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Optimization of ART and DC for Scalable MANET

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***Abstract* - Now days, Ad-hoc network play an important role in our daily lives because of their extensive capability of uses in various fields. Mobile Ad-hoc Networks (MANETs) are very popular network with large number of users and due to development of large scale ad-hoc network; scalability has been one of the issue we need to concentrate. MANETs has a various types of routing protocols. One of the popular routing protocols is AODV (Ad-hoc On-demand Distance Vector) which provide route for communication between nodes. Route maintenance parameters such as ART (Active Route Timeout) and DC (Delete Period Constant) are stores in routing table of nodes. This paper is optimized the value of ART and DC for scalable MANET.**

***Keywords*- MANET (Mobile Ad-Hoc Network), Active Route Timeout, Delete Period Constant, Scalability.**

I. INTRODUCTION

Mobile Ad-hoc Network (MANET) is self-organized, self configuring network consisting of set of nodes that communicate with each other wirelessly via radio waves which are in the radio range of each other. Each node is free to move randomly in any direction which causes a change in the network topology. In other words due to mobility of nodes, network has a dynamic topology and that cannot be predictable. These networks can be setup at any place and time because it does not required any fixed infrastructure centralized administration for communication and therefore these networks are highly flexible.

Routing is a standard or convention that ensures the communication between the active nodes. Routing process usually directs forwarding on the basis of routing tables which maintain records of the routes to various network destinations. MANETs consist of various routing protocols which can be categorized as Proactive (Table driven) routing protocol, Reactive (On-demand) routing protocol and Hybrid 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 is 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. Proactive Routing Protocols are Destination Sequenced Distance Vector (DSDV), Optimized Link State Routing (OLSR) and Wireless Routing Protocol (WRP). 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 needs for a route bring about 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 Ad hoc On Demand Distance Vector (AODV), Dynamic Source Routing (DSR), and Temporally Ordered Routing Algorithm (TORA).

Hybrid Routing Protocol shows properties 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 protocol is ideal for Zone Based Routing Protocol (ZRP).

The scalability of an ad-hoc network is directly related to routing protocols [12] therefore this paper focusing specifically on the AODV routing protocol. Scalability is the ability of the network to perform efficiently to the large number of nodes without losing quality of the service. In this paper, we concentrate on the performance analysis of ad-hoc network while changing route maintenance parameters such as ART and DC, Also optimizing values of these parameters by considering different network size, node density and links. Route maintenance is the mechanism used to detect a link breakage by a source node along its source route to a destination node. This mechanism is used in order to maintain the actively participated routes in the network and ensures source node that it can still use the route or not. When broken link is detected by the source node in the source route, it can use another route or trigger a new route discovery process. ART (Active Route Timeout) is a fixed parameter that tells duration of route state information in the routing table after the transmission of last packet from the route.

Mainly, it is a time at which route is considered to be valid [3]. The route state information is eliminated by the nodes from the routing table whenever a route is not used for some period of time. The time, until the node removes the route state is called Active route timeout [9].Delete Period Constant (DC) 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 [2, 3].Delete Period = Delete Period Constant × max (active route timeout or hello interval) Where delete period constant is having default value of 5s. The paper is organized as follows. In section II, we discuss overview of AODV routing protocol. In section III, we describe simulation parameters that are used in this work. In section IV, we describe simulation result. Conclusion is presented in Section V.

II. OVERVIEW OF AODV ROUTING PROTOCOL

AODV is Ad-hoc On Demand Distance Vector. It is reactive in nature and required to maintain the routing information about the active paths. It includes two basic operations that is route discovery and route maintenance mechanism. In AODV, when node want to send packets from the source to the destination. Firstly, it checks for the availability of route from source node to the destination. If available then it forwards the packet to the immediate neighbors, otherwise source node initiates the route discovery mechanism in order to find the exact route to destination. Route maintenance mechanism is used to maintain routes that are actively participated in the network. AODV use three basic control packets RREQ (Route Request), RREP (Route Reply), RERR (Route Error) for route discovery and route maintenance.

Advantages of AODV

1. In AODV, routes are established only on demand.
2. AODV is loop free.
3. No centralized administration is required for the process of routing.
4. In the active route, it is capable of handling link failures efficiently.
5. In AODV, using destination sequence number we can easily found most recent route to destination.

III. SIMULATION ENVIRONMENT

Simulation work was carried out using QUALNET 5.2 simulator which is a product of scalable network and capable of simulating both the wired or wireless scenarios. The various parameters are described in this section which is affected by varying ART & DC. In this case, value of DC and ART has been changed and analyzed for different scenarios. The DC is taken as (1, 2, 3, 4, 5, 6, 7) & ART is taken as (0.1, 1, 1.5, 2.5, 3, 4, 6, 8) in this simulation environment. Following Performance parameters are considered for analysis:- Throughput, Packet delivery ratio (PDR), Average end to end delay, Average jitter

Table I: shows the simulation parameters such as pause time, packet interval, node speed transmission power, simulation time etc which were constant, throughout the analysis.

Table I: Simulation Parameter

Parameter	Value
Simulator	QualNet 5.2
Packet interval	1 sec
Pause time	1 sec
Node speed (min)	1 m/s
Node speed (max)	10 m/s
Total packet send	4000 packet/s
Transmission power	10 dbm
Simulation time	900 sec
Mobility model	Random way point
Antenna	Omni directional
Packet size	512byte/packer
Active Route Timeout(ART)	3s (default)
Delete Period Constant(DC)	5s (default)
Traffic type	CBR

IV. SIMULATION RESULT

In this work the performance of AODV is enhanced by optimizing ART (Active Route Timeout) and DC (Delete

Period Constant) values for scalability. We considered four scenarios of different network size, node density and links. Firstly value of ART is kept constant that is 3s while changing DC for given simulation upto 900sec, different values of throughput, PDR, average end to end delay and average jitter has been generated in Qualnet which are listed in Tables.

Table II: Different scenarios with their respective Area size, Nodes and Links.

Scenarios	Area size	Nodes	Links
Scenario 1	1000 x 1000m^2	100	20
Scenario 2	2000 x 2000m^2	125	30
Scenario 3	3000 x 3000m^2	150	40
Scenario 4	4000 x 4000m^2	175	50

1. Analysis of scenario 1 for ART= 3 sec

Table III: Table for scenario 1 ART=3s

DC(s)	Throughput (bits/s)	PDR(%)	Average end to end delay(s)	Average jitter(s)
1	3108.9	0.7576	0.20388	0.10797
2	3085.7	0.75183	0.208069	0.11221
3	3115.2	0.7590	0.205699	0.108387
4	3139.15	0.7649	0.2022	0.104633
5	3096.2	0.7543	0.203764	0.10789
6	3082.1	0.7510	0.203197	0.104897
7	3120.05	0.7604	0.203106	0.104741

2. Analysis of scenario 2 for ART= 3 sec

Table IV: Table for scenario 2 ART=3s

DC (s)	Throughput (bits/s)	PDR(%)	Average end to end delay(s)	Average jitter(s)
1	1736.17	0.4219	0.384192	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	0.221259

3. Analysis of scenario 3 for ART= 3 sec

Table V: Table for scenario 3 ART =3s

DC(s)	Throughput (bits/s)	PDR(%)	Average end to end delay(s)	Average jitter(s)
1	958.55	0.2184	0.522772	0.341345
2	926.7	0.2118	0.531194	0.356541
3	945.15	0.2155	0.548809	0.360926
4	935.625	0.2150	0.544246	0.373128
5	932.45	0.2142	0.545296	0.36411
6	946.25	0.2173	0.54711	0.371245
7	957.875	0.2204	0.531105	0.350232

4. Analysis of scenario 4 for ART= 3 sec

Table VI: Table for scenario 4 ART =3s

DC(s)	Through put (bits/s)	PDR(%)	Average end to end delay(s)	Averag e jitter(s)
1	553.633	0.11164	0.54082	0.23535 3
2	570.125	0.1095	0.492747	0.25223 3
3	544.562	0.1095	0.537802	0.25083 7
4	570.729	0.1140	0.431943	0.22013
5	556.592	0.1101	0.701265	0.25083 7
6	556.298	0.11168	0.552947 1	0.25707 2
7	571.745	0.1149	0.469335	0.21392 8

In this section, table III shows maximum value of throughput, PDR, average delay and average jitter is at DC= 4s and next 7s respectively for ART=3s. Table IV present outputs of scenario 2 which indicate high performance of network at DC= 4s and DC=7s but delay & jitter also show better results at DC=1s. Table 4.4 shows best performance of scenario at DC=1s and DC=7s for ART=3s. Table 4.5 represent maximum result at DC=7s but delay is minimum at DC=4s.

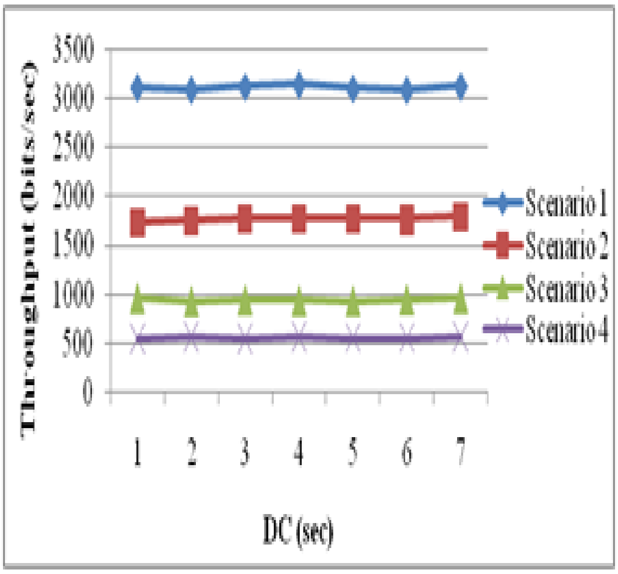

Fig.1. Throughput comparison for different values of DC.

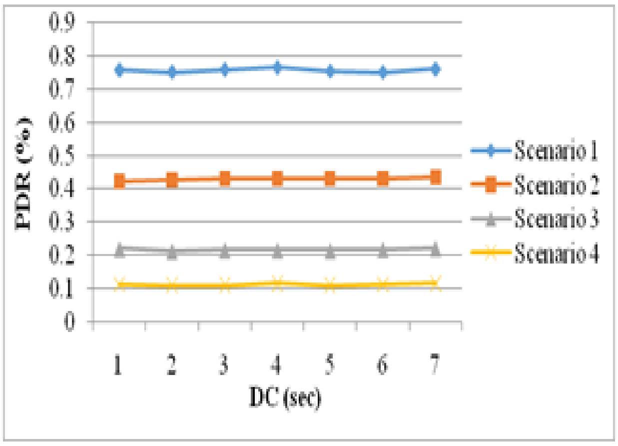

Fig.2. PDR comparison for different values of DC.

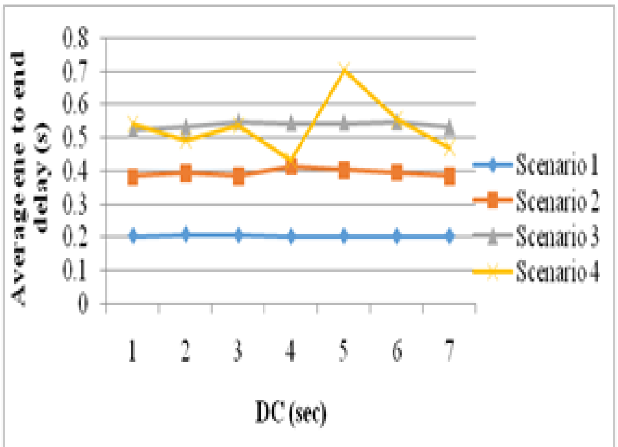

Fig.3. Delay comparison for different values of DC.

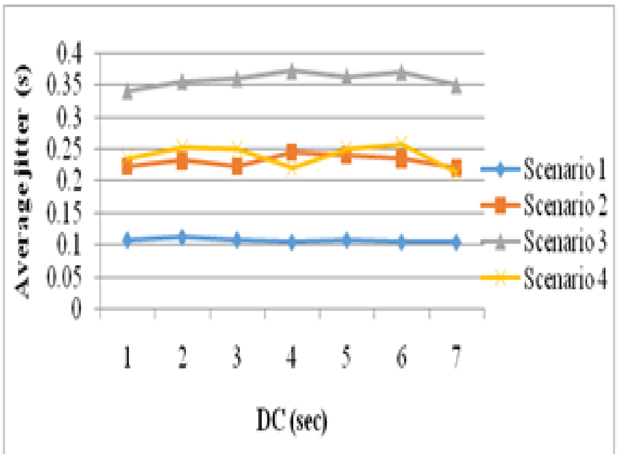

Fig.4. Jitter comparison for different values of DC.

Fig1, fig2, fig3, fig4 shows comparative results of throughput, packet delivery ratio, delay and jitter of all four scenarios for different values of DC.

5. Optimization of DC

Table VII

Scenarios	Throughput	PDR	Average end to end delay	Average jitter
Scenario 1	4 s	4s	4s	4s
Scenario 2	7s	7s	1s	7s
Scenario 3	1s	7s	1s	1s
Scenario 4	7s	7s	4s	7s

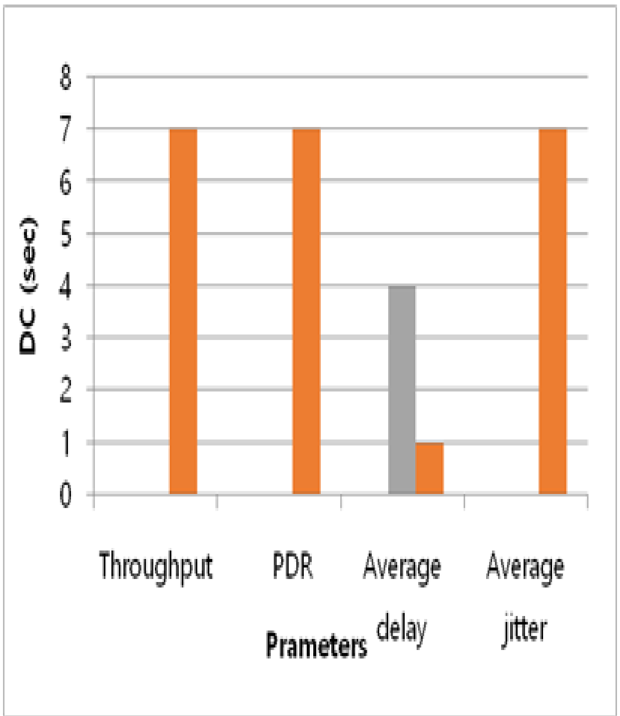

Fig.5. Optimized value of DC for different parameters.

Table VII shows the best values of performance parameters for all scenarios which we get after comparing the results of figure1, 2, 3, 4 and then optimize the value of DC for these parameters, which is presented graphically in figure 5. From above graph, we can conclude that parameters outperform at DC=7s therefore optimized value of DC=7s. We can also take value of DC=1s and 4s for less delay. For further analysis, DC is kept constant i.e. 7s while varying ART for all four scenarios.

6. Analysis of scenario 1 for DC= 7 sec

Table VIII: Table for scenario 1 DC=7s

ART (s)	Throughput (bits/s)	PDR(%)	Average end to end delay(s)	Average jitter(s)
0.5	2555.95	0.669	0.314387	0.192137
1	2629.05	0.6409	0.306622	0.188998
1.5	3090.45	0.7531	0.20401	0.108634
2.5	3099.7	0.7552	0.204709	0.106938
3	3108.9	0.7576	0.20388	0.10687
4	3097.75	0.7550	0.206093	0.108641
6	3108	0.7573	0.208857	0.111205
8	3097.9	0.7548	0.207839	0.107803

7. Analysis of scenario 2 for DC= 7 sec

Table IX: Table for scenario 2 DC=7s

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	0.425 6	0.393382	0.2351 22
6	1769.7	0.429 6	0.392104	0.2356 87
8	1774.9	0.430 8	0.397991	0.2369 28

7. Analysis of scenario 3 for DC= 7 sec

Table X: Table for scenario 3 DC=7s

ART(s)	Throughput (bits/s)	PDR(%)	Average end to end delay(s)	Average jitter(s)
0.5	880.425	0.2017	0.58683 4	0.39354 3
1	925.875	0.2115	0.55252 9	0.39196 4
1.5	924.925	0.2110	0.55411 7	0.37663 3
2.5	931.55	0.2129	0.52069 8	0.35558 6
3	946.25	0.2173	0.54711	0.37112 45
4	951.65	0.2177	0.52887 9	0.34522 6
6	944.225	0.2174	0.56861 2	0.37496
8	926.125	0.2127	0.53299 4	0.35715 1

8. Analysis of scenario 4 for DC= 7 sec

Table XI: Table for scenario 4 DC=7s

ART(s)	Throughput (bits/s)	PDR(%)	Average end to end delay(s)	Average jitter(s)
0.5	499.229	0.1018	0.5458 64	0.2680 8
1	552.447	0.1099	0.5555 6	0.2822 29
1.5	570.125	0.1095	0.4946	0.2553 88
2.5	537.959	0.1092	0.4610	**0.2363**

			37	**18**
3	577.745	0.1145	0.4927 47	0.2522 33
4	573.553	0.1114	0.6018 18	0.2420 27
6	537.306	0.1069	0.5610 98	0.2385 53
8	576.17	0.1136	0.4861 58	0.2413 78

Table VIII shows high values of performance parameters for scenario of 1000 x 1000 area size at ART=3s. Table 4.8 shows changes in performance parameters for respective values of ART with best results at ART=3s except jitter which is best at 4s.Table IX shows varied result of ART, for throughput and PDR it is 4s,delay and jitter is minimum at 2.5s and 4s. Table X shows the high value of ART=3s for throughput and PDR but delay and jitter is minimum at ART= 2.5s for scenario 4.

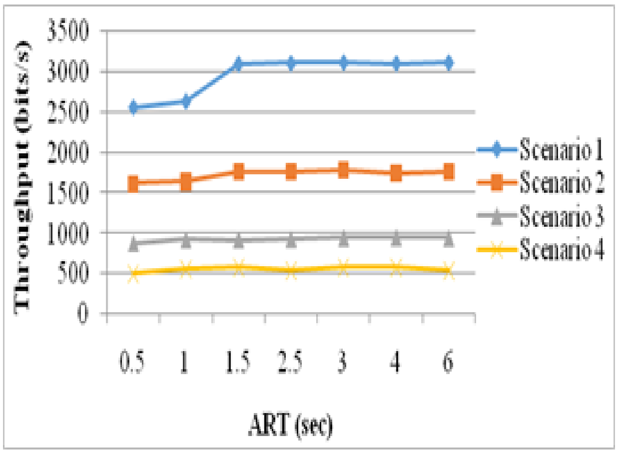

Fig.6. Throughput comparison for different values of ART.

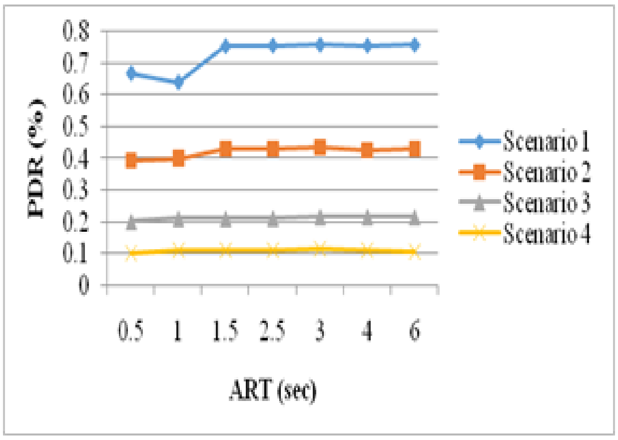

Fig.7. PDR comparison for different values of ART.

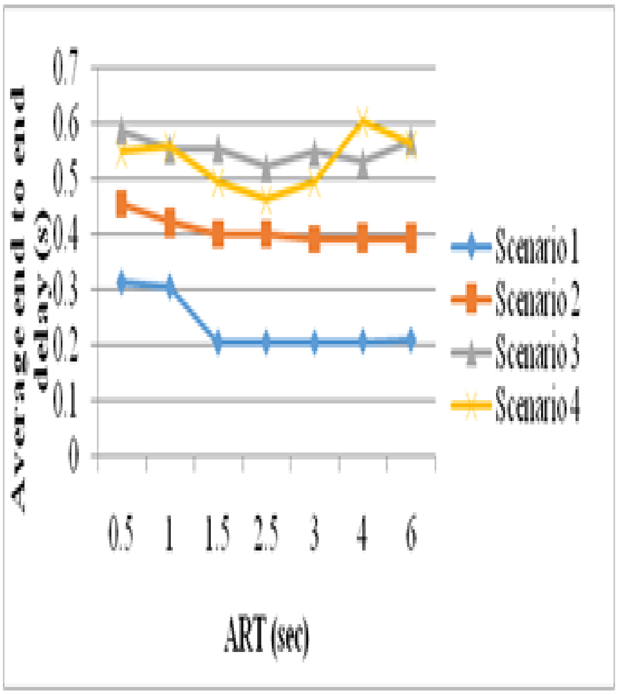

Fig.8. Delay comparison for different values of ART.

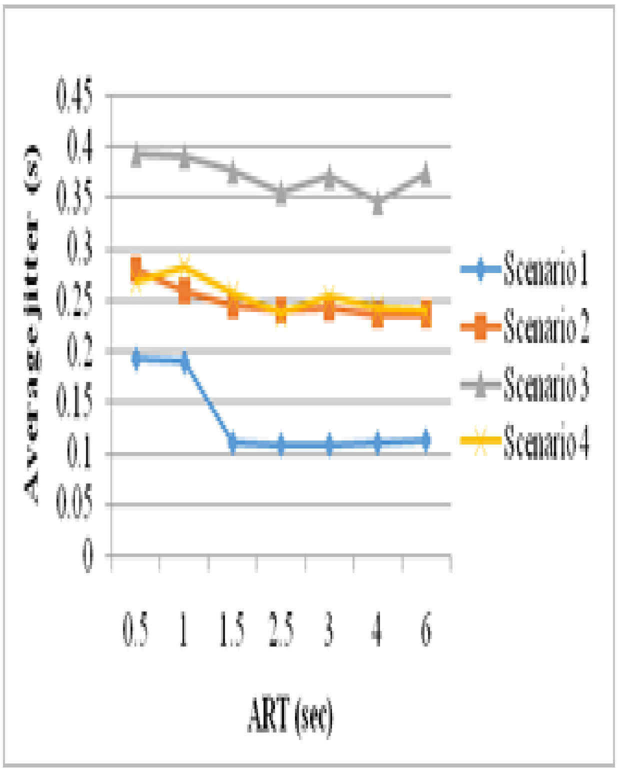

Fig.9. Jitter comparison for different values of ART.

Fig 6, fig 7, fig8, fig9 shows comparative results of throughput, packet delivery ratio, delay and jitter of all four scenarios for different values of ART.

9. Optimization of ART for DC= 7s

Table XII:

Scenarios	Throughput	PDR	Average end to end delay	Average jitter
Scenario 1	3s	3s	3s	3s
Scenario 2	3s	3s	3s	4s
Scenario 3	4s	4s	2.5s	4s
Scenario 4	3s	3s	2.5s	2.5s

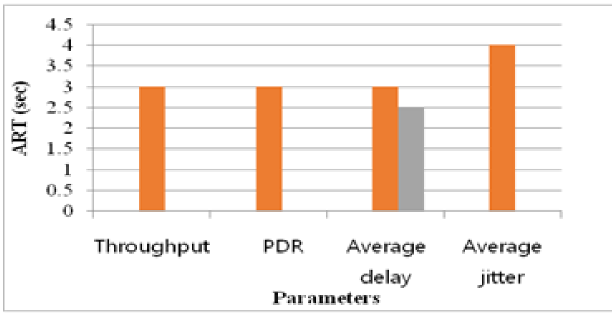

Fig.10. Optimized value of ART for different parameters.

Table XII shows the best values of performance parameters for all scenarios which we get after comparing the results of figure 6, 7, 8, 9 and then optimize the value of ART for these parameters, which is presented graphically in figure 10. From above graph, we can conclude that parameters outperform at ART=3s therefore optimized value of ART=3s for DC=7s, also consider value of ART=2.5s and 3s for less delay and jitter.

V. 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 parameters which affect the process of route setup and its maintenance therefore scalability of ad-hoc network are important point of concern in this work. The scalability issues are analyzed with respect to the performance parameters of throughput, PDR, delay and jitter for different values of ART and DC. It has been observed from the result of simulation that performance parameters vary with the changes in ART and DC of considered scenarios (1000 x1000 m2, 2000 x 2000 m2, 3000x 3000 m2, 4000 x 4000 m2).The effect of changing route maintenance parameters (ART and DC) on the performance of AODV on scalable network has been analyzed and optimized their values in this paper. The result shows best performance at (ART, DC) = (3sec, 7sec).

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