Research Journal of Applied Sciences, Engineering and Technology 12(2): 147-153, 2016
DOI:10.19026/rjaset.12.2315
ISSN:2040-7459; e-ISSN: 2040-7467

Submitted: April 14, 2015 Accepted: May 22, 2015 Published: January 20, 2016

Research Article

Scalable Channel Access Optimized Cross Layer Protocol for Mobile Ad Hoc Networks

A. Vijayalakshmi and Dr. P. Ramamoorthy
ECE,InfoInstituteofEngineering,Coimbatore, India Adithya
Instituteof Technology, Coimbatore, India

Abstract: In Mobile Ad hoc Network (MANET) multicast protocols are tightly coupled with association of nodes-channel ratio which leads to non-interference or low-interference communication. It is purely based on the linear and sequential approach to solve the channel assignment unicast routing or multicast routing as two disjoint sub-problems. To overcome this, heuristic routing planner for exposure calculation and non-interference greedy optimized routing is designed by using genetic operator. The main focus of this study is genetic based cross layer optimization of relay selection for both unicast and multicast communication. Performance evaluation shows that the proposed scheme exhibits high performance in terms of packet delivery ratio, bandwidth utilization, throughput and delay when compared to Ad hoc On Demand Distance Vector (AODV) and Multicast Ad hoc On Demand Distance Vector (MAODV).

Keywords: Cover set, QoS, RDP, RPR, time-slot, traffic

INTRODUCTION

Mobile Ad hoc Network (MANET) is a group of mobile nodes which communicate with each other without any centralized support and the nodes are connected by wireless links that can communicate dynamically. Each and every nodes in MANETs act as a router or a source node and receiver node. Thus, nodes communicating in adhoc networks may require a relay or shall cooperate with all other nodes which act as relay (Perkins and Bhagwat, 1994). MANET is an autonomous network of wireless nodes without any centralized routing and transmission control (Xiaoyan *et al*., 2002).

In MANET, routing in sensor networks is usually challenging due to several characteristics that distinguish them from current communication and wireless Mobile Ad hoc networks. Initially, to build a global addressing scheme for the deployment of Sheer number of sensor nodes is tough. Therefore, classical IP-based protocols cannot be applied to sensor networks. Then, in divergent to ordinary communication networks almost all applications of sensor networks require the flow of sensed data from multiple regions (sources) to a particular sink. Next, data generation for traffic has significant redundancy, since multiple sensors may generate same data within the vicinity of a phenomenon. Such redundancy needs to be exploited by the routing protocols to improve energy and bandwidth utilization. Finally, sensor nodes are tightly constrained in terms of transmission power, on-board energy, processing capacity and storage (Xiaoyan *et al*., 2002).

Energy Efficient protocol is a needed criterion while designing protocol, there are many cross-layer designs for different optimization purpose. The focus of each cross layer includes different optimization purposes, various QoS metric, priority handling, security and delay (Lakshmisudha and Arun, 2014).

Usually, the cross-layer designs are done by the combination of layers Physical-Media Access Control (MAC)-network, MAC network, Network-Transport only. For complete integration of MAC-Network Transport layers solution, it is not focused. The cross-layer designs provide individual solution for congestion control, flow control, fault tolerance, power conservation and energy minimization.

In this study, a cross layer design is utilized for joint optimization of channel assignment model, which is accomplished by considering low interference or non-interference greedy genetic algorithm. Here, Genetic algorithm based routing is used to make an important traffic traverse route that maximizes their overall sampling rate. Genetic routing can be used to populate the solution that can guide the traffic across the path with greater measurement potential. A scheduling and optimization scheme is introduced to construct interference-free link set. This can be used to obtain the best transmission flows and the time shares in which the different interference-free link sets should be active and transmitting.

LITERATURE REVIEW

Chen and Heinzelman (2007) offered a general sketch on routing communications protocol that furnish

Corresponding Author: A. Vijayalakshmi,ECE,Info Institute of Engineering, Coimbatore, India

a few kind of support for QoS in MANETs. The authors equated a few of the proactive and reactive protocols such as, Core-Extraction Distributed Ad-Hoc Routing Protocol (CEDER), Ticket -Based Routing Protocol (TDR), Optimized Link State Routing Protocol (OLSR), AdHoc QoS On-demand Routing in MANET (AQOR), Adaptive QoS routing algorithm (ADQR) and QoS-aware routing based on Bandwidth Estimation for MANET (BEQR) (Ravinder, 2010). The outstanding part of this study is marked out the open events of QoS-aware routing and equivalence of QoS-aware routing protocols in terms of bandwidth, delay, path breakthrough, resource reservation and route sustainment.

Setton *et al*. (2005) have proposed a cross-layer framework that incorporates adaptations across all layers of the protocol stack. Network stability metric based evaluation was proposed by Yuanyuan and Yang (2012) in which a normalized method in merging mutual tree is used for network stability mechanism based on mobility in the nodes. NBS-MAODV was proposed the GPS positional device to identify the location of each nodes and it reduces the link fracture links.

The author Chen*et al*. (2006) focused to produce jointly optimal design of cross-layer congestion control, routing and scheduling for ad hoc wireless networks. Initially the rate constraint is formulated and then scheduling constraint using multi-commodity flow variables and formulate resource allocation in networks with fixed wireless channels as a utility maximization problem with these constraints. By this dual decomposition, the resource allocation problem is decomposed into three sub problems of congestion control routing and scheduling that interact through congestion price.

Xinsheng *et al*. (2006) also investigated a method for cross-layer design in MANET. In which Fuzzy Logic System (FLS) is used to coordinate physical layer, data link layer and application layer for cross-layer design. For the FLS, the Ground speed, average delay and packets successful transmission ratio are selected. The output of FLS has provided adjusting factors for the AMC (Adaptive Modulation and Coding), transmission power, retransmission times and rate control decision.

Hoffmann *et al*. (2011) introduced a Genetic Algorithm technique to resolve the combined Internet gateway allocation, routing and scheduling problem in wireless ad hoc networks. The performance of the Genetic Algorithm is estimated by the simulations that it provides a hop count based routing and gateway selection solution. The studies examine the benefits that can be attained by optimizing the allocation of Internet gateways or the routing. The experimental results show that the Genetic Algorithm provides better performance in terms of delay and packet delivery ratio.

Chuan-Chi *et al*. (2012) proposed an energy-efficient cross-layer design for the network layer and Medium Access Control (MAC) layer that reduces energy consumption and prolongs network lifetime. In the network layer, a Minimum Transmission Energy Consumption (MTEC) routing protocol is proposed for selecting the MTEC path for data transmission, based on the proportion of successful data transmissions, the number of channel events, the remaining node energy of nodes and the traffic load of nodes. They design an Adaptive Contention Window (ACW) for the MAC layer that provides nodes with high successful transmission rates with greater opportunity for contending for a channel to save energy. The simulation results showed that the proposed cross-layer design (MTEC with ACW) provided better packet delivery rate and throughput than existing protocols. MTEC with ACW also exhibited lower-energy consumption during data transmission and a higher network lifetime than existing protocols.

Thaalbi *et al*. (2013) designed cross layer design is deployed to get in-formation about the predicted end-to-end path quality and exploit this information to improve the behavior of the routing protocol in Mobile Ad hoc Networks (MANETs). To achieve greater routing performance for applications with real time constraints, interaction between application layer and routing layer are needed. In this cross layer design between application layer and routing layer is defined to take into account the application QoS class. This proposed routing protocol is suggested as an enhancement to the AOMDV: Ad hoc On-demand multipath Distance Vector protocol.

Garcia-Luna-Aceves and Menchaca-Mendez (2011) proposed the routes established in STORM are shown to be loop-free and real time packets forwarded along these routes are shown to have bounded end-to-end delays. Garcia-Luna-Aceves and Menchaca-Mendez (2012) designed a cross-layer framework for the effective dissemination of real-time and elastic traffic in multihop wireless networks called Scheduling and Traffic Management in Ordered Routing Meshes (STORM). Unicast and multicast routes are established in coordination with the scheduling of transmissions and bandwidth reservations in a way that bandwidth and delay guarantees can be enforced on a per-hop and end-to-end basis (Cai *et al*., 2003). Maamar *etal*. (2011) proposed variant (M-AODV) to determine the reconstruction paths from source and also to find routes for multiple disjoint.

Problem definition and network model: In MANET, connectivity model is described as G = (V, E), where, G= Graph or network, V = Vertices or nodes and E = edges or wireless links with communication radius R.

In the network model, V = {A, B, C, D, E}, E = {(A,B), (A,C), (B,C), (B,D), (D, E), (C, E)}, Path (P) = {(AB, AC, ABD, ACE}. Where, P represents multi-hop connectivity among all nodes. In this model each node has its own transmission range which is known as coverage ‘R’. Each and every node is equipped with battery power and it has equal initial energy (e). Distance between two nodes are computed using Euclidean distance measurement as:

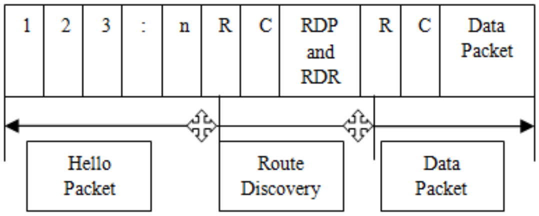


Fig. 1: Time frame format for hello, data packet, RDP and RPR messages

$$Dist_{i,j} = \sqrt{\left[\left(x_i - x_j\right)^2 + \left(y_i - y_j\right)^2\right]}$$

Where $i, j \in V,\ i \neq j$.

$$Dist_{i,j} = \begin{cases} 0,\ Dist_{i,j} \geq R \\ 1,\ Dist_{i,j} \leq R. \end{cases}$$

Problem definition: All nodes in the network exhibit its dynamics in terms of connectivity. And nodes in the network are operated using limited resources such as bandwidth, battery power, transmission range and buffer. To utilize these resources apart from routing model, resource utilization model is also required. To fulfill this measurement, channel optimization model is established in nodes.

Proposed work: In this study, scalable greedy genetic based routing and channel access model is defined to operate among nodes during data transmission.

Route selection: Route selection is accomplished between nodes to generate multiple paths from source to destination and among them the best path is utilized. Route discovery process is initiated by sending Route Discovery Process (RDP) message as network wide broadcast message. Before starting the data transmission process, it validates the route in a proactive manner. If the proactive process fails to identify the path to destination then it immediately starts the RDP.

Channel reservation: Channel access and reservation model is purely a heuristic approach, which is based on the connectivity among nodes. Initially, slot duration is calculated based on average node density, which is observed from the number of nodes in the network, network topography size and node transmission range. From these three values, hello message slot and remaining slots are computed as follows.

$$Averageneighbour = \frac{Numberofnodes}{Topology * Topology \times TransmissionRange}$$

$$Helloslotduration = \frac{singleslotdurationforhellomessage}{AverageNeighbourdensity}$$

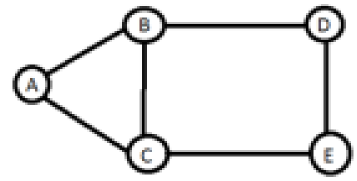


Fig. 2: Network model

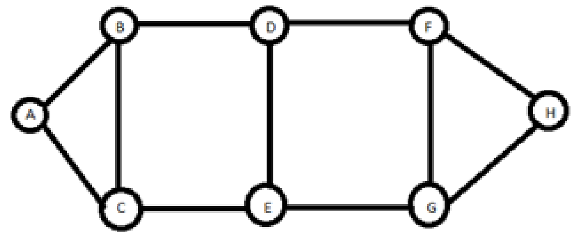


Fig. 3: Network model

0	0	0	0	0	0	0	0
A	B	C	D	E	F	G	H

Fig. 4: Initial chromosome

$$Remainingslot = [slotdeuration - helloslotduration]$$

Figure 1 shows the time frame format. Here, R = Reservation message slot, C = Competition slot and RDP represent control messages.

Traffic management and queue management: In this study,bothtraffic management and queue managementmodels are designed to work together. Based on the application packet type, packet is handled by RQ, RTQ and NRTQ queues. Among these three queues RQ preserve high priority, RTQ preserve 2nd high priority and NRTQ preserves low priority. In RTQ, stream video, video, voice, audio is the priority order. In NRTQ File, Telnet, CBR and VBR is the priority order.

Formation of initial solution: The chromosome contains n bits, where ‘n’ is number of nodes in the network. And initially all bits are assigned to ‘0’. The initial set of chromosomes contains ‘m’ solutions communicate with other nodes. The sample network and chromosome is shown in Fig. 2 to 4.

Selection and fitness evaluation: Fitness metric of a chromosome is considered by using bandwidth, energy, speed, percentage of buffer occupancy, current traffic class and probability of channel access:

Objective Value of Chromosome = [α1NB+α2NE+ α3NS-1+α4NBO-1+α5TC+α6CA-1/6].

where,

α1+α2+….+α6 = 1

NB : Network bandwidth

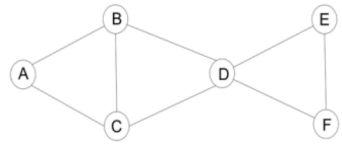


Fig. 5: Network model

1	0	0	1	0	0	0	1	0	0	1	0	0	0	1	0	0	1
A	B	C	D	E	F	A	B	C	D	E	F	A	B	C	D	E	F

Fig. 6: Initial chromosome

0	0	1	0	1	0	1	0	0	1	0	0	0	1	0	0	0	1
A	B	C	D	E	F	A	B	C	D	E	F	A	B	C	D	E	F

Fig. 7: Final chromosomes

NE : Network Energy
NBO : Network Buffer Occupied
TC : Network Traffic Class
CA : Channel Access

The fitness value is computed for all initial chromosome based on the node formation.

Channel access scheduling: Channel access scheduling model is executed as cross layered model, since both the network layer and MAC layer information's are combined together. From the network layer the hello information is received by the neighbor node information. This model is the combination of non-interference channel access scheme with balanced channel-node scheduling.

Chromosome representation: For time slot allocation, chromosome is created as follows. Here, the length of chromosome bit is fixed. i.e., the number of neighbors and average interference range.

Fitness evaluation for channel scheduling: Fitness parameter is computed using the traffic class, queue length and channel access probability:

$$NormalizedTrafficclass = \frac{Maximumclass - currentclass}{Maximumclass}$$

$$NormalizedQueueOccupying = \frac{OccupiedPacketLenght}{MaximumLength}$$

$$NormlizedChannelAccess = \frac{ChannelAccessTime}{Totaltime}$$

$$Finalobjectivevalueofanode = \frac{[\alpha_1 NT + \alpha_2 NQ + \alpha_3 NC]}{3}$$

Here $[\alpha_1 + \alpha_2 + \alpha_3 = 1]$

$$ObjectiveValueofasinglechromosome = \frac{Objectiveofeachnode}{Numberofactivenode}$$

Once the chromosome is generated crossover, mutation, selection, iteration are applied to establish optimization. At the end of iteration final chromosome is selected and decoded. Decoding of final chromosome is given Fig. 5 to 7. Here, CE use nodes C and E, First slot, AD use Second slot and BF use last slot.

RESULTS AND DISCUSSION

Simulation is performed using the discrete event simulator (Network Stimulator-2) version 2.32 with Carnegie Mellon University (CMU) extension. Network protocol performance is evaluated in terms of packet delivery ratio and bandwidth utilization ratio for both unicast and multicast traffic, by varying number of nodes from 50 to 150 with 4 m/s speed. CBR data source generates 10 packets and each packet has 1024 bytes. Here the performance is evaluated using metrics such as bandwidth, PDR, through put calculation and delay with nodes for SCAO-unicast and multiple MAODV and AODV unicast.

Bandwidth: The available bandwidth between two nodes is defined as the maximum throughput that can be transmitted between these two peers without disrupting any ongoing flow in the network.

PDR: The ratio between the numbers of packets successfully received at the destinations and the total number of packets sent by the sources defined as follows:

$$PDR = \frac{receivedpackets}{sentpackets} * 100$$

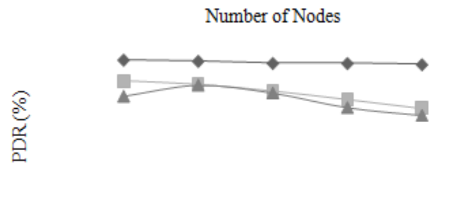
Throughput: The time average of the number of bits that can be transmitted by each node to its destination is called the per-node throughput. The sum of per-node throughput over all the nodes in a network is called the throughput of the network.

Average delay: The average delay is calculated by taking the average of delays for every data packet transmitted to the total number of received packets as defined below equation. The parameter is measured only when the data transmission has been successful:

$$AverageDelay = \frac{SumofAllPacketsDelay}{TotalNoofReceivedPackets}$$

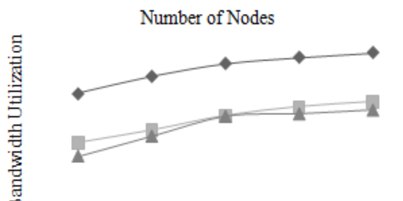
Figure 8 shows the PDR value of the nodes of 50, 75, 100, 125 and 150 for different unicast techniques such as SCAO-unicast, MAODV-unicast and AODV-unicast routing. From the graph it shows SCAO-unicast receives more number of packets than the other two techniques.

Figure 9 shows the Bandwidth Utilization for the nodes of 50, 75, 100, 125 and 150 for different unicast techniques of SCAO-unicast, MAODV-unicast and AODV-unicast routing.From the graph the SCAO-



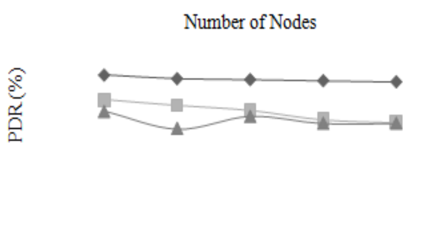
	50	75	100	125	150
SCAO-Unicast	99	99	97	97	97
MAODV-unicast	87	85	81	76	70
AODV-unicast	77	84	79	70	66

Fig. 8: PDR Vs nodes



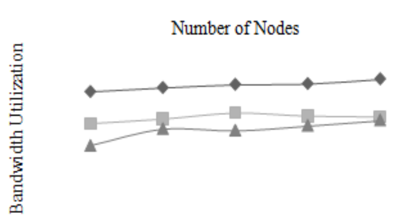
	50	75	100	125	150
SCAO-Unicast	0.63	0.72	0.79	0.82	0.85
MAODV-unicast	0.35	0.42	0.50	0.55	0.58
AODV-unicast	0.2767	0.3888	0.4988	0.5129	0.534

Fig. 9: Bandwidth utilization Vs nodes



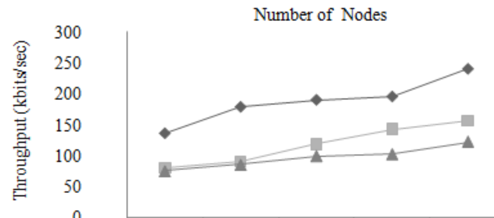
	50	75	100	125	150
SCAO-Multicast	96	94	93	92	92
MAODV-Multicast	82	78	76	71	69
AODV-mcast	75	65	72	68	68

Fig. 10: PDR Vs nodes



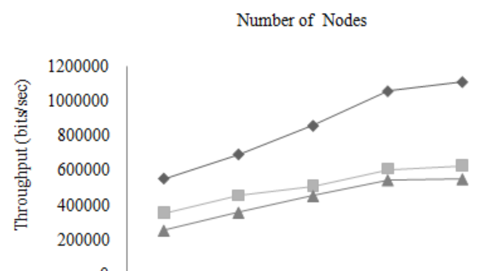
	50	75	100	125	150
SCAO-Multicast	0.89	0.91	0.93	0.94	0.97
MAODV-Multicast	0.680	0.710	0.750	0.730	0.725
AODV-mcast	0.5344	0.644	0.633	0.66444	0.7

Fig. 11: Bandwidth utilization Vs nodes



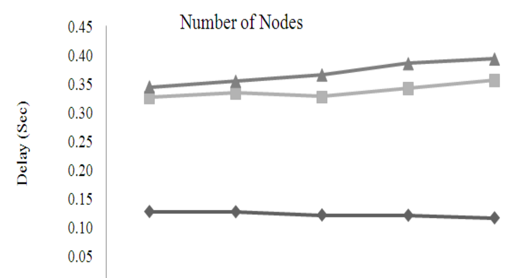
	50	75	100	125	150
SCAO-Unicast	135 2/	178 2/	190	195 1/	240 1/
MAODV-unicast	81	90 2/3	118 59/	143 21/	156 53/
AODV-unicast	76	86	99	102	122

Fig. 12: Throughput Vs nodes



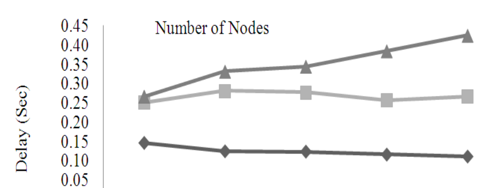
	50	75	100	125	150
SCAO-Multicast	550005	690055	855555	1055525	1108585
MAODV-Multicast	350055	452535	505523	605824	625532
AODV-mcast	253242	355500	450234	540020	546000

Fig. 13: Throughput Vs nodes



	50	75	100	125	150
SCAO-Unicast	0.13	0.13	0.12	0.12	0.12
MAODV-unicast	0.33	0.33	0.33	0.34	0.36
AODV-unicast	0.34333	0.35333	0.36444	0.384234	0.39234

Fig.14: Average delay Vsnodes



	50	75	100	125	150
SCAO-Multicast	0.15	0.12	0.12	0.12	0.11
MAODV-Multicast	0.25	0.28	0.28	0.26	0.27
AODV-mcast	0.2644	0.3299	0.343	0.3833	0.42399

Fig.15: Average delay Vsnodes

Table 1: Performance of BW utilization Vs number of nodes

	Unicast routing			Multicast routing		
Number of nodes	SCAO	MAODV	AODV	SCAO	MAODV	AODV
50	0.6	0.4	0.3	0.9	0.7	0.5
75	0.7	0.4	0.4	0.9	0.7	0.6
100	0.8	0.5	0.5	0.9	0.8	0.6
125	0.8	0.6	0.5	0.9	0.7	0.7
150	0.9	0.6	0.5	1.0	0.7	0.7

Table 2: Performance of packet delivery ratio Vs number of nodes

	Unicast routing			Multicast routing		
Number of nodes	SCAO	MAODV	AODV	SCAO	MAODV	AODV
50	99	87	77	96	82	75
75	99	85	84	94	78	65
100	97	81	79	93	76	72
125	97	76	70	92	71	68
150	97	70	66	92	69	68

unicast utilizes more bandwidth than the other techniques.

Figure 10 shows the PDR value of the nodes of 50, 75, 100, 125 and 150 for different multicast techniques of SCAO-multicast, MAODV-multicast and AODV-multicast routing. From the graph it shows SCAO-multicast receives more number of packets than the other two techniques.

Bandwidth Utilization for the nodes is shown in Fig. 11 for the nodes of 50, 75, 100, 125 and 150 for different multicast techniques such as SCAO-multicast, MAODV-multicast and AODV-multicast routing. From the graph the SCAO-multicast utilizes more bandwidth than the other techniques.

Figure 12 shows the Throughput for the nodes of 50, 75, 100, 125 and 150 for different unicast techniques such as SCAO-unicast, MAODV-unicast and AODV-unicast routing. From the graph it illustrates SCAO-unicast gives more throughput for 50 and 75 nodes and for 100 to 150 nodes MAODV gives more throughput than the other two techniques.

Figure 13 shows the Throughput for the nodes of 50, 75, 100, 125 and 150 for different multicast techniques of SCAO-multicast, MAODV-multicast and AODV-multicast routing. From the graph the SCAO-multicast gives added throughputs for 50 to 150 nodes than the other two techniques.

Figure 14 shows the Average delay for the nodes of 50, 75, 100, 125 and 150 for different unicast techniques such as SCAO-unicast, MAODV-unicast and AODV-unicast routing. From the graph it shows the delay for SCAO-unicast takes less delay for 50 to 150 nodes than the other two techniques takes delay.

Figure 15 shows the Average delay for the nodes of 50, 75, 100, 125 and 150 for different multicast techniques of SCAO- multicast, MAODV-multicast and AODV-multicastrouting. From the graphthe SCAO-multicast takes very minimum delay than the other two techniques taken delay.

The performance evaluation of Scalable Channel Access Optimized (SCAO) against AODV and MAODV of unicast and multicast is shown in Fig. 8 to 15. The proposed SCAO utilizes the bandwidth, throughput and PDR in an efficient manner and achieves High packet delivery ratio in both unicast and multicast routing with minimum delay (Table 1 and 2).

CONCLUSION

In this study, genetic based optimization model is presented to utilize available resources such as bandwidth, energy and link capacity effectively. The proposed channel scheduling is obtained by genetic operator as best channel access combination, which produces better and comparable performance interms of utilization ratio, packet delivery ratio, delay and throughput. This model is improved by the traffic management and queue management. In the future, this model can be applied for large scale devices and the complete network is partitioned into small regions. And also routing scheme is applied inside and outside the small regions to achieve further improvement in this channel scheduling model. Finally this protocol can be improved using genetic algorithm for routing and channel optimization.

REFERENCES

Cai, Z., M. Lu and X. Wang, 2003. An end-to-end bandwidth allocation algorithm for ad hoc networks. Telecommun. Syst., 22(1): 281-297.

Chen, L. and W.B. Heinzelman, 2007. A survey of routing protocols that support QoS in Mobile Ad Hoc Networks. IEEE Network, 21(6): 30-38.

Chen, L.,S.H. Low, M. Chiang and J.C. Doyle, 2006. Cross-layer congestion control, routing and scheduling design in ad hoc wireless networks. Proceeding of the 25th IEEE International Conference on Computer Communications, pp: 1-13.

Chuan-Chi, W., C. Ching-Wen, C. Po-Yueh and C. Kuei-Chung, 2012. Design of an energy-efficient cross-layer protocol for mobile ad hoc networks. IET Commun., 7(3): 217-228.

Garcia-Luna-Aceves, J.J. and R. Menchaca-Mendez, 2011. PRIME: An interest-driven approach to integrated unicast and multicast routing in MANETs. IEEE ACM T. Network., 19(6): 1573-1586.

Garcia-Luna-Aceves, J.J. and R. Menchaca-Mendez, 2012. STORM: A framework for integrated routing, scheduling, and traffic management in ad hoc networks. IEEE T. Mobile Comput., 11(8): 1345-1357.

Hoffmann, F., D. Medina and A. Wolisz, 2011. Optimization of routing and gateway allocation in aeronautical ad hoc networks using genetic algorithms. Proceeding of the 7th International Conference on Wireless Communications and Mobile Computing (IWCMC, 2011).

Lakshmisudha, K. and C. Arun, 2014. Cross layer designs to optimize the power consumption in wireless sensor networks. J. Theor. Appl. Inform. Technol., 62(2): 380-386.

Maamar, S., B. Azeddine and B. Mohammed, 2011. M-AODV: AODV variant to improve quality of service in MANETs. IJCSI Int. J. Comp. Sci. Issues, 8(1).

Perkins, C.E. and P. Bhagwat, 1994. Highly dynamic Destination sequenced distance-vector routing (DSDV) for mobile computers. Proceeding of the Conference on Communications Architectures, Protocols and Applications, New York, pp: 234-244.

Ravinder, A., 2010. Simulation based performance evaluation and comparison of reactive, proactive and hybrid routing protocols based on random waypoint mobility model. Int. J. Comput. Appl., 7(11): 20-24.

Setton, E., T. Yoo, X. Zhu, A. Goldsmith and B. Girod, 2005. Cross-layer design of ad hoc networks for real-time video streaming. IEEE Wirel. Commun., 12(4): 59-65.

Thaalbi, M., N. Tabbane, T. Bejaoui and A. Meddahi, 2013. An enhanced quality aware multi path routing protocol over MA-NETs based on cross layer approach. Proceeding of the 10th International Symposium on Wireless Communication Systems (ISWCS, 2013), pp: 1-5.

Xiaoyan, H., X. Kaixin and M. Gerla, 2002. Scalable routing protocols for mobile ad hoc networks. IEEE Network, 16(4): 11-21.

Xinsheng, X., R. Qingchun and L. Qilian, 2006. Cross-layer design for mobile ad hoc networks: Energy, throughput and delay-aware approach. Proceeding of the IEEE Conference on Wireless Communications and Networking, 2: 770-775.

Yuanyuan, Z. and T. Yang, 2012. A method of selecting path based on neighbor stability in ad hoc network. Proceeding of IEEE International Conference on Computer Science and Automation Engineering (CSAE, 2012), pp: 675-678.