WiBi MAC: Biased Medium Access Control for WiFi

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ABSTRACT

In this paper, we present WiBi MAC, a biased Medium Access Control (MAC) protocol for WiFi. The standard medium access approach utilized by WiFi relies upon Carrier Sense Multiple Access with Collision Avoidance (CSMA/CA) combined with slotted Aloha. This approach achieves a fair packet access scheme that is similar to Processor Sharing (PS). Biased scheduling approaches, such as Shortest Remaining Processing Time (SRPT), have been shown to yield better throughput and faster expected completion times than PS in computer process scheduling. The WiBi MAC for Wifi approximates SRPT in order to achieve greater throughput and utilization of the wireless medium. WiBi MAC operates by having each node choose a maximum potential back off time that is proportional to the number of packets that are ready to send. By favoring packets belonging to short streams over packets belonging to longer streams, we achieve a simulated throughput improvement of XXXX over the standard fair exponential back off approach used by WiFi.

1. INTRODUCTION

Current WiFi MAC protocols are based on the network having a fair/equal chance for any node on thenetwork to send a packet they have ready to send. This approach is similar to a basic Processor Sharing algorithm. This paper discusses a different approach by testing different methods of biasing WiFi MAC protocols by using an algorithm similar to Shortest Remaining Processing Time (SRPT) to determine the maximum for a pckets Random back off. In addition we will be testing this apporach along with using the current frame number of the packet being sent as the maximum value for the back off, as well as a dynamic approach of varying the back off window based on the level of traffic in the network.

These approaches are looking to improve the through put of the network by looking to improve the mean time to complete the data streams from nodes in a network. This approach would prefer nodes that have shorter data streams being sent leadinging to a higher number of completed data streams over a period of time when compared to the current fair exponential back off approach used by WiFi.

The remainder of this paper is organized as follows. In Section 2 we review related work to medium access control. In Section 3 we discuss the results of the four different simulations: startard WiFi MAC, MAC protocol based on the SRPT algorithm, back off based on the current frame number in the stream, and lastly a dynamic back off window changed based on the traffi level in the network. Finally, we draw the relevant conclusions in Section 4.

2. RELATED WORK

So far, very little work has been done on the optimization of unfair Medium Access Protocols; most work has been done on solving the unfair MAC problem while reducing collisions. For wireless networks, a principle problem is the hidden terminal problem. In a wired network, it is possible to sense when another node is being sent, and a collision will occur [1]. In a wireless network, however, this cannot be done, resulting in the need for an alternative method of handling collisions [4]. Thus, wireless MAC protocols like Slotted-Aloha were created. In the Slotted Aloha Protocol, a node can only be sent at the beginning of a time slot [2]. This ensures that one node can finish sending before another one is sent, reducing the number of collisions. Under a network with a light load, this approach has a low chance of collision. However, collisions can still occur if two nodes are sent in the same timeslot. Under heavy loads, the probability that a node will be sent in the same timeslot as another node will increase. Most research into this problem is based on reducing collisions while keeping the distribution of sent nodes fair. An improvement on the Slotted Aloha Protocol is the Frameless ALOHA protocol, which uses a random access scheme to decide which nodes should be sent in which spot [8]. Another attempt at improving the Slotted-ALOHA protocol is the Generalized Slotted ALOHA protocol, in which nodes are sent according to their probability of being transmitted successfully. However, an issue with this protocol is that if every node is attempting to maximize its own transmission rate, then the network can jam. [7]. The Multiple Access with Collision Avoidance for Wireless (MACAW) protocol is one attempt at improving on the Slotted-Aloha Protocol and solving the hidden terminal and unfair MAC problems.

MACAW introduces fairness, in which every stream sent on the network is treated equally. This contrasts our proposal in that we create an optimal MAC protocol by prioritizing certain streams, thus creating an unfair MAC protocol that optimizes the network.

Most research done on unfair MAC protocols has been conducted on how to detect and prevent unfair behavior from a node on the network. Some has focused on merely detecting and blocking the misbehaving node, while others have suggested implementing a punishment of sorts on the misbehaving nodes. Ways that nodes can misbehave in order to increase their own performance is to refuse to forward packets in order to save energy, or to select a smaller backoff in order to increase throughput for their own traffic. These misbehaving nodes can seriously degrade the network throughput for other, well-behaved nodes. [5].

A similar task to creating an unfair MAC protocol that everyone follows is detecting when a single user, or a small group of users, is being unfair and the process of handling them. A few approaches to remediate unfair behavior have been to exclude the misbehaving node from routing operations, encourage nodes to cooperate by penalizing misbehavior, or to incentivise good behavior by paying nodes for cooperating. Another protocol detects unfair behavior by having a sender transmit an RTS (Request to Send) after waiting for a randomly selected number of slots in the range [0; CW].After the initial transmission between hosts, the recieving host sends with their acknowledgement: a random value that the sender then uses as the back off counter for each subsequent transmittion during the stream. [5] With this protocol, if a recieving node recieves a packet before the appropriate number of frames has passed, then the sending host is not obeying the Protocol and can then be handled accordingly.

Our purpose, however, is to prove that implementing an unfair protocol where network traffic is sent according to a certain priority will actually improve throughput for all nodes in the network. The proposed protocol will ideally also maintain its increased performance even when all nodes on the network are not operating under the same protocol.

3. ANALYSIS

4. CONCLUSIONS

5. REFERENCES

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