Biased Medium Access Control: Can a Biased Protocol be more Effecient than a Fair one?

CSE4344

Cameron A. Keith
Computer Science and Engineering Department
Southern Methodist University
Dallas, Texas USA
ckeith@smu.edu

Anna A. Carroll
Computer Science and Engineering Department
Southern Methodist University
Dallas, Texas USA
aacarroll@smu.edu

Dylan C. Fansler
Computer Science and Engineering Department
Southern Methodist University
Dallas, Texas USA
dfansler@smu.edu

Ethan Busbee
Computer Science and Engineering Department
Southern Methodist University
Dallas, Texas USA
ebusbee@smu.edu

ABSTRACT

Current Medium Access Control, MAC, Protocols are based on the premise that every device has an equal probability to transmit to their data across a network. This method attempts to reduce the collisions in the network by having all users who want to send a packet wait a random time interval between 0 and a minimum starting back-off, and increasing a particular senders minimun back-off each time their packet does not sent. This paper attempts to discover if a Wireless MAC protocol based off of using the current frame number as the upper bound of the random number function in an attempt to see if a biased priority can improve the average complete time of stream transmittion time accross a particuar network.

1. INTRODUCTION

Current MAC protocols for 802.11 use a variation of the ALOHA Protocol known as p-persistant CSMA/CA, or Carrier Sense Multiple Access with Collision Avoidance. In this protocol, once a node has assembled a message, it checks to see if the channel is idle. If not, the node waits a random backoff time before checking the channel again. Once the node is able to send through the channel, it transmits a RTS (request to send) frame to the destination node, and waits for a CTS (clear to send) frame from the destination node. If the CTS frame is not received, then the node waits a random backoff time and attempts to send again. If the CTS frame is received, the node transmits its message to its destination. With this approach, all frames are given an equal chance to transmit. However, in this protocol, the packet delay tends to increase with the amount of stations (or nodes) on the network. Instead of using a fair approach with respect to each device on the network, we plan to explore the possibility of using a biased treatment of frames in the networks to increase the overall efficiency of the network.

Most work on biased MAC protocols is focused on either acting unfairly in order to increase one node's network performance at the cost of the performance of the other nodes on the network, or is done on keeping a node acting unfairly from destroying the network and discouraging that node from acting unfairly any more. It is our hypothesis that a biased protocol can be created that will actually increase the performance of the network. We plan to do this by examining different ways of prioritizing network traffic according to packet size, type, or even the size of the file to be transmitted.

2. BACKGROUND

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 [3]. 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 [6]. 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. [5]. 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 per stream fairness, in which every stream sent on the network is treated equally. This contrasts our proposal in that we will attempt to create an optimal MAC protocol by prioritizing certain streams, thus creating an unfair MAC protocol that optimizes the network.

A similar task to creating an unfair MAC protocol that everyone follows is how can a network detect when a single user, or a small group of users is being unfair and the process of handling them. With this protocol a sender transmits an RTS (Request to Send) after waiting for a randomly selected number of slots in the range [0; CW].After the initial transmittion between hosts, the recieving host sends with their acknowledgement a random value that the sender then uses as the back off counter for each subsiquent transmittion during the stream. [4] With this protocol, if a recieving node recieves a packet before the approiate number of frames has passed then the sending host is not obeying the Protocol and can then be handled accordingly.

3. RESEARCH PLAN

The plan for determining the an optimal method of creating a MAC protocol that has a bias towards certain packets is to first create a succicent list of possible ways that a system can prefer one type of packet or packet stream over another. The list of possible ways a system can prefer a packet/stream from one source to a different source will be determinded by the various ways that exists MAC Protocols currently divide network access fairly between nodes, take ths information and determine how someone can unfairly divide the network. With this idea, the next step is to determine how to gauge the efficiency of this method compared to the fair method from which it was derived from as well as how it can be compared to other methods that differ from it. Once this has been done for the list of possible biases the next step is to create a paper representation of each method and run several short sample runs of the different methods to see how each run in comparison to the others. The top methods, exact number depends on how many different ideas are originally tested, will be translated in to a simulation of an actual network environment with a multitude of users and the results of each simulation compared to each other to find which method based off of the choosen effeciency ranking is most optimal to use.

The purpose of multiple possible ideas being moved forward in each phase of testing allows for a quick change in focus later in development as you no longer have to go back and spend time in the research phase becuase you move forward in each step of the process with the best of the last process to eventually reduce the number of testing Protocols to a single one which has been determined to be the most optimal by a set of standards which were also formulated during testing. This also allows a high degree of flexability with the project as the requirements that the different MAC protocols are being judged against can be modified to better reflect normal use of the Network, as well adapt as deeper knowledge of MAC Protocols.

4. WORK REMAINING/PROBLEMS ENCOUNTERED

Work remaining: Finish the base case Network simulation based on the current Wireless MAC protocol and establish the goal metric that the frame number based delay Protocol needs to match or beat in order to be considered a viable alternative to CSMA/CA. Create the frame number based delay protocol network simulation and gather the performace based on the metrics defined previously in the paper. Problems encountered so far: errors installing NS3 to personal computers giving missing dependancy errors, previous lack of a solid plan (one has been developed in attempts to increase group efficiency), a lack of understanding on how to create a network simulation (online tutorials/guides were of some help but was needing to go through multiple before finding all pieces needed, also unsure if the code is creating the correct network that we want to simulate). Also if it is possible would it be possible to meet with you some time with in the next two weeks to talk about how coding in NS3 works, that would save a fari amount of time as opposed to contiously search online for details we need to get basic functionality of the simulation running, and would be very helpful to us :D

5. REFERENCES

[1] B. Bensaou, Yu Wang, and Chi Chung Ko. Fair medium access in 802.11 based wireless ad-hoc networks. In *Mobile and Ad Hoc Networking and Computing, 2000. MobiHOC. 2000 First Annual Workshop on*, pages 99–106, 2000.

[2] Ajay Chandra V. Gummalla and John O. Limb. Wireless medium access control protocols. *Communications Surveys Tutorials, IEEE*, 3(2):2–15, Second 2000.

[3] Peijian Ju, Wei Song, and Dizhi Zhou. Survey on cooperative medium access control protocols. *Communications, IET*, 7(9):893–902, June 2013.

[4] Pradeep Kyasanur and Nitin H. Vaidya. Selfish mac layer misbehavior in wireless networks. *IEEE Transactions on Mobile Computing*, 4(5):502–516, 2005.

[5] R.T.B. Ma, V. Misra, and D. Rubenstein. An analysis of generalized slotted-aloha protocols. *Networking, IEEE/ACM Transactions on*, 17(3):936–949, June 2009.

[6] C. Stefanovic, P. Popovski, and D. Vukobratovic. Frameless aloha protocol for wireless networks. *Communications Letters, IEEE*, 16(12):2087–2090, December 2012.