WN Project Presentation

Topic- Simulation of CSMA/CA performance in python

Sagar Suman
2019197

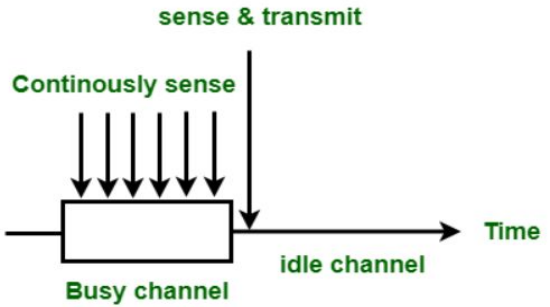
Arpit Kumar
2019153

Puneet Kumar
2019081

INDRAPRASTHA INSTITUTE *of*
INFORMATION TECHNOLOGY **DELHI**

Background

What is CSMA ?
Carrier sense multiple access (CSMA) is a network protocol used to coordinate the transmission of data between multiple devices and to manage access to a shared communication channel.



Before a device sends data, it listens for other devices that might be transmitting data on the same channel and checks channel activity in its vicinity. If it detects any ongoing transmission, it waits for the transmission to complete before attempting to transmit its own data. This helps prevent collision for cases when multiple devices try to transmit data simultaneously, reducing interference and data loss.

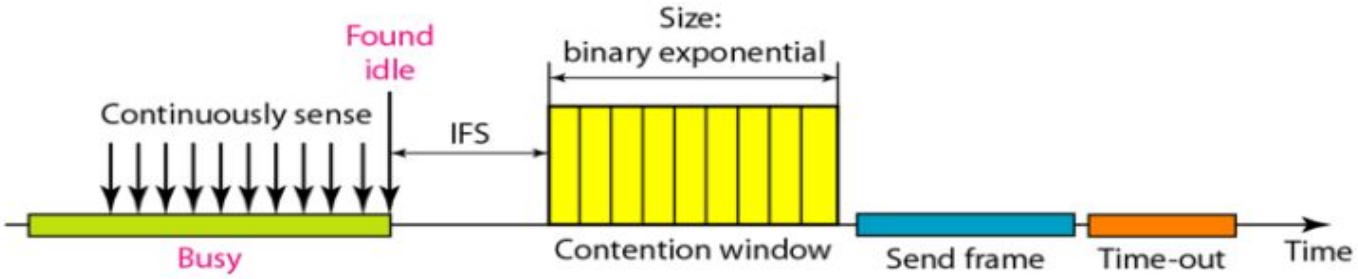
CSMA/CA

CSMA with collision avoidance is used in wireless networks. 3 to 4 major techniques are used -

- Interframe Spacing (IFS) - Immediate transmission of data is deferred even if the channel is found idle and the device has to wait a fixed amount of time
- Contention Window - The device chooses a random no. of slots as it wait-time before it can transmit the data. The Contention window is the amount of time divided into slots. This contention-window's size increases according to binary exponential backoff strategy.
- Acknowledgement - In order to ensure that the receiver has received the data, positive acknowledgement and timer timeout methods can be applied.
- RTS/CTS mechanism - ready-to-send and clear-to-send signals are sent by transmitter and receiver to reserve the channel

Why CSMA/CA

- For Wireless cases, detection of collision is not possible and thus techniques like CSMA/CD etc. can not be used
- Reduced Collisions are ensured by using a variety of techniques like IFS, contention window, and RTS/CTS etc.
- Relatively simplistic protocol that require low-cost and low-power solutions
- CSMA/CA is designed to be fair to all devices on the network, regardless of their location or transmission power.

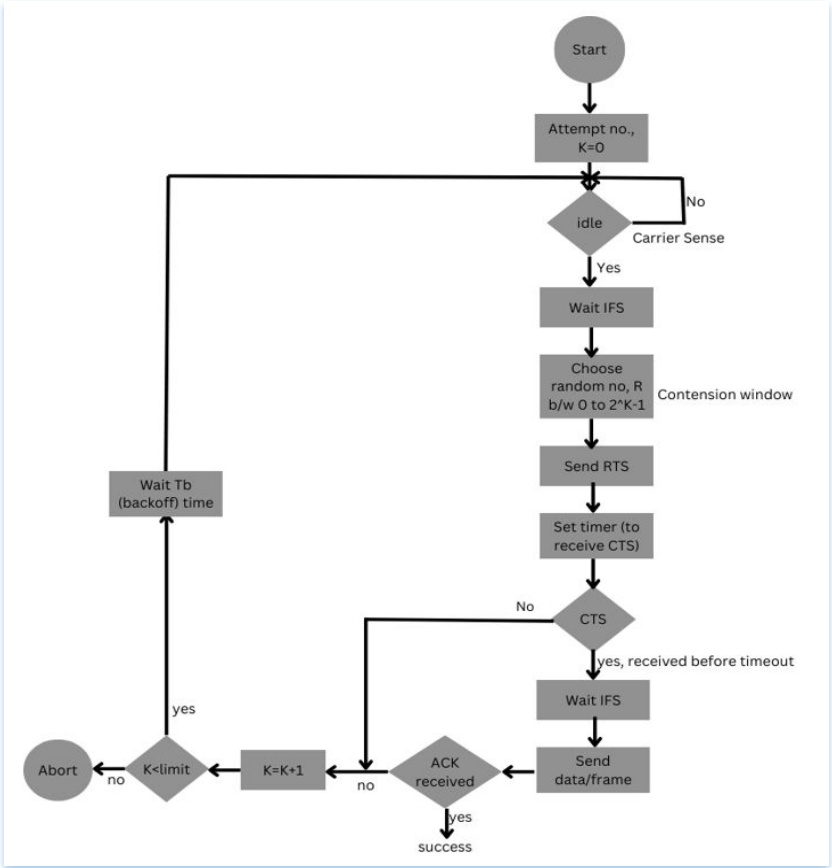


Problem Statement:

Simulation of CSMA/CA performance of different networks in python

Solution and Approach

Algorithm Overview: At start, attempt no. K=0. For each consecutive attempt of transmission, K increases by 1. CSMA is applied by sensing if the channel is idle in the device's vicinity. If it is, instead of directly attempting to transmit, we wait for IFS time, even after that if the channel is still idle we wait for amount of time-slots in contention windows (which consists of R slots of fixed time where R is some random number ranging from 0 to 2^K-1). After that, the device sends a ready-to-send signal to the receiver and if the clear-to-send signal is obtained before timeout the channel is reserved and the transmitter device finally waits for some time and sends the data. If the transmitter receives an acknowledgement back from the receiver, then it means data is successfully transmitted. If not, then variable K is increased by 1 (for next attempt). If the no. of attempts exceeds a specified limit, then this process is aborted. If not, then we try to repeat the process again from the start after a certain amount of random backoff time, as shown.



Algorithm Flowchart

Implementation Details

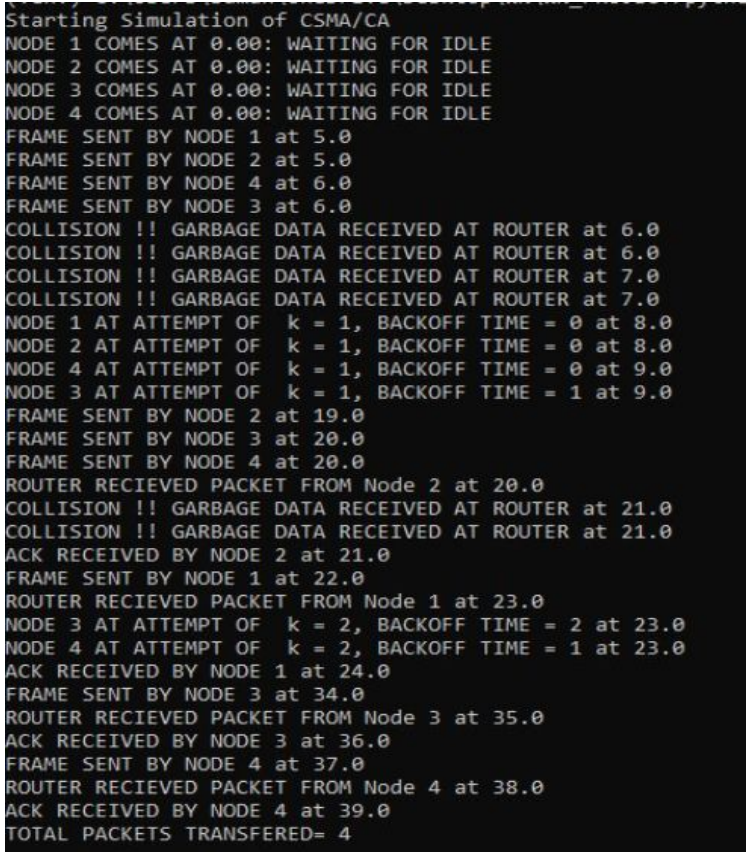
The implementation consists of these major steps in Python using simpy:

- Defining the network topology: Determining the total no. of nodes, and connections between nodes etc.
- Defining the simulation parameters: Determining duration of simulation, type of traffic etc.
- Implementation of CSMA/CA algorithm (using the discussed flowchart)
- Simulation of network traffic: traffic between nodes in the network is generated
- Collection of results: Collisions etc. are detected using the simulation and performance of the network based on metrics such as throughput, packet loss and delay etc is calculated.
- Analysis of results: Performance of network under different conditions is observed and analyzed

Results - 1

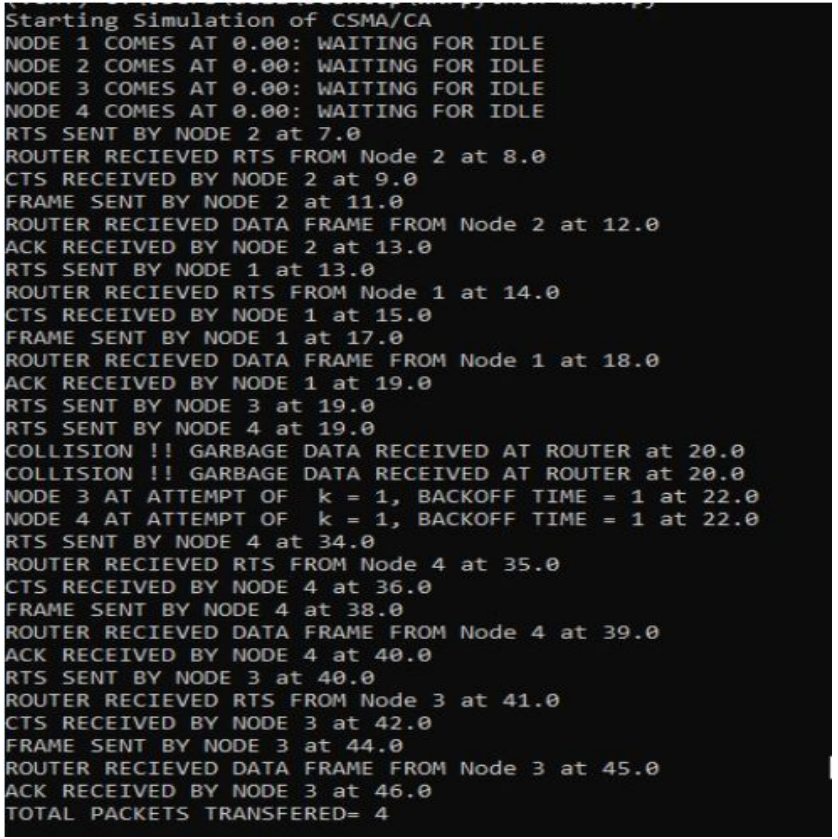
Simulation output without RTS/CTS ➜

Here, assumptions are that node takes 1 sec to send data to the router. The acknowledgment by Router also reaches nodes in 1 sec. Node waits for another 1 sec in case ACK isn't received before proceeding to the next phase (i.e. Incrementing attempt no. K by 1 and backoff time stage)
The Output is explained in detail in the report.



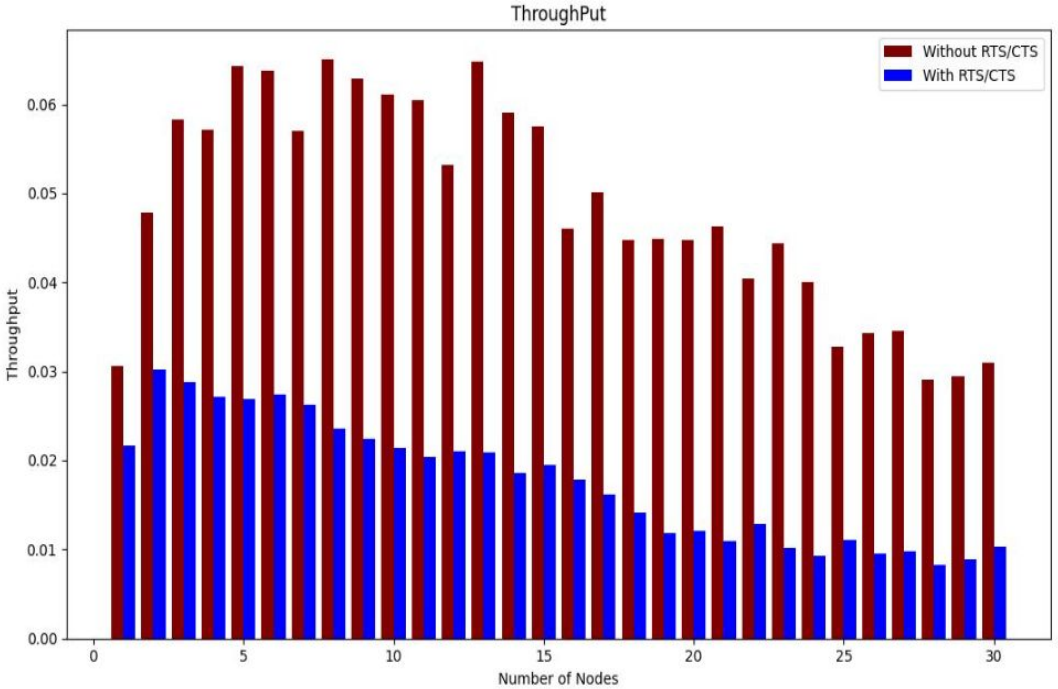
Results-2

Simulation Output with RTS/CTS ➜
On Using RTS/CTS mechanism, since the channel gets reserved for use by that particular node which sent the RTS and other nodes stop their transmission Temporarily, the chances of collisions are Much less likely and channel is more Efficiently used, which can be seen in the output as well.
Detailed-explanation of output is in the report.

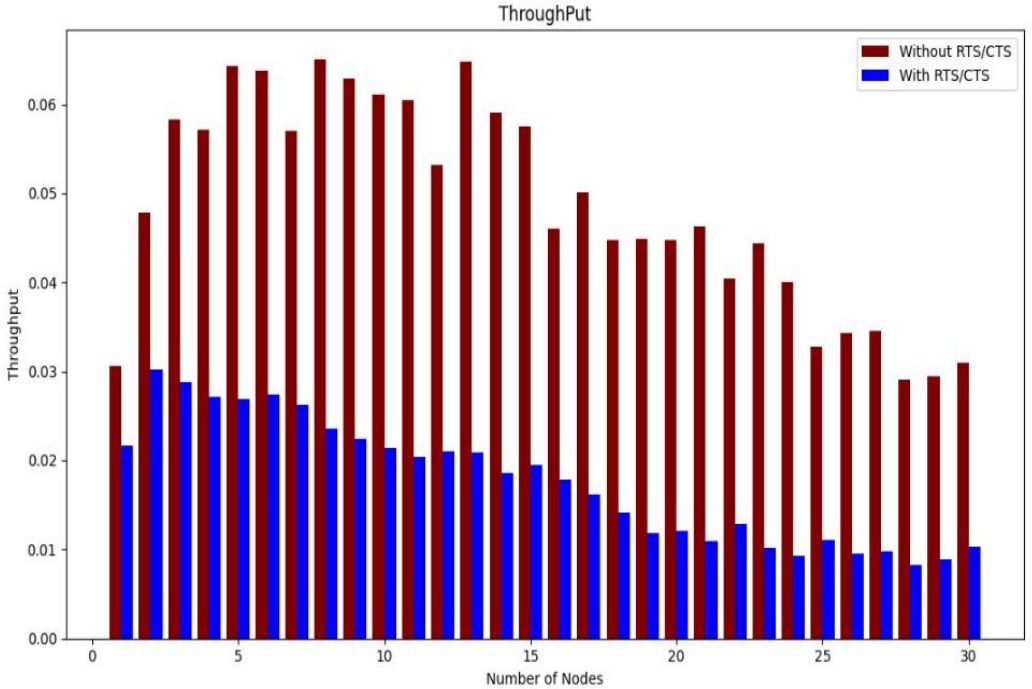


Analysis -

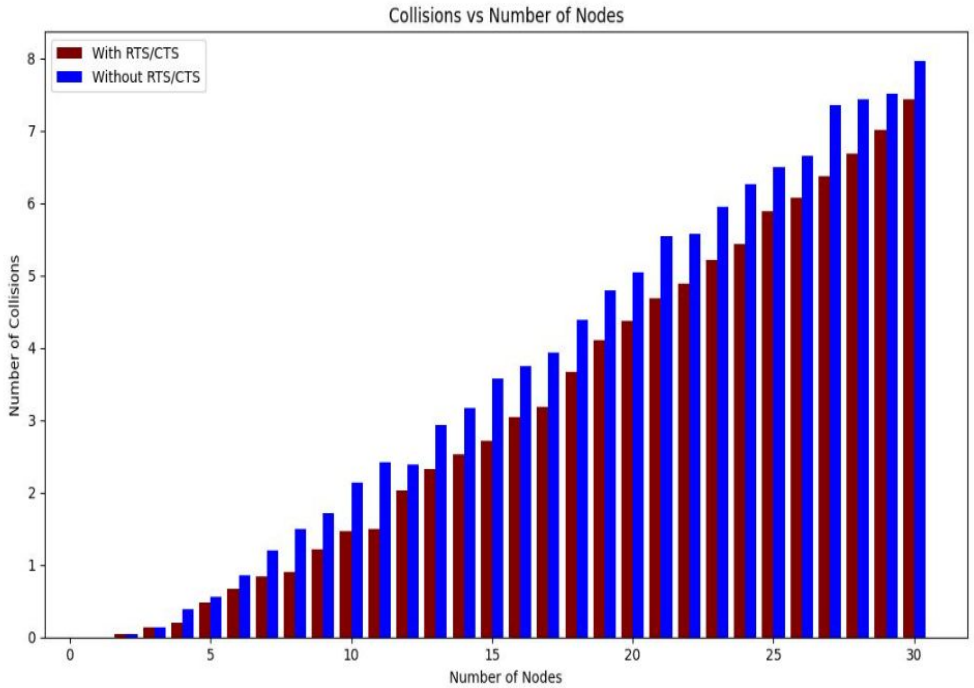
Analysis 1➔As no. of nodes increases in the network, throughput (total no. of packets transferred/total time taken) is decreasing. This is because the more the no. of nodes, more the communication and more the chances of collisions which leads to less efficient use of the channel and less throughput.



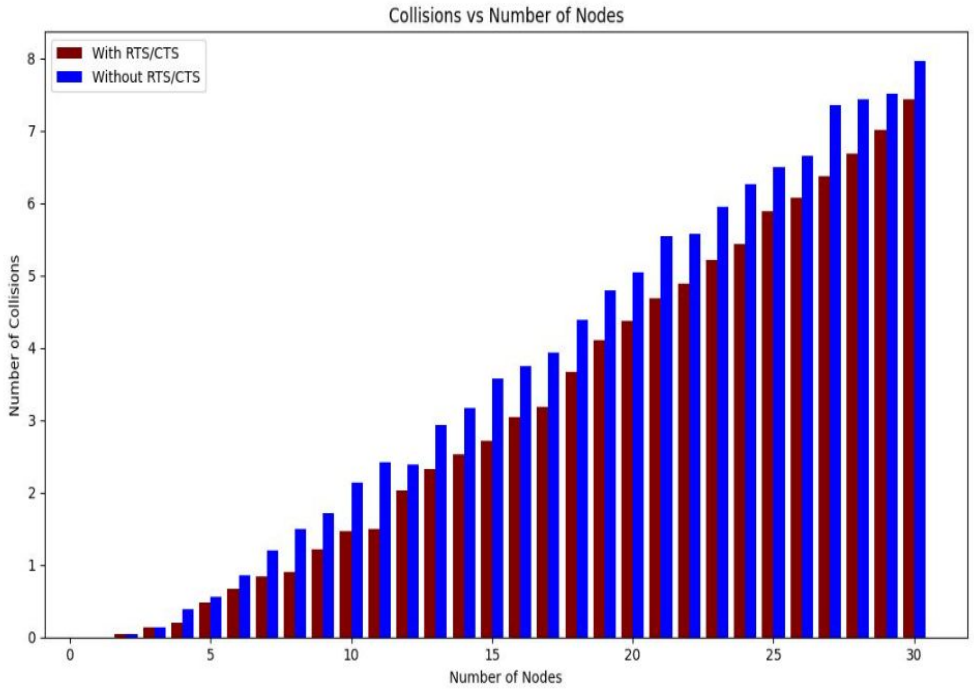
Analysis 2➔In our case (i.e. sparse network), we see that the throughput is high for without RTS/CTS mechanism (than RTS/CTS) because of the additional overhead of wait-time for all the nodes when channel is reserved by RTS/CTS. However, if we plot for dense networks the RTS/CTS one should perform better as less collisions in RT/CTS leads to less completion time and better throughput.



Analysis 3➔ We see that as no. of nodes increases, the no. of collisions in the network also increases due to more communication and more chances of collision



Analysis 4➔ Wee see that the no. of collisions in RTS/CTS case is lesser than no. of collisions in without RTS/CTS case, as RTS/CTS ensures the channel gets reserved and other nodes stop their transmission temporarily in order to reduce the chances of collisions.



Conclusion

We conclude that CSMA/CA is a powerful, relatively simplistic protocol that ensures collision avoidance in the wireless network. We also saw how RTS/CTS further improves its efficiency at the cost due to transmission of extra frames. Finally, we plotted some graphs and analyzed each of them carefully in order to back the statements above.

References

Research paper:
https://www.researchgate.net/publication/278729275_Performance_Analysis_of_CSMACA_in_Wireless_Local_Area_Network

Image references:
Image 1 [Link1]
Image 2[Link2]