MAC Sub-Layer

COMP90007 Internet Technologies

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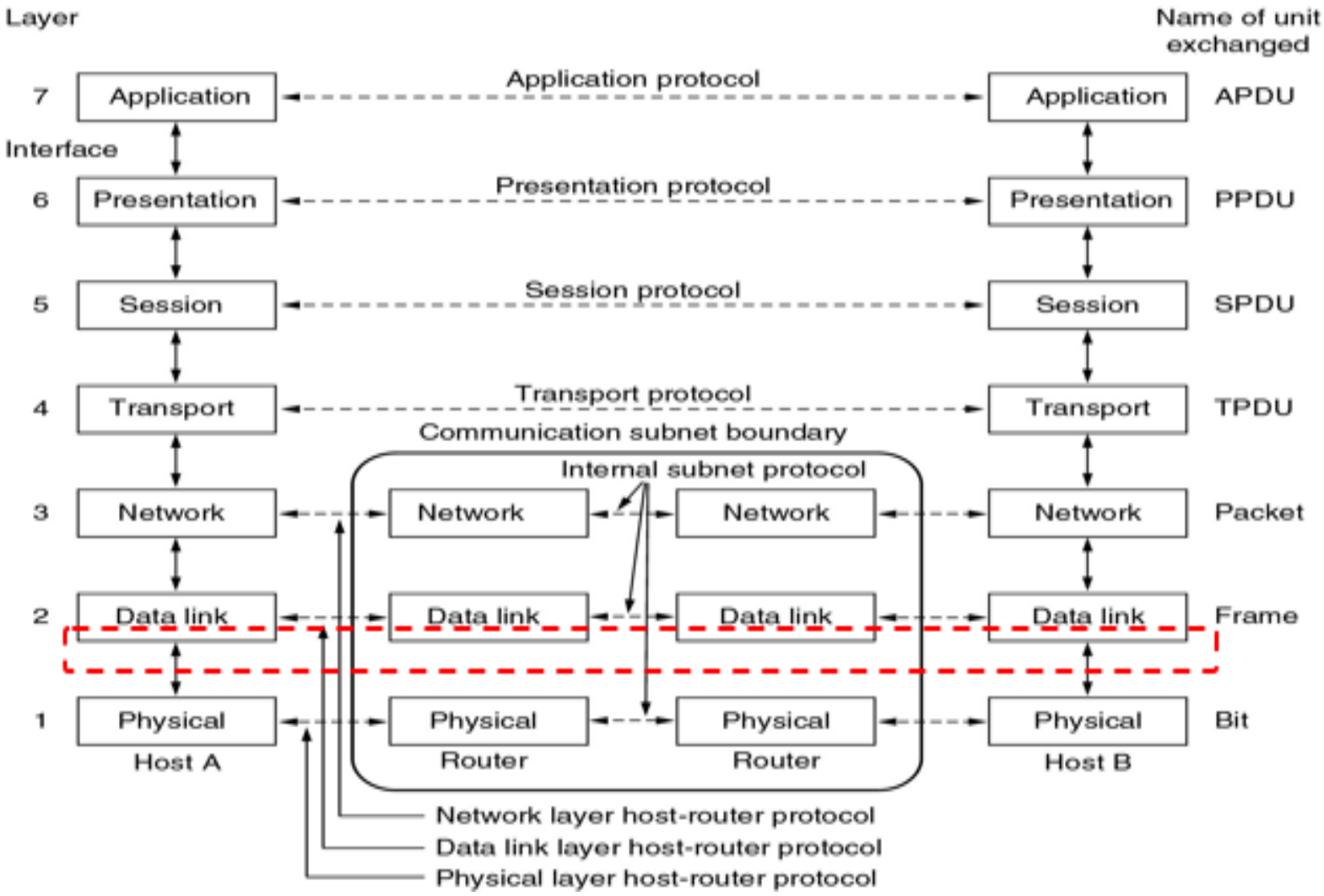
Introduction

- On **point to point networks**, there are only singular sender and receiver pairs, eliminating transmission contention
- On **broadcast networks**, determining right to transmit is a complex problem
- **Medium Access Control (MAC)** sub-layer is used to assist in resolving transmission conflicts

MAC Sub-layer



Types of Channel Allocation Mechanisms

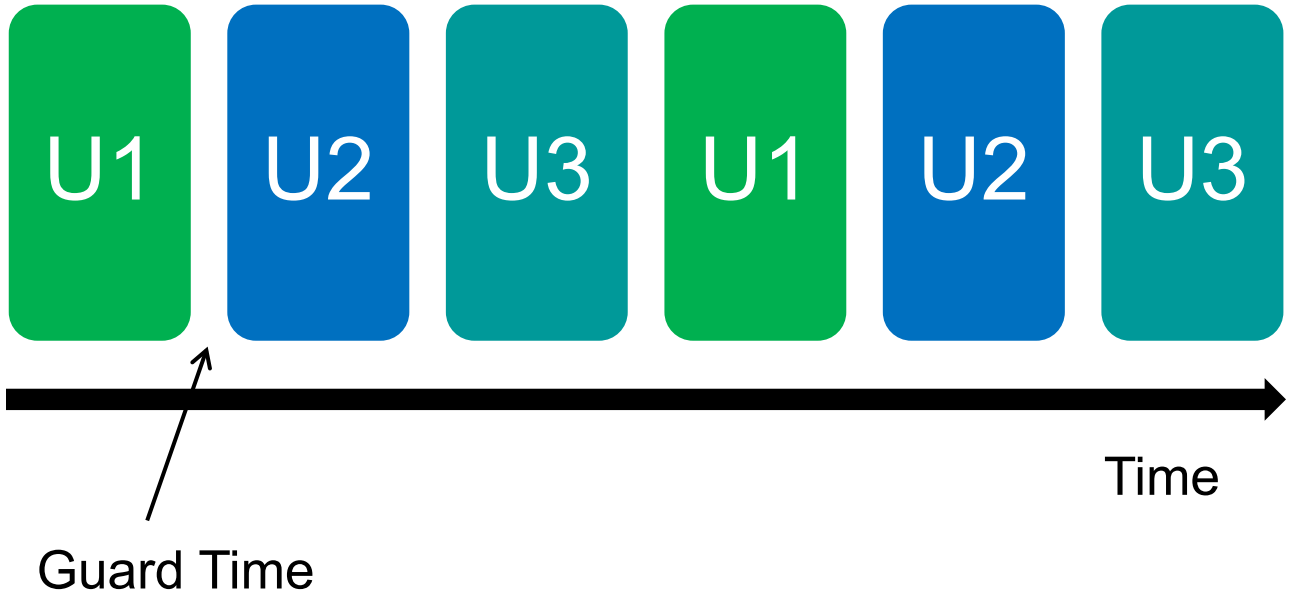
- Various methods exist for allocating a single broadcast channel amongst competing users
  - **Static Channel Allocation**
  - **Dynamic Channel Allocation**

Static Channel Allocation (1)

- Arbitrary division of a channel into segments and each user is allocated a dedicated segment for transmission
- Time Division Multiplexing (TDM) and Frequency Division Multiplexing (FDM)

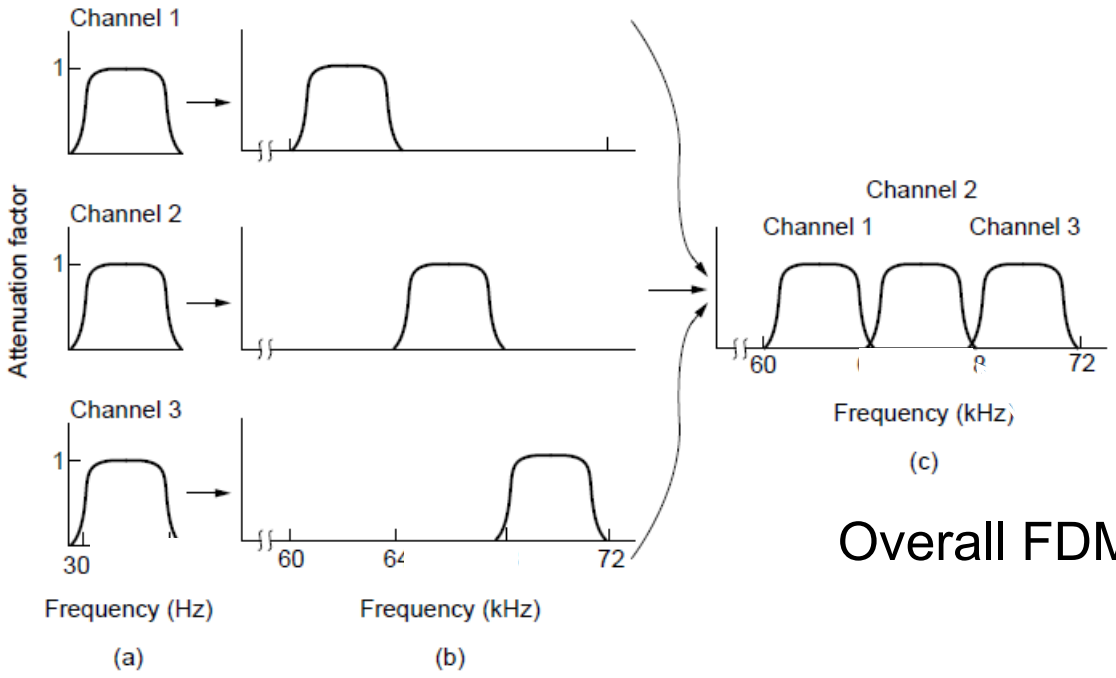
Time Division Multiplexing

- TDM: users take turns on a fixed schedule
- e.g. 2G uses TDM



Frequency Division Multiplexing

- FDM shares the channel by placing users on different frequencies.
- e.g. TV and Radio use FDM



Overall FDM channel

Static Channel Allocation (2)

- Usually good for fixed number of users
- Significant inefficiencies arise when:
  - Number of senders > allocated segments
  - Number of senders is not static
  - Network Traffic is bursty: static methods TDM and FDM try to give consistent access to the network

Dynamic Channel Allocation (1)

- Channel segmentation is dynamic, segment allocation is dynamic
- Assumptions for dynamic channel allocation:

1) Independent transmission stations
2) Single channel for all communication
3) Simultaneous transmission results in damaged frames (collision)

Dynamic Channel Allocation (2)

4) Time

- Continuous: Transmission can begin at any time
- Slotted: Transmission can begin only within discrete intervals

5) Carrier Sense

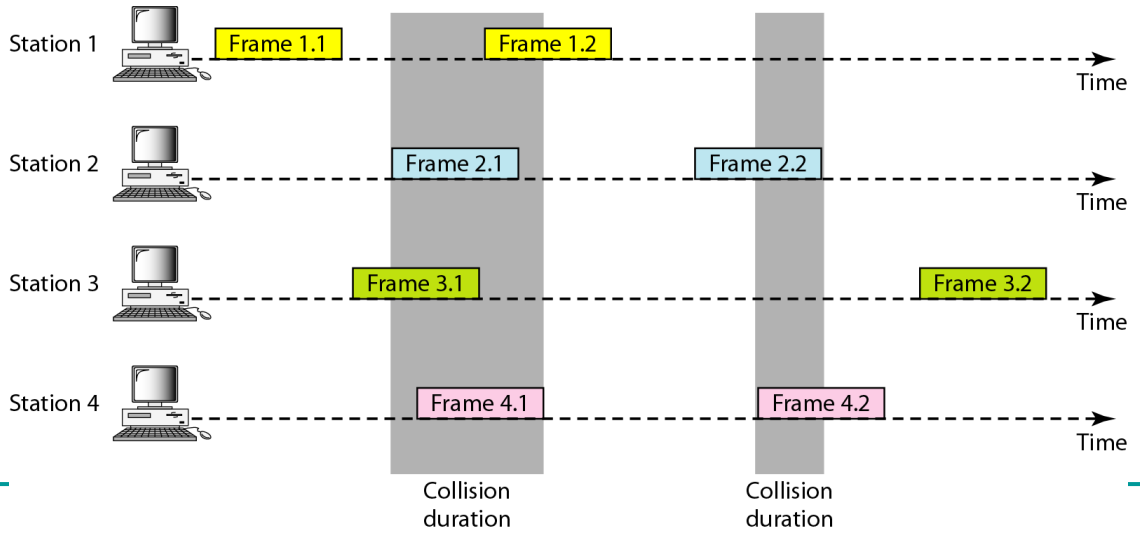
- Carrier Sense: Detection of channel use prior to transmission
- No Carrier Sense: No detection of channel use prior to transmission

Multiple Access Protocols

- Contention
  - ALOHA
  - Carrier Sense Multiple Access
- Collision Free
- Limited Contention
- MACA/MACAW (for Wireless LANs)

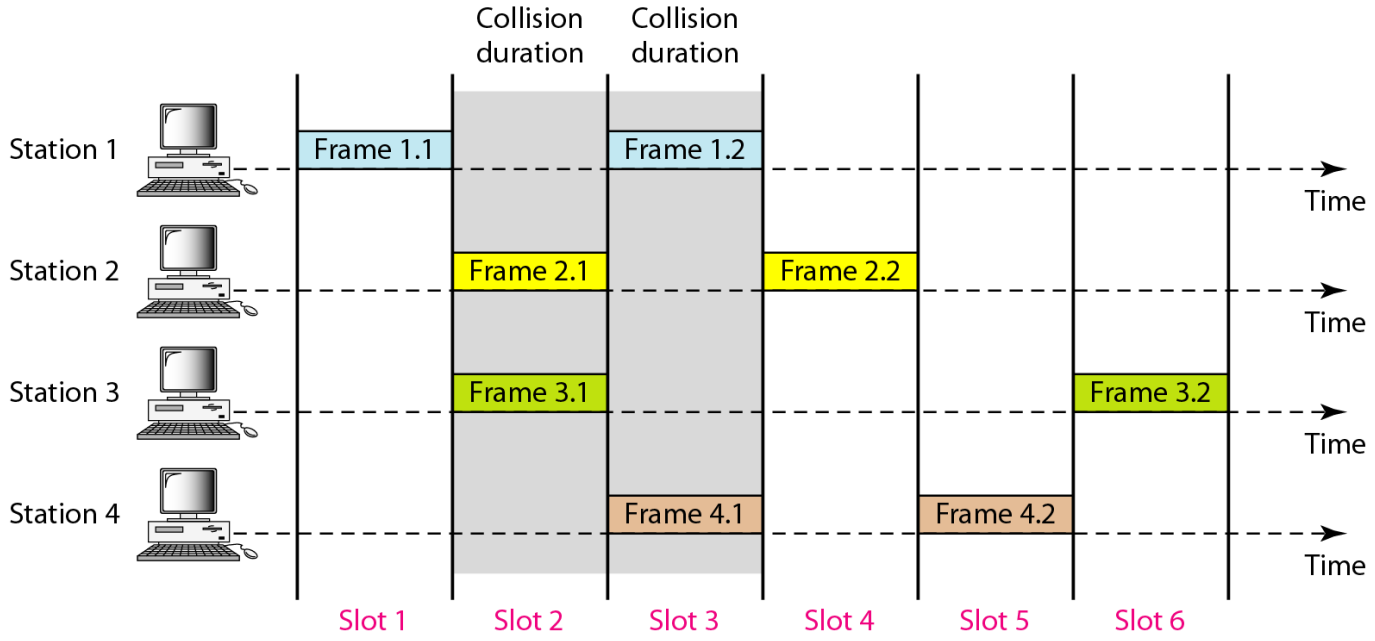
ALOHA

- Users transmit frames **whenever they have data**; **retry after a random time** if there are collisions (or no Ack is arrived)
- Requires **no central control mechanism**
- **Efficient under low load** but inefficient under high traffic loads



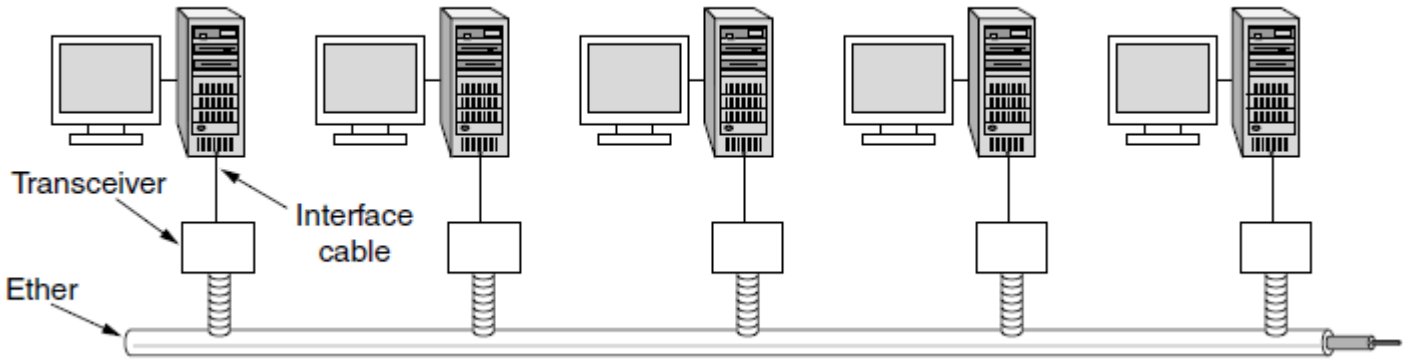
Slotted ALOHA

- Allows the users to start sending **only at the beginning of defined slots**.
- Increase efficiency of pure ALOHA by reducing possibility of collisions



Carrier Sense Multiple Access (CSMA)

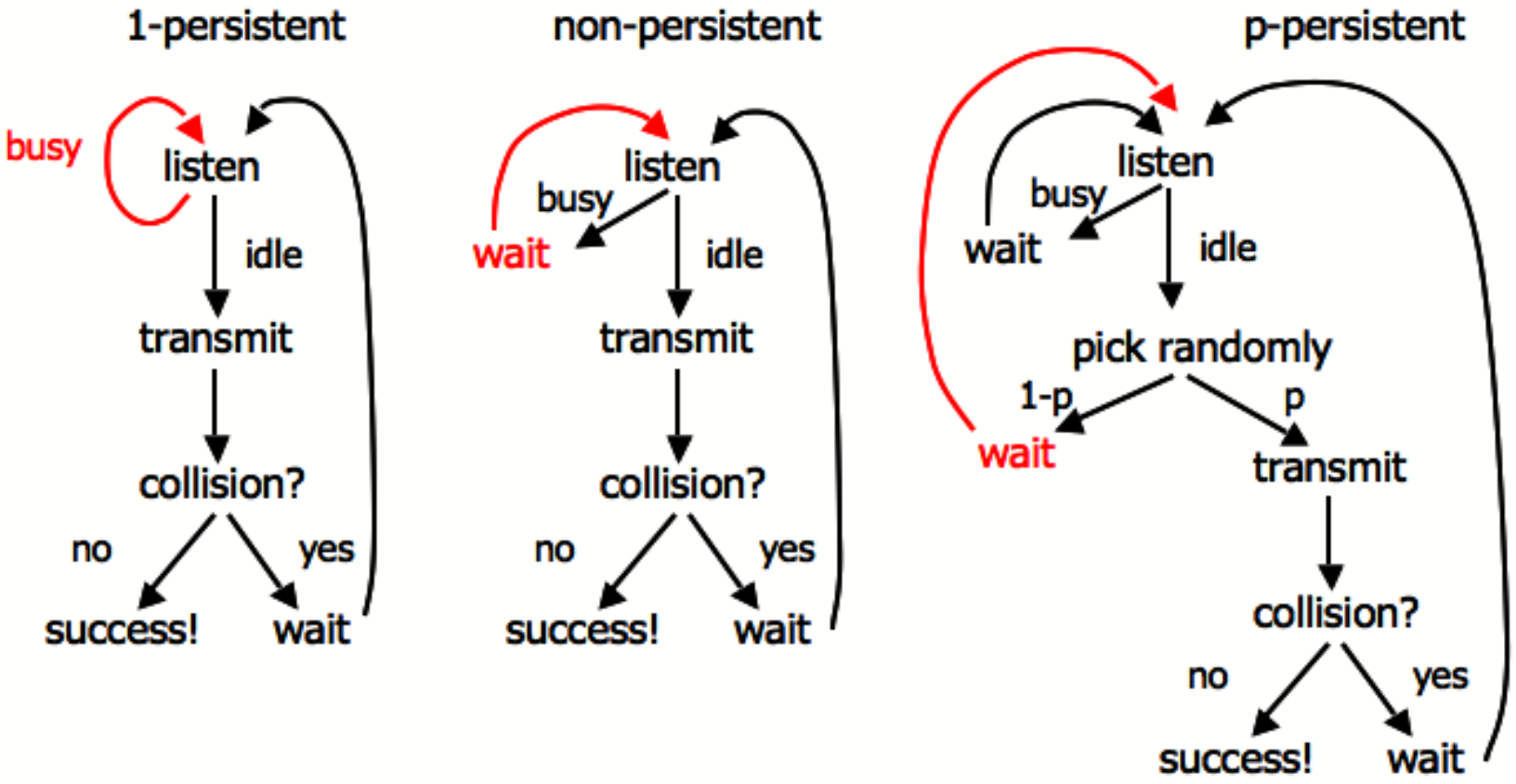
- **Require transmission state detection** to determine transmission rights dynamically, there are specific protocols which are used
  - Persistent and Non-Persistent CSMA
  - CSMA with Collision Detection



Persistent and Non-Persistent CSMA (1)

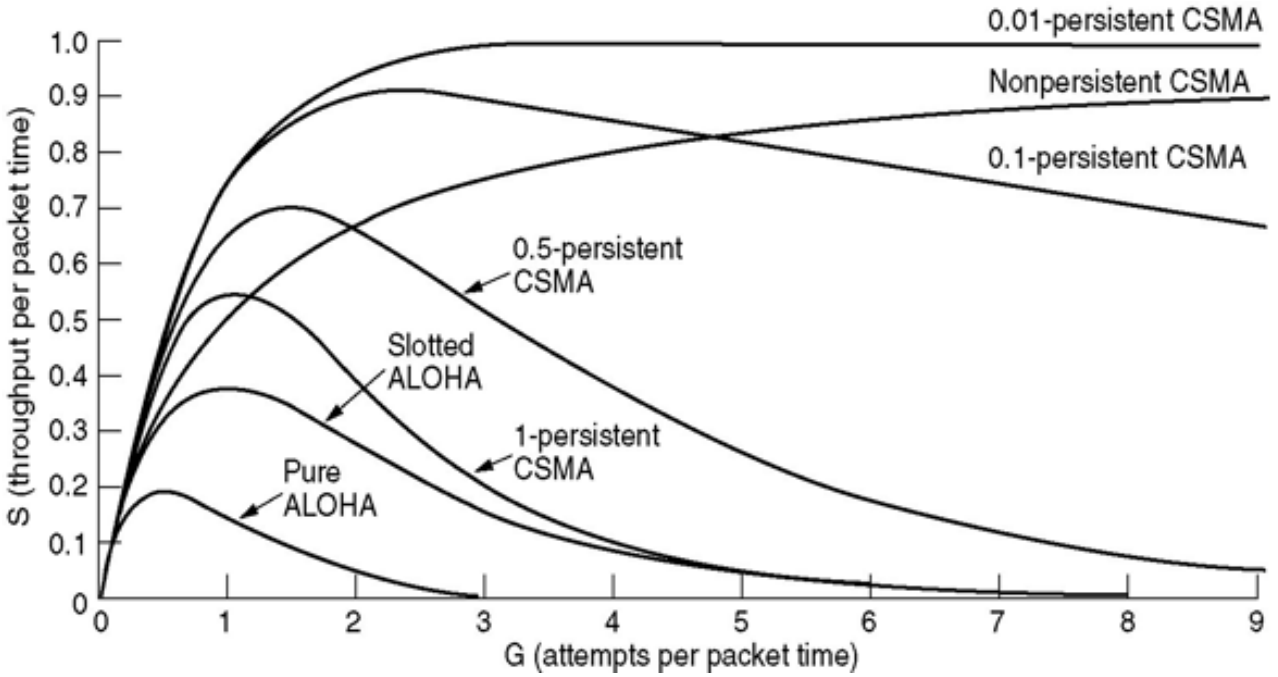
- When a sender has data to transmit, first check channel to **detect other active transmission**
- **1-persistent CSMA**
  - **Continuously check, and wait until channel idle; transmit one frame and check collisions**; if collision, wait for a random time and repeat
- **Non-persistent CSMA**
  - **If channel busy, wait random period and check again**; if idle, start transmitting
- **p-persistent CSMA**
  - **If channel idle, transmit with probability p, or wait with probability (1-p)** and check again

Persistent and Non-Persistent CSMA (2)



CSMA Variants

- Comparison of the efficiencies (channel utilisations) for various protocols



CSMA outperforms ALOHA, and being less persistent is better under high load