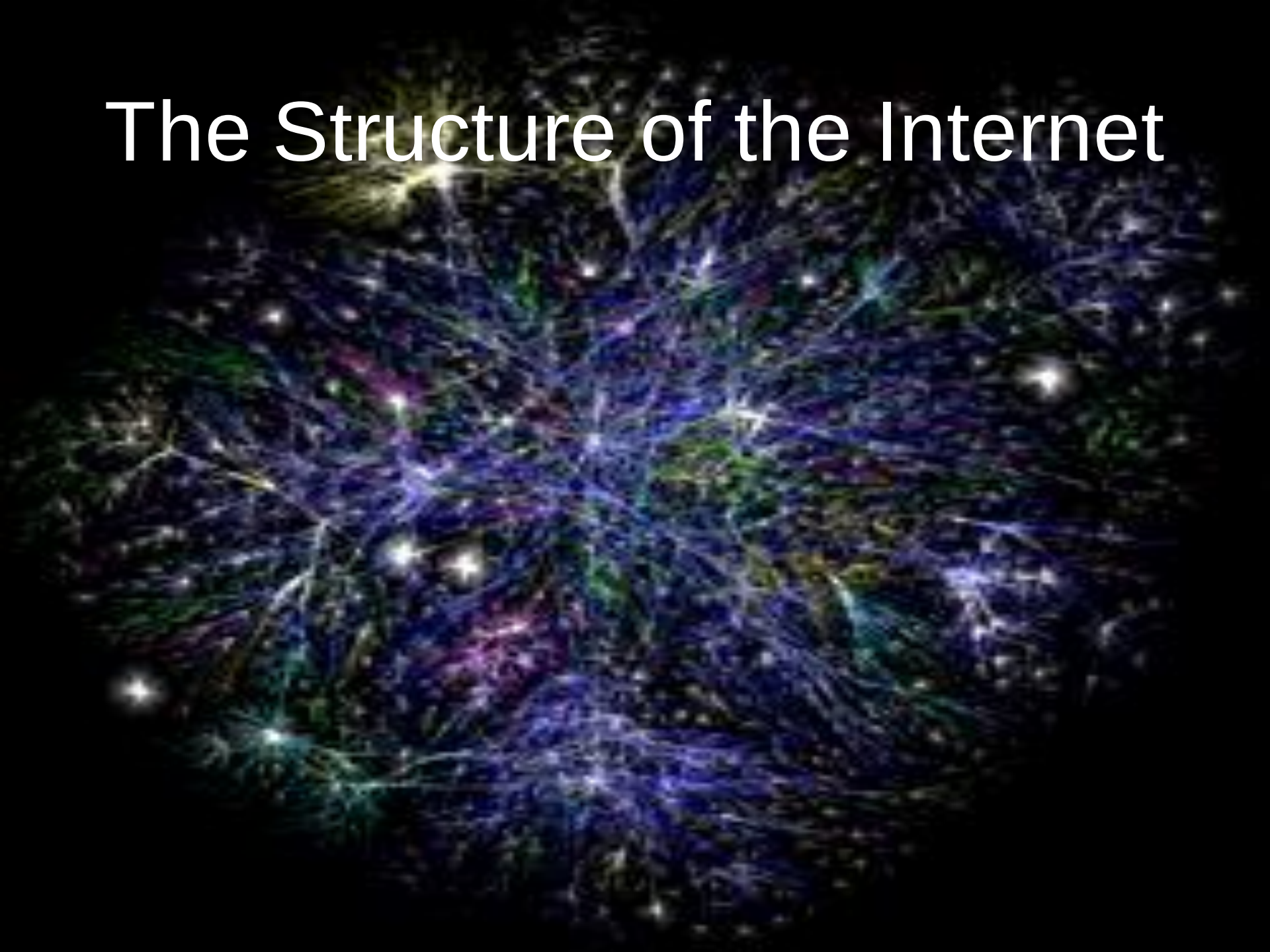
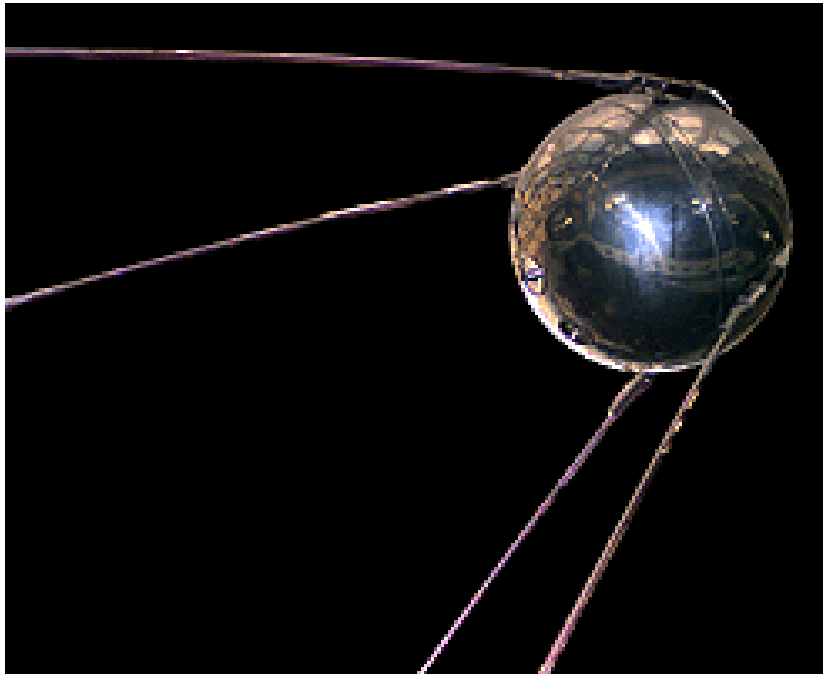
The Structure of the Internet



History

- Soviet Union first to launch a satellite into orbit
- Cold war: space race begins
- U.S. military launches Defence Advanced Research Projects Agency (DARPA)
  - Formed in 1962 to link military computers



Sputnik 1

Launched 1957 by USSR

ARPANET

- DARPA mission: keep U.S. technologically ahead of it's enemies
- created ARPANET
- started in California between UCLA and Stanford
  - Went live Oct. 29, 1969
- added universities and military sites
- evolved into the Internet
  - The term internet first appears in 1974
  - Meant any network using TCP/IP
  - Became global in the 1980's

Internet Protocols

The language at the heart of the Internet is TCP/IP…

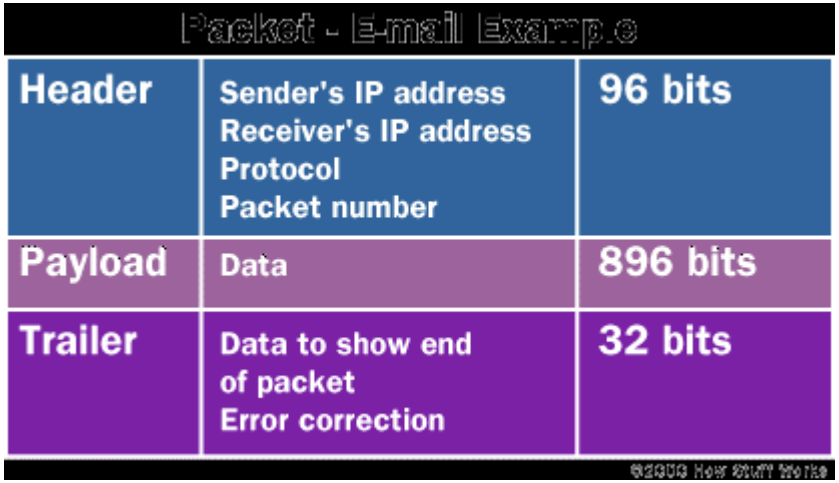
(actually a protocol stack – 4 layers)

Transmission Control Protocol/Internet Protocol

… that allows cross-network communication

Internet Protocols

- **TCP breaks messages into packets**
  - Each packet has all the information needed to travel from network to network
  - Host systems called *Routers* determine how to route transmissions



Internet Protocols

IP is about…

- Addressing & Delivery
  - Each Internet host computer has a unique *IP Address*
  - Each address is comprised of four sets of numbers separated by periods, such as

    142.104.95.126
  - Each set can contain numbers from 0 to 255
  - Separated into classes – A to E

Looking to the Future

IPv4 – (Internet Protocol version 4)

- e.g. 142.104.231.5
- addresses available: 4,294,967,296 (~4.3 billion)
- number of humans on the planet: ~6.5 billion
- Static vs. dynamic
- All have been allocated as of Feb. 3, 2011

IPv6 – (Internet Protocol version 6)

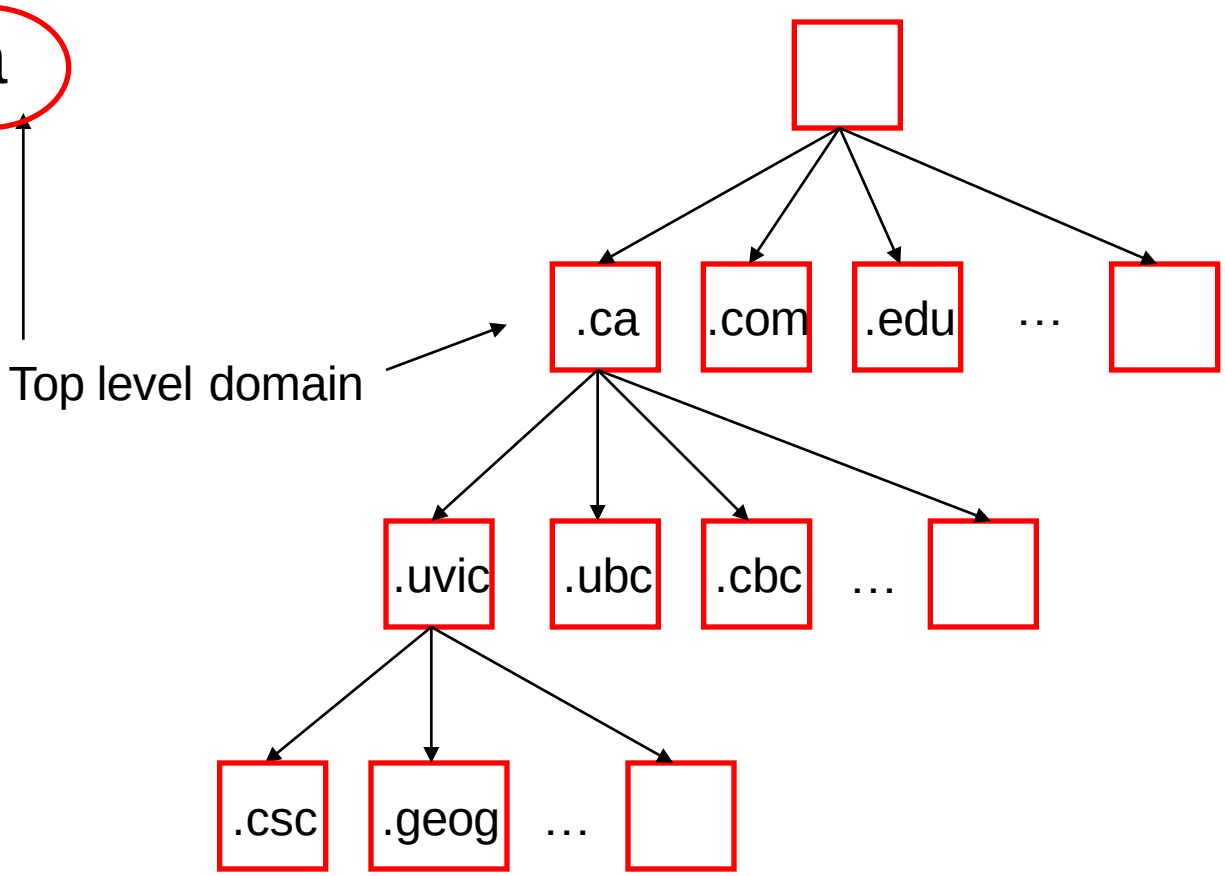
- Started in 1998
- e.g. 2001:0db8:0000:0000:0000:0000:1428:57ab
- addresses available: 340,282,366,920,938,463,463,374,607,431,768,211,456
- enough to give

Domain Name System

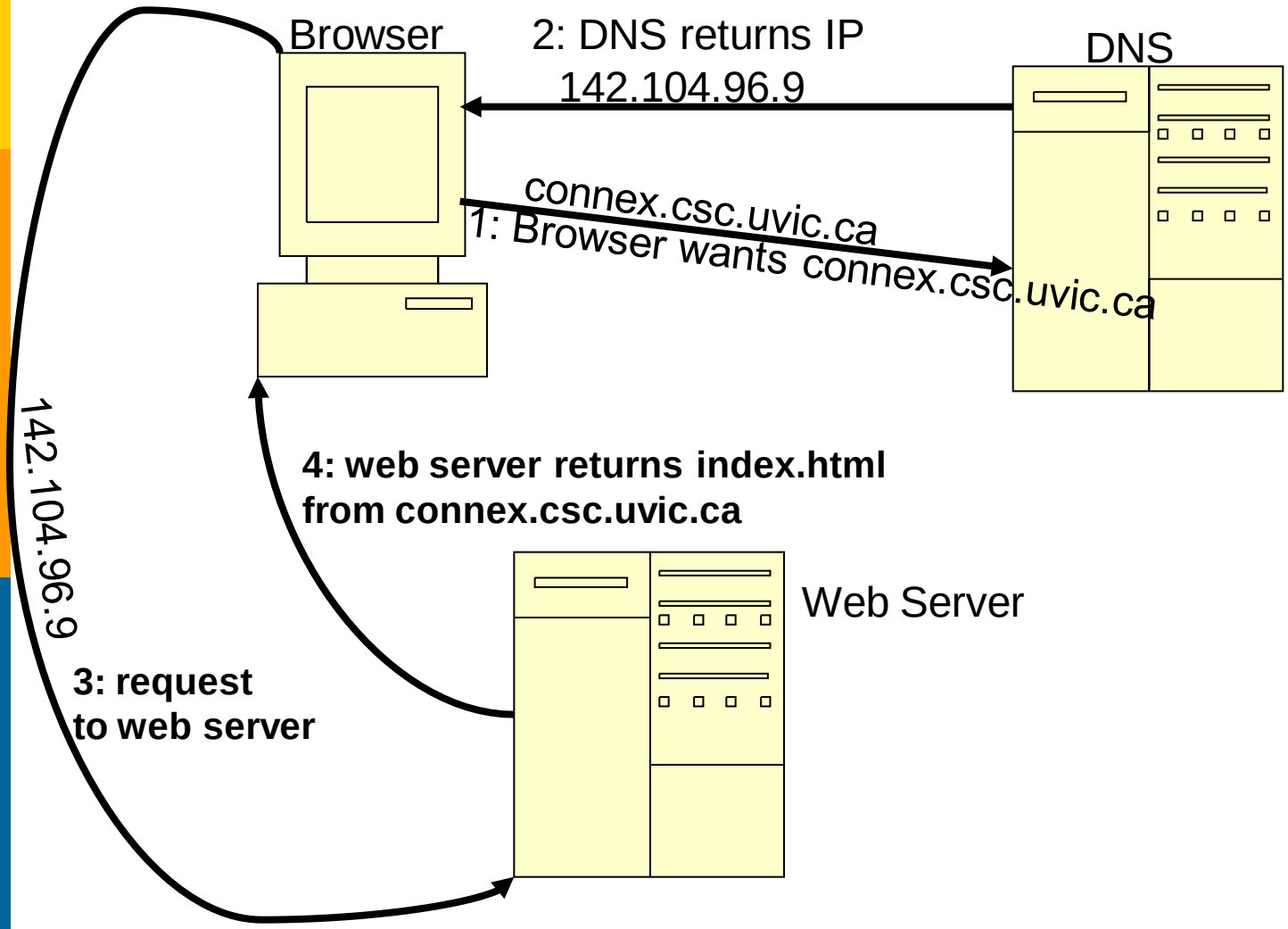
- translate domain names into internet addresses
- E.g. www.uvic.ca = 142.104.5.64
- Started in 1983
- Distributed database
- Complex, well-hidden task
  - Billions of IP addresses
  - Billions of DNS requests per day
  - Domain names and IPs change daily
  - New domain names created daily
  - Millions of people work on multiple systems

Domains

- www.uvic.ca



TCP-IP, the Domain Name System and Internet Routers
In-class diagram example



Internet Services

The Internet provides a variety of services such as:

- Electronic mail (send/receive mail messages)
- Remote login (Telnet - access to other computers)
- File transfer (ftp)
- WWW
- Talk/chat (instant messenger)
- Video conference
- VoIP

What's the common theme with all these services?

Internet and World Wide Web

The Internet and the World Wide Web are NOT the same thing

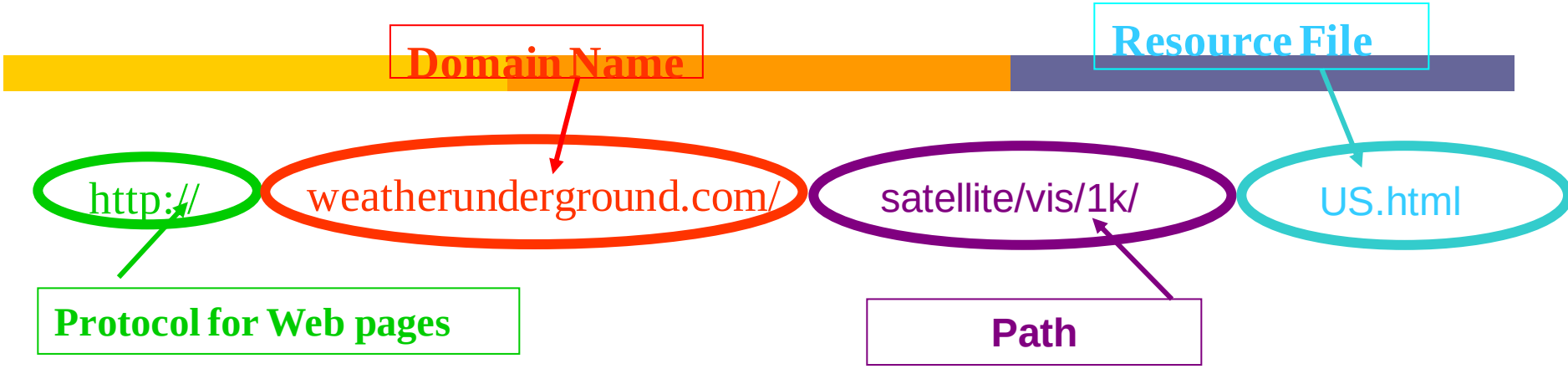
- **Internet:** A global interconnected network of computer networks that transmit data by packet switching

- **World Wide Web:** A collection of multimedia documents linked by hyperlinks. The WWW forms part of the Internet.

Inside the Web

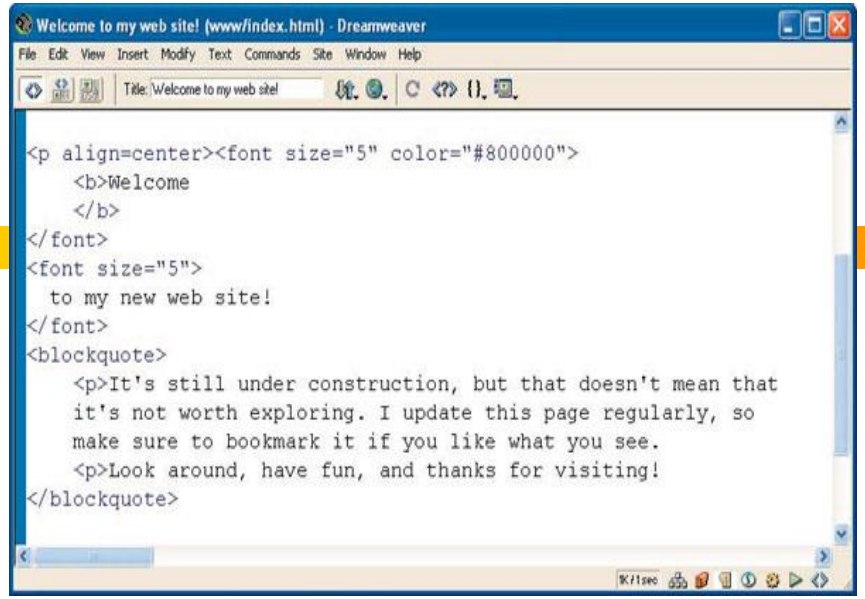
Web Protocols: HTTP and HTML

- ✓HTTP (Hypertext transfer protocol) used to transfer Web pages



- ✓HTML (HyperText Markup Language) created for encoding and displaying documents

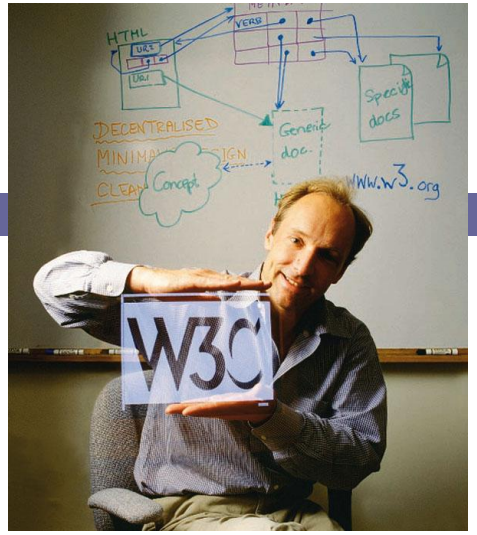
Inside the Web



- ✓ HTML is not WYSIWYG (What You See Is What You Get).

Tim Berners-Lee Weaves the Web for Everybody

- ✓Born in London in 1955
- ✓Wanted to create an open-ended distributed hypertext system with no boundaries, so scientists everywhere could link their work together
- ✓Invented the World Wide Web and gave it to all
- ✓Now works at MIT
- ✓Heads the World Wide Web Consortium (W3C)



Example

- Let's take an example and see how these pieces fit together.
- Example:
  - Your friend suggests that you take a look at Flickr, one of many places to share photos on the web. She sends you a link to: http://www.flickr.com/explore/
  - You open the link in a web browser.

HTTP Protocol

Step 1:

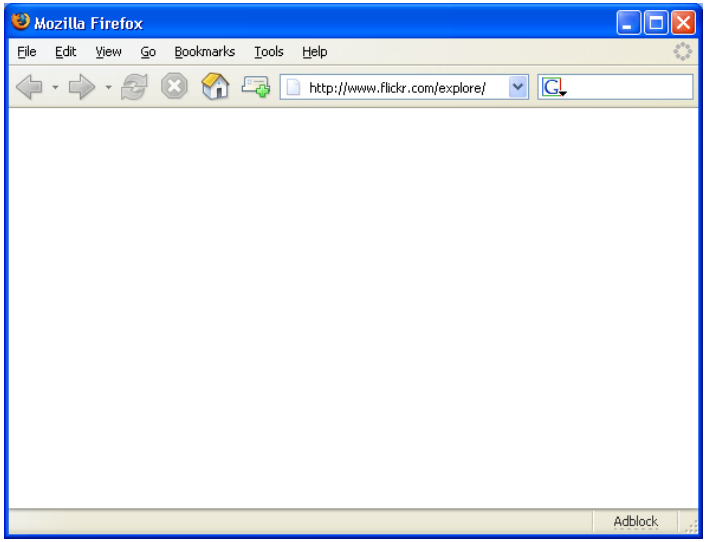
- The web browser prepares a request using the http protocol.

The address you entered:

http://www.flickr.com/explore

becomes the request:

```
GET /explore HTTP/1.1
Host: www.flickr.com
```



Uniform Resource Locator (URL)

Step 2:

- The Internet Protocol must interpret the web address – Universal Resource Locator (URL) – you entered.

```
GET /explore HTTP/1.1
Host: www.flickr.com
```

Domain Name System

Step 3:

- Access the Domain Name System (DNS) to translate the URL into an IP address.

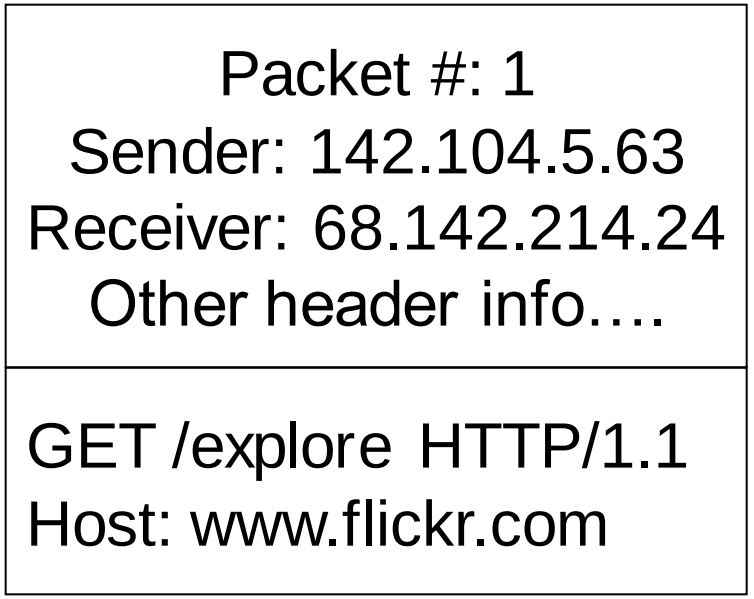
www.flickr.com

68.142.214.24

Transmission Control Protocol (TCP)/ Internet Protocol (IP)

Step 4:

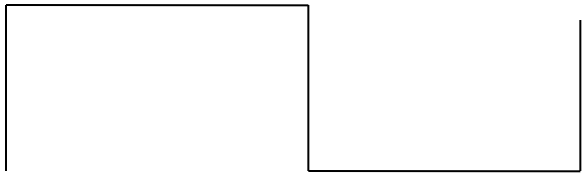
- We can now split the message into packets and add headers
- Address the packets
- Send the message out.



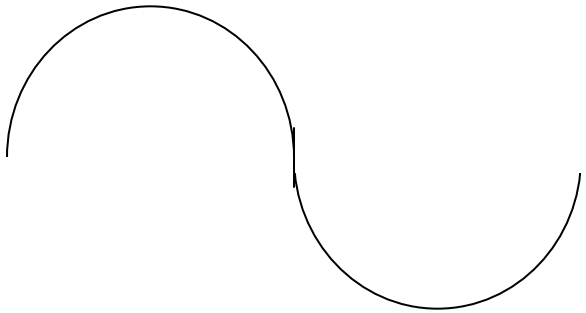
ADSL, Cable and Phone

Step 5:

- The message passes through the modem – whether it is an ADSL, cable or phone modem.



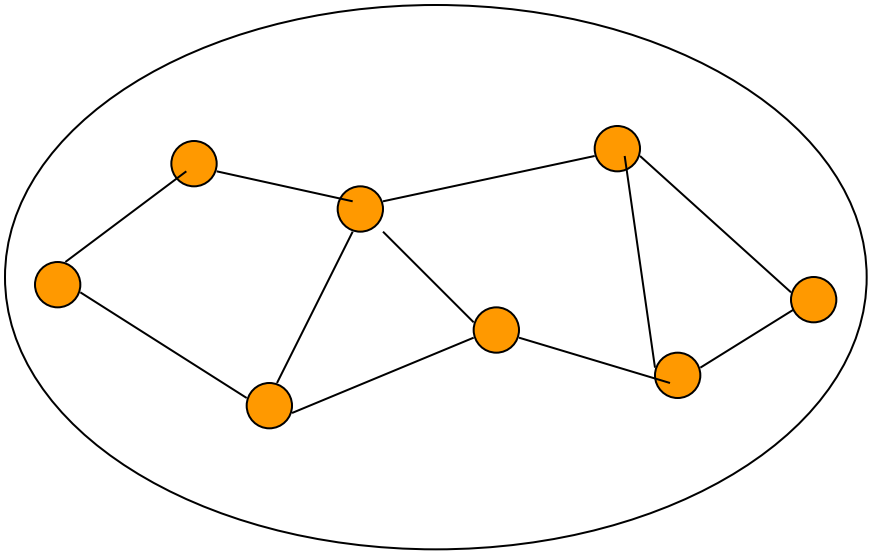
- The modem converts from digital to analog, as necessary.



Routing

Step 6:

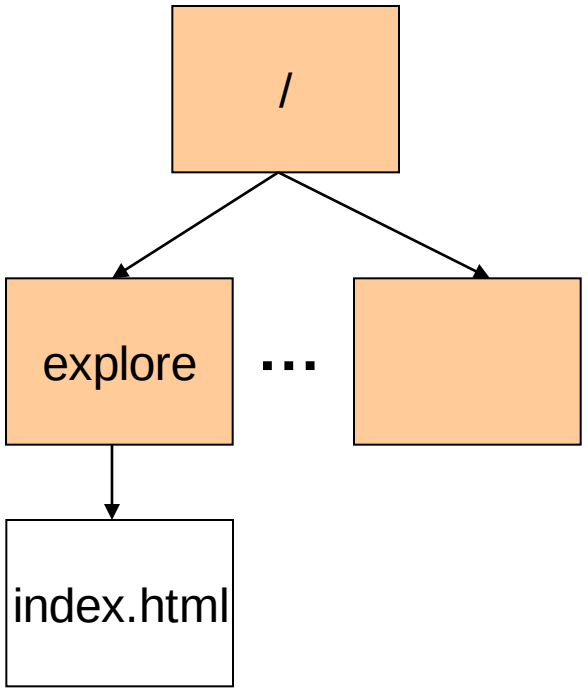
- The message is routed through the Internet.

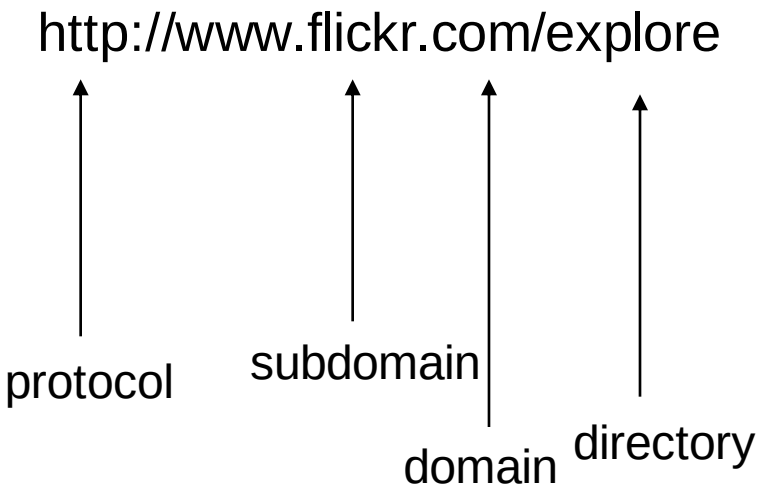


Client / Server

Step 7:

- The appropriate web server receives the request and uses the path to find the files.





Response

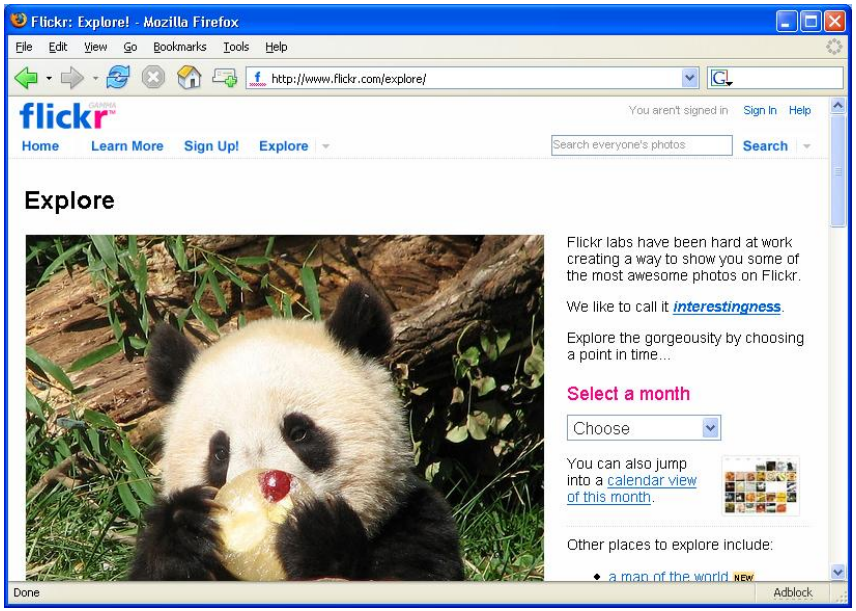
Step 8:

- Send a response
  - Prepare files
  - IP protocol
  - TCP protocol
  - Send through hardware
  - Route through Internet

Receive response

Step 9:

- Received by your computer
  - Converted through modem
  - Collected by TCP
  - Reassembled by IP
  - Rendered by your web browser



Tools

- Can we see this routing?
  - tracert domain name
- What's your IP address
  - ipconfig/all

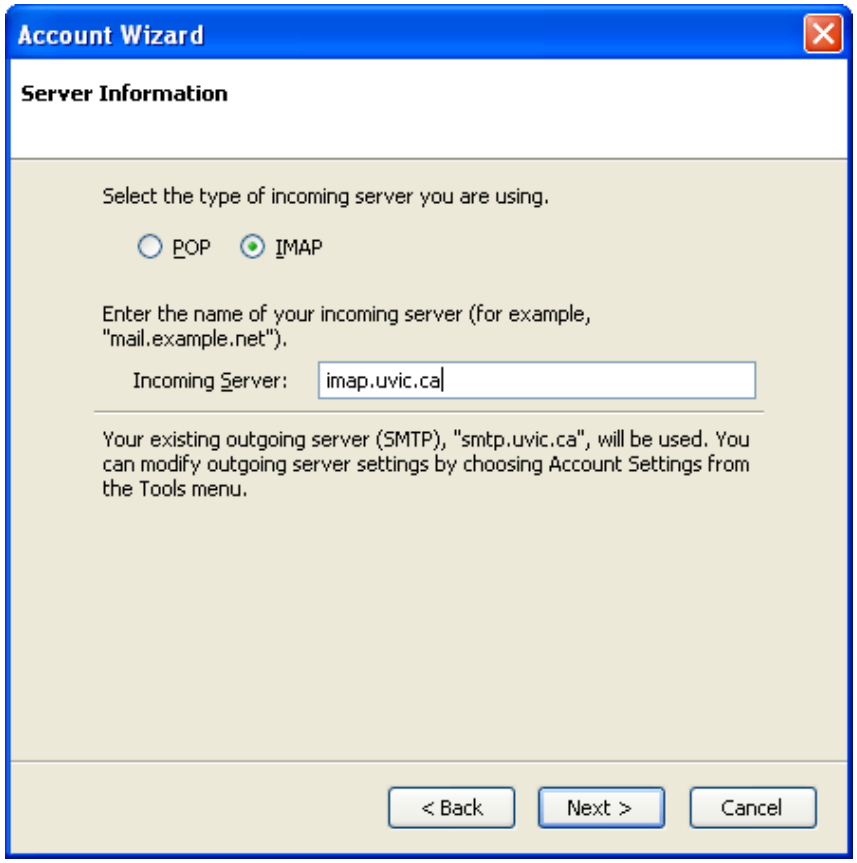
E-mail Addresses

An Internet address includes:
username@hostname.sub.dom

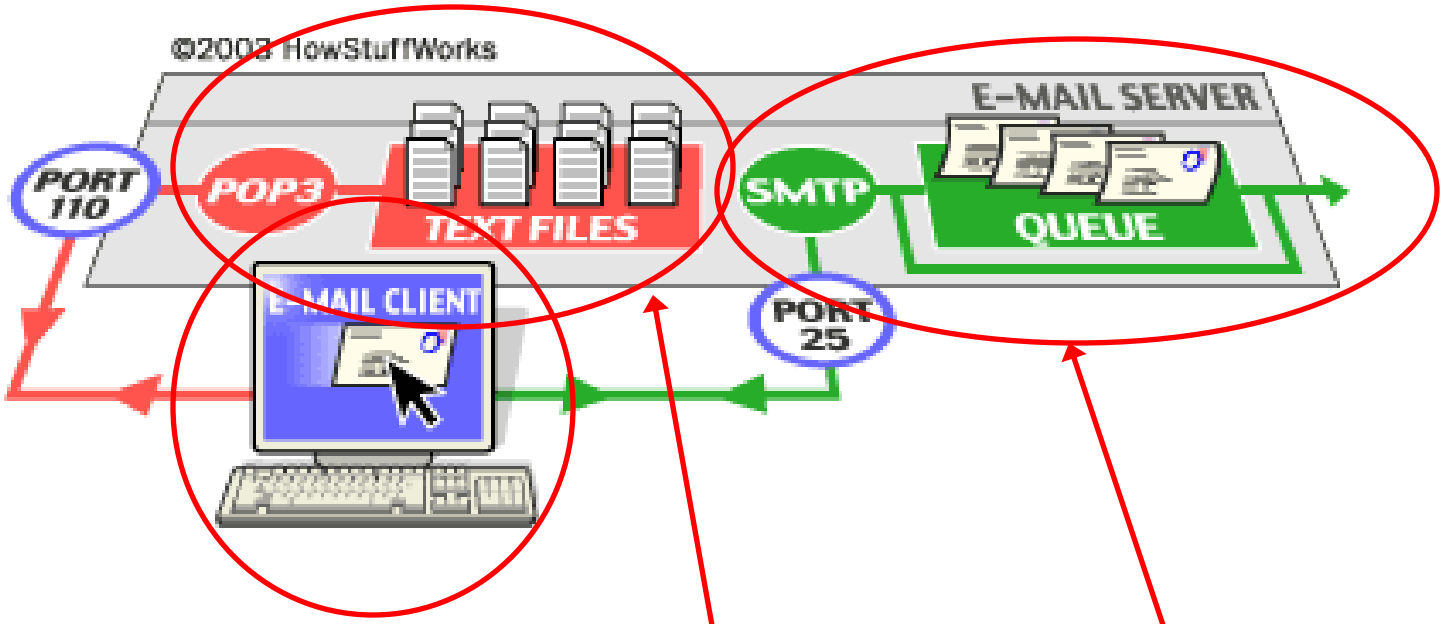
- **username** is the person's "mailbox"
- **hostname** is the name of the host computer and is followed by one or more domains separated by periods:
  - host.subdomain.domain
  - host.domain
  - host.subdomain.subdomain.domain

How does email work?

- We saw how messages are divided up when they are sent
- But where is the mailbox actually kept?
  - They are kept on a server
  - We tell our email client (application) where to look for our messages
- Example email clients:
  - Microsoft Outlook
  - Microsoft Outlook Express
  - Mozilla Thunderbird



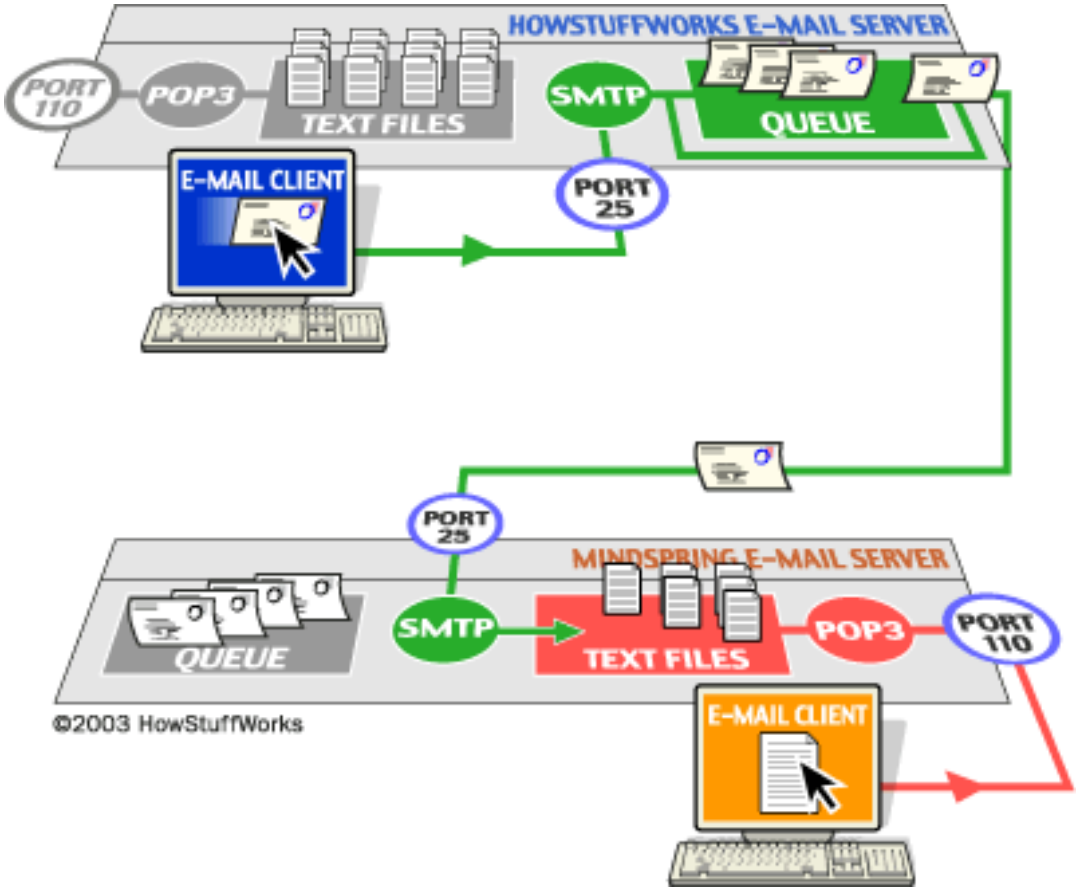
Accessing Email



Incoming mail
(i.e. mail sent to us)

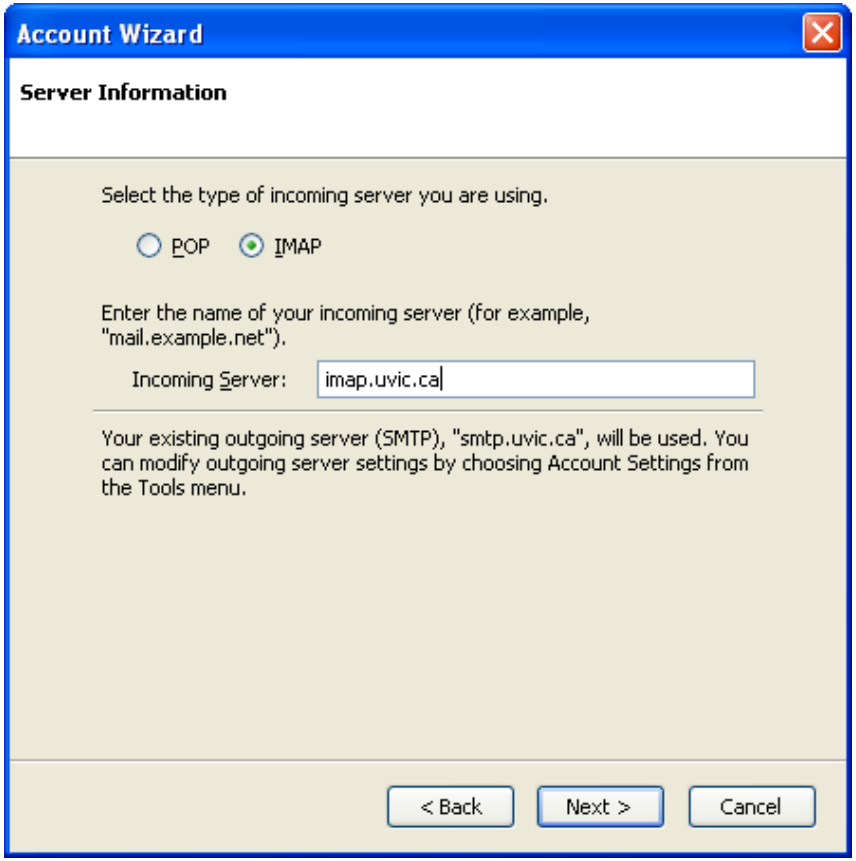
Outgoing mail
(i.e. mail we send)

Sending and Receiving Email



How does email work?

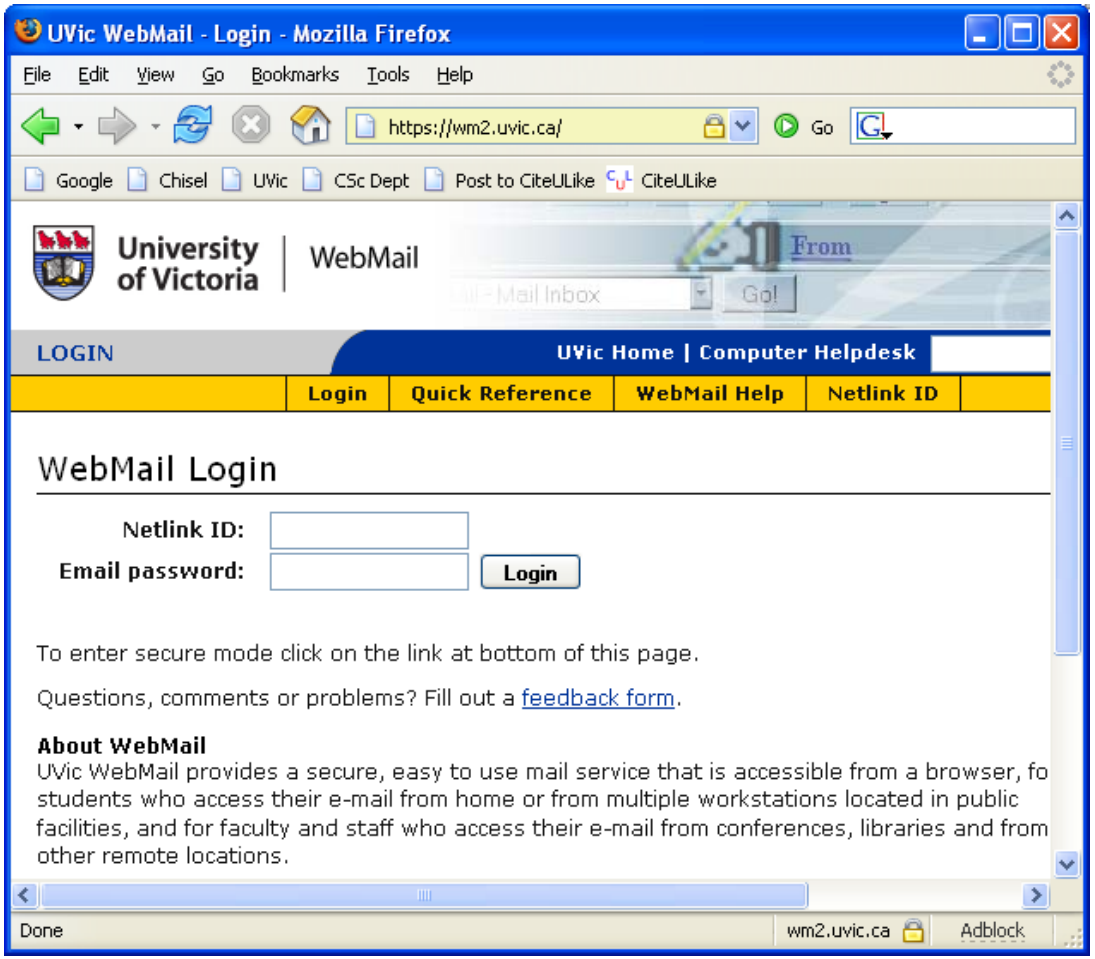
- When you set up your email client, it will ask you for information about the servers to use.
  - What is your incoming server?
  - What is your outgoing server?



What's with all the protocols?

- POP (Post Office Protocol) – e.g. pop.uvic.ca
  - messages downloaded to computer, not kept on server
  - once downloaded, can only be viewed on that computer, but you don't need access to the Internet to read them
- IMAP (Internet Messaging Access Protocol) - imap.uvic.ca
  - messages kept on server
  - messages accessible anywhere, but requires Internet connection
- SMTP (Simple Mail Transfer Protocol) – e.g. smtp.uvic.ca
  - common protocol for sending email

Online email

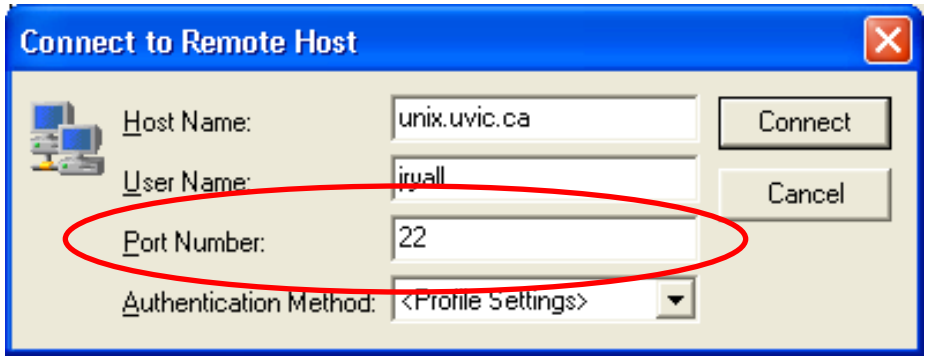


With online email, this process still exists.

However, since you're viewing them in a web browser and not downloading them, these details are hidden from you.

Ports

- How does a server know it is receiving an http request?
- How does a server know it is receiving an ftp request?
- How does a server know it is receiving an e-mail request?



Port Numbers

- Specify the type of communication
- In the header of the packet
- Maps the body of the packet to the proper application
- There are 50,000 ports with some conventions:
  - smtp = 25
  - pop3 = 110
  - http = 80
  - ftp = 22
  - https = 443