MAC Layers Report

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December 9, 2018

1 Introduction

In the field of networks, the **Medium Access Control** (MAC) layer communicates directly with the physical layer and provides flow control for the transmission medium.

In wireless networks, a mobile station communicates via a channel shared by other mobile stations using transceivers. The transmission from one mobile station is received by all near mobile stations. Collisions may occurs if many nodes communicate at the same time.

To avoid this problem, the MAC layer must ensure that the medium is shared equitably and efficiently between entities of a network. Moreover, MAC layer protocols must be energy efficient to maximize nodes lifetime and must be scalable to get used to update a network (addition of nodes, death of existing nodes, etc. . .).

There is two types of MAC layers : contention based protocols, with CSMA and Aloha for example, and scheduled based protocols, with TDMA.

This document will present some existing MAC protocols for wireless networks and will compare them.

2 Medium Access Control Protocols

The main protocols used in wireless networks are **TDMA** (Time Division Multiple Access) and **CSMA/CA** (Carrier Sense Multiple Access Collision Avoidance), as **FDMA** (Frequency Division Multiple Access) requires complex hardware and **CDMA** (Code Division Multiple Access) has high computational demands.

2.1 TDMA

TDMA is a scheduled based protocol which schedules nodes wihthin a network. It assigns, for each node, a certain amount of slots in a time frame depending on the number of slots required to get a packet from each source to the sink.

The protocol can use the same slot time for all nodes in the network in order to make synchronization easier, but it implies to propagate the maximum slot

time to all nodes which creates more traffic. Other choices are neighborhood and per node time frames which reduce the traffic but are more difficult to implement. Two types of conflict exist for transmissions :

- Primary conflicts caused by two adjacent nodes transmitting data at the same time
- Secondary conflicts caused by two non-adjacent nodes sending a data to the same receiver

In order to save power, nodes can shut down their radio interface when there is no activity. Moreover, nodes which are not in conflict can be active at the same time.

It can be necessary to reschedule nodes due to the frequent topology changes (node failures, new nodes being added to the network...). Rescheduling can be done on demand, or periodically.

2.2 CSMA/CA

CSMA/CA is based on **RTS/CTS** (Request To Send/Clear To Send) and **DCF** (Distributed Contention Function) mechanisms. This method was developed to prevent collisions by checking periodically if the medium is free. In wireless networks, the energy of received signal increases by only 5-10% if a collision occurs, so this is not enough to sense collisions. Therefore there are three type of strategies to detect collisions with **CSMA/CA** :

- **InterFrame Space (IFS)** : if a station finds that the medium is busy, it waits for a period of time called IFS
- **Contention Window** : it is the amount of time divided into slots. A station which is ready to send frames chooses random number of slots as wait time
- **Acknowledgements** : the positive acknowledgements and time-out timer can help a successful transmission of the frame

The entire process for collition avoidance is explained at the figure 1.

2.3 CSMA/TDMA Hybrid

There are hybrid algorithms which mix **CSMA** and **TDMA** protocols. On one hand, **TDMA** is efficient on high levels of network traffic where there is a constant stream of data exchange. On the other hand, **CSMA** achieves maximum efficiency for little traffic. Protocols like **ZMAC** achieve dynamical adaptation of the MAC to traffic load by using a **CSMA** phase at the beginning of every **TDMA** slot. The back-off period is shorter for the slot owners, but if they do not use their slot, other nodes can gain access to it if they have data to send. The disadvantage is that nodes will spend a part of the **TDMA** slots in listening which consumes more power.

3 Comparison

CSMA protocol has its channel utilization decreasing when the number of nodes increases, as bandwidth is wasted by taking repeated back-off to avoid collisions. **TDMA** protocol will only schedule the activity of the network and in that period, all nodes will be active. The main advantage of **TDMA** over **CSMA** is low power consumption. But **TDMA** is not appropriate for network changing frequently the topology. The table 1 gives a qualitative comparison of the two protocols.

	TDMA	CSMA/CA
Power consumption	Low	High
Bandwidth utilization	Maximum	Low
Preferred traffic level	High	Low
Dynamic (network change)	Poor	Good
Effect of packet failure	Latency	Low
Synchronyeation	Crucial	-

Table 1: Comparison of TDMA and CSMA/CA

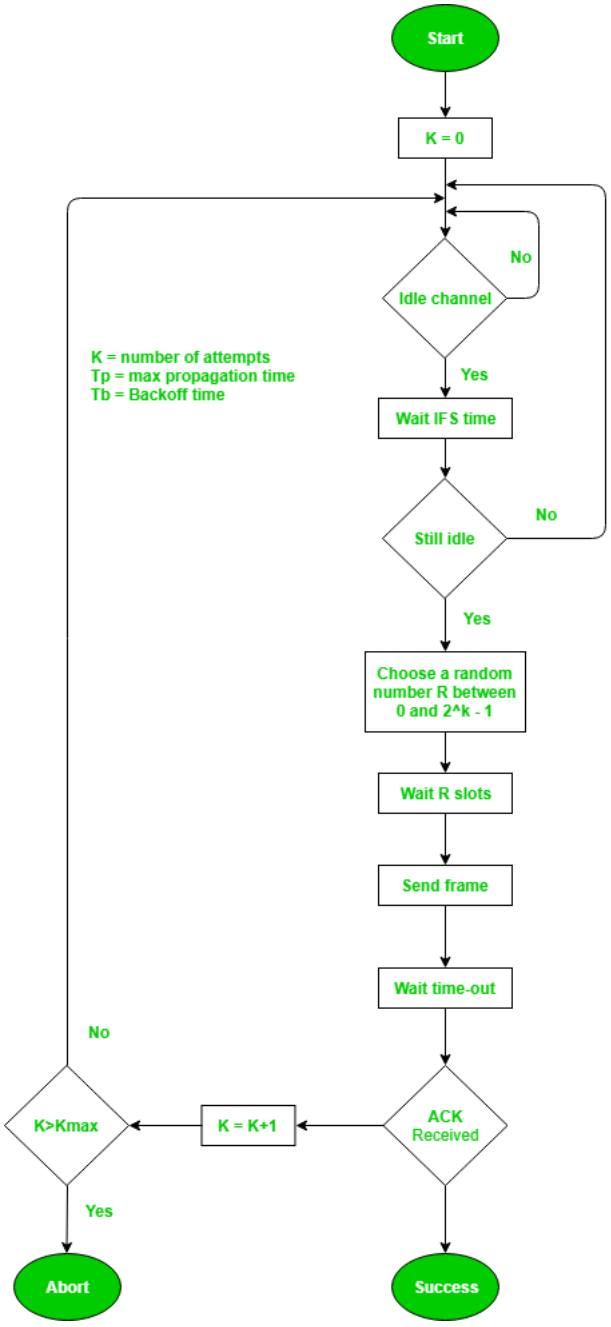

Figure 1: CSMA process