Energy Efficient and QoS sensitive Routing Protocol for Ad Hoc Networks

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Abstract. Efficient routing is an important part of wireless ad hoc networks. Since in ad hoc networks we have limited resources, there are many limitations like bandwidth, battery consumption, and processing cycle etc. Reliability is also necessary since there is no allowance for invalid or incomplete information (and expired data is useless). There are various protocols that perform routing by considering one parameter but ignoring other parameters. In this paper we present a protocol that finds route on the basis of bandwidth, energy and mobility of the nodes participating in the communication.

Index Terms: Adhoc Networks, Reactive Routing, QoS Routing, Bandwidth Reservation, FPGA

1. Introduction

Although MANET provides information through unguided media, there is no mandatory organized communication needed. They can be deployed anywhere at any time. The mobile nodes in MANET are self cooperating and they act as a router. Since the topology in MANET changes frequently due to the mobile nature of the node, the traditional protocols of routing are not efficient. Routing Protocols can be classified into two main types Proactive and Reactive.

Proactive protocols share network topology information and monitor the topology changes. Reactive protocols are on-demand routing protocols that find a route when it is necessary and save the route information for future use.

As WAN requires efficient battery power utilization, our designed protocol can be very useful in these scenarios, due to the overhead produced by the control packets. If it is required that there is no motion among devices, spontaneous protocols can be exercised. Using Hybrid protocol nodes can change their behaviour from reactive to proactive and the other way round, to save their battery power and to tackle mobility.
One feature of the practical routing protocol is that they transmit the information uniformly in order to check updates in the topology if any occurs and that information can be used for successful transmission with low delay. This type of routing protocol can have two types. The position of nodes plays very vital role to maintain topology, as nodes are mobile therefore there is strong need to send information to every mobile node including position of the other nodes and for that principle a lot of battery will be required. This high requirement of the battery is the one of the drawback of the pro-active protocols.

Therefore, to resolve the above issue, we need other routing protocols which can use the battery more effectively. Spontaneous protocols (Reactive) is one approach to solve the above mentioned problem, it connects the nodes only at the time of the requirement (or when we say there is data to send between the nodes by using any procedure contact between nodes). On one hand, the issue of battery life is solved, because now no connection is made when nodes have no information to send. But, on the other hand this practice has one drawback in cases where the network contains more than one hop. When there are two or more devices entertained in any network using spontaneous protocol, they should be able to create link between several nodes at the time of demand else searching for link could be the reason to effect the overall bandwidth as well as battery power.

2. RELATED WORK

[1] Cross layer optimization between MAC and network layer for routing. For a given path between a source and a destination, each intermediate node computes a new maximum number of transmissions based on a specific algorithm [1]. This parameter can be adjusted easily by each node. Using this new routing, we achieve a better average delay (resp. throughput) for each connection without changing the average throughput (resp. delay). In extreme cases, a reset technique is introduced to optimize performances [1].

The two layers are clearly separated. Attempting the channel begins by choosing the queue from which a packet must be selected. And then, this packet is moved from the corresponding queue from the network layer to the MAC layer where it will be transmitted and retransmitted, if needed, until its success or drop. In this manner, when a packet is in the MAC layer, it is itself attempted successively until it is removed from the node [1].

[2] In this paper writers have designed a protocol to increase the power efficiency. That protocol is the combined approach of both spontaneous (Re-active) protocol and practical (Pro-active) protocol. Based on the destination point, portable nature of nodes and remaining power, issue of battery life is solved. The author has focused on one protocol that is the ODMRP (ON-Demand Multicast Routing Protocol), which helped to know the spontaneous activities among the nodes that are necessary to create the links. The above mentioned protocol is the onward approach of the OLSR, in which every node has the authority to calculate its remaining power, remaining energy and mobile behavior. In the ODMRP, it is required to report to the beside node about any changing in the topology for that reason broadcasting is used.

[3] ORRP finds the shortest path without broadcasting the control packets by sending initiated protocol it assumes that at any given instance, any node in the network maintains a list of its neighbors and also stores the cost vectors to reach the neighboring nodes from the node [3]. Any change in the topology including deletion of a host or a link must be communicated to the neighboring nodes by an algorithm [3]. The procedure update assumes that each node maintains a list of neighbors. A cost vector stores the costs of reaching the members of [3] it stores the cost of reaching node from N.
To reduce the effect of interference, the low connection obstruction between transmitter and receiver can be used. In this paper the term average connection obstruction is utilized, instead of the low or high connection obstruction, because these both terms can change the actual measurement. The protocol designed in this paper is the ALIR, it calculates the obstruction between the nodes and attempt to sort out the reason behind it. After the specific mechanism applied finally it is possible to find the average obstruction between transmitter and receiver. The RRP namely route reply packet is send from source to destination that is helpful to find the actual information about the interference in the connection. When the destination receives this RRP, based upon this packet it is easy to find the average connection obstruction. This information can be used to update the routing table in which the path between sources to destinations is included. The nodes in between transmitter and receiver will also revise their required tables in order to forward the data to the proper destination.

This paper is based on the departed node issue or in another wording when destination is not available, to solve this issue without wasting efficiency of the routing protocols. The several topologies and problems geographic location service and greedy base algorithm solve the problem of dead end problem for wireless routing topologies by following a mechanism and create optimal connection between devices that is selected randomly using selection algorithm. For that purpose there is requirement of the to share the node ids and broadcast the initial packet but by following above mechanism we would have greedy routing algorithm limitation dead end problem periodic adjustments of hop-id causes the duplications of hop-id.

In this paper IQRP (Interference aware QoS routing protocol) protocol is introduced. It optimizes the network resource utilization. The term ‘LAB’ is discussed in this paper, if the value of this term is higher on any node it means that node has the low interference and is known as the practicable for the communication in any connection between the source and destination. It has got application in the both one-hop and two-hop neighbor conditions.

3. PROTOCOL DESCRIPTION

In our protocols some nodes are in proactive state and rests are in reactive state. When a node change its state it broadcast STATE PACKET on the network nodes having the proactive state will listen these packets and reactive will discard these packets. A node on leaving a group will be broadcast QUIT PACKET on the network these packets will again discard by reactive nodes of the network. To join a network applicant node broadcast a JOIN PACKET only proactive node will reply to those packet by sending a ACK PACKET to the applicant node then applicant node broadcast its STATE PACKET on the network as describe above on the description. If a node changes its state more than 3 times in X seconds so the proactive nodes mark that node as bad node and stop listening the broadcast from the that particular state and start HOLD-DOWN TIMER till Y seconds after sending the timer proactive nodes start listening the packet from bad node by resetting the STATE TIMER.

- \( X = \frac{Z}{3} \) (X is STATE TIMER)
- \( Y = \frac{Z}{2} \) (Y is HOLD DOWN TIMER)

Where Z is the Convergence time of the network.

Mobility Consideration

In our propose mechanism if a node change its location so it sends the QUIT PACKET on the network and all the proactive node discard the entry of this node when the node covers its distance and wants to join the network so it sends the JOIN PACKET on the network and proactive node
reply with **ACK PACKET** and then the requested node broadcast it **STATE PACKET**. If a node changes its state more than 3 times in X seconds so the proactive nodes mark that node as bad node and stop listening the broadcast from that particular state and start **HOLD-DOWN TIMER** till Y seconds after sending the timer proactive nodes start listening the packet from bad node by resetting the **STATE TIMER**.

### 4. BANDWIDTH CONSIDERATION

The widest shortest path provided by Algorithm to provide the requested Bandwidth, all nodes whose local available bandwidth is smaller than the requested bandwidth and all nodes in the interference area of such transmitter nodes are temporarily removed from the one and two hops neighborhood and the topology table. [7]

**Proof:** We prove this property by induction on the path length. By construction, this property is true for a path length = 1 and also for 2. We assume that this property is true until rank n − 1 and we prove it at rank n. Let us consider the shortest path A0, A1, ..., An between A0 and An with n ≥ 2 meeting the bandwidth request Bf. It follows that the path A0, A1, ..., An−1 of length n − 1 is a shortest path between A0 and An−1 meeting the bandwidth request Bf. As the property is true at rank n − 1, Algorithm 1 provides the widest shortest path between A0 and An−1 meeting the bandwidth request Bf, let A0,A_1, ...,A_n−2,An−1 be this path. As An−1 is one-hop from An and An−1 is one-hop from An, A_n−2 is two-hop from An. Let A_n−1 be the MPR of An allowing to reach A_n−2 with the highest bandwidth. As An−1 allows to reach A_n−2 by a path meeting Bf, the MPR selected by An meets Bf. Algorithm will find the path A0,A_1, ...,A_n−2,A_n−1,An.[7] This path is a widest shortest path between A0 and An, meeting Bf. After calculating the best path the senders mark the 1 to the route and then look for the required Energy.

### 5. ENERGY CONSIDERATION

Before presenting the protocol specification for Energy, we describe the Pricing scheme since the choice of the pricing scheme determines the minimum amount of Information that must be communicated to the destination node (which is in charge of computing the payments). Any pricing scheme that achieves individual rationality, truthfulness, and energy efficiency and pays only the nodes in the winning path must be based on the VCG mechanism. When adapted to our setting, the VCG mechanism, which optimizes the socially desirable goal of energy competence, it contains the certain laws through which optimal path and other parameter are selected. Whereas c(p) represents the cost and S & D are just source and destination of the connection.

\[ c(P) = \sum_{i=0}^{n} I(s) \]

The terms MP and v represent the minimum path cost and successful connection respectively. And c(p^-v) is the cost between the source and destination. If there is no any successful connection it means then path and winning path will be low. The final payment for any successful connection can be found by using below equation

\[ pay(v) = c(P^-v) - c(MP) + I(v) \]

### 6. APPLICATION AND MOTIVATION

Assume a Network of multi mobile nodes some of them are in proactive state and rest of them are in reactive state. Proactive nodes maintain their routing table and reactive maintains on demand temporary routing table.

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**Figure 1**
In Figure 1 Node 4, 7, 2, 11, 8 are in reactive state and rests of them are in proactive state and maintain their routing table. Now we suppose the node 3 want to send the data to node 9 hence its a proactive node so its already maintain its routing table through above algorithm of Energy and Bandwidth and the table is maintain in (Figure 2). Node 3 has three different paths to sends data to node 9. Node 3 compute the costs of all three path by energy and Bandwidth mechanism and find out the route best between source to destination is 2, 1, 6.

If the selected path energy and Bandwidth is enough to send data over the network so the sender marks it 1 and sender forward the packet on the route which has the maximum cost. The cost of route will be calculated on the basis of 0 and 1 the best path will always be 2 by adding the bandwidth and Energy cost and the next best path will be 1 to transfer a packet on the network. Figure 2 is the routing table of a Node 3 which has the cost of 2 and the rest of path will be the backup route which will be use in case of failure of any node or mobility nature of any intermediate node. Reactive nodes also maintain the same type of temporary table but they will maintain this when the require (On demand Routing).

| Source | Destination | Intermediate | Bandwidth | Energy | Cost |
|--------|-------------|--------------|-----------|--------|------|
| 3      | 9           | 5, 4, 7, 6, 10 | 1         | 0      | 1    |
| 3      | 9           | 5, 8, 11, 10  | 1         | 1      | 2    |
| 3      | 9           | 2, 1, 6       | 1         | 1      | 2    |
| 3      | 4           | 2             | 1         | 1      | 2    |
| 3      | 7           | 2, 4          | 1         | 0      | 1    |

If any of intermediate, source or destination node change its state the transfer would not effect and if the node change its position so it will broadcast the quite message on the network and when it needs to join the network it sends the join request to the network and proactive nodes will reply to the requested nodes. Suppose node 8 is fake node and change its state continuously and sends state packet on the network so the proactive node waits till state timer X then declare this node as fake node and stop listening its broadcast will hold down timer Z. The computation of these timer has already been discussed in the paper.

7. ASSUMPTIONS

For implementing the protocols we have five nodes three of them are in reactive state and other two are in proactive state. Each link has the 1 MB of data transfer rate and each link utilize its whole bandwidth to transfer the data on the network with 10 microseconds of delay. Initially node 0, 1, 4 are communicating with node 2 and node 2 is communicating with node 3 and acting as a bridge for node 3 to communicate on the network though packets may be dropped with certain probability based on the configuration. This simple model enables us to abstract the impact of message loss on routing performance and allows us focus on how well the proposed routing mechanism performs. Following is simulation results of our proposed protocol are shown below (NAM View).
A. Simulation Results

Figure 3's simulation is the propose mechanism of our protocol, the mobile nodes are communicating with each other, node 0, node 1, and node 4 are transmitting their data to node 2, and because of convergence at node 2, all the data are in queue and after filling the queue, the remaining packets would be dropped at node 2, and in the meantime, node 2 is also communicating with node 3.

![Simulation Results](image)

Figure 4

The figure 4 shows the protocols performance as a function of the mobility speed. Figure 4 shows the packet latency along with elapsed time.

B. Benefits of Protocol

Our proposed protocol is capable of finding a path on the basis of energy, bandwidth, and mobility nature of nodes along with QoS by maintaining the alternative path of the destination.

8. CONCLUSION AND FUTURE WORK

In this paper, we have shown how to provide QoS routing on the basis of Energy, Bandwidth, and mobility nature of nodes and restrict the fake node on the network to avoid flooding. High computation of Energy and Bandwidth would drain the battery and increase delay produced by the network convergence. In large network, where we have a large number of nodes on the network, each proactive node has to maintain that much large routing table, and it would be possible after some time because of energy the proactive node change its state to reactive.

9. References

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