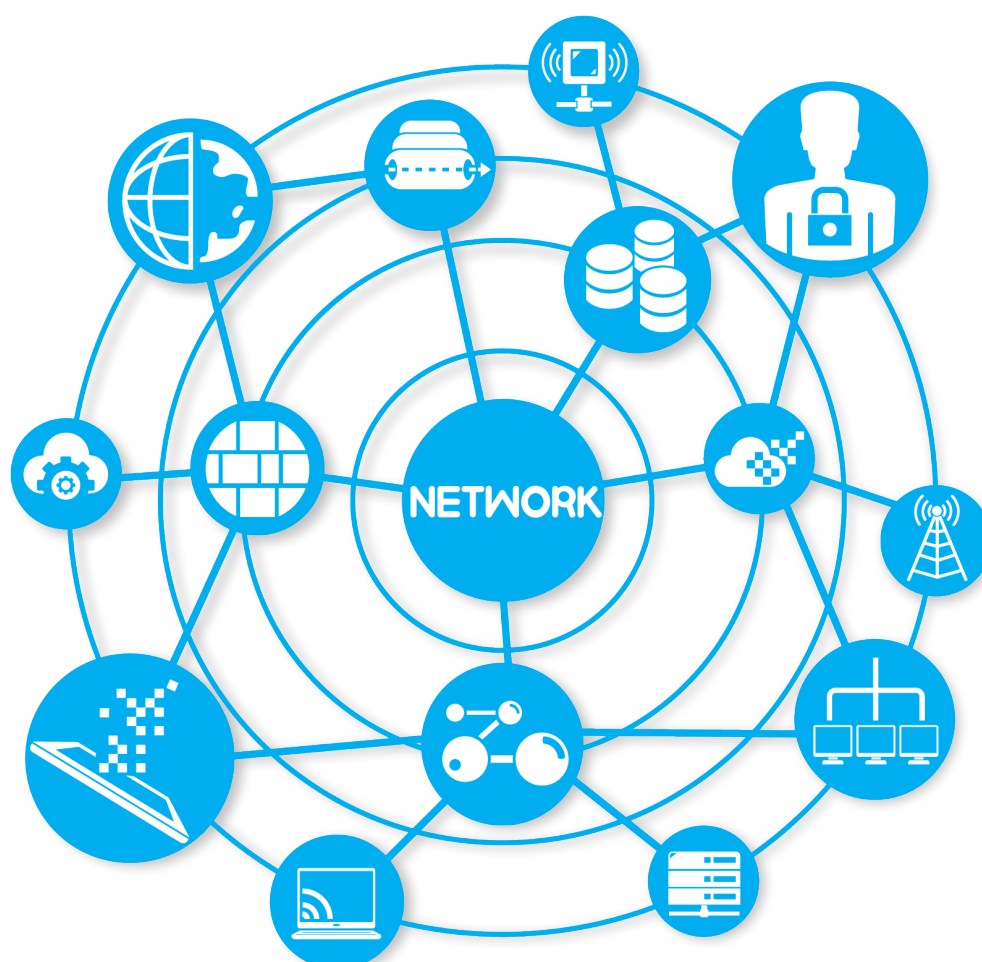**Course: Computer Networks (COE351)**
2nd Semester 1440/1441
Instructor: Dr. Dina M. Ibrahim
16/03/2020 AD

Students' names:

نجود الحربي

حصه نايف

شهد البليهد

فريده خليفه

خزامى السالم

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Carrier Sense Multiple Access (CSMA) :

Prerequisite – <u>Multiple Access Protocols</u>
This method was developed to decrease the chances of collisions when two or more stations start sending their signals over the datalink layer. Carrier Sense multiple access requires that each station **first check the state of the medium** before sending.

The persistence methods can be applied to help the station take action when the channel is busy/idle.

Type (CSMA):

1. Carrier Sense Multiple Access with Collision Detection (CSMA/CD) –

In this method, a station monitors the medium after it sends a frame to see if the transmission was successful.If succcessful, the station is finished, if not, the frame is sent again.

2. Carrier Sense Multiple Access with Collision Avoidance (CSMA/CA) –

The basic idea behind CSMA/CA is that the station should be able to receive while transmitting to detect a collision from different stations. In wired networks, if a collision has occurred then the energy of received signal almost doubles and the station can sense the possibility of collision. In case of wireless networks, most of the energy is used for transmission and the energy of received signal increases by only 5-10% if collision occurs. It can't be used by station to sense collision. Therefore CSMA/CA has been specially designed for wireless networks.

CSMA/CD: Explanation of the process

In a local Ethernet network (IEEE 802.3), all network participants usually meet on a common transmission medium – a cable. This meeting must be regulated to avoid chaos during data transmission, which could lead to data loss or damage. CSMA/CD offers a method that organizes data transmission properly.

This technique isn't suitable for WLAN. Therefore, the process has been adapted in the form of CSMA/CA. CSMA/CD is no longer important for most wired networks, since new cable technology offers other possibilities.

Collision Detection in CSMA/CD:

CSMA/CD (Carrier Sense Multiple Access/ Collision Detection) is a media-access control method that was widely used in Early Ethernet technology/ LANs, When there used to be shared.

Bus Topology and each Nodes(Computers) were connected By Coaxial Cables.Now a Days Ethernet is Full Duplex and CSMA/CD is not used as Topology is either Star (connected via Switch or Router)
or Point to Point (Direct Connection) but they are still supported though.

Consider a scenario where there are 'n' stations on a link and all are waiting to transfer data through that channel. In this case all 'n' stations would want to access the link/channel to transfer their own data.Problem arises when more than one station transmits the data at the moment. In this case, there will be collisions in the data from different stations.

CSMA/CD is one such technique where different stations that follow this protocol agree on some terms and collision detection measures for effective transmission. This protocol decides which station will transmit when so that data reaches the destination without corruption.
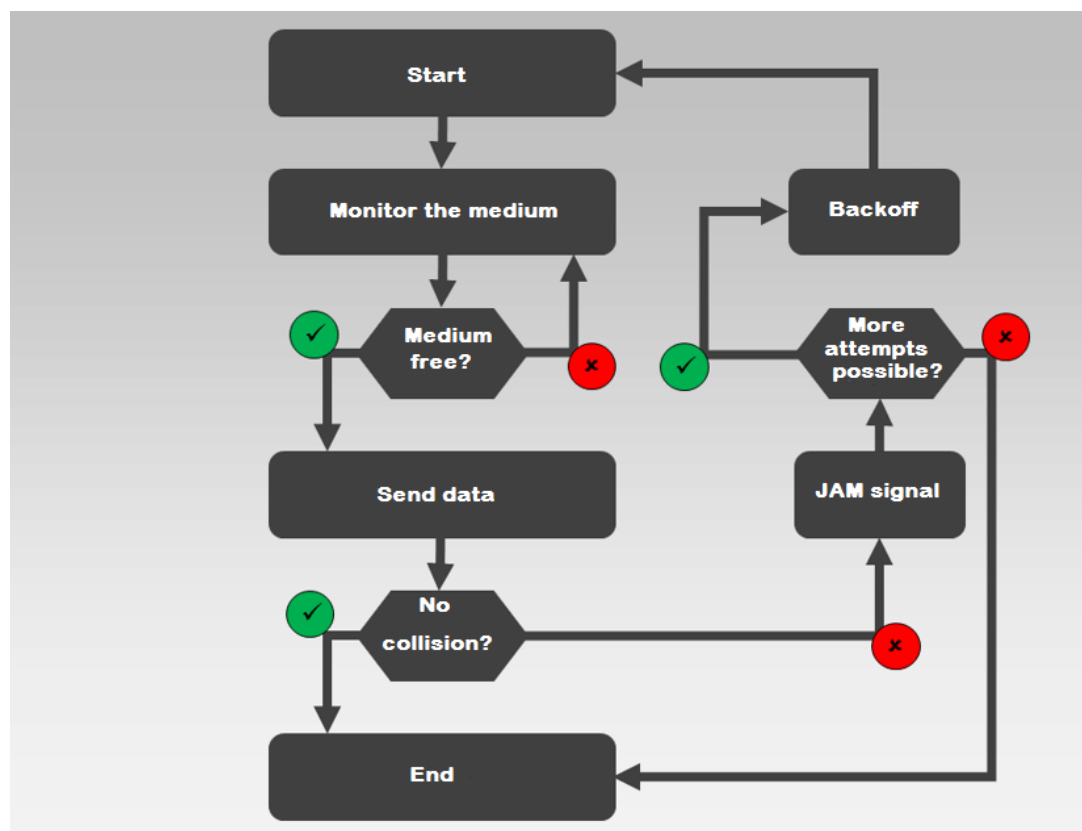
CSMA/CD follows a fixed scheme to handle collisions correctly.

How CSMA/CD works?

Step 1: Check if the sender is ready for transmitting data packets.

Step 2: Check if the transmission link is idle?
Sender has to keep on checking if the transmission link/medium is idle. For this it continously senses transmissions from other nodes. Sender sends dummy data on the link.If it does not receive any collision signal, this means the link is idle at the moment.If it senses that the carrier is free and there are no collisions, it sends the data. Otherwise it refrains from sending data.

Step 3: Transmit the data & check for collisions.
Sender transmits its data on the link. CSMA/CD does not use 'acknowledgement' system. It checks for the successful and unsuccessful transmissions through collision signals. During transmission, if collision signal is received by the node, transmission is stopped. The station then transmits a jam signal onto the link and waits for random time interval before it resends the frame. After some random time, it again attempts to transfer the data and repeats above process.

Step 4: If no collision was detected in propagation, the sender completes its frame transmission and resets the counters

CSMA/CA: definition and explanation of the method:

CSMA is a basic method that controls the communication of multiple participants on a shared and decentralized transmission medium. However, this is now available in **three different variants**, which depend on the transmission medium. While CSMA/CA is mainly used in wireless networks, CSMA/CD was developed for Ethernet, and CSMA/CR is used in controller area networks (CAN), which are mainly used in cars and machines.
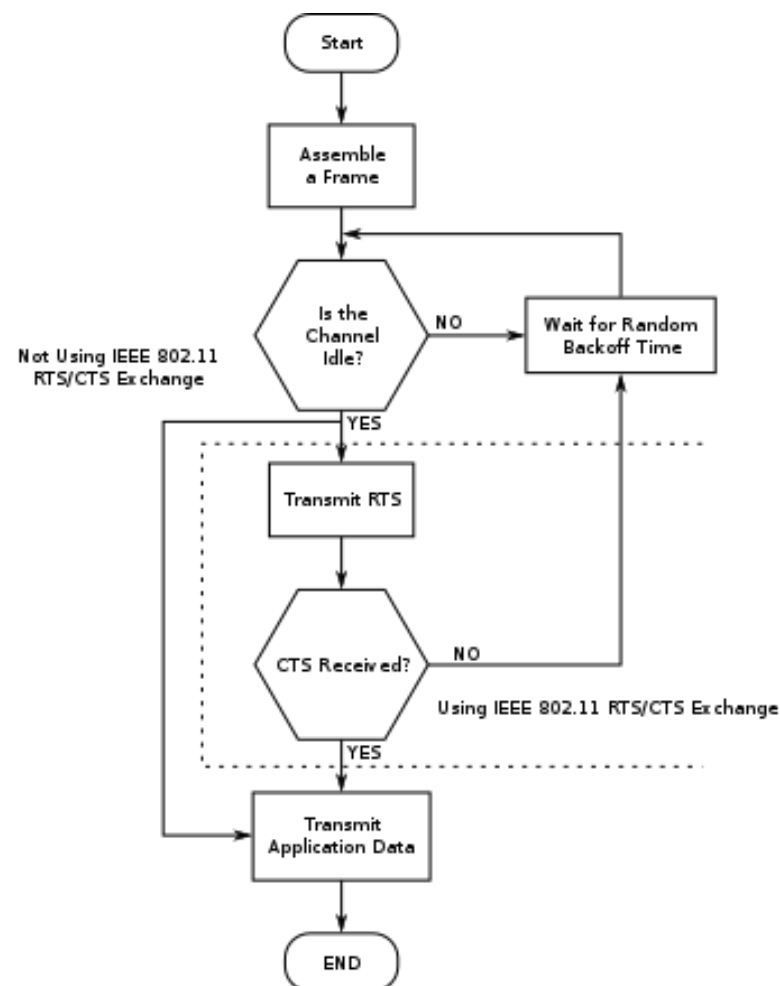
CSMA/CA :

(Carrier Sense Multiple Access/Collision Avoidance)

is a protocol for carrier transmission in 802.11 networks. Unlike CSMA/CD (Carrier Sense Multiple Access/Collision Detect) which deals with transmissions after a collision has occurred, CSMA/CA acts to prevent collisions before they happen.

How CSMA/CA works

The basic idea behind CSMA/CA is the "**Listen Before Talk**" (LBT) principle. This means that the line has to be checked to see if it's free ("idle") before the station can start a transmission. But this is just the first step. Further functions within the procedure ensure that collisions can be avoided to a large extent.

Simplified algorithm of CSMA/CA

The advantages and disadvantages of CSMA/CA

CSMA/CA solves some problems that occur in wireless networks and cannot be solved by CSMA/CD. However, the process is not without its disadvantages: on the one hand, certain problems cannot be solved

Advantages	Disadvantages
Helps prevent data collisions	Longer waiting times
Thanks to feedback, no data is unnoticeably lost	Causes additional traffic
Avoids unnecessary data traffic with the RTS/CTS extension	Solves the hidden station problem only by using RTS/CTS extension
	Creates the exposed station problem through using RTS/CTS

completely and, on the other hand, CSMA/CA brings new difficulties along with it.

Distributed coordination function (DCF)

Within CSMA/CA, the distributed coordination function (DCF) controls the time a station waits before initiating transmission in a free medium. DCF also assigns certain time slots to network participants for further actions, creating a **binding time structure**. This procedure is the focus of collision avoidance: a complex time structure that makes it possible to avoid collisions. DCF takes various intervals into account when creating the time structure.

- **DCF interframe space** (DIFS): In the first step, participants must monitor the network for the duration of the DIFS to determine whether it's currently free. For CSMA/CA, this means that no other station within range is sending out a transmission at the same time. The DIFS results from the SIFS almost double the slot time, which is between 28 and 50 µs long.

- **Contention window**: If participants determine that the channel is free, they wait a random amount of time before they start sending. This duration corresponds to the contention window. This time window doubles with each collision and corresponds to the binary exponential backoff (BEB) that is familiar from CSMA/CD.

- **Short interframe space** (SIFS): After sending the data packet, the recipient node sends a notification – if the RTS/CTS procedure is also utilized. However, this station also waits for a fixed time before sending. SIFS is the time it takes to process a data package. The duration depends on the IEEE-802.11 standard and is between 10 µs and 16 µs.

Difference between CSMA/CA and CSMA/CD

S.NO	CSMA/CD	CSMA/CA
1.	CSMA / CD is effective after a collision.	Whereas CSMA / CA is effective before a collision.
2.	CSMA / CD is used in wired networks.	Whereas CSMA / CA is commonly used in wireless networks.
3.	It only reduces the recovery time.	Whereas CSMA/ CA minimizes the possibility of collision.
4.	CSMA / CD resend the data frame whenever a conflict occurs.	Whereas CSMA / CA will first transmit the intent to send for data transmission.
5.	CSMA / CD is used in 802.3 standard.	While CSMA / CA is used in 802.11 standard.
6.	It is more efficient than simple CSMA(Carrier Sense Multiple Access).	While it is similar to simple CSMA(Carrier Sense Multiple Access).

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