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Performance Comparison of Routing Protocols in MANET

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Abstract – A Mobile Ad-Hoc Network [MANETs] is a collection of wireless mobile nodes forming a temporary network without any centralized access point, infrastructure, or centralized administration. To establish a data transmission between two nodes, typically multiple hopes are required due to the limited transmission range. In a MANET network topology can dynamically change in an unpredictable manner since nodes are free to move. In recent years several routing protocols have been proposed for mobile ad-hoc networks and prominent among them are AODV, DSR and TORA. In this paper presenting their overview, characteristics, functionality, benefits and limitations and makes their comparative analysis, so to analysis their performance. The objective is to make observations about how the performance of these protocols can be improved.

***Keywords – Adhoc* Networks, AODV, DSR, MANET, TORA.**

I. INTRODUCTION.

Mobile Adhoc Networks [MANETs] involve communication between various mobiles hosts which themselves act as routers and help in transmitting packets to the destination through intermediate nodes which lie within the radio transmission range of each other. Due to the mobility of nodes, MANETs have a dynamic topology where links are formed and broken with time. These links can be unidirectional or bi-directional. Due to high level of dynamism, reliable, fast and energy efficient routing of data packets from the source to the destination is an area of great concern for researches. Science it is an infrastructure network, one cannot rely on use of access points or other infrastructure for routing, thus leaving only one option of building multi-hop routes from source to destination, where intermediate nodes act as routers. Routing in MANETs involves designing a protocol which helps using routing data packets from source to destination with minimum possible hops and minimum battery power consumption of nodes. In MANET some of the challenges faced at different layers are shown in following figure.

II. ROUTING PROTOCOLS.

A routing protocols is needed whenever a packet needs to be transmitted to a destination via number of nodes and numerous routing protocols have been proposed for such kind of Adhoc networks. These protocols find a route for packet delivery and delivery packet to be correct destination. Basically, routing protocols can be broadly classified into three types as A) table -driven (or) proactive routing protocol, B) on-demand (or) reactive routing protocol C) hybrid routing protocol.

A). Table-Driven (or) Proactive routing protocols: every node maintains the network topology information in the form of routing tables by periodically exchanging routing information. Routing information is generally flooded in the whole network whenever a node requires a path to the destination. It runs an appropriate path-finding algorithm on the topology information it maintains. Some of the existing table-driven (or) proactive protocols are DSDV, WRP, CGSR, OLSR, STAR, FSR, HSR, GSR.

B). On-Demand (or) Reactive routing protocols: protocols that fall under this category do not maintain the network topology information. They obtain the necessary path when it is required, by using a connection establishment process. Hence these protocols do not exchange routing information periodically. Some of the existing routing protocols that belong to this category are DSR, AODV, TORA, ABR, SSA, FORP, PLBR.

C). Hybrid routing protocol: protocols belonging to this category combine the best features of the above two categories. Nodes within a certain distance from the node concerned or within a particular geographical region are said to be within the routing zone of the given node. For routing within this zone a table-driven approach is used. For nodes that are located beyond this zone an on-demand approach is used. Some of the protocols in this category are CEDAR, ZRP, and ZHLS.

In this paper it is observed on the comparison of various reactive/ on-demand protocols such as DSR, AODV and TORA as these are best suited for Adhoc networks. The next sub-section describes the basic feature of the protocols.

III. DSR (Dynamic Source Routing)

The dynamic source routing (DSR) protocol is an on-demand routing protocol based on source routing. In the source routing technique, a sender determines the exact sequence of the 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. Route discovery and route maintenance are the two major parts of the DSR protocol.

Route discovery: the source node starts by broadcasting a route request packet that can be received by all neighbor nodes within its wireless transmission range. The route request contains the address of the destination host, referred to as the target of the route discovery, the source address, a route record field and a unique identified number. At the end, the source host should receive a route reply packet containing a list of network nodes through which it should propagate the packets, supposed the route discovery, process was successful. During the route discovery process, the route record field is used to accumulate the sequence of hops already taken, first of all the sender initiates the route record as a list with a single elements containing itself. The next neighbor node appends itself to the list and soon.

Route maintenance: route maintenance can be accomplished by two different process:-

i). Hop-by-hop acknowledgement at the data link layer allows an early and retransmission of lost or corrupt packets.

ii). End-to-end acknowledgement may be used if wireless transmission between two hosts does not work equally well in both directions. As long as a route exists by which the two end hosts are able to communicate, route maintenance is possible.

Benefits and limitations of DSR: one of the main benefits of DSR protocol is that there is no need to keep routing table so as to route a given data packet as the entire route is contained in the packets header. The limitation of DSR protocol is that this is not scalable to large networks and even requires significantly more processing resources than most other protocols. In order to obtain the routing information, each node must spend lot of time to process any control data it receives, even if it is not the intended recipient

IV. AODV (Adhoc On-Demand Distance Vector)

AODV is a variation of destination sequenced distance vector (DSDV) routing protocol which is collectively based on DSDV and DSR. If aims to minimize the requirement of system –wide broadcasts to its extreme. It does not maintain routes from every node to every other node in the network rather they are discovered as and when needed and maintained only as long as they are required.

Route discovered: when trying to send a message to a destination node without knowing an active route. A route is considered active if it has an entry in the routing table that is marked as valid. Active routes expire after a certain amount of time or on occurred of a link failure. Only active router can be used to forward data packets. A route request message(RREQ) is broadcast to all neighbors, which continue to broadcast the message to their neighbors and so on. The forwarding process is continued until the destination node is reached or until a intermediate node knows a route to the destination that is new enough. To ensure loop-free and most recent route information, every node maintain two counters sequence number and broadcast-id. The broadcast-id and the address of the source node uniquely identify a RREQ message. Broadcast-id is incremented for every RREQ the source node initiates. An intermediate node can receive multiple copies of the same route request broadcast from various neighbors. In this case if a node has already received a RREQ with the same source address and broadcast-id it will discard the packet without broadcasting it furthermore. When an intermediate node forwards the RREQ message, it records the address of the neighbor from which it received the first copy of the broadcast packet. This way the reverse path from all nodes back to the source is being built automatically. The RREQ packet contains two sequence numbers. The source sequence number and the last destination sequence number known to the source. The source sequence number is used to maintain "freshness" information above the reverse route to the source while the destination sequence number specifies what activities a route to the destination must have before it is accepted by the source. When the route request broadcast reaches the destination or an intermediate node with a fresh enough route the node response by sending a unicast route reply packet(RREP) back to the node from which it received the RREQ. So actually the packet is sent back reverse the path built during broadcast forwarding.

Route Maintenance: if the source node moves, it is able to send a new RREQ packet to find a new route to the destination. If an intermediate node along the forward path moves, its upstream neighbor notices the move and sends a link failure notification message to each of its active upstream neighbors to inform them of the erasure of that part of the route. The link failure notification is forwarded as layers the source node is not reached. After having learned about the failure the source node may reinitiate the route discovery protocol. Optionally a mobile node may perform local connectivity maintenance by periodically broadcasting hello messages.

Benefits and limitations of AODV: the benefits of AODV protocol are that it favors the least congested route instead of the shortest route and it also supports both unicast and multicast packet transmission even for nodes in constant movement. It also responds very quickly to the topological changes that affects the active route. AODV does not put any additional overheads on data packets as it dose not make use of source routing.

The limitation of AODV protocol is that it excepts/requires that the nodes in the broadcast medium can detect each other broadcast. It is also possible that a valid route is expired and the determination of a reasonable expiry time is difficult. The reason behind this is that the nodes are mobile and their sending rates may differ widely and can change dynamically from node to node. In addition as the size of network grows, various performance metrics begin decreasing. AODV is vulnerable to various kinds of attacks as it based on the assumption that all nodes must cooperate and without their cooperation no route can be established.

V. TORA (Temporally Ordered Routing Protocol)

TORA is a distributed highly adaptive routing protocol designed to operate in a dynamic multihop network. Tora uses an arbitrary height parameter to determine the direction of link between any two nodes for a given destination.

Consequently multiple routes often exist for a given destination but none of them are necessarily the shortest route. To initiate the route, the node, the node rebroadcasted a query packet then broadcast the update packet which lists its height with respect to the destination. When this packet propagates in the network each node that receives the update packet sets its height to a value greater than the height of the neighbor from which the update was received. This has the effect of creating a series of directed links from the original sender of the query packet to the node that initially generated the update packet. When it was discovered by a node that the route to a destination is no longer valid, it will adjust its height so that it will be a local maximum with respect to its neighbors and then transmits an update packet. If the node has no neighbors of finite height with respect to the destination, then the node will attempt to discover a new route as described above. When a node detects a networks partition. It will generate a clear packet that results in reset of routing over the adhoc network.

Advantages: TORA supports multiple routes. It retains multiple route possibilities for a single source/destination pair. Bandwidth is conserved because of the fever route rebuilding. Tora also supports multicasts.

Disadvantages: TORA'S reliance on synchronized clocks limits in applicability. If the external time source fails, the algorithm ceases to operate. Also route rebuilding may not occur as quickly due to oscillations. During this period this can lead to lengthy delays while for the new routes to be determined.

VI. PERFORMANCE METRICS:

There are number of qualitative and quantitative metrics that can be used to compare reactive routing protocols. Most of the existing routing protocols ensure the qualitative metrics. Therefore the following different quantitative metrics have been considered to make the comparative study of their routing protocols through simulation.

Routing overhead: This metric describes how many routing packets for route discovery and route maintenance need to be send so as to propagate the data packets.

Average delay: This metric represents average end-to-end and indicates how long it took for a packets to travel from the source to the application layer of the destination. It is measured in seconds.

Throughput: This metrics represents the total number of bits forwarded to higher layers per second. It is measured in bps. It can also be defined as the total amount of data a receiver actually receiver to obtain the last packet.

Media Access Delay: The time a node takes to access media for starting the packet transmission is called as media access delay. The delay is recorded for each packet when it is sent to the physical layer for the first time.

Packet Delivery Ratio: The ratio between the amount of incoming data packets and actually received data packets.

Path Optimality: This metric can be defined as the difference between the path actually taken and the best possible path for a packet to reach its destination.

TABLE - I: Low Mobility and Low Traffic

Protocol	Routing Overhead	Average end-to-end delay	Packet delivery ratio	Path Optimality
DSR	Low	Average	High	Average
AODV	Low	Average	High	Average
TORA	Moderate	Low	High	Good

TABLE - II: High Mobility and High Traffic

Protocol	Routing Overhead	Average end-to-end delay	Packet delivery ratio	Path Optimality
DSR	Average	Average	Average	Low
AODV	Very High	Average	Average	Average
TORA	High	More	Low	Average

TABLE - III: Other Parameters

Protocol / Parameters	DSR	AODV	TORA

Category	On Demand or Reactive	On Demand or Reactive	On Demand or Reactive
Protocol Type	Source Routing	Distance Routing	Link Reversal
Routing Philosophy	Flat	Flat	Flat
Overall Complexity	Medium	Medium	High
Routes Maintained	Route cache	Route table	Route table
Route reconfigure	Erase route, notify source	Erase route, notify source	Link Reversal
Route Metrics	Shortest Path	Freshest & Shortest path	Shortest path
Loop Freedom	Yes	Yes	No
Multiple routes	Yes	No	No
Multicast	No	Yes	No
Security	No	No	No
Message Overhead	High	High	Moderate
Periodic broadcast	No	Possible	Possible
Require sequence data	No	Yes	Yes
Expiry of routing information	No	Yes	No
Summary	Route Discovery, Snooping	Route Discovery, Expanding Ring Search, Setting forward path	Route update packets

VII. CONCLUSION.

In this paper, the performance analysis of various on-demand/reactive routing protocols (DSR, AODV, and TORA) on the basis of above mentioned performance metrics. The result after analysis here reflected in Table-I and Table-II. The first table is description of parameter selected with respected to low mobility and low traffic. The second table is description of parameter selected with respected to high mobility and high traffic. The Table-III is described of other important parameters that make a protocol robust and steady in most cases overhead in some cases DSR and AODV outperformance TORA in all cases.

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