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Energy Efficient QoS Routing Protocol based on Genetic Algorithm in MANET

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Abstract- In mobile ad-hoc networks (MANETs), providing quality of service is more challenging than wired networks, because of multi hop communication, node connectivity and lack of central co-ordination. Mobile ad-hoc networks need sure distinctive characteristics which might cause difficulties providing QoS in such network. Coming up with of multi constrained QoS routing protocols remains troublesome. As a result of routing protocols must satisfy the numerous QoS metrics at a time. Genetic algorithm based routing protocol will give the solution for multi constrained QoS routing problem. In existing genetic algorithm based routing, achieving energy efficiency is the major drawback. To overcome this drawback, in this paper, we have proposed genetic algorithm based energy efficient QoS routing for MANET. Proposed GA based routing algorithm discovered the shortest path from source to destination, which can consumes less energy compare to existing algorithms. In this paper TCP,CBR and video sources are applied at a time then energy consumption of proposed algorithm is compared with existing normal GA based and AOMDV. Simulation results show that proposed algorithm consumes less energy towards given scenario. Simulations are performed in NS-2.

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GJCST-E Classification : C.2.2

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I. Introduction

a) MANET

A Mobile Ad hoc Network (MANET) consists of a collection of mobile nodes that are communicated in a multi-hop manner without any fixed infrastructure. Due to the characteristics like easy deployment and self-organizing capability, MANET has great potentials in many civil and military applications [1] [3].

MANETs have become an important medium of present day communication, and is easily deployable and infrastructure less. These networks are particularly suitable for emergency situations like warfare, floods and other disasters where infrastructure networks are not possible to operate [3]. In order to enable the data transfer, they communicate through single hop or through multiple hops with the help of intermediate nodes [9]. Nodes in MANETs are small radio devices with Limited computational capacity and memory. Routes are mostly multi-hop because of the limited radio propagation range [10]. In this regard multicasting protocol plays a critical role in the MANETs than uni cast protocols and are faced with the challenge of producing multi-hop routing under host mobility and band width constraint.

b) QoS Routing

Quality of Service (QoS) routing algorithms is different from the conventional routing algorithms. In QoS routing, the path from the source to the destination must satisfy the multiple constraints simultaneously (e.g., bandwidth, reliability, end-to-end delay, jitter and cost), while in conventional routing, routing decisions are made based only on a single metric [2]. The main purpose of QoS routing is to find a feasible path that has sufficient resources to satisfy the constraints. A main problem in QoS routing is to find a path between the source and destination that satisfies two or more end-to-end QoS constraints [4]. In MANET, providing QoS is more challenging than in wired networks, mainly due to node mobility, multi hop communication, contention for channel access, and lack of central coordination [5] [6]. The basic function of QoS routing is to find a network path, which satisfies the given constraints and optimize the resource utilization [7]. The role of QoS routing strategy is to compute paths that are suitable for different type of traffic generated by various applications while maximizing the utilizations of network resources [8].

The important objectives of QoS routing are:

- To find a path from source to destination while satisfying user's requirements.
- To optimize the usage of the network resource.
- To degrade the network performance when unwanted things like congestion, path breaks appear in the network [8].

c) Energy Efficiency in MANET

The two important characteristics of multi-hop wireless networks are:

- Available battery power on the constituent lightweight mobile nodes (such as sensor nodes or smart phones) is quite limited.
- Communication costs (in terms of requirement of transmission energy) are much higher than computing costs (on individual devices).

The insufficient lifetime of battery imposes a limitation on the network performance. To take the complete advantage of lifetime of nodes, traffic should be routed to minimize the energy consumption [5].

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Energy-aware routing protocols for such networks usually select routes that minimize the total transmission power. When the transmission power is fixed, each link has the same cost and the minimum hop path is selected. When the transmission power can vary with the link, as the link cost is higher for longer hops, the energy-aware routing algorithms select a path with large number of small-distance hops [6].

II. Literature Review

Jinhua Zhu and Xin Wang [11] have proposed an accurate analytical model to track the energy consumption. Then, they proposed a simple energy-efficient routing scheme called PEER to improve the performance of the routing protocol during route discovery and in mobility scenarios. Simulation results have indicated that PEER protocol reduces path discovery overhead and delay up to 2/3, and transmission energy consumption about 50 percent.

Gabriel Ioan Ivascu et al [14] have presented a new approach called Quality of Service Mobile Routing Backbone over AODV (QMRB-AODV) for supporting QoS using a mobile routing backbone to dynamically distribute the traffic and to select the route that can support the best QoS connection. Nodes in real-life MANET are heterogeneous and have different characteristics. Based on these characteristics, their solution classifies nodes as either QoS routing nodes, simple routing nodes that route the packets through the network without providing special service provisions or transceiver nodes, that send and receive the packets but cannot relay them. Simulation result shows that QMRB-AODV gives the best result in terms of packet delivery ratio and bandwidth utilization. The drawback of this paper is that this protocol cannot perform well when the number of route requests increased. Since it increases the average queuing time for packets, which leads to higher end-to-end delay.

In [13], a GA based QoS routing algorithm is proposed for solving the MCP problem. It is able to produce multiple feasible paths, which makes the algorithm more robust when the actual state information in the network changes. In GA, multiple feasible paths can be created by iterating the algorithm until multiple feasible paths are found. This process increases the success of finding feasible path that can fulfill the QoS requirement.
The drawbacks of this paper are:
Increase in end-to-end delay in the network.

- Lack of energy efficiency constraints.
- Less efficient utilization of bandwidth.
- Decrease in packet delivery ratio.

In [12], the minimum bandwidth, end-to-end delay and connectivity metrics are considered for fitness function. But, it does not consider the energy efficiency. Then various constraints like end-to-end delay, available bandwidth, and node connectivity index and resource availability are combined into a single constraint. In GA based routing algorithm, the fitness function is modified by incorporating the combined metric in such a way that it satisfies the set of QoS requirement. In this, we have given the preference for dynamic aspects of node while determining its performance in the network.

By implementing this method, we are minimizing the QoS values on links from source to destination and increasing the possibility for the path to satisfy the given QoS requirement and hence we can overcome the MCP problem.

III. Proposed Solution

Initially, a minimum energy shortest path is discovered. Several paths may exist between the source and the destination. Among them, the minimum energy shortest path (energy-efficient) is selected using this method.

For example, in an 802.11 network, the energy consumption by the RTS,CTS and Ack packets accounts for a significant part of the total energy consumption without considering such energy consumption, these protocols may tried to used a larger number of intermediate nodes. These resulting in more energy consumption, a lower throughput and /or a higher end to end packet error rate.

To address the deficiencies of the existing approach, in this section more accurate energy consumption model is applied, which uses minimum energy routing scheme.

a) Determining Average Power For Transmission

There are two types of MAC schemes in IEEE 802.11: Distributed Coordination Function (DCF) and Point Coordination Function (PCF). In our proposed protocol we will implement DCF as PCF is a centralized protocol.

DCF is actually based on Carrier Sensing Multiple Access with Collision Avoidance (CSMA/CA) mechanism that consists of two carriers sensing schemes: physical carrier sensing and virtual carrier sensing. The virtual carrier sensing scheme is implemented along with Network Allocation Vector (NAV). If a node receives a packet (such as RTS, CTS, and DATA packet) it updates NAV along with the duration included in the received packet. The NAV value indicates while the on-going transmission session ends. When a node wants to send data packet to another node, it first checks its NAV. If the NAV is larger than 0, it has to wait till NAV reaches 0. After this only, sender transmits RTS packet when the channel is available for a period greater than DCF InterFrame Space (DIFS) or when the backoff timer reaches zero. The receiver responds along with a CTS packet after receiving The RTS packet. After receiving the CTS, sender sends out the data packet and receiver reply with ack packet after receiving the data packet successfully. If the sender doesn't receive the ACK packet within the time defined, the entire process is repeated again.

Based on the above defined DCF protocol, the total power required for transmission can be estimated as follows:

Notations Used:

N	data size
N_{hdr}	802.11 header size
N_{rts}	RTS packet size
N_{cts}	CTS packet size
N_{ack}	ACK packet size
N_{phy}	size of physical layer overhead
$P_{,r,i,j}$	packet error rate of RTS packet
$P_{c,i,j}$	packet error rate of CTS packet
$P_{i,j}$	packet error rate of DATA packet
$P_{a,j,i}$	packet error rate of ACK packet

The total transmission power PT required to transmit a packet from node i to node j is given by

$$P_T(i,j)=\frac{P_m(N_r+N_c p_{r,i,j})}{p_{r,i,j}p_{c,j,i}p_{i,j}p_{a,j,i}}+\frac{P_{i,j}N_K+P_{j,i}N_a p_{i,j}}{p_{i,j}p_{a,j,i}} \quad (1) \quad [11]$$

Average total receiving power PR to receive a packet from node i to node j is given by

$$P_R(i,j)=\frac{\frac{N_r}{N_K}+\left(\frac{N_c}{N_K}+p_{i,j}+\frac{N_a}{N_K}p_{i,j}p_{a,i,j}\right)p_{c,i,j}}{p_{c,i,j}p_{i,j}p_{a,i,j}} \quad (2) \quad [11]$$

where $N_K = N + N_{hdr} + N_{phy}$

$N_r = N_{rts} + N_{phy}$

$N_c = N_{cts} + N_{phy}$

$N_a = N_{ack} + N_{phy}$

Here the network considers the transmission power PT and receiving power PR to estimate the link cost in the network. We assume that there are I-1 intermediate nodes between source and destination. Also the nodes along the path from source to destination are numbered from 0 to I.

Then, the total power required for reliable transmission along the path from source to destination is given by

$$P_m=\sum_{i=0}^{I-1}P_T\big((i,i+1)+P_R(i,i+1)\big) \quad (3) \quad [11]$$

b) Minimum Energy Shortest Route Discovery Process

Using the minimum energy shortest route discovery process, multi-route is selected. The main route is selected based on the QoS metric. The combined QoS constraint consists of end-to-end delay, bandwidth, packet loss rate, and node connectivity index (Ni) and dynamic resources availability. In this paper, we present simulation results only for energy consumption for TCP, CBR and video sources.

Proposed Genetic algorithm based energy efficient routing protocol (GAEEQR) discovered the optimized energy route from source to destination.

IV. Simulation Results

a) Simulation Model and Parameters

The Network Simulator (NS2) [16] is used to simulate the proposed architecture. In the simulation, the mobile nodes move in a 1250 m x 1250 m region for 50 seconds of simulation time. All available nodes have the same transmission range of 250 meters. The traffic used for simulation is Constant Bit Rate (CBR), Video and TCP.

The parameters used for simulation are summarized in table.

Table 1 : SIMULATION PARAMETERS

No. of Nodes	30,50,70,90 and 110
Area Size	1250 X 1250
Mac	IEEE 802.11
Transmission Range	250m
Simulation Time	50 sec
Traffic Source	CBR,Video and TCP
Packet Size	512
Routing Protocol	AOMDV,GA,GAEEQR
Speed	10,20,30,40 and 50m/s
Rate	50,100,150,200 and 250kb
Initial Energy	10.3 J
Transmission Power	0.660
Receiving power	0.395

The proposed Genetic Algorithm based QoS Routing is compared with the GA based QoS Routing technique [13] and AOMDV. The performance is evaluated mainly, energy consumption between the source and destination.

b) Results

Simulation experiments were conducted by varying

- Nodes
- Speed
- Rate

i. *Based on Nodes*

In this simulation experiment, we may vary the number of nodes as 30, 50, 70, 90 and 110.

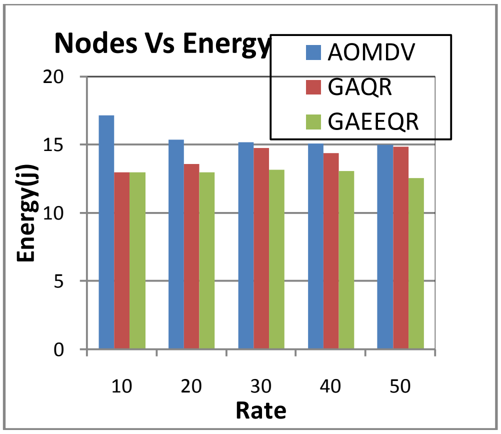

Figure 1 : Nodes Vs Energy consumption

Fig1 shows the energy consumption of all the 3 protocols for different number of nodes scenario. We can observe that the energy consumption of GAEEQR is 7% less than GAQR and 17% less than AOMDV.

ii. *Based on Speed*

In this experiment, we may vary the mobile speed as 10, 20, 30, 40 and 50 m/s

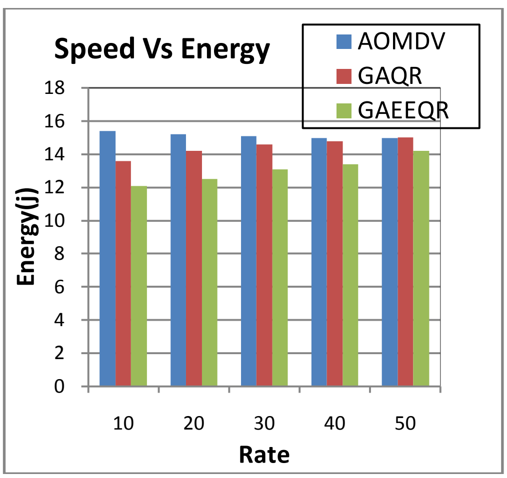

Figure 2 : Speed Vs Energy Consumption

Fig 2 shows the energy consumption of all the 3 protocols for different speed scenario. We can observe that the energy consumption of GAEEQR approach is 6.4% less than GAQR and 12% less than AOMDV.

iii. *Based on Rate*

In this experiment, by varying the rate as 50,100,150,200 and 250kbits then Energy consumption has calculated for three algorithms.

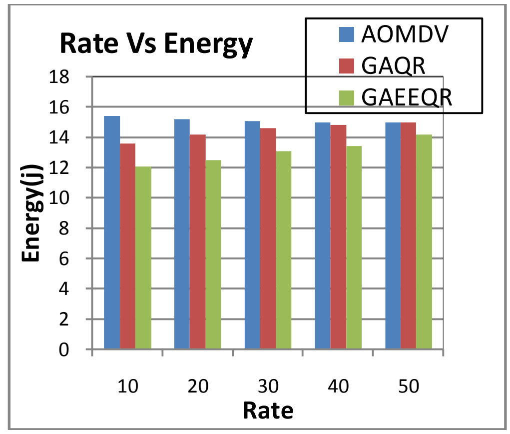

Figure 3 : Rate Vs Energy consumption

Fig 3 shows the Energy consumption of GAEEQR, GAQR and AOMDV protocols for different rates scenario. By observing above scenario it can conclude that, GAEEQR algorithm is giving better results, means it can consume less energy than AOMDV and GAQR.

V. Conclusion

In this paper, we have proposed GA based Energy Efficient QoS routing and Optimization Protocol in MANET. There are several paths between the source and destination, among them, the minimum energy shortest path (energy-efficient) is selected. Using the Minimum Energy Shortest Route Discovery Process, multiple routes are selected. The main route is selected based on the QoS metric. By observing above simulation results, it is conclude that,the proposed GA based energy efficient QoS routing protocol consumes less energy compare to existing GA based algorithm and AOMDV.

References Références Referencias

1. Wendong Xiao, Boon Hee Soong, Choi Look Law, Yong Liang Guan, “QoS Routing Protocol for Ad Hoc Networks with Mobile Backbones”, 2005.
2. Zhenjiang Li • J.J. Garcia-Luna-Aceves, “Finding multi-constrained feasible paths by using depth-first search”, July 2006.
3. Vinod Kone and Sukumar Nandi, “QoS Constrained Adaptive Routing Protocol For Mobile Adhoc Networks”, 2006.
4. R. Asokan, A. M. Natarajan and A. Nivetha, “A Swarm-based Distance Vector Routing to Support Multiple Quality of Service (QoS) Metrics in Mobile Adhoc Networks”, 2007.
5. LAJOS HANZO, RAHIM TAFAZOLLI, “A SURVEY OF QOS ROUTING SOLUTIONS FOR MOBILE AD HOC NETWORKS”, 2007.
6. L. Hanzo, R. Tafazolli, “A Survey of QoS Routing Solutions for Mobile Ad hoc Networks”, 2007.

7. Saida Ziane, Abdelhamid Mellouk, "AMDR: A Reinforcement Adaptive Mean Delay Routing Algorithm for MANET", 2007.
8. P. Deepalakshmi, Dr. S. Radhakrishnan, "Ant Colony Based QoS Routing Algorithm For Mobile Ad Hoc Networks", May 2009.
9. G. Santhi and Alamelu Nachiappan, "A SURVEY OF QOS ROUTING PROTOCOLS FOR MOBILE AD HOC NETWORKS", August 2010.
10. D.S. Thenmozhi, Dr. R. Lakshmipathi, " Highly Ensured QOS Routing in Mobile Ad Hoc Networks Based on Multiple Constraints", October 2010.
11. inhua Zhu and Xin Wang," Model and Protocol for Energy-Efficient Routing over Mobile Ad Hoc Networks", IEEE TRANSACTIONS ON MOBILE COMPUTING, VOL. 10, NO. 11, NOVEMBER 2011.
12. Jiwa Abdullah, M. Y. Ismail, N. A. Cholan, S. A. Hamnzah, "GA-based QoS route Selection Algorithm for Mobile Ad-Hoc Networ:ks", Proceedings of IEEE 2008 6th National Conference on Telecommunication Technologies and IEEE 2008 2nd Malaysia Conference on Photonlis, 26-27 August 2008, Prjaya, Malaysia .
13. Salman Yussof, Ong Hang See, "A Robust GA-based QoS Routing Algorithm for Solving Multi-constrained Path Problem", JOURNAL OF COMPUTERS, VOL. 5, NO. 9, SEPTEMBER 2010.
14. Ivascu, Gabriel Ioan, Samuel Pierre, and Alejandro Quintero. "QoS routing with traffic distribution in mobile ad hoc networks" Computer Communications 32.2 (2009): 305-316.
15. Floriano De Rango, Francesca Guerriero and Peppino Fazio," Link-Stability and Energy aware Routing Protocol in Distributed Wireless Networks", IEEE TRANSACTIONS ON PARALLEL AND DISTRIBUTED SYSTEMS, 2012.
16. Network simulator: ///http:www.isi.edu/nsnam

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