Experimental Analysis on Joint Optimal Data Rate and Power Allocation in Lossy Mobile Ad Hoc Networks

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ABSTRACT

In this paper, we consider lossy mobile ad hoc networks where the data rate of a given flow becomes lower and lower along its routing path. One of the main challenges in lossy mobile ad hoc networks is how to achieve the conflicting goal of increased network utility and reduced power consumption, while without following the instantaneous state of a fading channel. To address this problem, we propose a cross-layer rate-effective network utility maximization (RENUM) framework by taking into account the lossy nature of wireless links and the constraints of rate outage probability and average delay. We then present a distributed joint transmission rate, link power and average delay control algorithm, in which explicit broadcast message passing is required for power allocation algorithm. Motivated by the desire of power control devoid of message passing, we give a near-optimal power-allocation scheme that makes use of autonomous SINR measurements at each link and enjoys a fast convergence rate. Furthermore, we conduct extensive network-wide simulations in NS-2 simulator to evaluate the performance of the algorithm in terms of throughput, delay, packet delivery ratio and fairness.

Keywords: Mobile computing, Congestion control, Cross layer Optimization, Outage probability, Power control.

1. INTRODUCTION

A Mobile Ad-hoc Network (MANET) is a self-configured network of mobile terminals connected by wireless links. Mobile terminals such as cell phones, portable gaming devices, personal digital assistants, (PDAs) and tablets all have wireless networking capabilities. By participating in MANETs, these terminals may reach the Internet when they are not in the range of Wi-Fi access points or cellular base stations, or communicate with each other when no networking infrastructure is available. MANETs can also be utilized in the disaster rescue and recovery. One primary issue with continuous participation in MANETs is the network lifetime, because the aforementioned wireless terminals are battery powered, and energy is a scarce resource. Cooperative communication (CC) is a promising technique for conserving the energy consumption in MANETs. The broadcast nature of the wireless medium (the so-called wireless broadcast advantage) is exploited in cooperative fashion.

A distributed CMAC protocol has been proposed to improve the lifetime of wireless sensor networks, but it is based on the assumption that every node can connect to the base station within one hop, which is impractical for most applications.

There are two types of wireless mobile networks at present. These networks can be categorized into two architecture classes with different operation mechanisms and related issues. One type is infrastructured wireless networks, in which there are fixed wireless gateways that connect the mobile systems with a wired network. Typical applications of such networks are the cellular phone networks and the wireless local area networks (WLANs). The gateways in the cellular phone systems are known as base stations, and the infrastructure in a WLAN are called the access points (APs). The networks with infrastructure are suitable for locations where base stations are present or can be easily placed. An advantage of this type of networks is that the existing wired networks can be employed to support access from mobile users without modifications to the networks' control structure. A disadvantage of these networks is that the fixed infrastructure would constrain node mobility, limit network deploy ability, and increase installation and management costs of the networks.

There are generally two types of MANETs: closed and open [62]. In a closed MANET, all mobile nodes cooperate with each other toward a common goal, such as emergency search/rescue or military and law enforcement operations. In an open MANET, different mobile nodes with different goals share their resources in order to ensure global connectivity. No matter which type of MANETs is used, an ad hoc network can work properly only if the participating nodes cooperate in a proper way.

2. LITERATURE REVIEW

The F. Alizadeh-Shabdiz and S. Subramaniam.,[1],proposed that MAC layer is a challenging exercise due to the fact that the behavior of a node is dependent not only on its neighbors' behavior, but also on the behavior of other unseen nodes.

C. Perkins et al., [2], proposed that an ad hoc network is the cooperative engagement of a collection of mobile nodes without the required intervention of any centralized access point or existing infrastructure.

D. Johnson et al., [3], proposed a Dynamic Source Routing (DSR) protocol for wireless mesh networks. It is similar to AODV in that it forms a route on-demand when a transmitting computer requests one. However, it uses source routing instead of relying on the routing table at each intermediate device. Determining source routes requires accumulating the address of each device between the source and destination during route discovery.

Z. Hass et al., [4], proposed the gossiping-based approach, in which each node forwards a message with some probability, to reduce the overhead of the routing protocols. Gossiping exhibits bimodal behavior in sufficiently large networks. In some executions, the gossip dies out quickly and hardly any node gets the message. In the remaining executions, a substantial fraction of the nodes gets the message. The fraction of executions in which most nodes get the message depends on the gossiping probability and the topology of the network. For large networks, the simple gossiping protocol uses up to 35% fewer messages than flooding, with improved performance.

Abdulai et al., [5], proposed a Dynamic Probabilistic Route Discovery (DPR) scheme based on neighbour coverage. In this approach, each node determines the forwarding probability according to the number of its neighbours and the set of neighbours which are covered by the previous broadcast. The DPR scheme prioritizes the routing operation at each node with respect to different network parameters such as the number of duplicated packets, and local and global network density.

Xin Ming Zhang and et al., [6], suggested that the initial motivation of the system is to optimize broadcasting. For optimization of broadcasting in route discovery, many methods have been introduced.

3. DISCUSSION

We consider lossy mobile ad hoc networks where the data rate of a given flow becomes lower and lower along its routing path. Furthermore, we conduct extensive network-wide simulations in NS-2 simulator to evaluate the performance of the algorithm in terms of throughput, delay, packet delivery ratio and fairness.

NCPR (Neighbor Coverage Based Probabilistic Routing Protocol): The main aim of probabilistic rebroadcast protocol based on neighbor coverage is to reduce the routing overhead and improve the routing performance in MANETs. This approach combines the advantage of probabilistic method and neighbor knowledge method which can solve the broadcast storm problem. Algorithm of NCPR Assumptions: Ai is intermediate node, s is Source node, E(s) is the neighbour set of node s, RREQs is the route request packet received from node s, Rs.id is unique identifier of route request, U(s, i) is Uncovered Neighbour Set of node s for RREQ whose id is i and Timer(s,i) is timer of node s whose id is i. In NCPR Protocol, when source node sends different RREQ need uncovered neighbour set and Timer.

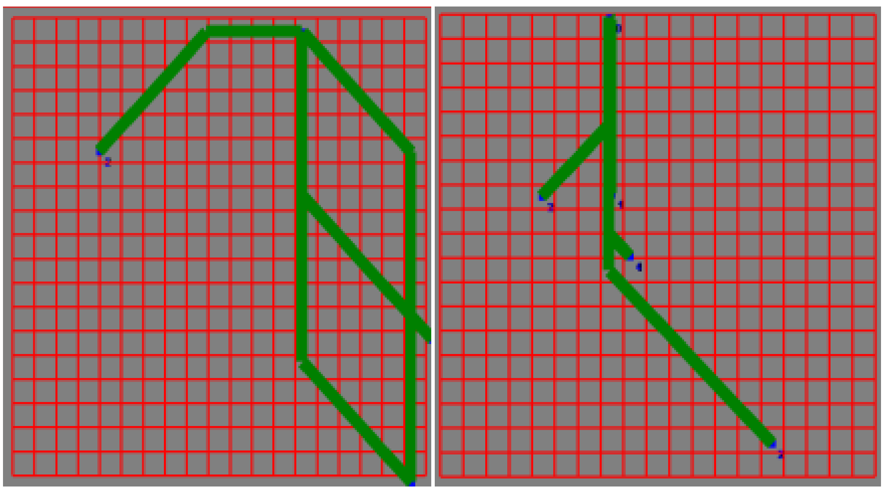
Step 1: If Ai received new RREQs from s then
Step 2: Calculate initial uncovered neighbour set U(Ai, Rs.ID) for RREQs
Step 3: Compute the Rebroadcast Delay i.e. Td(Ai)
Step 4: Set a Timer (Ai, Rs.ID) according to T(Ai)
Step 5: end if
Step 6: if Ni received new RREQs from S then repeat from step 2 to step 4
Step 7: While Ai receives a duplicate RREQm from node Am before Timer (Ai, Rs.ID) expires do…
Step 8: Adjust U (Ai, Rs.ID)

Step 9: Discard (RREQm)
Step 10: Repeat step 7 to 9 until Timer expired
Step 11: end while other node received a duplicate RREQ message repeat step 7 to 9
Step 12: If Timer (Ai, Rs.ID) expires then
Step 13: calculate Rebroadcast Probability P(Ai)
Step 14: Check random probability <=P(Ai)
Step 15: If Yes Broadcast (RREQs)
Step 16: Else Discard (RREQs)
Step 17: Repeat until it reach to Destination.

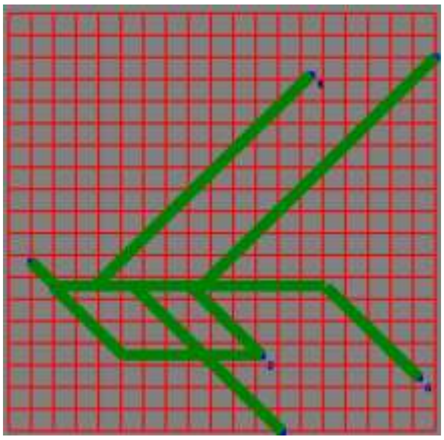
When source node send RREQ packet to intermediate node it check whether it receive RREQ packet first time then calculate initial UCN set i.e Uncovered neighbor set by comparing neighbor list of itself with previous node neighbor list. After that calculate rebroadcast delay to determine forwarding order, set timer according to rebroadcast delay. Due to characteristics of broadcasting RREQ packet node can receive the duplicate RREQ packet from its neighbor node could adjust the uncovered neighbor set until timer expired. As time expired with the help of finial UCN set it calculates rebroadcast probability by multiplying the additional coverage ratio and connectivity factor. This rebroadcast probability decide whether to rebroadcast the packet or not. As compare to flooding NCPR protocol generate less redundant rebroadcast and because of this protocol mitigates the network collision and contention, so as to decrease the average end to end delay and increase packet delivery ratio. Although the protocol increases the RREQ packet size, it reduces the number of RREQ packet more significantly.

Probabilistic Broadcasting Based on Coverage Area and Neighbor Confirmation: This approach combines the advantage of probabilistic and area based method. In probabilistic method depend on predefined fixed probability to determined whether to rebroadcast the packet or not but the problem is that how to set rebroadcast probability. As the values of all nodes are same so it is critical to identify and categorise the node in the various regions and appropriately adjust their rebroadcasting probability. So we can dynamically determine the rebroadcasting probability. By using dynamic probabilistic broadcasting based on coverage area and neighbour confirmation in that coverage area is used to adjust the rebroadcasting probability and by using neighbour confirmation confirm that all neighbour received the broadcast packet if some are not received forward packet to that node and determine the suitable probability. For this author used three steps to determine or adjust the rebroadcasting probability. Shadowing effect help to reduce number of rebroadcast packet. Each node is choosing different probability according to its distance from the sender. As mobile node are closer to the sender or distance from the sender are less than the retransmission probability are set low and if mobile node are far from the sender than retransmission probability of that node is set high. It is better for the node that is far away from the sender because it may potentially act as relay node on behalf of node closer to the sender. Based on shadowing effect we determine rebroadcast probability by calculating it coverage ratio and connectivity parameter. As distance between sender and node increase coverage area is also increase. As coverage area is directly proportional to distance from sender to node rebroadcast probability should be consider according to their coverage area. After determining the coverage ratio and adjust rebroadcasting probability we should confirmed that all neighbour should received the RREQ packet. If some of them not received RREQ packet its rebroadcast the packet.

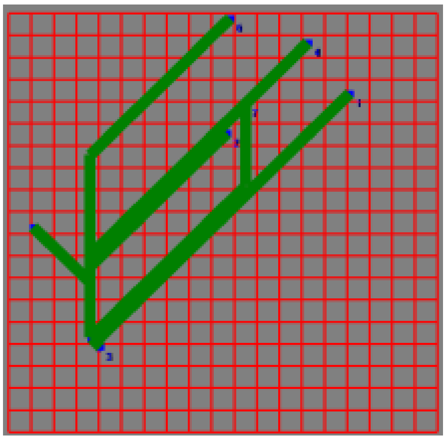
4. RESULTS



(a) (b)



(c)



(d)

Figure 1: Screenshots of simulator

Table 1: Power Allocation and Loss based on Probabilistic Broadcasting Approach

Nodes	Source	Destination	No of Data	Threshold	Loss
4	1	4	5	150	3
5	1	5	7	150	7
6	1	6	6	150	2
7	1	7	5	150	2

CONCLUSION

The routing overhead in MANET by introducing probabilistic rebroadcast mechanism based on neighbor coverage knowledge which includes additional coverage ratio and connective factor. Consider lossy mobile ad hoc networks where the data rate of a given flow becomes lower and lower along its routing path. Because of less redundant rebroadcast, the proposed work will mitigate the network collision and contention; this will increase the packet delivery ratio and reduce the average end to end delay. Although the network is in high density or the traffic is heavily loaded, the proposed work will have good performance.

Further work is required to address various properties of MARS and E-MARS. Currently, the basic MARS and E-MARS require a predetermined timeout value τ at the destination for misbehavior detection.

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