Data Transmission Based On Demand Routing In Manet

Pushpender Sarao

Abstract- Routing in ad-hoc networks is a big issue and challenge. AODV is most popular on demand routing protocol which is applicable in mostly all wireless ad-hoc networks. We here AODV routing protocol is analysed in wireless ad-hoc networks. Grid based topology has been used. Based on transmission rate and pause times, AODV is evaluated. Several routing parameters like throughput, dropped packets and average delay have been used for evaluation purposes. We have analysed AODV in several aspects at different network scenarios.

Index Terms- Normalized routing load, throughput, packet delivery ratio, average delay, AODV

I. INTRODUCTION

Routing is a process in wired and wireless networks, in which routes have to be decided so that communication can be carried out from source to destination. When in a network, number of nodes is less; routing process will be taken place in an easy way. But when the number of nodes will increase i.e. network density will be high, then it will be a complex problem for selecting the next hop for reaching the destination. Also in mobile ad-hoc networks, when mobility is high for nodes, link broken will be repeated more frequently. Also when network size is large and transmission rates are varying, network performance will be degraded.

Here, we are discussing the same scenario in communication systems as below:

- Build on the fly-a number of wireless mobile nodes work in cooperation without the engagement of any centralized access point or any fixed infrastructure.
- Two nodes can communicate in a bi-directional manner if and only if they are within the communication range of each other.
- The neighbours can communicate directly and no routing is required. But, if A and C want to communicate with each other, they must seek help from node B, who can help them by forwarding their data packets (as shown in figure 1).
  - Node A knows about B, so both A and C and use B as an intermediate node for their communications.
  - Simple neighbour information could be used here.

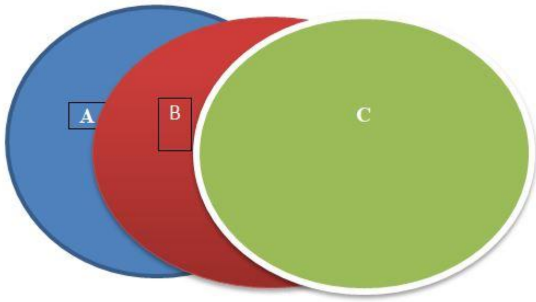

Figure 1: Transmission range of network nodes

Challenges:

Basically the major challenges for routing in MANET are imposed by the resource constraints and mobility of the nodes participating in the network.

- As there is no fixed infrastructure in such a network, we consider each node as a host and a router at the same time.
- Hence during routing of data packets, within the network at each hop, each host also has to perform the tasks of a router.
- Only neighbour information is not enough.

  To ensure the routing process easy and optimize, many routing protocols have developed in literature. On different network scenarios, particular protocol is selected for data communication.

Mobile ad-hoc networks (MANETs) routing protocols can be classified into: proactive, reactive, hybrid routing protocol.

Proactive: proactive or table-driven routing protocol.

In proactive routing each node has to maintain one or more tables to store routing information and any changes in network topology need to be reflected by propagating updates throughout the network in order to maintain a consistent network view.

Reactive: reactive routing is also known as on-demand routing protocol since they do not maintain routing information or routing activity at the network nodes; if there is no communication. If a node want to send a packet to another node then this protocol searches for the route in an on-demand manner and establishes the connection in order to transmits and receive the packet. The route discovery occurs by flooding the route request packets throughout the network.

Revised Manuscript Received on March 10, 2019.

Pushpender Sarao, CSE, Hyderabad Institute of Technology and Management, Hyderabad, India.

Hybrid: they introduce a hybrid model that combines reactive and proactive routing protocols. The zone protocol (ZRP) is a hybrid routing protocol that divide the network into zones.One of the challenging tasks in ad-hoc networks is to select the right protocol for routing process. For that purpose, we should have exact detailed knowledge, behaviour in different network scenarios, performance and service quality of various routing protocols. For that purposes, performance evaluation have been carried out by number of researchers in literature. Several proactive and reactive routing protocols have been analysed by considering different networks parameters like throughput, end-t-end delay, normalized routing load, throughput, dropped packets, received packets etc. in this work, also transmission rate plays a great role during the routing performance. When transmission rate is increased or decreased, what will be performance and quality service of a particular routing protocol? Several routing protocols like AODV, DSR, and DSDV have been analysed with respect of transmission rate. Here we analysed the performance evaluation for AODV routing protocol in mobile ad-hoc networks with respect to different network metrics like throughput, end-to-end delay, normalized routing load, and pause times etc.

In section II, related work for AODV and other routing protocols have been presented. Also some enhanced models for AODV are identified. Route request and route reply process in AODV is discussed in section III. In section IV, simulation setup, implementation, results and discussion work is elaborated in details. This work is concluded in section V.

II. LITERATURE SURVEY

A. Mercy Rani et al [1]analysed the performance of AOMDV in different topologies (square topology and triangle topology) in wireless mesh networks. At different transmission rates with respect to different network parameters like packet delivery ratio, routing overhead, end-to-end delay, dropped packets, analysis work was implemented.

In [2], AODV and DSR routing reactive protocols were compared in wireless sensor networks. PDR, throughput, and E2E delay were considered as network parameters for comparing both of reactive protocols.

For homogeneous and heterogeneous MANETs, AODV routing protocol was enhanced by K.C. Kullayappa Naik[3]. At different density of nodes in both types of MANETs, AODV was enhanced. AODV produces best results in heterogeneous MANETs as compared to homogeneous MANETs.

A. Chavana et al[4] proposed an analysis work for AODV and DSDV routing protocol. Also enhancement of AODV with respect the black hole attack was proposed. PDR, E2E delay, throughput, routing overhead were considered as network metrics for performance analysis of DSDV and AODV routing protocols. AODV was modified for facing the black hole attack in the network.

Shubhangi Mahamuni et al presented the performance evaluation work for AODV in cognitive radio ad-hoc network[5]. Simulation work was carried out using network simulator (NS-2).

Kingsley et al proposed the performance evaluation of mobile IP in ad-hoc networks. mobile IP was implemented on AODV and DSDV routing protocols. Also a comparison work was carried out both for AODV and DSDV by considering the mobile IP. Throughput, end-to-end delay, packet delivery ratio, and normalized routing load were considred as performance evaluation metrics. It was concluded that AOMDV produces better results with mobile IP as compared to AODV and DSDV routing protocol[6].

Azzedine Boukerche et al proposed performance analysis for routing protocols in ad-hoc networks (like MANET). Several routing protocols (AODV, PAODV (pre-emptive AODV), CBRP, DSR, and DSDV) were evaluated. For performance evaluation purpose, network metrics (mobility, load, and network size) were used. Experimental work was processes using network simulator NS-2. Varying the number of nodes and network connections, performance evaluation was carried out. It was considered that preemptive AODV routing protocol produces better results[7] as compared to AODV routing protocol. In [8]Utpal Barman and Neelpawan Kalita proposed the evaluation of AODV in MANET. NS-2 simulator was used for analysis by considering the several routing metrics like average throughput, packet delivery fraction, and end-to-end delay in MANET. Varying the mobile nodes and several network metrics, performance evaluation was implemented. Amandeep and Gurmeet kaur also proposed the performance of AODV in MANET[9]. Performance parameters like average end-to-end delay, throughput, and packet delivery ratio were used. MATLab was used as a simulation tool for implementing this work. Performance analysis of AODV was carried out by varying the number of nodes and different parameters. It was concluded that AODV produces satisfactory outputs for packet delay network parameter. A detailed analysis work by Shang Liu in [10] was proposed for ad-hoc networks. Also a comparison of MANET and other communication systems were carried out. Reactive and proactive routing protocols were analysed and compared with respect to different networks metrics. An enhanced version for AODV was proposed and at the same time it was compared with existing AODV routing protocol. Control packet ratio of packets and end-to end delay were used as performance parameters during the comparison process. On the platform of network simulator NS-2, simulation work was carried out. It was concluded that enhanced version of AODV (B-AODV) improves the routing repair capacity and reduces the delay from node to node. It decreases the routing overhead. An performance analysis of AODV is proposed [11] in vehicular ad-hoc networks. SUMO, MOVE, and NS-2 were used as the simulation tools for implementing this work.

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For graph plotting, Tracegraph tool was used. Varying the number of nodes and different network parameters (throughput, packet size, dropped packets, and end-to-end delay), evaluation work was carried out.

Abdusy Syarif et al [12] proposed the performance evaluation for AODV-UI. In this work, existing AODV routing protocol is enhanced with some better features. The proposed enhanced AODV-UI routing protocol was analysed and compared with AODV at different mobility network scenarios. It was claimed that AODV-UI shows better results on the random way point mobility model at all speeds and number of sources. Three types of mobility models (Random way point, Gauss-Markov, RPGM) were used in simulation setup. In respect of routing overhead and energy consumption, AODV-UI produces better performance; it can be used in hybrid ad-hoc networks.

III. OVERVIEW OF AODV ROUTING PROTOCOL

- ✓ AODV is reactive protocol.
- ✓ Routes are created when needed so called "on-demand".
- ✓ Route discovery process can be categorized into two parts:

a.) Route request(RREQ)->broadcast

b.) Route reply(RREP)->unicast

- ✓ When a node wishes to send a packet to some destination then first it checks its routing table. If route exists, forward to next hop; if no, initiate route discovery.
- ✓ Each node in AODV, have a routing table.
- ✓ Route request (RREQ) packet have source ID, destination ID, source sequence no., destination sequence no., broadcast ID, TTL(time to live).
- ✓ Major difference between DSR and AODV: DSR uses source routing in which data packet carries complete path.
- ✓ In AODV, source node and intermediate node store next hop information corresponding to each transmission.
- ✓ AODV routing protocol is basically used for MANET.
- ✓ There are four types of routing protocols-proactive, reactive, hybrid, and hierarchical routing protocols.
- ✓ AODV belongs to reactive category. It is one of a reactive protocol.
- ✓ The network silent when there is no traffic to be routed. Reactive routing protocols don't maintain routes, but build them on demand. They have their own advantages and disadvantages.

Advantages:

- There is no wastage of memory because they don't use the old route.
- They have built the route when needed.
- No big overhead for global routing table maintenance as in proactive protocols.
- Quick reaction for network restructure and node failure
- There is no battery loss.

Disadvantages:

- High latency time in route finding
- Excessive flooding can lead to network clogging.

- ✓ Routing protocols in MANET: a. Reactive(DSR, AODV, TORA), b. Proactive(DSDV, GSR, WRP) , c. Hybrid (ZRP)
- ➢ In AODV algorithm, node maintains some routing information and with the help of this information, node sends the data to the destination.

Routing process in AODV(as shown in figure 2):

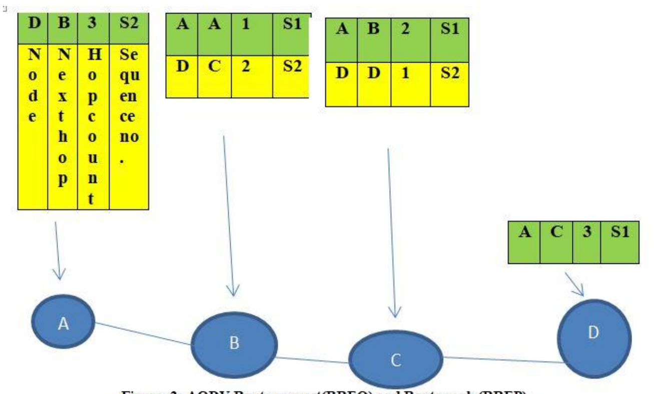

Figure 2: AODV Route request(RREQ) and Route reply(RREP)

A wants to send data to node D, A will starts route discovery. It will create RREQ (Route Request) packet, and it will forward to its neighbour (i.e. B) and B will create an entry for A to establish a reverse path. B will forward packet to C, C will create a reverse path, and again C will forward packet to D. D will create route path for A. D will decide, that it is a destination (with the help of RREQ). D will create reply. D will forward back reply packet to its neighbour (i.e. C). When reply packet reaches to C, C will create; it will create entry for D. Next C will forward back to B, B will create an entry for D. from B, reply packet will forward back to A. A will create entry for D. now, A having the information to send data to D. A will create data packet. A will send data to its neighbour B with hop count 3 and sequence number S2 and B will send data packet to C and so on.

IV.EVALUATION OF AODV ROUTING PROTOCOL IN GRID BASED TOPOLOGY

The performance evaluation of the AODV routing protocol using grid based topology is analysed using Network Simulator 2(NS-2.35). NS-2 is widely used open source network simulation software designed mainly for research in wireless ad-hoc networks. The analysis is carried out by considering the performance metrics Packet Delivery Fraction (PDF), Number of Dropped Packets, End to End Delay (E2E Delay), Normalized Routing Load (NRL) and Throughput by varying the pause time (10, 20, 30, 40 and transmission rate (0.016, 0.032, 0.064, 0.128, 0.256, 0.512, 0.750. 1.000 Mbps).

The simulation results are shown in the X- Graphs. The transmission rates are varied from 0.016 Mbps to 1.0 Mbps for each pause time such as 10, 20, 30 and 40. The simulation parameters used for the analysis in the proposed work is shown in Table 1

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Table 1: Network Simulator Parameters

Simulation Parameters	Description
Simulator type	NS 2.35
Simulation time	90s
Pause time	10, 20, 30, 40
Transmission rate	0.016, 0.032, 0.064, 0.128, 0.256, 0.512, 0.750, 1.000 Mbps
Topology	Grid Topology
Network size	1004×546 m
Maximum Speed	60 m/s
Number of Nodes	25
Network protocol	AODV
Packet Size	512 Bytes
Mac Protocol Type	Mac802.11
Traffic Type	CBR
Bandwidth	11 Mbps
Maximum packets in queue	50
Agent Type	UDP
Interval	0.05

Comparison Matrices used:

- Normalized Routing Load,
- End-to-End (E2E) Delay,
- Number of Dropped packets,
- Throughput
- PDF(Packet Delivery Fraction)

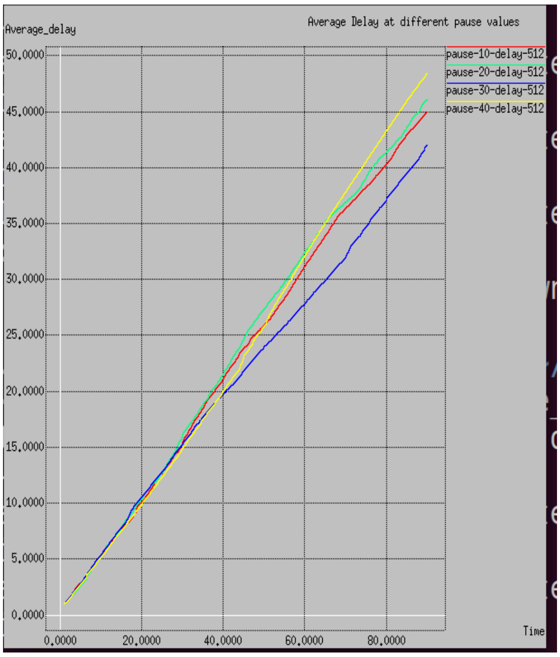

Figure 3: Average delay at different pause times w.r.t. transmission rate 0.512 Mbps

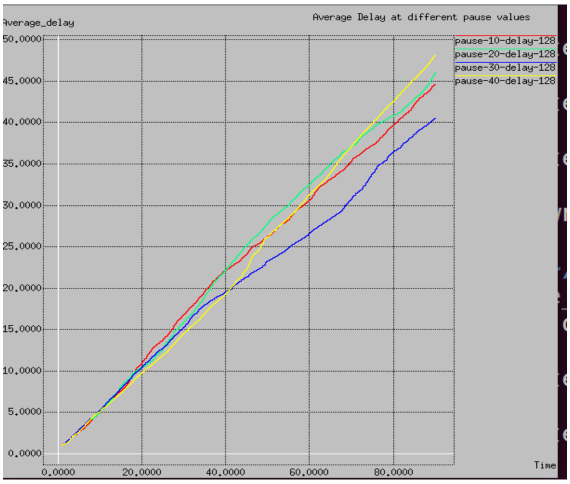

Figure 4: Average delay at different pause times w.r.t. transmission rate 0.128 Mbps

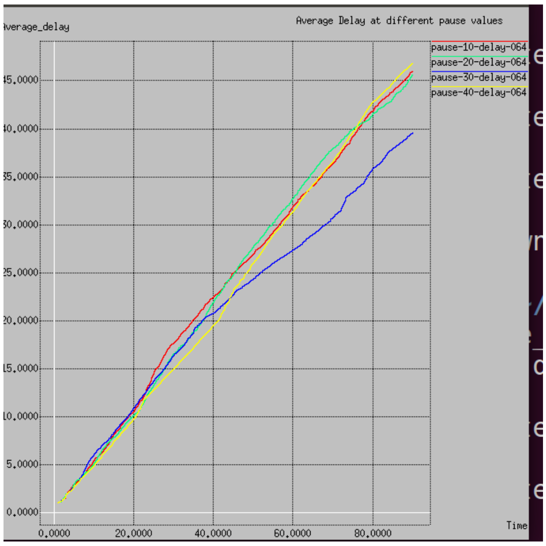

Figure 5: Average delay at different pause times w.r.t. transmission rate 0.064 Mbps

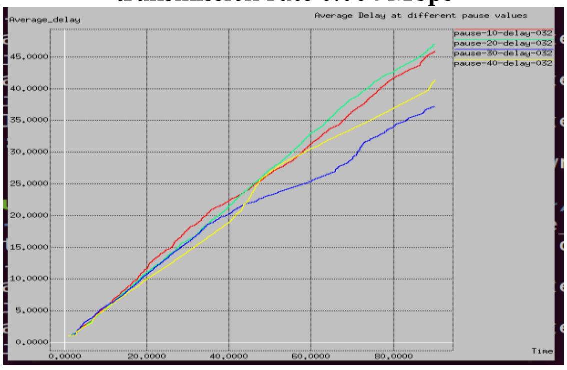

Figure 6: Average delay at different pause times w.r.t. transmission rate 0.032 Mbps

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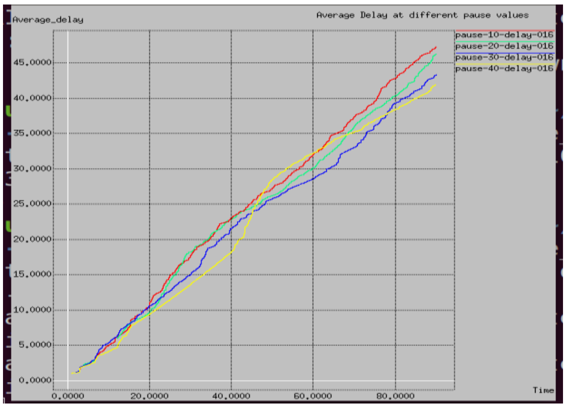

Figure 7: Average delay at different pause times w.r.t. transmission rate 0.016 Mbps

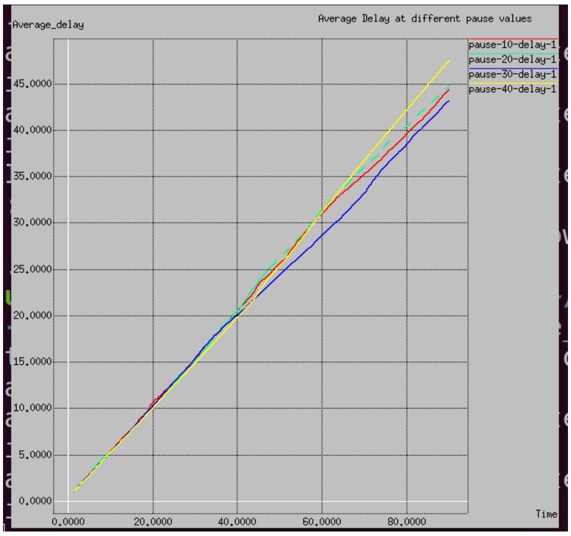

Figure 8: Average delay at different pause times w.r.t. transmission rate 1.000 Mbps

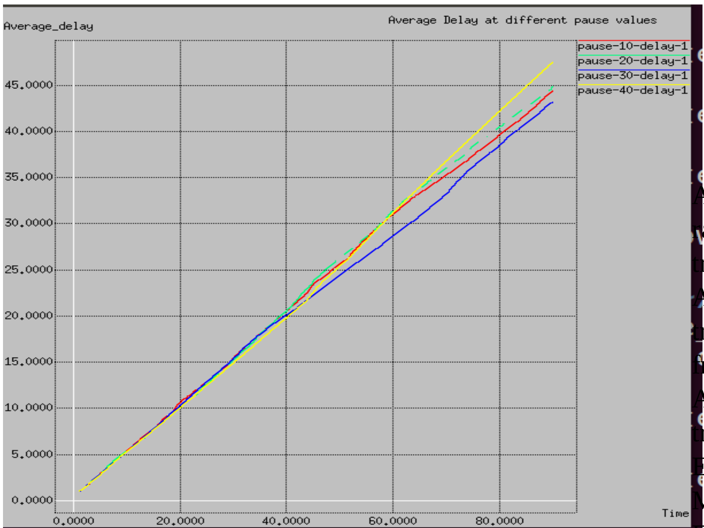

Figure 9: Average delay at different pause times w.r.t. transmission rate 1.000 Mbps

Table 2: Average delay varying the transmission rate and pause time

Average delay[ms]						
Pause time	**Transmission rate[Mbps]**					
	0.016	**0.032**	**0.064**	**0.128**	**0.152**	**1.000**
10	MAX					
20		MAX				
30		MIN	MIN	MIN	MIN	MIN
40	MIN		MAX	MAX	MAX	MAX

We analysed average delay (figure 5-9) for AODV varying the transmission rate (0.016 Mbps-1.000Mbps) and pause time (10-40). As depicted in table 3, from transmission rate 0.032 Mbps to 1.000 Mbps, average delay is minimum for pause time 30(table 2). From transmission rate 0.064 Mbps to 1,000 Mbps, average delay is maximum for pause time 40. When we evaluated average delay at transmission rate 0.016 Mbps, it is maximum at pause time 10, while it is minimum at pause time 40. At transmission rate 0.032 Mbps, average delay is maximum at pause time 20 and it is minimum at pause time 30.

Table 3: Transmission rate Vs E2E Delay

Transmission rate	E2E DELAY			
	Pause-10	pause-20	Pause-30	Pause-40
0.016	0.06225	0.12456	0.19555	0.02761
0.032	0.07027	0.11564	0.0526	0.0587
0.064	0.11757	0.17471	0.3603	0.3037
0.128	0.30058	0.38185	0.35784	0.37978
0.256	0.18855 9	0.40813	0.33017	0.29483
0.512	0.13902	0.14488	0.19751	0.10587
0.75	0.11807	0.12946	0.11334	0.08417 3
1.000	0.07469	0.10349 3	0.11953	0.06035

At pause time 10, E2E delay is increased from transmission rate 0.016 Mbps-0.128 Mbps, but it is decreased from transmission rate 0.256 Mbps-1.000 Mbps.

At pause time 20, E2E delay is approximately same from transmission rate 0.016 Mbps-0.064 Mbps. It is decreased from transmission rate 0.256 Mbps-1.000 Mbps(figure 10).

At pause time 30, E2E delay is approximately same from transmission rate 0.512 Mbps-1.000 Mbps. At pause time 40, E2E delay is decreased from transmission rate 0.128 Mbps-1.000 Mbps. From the results, it has been analysed that E2E delay is minimum for pause time 40 when transmission rate is 1.000 M

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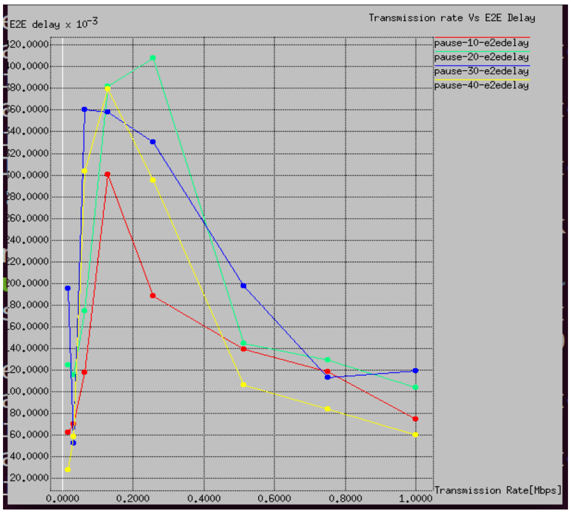

Figure 10: Transmission rate Vs E2E Delay

Table 4: Transmission rate Vs Dropped packets

Transmission rate	DROPPED PACKETS			
	Pause-10	Pause-20	Pause-30	Pause-40
0.016	7018	9519	5104	2430
0.032	11525	34394	9230	3951
0.064	17359	23206	13588	19747
0.128	24528	34140	20475	17629
0.256	44287	53043	39835	34671
0.512	84778	94190	86401	74200
0.75	125431	132860	128044	117423
1	171157	181939	171517	158109

We analysed number of dropped packets varying the values of transmission rate and pause time(table 4). At transmission rate 0.016 Mbps, when value of pause time increases from 10 to 40, the number of dropped packets are decreased. Numbers of dropped packets are very less at low transmission rate and highest pause time. At all transmission rates from 0.016 Mbps-1.000 Mbps, approximately number of dropped packets are increased from pause time 10-20 while it is decreased from pause time 20-40(figure 11).

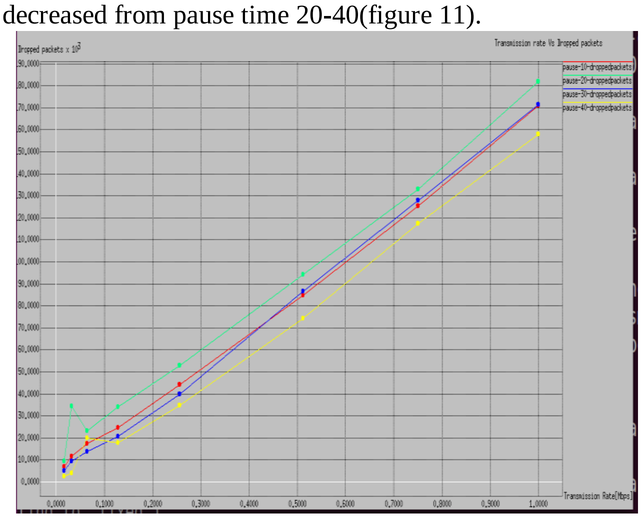

Figure 11: Transmission rate Vs Dropped packets

Table 5: Transmission rate Vs Throughput

Transmission rate	THROUGHPUT			
	Pause-10	Pause-20	Pause-30	Pause-40
0.016	121.3	122.47	121.56	118.39
0.032	222.75	235.86	215.35	235.43
0.064	281.25	208.96	303.06	447.71
0.128	347.88	205.66	398.8	496.34
0.256	390.33	220.68	416.12	584.86
0.512	480.67	286.16	360.51	841.65
0.75	497.56	300.41	392.13	774.6
1	473.27	230.96	353.73	864.99

At transmission rate 0.016, 0.032 Mbps, throughput is increased from pause time 10-20(table 5), while it is decreased from pause time 30-40. At transmission rate 0.064, 0.128, 0.256, 0.512, 0.750, and 1.000 Mbps, from pause time 10-20, throughput is decreased, while it is increased from pause time 20-40. Throughput value is highest at transmission rate 0.75 Mbps at pause time 10. Throughput value is lowest at transmission rate 0.016 Mbps at pause time 40 while it is highest at transmission rate 1.000 Mbps at the same pause time(figure 12).

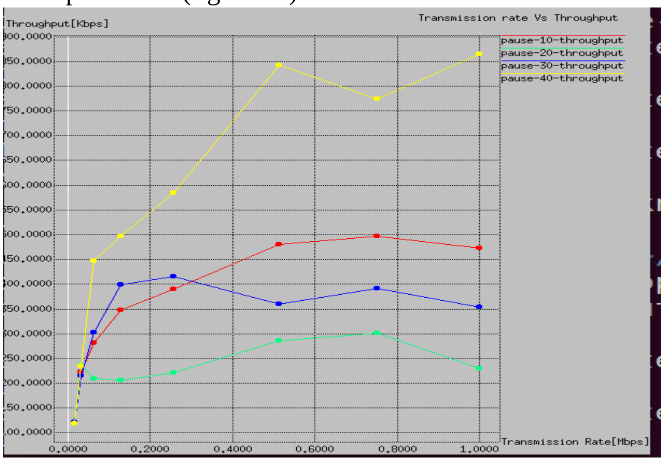

Figure 12: Transmission rate Vs Throughput

Table 6: Data Transmission rate Vs Packet Delivery Fraction

DATA TARNSMISSION RATE	PDF			
	Pause-10	Pause-20	Pause-30	Pause-40
0.016	5023	6480	5114	3461
0.032	8707	9445	7834	6363
0.064	8586	10554	9772	6751
0.128	8336	11365	9493	6819
0.256	7409	11301	10110	6562
0.512	7009	11097	11204	3113
0.75	7358	10820	10402	4661
1.000	6957	11435	11319	2934

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We analysed packet delivery fraction(as shown in figure 13) with varying the transmission rate (0.016-1.000 Mbps) and pause time (10-40). At transmission rates 0.016, 0.032, 0.064, 0.128, 0.256, 0.750 Mbps, packet delivery fraction (PDF) is increased (table 6). But at transmission rate 0.512 Mbps, it will vary from pause time 10-40. Packet delivery fraction is lowest at transmission rate 1.000 Mbps for pause time 40 and it is highest for pause time 20 at the same transaction rate. For pause time 40, packet delivery fraction is lowest for all transaction rates i.e. from 0.016-1.000 Mbps.

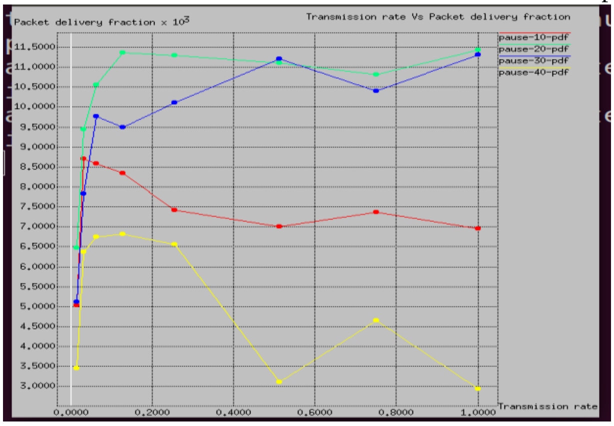

Figure 13: Transmission rate Vs Packet Delivery Fraction

Table 7: Data Transmission rate Vs Normalized routing load

Data transmission	NORMALIZED ROUTING LOAD(NRL)			
	Pause-10	Pause-20	Pause-30	Pause-40
0.016	1.968	2.152	1.146	0.609
0.032	1.465	2.01	1.208	0.342
0.064	1.401	2.179	0.885	0.314
0.128	0.85	2.283	0.462	0.317
0.256	0.698	1.598	0.31	0.102
0.512	0.416	1.089	0.402	0.082
0.75	0.386	0.861	0.44	0.107
1	0.477	1.453	0.402	0.069

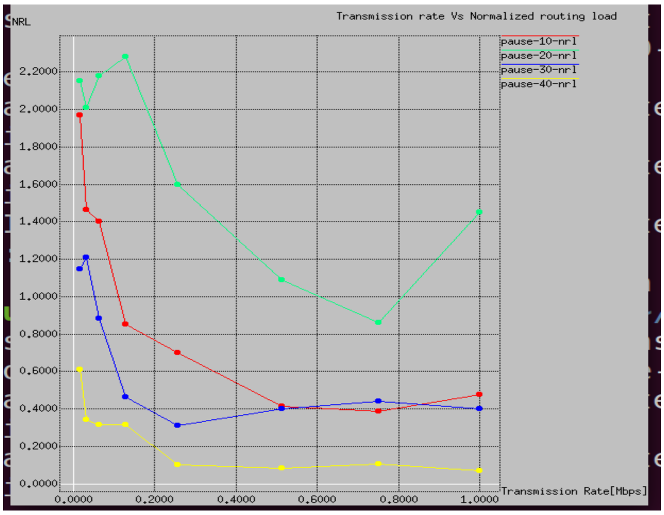

Figure 14: Transmission rate Vs Normalized Routing Load

We analysed the normalized routing load varying the transmission rate and pause time(as shown in figure 14). For all transmission rates (0.016-1.000 Mbps), normalized routing load is increased from pause time 10-20. But it is decreased from pause time 20-40. Overall normalized routing load is low, for all transmission rates (0.016-1.000 Mbps) at pause time 40. At pause time 10, normalized routing load is decreased from transmission rate 0.016-0.75 Mbps, but suddenly it increases at transmission rate 1.000 Mbps(table 7).

V. CONCLUSION

In this work, we analysed the performance of ad-hoc on demand distance vector routing protocol (AODV) in grid based topology of wireless ad-hoc networks. The evaluation of AODV is carried out by varying transmission rate and pause time. Simulation results concluded that, in grid based topology the Packet delivery fraction, Dropped Packets and average delays provides better results in all the considered pause time 10, 20, 30 and 40. The End-to-End delay has minimum values at pause time 30. When considering the analysis of pause time 10 and pause time 40, both the Packet delivery fraction and Dropped Packets provide better results at transmission rates from 0.016 Mbps to 0.128 Mbps, end to end delay parameter produce better results at transmission rate from 0.128 Mbps to 1 Mbps and throughput rate has best results in all the considered transmission rates at pause time 40.

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AUTHOR'S PROFILE

Dr. Pushpender Sarao is a Professor in CSE department. He is BE(honors), M.Tech, PhD in Computer Science and Engineering. He has worked as HOD and Dean Academics in Somany Institute of Technology & Management, Rewari (2011-2016). In 2013, he was awrded with "Best Teacher Award-2013" by Somany Educational Society. Also he got "RACE-2019 Bangkok Award for **Best Educators** in February,**2019** He is author of five books in computer science, wireless networks. He is a member of IEEE, ACM, ICSES, RES, and IAENG, and life member of CSI, ISTE and IEI. He got published more than 58 research papers in national and international reputed journals. Also he shared his research experience in more than 22 national and international conferences. He attended several FDP and seminars/workshops in engineering institutions and state universities. He is member of editorial board for 19 national and international journals. His main research work focuses on routing protocols in wireless mesh networks, mobile ad-hoc network. He has 8.5 years of teaching experience and 10 years of Industrial Experience.