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An Energy Efficient Multicast Scheduler for Multicast Protocol WEEM in Ad Hoc Networks

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ABSTRACT

Multicasting is an important operation in ad hoc networks. In this operation, a group of nodes termed as multicast members, are expected to receive same multicast message, at approximately same time if possible. They may be physically close or placed far apart. Earlier we have proposed the multicast scheduler WEEM. The present article proposes an energy efficient scheduler exclusively for WEEM in ad hoc network environment. Based on the advantages provided by underlying network architecture, a router can efficiently schedule multicast packets belonging to various multicast sessions. This promotes greenery in the network and significantly increases packet delivery ratio. These claims are supported and justified by experimental results presented in this paper. As far as the authors know, there is no multicast packet scheduler in the literature of ad hoc networks. Therefore, current approach of multicast scheduler design is novel and state-of-the-art.

Key words : Ad hoc networks; Energy efficiency; Fuzzy scheduler; Multicasting.

1. INTRODUCTION

A mobile ad hoc network consists of certain nodes that communicates via wireless links without any network infrastructure or centralized administration the nodes are free to move in arbitrary direction and arrange them in time – varying network topologies. These are particularly used in emergency scenarios like war, natural disaster etc [1]-[6]. Communication in ad hoc network either single-hop or multi-hop. In a single hop communication, destination stays within radio-range of source. On the other hand in multi-hop network, one or more routers have to bridge the gap between source and destination nodes.

As far as the authors know, no scheduler has yet been developed exclusively for multicast operation in ad hoc networks. Earlier we have developed a Weight-based Energy Efficient Multicast protocol (WEEM) [9] where packets were processed by routers in first-come-first-served or FCFS basis. Here we applied a different scheduling strategy named Energy Efficient Multicast Scheduler EEMS-WEEM particularly for the protocol WEEM, while the ethnic WEEM is referred to as FCFS-WEEM. EEMS-WEEM [10] is a weight based scheme that assigns higher weight to packets travelling through a path consisting of exhausted routers and expected to deliver multicast message to a good number of multicast destinations. Priority of the packet increases even more if it is part of a multicast session that has already suffered a huge number of route discoveries. Based on these observations, a fuzzy controller FUZZ-EEMS [7] is designed which is embedded in every node. This computes priority of each multicast packet [8].

2. RELATED WORK

Please note that there is no scheduler in literature of ad hoc networks that focus on multicast operation. Therefore, we discuss scheduling algorithms in general. Different routing protocols use different methods of scheduling. Among them, FCFS (first-come-first-served) is quite heavily used. This processes broadcast packets in order of arrival [1]. Priority scheduler is based on either internal or external priority. But these do not consider typical natures of different kinds of communication (unicast, multicast, broadcast, anycast) of ad hoc networks.

Certain scheduling schemes depend on the size of the message and number of hops to traverse. In smallest message first (SMF) [2] algorithm, packets that are part of smallest message are processed first. In order to implement this requires total message size to be attached to each packet. In smallest remaining message first scheme (SRMF) [3], [4] packets are ordered on the basis of the amount of message packets remaining to be sent after the current packet. On the other hand, in shortest hop length first (SHLF) scheduling [5], [6] the distance between the source and destination, measured in terms of the number of hops.

3. THE SCHEME OF EEMS-WEEM

Let a given packet pac be travelling through a route R_{pac} such that WEEM calculated its priority to be weight(R_{pac}). Also assume that dest(R_{pac}) is number of multicast destinations present in the route R_{pac}.

3.1 Input parameters of FUZZ-EEMS

Input parameters par1, par2 and par3 of FUZZ-EEMS are as follows:

$$par1 = 1 - f(pac) \,/\, \max_{pac1 \in competitor(pac)} \{f(pac1)+1\} \qquad (1)$$

$$f(pac) = weight(R_{pac}) \,/\, dest(R_{pac}) \qquad (2)$$

f(pac) of a packet pac expresses i) residual energy (above threshold energy which is 40% of initial energy as mentioned in WEEM) of routers in R_{pac} through which pac is supposed to travel, and ii) multicast packet transmission capability of routers in R_{pac}. As per reference [9], multicast packet transmission capability is the number of multicast packets that is expected to be delivered to multicast members before first route-breakage.

competitor(pac) is the set of multicast packets that compete with pac in terms of priority. From the formulation in (1) it is evident that the first input parameter par1 of FUZZ-EEMS lies between 0 and 1. High value of this parameter denotes that routers of path of packet pac are not much strong in terms of energy and are expected to suffer from frequent route rediscoveries. So, it is better to forward these packets before others. That will reduce number of route discovery packets injected in the network.

$$par2 = dest(R_{pac}) / M(pac) \quad (3)$$

Here M(pac) is the total number of members in the multicast group of packet pac. It is evident that $dest(R_{pac}) < M(pac)$, i.e. par2 is less than or equal to 1. High values of it denote that current packet pac is going to travel through a path that will deliver pac to a good number of multicast members compared to M(pac). So, it is better to forward pac fast to achieve high packet delivery ratio.

$$par3 = \sqrt{f1(pac) \times f2(pac)} \quad (4)$$

$$f1(pac) = seq\text{-}id(pac)/tot\text{-}ses\text{-}pack(pac)$$

$$f2(pac) = 1 - mptc(R_{pac})/ tot\text{-}ses\text{-}pack(pac)$$

seq-id(pac) and tot-ses-pack(pac) indicate sequence number of pac in the current multicast session and total number of packets in the current multicast session of which pac is a part. Definitely, f1(pac) is less than or equal to 1. If f1(pac) is high it means that the task of current multicast session is almost finished and it is wise not to face more route rediscoveries or more hazards for this multicast. Similarly, $mptc(R_{pac})$ specifies approximate number of multicast packets Rpac can deliver before a route rediscovery. Therefore, f2(pac) is expected number of route discoveries in the current session. This one also lies between 0 and 1. If f2(pac) is high, then we expect a huge number of route rediscovery, i.e. multicast packet transmission capability of current path of pac is not upto standard. So, priority of the packet will be high [11]-[16].

3.2 Rule bases of FUZZ-EEMS

Each parameter of the fuzzy controller FUZZ-EEMS lies between 0 and 1. They are divided into 4 uniform ranges (0-0.25 as fuzzy premise variable a, 0.25-0.5 as b, 0.5-0.75 as c and 0.75-1.00 as d). par1 and par2 are combined in Table 1 producing temporary output t1 while t1 is combined with par3 in Table 2 and Table 3 producing ultimate output priority. In Table 1, par1 is assigned higher weight age because it is concerned with residual energy of routers that has direct link with message cost, energy consumption of nodes in the network and possibility of route rediscovery while par2 concentrates on multicast packet delivery ratio. par3 again deals with chances of route rediscovery.

Table 1: Composition of par1 and par2 producing t1

par1 → par2 ↓	a	b	c	d
a	a	b	b	b
b	b	b	b	c
c	b	c	d	c
d	d	c	d	d

Table 2: par2 producing priority

par1 → par2 ↓	a	b	c	d
a	a	b	b	c
b	a	b	c	c
c	b	c	c	d
d	b	c	d	d

Table 3: Combination of t1 and par3 producing priority

t1 → par3 ↓	a	b	c	d
a	a	a	a	a
b	a	b	b	b
c	a	b	c	c
d	a	b	c	d

4. SIMULATION RESULTS

A. Simulation Environment

Simulation environment is same as WEEM. Network area has size 1000m. Mobility model is random waypoint where×1000m traffic type is constant bit rate [17]-[20]. Velocity of nodes can take different values from 2 to 10 km/h. Number of simultaneous senders are 1, 5, 9, 13 and 17 in different simulation runs. Group size varies from 2 to 8. Used MAC protocol is IEEE 802.11g. Broadcast channel capacity is 2 Mbps. Traffic sources generate traffic at a rate 20 packets/s. Size of each packet is 512 bytes. The nodes are equipped with queues for storing packets before forwarding. Maximum size of queue is 100. Radio-range varies from 50m – 300m. Transmission power varies between 1 and 10 W. Receiving power is 1 to 6 W. Processing power is 1 to 3 W.

Simulation metrics are

i) Cost of messages – It indicates the total message cost in the network throughout the simulation period.

ii) Energy consumption - It indicates the total energy consumption in the network throughout the simulation period [21], [22].

iii) Packet delivery ratio – It is the ratio of the number of packets received successfully and total number of messages transmitted [23].

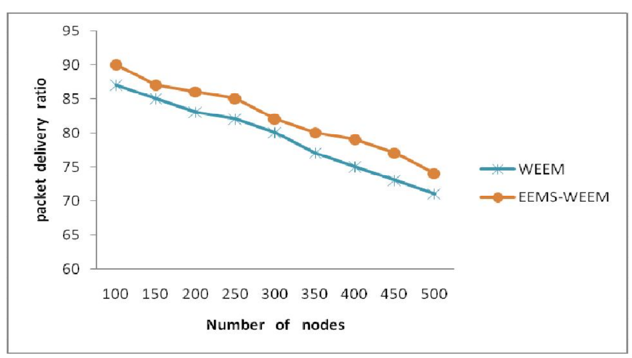

Figure 1: Packet delivery ratio vs number of nodes

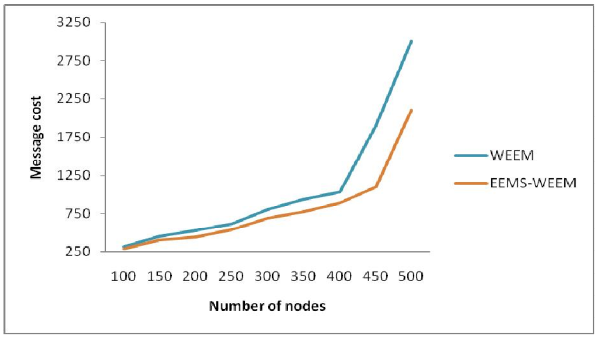

Figure 2: Message cost vs number of nodes

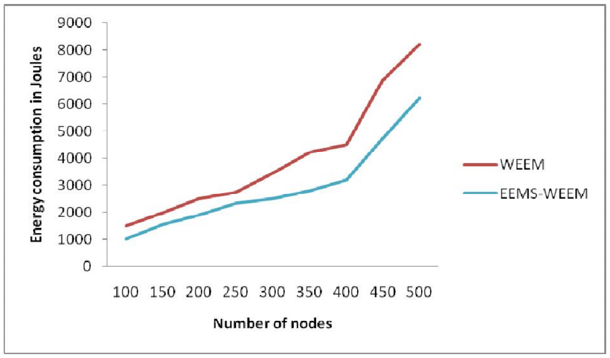

Figure 3: Energy consumption vs number of nodes

If a path is expected to suffer from more than one route discoveries, then EEMS understands that path of current packet is fragile and can break easily [24]. So, higher priority is assigned to the packets supposed to travel through unstable paths. Lesser number of route discoveries mean injection of smaller number of route-request packets in the network. This reduces message contention and collision in the network and number of possible retransmissions [25], [26]. Therefore energy consumption in the nodes decreases. As a result, higher number of packets is able to reach from source to respective destinations enabling EEMS-WEEM to produce higher packet delivery ratio. Improvements produced by EEMS-WEEM [27], [28] are evident from Figure 1, Figure 2 and Figure 3.

5. CONCLUSION

EEMS is a scheduling scheme designed particularly for multicast scheme WEEM [29]. WEEM itself is a very good multicast protocol but it forwards packets based on first-come first-served basis. But the present article shows that WEEM coupled with scheduling scheme EEMS produces much better performance than the ordinary or ethnic WEEM [30].

REFERENCES

[1] Mingyang Zhong, Vunqing Fu, Xinqiang Jia. "MAODV multicast routing protocol based on node mobility prediction ", E -Business and E -Government (ICEE), 2011 International Conference, June, 2011. https://doi.org/10.1109/ICEBEG.2011.5881805

[2] S.-J. Lee, M. Gerla and C.-C. Chiang, “On-Demand Multicast Rout- ing Protocol”, Proc. IEEE WCNC’99, New Orleans, LA, Sept 1999, pp. 1298-1304

[3] Xie, J., Talpade, R.R., McAuley, AMRoute: Ad Hoc Multicast Routing Protocol, Mobile Networks and Applications , Kluwer Academic Publishers. (2002) 7: 429.

[4] P. Sivasankar, C.Chellappan, Performance Evaluation of Energy Efficient On demand Routing Algorithms for M ANET, 2008 IEEE Region 10 Colloquium and the Third ICIIS, Kharagpur, INDIA December 8-10. https://doi.org/10.1109/ICIINFS.2008.4798361

[5] A. Banerjee, P. Dutta and S. Ghosh, “Fuzzy-Controlled Energy-Efficient Weight-Based Two Hop Clustering for Multicast Communication in Mobile Ad Hoc Networks”, in proceedings of the SEMCCO 2011, Vizag, India, Part – I, LNCS 7076, pp. 520 –529, 2012.

[6] W. Muhamad et. Al., Maximized Energy Efficient Routing For Ad Hoc Networks, IEEE ICMENS 2009, Dubai

[7] Tariq A. Murshedi, Xingwei Wang, and Hui Cheng, "On-demand Multipath Routing Protocols for Mobile Ad-Hoc Networks: A Comparative Survey," International Journal of Future Computer and Communication vol. 5, no. 3, pp. 148-157, 2016 https://doi.org/10.18178/ijfcc.2016.5.3.462

[8] Soni S.K. and Aseri T.Ci, "A review of current multicast routing protocol of mobile ad hoc network," in Proc. Second Int. Conf. Computer Modeling and Simulation ICCMS' 10, vol. 3, pp.207- 211, 2010.

[9] Anuradha Banerjee, Subhankar Ghosh, Weight-based Energy-efficient Multicasting (WEEM) In Mobile Ad Hoc Networks, In Proceedings of PerCAA 2019 https://doi.org/10.1016/j.procs.2019.05.014

[10] Katia Obraczka, Gene Tsudik, ”Multicast Routing Issues in Ad Hoc Networks,” IEEE International Conference on Universal Personal Communication (ICUPC’98), Oct. 1998.

[11] S. vasanthakumari, S. Satish, Optimizing Routing Algorithms for Mobile Ad Hoc Networks, SSRG International Journal of Computer Engineering, 2017

[12] Pariza Kamboj, A.K.Sharma, “Scalable Energy Efficient Location Aware Multicast Protocol for MANET (SEELAMP) “, Journal Of Computing, Vol. 2, Issue 5, May 2010

[13] Alak Roy, Manasi Hazarika, Mrinal Kanti Debbarma, Energy Efficient Cluster Based Routing in MANET, 2012 International Conference on Communication, Information & Computing Technology (ICCICT), Oct. 19-20, Mumbai, India.

[14] Shenbagaraj R, Dr. K. Ramar, An Optimized And Energy Efficient Multicast Routing Based On Genetic Algorithm For Wireless Mobile Ad Hoc Networks, IJRIM Volume 2, Issue 2 , February 2012

[15] Soni S.K. and Aseri T.Ci, "A review of current multicast routing protocol of mobile ad hoc network," in Proc. Second Int. Conf. Computer Modeling and Simulation ICCMS' 10, vol. 3, pp.207- 211, 2010. https://doi.org/10.1109/ICCMS.2010.487

[16] H. Kumar, N. Kushwaha, New multicast routing protocols mobile adhoc networks, International journal of Engineering and Computer Science, vol. 6 issue 5, 2017

[17] https://www.researchgate.net/publication/267989987_Node_Selection_Based_on_Energy_Consumption_in_MANET

[18] Pariza Kamboj, Ashok. K. Sharma, Scalable And Robust Location Aware Multicast Algorithm (SRLAMA) For Manet, International Journal of Distributed and Parallel Systems (IJDPS) Vol.1, No.2, November 2010

[19] P. Dutta and A. Banerjee, "Fuzzy-controlled Power-aware Multicast Routing (FPMR) For Mobile Ad Hoc Networks", in Proceedings of the second International Conference on Computer, Communication, Control and Information Technology (C3IT – 2012), Procedia Technology, Volume 4, 2012, Pages 38-49, 2012.

[20] Carlos de Morais et al, "Multicast over wireless mobile ad hoc networks: present and future directions", IEEE Network, Jan/Feb,2003pp 52-59.

[21] Hong Tang, Fei Xue, Peng Huang. MP-MAODV: a MAODV-Based Multi-path Routing Algorithm.IFIP International Conference on Network and Parallel Computing. 2008, Page(s):296-301 https://doi.org/10.1109/NPC.2008.23

[22] V. Rishiwal, M. Yadav, S. Verma, S. K. Bajapai, Power Aware Routing in Ad Hoc Wireless Networks, Journal of Computer Science and Technology, vol. 9, no. 2, pp. 101-109, October 2009.

[23] Busola S. Olagbegi, Natarajan Meghanathan,A Review Of The Energy Efficient And Secure Multicast Routing Protocols For M obile Ad Hoc Net works, International journal on applications of graph theory in wireless ad hoc net works and sensor networks (GRAPH-HOC) Vol.2, No.2, June 2010.

[24] Brahimi, Z. and Saadi, K.A.(2004) Color Image Coding based on Embedded Wavelet Zerotree and Scalar Quantization, ICPR, 17TH International Conference on Pattern Recognition (ICPR'04), Vol. 1, Pp. 504-507.

[25] L. Xi, L. Zhang. "A Study of Fractal Image Compression Based on an Improved Genetic Algorithm," International Journal of Nonlinear Science, 2007, vol.3, no.2, pp. 116-124.

[26] Bin Wang, Sandeep K. S. Gupta, S-REMiT: A Distributed Algorithm for Source-based Energy Efficient Multicasting in Wireless Ad Hoc Net works, GLOBECOM 2003.

[27] V.K. Tiwari, A. K. Malviya, An energy-efficient multicast routing (EEMR) protocol in MANET, International Journal of Engineering and Computer Sc., vol. 5, issue 11, 2016. https://doi.org/10.18535/ijecs/v5i11.77

[28] S.-J. Lee et al., "A Performance Comparison Study of Ad hoc Wireless Multicast Protocols", Porc. INFOCOM 2000, Mar. 2000, pp 564-574.

[29] D. Arivudainambi, D. Rekha, Heuristic approach for broadcast scheduling problem in wireless networks, AEU – International Journal of Electronics and Communications (Elsevier), vol. 68 issue 6, 2014.
https://doi.org/10.1016/j.aeue.2013.12.009

[30] M.A. Rahman, S.M. Saleh, S.M. Huq, Intrusion Detection System For Wireless Ad Hoc Network Using Time Series Technique, vol. 162, no. 1,2017.