

# Networking Fundamentals

# Agenda

Fasten Your  
Seatbelts!

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- **OSI Model**
- **Network Devices in the OSI Model**

# Graphic Symbols



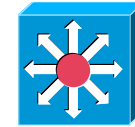
**Bridge**



**Switch**



**Router**



**Multi-layer  
switch**



**Firewall**



**IPS**



**Web Security  
Appliance**



**Email Security  
Appliance**



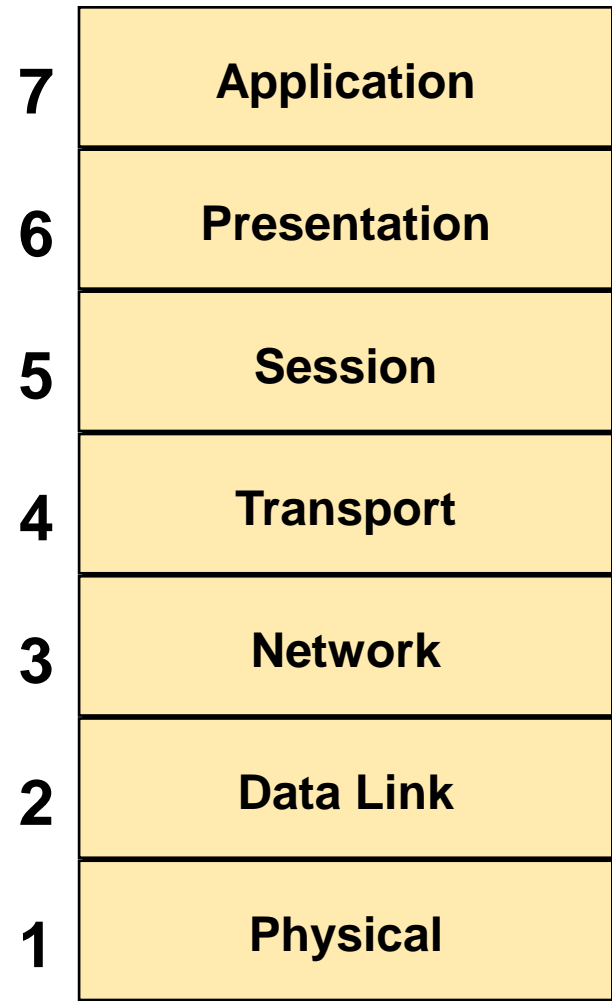
**WAN "cloud"**

# Internetworking Basics and the OSI Model

# OSI Reference Model

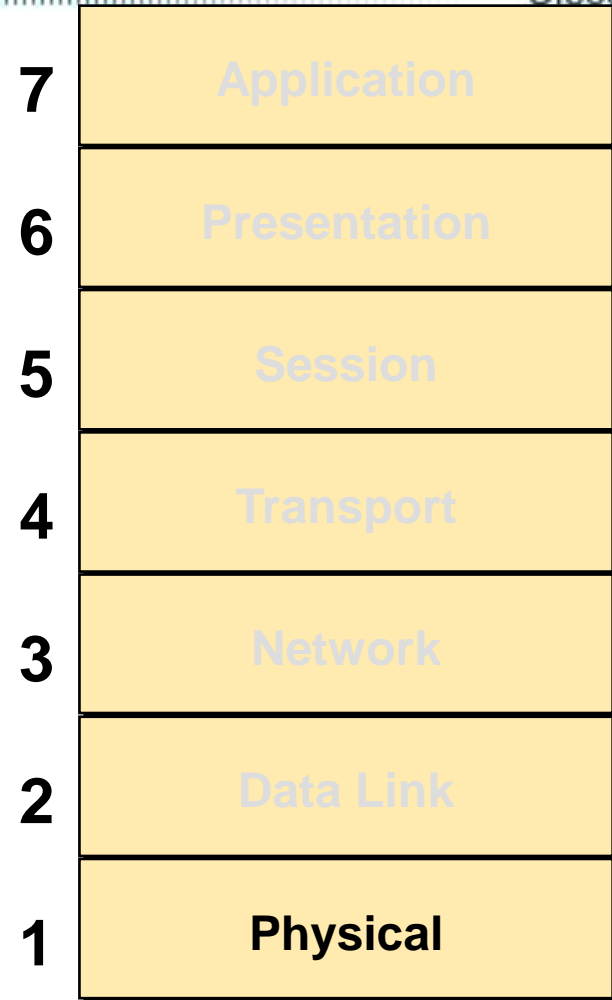
- **Architectural Model for Intercomputer Communications.**

- Reduce complexity
- Standard interfaces
- Modular engineering
- Interoperable Technology
- Accelerate evolution
- Discrete subsets



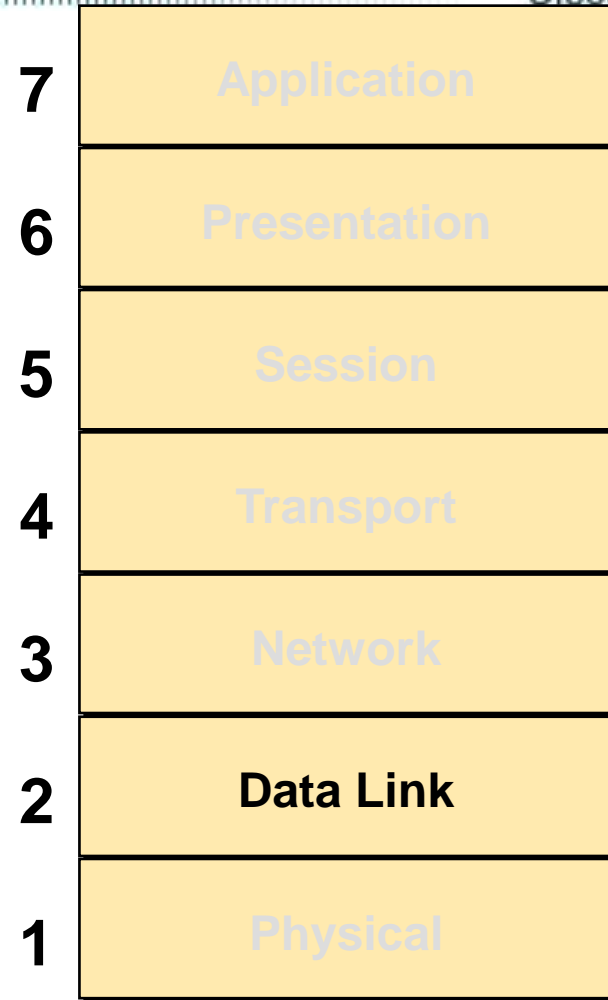
# OSI Reference Model

- Layer 1 - Physical
- Specifications:  
Electrical,  
Mechanical,  
Procedural  
Functional
- (ie.V.35,X.21,HSSI,  
EIA/TIA-232,FE,GE)
  - Signaling/Bits



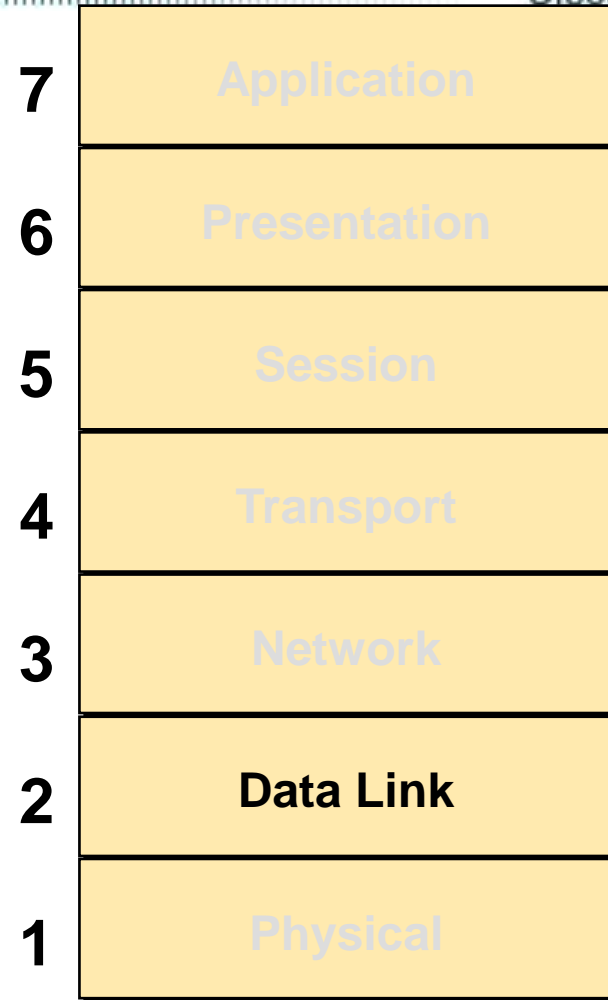
# OSI Reference Model

- **Layer 2 - Data Link**
- **Provides reliable transit of data across a physical link.**
- **Frames/Datagrams**



# OSI Reference Model

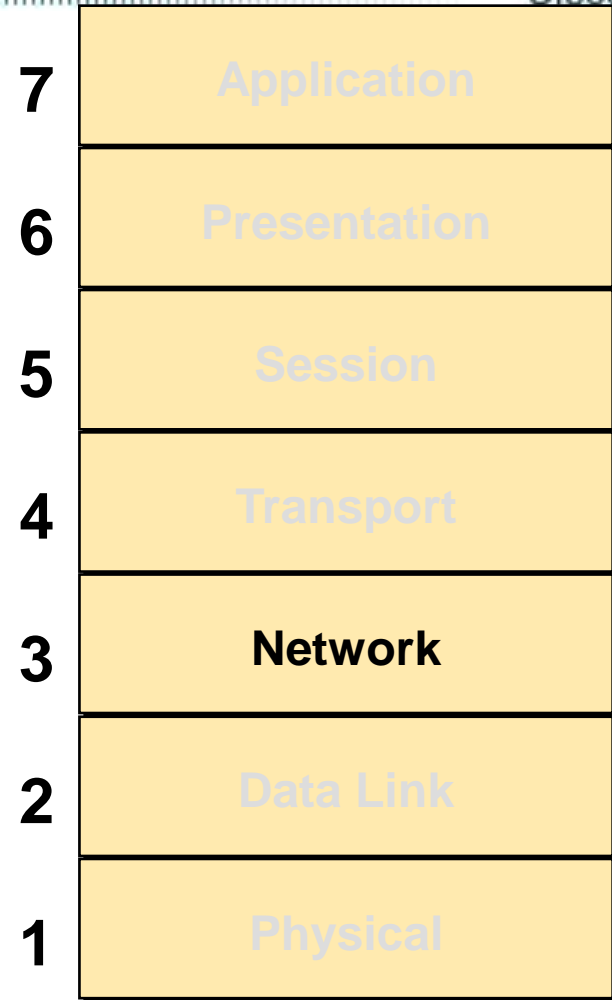
- **Data Link Sublayers**
  - **Logical Link Control**
    - Enable upper layers to gain independence
    - Allow service access points (SAPs) to interface sublayers to upper-layer functions
  - **Media Access Control**
    - MAC address burned into ROM (48 bits 24 bits vendor [OUI]/24 bits serial number)
    - Ethernet (CSMA/CD, 802.3, 802.2, Eth II)
    - Token Ring (802.5)
    - FDDI/CDDI





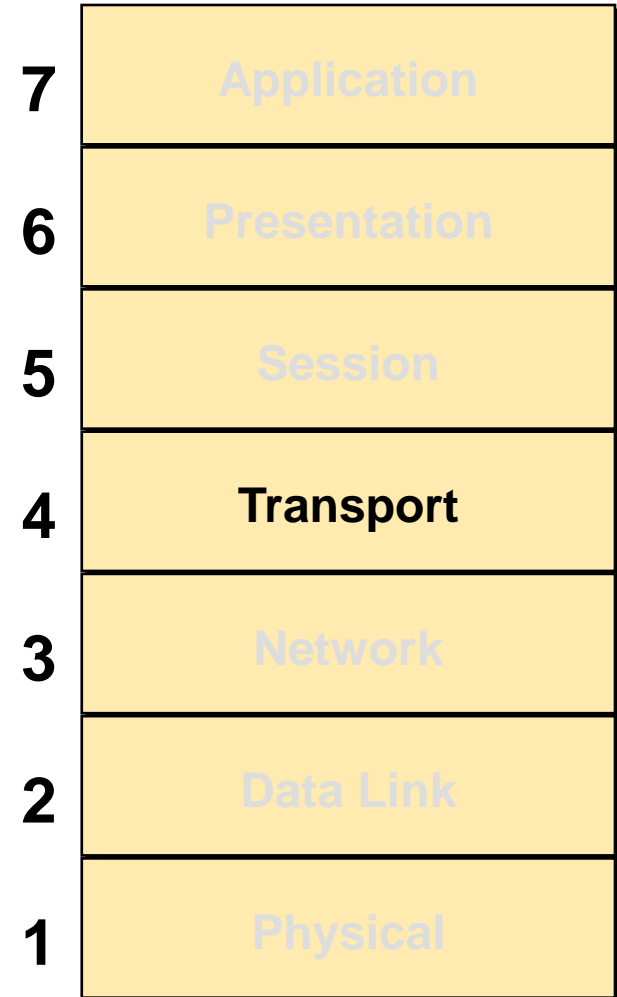
# OSI Reference Model

- Layer 3 - Network
- Complex Layer that Provides Connectivity and Path Selection
- **Packets**
- IP Address/Subnet
- Routing



# OSI Reference Model

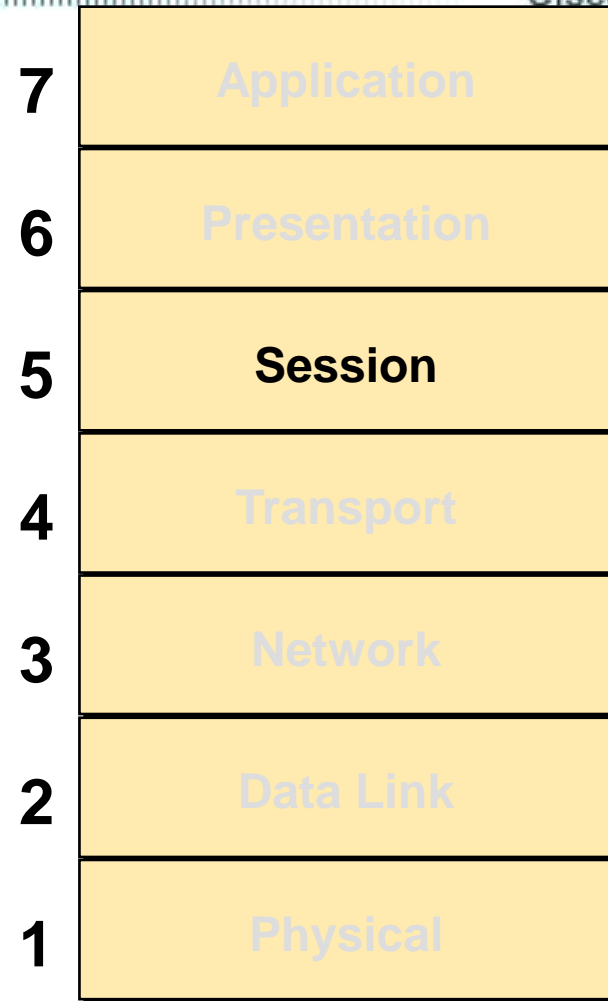
- **Layer 4 - Transport**
- **Segments** upper-layer applications
- Establishes an end-to-end connections
- Sends segments from one end host to another
- Optionally, ensures data integrity
- **Circuit setup & teardown, acknowledgement, multiplexing apps, flow control, & windowing**
- **TCP & UDP**



# OSI Reference Model

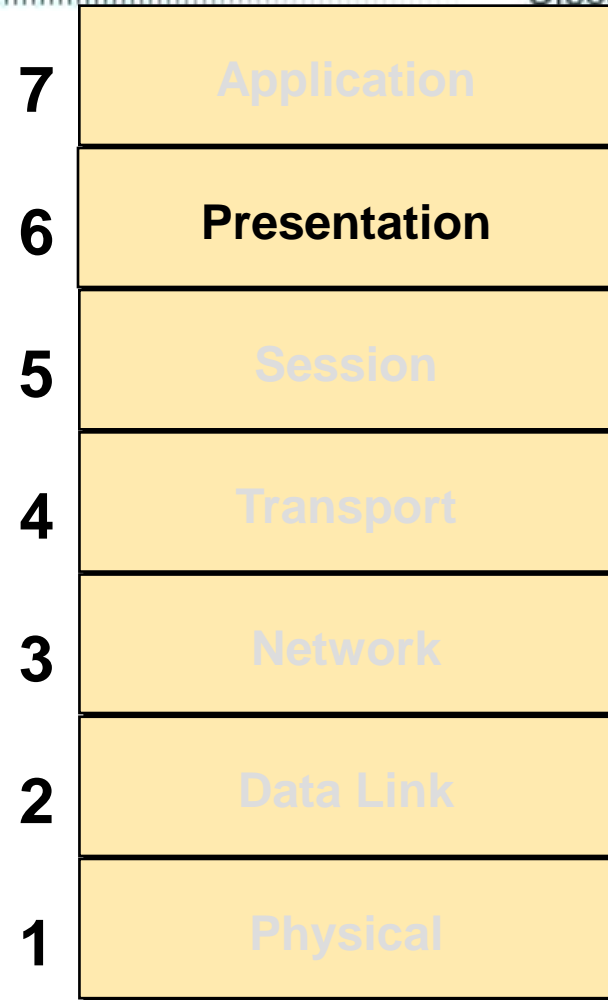
- **Layer 5 - Session**

- Establishes, manages, and terminates dialogues (aka sessions) between applications
- Synchronization services/ Checkpointing
- Graceful session close/restart
- Network File System (NFS)
- Structured Query Language (SQL)
- Remote Procedure Call (RPC) applications
- NetBIOS
- Named Pipes



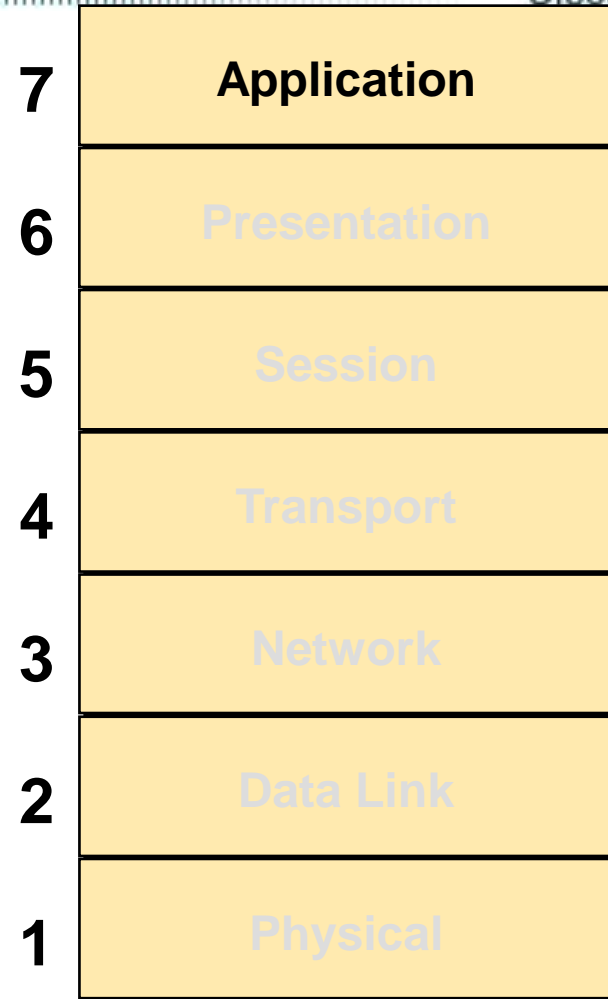
# OSI Reference Model

- **Layer 6 - Presentation**
- ASCII, EBCDIC, Encrypted
- Sound, Video (MIDI, MPEG, G729)
- Graphics (PICT, TIFF, JPEG, GIF)
  
- **Code formatting and conversion for applications**



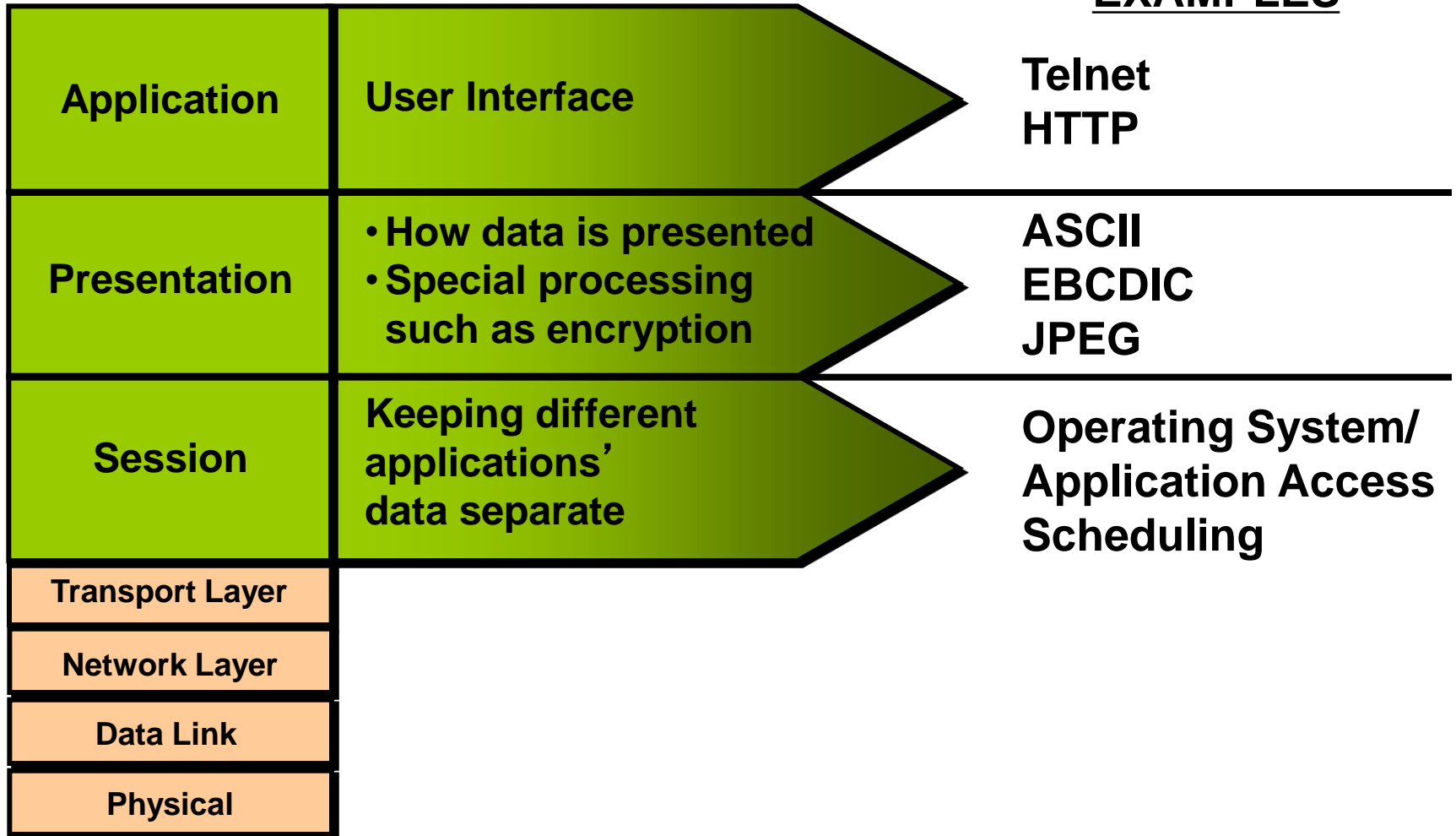
# OSI Reference Model

- **Layer 7 - Application**
- Word Processor
- Electronic Mail (SMTP, X.400)
- Remote Access (Telnet, SSH)
- Client-Server Process
- World Wide Web (WWW)
- EDI
- **Supports the communicating component of an applications**



# Role of Application Layers

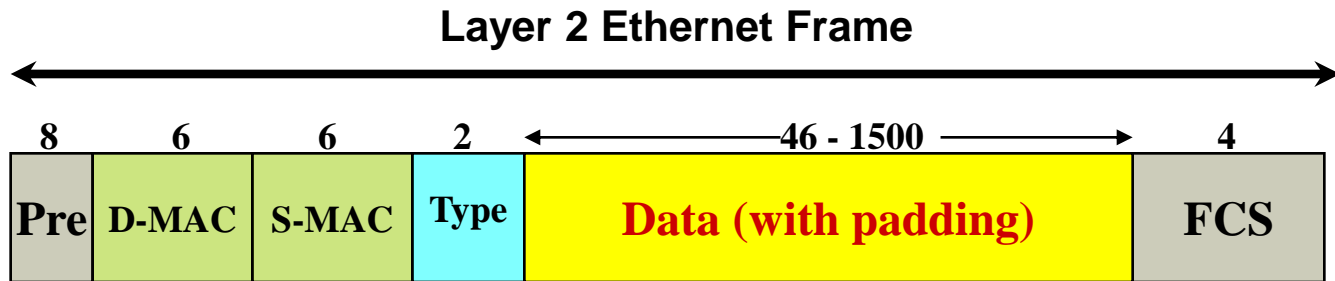
## EXAMPLES



# Role of Data Flow Layers

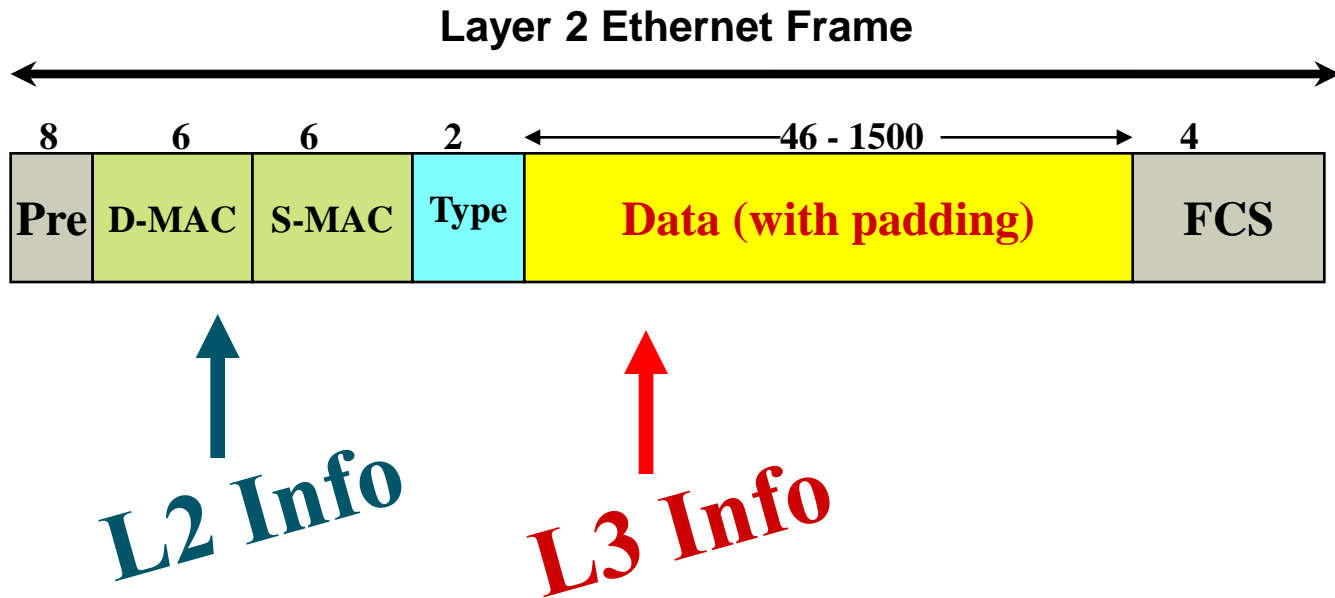
<b>Application</b>		
<b>Presentation</b>		
<b>Session</b>		<b><u>EXAMPLES</u></b>
<b>Transport</b>	<ul style="list-style-type: none"><li>• Reliable or unreliable delivery</li><li>• Error correction before retransmit</li><li>• Flow control</li></ul>	<b>TCP UDP SPX</b>
<b>Network</b>	<b>Provide logical addressing which routers use for path determination</b>	<b>IP IPX</b>
<b>Data Link</b>	<ul style="list-style-type: none"><li>• Combines bits into bytes and bytes into frames</li><li>• Access to media using MAC address</li><li>• Error detection not correction</li></ul>	<b>802.3 / 802.2 HDLC</b>
<b>Physical</b>	<ul style="list-style-type: none"><li>• Move bits between devices</li><li>• Specifies voltage, wire speed and pin-out cables</li></ul>	<b>EIA/TIA-232 V.35</b>

# A Layer-2 Frame





# A Layer-2 Frame - detail



# Ethernet Frame Types



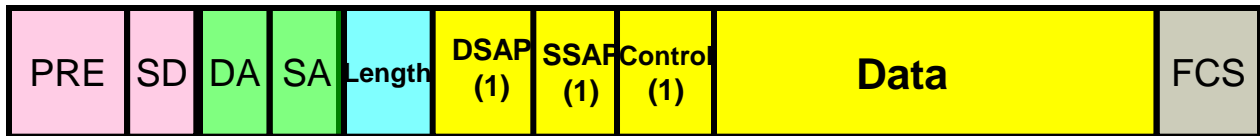
Cisco Name  
ARPA

Novell Name  
Ethernet\_II

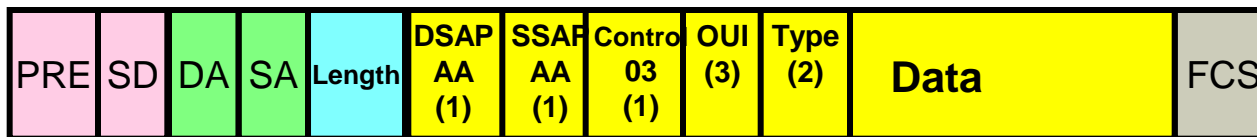


Novell Ether

Ethernet\_802.3

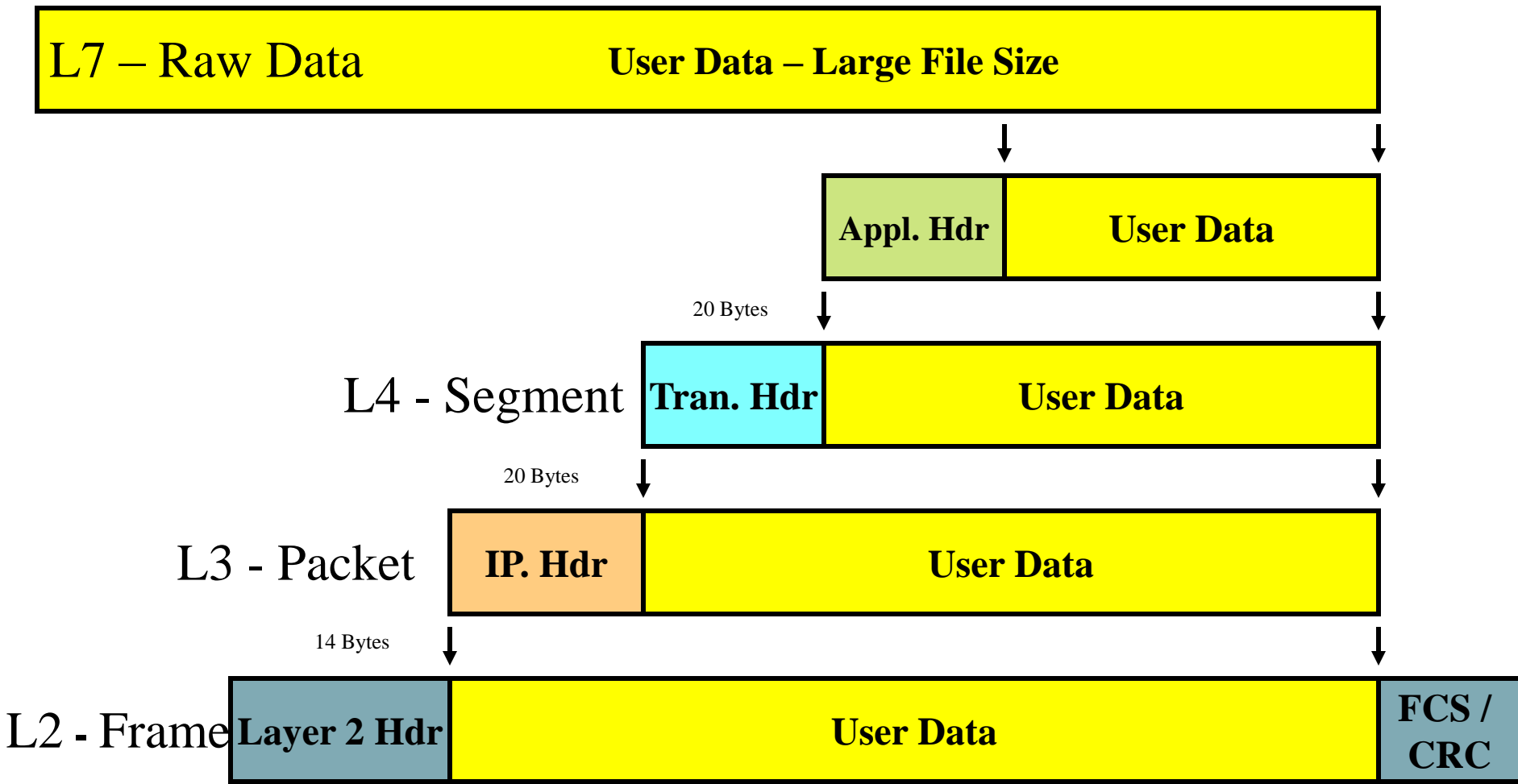


SAP Ethernet\_802.2

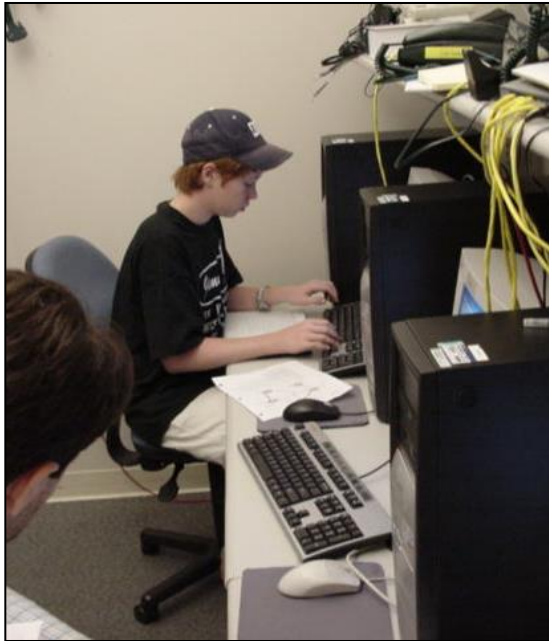


SNAP Ethernet\_SNAP

# Layer 2 – Data Link



# FCS - Frame Check Sequence

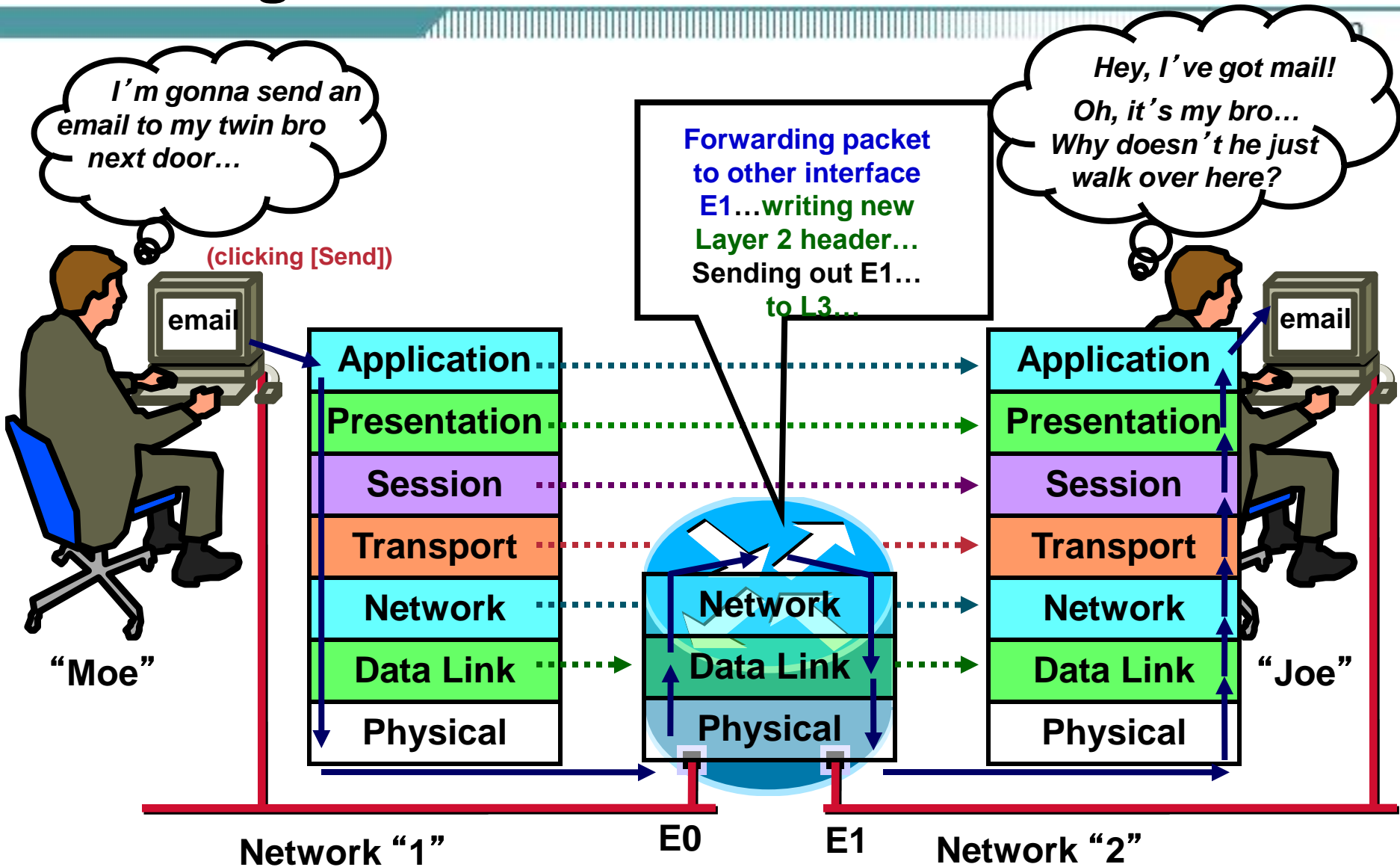


- The **FCS** detects errors.

The standard 16-bit cyclic redundancy check (CRC) is used for Frame Relay frames

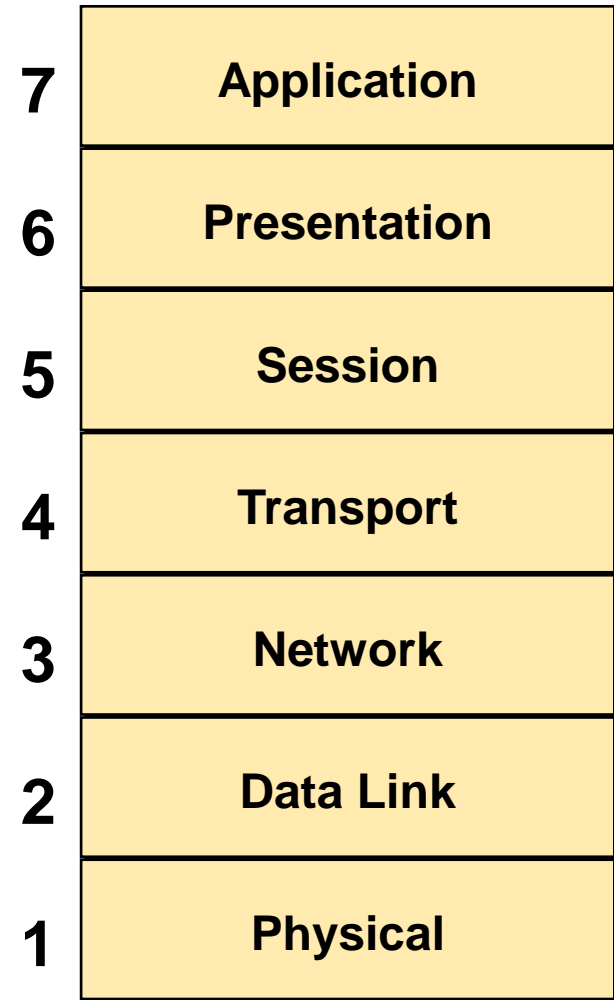
**CRC** - A mathematical computation to ensure the accuracy of frames transmitted between devices in a Frame Relay network.

# The Big Picture!

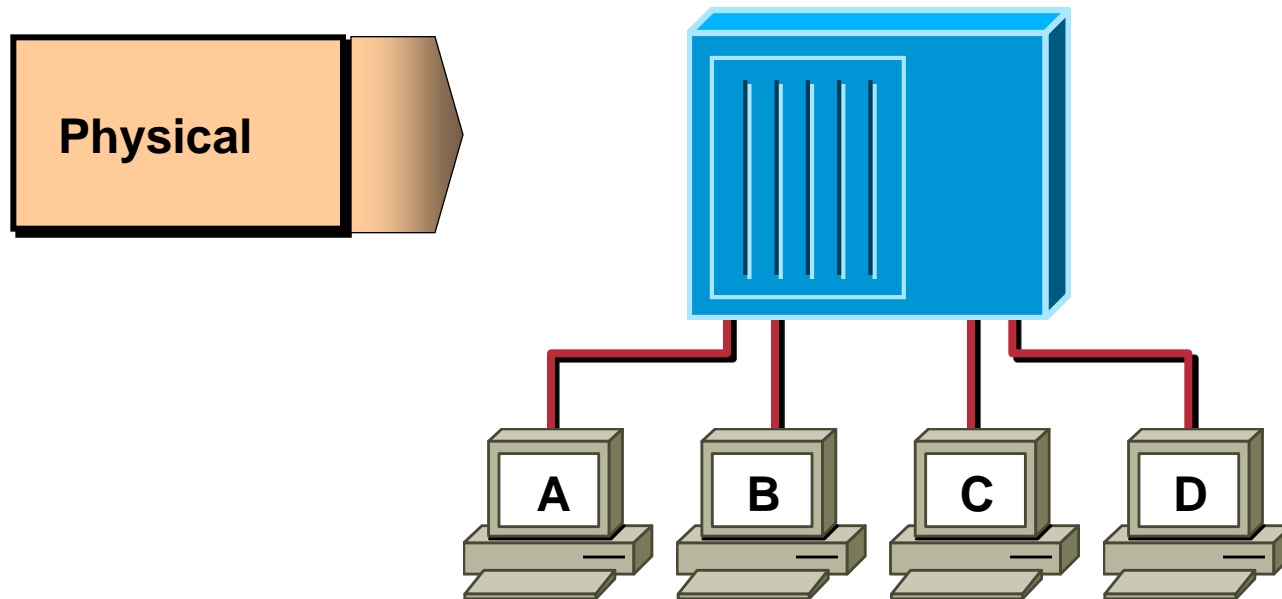


# Network Devices and OSI Model

- **Layer 5-7 – Firewalls, IPS**
- **Layer 3,4 - Routers**
- **Layer 2 – Bridges/Switches**
- **Layer 1 - Hubs**



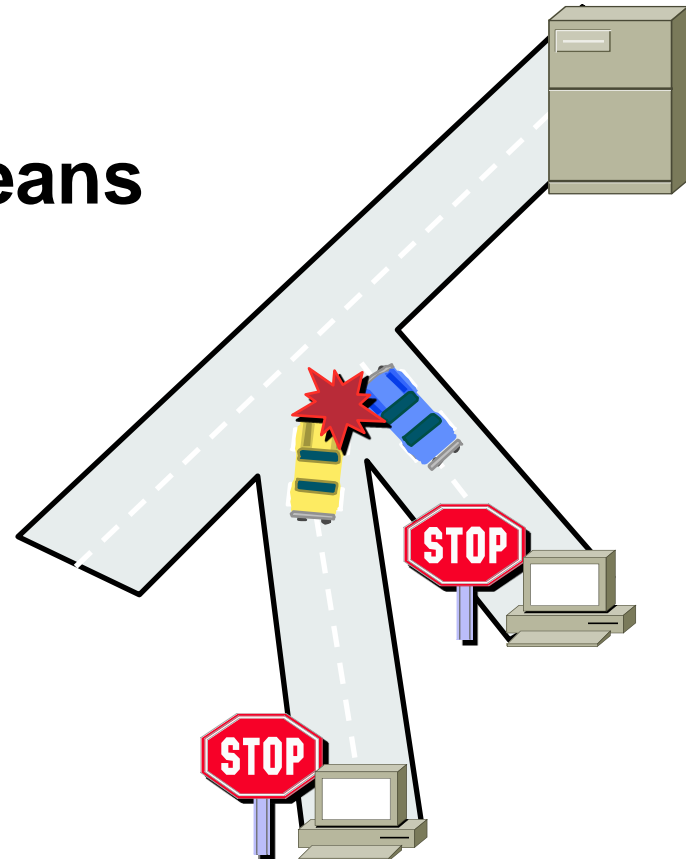
# Hubs Operate at Physical layer



- **All devices in the same collision domain**
- **All devices in the same broadcast domain**
- **Devices share the same bandwidth**

# Hubs: One Collision Domain

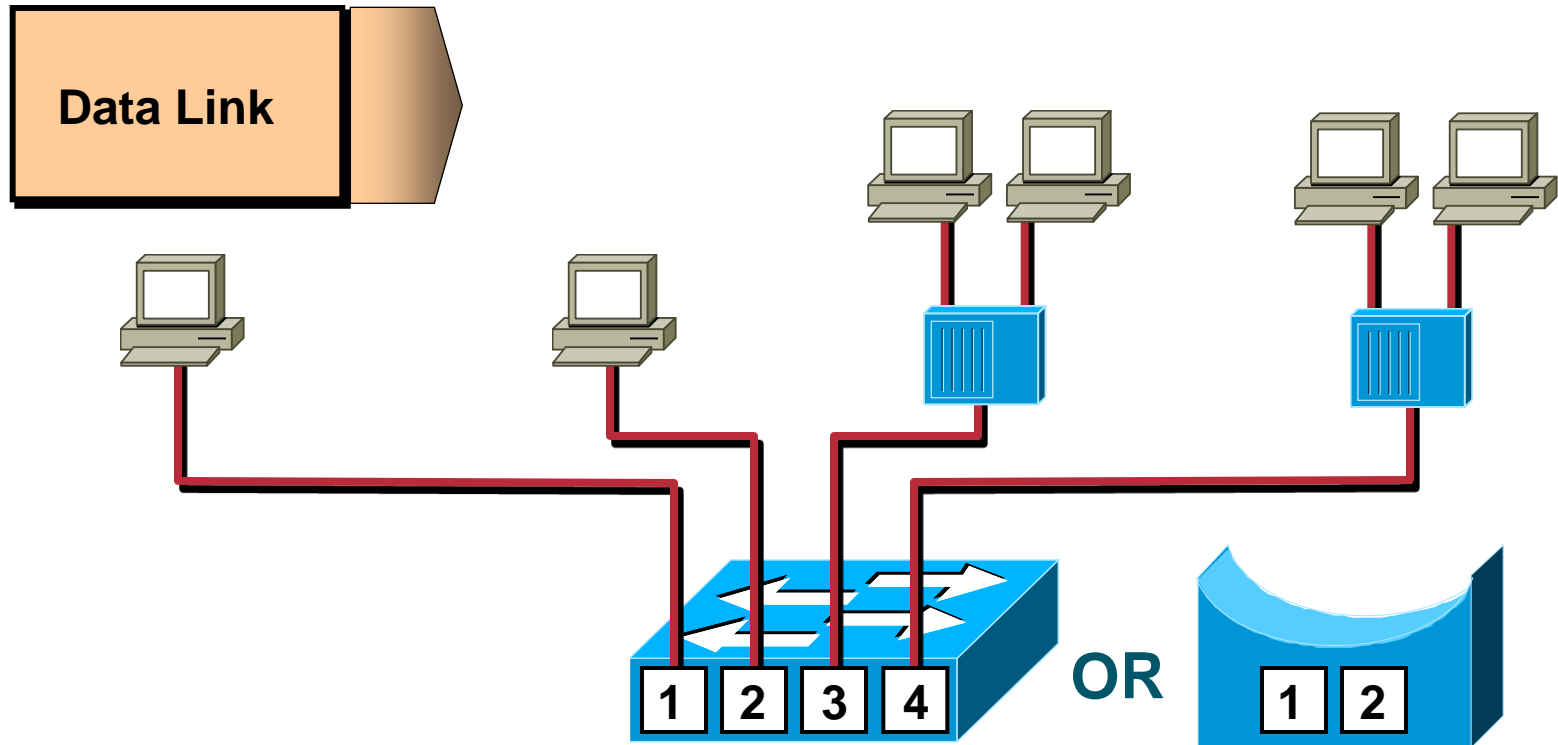
- More end stations means more collisions
- CSMA/CD is used





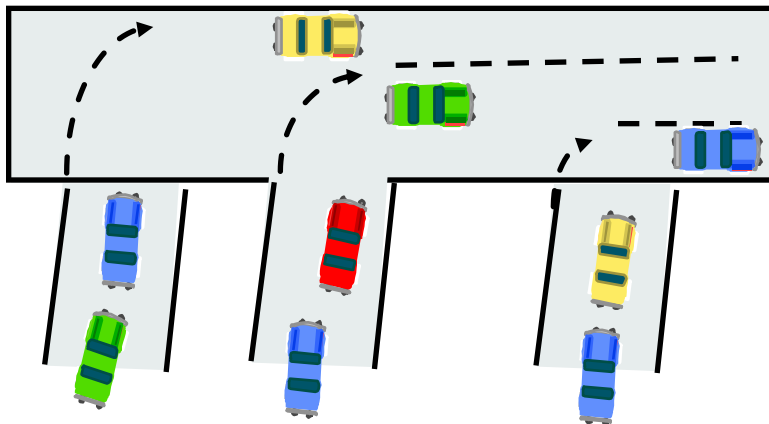
# Switches and Bridges Operate at Data Link Layer

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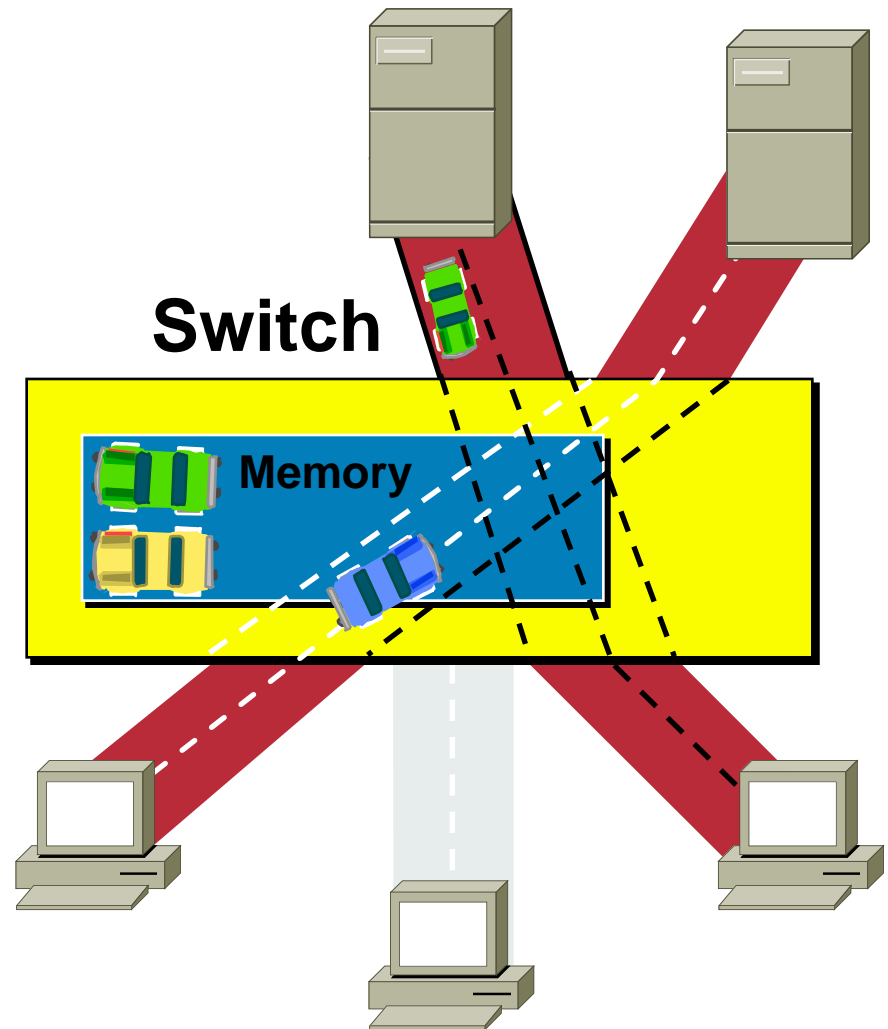


- Each segment has its own collision domain
- All segments are in the same broadcast domain

# Switches

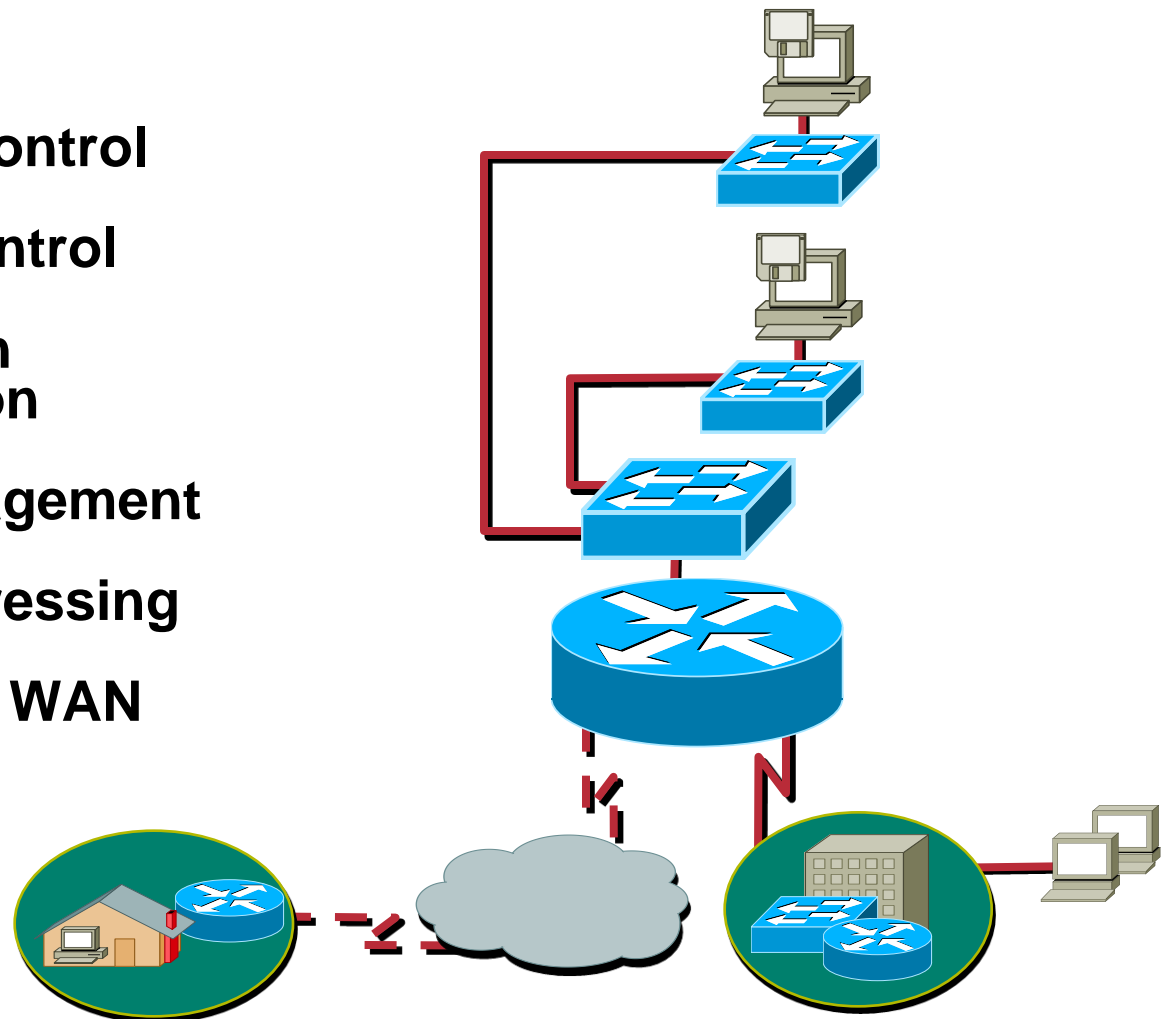


- Each segment has its own collision domain
- Broadcasts are forwarded to all segments



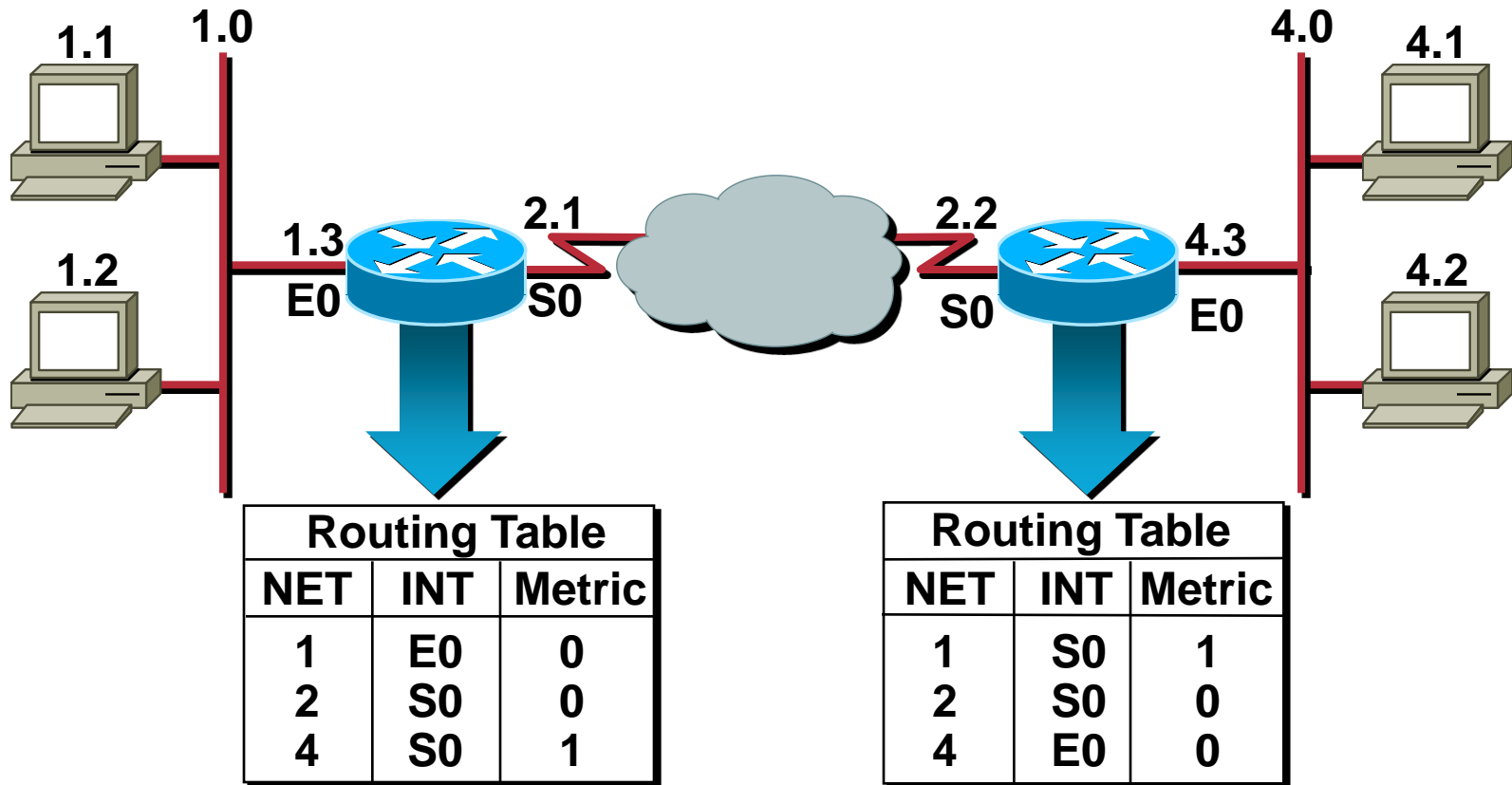
# Routers: Operate at the Network Layer

- Broadcast control
- Multicast control
- Optimal path determination
- Traffic management
- Logical addressing
- Connects to WAN services



# Network Layer Functions (cont.)

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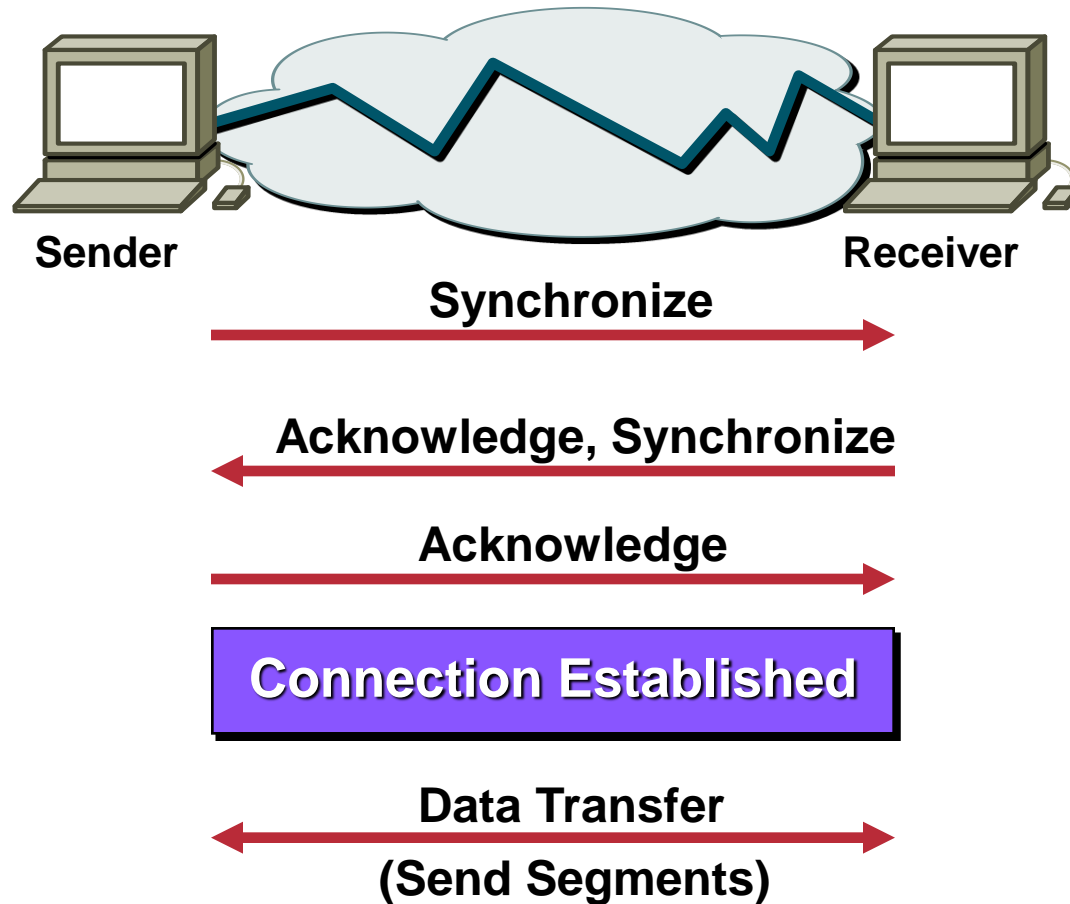
- Logical addressing allows for hierarchical network
- Configuration required
- Uses configured information to identify paths to networks

# Transport Layer Functions

- Distinguishes between upper layer applications
- Establishes end-to-end connectivity between applications
- Defines flow control
- Provides reliable or unreliable services for data transfer

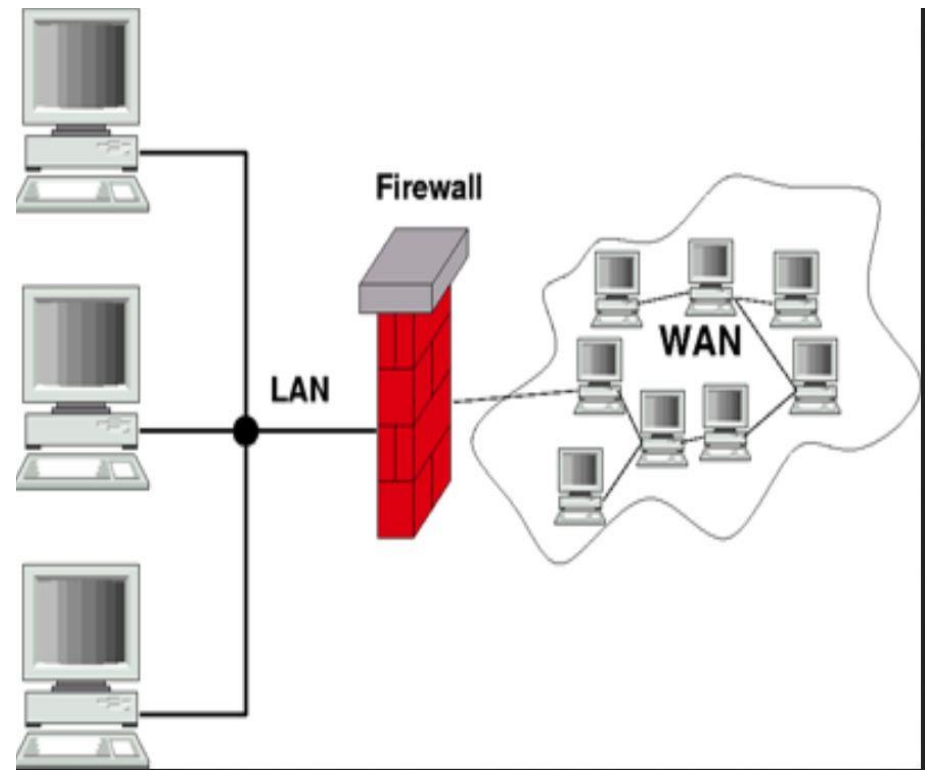
Transport	TCP	UDP	SPX
Network	IP		IPX

# Reliable Transport Layer Functions



# Firewalls: Operate at L2 – L7

- **Blocks unrequested traffic**
- **Allows return traffic from requested sessions**
- **Inspects for “impersonated” traffic**
- **Creates network boundaries**
- **Can be configured manually to allow or deny certain traffic**



# Intrusion Prevention Systems: Operate at L3 – L7

- Inspects traffic for attacks
- Can be deployed in-line or out of band
- Can send alert or block suspicious traffic
- Differs from firewall in that it inspects allowed traffic for suspicious behavior

