

Networks

Chapter 3

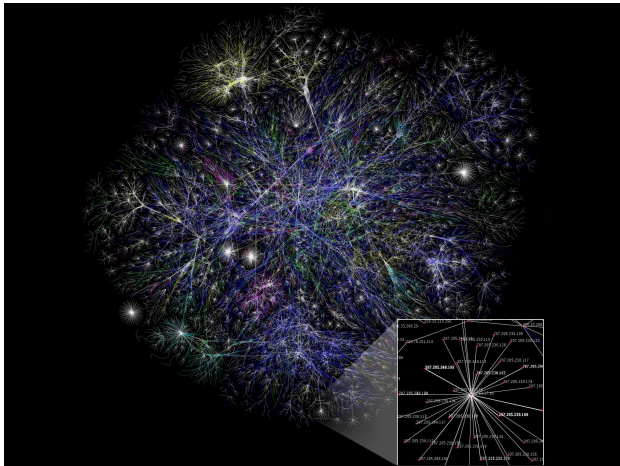
What Is The Internet?

It's not a big truck. It's a series of tubes.

Ted Stevens, former Alaskan Senator, 6/28/2006

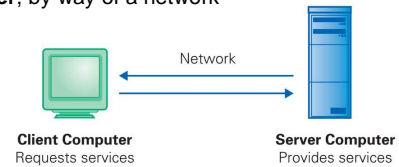
- **Internet:** global system of interconnected computer networks

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Client/Server Architecture

- Most interactions over the Internet use the client-server model.
- **client:** application or system that accesses a remote service on another computer system, known as a **server**, by way of a network



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Most Common Client?

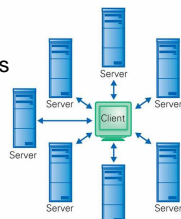
- **Web browsers** request documents (web pages) from *web servers*.

□ Examples:

- Firefox
- Internet Explorer
- Safari
- Opera

- **WWW (World Wide Web):** system of interlinked documents (web pages) accessible via the Internet

□ The WWW is a subset of the Internet.



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IP Address

- **IP (Internet Protocol) address:** numerical address given to each computer connected to the Internet

□ An IP address consists of four numbers (ranging from 0 to 255) separated by periods.

■ Examples:

- 128.95.1.207
- 209.131.36.158
- 4.2.2.1

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Getting an IP Address

- **DHCP (Dynamic Host Configuration Protocol):** protocol for assigning IP addresses to devices on a network
- **protocol:** standard procedure for sending and receiving data between computers
 - Examples:
 - HTTP (Hypertext Transfer Protocol)
 - SFTP (Secure File Transfer Protocol)
 - SMTP (Simple Mail Transfer Protocol)
 - IMAP (Internet Message Access Protocol)

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Getting an IP Address Via DHCP

1. Client broadcasts need for an IP address.
2. DHCP servers on the network respond.
3. Client chooses a server and sends the **MAC (Media Access Control) address** of its network card.
 - **MAC address:** globally unique identifier assigned to network cards by manufacturers
4. DHCP server responds with an IP address and other useful information. The server records that the address is now in use.
 - DHCP servers can also refuse to give an IP address for security reasons or if there are no more free addresses.

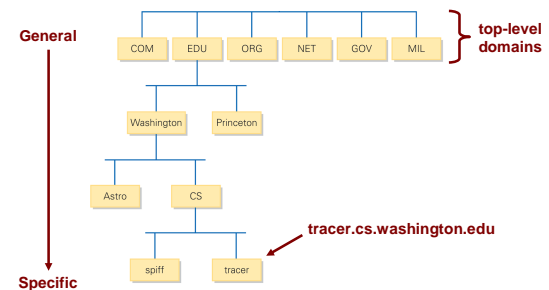
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Domain Name System (DNS)

- Unwieldy to remember IP address if you want to request information from another computer
- **domain name:** human-readable name given to a related group of networked computers
- **Domain Name System (DNS):** hierarchical naming system for computers connected to the Internet

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Internet Domain Hierarchy



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Top-Level Domain

- **top-level domain:** last part of domain name
 - Examples:
 - .com (commercial)
 - .org (organization)
 - .edu (education)
 - .gov (government)
 - .uk (United Kingdom)
 - .ca (Canada)
- Some top-level domains (e.g., .com and .org) are open for registration to anyone, whereas others (e.g., .gov and .edu) have rules restricting eligibility.
- List of top-level domains:
 - <http://www.iana.org/domains/root/db/>

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Top-Level Domain

- In the second quarter of this year (2009), rules for top-level domain names will be relaxed to include any name.
 - <http://www.icann.org/en/announcements/announcement-4-26jun08-en.htm>
- For example, the city of Seattle could get .seattle and Apple could get .apple or .mac

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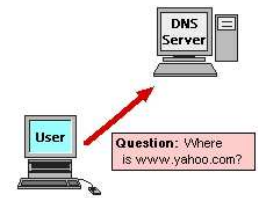
Domain Name System

- How do the convenient domain names like `www.yahoo.com` get translated into the IP addresses like `209.131.36.158` that computers need?

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DNS Server

- DNS server:** computer that keeps a list of the human-readable names and the corresponding IP addresses
- How does a computer get the IP address of a DNS server?
 - Provided by the DHCP server



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Sending Data Over The Internet

- TCP/IP (Transmission Control Protocol/Internet Protocol):** protocol providing reliable delivery of data across a network
 - <http://www.cs.washington.edu/education/courses/cse100/9wi/lectures/packetswitch.swf>
- Packets take several **hops** to be delivered.
 - Number of hops can change depending on traffic on the Internet
 - <http://www.webhostingshow.com/2008/03/21/how-to-traceroute-on-windows-and-mac/>

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Sending Data Over The Internet

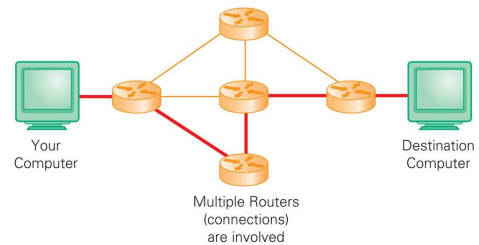


Figure 3.8. The Internet makes use of whatever routes are available to deliver packets.

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How Many Hops Does It Take?

A screenshot of a traceroute report for eth.ch (129.132.1.15). The report shows the path of the packet from the source to the destination, including the IP address, node name, location, and hop number for each step.

Hop	IP Address	Node Name	Location	Tzone	ms	Graph	Network
0	128.95.1.207	spiff.csresearch.cs.washington.edu	...	...	0	...	University of Washington VADSH
1	128.95.1.100	spiff.csresearch.cs.washington.edu	...	...	0	...	University of Washington VADSH
2	140.142.153.23	uwnet1-0E2-0-cac.washington.edu	...	...	0	...	University of Washington UWN-SI
3	198.107.151.12	hmg2-mega-gig-1-0-gig-gigapop.net	...	...	11	...	Vario, Inc. VRI0-188-108
4	198.107.144.2	abilene-gms-pnw-gigapop.net	...	...	25	...	Exchange Point Blocks NET-EP
5	198.23.8.56	dmwng-rtmg-abilene.ucad.edu	...	...	36	...	Exchange Point Blocks NET-EP
6	198.23.8.14	lscmg-dmwng-abilene.ucad.edu	...	...	52	...	Exchange Point Blocks NET-EP
7	198.23.8.86	spring-lscmg-abilene.ucad.edu	...	...	62	...	Exchange Point Blocks NET-EP
8	198.23.8.76	rtmg-gtmg-abilene.ucad.edu	...	...	70	...	Exchange Point Blocks NET-EP
9	198.23.8.53	rtmg-gtmg-abilene.ucad.edu	...	...	82	...	Exchange Point Blocks NET-EP
10	62.40.103.25	abilene-wk1.uk.gnet.net	...	...	140	...	IP allocation for GEANT network
11	62.40.86.86	ukr119.gnet.net	...	...	148	...	IP allocation for GEANT network
12	62.40.86.26	fr.chi.ch.gnet.net	...	...	156	...	IP allocation for GEANT network
13	62.40.103.18	swi202-P6-1-switch.ch	...	...	156	...	IP allocation for GEANT network
14	193.23.96.12	swi22-01-1-switch.ch	...	...	401 00	...	SWITCH-T-Telekomnetzwerk Service
15	193.23.92.1	noo-rz-giga-to-switch.ethz.ch	...	...	401 00	...	(Switzerland)
16	193.23.92.30	noo-ethz-accs-to-switch.ethz.ch	...	...	401 00	...	(Switzerland)
17	129.132.299.65	noo-rz-mega-transit.ethz.ch	...	...	401 00	...	(Switzerland)
18	129.132.1.15	eth.ch	401 00	...	(Switzerland)

Figure 3.9. A ping from the author's machine to eth.ch.

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Uniform Resource Locator (URL)

- Uniform Resource Locator (URL):** an identifier that specifies where a resource is available
 - Also referred to as a **web address**
 - Examples:
 - <http://www.washington.edu/students/reg/0809cal.html>
 - <https://weblogin.washington.edu/>

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Anatomy of a URL

<http://www.washington.edu/students/reg/0809cal.html>

protocol server's name pathname

- **pathname (or path):** name of a file or directory, specifying a unique location in a file system
 - The pathname tells the server which file (page) is requested and where to find it.
- **HTTP (Hypertext Transfer Protocol):** protocol for retrieving interlinked documents (web pages)

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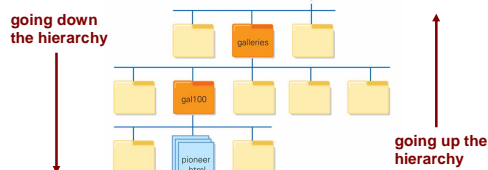
File Structure

- **directory (or folder):** collection of files, other directories, or both
- **directory hierarchy:** directories can contain other directories, which can contain other directories, etc...
- **root directory:** directory at the top of the hierarchy

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Directory Hierarchy

- Going *down* the hierarchy means into subfolders
- Going *up* the hierarchy means into **parent** (enclosing) folders; that is, towards the root



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Pathname

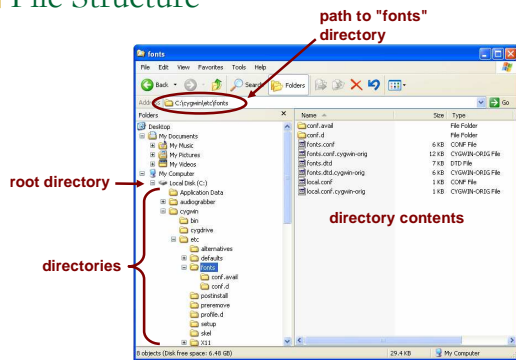
- Pathnames follow the hierarchy to the directory or file location separating components with slashes

going down the hierarchy →
 ... /galleries/gall100/pioneer.html
 ← going up the hierarchy

- In Windows, backslashes are used instead of slashes (e.g., C:\cygwin\etc\fonts\local.conf)

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File Structure



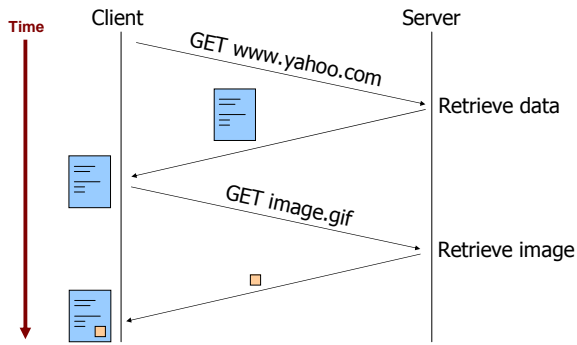
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Requesting a Web Page

1. Client requests web page from web server.
2. Server responds with web page.
3. Browser reads the web page and makes additional requests for images and any other files that form a part of the web page.
 - Additional requests might be to other servers.
4. Servers send requested resources.

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Requesting a Web Page



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Web Root Directory

- A web site's root directory is the topmost directory (in the directory hierarchy) accessible through a web browser.
- This directory might not be the absolute topmost directory in the directory hierarchy.

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Your Web Root Directory

- At the UW, your web site's root directory is called `public_html` (see Lab #2), but `public_html` is in a directory named after your UW NetID.
- `public_html` is not the absolute topmost directory, because it is in another directory!

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URL Pathname

- The pathname portion of a URL is *relative* to the web site's root directory.
- For example, if the UW's web site's root directory is called `public_html`, then the file `0809cal.html` in the URL:

<http://www.washington.edu/students/reg/0809cal.html>

is located on the server at

... `public_html/students/reg/0809cal.html`

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No Filename In URL?

- The URL `http://www.cs.washington.edu/events` points to the "events" directory (i.e., it does not specify a web page)
- What page does the web server return to the client in that case?
 - The web server will look for files with pre-defined names (like `index.html` or `index.htm`) in the specified directory in the URL.
 - If no file in the directory has any of the pre-defined names, then the server will respond with a "File not found" error.

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Exercise

- The URL `http://www.cs.washington.edu` does not specify a web page. What directory does the URL point to?
 - The web root directory of UW CSE's web space.

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Browser Tip

- Instead of typing `http://www.yahoo.com` in the address bar, just type `yahoo.com`

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Connecting To The Internet From Home

- **Internet Service Provider (ISP)**: company that offers its customers access to the Internet

- Connection types to ISP:

- Dial-up
- DSL (digital subscriber line)
- Cable Internet

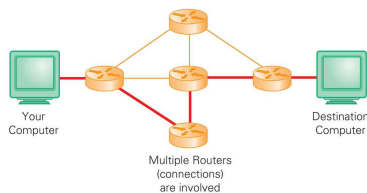
slow
↓
faster

- **broadband**: generic term for "fast" Internet access, typically contrasted with dial-up access over a modem

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Router

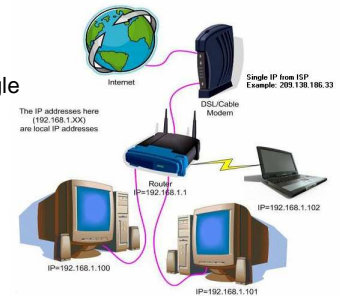
- **router**: networking device that routes and forwards information



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Router

- Can be used to connect multiple computers to a single Internet connection



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Wireless Networks

- **access point (AP)**: device that allows wireless communication devices to connect to a wireless network
- Most home wireless access points are also routers.



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Peer-To-Peer

- In a **peer-to-peer (P2P)** network, *peer* nodes simultaneously function as both client and server to the other nodes on the network.
- Some P2P networks have directory servers that inform peers of the network addresses of other peers



peer-to-peer



client-server

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