Networking Standards and the OSI Model

Network Communication

- Recognize data
- Divide data into manageable chunks (fragments)
- Add information to each chunk to:
  - Determine where the data is coming from
  - Identify where the data is going to
- Add timing and error checking information
- Put the data on the network and send it on its way

Standard Protocols Needed

- Network operating systems follow strict rules (protocols) to control how each of the previous tasks are accomplished.
- Need for standard protocols so that software/hardware from different vendors could communicate

Standards Organizations

- ANSI—American National Standards Institute
  - Determine standards for electronics industry
  - Represent US in setting international standards
- EIA—Electronics Industry Alliance
  - Trade organization representing electronic firms across US
- IEEE—Institute of Electrical and Electronic Engineers
  - International society of engineering professionals
  - Promote development and education in engineering and computer science fields
  - The **IEEE 802** LAN/MAN Standards **Committee** develops and maintains networking standards and recommended practices for local, metropolitan, and other area
- ISO—International Organization for Standardization
  - Collection of organizations from 130 countries
  - Establish international technological standards to facilitate global exchange of data
- ITU—International Telecommunication Union
  - United Nations agency that regulates international telecommunications including radio and TV frequencies, satellite and telephone specifications, and networking infrastructure

OSI and 802 Models

- Two primary sets of standards (LLC & MAC)
- Define rules for:
  - How network devices communicate
  - Methods used to determine when to send data
  - Methods to ensure that data is received correctly
  - How the network is cabled
  - How the network maintains the flow of data
  - How bits of data are represented

802 Model

- Model published by the Institute for Electrical and Electronic Engineers, Inc. (IEEE)
- Project began in February 1980 (802)
- Predates OSI standard but developed in cooperation with OSI
- Defines aspects of networking related to physical cabling, connectivity, error checking, data transmission, encryption, and emerging technologies

Open System Interconnection (OSI)

- 1977-78 International Organization for Standardization (ISO) began developing specifications for network communications
- 1984 OSI model was released
- International standard
- Best known and most widely used guide to understanding network communications
- The seven-layer OSI model (Mnemonic remember: All People Seem To Need Data Processing)

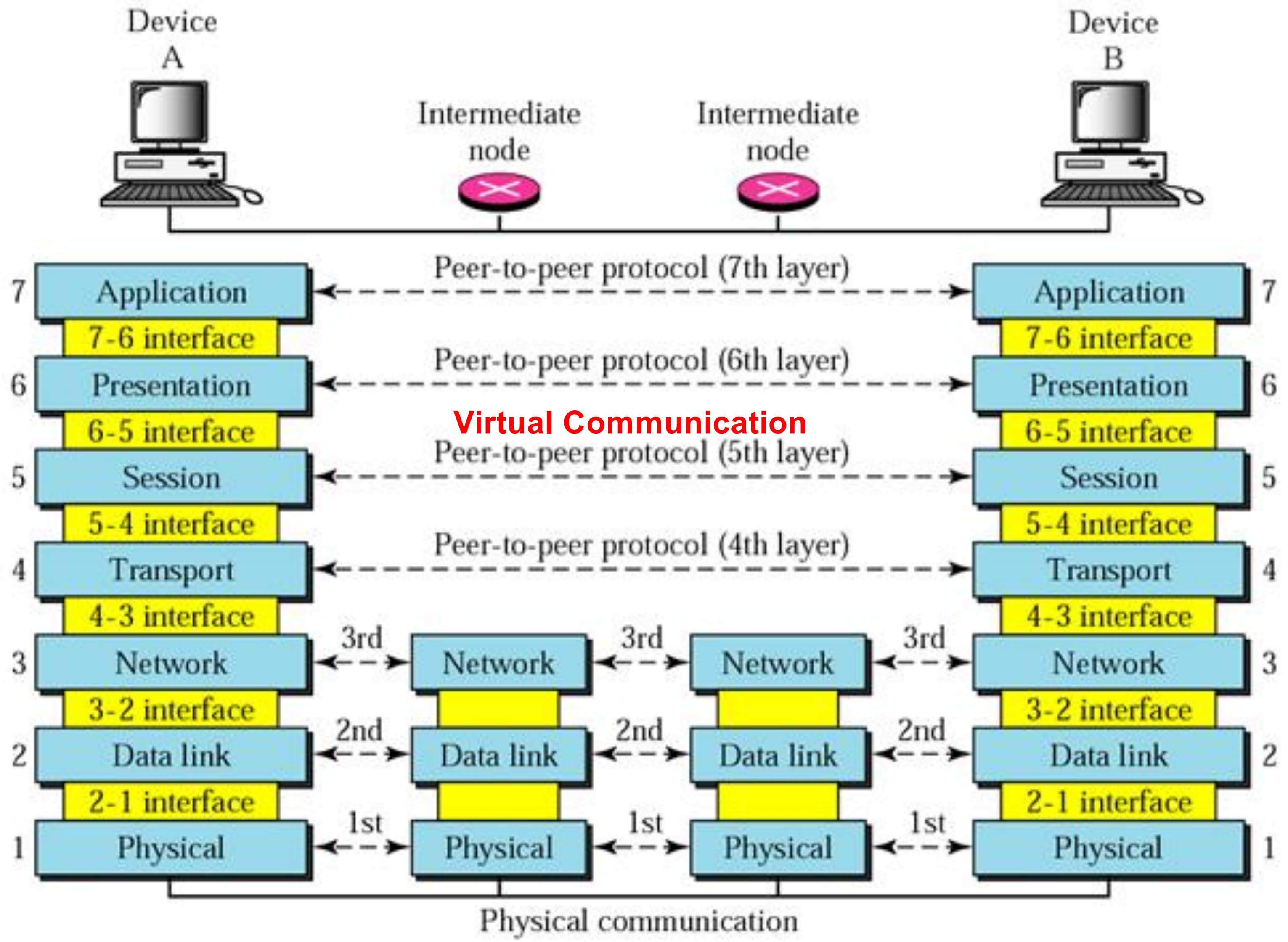
Layer	Type	OSI Model	TCP/IP Model	Authority
7	Data	Application Layer	Application Layer	RFCs, IETF, Industry Orgs, Etc.
7	Data	Presentation Layer		
5	Data	Session Layer		
4	Segments	Transport Layer	TCP/UDP	
3	Packets	Network Layer	IP	
2	Frames	Data Link Layer	Ethernet	IEEE 802.1
1	Bits	Physical Layer		IEEE 802.3

Network

Relationship of OSI Layers

- Each layer of the OSI model must communicate with the layer above and below it
  - For example, the Presentation layer must communicate with the Application layer (one above) and the Session layer (one below)
- As data passes down through the OSI layers, each layer (except Physical) adds some information to the data
- When data reaches the receiving computer, the information added by each layer of the OSI model is read and processed by the corresponding layer on the receiving computer
- This is referred to as peer-layer communications

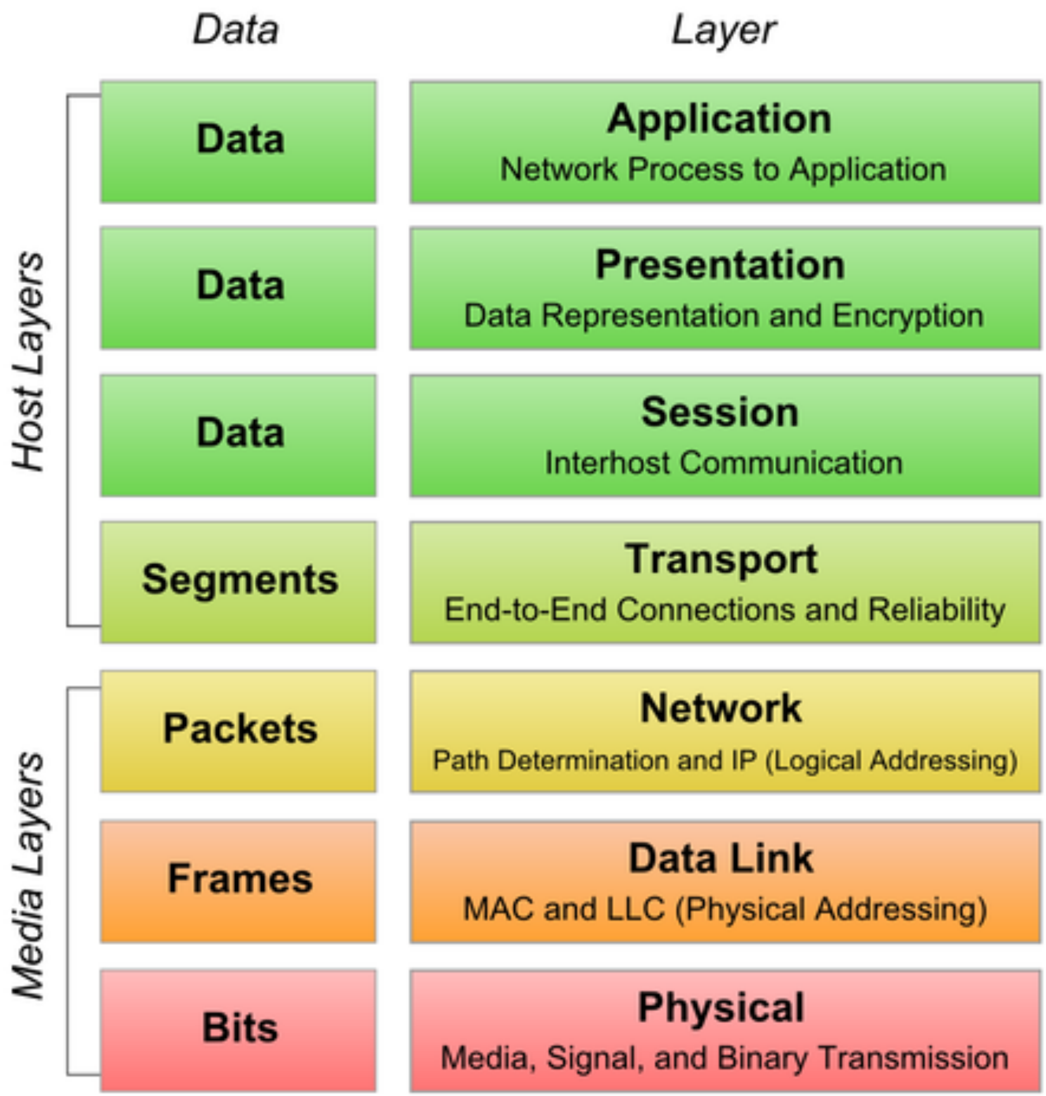
Relationships among OSI layers



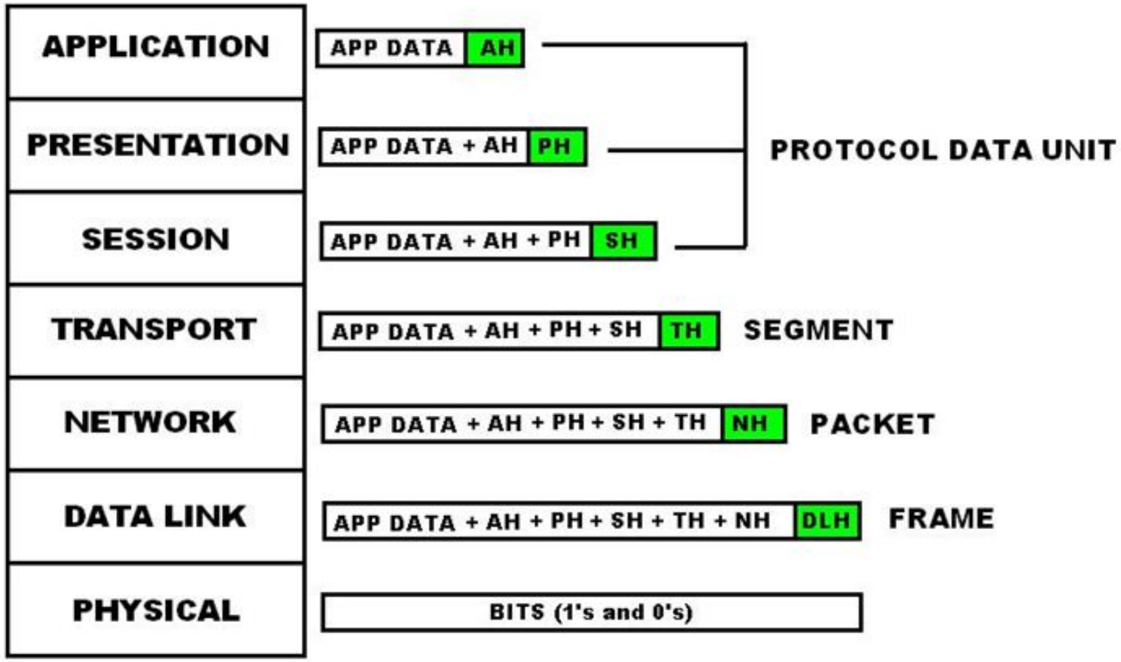
ISO/OSI RM

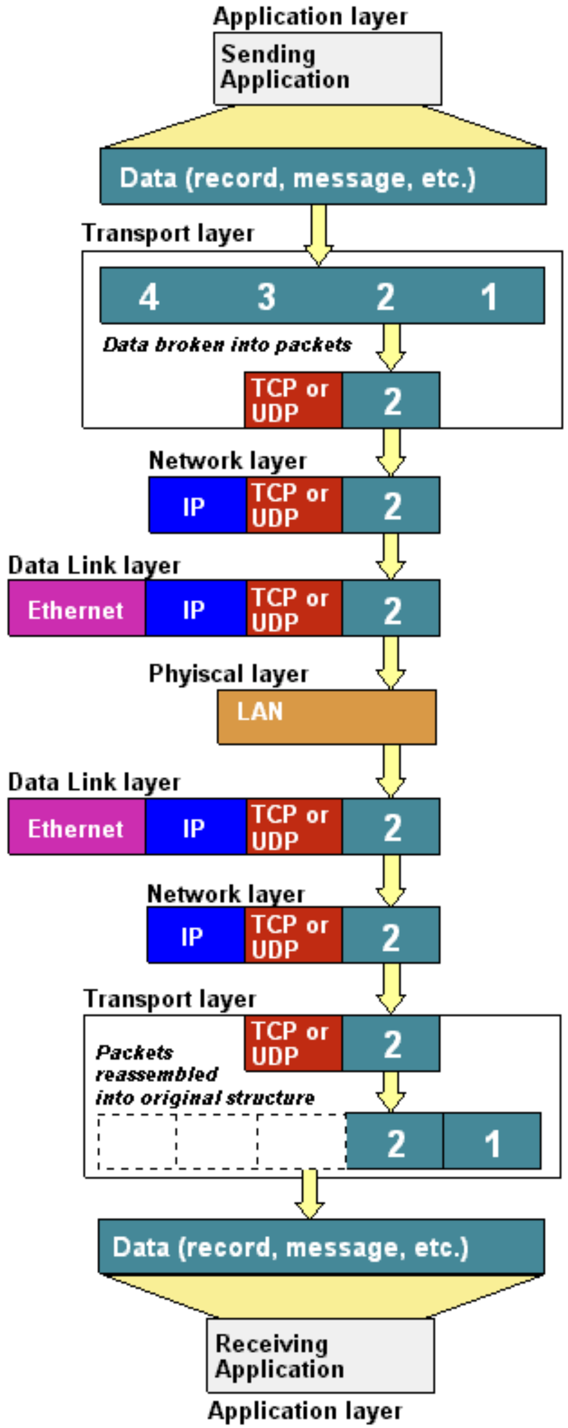
Datagram-Segment-Packet-Frame-Bits

- When data enters the top three layers of the model, it remains relatively unchanged and is essentially still data, it is called a **PDU** or *protocol* ***datagram*** *unit* at this point.
- When it reaches layer 4 it is known as a **Segment.**
- At layer 3 it becomes a **Packet.**
- At leyer 2 it becomes a **Frame**.
- The bottom layer converts the frame into **Bits** or (one's and zeros) for transport across the network medium.



Encapsulation-Decapsulation Process





OSI (Open Source Interconnection) 7 Layer Model

Layer	Application/Example		Central Device/ Protocols			DOD4 Model
Application (7) Serves as the window for users and application processes to access the network services.	**End User layer** Program that opens what was sent or creates what is to be sent Resource sharing • Remote file access • Remote printer access • Directory services • Network management		**User Applications** SMTP		**GATEWAY** Can be used on all layers	Process
Presentation (6) Formats the data to be presented to the Application layer. It can be viewed as the "Translator" for the network.	**Syntax layer** encrypt & decrypt (if needed) Character code translation • Data conversion • Data compression • Data encryption • **Character Set Translation**		JPEG/ASCII EBDIC/TIFF/GIF PICT			
Session (5) Allows session establishment between processes running on different stations.	**Synch & send to ports** (logical ports) Session establishment, maintenance and termination • Session support - perform security, name recognition, logging, etc.		**Logical Ports** RPC/SQL/NFS NetBIOS names			
Transport (4) Ensures that messages are delivered error-free, in sequence, and with no losses or duplications.	**TCP** Host to Host, Flow Control Message segmentation • Message acknowledgement • Message traffic control • Session multiplexing	PACKET FILTERING	TCP/SPX/UDP			Host to Host
Network (3) Controls the operations of the subnet, deciding which physical path the data takes.	**Packets** ("letter", contains IP address) Routing • Subnet traffic control • Frame fragmentation • Logical-physical address mapping • Subnet usage accounting		**Routers** IP/IPX/ICMP			Internet
Data Link (2) Provides error-free transfer of data frames from one node to another over the Physical layer.	**Frames** ("envelopes", contains MAC address) [NIC card — Switch — NIC card] (end to end) Establishes & terminates the logical link between nodes • Frame traffic control • Frame sequencing • Frame acknowledgment • Frame delimiting • Frame error checking • Media access control		**Switch** **Bridge** **WAP** PPP/SLIP	Land Based Layers		Network
Physical (1) Concerned with the transmission and reception of the unstructured raw bit stream over the physical medium.	**Physical structure** Cables, hubs, etc. Data Encoding • Physical medium attachment • Transmission technique - Baseband or Broadband • Physical medium transmission Bits & Volts		**Hub**			

7. Application Layer

- Provides services to support user applications, such as file transfer, database access, and e-mail
  - Not a particular application—but services that are provided to applications

6. Presentation Layer

- Translates data between the format the network requires and the format the application expects
- Responsible for encrypting data, changing or converting the character set and interpreting graphic commands
- Manages data compression to reduce number of bits to be transmitted

5. Session Layer

- Responsible for establishing and maintaining communications between two nodes on the network
- Allows applications on separate computers to share a connection (called a session)
- Provides data synchronization and checkpointing so that if there is a network failure only the data sent after the checkpoint must be resent
- Provides name recognition and security needed to allow two applications to communicate

4. Transport Layer

- Ensures data is delivered error-free in sequence and without duplication or loss
- Breaks large packets from the Session layer into segments to be sent to the receiving computer
- Adds sequencing information to segments
- Reassembles the segments into messages
- Sends acknowledgement to sending computer

3. Network Layer

- Responsible for addressing messages across networks
- Translates network logical addresses into physical machine addresses
- Breaks large segments into smaller packets
- Determines routing across networks
- Supports communications between logically separate networks
  - Routers and gateways (devices that pass data from one network to another) operate in the Network layer

2. Data Link Layer

- Accepts packets of data from Network layer and packages the data into data units called frames
- Adds information such as frame type and physical address
- Responsible for providing error-free transfer of data frames
  - Frame Check Sequence—error checking algorithm is added at the end of each frame so that receiving computer can detect damaged frames and request that frames be resent
    - Cyclic Redundancy Check (CRC)—most commonly used algorithm

■ Intelligent hubs, bridges, and switches are addressed by the Data Link Layer

■ Defines how media will be accessed

■ Divided by 802 model into two sub-layers:

  ◆ Logical Link Control (LLC) 802.2

  ◆ Media Access Control (MAC) 802.1

2. Data Link Layer

- Logical Link Control
  - Uses error check algorithm (FCS) to verify that data is received correctly
  - Ensures that the rate of transmission is appropriate for the receiving computer
  - Provides the link between the Data Link layer and the Network layer
- Media Access Control
  - Controls the way multiple devices share the same media channel
    - Defines the method the NAC will use to determine when to send data
  - Communicates directly with the network adapter card
  - MAC (physical) address for network adapter cards provide unique identifier for each NAC

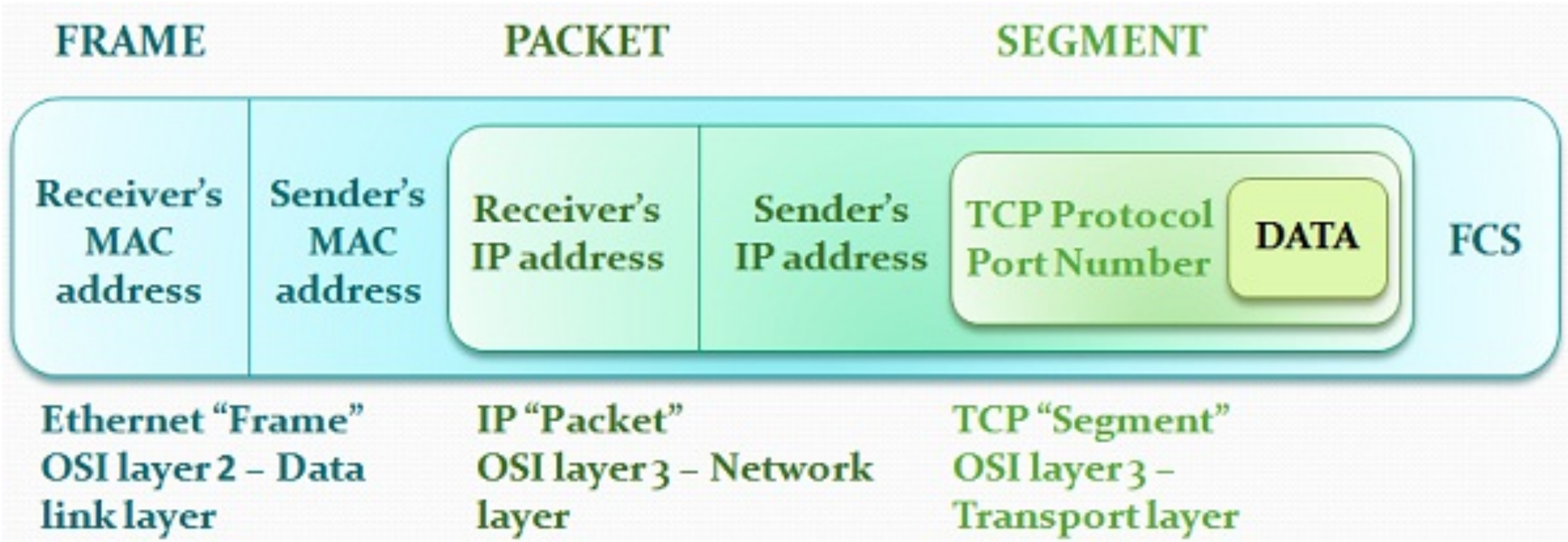
1. Physical Layer

- Responsible for transmitting bits from one computer to another
- Physical topology
- Network connection types
  - Number of pins on the network connector
  - Passive and active hubs, terminators, cables, repeaters, transceivers, etc.
- Defines the electrical details
  - Bit encoding—what represents 0 and 1
  - How data will be synchronized
  - Baseband/broadband transmission

Network Frame-Packet-Segment

Frame Structure

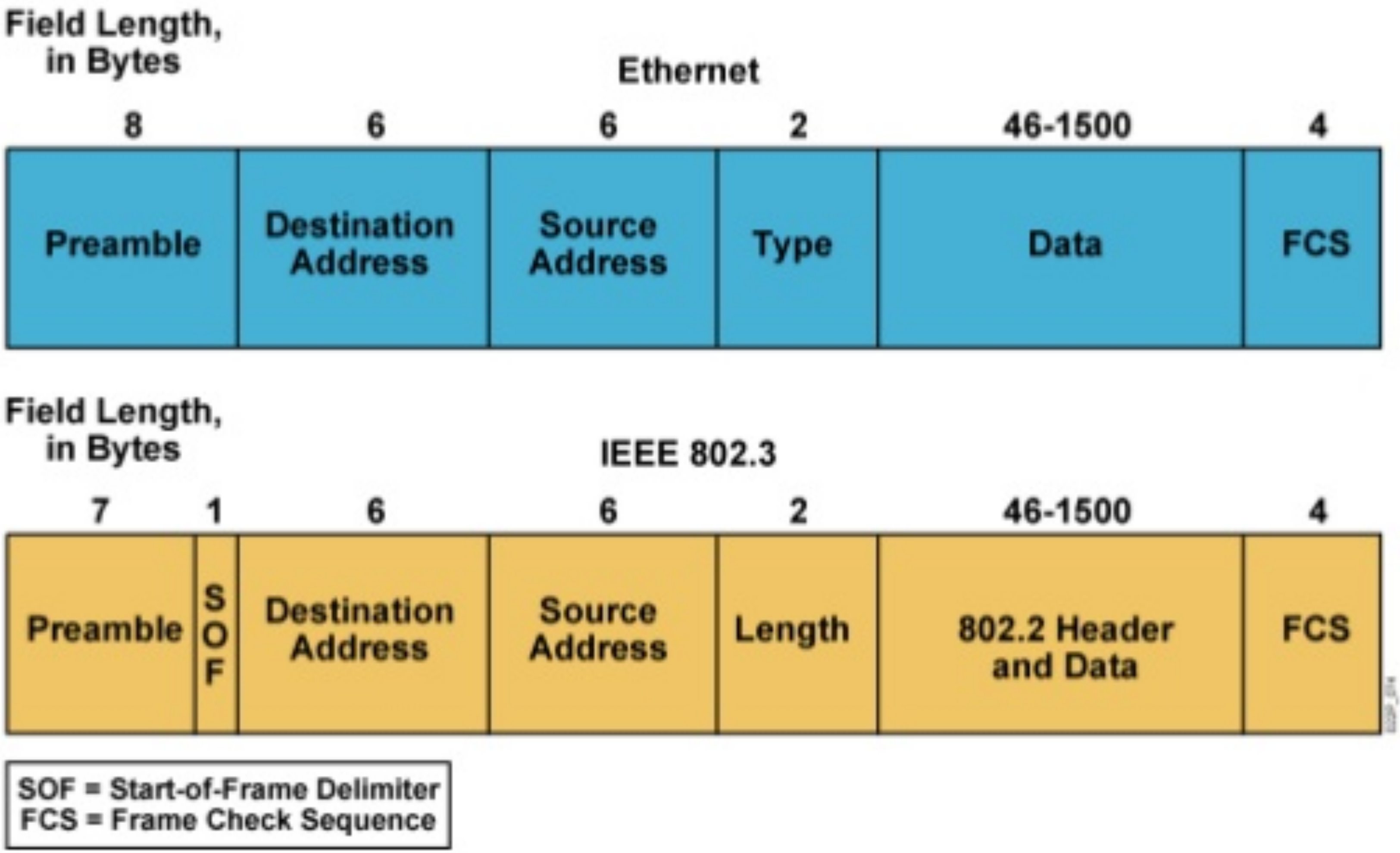
- Header
  - Destination address
  - Source address
  - Instructions that tell the computer how to pass the data along (routing)
  - Reassemble information
- Data
- Trailer containing error-check information



Major Frame Types

- Ethernet II
  - Networking technology developed in 1970
  - Most commonly used today
  - Used in bus and star topologies
- Token Ring
  - Developed by IBM in 1980s
  - Used in ring topology
- IEEE 802.3
- IEEE 802.2 LLC
- IEEE 802.2 SNAP
- WiFi 802.11

Ethernet Frame Structure



Ethernet (802.3) Frame Format

7 bytes	1 byte	6 bytes	6 bytes	2 bytes	42 to 1500 bytes	4 bytes	12 bytes
Preamble	Start of Frame Delimiter	**Destination MAC Address**	**Source MAC Address**	Type	Data (payload)	CRC	Inter-frame gap

For TCP/IP communications, the payload for a frame is a packet

WiFi (802.11) Frame Format

2 bytes	2 bytes	6 bytes	6 bytes	6 bytes	2 bytes	6 bytes	0 to 2312 bytes	4 bytes
Frame Control	Duration	MAC Address 1 (Destination)	MAC Address 2 (Source)	MAC Address 3 (Router)	Seq Control	MAC Address 4 (AP)	Data (payload)	CRC

Addressing

- MAC Address—physical address burned onto NIC card
  - Unique address for each NIC card produced in the world
  - Consists of a Block ID and a Device ID
    - Each manufacturer has one or more Block IDs
  - Added to frame by Data Link Layer—MAC sublayer

Addressing

- Network address (IP) —logical address assigned to a network device that identifies the network that a device belongs
  - Can be assigned automatically when a computer is turned on
    - DHCP server provides IP (network) addresses to computers
  - Can be assigned manually so that address remains the same each time computer is turned on
    - Addresses for servers and printers are assigned manually so that other devices can always locate them