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Advanced Approach for Collision Avoidance and Collision Detection

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Abstract - A technology named Carrier Sense Multiple Access with Collision Avoidance (CSMA/CA) is used to reduce collisions happened in a network. However, when network nodes increase, the contention window number may not be wide enough. It will cause collision probability to increase. We cannot avoid the chance of collision in a shared medium. This paper presenting an algorithm that tries to avoid collision and it also takes action if there is a collision exists. This single algorithm can be used for collision avoidance as well as collision detection. If any collision detected its retransmission policy can be used. It helps to reduce the waiting time of the stations for initiating transmission.

Keywords - **Aloha, CSMA/CA,CSMA/CD, Medium Access Control(MAC).**

1. Introduction

Random access methods are decentralized that means it do not have a arbitrator in the network. Consequently the random access method characterized by high probability of collision. A collision is happens when there is simultaneous attempt of frame transmission by several stations[1]. As the result of frame transmission signals from several transmitters overlap and information in all frame transmitted during collision time will be distorted.

Random access algorithm do not guarantee that a specific node will gain access to the shared medium within a specific time interval. No matter how large the chosen time value ,the probability of real waiting interval will exceed it is always greater than zero. Also random access algorithms do not provide any capabilities for differentiated quality of services (QoS) support different kinds of traffic. In any cases all frames have equal levels of access to the medium.

Every shared wireless communication channel needs a medium access control (MAC) protocol to arbitrate access to the channel. Over the past several decades, many MAC protocols have been designed and several are in operation in wireless networks today[4]

There are a lot of random access algorithms are used to reduce collisions, thus improve network performance. Examples of random access MAC protocols: Aloha, Slotted Aloha CSMA, CSMA/CA, CSMA/CD.

2. Random Access MAC Protocols

2.1 Pure Aloha

Pure Aloha is an unslotted, fully-decentralized protocol. It is extremely simple and trivial to implement. The ground rule is - "when you want to talk, just talk!". So, a node which wants to transmits, will go ahead and send the packet on its broadcast channel, with no consideration whatsoever as to anybody else is transmitting or not.

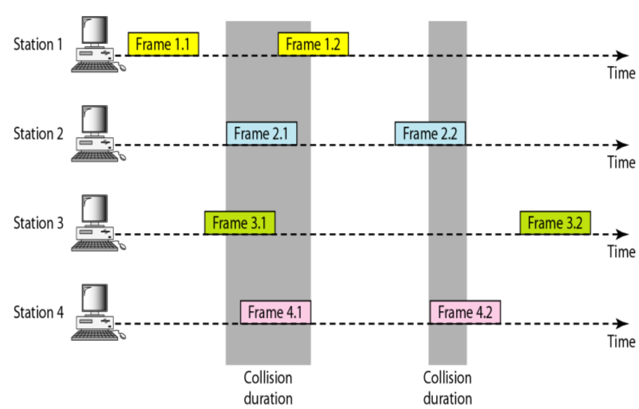

Fig.1: Pure Aloha

One serious drawback here is that, you don't know whether what you are sending has been received properly or not (so as to say, "whether you've been heard and understood?"). To resolve this, in Pure Aloha, when one node finishes speaking, it expects an acknowledgement in a finite amount of time - otherwise it simply retransmits the data. This scheme works well in small networks where the load is not high. But in large, load intensive networks where many nodes may want to transmit at the same time, this scheme fails miserably. This led to the development of Slotted Aloha.[1]

2.2 Slotted Aloha

This is quite similar to Pure Aloha, differing only in the way transmissions take place. Instead of transmitting right at demand time, the sender waits for some time. This delay is specified as follows - the timeline is divided into equal slots and then it is required that transmission should take place only at slot boundaries. To be more precise, the slotted-Aloha makes the following assumptions:

- All frames consist of exactly L bits.
- Time is divided into slots of size L/R seconds (i.e., a slot equals the time to transmit one frame).
- Nodes start to transmit frames only at the beginnings of slots.
- The nodes are synchronized so that each node knows when the slots begin.
- If two or more frames collide in a slot, then all the nodes detect the collision event before the slot ends.

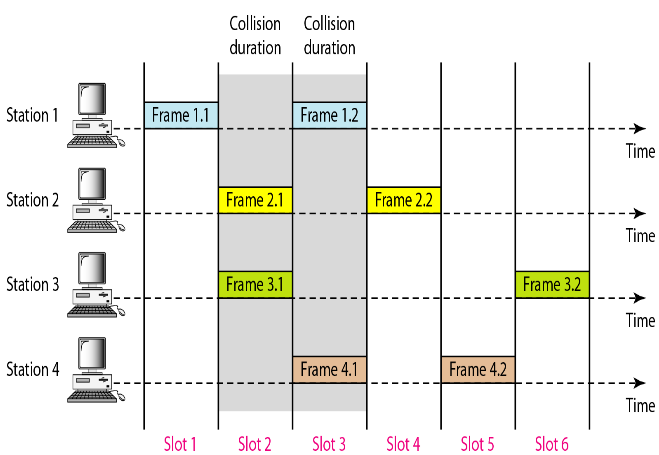

Fig:2: Slotted Aloha

In this way, the number of collisions that can possibly take place is reduced by a huge margin. And hence, the performance become much better compared to Pure Aloha. collisions may only take place with nodes that are ready to speak at the same time. But nevertheless, this is a substantial reduction.

2.3 Carrier Sense Multiple Access Protocols

In both slotted and pure ALOHA, a node's decision to transmit is made independently of the activity of the other nodes attached to the broadcast channel. In particular, a node neither pays attention to whether another node happens to be transmitting when it begins to transmit, nor stops transmitting if another node begins to interfere with its transmission. As humans, we have human protocols that allow allows us to not only behave with more civility, but also to decrease the amount of time spent "colliding" with each other in conversation and consequently increasing the amount of data we exchange in our conversations. Specifically, there are two important rules for polite human conversation:

1. **Listen before speaking:** If someone else is speaking, wait until they are done. In the networking world, this is termed carrier sensing - a node listens to the channel before transmitting. If a frame from another node is currently being transmitted into the channel, a node then waits ("backs off") a random amount of time and then again senses the channel. If the channel is sensed to be idle, the node then begins frame transmission. Otherwise, the node waits another random amount of time and repeats this process.

2. **If someone else begins talking at the same time, stop talking.** In the networking world, this is termed collision detection - a transmitting node listens to the channel while it is transmitting. If it detects that another node is transmitting an interfering frame, it stops transmitting and uses some protocol to determine when it should next attempt to transmit.

It is evident that the end-to-end channel propagation delay of a broadcast channel - the time it takes for a signal to propagate from one of the channel to another - will play a crucial role in determining its performance. The longer this propagation delay, the larger the chance that a carrier-sensing node is not yet able to sense a transmission that has already begun at another node in the network.

CSMA- Carrier Sense Multiple Access

This is the simplest version CSMA protocol as described above. It does not specify any collision detection or handling. So collisions might and WILL occur and clearly then, this is not a very good protocol for large, load intensive networks.

So, we need an improvement over CSMA - this led to the development of CSMA/CD.

CSMA/CD- CSMA with Collision Detection

In this protocol, while transmitting the data, the sender simultaneously tries to receive it. So, as soon as it detects a collision (it doesn't receive its own data) it stops transmitting. Thereafter, the node waits for some time interval before attempting to transmit again. Simply put, **"listen while you talk"**. But, how long should one wait for the carrier to be freed? There are three schemes to handle this:

1. **1-Persistent:** In this scheme, transmission proceeds immediately if the carrier is idle. However, if the carrier is busy, then sender continues to sense the carrier until it becomes idle. The main problem here is that, if more than one transmitters are ready to send, a collision is GUARANTEED!!

2. **Non-Persistent:** In this scheme, the broadcast channel is not monitored continuously. The sender polls it at random time intervals and transmits whenever the carrier is idle. This decreases the probability of collisions. But, it is not efficient in a low load situation, where number of collisions are anyway small. The problems it entails are:
   - If back-off time is too long, the idle time of carrier is wasted in some sense
   - It may result in long access delays

3. **p-Persistent:** Even if a sender finds the carrier to be idle, it uses a probabilistic distribution to determine whether to transmit or not. Put simply, "toss a coin to decide". If the carrier is idle, then transmission takes place with a probability p and the sender waits with a probability 1-p. This scheme is a good trade off between the Non-persistent and 1-persistent schemes. So, for low load situations, p is high (example: 1-persistent); and for high load situations, p may be lower. Clearly, the value of p plays an important role in determining the performance of this protocol. Also the same p is likely to provide different performance at different loads. [11]-[13]

CSMA/CD doesn't work in some wireless scenarios called **"hidden node"** problems. Consider a situation, where there are 3 nodes - A, B and C communicating with each other using a wireless protocol. More over, B can communicate with both A and C, but A and C lie outside each other's range and hence can't communicate directly with each other. Now, suppose both A and C want to communicate with B simultaneously. They both will sense the carrier to be idle and hence will begin transmission, and even if there is a collision, neither A nor C will ever detect it. B on the other hand will receive 2 packets at the same time and might not be able to understand either of them. To get around this problem, a better version called CSMA/CA was developed, specially for wireless applications.[8]

Overview of CSMA/CA Networks

The goal of the CSMA/CA protocol is to maximize throughput by reducing the collisions due to the contending nodes that share the same channel. Both physical channel sensing and virtual channel sensing are used to attain this goal. Like CSMA, a node in the CSMA/CA network senses the channel before it transmits a frame. If the channel is idle, the node does not transmits its frame. Otherwise, it randomly chooses a value, known as a contention window(Inter Frame Space ,IFS) , denoted by and initializes its *back off timer* . Since it is chosen randomly, the probability that two or more nodes choose the same back off value is very low. The timer has the granularity of a *slot time* and is decremented by one every time the channel is sensed to be idle. The back off timer is stopped in case the channel becomes busy and the decrementing process is resumed when the channel becomes idle again. The node is allowed to transmit its frame when the back off timer reaches zero. Each successful transmission is positively acknowledged so that transport layer retransmission is avoided. [7]

3. Proposed Algorithm

CSMA/CA have several problems. the contention window number may not be wide enough. when network nodes increase, It will cause collision probability to increase. We cannot avoid the chance of collision in a shared medium. Present CSMA/CA protocol have no mechanism when there is a collision. The proposed algorithm can be used for collision avoidance as well as collision detection. If there is any collision it will take appropriate action.

If a station want to send data it will follow the following procedure

1. Start
2. Set number of retransmission K=0
3. Apply one of the persistent strategy for finding idle time of the channel.
4. Wait IFS time and repeat step 3 once again. If channel found idle go to step 5
5. After found the is idle ,warning signal to all the stations uses the shared medium for informing about the data transmission.
6. Start data transmission.

7. Check whether transmission done or any collision detected. If it is false continue transmission else go to next step.
8. Check whether collision is detected, if it is false that means transmission is success then send a wake up signal through the channel, now other stations can follow persistent procedure for starting a transmission. Else go to next step
9. Increase number of retransmission K=K+1.
10. Check whether K<Kmax(Set Kmax=15 normally) ,if it is true go to next step else repeat all the above steps.
11. Select a random number(R) between 0 and 2^k -1
12. Wait R slots then go to step 3.

Here we uses two kinds of signals –warning signal and wake up signal. This helps the algorithm to perform better. Once all the stations connected to a shared medium got the warning signal it means that some other station using the medium now. So no need of perform persistent strategy. Untill the stations get the wake up signal all the stations exits their waiting state. Wake up signal is used to inform the stations that now the medium is idle and other stations can able to use the medium.

4. Conclusions

This paper presents a new algorithm for accessing a shared medium. It provides better performance as compared to other MAC protocols. This algorithm tries to avoid collisions and also detect if there is any collision exist during transmission. It can avoid most of the problems of other MAC protocols. This single algorithm can do the functionality of both collision detection and collision avoidance algorithms. As compared to CSMA/CA, this new approach reduces the waiting time of the stations, want to transmit.

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