

Experimental Analysis of UDP Performance in Mobile Ad Hoc Networks with Different Routing Protocols and varying payload

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ABSTRACT

The purpose of this paper is to investigate the performance of UDP over various routing protocols in ad hoc networks. For this investigation we have chosen three routing schemes, DSDV, DSR and AODV and four network scenarios of 4, 8, 16 and 32 nodes of various node mobility speeds. Results are produced by evaluating throughput and end to end packet delay over the UDP connection through simulation experiments.

KEY WORDS:

Mobile Ad hoc Network, UDP, CBR, Routing, Mobility.

1. INTRODUCTION

Mobile Ad Hoc Network (MANET) [1] is a great innovation of modern technology. In such network each mobile node operates not only as a host but also as a router and does not rely on any pre-established infrastructure.

There are two transport layer protocols: UDP and TCP. Both of these are responsible for hooking up the programs that are communicating with each other, whereas the underlying IP is simply responsible for getting the packets from machine to machine.

Because nodes in mobile ad hoc networks (MANETs) are forwarding packets for each other, some short of routing protocols is necessary to make the routing decisions. Although a number of studies have been conducted, improving and analyzing UDP performance in MANETs is still an active area of research and also a challenging task.

The remainder of this paper is organized as follows: Section 2 depicts the related works; mechanisms of routing protocols are shown in Section 3. We define the simulation model in Section 4 and present our analytical results in Section 5. The conclusion and future work follow in Section 6.

2. RELATED WORKS

Since UDP is fast and less complex protocol used in internet for real time transmissions, its performance in MANET has become an interesting and active area of research.

Christian Rohner et al. [2] have studied the effects on a low rate multihop UDP flow from a competing TCP flow. The results of this study indicated that TCP's congestion control does not seem efficient enough to only have marginal impact on the other traffic in the network. When the two data flows do not share common links, they observed increased packet interspacing in the UDP flow, caused by jitter and to some extent packet loss. In the case where UDP and TCP share a common link, contention is significantly higher resulting in increased UDP packet loss and more significant TCP interruptions.

Martin Connolly et al. [3] examined the performance of the Bluetooth protocol. Their paper presents an assessment of the performance of UDP over the Bluetooth protocol.

As stated above, most related earlier works focus on measuring performance of UDP with various protocols. But there is no absolute measurement of UDP performance as transport layer protocol for MANET. In this paper for real time transmission we evaluated the performance of UDP over DSDV, AODV and DSR routing protocols in terms of matrices such as throughput and end-to-end packet delay. Thus our work compliments previous work and can be combined to help UDP for achieve better performance in mobile ad hoc networks.

3. ROUTING PROTOCOLS IN MANET

This section describes three prominent ad hoc routing protocols in the ad hoc networking community today.

Destination Sequenced Distance Vector (DSDV): DSDV [4] is a proactive or table-driven routing protocol. In DSDV, each node maintains a routing table that has an entry for each destination in the network. The attributes for each destination are the next hop ID, hop count metric and a sequence number which is originated by the destination node. DSDV uses both periodic and triggered routing updates and guarantees loop freedom. Upon receiving a route update packet, each node compares it to the existing information regarding the route. Routes with old sequence numbers are simply discarded.

Dynamic Source Routing Protocol (DSR): The Dynamic Source Routing (DSR) [5] protocol is an on-demand routing protocol based on source routing. In the source routing technique, a sender determines the exact sequence of nodes through which to propagate a packet. The list of intermediate nodes for routing is explicitly contained in the packet's header. In DSR, every mobile node in the network needs to maintain a *route cache* where it caches source routes that it has learned. When a host wants to send a packet to some other host, it first checks its route cache for a source route to the destination. In the case a route is found, the sender uses this route to propagate the packet. Otherwise the source node initiates the route discovery process. In route discovery, the source floods a query packet through the ad-hoc network, and the reply is returned by either the destination or another host that can complete the query from its route cache. Upon reception of a query packet, if a node has already seen this ID (i.e. it is a duplicate) or if it finds its own address already recorded in the list, it discards the copy and stops flooding; otherwise, it appends its own address to the list and broadcasts the query to its neighbors. For route maintenance when a route failure is detected the node detecting the failure sends an error packet to the source, which then uses the route discovery protocol to find a new route.

Ad hoc On-demand Distance Vector Routing (AODV): The AODV [6] is a reactive protocol, which combines both DSR and DSDV characteristics. AODV borrows the basic route discovery and route-maintenance of DSR as well as hop-by-hop routing, sequence numbers and beacons of DSDV. When a source node desires to establish a communication session, it initiates a route discovery process by generating a route request (RREQ) message, which might be replied by the intermediate nodes in the path to destination or the destination node itself with the route reply (RREP) message contains the whole path to destination. Failure of a link can be detected via hello messages. Failure to receive three consecutive HELLO messages from a neighbor is taken as an indication that the link to the neighbor in question is down.

4. SIMULATION MODE

We used the discrete event Network simulator 2(Ns2) [7] from Berkley for analysis and comparison of the ad hoc routing protocols. The network simulations carried out for our study are based in 500 x 500 meter flat grid topography. We have considered four network scenarios of 4,8,16 and 32 nodes in which we have varied the speed of nodes. The mobility model uses the *random waypoint model* in a rectangular field. Each movement simulation lasted for a period of 200s. For this measurement, we have used the same traffic model that has maximum connection of 2, 4, 8 and 16 CBR (Constant Bit Rate) sources in four networks of 4,8,16 and 32 nodes respectively. The transmission rate of each node is 4 packets per second where each packet size fixed at 512 bytes.

5. PERFORMANCE RESULT

In this section we analyze the performance of UDP over AODV, DSDV and DSR based on two parameters such as mobility speed (m/s) and number of nodes considering throughput and average end to end delay for data packet delivery.

Throughput Performance: Figure1 shows the relative throughput performance of three routing protocols for various node mobility. It can be recognize that the UDP throughput for DSDV is low for all network scenarios.

In DSDV, each node maintains routing information for all other nodes. Collecting such information requires substantial amount of time. So, as topology changes due to nodes movement each node has to update its routing table. At those moments, sources fail to deliver data packets to the destination. Moreover, DSDV uses stale routing table entry that causes data packets to be forwarded over a broken link.

But DSR and AODV are reactive routing protocols. They force the nodes to maintain routing information as “on demand” basis. So throughput of AODV and DSR are grater than DSDV.

In comparison of DSR and AODV in figure1, DSR is the best cause of its having route cache. In DSR the host can buffer the data packet in order to transmit it once the route is learned using route discovery.

In the network scenarios of 4 and 8 nodes DSR and AODV fails to converge their performance due to limited routing traffic. As the number of nodes increases, more routing traffic generates. So DSR and AODV performs almost 100% throughput in the network of 16 and 32 nodes even with high mobility.

Average End-to-End Delay Performance: In figure2 DSDV shows the lowest end to end delay for UDP transmission than AODV and DSR. Because in order to discover routs DSDV takes routing information from its stale routing table that is build by periodic broadcasting. But AODV and DSR take more time to complete their route discovery processes for their on demand characteristic.

In DSR only the source takes the responsibility to store the route information in the packet header. So when a link breaks the source must need to know about the link breakage information and another new route. But in AODV not only the source but also the neighbor nodes can transmit packet through new routs after route maintenance. This is the cause of more end to end delay of DSR than AODV.

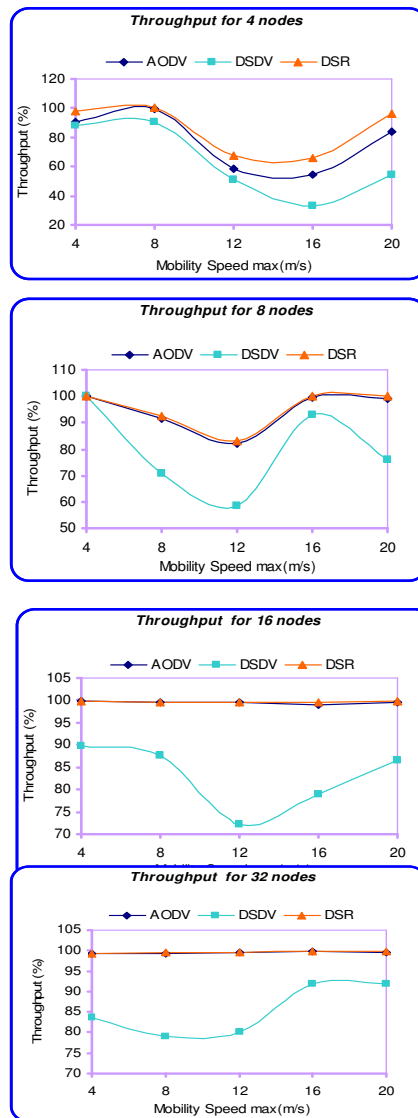


Figure 1: UDP Throughput for various nodes with various node movement speeds

Additional Measurements: From figure3 we have seen an important thing that every protocols throughput increased with the number of nodes increased as the topology is dense and the connectivity is rich.

Moreover, when the node number is small such as 4 then the end to end delay of DSR and AODV are more but after increasing the nodes such as 8, 16 and 32 the end to delay almost zero that we have seen in figure4. Because they can establish connections quickly at the time of link breakage due to neighbor nodes availability.

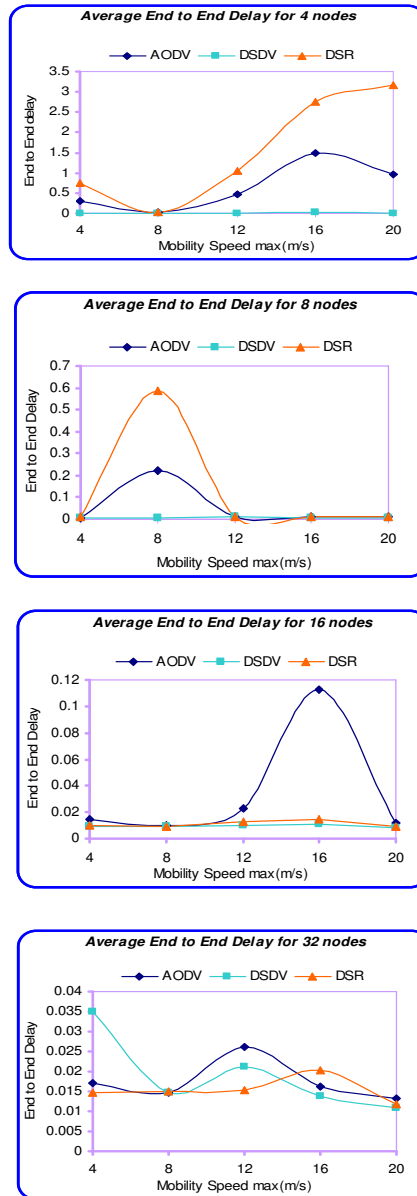


Figure 2: UDP average End to End Delay various nodes with various node movement speeds

6. CONCLUSION & FUTURE WORK

In this paper, we have investigated the performance of UDP over DSDV, DSR and AODV protocols using simulation in ns-2 for a range of node mobility. The performance metrics that we considered includes throughput, end-to-end packet delay.

We observed from the results of simulations for four network scenarios of 4, 8, 16 and 32 nodes that UDP performance (throughput) increases with the node number increases. The UDP throughput is largest over the DSR routing protocol. For AODV the throughput is almost same but DSDV degrades the performance for the largest routing overload.

We also observed that DSDV shows the lowest end-to-end packet delay for UDP transmission than AODV and DSR because for its table-driven characteristics.

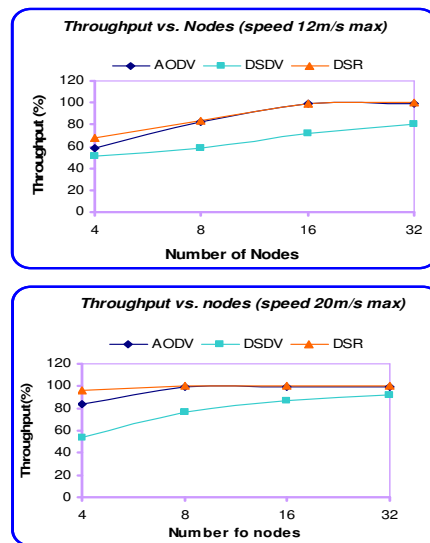


Figure 3: Throughputs in speeds 12m/s and 20m/s with respect to the number of nodes

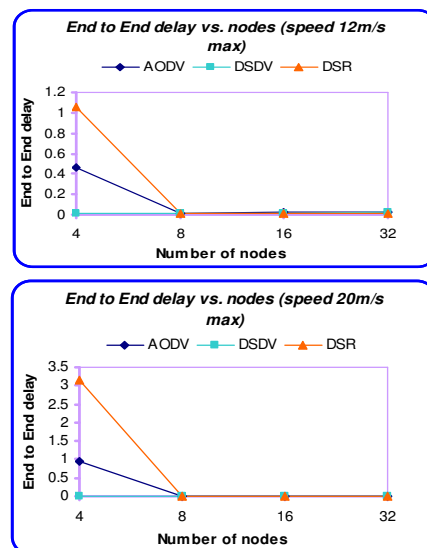


Figure 4: End to end delay in speeds 12m/s and 20m/s with respect to the number of nodes.

UDP is a fast transport layer protocol. When it is used over DSDV then it become more faster. But the source is able to deliver fewer packets. On the other hand, DSR is slower than DSDV, but its end to end delay performance is tolerable. Moreover, Source will able to deliver more packets successfully to the destination using DSR protocol, which fulfill our requirements. Thus accordingly to our observation, DSR is best suited for MANET when considering UDP as a transport layer protocol.

Because ad-hoc networks are formed without centralized control, security must be handled in a distributed fashion. Moreover, routing protocols are prime targets for impersonation attacks. Next, we plan to consider the security features of routing protocols for ad hoc networks.

References

- [1] M. Fordigh, P. Johansson and P. Laesson. "Wireless ad hoc networking the art of networking without a network", *Ericsson Review*, No.4, 2000.
- [2] Christian Rohner, Erik Nordstrom, Per Gunningberg, Christian Tschudin, "Interactions between TCP, UDP and Routing Protocols in Wireless Multi-hop Ad hoc Networks", *Uppsala University, Sweden and University of Basel, Switzerland*.
- [3] Martin Connolly, Cormac J. Sreenan, "Analysis of UDP Performance over Bluetooth", University College Cork, *Department of Computer Science*.
- [4] Charles E. Perkins and Parvin Bhagwat, "Highly dynamic destination-sequenced-distance-vector routing (DSDV) for mobile computers", *Technical report, IBM Research and University of Maryland, USA*.
- [5] David B. Johnson, David A. Maltz, "Dynamic Source Routing in Ad Hoc Wireless Networks", *Computer Science Department, Carnegie Mellon University, 5000 Forbes Avenue, Pittsburgh, PA 15213-3891, dbj@cs.cmu.edu, Kluwer Academic Publishers, 1996*.
- [6] C. E. Perkins and E. M. Royer, "Ad-hoc on-demand Distance Vector (AODV) Routing", in *MANET Working Group. IETF, Internet Draft, draft-ietf-manet-aodv-12.txt*, Nov 2002.
- [7] Kevin Fall, "Network Emulation in the VINT/NS Simulation", In Proceedings of the Fourth *IEEE Symposium on Computers and Communications (ISCC'99)*, July 2005.