UKRIDA
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Transport Layer: Access Control & TCP/IP

W5-M5

Expert System

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Learning Objective

- Students can distinguish between centralized access and distributed access.
- Students understand the role of ‘reliability’ in the data transmission process.
- Students can explain the difference between TCP and UDP.
- Students can explain how the 3-way handshake works.

OUTLINE

- Access Control
- UDP (User Datagram Protocol)
- TCP (Transmission Control Protocol)
- 3-Way Handshake

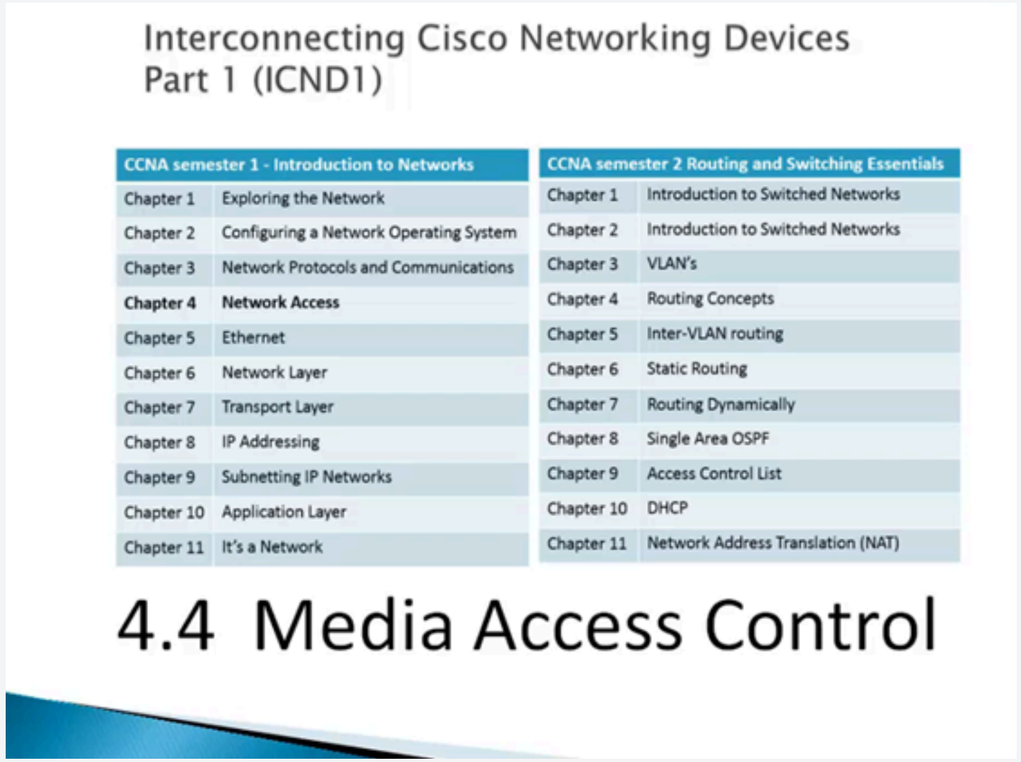
NETWORK ACCESS CONTROL

Centralized Access:

- Access controller exists
- Master & Slave
- Minimal collision

Distributed Access:

- Each device can control its own access
- No master & slave
- Prone to collision



Centralized Access

CENTRALIZED ACCESS METHOD

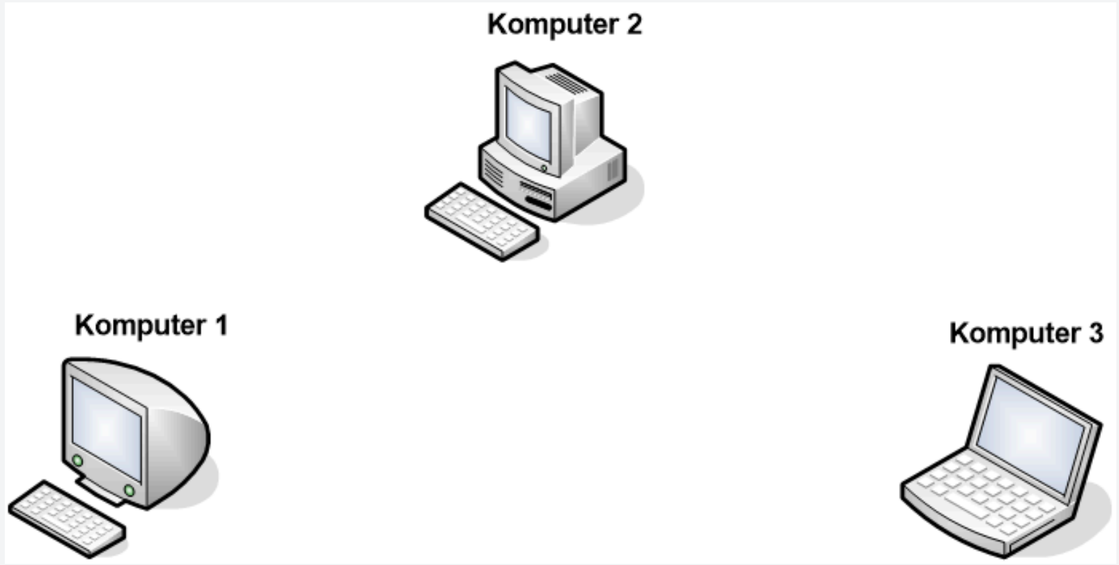
- Master Device: access controller
- Slave Device: receives access rights from the master device
  - Modes in Centralized Access Method:
    - Circuit Mode Access
    - Polling (Packet Mode) Access
    - Reservation-Based Access
  - Disadvantages:
    - Idle Time → must wait for turn to use the medium
    - Delay → involves the master device & requires waiting for turn
    - Single Point of Failure → if the master device fails, the whole network fails
  - Advantages:
    - Network usage is more controlled
    - Access based on priority
    - Reduced collision

CIRCUIT MODE ACCESS

- Example: Cellular network
  - How It Works:
    - Send a reservation message to the Base Station
    - Base Station manages channel usage
    - 1 channel = 1 communication
    - Multiple channels can operate simultaneously
    - Circuit creation technology depends on the **Base Technology** vendor → CDMA, FDMA, TDMA
  - Advantages:
    - Multiple communications can occur at the same time
    - Communications do not interfere with each other
  - Problems:
    - Hidden terminal problem
    - Exposed terminal problem

HIDDEN TERMINAL PROBLEM

- Occurs when a device cannot “hear” another device that is currently using the network.
- A device that does not “hear” the ongoing usage will assume the network is free.
- As a result, collisions may occur.
- This can be overcome using BTMA (Busy Tone Multiple Access) and MACA (Multiple Access Collision Avoidance).



I cannot “hear” that Computer 1 is using the network.

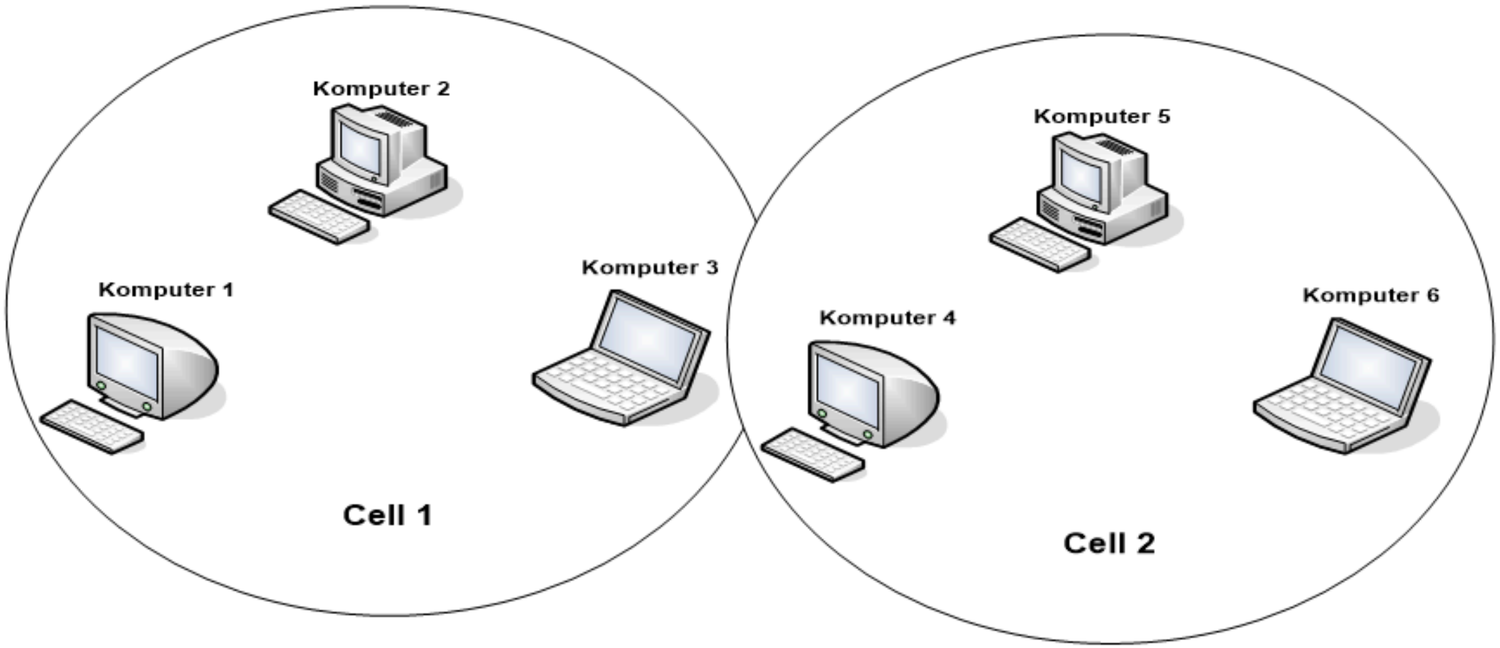
BTMA VS. MACA

- **BTMA:**
  - Divides bandwidth into a busy tone channel and a message channel.
  - Crosstalk may occur between the busy channel and the message channel.
- **MACA:**
  - Uses a busy tone.
  - The busy tone is sent as a special message so that all devices know the channel is currently in use.
  - Differentiates between busy tone and data tone.

Crosstalk: Energy leakage between cables or within a single cable due to damage to devices or transmission media, which can reduce signal quality.

EXPOSED TERMINAL PROBLEM

- Occurs because a device “hears” network usage in multiple cells.
- Usually experienced by devices located at the cell boundaries.
- Solved with: BTMA & MACA.



I can “hear” the network usage in cell 1 & cell 2.

POLLING (PACKET MODE) ACCESS

- Turn-based access between devices.
- At any given time, only 1 device uses the medium.
- Example: FDDI & Token Ring.
  - **How it works:**
    - The master device goes around all devices to ask if there is data to be sent.
    - Each device can only send data when it gets its turn.
    - All data transmissions must go through the master device → “polling” technique.
  - **Weakness:** Time delay.
  - **Strength:** Reduces collision.
  - **Improvement alternative:** “probing” technique (scanning network conditions).

RESERVATION-BASED ACCESS

- **Using 2 timeslots:**
  - Reservation Timeslot
  - Data Timeslot
- **How it works:**
  - The slave sends a reservation message using the reservation timeslot.
  - The master determines the schedule and time for the slave (data timeslot).
  - The slave uses its assigned data timeslot.
- **Methods for assigning reservation timeslot:**
  - Fixed-Priority Oriented Demand Assignment (FPODA).
  - Packet-Demand Assignment Multiple Access (PDAMA).
- **Example**: Satellite networks → fast and wide coverage.

Distributed Access

DISTRIBUTED ACCESS METHOD

- No specific device manages access to the medium.
- High potential for collisions.
- **Methods to prevent/minimize collisions:**
  - Carrier Sense Multiple Access/Collision Avoidance (CSMA/CA).
  - Carrier Sense Multiple Access/Collision Detection (CSMA/CD).

CSMA / CA (COLLISION AVOIDANCE)

- Applied in wireless networks.
- A time interval must pass before transmitting data (recall the discussion on access methods in wireless networks).
- This method only prevents collisions; it cannot recover from them.
- **Three Types of Timers in CSMA/CA:**
  - Interframe Spacing Time (IFS Time)
  - Contention Time
  - Transmit Time

HOW CSMA/CA WORKS

1. The device waits during the IFS Time to ensure the medium is idle.
2. The device must then wait through a contention time, which is randomly generated and counted down.
3. If another device uses the medium during the contention countdown, the countdown is paused (hold).
4. Once the medium is idle again, the countdown resumes from the last number when it was paused.
5. The device can then transmit data during the transmit time.

CSMA / CD (COLLISION DETECTION)

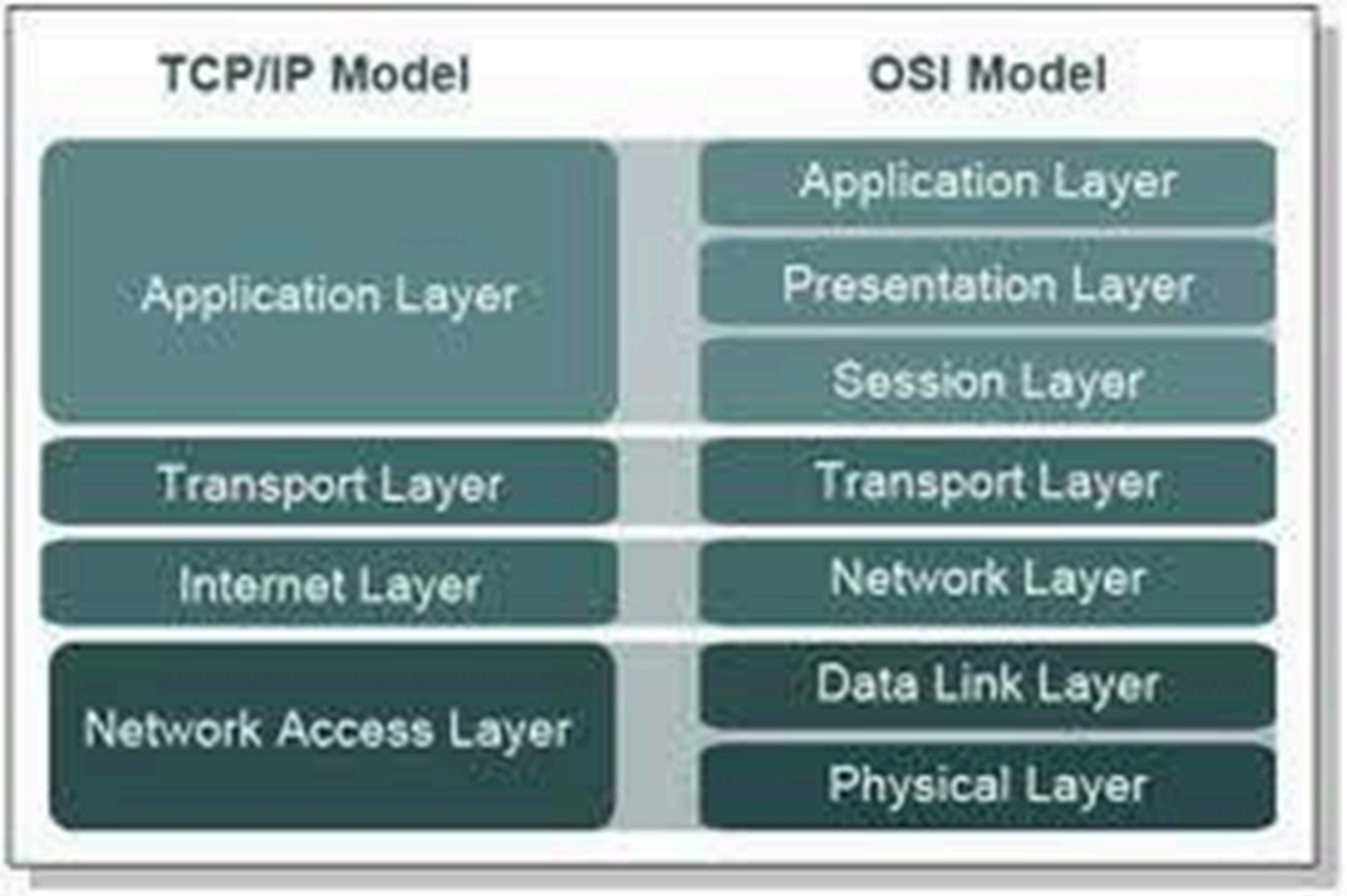
- Access Control in Ethernet
- Collision is detected by an increase in the signal on the medium.
- **Collision Detect** → the process of checking the medium to monitor the signal condition. If the received signal is different from the transmitted one, a collision has occurred.
- This method can prevent multiple collisions.

HOW CSMA/CD WORKS

1. The device will listen to the medium condition before sending its data.
2. If the medium is idle, the device will send the data. If the medium is being used, the device will delay the data transmission.
3. If a collision occurs, a jamming signal will be sent to all devices.
4. Devices that receive the signal will perform the Binary Exponential Backoff Algorithm → time interval.
5. The device will stop transmission during the resulting time interval.
6. The maximum limit for retransmission is 16 times.

TCP/IP : Transport Layer

COMPARISON: TCP/IP & OSI MODEL



TCP/IP TRANSPORT LAYER

TCP (Transmission Control Protocol)	IP (Internet Protocol)
• Establish virtual connection. • TCP software on the sender and receiver must be active. • Sends data based on port number.	• Route from sender to receiver (best path determination). • IP software on each device along the route must be active. • Sends data based on IP address.

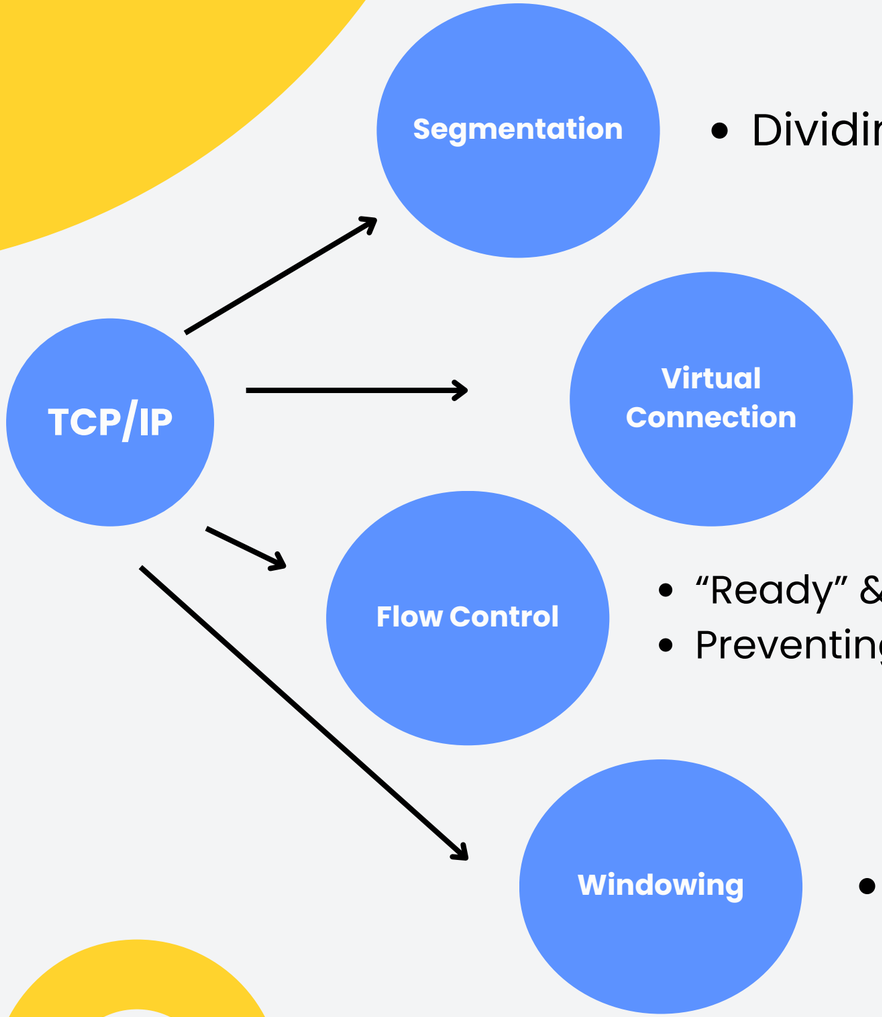
Functions:

- Data segmentation.
- Establishing a virtual connection.
- Delivering data segments.
- Flow Control → sliding windows.
- Reliability of Delivery → sequence number & acknowledgment number.

Protocol Examples:

- Transmission Control Protocol (TCP).
- User Datagram Protocol (UDP).
- Sequenced Packet Exchange (SPX).
- X.3

TCP/IP TRANSPORT LAYER



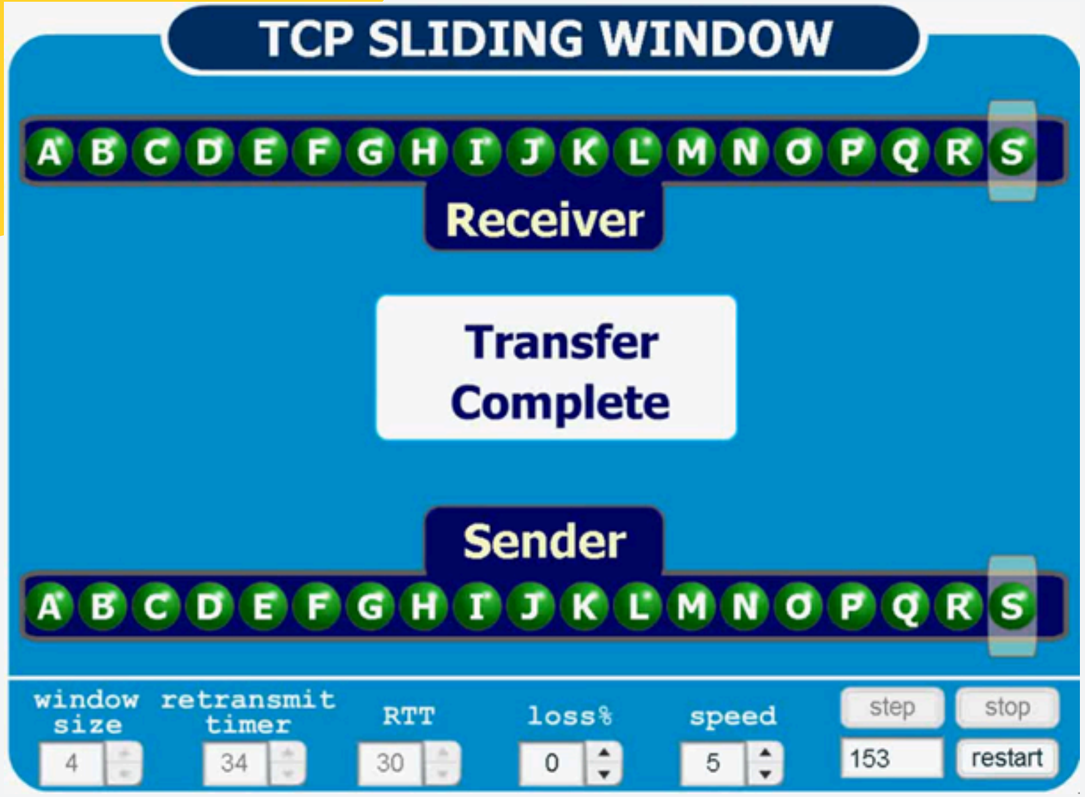
- Dividing data into Segments (PDU)

- Establishing a virtual connection between Source–Destination
- 3-Way Handshake

- “Ready” & “Not Ready” Indicator
- Preventing data discarding

- Negotiation of the number of segments to be sent

SLIDING WINDOWS & WINDOWING

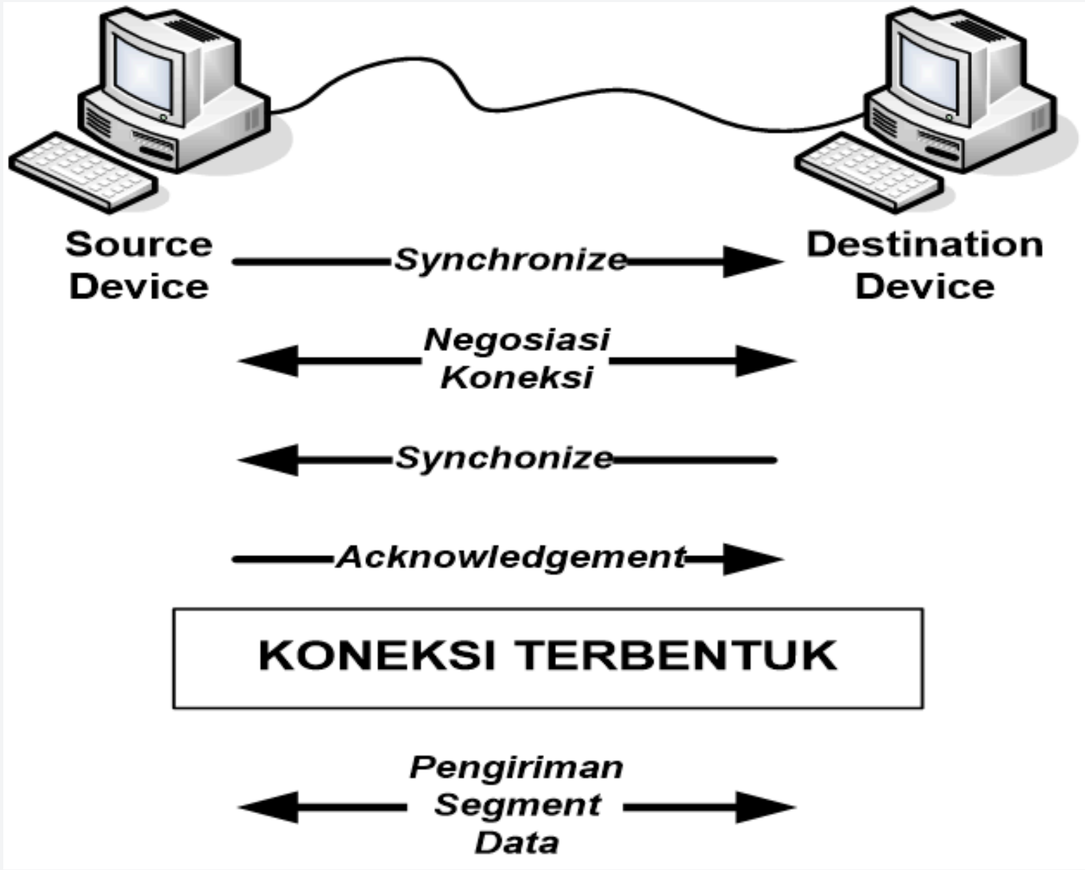


TCP Windowing

bosscbt.tv

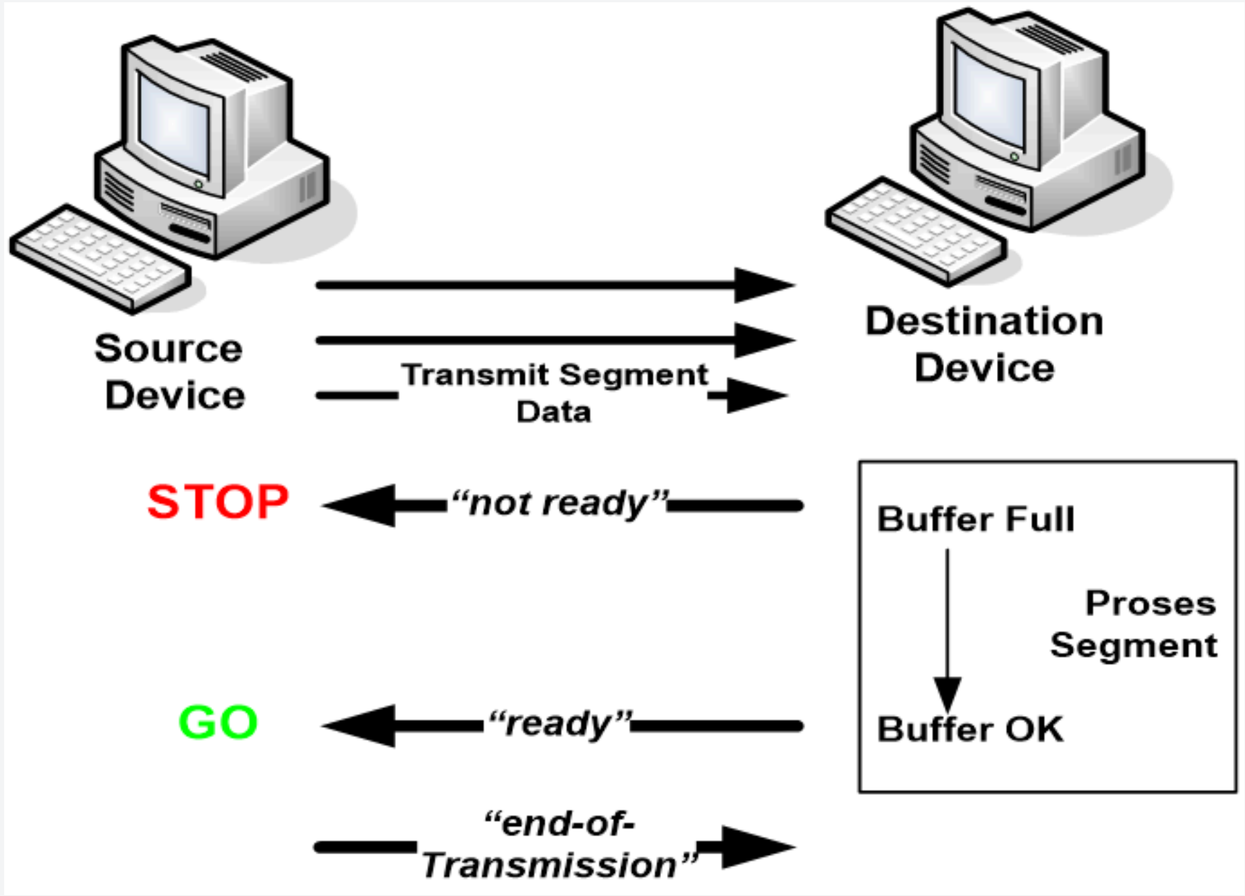
TCP/IP TRANSPORT LAYER

Formation of Virtual Connection:



TCP/IP TRANSPORT LAYER

Flow Control Process:

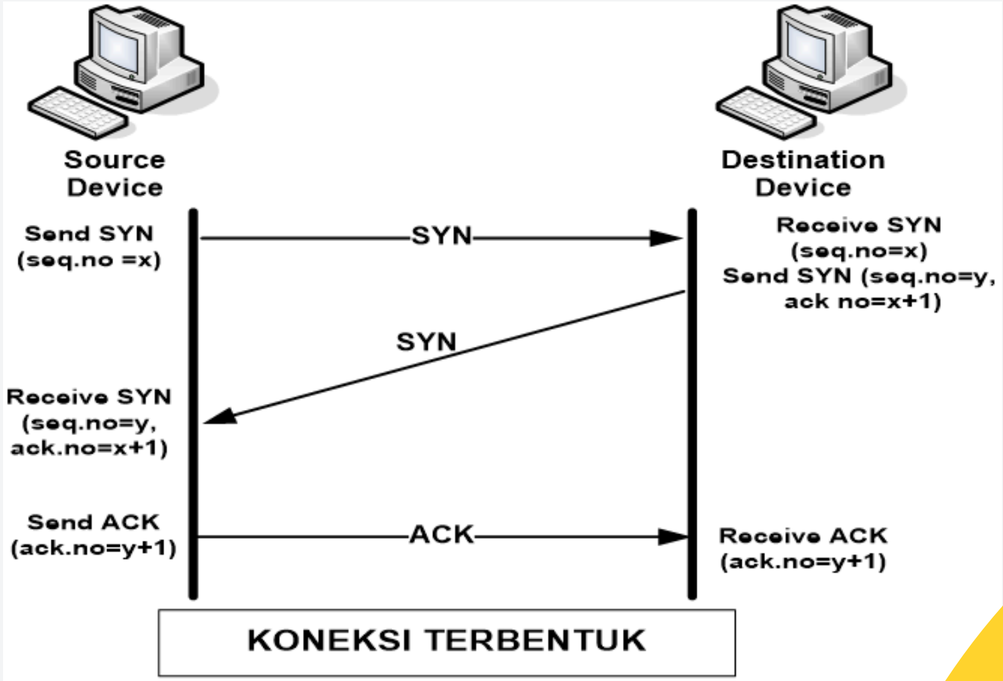


TCP & UDP

TCP	UDP
Characteristics: • Connection-oriented • End-to-end protocol • Full Duplex • Reliability of Delivery (sequence no., ack no.) • Flow control (window size, sliding window)	**Characteristics:** • Connectionless • Unreliability of Delivery • No flow control • Reliable enough for stable networks • Typically used for data that can be sent in one transmission only
Applications: • HyperText Transfer Protocol (HTTP) • File Transfer Protocol (FTP) • Simple Mail Transfer Protocol (SMTP) • Telnet	**Applications:** • Domain Name Systems (DNS) • Trivial File Transfer Protocol (TFTP) • Simple Network Management Protocol (SNMP) • Routing Information Protocol (RIP)

3-WAY HANDSHAKE

- Synchronization process between sender and receiver before the connection is established.
- Consists of 3 stages.
- Sender and receiver exchange SYN and ACK.
- Negotiation of window size → Flow Control.



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- Sandberg, B., “The Complete Reference Networking”, 3rd Edition, McGraw-Hill, 2015.

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