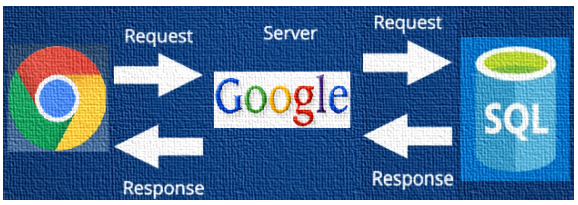
Network

Shih-Yi (James) Chien
Assistant Professor
Dept. of Management Information Systems
National Chengchi University, Taiwan
sychien@nccu.edu.tw

How does internet work?

1. Input google.com in the browser's address bar 

2. Browser asks DNS server: how to reach google.com (DNS server is maintained by service providers)
3. DNS looks up domain name and its associated IP address
4. DNS replies: go to 172.217.27.142 (try nslookup)
5. Browser uses the IP address and contact the Google web server to request the content
6. Google server checks with its DB regarding the requested content
7. DB finds the relevant information and responds to Google server
8. Google server sends the requested content to the user's browser (webpages)
9. Browser shows whatever it receives from the Google server on the screen



The ARPANET

The Internet originated as ARPANET in September 1969

Two main goals :

1. Allow scientists at different **physical locations** to share information and work together
2. Function even if **part** of the **network** were **disabled or destroyed** by a disaster

1969 ARPANET becomes functional

1984 ARPANET has more than 1,000 individual computers linked as hosts

Today numerous of hosts connect to the Internet

Clip: https://www.youtube.com/watch?v=h8K49dD52WA&ab_channel=LifeNoggin

What is a Network

Network is a system of multi-devices linked by wires, cables, or a telecommunications system

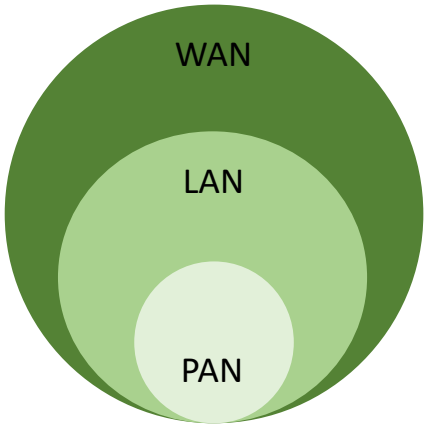
- Combine hardware and software
- Enable a networks to communicate
- Allow computers to share resources
  - Hardware, software, data, and information

Computer network to connect to each other

- Wide area network (WAN)
- Local area network (LAN)
- Personal area network (PAN)

Computer network for sharing information

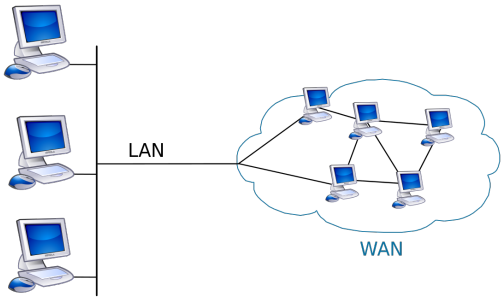
- Internet, Extranet, Intranet



Wide Area Network (WAN)

WAN extends over a large geographic area for the primary purpose of computer networking

- Businesses, schools and government entities use WAN to relay data to users from various locations across the world
- Transmit data over long distances, and between different networks



Source: https://en.wikipedia.org/wiki/Wide_area_network

Local Area Network (LAN)

LAN is a network that connects computers and devices in a limited geographical area

- Home, school, office building, departments, etc.

- Each computer or device on the network, called a **node**, which often shares resources
  - Printers, hard drives, etc.

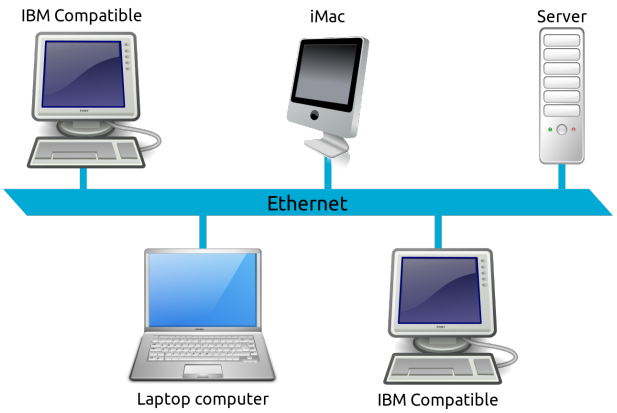
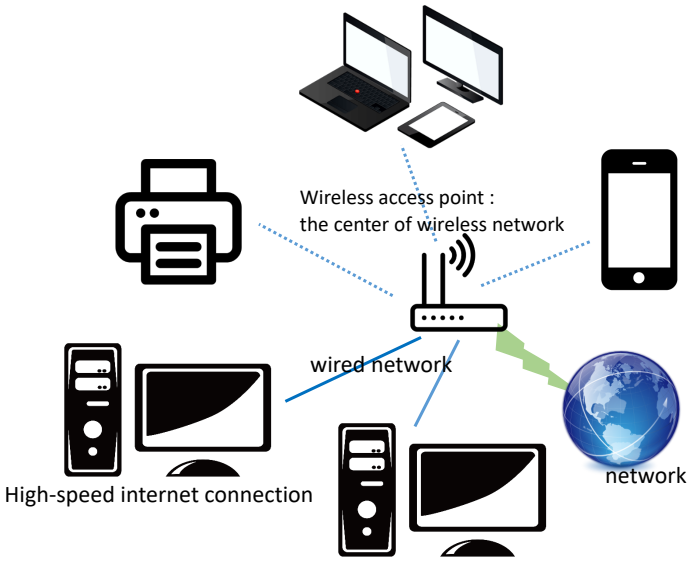


Image credit: https://en.wikipedia.org/wiki/Local_area_network#/media/File:Ethernet_LAN.svg

Wireless LAN (WLAN)

Wireless LAN (WLAN) is a LAN which without using physical wires

- Computers and mobile devices on a WLAN may communicate via wireless access point with a wired LAN to access shared resources



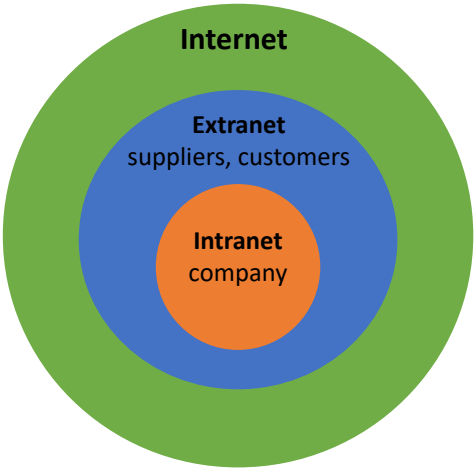
Personal Area Network (PAN)

PAN is a network for interconnecting devices centered on an individual's workspace

- A network that connects computers and devices in an individual's workspace through wired and wireless technologies
- Devices on PAN are usually connected via Bluetooth
  - Bluetooth: a short-range wireless technology
  - Physical range: typically less than 10 m

Computer Network Type for Sharing Data

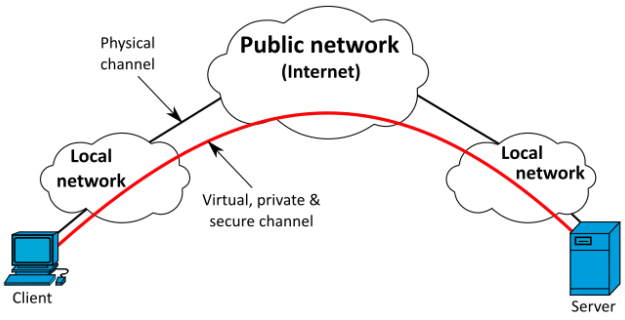
- Extranet
  - Allows outsiders (such as customers and suppliers) to access an organization's intranet
  - A supplier can check the customer's inventory level before deciding whether to ship other products
- Intranet
  - A private network for authorized individuals
  - Companies use the intranet to communicate internally
  - Intranets are preferable when data being transferred should not necessarily reach the Internet



Parameter	Internet	Extranet	Intranet
Type of Network	Public	Private	Private
Accessibility	Anyone	Authorized people	Authorized people
Size	Large number of connected to the devices	Limited number of connected devices over internet	Limited number of connected devices
Information Sharing	Information can be shared across the world	Information can be shared between employees and external people	Information can be shared securely within an organization
Example	World Wide Web, social media, Email	Network of collaboration between corporations	Internal operations within an organization

Virtual private network (VPN)

- VPN extends a private network to a public network and allows users to send and receive data through networks
- VPN provides a secure path across public networks, allowing authorized users to access the organization's network
- By using encryption technologies, VPN can protect the data transmitted along the path



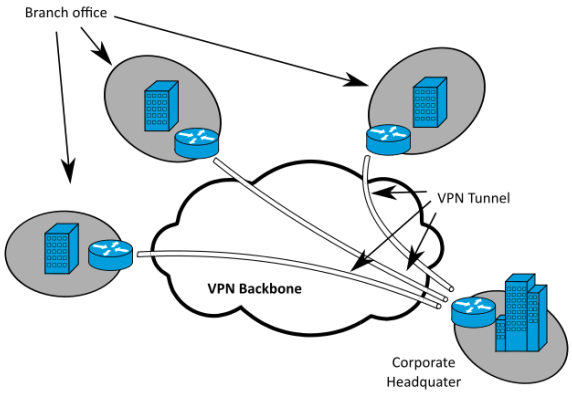


Image credit: https://en.wikipedia.org/wiki/Virtual_private_network

Standard and Protocols

Standard defines guidelines that specify the way computers access the connected media

- Ethernet: guidelines for the physical configuration of a network (1-physical layer)
- Wi-Fi: how two wireless devices communicate with each other

Protocol is the characteristics of two devices communicating on the network

- TCP/IP: how to transmit data from one end of the network to the other
- Bluetooth: how two Bluetooth devices use short-range radio waves to transmit data

Ethernet	Standard
Wi-Fi	Standard
TCP/IP	Protocol
Bluetooth	Protocol
RFID	Protocol
NFC	Protocol

Clip: https://www.youtube.com/watch?v=5u52wbqBgEY
5G: https://www.youtube.com/watch?v=Agw4bnvgLxc

Communication Standards

Request an online content

- TCP/IP: your computer uses TCP/IP to establish a connection with the Web server that stores the requested content (webpages)
  - Webpages is divided into packets and send to your computer based on the provided address
  - Router sends the packets over internet from web server to your computer
  - Once arrived, reassemble all the packets
- Ethernet: how devices communicate, exchange data, or share access to each other
  - Modem, router, etc.

OSI Model

OSI Model: conceptual model that characterizes and standardizes the communication functions of a telecommunication or computing system

7	Application	High-level APIs, including resource sharing, remote file access
6	Presentation	Translation of data between a networking service and an application; including character compression and encryption/decryption
5	Session	Managing communication sessions, i.e. continuous exchange of information in the form transmissions between two nodes
4	Transport	Reliable transmission of data segments between points on a network, including segmentation, acknowledgement and multiplexing
3	Network	Structuring and managing a multi-node network, including addressing, routing and traffic
2	Data link	Reliable transmission of data frames between two nodes connected by a physical layer
1	Physical	Transmission and reception of raw bit streams over a physical medium

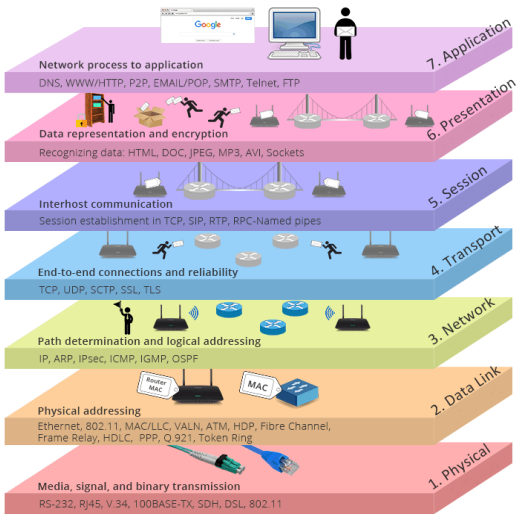


Photo: https://en.wikipedia.org/wiki/OSI_model
https://community.fs.com/blog/tcpip-vs-osi-whats-the-difference-between-the-two-models.html

Connecting to the Internet

Connects the network to the Internet through an Internet Service Provider (ISP)

- ISP is a business that provides Internet access to individuals and organizations for free or for a fee
- ISP is the company that provides Internet connections to users or companies
- ISP may also provide online services, such as e-mail, personal Web site or home page

- **Latency** is the time it takes a signal to travel from one location to another on a network
- **Bandwidth**: the amount of data and information that can be transmitted through the transmission medium
  - The measure of the network's capability to send and receive data
  - Megabyte (MB), Gigabyte (GB)

IP address and Domain Name System

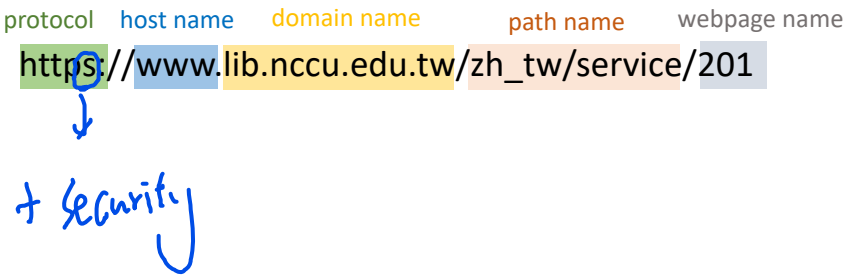
- An IP address is a sequence of numbers that uniquely identifies each computer or device's location to connected to the Internet or any other network
- The domain name is a text-based name which corresponds to the IP address of the server
- The Domain Name System (DNS) server converts the domain name to its associated IP address

IPv4 address: 74.125.22.139
IPv6 address: 2001:4860:4860::8844
Domain name: google.com

	IPv4	IPv6
Full Name	Internet Protocol version 4	Internet Protocol version 6
Format	32-bit Internet addresses	128-bit Internet addresses
Capacity	2^32 IP addresses (4.29 billion)	2^128 IP addresses

Uniform Resource Locator (URL)

Webpage has a unique address, called a **web address** or Uniform Resource Locator (URL)

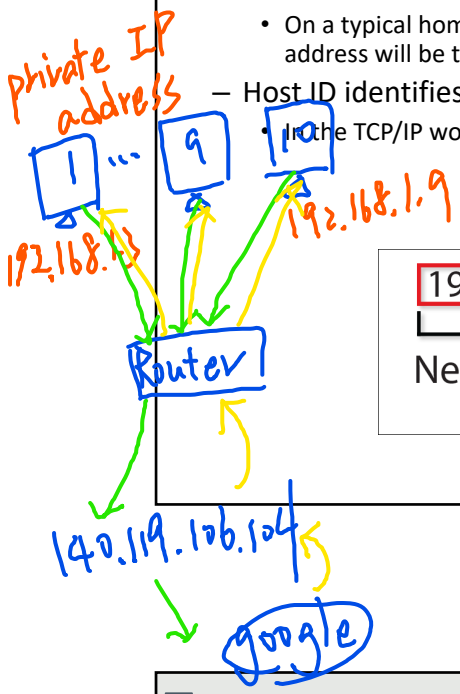


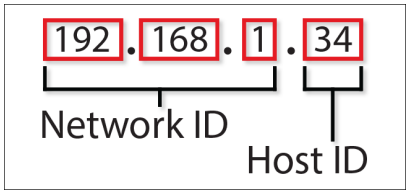
Popular Top Level Domain (TLD)

TLD	Intended Purpose
.com	Commercial organizations, businesses, companies
.edu	Educational institutions
.gov	Government agencies
.org	Nonprofit organizations

TANet (Taiwan Academic Network)

- Most of TANet IP begins with 140.92, 140.109 to 140.138
- Domain name mainly end with edu.tw
  - Network ID identifies the specific network on which the device is located
    - On a typical home network, where a device has the IP address 192.168.1.34, the 192.168.1 part of the address will be the network ID
  - Host ID identifies a specific device on that network
    - In the TCP/IP world, we call devices "hosts"





public IP address
eg. 140.119.xxx.xxx

University College IP Range [edit]

IP begins with **140**

- National Taiwan University——————140.**112**
- National Chiao Tung University——————140.**113**
- National Tsing Hua University——————140.**114**
- National Central University——————140.**115**
- National Cheng Kung University——————140.**116**
- National Sun Yat-sen University——————140.**117**
- National Taiwan University of Science and Technology———140.**118**
- National Chengchi University——————140.**119**

Traceroute

traceroute and tracert are computer network diagnostic commands for displaying possible routes (paths) and measuring transit delays of packets across an Internet Protocol (IP) network

```
C:\Users\admin>tracert google.com

在上限 30 個躍點上
追蹤 google.com [172.217.27.142] 的路由:

  1     1 ms    <1 ms    <1 ms  192.168.1.1
  2    <1 ms    <1 ms    <1 ms  140.119.113.254
  3     1 ms    <1 ms    <1 ms  140.119.240.254
  4     1 ms    <1 ms    13 ms  140.119.240.230
  5     2 ms     1 ms     1 ms  140.119.243.5
  6     3 ms     3 ms     4 ms  192.192.61.90
  7     4 ms     4 ms     4 ms  192.192.61.185
  8     4 ms     3 ms     3 ms  192.192.61.198
  9     3 ms     2 ms     3 ms  72.14.196.229
 10     4 ms     4 ms     4 ms  108.170.244.97
 11     4 ms     5 ms     4 ms  209.85.142.13
 12     4 ms     4 ms     4 ms  tsa03s02-in-f14.1e100.net [172.217.27.142]
```

Try tracert google.com
Try traceroute google.com

https://en.wikipedia.org/wiki/Traceroute

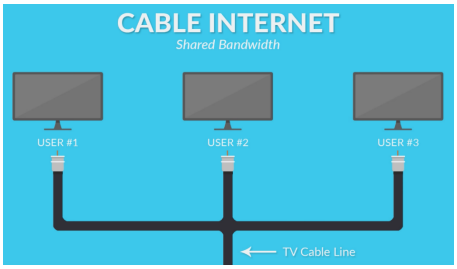
Communications Lines

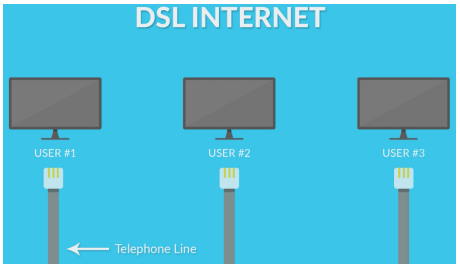
Dedicated line is a type of always-on physical connection that is established between two communication devices

- Cable
- DSL
- T-Carrier: carry multiple signals over a single communication line via multiplexing technique

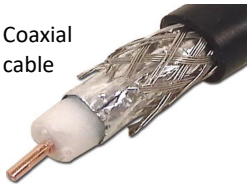
Cable	256 Kbps to 100 Mbps or higher
DSL	256 Kbps to 8.45 Mbps
T1	1.544 Mbps
T3	44.736 Mbps

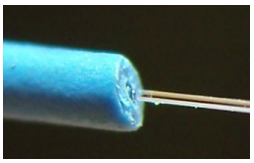
Cable, DSL, Fiber (wired connection)





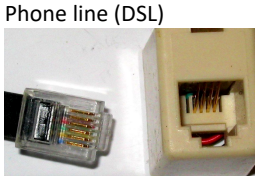
Coaxial cable





Fiber-optic

Phone line (DSL)



ADSL (***Asymmetric*** DSL)
Speed: Download>Upload

SDSL (***Symmetric*** DSL)
Speed: Download=Upload

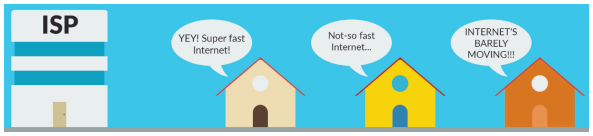


Image credit: https://www.youtube.com/watch?v=6NwmWP6EQxQ

Network Devices

- Network interface controller/card: a computer hardware component which connects a computer to a wired or wireless network
- Cable modem: send and receive data through a cable TV connection (coaxial cable)
  - Pro: speed faster than DSL, signal strength stays the same regardless of the proximity to ISP
  - Con: internet runs through cable lines, slower speeds during peak times in more congested areas
- DSL modem: connect a computer or router to a phone line (landline phone wires)
  - Pro: higher likelihood that it is accessible in a remote area
  - Con: depends on the distance b/t a consumer and DSL hub further away from the hub → slower service

Modem

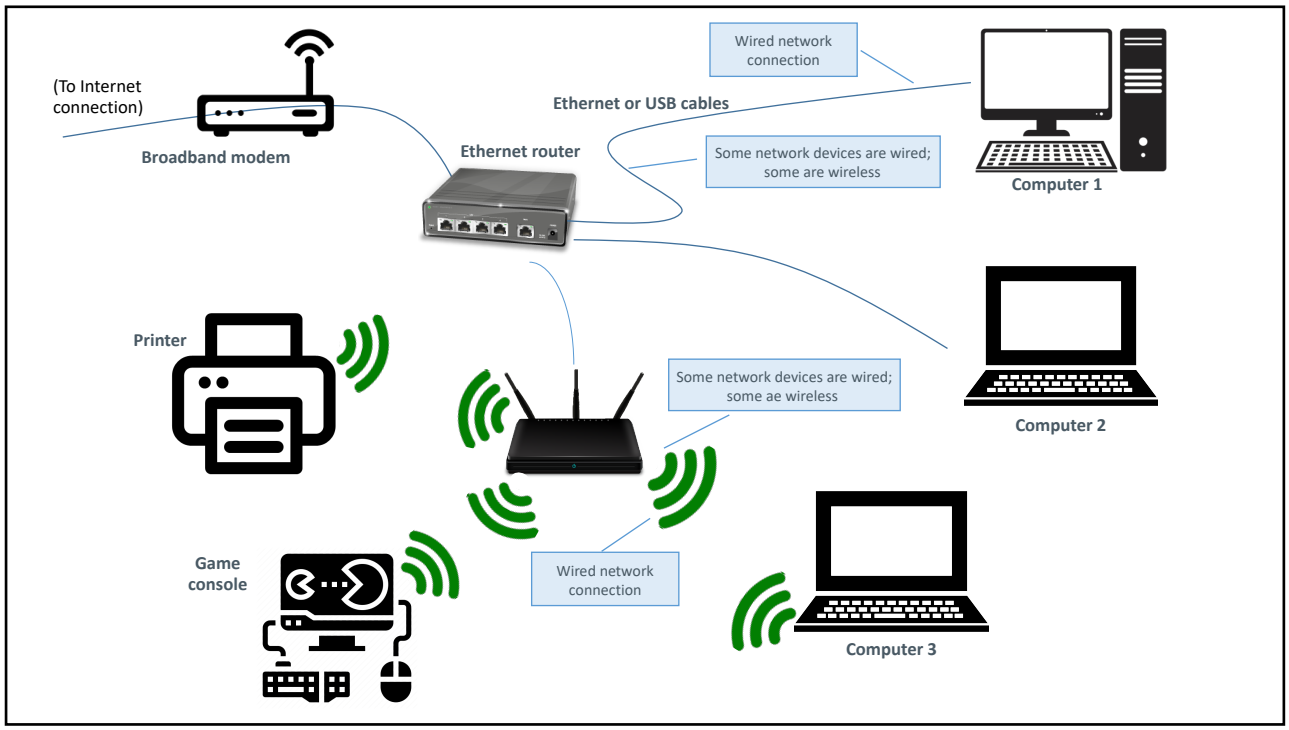
Wireless Router

Image credit: https://images.app.goo.gl/Z5WuitxzCSfQPz2k8

Elements and Devices to Create a Network

- Hub: a central point in a network; transmit data to all devices
- Switch: a central point in a network; only transmits data to the intended device(s)
- Router: device that connects two or more networks
  - Connect the computer to the Internet
  - Wireless router: provide wireless network access to the devices
- Modem: the communications device that connects a communications channel to a device

X intelligence



Network Interface Controller/Card (NIC)

- NIC enables computers or devices that without built-in networking capability can access network
- NIC may have a visible antenna to communicate with the wireless network
  - Wireless network interface card (WNIC)

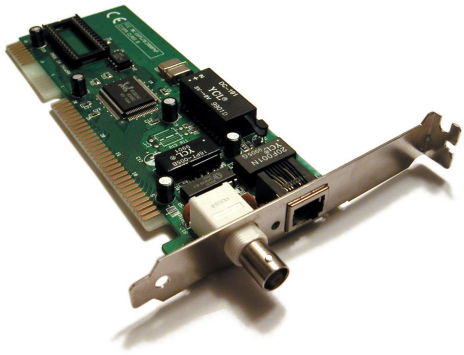


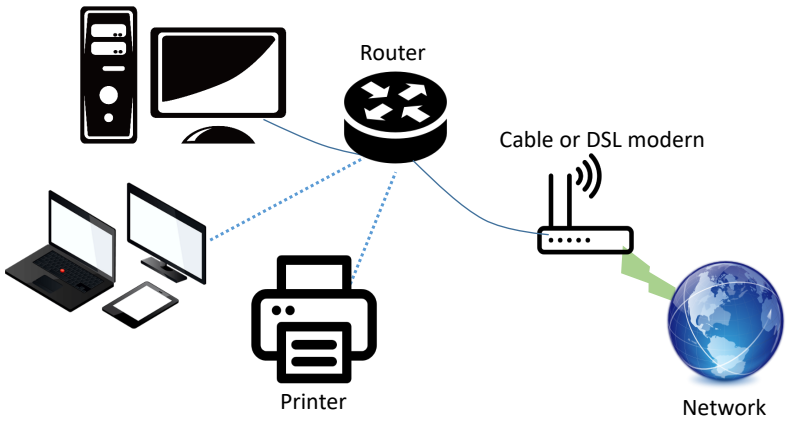
Image credit: https://en.wikipedia.org/wiki/Network_interface_controller

Image credit: https://networkustad.com/2019/11/17/wireless-network-interface-card-wnic/

Router

A router connects multiple computers/devices or other routers together and transmits data to the destination on a network

- Through a router, the networks can share access to a broadband Internet connection, such as through a cable or DSL modem



Wi-Fi Router & Range Extender

- Wi-Fi router mode
- 4G (SIM card) + Router

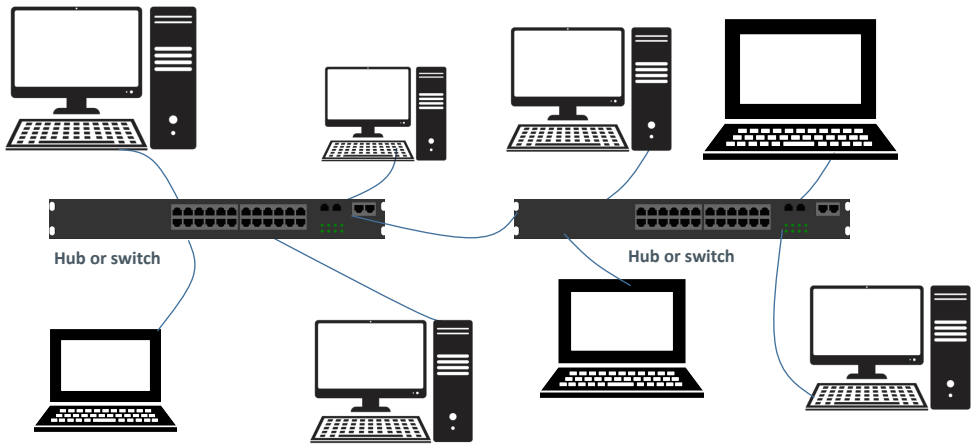
Image credit: https://www.tp-link.com/uk/home-networking/3g-4g-router/archer-mr600/

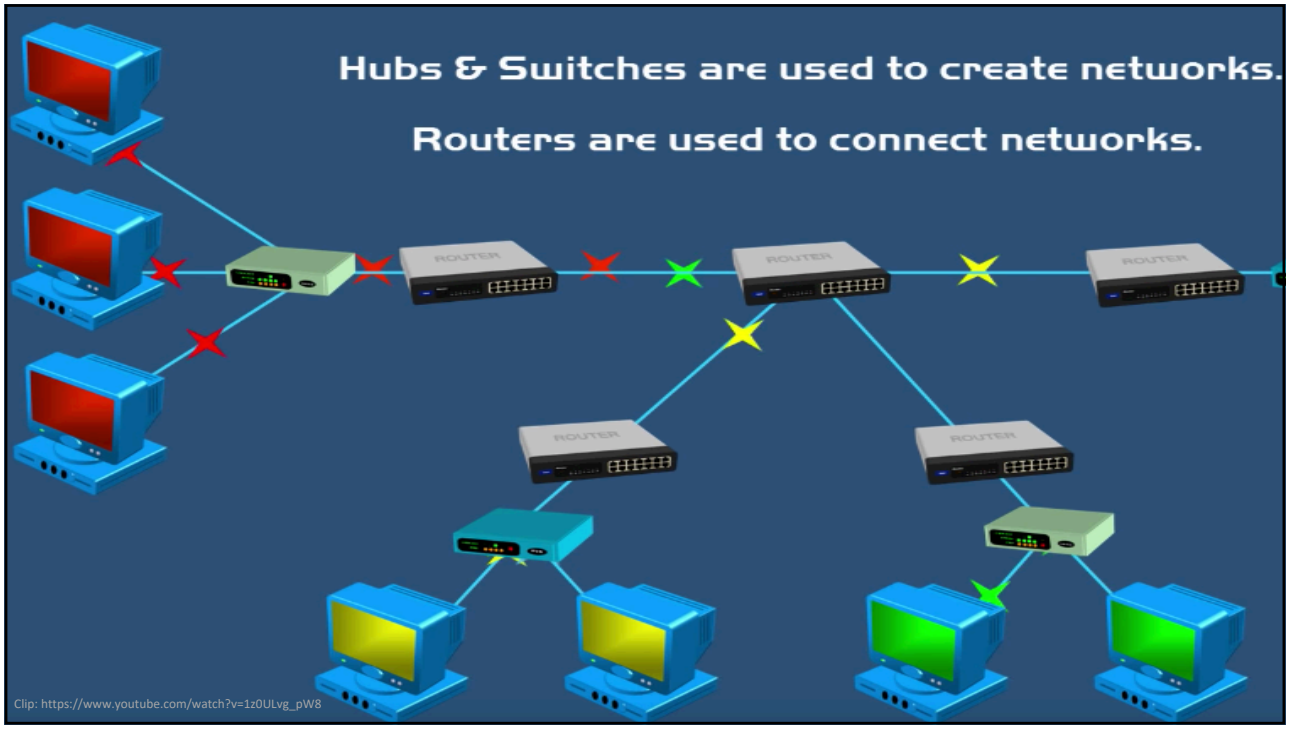
- Boosts wireless signal to previously unreachable areas
- expand wireless coverage

Image credit: https://www.tp-link.com/us/home-networking/range-extender/tl-wa850re/

Hub vs. Switch

- A hub or switch is a device which provides a central point for cables in a network

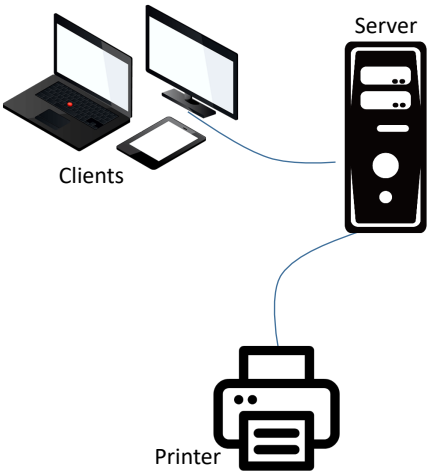




Network Architecture- Client/Server

Client/server network

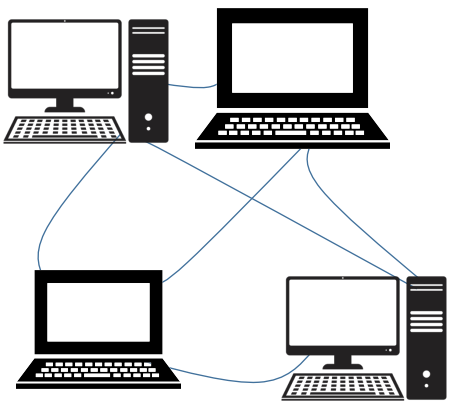
- Server: one or more computers
  - Computer on the network controls access to hardware, software, and other resources
  - Centralized storage location which is accessible to other computers on the network
- Client: other computers on the network request resource from the server
  - Rely on the server for its resources
  - Different clients may have different permissions to access files or resources
- Can connect to one or more servers to sharing files or resources



Network Architecture- P2P

Peer-to-peer (P2P) network

- Computers communicate directly with each other and share each other's resources
  - Computer-A uses a printer connected to Computer-B and revising a file stored on Computer-C
- Administrator is not required since the P2P network treats all computer equally



Network Topology

Bus Network
All devices attach to a central cable (called bus) to transfer data
If the bus fails, the devices on the network will not be able to communicate

Ring Network
Data is transferred sequentially from one device to another
If one of the devices on the network fails, the communication is no longer available

Network Topology

Star network

- Every device on the network is connected to the central device (server/switch)
- If the central device fails, other devices will not be able to communicate
- If the connected device fails, other devices will still be able to communicate.
- The bus can also be used to connect multiple star networks together to form a tree topology
- Tree topology is usually used in schools and enterprises

Mesh network

- All devices interconnect with each other
- If a single device on the network fails, the rest of the network will communicate through the alternate route to continue operation
- Full mesh topology: each device on the network is connected to all other devices on the network
- Partial mesh technology: each device may or may not be connected to all other devices on the network

Network Architecture- Cloud Computing

Cloud computing is an Internet-based service

- Data storage, data computing, etc.
- Data may store on one or more servers in different locations (backup copies)

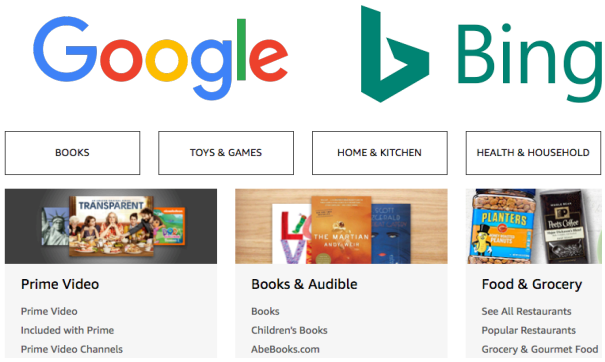
- Pros
  - Easy to share files and control who has access to each file
  - If there is any problem with your computer, the file will remain unchanged
- Cons
  - Cost of managing the accessibility
  - Internet connectivity

The World Wide Web

- The **World Wide Web** (**WWW**), or web, consists of a worldwide collection of electronic documents (**webpages**)
- A website is a collection of related webpages and related items
- A **web server** is a computer that delivers requested webpages to your computer or mobile device
- **HTML** (Hypertext Markup Language) is a set of symbols used by developers to specify the headings, paragraphs, images, links, and other content elements that contained in webpages

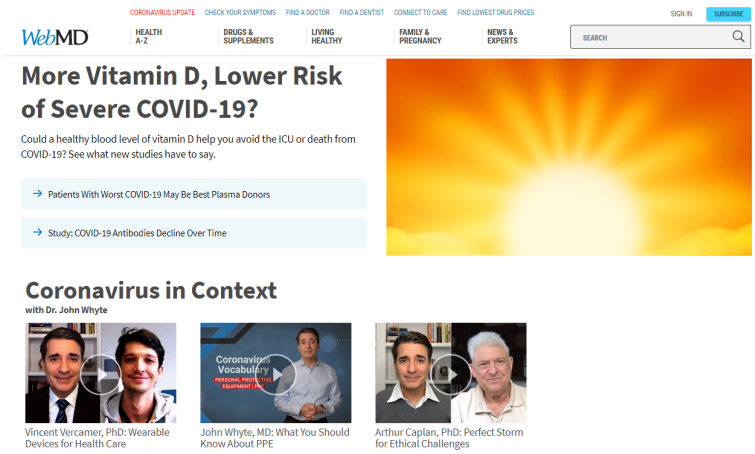
Types of Websites - Search Engine

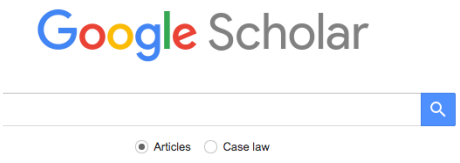
- A web **search engine** is software that finds websites, webpages, images, videos, news, maps, and other information related to a specific topic
  - Adaptive results
- A subject directory classifies webpages in an organized set of categories, such as sports or shopping, and related subcategories



Types of Websites - Informational and research

- Informational and research websites contain factual info
  - Library, encyclopedias, dictionaries, etc.





Types of Websites – E-commerce

Course activity- compare the following E-commerce website

– Similarity, difference, uniqueness, characteristic, etc.

amazon jet PChome ONLINE 露天拍賣

ebay Walmart Save money. Live better. YAHOO! 奇摩 拍賣 蝦皮購物

Types of Websites - Online social network

Photo credit: http://MakeAWebsiteHub.com

Types of Websites - Wikis and Collaboration

WIKIPEDIA
The Free Encyclopedia

wikimapia

scistarter
Citizen Science Projects

Photo credit: http://MakeAWebsiteHub.com

Other Internet Services

- **VoIP** (Voice over IP) lets users to speak to other users via their Internet connection
  - Broadband network connection
  - Microphone & speaker

skype™

Google Hangouts
Messaging, Voice and Video Calls

Source: Microsoft

Other Internet Services

- **FTP** (File Transfer Protocol) is an Internet standard that allows file upload and download to and from other computers on the Internet
  - Some of the FTP sites have anonymous FTP
  - Some FTP sites require an authorized account
- Many operating systems include FTP capabilities
- An **FTP server** is a computer that allows users to upload and/or download files using FTP

CH

科目代號(Course #)：306005001
科目名稱：計算機概論
Course Name：Introduction to Computer Science
授課教師：簡士鎰
Instructor：CHIEN SHIH-YI
系所：資管一甲、資管一乙
上課時間 (Session)：五23 (fri09-11)

EN

科目代號(Course #)：306005011
科目名稱：計算機概論
Course Name：Introduction to Computer Science
授課教師：簡士鎰
Instructor：CHIEN SHIH-YI
系所：資管一甲、資管一乙
上課時間 (Session)：五D5 (fri13-15)