Journal of Theoretical and Applied Information Technology
15th October 2018. Vol.96. No 19

ISSN: 1992-8645 www.jatit.org E-ISSN: 1817-3195

ENHANCED MAC WITH DELAY AWARE MULTIPATH ROUTING (EMAC – DAMR) MECHANISM FOR QUALITY OF SERVICE IN MOBILE AD HOC NETWORKS

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ABSTRACT

Mobile ad hoc networks (MANETs) is a kind of wireless network which can be deployed anywhere, anytime. Its applications extend its wings to larger extent and there exists a vast research scope for ensuring Quality of Service (QoS). In this research work, an Enhanced (Medium Access Control) MAC with Delay Aware Multipath Routing (EMAC – DAMR) Mechanism for Quality of Service in MANETs has been proposed. Certain enhancements are made with the conventional MAC in terms of remaining time, packet transmission delay and usage of Erlang factor. Simulations are conducted using NS3, and the performance metrics such as throughput, packet delivery ratio, delay, overhead and packets drop are taken into account for analysing the performance of the EMAC-DAMR. EMAC-DAMR has been compared with existing routing solutions and the results significantly prove that EMAC-DAMR attains better throughput and packet delivery ratio. Also, EMAC-DAMR reduces the packet delay, number of packets drop and overhead packets.

Keywords: *MANET, Wireless Link, Throughput, Packet Delay, MAC.*

1. INTRODUCTION

Mobile Ad hoc Networks (MANETs) are an ordinary remote networks involve mobile hubs of differing portability where a foundation of base stations isn't exist. Every mobile hub in MANETs acts as a basic hub as well as a switch and subsequently multi-jump networks. The some particular issues and conceivable uses of MANETs have made this an exceptionally prominent research zone, and a ton of routing instruments have been proposed. Scientists traditionally arrange these components as either proactive or reactive one. In absolutely proactive conventions, hubs endeavor to keep up courses to every other hub constantly. This implies they monitor all topology changes proactively. This can wind up troublesome if there are a great deal of hubs with bigger versatility rate. In reactive conventions, hubs just accumulate routing data on request i.e way being built just when hubs have information for a specific goal. These sorts of components enormously diminish the routing overhead, however experience the ill effects of variety in execution since they are never arranged for troublesome occasions. Quality of Service (QoS) is described as the performance amount of a task which the wired / wireless network offers. The reason of offering better QoS is to accomplish a complete wired / wireless network performance, that results the information approved by a network is capable enough to bring in an improved way and network assets can be utilized adeptly. To hold up QoS, the parameters such as cost, jitter, minimum bandwidth, maximum delay, and maximum packet loss rate should be available and manageable.

ISSN: 1992-8645 www.jatit.org E-ISSN: 1817-3195

Quality of service in mobile ad hoc networks is intended to give continuous services over a remote connection. A portion of the services request continuous media correspondence and unbendable bandwidth necessities because of their differed service qualities. In this way, there is a necessity for plan and advancement of productive bandwidth assignment instruments to accomplish quality of service and address the above difficulties. To adapt up to the present prerequisites; remote mobile ad hoc networks are relied upon to help interactive media services, for example, transmission of sound, video, content, illustrations, movement, pictures, and so forth. These services make a decent interest for bandwidth on the remote networks as clients needs to send various types of information as voice, video and so on.. Consequently, there is a requirement for ensure the ideal quality of service by giving adequate bandwidth, accomplishing low delay, better throughput and packet conveyance proportion, and less overhead and packets drop. A sample sketch of MANET is presented in Fig.1.

The QoS routing protocols will certainly elevate the performance of the wireless network, in particularly mobile ad hoc networks. In other words it can be said that, routing protocols obtains a route to target as well as it computes the QoS. The accumulation of QoS parameters is the first step in a QoS routing protocol. With the help of these QoS parameters a loop free path is determined. Delay, throughput, jitter, packet loss rate, bit error rate, packet delivery ratio and path loss are the parameters that are used for QoS routing. If a valid path from one host to another is detected by meeting the QoS requirements of desired services, then only it accepts a new connection request, or else the connection request is discarded. QoS parameters that have been used for a particular routing is defined based on the application used and the underlying network have to meet it. For example, in an application where bandwidth is the QoS parameter, then routing protocol utilizes link to select a path with necessary bandwidth.

1.1. Features of MANETs

Network topology: In ad hoc wireless network, nodes are mobile most of the time, which leads to active changes in the network topology which in turn leads to frequent path or a link breaks thereby requiring alternate or new path.

Imprecise state information: Due to dynamically varying network topology state information that has been transmitted from one node to the other may become imprecise and out of date which leads to a wrong routing decision.

Lack of central administration: In ad hoc network basically there does not exist any base station unlike cellular network thus makes difficult to provide Quality of Services.

Hidden terminal problem: In hidden terminal problem, when two or more sources which are not aware of each other tries to transmit to the common destination, then a collision occurs due to which retransmission of packets has to be done which makes complex to provide QoS hold in an ad hoc wireless network.

Lack of secure medium: Communication via wireless media is extremely timid due to the way messages are broadcast. Security is a very necessary concern in ad hoc wireless networks, mostly for military applications. It is very complicated to provide protected transmission without any efficient secure mechanism.

1.2. QoS Models

Integrated services (Int-Serv): It is a fine-grained approach that provides the expected behaviour of the network for applications. It provides various services like to grant service, controlled load service and best effort service that contain multiple QoS requirements. It is implemented by using the Resource Reservation protocol (RSVP. This model is not flexible for internet but is flexible for small sized ad hoc wireless network.

Differentiated services (Diff-Serv): It is a coarse-grained approach which gives various levels of service that satisfies inconsistent QoS requirements. This model is developed with the intention to overcome the trouble faced by the Int-Serv model. Flows are amalgamated into a confined numeral job classes where each flow is associated to one of the

Journal of Theoretical and Applied Information Technology
15th October 2018. Vol.96. No 19

ISSN: 1992-8645 www.jatit.org E-ISSN: 1817-3195

Diff-Serv classes of jobs. This solves the scalability problem faced by the Int-Serv model.

1.3. QoS Resource Reservation

QoS resource reservation is a significant mechanism of any QoS framework. It is categorized into two types:

1) Hard state resource reservation scheme: In this scheme, throughout the QoS session resources is kept at all the intermediary nodes until the source received an acknowledgement from the required destination which in turn wastes much time and resources and further leads to additional control overhead in case of a path or link break or failure.

2) Soft state resource reservation: In order to overcome the difficulty faced by hard state resource reservation scheme, soft state resource reservation scheme is used, where resources are reserved for a small interval of time i.e. a timer is activated and will be updated in a permanent manner.

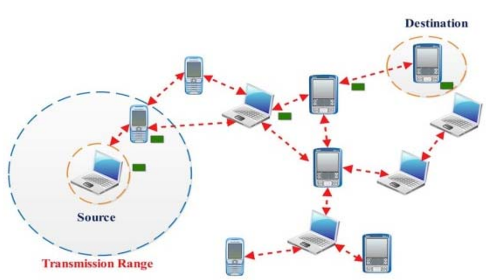


Fig.1. Sketch of MANET

2. RELATED WORKS

In the different channel networks, by allowing the various transmission on moving nodes upon its normal transmission extend, will enhance powerful usage of accessible data transfer capacity [1]. At the point when the few channels are utilized, the mobile nodes ought to do transmission and gathering simultaneously to reduce the transmission delay and for boosting the throughput. So in sensible networks, every one of the channels is utilized to make best utilization of throughput. Further, to limit the cost, a best-exertion transmission which is barged in nature with least data transfer capacity and postpones necessities is utilized. With a specific end goal to improve the framework execution, nature of administration is compulsory [2, 3]. Leonardi et al. [5] proposed a QoS adaptable engineering which grows the adaptability in unconstrained mobile networks. In the versatile engineering, the vast majority of the work is performed by the source nodes and the center nodes are restricted to finish the little measure of work without considering the motivation behind information which is identified with the status.

This model is an augmentation of the LANMAR [4] routing protocol that performs skilfully within the sight of thousands of nodes in a broad mobile system circumstance. To enhance the mobile system execution, it uses a mobile spine structure. What's more, Yu and Malvankar, PARIS [6] proposed way based QoS routing (PBQ) protocol for estimation of connection quality and forecast of versatility design. The fundamental point of PBQ is to offer fair and solid transmission connect with the vitality potential by figuring the vitality usage. Further, PBQ works for decreasing the breakage in the way to diminish the correspondence overhead in retransmission to an incredible level. Moreover, to give solid routing it enhances the lifetime of the centers by methods for limiting point to point defer in the transmission. Also, Sichitiu and Jun [7] inquired about the critical reasonableness issue of QoS that ordinarily exists together in all remote multi-bounce useful frameworks. To take care of critical reasonableness issue of QoS in a system, distinctive system layer arrangements are proposed. It moreover helps in upgrading the decency file which relates to the total asset speculation of the framework. They additionally showed that legitimate utilization of existing transfer speed which is actualized on arrange layer enhances the decency of the framework. They additionally confirm that MAC layer is proficient in remaking the framework viably by giving decency in the system layer. DLite calculation which gives separated administrations to the remote extemporary system is examined by Gerharz et al. [8].

The Fair lining plan is joined with a Dlite calculation to permit distinctive line properties that related with various administration should have been given. The middle of the road nodes or a switch gives diverse assortments of administrations to delays in bundles. It additionally gives great surroundings to the sight and sound adaptive administrations. To improve QoS in a foundation less unconstrained system, Congestion Routing Protocol (CRP) was proposed by Raghavendra and Tran [9]. On contrasting this CRP and ordinary routing protocols, CRP is better flexible with congestion condition. CRP is profoundly customizable in the high activity circumstance when contrasted and QoS routing protocol display in the review. On account of proactive property, keeping away from movement in the remote system makes this CRP generally capable. By giving a sidestep way, CRP's proactive technique limits bundle overhead to an extraordinary level. Further, to enhance high asset uses, Xue et al. [10] proposed another protocol ASAP (Adaptive Qos Protocol).

It acquaints two flag messages with diminish the squandered reservation and for giving fast and compelling QoS bolster by keeping adjustment adaptability. Narasimhan and Baboo explored a productive Congestion Routing Protocol [11]. In this protocol the execution metric like lining delay, information rate, lingering vitality and overhead are joined for taking care of the issues in congestion stage. This strategy is extremely viable in light of the fact that the joined metric are used to evacuate the befuddled connection because of the disappointment of a connection.

C. Perkins and E. Royer have proposed an Ad Hoc OnDemand Distance Vector (AODV) routing protocol. AODV is one of the most widely used on-demand routing protocols [15], [16] in MANET. In AODV, a source host broadcasts a route request (RREQ) packet when it needs a route to a specific host Each host that receives the RREQ packet checks whether it is the destination, if it is the destination, then it sends a route reply (RREP) packet; otherwise it rebroadcasts the RREQ packet The intermediate hosts forward the RREP packet to the source according to their own routing tables. In AODV the established route has no knowledge about the network status. H. XIAO, Winston K.G. SEAH, Anthony LO and Kee Chiang CHU A have proposed the FQMM as the first QoS model for MANET which is a hybrid of both Integrated Service and Differentiated Services architectures. Salient features of FQMM include: adaptive conditioning, dynamic roles of nodes and hybrid provisioning [17]. P. K. Suri, M.K. Soni and P. Tomar have proposed the Cluster based QoS routing (CBQR) [18]. It is a table driven routing protocol that provides support for bandwidth efficiency and deals with the bandwidth requirement over the wireless network, takes care regarding the stale routes, storage overheads and limited battery power.

Moh. Sangman in [19] proposed link quality routing protocol for MANET. It finds a reliable path with strong link between source and destination node for robust delivery and high performance. Leung Roy in [20] present a routing protocol called MP-DSR (multi-path Dynamic Source Routing protocol). It improves QoS constraints with respect to end-end reliability. The reliability is calculated as the multiplication of link availability of all links along the path between the source node to destination node. However, there is more probability that the path, having more reliability, requires more delay to transfer the data than a less reliable path. Ye. Zhenqiang in [21] proposed Ad Hoc on-demand Distance Vector multi-path routing protocol (AODVM). It finds multiple node disjoint paths between source to destination node. It introduces the Rnodes, which are rich in resources, for improving the transmission reliability between the source and destination node.

3. PROPOSED WORK

The proposed EMAC – DAMRmechanism integrates the control wireless link establishment and wireless link contention in multi-wireless link mobile ad hoc networks. The EMAC – DAMRmechanism has five functionalities. The mechanism begins with the wireless link recognizingprocedure to collect the environmental factors (noise etc). Then verdictprocedure is carried out in order tosort the wireless links based on availability and occupancy rate.Theseobtained information / data are auxiliaryexploited by

ISSN: 1992-8645 www.jatit.org E-ISSN: 1817-3195

engagement process for control wireless link establishment.

Upon successful engagement, thereceiver selects the three wireless links for on-going communication: (i)data wireless link (DWL) for data transmission (ii) backup wireless link (BWL) tominimise service interruption in case PU re-appearance on servingdata wireless link and (iii) engagement wireless link (EWL) to maintain or reestablishedrendezvous. During the above said method, priority alwaysgoes to licensed wireless link first then unlicensed wireless link assumingthat unlicensed wireless link is mostly overcrowded (Algorithm 1).

Algorithm 1 Available wireless linkincline with proactive wireless link prediction.

1: $Load\ LicensedUsers\ Database$

2: $K = Number\ of\ LicensedUsers \begin{pmatrix} protected\ by \\ regulation \end{pmatrix}$

3: **for** $i = 1$ to $N - K$ **do**

4: $Calculate\ P_{OFF}(t)$

5: **if** $E[T_{OFF}] \geq E[T_{MIN}]$ **then**

6: $Avail\_WL\_list \leftarrow WirelessLink(i)$

7: **else**

8: $Avail\_WL\_list \leftarrow WirelessLink(unlicensed)$

9: **endif**

10: **endfor**

It is significant to note that for successful rendezvous, wireless link disputation is equally critical as wireless link hopping sequence design.A wireless link hopping sequence cannot guarantee the rendezvous if multiple users attempt to achieve rendezvous on the same wireless link.Hence, to achieve rendezvous, the ad hoc node in the MANET hops onto wireless links according to wireless link hopping sequence and send an request-to-send RTS packet tothe receiver. If the receiver is on the same wireless link and successfullyreceived the RTS, a clear-to-send CTS will be replied. The enhancement in MAC is carried out as follows.

1. Before each transmission, the wireless node in the MANET will evaluate the remainingtime of the transmission session (T_R).

2. If $T_R \geq T_{packet}$; packet transmission will take place. Provided that $T_{packet} = T_{RTS} + T_{3SIFS} + T_{CTS} + T_{DATA} + T_{ACK}$

3. If $T_R \geq T_{packet}$; defer the packet transmission till the next slot isunoccupied.

After that, the wireless link allotment and re-allotment in availability scheme is designed with Time Continuous Markov Chain (TCMC), where present assignment and reassignment of a wireless link does not depend upon the past or previous assignment and reassignment of that wireless link due to its memory less property [12]. QoS adaptation metric called the wireless link constant state possibility factor $(WLCSPF_{(x)})$ is calculated by availability scheme and it is given by Eq. (1)

$$\lambda_x = \frac{1}{x!}\left(\frac{A_r}{S_r}\right)^x \lambda_0 \qquad (1)$$

where 'λ_0' denotes the wireless link inaccessibility feature as stated by the Eq. (2)

$$\lambda_0 = \left[\sum_{x=0}^{m} \frac{1}{x!}\left(\left(\frac{A_r}{S_r}\right)^y\right)\right]^{-1} \qquad (2)$$

where 'x' and 'y' represents the number of accessible wireless links and user requests for the accessible wireless links of the network.Blocking probability $P_{b(x)}$ is computed using performance scheme. It measures the user request rejection rate caused by the inaccessibility of wireless links. This blocking probability is given by Erlang Factor in Eq. (3).

$$P_{b(x)} = \frac{T_x / x!}{\sum_{y=0}^{m} Ty / y!} \qquad (3)$$

ISSN: 1992-8645 www.jatit.org E-ISSN: 1817-3195

where 'T_x', represents the traffic strength assigned to every wireless link based on the user requests. This scheme is also used to derive a scheduling probability that improves the capability of a node and delivering the packet within QoS requirements to the destination.

4. SIMULATION SETTINGS AND PERFORMANCE METRICS

Table – 1. Simulation Settings

Parameters	Values
Simulation area	1500 X 1500 m
Mobile nodes	100
Mobility model	Random way-point
Node placement	Random
Propagation type	Two – ray ground
Transferal power	20 dbm
MAC procedure	802.11
Data Rate	128 Kbps, 256 Kbps and 512 Kbps
Pause time	10 s
Minimum velocity of node	10 m/sec
Simulation time	100 s

Performance Metrics

- Packet delivery ratio
- Throughput
- Packets drop
- Overhead packets (and)
- Delay

5. RESULTS AND DISCUSSIONS

Table 2 shows the performance of the EMAC-DAMR in terms of packet delivery ratio with varying data rate between 128kbps to 512 kbps. When compared with the existing protocols namely PA-AOMDV [13] and CSOAODV [14], the packet delivery ratio has been perked up to 12% when compared with PA-AOMDV and 8 % when compared with CSOAODV.

The performance analysis in terms of packet delivery ratio with varying 128kbps, 256 kbps and 512 kbps are presented in Fig.2, Fig.3 and Fig. 4 respectively. Hence it is inferred that the proposed EMAC-DAMR obtains better packet delivery ratio.

Table 2. Packet Delivery Ratio of the Protocols with varying Data Rate

Pausetime (seconds)	128 Kbps			256 Kbps			512 Kbps		
	PA-AOMDV	CSOAODV	EMAC – DAMR	PA-AOMDV	CSOAODV	EMAC – DAMR	PA-AOMDV	CSOAODV	EMAC – DAMR
10	0.720	0.778	0.853	0.707	0.781	0.860	0.715	0.785	0.831
20	0.716	0.748	0.853	0.698	0.774	0.830	0.743	0.809	0.851
30	0.706	0.756	0.863	0.737	0.756	0.854	0.697	0.744	0.846
40	0.728	0.784	0.832	0.703	0.799	0.842	0.702	0.792	0.840
50	0.714	0.793	0.852	0.697	0.748	0.840	0.724	0.769	0.850
60	0.745	0.743	0.835	0.731	0.760	0.855	0.725	0.783	0.847
70	0.693	0.787	0.859	0.699	0.800	0.835	0.731	0.800	0.842
80	0.719	0.754	0.841	0.732	0.799	0.854	0.743	0.744	0.834
90	0.706	0.767	0.852	0.740	0.777	0.857	0.720	0.798	0.855
100	0.715	0.798	0.870	0.714	0.810	0.843	0.711	0.805	0.844

Table 3 portrays the performance of the EMAC-DAMR in terms of throughput with varying data rate between 128kbps to 512 kbps and it haas been compared with the existing protocols namely PA-AOMDV [13] and CSOAODV [14]. The throughput has been improved up to 13% when compared with PA-AOMDV and 9 % when compared with CSOAODV. The performance analysis in terms of throughput with varying 128kbps, 256 kbps and 512 kbps are presented in Fig.5, Fig.6 and Fig. 7 respectively. Hence it is inferred that the proposed EMAC-DAMR obtains improved throughput.

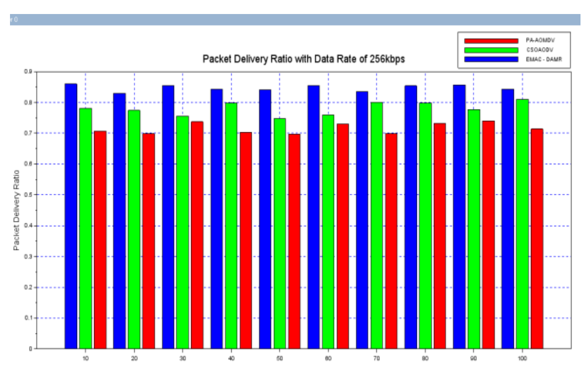


Fig. 2. Packet Delivery Ratio with Data Rate of 128 kbps

Journal of Theoretical and Applied Information Technology
15th October 2018. Vol.96. No 19

ISSN: 1992-8645 www.jatit.org E-ISSN: 1817-3195

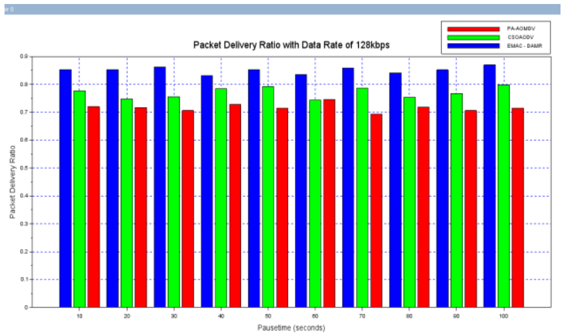


Fig. 3. Packet Delivery Ratio with Data Rate of 256 kbps

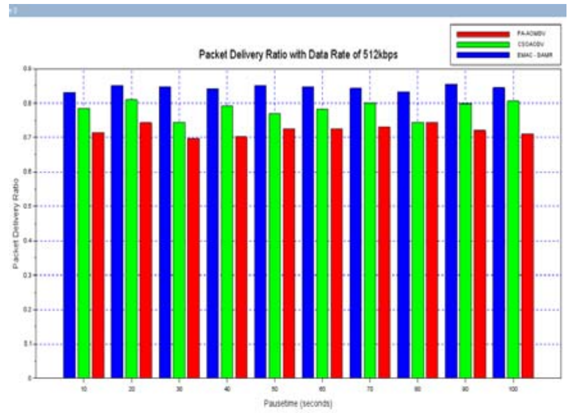


Fig. 4. Packet Delivery Ratio with Data Rate of 512 kbps

Table 4displays the performance of the EMAC-DAMR in terms of packet drop with varying data rate between 128kbps to 512 kbps and it haas been compared with the existing protocols namely PA-AOMDV [13] and CSOAODV [14]. The packet drop has been lessened up to 14% when compared with PA-AOMDV and 10 % when compared with CSOAODV. The performance analysis in terms of packets drop with varying 128kbps, 256 kbps and 512 kbps are presented in Fig.8, Fig.9 and Fig. 10 respectively. Hence it is inferred that the proposed EMAC-DAMR obtains decreased packets drop.

Table 5 portrays the performance of the EMAC-DAMR in terms of packets overhead with varying data rate between 128kbps to 512 kbps and it haas been compared with the existing protocols namely PA-AOMDV [13] and CSOAODV [14]. The packets overhead has been reduced upto 10% when compared with PA-AOMDV and 8 % when compared with CSOAODV. The performance analysis in terms of packets overhead with varying 128kbps, 256 kbps and 512 kbps are presented in Fig.11, Fig.12 and Fig. 13 respectively. Hence it is inferred that the proposed EMAC-DAMR reduces the packets overhead.

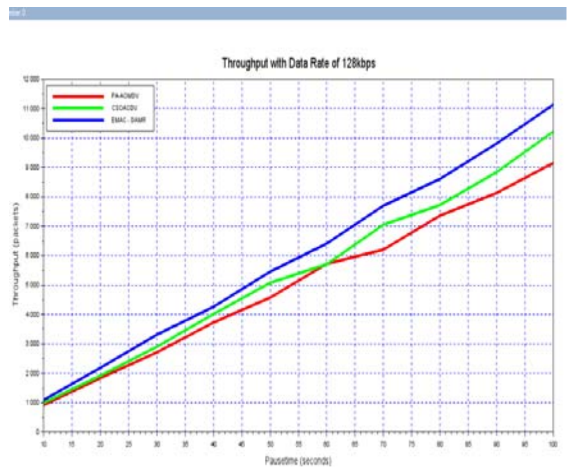


Fig. 5.Throughput with Data Rate of 128 kbps

Table 6shows the performance of the EMAC-DAMR in terms of packets delay with varying data rate between 128kbps to 512 kbps and it haas been compared with the existing protocols namely PA-AOMDV [13] and CSOAODV [14]. The packets delay has been reduced upto 11.5% when compared with PA-AOMDV and 10.6 % when compared with CSOAODV. The performance analysis in terms of packets delay with varying 128kbps, 256 kbps and 512 kbps are presented in Fig.14, Fig.15 and Fig. 16 respectively. Hence it is inferred that the proposed EMAC-DAMR reduces the packets delay.

ISSN: 1992-8645 www.jatit.org E-ISSN: 1817-3195

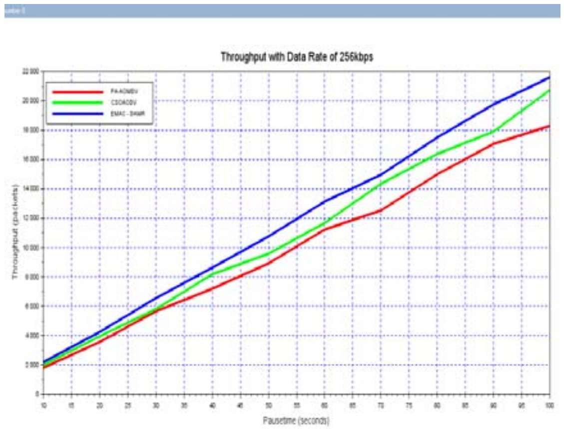


Fig. 6. Throughput with Data Rate of 256 kbps

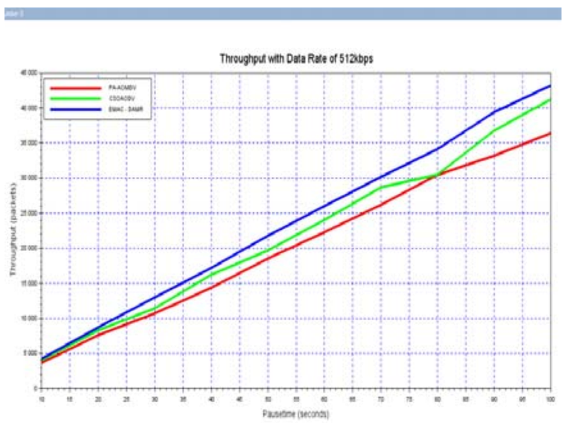


Fig. 7. Throughput with Data Rate of 512 kbps

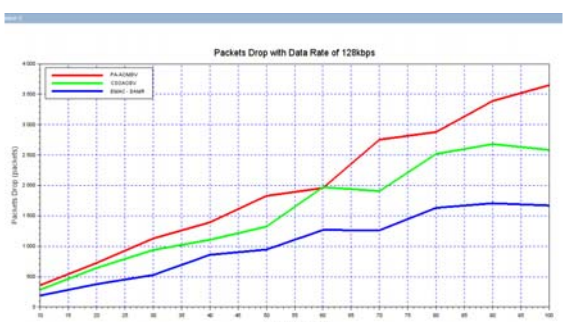


Fig. 8. Packet Drop with Data Rate of 128 kbps

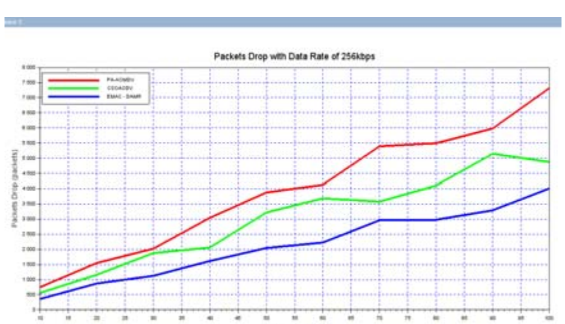


Fig. 9. Packet Drop with Data Rate of 256 kbps

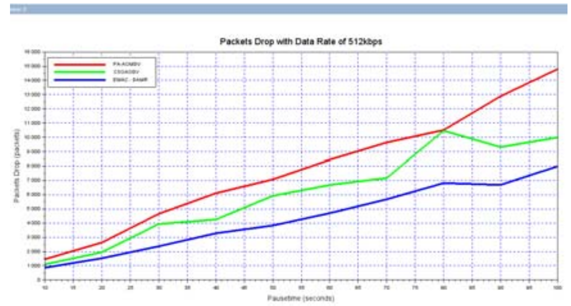


Fig. 10. Packet Drop with Data Rate of 512 kbps

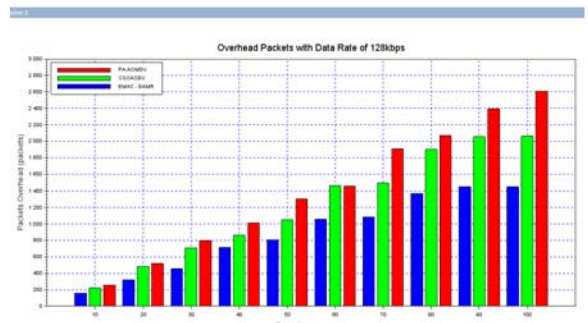


Fig. 11.Packet Overhead with Data Rate of 128 kbps

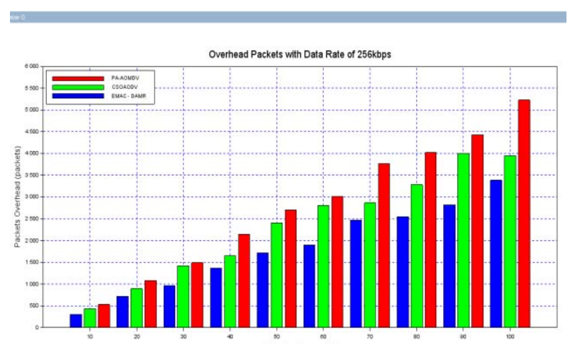


Fig. 12. Packet Overhead with Data Rate of 256 kbps

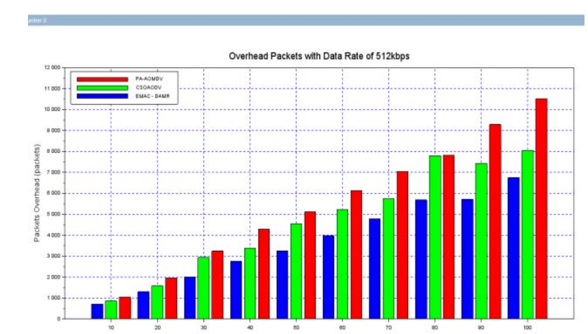


Fig. 13. Packet Overheadwith Data Rate of 512 kbps

Journal of Theoretical and Applied Information Technology
15th October 2018. Vol.96. No 19

ISSN: 1992-8645 www.jatit.org E-ISSN: 1817-3195

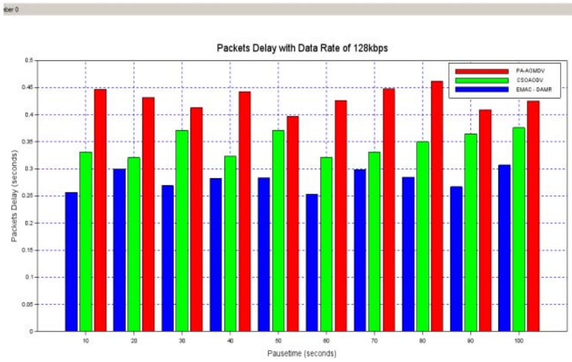


Fig. 14.Packet Delay with Data Rate of 128 kbps

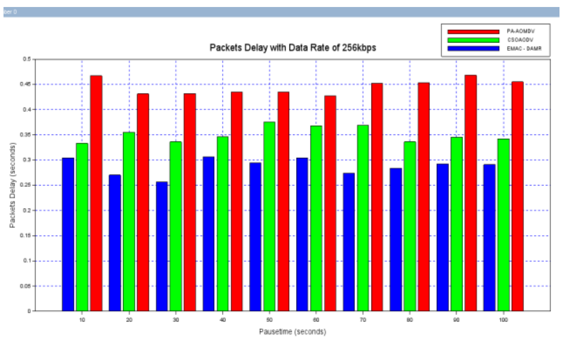
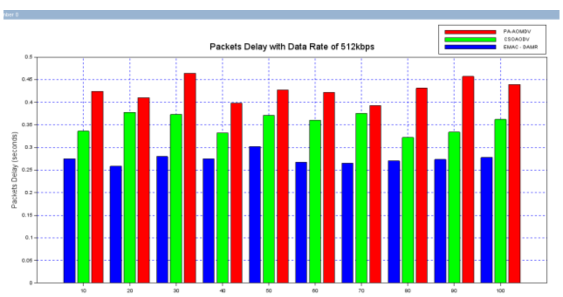


Fig. 15. Packet Delay with Data Rate of 256 kbp



16. Packet Delay with Data Rate of 512 kbps

Table 3. Throughput of the Protocols with varying Data Rate

Pausetime (seconds)	128 Kbps			256 Kbps			512 Kbps		
	PA-AOMDV	CSOAODV	EMAC-DAMR	PA-AOMDV	CSOAODV	EMAC-DAMR	PA-AOMDV	CSOAODV	EMAC-DAMR
10	922	995	1091	1810	2000	2201	3659	4021	4255
20	1834	1916	2183	3572	3962	4250	7605	8289	8711
30	2712	2902	3313	5658	5803	6556	10703	11420	12989
40	3727	4014	4261	7196	8180	8626	14377	16228	17196
50	4572	5077	5455	8918	9580	10755	18527	19679	21767
60	5722	5709	6413	11230	11673	13133	22284	24041	26018
70	6206	7052	7698	12529	14341	14957	26203	28665	30162
80	7362	7722	8609	14988	16373	17500	30451	30495	34142
90	8131	8840	9813	17061	17897	19748	33189	36770	39392
100	9151	10216	11130	18288	20724	21588	36401	41208	43204

Table 4. Packets Drop of the Protocols with varying Data Rate

Pausetime (seconds)	128 Kbps			256 Kbps			512 Kbps		
	PA-AOMDV	CSOAODV	EMAC-DAMR	PA-AOMDV	CSOAODV	EMAC-DAMR	PA-AOMDV	CSOAODV	EMAC-DAMR
10	358	285	189	750	560	359	1461	1099	865
20	726	644	377	1548	1158	870	2635	1951	1529
30	1128	938	527	2022	1877	1124	4657	3940	2371
40	1393	1106	859	3044	2060	1614	6103	4252	3284
50	1828	1323	945	3882	3220	2045	7073	5921	3833
60	1958	1971	1267	4130	3687	2227	8436	6679	4702
70	2754	1908	1262	5391	3579	2963	9637	7175	5678
80	2878	2518	1631	5492	4107	2980	10509	10465	6818
90	3389	2680	1707	5979	5143	3292	12891	9310	6688
100	3649	2584	1670	7312	4876	4012	14799	9992	7996

Table 5. Overhead Packets of the Protocols with varying Data Rate

Pausetime (seconds)	128 Kbps			256 Kbps			512 Kbps		
	PA-AOMDV	CSOAODV	EMAC-DAMR	PA-AOMDV	CSOAODV	EMAC-DAMR	PA-AOMDV	CSOAODV	EMAC-DAMR
10	258	221	161	530	438	309	1044	863	719
20	520	482	321	1080	896	722	1957	1579	1301
30	797	709	455	1490	1418	960	3245	2929	2005
40	1014	867	715	2139	1646	1360	4284	3369	2757
50	1306	1050	805	2705	2410	1719	5119	4551	3259
60	1459	1465	1058	3019	2802	1904	6120	5227	3982
70	1908	1502	1084	3769	2864	2473	7045	5738	4778
80	2069	1899	1371	4019	3283	2547	7813	7791	5683
90	2392	2056	1454	4427	3995	2821	9285	7429	5718
100	2609	2063	1452	5224	3947	3383	10521	8042	6748

Table 6. Packet Delay of the Protocols with varying Data Rate

Pausetime (seconds)	128 Kbps			256 Kbps			512 Kbps		
	PA-AOMDV	CSOAODV	EMAC-DAMR	PA-AOMDV	CSOAODV	EMAC-DAMR	PA-AOMDV	CSOAODV	EMAC-DAMR
10	0.447	0.331	0.257	0.467	0.333	0.304	0.424	0.336	0.274
20	0.432	0.321	0.300	0.431	0.355	0.270	0.410	0.378	0.258
30	0.413	0.371	0.269	0.432	0.336	0.257	0.464	0.373	0.279
40	0.442	0.324	0.282	0.435	0.346	0.306	0.398	0.332	0.275
50	0.397	0.371	0.284	0.435	0.375	0.294	0.427	0.371	0.301
60	0.426	0.321	0.253	0.427	0.368	0.304	0.422	0.360	0.267
70	0.448	0.331	0.299	0.452	0.369	0.274	0.393	0.375	0.265
80	0.462	0.350	0.285	0.453	0.336	0.284	0.431	0.322	0.270
90	0.409	0.365	0.267	0.468	0.345	0.292	0.457	0.334	0.273
100	0.425	0.376	0.307	0.455	0.342	0.291	0.439	0.362	0.278

6. CONCLUSION

This research work aims to propose an Enhanced (Medium Access Control) MAC with Delay Aware Multipath Routing (EMAC – DAMR) Mechanism for Quality of Service in MANETs has been proposed. Certain enhancements are made with the conventional MAC in terms of remaining time, packet transmission delay and usage of Erlang factor. Simulations are conducted using NS3, and the performance metrics such as throughput, packet delivery ratio, delay, overhead and packets drop are taken into account for analysing the performance of the EMAC-DAMR. EMAC-DAMR has been compared with existing routing solutions and the results significantly prove that EMAC-DAMR attains better throughput and packet delivery ratio. Also, EMAC-DAMR reduces the packet delay, number of packets drop and overhead packets.

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