

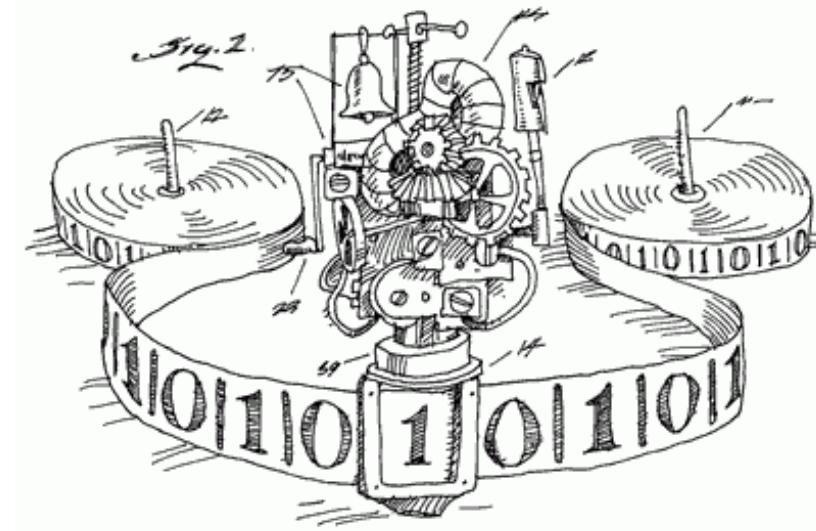
INFO 101 – Introduction to Computing and Security

[2020 - Week 2 / 2]

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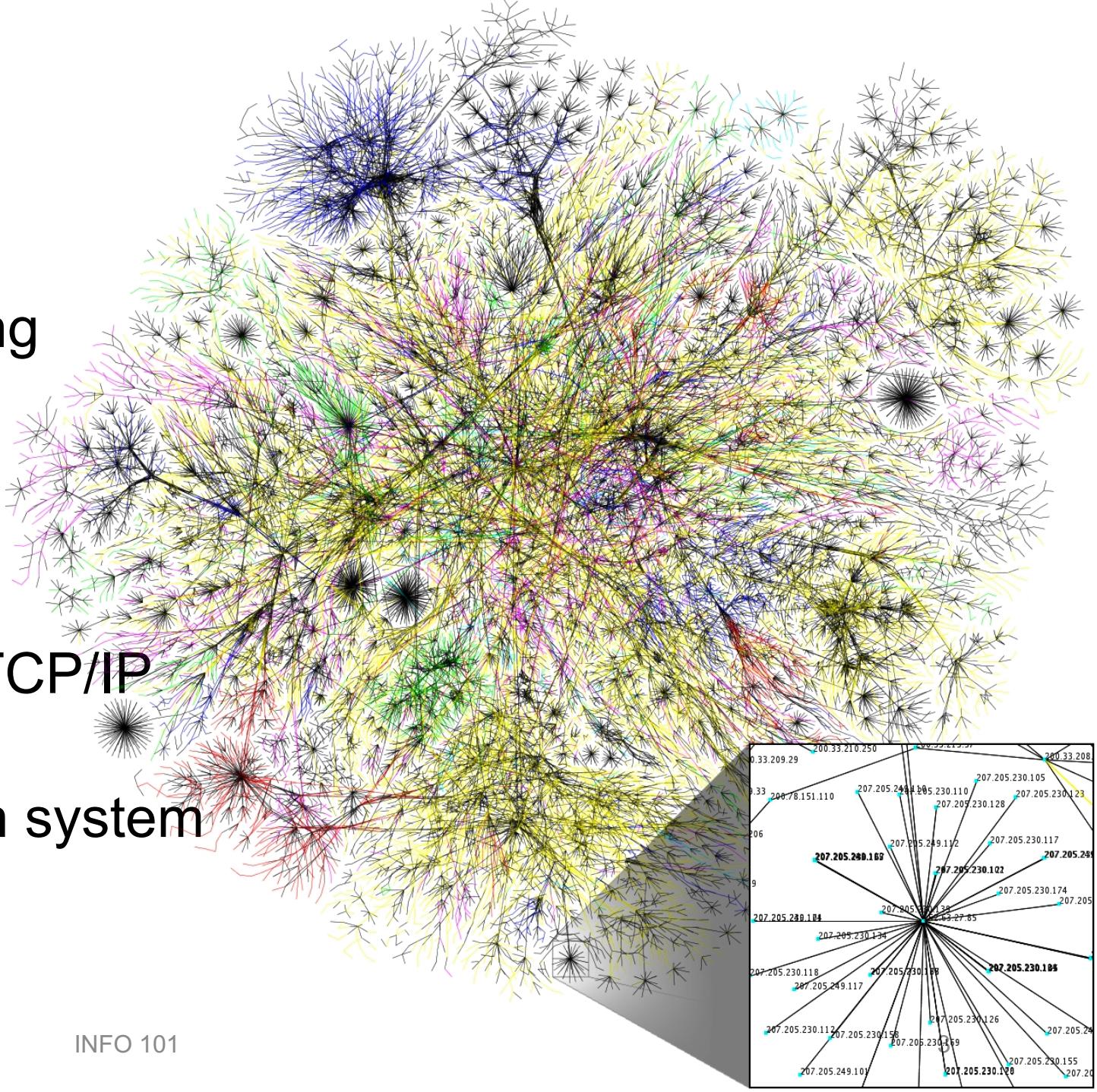
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Internet and the World Wide Web

The Internet

- Worldwide packet-switching network of computers
 - Connected by high-speed telephone and other communication links
 - Internet protocols (rules) TCP/IP for communication
 - Distributed communication system with no centralized control

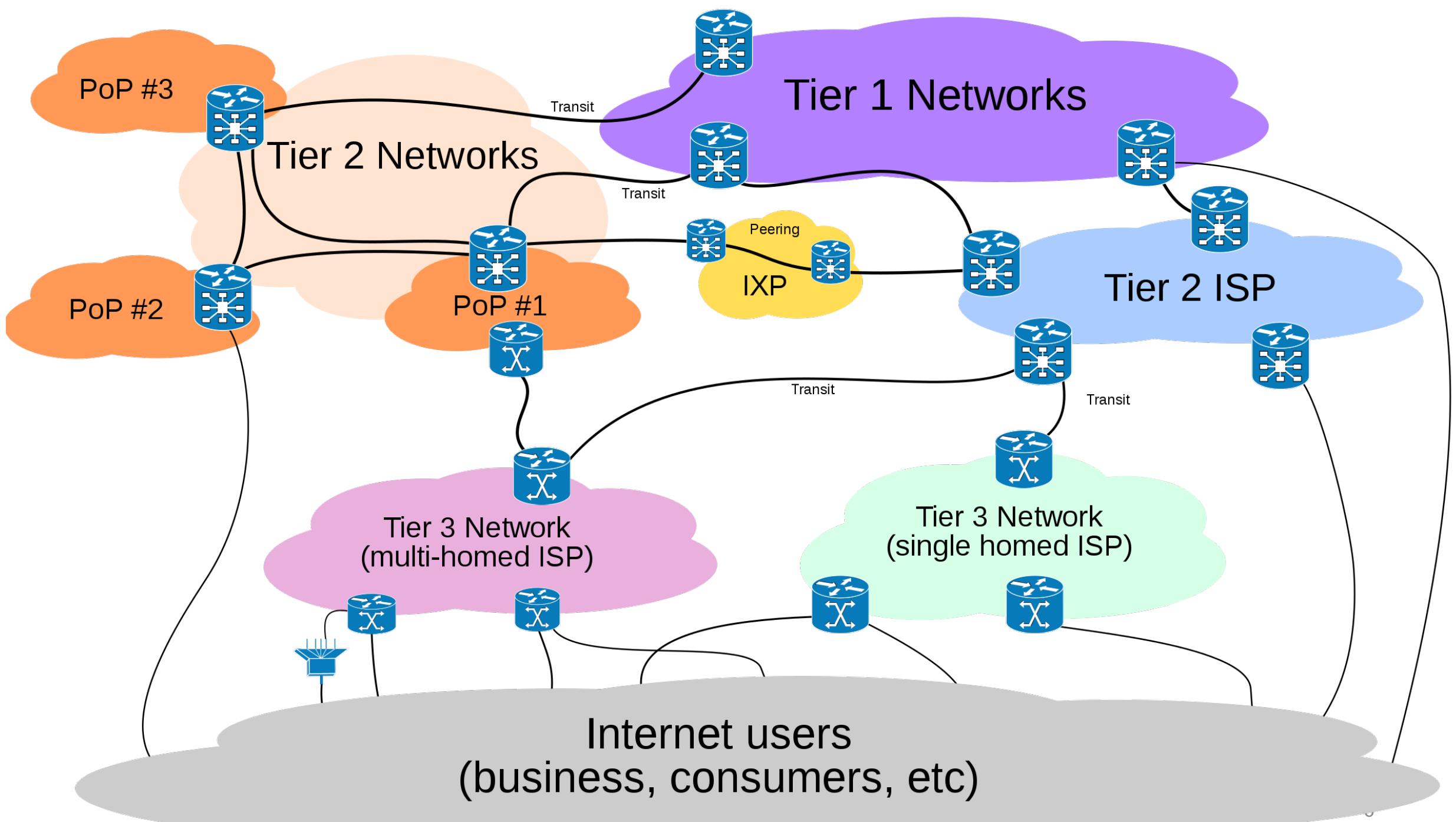


History

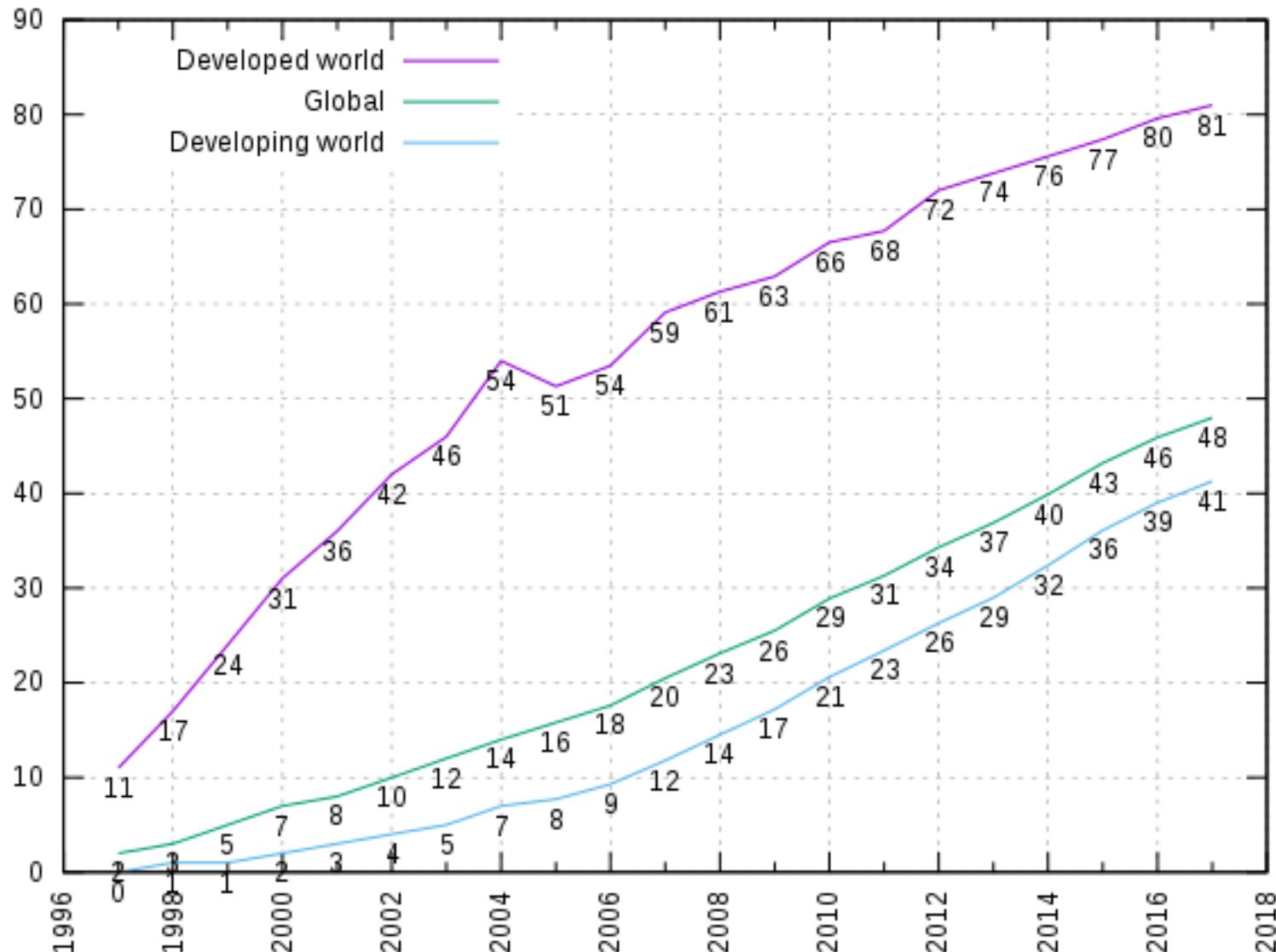
- 1957 when Sputnik from the USSR (Union of Soviet Socialist Republics) was launched, the US creates 1958 the Advanced Research Project Agency (ARPA from which DARPA derives)
- Objective: regain technological lead to the US
- At those time communication infrastructure was mainly centralized and vulnerable for attacks.
- Therefore, in **1961** the packet-switching network **ARPANET** was invented and implemented
 - Works even in case of damaged nodes
 - Client-server model

Protocols

- Define how computers, e.g., client and servers, interact with each other, i.e., exchange data.
- Important internet communication protocols:
 - TCP/IP
 - HTTP, HTTPS
 - SMTP
 - POP
 - FTP



Internet Users Per 100 Inhabitants

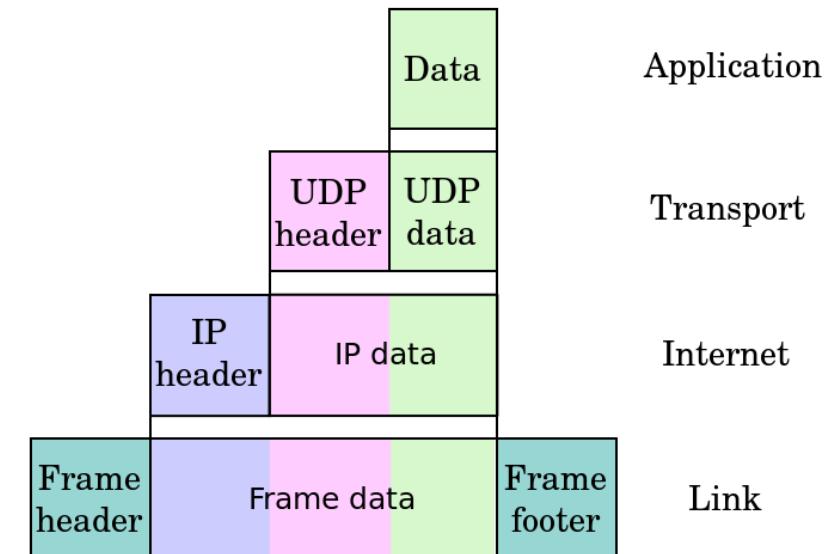
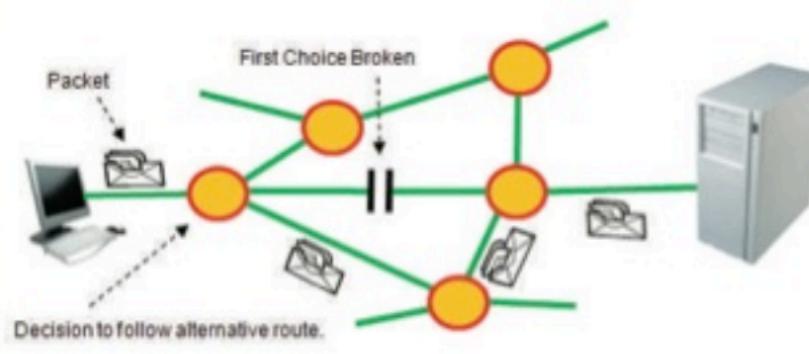


TCP/IP

- Fundamental internet protocol
- “Transmission Control Protocol / Internet Protocol”
- **IP:** Responsible for communicating packets of data from one node to another
- **TCP:** Responsible for verifying the correct delivery of packets from client to server
- **Packet:** Address & Content
 - IP address: a unique number for each computer of the form ddd.ddd.ddd.ddd
- A packet is passed from server to server until its reaches its goal.

TCP/IP

- Larger content is separated into smaller chunks to be delivered separately over the internet.



- Not all packages need to take the same route.

TCP/IP

- Internet nodes are computers connected to the internet with a unique IP number
- Regional **Internet Registries** (RIR): allocate IP addresses
- **ICANN**: Internet Corporation for Assigned Names and Numbers
 - Coordination of IP addresses and domain names
 - For every domain name like www.tugraz.at there is at least one IP address
- **Internet service providers** (ISPs) establish the worldwide connectivity between individual networks
- IPv4 (4.3 billion addresses), IPv6 (5000 x 6.5 billion addresses)

DNS

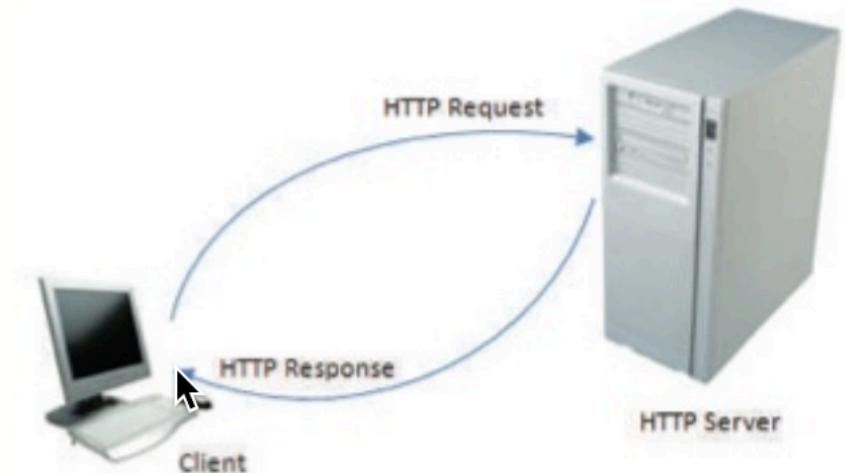
- Domain Name Service
- Used to map English-like computer names to IP addresses
- Your computer access DNS via a known local DNS server

E-Mail Protocols

- E-Mail messages are sent to an e-mail server
- Access to messages via e-mail server (using client programs like Thunderbird or Internet Browsers like Firefox)
- For sending: **SMTP** (Simple Mail Transfer Protocol)
- For retrieving: **POP3** (Post Office Protocol) or **IMAP4** (Internet Mail Access Protocol)

WWW Protocols

- HTTP
 - Hypertext Transfer Protocol
 - Request-response protocol between clients and servers
 - Client request page
 - Server returns page mainly in form of a HTML file
- HTTPS: Secure HTTP
 - Like HTTP but with an added encryption layer to protect traffic, e.g., SSL (Secure Sockets Layer)



WWW Protocols

- URL – Universal Resource Locator
 - A URL (e.g. www.tugraz.at) is an Internet address usually combined with the name of the resource to be accessed.
 - In case of www.tugraz.at the resource is the start page, which is defined on side of the server software

[“HTTP://” | “HTTPS://”] <WWW-Server> [“/ Directory” *] [“/” <File name>]

Getting information from a (Linux/Unix) shell

```
$ nslookup www.tugraz.at
```

```
Server: 10.0.0.138
```

```
Address: 10.0.0.138#53
```

```
Non-authoritative answer:
```

```
Name: www.tugraz.at
```

```
Address: 129.27.2.244
```

```
$ ping 129.27.2.244 -c 2
```

```
PING 129.27.2.244 (129.27.2.244): 56 data bytes
```

```
64 bytes from 129.27.2.244: icmp_seq=0 ttl=247 time=12.712 ms
```

```
64 bytes from 129.27.2.244: icmp_seq=1 ttl=247 time=12.870 ms
```

```
--- 129.27.2.244 ping statistics ---
```

```
2 packets transmitted, 2 packets received, 0.0% packet loss
```

```
round-trip min/avg/max/stddev = 12.073/12.586/12.966/0.341 ms
```

Other useful information

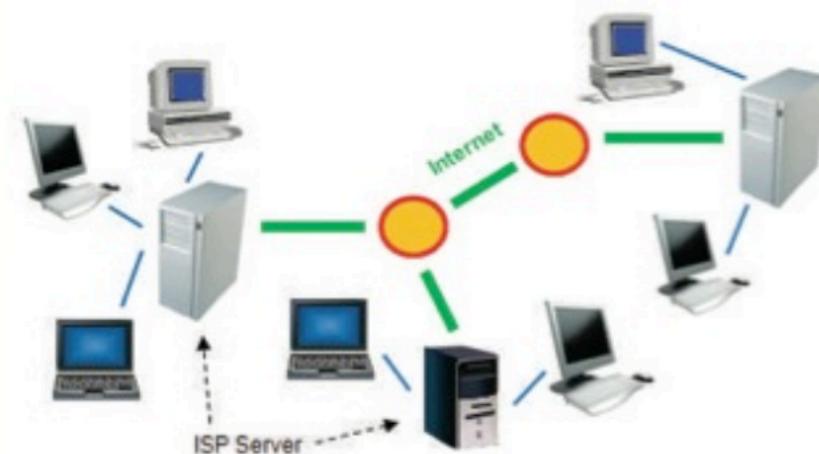
- **Dynamic IP address**
 - The Internet provider is dynamically assigning an IP address from a pool to a computer
- **Static IP address**
 - A fixed IP address (mainly for servers) that is never changed
- **Domain Name:** Unique alphabetical address of a node
- **Top Level Domain Names (TLD):** List of names used at the end of a domain name, e.g., “.com” or “.at” or “.edu”,....
- **Internet Assigned Numbers Authority (IANA)** classifies TLDs

FTP / P2P

- FTP
 - File Transfer Protocol
 - Used to exchange files over the Internet
 - Like HTTP
- P2P
 - Peer-to-peer file sharing
 - File sharing without servers

Accessing the Internet

- You need:
 - Service provider
 - Internet service provider (ISP) – for connectivity (backbone of the Internet)
 - Application service provider (ASP) – for application services like WWW, e-mails, ...
 - Communication hardware
 - A line - A physical connection



Tools and services

- Web Browsers
- E-Mail Clients

Information Security

- **Computer security:** preventing and detecting unauthorized use of your computer
- **Objective:** stop unauthorized users (intruders)
- Information security is concerned with three main areas:
 - **Confidentiality** – Information should be available only to those with the specific rights
 - **Integrity** – Information should be modified only by those who are authorized
 - **Availability** – Information should be accessible when needed

Information Security

- Intruders (sometimes also known as hackers) may be able to watch all your actions on your computer, or cause damage to your computer by reformatting your hard drive or changing your data.
- Intruders are often discovering (new) vulnerabilities to exploit in computer software

Common methods used by intruders

- A **virus** is a small piece of software that piggybacks on real programs. E.g. an e-mail virus moves around in e-mail messages, and usually replicates itself by automatically mailing itself to dozens of people in the victim's e-mail address book.
- **Trojan horse programs** are a common way for intruders to trick you into installing “back door” programs. These can allow intruders easy access to your computer without your knowledge.
- Another form of attack is called a **denial-of-service (DoS)** attack. This type of attack causes your computer to crash or to become so busy processing data that you are unable to use it.
- **Being an intermediary for another attack**—Intruders often use compromised computers as launching pads for attacking other systems. You are unlikely to know if this is happening.
- **Spyware**—When a PC is infected with spyware every keystroke and every Web site visited can be recorded or monitored by the people or companies that may have secretly installed software on the PC.

How to protect your computer?

- **Firewall**—Any Internet user should want to protect their computer from intrusion. One of the best forms of protection is called a firewall. Intruders are constantly scanning systems for known vulnerabilities. A firewall is a program or hardware that examines packet addresses as they arrive at the computer (client or server) and only allows those with safe addresses to pass through.
- **Anti-Virus Software**
- **Anti-Spyware Software**

How to protect your computer?

- Do not open unknown e-mail attachments!**
- Backup all data**
- Maintain your computer's performance**
- Keep all applications, including your operating system, patched!**

Data communication

Communication

- **Earliest forms:** talking to each other or drawing pictures
- **Requirements:**
 - The **speaker** (the transmitter) and the **listener** (the receiver) must have a **common understanding of the meaning of words or symbols.**
 - Both must have an **agreement that when one speaks the other listens.**
 - They further agree that **after a period or a pause the listener may become the speaker and the other the listener.**
- Transmitter and receiver share a **communication channel** and agree on a **communication protocol**

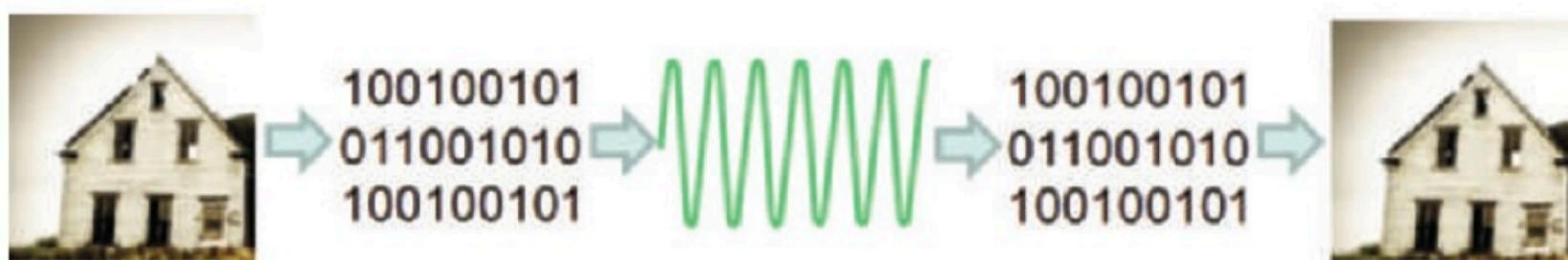


Distinguishing two forms of communication

- **Telecommunication**—The transmission of signals over a distance for the purpose of communication. Today telecommunication almost exclusively involves the sending of electromagnetic waves (radio, light) and electrical currents by electronic transmitters via wireless or cable transmission systems.
- **Data Communications**—The engineering devices and circuits that permit signals to be communicated between computer systems. Such communicating computer systems form a computer network and these networks involve at least two devices capable of being networked with at least one usually being a computer.

Tele- vs. data communication

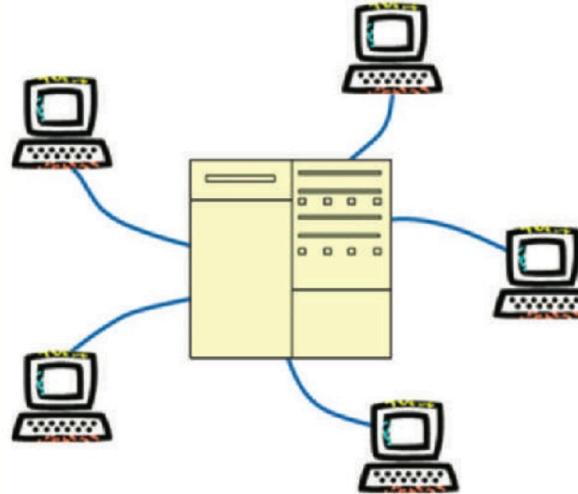
- **Telecommunication** is about the **coding of data** and **data communication** is about the **transmission and delivery** of data in a network. Together they form the basis of electronic communication



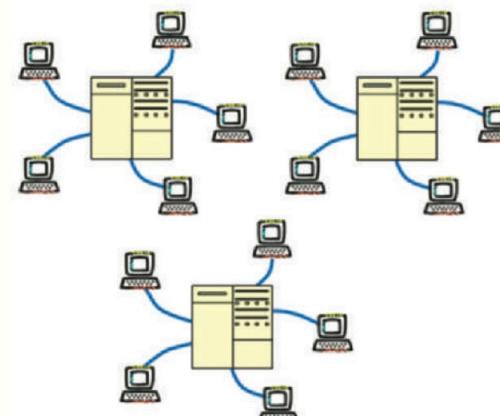
- **Communication:** Encoding, Transmission, Decoding, and Delivery of Data

Types of data processing

- **Centralized processing**
 - Once central point where data is processed
 - Computational requirements may not be satisfied (one central unit handles everything)



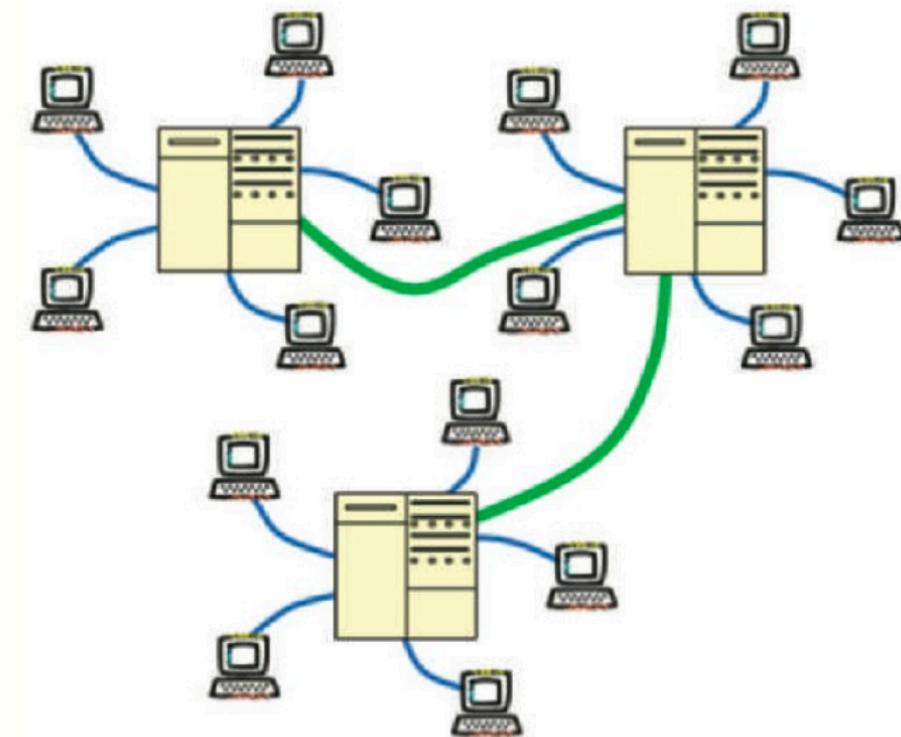
- **Decentralized processing**
 - Each part has its own data processing
 - No shared resources



Types of data processing

- **Distributed processing**

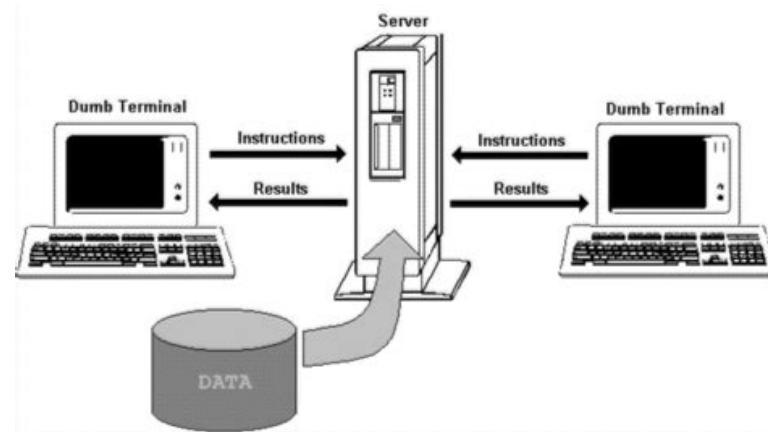
- Connected decentralized processing
- Shared resources possible
- Means for communication necessary



Computer networks

- **Sender / Receivers**

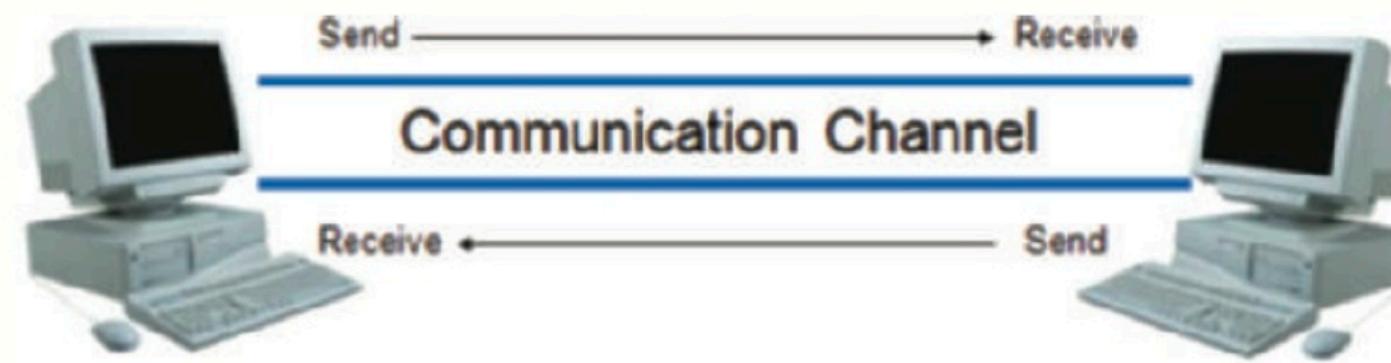
- **Dumb terminals:** connection to mainframe computer, has no computing ability besides presenting content and taking inputs from a keyboard



- **Workstation:** computer that is able to perform stand alone processing, e.g., a PC.

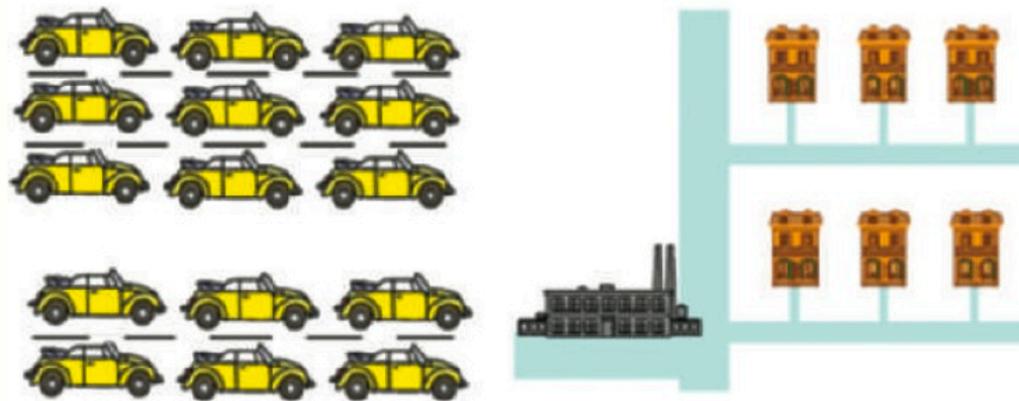
Communication channel

- Means for carrying the sender's signals to the receiver
- Also referred to as carrier



Bandwidth

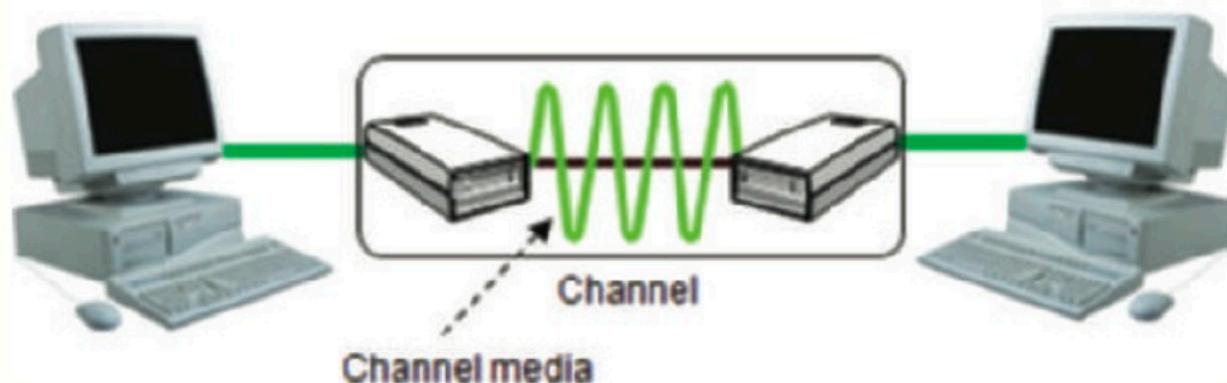
- Communication channel's transmission speed
- Usually given in bits per second (bps) or boud (symbols per second)



- **Data transfer rate:** quantity of digital data that is moved from one machine to another in a given time

Channel media

- Channel media carries communication signals between computers and other network devices.
- Two types:
 - Guide media
 - Wireless

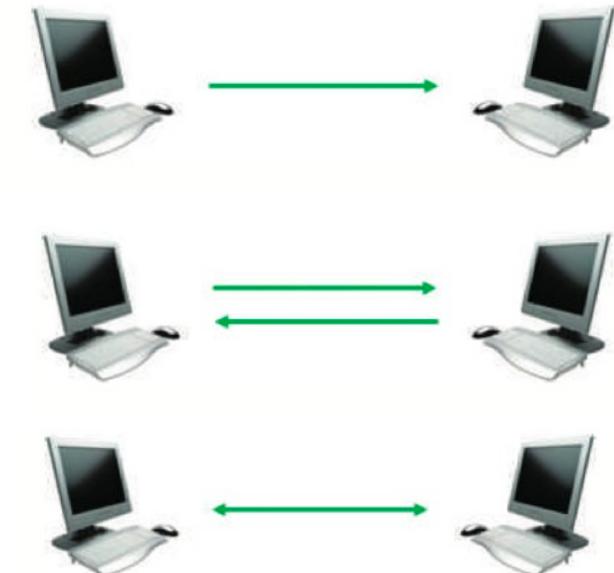


Channel media

- Guide media
 - Wire pair / twisted pair: two twisted cables for transporting electrical signals
 - Coaxial cable
 - Fiber optics: signal transfer using light waves
- Wireless media
 - Microwave
 - Infrared
 - Satellite
 - Radio frequency
 - WiFi 802.11b/g
 - Bluetooth

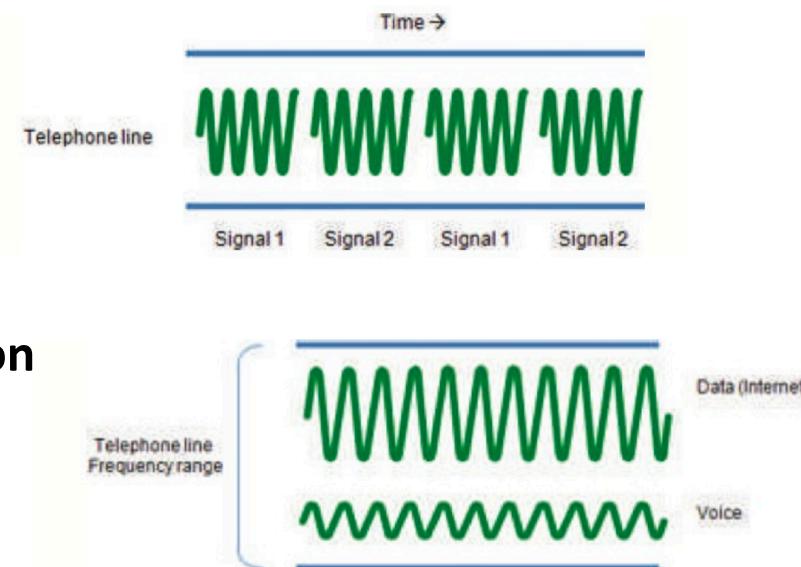
How channels work

- **Communication protocol**
 - Usually starting with a **handshake**
 - Two types:
 - **Asynchronous** — slower but less expensive; special signal bits are added to each transmission to indicate the beginning and end of each block of data that is sent.
 - **Synchronous** — require that the sender and receiver are synchronized in time. This means that the receiver knows when to expect a transmission from the sender. More expensive because we need to synchronize time between sender and receiver.
- **Line configuration**
 - **Simplex**—Line permits communication in one direction only.
 - **Half Duplex**—Data flows in both directions on a line but not at the same time.
 - **Full Duplex**—A full duplex line permits data to flow in both directions at the same time.



How channels work

- **Line configuration (cont):**
 - **Multiplex** — A multiplex configuration involves several computers sharing the same channel. The line (usually full duplex) can carry several signals simultaneously in both directions between several computers.
 - **Time division**



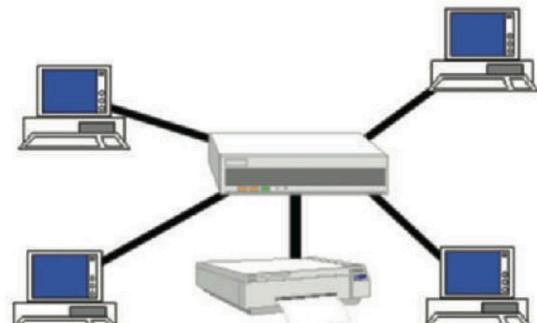
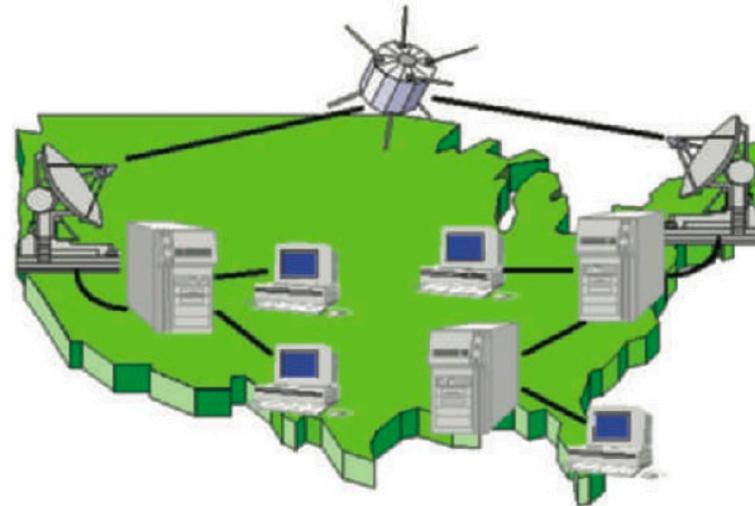
Modems

- A modem (**modulator demodulator**) permits a computer's digital signals to be carried over an analog channel. The modem is a device that modulates an analog carrier signal to encode digital information, and also demodulates such a carrier signal to decode the transmitted information.

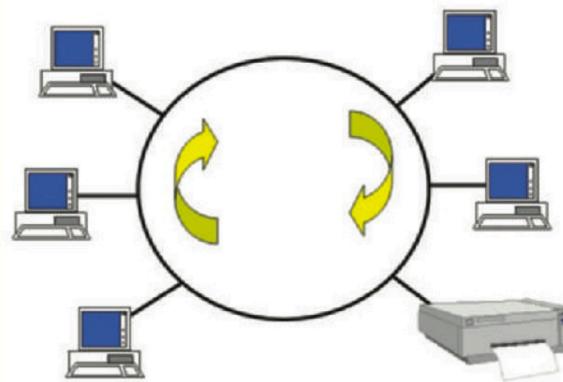


Networks

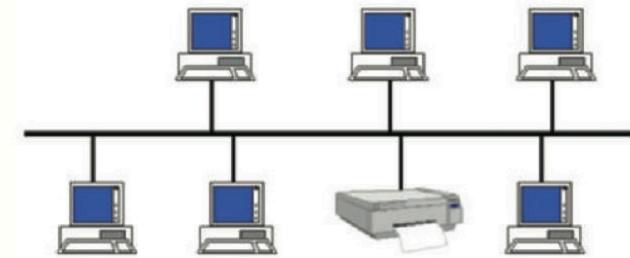
- WAN – Wide area network
- MAN – Metropolitan area network
- LAN – Local area network
 - Topologies:



Star



Ring (often using a token for communication)



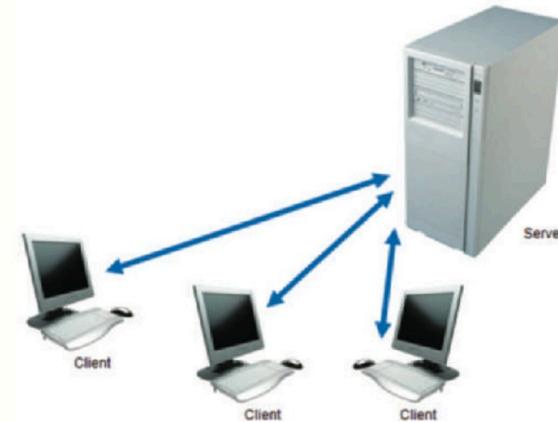
Bus (the today most common topology for computer networks)

Networks

- We also distinguish
 - **Intranets** – only private data communication networks within one business
 - **Extranets** – like intranets but access is limited to an organization and not one business (E.g. trade organizations that include representatives from several businesses in the same industry group).

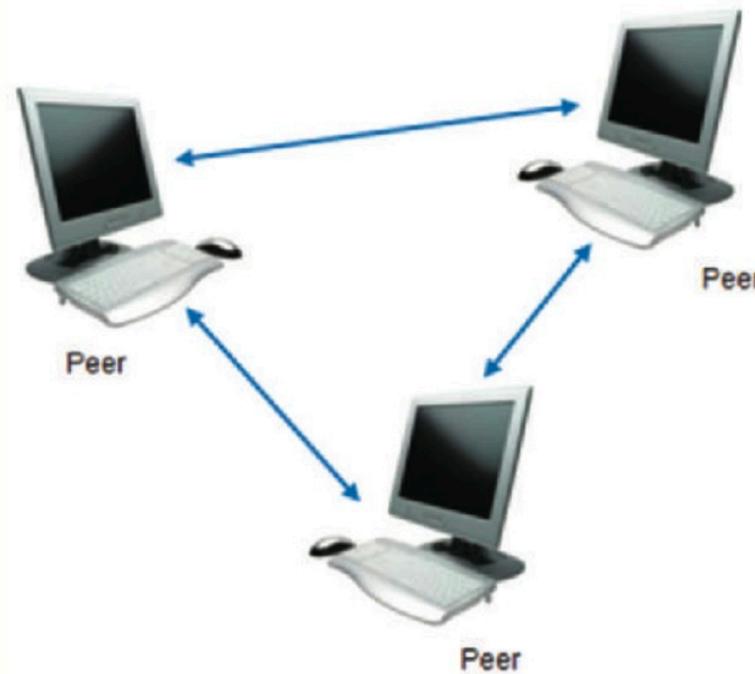
Network architectures

- **Packet switching**
 - Data is broken into small pieces of equal size for communication purposes called **packets**.
 - Packets are carried from one node to another in the direction from the sender to the receiver. It is necessary to switch between different communication lines to reach the goal.
- **Architectures**
 - **Client/server architecture**



Network architectures

- Peer-to-peer networks
 - Distributed networks without a particular server

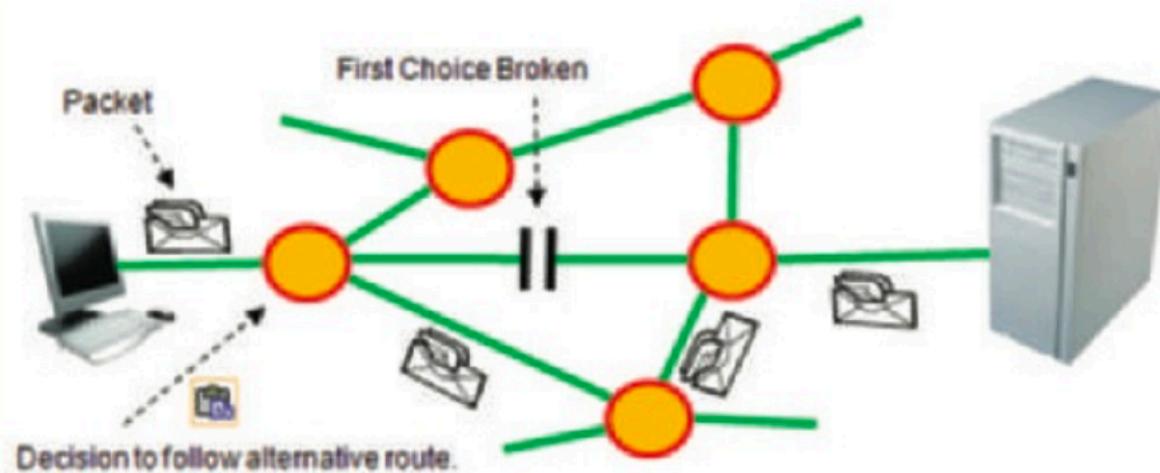


Communication standards

- Organizations
 - IEEE (Institute of Electrical and Electronics Engineers, Inc.)
 - Internet Engineering Task Force (IETF)
 - World Wide Web Consortium (W3C)
 - International Organization for Standardization (ISO)
- Communication standards
 - Open System Interconnect Model (OSI)
 - Ethernet (IEEE 802.3)
 - Token Ring (IEEE 802.5)
 - Asynchronous Transfer Mode (ATM)
 - TCP/IP

TCP/IP

- TCP/IP is a suite of communications protocols that define how messages are created and routed to destinations through the Internet.
- Based on packets and packet switching
- Each packet has an IP address of the destination computer

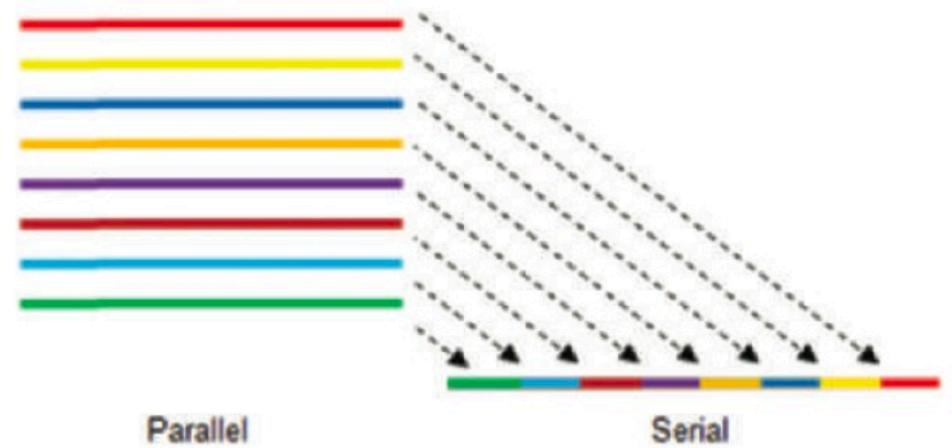


Wireless communication standards

- WiFi (IEEE 803.11) – short range; local
- WiMax (IEEE 802.16) – long range (many miles) system to deliver a point-to-point connection to the Internet from an ISP to an end user
- Bluetooth – (very) short range
- Radio-Frequency Identification (RFID)
- Infrared Data Association (IrDA)

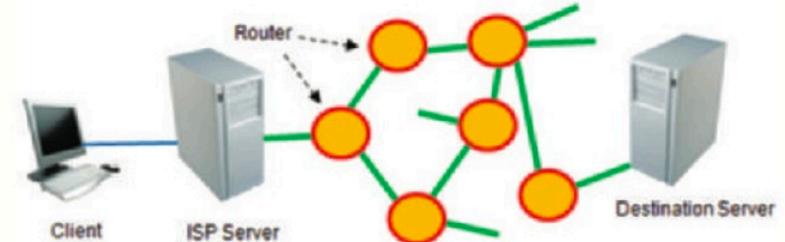
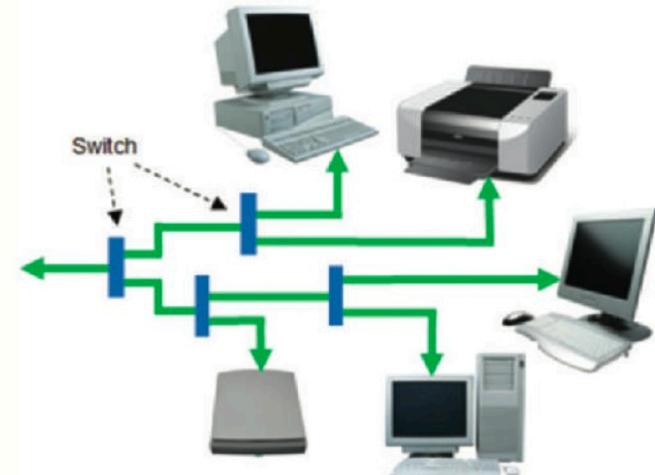
Communication devices

- Serial vs. parallel transmission
 - UART (Universal Asynchronous Receiver Transmitter) – serial transmission
- Access to the internet via phone lines:
 - Dial-Up modems
 - ADSL or DSL modems



Communication devices

- Wireless modem / Wireless access point
- **Switch** - directs packets to a specific hardware device attached to a network.
- **Ethernet hub** – is for connecting connecting multiple lines
- **Router** – buffers and forwards data packets across networks toward their destinations through a process known as routing.



Communication devices

- **Multiplexer** - selects one of many data-sources and outputs that source into a single channel.
- **Repeater** - receives a weak or low-level signal and retransmits it at a higher level or higher power so that the signal can cover longer distances.
- **Gateway** – is an entrance from one network to another network.

