Group Project Report

A simulation scenario

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All Concepts Explained

Ad-hoc Network

An **ad-hoc** network is one that is spontaneously formed when devices connect and communicate with each other.

Ad-hoc mode refers to a wireless network structure where devices can communicate directly with each other. It is an additional feature that is specified in the 802.11 set of standards, which is referred to as an independent basic service set (IBSS).

This type of wireless network is also called peer-to-peer mode.

CSMA/CA Protocol

Overview

1. https://www.youtube.com/watch?v=iKn0GzF5-IU

- CSMA/CA is used on wireless networks.

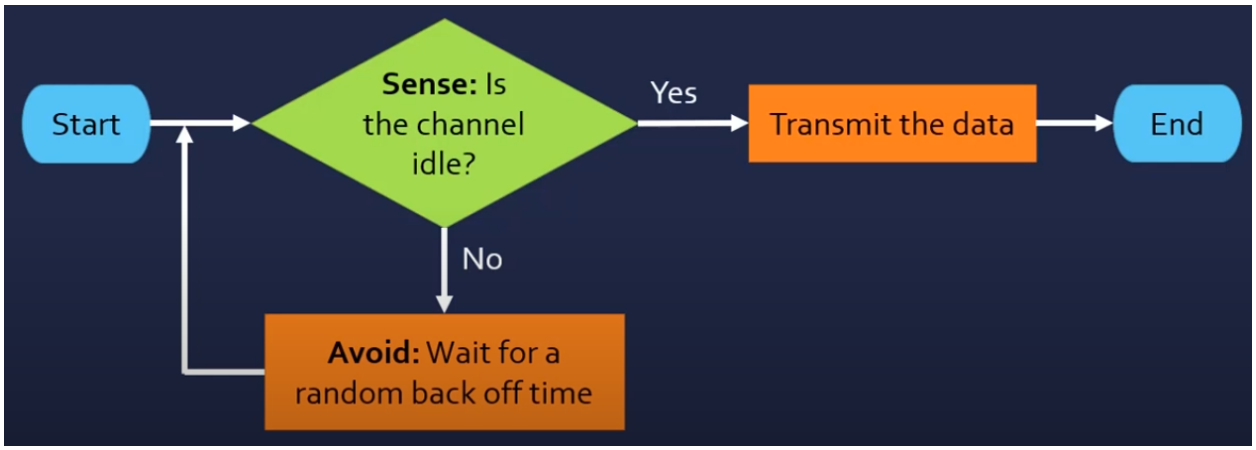
2. https://www.techtarget.com/searchnetworking/definition/CSMA-CA

- CSMA/CA Is a protocol for carrier transmission in 802.11 networks.
- It was developed to minimize the potential of a collision occurring when two or more stations send their signals over a data link layer.

3. https://www.youtube.com/watch?v=MAZi6VoekYw

- To minimize the chance of signal collisions among devices in a network

Process



CSMA/CA Workflow - source: https://www.youtube.com/watch?v=My4VDzviiNg

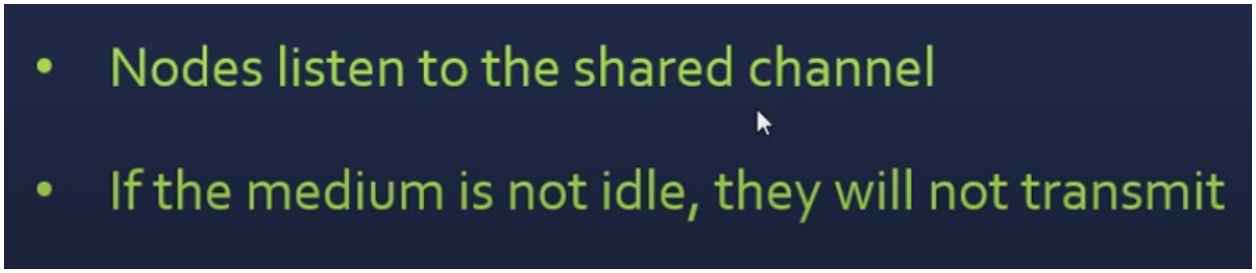
The protocol requires each device first checks the state (idle or not) of the channel before transmitting.

If the channel is idle, the device will send the data over. In this case, the receiver will respond to the device with an ACK, or acknowledgement message.

If the device does not receive an ACK from the receiver, it will assume no data was successfully received by the receiver.

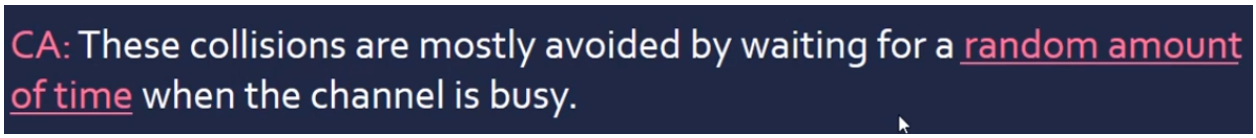
In this case, the device will wait for a short random amount of time before transmitting the data again.

About CSMA



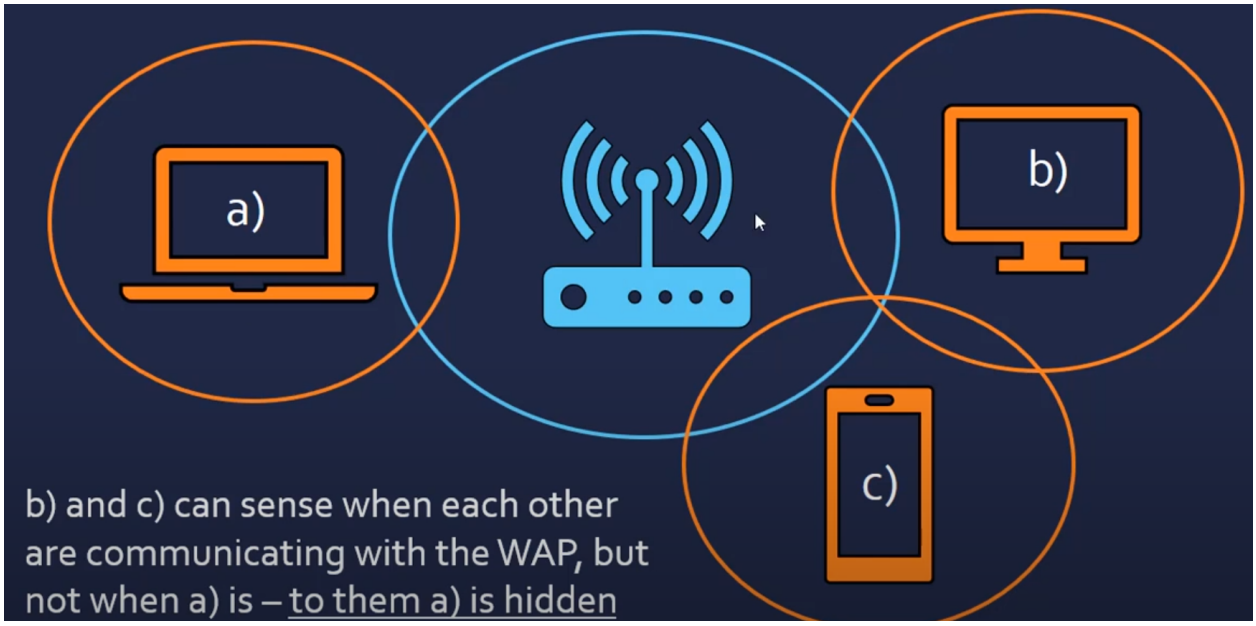
About CSMA

About CA



About CA

The Hidden Node Problem



Hidden Node Problem

B and C can sense each other communicating with the WAP in the centre, however, A is hidden from the sight of B and C due to its limited range, making it impossible for B and C to know whether the current channel is idle (no activity) or not.

RTS/CTS Scheme

Overview

- RTS/CTS (Request To Send / Clear To Send) is the mechanism used by the 802.11 wireless networking protocol
- To reduce frame collisions introduced by the hidden node problem
- Used by CSMA/CA as an optional protocol.
- WAP or Wireless Access Point serves as a traffic controller

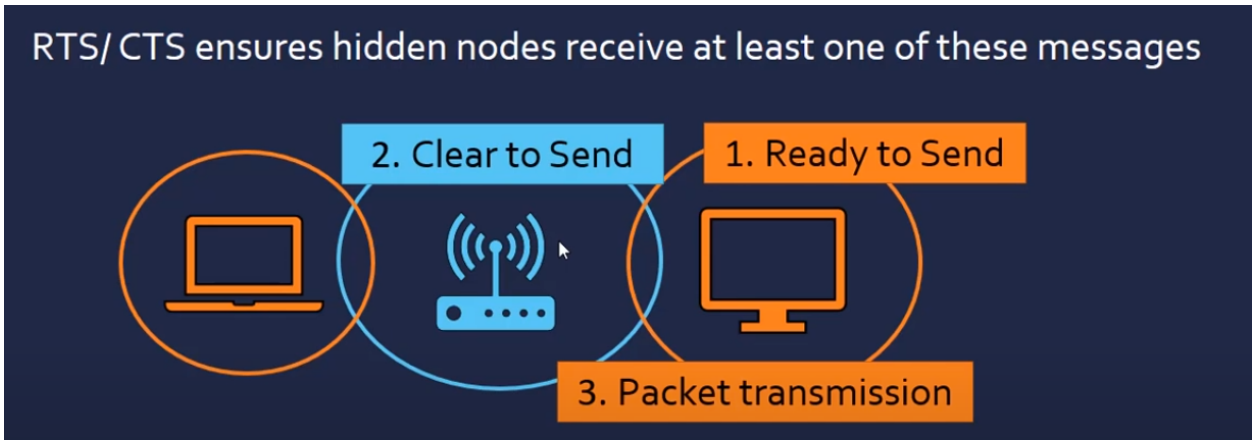
Process

RTS, or Ready To Send, is a request to send data coming from a sender (a computer). CTS, or Clear To Send, is the approval signal from the WAP (a modem) which grants the request.

The sender (a computer) sends a Ready To Send signal to a Wireless Access Point (a modem) to inform that it is ready to send data over.

The receiver (a modem) on receiving the RTS signal grants this request, temporarily stops the communication to other devices and responds with a Clear To Send or CTS signal to the sender which tells it to send the data over.

Pros



RTS/CTS prevents the hidden node problem

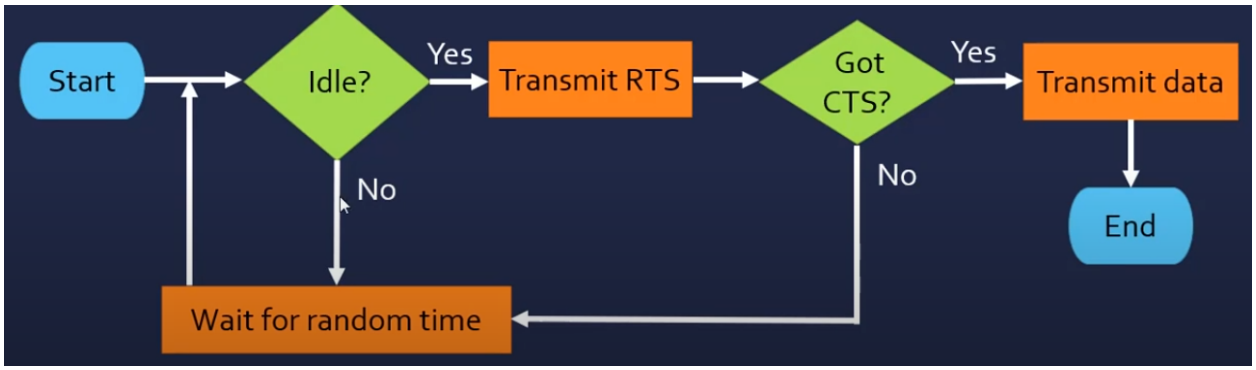
Cons

However, RTS/CTS add an overhead or the information that must be sent with data being routed through the network toward a destination, to each packet, which increases the load and worsens the congestion.

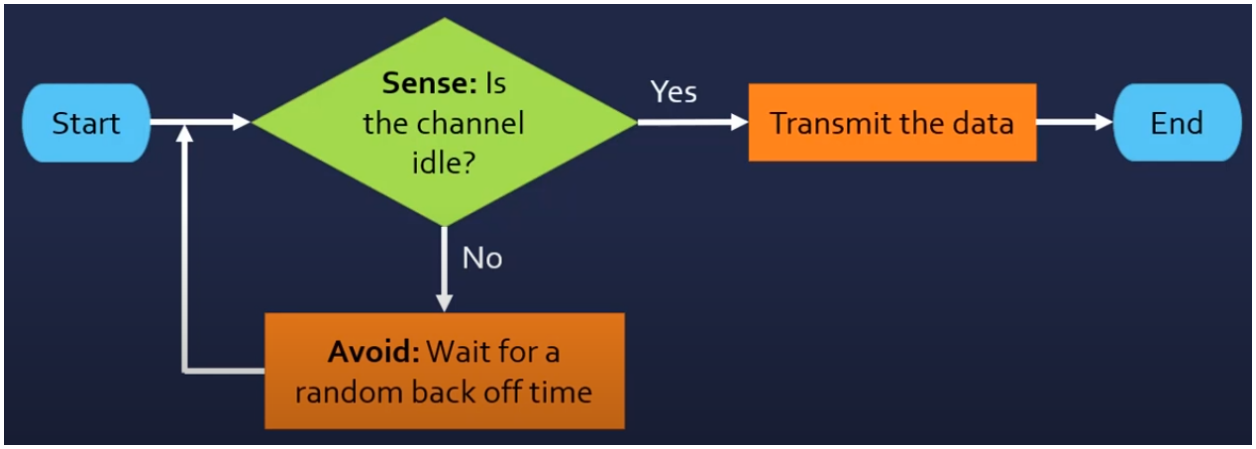
It is advisable to remove RTS/CTS for small packages.

CSMA/CA with and without RTS/CTS

https://www.youtube.com/watch?v=My4VDzviiNg



CSMA/CA with RTS/CTS



CSMA/CA without RTS/CTS

Practical Example

Topic

Consider CSMA/CA protocol in Wifi networks that working in ad-hoc mode.

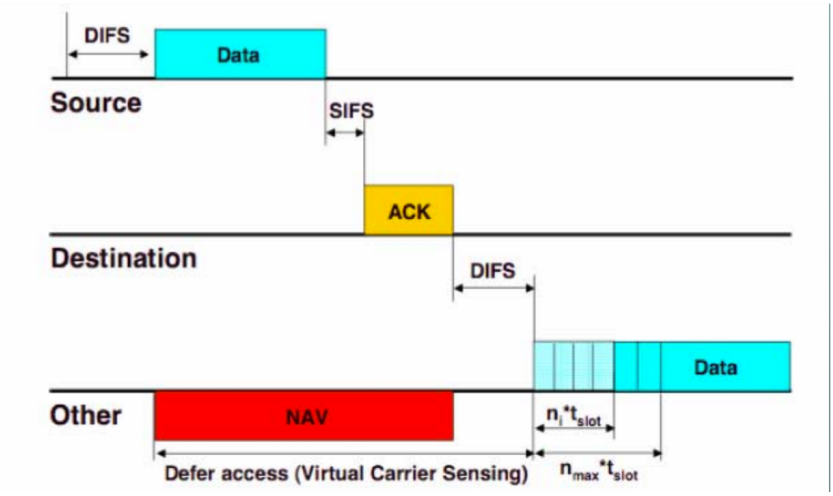
Evaluate performance of the protocol without RTS/CTS scheme when the number of nodes within a communication range increases from 2 to 30.

Hints:
Please follow steps to create a network simulation

1. Design
2. Implementing
3. Data Collection and Report

CSMA/CA without RTS/CTS

Design



CSMA/CA without RTS/CTS - source:
https://www.google.com/url?sa=i&url=http%3A%2F%2Fciscowirelesstesting.blogspot.com%2F2016%2F04%2Fcsmaca-withwithout-rtscts.html&psig=AOvVaw2_2q__jDD7lrtI46LsIk5H&ust=1649091563827000&source=images&cd=vfe&ved=0CAsQjRxqFwoTCIi44fqu-PYCFQAAAAAdAAAAABA0

There are three steps our design follows:

1. The source transmits the data, the destination will respond with an ACK, or acknowledgement message if the data is successfully transmitted and received on the destination.
2. Other (sources) senses the data transmission defers their transmission in the same duration.
3. With the NAV[1], other (sources) will know when the channel is available.

[1] The network allocation vector (NAV) is a virtual carrier-sensing mechanism used with wireless network protocols such as IEEE 802.11 (Wi-Fi) and IEEE 802.16 (WiMax) - https://en.wikipedia.org/wiki/Network_allocation_vector#:~:text=The%20network%20allocation%20vector%20

Implementation

Code

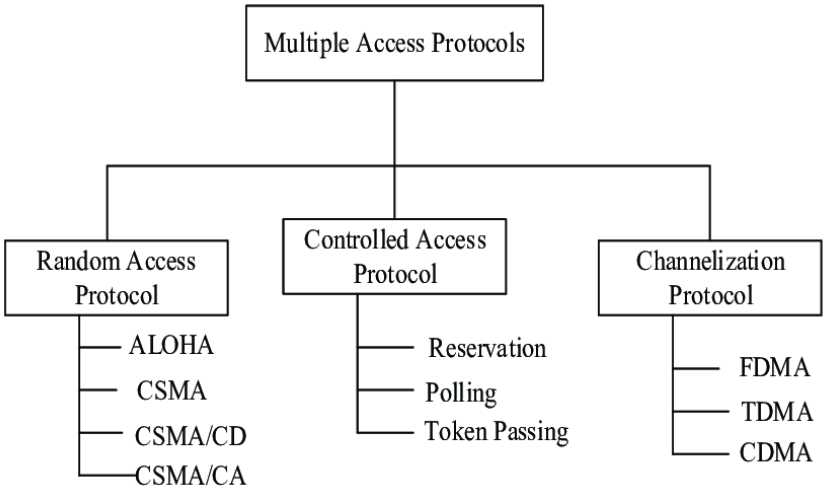
1. Set the number of nodes in the channel
2. Set the wifi channel
3. Add a MAC - Medium Access Control
4. Set the position of the nodes
5. Establish an Internet Stack and assign IP addresses to the nodes
6. Generate the traffic
7. Print out the result

The C++ code could be found in the following private repository https://github.com/vietanh2000april/CSMA-CA-Without-RTS-CTS-Implementation/blob/main/group4_csmaca_without_rtscts.cc

Terminology

MAC

https://en.wikipedia.org/wiki/Medium_access_control: In IEEE 802 LAN/MAN standards, the medium access control sublayer is the layer that controls the hardware responsible for interaction with the wired, optical or wireless transmission medium…



source - *https://www.researchgate.net/figure/Taxonomy-of-existing-medium-access-control-MAC-protocols-for-wireless-local-area_fig2_340704661*

Data Collection And Conclusion

Data Collection

Node count = 5

```
Sent Packets = 11
Received Packets = 11
Delay: 97.0909 ms
8.8e-06 Mbit/s
```

Node count = 10

```
Sent Packets = 24
Received Packets = 8
Delay: 1.08333 ms
6.4e-06 Mbit/s
```

Node count = 20

```
Sent Packets = 49
Received Packets = 16
Delay: 2.30612 ms
1.28e-05 Mbit/s
```

Node count = 30

```
Sent Packets = 76
Received Packets = 18
Delay: 2.96053 ms
1.44e-05 Mbit/s
```

Conclusion

The more nodes we have in a network, the less likely the transferred packets will be delivered and received correctly when the CSMA/CA protocol is implemented without the use of RTS/CTS.

Without RTS/CTS, we will face the Hidden Node problem discussed above, where one device can not detect the others due to limited range.

Therefore, it is advisable to implement CSMA/CA with the RTS/CTS protocol.