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Analysis of Routing Protocols in MANETs

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ABSTRACT: The wireless networking is an emerging technology that allows users to access information and services regardless of their geographic position. This led to the development of MANET. It is a kind of wireless ad hoc network, and is a self-configuring network of mobile routers connected by wireless links – the union of which form an arbitrary topology. The routers are free to move randomly and organize themselves arbitrarily which leads to dynamic changing topology. Each node will act as router in forwarding the packets to the destination. This network is formed by the nodes which are characterized by mobility. Mobile Ad hoc networks (MANET) are characterized by wireless connectivity, continuous changing topology, distributed operation and ease of deployment. The data is being transmitted from source node to destination through multiple intermediate nodes i.e., in a multi-hop fashion. Each node has a particular range in which the transmission takes places. When a packet is being transmitted they move from one range to the other range in the network where this may lead to packet loss due to link failure and dynamic changing nature. Communication among these nodes is made possible by protocols. This paper analyses the performance of various protocols available in MANETs with the help of performance metrics such as throughput, packet delivery fraction and end to end delay.

KEYWORDS: Routing protocols, MANETs, Performance metrics.

I.INTRODUCTION

MANET is acronym for Mobile Ad-hoc Network, it is a kind of wireless ad hoc network, and is a self-configuring network of mobile routers connected by wireless links – the union of which form an arbitrary topology[1]. Each node will act as router in forwarding the packets to the destination. Mobile Ad hoc networks (MANET) are characterized by wireless connectivity, continuous changing topology, distributed operation and ease of deployment. The data is being transmitted from source node to destination through multiple intermediate nodes i.e., in a multi-hop fashion. Each node has a particular range in which the transmission takes places. MANETs are also characterized by a random, dynamic and rapidly changing topology. The challenge in ad-hoc networks is the development of dynamic routing protocols that can efficiently find routes between two communicating nodes. The routing protocols must be able to keep up with the high degree of node mobility, which effects rapid and unpredictable topological changes.

II. ROUTING PROTOCOLS IN MANET

A sender in an ad hoc network may not always be able to pass its packets directly to the intended receiver. So, routing mechanisms are required whenever an intended receiver is outside the transmission range of the sender. The goal of the routing protocol is to discover the latest topology. The routing protocols in MANET can be classified into following categories[2]:

a) Proactive routing protocols: In this family of routing protocol, all nodes exchange routing information periodically or whenever the topology changes. Since each node maintains a consistent view of the network, a route to the destination (if it can be reached) is always available. Examples of proactive routing protocols include: Destination-Sequenced Distance-Vector (DSDV) or Optimized Link State Routing (OLSR).

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b) Reactive routing protocols: In reactive routing, the route discovery process is initiated by a sender whenever it wants to send packets to a destination. The route is maintained until the destination becomes unreachable or is not needed anymore. Examples are: Ad hoc on demand Distance Vector (AODV), Dynamic Source Routing (DSR), and Temporally Ordered Routing Algorithm (TORA)

c) Hybrid routing protocols: The characteristics of proactive and reactive routing protocols are combined to avoid the shortcomings of the two families and to retain most of their benefits. Examples of hybrid routing protocols include: Zone Routing Protocol (ZRP), and Wireless Adaptive Routing Protocol (WARP).

III. ANALYSIS

Only four protocols have been considered in our paper which include AODV,DSDV, DSR and AOMDV.

a)Ad-hoc On-Demand Distance Vector Routing (AODV)

The AODV routing algorithm is a source initiated, on demand routing algorithm. Therefore a route is discovered only if and when a source wants to send data to a specific destination. Once the route is established between the source and the destination, it remains as long as it's needed for further communication. [3]One of the main features of AODV is that unlike other on-demand routing protocols, it uses traditional routing tables to maintain routing information, with one entry per destination. Each entry in the table has a destination sequence number. This number is included in the RREQ (Route Request) of any node that desires to send data.

AODV uses these sequence numbers to ensure the validity of the routing information and to prevent routing loops. For instance, a requesting node always chooses a route with the greatest sequence number to communicate with its destination node. Once a new path is found, a RREP (Route Reply) is sent back to the requesting node. AODV also has an important feature that informs nodes of any possible link breaks that might have occurred. A table entry is deleted if not used recently. A set of predecessor nodes is maintained for each routing table entry, indicating the set of neighbouring nodes, which use that entry to route the data packets. These nodes are notified when the next-hop link breaks with RERR (Route Error) packets. On the receiving of these packets each predecessor node, in turn forwards the RERR packets to its own predecessors, thus erasing all routes with broken links. When a node S needs a route to some destination D, it broadcasts a Route Request message to its neighbours, including the last known sequence number for that destination. The Route Request message is flooded in a controlled manner through the network until it reaches a node that has a route to the destination. Each node that forwards the Route Request creates a reverse route for itself back to node S. When the Route Request reaches a node with a route to D, that node generates a Route Reply that contains the number of hops necessary to reach D and the sequence number for D most recently seen by the node generating the Reply. Each node that participates in forwarding this Reply back toward the originator of the RouteRequest (node S), creates a forward route to D. The state created in each node along the path from S to D is hop-by-hop state that is, each node remembers only the next hop and not the entire route, as it would be done in source routing.

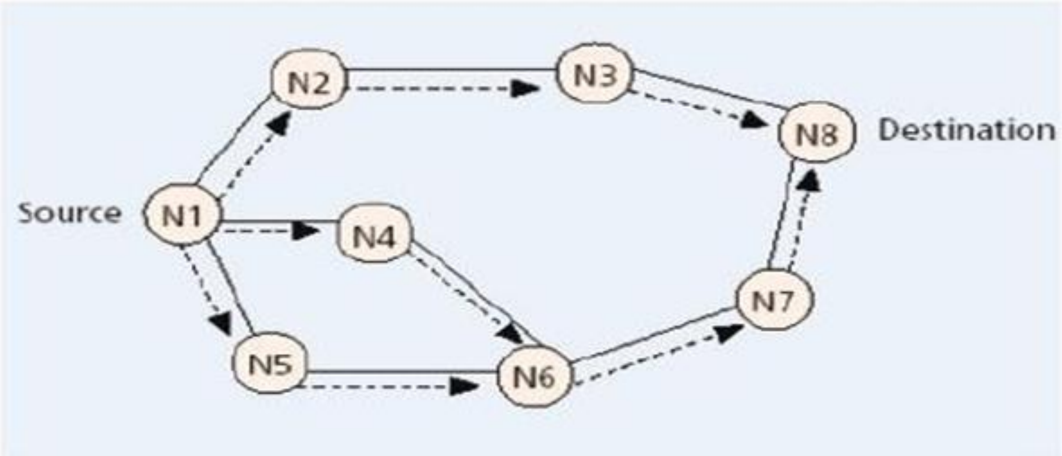

Fig.1.Path Discovery in AODV (Deng et al. 2002)

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b) Ad-hoc on demand Multicast Distance Vector (AOMDV)

This protocol is similar to AODV but the difference is that it uses multicasting in the route request. So only a set of nodes will get the route request.

c)Dynamic Source Routing (DSR)

DSR, like AODV falls under the family of On-Demand routing protocols. That is, it also discovers routes only when needed by the source. Unlike AODV, DSR doesn't use traditional routing tables to maintain routing information. The key characteristic of DSR is the use of source routing and route cache.[3] That is, the sender knows the complete hop-by-hop route to the destination. These routes are stored in the route cache. The data packets carry the source route in the packet header. When one host sends a packet to another host and does not know the route to the destination, it broadcasts a route request packet to dynamically discover the route to the destination. The route discovery mechanism works by flooding the network with RREQ packets. When a node receives a RREQ it forwards it, unless the node is the destination or it has knowledge of a route to the destination. If the node happens to be the destination or knows the route to the destination, it replies with a RREP packet that is routed back to the original source. The DSR protocol consists of two mechanisms: Route Discovery and Route Maintenance. Route Discovery is the mechanism by which a node S wishing to send a packet to a destination D obtains a source route to D. To perform a Route Discovery, the source node S broadcasts a Route Request packet that is flooded through the network in a controlled manner and is answered by a Route Reply packet from either the destination node or another node that has a route to the destination. Route Maintenance is the mechanism by which a packet's sender S detects if the network topology has changed such that it can no longer use its route to the destination D because two nodes listed in the route have moved out of range of each other. When Route Maintenance indicates a source route is broken, S is notified with a Route Error packet. The sender S can then attempt to use any other route to D already in its cache or can invoke Route Discovery again to find a new route. To reduce the cost of Route Discovery, each node maintains a cache of source routes it has learned or overheard which it aggressively uses to limit the frequency and propagation of Route Request.

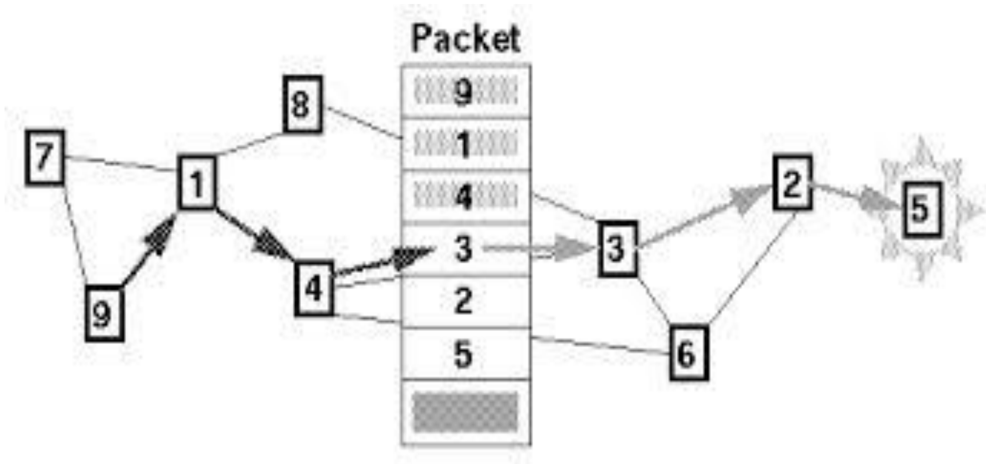

Fig.2. Route Discovery in DSR

d) Destination Sequence Distance Vector (DSDV)

DSDV is a proactive or table driven routing protocol. That is the protocol maintains a correct route to any node in the network. The DSDV routing algorithm is based on the idea of the classical Bellman-Ford Routing, with some major improvements to make it suitable for wireless schemes. DSDV uses a sequence number for each routing table entry to distinguish stale routing information from new routing information, and thus avoids looping. The nodes communicate with each other to update their routing tables. The update is both time-driven and event-driven. That is, the nodes periodically transmit their routing tables to their neighbours. A node also transmits its routing table if a significant change has occurred in its table since the last update was sent. Any routing table changes are relayed to all the other nodes, which imposes a large overhead on the whole network. To reduce this traffic, routing table updates can be sent in two ways: a full dump or an incremental update. A full dump sends the full routing table to the neighbours and could span into many packets.

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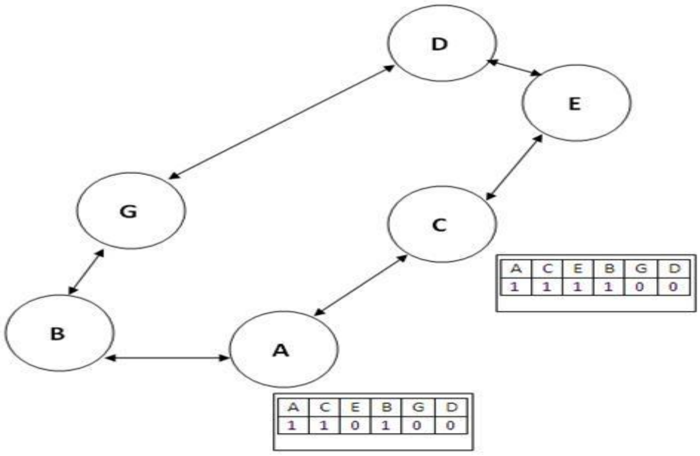

Fig.3. Route Discovery in DSDV

This type of update should be used as infrequently as possible and only in the case of complete topology change. Incremental update, updates only those entries from the routing table are sent that has a metric change since the last update.

Performance Metrics:

In comparing the protocols, it was chosen to evaluate them according to the following three metrics:

Packet delivery ratio: The ratio between the numbers of packets originated by the "application layer" CBR sources and the number of packets received by the CBR sink at the find destination.

Throughput: The total size of routing packets received during the simulation upon difference between start time and stop time of the simulation.

Delay: The summation of difference between the stop time and start time of individual packets upon the number of packets transmitted through the network . It refers to the time taken for a packet to be transmitted across a network from source to destination.

While comparing the protocols we come across two scenarios .Firstly nodes without mobility and next comes nodes with movement. Incase of with mobility we need to generate traffic pattern and scenario pattern appropriately and then with the help of awk scripts the values of the performance metrics is obtained and the graphs are plotted.

IV.RESULTS

A Tcl Script is designed based on the requirements of the simulation script. This phase of the implementation is known as pre-processing in NS-2. When we execute a Tcl Script, it generates two output files: network animator (nam) file and trace (tr) file. NAM file is useful for the visual demonstration of the simulation environment. Trace file is useful for analyzing the results obtained from the simulations. In NS-2 we have different formats of trace file for different types of networks. The trace file format for a wired network is different than the trace file format for a wireless network. Knowing the trace file format is very important because we have to design AWK scripts depending on the same format of the trace file. These AWK scripts are pattern matching scripts and are useful in plotting graphical results for the simulations. AWK is a programming language that is designed for processing text-base data, either in files or data streams. Following is the AWK script designed to extract the information about our performance metric, Packet Delivery Fraction.

Traffic pattern (change the path to ~/ns-2.34/indep-utils/cmu-scen-gen)Random traffic connections of TCP and CBR can be setup between mobilenodes using a traffic-scenario generator script. This traffic generator script is available under directory ~/ns-2.34/indep-utils/cmuscengenand
is called cbrgen.tcl.
nscbrgen.tcl [-type cbr|tcp] [-nn nodes] [-seed seed] [-mc connections][-rate rate]
>[traffic-file]

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-type: Traffic type (cbr or tcp)
-nn: Number of nodes
-seed: Seed to Random Number Generator that generates a random traffic pattern
-mc: Maximum Number connections
-rate: Traffic rate in kbps
a. Traffic flows that are setup between the mobile nodes are to read from a trafficpatternfile.
b. Traffic pattern files for performance analysis are read from different traffic patternfiles viz. cbr-10,cbr-20,cbr-30,cbr-40.
c. These traffic-pattern files are generated using TCP/CBR traffic generator patternfiles with the help of cbrgen.tcl.

Scenario pattern (change the path to ~/ns-2.34/indep-utils/cmu-scen-gen/setdest)
To define the movement we use an executable file called setdest present in the directory~/ns-2.34/indep-utils/cmu-scen-gen/setdest.
To generate the positions of nodes and their moving speed and moving directions setdest tool is used.
./setdest [-n num_of_nodes] [-p pausetime] [-M maxspeed] [-t simtime] [-x max X] [-y max Y] > [movement-file]
-n: Number of nodes
-p: Pause time
-M: Maximum speed
-t: Simulation time
-x: X dimension of topography
-y: Y dimension of topography
a. Mobile nodes move within the boundaries of a defined topology.
b. Node movements for performance analysis are read from different node movement files viz. scen-10,scen-20,scen-30,scen-40.
c. Random node movement files can be generated using node-movement generator "setdest".

Recompilation of NS-2
Change the path to ~ns-allinone-2.34/ns-2.34 and do
a. configure - the Makefile will be replaced with modified one.
b. make clean - it will recompile the whole ns-2 and remove all the object files.
c. make - removes all object files which are old and generates new object files.
d. make install - updates executable file of ns2
The values obtained for AODV,DSDV,DSR and AOMDV protocols without mobility is shown below:

Table 1 : Throughput values without mobility

AODV	639.73
DSDV	751.77
DSR	607.79
AOMDV	620.77

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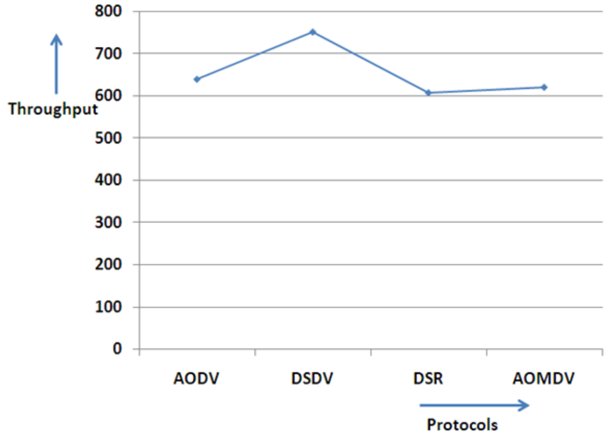

Fig.4. Throughput values without mobility

When we consider the case of without mobility of nodes, the throughput value is better in case of DSDV protocol when compared to other protocols considered because DSDV is table driven . The path to be taken by the packets is known priorly since the routing tables have data regarding the next hop. The values obtained in Table 1 are from simulation performed and the graph is plotted accordingly which is shown in Fig 4.

Table 2: Delay values without mobility

AODV	**65.5438**
DSDV	**42.9024**
DSR	**122.28**
AOMDV	**86.0308**

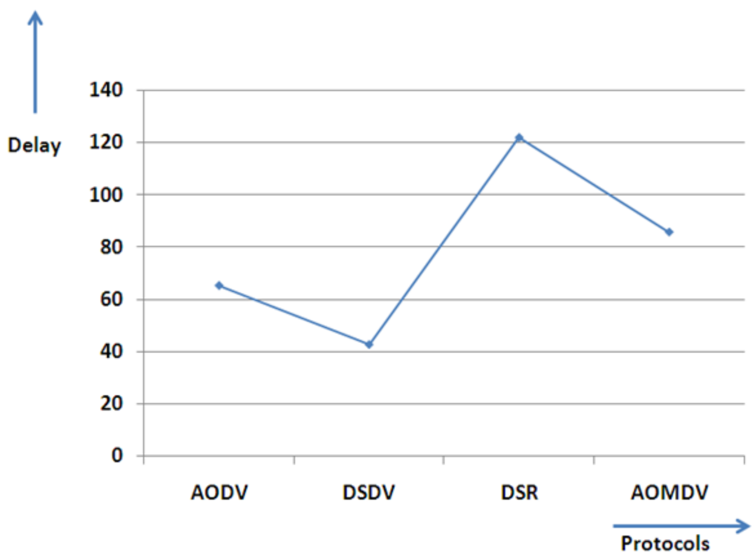

Fig.5. Delay values without mobility

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When we consider the case of without mobility of nodes, the delay value is less in case of DSDV protocol when compared to other protocols considered because DSDV is table driven . The path to be taken by the packets is known priorly since the routing tables have data regarding the next hop. The values obtained in Table 2 are from simulation performed and the graph is plotted accordingly which is shown in Fig 5.

Table 3 :Throughput values with mobility

AODV	**408.61**
DSDV	**356.62**
DSR	**393.38**
AOMDV	**438.78**

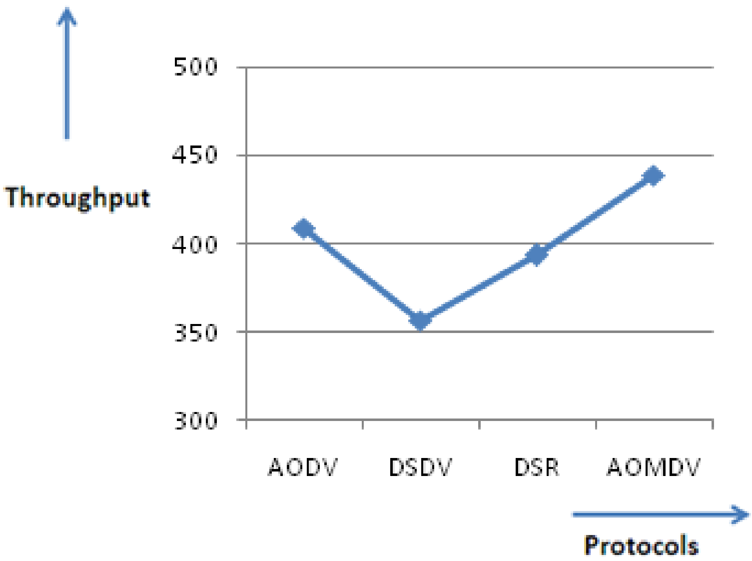

Fig.6. Throughput values with mobility

The throughput values obtained for AODV,DSDV,DSR and AOMDV protocols with mobility are shown above. The throughput value goes low incase of DSDV protocol when compared to the rest. That is because since the nodes are under motion, the table driven approach doesn't help much in terms of determining the next hop with respect to the contents in the routing table. Where as the reactive routing protocols show better performance under the same scenario. The values obtained in Table 3 are from simulation performed and the graph is plotted accordingly which is shown in Fig 6.

As shown in the graphs above, the table driven protocols provide better performance incase of without mobility scenarios where the nodes are not under motion. Where as the reactive routing protocols show less performance under the same scenario.

The table driven protocols provide less performance incase of with mobility scenario since routing table has to updated while nodes change their position when under motion. Where as the reactive routing protocols show better performance under the same scenario.

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V.CONCLUSION AND FUTURE WORK

This work proposes the various routing protocols used in MANETs with mobility and without mobility scenarios. From analytical study, it is concluded the selection of suitable protocol according to the network definitely increases the reliability of that network, for example in case of mobile ad hoc networks routing protocols should have low delay, network load and high throughput according to our research. From the simulation study, it is observed that increase in number of nodes causes increase in the average delay, network load and throughput for several protocols. This is because when the numbers of mobile nodes are increased, the data which is needed to deliver to the specific destination have to pass from many mobile nodes which cause more delay and network load. However, reactive protocols act in different manner when node density is increased. In this project we have analysed different MANET routing protocols on the basis of different performance metrics such as packet delivery ratio, transmission delay and path length. For table-driven protocol the throughput was found to be high as each node maintains the table.

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