MAC Sub-Layer

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COMP nologies

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Introduction

- On **point-to-point networks**, there are only singular sender and receiver pairs, eliminating transmission contention
- On **broadca** ining right to transmit is a
- **Medium Access Contr** ub-layer is used to assist in resolving transmission conflicts

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MAC Sub-layer

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Types of Channel Allocation Mechanisms

- Various methods exist for allocating a single broadcast channel amongst competing
  - Static Cha
  - Dynamic Channel Allo

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Static Channel Allocation

- Arbitrary division of a channel into segments and each user is allocated a dedicated segment for transmission
  - Time Divisio
  - Frequency (M)

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Time Division Multiplexing

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

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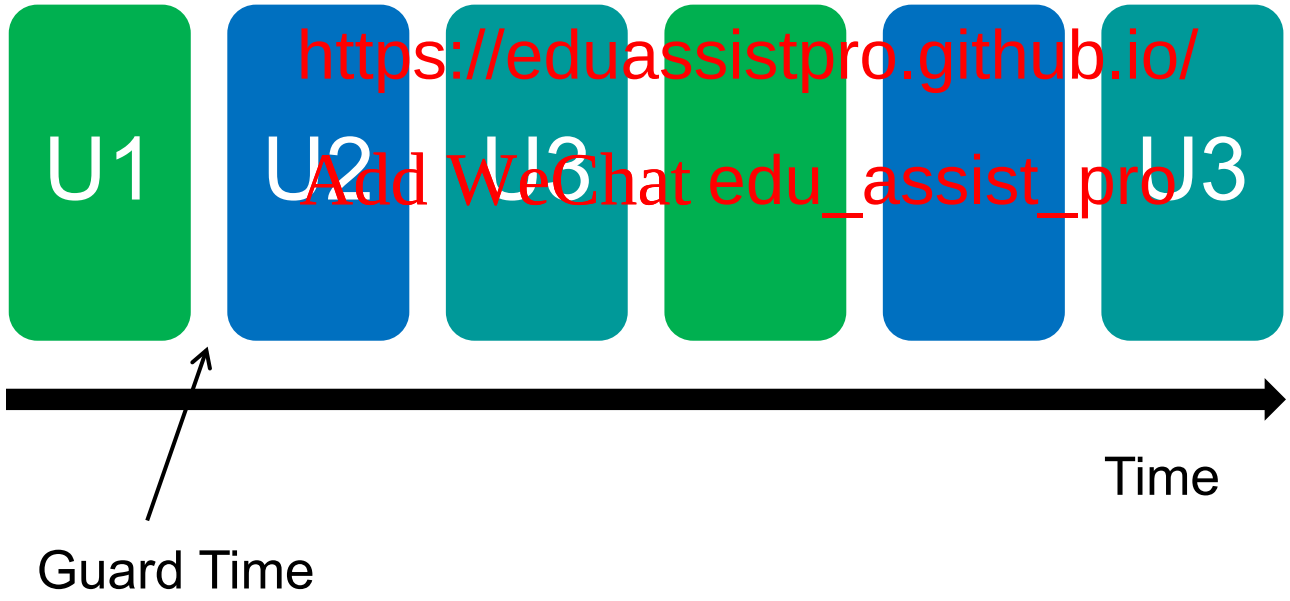

Frequency Division Multiplexing

- FDM shares the channel by placing users on different frequencies.
- e.g. TV and Radio; ADSL; 4G

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Overall FDM channel

Static Channel Allocation

- Usually good for fixed number of users
- Significant inefficiencies arise when:
  - Number of senders > allocated segments
  - Number of s
  - Network traffic is bursty, b thods TDM and FDM try to give consistent ne network

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Dynamic Channel Allocation (1)

- Channel segmentation and segment allocation are dynamic
- Assumptions for dynamic channel allocation:

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1) Single cha n

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2) Independent transmission

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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 Sen

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

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Multiple Access Protocols

- Contention
  - ALOHA, Slotted ALOHA
  - Carrier Sense Multiple Access
- Collision Fre
- Limited Contention
- MACA/MACAW (for Wire s)

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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 under high traffic loads

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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

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Carrier Sense Multiple Access (CSMA)

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

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Persistent and Non-Persistent CSMA (1)

CSMA: when a sender has data to transmit, first check channel to detect other active transmission

- **1-persistent CSMA**
  - Continuously c … idle; transmit one frame and che … for a random time and repeat
- **Non-persistent CSMA**
  - If channel is busy, wait random period and check again; if idle, start transmitting
- **p-persistent CSMA**
  - If channel is idle, transmit with probability *p*, or wait with probability *(1-p)* and check again

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Persistent and Non-Persistent CSMA (2)

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CSMA Variants

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

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

CSMA with Collision Detection

- Process: After collision detected, abort transmission, wait random period, try again
- Channel must be continually monitored
- Reduce conte erformance

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Collision Free Protocols (1)

- Bit Map Protocol
  - Reservation-based protocol
  - Overhead: 1 bit per station
  - Division of tr ansmission event - no collisions

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Collision Free Protocols (2)

- Binary Countdown Protocol
  - Defines transmission order based on the binary station addressing
  - Higher num gher priority - no collisions

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Collision Free Protocols (3)

- Binary Countdown Protocol
  - Stations send their address from high-order bit in contention slots ($\log_2 N$ slots instead of N)
  - Channel means stations give up when they send a "0" but see a "1"
  - The station that sees its full address is the next to send

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Contention vs. Collision Free

- **2 strategies: contention** and **collision free**
  - Under **low loads** (collisions are rare), the collision free is less attractive due to the overhead.
  - Under **high** thod is less attractive du ollisions.
- Both become inefficient at diff s

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