International Journal of Applied Engineering Research
ISSN 0973-4562 Volume 10, Number 4 (2015) pp. 8699-8713

http://www.ripublication.com

Enhanced Round Robin Packet Scheduling Technique to Support Multimedia Applications in MANET

M.Syed Masood
Dr.P.Sheik Abdul Khader
Department of Computer Applications,
B.S.Abdur Rahman University,Chennai – 48, India
E-mail: ms_masood@yahoo.com, psakhader@bsauniv.ac.in
http://www.bsauniv.ac.in/mode/faculty/action/list/department/8-Computer-Applications

Abstract

In the modern era a lot of research is being done in the area of Mobile Ad-hoc Networks (MANETs). There is a need to support video traffic applications in MANETs as they grow popularity. This paper focuses on performance analysis of different packet scheduling techniques with different reactive protocols in video traffic with increasing number of destination nodes. The main objective of this paper is to minimize the Inter-Packet Delay (IPD) in wireless mobile ad hoc networks for multimedia application (video traffic) using proposed Enhanced Round Robin (ERR) packet scheduling technique through cross-layer approach. In MANET environment, the IPD is the major issue in transmitting the multimedia applications from source to multiple ad hoc nodes. In the existing scheduling algorithms, the IPD is relatively large with the available bandwidth. However, it can be reduced using this proposed ERR packet scheduling technique. The proposed algorithm allows the packets over a link by determining the priority for each flow and then the packets are transmitted in a round-robin manner. To achieve the minimum Inter-Packet Delay various priority metrics have been considered. The order of packets will be transmitted over MANET based on the metrics such as packet priority, node priority and route priority. This work uses the cross layer approach by considering network and MAC layer. The Loop-free Multipath Probabilistic Scheme based AODV (LMPSAODV) is used as routing protocol and the ERR packet scheduling algorithm is used for the order of packet transmissions [17]. The performance of this algorithm was analyzed with existing First-In-First-Out (FIFO) and Round Robin (RR) packet scheduling techniques. This algorithm is simulated using network simulator NS-2.34 to evaluate the performance of FIFO, RR and ERR. The results are presented on various scenarios with different number of destinations in terms of Inter-Packet Delay, packet delay variations and routing overhead. The result shows that the proposed ERR scheduling algorithm provides minimum delay when compared to other existing packet scheduling techniques.

Key Words: FIFO, RR, ERR packet scheduling, Inter-Packet Delay, packet delay variations, routing overhead, Quality of Service.

Introduction

A Mobile Ad hoc Network (MANET) is a wireless infrastructureless multi hop network, in which each node acts as a router that has the capability to forward packets. In MANET the nodes can be dynamically connected by radio waves. The data transmissions between the nodes are takes place without central controller, access point and base station. In this work, the cross layer approach is used to support multimedia traffic with minimum delay for data transmission in ad hoc nodes. Here the MAC and network layers are considered. The delay may happen due to various reasons such as nodes mobility, routing, scheduling of packets etc. In this paper the scheduling of packets for transmissions is carried out, so as to improve the performance.

There are various packet scheduling algorithms are supported in MANET, like First-In-First-Out (FIFO), Priority Queuing Algorithm, Weighted Fair Queuing, Class Based Weighted Fair Queuing and so on. In this paper the Enhanced Round Robin scheduling technique is proposed by combining the features of round robin and Priority Queuing algorithm. This work investigates the use of ERR scheduling algorithm for MANET by analyzing the various scheduling algorithms in real time applications.

There are two main categories of routing protocol in MANET. They are proactive and reactive. Proactive protocols maintain fresh lists of destinations and their routes by periodically distributing routing tables throughout the network. Reactive protocols find a route on demand (only when needed) by flooding the network with route request packets. In this paper the second type of protocols which is suitable for the limited resources of MANET's. In this research work, the existing AODV is already modified and tested to provide Loop-free Multipath with minimum routing overhead and it is named as Loop-free Multipath Probabilistic Scheme based AODV (LMPSAODV) [17]. It is the simplest and widely used reactive routing protocol, which consume low energy, as it searches for a path to reach the destination on demand (only when a node needs to send packets). AODV do not store periodically the paths to destinations in routing tables.

In this paper, ERR packet scheduling and routing algorithm which is suitable for the transmissions of delay-sensitive applications over mobile ad hoc networks are proposed. One of the distinct features of the proposed algorithm is that packet scheduling algorithm at the MAC layer and routing algorithm at the network layer are tightly-coupled to enhance the end-to-end Quality of Service (QoS).

Related Works

In the following paragraphs it is presented the survey about existing work done in the field of MANET routing protocol, congestion control, scheduling algorithms and real-time traffic transmissions under MANET environment.

Rukmani P et. al. in her work titled "Scheduling algorithm for real time applications in mobile ad hoc network with opnet modeler" makes primary contribution on scheduling algorithms that categorizes and prioritizes the real-time traffic with the intention of improving the performance of the real-time applications. Five types of scheduling algorithms have been analyzed using OPNET simulator [20].

Nidhi Shukla et al , published the paper titled "Survey of Cross Layer Based TCP congestion control techniques in MANET", has analyzed the congestion control on the bases of queue scheme as well as drop analysis base layer working updating scheme and minimize congestion and delay of the network, for that they deploy queue in each node for minimization congestion base drop and also identify drop reason of packet and if any drop information, then the reason for drop like MAC, Collisions and congestion, that all the drop are minimized through queue technique base and routing module updating scheme[12].

Senthil Kumaran et. al. presented the Congestion Free Routing in ad-hoc networks (CFR), based on dynamically estimated mechanism to monitor network congestion by calculating the average queue length at the node level. While using the average queue length, the nodes' congestion status divided into the three zones (safe zone, likely to be congested zone and congested zone) [15].

V. Thilagavathe et. al. in their research work, the cross layer congestion aware is proposed to overcome the congestion problem encountered in transport, data link and network layers. In transport layer, if the rate of packet delivered through the route exceeds the predefined threshold, it will lead to congestion problem. In MAC layer the congestion occurs due to the signal interference. If the congestion problem occurs in both the layers at the same time, a node formulates a list containing affected route entries and this information is broadcasted to the corresponding nodes [18].

An adaptive selfish aware queue scheduler for an M/M/1 and M/M/n queuing mechanism to schedule the packets for selfish nodes in mobile ad-hoc networks using AODV as the routing protocol. The performance of this scheduler has been studied using ns-2 simulator and performance were analyzed by using metrics such as packet delivery ratio, end to end delay, throughput, control overhead and total overhead. This scheduler provides overall improvement under different packet sizes [22].

Queue scheduling algorithms are important components in the provision of guaranteed Quality of Service (QoS) parameters. It will manage the changes in queuing dynamics in different situation also improves the performance of the network. The emergence of new multimedia and Internet applications has insisted to study the scheduling algorithms for providing QoS guarantees. These guarantees are usually in the form of bounded delay, jitter, guaranteed rate and fairness among sessions [23].

The main objective of this work is to provide reliable transmission for delay-sensitive applications using Enhanced Round Robin (ERR) packet scheduling technique and the routing protocol as Loop-free Multipath Probabilistic Scheme based

AODV (LMPSAODV) to minimize the Inter-Packet Delay (IPD) and routing overhead in real-time multimedia transmissions over MANET.

Problem Statement

In MANET environment, the IPD is the major issue in transmitting the multimedia applications from source to multiple ad hoc nodes. It is the time gap between two packets received by the destination nodes. In the existing scheduling algorithms, the IPD is relatively large with the available bandwidth. However, it can be reduced using this proposed ERR packet scheduling technique. The proposed approach will provide better performance for packet scheduling.

In a network there may be 'N' number of mobile ad hoc nodes. Let 'S' be the source node and it transmits 'm' packets to the 'k' destination nodes given by the set D = {D1, D2, D3 … Dk}, where D is N- S with available bandwidth 'B' {b1, b2 … bk}. In the existing packet scheduling algorithm the transmission of packets either in FIFO or in RR or in priority queue scheduling algorithms leads to more Inter-Packet Delay. The ERR technique for scheduling the packets with cross layer approach will minimize the IPD and routing overhead.

Proposed Enhanced Round Robin (ERR) Packet Scheduling Technique

In our previous work [17] the Loop-free Multipath Probabilistic Scheme based AODV (LMPSAODV) approach is used to provide disjoint path with reduced routing overhead. As an extension to this work, the ERR technique have been developed to allow the packets over a link by determining the priority for each flow in the node and the packets are transmitted in a round-robin manner. Using this proposed cross layer approach it is possible to reduce the Inter-Packet Delay in video transmission over MANET.

Round Robin (RR) scheduling maintains per-flow, each flow can identify by a source and destination (IP address, Port number) pair. In RR scheduling, each flow is allowed to send one packet at a time in round robin fashion. In RR scheduling, the time quantum (time slice) is fixed and then the packets are scheduled in RR scheme only without considering any priority metrics.

In the proposed ERR scheduling the various priority metrics are defined along with this round robin fashion to achieve the minimum Inter-Packet Delay. The order of packets will be transmitted over MANET based on the metrics such as packet priority ,node priority and route priority and then the packets will get a chance to enter in to the queue in RR fashion.

The algorithmic steps of an Enhanced Round Robin packet scheduling technique are as follows:

- Construct the MANET topology with 'N' number of ad hoc nodes.
- Set the values for packet size, terrain size, simulation time etc.
- Choose the multimedia file; specify the source node and the destination nodes to be transmitted over the MANET.

- Use the FIFO and RR to schedule the packets with AODV and LMPSAODV as routing protocol.
- Determine the IPD, delay variations and routing overhead.
- The ERR scheduling technique will determine the following priority metric values as follows.

Determine the packet priority Ppkt (t).
The packet priority Ppkt (t) can be determined by equation (1).

$$Ppkt(t) = Dmax - dj(t) \quad (1)$$

Where
Ppkt (t) is the packet priority at time‘t’,
Dmax is the maximum tolerable end-to-end delay and
dj(t) is the residual delay for node ‘j’ at time ‘t’ along a route ‘R’.

Find the node priority Pnode (t).
The node priority can be computed using equation (2) as the sum of packet priority of all ‘m’ packets in the buffer as:

$$P_{node}(t) = \sum_{i=1}^{m} \left(P_{node}(t)\right) \quad (2)$$

Determine the route priority Proute (t).The route priority is the sum of node priority of all the ‘j’ nodes in the route R. It can be calculated by the equation (3).

$$P_{route}(t) = \sum_{i=1}^{j} \left(P_{node(i)}(t)\right) \quad (3)$$

- Now transmit the packets using the packet, node and route priority values in RR fashion for each destination using the route discovered by AODV and then by LMPSAODV as the routing protocol.
- Now find the values of delay variations, IPD and routing overhead.
- Finally compare the results of delay variations, IPD and routing overhead using FIFO, RR and ERR packet scheduling techniques with AODV and LMPSAODV as routing protocols.

The diagrammatic representation of the algorithmic steps of an Enhanced Round Robin packet scheduling technique is as shown in Fig. 1.

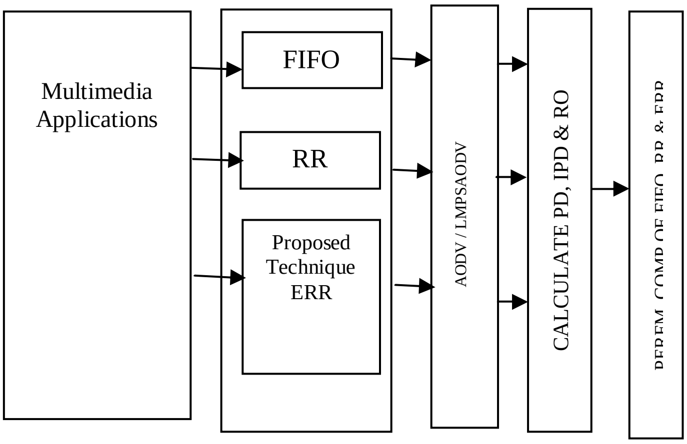

Figure 1: Proposed work

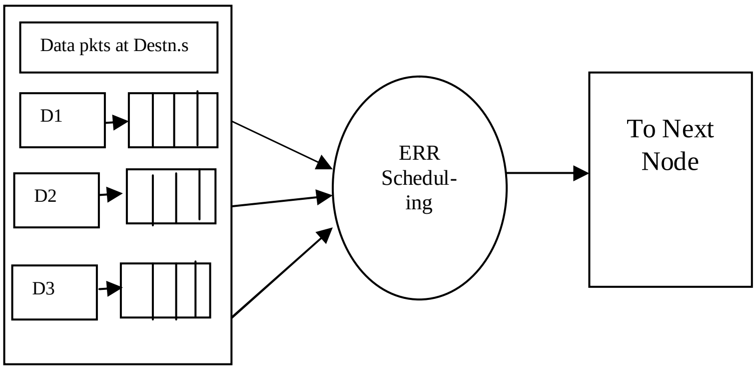

Figure 2: Transmission order of data packets

The Fig. 2 describes the order of transmissions of data packets to various destinations through ERR scheduling algorithm.

The Fig. 3 depicts the proposed algorithm with LMPSAODV.

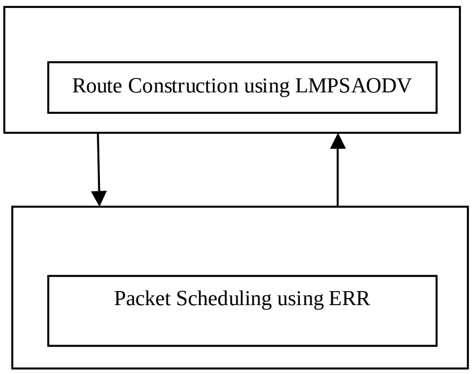

Figure 3: Proposed algorithm ERR with LMPSAODV

Simulations

Simulation Parameters

The performance of the proposed ERR scheduling technique is evaluated and compared with FIFO and RR. Simulations are performed in NS2.34. All simulations are conducted for a 1000m × 1000m grid consisting of 50nodes, distributed randomly over the two-dimensional grid. .The type of traffic is the Constant Bit Rate (CBR) and it implies that data will be transmitted at a fixed bit rate, fixed size and a fixed interval between each packet. The simulation parameter values are given in Table 1.

Table 1: Simulation Settings

Parameters	**Settings**
Transmission range	250 m
Bandwidth	2 Mbps
Simulation time	**600 s**
Packet size	**512 Bytes**
Packet rate	5 Packets / sec
Topology size	1000 m X 1000 m
Number of mobile nodes	50
Pause time	0 s
Traffic type	CBR(Constant Bit Rate)
MAC Protocol	IEEE 802.11
Routing protocols	AODV, LMPSAODV
Mobility model	Random Waypoint
Services	Video transmission
NS-2	Version 2.34

The initial position of 50 mobile nodes is placed as shown in Fig. 4.

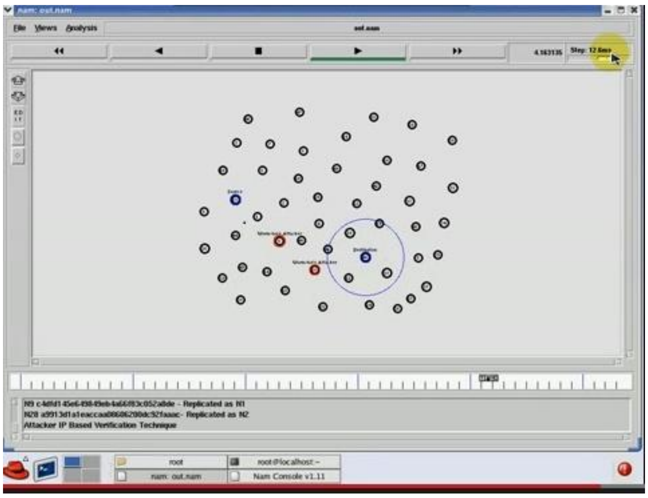

Figure 4: Sample Screen

Performance Metrics

The results are presented on various scenarios under different number of destinations in terms of packet delay variations, Inter-Packet Delay (IPD) and routing overhead. The packet delay variations can be measured at two points; one is at source end and the other is at the destination.

Packet delay variations

The packet delay variations are at two ends, one at the source end and another at the destination end. The packet delay at source is denoted by PDs can be calculated by using the equation (4).

$$PD_s\,[i] = PD_s\,[i+1] - PDs\,[i] \quad (4)$$

The packet delay at destination is designated as PDd can be calculated by using the equation (5).

$$PD_d\,[j] = R[j+1] – R[j] \quad (5)$$

Let us consider D_{Sm} is the minimum delay at source and D_{dm} is the minimum delay at destination. The D_{Sm} and D_{dm} can be calculated using the equations 6 and 7 respectively.

$$D_{Sm} = \min \{PD_s\,[i]\} \quad (6)$$

$$D_{dm} = \min \{ PD_d\,[j]\} \quad (7)$$

Using the proposed scheduling algorithm, the packets can be delivered to the destinations with minimum delay.

Inter-Packet Delay (IPD)

A time delay between successive data packets is referred as IPD. The Inter-Packet Delay can be computed for ‘m’ packets using equation (8).

$$IPD = \sum_{i=1}^{m} (PD_d[i]) - \sum_{i=1}^{m} (PD_s[i]) \quad (8)$$

Routing Overhead (RO)

As for as multimedia transmission is concerned, the routing overhead can be calculated using equation (9).

$$RO = T_{cp} / T_{sd} \quad (9)$$

Where

T_{cp} is the total number of control Packets generated by the network

and

T_{sd} is the total number of successfully decoded video frames at each destination.

Results

The performance comparison of FIFO, RR and ERR with AODV and LMPSAODV routing protocols are carried out in terms of the performance metrics namely packet delay variations, IPD and routing overhead.

Analysis of Packet delay variations

Both the packet delay at source and packet delay at destination are the significant parameters as for as delay sensitive application is concerned and it must be low for better transmission. Packet delay at source with respect to different simulation time for various types scheduling algorithms using AODV and LMPSAODV is shown in Fig. 5 and Fig. 6 respectively. Packet delay at destination with respect to different simulation time for various types scheduling algorithms using AODV and LMPSAODV is shown in Fig. 7 and Fig. 8 respectively.

From the simulation results obtained, it is noted that occasionally the delay increases, when the simulation time increases. This is due to the efficiency of different scheduling algorithms, movement speed of mobile nodes, number of packets travelled in the route and the number of time the path break occurs.

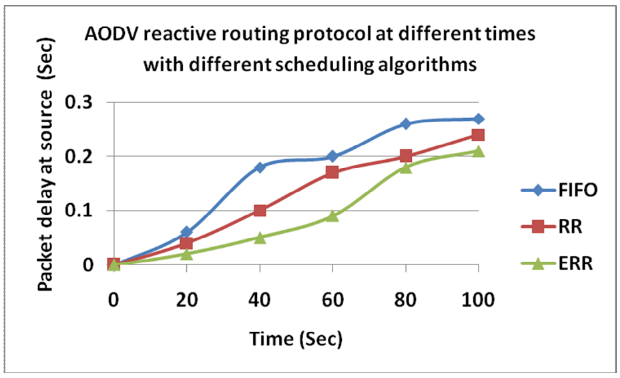

Figure 5: Packet delay at source using AODV

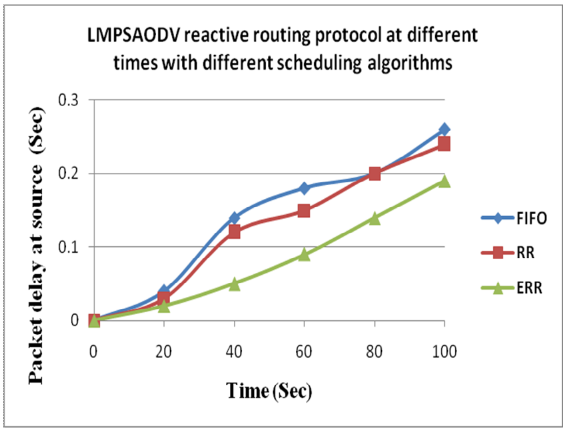

Figure 6: Packet delay at source using LMPSAODV

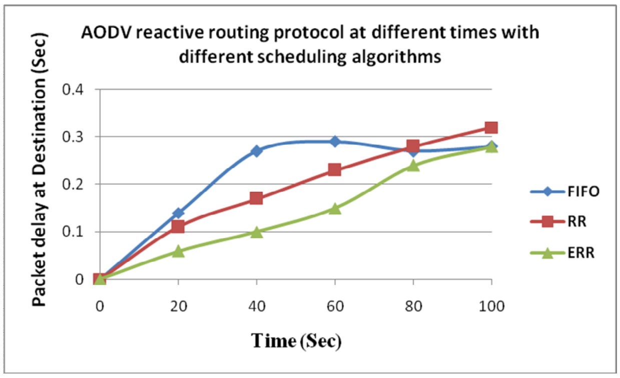

Figure 7: Packet delay at destination using AODV

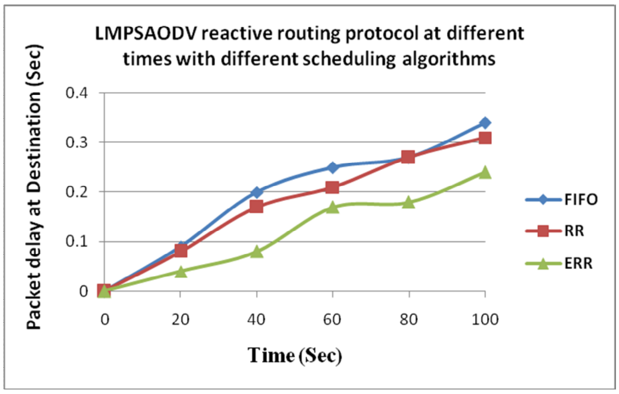

Figure 8: Packet delay at destination using LMPSAODV

Analysis of Inter-Packet Delay

The Inter-Packet Delay is the very important QoS metric particularly during multimedia transmission in MANETs. This kind of transmission is to be used in real-time applications, the delay between the video frames delivered to destinations needs to be very low. In this work, this delay is calculated with respect to simulation time for various types scheduling algorithms using AODV and LMPSAODV is as shown in Fig. 9 and Fig. 10 respectively. From the results, it is found that the IPD is reduced in case of LMPSAODV with proposed scheduling algorithm as it select not only in round robin scheme, but also considered the node and route priority in delivering the packets to destinations.

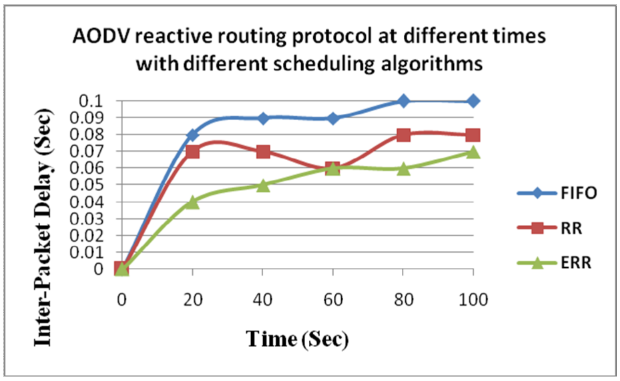

Figure 9: Inter-Packet Delay using AODV

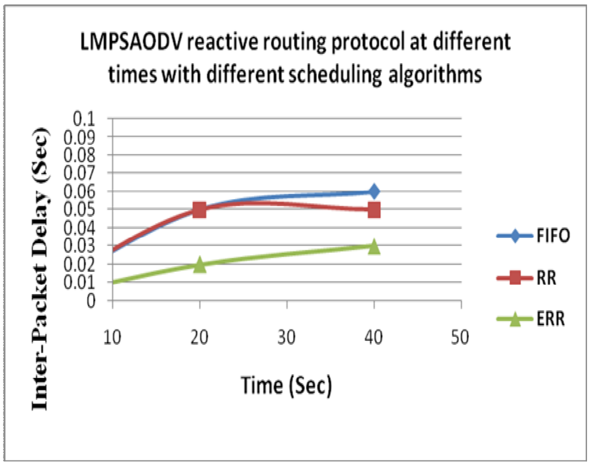

Figure 10: Inter-Packet Delay using LMPSAODV

Analysis of routing overhead

In this work, the routing overhead is calculated against changing the number of destination nodes using AODV and LMPSAODV routing protocols. In all the scenarios the routing overhead is calculated for three different scheduling techniques namely FIFO, RR and ERR. The routing overhead must be minimized for delay-sensitive applications, so that the data packets can be able to deliver to destinations without any delay between packets to achieve smooth transmission. The performance of AODV and LMPSAODV with various scheduling algorithms is as shown in Fig. 11 and Fig. 12 respectively. The routing overhead with LMPSAODV provides less control packets compared to AODV routing protocol. This is due to AODV broadcasts the RouteRequest packets in simple flooding, whereas LMPSAODV rebroadcast the RouteRequest packets based on probability.

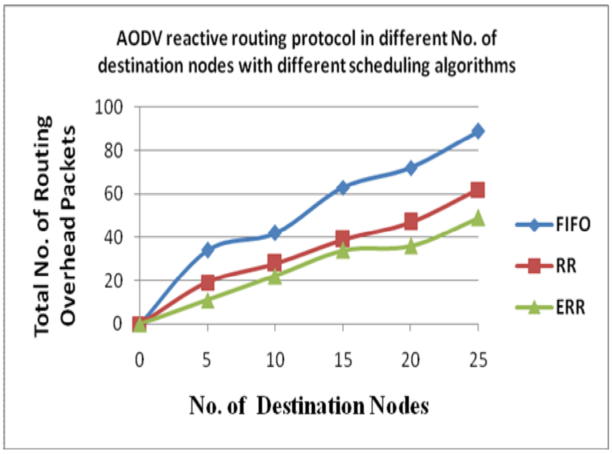

Figure 11: Routing overhead using AODV

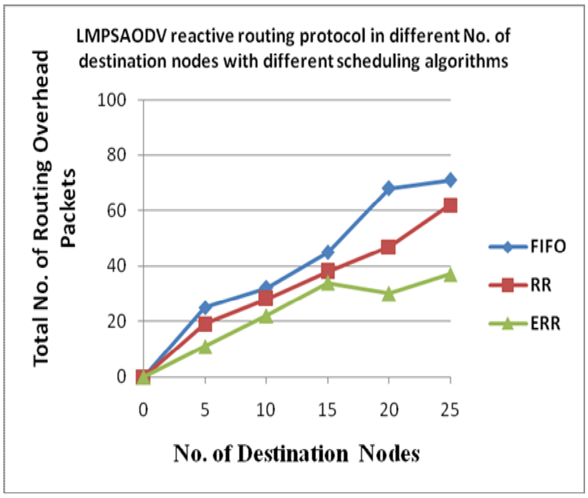

Figure 12: Routing overhead using LMPSAODV

Conclusion

In this work, the problem in packet scheduling when the video transmissions over Mobile ad hoc Networks has been studied. The Loop-free Multipath [17] with minimum routing overhead for multimedia transmissions and the ERR packet scheduling technique is proposed to reduce the control packets, packet delay at source, packet delay at destination and Inter-Packet Delay. Here it is analyzed the performance of AODV and LMPSAODV with three different packet scheduling algorithms namely First-In-First-Out, Round Robin and Enhanced Round Robin. From the results, it is found that ERR packet scheduling with LMPSAODV outperforms when compared to FIFO and RR scheduling algorithms. In all the scenarios of scheduling algorithms AODV routing protocol is also analyzed to determine the routing overhead and Inter-Packet Delay in the multimedia transmission over MANET.

Thus, the results show that the interaction between MAC layer and the network layer has a significant impact on the achievable performance for delay-sensitive applications in ad hoc networks. Results further shows that, in all scenarios the QoS parameters give 11%-15% performance improvement in delay metric and 40-45% of routing overhead is reduced. From the results found, it is concluded that the LMPSAODV with ERR performs better with different number of destinations.

References

[1] Alaa Seddik-Ghaleb, Yacine Ghamri-Doudane, Sidi-Mohammed Senouci, "Effect of Ad Hoc Routing Protocols on TCP Performance within MANETs", 2006 IEEE International Conference, page no 866 – 873.

[2] Alaa Seddik-Ghaleb,Yacine Ghamri-Doudane, Sidi-Mohammed Senouci, "TCP Welcome: TCP variant for Wireless Environment, Link losses, and Congestion packet loss ModEls", IEEE International Conference, page no 1 – 8.

[3] Aruna Bansal, Mridula Singh, "Enhancing MANET’s Performance: A Cross-layer Solution",2012 ,2nd IEEE International Conference on Parallel, Distributed and Grid Computing,page no 407 - 412.

[4] Chandreyee Chowdhury,Sarmistha Neogy, "Reliability Estimate of Mobile Agent System for QoS MANET Applications",2011 IEEE International Conference, page no 1- 6.

[5] Chhagan Lal, Vijay Laxmi, and Manoj Singh Gaur, "An Adaptive Cross-Layer Routing Protocol for Delay-Sensitive Applications Over MANETs", International Conference on Advances in Computing, Communications and Informatics (ICACCI), 2013 IEEE, page no 610 – 615.

[6] Devi .M,V.Rhymend Uthariaraj, "Congestion Based Route Recovery Technique For MANET",Journal of Theoretical and Applied Information Technology,10th August 2013. Vol. 54 No.1, E-ISSN: 1817-3195, page no 73 – 81.

[7] José L Gil, "Performance Analysis of The TCP SACK-based Loss Recovery Mechanism (RFC 3517) Under Correlated Losses", 2006 ACM, page no 64 – 73.

[8] Komal Zaman, Muddesar Iqbal, Muhammad Shafiq, Azeem Irshad, Saqib Rasool, "A Survey: variants of TCP in Ad-hoc networks",Advances in Computer Science: an International Journal, ISSN : 2322-5157 ,Vol. 2, Issue 5, No.6, November 2013, page no 80 – 87.

[9] Krishna Singh, "Path Reliability of Multi Path Routing in MANET",International Journal of Science and Research (IJSR), ISSN: 2319-7064, Volume 2 Issue 6, June 2013, page no 137 – 139.

[10] Majid Ahmad,Durgesh Kumar Mishra, " A Reliability Calculations Model for Large-Scale MANETs", International Journal of Computer

Applications (0975 – 8887), Volume 59– No.9, December 2012,- page no 17 – 21.

[11] Miguel Catalan-Cid, Carles Gomez,Josep Paradells,Jose Luis Ferrer, "DEMON: preemptive route recovery for AODV in multi-hop wireless networks based on performance degradation monitoring",Journal on Wireless Communications and Networking,Springer,page no 1 – 21.

[12] Nidhi Shukla, Neelesh Gupta, Naushad Parveen, "Survey of Cross Layer Based TCP Congestion Control Techniques in MANET",International Journal of Emerging Technology and Advanced Engineering,Volume 4, Issue 3, March 2014,page no 446 – 452.

[13] Ns-2 Network simulator. http://www.isi.edu/nsnam/ns.

[14] Rachid Haboub and Mohammed Ouzzif, "Secure and Reliable Routing In Mobile Adhoc Networks", International Journal of Computer Science & Engineering Survey (IJCSES) ,Vol.3, No.1, February 2012.

[15] Senthil Kumaran, T. and V. Sankarana rayanan, “Congestion Free Routing in Adhoc Networks”, Journal of Computer Science, Vol.8 (6), 2012, pp.971-977.

[16] Sivakumar P,Durai Swamy K, "Reliable Real-Time Data Transmission in MANET Using Connection Possibility", Journal of Theoretical and Applied Information Technology,E-ISSN: 1817-3195,10th March 2013. Vol. 49 No.1, page no 16 – 22.

[17] Syed Masood M, Sheik Abdul Khader P,Mohamed Abbas A, “Performance of TCP TAHOE and SACK over Loop-Free Multipath Reactive Routing Protocol in MANET”, Journal of Theoretical and Applied Information Technology, Vol. 64 No.2, June 2014, E-ISSN: 1817-3195, page 504 – 510.

[18] Thilagavathe V,Duraiswamy K, "Cross Layer based Congestion Control Technique for Reliable and Energy Aware Routing in MANET",International Journal of Computer Applications ,Volume 36– No.12, December 2011,(0975 – 8887),page no 1 -6.

[19] Xibin Zhao, Zhiyang," A Novel Two-Terminal Reliability Analysis for MANET",Journal of Applied Mathematics,2013.

[20] Rukmani P ,Ganesan R, "Scheduling algorithm for real time applications in mobile ad hoc network with opnet modeler",International Conference on design and manufacturing, IConDM 2013,Elsevier, Procedia Engineering, 1877-7058, 64 (2013) 94 – 103.

[21] Pi-Rong Sheu, Chuan-Fu Hu, Chi-Chiuan Liou, Fang-Chen Chuang, Yi-Cyun Chen, "An Efficient and Interference-Aware Centralized Routing Tree Algorithm for the Routing and Packet Scheduling Problem in IEEE 802.16 Mesh Networks",2010 IEEE, International Conference on Communications and Mobile Computing, pg no 496 – 503.

[22] Lakshmi S, Radha S, “Design And Analysis of An Adaptive Selfish Scheduling Algorithm Using AODV Protocol In MANET",Indian Journal of Computer Science and Engineering (IJCSE),ISSN : 0976-5166 ,Vol. 3 No.3 Jun-Jul 2012,page no. 428 - 435.

[23] Hyunchul Joo, Ki Jin An, and Hwangjun Song, “Urgency-Based Packet Scheduling and routing algorithms for video transmission over MANETs", CCWMC2011, page no 403 – 408.
[24] Ki Jin An and Hwangjun Song, "An Effective Cross-layer Packet Scheduling and Routing Algorithm for Delay-sensitive Media Transmission over MANET", IEEE ICC 2009 proceedings.