Session 2

Background

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Lecture Objectives

- Understand how an Internet resource is accessed
- Understand the high level structure of the "Internet cloud"
- Understand the high level structure of the TCP/IP protocols
- Understand how a computer finds the IP address of a host using DNS
- Know the structure of MIME type standards

Reference

- Mime types
  http://www.w3schools.com/media/media_mimeref.asp
- Cyber Security
  - Cyber War by Richard Clarke and Robert Knake, Harper Collins, 2010

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What is a URL?

- A short string that identifies a resource on the Web
- Stands for Uniform Resource Locator
  - Uniform - varied and new types of resources
  - Resource - Anything that has identity (e.g., image)
- Reduces the tedium of connecting to a host, selecting a path, selecting a resource, etc. into a single string that:
  - Can be saved as a bookmark in your browser
  - Can be saved as an object in your Java code

URL Example

http://www.cs.sunysb.edu

Protocol identifier *Resource name*

- Protocol Identifier - Indicates the name of the protocol to be used to fetch the resource
- Resource name is the complete address of the resource
- Resource name may be appended with a fragment / reference / named anchor (denoted by #) or include a query string (denoted by ?)

URL Resource Name

- For http, the name includes: host name, path name to the file, port number (optional), and location within the resource (optional)
- The resource is not necessarily a file, it can be generated on the fly

Very important concept

- A trailing slash (www.sun.com/) is shorthand for the file named /index.html

Relative URLs

- Contains only enough information to reach the resource relative to (in the context of) another URL
- Used within HTML files

```
<td> <a href="LectureCode.html" >Intro</a></td>
```

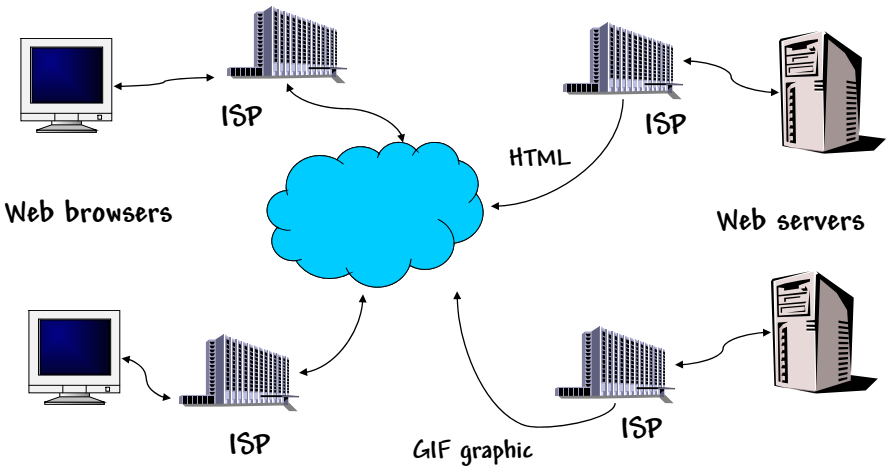
- specified relative to the location of the file in which they are contained

```
URL context =
  new URL("http://www.sciam.com/feature_directory.cfm");
  URL aURL = new URL(context, "myImage.gif");
```


Examples of URL Schemes

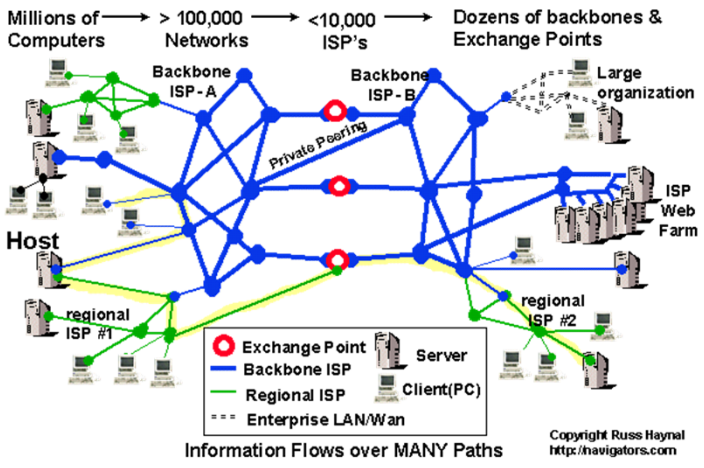
- The standard Java library currently provides support for http and ftp
- Other protocols can be used with some extra coding
  - tel:+358-555-1234567
  - fax:+358.555.1234567
  - modem:+3585551234567;type=v32b?7e1;type=v110
  - tel:+358-555-1234567;postd=pp22
  - mailto:majordomo@example.com?body=subscribe%20bamboo-l

Web Architecture



Internet Physical Layer

- Multiple backbones
- Multiple ISPs
- Multiple exchange points



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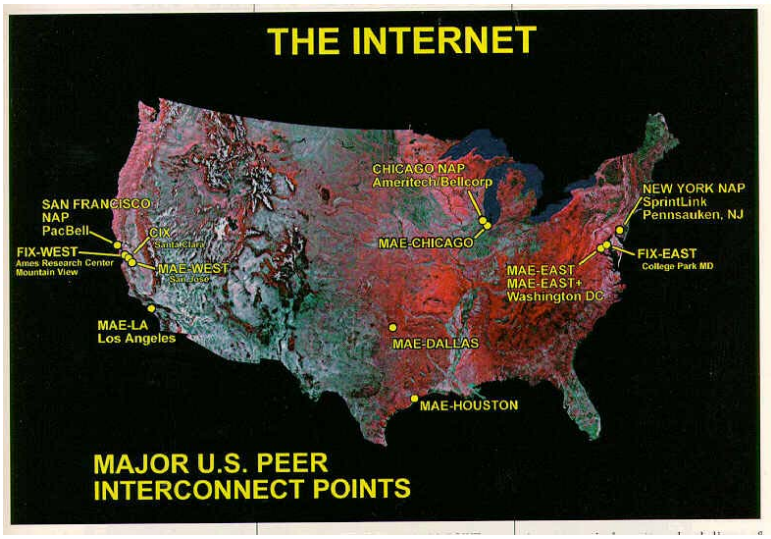
Internet Interconnect Points



US Backbone Providers

- Tier 1 ISPs
  - Verizon
  - AT&T
  - Qwest
  - Sprint
  - Level 3
  - Global Crossing

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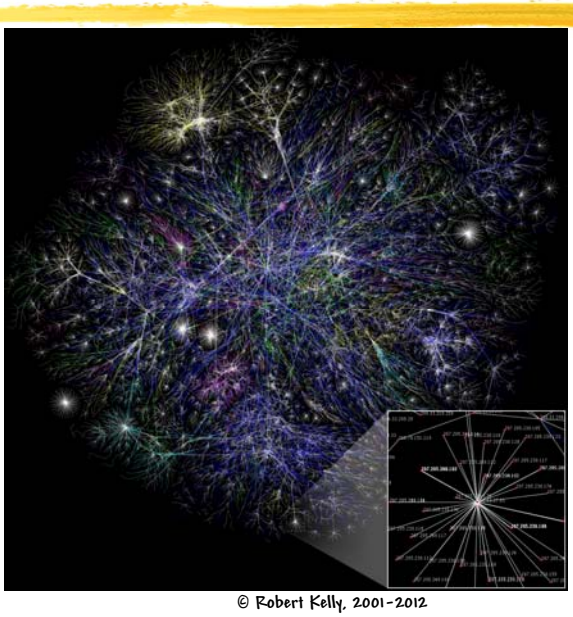
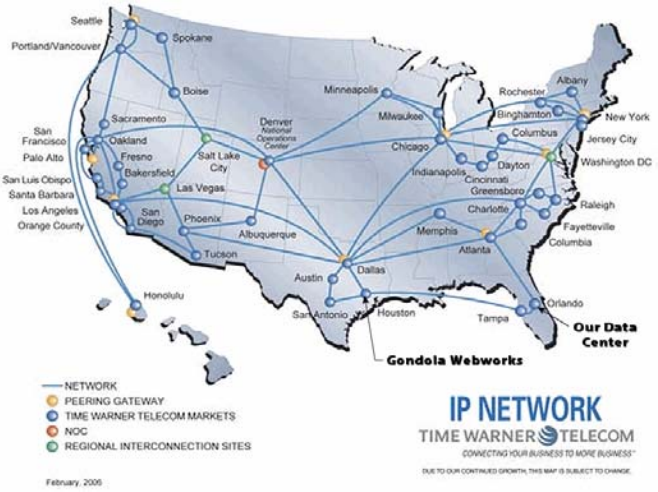
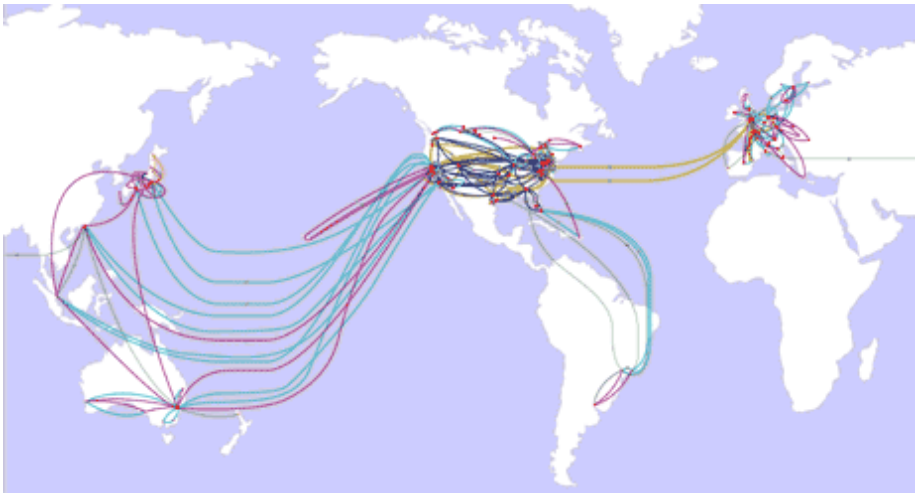
Internet



Time Warner Network Map



WorldCom Backbone



Asia Backbone

Terms

- Protocols - control the sending and receiving of information over the Internet
- Physical media - cable, copper wire, fiber, radio spectrum
- Routers - intermediate switching devices
- Route (or path) - sequence of physical media and routers to complete end-to-end communication
- Packet switching - decomposing a message into packets and routing the packets to a destination

Transport Protocols

- Internet connection-oriented service is implemented through buffers at the sending and receiving end

TCP

- Transmission Control Protocol
- Connection based
- Reliable flow of data between two computers

UDP

- User Datagram Protocol
- Connectionless service
- Order of delivery is not guaranteed

TCP/IP

- IP (Internet Protocol) - network layer protocol that specifies the format of information that is sent and received among routers and end nodes

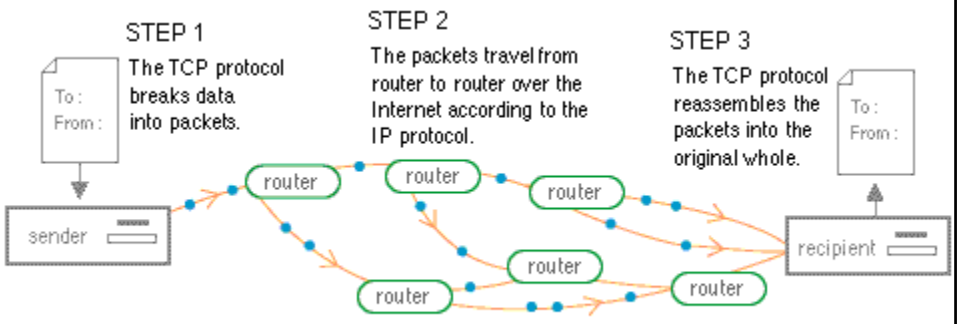
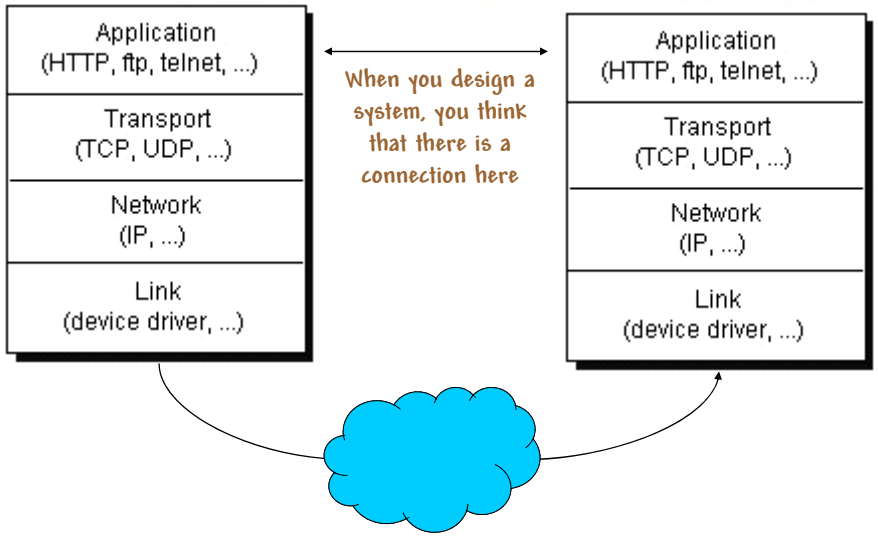


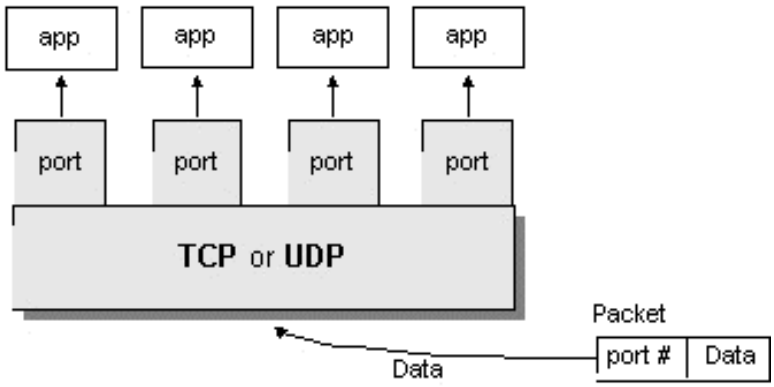
Figure 2. How data travels over the Net.

Internet Protocol Stacks



Port

- To communicate with a computer, you need to specify the address of the host computer and the identity of the receiving process on the host computer



Typical Port Number Assignments

Service	Port
telnet	23
smtp	25
whois++	63
http	80

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How Does a Browser Work?

- It reads a named resource (usually an HTML document) on an Internet-based server
- Begins to display the page
- Finds all the URLs in the HTML
- Requests the resources associated with the other URLs (e.g., images)
- Includes the additional resources in the display of the page

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How Does the Internet Find a Host?

- URL contains a host name, (e.g., www.cnn.com)
- Internet routers identify hosts by their IP address
  - 4 bytes, presented in dotted-decimal notation
    - decimal numbers, separated by periods (e.g., 121.7.106.83)
    - Each number is between 0 and 255
  - The 4 fields identify 4 levels in the network hierarchy
  - 2^{32} possible IP addresses (in IP V4)
- DNS (Domain Name System) is a directory service that translates host names (sometimes referred to as domain names) into IP addresses

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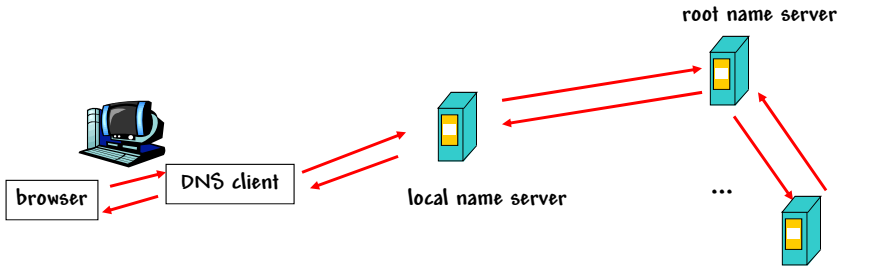
How DNS Works



- Browser passes host name to DNS client.
- DNS client looks up IP address from the distributed database located on the DNS name servers
  - Local
  - Root
  - Authoritative

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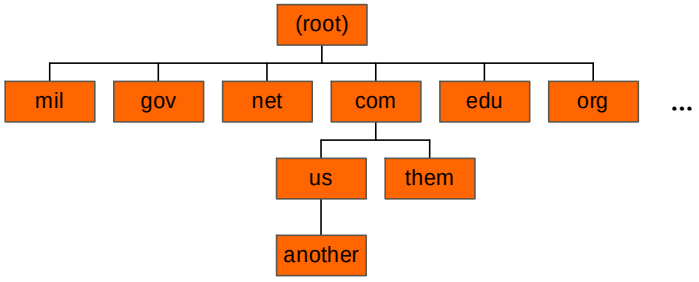
Domain Name Service

- Used to map host names (contained within a URL) into network addresses (32 bit IP address)
- Name space (partial)



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Other DNS Services

- Host aliasing - a host can have one or more alias names (e.g., ibm.com and www.ibm.com), one of which is the canonical hostname
- Aliasing by service - a company can use the same host name for its Web server, mail server, ftp server, etc. even though these are different computers with different IP addresses
- Load distribution - a set of IP addresses can be associated with a canonical hostname. DNS will return the set of addresses, varying the order of addresses each time it is accessed

How many hosts do you think are associated with google.com?

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DNS Concepts to Remember

- DNS provides name to address mapping
- DNS is implemented through local address caching
- DNS is a distributed database service
  - Very reliable
  - Not always fast
  - Not always up to date

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Cyber Security Issues

- Internet is inherently insecure
- Industries and country economies are increasingly dependent on the Internet
- Many successful cyber attacks
- Examples of cyber warfare (e.g., Estonia and Georgia)
- Development of cyber warfare capabilities by some countries

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Vulnerabilities of the Internet[1]

- Routing among ISPs - Border Gateway Protocol routes packets across the Internet, but there is no checking of authenticity of messages
- No governance of the Internet beyond domain names
- Operational messages are unencrypted
- Malware can be easily propagated
- Decentralized design

An advanced packet sniffer on an Ethernet network can look at all the traffic

1. Clarke, R. Cyber War

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What is a MIME Type?

- Multipurpose Internet Mail Extensions
- Designed for the interchange of data among various e-mail systems
- Allows for universal interchange of data
- Defines naming of file types
- Organized into 8 base type categories

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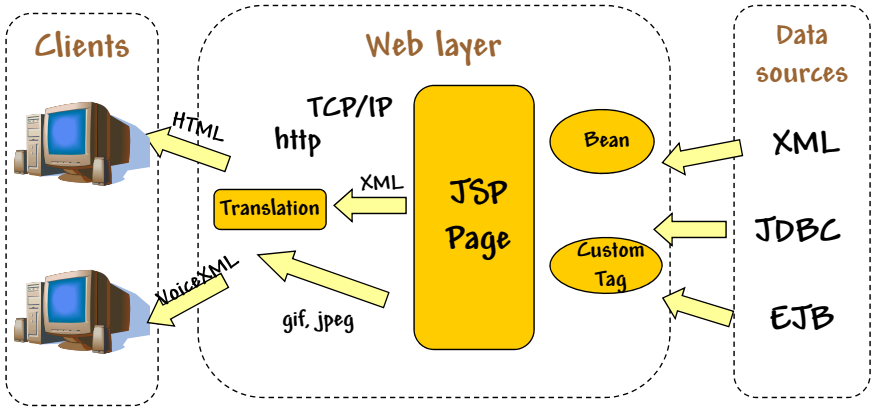
Extended Web Architecture



The host-host data transfers usually involve one MIME file

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"Base" Media Types

- application - application and miscellaneous
- audio - audio data
- image - image data
- message - news, e-mail, etc.
- model - models (e.g., geometric)
- multipart - multipart
- text - HTML, CSS, etc.
- video - video data
- unregistered - name usually begins with an "x-"
  - x-troff-ms

e.g., image/png

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MIME Type Concepts to Remember

- Internet files have standard formats so that data can be exchanged easily between very different computers (hardware, OS, etc.)
- Sender specifies the type and receiver interprets the data accordingly, taking into account all the differences in internal data representation

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Did You Achieve the Lecture Objectives?

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