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Optimization of cooperation in wireless Ad-hoc Network

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Abstract: To enforce co-operation it is of utmost importance that there should be means to identify malicious, selfish and other nodes, so that it is known with whom to co-operate and not co-operate .As discussed previously there are many kinds of nodes in a network Co-operative network or co-operative communication is a promising technique to improve throughput, reduce power consumption and reduce the packet loss rate. J.P. Hubaux [5] was the first one to bring out the concept of co-operation in 2001.Wireless medium has a broadcast nature and this communication takes that advantage by overhearing the ongoing transmissions, in case of weak and unreliable wireless links.
Co-operative communication [7] can be applied in various networks like ad-hoc, mobile, sensor, mesh and the latest vehicular network [23] Co-operation is not just relaying or forwarding source's data but it has many other flavors too. Nodes like source and the relays can co-operate to forward the data together, they can co-operate in deciding the contention window size and can also co-operate in detecting and removing the attacker nodes. A fixed wireless network uses point co-ordinate function (PCF) and an ad hoc wireless network uses distributed coordinate function (DCF).

Keywords: Ad-hoc network, vehicular network, distributed co ordinate function (DCF), PCF.

Introduction

Once the misbehaving nodes are identified, the routes which pass through these nodes are rejected and other routes are considered for routing. There should be some stimulation mechanism which will encourage the nodes to co-operate and relay the traffic. So two approaches have been identified .One is the reputation based approach, and another is the credit based approach. One such credit based approach is applied by using models like Packet purse model and Packet trade model developed by L. Buttyan and J. P. Hubaux in [3].Here a currency is introduced called nuggets. The nodes that use the service has to pay for it in nuggets and the nodes that provide the service are remunerated. Hence nodes are motivated to increase their number of nuggets by relaying traffic i.e. by providing service to others. The nodes also no longer send useless messages because in that way they will lose their nuggets.

Another remuneration algorithm developed was Nuglet, a micro payment system. It does this through the use of a nuglet counter, which is incremented whenever nodes forward packets for others. Conversely, the nuglet counter is decremented when a node, sends out a packet. If required number of nuglets is not available then nodes cannot send out packets. Hence, nodes increase their counter values by forwarding packets. Also, the algorithm includes a battery counter, which is decremented whenever a node sends or receives a data packet. It represents the battery power that is left in the node as well the number of packets that a node can send out before its battery life runs out. Based on these counter values it decides whether to or not to relay packets.

Proposed Work

The cooperative communication approach promises improved throughput and delay performance by effective use of spatial diversity in wireless ad hoc networks. The CoopMAC I protocol proposed by Liu et al. picks either a direct path or a relay path based on rate comparison to enhance average throughput and delay performances. However, its performance deteriorates under fading conditions due to lower direct path or relay path reliability.

UtdMAC, which was proposed by Agarwal et al., performs better than CoopMAC I in terms of average throughput and delay performances due to improved transmission reliability provided by the backup relay path. Although it is better than CoopMAC I, UtdMAC does not fully benefit from higher throughput relay path (compared with the direct path) since it uses relay path only as a secondary backup path. In this paper, a new cooperative medium access control (MAC) protocol, which is termed the 2rcMAC protocol, is proposed for a small-sized network. The protocol makes use of two cooperating nodes to achieve superior throughput and delay performances, compared with the existing cooperative MAC protocols. The secondary relay path is invoked as a backup path for better transmission reliability

and higher throughput through the relay path. Moreover, handshaking and single-bit feedbacks resolve contentions among relay nodes in proximity at the time and further provide the source node with rate information on source-to-destination, source-to-relay, and relay-to-destination links. Performance gains achieved by the 2rcMAC protocol under fast-fading conditions over the existing cooperativeMAC protocols.

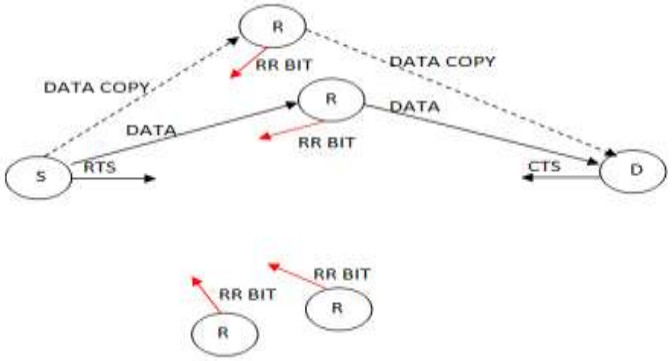

Figure 1: 2 relay Co-operative MAC

First the transmission takes place through the first relay. And for that duration the other neighbouring nodes update their NAV. It is expected that after the SIFS duration ACK is received. The second relay waits to overhear the response for 2 SIFS duration .If no response is received then it jumps in to resend the data. After data received successfully, an ACK is sent after SIFS duration. Hence the 2rc MAC protocol guarantees higher throughput and greater reliability.

Different kinds of nodes exist in the system like selfish, overloaded, misbehaving, or broken. A selfish node is not ready to spend his energy to provide service, but expects other nodes to provide service to it. An overloaded node does not have enough battery or network resources to relay traffic for others. Malicious nodes purposely drop packets and are unwilling to provide service. And a broken node may have a software fault in it. Various scheme and algorithms have been proposed to enhance co-operation in the network which have various kinds of nodes.

Many successful routing mechanisms have been developed. But just routing will not solve all the problems related to communication. Routing just provides the rules and the route that the nodes should follow. But there should be some motivation schemes like incentive scheme, remuneration schemes when they co –operate and punishment schemes when they do not. So if co-operation is included in the routing then it will result in efficient communication.

IEEE 802.11 physical layer, support multirate capability [1]. For example, IEEE 802.11a support data rates of 6, 9, 12, 18 …. 54Mbps and IEEE 802.11b support data rates of 1, 2, 5.5 and 11 Mbps. This multirate capability can be efficiently exploited at the MAC layer which is closest to the physical layer by introducing the new paradigm called co-operation. Co-operative transmission utilizes the indirect link between the source and the destination. This indirect link is via neighbour nodes called helpers or relay nodes. These relay nodes have a better link quality to both the sender and the receiver than the direct link between sender and he receiver. Hence they can be efficiently used to improve the transmission success rate.

Suppose station S1 wants to send data to station S2. The data rate of the link between S1 and S2 is 2 Mbps, which show that the link is weak. If there exists another station S3 neighbouring to both stations S1 and S2 and the data rates from S1 to S3 is 5.5 Mbps and from S3 to S2 is 11Mbps, which implies that the channel condition is much better than the direct link. Assume the length of the packet to be L. The delay observed in the path S1-S3-S2 would be ((1/5.5) + (1/11)) L ms .So the actual data rate would be (5.5*11) /(5.5+11) = 3.7 Mbps which is much better than 2 Mbps. So based on this a co-operative MAC protocol can be devised to improve the throughput and reduce the delay.

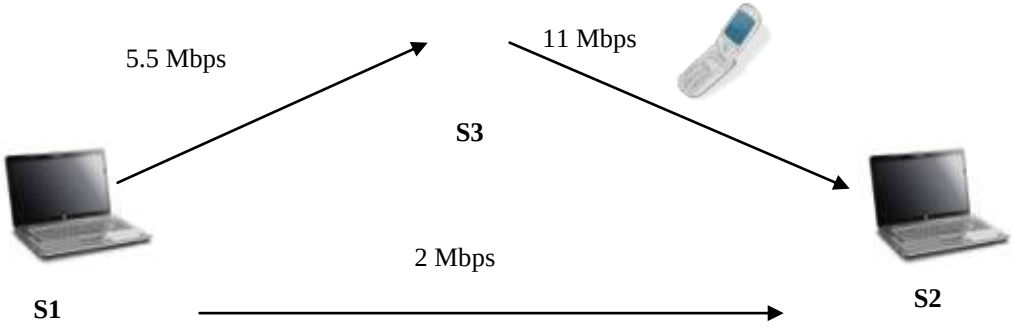

Figure 2: Co-operative Data Transmission

Results

In this research work MAC protocol will be modified which will be an extension to the existing two relay co-operative MAC [9] protocol. Here, two relays are used to transmit data between the source and the destination. One relay acts as a helper and the other relay acts as a backup which jumps in to transmit the data if ACK is not received or some failure in the transmission occurs due to interference or collision. The relays are high data rate nodes but may fail to transmit data due to interference or some other reasons. In HF-MAC protocol proposed, in order to choose the helper nodes, three parameters have been taken. First is the data rate between the source and relay and the relay and destination. Second is the relay reliability and the third is the energy left in the relay to transmit the source's data to the destination.

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