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Analysis of Performance of Different Routing Protocols with Varying Number of Nodes: A Review

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Abstract- The field of Mobile Ad hoc Networks (MANETs) has become very popular and an important part in research. It is a dynamic wireless network in which there is no need of any specific structure to perform its (MANET) operations. Due to increase in availability and popularity of mobile wireless devices, researchers are working to develop a wide variety of Mobile Ad-hoc Networking (MANET) protocols. This helps to exploit the unique communication opportunities presented by these devices. Simulation is the main method used for evaluating the performance of MANETs. In this paper performance of different protocols (AODV, AOMDV, DSR, DSDV) is analyzed by putting them in different environments. This environment is created by creating different scenarios on the basis of changing number of nodes. This paper evaluates their relative performance with respect to the three performance metrics: average End-to-End delay, Throughput and packet delivery ratio. From the detailed simulation results and analysis, a suitable routing protocol can be chosen for a specified network and goal.

Keywords: AODV, AOMDV, DSDV, DSR, MANET

I. INTRODUCTION

Wireless networks have become increasingly popular in the computing industry. Wireless computer network or data network which is a telecommunications network are used to allow computers to exchange data. Data is passed to each other along data connections among different computing devices in computer networks. There are two types of connections (network links) between nodes. They are built using either cable media or wireless media. Internet is the best-known computer network. Network nodes are the computer devices in network that originate, route and terminate the data. These nodes include hosts such as personal computers, phones, servers as well as networking hardware. When one device can exchange information with the other device than such devices are said to be networked together. These connected nodes may or may not have a direct connection to each other. [1]

A MANET consists of a self configuring network in which wireless links are used to connect mobile devices. A key challenge of a mobile Ad Hoc network (MANET) is well-organized routing. In this type of network links with other devices change commonly because each device in the network is free to move in any path. There are no permanent base stations in these networks. Hence each and every node should behave as a router. A routing protocol is used to find out routes between nodes to make the working and communication easy and accurate. The main goal of different ad-hoc network routing protocols is to provide an accurate and an efficient route organization among a pair of nodes to deliver the messages in an appropriate method. This Routing in Ad Hoc Networks has led the researchers to an important consideration with a number of dissimilar routing protocols. Different categories of routing protocols are proactive, reactive and hybrid. Normal routing protocol like DSR, DSDV, TORA, AODV and AOMDV which are the shortest path protocols for Ad Hoc networks. One thing is common in all these protocols that all these routing protocols have some compensation and disadvantage of their individual. This paper analysis performance of these protocols and accordingly a suitable protocol can be chosen for better performance and communication and exchange of data among different mobile devices.

Mobile ad hoc network MANET is a set of mobile nodes connected via wireless media without infrastructure. Applications of MANET plays an important role in network in various fields for example Military, civilian, emergency fields and Personal areas etc. Since the nodes can move randomly and rapidly, so there is no fixed topology in this network. MANET has unique features and these features make MANET face several challenges such as security threats and inaccurate routing process. To routing overcome these problems a suitable protocol is needed to deal with these problems this provides MANET with high performance.

The mobility of nodes is also a major factor within MANETs due to limited wireless transmission range; this can cause the network topology to change unpredictably as nodes enter and leave the network. Node mobility can cause broken routing links which force nodes to recalculate their routing information; this consumes processing time, memory, device power and generates traffic backlogs and additional overhead traffic on the network [2].

In this paper different routing protocols like AODV, AOMDV, DSR, TORA, DSDV, OLSR, ZRP, etc are verbalized. The main protocols that are under main focus of this paper are AODV, AOMDV, DSR, and DSDV.

Different scenarios will be created by varying number of nodes. In this paper nodes will be increasing in number from one scenario to another. Each protocol under consideration will subjected to each of these scenarios. Then the simulation will be performed on these scenarios and results will be calculated.

There are three performance metrics taken under consideration. They are PDF (Average Throughput), PDR (Packet Delivery Ratio), and E2ED (End- to- End Delay). Simulation will be done to check that how these three performance metrics are affected may be affected when changing the number of nodes in case of implementing the mentioned routing protocols.

Different graphs will be used to show the results and they will discussed and analyzed to know that which protocol is best or gives better performance in communication and exchange of data and messages among various mobile devices accurately of simulation

The simulation results will be discussed to show the effect of change in the number of nodes on PDR, PDF and E2ED and to conclude which routing protocol can gives the best value for PDR, PDF and E2ED.

1. Performance Metrics

Simulation in this research is performed by using three types of performance metrics. The Trace file (*.tr)* which is an output file generated by the simulation is used to obtain the data and to show results. These performance metrics are vital to measure the performance and activities which are in operation in NS-2 simulation. [3]

1) Average Throughput (PDF)

Average Throughput or Total Throughput put is defined as the number of exclusive packets delivered from source to destination in a given period of time. It is total the amount of data moved successfully from one place to another in a given time period.

Throughput=Packet Delivered/ Time taken

2) Average End- to- End Delay (E2ED)

It represents an average delay and indicates the time taken by data bits to travel from source to intended node. It is defined as the time taken for a packet to be transmitted across a network from source to intended destination.

Average End-to-End Delay

=Average time taken by a nodes to transfer data to destination

3) Packet Delivery Ratio (PDR)

PDR is a metric that indicates the reliability of delivery of data packets. The packet delivery ratio is defined as the ratio of number of packets received by the destination to that of the number of packets sent by the source or generated by the source.

Packet Delivery Ratio

=Total Packet received/Total Packet Generated [3]

II. ROUTING PROTOCOLS

MANET routing protocols are categorized into two types according to the ability of providing a track of routes for all destination:

- Proactive or table- driven routing protocols.
- Reactive or on-demand routing protocols. [4]

A. Destination Sequenced Distance Vector (DSDV)

The proactive DSDV protocol was proposed by and is based upon the Bellman-Ford algorithm to calculate the shortest number of hops to the destination. Each DSDV node maintains a routing table which stores; destinations, next hop addresses and number of hops as well as sequence numbers; routing table updates are sent periodically as incremental dumps limited to a size of 1 packet containing only new information.[5] DSDV compensates for mobility using sequence numbers and routing table updates, if a route update with a higher sequence number is received it will replace the existing route thereby reducing the chance of routing loops, when a major topology change is detected a full routing table dump will be performed, this can add significant overhead to the network in dynamic scenarios. [2]

B. Dynamic Source Routing (DSR)

The reactive DSR Protocol was developed by**,** operation of the DSR protocol is broken into two stages; route discovery phase and route maintenance phase, these phases are triggered on demand when a packet needs routing. Route discovery phase floods the network with route requests if a suitable route is not available in the route**.** [5] DSR uses a source routing strategy to generate a complete route to the destination, this will then be stored temporarily in nodes route cache**.** DSR addresses mobility issues through the use of packet acknowledgements; failure to receive an acknowledgement causes packets to be buffered and route error messages to be sent to all upstream nodes. Route error messages trigger the route maintenance phase which removes incorrect routes from the route cache and undertakes a new route discovery phase. [2]

C. Wireless Routing Protocol (WRP)

The Wireless Routing Protocol, as proposed by Murthy and Garcia-Luna-Aceves, is a table-based protocol similar to DSDV that inherits the properties of Bellman- Ford Algorithm. The main goal is maintaining routing information among all nodes in the network regarding the shortest distance to every destination. Wireless routing protocols (WRP) is a loop free routing protocol. WRP is a path-finding algorithm with the exception of avoiding the count-to-infinity problem by forcing each node to perform consistency checks of predecessor information reported by all its neighbors. Each node in the network uses a set of four tables to maintain more accurate information: Distance table (DT), Routing table (RT), Link-cost table (LCT), Message retransmission list (MRL) table. In case of link failure between two nodes, the nodes send update messages to their neighbors. WRP belongs to the class of path-finding algorithms with an important exception. It counters the count-to-infinity problem by forcing each node to perform consistency checks of predecessor information reported by all its neighbors. This eliminates looping situations and enables faster route convergence when a link failure occurs.[6]

D. Ad hoc On-demand Distance Vector Routing (AODV)

AODV is a reactive protocol that discovers routes on an as needed basis using a route discovery mechanism. It uses traditional routing tables with one entry per destination. Without using source routing, AODV relies on its routing table entries to propagate an RREP (Route Reply) back to the source and also to route data packets to the destination. AODV uses sequence numbers maintained at each destination to determine freshness of routing information and to prevent routing loops. [7] All routing packets carry these sequence numbers. AODV maintains timer-based states in each node, for utilization of individual routing table entries, whereby older unused entries are removed from the table. Predecessor node sets are maintained for each routing table entry, indicating the neighboring nodes sets which use that entry to route packets. These nodes are notified with RERR (Route Error) packets when the next-hop link breaks. This packet gets forwarded by each predecessor node to its predecessors, 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. [7] The advantages of AODV are that less memory space is required as information of only active routes are maintained, in turn increasing the performance, while the disadvantage is that this protocol is not scalable and in large networks it does not perform well and does not support asymmetric links.[8]

E. Ad-hoc On-demand Multipath Distance Vector

Ad-hoc On-demand Multi path Distance Vector Routing (AOMDV) Ad-hoc On-demand Multi path Distance Vector Routing (AOMDV) protocol is an extension to the AODV protocol for computing multiple loop-free and link disjoint paths. The routing entries for each destination contain a list of the next-hops along with the corresponding hop counts. All the next hops have the same sequence number. This helps in keeping track of a route. For each destination, a node maintains the advertised hop count, which is defined as the maximum hop count for all the paths, which is used for sending route advertisements of the destination. Each duplicate route advertisement received by a node defines an alternate path to the destination. Loop freedom is assured for a node by accepting alternate paths to destination if it has a less hop count than the advertised hop count for that destination. Because the maximum hop count is used, the advertised hop count therefore does not change for the same sequence number. When a route advertisement is received for a destination with a greater sequence number, the next-hop list and the advertised hop count are reinitialized. AOMDV can be used to find node-disjoint or link-disjoint routes. To find node-disjoint routes, each node does not immediately reject duplicate RREQs. Each RREQs arriving via a different neighbor of the source defines a node-disjoint path. This is because nodes cannot be broadcast duplicate RREQs, so any two RREQs arriving at an intermediate node via a different neighbor of the source could not have traversed the same node. In an attempt to get multiple link-disjoint routes, the destination replies to duplicate RREQs, the destination only replies to RREQs arriving via unique neighbors. After the first hop, the RREPs follow the reverse paths, which are node disjoint and thus link-disjoint. The trajectories of each RREP may intersect at an intermediate node, but each takes a different reverse path to the source to ensure link disjointness. The advantage of using AOMDV is that it allows intermediate nodes to reply to RREQs, while still selecting disjoint paths. But, AOMDV has more message overheads during route discovery due to increased flooding and since it is a multipath routing protocol, the destination replies to the multiple RREQs those results are in longer overhead**.** [8]

F. Cluster Based Routing Protocol (CBRP)

In Cluster Based Routing Protocol (CBRP), unlike the on-demand routing protocols, the nodes are organized in a hierarchy. The nodes in CBRP are grouped into clusters. Each cluster has a cluster-head, which coordinates the data transmission within the cluster and to other clusters. The advantage of CBRP is that only cluster heads exchange routing information, therefore the number of control overhead transmitted through the network is far less than the traditional flooding methods. The protocol suffers from temporary routing loops. This is because some nodes may carry inconsistent topology information due to long propagation delay. [6]

G. *Zone routing protocol* (ZRP)

In ZRP, the nodes have a routing zone, which defines a range (in hops) that each node is required to maintain network connectivity proactively. Therefore, for nodes within the routing zone, routes are immediately available. For nodes that lie outside the routing zone, routes are determined on-demand (i.e. reactively), and it can use any on-demand routing protocol to determine a route to the required destination. The advantage of this protocol is that it has significantly reduced the amount of communication overhead when compared to pure proactive protocols. It also has reduced the delays associated with pure reactive protocols such as DSR, by allowing routes to be discovered faster. This is because, to determine a route to a node outside the routing zone, the routing only has to travel to a node which lies on the boundaries (edge of the routing zone) of the required destination. Since the boundary node would proactively maintain routes to the destination (i.e. the boundary nodes can complete the route from the source to the destination by sending a reply back to the source with the required routing address). The disadvantage of ZRP is that for large values of routing zone the protocol can behave like a pure proactive protocol, while for small values it behaves like a reactive protocol. [9]

H. Global state routing (GSR)

The GSR protocol is based on the traditional Link State algorithm. However, GSR has improved the way information is disseminated in Link State algorithm by restricting the update messages between intermediate nodes only. In GSR, each node maintains a link state table based on the up-to-date information received from neighboring nodes, and periodically exchanges its link state information with neighboring nodes only. This has significantly reduced the number of control message transmitted through the network. However, the size of update messages is relatively large, and as the size of the network grows they will get even larger. Therefore, a considerable amount of bandwidth is consumed by these update messages. [9]

I. Fisheye state routing (FSR)

The FSR protocol is the descendent of GSR. FSR reduces the size of the update messages in GSR by updating the network information for nearby nodes at a higher frequency than for the remote nodes, which lie outside the fisheye scope. This makes FSR more scalable to large networks than the protocols described so far in this section. However, scalability comes at the price of reduced accuracy. This is because as mobility increases the routes to remote destination become less accurate. This can be overcome by making the frequency at which updates are sent to remote destinations proportional to the level of mobility. [9]

J. Temporally Ordered Routing Algorithm (TORA)

TORA comes under a category of algorithms called “Link Reversal Algorithms”. TORA is an on demand routing protocol. Unlike other algorithms the TORA routing protocol does not uses the concept of shortest path for creating paths from source to destination as it may itself take huge amount of bandwidth in the network. Instead of using the shortest path for computing the routes the TORA algorithm maintains the "direction of the next destination" to forward the packets. Thus a source node maintains one or more "downstream paths" to the destination node through multiple intermediate neighboring nodes. TORA reduces the control messages in the network by having the nodes to query for a path only when it needs to send a packet to a destination. In TORA three steps are involved in establishing a network. A) Creating routes from source to destination, B) Maintaining the routes and C) Erasing invalid routes. TORA uses the concept of "directed acyclic graph (DAG) to establish downstream paths to the destination". This DAG is called as "Destination Oriented DAG". A node marked as destination oriented DAG is the last node or the destination node and no link originates from this node. It has the lowest height. Three different messages are used by TORA for establishing a path: the Query (QRY) message for creating a route, Update (UPD) message for creating and maintaining routes and Clear (CLR) message for erasing a route. Each of the nodes is associated with a height in the network. A link is established between the nodes based on the height. The establishment of the route from source to destination is based on the DAG mechanism thus ensuring that all the routes are loop free. Packets move from the source node having the highest height to the destination node with the lowest height. It is the same top to down approach. [10]

III. CONCLUSION

This paper assesses the performance of AODV, AOMDV, DSR and DSDV using ns-2. The evaluation of the performance of these different protocols is based on three different performance matrices. These performance matrices are the packet delivery fraction, throughput and end-to-end delay. These routing protocols are subjected to different scenarios created by increasing the number of nodes. Further research will be carried out to find out that which protocol gives better performance in these different environments. The performance will be calculated in terms of given parameters.

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