Network Lab Report

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Assignment 3:
Implement 1-persistent, non-persistent and p-persistent CSMA techniques.

Theory

Carrier-sense multiple access (**CSMA**) is a media access control (MAC) protocol in which a node verifies the absence of other traffic before transmitting on a shared transmission medium, such as an electrical bus or a band of the electromagnetic spectrum.

A transmitter attempts to determine whether another transmission is in progress before initiating a transmission using a carrier-sense mechanism. That is, it tries to detect the presence of a carrier signal from another node before attempting to transmit. If a carrier is sensed, the node waits for the transmission in progress to end before initiating its own transmission. Using CSMA, multiple nodes may, in turn, send and receive on the same medium. Transmissions by one node are generally received by all other nodes connected to the medium.

We discuss three aggression methods based on the aggression of the algorithms.

1-persistent

1-persistent CSMA is an aggressive transmission algorithm. When the transmitting node is ready to transmit, it senses the transmission medium for idle or busy. If idle, then it transmits immediately. If busy, then it senses the transmission medium continuously until it becomes idle, then transmits the message (a frame) unconditionally (i.e. with probability=1). In case of a collision, the sender waits for a random period of time and attempts the same procedure again. 1-persistent CSMA is used in CSMA/CD systems including Ethernet.

Non-persistent

Non persistent CSMA is a non aggressive transmission algorithm. When the transmitting node is ready to transmit data, it senses the transmission medium for idle or busy. If idle, then it transmits immediately. If busy, then it waits for a random period of time (during which it does not sense the transmission medium) before repeating the whole logic cycle (which started with sensing the transmission medium for idle or busy) again. This approach reduces collision, results in overall higher medium throughput but with a penalty of longer initial delay compared to 1–persistent.

P-persistent

This is an approach between 1-persistent and non-persistent CSMA access modes.[1] When the transmitting node is ready to transmit data, it senses the transmission medium for idle or busy. If idle, then it transmits immediately. If busy, then it senses the transmission medium continuously until it becomes idle, then transmits with probability *p*. If the node does not transmit (the probability of this event is *1-p*), it waits until the next available time slot. If the transmission medium is not busy, it transmits again with the same probability *p*. This probabilistic hold-off repeats until the frame is finally transmitted or when the medium is found to become busy again (i.e. some other node has already started transmitting). In the latter case the node repeats the whole logic cycle (which started with sensing the transmission medium for idle or busy) again. p-persistent CSMA is used in CSMA/CA systems including Wi-Fi and other packet radio systems.

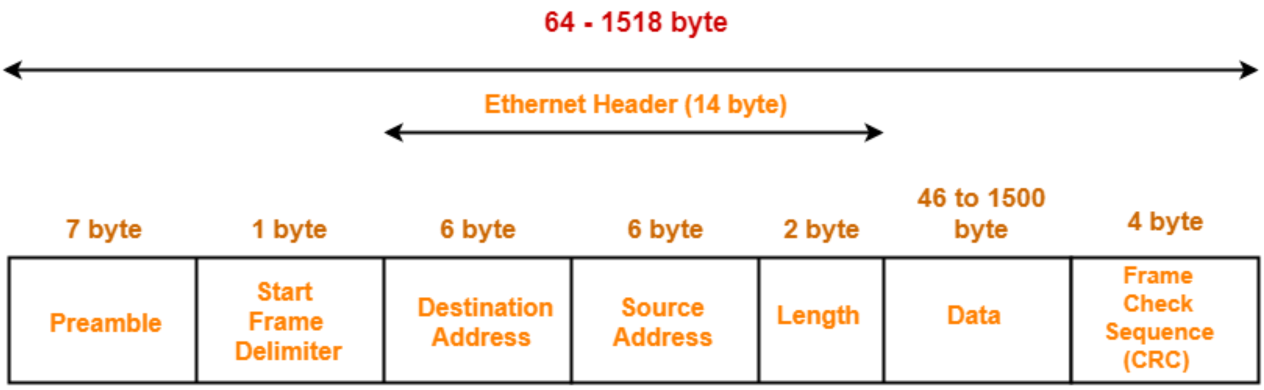
Implementation

Approach

The simulation was done in Java language. The senders were simulated as independent threads working to implement each of the persistent methods described as before.

Frame Format

The frame format used for this simulation is the IEEE 802.3 frame format.



IEEE 802.3 Ethernet Frame Format

The only change in the format is the addition of sequence number of size 1 byte which is added to the frame after the source address.

PREAMBLE - Ethernet frame starts with 7-Bytes Preamble. This is a pattern of alternative 0's and 1's which indicates starting of the frame and allow sender and receiver to establish bit synchronization
Start of frame delimiter (SFD) - This is a 1-Byte field which is always set to 10101011.
Destination Address - This is 6-Byte field which contains the MAC address of machine for which data is destined.

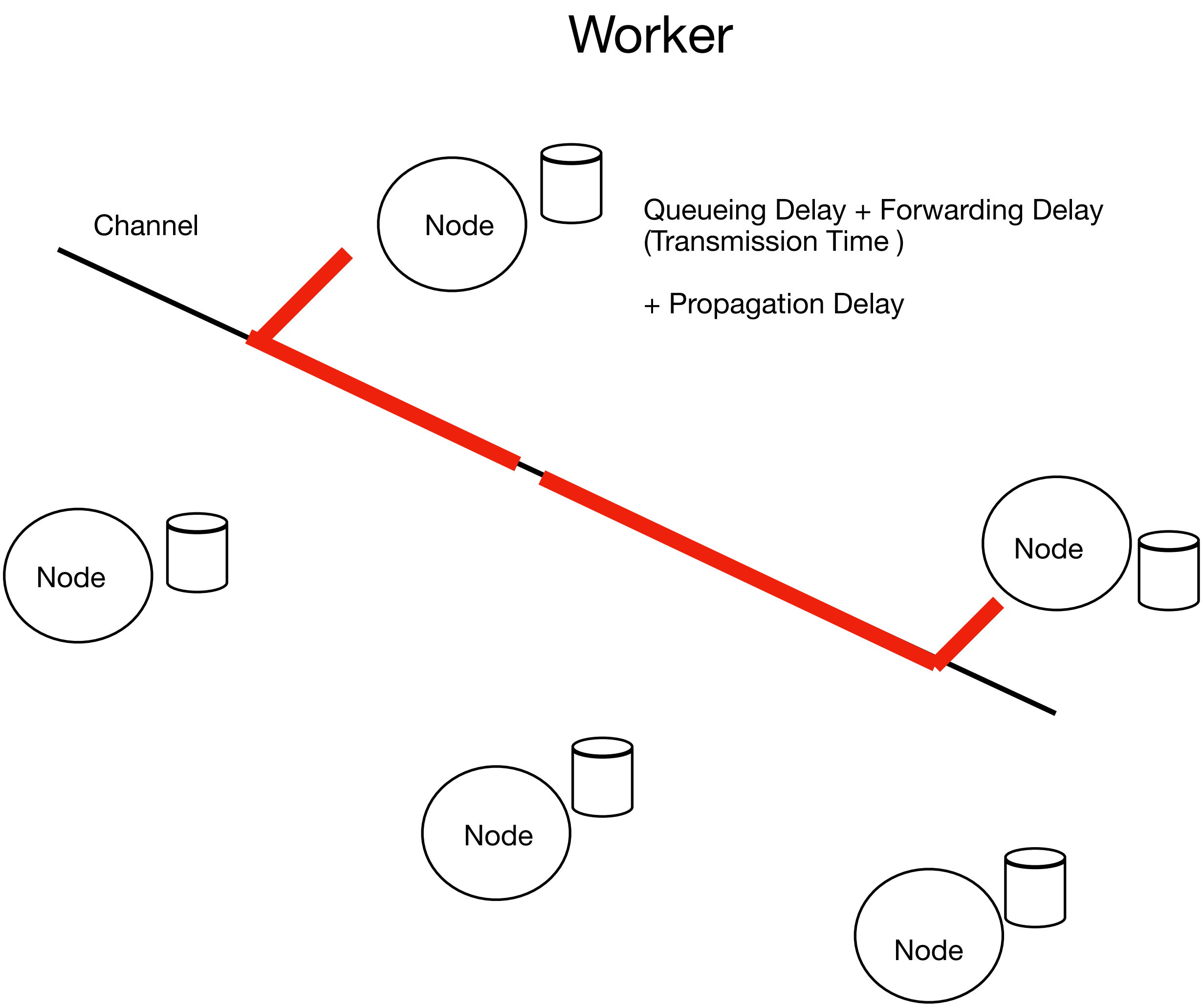
Source Address - This is a 6-Byte field which contains the MAC address of source machine. As Source Address is always an individual address (Unicast), the least significant bit of first byte is always 0.

Length : Length is a 2-Byte field, which indicates the length of entire Ethernet frame. This 16-bit field can hold the length value between 0 to 65534, but length cannot be larger than 1500 because of some own limitations of Ethernet.

Data - This is the place where actual data is inserted, also known as Payload.

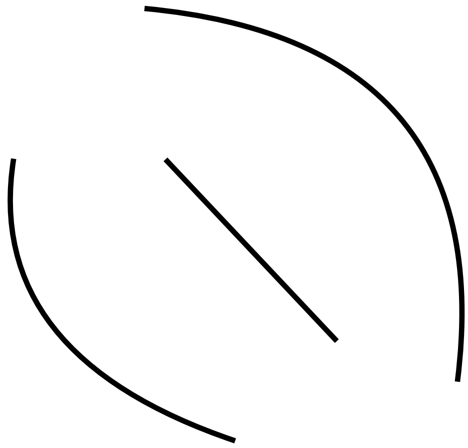
Cyclic Redundancy Check (CRC) - CRC is 4 Byte field. This field contains a 32-bits hash code of data, which is generated over the Destination Address, Source Address, Length, and Data field.

Schematic Diagram of the workflow

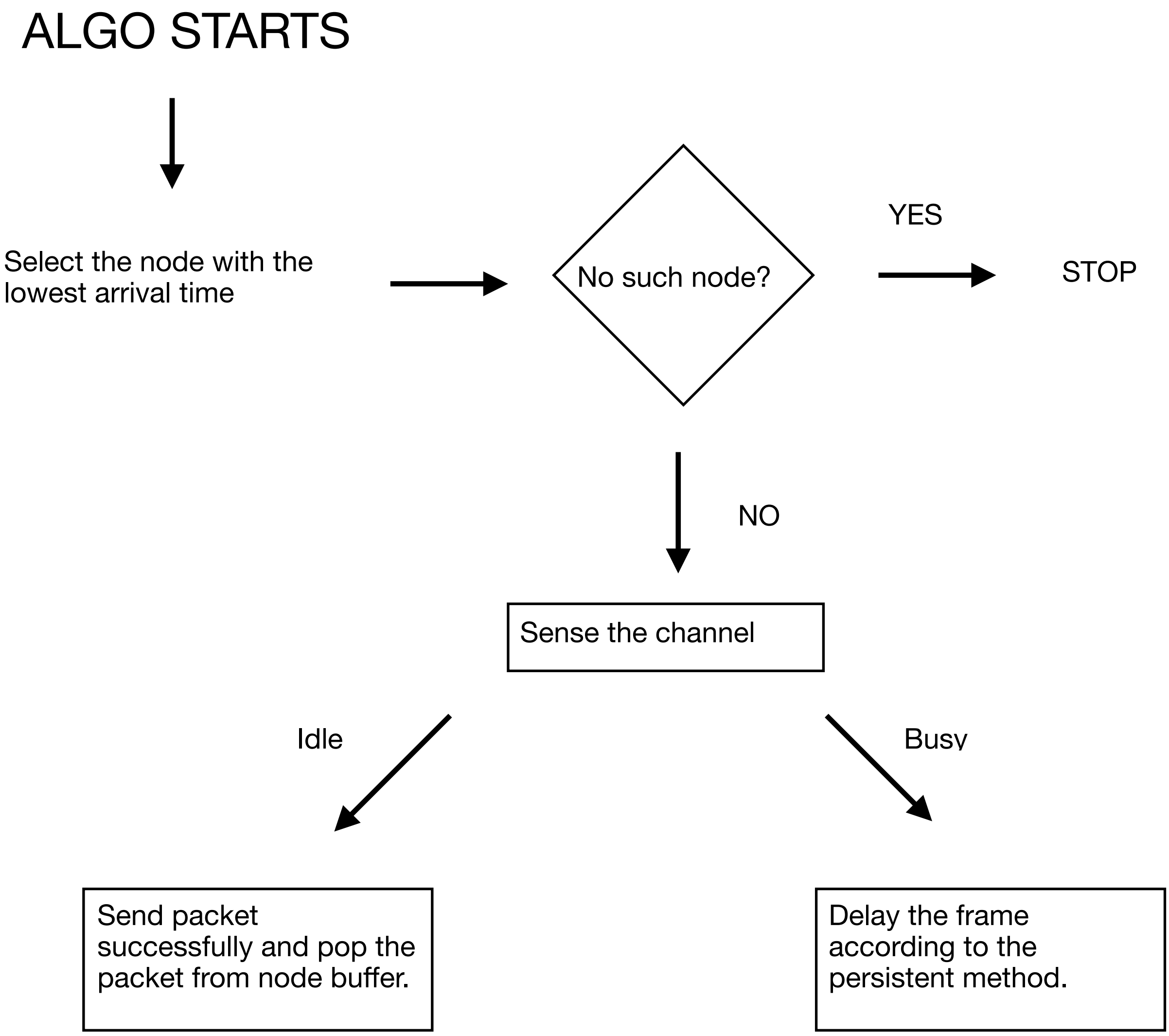


Nodes with their empty buffers on the channel ready for receiving data.

Worker.java



Different Sender Threads
Trying to fill up their buffers



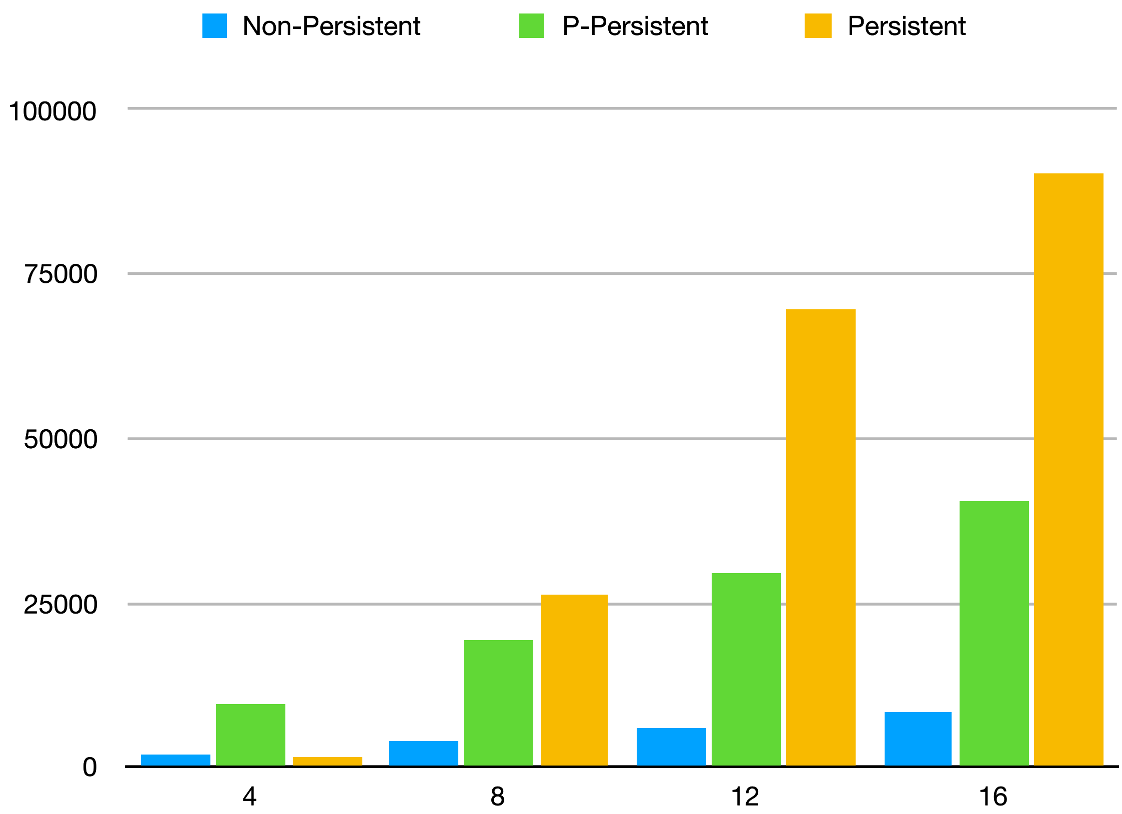
Some Definitions

Throughput: Throughput is defined as the ratio of total data bits successfully sent to time taken in transmission including all delays.

Efficiency: The ratio of successfully sent packets to the total number of transmitted packets.

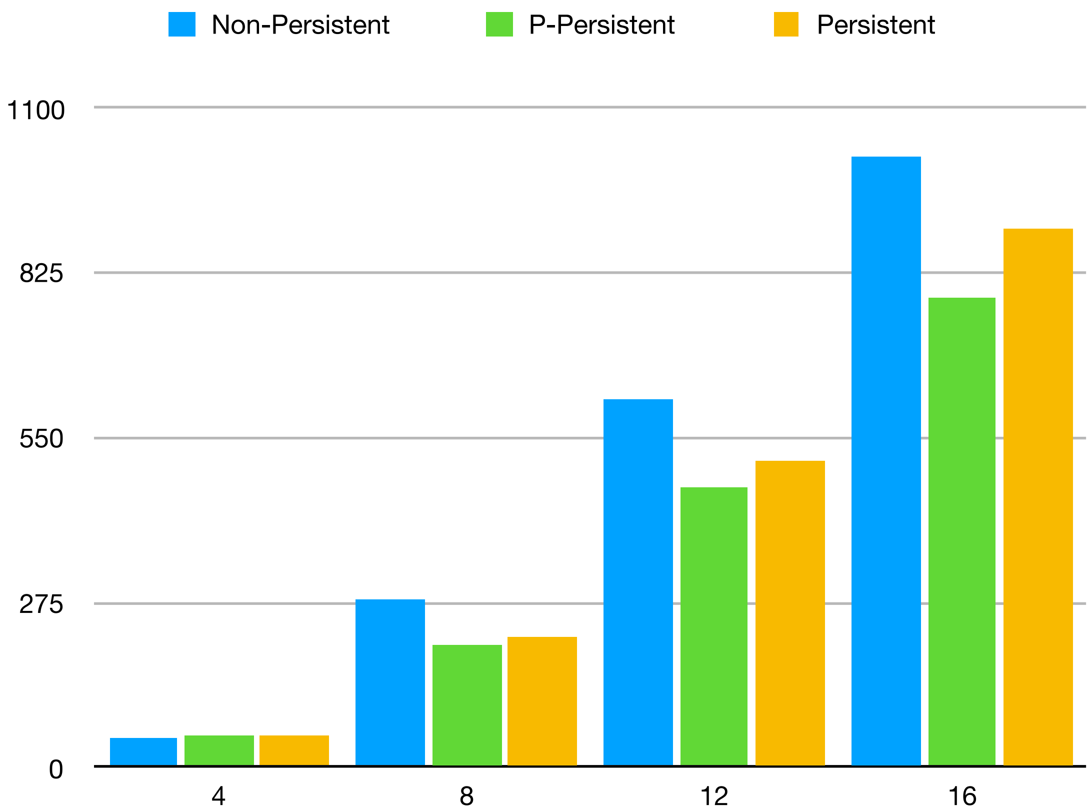
Analysis

#Case 1: Varying number of nodes with respect to the different persistent methods and checking the number of collisions faced.
X-axis gives the number of nodes and the Y-axis gives the total number of collisions faced.

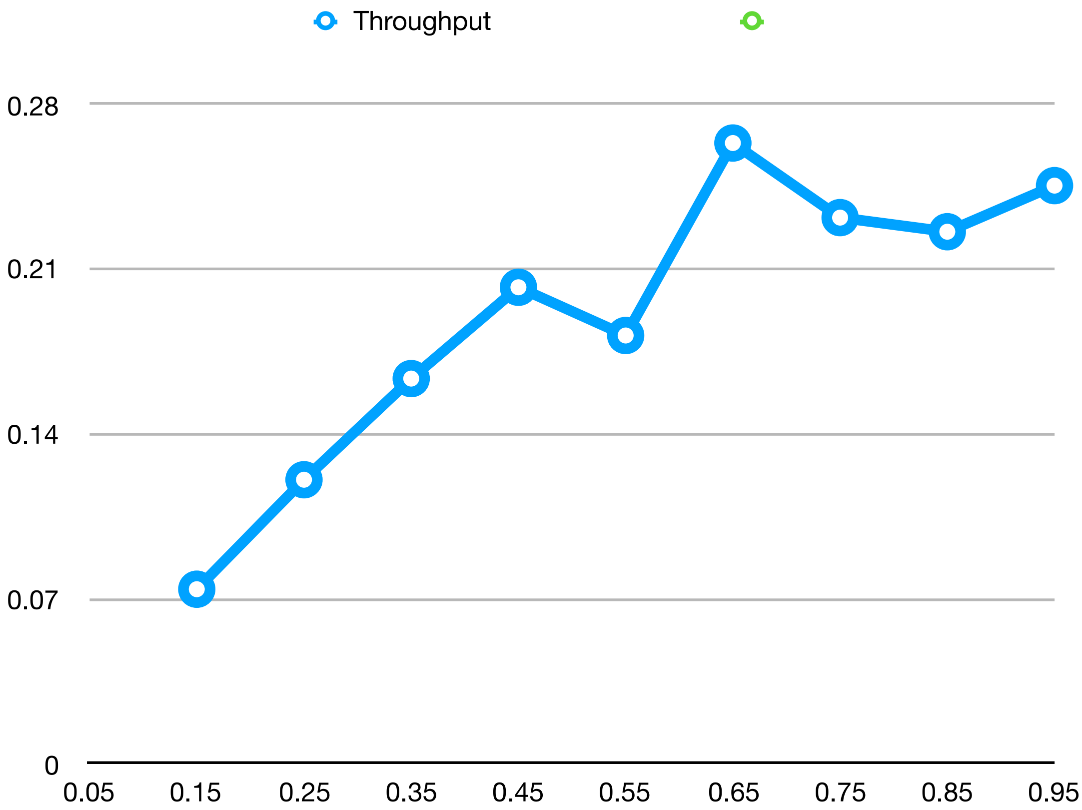


As the number of nodes increases, the congestion in the network increases and the hence the number of collisions increases. The increase in more pronounced in case of persistent approach.

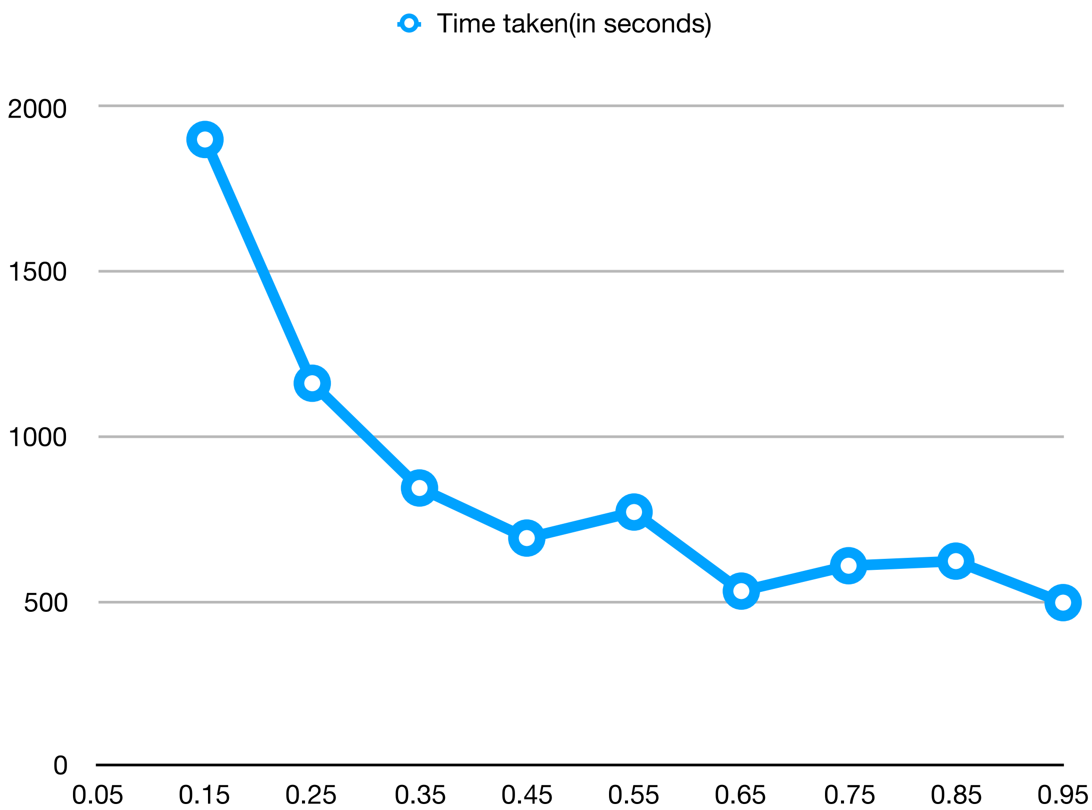
#Case 2: Comparing the time taken by the three persistent methods. X-axis gives the number of nodes and the Y-axis gives the total time including queueing delays and propagation time.



#Case 3: Comparing the throughput by varying p of the p-persistent CSMA approach. The p is varied according to the X-axis, and the throughput is along the Y-axis. The number of nodes considered for this simulation is **12.**



#Case 4: Comparing the time taken by varying p of the p-persistent CSMA approach. The p is varied according to the X-axis, and the throughput is along the Y-axis. The number of nodes considered for this simulation is **12.**



Key Takeaways:

- In case of small networks , that is, with less number of nodes the **persistent** approach performs the best. In case of medium networks, the non-persistent approach can be a good choice. In case of huge networks, the p-persistent approach with a particular value of p can produce a good throughput with less collisions.
- The choice of p depends on the number of nodes in the network.

Comments

The assignment greatly helped in understanding the CSMA protocol for medium access and was overall a great experience.