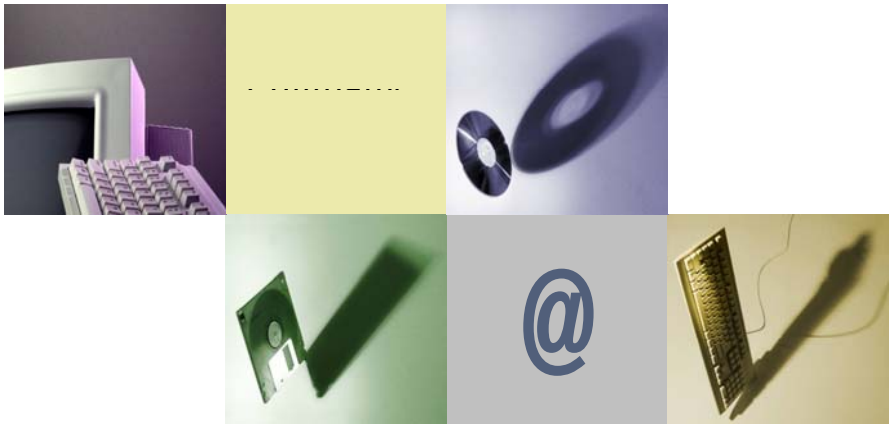
Data Communications



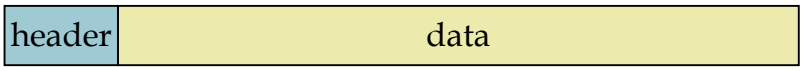
Digital Computer Concept and Practice

Data Communications

- Process in which two or more computers or devices transfer data, instructions, and information

Features

- Digital data
  - Durability of noise
  - Advanced IC technology → cheap
  - Fiber-optics → high speed
- Packets
  - A packet is a formatted block of data carried by a packet mode computer network
  - Header and data



Components

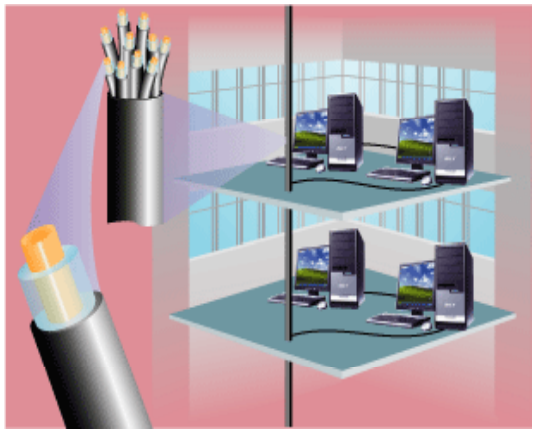
- Source + Destination + Communication channel
- Transmission media (cable/wireless)
  - Transmission quality
    - Cable: media itself
    - Wireless: frequency
- Hardware
  - Modem, Hub, Router, etc.

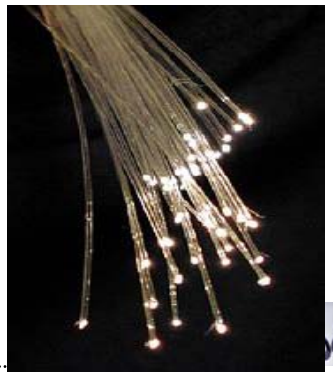
Cable Media

- Twisted pair
  - Telephone systems or local area network (LAN)
- Coaxial cable
  - As a high-frequency transmission line to carry a high-frequency or broadband signal
  - Long-distance telephone network, cable TV (CATV), and short-distance network

Cable Media

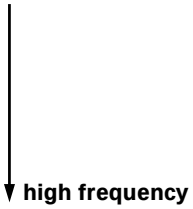
- Fiber optics
  - Capable of carrying significantly more data at faster speeds than wire cables
  - Less susceptible to interference (noise) and therefore more secure
  - Thinner and lighter
  - Expensive





Wireless Media

- To transport information through the air or outer space without wires
- Types
  - Radio waves
  - Infrared waves
  - Ground microwaves
  - Satellite microwaves



Wireless Media

(1) Radio waves

- Relatively long wavelength in the electromagnetic spectrum
- AM / FM radio broadcasts

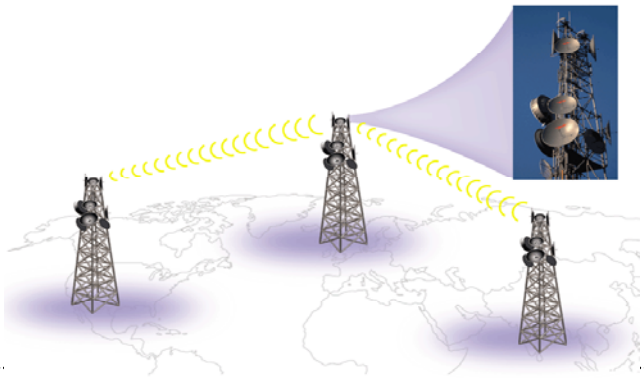
(2) Infrared waves

- Short distance communications (remote controls of TV, video and audio)
- Directional, cheap

Wireless Media

(3) Ground microwaves

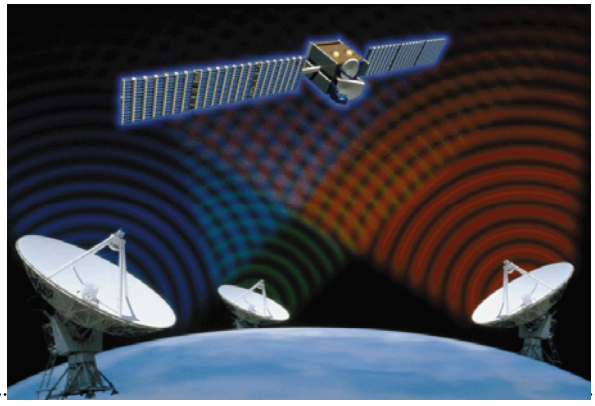
- Earth-based reflective dish used for microwave communications
- Must transmit in straight line with no obstructions
- Using 2 ~ 40 GHz bandwidth
- TV, PCS, wireless LAN, bluetooth



Wireless Media

(4) Satellite microwaves

- Space station that receives microwave signals from earth-based station, amplifies signals and broadcasts signals back to a number of earth-based stations
- Transmitted waves can be received on the all ground through a satellite antenna. → security issue



Mobile Phone

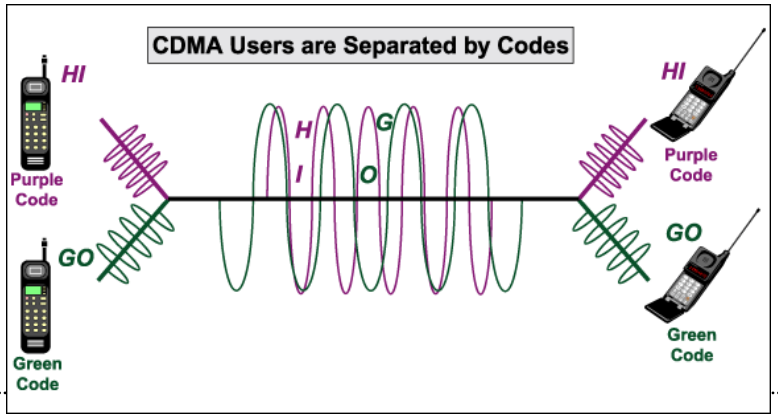
- Cellular systems
  - GSM, CDMA → 2G networks
  - W-CDMA → 3G networks

GSM (Global System for Mobile communications)

- GSM is the most popular standard for mobile phones in the world
- GSM uses a variation of TDMA (Time Division Multiple Access)
  - It digitizes and compresses data then sends it down a channel with two other streams of user data, each in its own time slot
  - 900 MHz or 1800 MHz frequency band

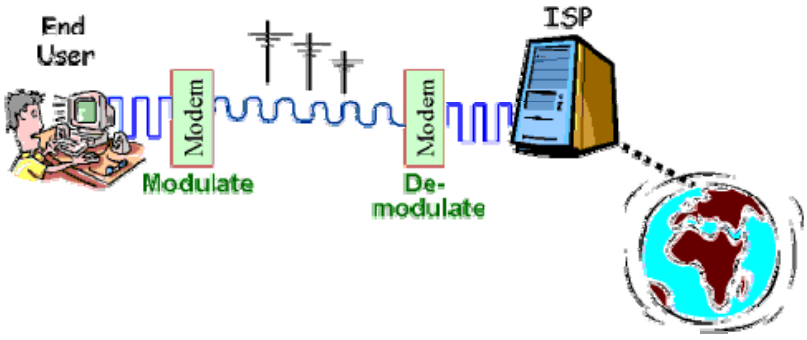
CDMA (Code Division Multiple Access)

- A channel access method utilized by various radio communication technologies
- It is a form of multiplexing, which allows numerous signals to occupy a single transmission channel, optimizing the use of available bandwidth



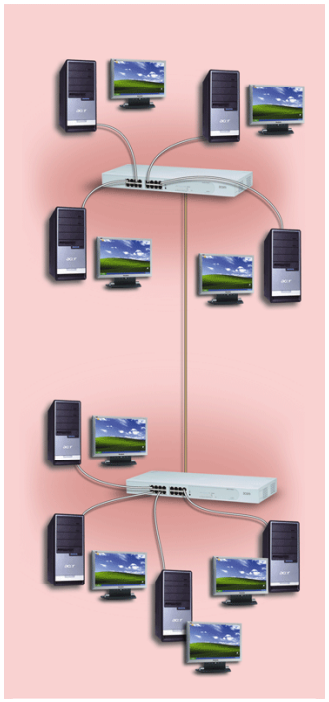
Hardware

- Modem (MOdulation + DEModulation)
  - Modem is a device that modulates an analog carrier signal to encode digital information and demodulates such a carrier signal to decode the transmitted information



Hardware

- Hub
  - Device that provides a central point for cables in network
  - Passive hub/active hub
  - cf.) IP sharer

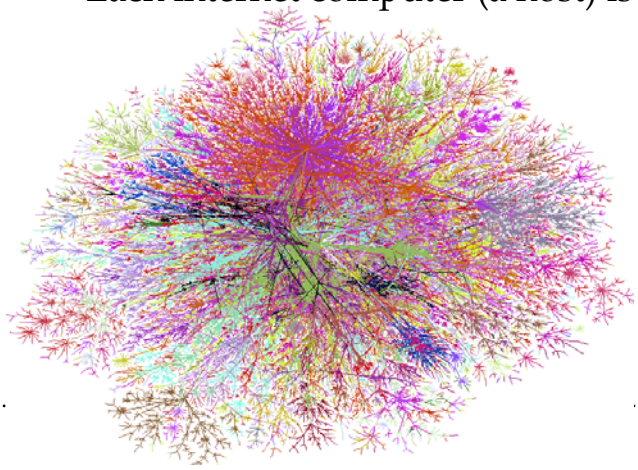


Hardware

- Router
  - Connects computers and transmits data to correct destination on networks
  - Routers forward data on internet using the fastest available path

Internet

- A large network made up of a number of smaller networks irrespective of OS or kinds of computers
- A worldwide, publicly accessible series of interconnected computer networks that transmit data by packet switching using TCP/IP protocol
- Internet is decentralized
  - Each internet computer (a host) is independent



Different colors based on IP address
http://research.lumeta.com/ches/map

Requirements of Internet Uses

- Computer
- Modem or LAN card
- Browser
- ISP (Internet Service Provider)
  - A company or business that provides access to the internet and related services
- NIC (Network Information Center)
  - IP address, domain name

Internet protocol
Internet address
Internet services (WWW, E-mail, FTP)

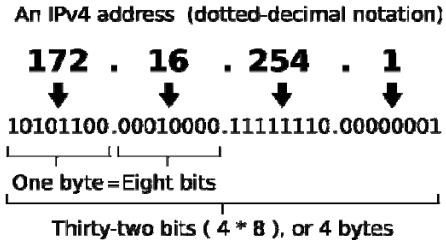
(1) Internet Protocol

- Protocol
  - Can be defined as a set of rules governing the syntax, semantics and synchronization of communication
  - Communication by sending or receiving packets

    → Rules for converting a "message" into "packets"
- TCP/IP
  - A set of rules to enable computers to communicate over internet
  - TCP (Transmission Control Protocol)
  - IP (Internet Protocol)

(2) Internet Address

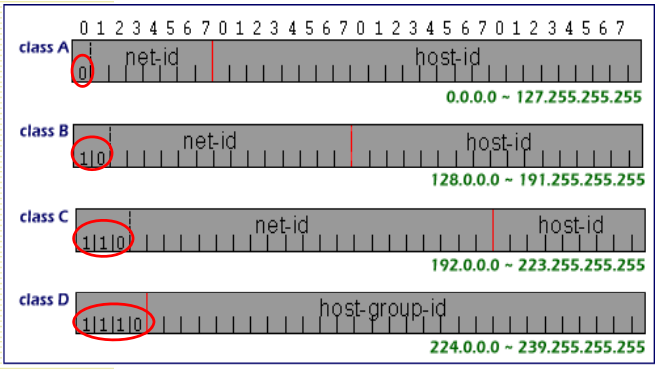
- IP address (IPv4)
  - A unique identifier for a computer or device on a TCP/IP network
  - Uses 32-bit addresses, which limits the address space to 2^{32} possible unique addresses → IPv6 (128-bits)
  - Written as four numbers separated by periods

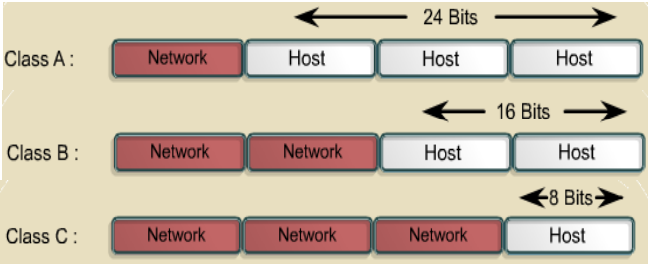


  - Network address + host address

    cf.) MAC (Media Access Control) address

IP Address Class (optional)





- Class A: large organizations, governments
- Class B: medium-sized organizations
- Class C: small organizations

Port

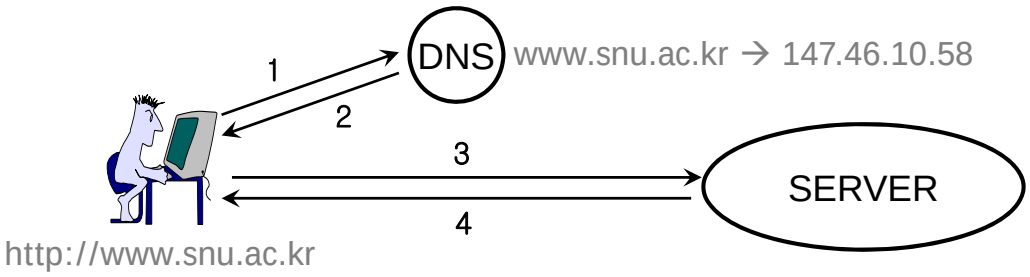
- Several programs in a computer use the same network → Assign a unique number (port) to each program
- Port number is a way to identify a specific process to which an internet or other network message is to be forwarded when it arrives at a server.
- Needs "IP address" and "port" to communicate with other computers
- Common port numbers
  - WWW: 80
  - FTP: 21
  - Telnet: 23

DNS (Domain Name System)

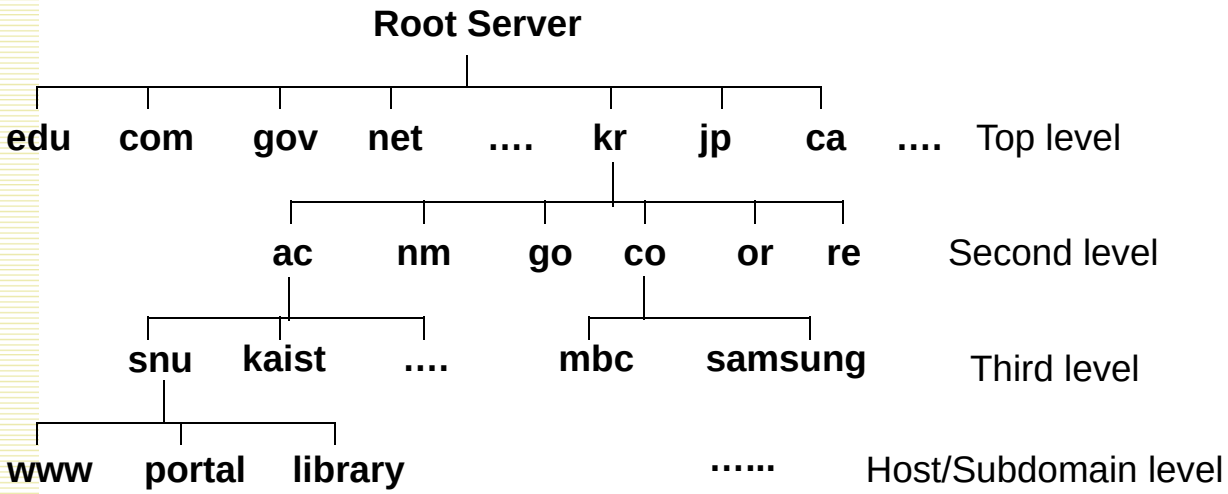
- IP address only?
- Domain name
  - Human-readable computer names
    - e.g. 147.46.10.20 → portal.snu.ac.kr
  - Host name + domain name
    - portal.snu.ac.kr
      - host
      - domain

DNS (Domain Name System)

- DNS
  - DNS server translates a domain name into the corresponding IP address.
  - If a host does not know the IP address of a domain name → ask a designated name server
  - e.g. SNU: 147.46.80.1, 147.46.37.10



Domains



www	.	snu	.	ac	.	kr
Host Name		Seoul National Univ.		School		Korea

URL (Uniform Resource Locator)

- Global address of documents and other resources on the World Wide Web
- URL format

Protocol://Domain (IP) address [:Port number] / Directory / File

  - e.g. http://www.naver.com:80/index.html

(3) Internet Services

- WWW (World Wide Web)
  - Supports text, images, videos, and other multimedia and navigates between them using hyperlinks.
  - Internet Explorer, Firefox, Netscape, …
- E-mail (Electronic Mail)
  - Internet mailing systems
  - Web mail service: Hanmail, Hotmail, Gmail, etc
  - Mailer: Outlook Express, Thunderbird
- FTP (File Transport Protocol)
  - Used to transfer data (file) through a network.
  - ALFTP, Cute FTP

Internet Services

- Telnet
  - Telnet is a common way to remotely control servers.
  - Windows telnet program
- Internet chatting
  - IRC (Internet Relay Chatting): mIRC
  - IM (Instant messenger): MSN (Live) messenger, NateON
- P2P (peer to peer)
  - Napster, eMule, Pruna