pollution of caches in other nodes.

With high mobility, the chances of the caches being stale are quite high in DSR. Eventually when a route discovery is initiated, the large number of replies (as all RREQs are replied) received in response is associated with higher MAC overhead and cause increased interference to data traffic. Hence, the cache staleness and high MAC overhead together result in significant degradation in performance for DSR in high mobility. An efficient mechanism to remove stale cached routes can improve performance of DSR.

On other hand since in AODV only the first arriving request packet (RREQs) is answered and further no RREQs are answered therefore it leads to less no. of replies (RREPs) Also the error packets RERRs are are broadcasted in AODV which leads to lesser MAC load as compared to unicasted REERs of DSR which leads to much MAC layer load.

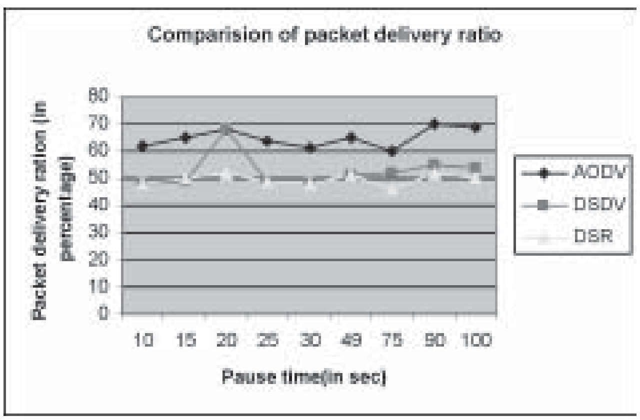

Figure 3: Packet Delivery Ratios

CONCLUSION

We have compared the performance of DSDV, AODV and DSR We used a detailed simulation model to demonstrate the performance characteristics of these protocols. By simulating we can argue that if delay is our main criteria than DSDV can be our best choice But if reliability and throughput are our main parameters for selection then AODV gives better results compare to others because its throughput and packet delivery ratio is best among others. While there are many other issues that need to be considered in analyzing the performance of ad hoc networks, we believe that our work could provide intuition for future protocol selection and analysis in ad hoc networks. While we focus only on the network throughput, reliability and the delay, it would be interesting to consider other metrics like power consumption, the number of hops to route the packet, fault tolerance, minimizing the number of control packets etc.

REFERENCES

[1] The Network Simulator-ns-2, *http://www.isi.edu/nsnam/ns/index.html,* (2005).

[2] S. R. Das, C. Perkins, and E. Royer, Performance Comparison of Two On-demand Routing Protocols for Ad Hoc Networks, Proc. of *IEEE INFOCOM,* (2000).

[3] J. Broch, D. A. Maltz, D. B. Johnson, Y. C. Hu, and J. Jetcheva, A Performance Comparison of Multi-Hop Wireless Ad Hoc Network Routing Protocols, Proc. of the ACM/IEEE International Conference on Mobile Computing and Networking (MobiCom), (1998).

[4] C. E. Perkins and P. Bhagwat, “Highly Dynamic Destination-Sequenced Distance-Vector Routing (*dsdv*) for Mobile Computers,” in Computer Communication Rev., (1994) 234-244.

[5] C. Perkins, E. Belding-Royer, and S. Das, “Ad hoc On-Demand Distance Vector (*aodv*) Routing,” in Internet Engineering Task Force (IETF) Draft, (2003).

[6] C. E. Perkins and E. M. Royer, “Ad-hoc On-Demand Distance Vector Routing,” Proc. 2nd *IEEE* Wksp. Mobile Comp. Sys. and Apps..

[7] J. Macker and S. Corson, “Mobile Ad Hoc Networks (MANET),” IETF WG Charter *http://www.ietf.org/html.charters/manet.*

[8] J. Broch, D. Johnson, and D. Maltz. “The Dynamic Source Routing Protocol for Mobile Ad Hoc Networks,” *http://www.ietf.org/internet-drafts/draft-ietfmanet-dsr-03.txt*, IETF Internet Draft, (1999), Work in Progress. 1068-MAHESH K. MARINA [StM] is a Ph.D. Student in Computer Science at the University.