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Performance Analysis of Mobile Ad-Hoc Network Routing Protocols using Network Simulator – 2

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Abstract: Ad-hoc network is a network which consists of nodes that use a wireless interface to send packet data. Since the nodes in a network of this kind can serve as routers and hosts, they can forward packets on behalf of other nodes and run user application. A mobile ad-hoc network (MANET) is probably the most well-known example of this networking paradigm have been around for over twenty years, mainly exploited to design tactical networks. Furthermore, the multi-hop ad-hoc networking paradigm is often used for building sensor networks to study, control, monitor events and phenomena. To exploit these potentialities, modeling, simulation and theoretical analyses have to be complemented by real experiences, which provide both a direct evaluation of ad-hoc networks and at the same time precious information for a realistic modeling of these systems. Different routing protocols namely Ad-hoc On-demand Distance Vector (AODV) protocol, Dynamic Source Routing (DSR) protocol and Destination Sequenced Distance Vector (DSDV) protocol in MANET are compared and the performance are evaluated based on various metrics like Packet Delivery ratio, Avg. end-to-end delay, throughput, etc. For this purpose, a discrete event simulator known as NS2 is used.

Keywords: MANET, AODV, DSR, DSDV, TCP, CBR, NS2

I. INTRODUCTION

When the importance of computers in our daily life increases, it also sets new demands for connectivity. Wired solutions have been around for a long time but there is increasing demand on working wireless solutions for connecting to the Internet, reading and sending E-mail messages, changing information in a meeting and so on. There are solutions to these needs, one being wireless local area network that is based on IEEE 802.11 standard. However, there is increasing need for connectivity in situations where there is no base station available. This is where ad-hoc networks step in. They can be set up anywhere without any need for external infrastructure. They are often mobile and that's why a term MANET is often used when talking about Mobile Ad-hoc NETworks.

A "Mobile Ad-hoc Network" is an autonomous system of mobile routers connected by wireless links the union of which forms an arbitrary graph. The routers are free to move randomly and organize themselves arbitrarily, thus the network's wireless topology may change rapidly and unpredictably. Such a network may operate in a standalone fashion, or may be connected to the larger Internet. Ad-hoc networks are networks that are not connected to any static infrastructure. Ad-hoc network is a LAN or other small network, especially one with wireless connections in which some of the network devices are part of the network only for the duration of communications session or in the case of mobile or portable devices, while in some close proximity to the rest of the network.

II. WIRELESS AD-HOC ROUTING PROTOCOLS

According to differences in network topology reaction, the routing protocols in MANET can be categorized into table driven routing protocol and reactive routing protocol. Destination sequenced distance vector (DSDV) is a typical table-driven protocol. While the typical reactive routing protocol includes Ad-hoc on demand vector routing (AODV) and Dynamic source routing (DSR).

A. Ad-hoc on demand vector routing (AODV) protocol

AODV is a method of routing messages between mobile computers. AODV is capable of both unicast and multicast routing. It allows these mobile computers or nodes, to pass messages through their neighbors to nodes with which they cannot directly communicate. AODV does this by discovering the routes along which messages can be passed. AODV makes sure these routes do not contain loops and tries to find the shortest route possible. AODV is also able to handle changes in routes and can create new routes if there is an error.

AODV builds routes using a route request / route reply query cycle. When a source node desires a route to a destination for which it does not already have a route, it broadcasts a route request (RREQ) packet across the network. Nodes receiving this packet update their information for the source node and set up backwards pointers to the source node in the route tables. In addition to the source node's IP address, current sequence number and broadcast ID, the RREQ also contains the most recent sequence number for the destination of which the source node is aware. A node receiving the RREQ may send a route reply (RREP) if it is either the destination or if it has a route to the destination with corresponding sequence number greater than or equal to that contained in the RREQ. Nodes keep track of the RREQ's source IP address and broadcast ID. If they receive a RREQ which they have already processed they discard the RREQ and do not forward it.

An important feature of AODV is the maintenance of timer based states in each node, regarding utilization of individual routing table entries. A set of predecessor nodes is maintained for each routing table entry, indicating the set of neighboring nodes which use that entry to route data packets. These nodes are notified with RRER packets when the next-hop link breaks. Each predecessor node, in turn forwards the RRER to its own set of predecessors, thus effectively erasing all routes using the broken link. Route error propagation in AODV can be visualized conceptually as a tree whose root is the node at the point of failure and all sources using the failed link as the leaves.

B. Destination sequenced distance vector (DSDV) protocol

In DSDV, routing messages are exchanged between neighboring mobile nodes. Routing updates may be triggered. Updates are triggered in case routing information from one of the neighbors forces a change in the routing table. A packet for which the route to its destination is not known is cached while routing queries are sent out. The packets are cached until route-replies are received from the destination. There is a maximum buffer size for caching the packets waiting for routing information beyond which packets are dropped.

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. If a router receives new information then it uses the latest sequence number. If the sequence number is the same as the one already in the table, the route with the better metric is used. Stale entries are those entries that have not been updated for a while. Such entries as well as the routes using those nodes as next hops are deleted.

The destination sequenced distance vector routing protocol is a proactive routing protocol which is a modification of conventional Bellman-Ford routing algorithm. This protocol adds a new attribute, sequence number, to each route table entry at each node. Routing table is maintained at each node and with this table; node transmits the packets to other nodes in the network. This protocol was motivated for the use of data exchange along changing and arbitrary paths of interconnection which may not be close to any base station.

C*. Dynamic source routing (DSR) protocol*

DSR is a reactive routing protocol which is able to manage a MANET without using periodic table-update messages like table-driven routing protocols do. DSR was specifically designed for use in multi-hop wireless ad hoc networks. Ad-hoc protocol allows the network to be completely self-organizing and self-configuring which means that there is no need for an existing network infrastructure or administration.

For restricting the bandwidth, the process to find a path is only executed when a path is required by a node (On-Demand Routing). In DSR the sender (source, initiator) determines the whole path from the source to the destination node (Source-Routing) and deposits the addresses of the intermediate nodes of the route in the packets. Compared to other reactive routing protocols like ABR or SSA, DSR is beacon-less which means that there are no hello-messages used between the nodes to notify their neighbors about her presence. DSR was developed for MANETs with a small diameter between 5 and 10 hops and the nodes should only move around at a moderate speed. DSR is based on the Link-State-Algorithms which mean that each node is capable to save the best way to a destination. Also if a change appears in the network topology, then the whole network will get this information's by flooding.

DSR contains 2 phases

- Route Discovery (find a path)
- Route Maintenance (maintain a path)

III. PERFORMANCE ANALYSIS

The Network Simulator (NS2) is used as the tool for network simulations. Three different scenarios using TCP are considered. In the first scenario, traffic pattern is taken as TCP and the number of nodes has been varied in AODV.

In the second scenario, traffic pattern is taken as TCP and the number of nodes has been varied in DSDV. In the third scenario, traffic pattern is taken as TCP and the number of nodes has been varied in DSR protocols.

A. Test Scenario for AODV

In the first scenario, the traffic pattern is taken as TCP. Parameters of this scenario are summarized in Table I.

PROTOCOL	AODV
Simulation time	100 seconds
Number of nodes	20
Map size	450×600
Max speed	20 ms
Mobility model	Randam Way Point
Traffic type	TCP
Packet size	512 bytes
Connection Rate	4 pkts/sec
Pause time	0,10,20,50,100,200

AODV Parameters Scenario

B. Test Scenario for DSDV

In the second scenario, the traffic pattern is taken as TCP. Parameters of this scenario are summarized in Table II.

DSDV Parameters Scenario

C. Test Scenario for DSR

PROTOCOL	DSDV
Simulation time	100 seconds
Number of nodes	20
Map size	500×500
Max speed	20 ms
Mobility model	Randam Way Point
Traffic type	TCP
Packet size	512 bytes
Connection Rate	4 pkts/sec
Pause time	0,10,20,50,100,200

In the third scenario, the traffic pattern is taken as TCP. Parameters of this scenario are summarized in Table III.

PROTOCOL	DSR
Simulation time	100 seconds
Number of nodes	20
Map size	450×600
Max speed	20 ms
Mobility model	Randam Way Point
Traffic type	TCP
Packet size	512 bytes
Connection Rate	4 pkts/sec
Pause time	0,10,20,50,100,200

DSR Parameters Scenario

IV. PERFORMANCE METRICS

The following four important performances metrics are considered for evaluation of these routing protocols:

- **Packet delivery ratio:** The fraction of the data packets delivered to the destination to those generated by the sources.
- **Average End-To-End Delay:** This includes retransmission delays at the MAC, propagation and transfer times.
- **Throughput:** The throughput of the protocols can be defined as percentage of the packets received by the destination among the packets sent by the source. It is the amount of data per time unit that is delivered from one node to another via a communication link. The throughput is measured in bits per second (bit/s or bps).
- **Packet Loss/Drop:** Packet loss describes an error condition in which data packets appear to be transmitted correctly at one end of a connection, but never arrive at the other. There might be different reasons like corrupted packets will be dropped by nodes; the link/route between nodes is not working, insufficient bandwidth, etc.

V. SIMULATION RESULTS

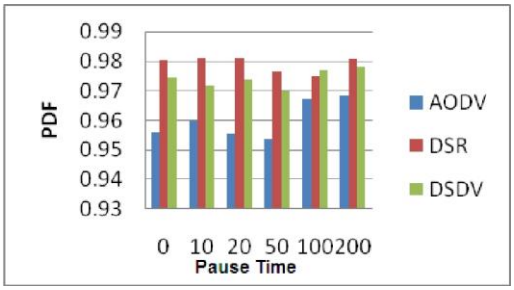

Fig.1. Pause Time with varying Packet Delivery Ratio

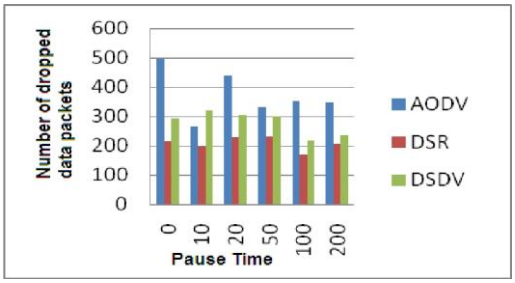

Fig.2. Pause Time with varying Avg. end to end delay

VI. RESULT & PERFORMANCE COMPARISON

Performance of AODV, DSR and DSDV protocols is

evaluated under TCP traffic pattern. The paper introduces Ad Hoc network and its three protocols (AODV, DSDV and DSR) and we use simulation software NS2 to simulate the protocols. We test three routing protocols and their performance under different traffic conditions.

A. Packet delivery fraction

From the graphs obtained we may conclude that for TCP traffic source the value of PDF of DSR is higher than AODV and DSDV except for pause time of 100.

B. Average end to end delay

From the graph, obtain the value of avg. end to end delay of AODV and DSR are comparable for pause time above 20 using TCP traffic source

C. Number of dropped data (packets)

For TCP traffic source the number of dropped data (i.e. packets) of AODV is higher than DSDV and DSR except for pause time of 10.

VII. CONCLUSION

The objective of this work is to analyze the performance of AODV, DSR and DSDV protocols of MANET based on traffic. For this purpose, three test scenario were created using Network Simulator (NS2). We compared these three protocols on the basis of three parameters i.e. Packet delivery ratio, Number of Dropped Data and Avg. End to End Delay. Simulation result shows overall performance of Reactive protocols is better in terms of packet delivery fraction, average end-to-end delay.DSR and AODV both use on-demand route discovery, but with different routing mechanics. Future work will be to evaluate the performance of these protocols by varying speed, simulation time, packet size and also by changing the number of nodes and traffic conditions.

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