

# VE489 Recitation 4 -- Medium Access Control

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# Recap

- Data Link Layer
  - Logical Link Control
  - Medium Access Control
    - Channelization (e.g. TDMA, FDMA, CDMA)
    - Random Access (e.g. Aloha, Slotted Aloha, CSMA/CD)
    - Scheduling

# Scheduling

- Aim: allocate resource; schedule frame transmission to avoid collision
- Goal:
  - Channel utilization
  - Reduce var in delays
  - Fairness between stations
- Approaches
  - Reservation
  - Polling
  - *Diff?*

# Reservation

- Centralized reservation: a central controller accepts requests from station and issues grants to transmit
- Distributed reservation: a decentralized algorithm to determine transmission order

# Channelized vs. Random Access Reservation

$M$  : # of minislots in a frame

$N$  : # of users

- Channelized reservation
  - If  $M = N$
  - Reservation message typically follows TDMA
- Random Access reservation
  - If  $M \ll N$
  - Reservation message are transmitted randomly

# Efficiency of Channelized Reservation

$X$ : transmission time of a frame

$M$ : # of minislots in a frame

$N$ : # of users

- Single Frame Reservation

$$\rho_{max} = \frac{MX}{MvX + MX} = \frac{1}{1 + v}$$

- Multiple Frame Reservation

$$\rho_{max} = \frac{MkX}{MvX + MkX} = \frac{1}{1 + \frac{v}{k}}$$

## Efficiency of Random Access Reservation

$$\rho_{max} = \frac{X}{X(1 + ev)} = \frac{1}{1 + 2.71v}$$

e.g. GPRS

- Uses slotted Aloha for reservation
- Single / multiple frame reservation

# Polling

Centralized Polling

Distributed Polling



# Polling Service Limit

How much is a station allowed to transmit per poll?

- Exhaustive
- Gated
- Frame-limited
- Time-limited

## Walk Time & Cycle Time

- Walk time: from a station completes transmission to the next station begins transmission
- Cycle Time: between consecutive polls of one station

$$\frac{\text{Overhead}}{\text{cycle}} = \frac{\Sigma \text{ Walk Time}}{\text{Cycle Time}}$$

## Avg Cycle Time (assuming exhaustive service)

- $M$ : # of stations
- $t'$ : walk time
- $\lambda$ : frame arrival rate at the system
- $X$ : frame transmission time

Then, average cycle time is

$$T_C = \frac{Mt'}{1 - \rho}, \text{ where } \rho = \lambda X$$

## Efficiency

- If exhaustive service

$$\text{Efficiency} = \frac{T_C - Mt'}{T_C} = \rho$$

- If limited service, (assume single frame per poll)

$$\text{Efficiency} = \frac{MX}{MX + Mt'} = \frac{1}{1 + t'/X}$$

# Token-Passing Rings -- a Distributed Polling Method

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# Comparision between MAC approaches

- Random Access
  - Aloha, Slotted Aloha
  - CSMA, CSMA/CD, CSMA/CA
- Scheduling
  - Reservation
  - Polling

# IEEE 802

- A family of IEEE standards dealing with local area networks and metropolitan area networks
- Map to Data Link Layer and Physical Layer
- Splits Data Link Layer LLC and MAC

Ref: [Wikipedia](#)

Name	Description	Note
IEEE 802.1	Higher Layer LAN Protocols (Bridging)	active
IEEE 802.2	LLC	disbanded
IEEE 802.3	Ethernet	active
IEEE 802.4	Token bus	disbanded
IEEE 802.5	Token ring MAC layer	disbanded
IEEE 802.6	MANs (DQDB)	disbanded
IEEE 802.7	Broadband LAN using Coaxial Cable	disbanded
IEEE 802.8	Fiber Optic TAG	disbanded
IEEE 802.9	Integrated Services LAN (ISLAN or isoEthernet)	disbanded
IEEE 802.10	Interoperable LAN Security	disbanded
IEEE 802.11	Wireless LAN (WLAN) & Mesh (Wi-Fi certification)	active

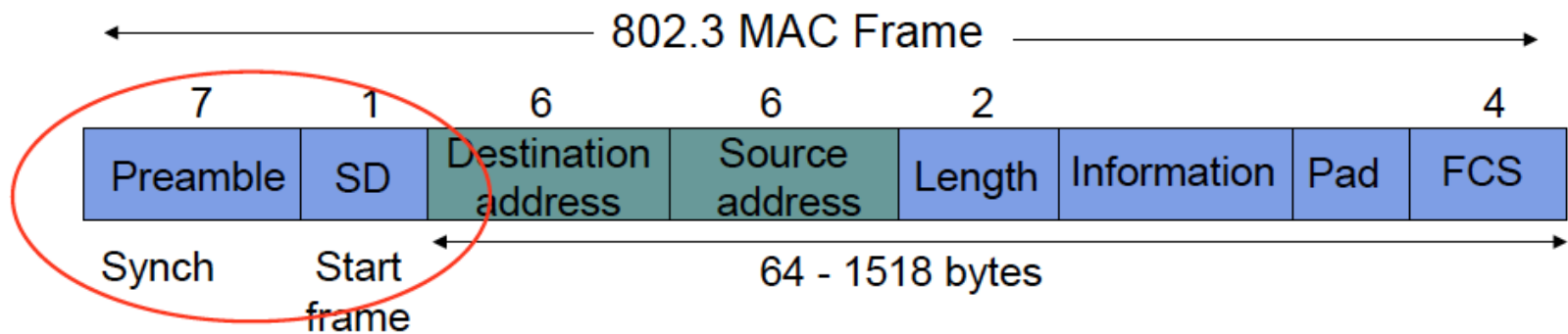


## IEEE 802.3: Ethernet

- CSMA/CD
- Slot time
- Binary exponential back off
  - For nth retransmission:  $0 < r < 2^k$ , where  $k = \min(n, 10)$
  - Gives up after 16 transmissions

# IEEE 802.3: Ethernet

- Preamble: 10101010 \* 7 times
- SD: 10101011
- FCS (Frame Checking Sequence): for error checking



# 802.11 Wireless LAN

## Definitions:

- Basic Service Set (BSS)
- Extended Service Set (ESS): a set of BSS with with the same network name
- Each BSS has an Access Point (AP)

# Types of Wireless Network

- Infrastructure Network
- Ad-hoc Network
- WiFi Direct Network e.g. AirDrop
- Mesh Network

## Hidden Node & Exposed Node

# Distributed Coordination Function

- Distributed Coordination Function (DCF)
  - Contention Period (CP)
- Polling-based Coordination Function
  - Contention-Free Period (CFP)
  - AP act as the controller

Beacon Interval

## CSMA/CA (Subset of DCF)

-- Carrier-Sence Multiple Access w/ Collision Avoidance

1. Virtual Carrier Sensing

- RTS/CTS
- NAV

2. Backoff & Deferral

3. ACK Protection

## Virtual Carrier Sensing

- RTS/CTS
- NAV (Network Allocation Vector)
  - Reduce collision and saves power



## Backoff & Deferral

## ACK Protection with DIFS & SIFS

- DIFS: Destributed Inter-Frame Space
  - A design parameter
- SIFS: Short Inter-Frame Space
  - A system parameter

We want

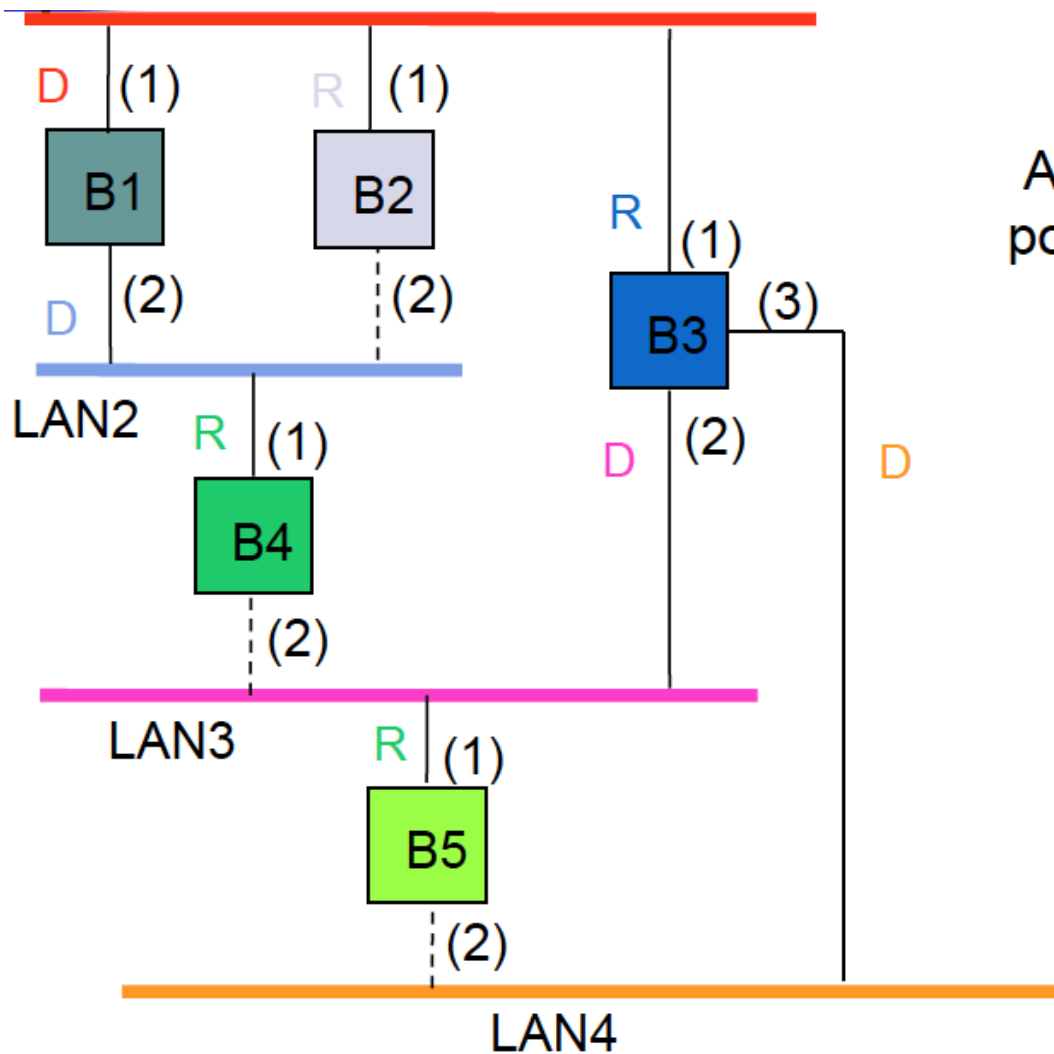
$$DIFS > SIFS$$

# Bridging and Switching

- Physical Layer: hub, repeater
- Data Link Layer: bridge, switch
- Network Layer: router
- Transport and Application Layer: gateway

# Spanning Tree Algorithm

- Why? To solve broadcast storm
1. Select root bridge
  2. Select root port for every bridge except the root bridge
  3. Select designated bridge for each LAN



All root ports & designated ports put in forwarding state