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Evaluation and Delay of the Routing Protocols in Ad-Hoc Wireless Networks

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***Abstract* - A wireless Ad-hoc network consists of wireless nodes communicating without the need for a centralized administration, in which all nodes potentially contribute to the routing process. A user can move anytime in an ad hoc scenario and, as a result, such a network needs to have routing protocols which can adopt dynamically changing topology. To accomplish this, a number of ad hoc routing protocols have been proposed and implemented, which include Dynamic Source Routing (DSR), Destination Sequenced Distance Vector (DSDV) and ad hoc on-demand distance vector (AODV) routing. In this paper, we analyze the performance differentials to compare the above-mentioned commonly used ad hoc network routing protocols. We report the simulation results of three different protocols for wireless ad hoc networks having thirty nodes. The performances of proposed networks are evaluated in terms of number of retransmission attempts, Control traffic sent, Control traffic received, Data Traffic sent, Data Traffic received and throughput with the help of OPNET simulator. Data rate 2Mbps and simulation time 20 minutes were taken. For this above simulation environment, AODV shows better performance over the other two on-demand protocols, that is, DSR and DSDV.**

Index Terms - DSDV, DSR, Ad-hoc On-Demand Distance Vector Routing.

I. INTRODUCTION

Wireless networking is an emerging technology that allows users to access information and services electronically, regardless of their geographic position. Wireless networks can be infrastructure networks [1] or infrastructureless (Ad-hoc) networks. n Ad-hoc network [2] is a collection of mobile nodes which forms a temporary network without the aid of centralized administration or standard support devices regularly available in conventional networks. These nodes generally have a limited transmission range and, so, each node seeks the assistance of its neighboring nodes in forwarding packets and hence the nodes in an ad-hoc network can act as both routers and hosts, thus a node may forward packets between other nodes as well as run user applications. By nature these types of networks are suitable for situations where either no fixed infrastructure exists or deploying network is not possible. Ad-hoc mobile networks have found many applications in various fields like military, emergency, conferencing and sensor networks. Each of these application areas has their specific requirements for routing protocols. Since the network nodes are mobile, an Ad-hoc network will typically have a dynamic topology which will have profound effects on network characteristics. Network nodes will often be battery powered, which limits the capacity of CPU, memory, and bandwidth. This will require network functions that are resource effective. Furthermore, the wireless (radio) media will also affect the behavior of the network due to fluctuating link bandwidths resulting from relatively high error rates. These unique features pose several new challenges in the design of wireless, ad-hoc networking protocols. Network functions such as routing, address allocation, authentication, and authorization must be designed to cope with a dynamic and volatile network topology. In order to establish routes between nodes which are farther than a single hop, specially configured routing protocols are engaged. The unique feature of these protocols is their ability to trace routes in spite of a dynamic topology. Routing Protocols in Ad-hoc networks can be basically classified as Proactive (table driven) routing protocols and Reactive (on demand) routing protocols [3]. In Proactive routing, routes to all destinations are computed a priori and link states are maintained in node's routing tables in order to compute routes in advance. In order to keep the information up to date, nodes need to update their information periodically. The main advantage of proactive routing is when a source needs to send packets to a destination, the route is already available, i.e., there is no latency. The disadvantages of proactive routing are some routes may never be used and dissemination of routing information will consume a lot of the scarce wireless network bandwidth when the link state and network topology change fast. (This is especially true in a wireless Ad-hoc network.) In Reactive routing, protocols update routing information only when a routing requirement is presented. This implies that a route is built only when required. The main advantage of Reactive routing is that the precious bandwidth of wireless Ad-hoc networks is greatly saved. The main disadvantage of Reactive routing is if the topology of networks changes rapidly, a lot of update packets will

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be generated and disseminated over the network which will use a lot of precious bandwidth, and furthermore, may cause too much fluctuation of 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 some scenarios, proactive protocols can outperform reactive ones and vise versa. To compare the protocol behaviors, simulation results performed with NSTU Simulator. The paper is structured as in the following: in Section 2, a brief description of routing protocols is discussed. In Section 3 the parameters of simulation and the scenario are shown, in Section 4 the simulation results are plotted and argued, in Section 5 some conclusions are discussed.

II. Routing Protocols

DSR: Dynamic source routing protocol (DSR) is a reactive protocol that is known as simple and efficient, specially designed for the multi-hop mobile ad hoc network. Often called “On-demand” routing protocol as it involves determining the routing on demand unlike the pro- active routing protocols that has periodic network information. Network 12 nodes use multiple- hops to communicate, DSR protocol plays a key role in determining and maintaining all the routing automatically as the number of hops needed changes at anytime and the mobile nodes involved may leave or join the network. DSR protocol involves two major mechanisms to establish the routing process. These are route discovery and route maintenance.

DSDV: Destination Sequenced Distance Vector is a Proactive routing protocol that solves the major problem associated with the Distance Vector routing of wired. The DSDV protocol requires each mobile station to advertise, to each of its current neighbours, its own routing table (for instance, by broadcasting its entries). The entries in this list may change fairly dynamically over time, so the advertisement must be made often enough to ensure that every mobile computer can almost always locate every other mobile computer. In addition, each mobile computer agrees to relay data packets to other computers upon request. At all instants, the DSDV protocol guarantees loop-free paths to each destination. [7].

AODV: AODV [5] [6] Mobile nodes in the ad hoc network are dynamic and they use multi-hop routing by using Ad-Hoc On-Demand Distance Vector algorithm. AODV will not maintain the routes unless there is a request for route. Mobile nodes respond to the any change in network topology and link failures in necessary times. In case of the link failures the respective defective nodes are notified with the message, and then the affected nodes will revoke the routes using the lost link. This will help AODV to avoid the Bellman-Ford “counting to infinity” problem and then its operation is known as loop-free. AODV uses Destination Sequence Numbers (DSN) for every route entry. DSN is created by the destination this DSN and the respective route information have to be included by the nodes while finding the routes to destination nodes. Routes with the greatest DSN are preferred in selecting the route to destination. AODV uses the message types Route Request (RREQ), Route Replies (RREP) and Route Error (RERR) in finding the route from source to destination by using UDP (user datagram protocol) packets [19]. A typical AODV protocol follows the following procedure while routing. A source node intending to communicate to a destination it generally uses the RREQ constituting the source address and the broadcast ID address to its neighboring nodes to find the route to destination. This broadcast ID is incremented for every new RREQ. Once a neighbor notice a destination route it will respond with RREP to the source 16 If the destination route is not found then it will re-broadcast the RREQ to its corresponding neighboring nodes by incrementing hop count. In this process a node participating in communication may receive the numerous copies of the broadcast packets in the pool of transmissions from all the corresponding nodes. Then the node cross check the broadcast ID of the request if the broadcast ID is new and have not received so far by the particular node then it will process the request if not the node drops down the superfluous RREQ and avoids the rebroadcast.

III. (1) Simulation Parameters

Our protocol evaluations are based on the simulation of 25 wireless nodes forming an ad hoc network, moving about over a rectangular (150 m x 30 m) flat space for 50 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 150 m X30 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 50 seconds of simulated time. We ran our simulations with movement patterns generated for 9 different pause times: 2, 10, 15, 25, 35, 50,75,90,100 seconds. A pause time of 0 seconds corresponds to continuous motion, and a pause time of 50 (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.

(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.

(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.

IV. SIMULATION RESULTS

The simulation results bring out some important characteristic differences among these routing protocols. The presence of high mobility implies frequent link failures and each routing protocol reacts differently during link failures. The different basic working mechanism of these protocols leads to the differences in the performance. DSDV fails to converge at lower pause times hence performance of the protocol decreases as mobility increases. At higher rates of mobility (lower pause times), DSDV performs poorly dropping more number of packets.

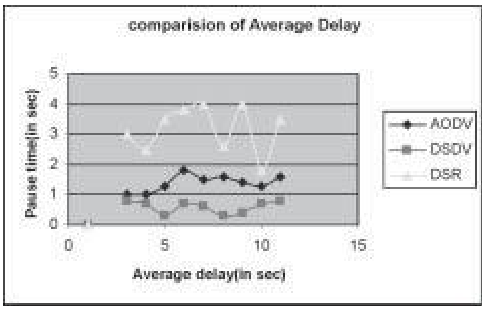

Figure 1. Average End To End Delay

As DSDV maintains only one route per destination, each packet that the MAC layer is unable to deliver is dropped since there are no alternate routes. For DSR and AODV, packet delivery ratio is independent of offered traffic load, with both protocols delivering between 95% and 100% of the packets in all cases. The reason for having better packet delivery ratio of DSR and AODV is that both allow packets to stay in the send buffer for 30 seconds for route discovery and once the route is discovered, data packets are sent on that route to be delivered at the destination. If we see DSR and AODV deliver more packets at the destination as compared to DSDV because these two protocols try to provide some sort of guarantee for the packets to be delivered at the destination by compromising at the delay. Where as DSDV, try to drop the packets, if it is not possible to be delivered hence the lesser delay and lesser packet delivery ratio. DSDV uses the table-driven approach of maintaining routing information. It is not as adaptive to the route changes that occur during high mobility. DSDV sends periodic routing updates at every 15 seconds in the network.

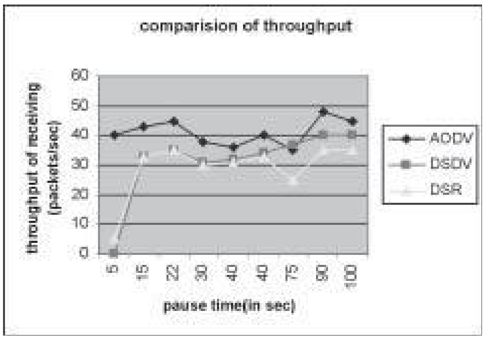

Figure 2. Throughput of Receiving Packets

These periodic broadcasts increase routing load in the network. Hence for DSDV we will have more routing overhead irrespective of mobility and traffic load and this increases more if we simulate a network for longer duration as DSDV sends periodic updates at regular intervals. In contrast, the lazy approach used by the on-demand protocols, AODV and DSR to build the routing information as and when they are created make them more adaptive and result in better performance (high packet delivery fraction) and less routing load. 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.

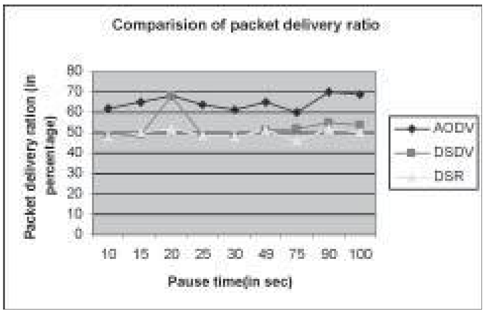

Figure 3. Packet Delivery Ratios

V. 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.

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