SCS 2105
Computer Networks I

Multi Access Protocols
ALOHA

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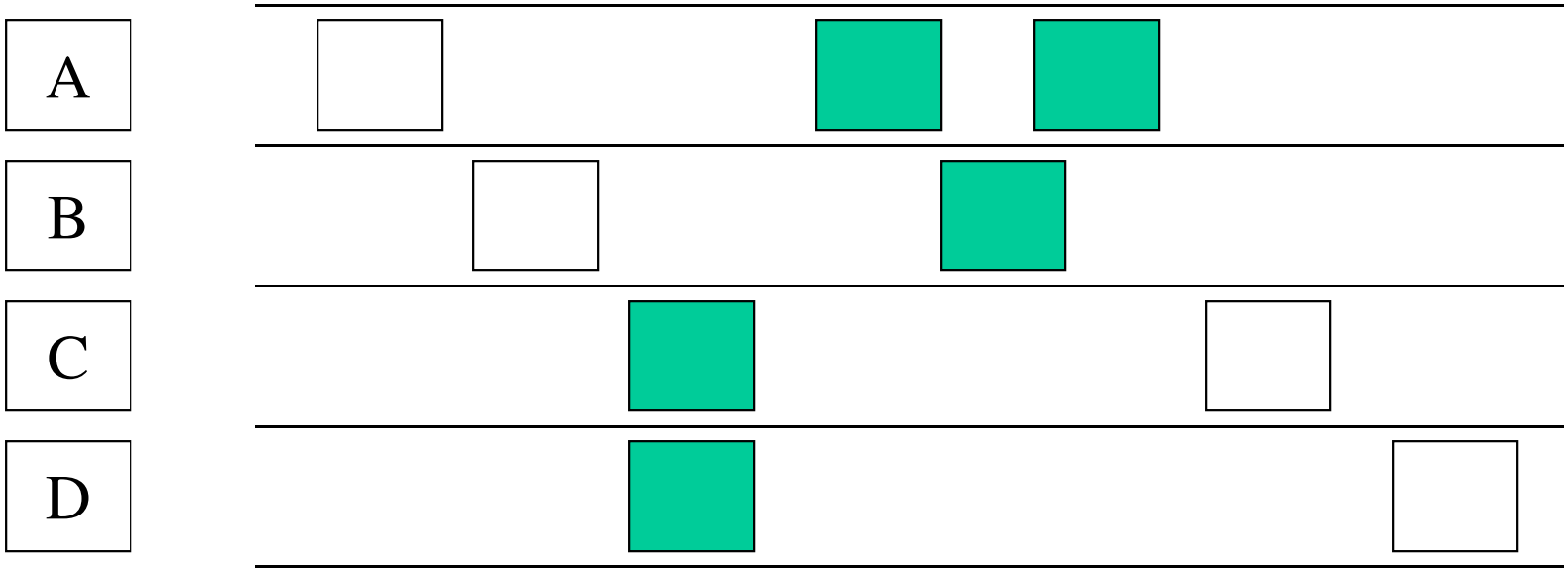
- **Multiple Access Protocols**
  - There are a number a number of algorithms or **Multiple Access Protocols** for allowing multiple computers to access the same channel
  - The first protocol that we will look at is the **ALOHA** protocol.
  - It was developed by Norman Abramson in Hawaii and it allowed multiple uncoordinated users access to a shared channel.
  - The shared channel used in this instance was ground based radio broadcasting.
  - Ideas used in the protocol are applicable to any single shared channel with uncoordinated users or computers competing to transmit messages.
  - Two types were developed:
    1. Pure ALOHA
    2. Slotted ALOHA

- **Multiple Access Protocols**

1. Pure ALOHA
   - Users or computers can transmit when they have data to send.
   - Collisions will occur, colliding frames will be **destroyed** and **re-transmitted** later.
   - Because the frame is broadcast to all, the sender can always find out whether his frame was transmitted or not by listening to the channel as it is sending.
     - In a Local Area Network setting, collision detection is immediate.
     - In a Satellite Network, then there is a delay of 270 milliseconds.
   - If a frame is destroyed, the sender just waits a random time before it transmits again
   - The waiting time must be **random** or the same frames will collide over and over again.

- **Multiple Access Protocols**
  1. Pure ALOHA
     - Pure ALOHA frames are transmitted at random times.
     - The frames are all the same size (called the 'ideal' ALOHA system).



- **Multiple Access Protocols**

1. Pure ALOHA
   - Whenever two frames try to occupy the channel at the same time they cause a collision and both frames will be corrupted.
   - If the first bit of a new frame overlaps with just the last bit of another frame, both frames will be corrupted.
   - Both frames will need to be retransmitted later.

- **Efficiency of Pure ALOHA is not very encouraging**
  - **Throughput is 18%**

- **Multiple Access Protocols**

2. Slotted ALOHA
   - In 1972, Roberts described a method for doubling the capacity of ALOHA.
   - He proposed to divide up time into slots, each slot corresponding to one frame (not to be mixed up with slot time).
   - Senders must agree on the slot boundaries, this requires **synchronisation**.
   - Synchronisation is achieved by a special station emitting a short frame at the start of each slot interval (similar to a clock tick).
   - The main difference between Slotted ALOHA and Pure ALOHA is that a computer is not allowed to transmit until the start of a slot (after the clock tick).

- **Efficiency of Slotted ALOHA is approximately twice that of Pure ALOHA**
  - **Throughput: 37% of slots empty, 37% successes and 26% collisions.**

- **Carrier Sense Multiple Access Protocols**
  - With slotted ALOHA, there are many collisions since two or more computers can transmit at once.
  - No computer **checks** if any other computer is already transmitting.
  - In Local Area Networks, it is possible for computers to detect whether other computers are transmitting or not.
  - Computers can then modify their behaviour accordingly.
  - These networks have a much better throughput rate (% of successfully transmitted frames) compared to ALOHA.
  - Protocols in which computers listen for a carrier (signal on the cable) and act accordingly are called **carrier sense** protocols.
  - Carrier sense meaning that any computer can check if the transmission of a frame on the cable has already started.
  - There are two different types of carrier sense protocols:
    1. **Persistent** Carrier Sense Multiple Access
    2. **Non persistent** Carrier Sense Multiple Access

- **Carrier Sense Multiple Access Protocols**
  - The first Carrier sense protocol is called a 1-persistent Carrier Sense Multiple Access (**CSMA**).
  - Computers using the 1-persistent Carrier Sense Multiple Access execute the following steps.

1. When a computer has data to send, it first listens to the channel to see if it is busy.
2. If the channel is busy, then the computer waits until it becomes idle.
3. When the channel is idle (i.e. there is no transmission in progress on the cable), the computer transmits a frame.
4. While transmitting the frame, the computer listens to the channel to see if there has been a collision.
5. If a collision occurs, the computer waits a random amount of time and attempts to transmit again using the previous steps.

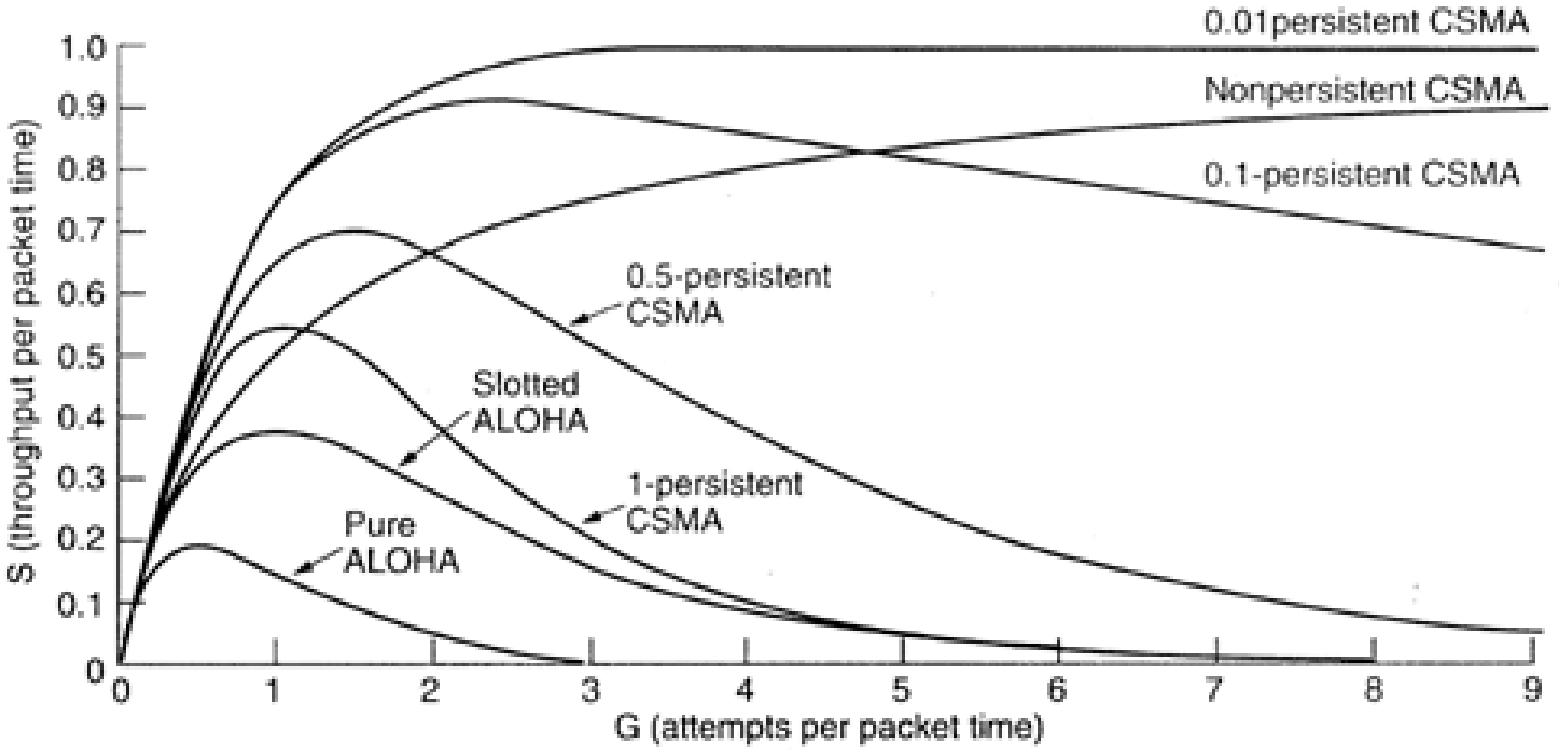
- **Carrier Sense Multiple Access Protocols**
  - The protocol is called 1-persistent because when the channel is idle, the computer transmits with probability 1.
  - The time it takes for the electrical signal to propagate over the cable has an important effect on the performance of the protocol. This time is known as the **propagation delay**.
  - There is a small chance that after one computer begins sending, another computer becomes ready to send and senses the channel.
  - If the first computer's signal has not reached the second computer, then the second will begin transmitting, resulting in a collision.
  - Even if the propagation delay was zero, there would still be collisions.
  - For example, if two computers become ready to transmit during another computers transmission.
  - Both computers will wait until the channel becomes idle and then begin to transmit resulting in a collision.

- **Carrier Sense Multiple Access Protocols**
  - 1-Persistent CSMA is better than Pure ALOHA because at least computers wait until there are no transmissions before attempting to transmit.
  - Similar to Slotted ALOHA, collisions can still occur if two computers try to transmit at the exact same time after the channel becomes idle.
  - A second carrier sense protocol is **Non persistent CSMA**.
  - In this protocol, an attempt is made to be less greedy than 1-Persistent CSMA.
  - Instead of waiting for the channel to become idle as in the 1-Persistent case, on detecting that the channel is busy, a computer using the Non persistent CSMA protocol waits a random time before listening again.
  - If it is idle, then it transmits its frame.

- **Carrier Sense Multiple Access Protocols**
  - A third carrier sense protocol is **p-persistent CSMA**.
  - This protocol applies to slotted channels.
  - When a station is ready to transmit, it senses the channel.
  - If the channel is busy, it waits until the channel become idle.
  - If the channel is idle, the computer either transmits with a probability **p** or waits a further slot with probability **1 - p**.
  - If the channel remains idle during this slot, then again the computer either transmits with probability **p** or waits a further slot with probability **1 - p**.
  - If the channel is busy, then the computer waits a random time and starts again.
  - For example, if we set p = 0.9. Then the probability of a host **not** transmitting after 4 idle slots is

    (1 – 0.9) * (1 – 0.9) * (1 – 0.9) * (1 – 0.9) = 0.0001

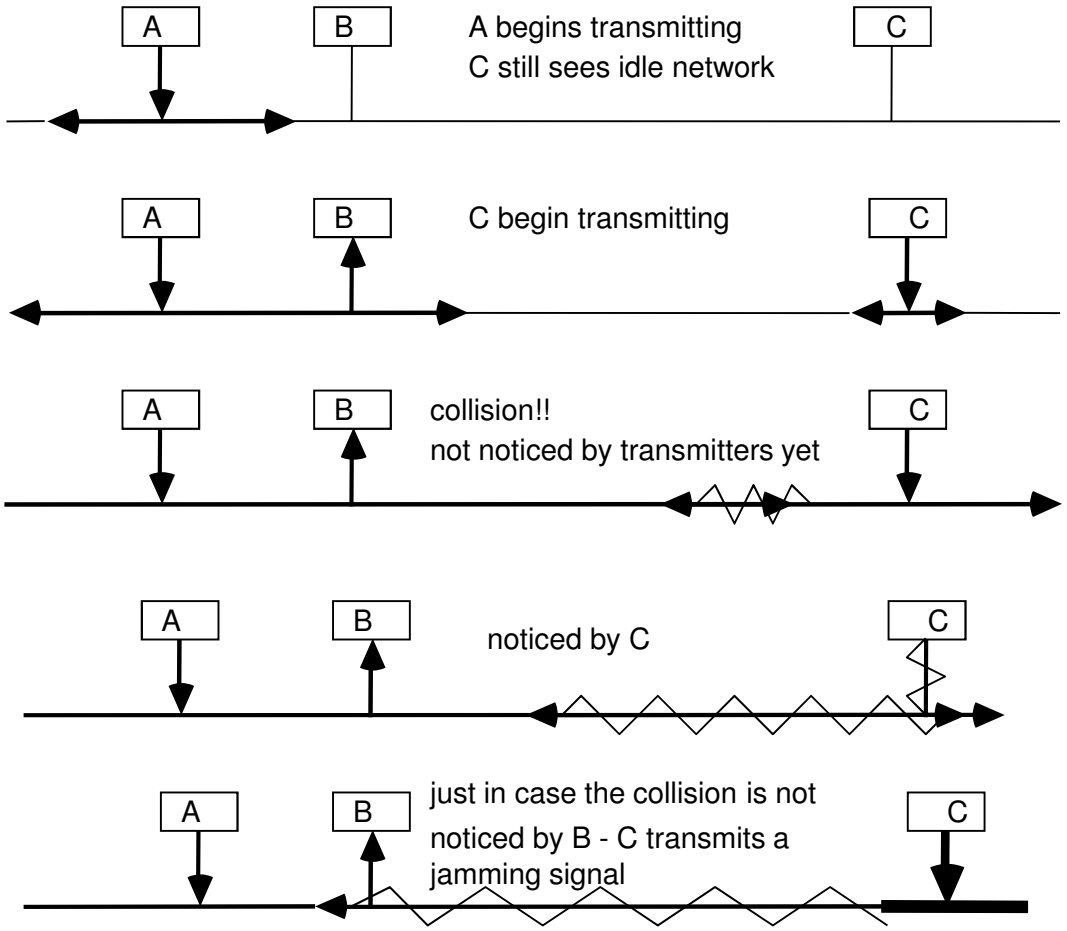
Comparison of CSMA and ALOHA Protocols



(Number of Channel Contenders)

- **CSMA with Collision Detection**
  - Both **persistent** and **non persistent** are clearly an improvement on ALOHA because no computer transmits when it senses the channel busy.
  - Another improvement would be if computers were to abort their transmissions as soon as they detect a collision.
  - In other words, if two computers sense the channel idle and begin transmission simultaneously they will both detect the collision immediately.
  - Rather than finishing transmitting their frames, which will be corrupted, they should stop transmitting their frames as soon as a collision is detected.
  - They should transmit a short **jamming signal** to notify all computers connected to the channel that a collision occurred.
  - This protocol is called **CSMA/CD** (Carrier Sense Multiple Access with Collision Detection).

- **CSMA with Collision Detection**
  - At any given time, when a computer has finished transmitting its frame any other computer may now send a frame.
  - If two computers decide to transmit at the same time, there will be a collision.
  - Collisions can be detected by each transmitting computer looking at the power or pulse width of the received signal and comparing this to the power or pulse width of the transmitted signal.
  - After a computer detects a collision, it aborts its transmission and transmits a jamming signal for a well known duration (the slot time).
  - The computer then waits a random time (backoff) and tries again if the channel is not busy.
  - The back-off algorithm that CSMA/CD uses is called **Binary Exponential Backoff Algorithm**.



B sees jamming signal – It rejects the current frame or packet

A also sees jamming signal – It rejects current frame or packet

The End !