

# Computer Networks

## OBJECTIVES

*After reading this chapter, the reader should be able to:*

- Understand the rationale for the existence of networks.
- Distinguish between the three types of networks: LANs, MANs, and WANs.
- Understand the OSI model and TCP/IP.
- List different connecting devices and the OSI layers in which each device operates.
- Understand client-server models.

### 6.1

## NETWORKS, LARGE AND SMALL (LAN, MAN, WAN)

## Terminologies

- Computer network:
  - Combination of systems through transmission media.
- According to the spanning area of the network:
  - LAN: Local Area Network
  - MAN: Metropolitan Area Network
  - WAN: Wide Area Network
- Connecting the networks using the connecting devices: internet.

6.2

## OSI MODEL



Note:

***The Open Systems Interconnection model (OSI model) is a theoretical model that shows how any two different systems can communicate with each other.***

## OSI Model

- A frame work of seven layers that suggests the functionality of each separate but related layer.
- Not all devices need to implement all the layers.
  - depends on the location and the functionalities.

Figure 6-1

## The OSI model

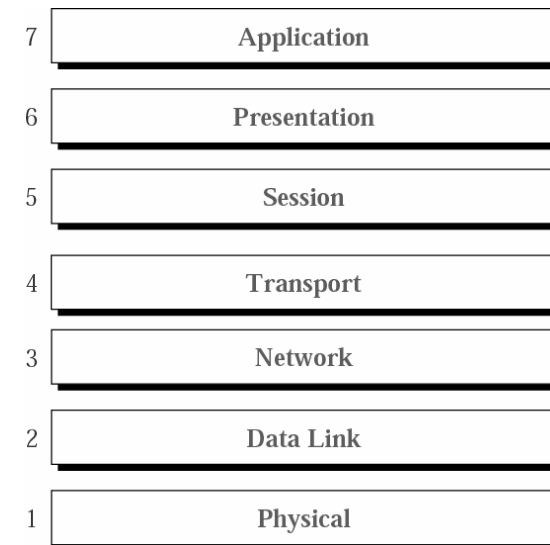
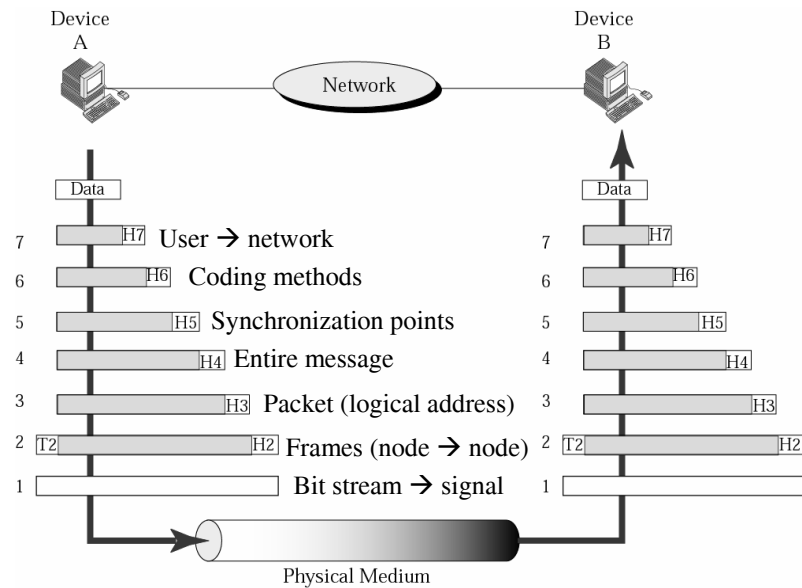


Figure 6-2

## Flow of data in the OSI model



## Sending Data from Device A to B

- (At A) Data move down until they reach the physical layer.
  - Control information is added as header or trailer at each node.
- (At B) Data move up until they reach the application layer.
- Data may pass through intermediate nodes that only involves the first three layers of OSI model.

## Functionalities of the Layers

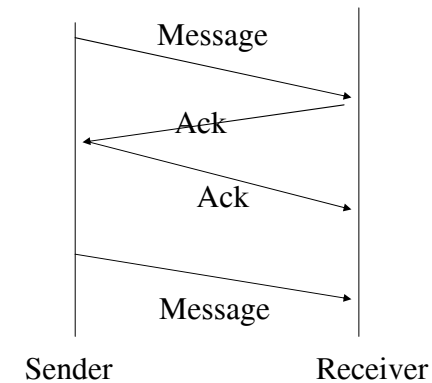
- Physical layer:
  - Transmitting a bit stream over a physical medium.
  - Encode-> Group of bits->signal-> physical medium.
- Data link layer:
  - Organize data into units called frame.
  - Responsible for node-to-node delivery.
  - Headers and trailers contain:
    - Addresses of two adjacent stations (senders and receivers)
    - Error correction or detection codes.

## Functionalities of the Layers

- Network Layer:
  - Delivery of a packet (data units handled by network layer)
  - From source to destination
  - Add source and destination addresses to the header.
    - Called IP address (or logical address)
    - IP address should be unique => 140.112.29.21
- Transport layer:
  - Delivery of the entire message
    - A message is composed of packets.
    - Packets might be lost or might arrive out of order.
    - Resend lost packets and reorganize the packets.

# Functionalities of the Layers

- Session layer:
  - Control dialog between users.
  - Decompose a long message into smaller one.
  - Add synchronization points for backup delivery.
  - When message lost due to network failure, the sender resend the message after the synchronization point.



# Functionalities of the Layers

- Presentation layer:
  - Concerned with the format and semantics of information. => Like ASCII to Unicode
  - Data compression and decompression
  - Data encryption and decryption
- Application layer:
  - Enable user (human or software) to access network.

# Handout

| Layer        |                       |               |  |
|--------------|-----------------------|---------------|--|
| Application  |                       |               | Enable user to access network                    |
| Presentation |                       |               | Concerned data format and semantics              |
| Session      |                       | dialog        | synchronization point.                           |
| Transport    | Source-to-destination | Message       | Resend and reorganize the packets                |
| Network      | Source-to-destination | Packet        | Use IP address                                   |
| Data link    | Node-to-Node          | Frame         | Error correction or detection codes.             |
| Physical     | Physical Medium       | Group of bits | Transmitting a bit stream over a physical medium |

## 6.3

# CATEGORIES OF NETWORKS

Figure 6-3

## Categories of networks

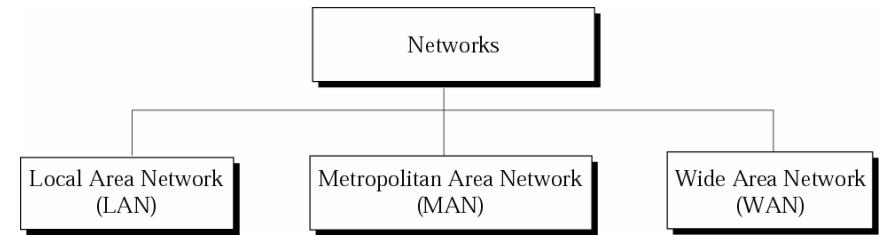
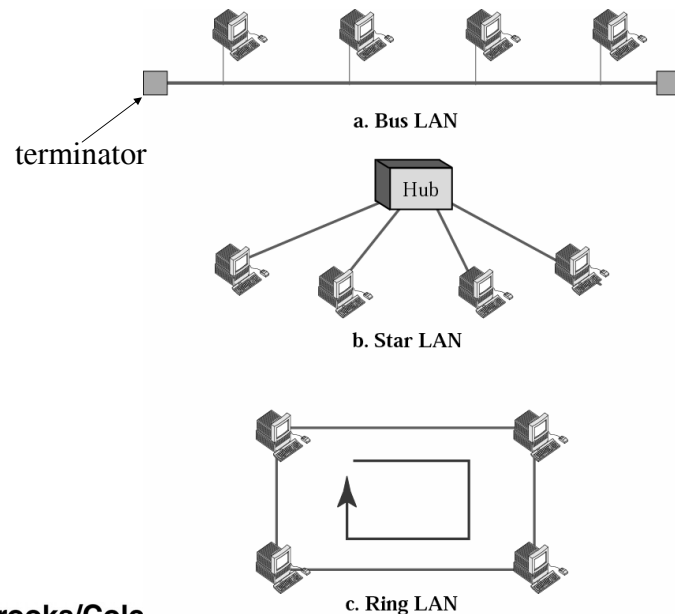


Figure 6-4

## Three Examples of LANs



## BUS topology

- Computer are connected through a common medium called bus.
- All computers receive the frames and check destinations.
- Use cable terminators to kill the signals.
- The BUS is “occupied” by the sender.
  - Two senders resulting in collisions.

# Star topology

- Computers are connected via a hub or a switch.
  - Hub sends data to all its interface.
  - switch checks the address of the receiver, and sends out the frame to receiver.

# Ring Topology

- Computer send a frame to its neighbors.
- The frame is regenerated and sent to its neighbor until it reaches the destination.
- The destination removes the frame and sends ACK back to the sender.
- The sender will remove the ACK when it receive.

Figure 6-5

## MAN

Services provided by network service provider like telephone company.

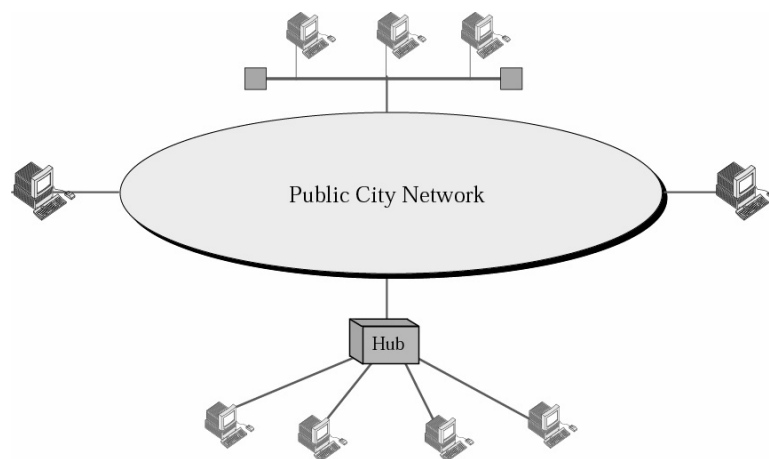
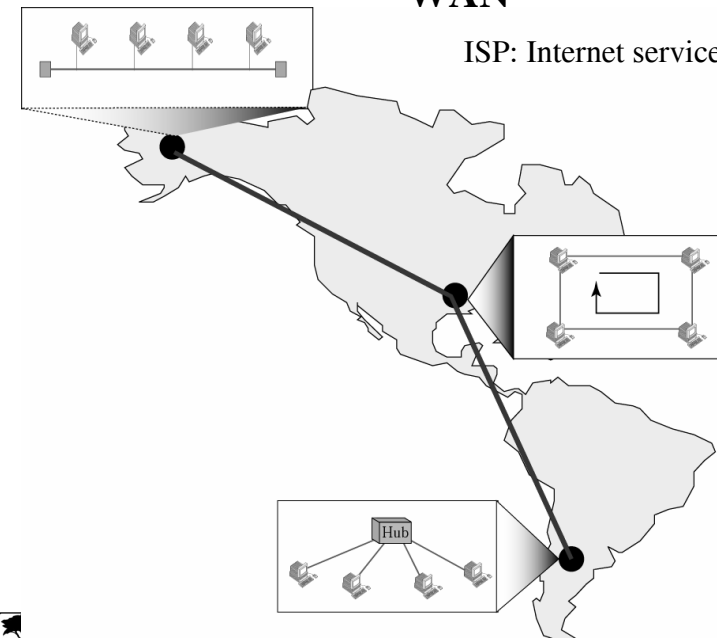


Figure 6-6

## WAN

ISP: Internet service provider.



# 6.4

## CONNECTING DEVICES

Figure 6-7

## Connecting devices

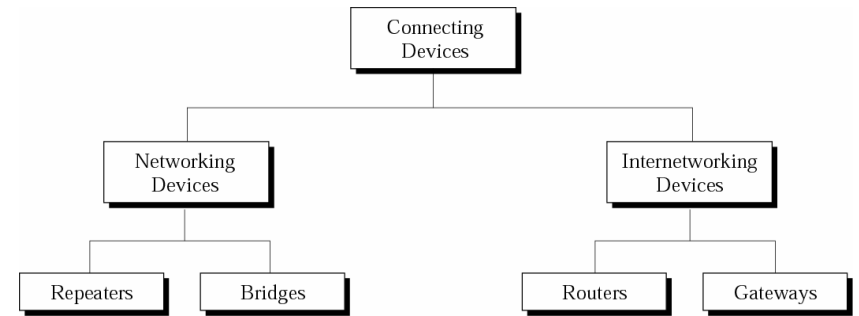
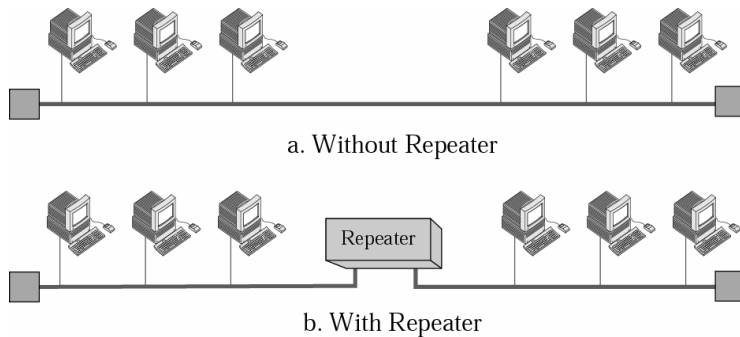


Figure 6-8

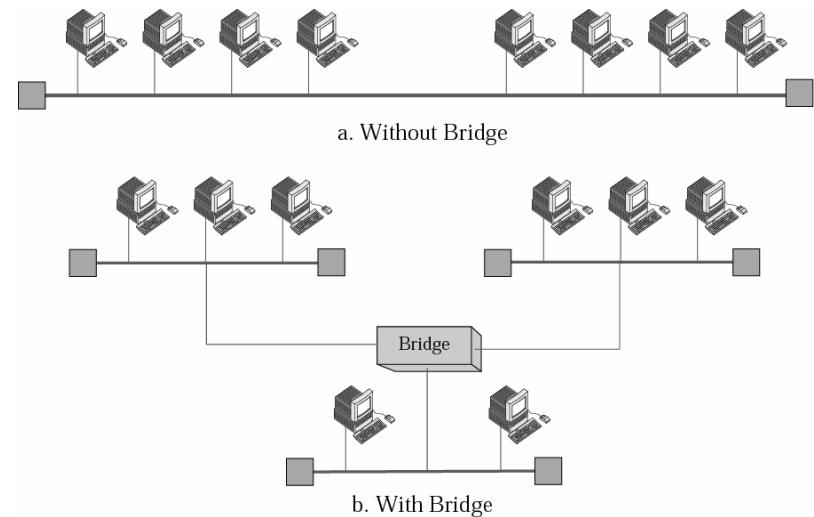
## Repeater



Regenerate signals to extend network length.  
Otherwise, signals may become weak.  
Operate on the first layer of OSI model.  
Usually used in BUS topology.

Figure 6-9

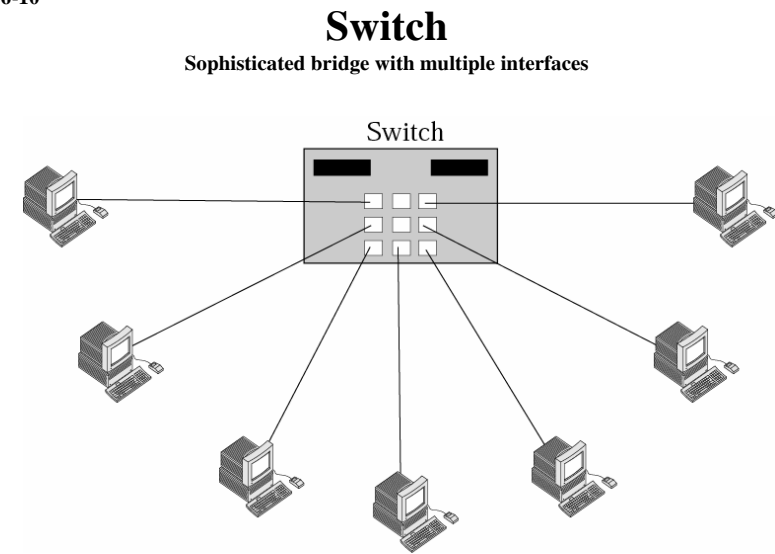
## Bridge



# Bridge

- Operate on the second layer of OSI model
- Divide a bus into segments.
- Pass or block frames according to the destination of the frame.
- Two or more computers can communicate at the same time.

Figure 6-10

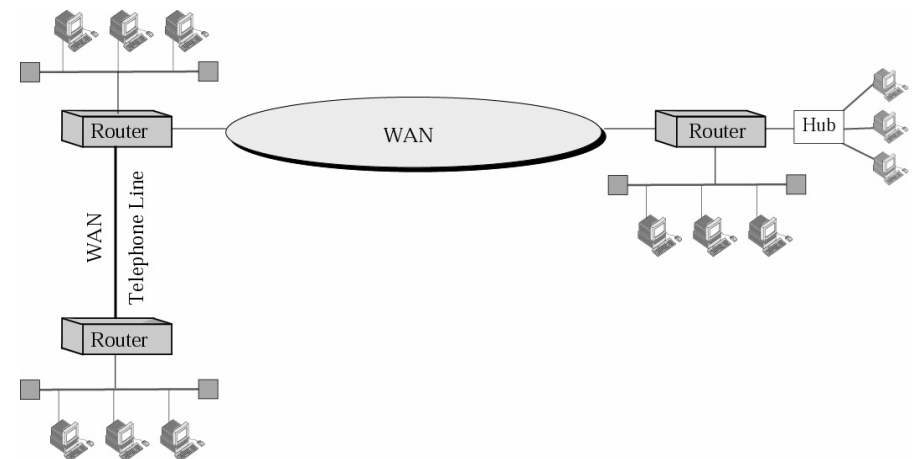


# Router

- Operate at the first three layers of the OSI model.
- Connect two independent networks
  - Like LAN to WAN
- Router routes packets based on physical address.

Figure 6-11

## Routers in an internet



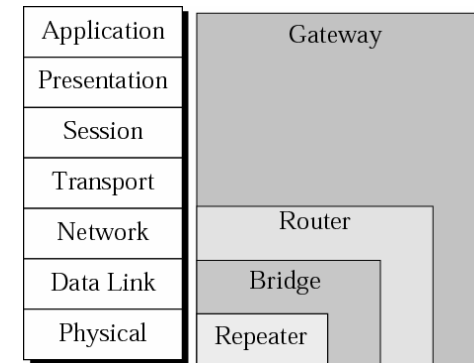


# Gateway

- Act as a protocol converter.
  - Allow two different networks to communicate.
  - Usually a computer with necessary software.
  - The distinction between gateway and router is disappearing.

Figure 6-12

# Connecting devices and the OSI model



## 6.5

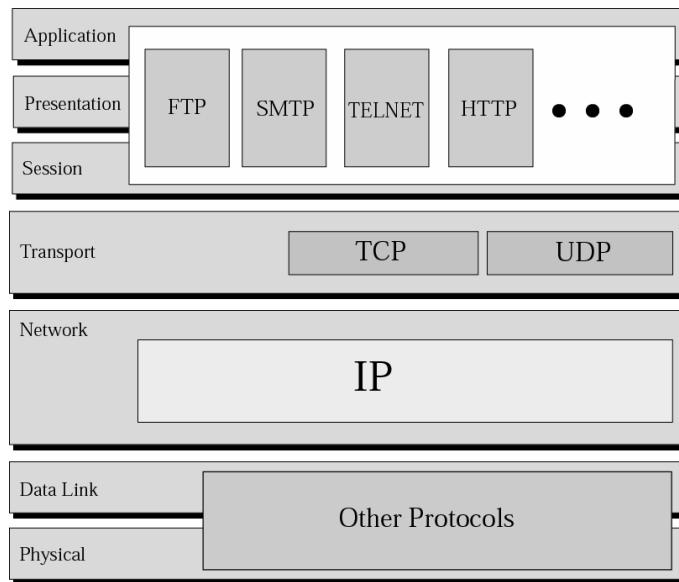
# *THE INTERNET AND TCP/IP*

# Internet

- The most famous internetwork.
- Originally a internetwork research work to connect heterogeneous networks.
- Sponsored by Defense Advanced Research Projects Agency (DARPA)
- Officially Use TCP/IP
  - Transmission Control Protocol/Internet Protocol

Figure 6-13

## TCP/IP and OSI model

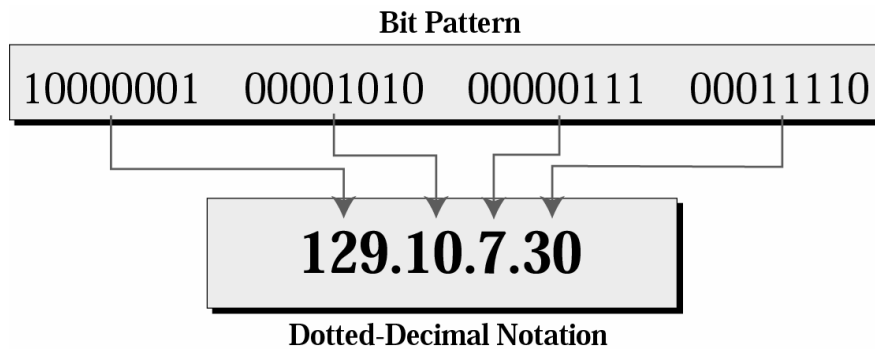


## Network Layer

- TCP/IP use IP (internet protocol)
- Data packet in IP layer is called IP datagram.
- Datagram may travel along different routes, lose, arrive out of order.
- IP do not handle the above problems.
- Each device on the Internet is identified by a unique international address (IP address)

Figure 6-14

## IP addresses in dotted-decimal notation

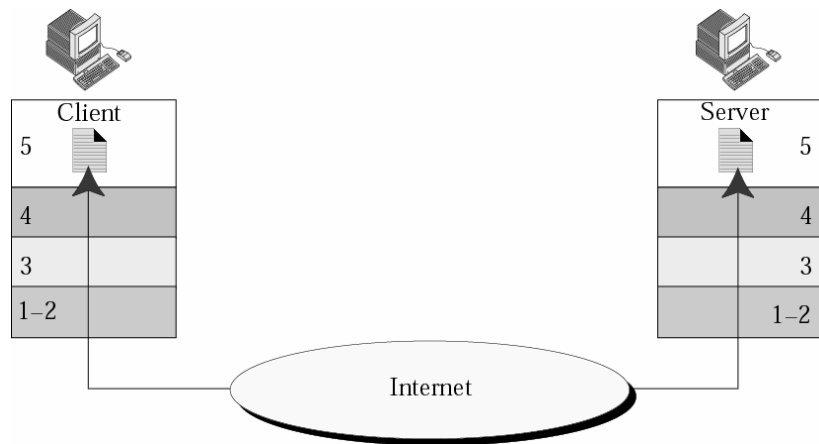


## Transport Layer

- TCP/IP defines two protocols:
  - TCP (Transmission Control Protocol)
  - UDP (User Datagram Protocol)
- UDP is simpler
  - Provide the basic necessities for end-to-end delivery.
- TCP provide full transport layer service.
  - Divide message into numbered segments.
    - Resend lost segment
    - Reorder received segments.

Figure 6-15

## Client-server model



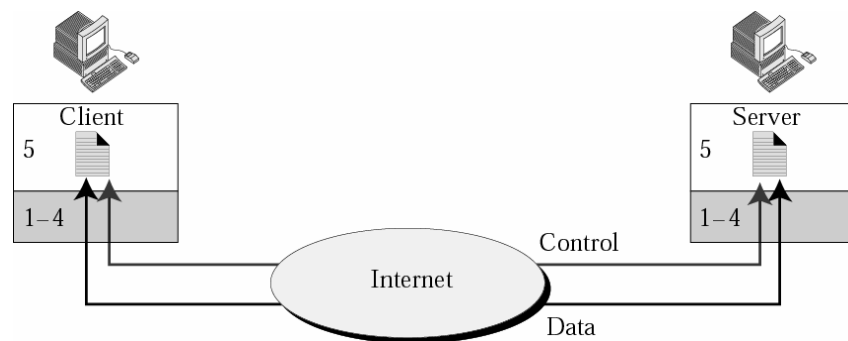
Server program is always running, waiting for request.  
Client program runs only when needed.

## Important Protocols on Internet

- OSI model 5~7.
- FTP (File transfer protocol)
- SMTP (Simple Mail Transfer Protocol)
- POP (Post office protocol)
- TELNET (TERminal NETwork)
- HTTP (Hypertext transfer protocol)

Figure 6-16

## FTP



Transfer files from one machine to another.  
Can handle:  
Different coding methods (ASCII to Unicode)  
Different file format.

Figure 6-17

## SMTP

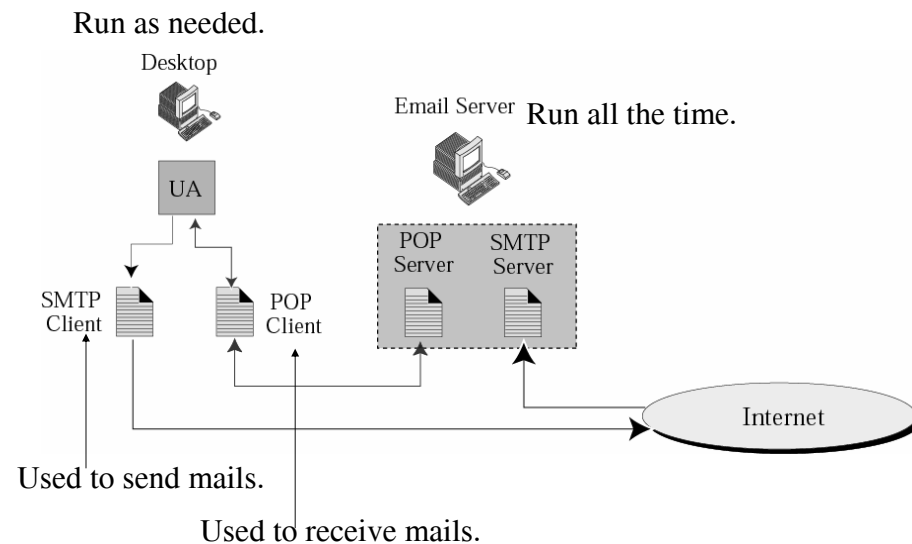


Figure 6-18

## Email address

SMTP uses a unique addressing system to address an email box.

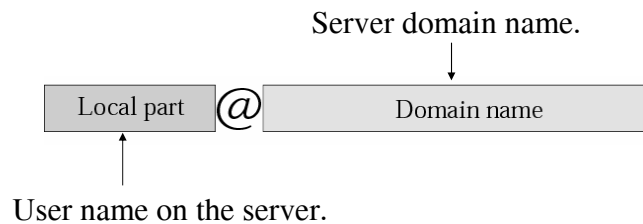
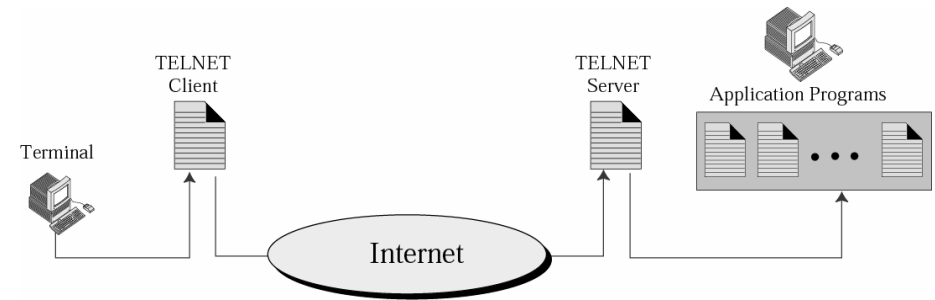


Figure 6-19

## TELNET



FTP and SMTP focus on specific services.  
 TELNET is a general-purpose client-server program.  
 Control remote computer to do something.  
 Allow remote login  
 Login: Local login/ Remote Login

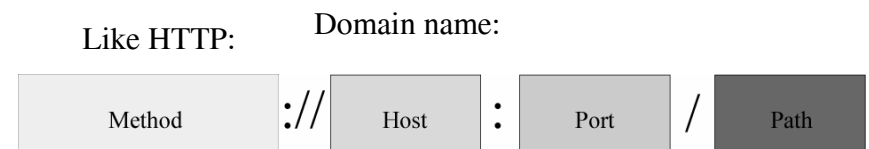
## HTTP

- Hypertext Transfer Protocol
- Allow to transfer documents over WWW – especially hypertext.
- WWW (World Wide Web)
  - Sharing information over Internet.
- Client and server architecture.
  - Use letter-like string to send message.

Figure 6-20

## URL

Uniform Resource Locator.  
 An addressing method used to address a resource.



http://directory.google.com:80/Top/World/Chinese\_Traditional/



## Dynamic document

- Program runs at the server.
- Browser → Send request → Server → Program → Generate results → A web page → Browser
- Popular Approaches
  - CGI (Common Gateway Interface)
  - Perl
  - PHP
  - ASP

## Active Programs

- A program runs at the client site.
- Browser → Send request → Server → Send Program → Browser → Execute Program → Generate Results
- Like JAVA.