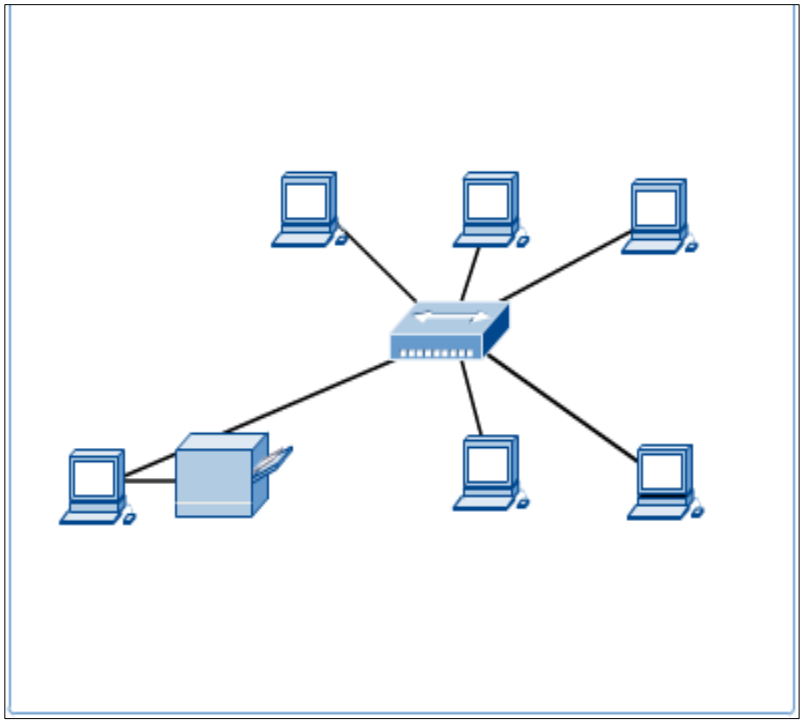
INTRODUCTION TO COMPUTER NETWORKS

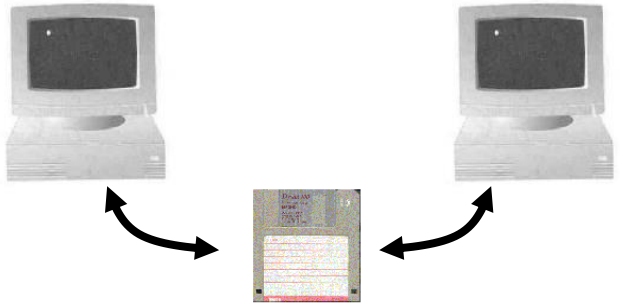
Computer Networks

- Two or more computers or communications devices connected by **transmission media and channels** and guided by **a set of rules** for communication purposes that allow users to communicate with each other and share applications and data.

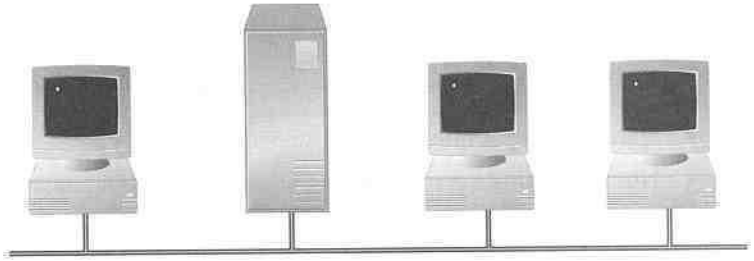


Why Networking?

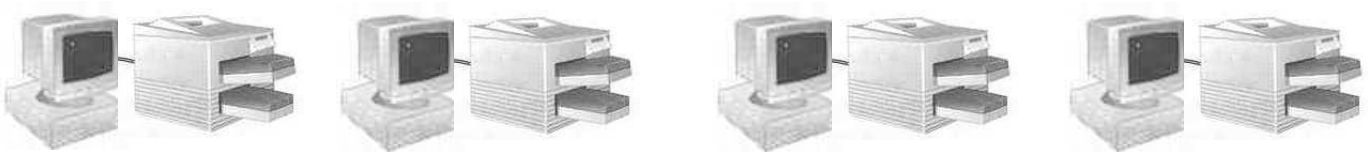
- **Sharing information — i.e. <u>data communication</u>**
  - **Do you prefer these?**



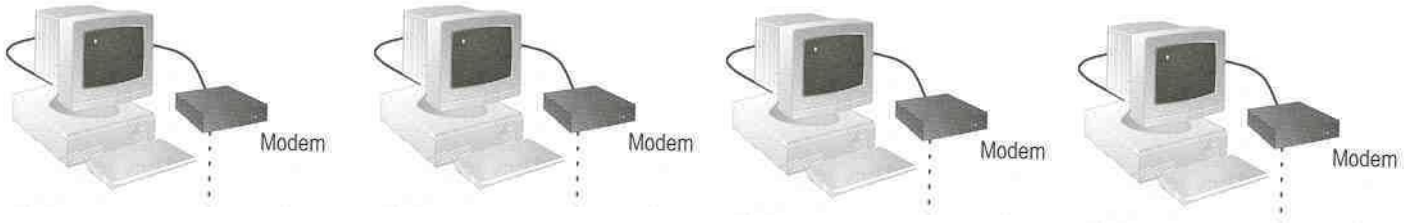
  - **Or this?**



- **Sharing hardware or software**
  - **E.g. print document**



- **Centralize administration and support**
  - **E.g. Internet-based, so everyone can access the same administrative or support application from their PCs**



How many kinds of Networks?

- Depending on one's perspective, we can classify networks in different ways
  - Based on transmission media: Wired (UTP, coaxial cables, fiber-optic cables) and Wireless
  - Based on network size: LAN and WAN (and MAN)
  - Based on management method: Peer-to-peer and Client/Server
  - Based on topology (connectivity): Bus, Star, Ring …

Transmission Media

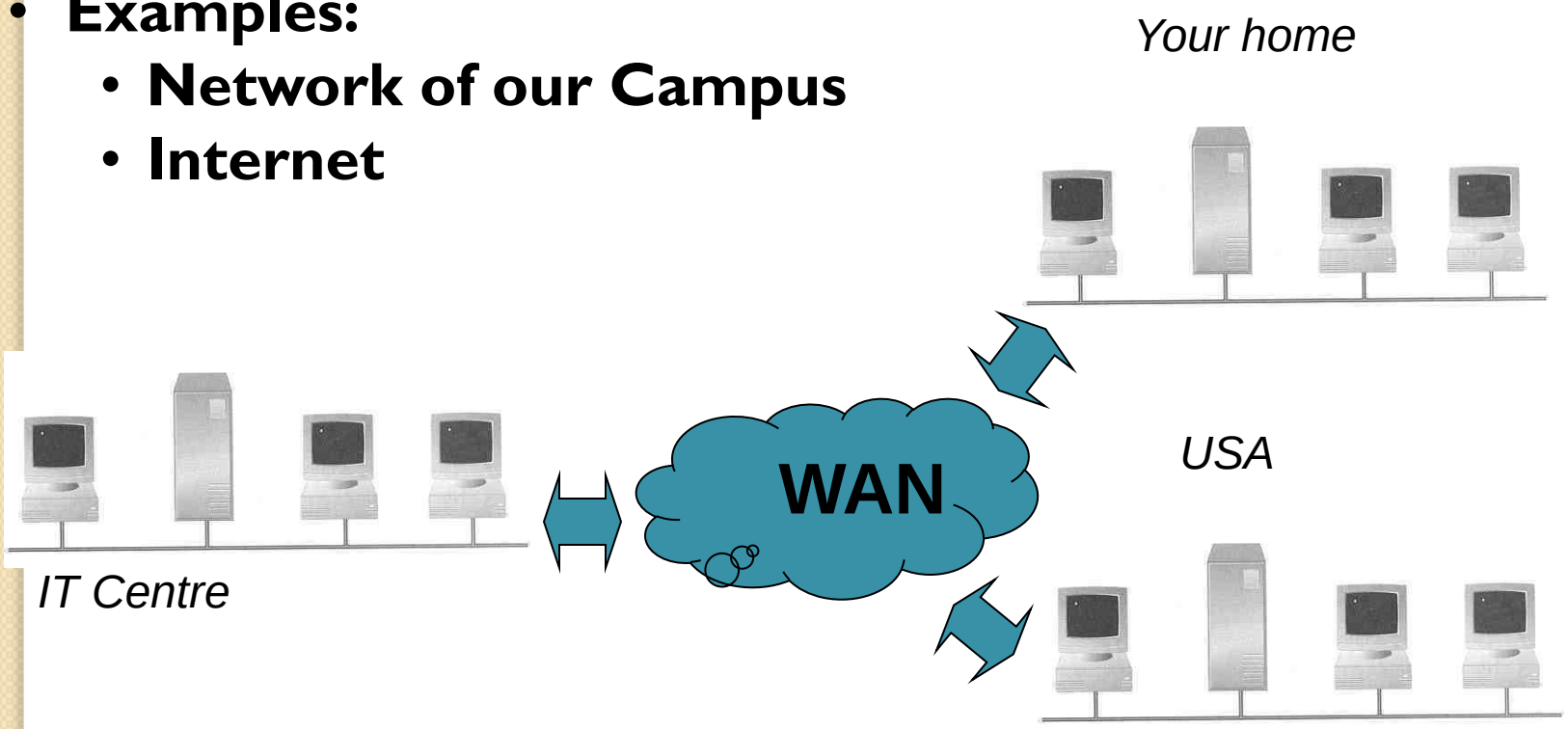
- **Two main categories:**
  - **Guided — wires, cables**
    - **Twisted-Pair cables:**
      - **Unshielded Twisted-Pair (UTP) cables**
      - **Shielded Twisted-Pair (STP) cables**
    - **Coaxial cables**
    - **Fiber-optic cables**
  - **Unguided — wireless transmission, e.g. radio, microwave, infrared, sound**

LAN and WAN

- Local Area Network (LAN)
  - Small network, short distance
    - A room, a floor, a building
    - Limited by no. of computers and distance covered
    - Usually one kind of technology throughout the LAN
    - Serve a department within an organization
  - Examples:
    - Network inside the Student Computer lab
    - Network inside a small office
    - Network inside your home

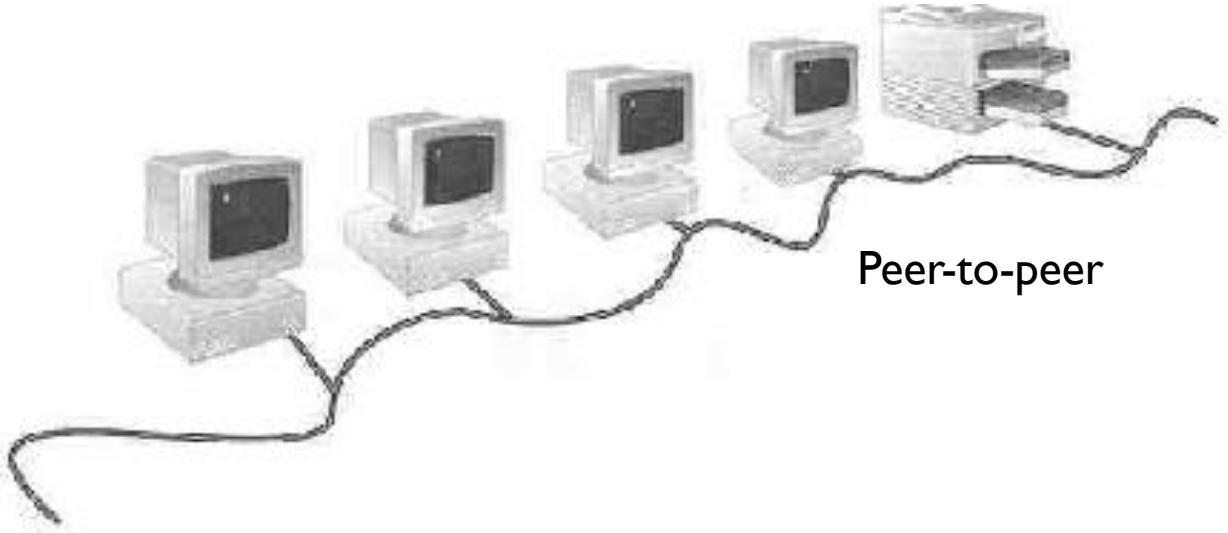
Wide Area Network (WAN)

- **A network that uses long-range telecommunication links to connect 2 or more LANs/computers housed in different places far apart.**
  - **Towns, states, countries**
- **Examples:**
  - **Network of our Campus**
  - **Internet**



Peer-to-Peer Networks

- **Peer-to-peer network is also called workgroup**
- **No hierarchy among computers ⇒ all are equal**
- **No administrator responsible for the network**



- **Advantages of peer-to-peer networks:**
  - Low cost
  - Simple to configure
  - User has full accessibility of the computer
- **Disadvantages of peer-to-peer networks:**
  - May have duplication in resources
  - Difficult to uphold security policy
  - Difficult to handle uneven loading
- **Where peer-to-peer network is appropriate:**
  - 10 or less users
  - No specialized services required
  - Security is not an issue
  - Only limited growth in the foreseeable future

Clients and Servers

- **Network Clients (Workstation)**
  - **Computers that request network resources or services**
- **Network Servers**
  - **Computers that manage and provide network resources and services to clients**
    - **Usually have more processing power, memory and hard disk space than clients**
    - **Run Network Operating System that can manage not only data, but also users, groups, security, and applications on the network**
    - **Servers often have a more stringent requirement on its performance and reliability**

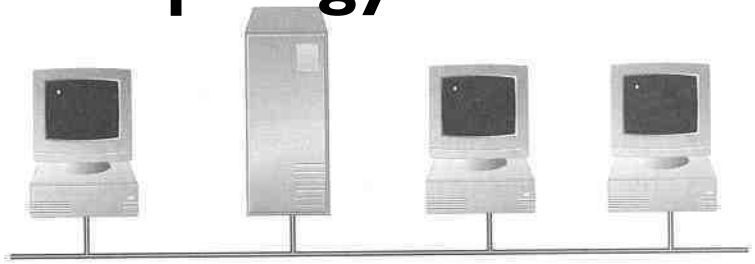
- **Advantages of client/server networks**
  - **Facilitate resource sharing – centrally administrate and control**
  - **Facilitate system backup and improve fault tolerance**
  - **Enhance security – only administrator can have access to Server**
  - **Support more users – difficult to achieve with peer-to-peer networks**

- **Disadvantages of client/server networks**
  - **High cost for Servers**
  - **Need expert to configure the network**
  - **Introduce a single point of failure to the system**

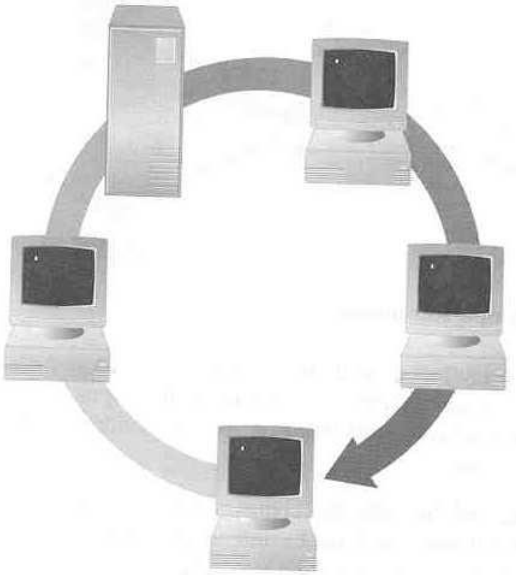
Topology — 3 basic types

- **How so many computers are connected together?**

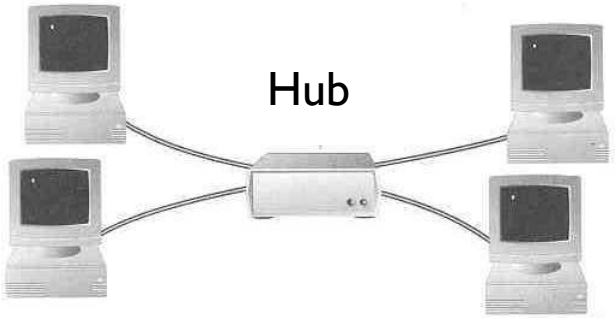
Bus Topology



Ring Topology



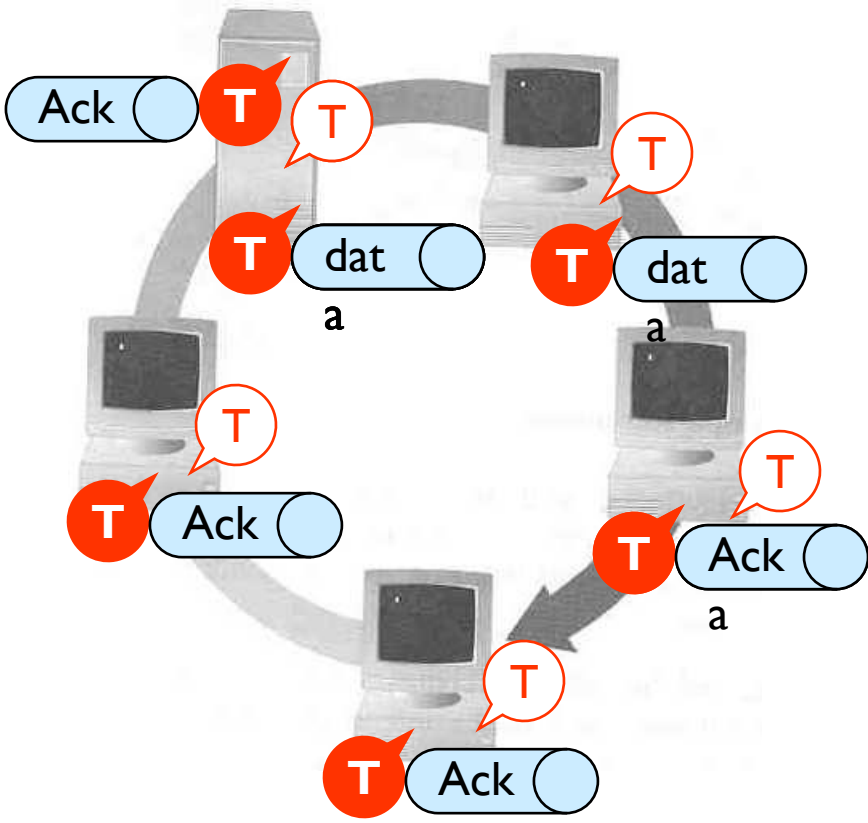
Star Topology



- **Bus Topology**
  - Simple and low-cost
  - A single cable called a trunk (backbone, segment)
  - Only one computer can send messages at a time
  - Passive topology - computer only listen for, not regenerate data
- **Star Topology**
  - Each computer has a cable connected to a single point
  - More cabling, hence higher cost
  - All signals transmission through the hub; if down, entire network down
  - Depending on the intelligence of hub, two or more computers may send message at the same time

Ring Topology

- Every computer serves as a repeater to boost signals
- Typical way to send data:
  - Token passing
    - only the computer who gets the token can send data
- Disadvantages
  - Difficult to add computers
  - More expensive
  - If one computer fails, whole network fails



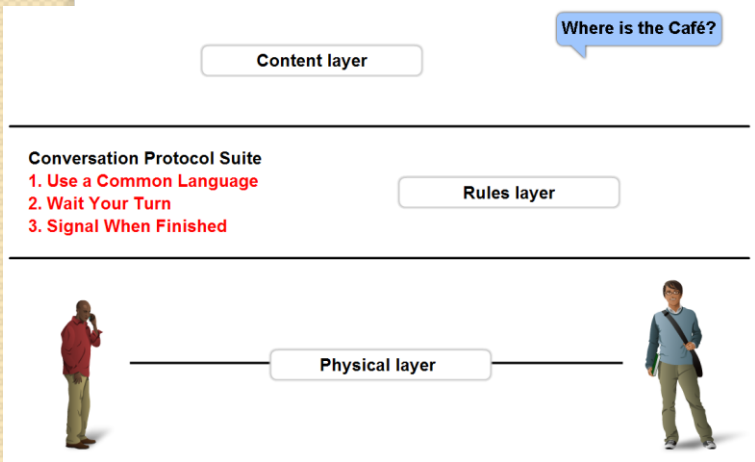
Protocols

- A set of predetermined rules
- Protocol Suite

  A group of inter-related protocols that are necessary to perform a communication function
- Implemented in software and hardware that is loaded on each host and network device
- Individual protocols in a protocol suite may be ***vendor-specific*** and ***proprietary***

Function of Network Protocol

- Network protocols are used to allow devices to communicate successfully



Protocols provide:

The format or structure of the message

The process by which networking devices share information about pathways to other networks

How and when error and system messages are passed between devices

The setting up and termination of data transfer sessions

Network Technologies

Ethernet

- Based on bus topology; but can be used in star topology;
- Higher speed: first Fast Ethernet, then Gigabit Ethernet;
- Most popular: inexpensive, easy to install and maintain.

Token Ring

- Based on a ring topology; but can use a star topology;
- Token-passing scheme to prevent collision of data;
- The second most widely-used protocol after Ethernet.

TCP/IP

- Based on client/server model of network computing;
- Uses packet switching technique for data transmission;
- Commonly used for Internet applications.

WAP

- Uses client/server model of network computing;
- Allows wireless devices to access the Internet and WWW;
- Meets increasing demands for wireless Internet access.

Network Operating Systems

What is a Network Operating System?

- An operating system that includes special functions for connecting computers and devices into a local-area network (LAN). Some operating systems, such as UNIX and the Mac OS, have networking functions built in. The term network operating system, however, is generally reserved for software that enhances a basic operating system by adding networking features.

Examples

- Microsoft Windows Server 2003
- Microsoft Windows Server 2008
- UNIX
- Linux
- Mac OS X
- Novell NetWare

Characteristics of a Network Operating System

Network Operating Systems are based on a client/server architecture in which a server enables multiple clients to share resources

The Network Operating System can also do the following:

- Centrally manage network resources, such as programs, data and devices.
- Secure access to a network.
- Allow remote users to connect to a network.
- Allow users to connect to other networks like the Internet.
- Back up data and ensure its availability.
- Allow for simple additions of clients and resources.
- Monitor the status and functionality of network elements.
- Distribute programs and software updates to clients.
- Ensure efficient use of a server's capabilities.

Internet

What is the Internet?

The Internet is a global network of computer networks utilizing a suite of protocols called TCP/IP (Transmission Control Protocol/Internet Protocol) that supports interconnection of a number of different computer networks

What is the Internet?

The Internet covers large, international Wide Area Networks (WAN's) as well as smaller Local Area Networks (LAN's) and individual computers connected to the Internet worldwide

What is the Internet?

The Internet supports communication and sharing of data, and offers vast amount of information through a variety of services and tools

What are the major Internet tools and services?

- Electronic mail (email)
- Newsgroups
- Internet Relay Chat (IRC)
- Telnet
- File Transfer Protocol (FTP)
- World Wide Web (www)

What are the major Internet tools and services?

E-mail

- The most popular use of the Internet
- Available for free on the Web
  - Yahoo Mail, Gmail, Hotmail, Eudoramail
- Valid e-mail address consists of a username and a domain name separated by the @ sign
  - ex. abc@mail.com

What are the major Internet tools and services?

Newsgroups

- Service dedicated to discussions on a particular topic through posted articles
- Accessible through newsreaders
- Names signify to users the topic of discussion
  - ex. http://www.vetclick.com

What are the major Internet tools and services?

IRC (Internet Relay Chat)

- Allows real-time text based communication through the Internet
- Organized by topic of interest into "channels"
- Discussion occurs in "chatrooms"
- Some Websites have built-in chatrooms

What are the major Internet tools and services?

Telnet

- Service that allows one computer to access another computer
- Enables the user to exchange data and issue commands on the other computer, the Telnet host
- Mainly used by libraries to allow access to information stored in their computers

What are the major Internet tools and services?

FTP (File Transfer Protocol)

- Allows the transfer or copying of files from one computer to another
- Ideal for procuring or sending files to a remote computer
- FTP Programs available freely
- Modern browsers have built in FTP capabilities

What are the major Internet tools and services?

World Wide Web (www)

- Invented in 1991 by Tim Berners-Lee, the web is the fastest-growing Internet service.
- Based on HTML (Hyper Text Markup Language) allowing users to access data in multimedia format
- Simplest unit is the Webpage, primarily a document encoded in HTML format that can be accessed by using a browser
- HTML links contents of a Webpage to each other as well as to other Web pages through a hyperlink
- Each page has an address, a Uniform Resource Locator (URL)

What is the Internet's history?

- The Internet grew from ARPANET the first computer network designed for the Advanced Research Projects Agency (ARPA) of the U.S Department of Defense
- ARPA sponsored research on interconnecting geographically remote computers to allow communication and sharing of data and resources
- The goal was to create a communications network that could exist even if parts of it was incapacitated

What is the Internet's history?

- One of the early developments that proved significant to the success of ARPANET (which later on becomes the Internet) were "packet switching" and "TCP/IP"
- Packet switching involves digital systems that transmit data in small packets that use the best current path to their destination
- TCP/IP is the core Internet protocol that allows computers to communicate with each other

What is the Internet's history?

- Realizing the value of interconnected computers the academic community started with its own research network
- The NSFNet, created and named for the National Science Foundation, linked academic networks that connected universities and research organizations around North America.
- Networks from Europe and other countries were connected to NSFNet making it the backbone of the Internet.

What is the Internet's history?

- ARPANET was decommissioned and the management of the Internet was passed on to the NSFNET
- Restriction on commercial use was lifted
- The emergence of World Wide Web, and Mosaic brought an unprecedented growth to the Internet
- NSFNET reverts back to a research project, leaving the Internet in commercial hands and its management to independent organizations

What is the Internet's history?

Summary

- The Internet started as a military network called ARPANET, which was involved in networking research
- The Internet later expanded to include universities, businesses and individuals
- Today, the Internet is also referred to as the Net, Information Superhighway, and Cyberspace

How does the Internet work?

- Protocols – standardized rules that define how computers communicate and exchange data
- IP address – unique number used to identify computers on the Internet
- Domain name – structured naming system to locate computers on the Internet
- URL – uniform naming scheme that specifies unique addresses of Internet resources
- Client and server – computing architecture used by most Internet services

How does the Internet work?

TCP/IP (Transmission Control Protocol / Internet Protocol)

- The Internet is a packet-switching network that uses TCP/IP as its core protocol
- TCP/IP is a suite of protocols that govern network addresses and the organization and packaging of the information to be sent over the Internet
  - TCP – flow control and recovery of packets
  - IP – addressing and forwarding of individual packets

How does the Internet work?

Internet Protocols

- HTTP (Hypertext Transfer Protocol Protocol) - for accessing and transmitting World Wide Web documents
- FTP (File Transfer Protocol Protocol) - for transferring files from one computer to another
- Gopher Protocol - for accessing documents via Gopher menus (no longer widely used)
- Telnet Protocol - allows users to logon to a remote computer
- SMTP (Simple Mail Transfer Protocol) for sending and managing electronic mails (e-mail)

How does the Internet work?

IP address

- IP address is a unique address assigned to each computer connected to the Internet
- It is used by TCP/IP to route packets of information from a sender to a location on the Internet
- IP address consist of four sets of numbers ranging from 0 to 255 Ex. 249.7.13.53

How does the Internet work?

IP address

- 192.168.213.4
- The first two number sets designate the network
- The third number set identifies the local network
- The fourth number set identifies the particular machine

How does the Internet work?

Domain names

- Domain names are the alias or English language equivalent of a computer's IP addresses
- Domain Name System (DNS) allows the use of easier to remember domain names instead of IP addresses to locate computers on the Internet
- Domain Name Resolvers scattered across the Internet translate domain names into IP addresses

How does the Internet work?

Domain names

- Domain names have two parts:
  - First part names the host computer
  - Second part identifies the top level domain
- Top level domains (TLD) – identifies the type of host
  - Generic Top Level Domains
  - Country Code Top Level Domains
- Domain names are used in URLs and e-mail addresses

How does the Internet work?

Top Level Domains

- **.com** – commercial/company site
- **.edu/ac -** educational/academic
- **.gov** – government site
- **.org** – non-profit organization
- **.mil** – military sites
- **.int** – international organizations
- **.net** – network providers

How does the Internet work?

Additional Top Level Domains

- **.aero** - restricted use by the air transportation industry
- **.biz** - general use by businesses
- **.coop** - restricted use by cooperatives
- **.info** - general use by both commercial and non-commercial sites
- **.museum** - restricted use by museums
- **.name** - general use by individuals
- **.pro** - restricted use by certified professionals and professional entities

How does the Internet work?

Country Code Top Level Domains

- **.lk –** Sri Lanka
- **.au** – Australia
- **.cn –** China
- **.fj** – Fiji
- **.id** – Indonesia
- **.jp** – Japan
- **.mn** – Mongolia
- **.ph –** Philippines
- **.sg –** Singapore
- **.uk** – United Kingdom
- **.us –** United States
- **.tw -** Taiwan
- **.vn -** Vietnam
- The complete list can be accessed at http://www.iana.org/cctld/cctld-whois.htm

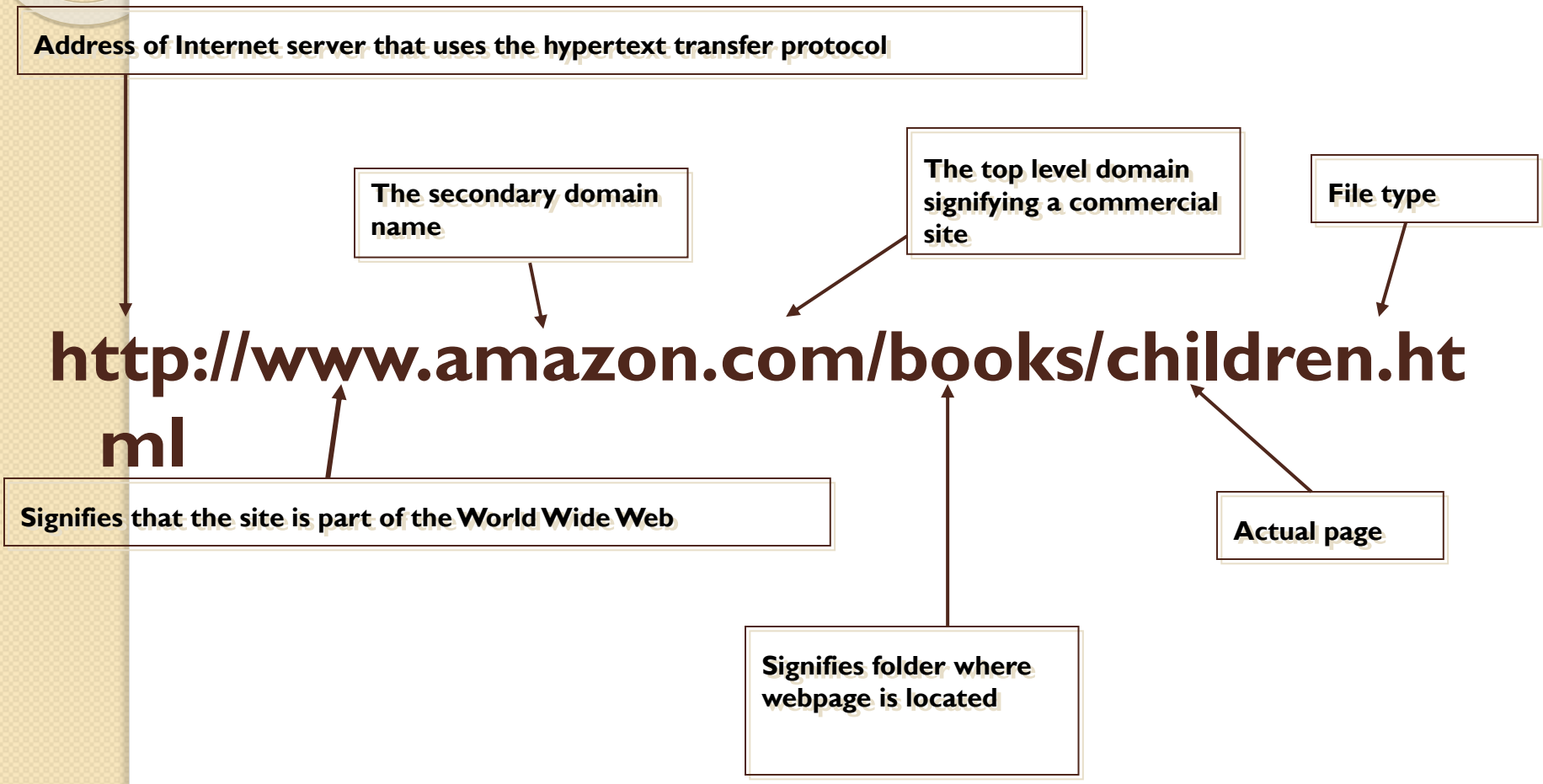
How does the Internet work?

Uniform Resource Locator (URL)

- Each Internet document or file has a unique address called a URL
- The URL comprises of three parts:
  - Protocol – lets the computer know how to process the information it receives
  - Domain name – Internet address of the computer hosting the site and storing the documents
  - Path – lets the computer which directory and file to access

What is URL?

UNIFORM RESOURCE LOCATOR



How does the Internet work?

http://www.amazon.com/books/children.html

- **"http“**
  - transfer protocol
- **"www"**
  - server name
- **“amazon"**
  - second-level domain name
- **“com"**
  - top-level domain name
- **"books"**
  - directory name
- **“children"**
  - file name
- **"html"**
  - file type

How does the Internet work?

Client Server

- The client server model is the distributed computing architecture used by most Internet services, generally classifying hosts on the Internet as clients and servers
- Client programs are used to access Internet services provided by host computers running server programs that provide the information or service needed
- For example web browsers are client programs used to access information hosted by web servers

What are the ways to find information on the Internet?

- Net surfing –involves scanning pages and clicking on links randomly
- Using a URL – quickest way to find information on the Internet but you must know where it is located
- Use search tools and services – can assist you in locating the information you need among the vast amount of information available on the Net

What are the Internet search tools and services?

- Search engines
- Subject directories
- Invisible Web
- Meta-search engines
- Specialized search engines
- Other search tools

What are the Internet search tools and services?

Search engines

- Websites that uses "bots" or "spiders" that periodically search the World Wide Web and automatically index and store the information in their database
- Examples
  - Google - http://www.google.com
  - Alltheweb - http://www.alltheweb.com
  - Altavista - http://www.altavista.com

What are the Internet search tools and services?

Subject directories

- Listings and directories of web page files that have been assembled manually, selected and evaluated by humans
- Examples
  - Yahoo - http://www.yahoo.com
  - Librarian's Index – http://www.lii.org
  - LookSmart - http://www.looksmart.com

What are the Internet search tools and services?

Invisible Web

- Web pages that cannot be ordinarily reached through search engines or subject directories
- Examples
  - Langenberg – http://www.langenberg.com
  - Complete Planet - http://www.completeplanet.com
  - Direct Search - http://gwis2.circ.gwu.edu/~gprice/direct.htm

What are the Internet search tools and services?

Meta-search engines

- Send your search query to several search engines simultaneously and give you a consolidated report of their findings
- Examples
  - Metacrawler – http://www.metacrawler.com
  - Dogpile – http://www.dogpile.com
  - ProFusion – http://www.profusion.com

What are the Internet search tools and services?

Specialized search engines

- Search engines dedicated to indexing web pages on specific topics
- Examples
  - Locate mailing lists and newsgroups
    - The Lizt – http://www.liszt.com
    - Mailbase – http://www.mailbase.ac.uk
    - Dejanews – http://www.dejanews.com
    - Google groups - http://groups.google.com/

What are the Internet search tools and services?

Other search tools and services

- FTP archives - locate files on anonymous FTP sites
  - Ex. - ArchiePlex -http://archie.emnet.co.uk/form.html
- Web and e-mail people finder
  - Ex. – Four11 – http://people.yahoo.com
- Multimedia search
  - Ex. - Webseek - http://www.ctr.columbia.edu/webseek/

What are the Internet search tools and services?

Other search tools and services

- Virtual Reference Libraries – online dictionaries, indexes, etc.
  - Ex. Research-it – http://www.iTools.com/research-it
- Virtual Reference Desks – online reference services
  - Ex – AskA+Locator - http://www.vrd.org/locator/subject.shtml

How to use the Internet tools and services?

- Most if not all of the Internet tools and services can be used through the World Wide Web
- To be able to use the search tools on the Web to find information resources on the Net one must first know how to use a browser
- Features and functions of available search tools and services vary accordingly, one must be familiar with at least two or more search tools to become effective in finding information

How to use the Internet tools and services?

Browsers

- Programs used to access the World Wide Web
- Allows a user to access resources on a server
- Displays the contents of the web in multimedia format
- Examples of browsers
  - Internet Explorer, Mozilla Firefox, Opera, Google Chrome

How to use the Internet tools and services?

Using a Browser

- You need to be familiar with the features of your web browser and know how to use it
  - enter a URL in the location or address bar to visit a particular web site
  - open, resize, close a browser window
  - locate and use the navigation tools on your browser ie., back, reload/refresh, home, print
  - identify and use hyperlinks to get around the web
  - download documents and files
  - use plug-ins like Adobe Acrobat or Macromedia Shockwave

How to use the Internet tools and services?

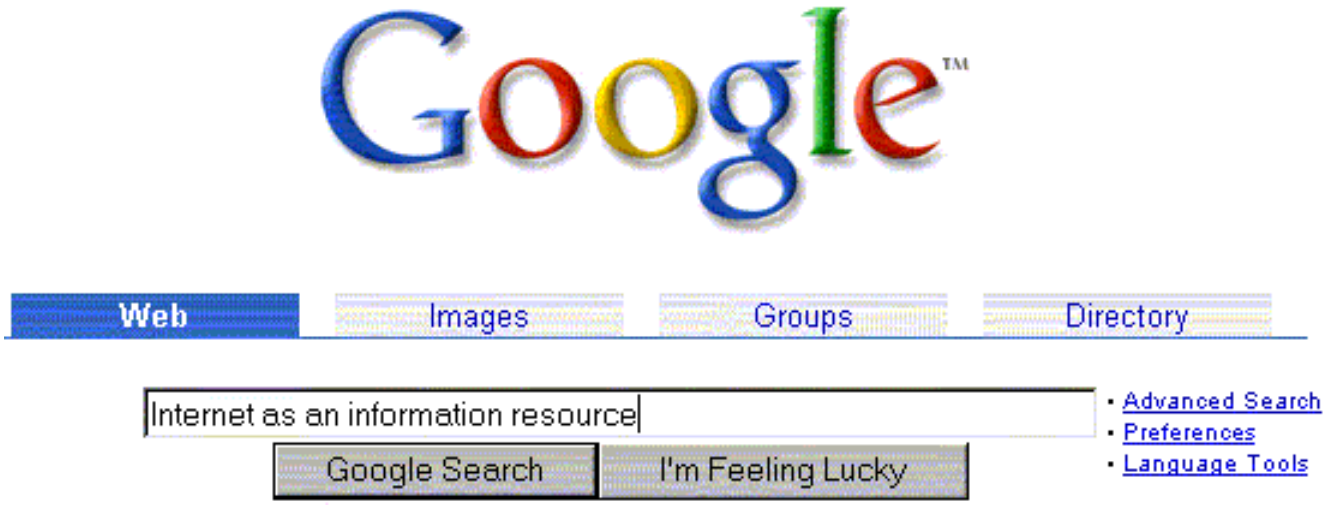
- **Generally there are two ways of using search tools and services**
  - **Browsing** – usually applied to directories where subjects are arranged hierarchically
  - **Keywords search** – search box is provided for entering keywords to search the database
    - Simple search – search on the keywords
    - Advanced search – search can be refined using various techniques

How to use the Internet tools and services?

- **Browsing subject directories**
- **From the home page you start with a broad subject area and follow the links to more specific areas until you reach the subject you wish to explore, then you click on one of the displayed results to go to the selected page (document)**

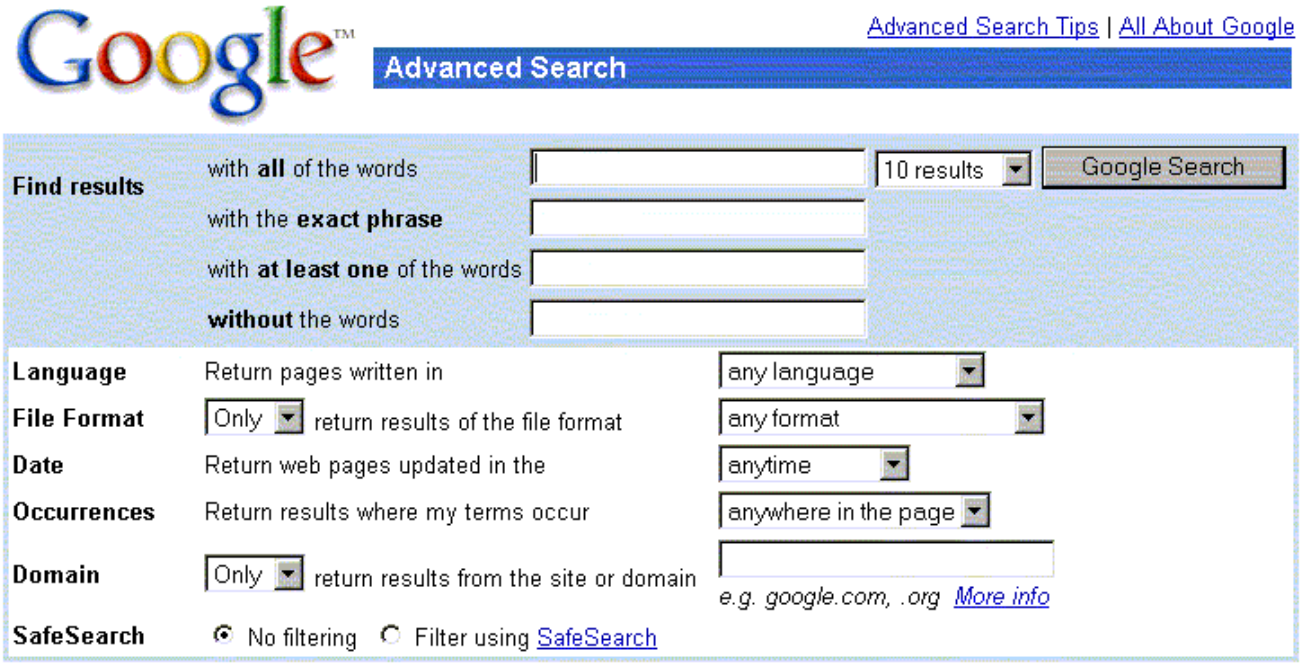
How to use the Internet tools and services?

- Simple keywords search
- Type keywords on the search box , press Enter on the keyboard and then select from the results



How to use the Internet tools and services?

- Advanced search
- Most search engines allow you to refine your search

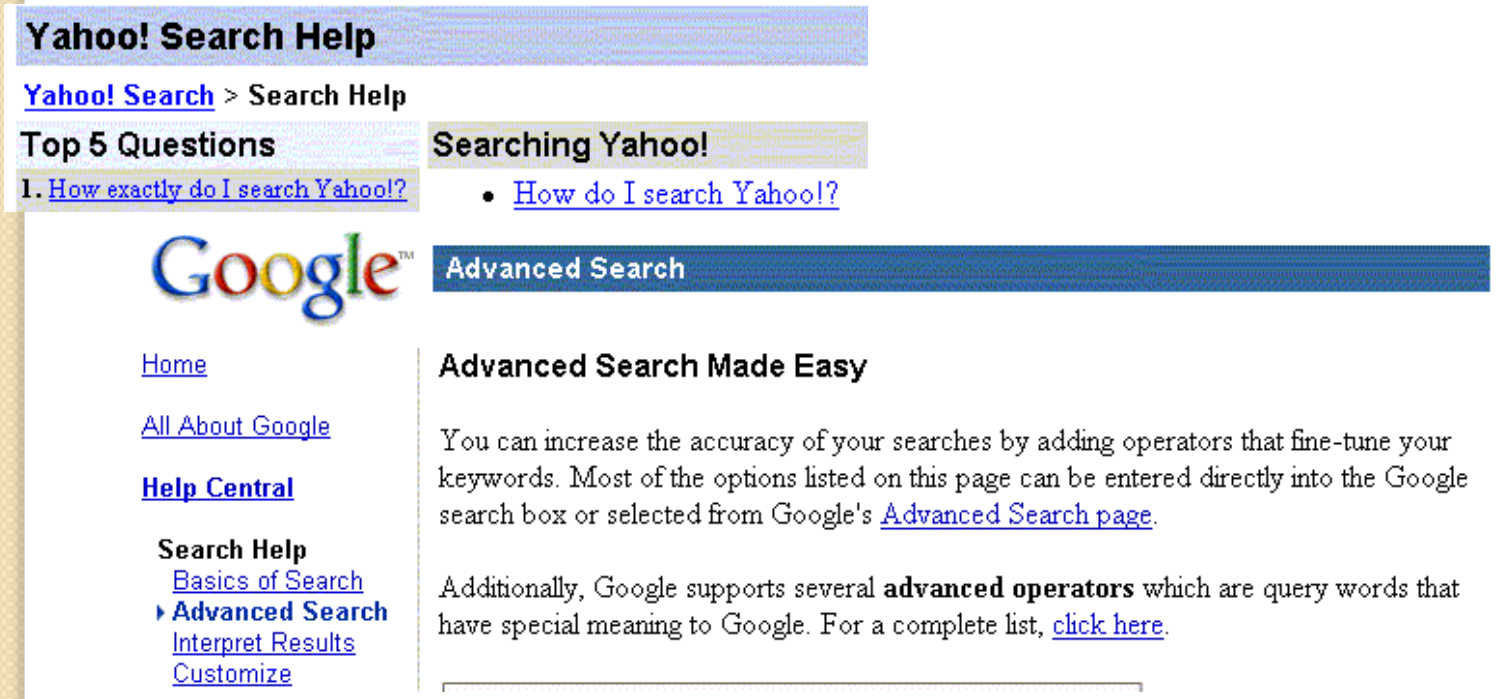


How to use the Internet tools and services?

- Meta-search engines, invisible web, specialized search engines and other search tools and services use the same basic principles in locating your information need
- Ideally combinations of both browsing and keyword searching (simple and advanced) will yield more accurate results

How to use the Internet tools and services?

- Each Internet tool and service provides help files that can guide you in utilizing it more effectively



How to find information on the Internet?

- Analyze your topic
- Choose the search tool you need
- Learn how to use the search tools
- Formulate your search strategy
- Search with a question in mind

How to find information on the Internet?

- **Analyze your topic**
- What are you searching? for what purpose?
- What type of information do you want?
- The purpose is to determine what terms to use in your search and what search tool features you need to search successfully

How to find information on the Internet?

- **Choose the search tool you need**
- Search tools find documents matching your information need
- Every search tool is different. They vary in features and size/comprehensiveness
- The most important features in selecting a search tool are those which allow you to refine or focus your search when you need to

How to find information on the Internet?

- **Learn how to use the search tools**
- Being familiar with most of the major search tools and their capabilities allows you to zero in on your search
- Learn how to use Boolean logic, phrase searching, truncation, field searching, etc.
- Spend time reading the Help files to know its features and capabilities

How to find information on the Internet?

- **Formulate your search strategy**
- Formulating your search strategy beforehand allows you to search for information systematically
- It also saves you a lot of time and money if you are paying for Internet access by the minute
- Your search strategy should be based on your information need

How to find information on the Internet?

- **Search with a question in mind**
- How am I going to use this?
- Do I have enough or too much information?
- Scan the content of the material to find out if it has anything of value
- Evaluate the website for accuracy and authority

How to find information on the Internet?

Simple search strategy

- pick your site
- learn to use the search tools
- choose your words carefully
- vary your spelling
- know how to widen your search
- know how to use the refining techniques
- use multiple search engines
- use meta-search engines
- use specialized search engines
- reuse your search

How to find information on the Internet?

Tips in finding information on the Internet

- Learn the features and functions of your browser
- If you know the URL go directly to it
- Always check for typing errors
- Define the topic in terms of concepts
- Express each concept using keywords multiple keywords or phrases
- Search multiple terms or exact phrase and not single words

How to find information on the Internet?

Tips in finding information on the Internet

- Read the help screens and search tips
- Utilize two or more search tools
- Use any advanced features of the search engine
- Use services which index quality sites
- Evaluate the results
- Download the information
- Cite your source properly

How to find information on the Internet?

Pitfalls

- endless links that leads to getting lost
- data traffic takes eternity to download
- too many; too few; many irrelevant sites
- information overload

Solutions

- stop / try another search
- try it another time /site; change ISP
- refine or vary your search
- search with a more specific question in mind

How to find information on the Internet?

To effectively find information we must:

- Clearly define what we are looking for
- Become familiar with the information resources and different search tools available via the Internet
- Learn how to use at least one or two of the search tools effectively
- Create and try your own search strategy
- Evaluate retrieved information and cite the source properly

Web 2.0

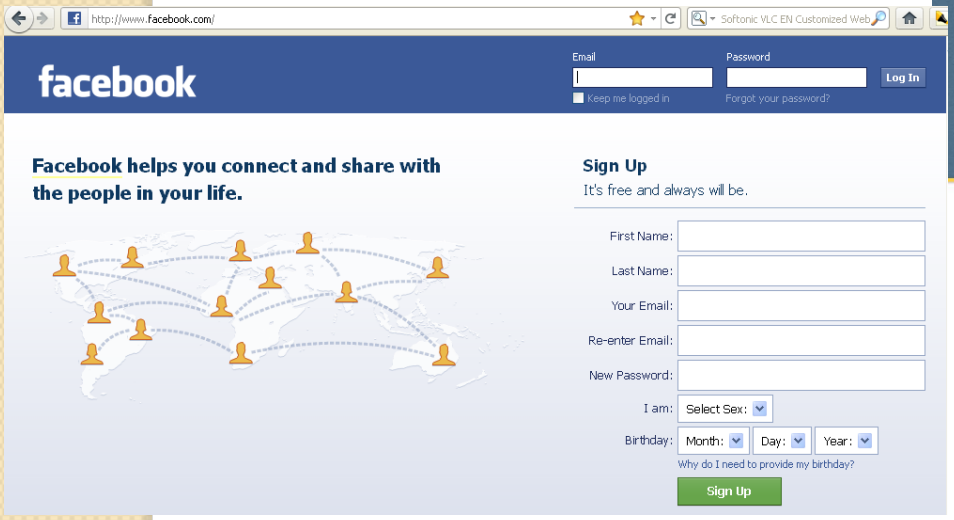
- The term **Web 2.0** is associated with web applications that facilitate participatory information sharing, interoperability, user-centered design, and collaboration on the World Wide Web.

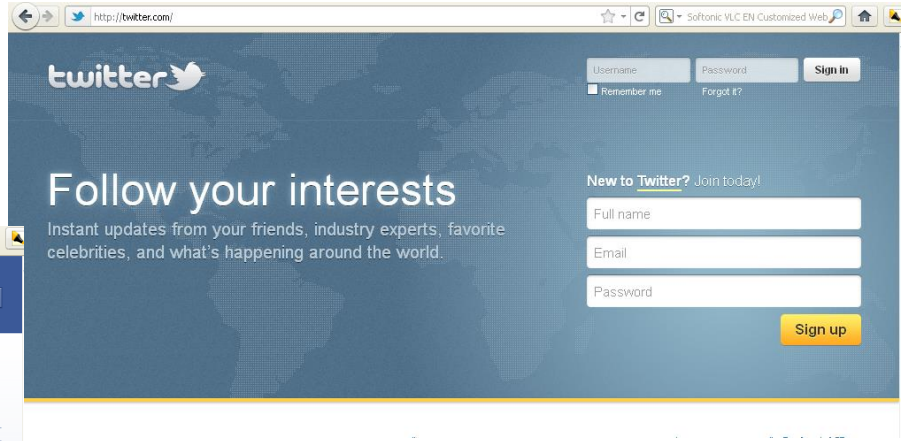
http://en.wikipedia.org/wiki/Web_2.0

- A Web 2.0 site allows users to interact and collaborate with each other in a social media dialogue as creators of user-generated content in a virtual community, in contrast to websites where users are limited to the passive viewing of content that was created for them.
- Examples : social networking sites, blogs, wikis, video sharing sites, hosted services, web applications

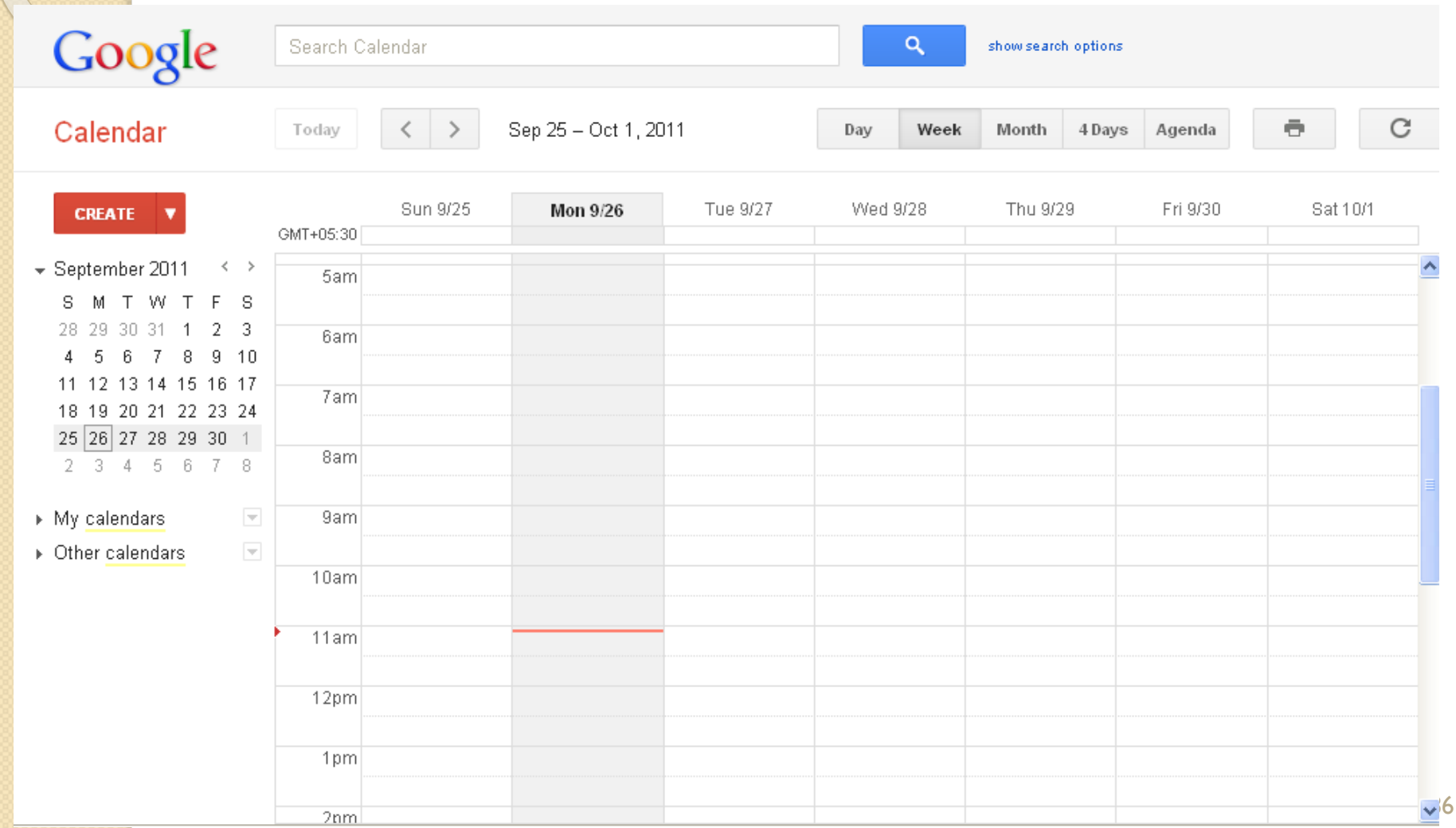
Social Networking Sites

- Facebook (www.facebook.com)
- Twitter (http://twitter.com)





Google Calendar is a contact and time-management web application offered by Google.



Horde groupware is an open source web application.