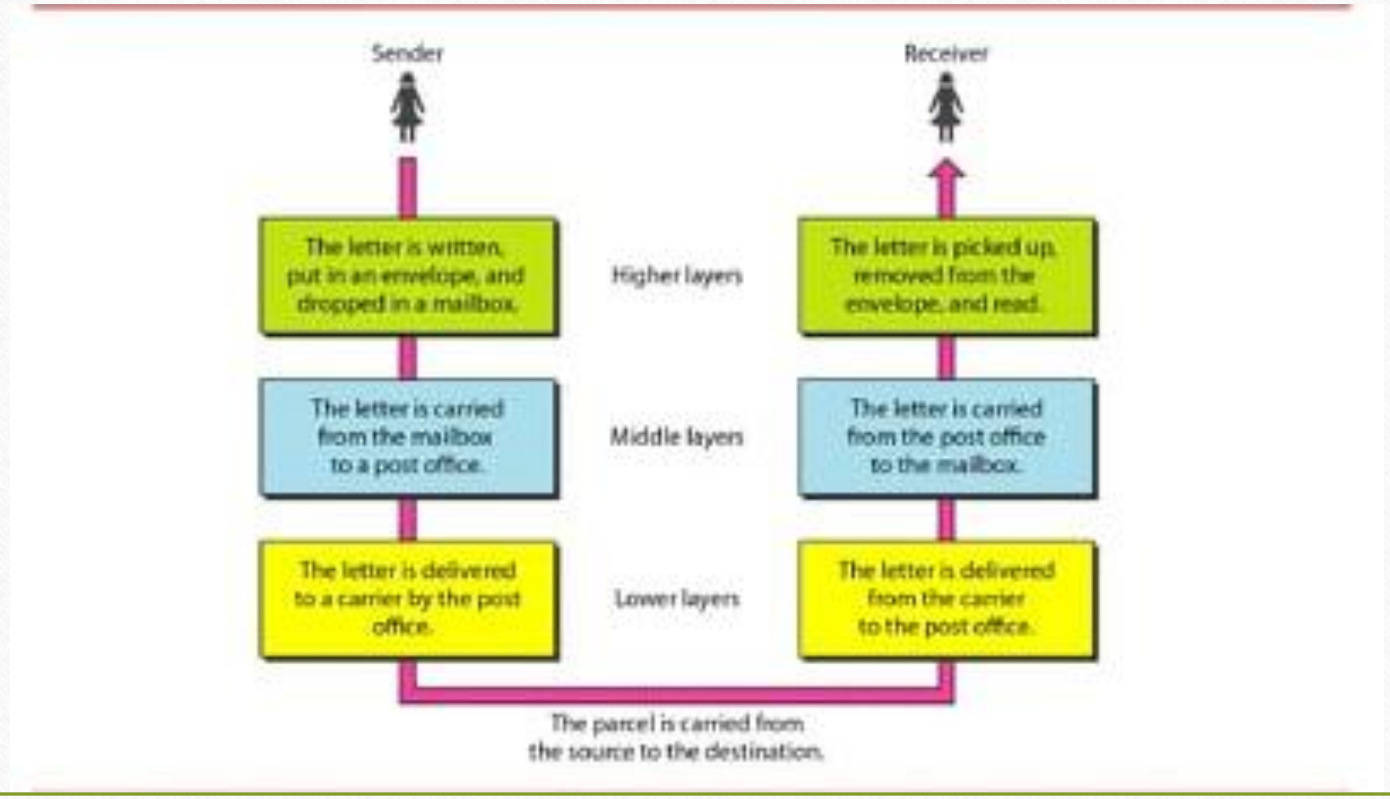
Data Communications and Computer Network

PART III: COMPUTER NETWORK MODEL

Task involve in sending a letter

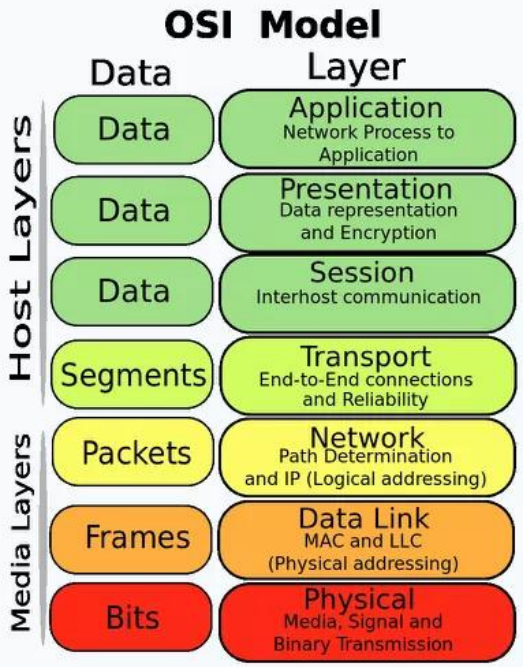


INTRODUCTION to Network Model

- Network engineering is a complicated task, which involves software, firmware, chip level engineering, hardware, and electric pulses. To ease network engineering, the whole networking concept is divided into multiple layers. Each layer is involved in some particular task and is independent of all other layers. But as a whole, almost all networking tasks depend on all of these layers. Layers share data between them and they depend on each other only to take input and send output.
- In layered architecture of Network Model, one whole network process is divided into small tasks. Each small task is then assigned to a particular layer which works dedicatedly to process the task only. Every layer does only specific work.
- In layered communication system, one layer of a host deals with the task done by or to be done by its peer layer at the same level on the remote host. The task is either initiated by layer at the lowest level or at the top most level. If the task is initiated by the topmost layer, it is passed on to the layer below it for further processing. The lower layer does the same thing, it processes the task and passes on to lower layer. If the task is initiated by lowermost layer, then the reverse path is taken.

OSI MODEL

- Open System Interconnect is an open standard for all communication systems. OSI model is established by International Standard Organization (ISO). This model has seven layers:



LAYER 7:APPLICATION

- This layer is responsible for providing interface to the application user. This layer encompasses protocols which directly interact with the user.
- To further our bean dip analogy, the Application Layer is the one at the top - it's what most users see. In the OSI model, this is the layer that is the "closest to the end user". Applications that work at Layer 7 are the ones that users interact with directly. A web browser (Google Chrome, Firefox, Safari, etc.) or other app - Skype, Outlook, Office - are examples of Layer 7 applications.

LAYER 7:APPLICATION

- The application layer is where the end users interact with the network. This layer determines the availability of the receiving program and checks if enough resources exist for that communication. Authentication services run at this layer.

Protocols use for application layer:

- POP3 – Post Office Protocol Version 3 – a protocol used to retrieve electronic mail from a server
- SMTP – Simple Mail Transfer Protocol - A protocol used for sending electronic mail
- HTTP – Hyper Text Transfer Protocol - A protocol used to retrieve content from a web server.
- HTTPS – Secure HTTP – A protocol that allows a secure web browsing
- FTP – File Transfer Protocol – A protocol used to transfer files with a remote host (requires authentication of user credentials).
- TFTP – Trivial FTP – A protocol used to transfer files with a remote host (does not require authentication of user credentials)
- TELNET – TELecommunications NETwork – a protocol used to connect a remote host (Typically via a terminal emulator)
- SSH – Secure Shell – A protocol used to securely connect to a remote host (typically via a terminal emulator)

LAYER 6: PRESENTATION

- This layer defines how data in the native format of remote host should be presented in the native format of host.
- The Presentation Layer represents the area that is independent of data representation at the application layer - in general, it represents the preparation or translation of application format to network format, or from network formatting to application format. In other words, the layer "presents" data for the application or the network. A good example of this is encryption and decryption of data for secure transmission - this happens at Layer 6.
- The job of this layer is to take the data and format it into a genetic language that industry standard applications can understand. Data encryption also takes place in this layer

Presentation formats (genetic languages):

- ASCII
- EBCIDC
- UNICODE
- RTF

LAYER 6: PRESENTATION

CONT…

- MIDI
- MPEG
- AVI
- WAV
- MP3
- HTML
- XML
- GIF
- TIFF
- JPG

LAYER 5: SESSION

- This layer maintains sessions between remote hosts. For example, once user/password authentication is done, the remote host maintains this session for a while and does not ask for authentication again in that time span.
- When two devices, computers or servers need to "speak" with one another, a session needs to be created, and this is done at the Session Layer**.** Functions at this layer involve setup, coordination (how long should a system wait for a response, for example) and termination between the applications at each end of the session.
- The manager of two way communication between two endpoints. It is responsible for the creation maintenance and teardown of connections.

LAYER 4: TRANSPORT

- This layer is responsible for end-to-end delivery between hosts.
- The Transport Layer deals with the coordination of the data transfer between end systems and hosts. How much data to send, at what rate, where it goes, etc. The best known example of the Transport Layer is the Transmission Control Protocol (TCP), which is built on top of the Internet Protocol (IP), commonly known as TCP/IP. **TCP** and **UDP** port numbers work at Layer 4, while IP addresses work at Layer 3, the Network Layer.
- The layer uses acknowledgements, sequencing and flow control to ensure that reliable networking occurs.
- In the transport layer, the data is encapsulated with headers (segment).

LAYER 4: TRANSPORT

- Data Delivery

➢ TCP (*Transmission Control Protocol*)– reliable delivery but slow, it uses a three way handshake (SYN, SYN/ACK, ACK).

- Connection oriented
- Supports retransmission
- Slow delivery

➢ UDP (*User Datagram Protocol*) – unreliable delivery but fast

- Connectionless
- No retransmission
- Fast Delivery

LAYER 4: TRANSPORT

Application Type

- Port Numbers - used to identify a specific application. Range from 0 to 65535.
  - Well known ports: 0 to 1023
  - Dynamic (Private ports): 49152 to 65535
  - Registered: 1024 to 49151

LAYER 4: TRANSPORT

- Example of TCP and UDP Ports

Assignment: What application uses port numbers 137, 138 and 139 and 1720?

Protocol	UDP Port
DNS	53
DHCP	67, 68
TFTP	69
SNMP	161

Protocol	TCP Port
POP3	110
SMTP	25
HTTP	80
HTTPS	443
FTP	21
DNS	53
TELNET	23
SSH	22

LAYER 3: NETWORK

- This layer is responsible for address assignment and uniquely addressing hosts in a network.
- Here at the Network Layer is where you'll find most of the router functionality that most networking professionals care about and love. In its most basic sense, this layer is responsible for packet forwarding, including routing through different routers. You might know that your Boston computer wants to connect to a server in California, but there are millions of different paths to take. Routers at this layer help do this efficiently.

LAYER 3: NETWORK

- This layer features
  - **Logical Addressing**: IP version 4 and IP version 6 Addresses
  - **Maximum Transmission Unit** (MTU): Largest packet size (in bytes) that can traverse over a link. Default size (Ethernet): 1500 bytes

Device operation in this layer: Routers and Layer 3 Switches

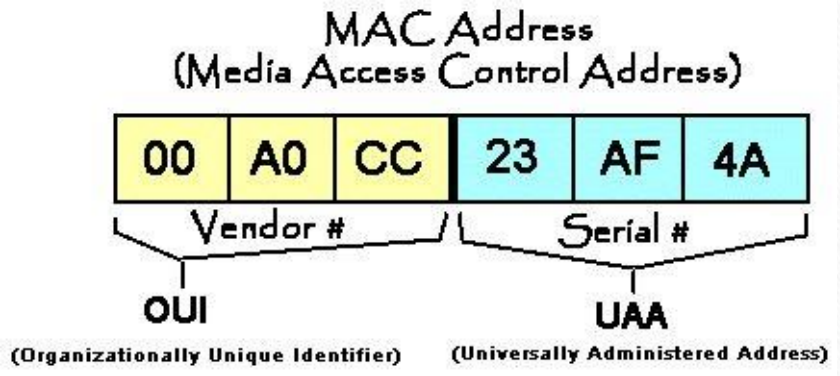
LAYER 2: DATA LINK

- This layer is responsible for reading and writing data from and onto the line. Link errors are detected at this layer.
- The Data Link Layer provides node-to-node data transfer (between two directly connected nodes), and also handles error correction from the physical layer. Two sublayers exist here as well - the Media Access Control (MAC) layer and the Logical Link Control (LLC) layer. In the networking world, most switches operate at Layer 2.

LAYER 2: DATA LINK

- This layer defines two main features:
  - Physical Addressing: Media Access Control addresses
  - Error detection: Frame check sequences (FCS)

Device operation on this layer: Bridges and Layer 2 switches



LAYER 2: DATA LINK

- Functionality of Data Link: Data Link Layer does many tasks on behalf of upper layer These are
  - Framing - Data-link layer takes packets from Network Layer and encapsulates them into Frames. Then, it sends each frame bit-by-bit on the hardware. At receiver end, data link layer picks up signals from hardware and assembles them into frames.
  - Addressing - Data-link layer provides layer-2 hardware addressing mechanism. Hardware address is assumed to be unique on the link. It is encoded into hardware at the time of manufacturing.
  - Synchronization - When data frames are sent on the link, both machines must be synchronized in order to transfer to take place.
  - Error Control - Sometimes signals may have encountered problem in transition and the bits are flipped. These errors are detected and attempted to recover actual data bits. It also provides error reporting mechanism to the sender.
  - Flow Control - Stations on same link may have different speed or capacity. Data-link layer ensures flow control that enables both machine to exchange data on same speed.
  - Multi-Access - When host on the shared link tries to transfer the data, it has a high probability of collision. Data-link layer provides mechanism such as CSMA/CD to equip capability of accessing a shared media among multiple Systems.

LAYER 1: PHYSICAL

- This layer defines the hardware, cabling, wiring, power output, pulse rate etc.
- At the bottom of our OSI bean dip we have the Physical Layer, which represents the electrical and physical representation of the system. This can include everything from the cable type, radio frequency link (as in an 802.11 wireless systems), as well as the layout of pins, voltages and other physical requirements. When a networking problem occurs, many networking pros go right to the physical layer to check that all of the cables are properly connected and that the power plug hasn't been pulled from the router, switch or computer, for example.

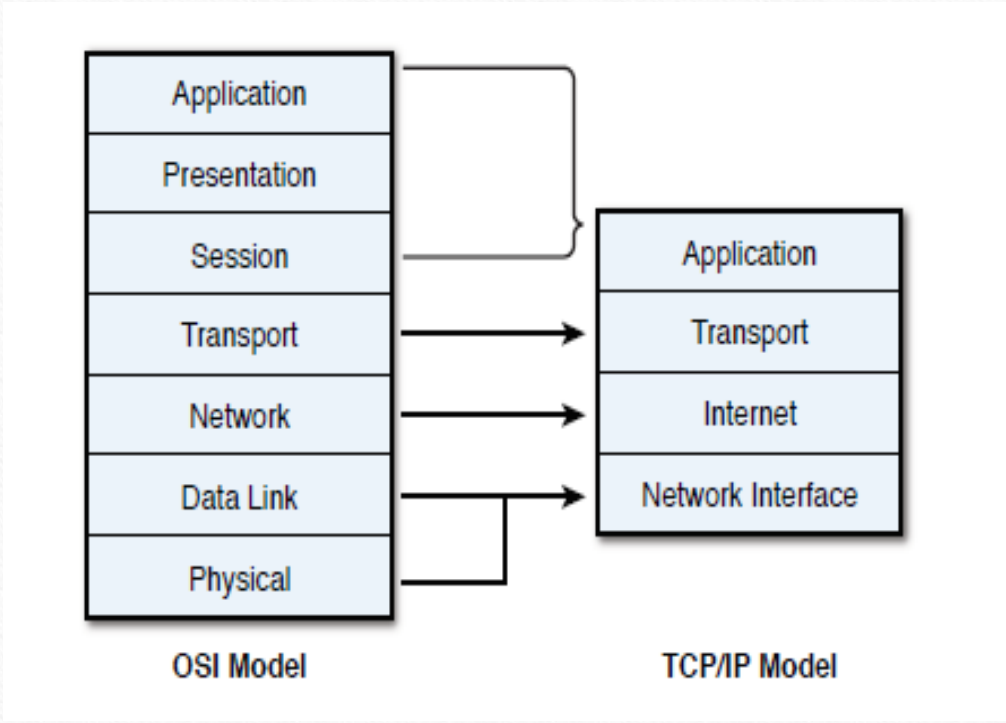
LAYER 1: PHYSICAL

- The Physical layer features:
  - Physical aspects: connector, cables, interface cards

  Device operating in this layer: repeaters and hubs

TCP/IP MODEL

- Internet uses TCP/IP protocol suite, also known as Internet suite. This defines Internet Model which contains four layered architecture. OSI Model is general communication model but Internet Model is what the internet uses for all its communication. The internet is independent of its underlying network architecture so is its Model. This model has the following layers:



APPLICATION

- This layer defines the protocol which enables user to interact with the network. For example, FTP, HTTP etc.

TRANSPORT

- This layer defines how data should flow between hosts. Major protocol at this layer is Transmission Control Protocol (TCP). This layer ensures data delivered between hosts is in-order and is responsible for endto-end delivery.

INTERNET

- **:** Internet Protocol (IP) works on this layer. This layer facilitates host addressing and recognition. This layer defines routing.

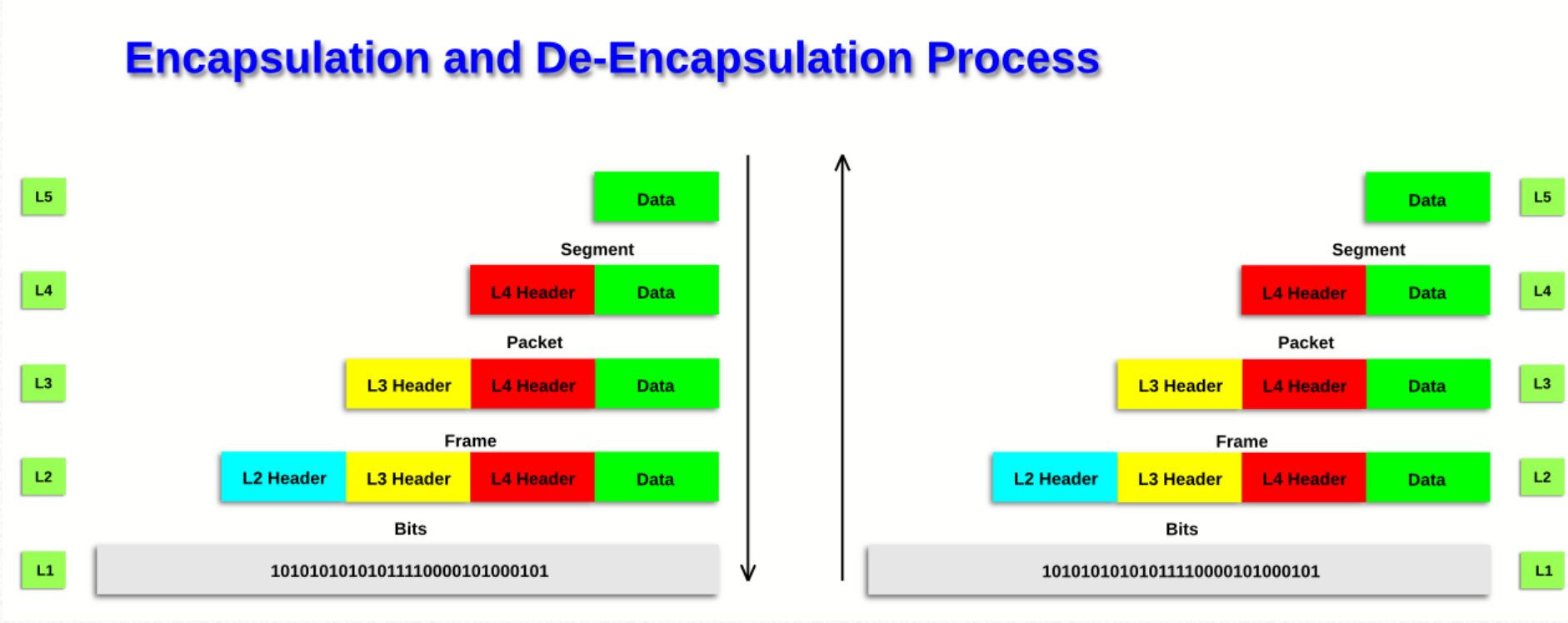
NETWORK ACCESS

- This layer provides mechanism of sending and receiving actual data. Unlike its OSI Model counterpart, this layer is independent of underlying network architecture and hardware.

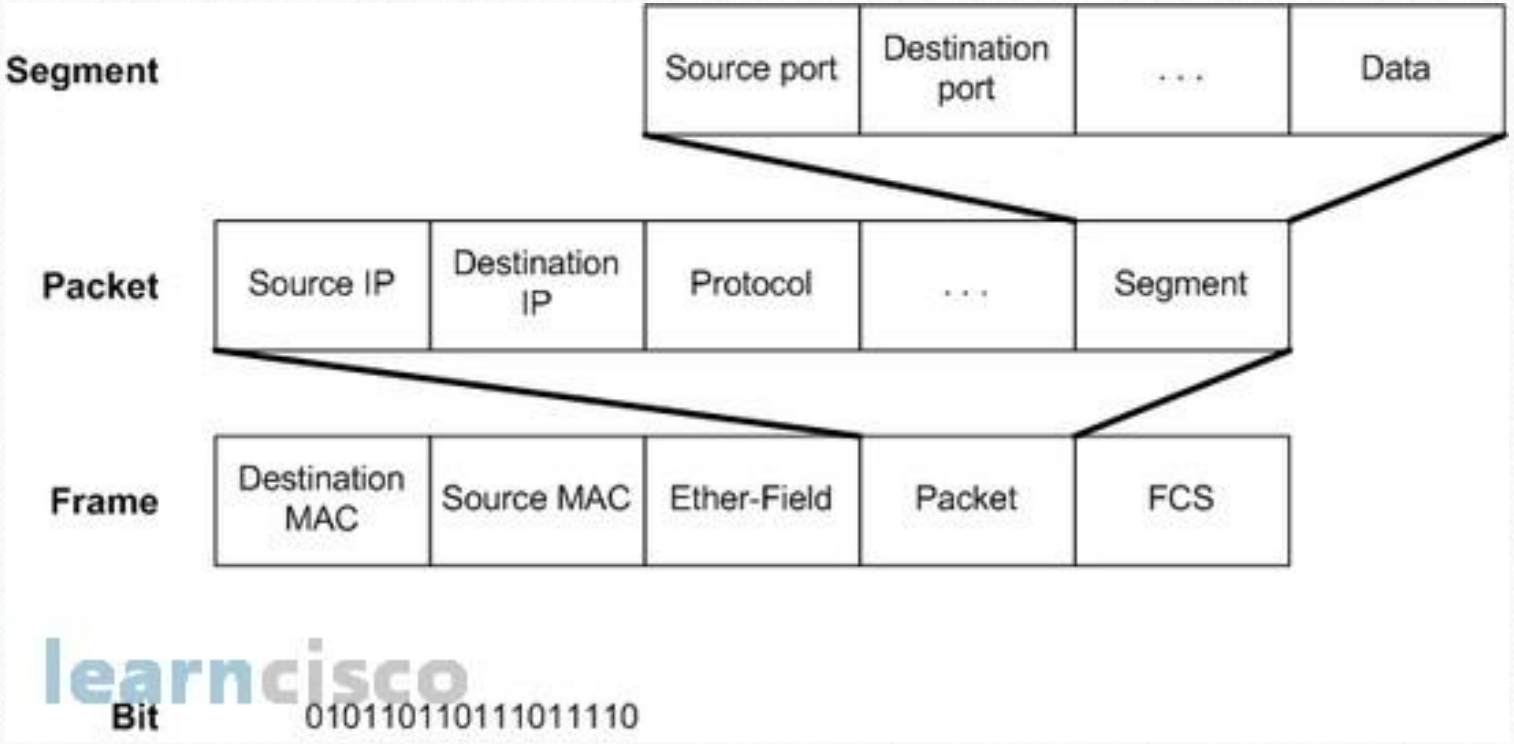
DATA ENCAPSULATION

- In networking model, the terms encapsulation and de-encapsulation refer to a process in which protocol information is added to the data and removed from the data when it passes through the layers.
- Protocol information can be added before and after the data. If information is added before the data, it is known as header. If information is added after the data, it is known as trailer.

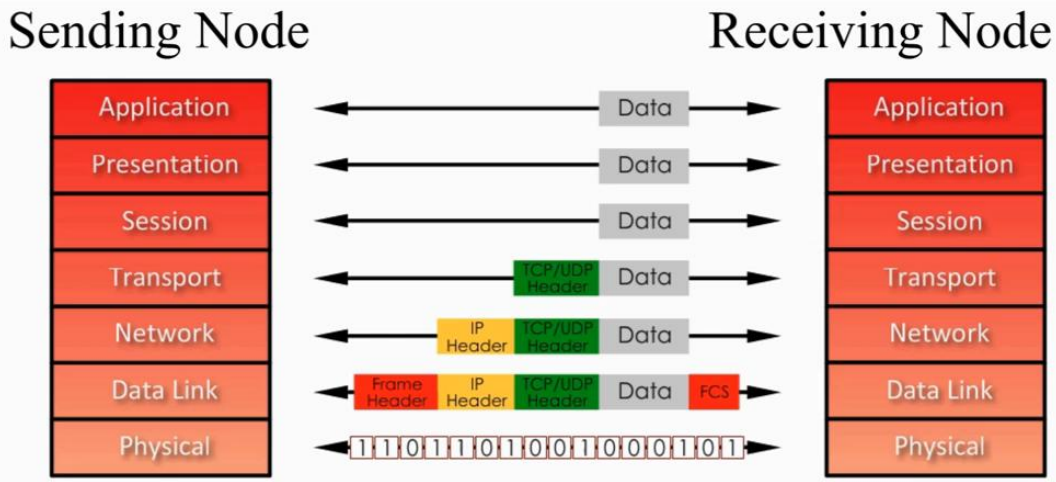
DATA ENCAPSULATION



DATA ENCAPSULATION



DATA ENCAPSULATION/DECAPSULATION



When a sender's data travels down the stack of the layers,