Analysis of ART and DC for Scalable MANET

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Abstract— MANET stands for Mobile Ad-hoc Network are self-created and self-organized by a collection of independent mobile nodes that communicate with each other through making a route. Route can be formed with the help of routing protocol. One of the popular routing protocols is AODV. AODV is an Ad-hoc On-demand Distance Vector is a routing protocol designed for wireless and mobile ad-hoc network, routing information about the active path maintain by AODV. Each node keeps a routing table for communication among nodes. ART (Active Route Timeout) and DC (Delete Period Constant) stores in routing table. In this paper value of ART, DC, can be analyzed for scalable MANET.
Keywords: MANET mobile ad-hoc networks; AODV; ad hoc on-demand distance vector; ART; active route timeout; DC; delete period constant; QualNet 5.2

I. Introduction

Mobile Ad-hoc Network (MANET) is self-configuring infrastructure-less network without centralized control. This means that independent nodes can communicate to each other wirelessly via radio waves which are in the radio range of each other, whereas other nodes which are not in the same range can converse with each other through multiple intermediate nodes means through multi hop to route their packets [2]. Each node is free to move randomly in any directions which cause a change in the network topology and the event cannot be predictable. Each must forward traffic unrelated to its own use and therefore be a router. Because of the dynamic nature of MANETs, There is a security issue, so it is important to be cautious what data is sent over a MANET

Fig. 1: Mobile Ad-hoc Network

The characteristics of MANETs are:-
- Dynamic topology
- Multi hop routing
- Limited security.
- Bandwidth and energy constraints.
- No centralized controller.

Advantages of MANETs are:-
- Self configuring network.
- Nodes act as both host and routers.
- Less time consuming.
- More robust than cellular system.
- Improved flexibility.
- Less expensive
- Network can be setup at any place and time.

Issues in MANETs are:-
- Route discovery
- Resource - Constrained nodes.
- Dynamic topology due to mobility
- Battery power constraints
- Security issues.
- Node failure.
- Frequent link breakage.
- Route delay.
- Transmission errors.

Application areas of MANETs are:-
- Emergency operations (search, rescue, crowd control and commando operations as well as disaster recovery. Replacement of a fixed infrastructure in case of earthquake, hurricanes, fire etc.)
- Educational applications (to set up virtual classrooms or conference rooms)
- Military environment (coordination of military objects moving at high speeds such as fleets of airplanes or ships)
- Sensor network (collection of embedded sensor devices used to collect real time data to automate everyday functions)
- Entertainment and Home (multi user games, outdoor internet access)

A. *Routing Protocols*

Routing is a standard or convention that ensures the communication between active nodes, Provide route that packets need to follow from source node to destination node. Routing process usually directs forwarding on the basis of routing tables which maintain records of the routes to various network destinations. The Routing Protocols are accomplished to handle a lot number of nodes with restricted resources.

B. *Classification of routing protocols*

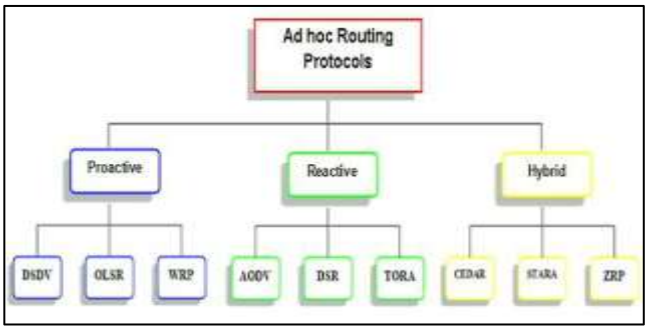

Fig. 2: Classification of routing protocols

1) *Proactive Routing Protocol*

Proactive also called table driven routing protocol in which nodes have information about every other node in the network. Each node in the network maintains one or more routing table which are updated regularly. Each node send data packets and want to establish connection to other nodes in the network, these nodes record for all destinations, number of hops required to arrive at each destination in the Routing Table.

When the network topology changes too frequently, each node send a broadcast message to the entire network. This protocol is suitable for less number of nodes in network, as every time they need to update the node entries for each and every node in the Routing Table. The cost of maintaining the network might be very high and also bandwidth consumption is more.

Proactive Routing Protocols are:-

1) Destination Sequenced Distance Vector (DSDV)
2) Optimized Link State Routing (OLSR)
3) Wireless Routing Protocol (WRP)

2) Reactive Routing Protocols

Reactive Routing Protocol is a bandwidth efficient protocol which searches for the routes in an on-demand and set the link to send out and accept the packet from source node to destination node. Thus the need for a route triggers the process of route search.

In other words, Route discovery process is used in on demand routing by flooding the Route Request (RREQ) packet throughout the network, it does not use any broadcast based method for new route discovery but uses the incremental search method.

Reactive Routing Protocols are:-

1) Ad hoc On Demand Distance Vector (AODV)
2) Dynamic Source Routing (DSR)
3) Temporally Ordered Routing Algorithm (TORA)

3) Hybrid Routing Protocols

Hybrid Routing Protocol is a combination of both Reactive and Proactive routing protocol. This approach is introduced to overcome the shortcomings of both Reactive and Proactive protocols. It reduce the control overhead of proactive protocol and also decrease the latency caused by route discovery in Reactive protocol.

Hybrid routing algorithm is ideal for Zone Based Routing Protocol (ZRP)

4) AODV Routing Protocol

Ad hoc On Demand Distance Vector (AODV) is a reactive routing protocol which is utilized in Mobile Ad hoc Network. It is known as on demand routing algorithm that provide a very easy way to change link condition. It required to minimize the network usage by creating route between source node and destination node. WLAN (IEEE 802.11/b), which is mostly used in ad-hoc network to make physical connection directly between two nodes.

C. Path discovery

The path discovery process is initiated whenever a source node needs to communicate with another node for which it has no routing information in its table. Path discovery process begins with the creation of Route Request (RREQ) packet by source node. The packet contain source node IP address, Broadcast ID number, Source node's current sequence number, Destination IP address, Destination sequence number. Broadcast ID get incremented each time a source node uses RREQ broadcast ID and source IP address for a unique identifier for the RREQ.

D. Reverse path setup

There are two sequence numbers included in a RREQ; the source sequence number and the last destination sequence number known to the source. The source sequence number is used to maintain fresh information about the reverse route to the source and the destination sequence number specifies how fresh a route to the destination must be before it can be accepted by the source. As shown in the Figure 1.4.2.When the source node S determines that it needs a route to the destination node D and does not have the rot available. Immediately node S starts broadcasting RREQ message to its neighboring nodes in quest of route to the destination. The nodes 1 and 4 being as neighbors to the node S receive the RREQ message. So, nodes 1 and 4 create a reverse link to the source from which they received RREQ. Since the nodes 1 and 4 are not aware of the link to the node D, they simply rebroadcast this RREQ to their neighboring nodes 2 and 5. As the RREQ travels from a source to various destinations, it automatically sets up the reverse path from all nodes back to the source. This reverse route will be needed if the node receives a RREP back to the node that originated the RREQ. Before broadcasting the RREQ, the originating node buffer the RREQ ID and the originator IP address. In this way, when node receives the packet again from its neighbors, it will not reprocess and re-forward the packet.

E. Forward path setup

Eventually, a RREQ will arrive at a node that possesses a current route to the destination or the destination itself. The receiving node first checks that the RREQ was received over a bi-directional link. If an intermediate node has a route entry for desired destination, it determines whether the route is current by comparing the destination sequence number in its own route entry to the destination sequence number in the RREQ, If the RREQ's sequence number for the destination is greater than that recorded by the intermediate node, the intermediate node must not use its recorded route to respond to the RREQ. Instead the intermediate node rebroadcasts the RREQ. The intermediate node can reply only when it has a route with a sequence number that is greater than or equal to that contained in the RREQ. If it does have a current route to the destination and if the RREQ has not been processed previously, the node then unicast a route reply packet (RREP) back to its neighbor from which it received the RREQ. By the time a broadcast packet arrives at a node that can supply a route to the destination, a reverse path has been established to the source of the RREQ. As the RREP travels back to the source each node along the path sets up a forward pointer to the node from which the RREP came, updates its timeout information for route entries to the source and destination, and records the latest destination sequence number for the requested destination. Figure 1.4.3 represents the forward path setup as the RREP travels through the nodes 3, 2, 1 from the destination D to the source node S. Nodes 4 and 5 are not along the path determined by the RREP, and will timeout after ART and will delete reverse pointers from these nodes.

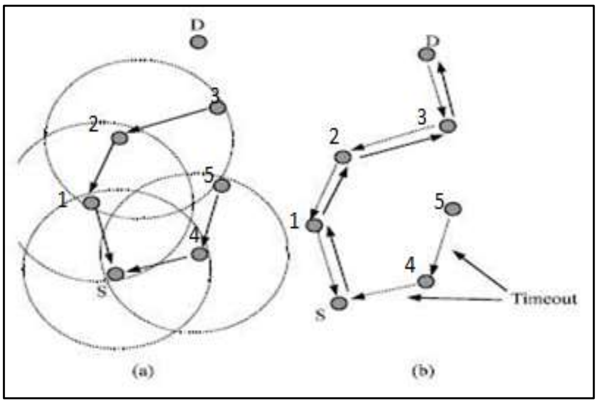

Fig. 3: Reverse path and forward path setting

II. LITERATURE SURVEY

1) Ritesh Kumar Mohapatra et.al [1] analyzed the performance of various Reactive Routing protocols such as DSR, AODV, DSDV on the basis of Throughput, Normalized Routing Overhead and Average end to end delay. The simulation is carried out by using NS2 and in different network sizes and by different number of nodes. The result shows DSR perform better in terms of packet delivery ratio, throughput and normalized routing overhead, Also AODV perform better in small and medium networks
2) Sachin k Gupta et.al [2] proposed how different route maintenance parameter such as Active Route Timeout (ART) and Delete Period Constant (n) effect the performance of Ad hoc On-Demand Distance Vector (AODV) routing protocol for constant scenario ,which is tested on Random Way Point model for a specified number of nodes (here taken 50) with IEEE 802.11/b MAC protocol. ART is a time period at which route is consider valid. Delete period constant define the time after that expired route is deleted. Expired route is deleted after delete period multiplied by the greater of Active Route Time or hello interval. The simulation result for performance metric net throughput and packet delivery ratio are analyzed for different 'ART' and 'n' using NS-3 simulator shows that for ART=2.5 and n=5 AODV gives maximum performance.
3) Mahtab Singh et.al [3] analyzed the performance of Ad-hoc On-Demand Distance Vector (AODV) routing protocol by changing values of Active Route Timeout (ART) and Delete Period Constant (DPC) at different source-destination (node) pair. The simulation results of different 'ART' and 'DPC' for the performance metrics net throughput, average delay, percentage of drop packets, average jitter are analyzed graphically. The paper define the default values of route maintenance parameters i.e. ART=3s and DPC=5s respectively. Simulation of was carried out using QualNet 7.1, shows maximum throughput is at ART=3s and DPC=4s.
4) CharuWahiet.al [4] presented simulation of two most prominent on-demand routing protocol Ad hoc On-Demand Distance Vector (AODV) and Dynamic Source Routing (DSR) by varying pause time from 0s to 300s for a MANET ranging from 30, 50 and 70 nodes using QualNet and analyzed how scalability and mobility affect their performance. Conclusion showed that by varying Pause Time and network size DSR attain higher throughput than AODV but with an increase in mobility and scalability Average End-to-End Delay of DSR increases whereas Delay of AODV decreases.
5) Richasinglaet.al [5] studied the scalability of the reactive Ad-hoc On-Demand distance vector (AODV) routing protocol and proactive Destination Sequenced Distance Vector (DSDV) routing protocol by varying number of source node and considering different performance metrics such as Throughput, Packet Delivery Ratio and End to End Delay. Simulation result of NS-2 simulator for considered scenarios (10, 20, 30, 40, 80 nodes) concluded that AODV is not affected by the changes in the parameters during simulation in considered scenarios and shows that reactive routing protocol AODV performs better than the proactive routing protocols DSDV.
6) Martin Appiah et.al [6] analyzed the performance of two mobility model Random Way Point (RWP) and Manet_Down_Left (MDL) with OLSR (optimized link state routing) protocol by varying different parameters i.e. pause time (5s & 5-10 m/s respectively) and speed (15s & 25-30s respectively) in each scenarios. The aim of a mobility model is to portray the movement pattern of mobile nodes in MANET under different network scenarios. In Random Way Point, mobile nodes normally wait for a period of time before it moves to its destination at a given speed. Mobile nodes in RWP normally travel near the Centre of the simulation area. However, in Manet_Down_Left, mobile nodes keep on moving in the same direction until they get to the border of the simulation area. The paper describe that simulation was carried out using OPNET in area of 500 m × 500 m and all scenario have an equal number of nodes i.e. 500. Simulation result shows that in all scenarios random way point configured with OLSR perform best.
7) Abdalftahkaid et. al [7] provided a performance comparison of various reactive protocols such as Ad-hoc On-Demand distance vector (AODV), Dynamic Source Routing (DSR), Temporally-ordered Routing Algorithm (TORA) in different QoS parameters under varying node density. Simulation have been carried out for different node density such as 25, 50, 75 and 100 mobile nodes for proactive routing protocols. All simulation are for IEEE 802.11g WLAN standard. The type of data and size of area are considered to be constant, and the data rate is considered to be 54 Mb/s for 802.11g. OPNET simulation concluded that in terms of throughput and routing traffic DSR perform better but in all AODV excel others in terms of Load, Data Drop Retry, Media Access Delay and retransmission attempts.
8) Rajneesh Kumar Gujralet.al [8] determine the scalability effect on various QoS parameters such as packet delivery ratio, end to end delay, routing overhead, throughput and jitter for routing protocols such as Ad-hoc on-demand Distance vector (AODV), Dynamic Source Routing (DSR), Destination Sequenced Distance Vector (DSDV) is studied by altering packet size, time interval between packets, number of nodes and mobility rates. After considering eight scenarios NS-2.34 simulation

indicated that out of six, four QoS parameters has favorable results which concluded that overall AODV performs better.

9) A Rama Rao et.al [9] proposed backup route establishment for QoS routing protocol. The main aim of QoS is to provide preferential delivery service for the application that need it by ensuring sufficient bandwidth, controlling latency and jitter, and even reducing data loss. In this paper failures of nodes and networks are deduce by path evaluation function, means for detection of failures, a path evaluation function is determined based on the metrics energy drain rate and interference, congestion status are measured. After determining failures, backup routes are established and transmission is forwarded on these routes. Simulation is carried out using NS-2 simulator which showed that this protocol improved throughput and minimize recovery delay
10) Wadhah Al-Mandhariet.al [10] identified the performance of Ad- hoc On-Demand Distance Vector (AODV) routing protocol by varying Active Route Timeout (ART) value and the effect of changing nodes movement speed and number of station on the Packet Delivery Rate (PDR) in ad-hoc network. When a route is not used for some time, the nodes will remove the route state from the routing table. The time until the node removes the route state is called Active Route Timeout. PDR is the ratio of the number of delivered data packets to the destination. This paper define two scenarios, first scenario shows the comparison of ART and PDR for varying station speed and other scenario shows comparison of station movement speed and PDR for different stations. OPNET simulation concluded that for higher speed values, AODV perform better at low values of ART.
11) Asha Ambhaikaret.al [11] evaluated the performance comparison of two reactive routing protocol AODV and DSR for constant network of 100 nodes under different values of Pause Time, here taken in increasing manner from 5sec to 40sec (i.e. 5,10,15,20,25,30,35,40). The time taken by node to choose the destination for packet delivery is called pause time. Simulation result of NS-2.33 illustrated that at given scenario as Pause Time increases than parameters such as Loss Packet Ratio, Routing Overhead increases and Packet Delivery Ratio decreases indicated that at higher values of pause time AODV performs better while at lower values of pause time DSR performs better.

III. Problem Formulation

In Mobile Ad hoc Network, since the nodes arbitrarily move, the network topology changes frequently and unpredictably, so route setup and its maintenance are a challenge due to nodes mobility. Reactive protocols such as AODV, find a route whenever a source node needs to communicate with another node for which it has no routing information in its routing table. There are various route maintenance parameters like RREQ rate, RREP rate, route failure rate TTL, ART (Active Route Timeout), DPC (Delete Period Constant) of AODV Routing Protocol. Among them only two route maintenance parameter have been considered (ART and DPC), to analyze the performance of AODV Routing Protocol. Due to the massive use of wireless devices is necessary to develop ad hoc networks with the ability to reacting properly to the increase in the number of nodes, network size without losing quality of the service. Achieving scalability in the ad hoc networks is one of the main challenges; Scalability in ad hoc network is the capability of the network to handle a growing amount of nodes, traffic, network size etc. It is required to check effect of ART and DPC on scalability and to optimize these parameters for scalable MANET.

IV. Methodology & Proposed Work

A. Methodology

To analyze the performance of AODV on scalable network, we will take different scenarios with different network sizes and study the effect on Throughput, Delay, Jitter, Percentages of drop packets etc. by changing the route maintenance parameters basically Active Route Timeout (ART) and Delete Period Constant (DPC). The ART and DPC are important metrics in AODV and also play important role on scalability. Simulation will be carried out using QualNet simulator.

1) QualNet Simulator

The QualNet communications simulation platform (QualNet) is a product of Scalable Network Technologies, Culver city, CA, 90230, USA. It is a discrete event simulator and capable of simulating both the wired or wireless scenarios from simple to the cumbersome conditions. It is a planning, testing, and training tool that mimics the behavior of a real communications network. Simulation is a cost effective method for developing, deploying and managing network-centric system throughput their entire lifecycle. Users can evaluate the basic behavior of a network, and test combinations of network features that are likely to work. QualNet provides a comprehensive environment for designing protocols, creating and animating network scenarios, and analyzing their performance. QualNet simulator has the following features:

– Instant playback of simulation results to minimize unnecessary model executions.
– Fast simulation result for thorough exploration of model parameters.
– Real time simulation for man in loop hardware in the loop models.
– Scalable up to tens of thousands of nodes.
– Fast model setup with a powerful Graphical User Interface for custom code development and reporting options.
– Multi-platform support.

2) Performance Parameters

Following Performance parameters affected by varying ART and DPC are:-

a) Throughput:

It is the number of packets passing through the network in a particular unit of time. It is the ratio between the number of data packets sends and the number of data packets received. This is measured in bits/sec.

Throughput =Total packet receive/Total packet sent

b) Packet delivery ratio (PDR):

It is the ratio of the number of delivered packets to the destination. It shows the level of delivered data to the destination.

∑ Number of packet receive / ∑ Number of packet sent

c) End to End Delay:

It is an average time period from starting the delivery of packet from source node until it delivers to the destination. It also contains the delay caused by route discovery process and the queue in data packet transmission. Only the data packets those successfully delivered to destination are counted. It is measured in seconds.

∑ (arrive time - send time) / ∑ Number of connections

d) Average Jitter :

It is a measurement of variation over time of the latency of packet across a network. It is deviation of some aspects of the clock pulses from source to reach the destination with different delays.

B. *Proposed Work*

The static parameter Active Route Timeout (ART) defines how long a route is remained in the routing table after the last transmission of packet on this route.

Delete Period Constant (DPC) defines the time after which an expired route is deleted. An expired route is deleted after delete period multiplied by the greater Active Route Timeout (ART) or hello interval.

Delete Period = Delete Period Constant × max (active route timeout or hello interval) Where delete period constant is having default value of 5s.

A mobile node maintains a route table entry for each destination of interest. Each time a route entry is used to transmit data from source to destination. The timeout for the entry is reset to the current time plus ART

Aim of this work to identify the effect of route maintenance parameters Active Route Timeout and Delete Period Constant on scalability. The expected result will show that Scenarios with different network area, node density, and links will be simulated and analyzed. Such route maintenance parameters will be analyzed for scalable network.

Active Route Timeout	3s
Delete Period Constant	5s
My Route Timeout Interval	2×Active Route Timeout
Node Traversal Time	40s
Maximum Route Request Retries	2
Maximum Number of Buffer Packets	100
Net_ Traversal_ Time	2*Node_Traversal_Time* Net_Diameter
Path_ Discovery _ Time	2*Net_Traversal_Time

Table 4.1: Default Value of Route Maintenance Parameters of Aodv Routing Protocols

V. SIMULATION & RESULT ANALYSIS

In this work the performance of AODV is enhanced by optimizing ART (Active Route Timeout) and DC (Delete Period Constant) values for scalability.

The following table shows the parameters and there values.

Parameter	Value
Simulator	QualNet 5.2
Traffic type	CBR
Packet interval	1sec
Pause time	1sec
Node speed (min)	1m/s
Node speed (max)	10m/s
Total packet send	4000 packet/s
Transmission power	10dbm
Simulation time	900sec
Mobility model	Random way point
Antenna	Omni directional
Terrain size	2000 m x 2000 m
Node density	125 nodes
Links	30
Data payload	512 bytes/packet

Table 5.1: Simulation Parameter

A. *Analysis of network for ART=3sec*

DC(s)	Throughput (bits/s)	PDR (%)	Average end to end delay(s)	Average Jitter(s)
1	1736.17	0.4219	0.381192	0.222612
2	1752.17	0.4252	0.394173	0.231943
3	1770.93	0.4297	0.385222	0.22378
4	1777.6	0.4314	0.414148	0.244591
5	1771.63	0.4299	0.403397	0.240011
6	1765.27	0.4284	0.396071	0.23422
7	1788.7	0.4341	0.384436	0.241259

Table 5.2:

Table 5.2 shows maximum throughput is at DC=7sec and next at DC =4sec.

DC is set at 4sec and 7sec in table 5.2 and table 5.3 for different values of ART

B. *Analysis of network for DPC=4sec*

ART(s)	Throughput (bits/s)	PDR (%)	Average end to end delay(s)	Average Jitter(s)
0.5	1618.07	0.3930	0.44671	0.277247
1	1649.93	0.4009	0.432319	0.255727
1.5	1769.87	0.4292	0.396186	0.232553
2.5	1777.6	0.4319	0.386321	0.229335
3	1777.13	0.4314	0.414148	0.244591
4	1759.9	0.4268	0.391975	0.231356
6	1761.13	0.4276	0.392893	0.232213
8	1761.57	0.4275	0.389749	0.229416

Table 5.3:

Table 5.3 shows high throughput, PDR and less end to end delay, Jitter at ART = 2.5sec

Analysis of network for DPC =7sec

ART(s)	Throughput (bits/s)	PDR (%)	Average end to end delay(s)	Average jitter(s)
0.5	1621.97	0.3941	0.453136	0.279307
1	1645.43	0.3999	0.420664	0.25865
1.5	1774.7	0.4304	0.400725	0.244128
2.5	1768.73	0.4298	0.400235	0.239476
3	1788.7	0.4341	0.391436	0.241259

4	1753.93	0.4256	0.393382	0.235122
6	1769.7	0.4296	0.392104	0.235687
8	1774.9	0.4308	0.397991	0.236928

Table 5.4:

Table 5.4 shows high value of throughput, PDR and less delay at ART=3sec

VI. Conclusion

In this paper, performance analysis of AODV protocol has been done by varying route maintenance parameters. ART(Active Route Timeout) and DC(Delete period Constant) are varied and throughput, packet delivery ratio, average end to end delay and average jitter has been analyzed.

The default value of ART is 3sec and DC is 5sec.The analysis is begin with range of DC (1,2,3,4,5,6,7) and keeping ART at 3sec. Here maximum throughput and Packet delivery ratio is observed at DPC =7sec and next at DC= 4sec which is away from its default value. Therefore, analysis is extended by varying ART (0.5, 1, 1.5, 2.5, 3, 4, 6, 8) and keeping DC at 4sec and 7sec. So, from this analysis it is clear that if there is a change in the route maintenance parameters, the performance has also changed.

The effect of changing route maintenance parameters (ART and DC) on the performance of AODV on scalable network has been analyzed in this paper. The result shows best performance at (ART, DC) = (3sec, 7sec) and (2.5sec, 4sec).

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