Networking and Internet Services

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Networking Models & OSI Model

OSI Model

- Acronym: Open Systems Interconnection (OSI)
- Based on the TCP/IP protocol (Transmission Control Protocol, Internet Protocol)
- A theoretical and formal model that standardizes the communication functions of a network through abstract layers

Why OSI

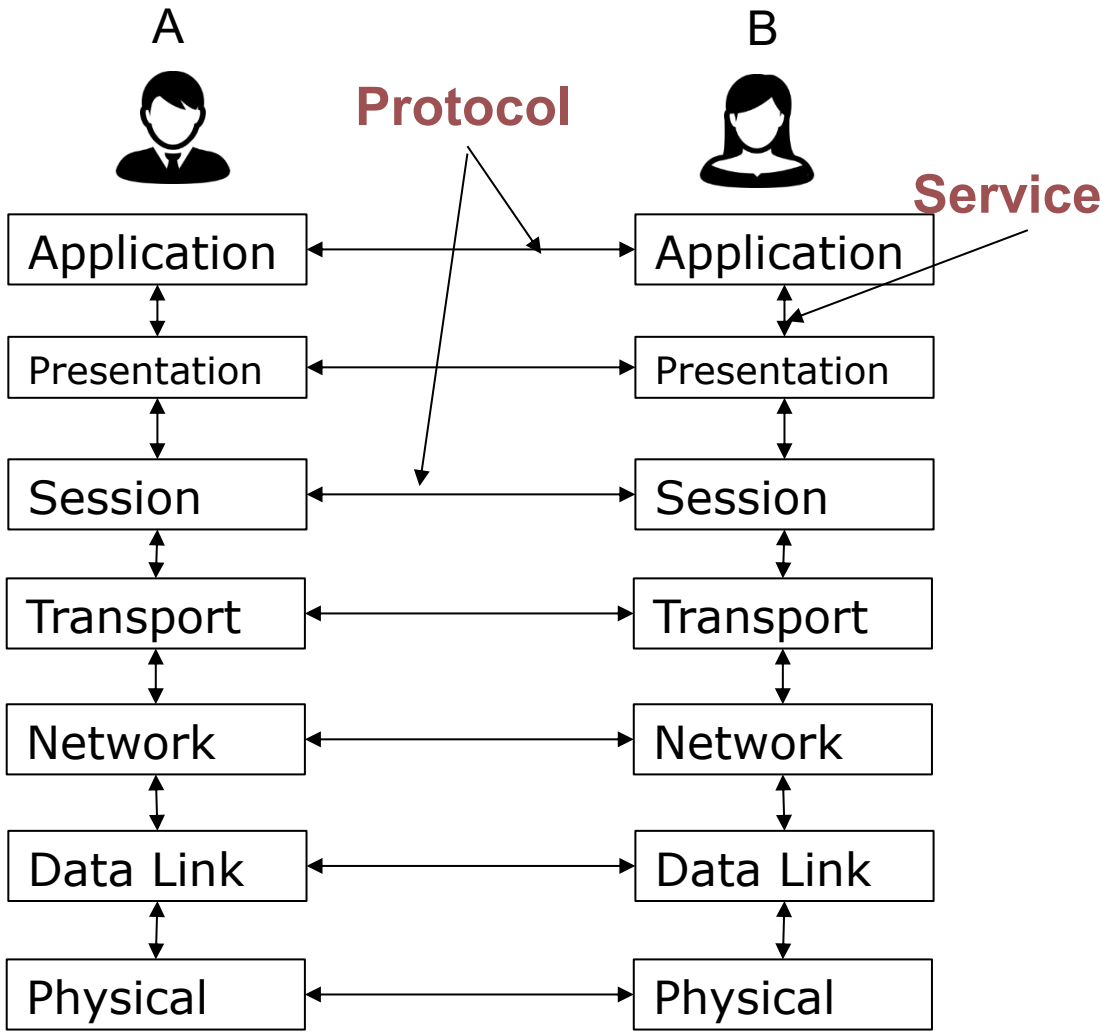
- Provides a better strategy for troubleshooting network problems.
- Provides a common ground language for describing networking

OSI Layer

Layer	Function
Application (7)	Services that are used with end user applications
Presentation (6)	Formats the data so that it can be viewed by the user Encrypt and decrypt
Session (5)	Establishes/ends connections between two hosts
Transport (4)	Responsible for the transport protocol and error handling
Network (3)	Reads the IP address form the packet.
Data Link (2)	Reads the MAC address from the data packet
Physical (1)	Send data on to the physical wire.

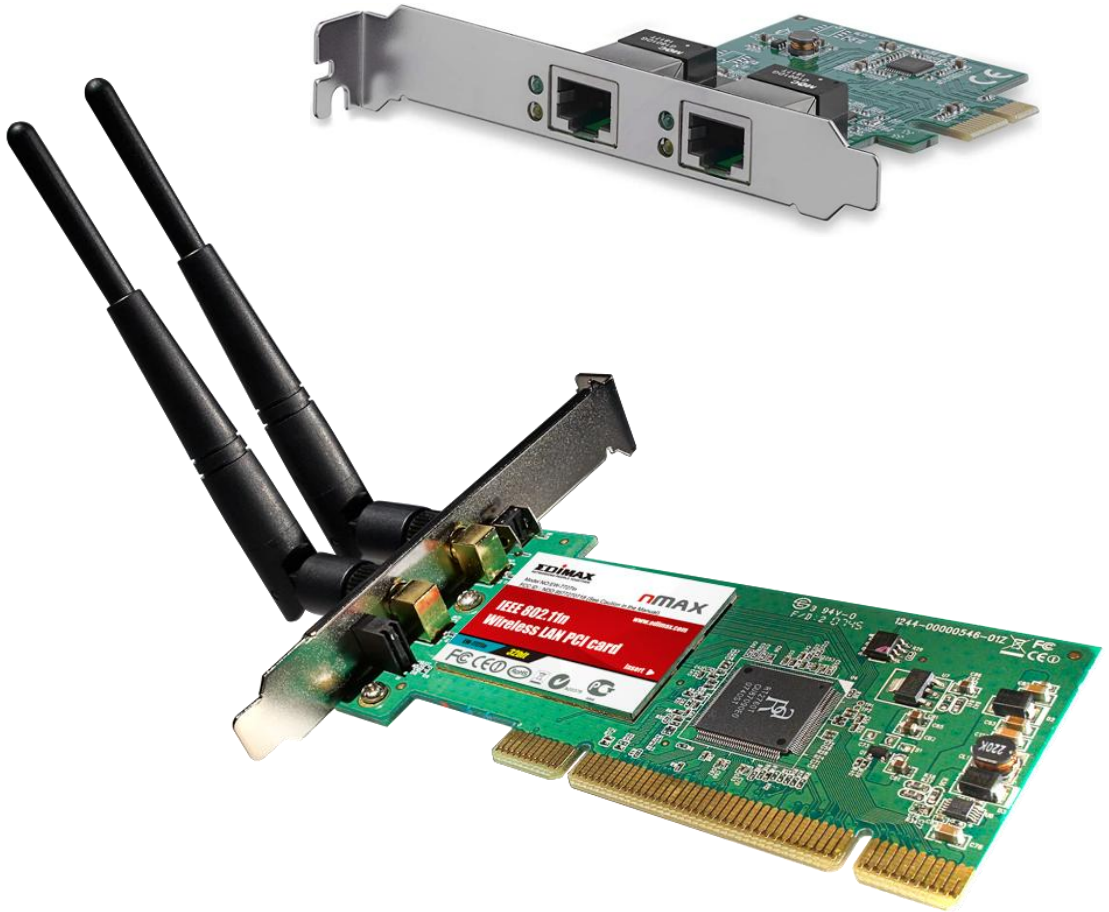
OSI Model Key Concepts

- A layer serves the layer above it and is served by the layer below it
- At each layer the information is referred to as a data unit
- Each layer encapsulates the data unit from the layer above
- A protocol defines the sequence of messages exchanged between communicating entities and defines actions taken accordingly



Layer 1 (Physical)

- What is classified as the Physical (1) layer?
  - Cabling
  - Hubs
  - NICS



NICS

- Identifiable by a unique identifier called a MAC (media access control) address
- MAC address is a 48 bit identifier registered with the IEEE that has 12 hexadecimal values that look like this: 01-02-03-AA-BB-CC.
- What is your MAC address? (windows)
- Operate between layer 1 and layer 2 of the OSI

Two jobs of the NIC

- Logical Link Control (LLC)
  - The software component that communicates to the OS via drivers, provides flow control and protocols.
- Media Access Control (MAC)
  - Creates the frame itself and passes it to the LL

Summary – Layer 1

- Moving individual bits from one node to the next
- Defines relationship between a device and a physical transmission medium (e.g. cable specifications, frequency)
- Equipment
  - Transceivers
  - Repeaters
  - Hubs
  - Patch panel
  - Cables and connectors

Layer 2 (Data)

- Data (2)
  - Represents the frame *and packet* information being sent over the devices in layer 1 above.

MAC Address and Frames

1	2	3	4	5
Destination Mac Address	Sender's Mac Address	Type	Data	FCS

- Type: The networking technology of the frame
- Data: The payload (Carries at most 1500 bytes of data)
- FCS: This is data called CRC to check the validity of the payload. (This is 4 bytes)

MAC Addresses

- Broadcast address usually is FF:FF:FF:FF:FF:FF
- A MAC address is called a Physical address

Summary – Layer 2

- Moving data units from one node to the next node on the delivery path

- Functions
  - Physical addresses (MAC)
  - Error detection
  - Flow control
  - Collision management
  - Topology definition

- Equipment
  - NICs, Modems

Typical Route

1. Build a data frame.
2. Send it out via broadcast.
3. All machines get the frame.
    1. Incorrect destination machine: Erase and forget
    2. Correct destination machine: Process frame

Layer 3 (Network)

- Called the network layer.
- Contains logical network addressing called IP addresses (As you've probably seen already).
- Notation: 0-255.0-255.0-255.0-255
- Data sent over a packet.

1	2	3
Destination IP address	Sender's IP address	Data

Summary – Layer 3

- Ensures moving data units from one host to another
  - Logical addresses – source and destination
  - Path determination
  - Packet switching
  - Involves routing protocols
    - RIP, OSPF, EIGRP
- Example:
  - IP addresses
- Equipment:
  - Routers, Switches

Full Frame with Packet Illustrated

- As frames pass through routers, the frames are stripped, packet is conserved, and new frames are added.

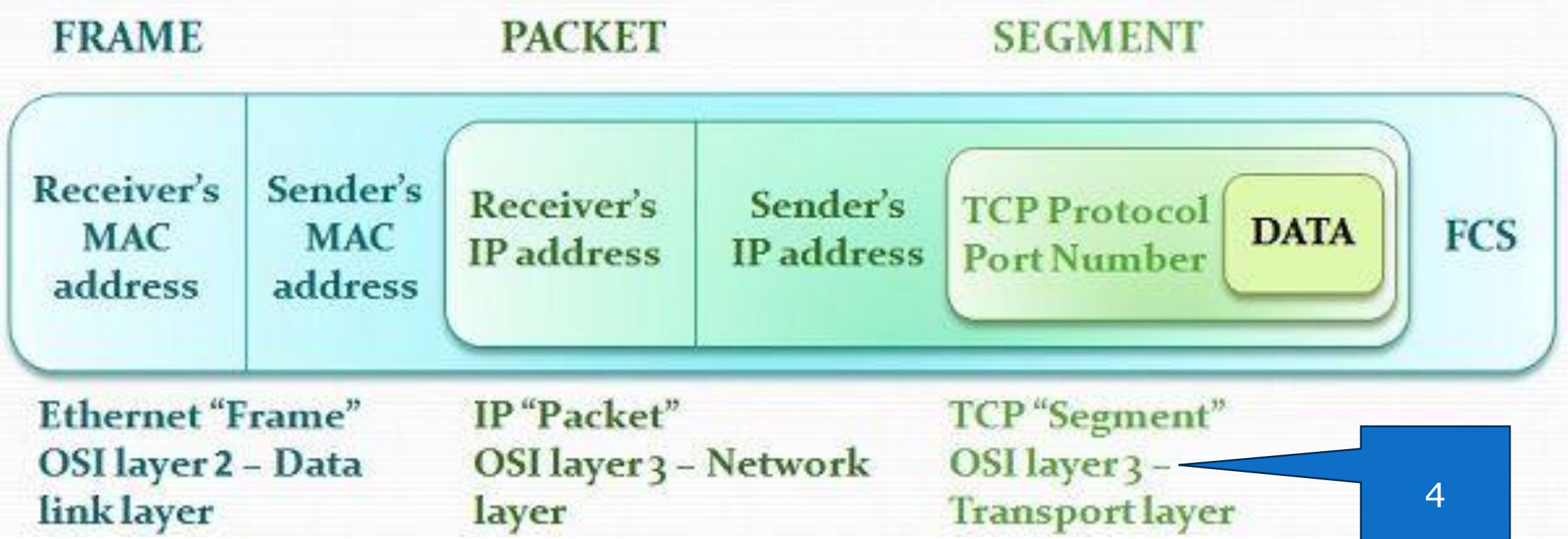
Frame vs Packet Encapsulation Diagram

Frame Start	Frame Header	Packet Header	Data	FCS	Frame End
		Packet Start			Packet End

Analogy:
Frame = envelope

- Frame Start = "Dear Receiver, here comes a new envelope"
- Frame Header = delivery address (MACs)
- Packet = letter inside (with its own header and message)
- FCS = seal + checksum to make sure it hasn’t been tampered with
- Frame End = End of this envelope

Frame vs. Packet



level 4 (Transport)

- Called the Transport Layer
- Puts the packets together and separates them (like a controller).
- Ensures delivery of the packets and frames.
- Requests re-transmittal if necessary.
- Ensures ordered delivery
- Think of this layer as the delivery service like UPS.

Summary – Layer 4

- Transports data units between end-points
- Two protocols:
  - TCP: Guaranteed delivery, flow control, congestion control, error recovery

  - UDP: No reliability, no flow control, no congestion control or error recovery
- Equipment
  - Hardware firewalls

Layer 5 (Session)

- Controls sessions
- Enables "persistence" in a dialog of network packets
- Opens – closes – resumes sessions.
- Generally think of a session as a persistent pathway for a specific sequence of packets to travel through.
- https://www.osi-model.com/session-layer/
- How to see your sessions: netstat -a

Summary – Layer 5

- Controls the connections between applications
- Establishes, manages and terminates connections between applications
- Flow control
  - Simplex
  - Duplex –Half or Full
- Example:
  SCP: Control sessions

Layer 6 (Presentation)

- The presentation layer is responsible for the adaptability and conversion of information to the application layer for further processing or display.
- This is the least used layer, and the hardest to describe.

Layer 6 Functions

- **Translation**: Networks can connect very different types of computers together: PCs, Macintoshes, UNIX systems, AS/400 servers and mainframes can all exist on the same network. These systems have many distinct characteristics and represent data in different ways; they may use different character sets for example. The presentation layer handles the job of hiding these differences between machines.

- **Compression**: Compression (and decompression) may be done at the presentation layer to improve the throughput of data. (There are some who believe this is not, strictly speaking, a function of the presentation layer.)

- **Encryption**: Some types of encryption (and decryption) are performed at the presentation layer. This ensures the security of the data as it travels down the protocol stack. For example, one of the most popular encryption schemes that is usually associated with the presentation layer is the Secure Sockets Layer (SSL) protocol. Not all encryption is done at layer 6, however; some encryption is often done at lower layers in the protocol stack, in technologies such as IPSec.

Summary – Layer 6

- Allows interpretation between communicating applications
- Functionalities: Compression, encryption, decryption
- Example:
  SSL Encryption for websites.

Layer 7 (Application)

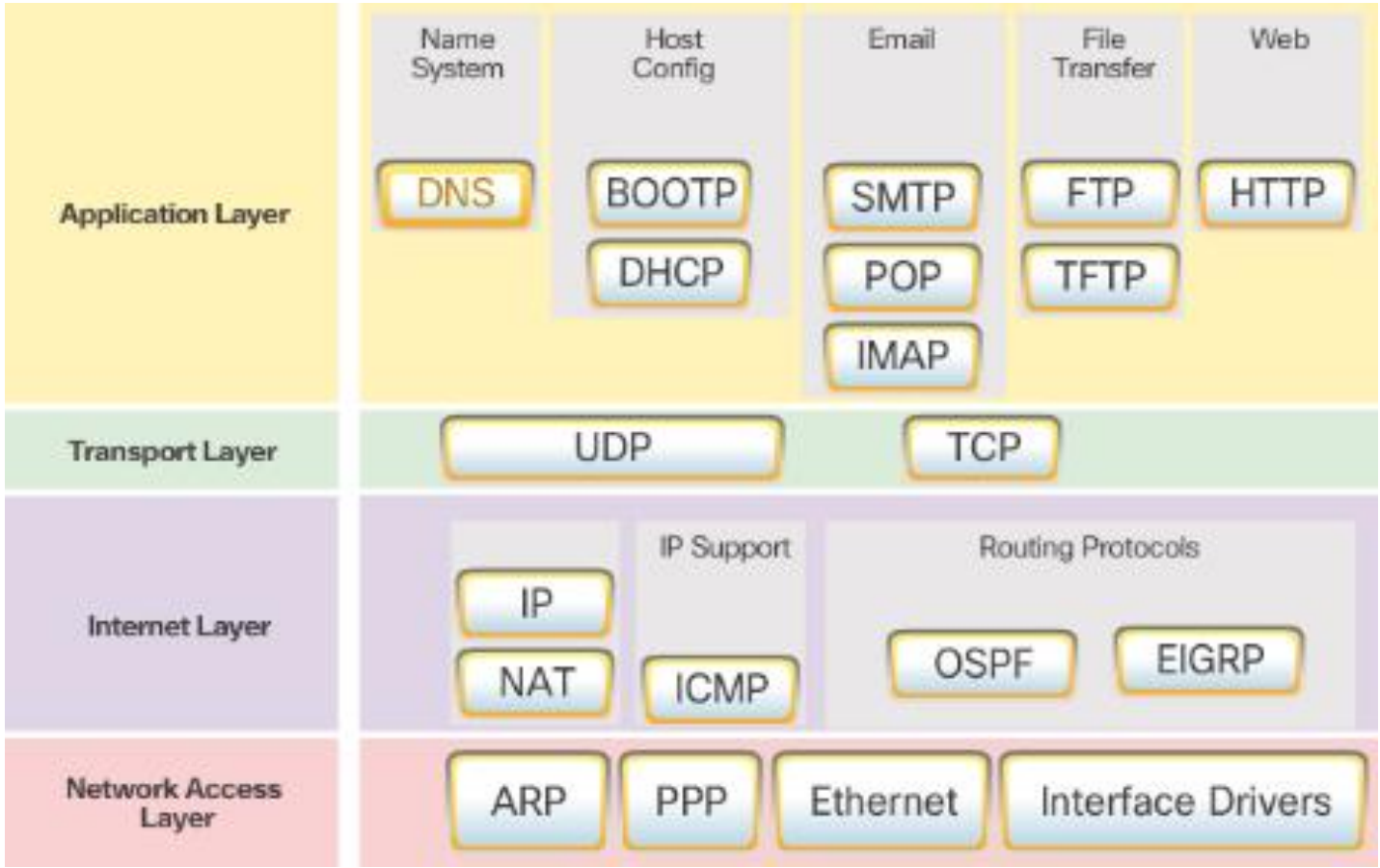
- An application layer is an abstraction layer that specifies the shared protocols and interface methods used by hosts in a communications network. The application layer abstraction is used in both of the standard models of computer networking; the Internet Protocol Suite (TCP/IP) and the Open Systems Interconnection model (OSI model).
- Common protocols: HTTP, LDAP, NFS, NTP,FTP

Layer 7

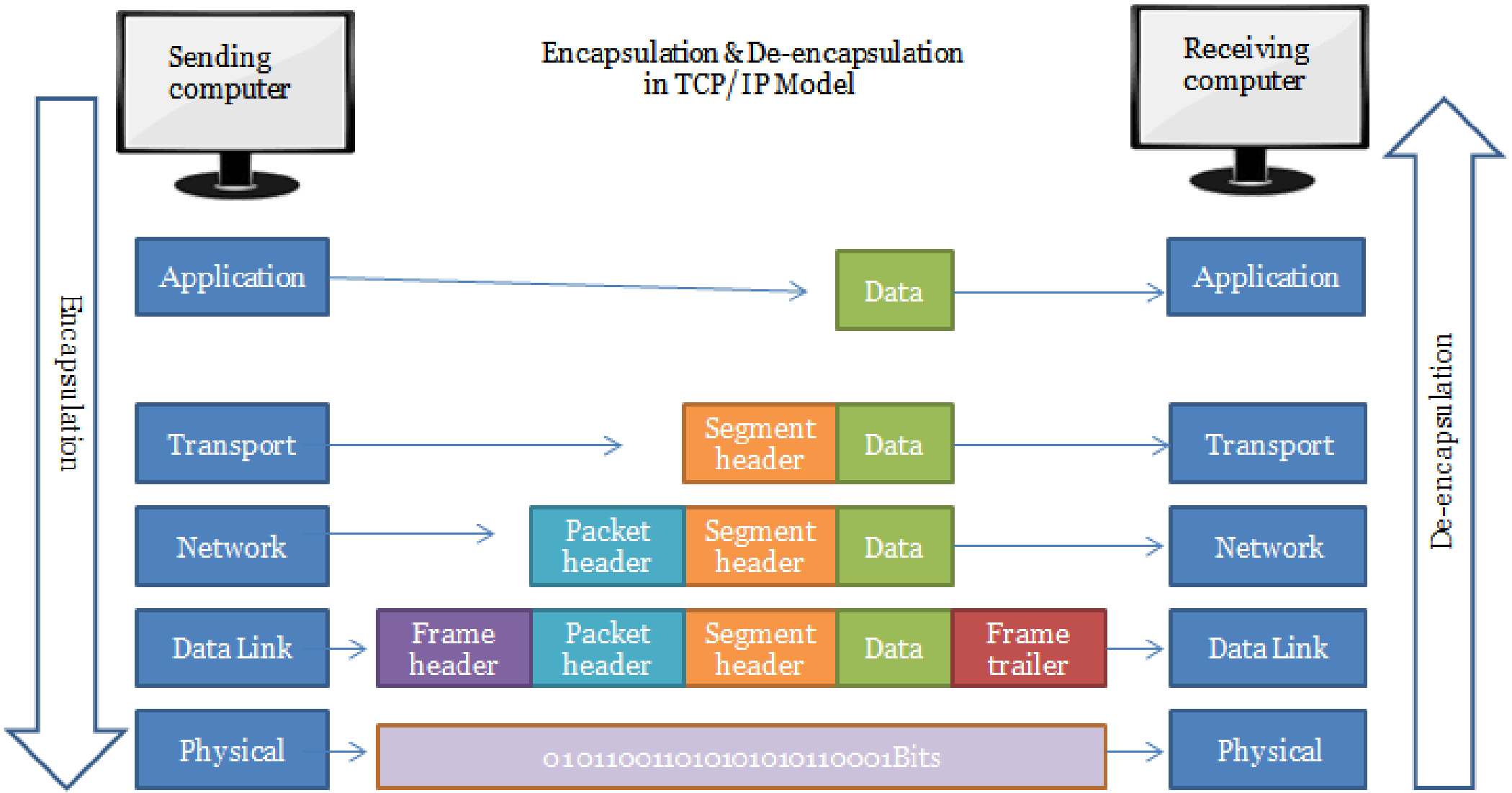
- Covers network applications and application-layer protocols
- Protocols
  - HTTP, HTTPS Web document request and transfer
  - DNS Domain Name Resolution
  - Telnet Remote Access
  - SMTP, POP Email
  - SNMP Network Management
  - TFTP, FTP File Transfer
- Equipment
  - PC, servers, nodes, cloud

Protocol Suites

- Protocol Suites and Industry Standards
  - TCP/IP is an open standard
- TCP/IP Protocol Suites
  - Let's break it down to different layers with their protocols.



Summary


Sending computer
Encapsulation & De-encapsulation in TCP/IP Model
Receiving computer
Encapsulation
De-encapsulation
Application
Data
Application
Transport
Segment header
Data
Transport
Network
Packet header
Segment header
Data
Network
Data Link
Frame header
Packet header
Segment header
Data
Frame trailer
Data Link
Physical
0101100110101010101100001Bits
Physical

Exercise

- Try to identify common networking protocols , use internet to have 1 sentence definition of each of the following networking protocols

HTTP	BitTorrent	HTTPS	LDAP	SFTP
NFS	NTP	RDP	SNTP	SSH

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