

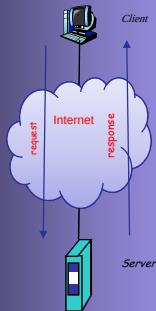
INTERNET PROTOCOLS AND CLIENT-SERVER PROGRAMMING SWE344

Fall Semester 2008-2009 (081)

**Module 4.1: Internet Basics &
TCP/IP Protocol Suite**

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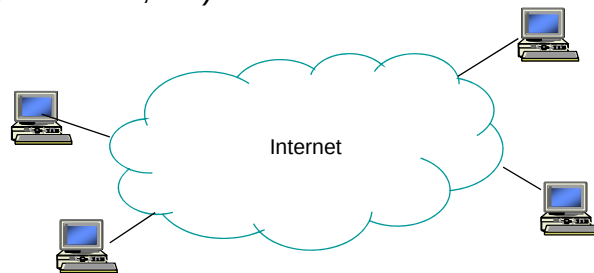


Objectives

- ⊕ Review some basic network terminology
- ⊕ Understand the concept and role of network software layers
- ⊕ Learn how network communication is achieved using protocols & layers
- ⊕ Learn the TCP/IP Protocol Stack: TCP, UDP, IP

What is the Internet?

- ✦ A global heterogeneous network that connects a collection of computers all over the world
 - Using transmission media (copper, fiber, wireless, etc.), special purpose devices (routers, switches, etc.), network operating systems (NOS) and applications software (email, browsers, etc)

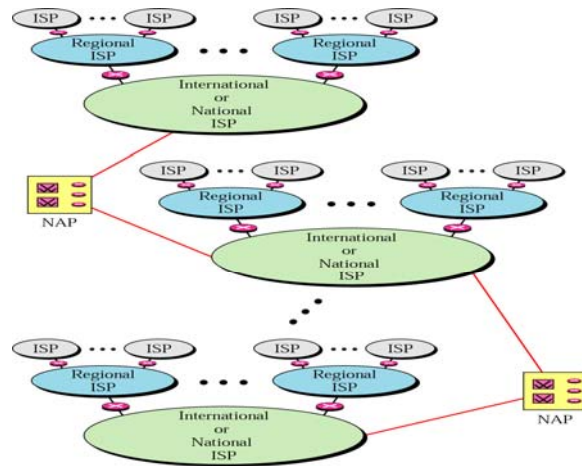


What is the Internet? ...

- ✦ The goal is to provide connectivity between machines and between users to
 - Share resources
 - Increase reliability and availability
 - Collaborate (email, distributed computing, etc)
 - Access remote information
- ✦ Thus the Internet is a vehicle for transferring data from one machine to another.

Internet Hierarchical Structure

- ✦ To manage the growth of the Internet (scalability), it is *roughly* structured in a hierarchical manner

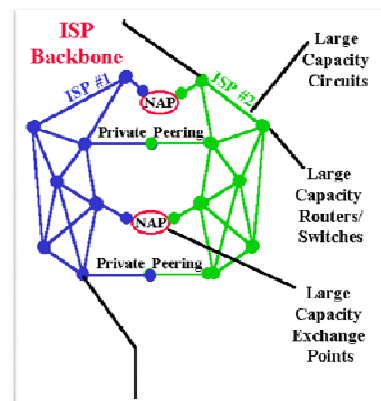


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Internet Hierarchical Structure ...

- ✦ Internet Service Provider (ISP)
 - International, National, Regional, Local
- ✦ At the lowest level are the organizations networks
 - e.g. KFUPM network
 - Which can act as ISP for lower-level user networks as well (e.g. home networks or small office networks)
- ✦ Two ISP networks can be connected to each other through network access points (NAP) or private peering.
 - NAP: data communication facilities that provide access to higher-speed links
- ✦ Routers:
 - Computer networking devices that forward data packets across a network toward their destinations



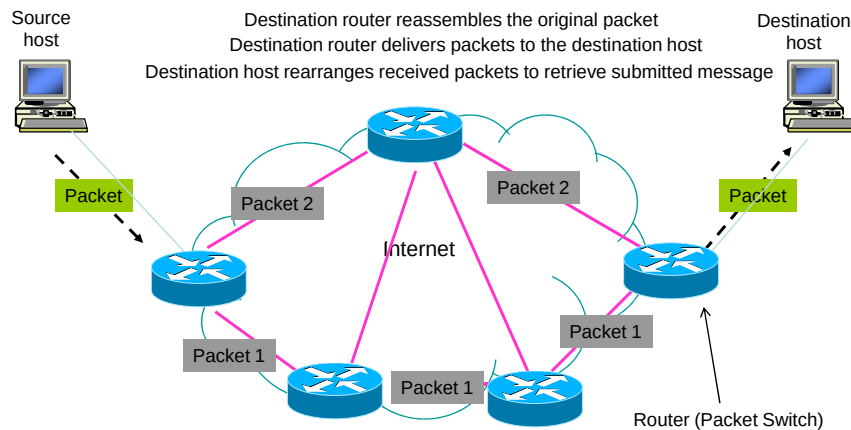
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How does it work?

✦ An example of a packet-switched computer network

- Source host generates a message & converts it to packets
- Source router may fragment a packet into smaller packets (fragments)
- Packets transferred independently across network
- Destination router reassembles the original packet
- Destination router delivers packets to the destination host
- Destination host rearranges received packets to retrieve submitted message



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Internet Applications

✦ An Internet application is a distributed system in which computations are performed by separate programs, normally running on separate pieces of hardware, that cooperate to perform the task of the system as a whole

✦ Examples of popular network applications

- Electronic mail (e-mail)
- The World Wide Web (WWW)
- File transfer (FTP)
- Remote login such as Telnet and SSH
- Chatting
- Newsgroups
- Internet phone (VoIP)
- Real-time video conferencing
- Streaming audio and video
- Multi-user networked games
- Instant messaging
- P2P file sharing

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Why Distributed Systems?

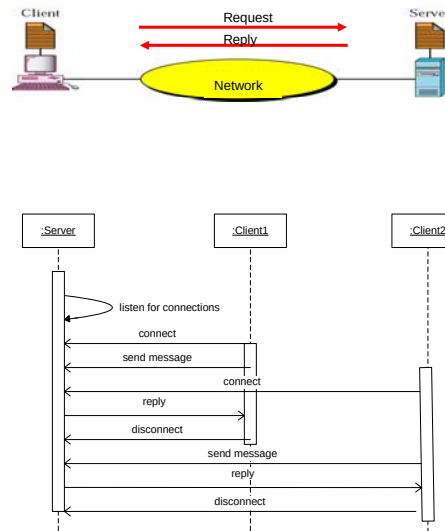
- ⊕ The computational work can be distributed among different machines
 - Reduce the workload per machine (hence low cost and low performance machines can be used)
- ⊕ Remote access for some services
- ⊕ Centralized data thus increase its reliability
 - But in some cases distributing data can minimize its loss
- ⊕ Implementation is easier since the functions of server and client are separated.

Application Architecture

- ⊕ The most common approach to organize and connect software modules in a distributed system
 - Client/Server Architecture (C/S)
 - One piece of the application acts as a server and another piece acts as a client
 - The server program starts first and provides some service for other programs that connect to it using a communication channel
 - The client program requests service from the server; several clients can communicate with the server at the same time
 - Peer-to-peer architecture (P2P)
 - A system in which each program can act as both a client and a server for all the other programs
 - Hybrid (e.g. P2P with Centralized Index)
 - Certain functions are can be implemented as C/S and other parts as P2P
 - E.g. a client may first contact a server to get the address of another client then starts a new session with that client

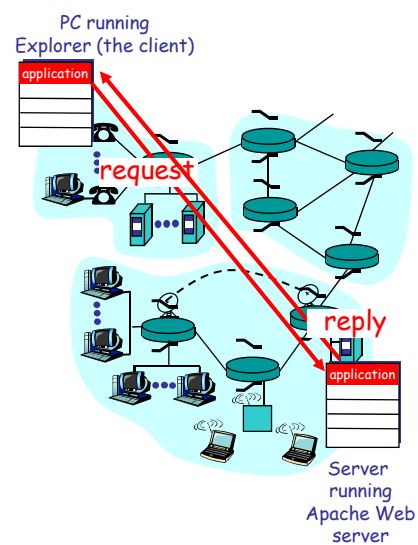
C/S Interaction ...

- ✦ The server starts running
- ✦ The server waits for clients to connect to (listening)
- ✦ Clients start running and perform various operations
 - Some operations require connecting to the server to request a service
- ✦ When a client attempts to connect, the server accepts the connection if it is willing
- ✦ The server waits for messages to arrive from connected clients
- ✦ Then the server takes some action in response
 - Typically the server sends a message back to the client
- ✦ Clients and servers continue functioning in this manner until one of them decides to shut down

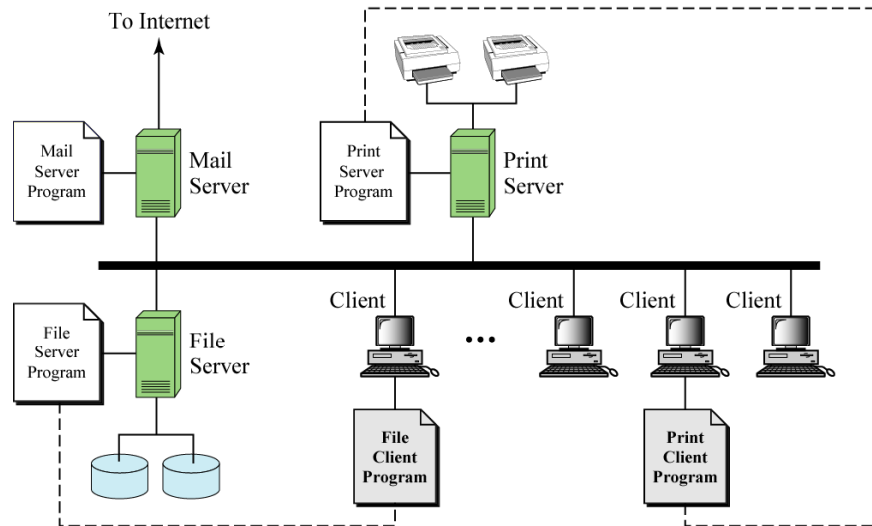


Example: The WWW

- ✦ Web application is implemented using C/S model
 - Client: Web Browser (e.g. Internet Explorer)
 - started by the user, requests, and displays Web objects
 - terminates when the service is complete
 - Server: Web Server (e.g. Apache Web Server)
 - provides requested service to client
 - when started, it runs infinitely listening for incoming requests



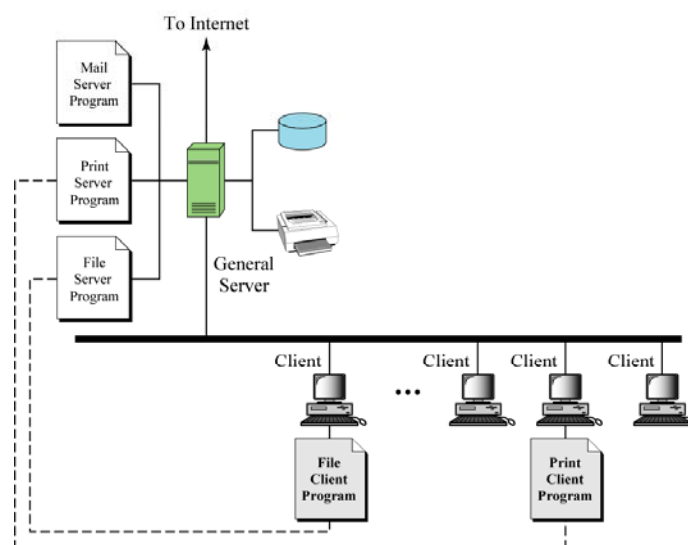
C/S Model with Dedicated Servers



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C/S Model with a General Server

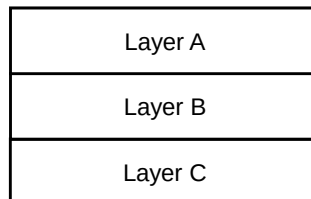


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Software Layers

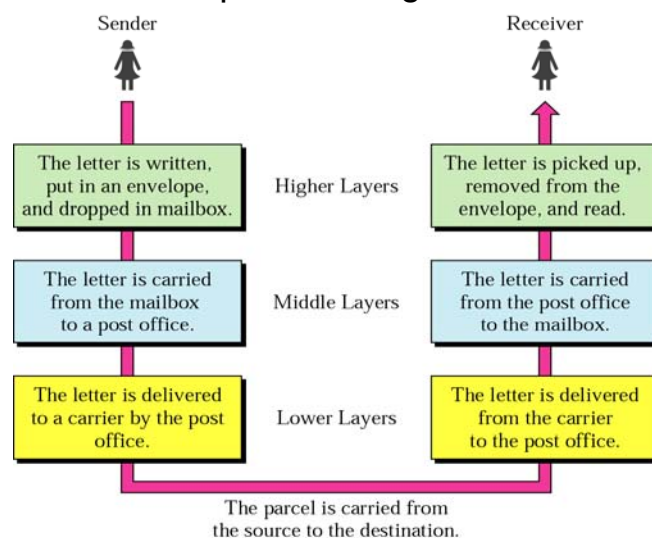
- ✦ Breaking the problem to be solved into modules where each module
 - has distinct functionality/services
 - provides high level services to some other modules
 - deploys low level services provided by some other modules
 - hides the details of low level service implementation



- ✦ Reduce the complexity when developing large programs
- ✦ Promote reusability and portability across multi-platforms

Software Layers Illustration

- ✦ A real life example: sending a letter

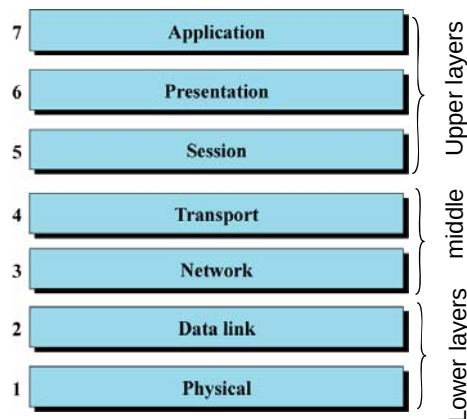


Protocol Stack

- ✦ The functionalities of a network OS are organized into different layers (called Protocol Model or Protocol Stack)
- ✦ The protocol stack describes how information from a software application in one computer moves through a network medium to a software application in another computer
- ✦ There are two popular standardized protocol models
 - Open Systems Interconnection (OSI) Model
 - Introduced by ISO (International Standards Organization) in 1984 and dominated the networking and data communication literature until 1990.
 - A conceptual model that is never fully implemented but was used to guideline the understanding and designing of a network architecture
 - **Open System** is a set of protocols that allows two different systems to communicate regardless of their underlying architectures
 - Internet (TCP/IP) Model
 - Became the dominant commercial architecture because it was first provided free with the UNIX operating system

OSI Model

- ✦ There are seven layers; each layer can be implemented in software, hardware, or both
- ✦ The layers can be divided into three categories
 - upper layers (deal with application issues and only implemented in software)
 - lower layers (handle data transport issues and implemented mostly in hardware)
 - middle layer (interface between upper and lower layers and have mixed implementation)



OSI Model ...

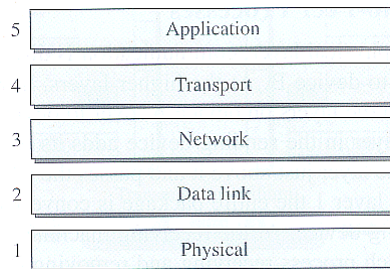
- ✦ Physical Layer: hop-to-hop transmission of bits
 - Physical characteristics of interfaces and media.
 - Representation of bits
 - Data Rate
 - Synchronization
- ✦ Data Link Layer: hop-to-hop transmission of frames
 - Framing
 - Physical Addressing
 - Flow Control
 - Error Control
 - Medium Access Control
- ✦ Network Layer: end-to-end transmission of packets
 - Logical Addressing
 - Routing

OSI Model ...

- ✦ Transport Layer: process-to-process transmission of messages
 - Port Addressing
 - Segmentation and re-assembly
 - Quality of Service: Speed (UDP) or Reliability (TCP)
 - Error Control and Flow Control (end-to-end)
- ✦ Session Layer: Allows devices to establish & manage session – a persistent logical link between one system to another.
- ✦ Presentation Layer:
 - Translation of message format between different systems (PCs, Macs, UNIX, etc)
 - Compression
 - Encryption
- ✦ Application Layer : Enable the user to access the network and obtain some service.
 - Mail Services, File Transfer, WWW, Remote Login, Chatting, etc.

TCP/IP Model

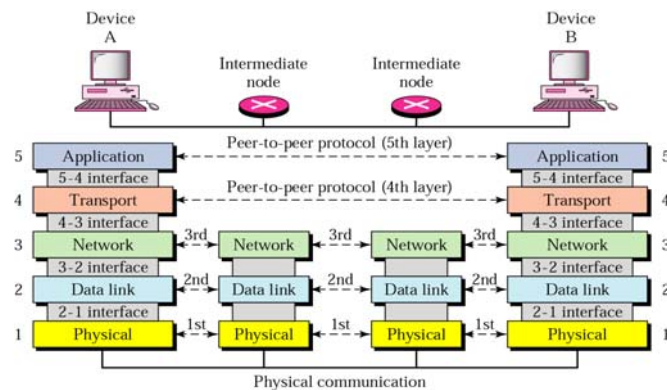
- ✦ Also called Internet reference model
- ✦ It operates using a total of five layers.
- ✦ The main differences is the absence of Presentation and Session Layers, whose functions are shared between Application and Transport layers.



TCP / IP Reference Model

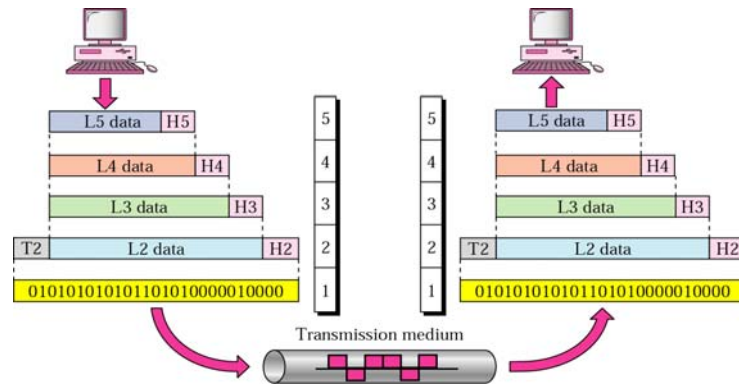
TCP/IP Model ...

- ✦ Two types of communications takes place
 - Same layers on different machines communicate using layer protocol (Peer-to-Peer communication)
 - Adjacent layers on the same machine communication through interfaces



TCP/IP Model ...

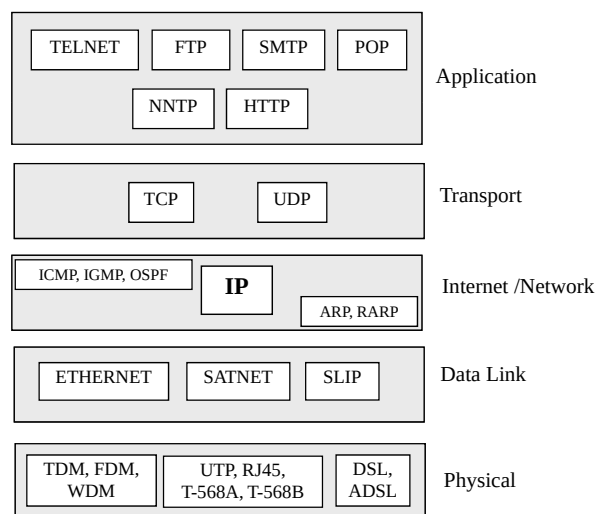
- Each layer adds meta-data (control information) to facilitate communication between layers
 - E.g. source address, destination address, identification, error control information, etc.



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TCP/IP Reference Model Summary



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Resources

✦ Books

- Richard Blum, C# Network Programming. Sybex 2002.
- [Data Communications and Networking](#), 4/e. Behrouz A Forouzan, McGraw-Hill Higher Education
- Computer Networking: A Top Down Approach Featuring the Internet, 4/e, J. Kurose & Keith Ross, Addison Wesley, 2008

✦ Lecture notes of previous offerings of SWE344 and ICS343

✦ Some other web sites and books; check the course website at

- <http://faculty.kfupm.edu.sa/ics/alfy/files/teaching/swe344/index.htm>