Lecture (03)
Network Model

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Agenda

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- History
- Discovering the network layers
- Application Layer
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- Transport Layer
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- Internetwork Layer
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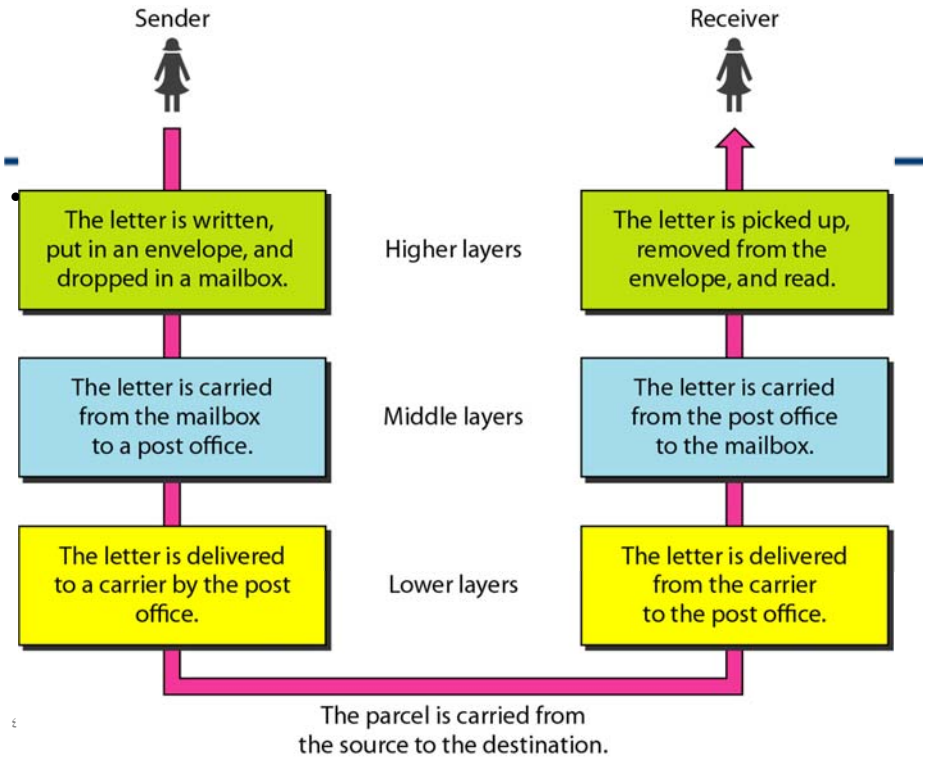
Layering concept

- We use the concept of layers in our daily life. As an example, let us consider two friends who communicate through postal mail.
- The process of sending a letter to a friend would be complex if there were no services available from the post office.



History

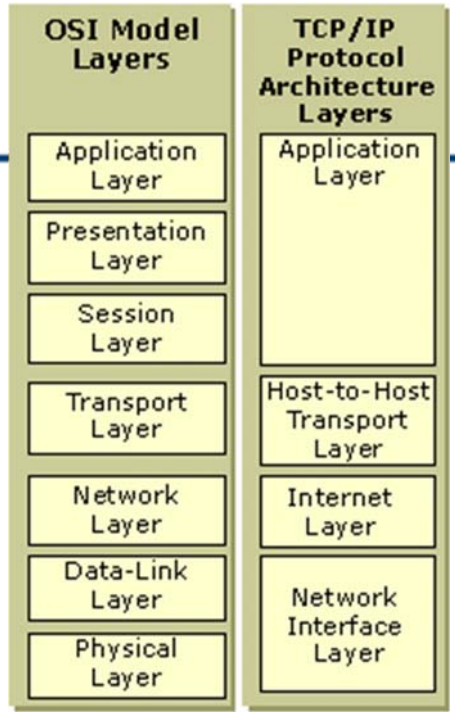
The International Organization for Standardization (ISO) took on this task starting as early as the late 1970s, beginning work on what would become known as the **Open Systems Interconnection (OSI)** networking model.

The ISO had a noble goal for the OSI: to standardize data networking protocols to allow communication between all computers across the entire planet.

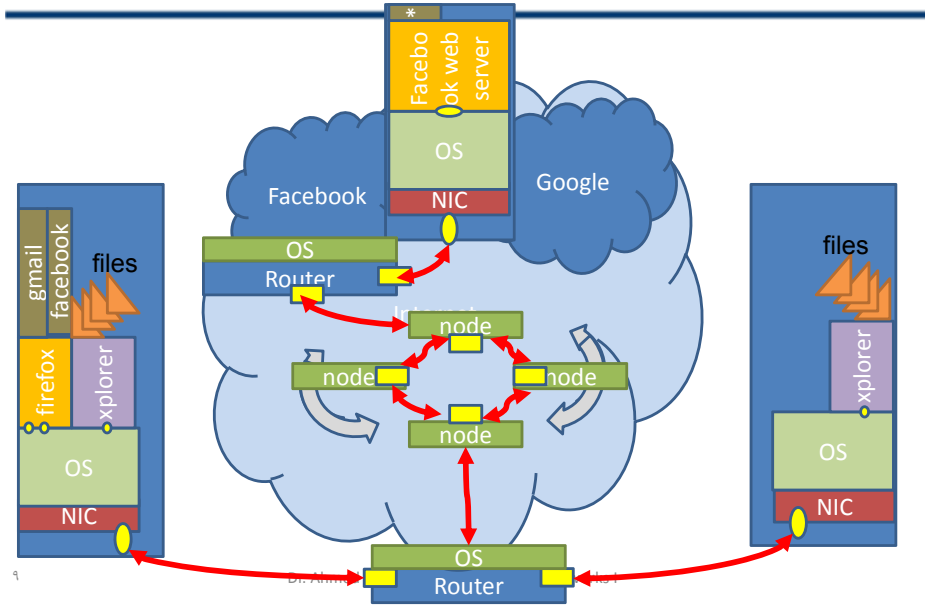
- U.S. Defense Department did a less formal effort to create a standardized, public networking model sprouted forth from a contract.
- Researchers at various universities volunteered to help further develop the protocols surrounding the original department's work.
- These efforts resulting in a competing networking model called TCP/IP.

The world now had many competing vendor networking models and two competing standardized networking models.

So what happened? TCP/IP won the war.

- 

Discovering the network layers



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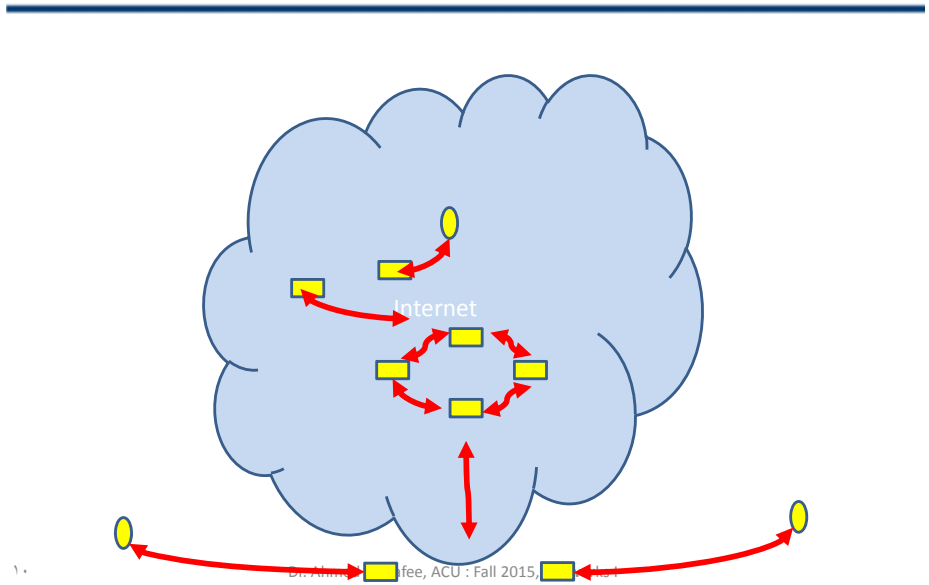

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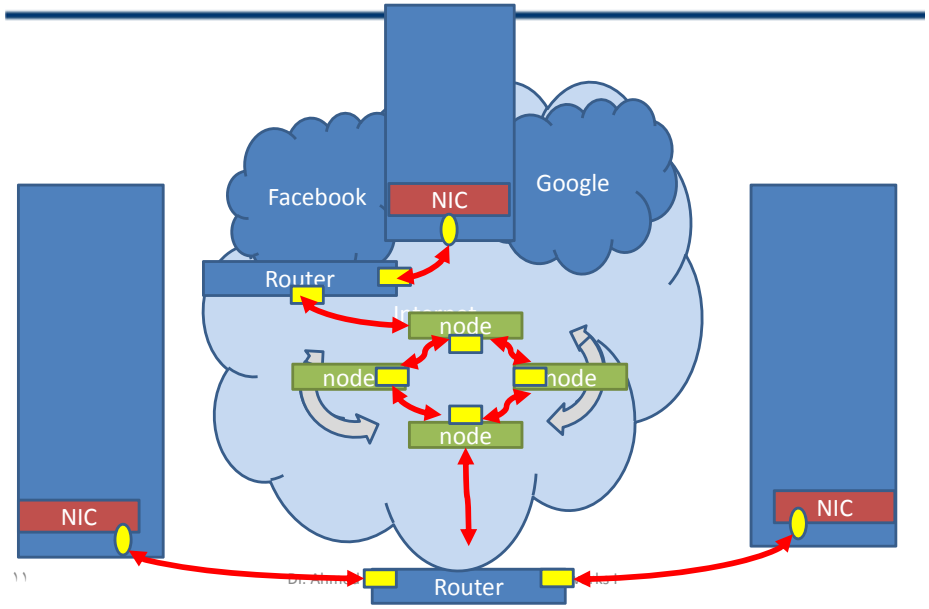

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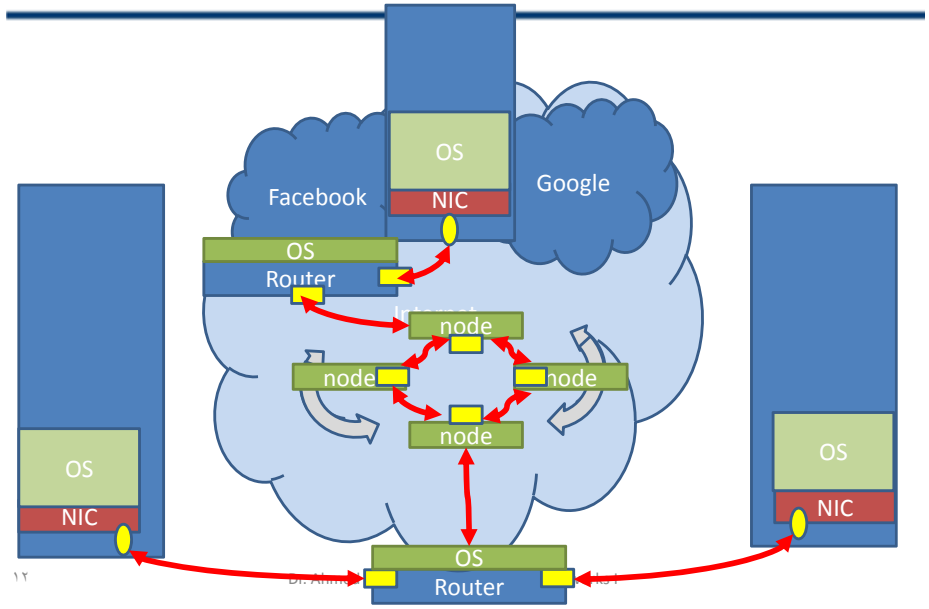

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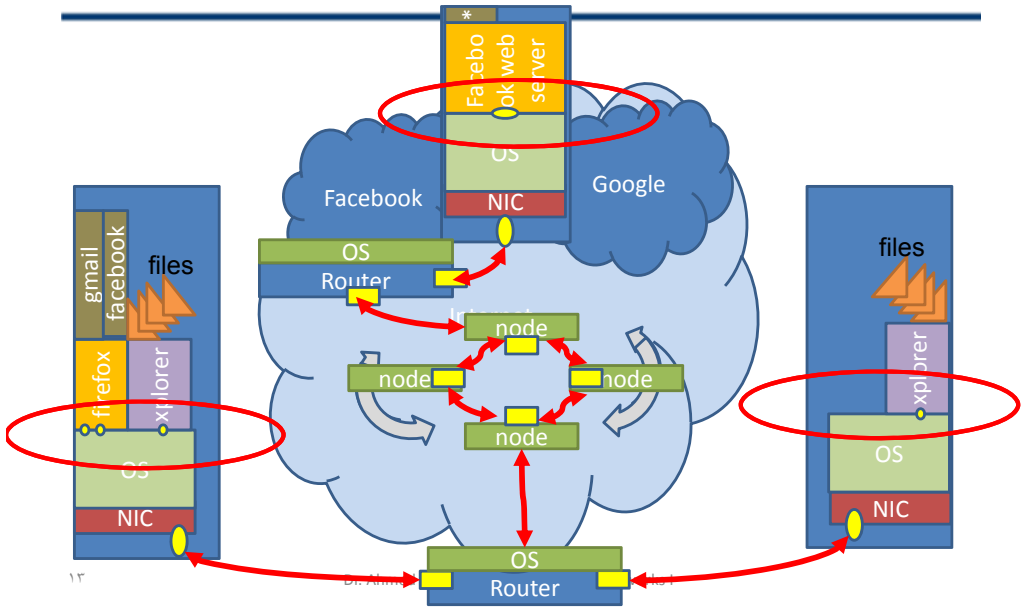

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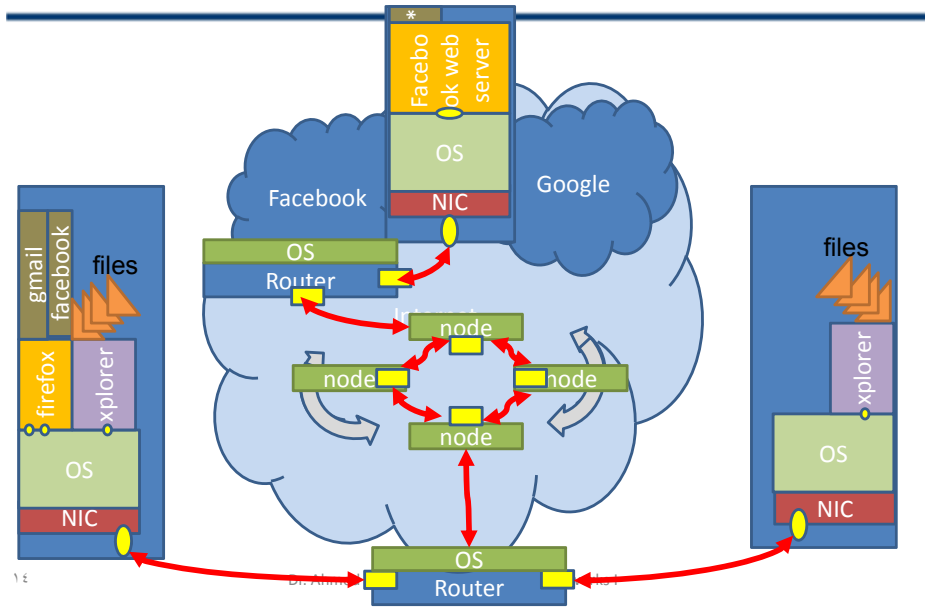
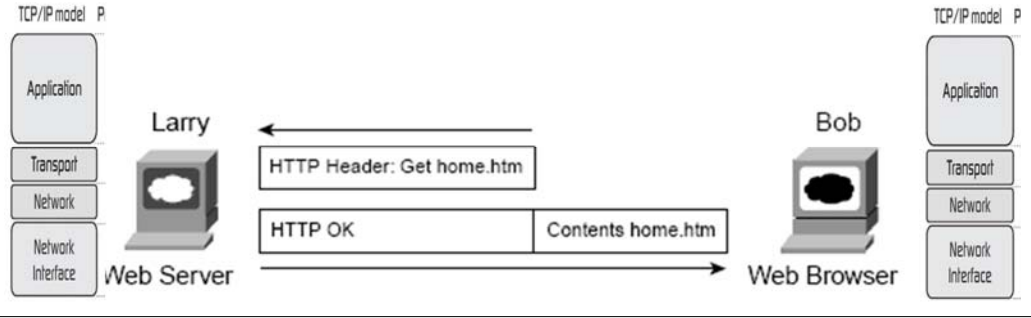


Application Layer

- The most popular TCP/IP application today is the web browser.
- Many major software vendors either have already changed or are changing their software to support access from a web browser (web based app).
- Using a web browser is easy—you start a web browser on your computer and select a web site by typing in the name of the web site, and the web page appears.

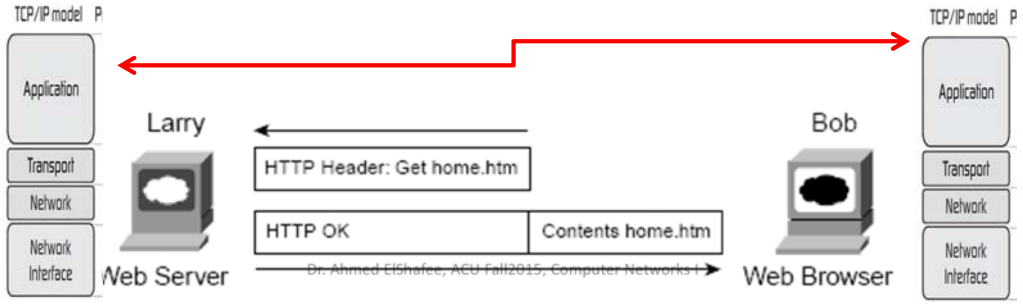
- ***What really happens*** to allow that web page to appear on your web browser?
- Imagine Bob opened his web browser, and wrote in address bar Larry Web Server address.
- Bob's initial request actually asks Larry to send his home page back to Bob.



- Bob receives the file from Larry as HTML file.
- HTML defines how Bob's web browser should interpret the text inside the file he just received.
- For instance, the file might contain directions about making certain text be a certain size, color, and so on.
- In most cases, it also includes directions about other files that Bob's web browser should get— things such as graphics images and animation.
- HTTP would then be used to get those additional files from Larry, the web server.

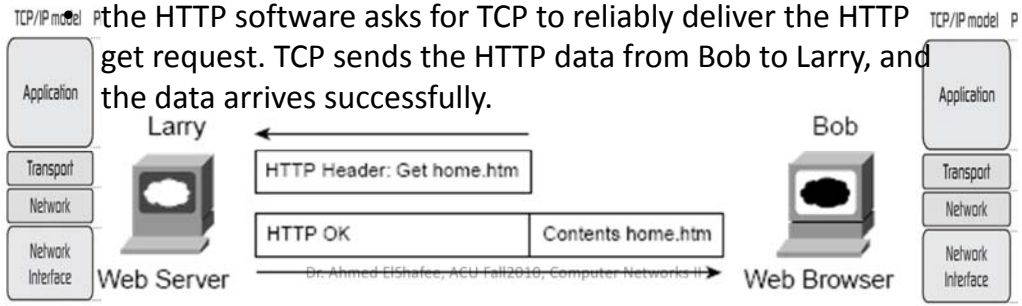
same-layer interaction concept;

- When a particular layer wants to communicate with the same layer on another computer, the two computers use headers to hold the information that they want to communicate.
- The headers are part of what is transmitted between the two computers. This process is called *same-layer interaction.*

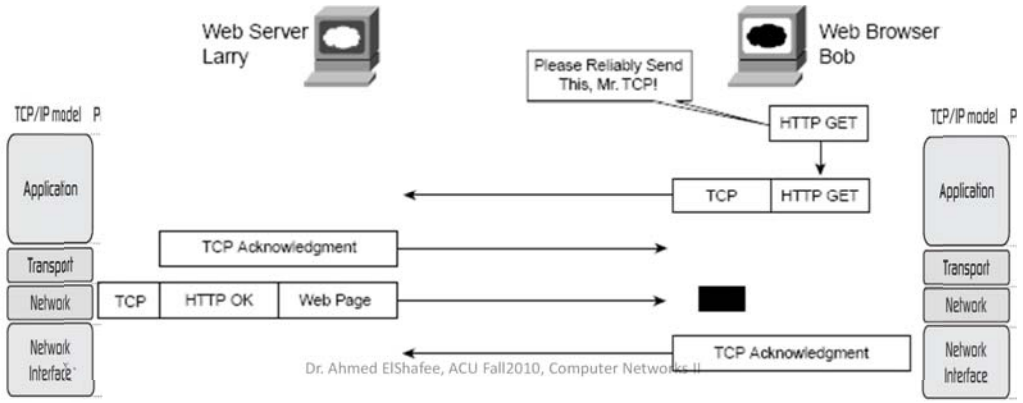


Transport Layer

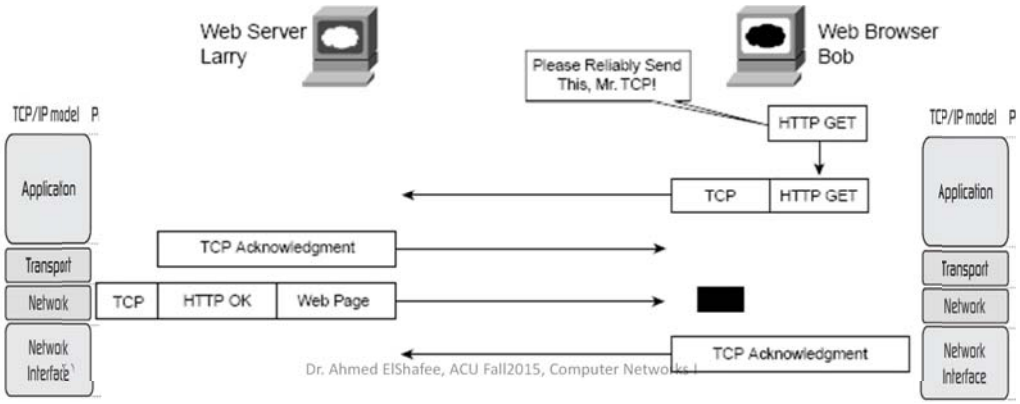
- Transport layer is responsible of identify and distinguishing packets of each software program running inside the same host (PC)
- Each software defines its default destination port (identifier) and random source port (identifier).
- both ports are included in TCP header.
- the HTTP software asks for TCP to reliably deliver the HTTP get request. TCP sends the HTTP data from Bob to Larry, and the data arrives successfully.



- Larry's TCP software acknowledges receipt of the data and also gives the HTTP get request to the web server software.
- The reverse happens with Larry's response, which also arrives at Bob successfully

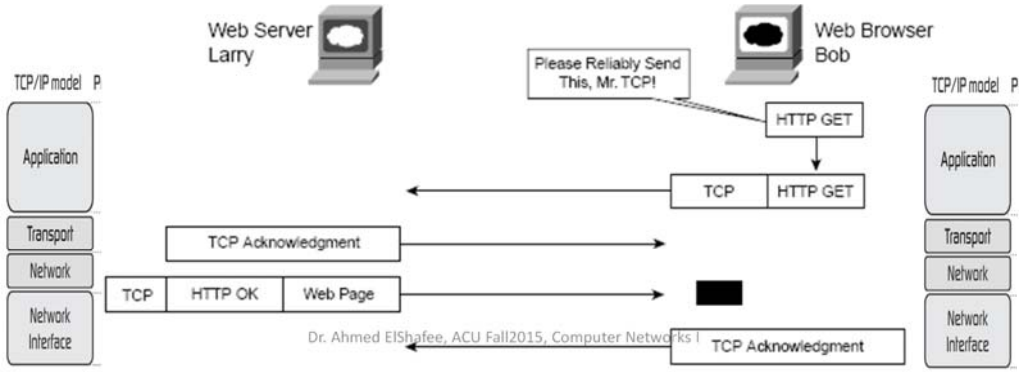


- assume that if either transmission had been lost, that HTTP would not be concerned, and that TCP would resend the data and ensure that it was received successfully.



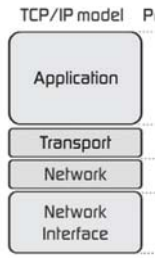
Adjacent layer interaction concept

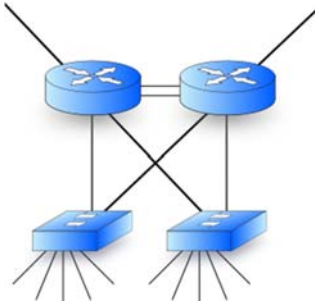
So, the higher layer asks for the next lower-layer protocol (TCP) to perform the service, and the next lower layer performs the service. The lower layer provides a service to the layer above it.



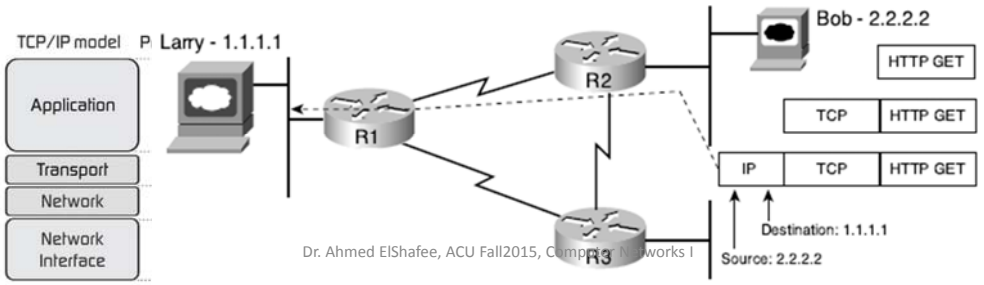
Internetwork Layer

- the internetwork layer of the TCP/IP networking model, the Internet Protocol (IP), works much like the postal service.
- IP defines addresses so that each host computer can have a different IP address,
- IP defines the process of routing so that devices called routers can choose where to send packets of data so that they are delivered to the correct destination.

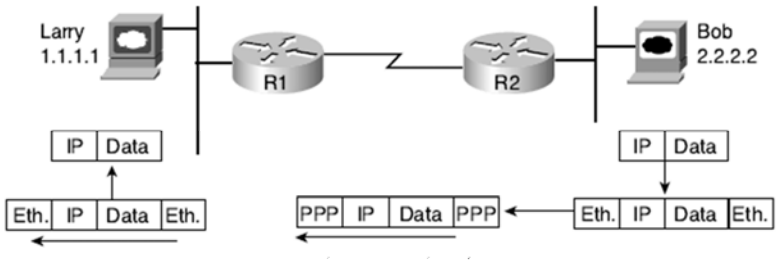




- The IP header includes both a source and a destination IP address field, with Larry's IP address as the destination address and Bob's as the source.



- The network interface layer includes a large number of protocols like Ethernet protocols and other LAN standards.
- This layer also includes the popular WAN standards, such as the Point-to-Point Protocol (PPP) and Frame Relay.



- IP uses the network interface layer protocols to deliver the IP packet to the next router or host, with each router repeating the process until the packet arrives at the destination.
- Each network interface protocol uses headers to encode the information needed to successfully deliver the data across the physical network, much like other layers use headers to achieve their goals.
- In short, the TCP/IP Network Interface layer includes the protocols, cabling standards, headers and trailers that define how to send data across a wide variety of types of physical networks.

CAUTION Many people describe the network interface layer of the TCP/IP model as two layers,

- the data link layer and
- the physical layer.

Data Encapsulation

What? And why?

The term encapsulation describes the process of putting headers and trailers around some data.

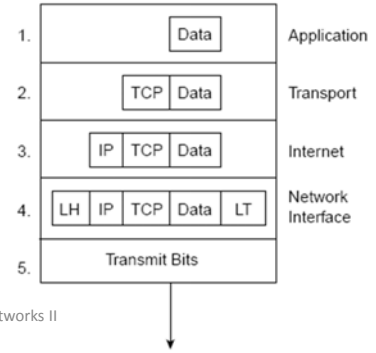
A computer that needs to send data encapsulates the data in headers of the correct format so that the receiving computer will know how to interpret the received data.

Steps:

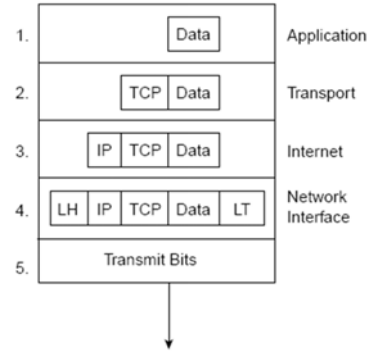
Regarding the previous Bob and Larry example, encapsulation process consists of 5 successive steps;

Step 1: Create the application data and headers—This simply means that the application has data to send.

Step 2: Package the data for transport—In other words, the transport layer (TCP or UDP) creates the transport header and places the data behind it.

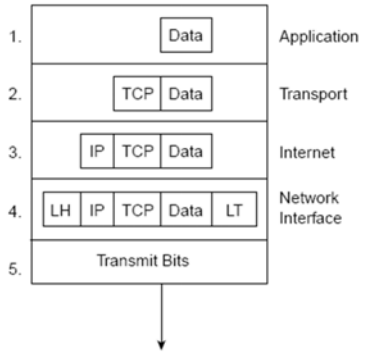


Step 3: Add the destination and source network layer addresses to the data— The network layer creates the network header, which includes the network layer addresses, and places the data behind it.

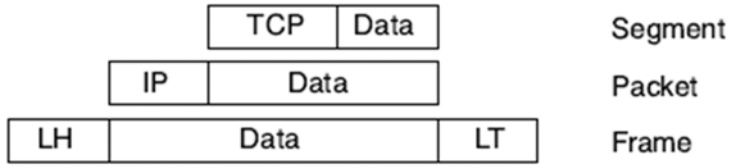


Step 4: Add the destination and source data link layer addresses to the data— The data link layer creates the data link header, places the data behind it, and places the data link trailer at the end.

Step 5: Transmit the bits—The physical layer encodes a signal onto the medium to transmit the frame



Perspectives on Encapsulation and "Data"



OSI Layers

OSI consists of 7 different layers

- The upper layers of the OSI reference model (application, presentation, and session—Layers 7, 6, and 5) define functions focused on the application.
- The lower four layers (transport, network, data link, and physical—Layers 4, 3, 2, and 1) define functions focused on end-to-end delivery of the data.

Layers function

7 application	**Layer 7** **defines the interface between the communications software and any applications that need to communicate outside the computer on which the application resides.** **For example, a web browser is an application on a computer. The browser needs to get the contents of a web page;** **OSI Layer 7** **defines the protocols used on behalf of the application to get the web page.**

6 Presentation	**•Defines data formats, such as ASCII text, EBCDIC text, binary, BCD, and JPEG.** **•Encryption also is defined by OSI as a presentation layer service.** **For example,** **FTP enables you to choose binary or ASCII transfer.** **If binary is selected, the sender and receiver do not modify the contents of the file.** **If ASCII is chosen, the sender translates the text from the sender's character set to a standard ASCII and sends the data.** **The receiver translates back from the standard ASCII to the character set used on the receiving computer.**

5 Session	**defines how to start, control, and end conversations (called sessions).** **This includes the control and management of multiple bidirectional messages so that the application can be notified if only some of a series of messages are completed.** **This allows the presentation layer to have a seamless view of an incoming stream of data.** **The presentation layer can be presented with data if all flows occur in some cases.** **For example, an automated teller machine transaction in which you withdraw cash from your checking account should not debit your account and then fail before handing you the cash, recording the transaction even though you did not receive money.** **The session layer creates ways to imply which flows are part of the same session and which flows must complete before any are considered complete.**

4 Transport	provide a large number of services, Although Layers 5 through 7 focus on issues related to the application, Layer 4 focuses on issues related to data delivery to the other computer— For instance, • error recovery, • segmentation of large application data blocks into smaller ones for transmission, and • reassembly of those blocks of data on the receiving computer.

3 Network	defines end-to-end delivery of packets. To accomplish this, the network layer defines logical addressing so that any endpoint can be identified. It also defines how routing works and how routes are learned so that the packets can be delivered. For example, IP running in a router is responsible for •examining the destination IP address of a packet, •comparing that address to the IP routing table, •fragmenting the packet if the outgoing interface requires smaller packets, •And queuing the packet to be sent out to the interface.

2 Data link	Defines specifications of particular link or medium to deliver data across it. These protocols are necessarily concerned with the type of media in question; for example, •802.3 and 802.2 define Ethernet for the IEEE, which are referenced by OSI as valid data link layer (Layer 2) protocols. •Other protocols, such as High-Level Data Link Control (HDLC) for a point-to-point WAN link, deal with the different details of a WAN link.

1 physical	These physical layer (Layer 1) specifications, which are also typically standards from other organizations that are referred to by OSI, deal with the physical characteristics of the transmission medium. Connectors, pins, use of pins, electrical currents, encoding, and light modulation are all part of different physical layer specifications. Multiple specifications sometimes are used to complete all details of the physical layer. For example, •RJ-45 defines the shape of the connector and the number of wires or pins in the cable. •Ethernet and 802.3 define the use of wires or pins 1, 2, 3, and 6. So, to use a Category 5 cable with an RJ-45 connector for an Ethernet connection, Ethernet and RJ-45 physical layer specifications are used.

Example protocols

Layer Name	Examples
Application (Layer 7)	Telnet, HTTP, FTP, WWW browsers, NFS, SMTP gateways (Eudora, CC:mail), SNMP
Presentation (Layer 6)	JPEG, ASCII, EBCDIC, TIFF, GIF, PICT, encryption, MPEG, MIDI
Session (Layer 5)	RPC, SQL, NFS, NetBIOS names, AppleTalk ASP, DECnet SCP
Transport (Layer 4)	TCP, UDP, SPX
Network (Layer 3)	IP, IPX, AppleTalk DDP
Data link (Layer 2)	IEEE 802.3/802.2, HDLC, Frame Relay, PPP, FDDI, ATM, IEEE 802.5/802.2
Physical (Layer 1)	EIA/TIA-232, V.35, EIA/TIA-449, RJ-45, Ethernet, 802.3, 802.5, B8ZS

OSI Layering Concepts and Benefits

- Many benefits can be gained from the process of breaking up the functions or tasks of networking into smaller chunks, called *layers, and defining standard interfaces between these* layers.

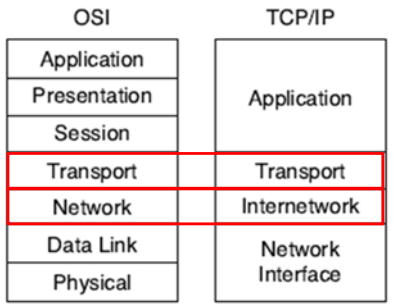
- **Easier to learn**—Humans can more easily discuss and learn about the many details of a protocol specification.
- **Easier to develop**—Reduced complexity allows easier program changes and faster product evolution.
- **Multivendor interoperability**—Creating products to meet the same networking standards means that computers and networking gear from multiple vendors can work in the same network.

- **Modular engineering**—One vendor can write software that implements higher layers— for example, a web browser—and another can write software that implements the lower layers—for example, Microsoft's built-in TCP/IP software in its operating systems.

OSI Terminologies

1. Some OSI layers are correlated to TCP/IP layers;

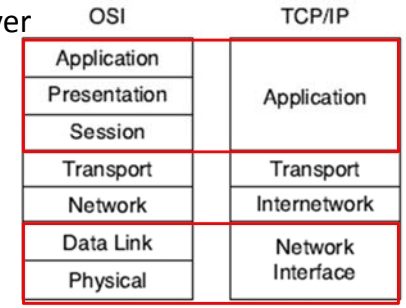
OSI transport layer correlate to TCP/IP transport layer (layer defines error recovery and segmentation)



OSI network layer correlate to TCP/IP internetwork layer (layer defines logical addressing and routing)

Some OSI layers refers to a single layer in TCP/IP

TCP/IP Application layer mapped to Layers 5,6,7 in OSI



Network layer in TCP/IP mapped to data link layer (Ethernet or HDLC) and physical layer (RJ45/Cat5)

protocol data unit, or PDU represents the bits that include the headers and trailers for that layer, as well as the encapsulated data.