Computer Networks 1
(Mạng Máy Tính 1)

Lectured by: Dr. Phạm Trần Vũ

Lecture 3: Networking Technologies

Reference:

Chapter 4 - "*Computer Networks*",

Andrew S. Tanenbaum, 4th Edition, Prentice Hall, 2003.

Content

- Channel allocation problem
- Multiple access protocols
- Ethernet LAN
- Wireless LAN

Channel Allocation Problem

- How to allocate a single broadcast channel amongst competing users?
- Static method
- Dynamic method

Static Channel Allocation in LANs and MANs

- Each user is assigned with a equal-portion of the bandwidth
- No interference between users
- Simple
- In efficient if there are a lot of users in the network

Dynamic Channel Allocation in LANs and MANs

- Five key assumptions
  - Station Model:
    - The model consists of N stations
    - Once a frame is generated, the station blocks until the frame has been successfully transmitted
  - Single Channel Assumption
  - Collision Assumption
    - Collision happens when two frames are transmitted simultaneously and overlap in time
  - (a) Continuous Time vs (b) Slotted Time
  - (a) Carrier Sense vs (b) No Carrier Sense

Multiple Access Protocols

- **ALOHA**
- **Carrier Sense Multiple Access Protocols**
- Collision-Free Protocols
- Limited-Contention Protocols
- Wavelength Division Multiple Access Protocols
- **Wireless LAN Protocols**

ALOHA

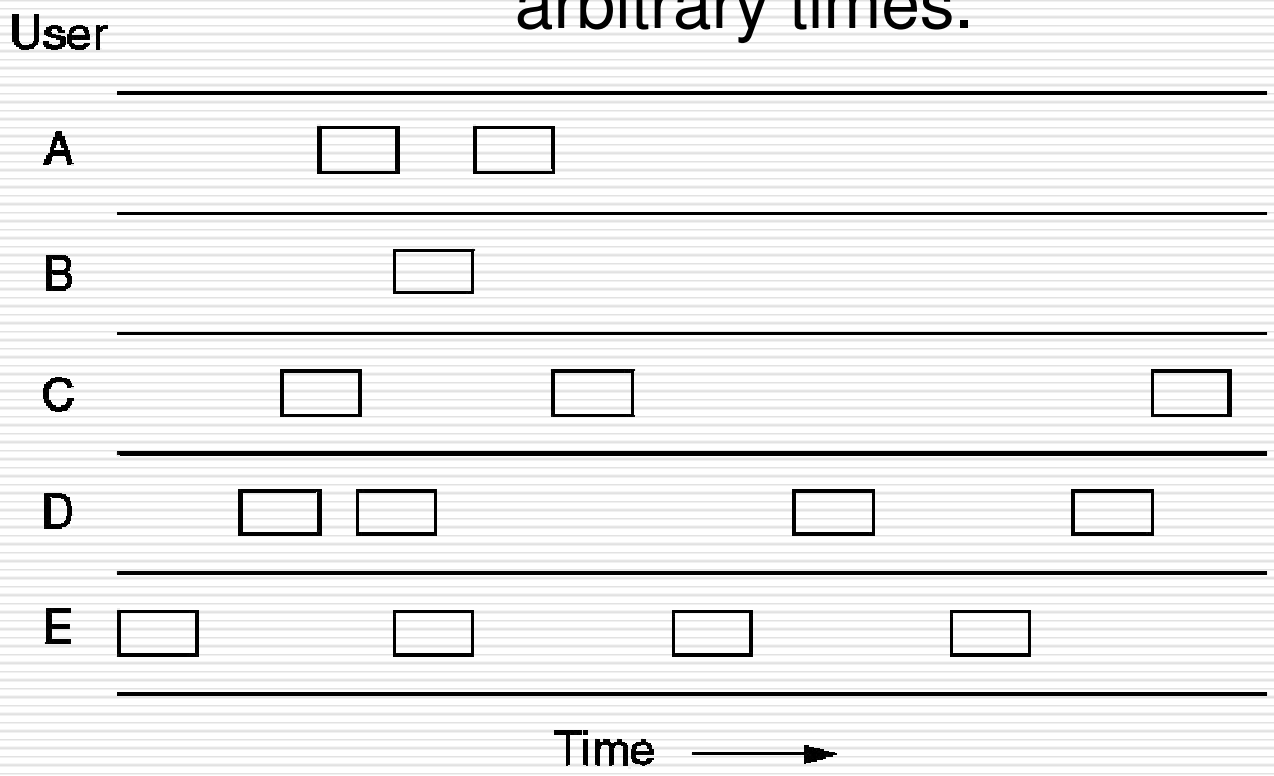
- Developed by Norman Abramson, in 1970s
- Used ground-based radio broadcast
- Pure ALOHA
  - Use continuous time
  - No need for global time
- Slotted ALOHA
  - Need global time synchronisation

Pure ALOHA (1)

- Users can transmit whenever they have data to send
- If there is a collision, colliding frames will be damaged and will be destroyed
- Senders need to wait for some time to know if there is a collision
- Senders wait for a random time to transmit destroyed frames

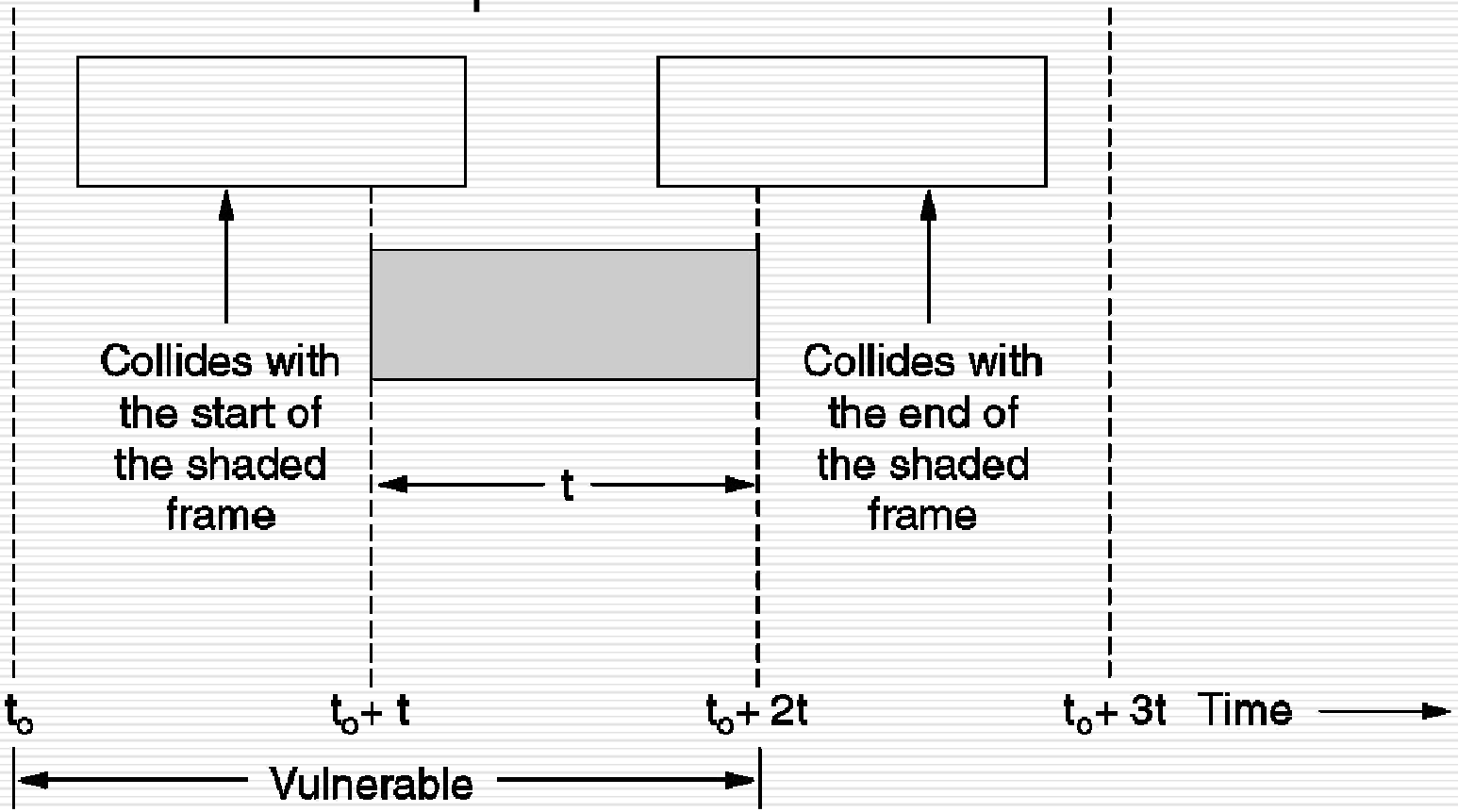
Pure ALOHA (2)

In pure ALOHA, frames are transmitted at completely arbitrary times.



Pure ALOHA (3)

Vulnerable period for the shaded frame.

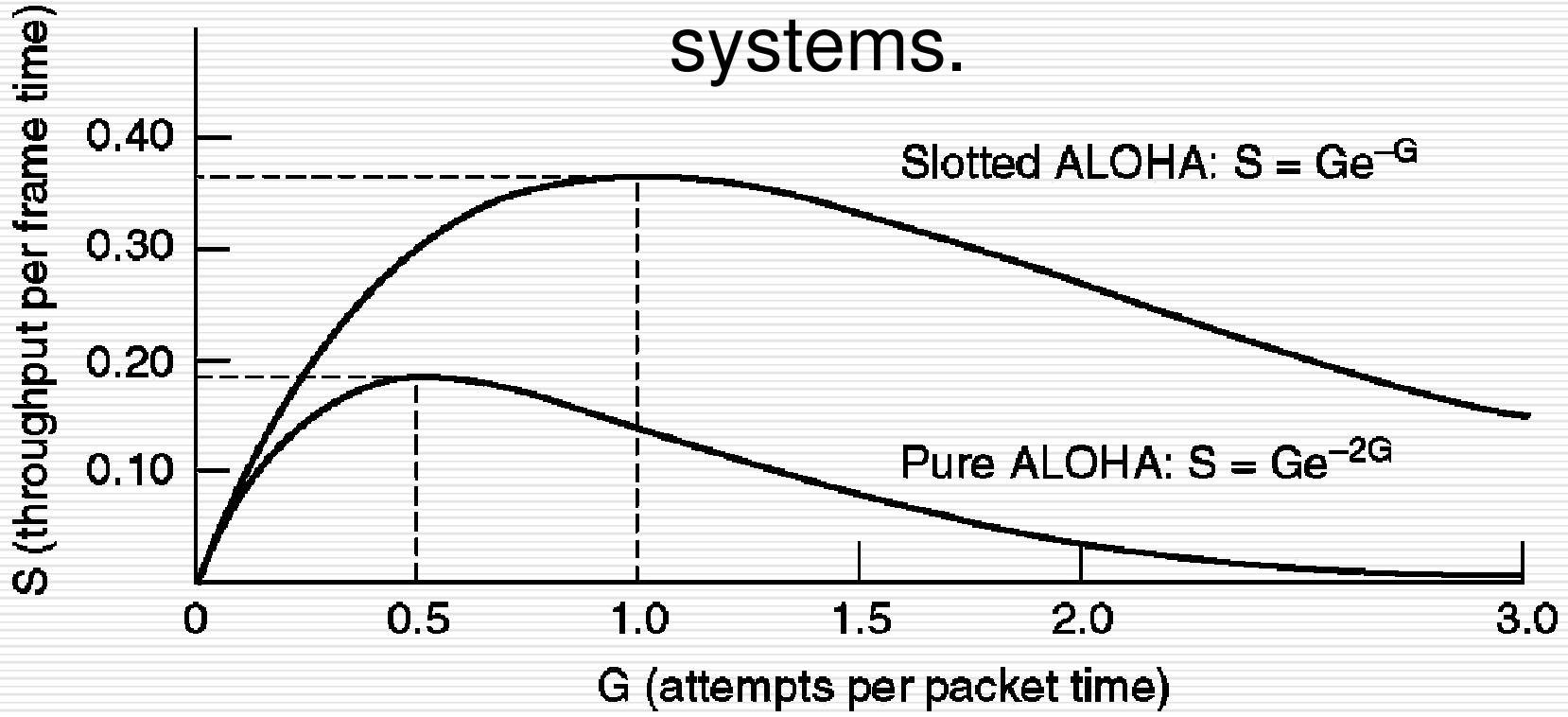


Slotted ALOHA

- Time is divided into fixed interval (slot)
- Each slot is equal to a frame time
- Need time synchronisation among stations
  - E.g. use a special station for timing
- Frames can only be transmitted at starts of time slots

ALOHA System Performances

Throughput versus offered traffic for ALOHA systems.

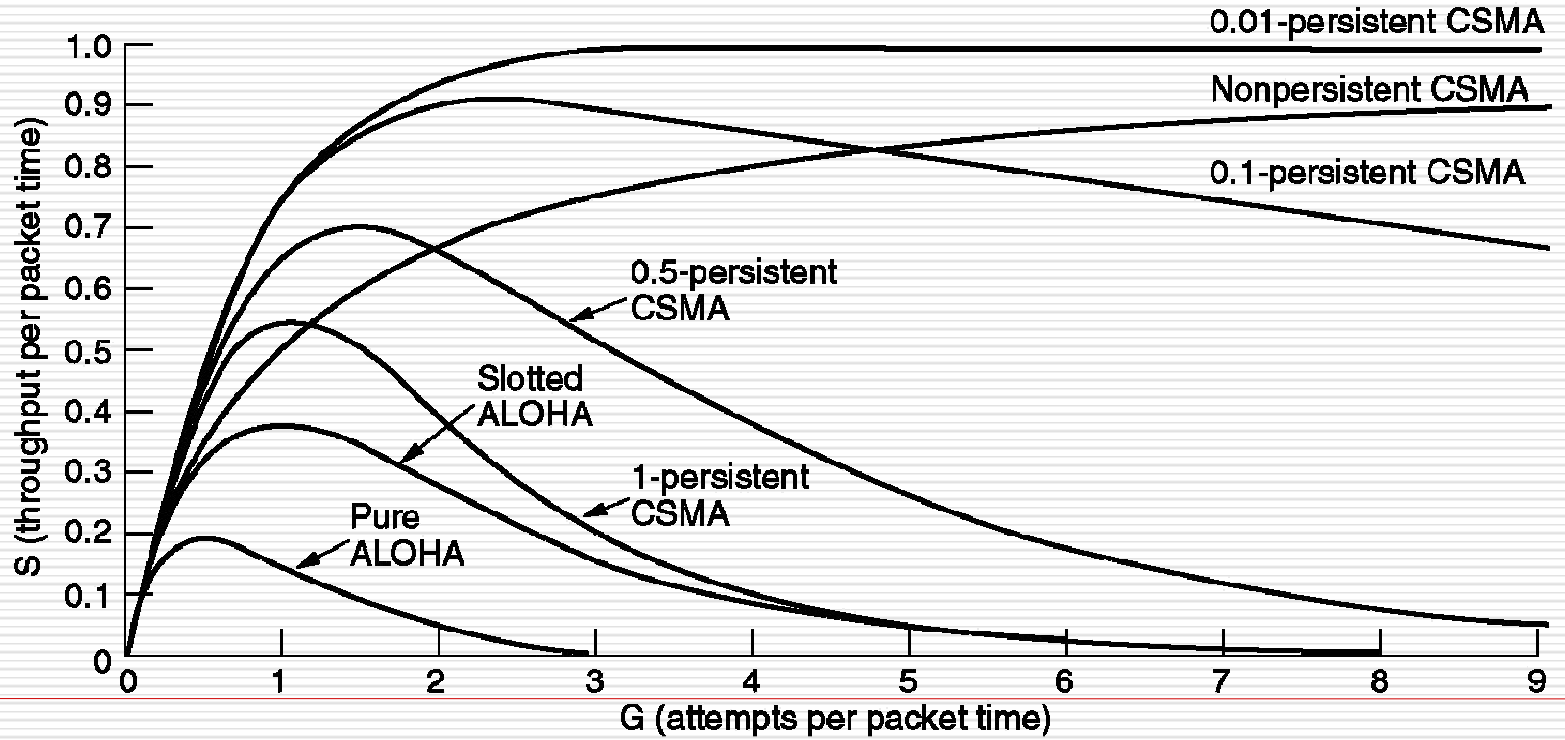


Carrier Sense Multiple Access Protocols

- When there is data to send, a station senses carrier first
- If the carrier is free, it starts sending
- Else, it waits until the carrier becomes free
- Common carrier sense protocols
  - 1-Persistent
  - Nonpersistent
  - p-Persistent

Persistent and Nonpersistent CSMA

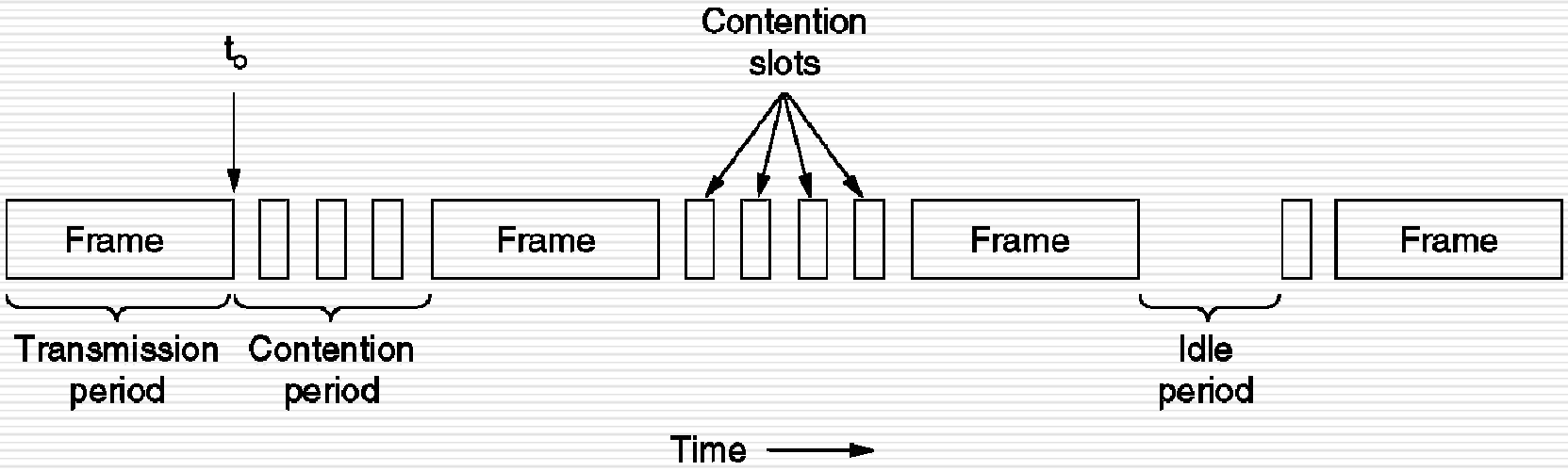
Comparison of the channel utilization versus load for various random access protocols.



CSMA with Collision Detection

- An improvement to CSMA
- A station stops transmitting its frame immediate after a collision is detected to save time and bandwidth
- A basis for Ethernet LAN protocol

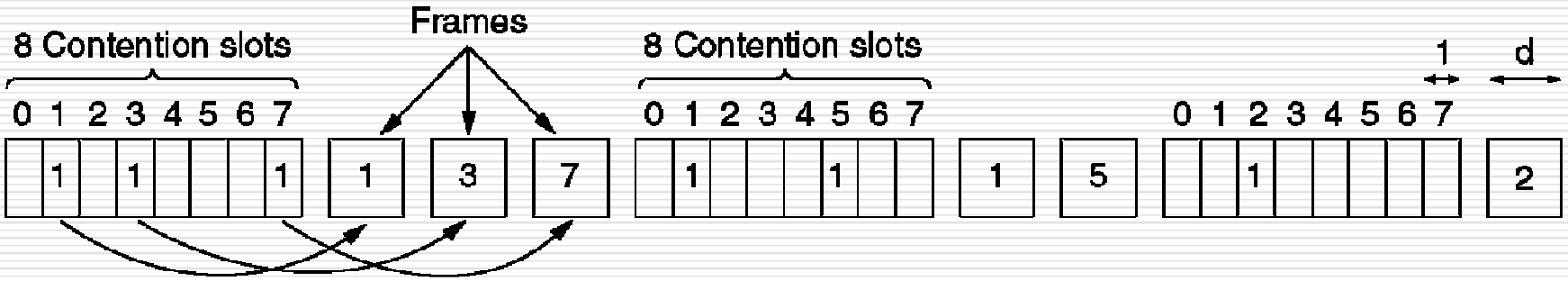
CSMA with Collision Detection



CSMA/CD can be in one of three states: contention, transmission, or idle.

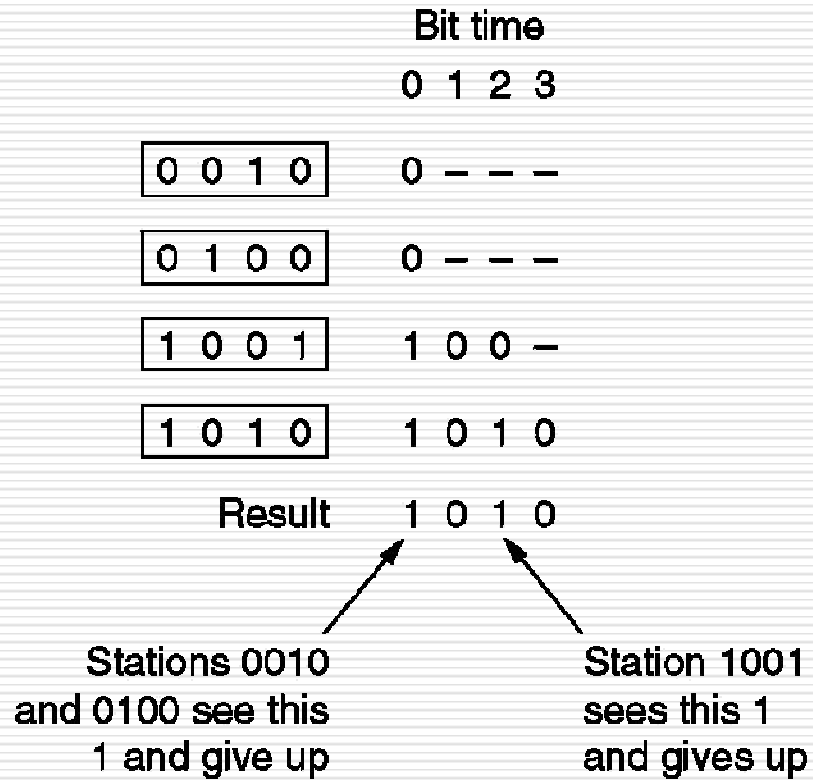
Collision-Free Protocols

The basic bit-map protocol.



Collision-Free Protocols (2)

The binary countdown protocol. A dash indicates silence.



Ethernet

- Ethernet Cabling
- Manchester Encoding
- The Ethernet MAC Sublayer Protocol
- Switched Ethernet
- Fast Ethernet
- Gigabit Ethernet

Ethernet Cabling

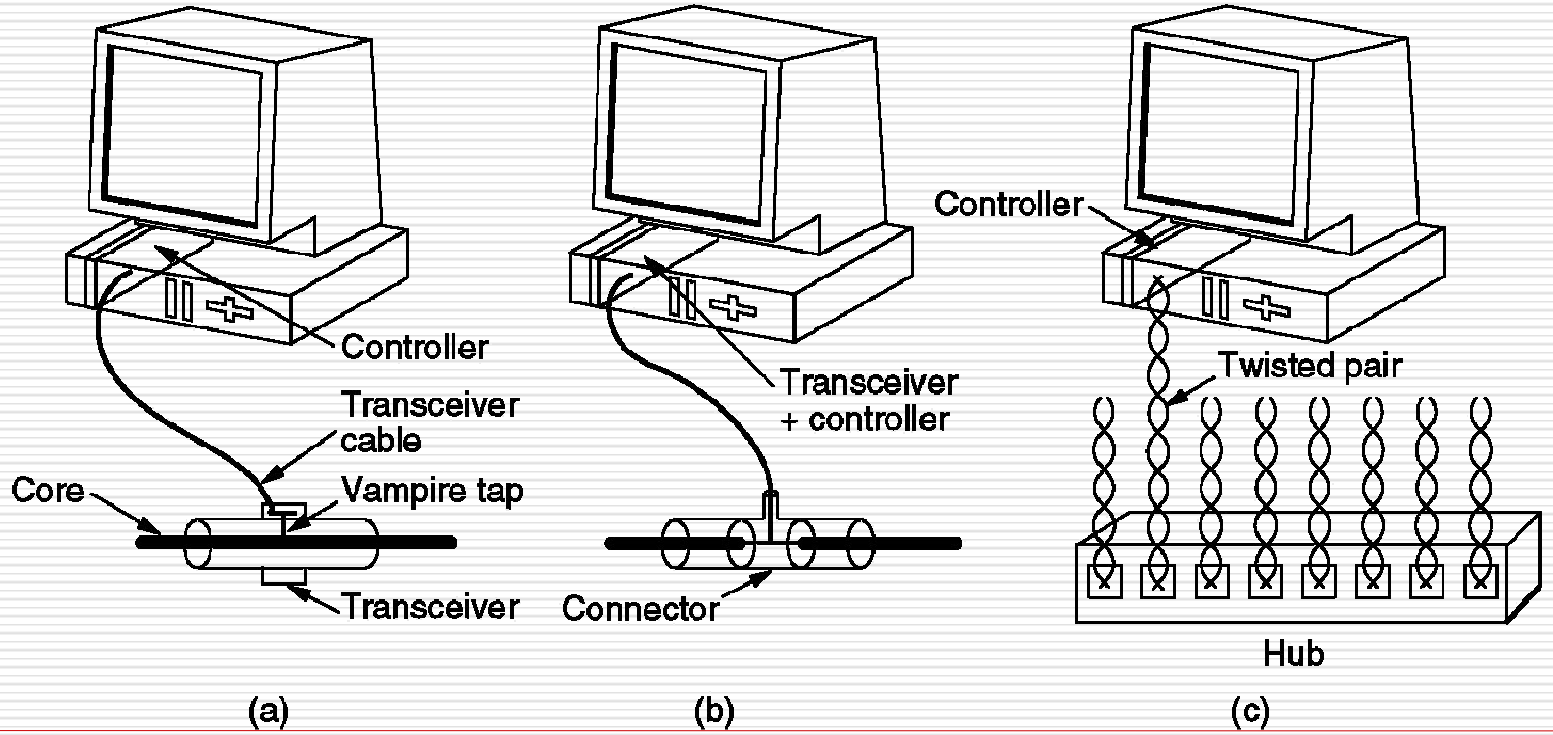
The most common kinds of Ethernet cabling.

Name	Cable	Max. seg.	Nodes/seg.	Advantages
10Base5	Thick coax	500 m	100	Original cable; now obsolete
10Base2	Thin coax	185 m	30	No hub needed
10Base-T	Twisted pair	100 m	1024	Cheapest system
10Base-F	Fiber optics	2000 m	1024	Best between buildings

Ethernet Cabling (2)

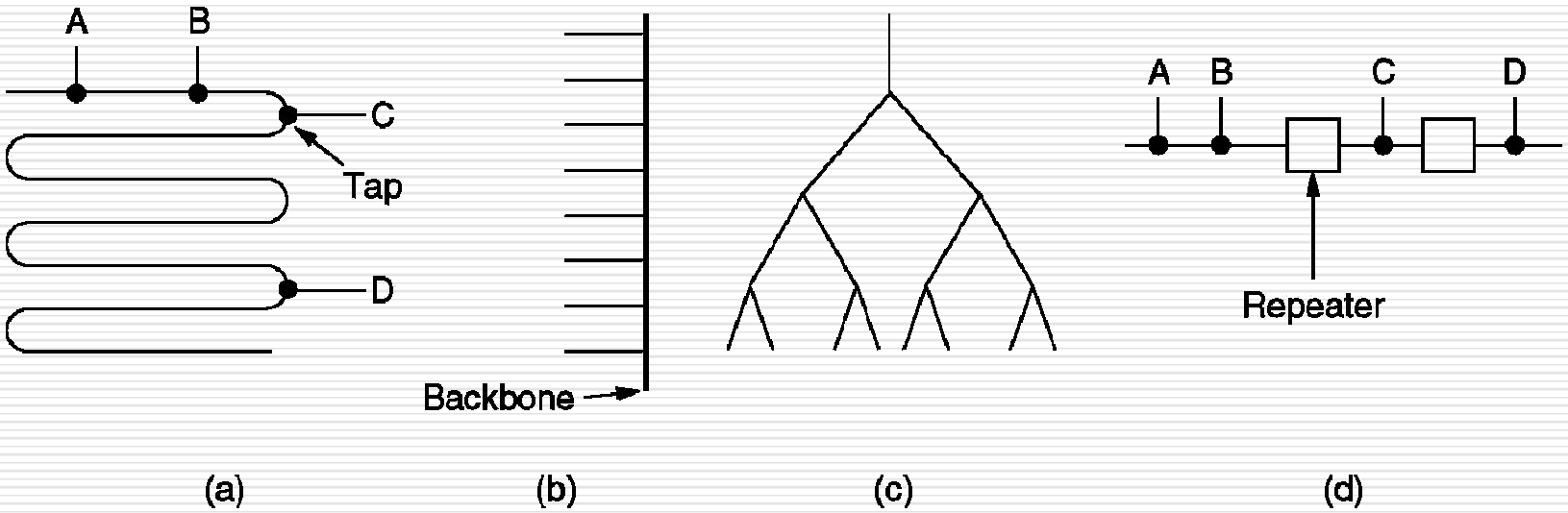
Three kinds of Ethernet cabling.

(a) 10Base5, (b) 10Base2, (c) 10Base-T.



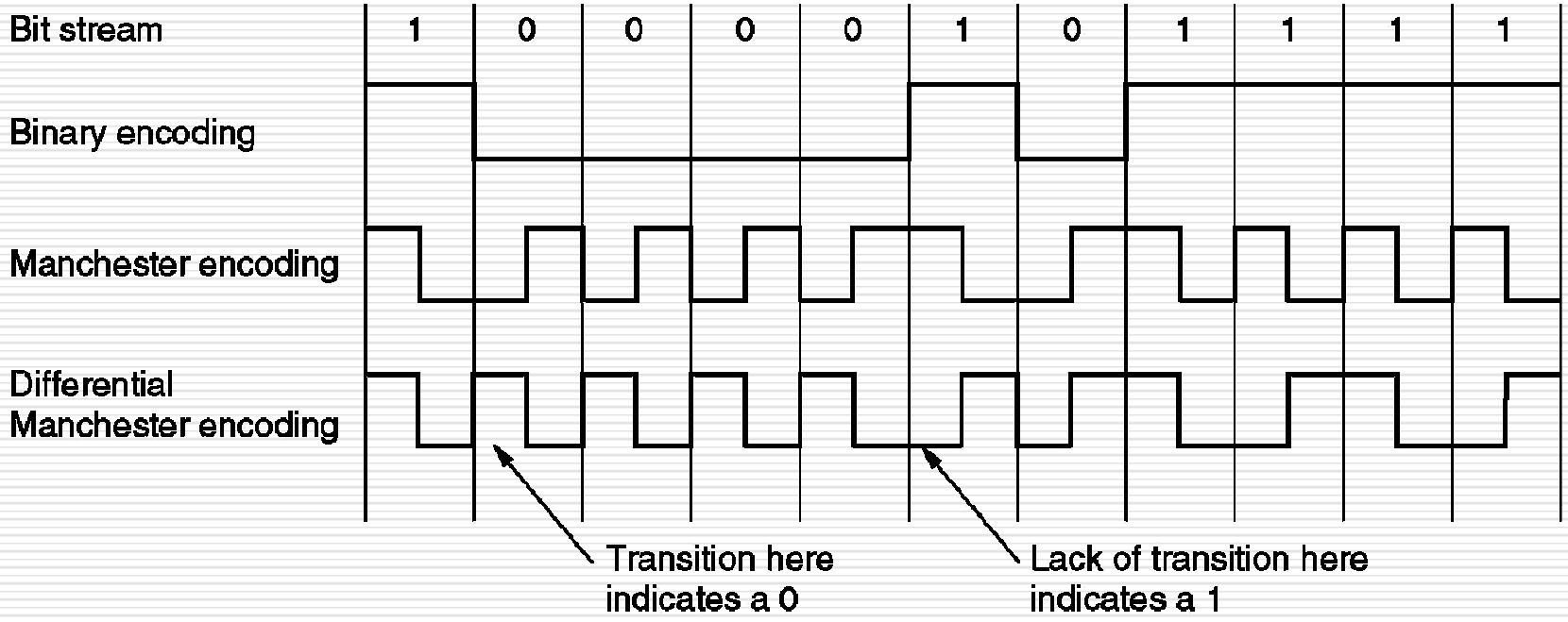
Ethernet Cabling (3)

Cable topologies. (a) Linear, (b) Spine, (c) Tree, (d) Segmented.

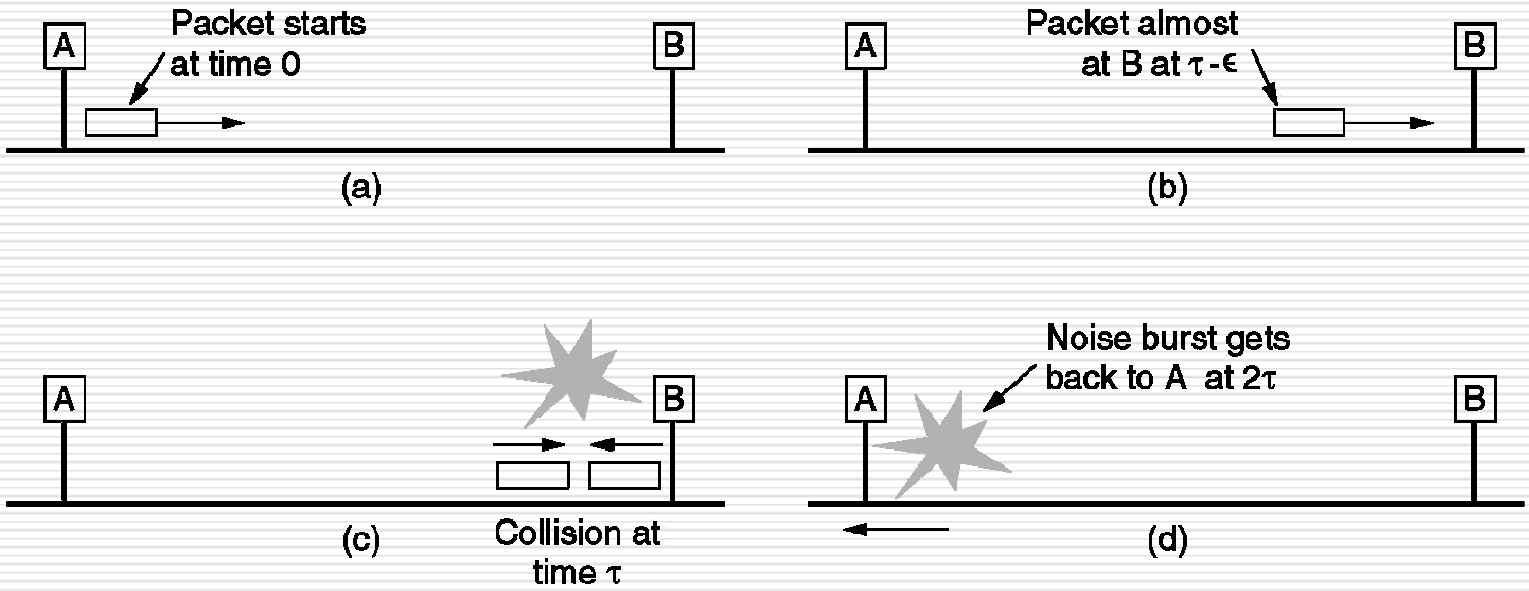


Ethernet Cabling (4)

(a) Binary encoding, (b) Manchester encoding,
(c) Differential Manchester encoding.



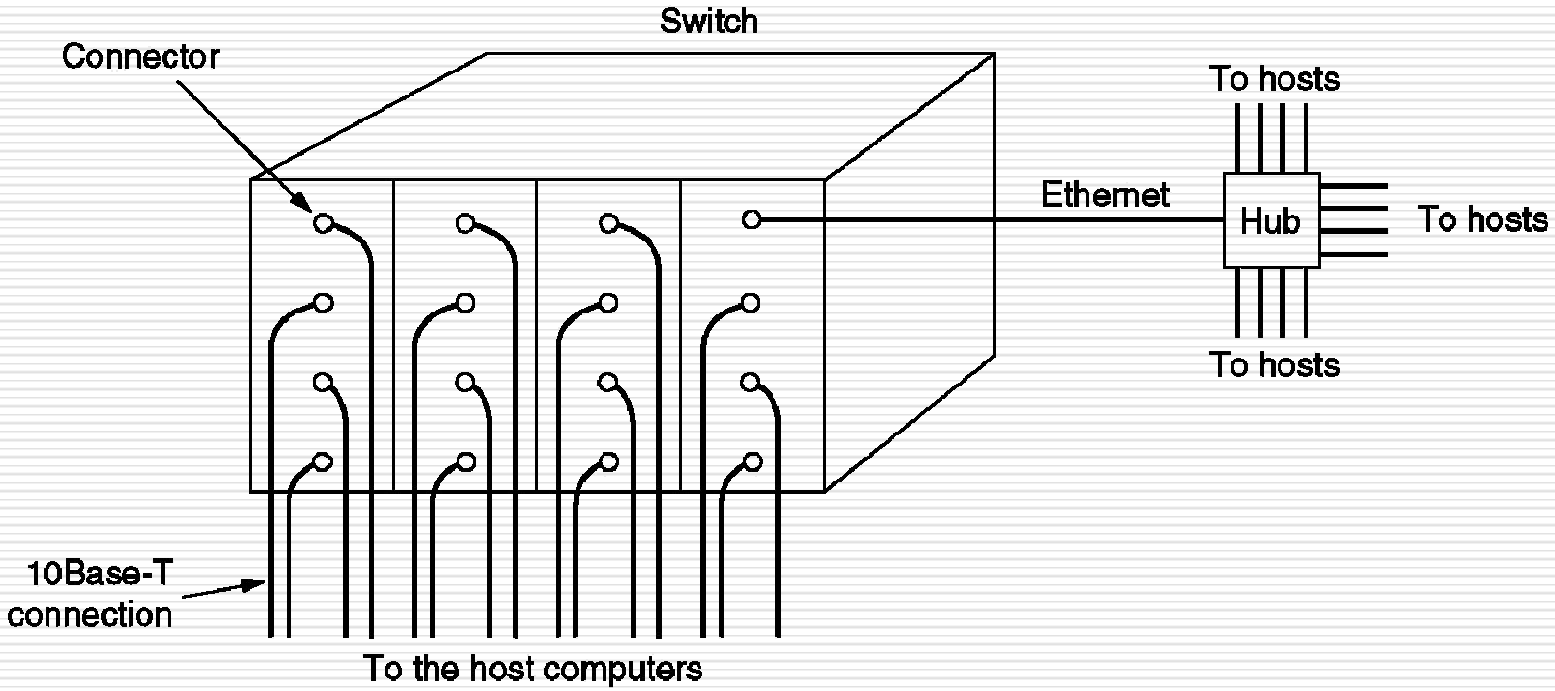
Ethernet MAC Sublayer Protocol



Collision detection can take as long as 2τ.

Switched Ethernet

A simple example of switched Ethernet.

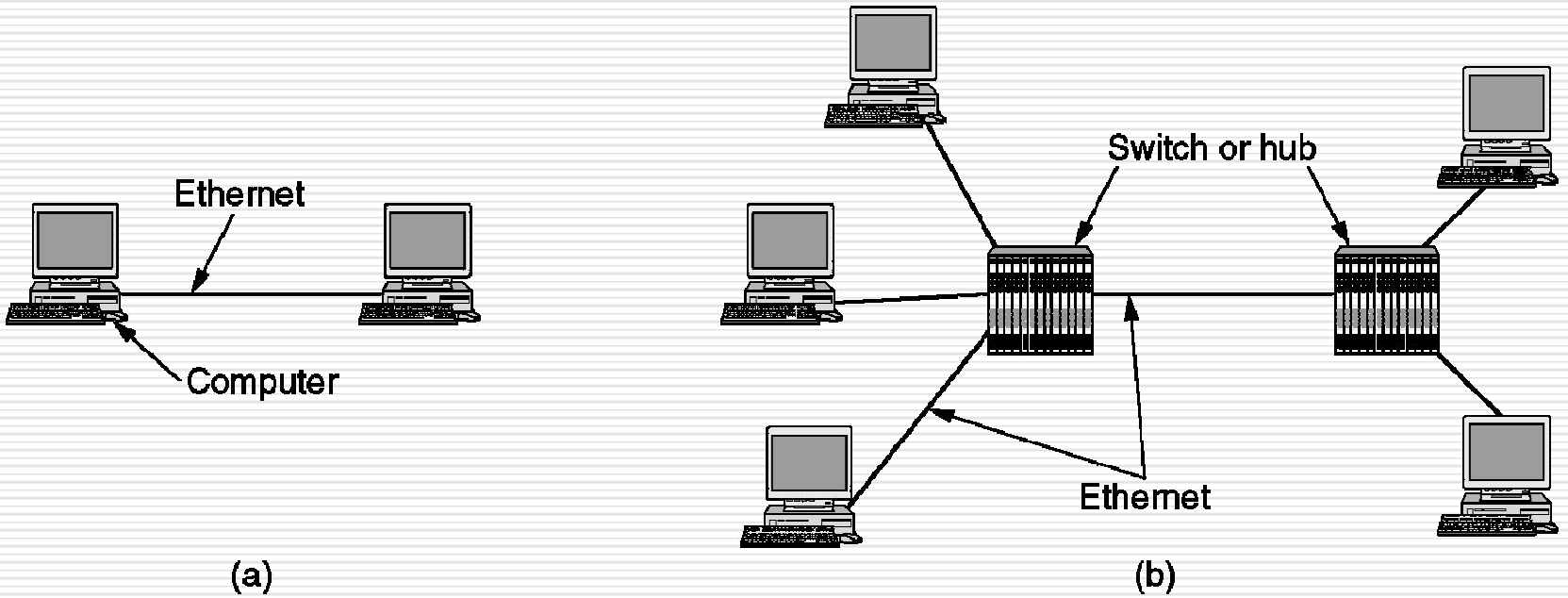


Fast Ethernet

The original fast Ethernet cabling.

Name	Cable	Max. segment	Advantages
100Base-T4	Twisted pair	100 m	Uses category 3 UTP
100Base-TX	Twisted pair	100 m	Full duplex at 100 Mbps
100Base-FX	Fiber optics	2000 m	Full duplex at 100 Mbps; long runs

Gigabit Ethernet



(a) A two-station Ethernet. (b) A multistation Ethernet.

Gigabit Ethernet (2)

Gigabit Ethernet cabling.

Name	Cable	Max. segment	Advantages
1000Base-SX	Fiber optics	550 m	Multimode fiber (50, 62.5 microns)
1000Base-LX	Fiber optics	5000 m	Single (10 μ) or multimode (50, 62.5 μ)
1000Base-CX	2 Pairs of STP	25 m	Shielded twisted pair
1000Base-T	4 Pairs of UTP	100 m	Standard category 5 UTP

Wireless LAN Protocols

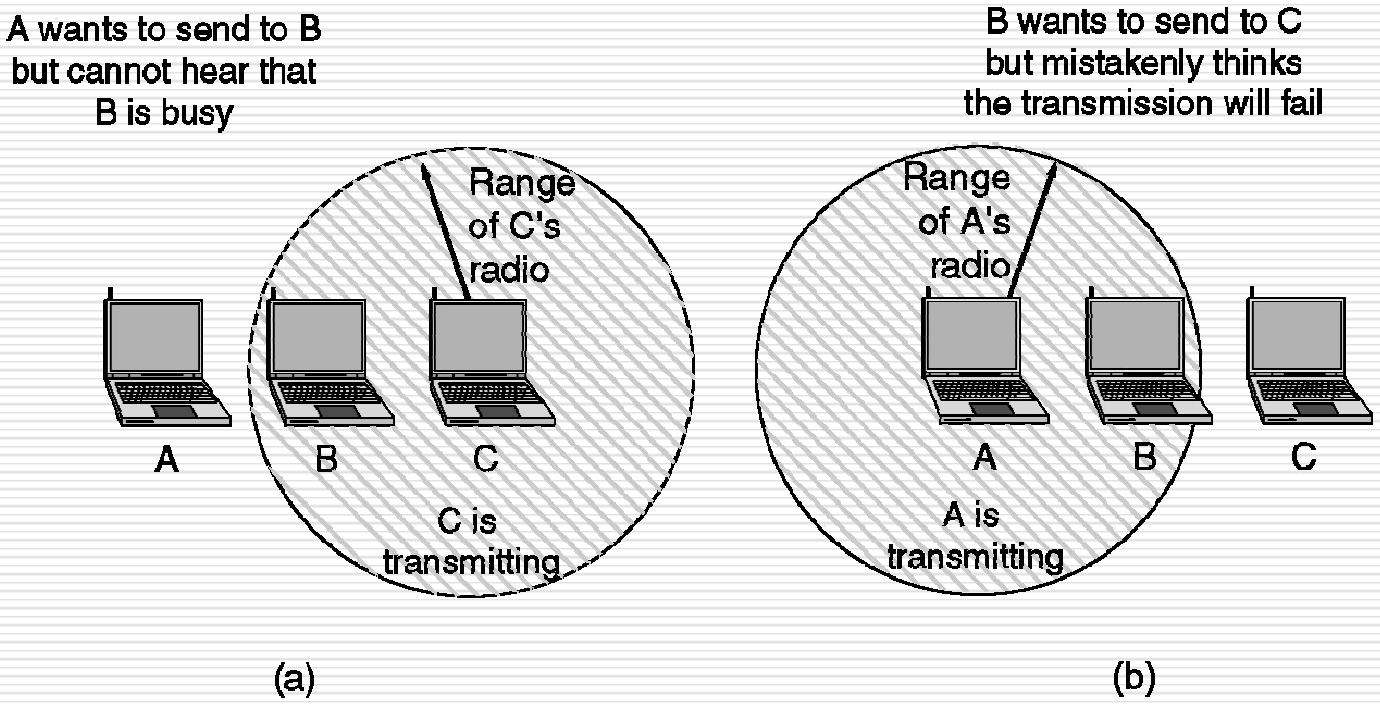
- Hidden station problem
- Exposed station problem

A wireless LAN. (a) A transmitting B. (b) B transmitting A.

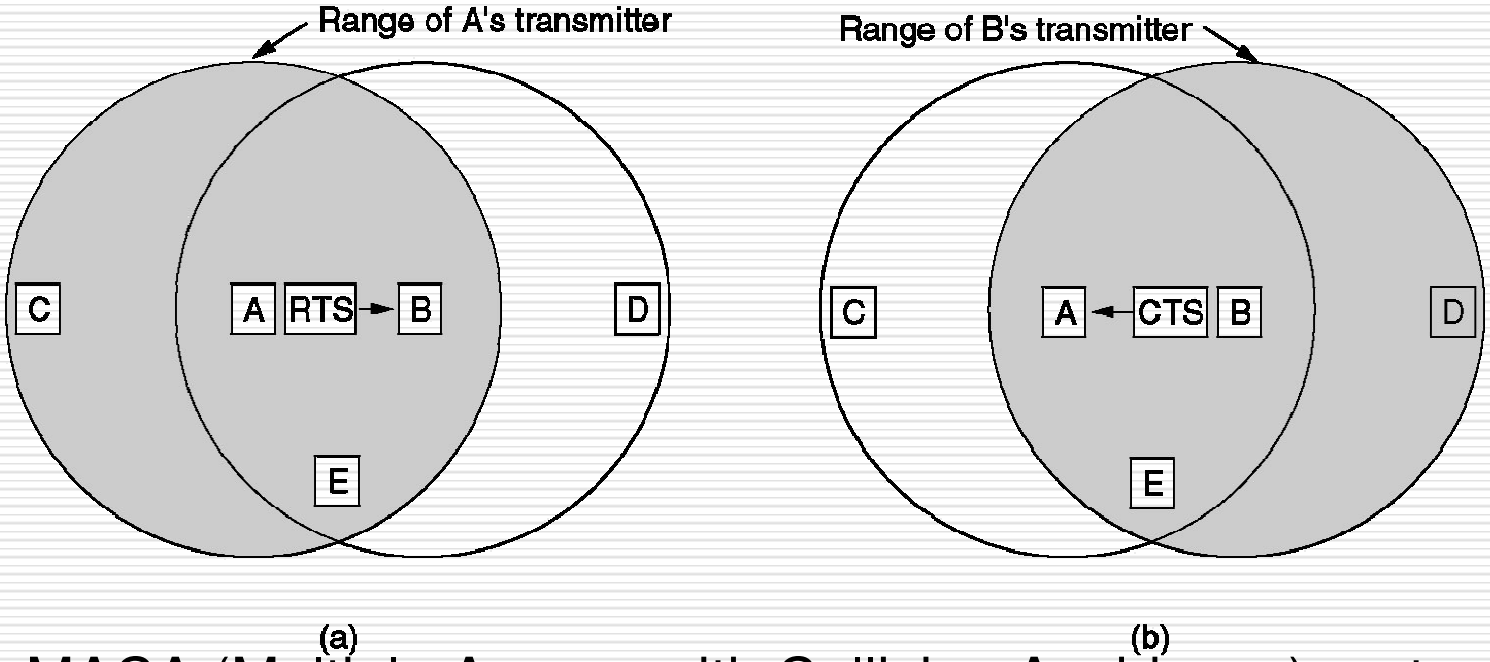
Wireless LAN Protocols (2)

(a) The hidden station problem.

(b) The exposed station problem.



Wireless LAN Protocols (2)



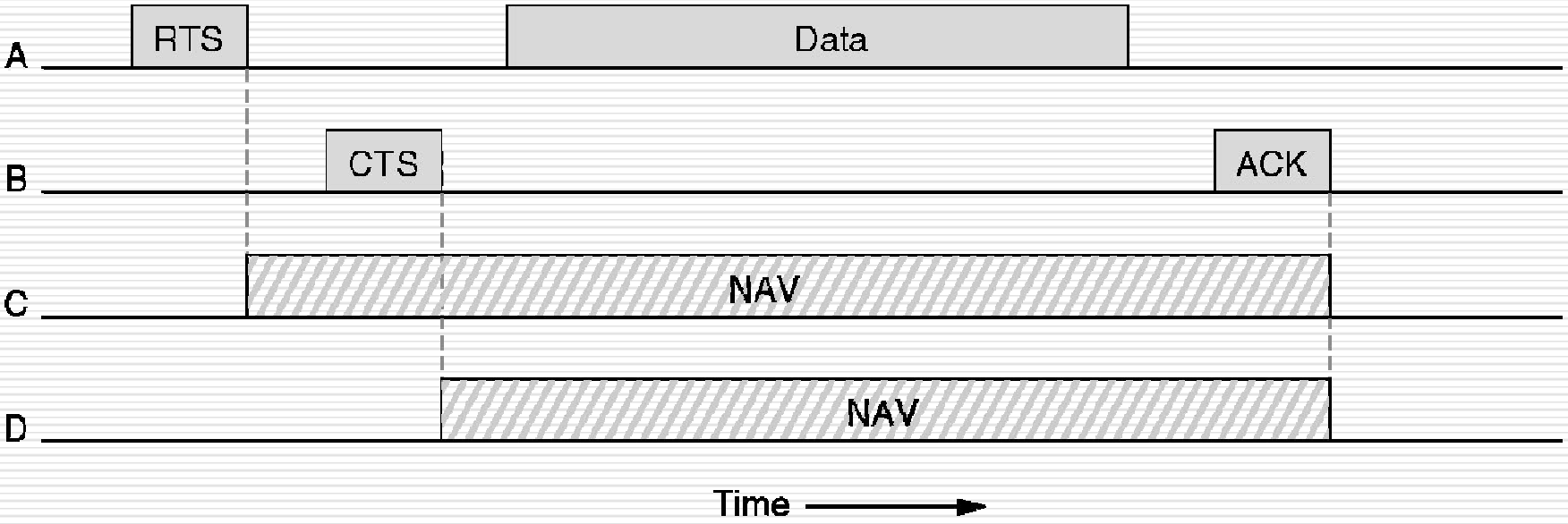
The MACA (Multiple Access with Collision Avoidance) protocol:

(a) A sending an RTS to B.

(b) B responding with a CTS to A.

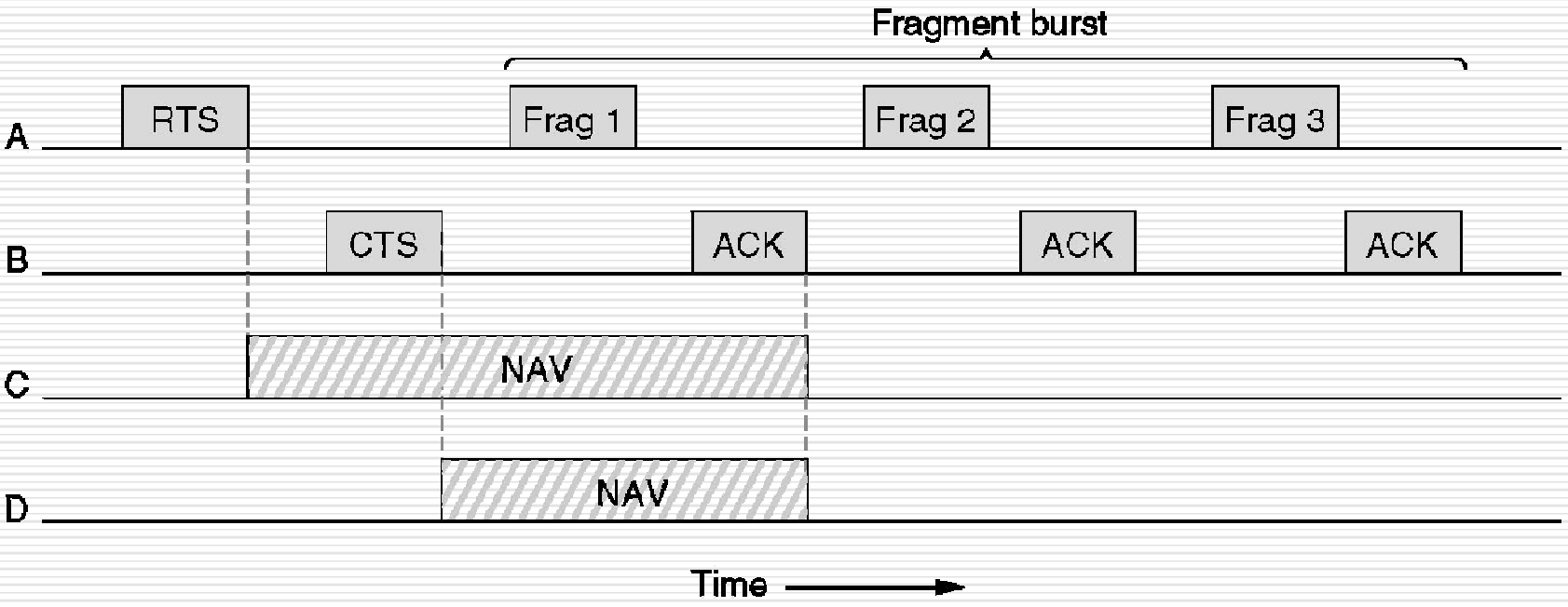
The 802.11 MAC Sublayer Protocol (1)

The use of virtual channel sensing using CSMA/CA



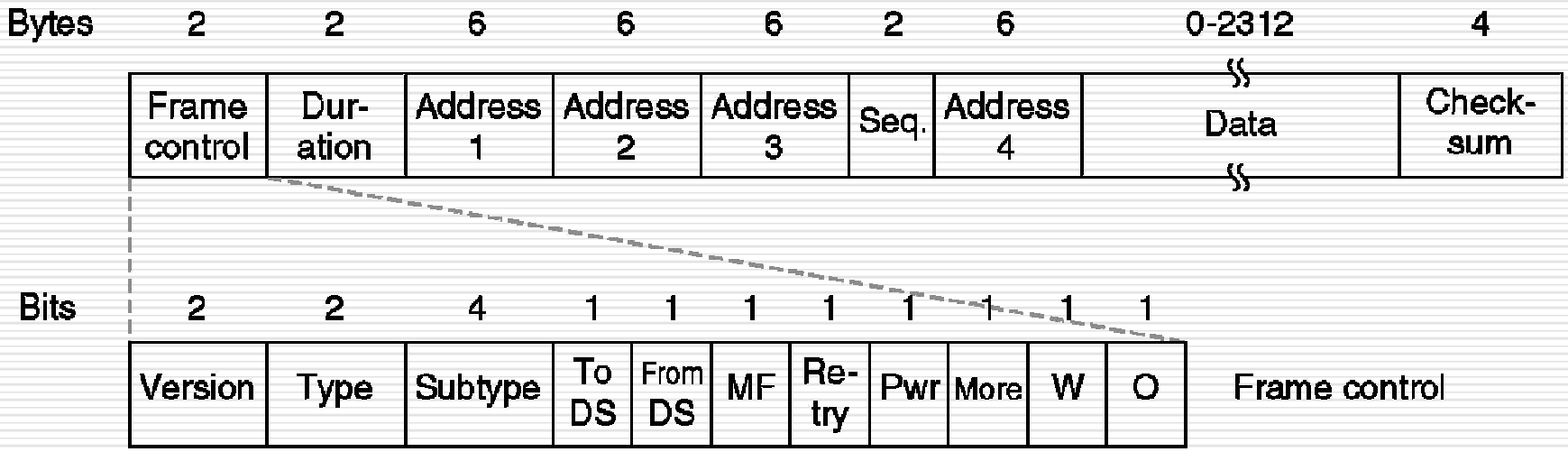
The 802.11 MAC Sublayer Protocol (2)

A fragment burst.



The 802.11 Frame Structure

The 802.11 data frame.



802.11 Services

Distribution Services

- Association
- Disassociation
- Reassociation
- Distribution
- Integration

802.11 Services

Intracell Services

- Authentication
- Deauthentication
- Privacy
- Data Delivery