Computer Networks

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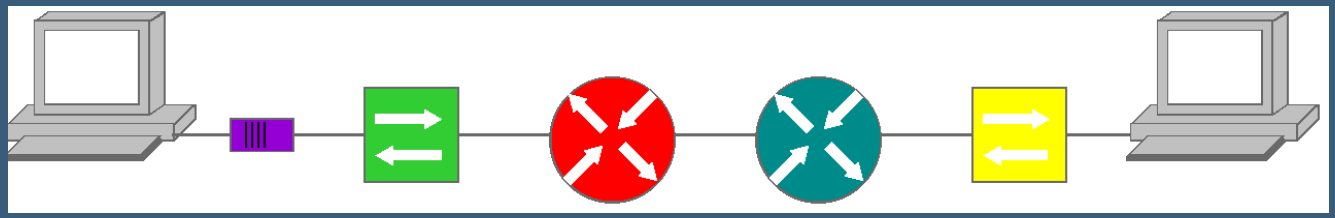
Lect_2

Lecture 2
Network Model

Network model

- It is a group of concepts that will be make a device know how to send data hop by hop(step by step) & then end to end



- All devices must have operating system
- Operating system for end devices :windows , Linux, Mac, iOS (i refers to ipad, ipod iphone),….
- For intermediate devices : IOS (Internetwork Operating System)

Network Model

- A networking model, sometimes also called either a networking architecture or networking blueprint, refers to a comprehensive set of documents.
  - Individually, each document describes one small function required for a network; collectively, these documents define everything that should happen for a computer network to work.
  - Some documents define a protocol, which is a set of logical rules that devices must follow to communicate. Other documents define some physical requirements for networking. For example, a document could define the voltage and current levels used on a particular cable when transmitting data.
- When we install any operating system (for end devices or intermediate device), Network model must install with it (i.e. any operating system have the network model).

Network Model

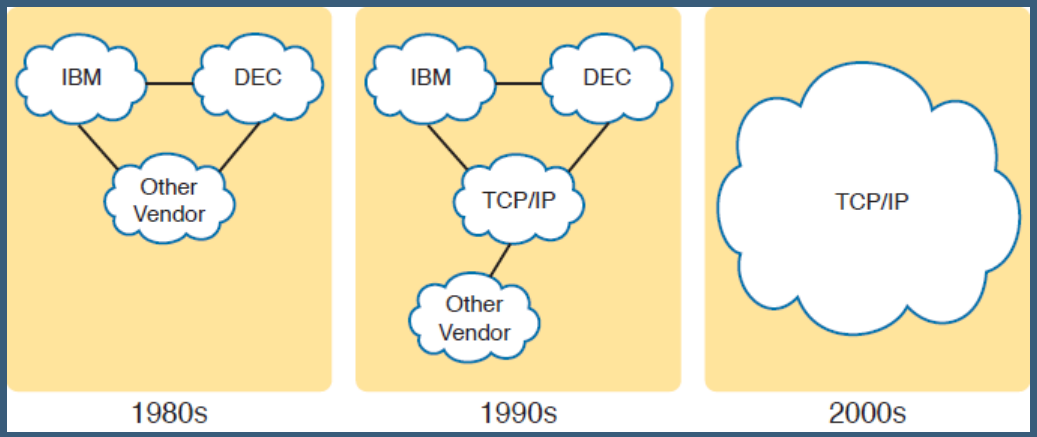
- If the operating system install on any device without the network model, this device can’t connect with other devices.
- Network models such as:
  1. OSI (Open System Interconnection) was the common network model developed by ISO (The International Organization for Standardization)
  2. DOD model (Department of Defense) is developed by DARPA, after that it called TCP/IP model. Nowadays TCP/IP is the common model on all operating systems.

Network Model

- History Leading to TCP/IP
  - Once upon a time, networking protocols didn’t exist, including TCP/IP. Vendors created the first networking protocols; these protocols supported only that vendor’s computers..
  - For example, IBM published its Systems Network Architecture (SNA) networking model in 1974. Other vendors also created their own proprietary networking models.
  - Although vendor-defined proprietary networking models often worked well, having an open, vendor-neutral networking model would aid competition and reduce complexity.
  - The International Organization for Standardization (ISO) took on the task to create such a model, starting as early as the late 1970s, beginning work on what would become known as the Open Systems Interconnection (OSI) networking model.
  - A second, less-formal effort to create an open, vendor-neutral, public networking model supported from a U.S. Department of Defense (DoD) contract. Researchers at various universities volunteered to help further develop the protocols surrounding the original DoD work. These efforts resulted in a competing open networking model called TCP/IP.

Network Model

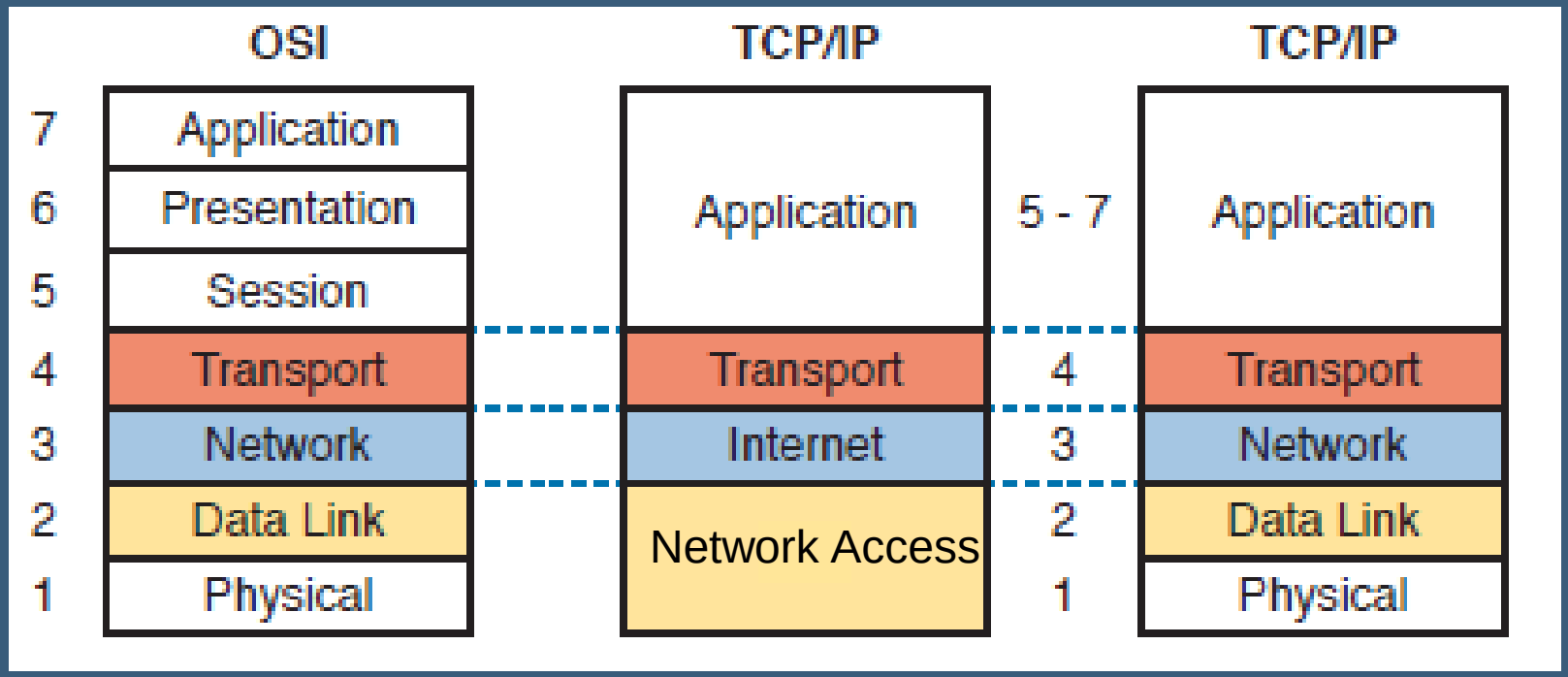
- History Leading to TCP/IP
  - During the 1990s, companies began adding OSI, TCP/IP, or both to their enterprise networks. However, by the end of the 1990s, TCP/IP had become the common choice, and OSI fell away.
  - Here in the twenty-first century, TCP/IP dominates. Proprietary networking models still exist, but they have mostly been discarded in favor of TCP/IP.



Network Model

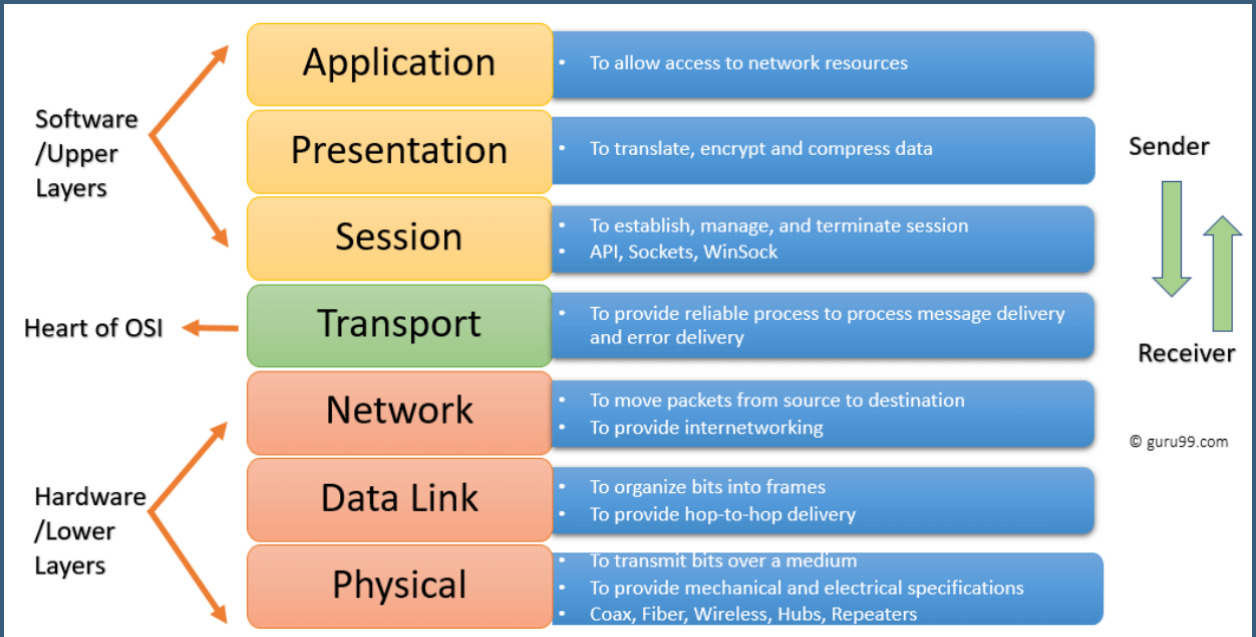
- The TCP/IP model contain a large collection of protocols that allow computers to communicate.
- A protocol, is a set of logical rules that devices must follow to communicate.
- To help people understand a networking model, each model breaks the functions into a small number of categories called layers, hence, any model consist of some layers.
- Each layer includes protocols and standards that relate to that category of functions, hence, inside each layer there are some functions that can be done either by S/W or H/W.
- Each layer defines a set of typical networking functions
- The name layer is due to these functions are executed sequentially.

Network Model



OSI Model Compared to the Two TCP/IP Models

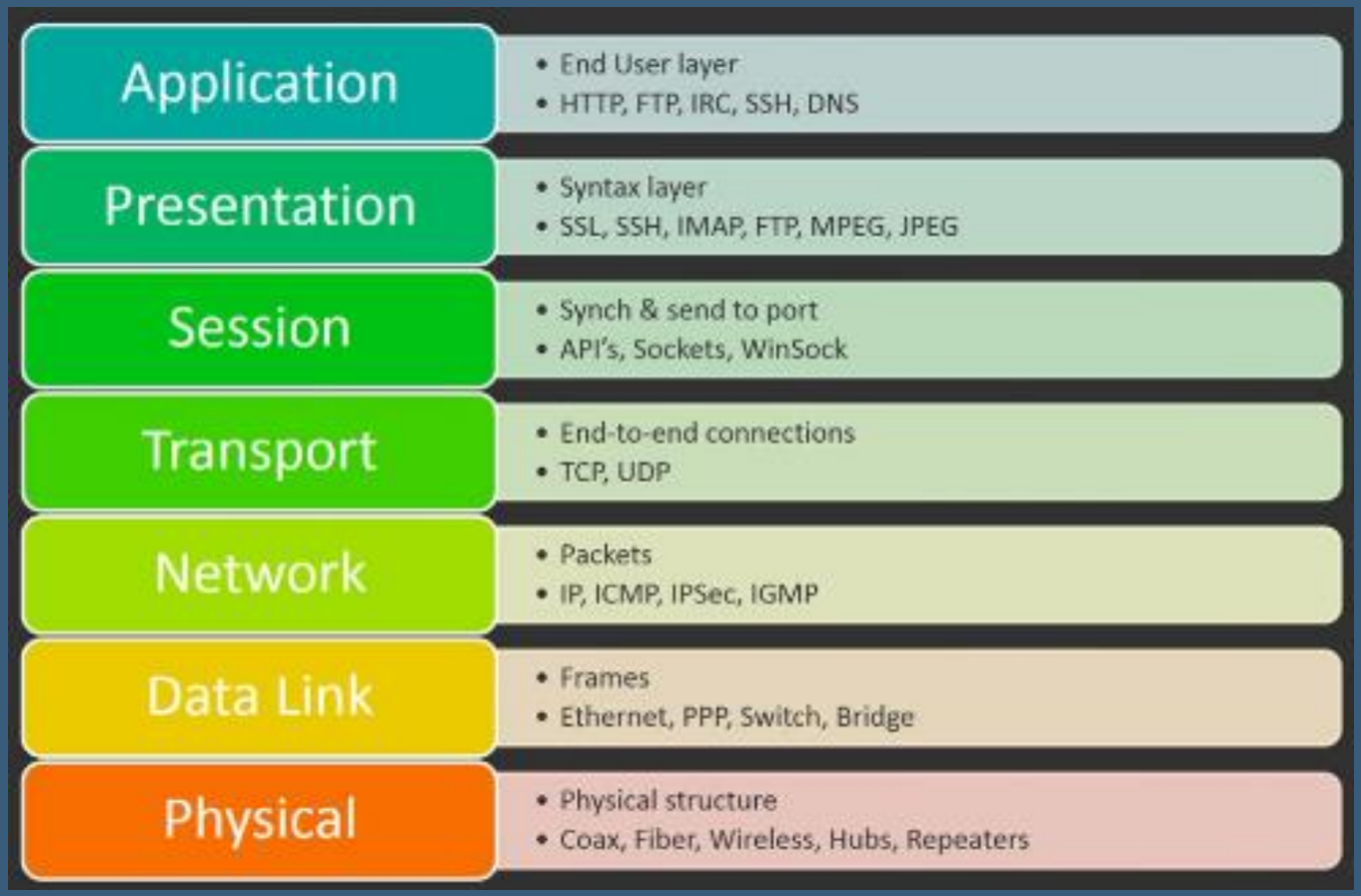
OSI model (HW/SW layers)



- **The Upper Layers:** It deals with application issues and mostly implemented only in software. The highest is closest to the end system user. In this layer, communication from one end-user to another begins by using the interaction between the application layer. It will process all the way to end-user.

- **The Lower Layers:** These layers handle activities related to data transport. The physical layer and datalink layers also implemented in software and hardware.

OSI model (Layers and Protocols)



The OSI Model

Application Layer

- Application layer protocols provide services (i.e., HTTP) to the application software (i.e., any web browser) running on a computer.
- The application layer does not define the application itself, but it defines services that applications need. So, it is responsible for preparing the suitable protocol for the required service
- For example, application protocol HTTP defines how web browsers can pull(ينتزع أو يجذب) the contents of a web page from a web server.
- In short, the application layer provides an interface between software running on a computer (web browser) and the network itself (i.e., facebook server).

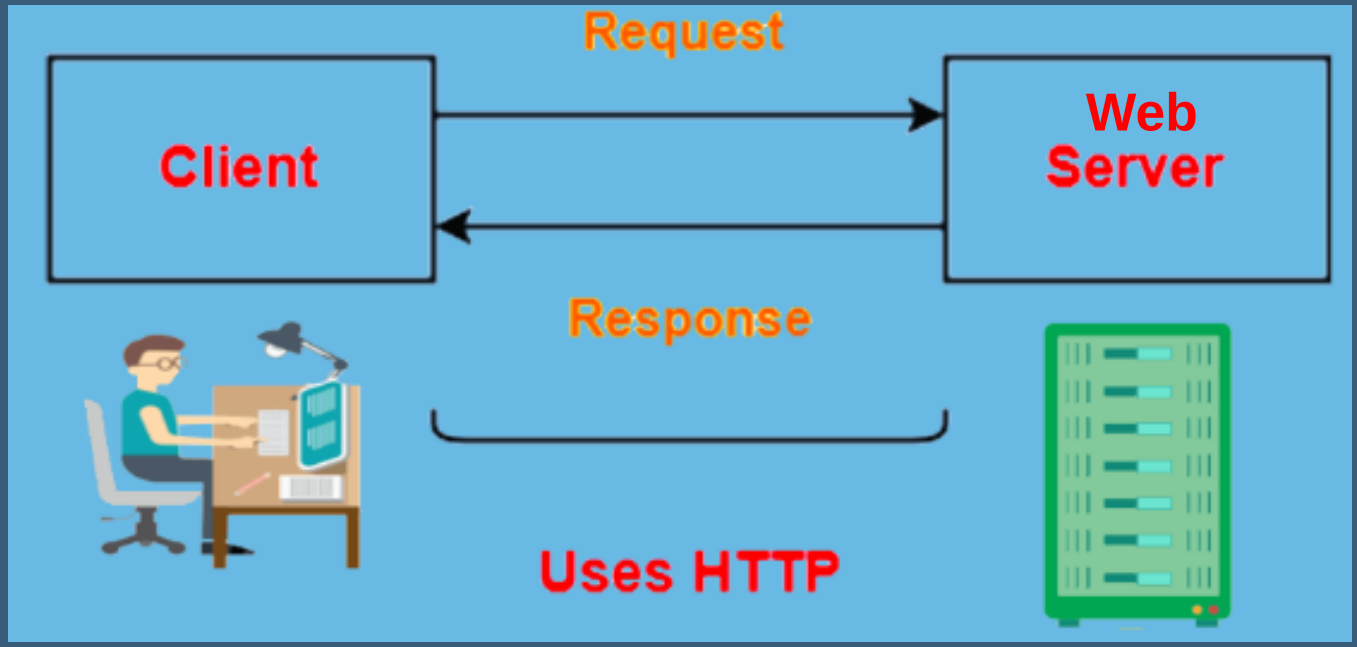
Application Layer

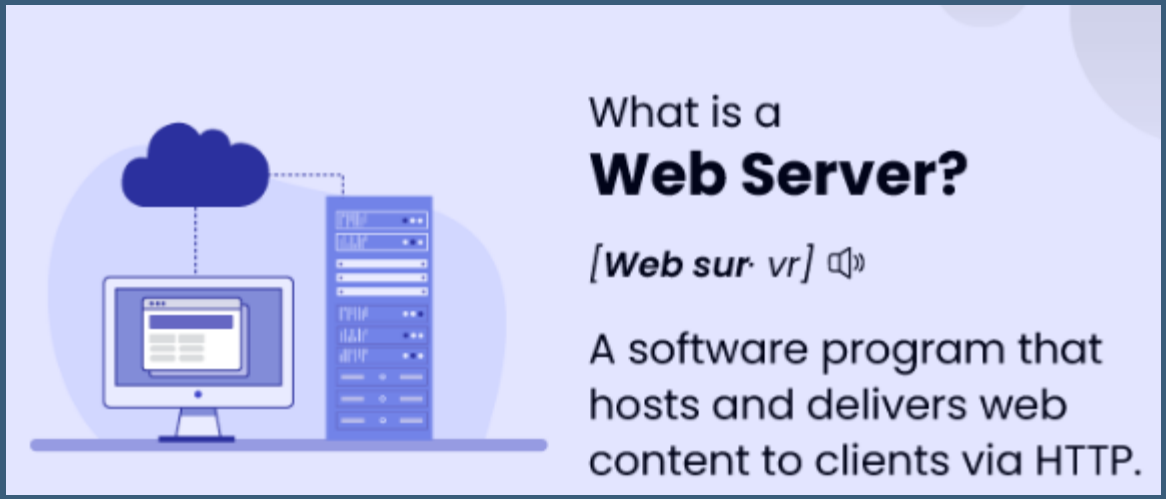
- This layer deals with networking applications.
- Examples:
  - Email
  - Web browsers
- Examples

Services	Protocol (Application)
Browsing	HTTP
File upload/download	FTP
Send/retrieve email	SMTP/POP3
Remote login	telnet
Voice, video, game (real time)	RTP (Real time Transport Protocol)

- RTP is responsible for any real time service

Application Layer





Presentation Layer

- This layer negotiates data formats, such as ASCII text, or image types like JPEG.
- It is responsible for finding common data representation between sender and receiver.
- Common data representation means encoding and decoding data through suitable extension.

- Examples

data	code
Text	ASCII
Image	JPG, GIF, tif,…
Audio	mp3
Video	Avi, MPEG, mp4,…

Session Layer

- This layer provides methods to group multiple bidirectional messages (i.e., messages from sender to user and vice versa) into a workflow for easier management and easier back out of work that happened if the entire workflow fails.
- It is responsible for making sure that all information required for session opening become ready.
- Session means any connection between two sides from end to end

Example:

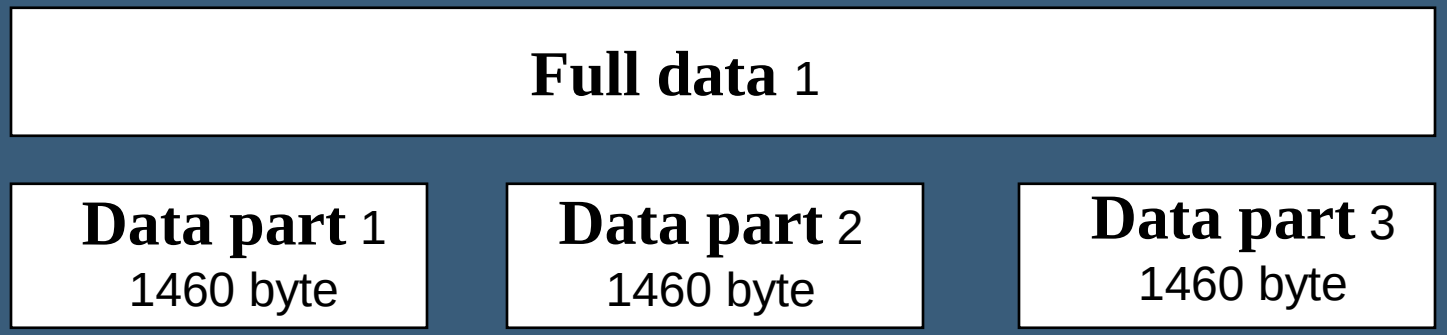
- In case of send an email, the main objective of session layer is to make sure that the requirements for sending an email are ready. These requirements are:
  - To whom (mail box @ post office.com)
  - Subject
  - Mail body
  - Attachment size.
- After that session layer will give orders to the following layer (Transport layer) to do the following : session establishment, session management and session termination.

Transport Layer

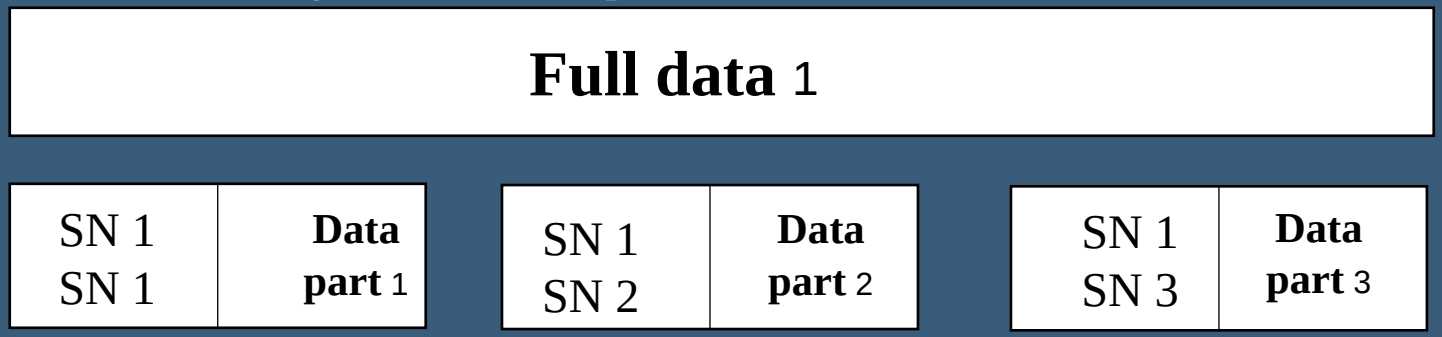
- This layer focuses on data delivery between the two endpoint hosts, providing reliable data transfer services to the upper layers. (for example, error recovery).
- The main objective of TCP and UDP is to secure reliable data transport across the network (i.e., from end to end).
- When data arrive to transport layer, three operations occur:
  1. Data segmentation.
  2. Addressing and sequencing.
  3. Error detection.
- The protocols that responsible for the previous tasks in transport layers are:
  - TCP (Transmission Control Layer).
  - UDP (User Datagram Protocol).

Transport Layer

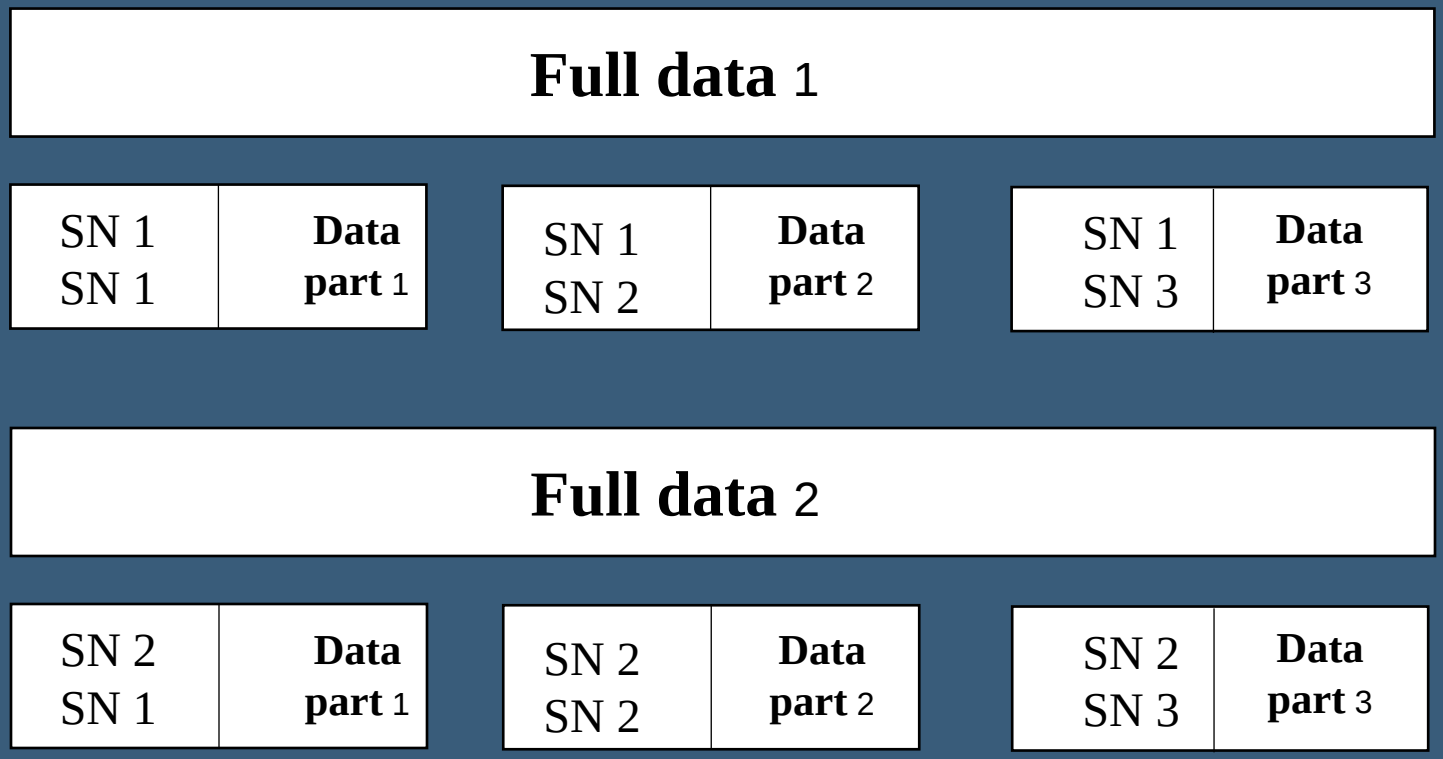
1. Data segmentation
   - When different data types are send, then each data type is divided into small parte called **data parts** , the size of each part is 1460 byte.



2. Addressing and sequencing
   - In this stage, a header is added to each data part; 4 byte called session number and 4 byte called sequence number.

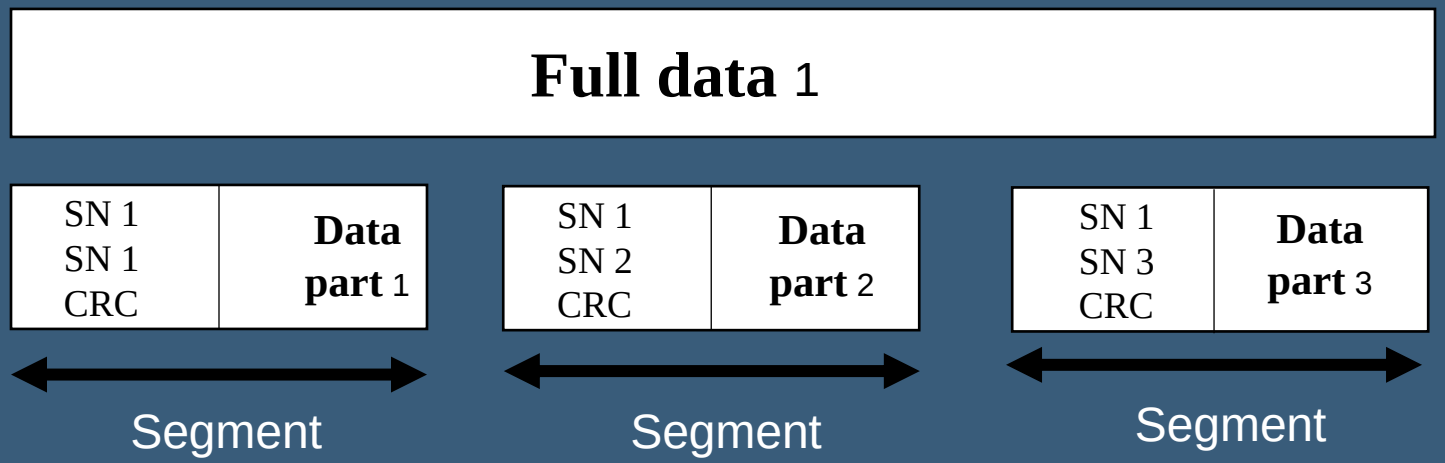


Transport Layer



Transport Layer

3. Error Detection
   - In this stage, data part, session number and sequence number are compressed into **Cyclic Redundancy Check (CRC)** which has 2 byte size.
   - CRC is used to insure reliable data transport across the network.
   - Each data part with session number, sequence number and CRC is called **segment**



Internet or Network or IP Layer

- Like the TCP/IP network (Internet) layer, this layer defines logical addressing, routing (forwarding), and the routing protocols used to learn routes.
- The application layer includes many protocols.
- The transport layer includes fewer protocols, most notably, TCP and UDP.
- The TCP/IP network layer includes a small number of protocols, but only one major protocol: the Internet Protocol (IP) .
- In fact, the name TCP/IP is simply the names of the two most common protocols (TCP and IP) separated by a /.
- IP provides several features, most importantly, addressing and routing.
- Network layer determines the route from the source to the destination.
- The main role of the network layer is to move the packets from sending host to the receiving host.
- Hence the main functions performed by network layer are logical addressing and routing.

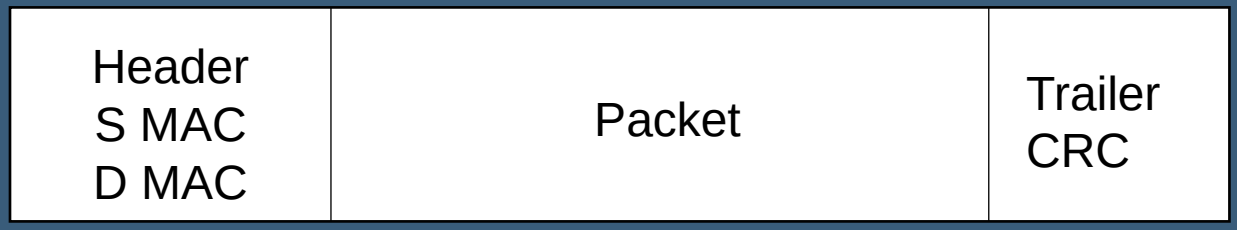
Internet or Network or IP Layer

- TCP/IP defines two versions of IP: IP version 4 (IPv4) and IP version 6 (IPv6). The world still mostly uses IPv4.
- Network layer receive segment from transport layer, hence a header of 20 byte size is added to form **Packet.**
- The 20 byte header contain source IP and destination IP.

Packet

Data link layer

- This layer deliver the packet from the previous layer (above layer) and encapsulate it with:
  1. 14 byte header represent 12 bytes for source and destination MAC, they are responsible for hop to hop data delivery. Also, 2 bytes define the type of the packet.
     - Type = 4, In case of IPv4 packet.
     - Type = 41, In case of IPv6 packet.
  2. 4 byte trailer (tail) represent CRC (Cyclic Redundancy Check).



Frame

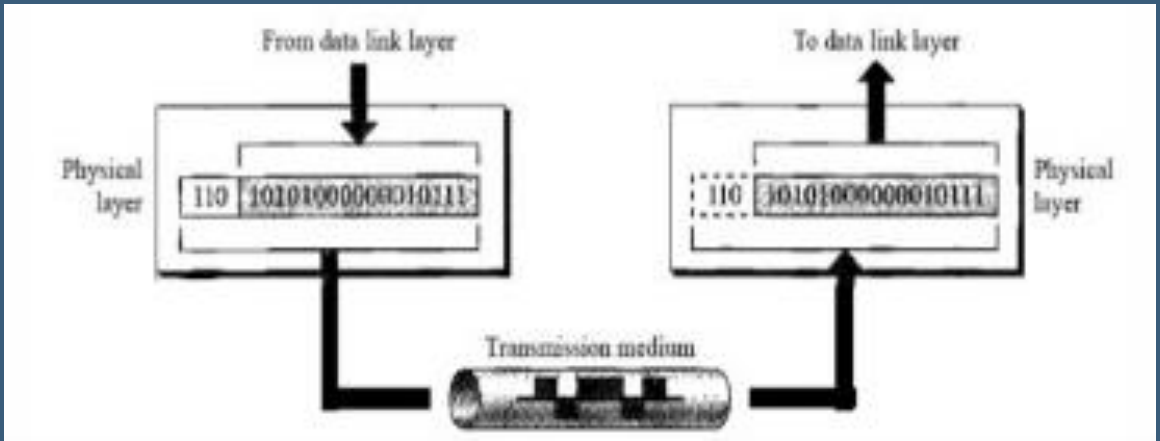
- MAC address represent next hop address

Note that:

1. IP address is an address for end devices only.
2. MAC address is an address for all devices (i.e., end and intermediate devices)

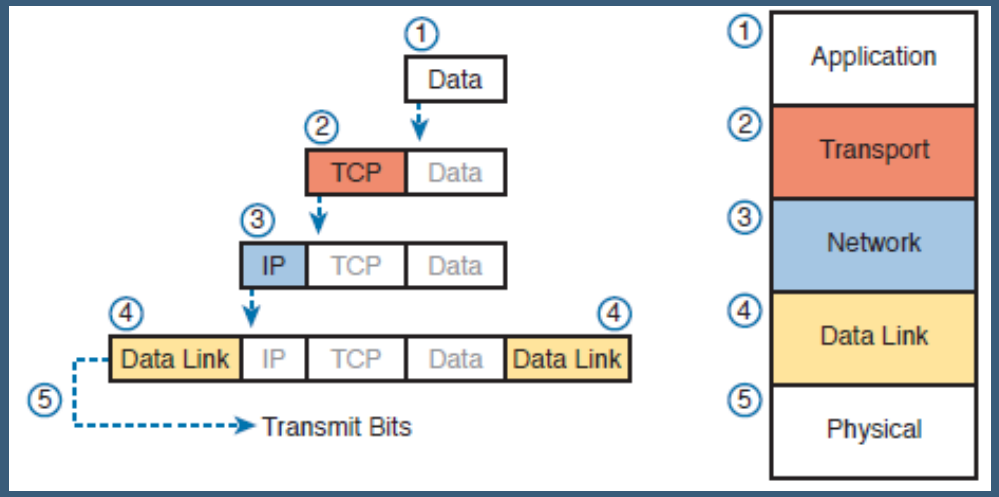
Physical layer

- This layer is responsible for Bit transmission.
- This layer defines the physical characteristics of the transmission medium, including connectors, pins, use of pins, electrical currents, encoding, light modulation, and so on.
- The physical layer encodes a signal onto the medium (Cable)to transmit the frame.
- The layer most closely associated with the physical connection between devices

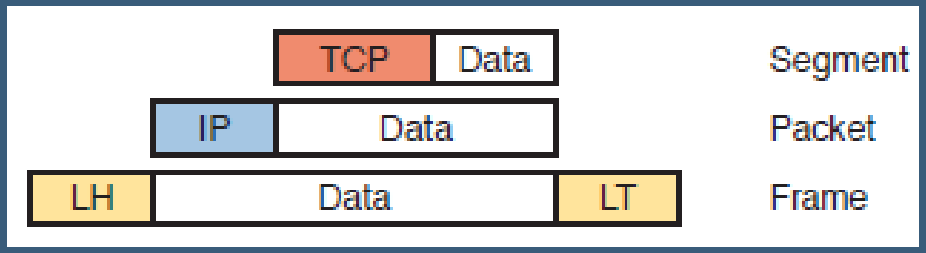


Encapsulation

- The term *encapsulation* refers to the process of putting headers (and sometimes trailers (tail)) around some data.



Five Steps of Data Encapsulation: TCP/IP



THANK YOU

For any questions feel free
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