# CHAPTER 7
# THE APPLICATION LAYER
# (应用层)

- **DNS**
- **WWW**
- **EMAIL**
- Multimedia*
- Content Delivery*

# DNS (Domain Name System, 域名服务)

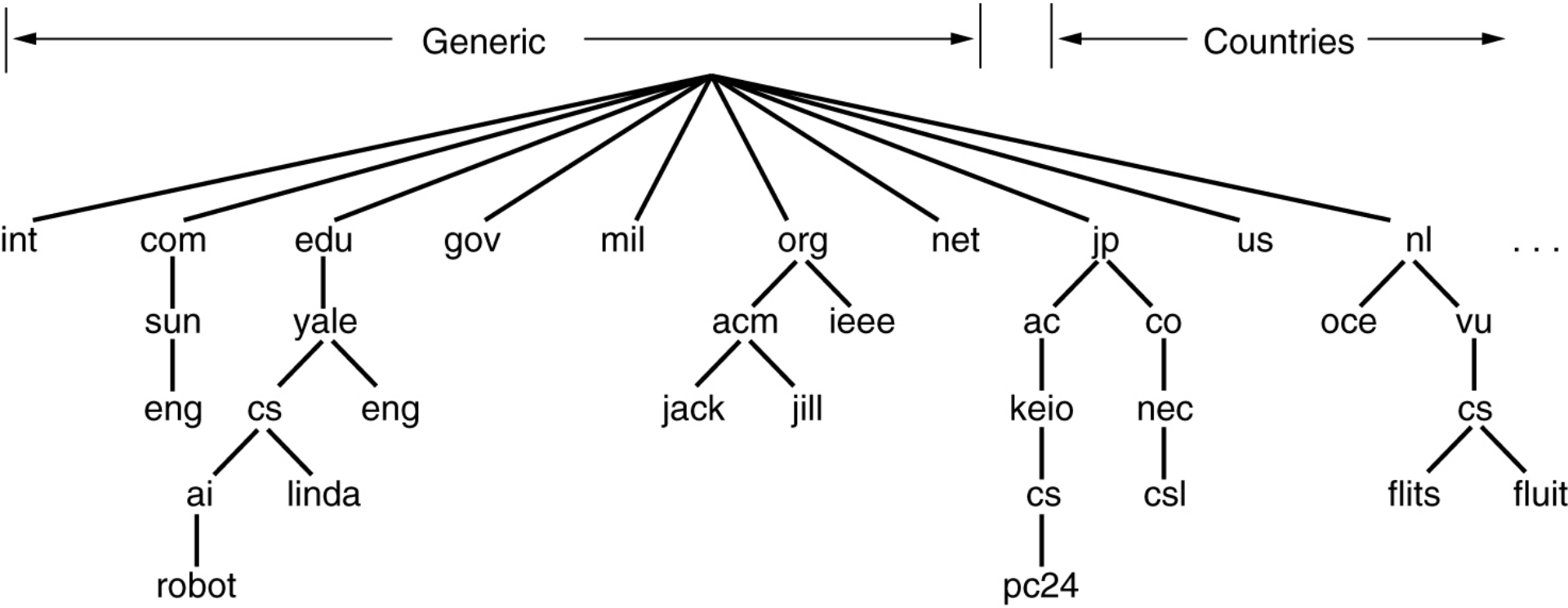
- Why DNS?
- The DNS Name Space
- Resource Records
- Name Servers

# DNS: Why?

- Machine addresses vs. machine names
- Hosts.txt
  - Good for a small network
  - The size of the file would be a problem for a large network.
  - Hostnames would conflict.
  - → DNS (Domain Name System).
- DNS (RFCs 1034, 1035, 2181)
  - A hierarchical, domain-based naming scheme
  - A distributed database system for implementing this scheme.

# DNS: Name space

A portion of the Internet domain name space.



# DNS: Name space

## Generic top-level domains

| Domain | Intended use | Start date | Restricted? |
|---|---|---|---|
| com | Commercial | 1985 | No |
| edu | Educational institutions | 1985 | Yes |
| gov | Government | 1985 | Yes |
| int | International organizations | 1988 | Yes |
| mil | Military | 1985 | Yes |
| net | Network providers | 1985 | No |
| org | Non-profit organizations | 1985 | No |
| aero | Air transport | 2001 | Yes |
| biz | Businesses | 2001 | No |
| coop | Cooperatives | 2001 | Yes |
| info | Informational | 2002 | No |
| museum | Museums | 2002 | Yes |
| name | People | 2002 | No |
| pro | Professionals | 2002 | Yes |
| cat | Catalan | 2005 | Yes |
| jobs | Employment | 2005 | Yes |
| mobi | Mobile devices | 2005 | Yes |
| tel | Contact details | 2005 | Yes |
| travel | Travel industry | 2005 | Yes |
| xxx | Sex industry | 2010 | No |

# DNS: Name space

- The top-level domains come in two flavors:
  - generic (*com, edu, gov, int, mil, net, org, biz, info, pro, aero, coop, museum,* ...) and
  - countries (*cn, uk,* ...).
- The lower level-domains are easy to get.
- Each domain is named by the path upward from it to the (unnamed) root, such as *zju.edu.cn.*
- Domain names can be either absolute or relative.
  - An absolute domain name always ends with a period (e.g., *eng.sun.com.),*
  - whereas a relative one does not.

# DNS: Name space

- Domain names are **case insensitive**, so *edu*, *Edu*, and *EDU* mean the same thing.
- Component names can be up to 63 characters long, and full path names must not exceed 255 characters.
- Domains can be inserted into the tree in either generic or country domains.  For example, sony.com, sony.nl.
- Each domain controls how it allocates the domains under it.
- To create a new domain, permission is required of the domain in which it will be included
- Naming follows organizational boundaries, not physical networks.

# DNS: Resource records

- Every domain, whether it is a single host or a top-level domain, can have a set of resource records associated with it.
- A resource record is a five-tuple

  (Domain_name, Time_to_live, Class, Type, Value).

**The principal DNS resource records types.**

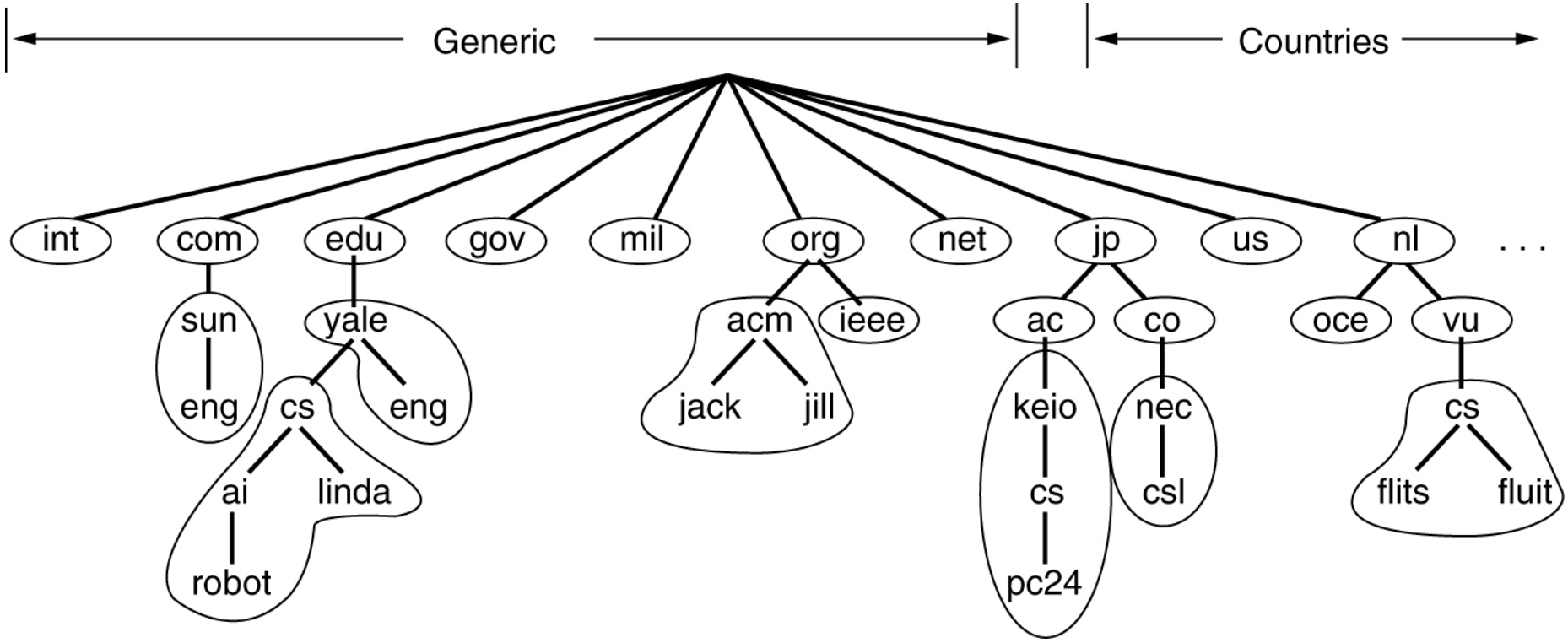
| Type | Meaning | Value |
|---|---|---|
| SOA | Start of authority | Parameters for this zone |
| A | IPv4 address of a host | 32-Bit integer |
| AAAA | IPv6 address of a host | 128-Bit integer |
| MX | Mail exchange | Priority, domain willing to accept email |
| NS | Name server | Name of a server for this domain |
| CNAME | Canonical name | Domain name |
| PTR | Pointer | Alias for an IP address |
| SPF | Sender policy framework | Text encoding of mail sending policy |
| SRV | Service | Host that provides it |
| TXT | Text | Descriptive ASCII text |

# A portion of a possible DNS database for *cs.vu.nl.*

```
; Authoritative data for cs.vu.nl
cs.vu.nl.       86400   IN   SOA     star boss (9527,7200,7200,241920,86400)
cs.vu.nl.       86400   IN   MX      1 zephyr
cs.vu.nl.       86400   IN   MX      2 top
cs.vu.nl.       86400   IN   NS      star

star            86400   IN   A       130.37.56.205
zephyr          86400   IN   A       130.37.20.10
top             86400   IN   A       130.37.20.11
www             86400   IN   CNAME   star.cs.vu.nl
ftp             86400   IN   CNAME   zephyr.cs.vu.nl

flits           86400   IN   A       130.37.16.112
flits           86400   IN   A       192.31.231.165
flits           86400   IN   MX      1 flits
flits           86400   IN   MX      2 zephyr
flits           86400   IN   MX      3 top

rowboat                 IN   A       130.37.56.201
                        IN   MX      1 rowboat
                        IN   MX      2 zephyr

little-sister           IN   A       130.37.62.23

laserjet                IN   A       192.31.231.216
```

# DNS: Name servers

Part of the DNS name space showing the division into zones.

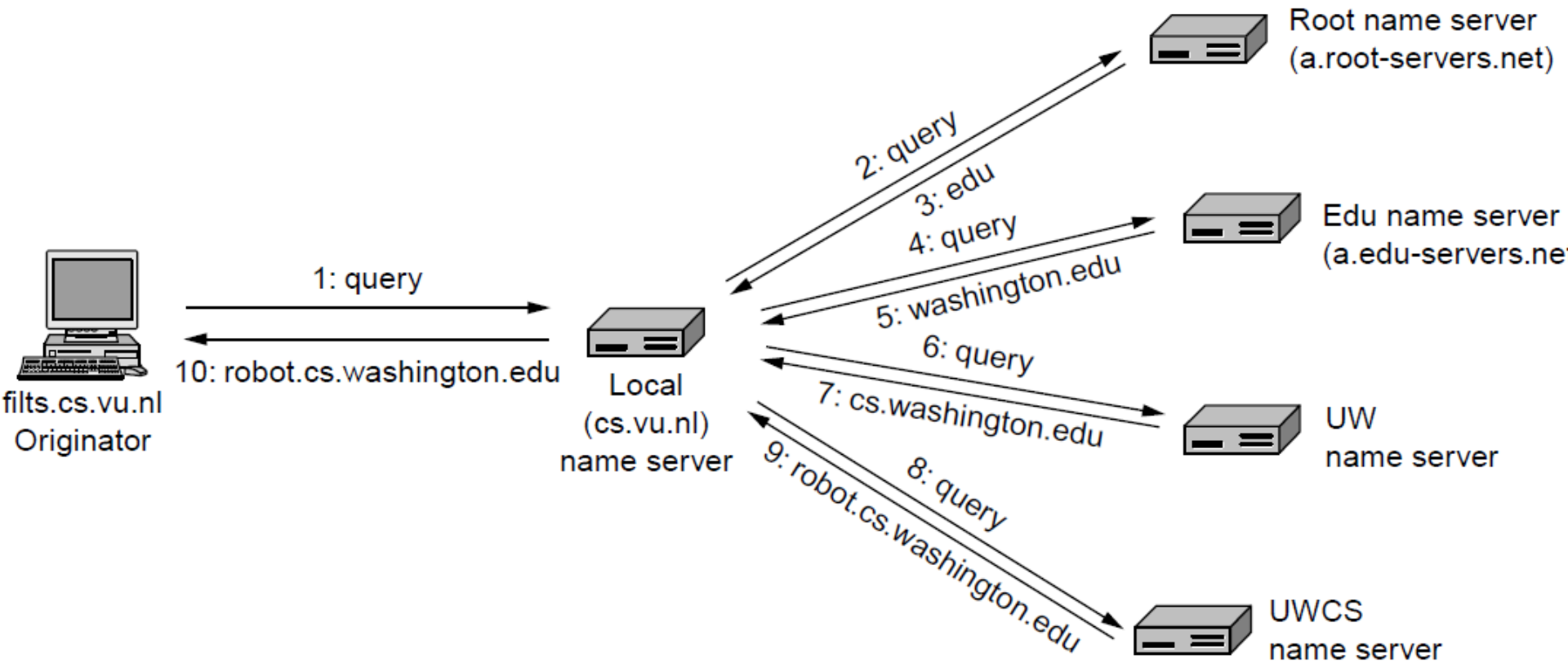


# DNS

- An **authoritative record** is one that comes from the authority that manages the record and is thus always correct. → **authoritative server.**
- **Cached records** may be out of date.
- **root name servers:** There are 13 root DNS servers, unimaginatively called *a-root-servers.net* through *m.root-servers.net*. They have information about each top-level domain.

# DNS: Name servers

Example of a resolver looking up a remote name **robot.cs.washington.edu** in 10 steps.



# DNS: Query mechanism

- **Recursive query**: The mechanism that a host queries the local name server. E.g. when the host *flits.cs.vu.nl* sends its query to the local name server, that name server handles the resolution on behalf of *flits* until it has the desired answer to return. It does *not* return partial answers. They might be helpful, but they are not what the query was seeking.
- **Iterative query**. The mechanism that the local name server queries the root name server and each subsequent name server. e.g. root name server does not recursively continue the query for the local name server. It just returns a partial answer and moves on to the next query. The local name server is responsible for continuing the resolution by issuing further queries.

# DNS: useful commands

- **nslookup** –qt=A emnets.org
- **nslookup** –qt=MX mail.emnets.org

- **dig**@a.edu-servers.net  robot.cs.washington.edu // send a query for *robot.cs.washington.edu* to the *a.edu-servers.net* name server and print out the result.

# WORLD WIDE WEB

- Architectural Overview
- Static Web Pages
- Dynamic Web Pages
- HTTP – The HyperText Transfer Protocol
- The Mobile Web
- Web Search

# WWW: Introduction

- The Web (also known as WWW) began in 1989 at CERN (The European center for nuclear research).
- The initial proposal for a web of linked documents came from CERN physicist **Tim Berners-Lee** in March 1989.
- In December 1991, a public demonstration was given at the Hypertext'91 conference in San Antonio, Texas.
- In 1993 **Mosaic** was released in February. Mark Andreessen at the University of Illinois.
- In 1995, **Netscape** Communications Corp went public.
- In 1998, America Online bought Netscape Communication Corp for $4.2 billion.
- W3C (www.w3.org).

# Marc Andreessen

Marc Andreessen is the co-creator of Mosaic, the Web browser that popularized the World Wide Web in 1993. Mosaic had a clean, easily understood interface and was the first browser to display images in-line with text. In 1994, Marc Andreessen and Jim Clark founded Netscape, whose browser was by far the most popular browser through the mid-1990s. Netscape also developed the Secure Sockets Layer (SSL) protocol and many Internet server products, including mail servers and SSL-based Web servers. He is now a co-founder and general partner of venture capital firm Andreessen Horowitz, overseeing portfolio development with holdings that include Facebook, Foursquare, Groupon, Jawbone, Twitter, and Zynga. He serves on numerous boards, including Bump, eBay, Glam Media, Facebook, and Hewlett-Packard. He holds a BS in Computer Science from the University of Illinois at Urbana-Champaign.

**Please describe one or two of the most exciting projects you have worked on during your career. What were the biggest challenges?**

Undoubtedly the most exciting project was the original Mosaic web browser in '92–'93—and the biggest challenge was getting anyone to take it seriously back then. At the time, everyone thought the interactive future would be delivered as "interactive television" by huge companies, not as the Internet by startups.

**Is there anything in particular students should be aware of as Web technology advances?**

The rate of change—the most important thing to learn is how to learn—how to flexibly adapt to changes in the specific technologies, and how to keep an open mind on the new opportunities and possibilities as you move through your career.

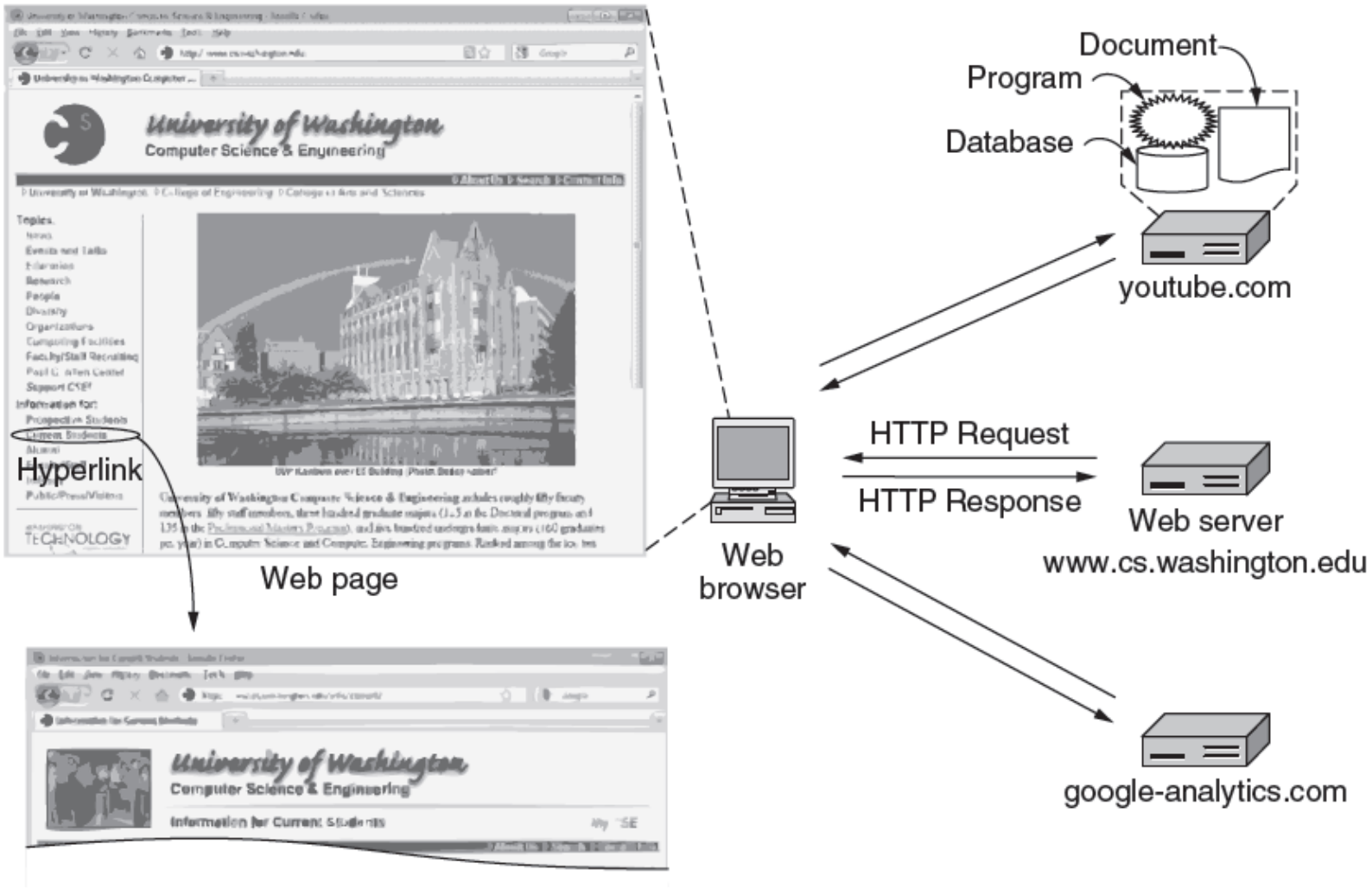
**What are your recommendations for students who want to pursue careers in computing and information technology?**

Go as deep as you possibly can on understanding how technology is created, and then complement with learning how business works.

**Can technology solve the world's problems?**

No, but we advance the standard of living of people through economic growth, and most economic growth throughout history has come from technology—so that's as good as it gets.

# WWW: Architectural overview



# WWW: Architectural overview: Browser

- What is the page called? (Filename)
- Where is the page located? (DNS Name)
- How can the page be accessed? (HTTP, FTP, …)

- URL: Universal Resource Locator
- URL = protocol (http) + DNS name + path name

# WWW: URL examples

| Name | Used for | Example |
|---|---|---|
| http | Hypertext (HTML) | http://www.ee.uwa.edu/~rob/ |
| https | Hypertext with security | https://www.bank.com/accounts/ |
| ftp | FTP | ftp://ftp.cs.vu.nl/pub/minix/README |
| file | Local file | file:///usr/suzanne/prog.c |
| mailto | Sending email | mailto:JohnUser@acm.org |
| rtsp | Streaming media | rtsp://youtube.com/montypython.mpg |
| sip | Multimedia calls | sip:eve@adversary.com |
| about | Browser information | about:plugins |

# WWW: Architectural overview: Browser

What does the browser do when one link is selected:

- The browser determines the URL (by seeing what was selected).
- The browser asks DNS for the IP address of *www.zju.edu.cn*.
- DNS replies with *210.32.0.9*.
- The browser makes a TCP connection to port 80 on *210.32.0.9*.
- It then sends over a request asking for file */home/index.html*.
- The *www.zju.edu.cn* server sends the file */home/index.html*.
- The TCP connection is released.
- The browser displays all the text in */home/index.html*.
- The browser fetches and displays all images in this file.

# WWW: URL → URI

- A URL points to one specific host, but sometimes it is useful to reference a page without simultaneously telling where it is. e.g."I want page *xyz*, but I do not care where you get it."
- To solve this kind of problem, **URLs have been generalized into URIs** (Uniform Resource Identifiers).
  - Some URIs tell how to locate a resource. These are the URLs.
  - Other URIs tell the name of a resource but not where to find it. These URIs are called URNs (Uniform Resource Names).
- The rules for writing URIs are given in RFC 3986

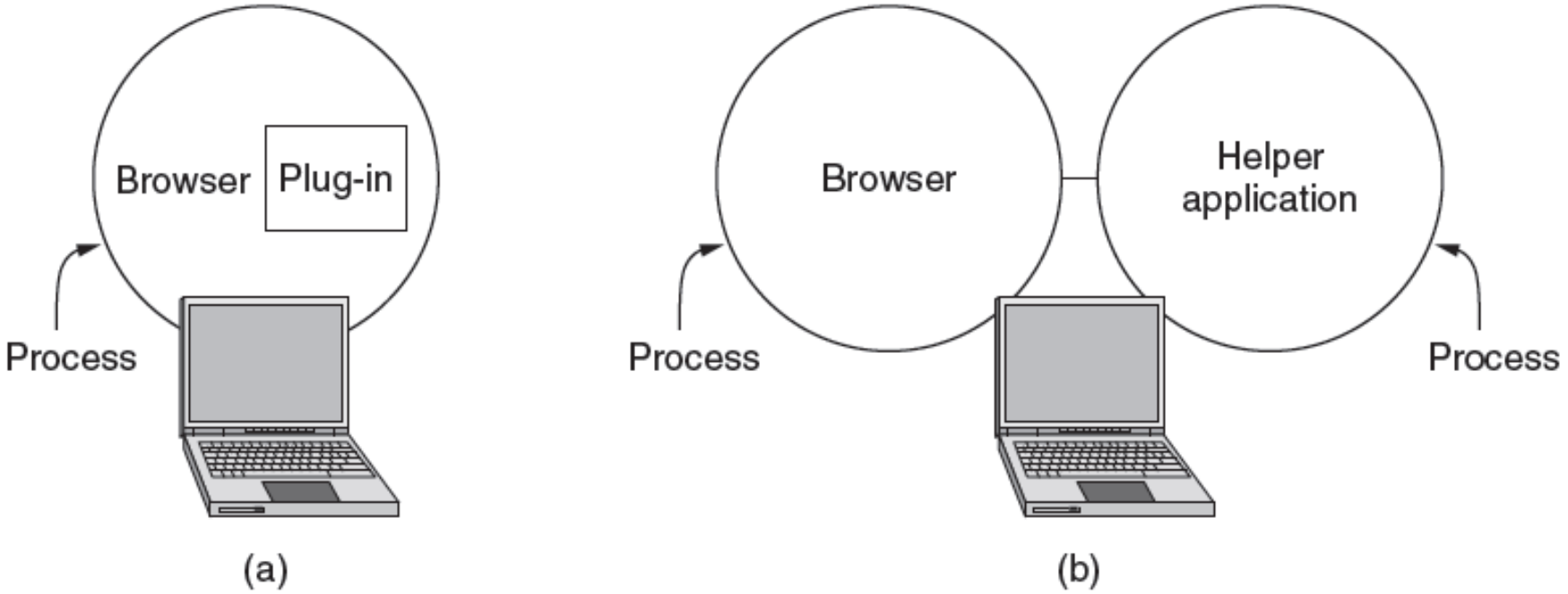
# WWW: Architectural overview: Browser

- Browsers can handle many additional types besides HTML pages.
- Browser can use MIME types.

- How to handle other MIME types:
  - Plug-ins: A plug-in is a code module that the browser fetches from a special directory on the disk and installs as an extension to itself.
  - Helper applications: A help application is a complete program, running as a separate process.

# WWW: Architectural overview: Browser

The client side: (a) A browser plug-in. (b) A helper application.



# WWW: Architectural overview: Server

The browser sends over a command containing the file name on that server. Then the server returns the file for the browser to display.

The short steps that the server performs in its main loop:

1. Accept a TCP connection from a client (a browser).
2. Get the name of the file requested.
3. Get the file (from disk).
4. Return the file to the client.
5. Release the TCP connection.

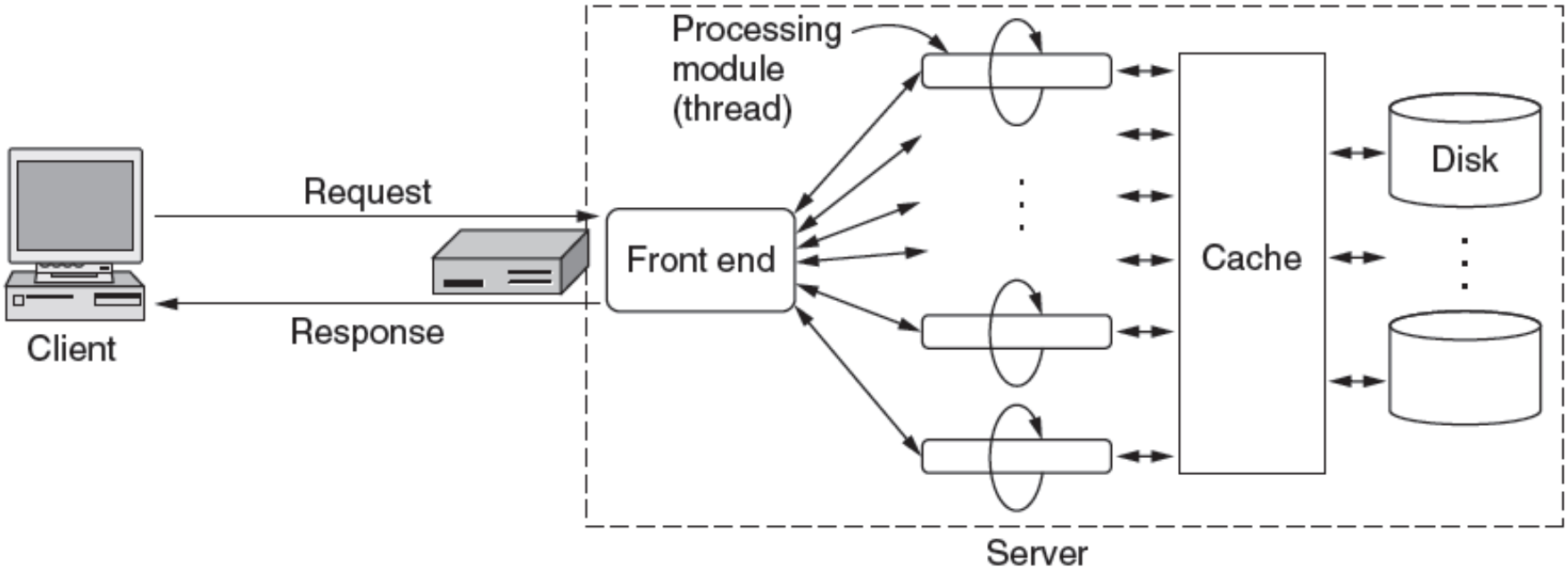
# WWW: Architectural overview: Server

The detailed steps that the server performs in its main loop are:

1. Resolve the name of the Web page requested.
2. Perform access control on the Web page.
3. Check the cache.
4. Fetch the requested page from disk or run a program to build it.
5. Determine the rest of the response (e.g., the MIME type to send).
6. Return the response to the client.
7. Make an entry in the server log.

# WWW: Architectural overview: Server

A multithreaded Web server with a front end and processing modules.



# WWW: Architectural overview: Cookies

- The Web is basically stateless.
  - How to distinguish between requests from registered users and everyone else?
  - How to keep track of the contents of the cart (for e-commerce)?
  - How to customize Web portals such as Yahoo?
- To track users by observing their IP addresses?
  - The IP address merely identifies the computers, not the user.
  - Many ISP use NAT (Network Address Translation).
- To track users by **cookies**.

# WWW: Architectural overview: Cookies

- A cookie may contain up to 5 fields
  - **Domain**: where the cookie came from
  - **Path**: which parts of the server's file tree may use it
  - **Content**: *name=value* lists
  - **Expires**: when the cookie expires.
  - **Secure**: can be set to indicate that the browser may only return the cookie to a server using a secure transport.

| Domain | Path | Content | Expires | Secure |
|---|---|---|---|---|
| toms-casino.com | / | CustomerID=297793521 | 15-10-10 17:00 | Yes |
| jills-store.com | / | Cart=1-00501;1-07031;2-13721 | 11-1-11 14:22 | No |
| aportal.com | / | Prefs=Stk:CSCO+ORCL;Spt:Jets | 31-12-20 23:59 | No |
| sneaky.com | / | UserID=4627239101 | 31-12-19 23:59 | No |

# WWW: Architectural overview: Cookies

- The first cookie was set by toms-casino.com and is used to identify the customer.
- When the client returns next week to throw away some more money, the browser sends over the cookie so the server knows who it is.
- Armed with the customer ID, the server can look up the customer's record in a database and use this information to build an appropriate Web page to display.
- Depending on the customer's known gambling habits, this page might consist of a poker hand, a listing of today's horse races, or a slot machine.

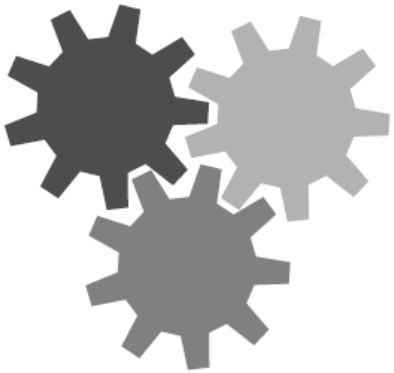
# WWW: Static Web Pages: HTML

- HTML (HyperText Markup Language)
  - (Markup for copyeditors → troff → Tex/Latex → HTML)
- A web page consists of a head and a body, each enclosed by <html> and </html>
  - The head is bracketed by the <head> and </head>
  - The body is bracketed by the <body> and </body>
- Tags:
  - <something> and </something>
  - Can have attributes
  - Can be in either lower case or upper case, but lower case is best for compatibility.
- Some special characters such as   (a space)

# WWW: Static Web Pages: HTML example

```
<html>
<head><title> AMALGAMATED  WIDGET,  INC. </title> </head>
<body> <h1> Welcome to AWI's Home Page</h1>
<img src="http://www.widget.com/images/logo.gif" ALT="AWI  Logo"> <br>
We are so happy that you have chosen to visit <b> Amalgamated  Widget's </b>
home page. We hope <i> you </i> will  find  all the information you need here.
<p>Below we have links to information  about our many fine products.
You can order  electronically (by WWW), by  telephone, or by fax. </p>
<hr>
```

## Welcome to AWI's Home Page



We are so happy that you have chosen to visit **Amalgamated Widget's** home page. We hope *you* will find all the information you need here.

Below we have links to information about our many fine products. You can order electronically (by WWW), by telephone, or by email.

---

# WWW: Static Web Pages: HTML example

```
<h2> Product information  </h2>
<ul>
   <li> <a href="http://widget.com/products/big">  Big widgets </a>
   <li> <a href="http://widget.com/products/little">   Little widgets </a>
</ul>
<h2> Telephone numbers</h2>
<ul>
   <li> By telephone: 1-800-WIDGETS
   <li> By fax:  1-415-765-4321
</ul>
</body>
</html>
```

**Product Information**

- Big widgets
- Little widgets

**Contact information**

- By telephone: 1-800-WIDGETS
- By email: info@amalgamated-widget.com

# WWW: Static Web Pages: HTML:
## A selection of common HTML tags. some can have additional parameters.

| Tag | Description |
|---|---|
| <html> ... </html> | Declares the Web page to be written in HTML |
| <head> ... </head> | Delimits the page's head |
| <title> ... </title> | Defines the title (not displayed on the page) |
| <body> ... </body> | Delimits the page's body |
| <h *n*> ... </h*n*> | Delimits a level *n* heading |
|  ...  | Set ... in boldface |
|  ...  | Set ... in italics |
|  ...  | Center ... on the page horizontally |
| <ul> ... </ul> | Brackets an unordered (bulleted) list |
| <ol> ... </ol> | Brackets a numbered list |
| <li> | Starts a list item (there is no </li>) |
| <br> | Forces a line break here |
| <p> | Starts a paragraph |
| <hr> | Inserts a Horizontal rule |
| <img src="..."> | Displays an image here |
| <a href="..."> ... </a> | Defines a hyperlink |

# WWW: Static Web Pages: HTML versions

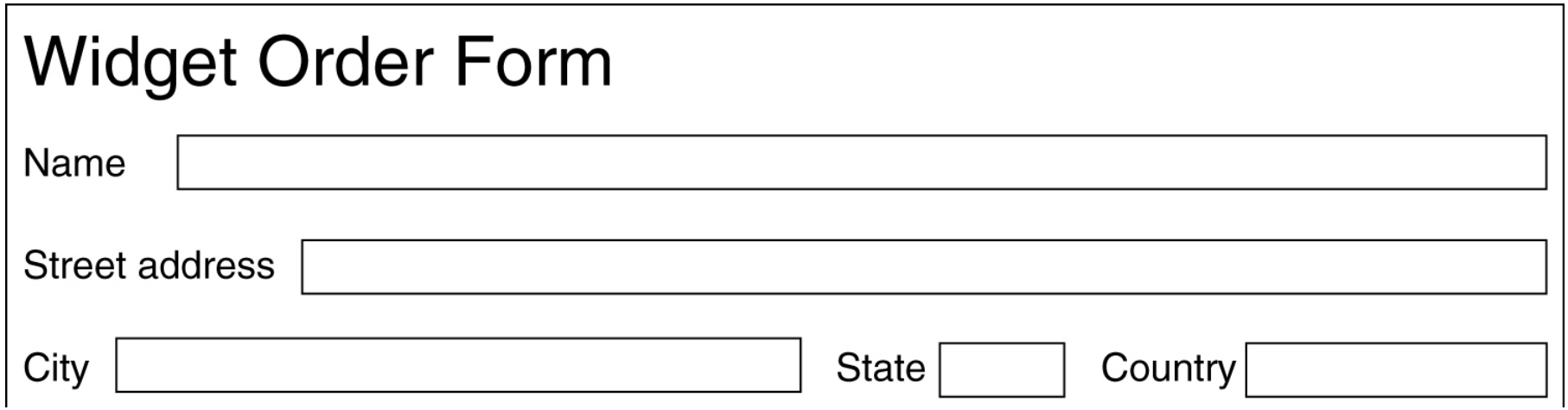
| Item | HTML 1.0 | HTML 2.0 | HTML 3.0 | HTML 4.0 | HTML 5.0 |
|---|---|---|---|---|---|
| Hyperlinks | x | x | x | x | x |
| Images | x | x | x | x | x |
| Lists | x | x | x | x | x |
| Active maps & images | | x | x | x | x |
| Forms | | x | x | x | x |
| Equations | | | x | x | x |
| Toolbars | | | x | x | x |
| Tables | | | x | x | x |
| Accessibility features | | | | x | x |
| Object embedding | | | | x | x |
| Style sheets | | | | x | x |
| Scripting | | | | x | x |
| Video and audio | | | | | x |
| Inline vector graphics | | | | | x |
| XML representation | | | | | x |
| Background threads | | | | | x |
| Browser storage | | | | | x |
| Drawing canvas | | | | | x |

# WWW: Static Web Pages: Form

- <form> </form>
  - <input name="variable_name"
    type="text|textarea|password|radio|check|submit"
    size="a_value" >
  - <form action="" method="POST|GET">

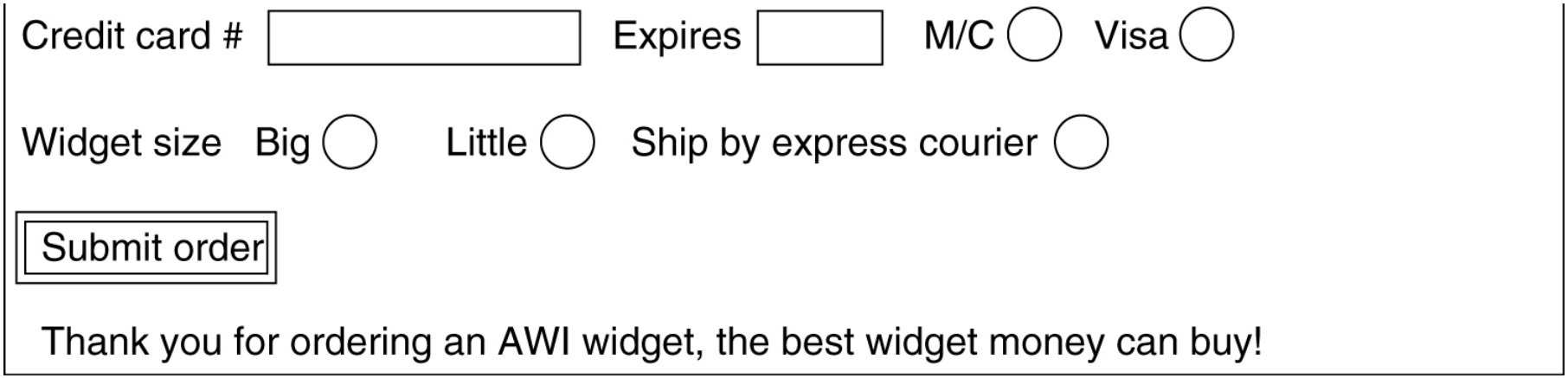
# WWW: Static Web Pages: Form

```
<html>
<head> <title> AWI CUSTOMER ORDERING FORM </title> </head>
<body>
<h1> Widget Order Form </h1>
<form ACTION="http://widget.com/cgi-bin/widgetorder" method=POST>
<p> Name <input name="customer" size=46> </p>
<p> Street Address <input name="address" size=40> </p>
<p> City <input name="city" size=20> State <input name="state" size =4>
Country <input name="country" size=10> </p>
```



# WWW: Static Web Pages: Form

```
<p> Credit card # <input name="cardno" size=10>
Expires <input name="expires" size=4>
M/C <input name="cc" type=radio value="mastercard">
VISA <input name="cc" type=radio value="visacard"> </p>
<p> Widget size Big <input name="product" type=radio value="expensive">
Little <input name="product" type=radio value="cheap">
Ship by express courier <input name="express" type=checkbox> </p>
<p><input type=submit value="submit order"> </p>
Thank you for ordering an AWI widget, the best widget money can buy!
</form>
</body>
</html>
```



# WWW: Static Web Pages: Form

- When the user clicks the submit button, the browser packages the collected information into a single long line time and sends it back to the server for processing.

```
customer=John+Doe&address=100+Main+St.&city=White+Plains&
state=NY&country=USA&cardno=1234567890&expires=6/98&cc=mastercard&
product=cheap&express=on
```

# WWW: Static Web Pages: CSS

- The original goal of HTML
  - structure
  - Style
- Some sytles

```
<font face="helvetica"
size="24"
color="red"> Deborah’s Photos
</font>
```

# WWW: Static Web Pages: CSS

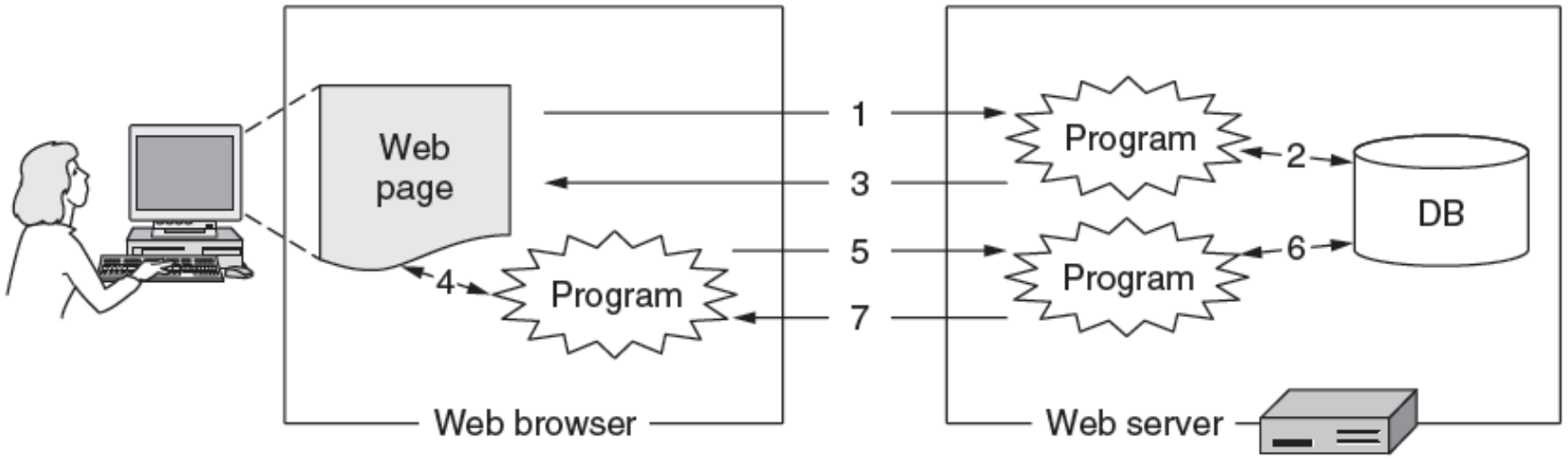
- Defining a **CSS** (Cascading Style Sheets) style sheet

```
body {background-color:linen; color:navy; font-family:Arial;}
h1 {font-size:200%;}
h2 {font-size:150%;}
```

- Using a CSS style sheet

```
<head>
<title> AMALGAMATED WIDGET, INC. </title>
<link rel="stylesheet" type="text/css" href="awistyle.css" />
</head>
```

# WWW: Dynamic Web Pages:



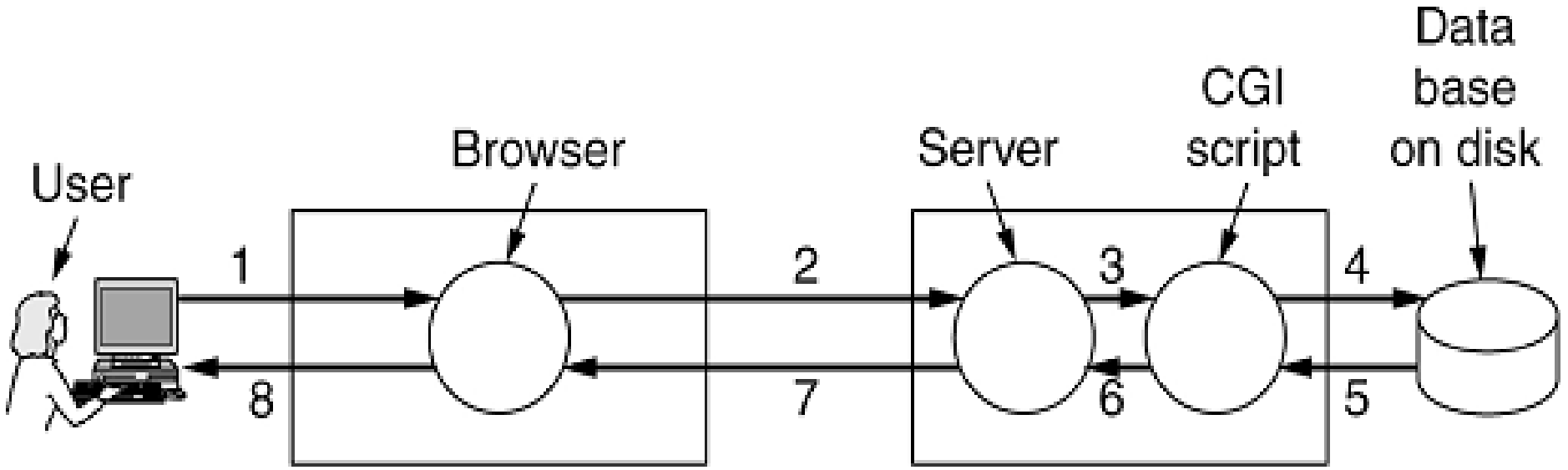
# WWW: Dynamic Web Pages:
## Server-side dynamic web page generation

- Two methods
  - CGI (Common Gateway Interface): provides an interface to allow Web servers to talk to back-end programs and scripts (e.g. Python, Ruby, Perl) that can accept input (e.g. from forms) and generate HTML pages in response.
  - Server pages: to embed little scripts inside HTML pages and have them be executed by the server itself to generate the page.
    - PHP: Hypertext Preprocessor
    - JSP: Java Server Pages
    - ASP.NET: Active Server Page

# WWW: Dynamic Web Pages:
## Server-side dynamic web page generation: CGI

Steps in processing the information from an HTML form

1. User fills in form
2. Form sent back
3. Handed to CGI
4. CGI queries DB
5. Record found
6. CGI builds page
7. Page returned
8. Page displayed



# WWW: Dynamic Web Pages:

## Server-side dynamic web page generation:

### PHP, JSP, ASP/ASP.NET

- PHP (Hypertext Preprocessor)
- JSP (JavaServer Pages): the dynamic part is written in the Java programming language. Pages using this technique have the file extension .jsp.
- ASP.NET (Active Server Pages .NET) is Microsoft's version of PHP and JavaServer Pages. It uses programs written in Microsoft's proprietary .NET networked application framework for generating the dynamic content. Pages using this technique have the extension .aspx.

# WWW: Dynamic Web Pages:
## Server-side dynamic web page generation: PHP

```
<html>
<body>
<form action="action.php" method="post">
<p> Please enter your name: <input type="text" name="name"> </p>
<p> Please enter your age: <input type="text" name="age"> </p>
<input type="submit">
</form>
</body>
</html>
```

•(a) A Web page containing a form. the <form> tag specifies that *action.php* is to be invoked to handle the parameters when the user submits the form

# WWW: Dynamic Web Pages:
## Server-side dynamic web page generation: PHP

```
<html>
<body>
<h1> Reply: </h1>
Hello <?php echo $name; ?>.
Prediction: next year you will be <?php echo $age + 1; ?>
</body>
</html>
```

(b) A PHP script for handling the output of the form. The server then starts to process the action.php file as a reply

# WWW: Dynamic Web Pages:
## Server-side dynamic web page generation: PHP

```
<html>
<body>
<h1> Reply: </h1>
Hello Barbara.
Prediction: next year you will be 33
</body>
</html>
```

(c) Output from the PHP script when the inputs are “Barbara” and “32”, respectively.

# WWW: Dynamic Web Pages:
## Client-side dynamic web page generation

- Server-side dynamic web page generation solve the problem of handling input and interactions with databases on the server. They can all accept incoming information from forms, look up information in one or more databases, and generate HTML pages with the results.
- What none of them can do is respond to mouse movements or interact with users directly. For this purpose, it is necessary to have scripts embedded in HTML pages that are executed on the client machine rather than the server machine.
- Starting with HTML 4.0, these scripts are permitted using the tag <script> and the technologies used to produce these interactive Web pages are broadly referred to as dynamic HTML

# WWW: Dynamic Web Pages:
## Client-side dynamic web page generation

- The most popular scripting language for the client side is **JavaScript**.
- JavaScript has almost nothing to do with the Java programming language.

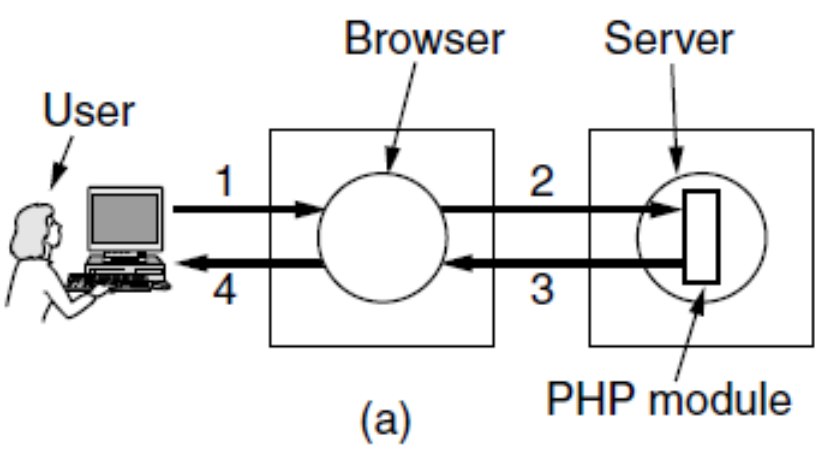
# WWW: Dynamic Web Pages:
## Client-side dynamic web page generation

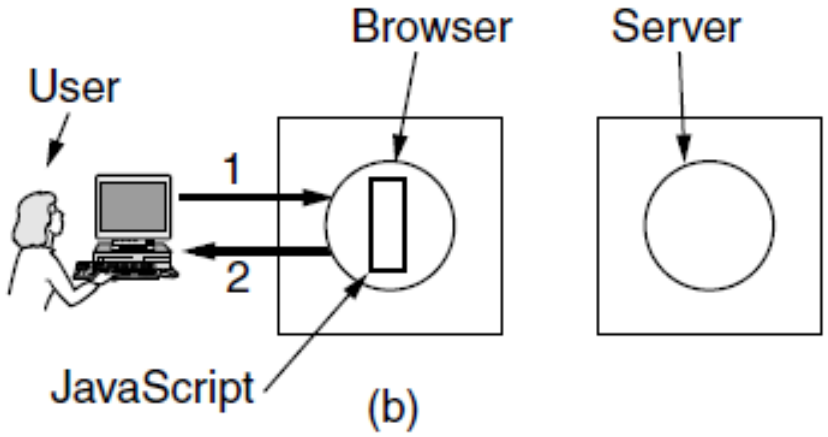
```
<html>
<head>
<script language="javascript" type="text/javascript">
function response(test_form) {
    var person = test_form.name.value;
    var years = eval(test_form.age.value) + 1;
    document.open();
    document.writeln("<html> <body>");
    document.writeln("Hello " + person + ".<br>");
    document.writeln("Prediction: next year you will be " + years + ".");
    document.writeln("</body> </html>");
    document.close();
}
</script>
</head>
<body>
<form>
Please enter your name: <input type="text" name="name">
<p>
Please enter your age: <input type="text" name="age">
<p>
<input type="button" value="submit" onclick="response(this.form)">
</form>
</body>
</html>
```

# WWW: Dynamic Web Pages:
## server-side scripting vs client-side scripting

(a)Server-side scripting with PHP.

(b)Client-side scripting withJavaScript.



# WWW: Dynamic Web Pages:
## Client-side dynamic web page generation

- JavaScript is very popular way to make Web pages highly interactive.
- VBScript (based on Visual Basic) is an alternative on Windows platfroms.
- Java applets runs on the JVM (Java Virtual Machine)
- ActiveX Controls (which are programs compiled to x86 machine language and executed on the bare hardware) from Microsoft runs on Windows.

# WWW: Dynamic Web Pages:
## AJAX (Asynchronous JavaScript And XML)

- AJAX is a set of technologies that work together to enable Web applications that are every bit as responsive and powerful as traditional desktop applications. The technologies are:

1. HTML and CSS to present information as pages.
2. XML (eXtensible Markup Language) to let programs exchange application data with the server.
3. DOM (Document Object Model) to change parts of pages while they are viewed.
4. An asynchronous way for programs to send and retrieve XML data.
5. JavaScript as a language to bind all this functionality together.

# WWW: Dynamic Web Pages:
## AJAX (Asynchronous JavaScript And XML): XML

- **XML** (eXtensible Markup Language), is a language for specifying structured content.
- HTML mixes content with formatting because it is concerned with the presentation of information.
- XML allows Web content to be structured for automated processing.
- There are no defined tags for XML. Each user can define her own tags.

# WWW: Dynamic Web Pages:
## AJAX (Asynchronous JavaScript And XML): XML

```
<?xml version="1.0" ?>

<book_list>

<book>
   <title> Human Behavior and the Principle of Least Effort </title>
   <author> George Zipf </author>
   <year> 1949 </year>
</book>

<book>
   <title> The Mathematical Theory of Communication </title>
   <author> Claude E. Shannon </author>
   <author> Warren Weaver </author>
   <year> 1949 </year>
</book>

<book>
   <title> Nineteen Eighty-Four </title>
   <author> George Orwell </author>
   <year> 1949 </year>
</book>

</book_list>
```

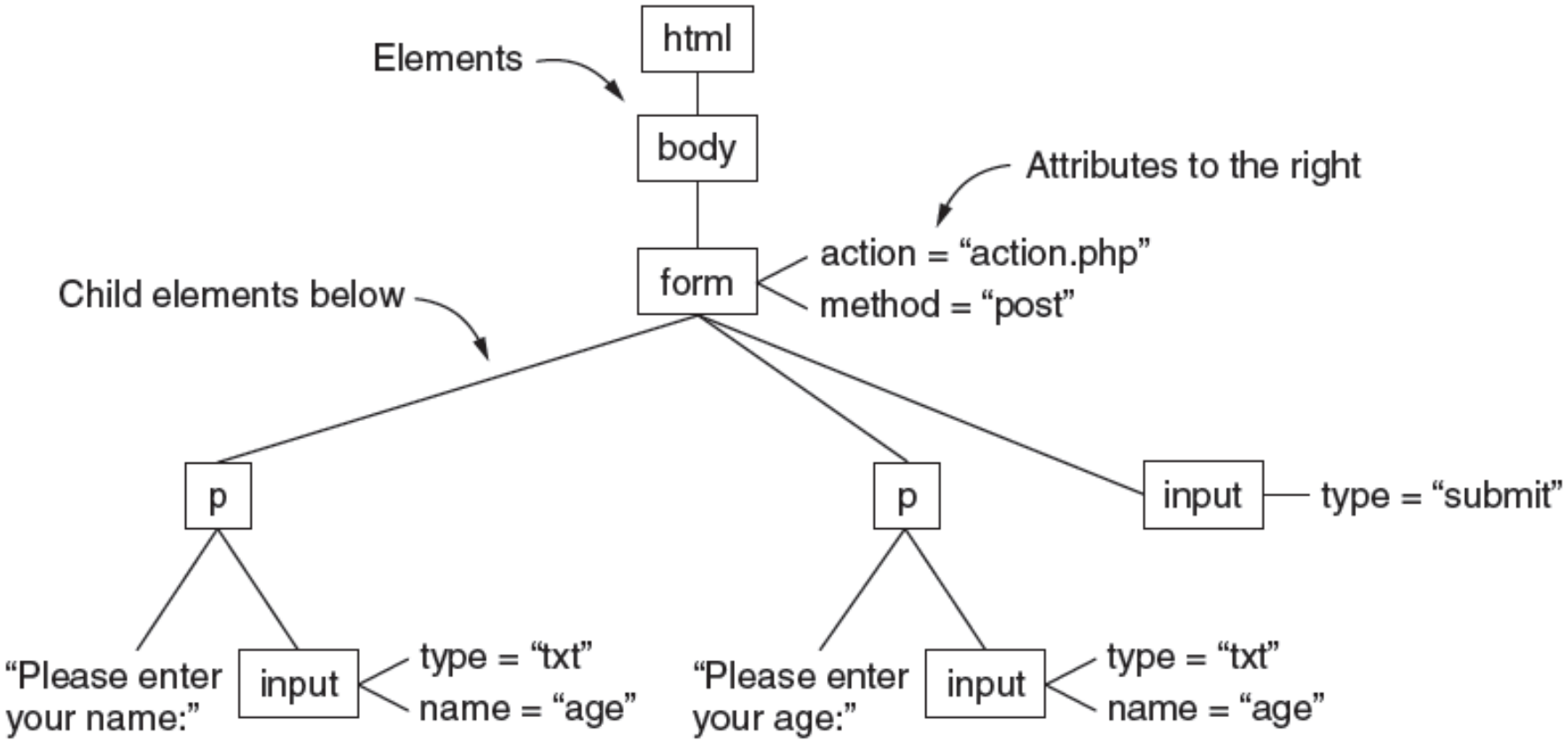
# WWW: Dynamic Web Pages:
## AJAX (Asynchronous JavaScript And XML): XML

- XSLT (eXtensible Stylesheet Language Transformations) can be used to define how XML should be transformed into HTML. XSLT is like CSS, but much more powerful.

- The data expressed in XML, instead of HTML, is that it is easier for programs to analyze.

# WWW: Dynamic Web Pages:
## AJAX (Asynchronous JavaScript And XML): DOM

### A DOM tree example



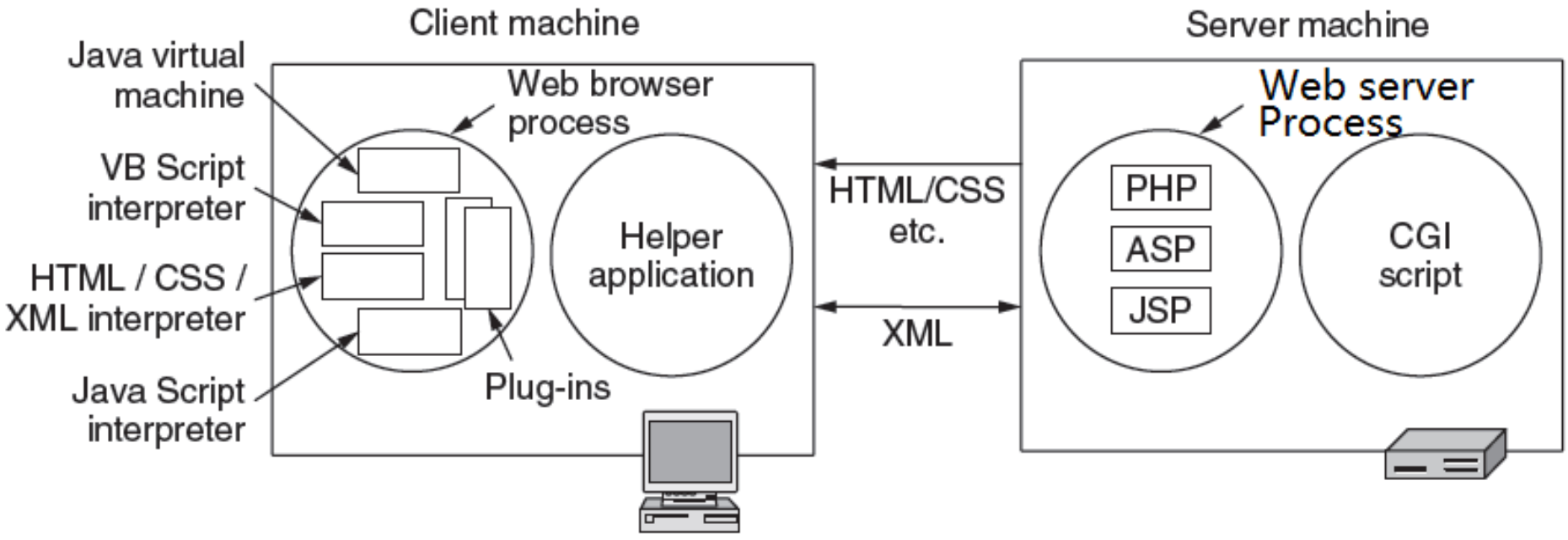
# WWW: Dynamic Web Pages:
## AJAX (Asynchronous JavaScript And XML): A-IO

To provide a responsive interface in the browser while sending or receiving data, it must be possible for scripts to perform asynchronous I/O that does not block the display while awaiting the response to a request.

- For example, consider a map that can be scrolled in the browser. When it is notified of the scroll action, the script on the map page may request more map data from the server if the view of the map is near the edge of the data.
- The interface should not freeze while those data are fetched.
- Instead, the scrolling should continue smoothly.
- When the data arrive, the script is notified so that it can use the data. If all goes well, new map data will be fetched before it is needed.
- Modern browsers have support for this model of communication.

# WWW: Dynamic Web Pages: **Summary**

The various ways to generate and display content.



# WWW: HTTP (HyperText Transfer Protocol)

- **HTTP** is an application layer protocol because it runs on top of TCP and is closely associated with the Web.
- Now HTTP is becoming more like a transport protocol that provides a way for processes to communicate content across the boundaries of different networks. These processes do not have to be a Web browser and Web server.
  - A media player could use HTTP to talk to a server and request album information.
  - Antivirus software could use HTTP to download the latest updates.

# WWW: HTTP (HyperText Transfer Protocol)

- Various usages of HTTP
  - Developers could use HTTP to fetch project files.
  - Consumer electronics products like digital photo frames often use an embedded HTTP server as an interface to the outside world.
  - Machine-to-machine communication increasingly runs over HTTP. For example, an airline server might use
  - SOAP (an XML RPC over HTTP) to contact a car rental server and make a car reservation, all as part of a vacation package. These trends are likely to continue, along with the expanding use of HTTP.

# WWW: HTTP

- Connections
- Methods
- Message Headers (parameters)
  - Request headers
  - Response headers
- Caching
- Experimenting with HTTP
  - telnet www.ietf.org 80

# WWW: HTTP: Connections

- HTTP 1.0 with multiple connections
  - Establish a TCP connection
  - Send a request
  - Get a single response
  - Terminate the TCP connection
- HTTP 1.1 with persistent connections
  - Establish a TCP connection
  - Looping for sending a request and getting a single response
  - Terminate the TCP connection
- HTTP 1.1 with persistent connections and pipeline requests.

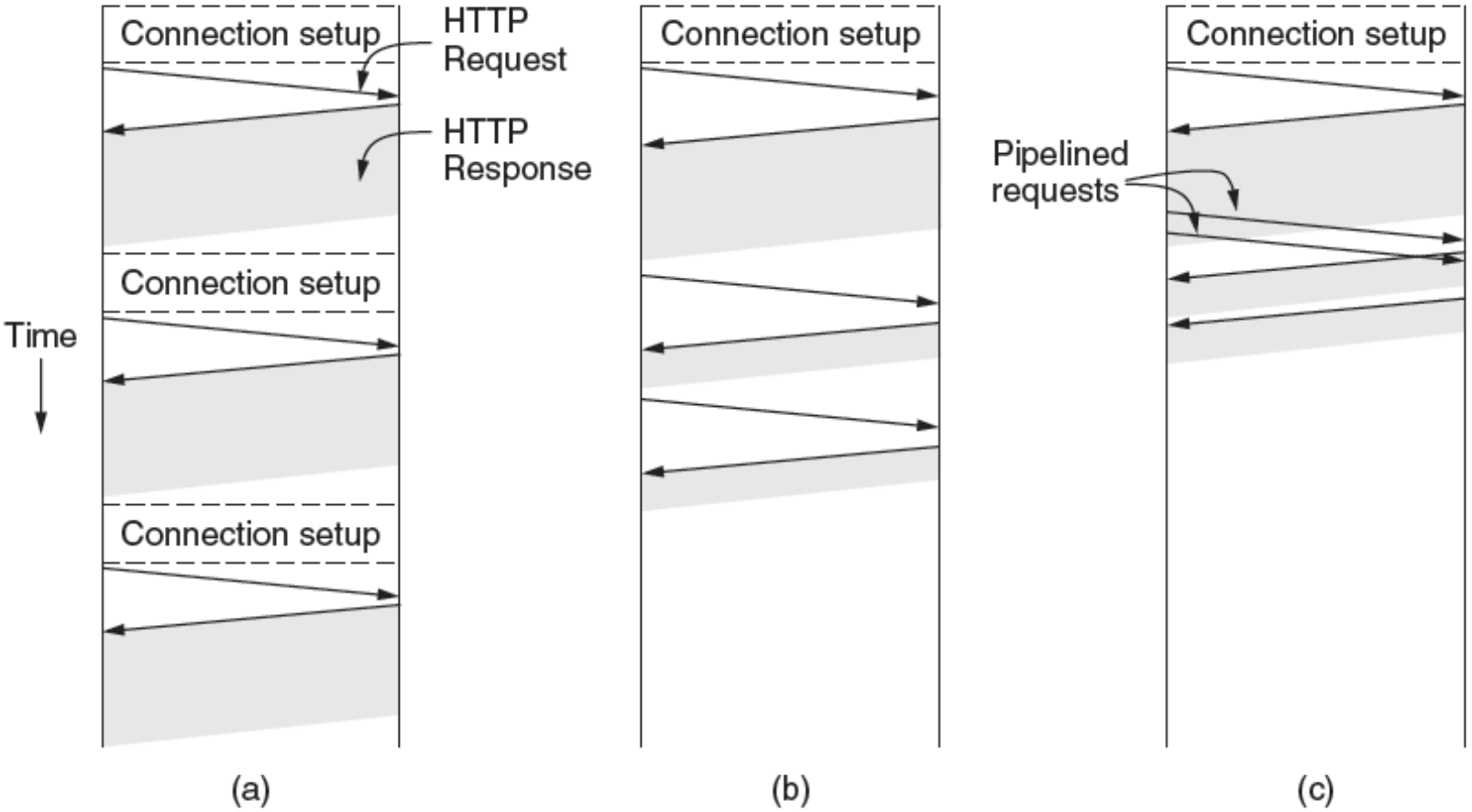
# WWW: HTTP: Connections

HTTP with

(a) multiple connections and sequential requests.

(b) A persistent connection and sequential requests.

(c) A persistent connection and pipelined requests.



# Some definitions

- **RTT**: round trip time; is the time it takes for a small packet to travel from client to server and then back to the client.
- The RTT includes
  - packet propagation delays,
  - packet queuing delays in intermediate routers and switches
  - packet processing delays.
- also known as the **ping time**

- Suppose within your Web browser you click on a link to obtain a Web page. Suppose that the IP address for the associated URL is not cached in your local host, so that a DNS lookup is necessary to obtain the IP address. Suppose that $n$ DNS servers are visited before your host receives the IP address from DNS; the successive visits incur an RTT of $RTT_1$, ..., $RTT_n$. Further suppose that the Web page associated with the link contains exactly one object, a small amount of HTML text. Let $RTT_0$ denote the RTT between the local host and the server containing the object. Assuming zero transmission time of the object, how much time elapses from when the client clicks on the link until the client receives the object?

- Suppose the HTML file indexes *three* very small objects on the same server. Neglecting transmission times, how much time elapses with

  (1) Multiple HTTP connections and sequential requests,

  (2) persistent HTTP connection and sequential requests,

  (3) persistent HTTP connection and pipelined requests

# WWW: HTTP: Methods

The built-in HTTP request methods.

| Method | Description |
|---|---|
| GET | Request to read a Web page |
| HEAD | Request to read a Web page's header |
| PUT | Request to store a Web page |
| POST | Append to a named resource (e.g., a Web page) |
| DELETE | Remove the Web page |
| TRACE | Echo the incoming request |
| CONNECT | Reserved for future use |
| OPTIONS | Query certain options |

# WWW: HTTP: Methods

Each request consists of one or more lines of ASCII text, with the first word on the first line being the name of the method requested. The method names are case sensitive, so *GET* is allowed but not *get*.

- The **GET** method requests the server to send the page.
- The **HEAD** method just asks for the message header, without the actual page. This method can be used to collect information for indexing purposes, or just to test a URL for validity.
- The **POST** method is used when forms are submitted. Both it and GET are also used for SOAP Web services.
  - It uploads data to the server (i.e., the contents of the form or RPC parameters).
  - The server then does something with the data that depends on the URL, conceptually appending the data to the object.
  - Finally, the method returns a page indicating the result.

# WWW: HTTP: Methods

- The **PUT** method is the reverse of GET: instead of reading the page, it writes the page. This method makes it possible to build a collection of Web pages on a remote server.
- **DELETE** removes the page, or at least it indicates that the Web server has agreed to remove the page. As with PUT, authentication and permission play a major role here.
- The **TRACE** method is for debugging. It instructs the server to send back the request.
- The **CONNECT** method lets a user make a connection to a Web server through an intermediate device, such as a Web cache.
- The **OPTIONS** method provides a way for the client to query the server for a page and obtain the methods and headers that can be used with that page.

# WWW: HTTP: Methods

## The status code response groups.

| Code | Meaning | Examples |
|---|---|---|
| 1xx | Information | 100 = server agrees to handle client's request |
| 2xx | Success | 200 = request succeeded; 204 = no content present |
| 3xx | Redirection | 301 = page moved; 304 = cached page still valid |
| 4xx | Client error | 403 = forbidden page; 404 = page not found |
| 5xx | Server error | 500 = internal server error; 503 = try again later |

# WWW: HTTP: Message headers

- The request line (e.g., the line with the *GET* method) may be followed by additional lines with more information.
- This information (**request headers**) can be compared to the parameters of a procedure call.
- Responses may also have **response headers**.
- Some headers can be used in either direction.

# WWW: HTTP: Message headers

| Header | Type | Contents |
|---|---|---|
| User-Agent | Request | Information about the browser and its platform |
| Accept | Request | The type of pages the client can handle |
| Accept-Charset | Request | The character sets that are acceptable to the client |
| Accept-Encoding | Request | The page encodings the client can handle |
| Accept-Language | Request | The natural languages the client can handle |
| If-Modified-Since | Request | Time and date to check freshness |
| If-None-Match | Request | Previously sent tags to check freshness |
| Host | Request | The server's DNS name |
| Authorization | Request | A list of the client's credentials |
| Referer | Request | The previous URL from which the request came |
| Cookie | Request | Previously set cookie sent back to the server |
| Set-Cookie | Response | Cookie for the client to store |
| Server | Response | Information about the server |

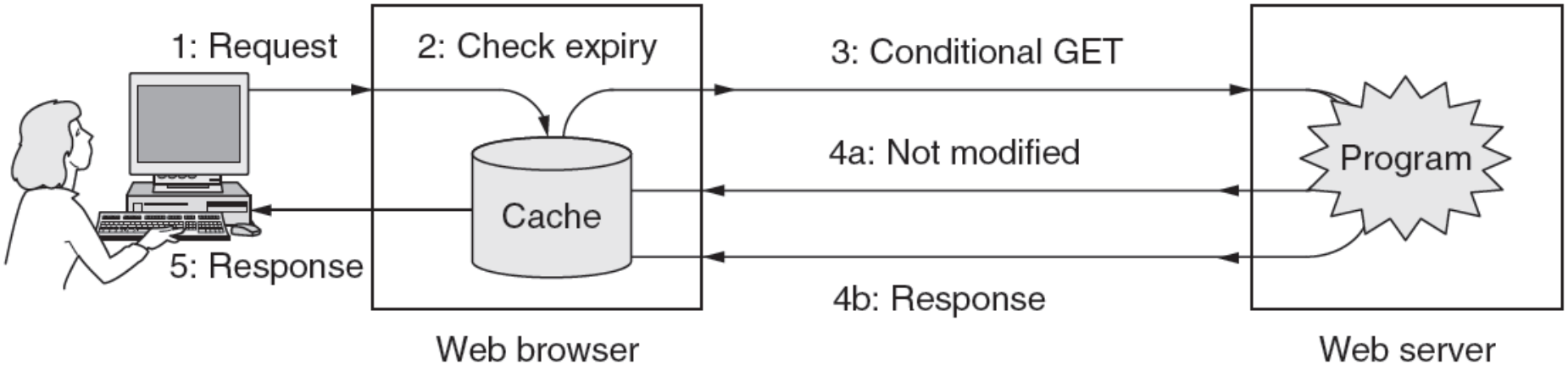
# WWW: HTTP: Message headers

| | | |
|---|---|---|
| Content-Encoding | Response | How the content is encoded (e.g., *gzip*) |
| Content-Language | Response | The natural language used in the page |
| Content-Length | Response | The page's length in bytes |
| Content-Type | Response | The page's MIME type |
| Content-Range | Response | Identifies a portion of the page's content |
| Last-Modified | Response | Time and date the page was last changed |
| Expires | Response | Time and date when the page stops being valid |
| Location | Response | Tells the client where to send its request |
| Accept-Ranges | Response | Indicates the server will accept byte range requests |
| Date | Both | Date and time the message was sent |
| Range | Both | Identifies a portion of a page |
| Cache-Control | Both | Directives for how to treat caches |
| ETag | Both | Tag for the contents of the page |
| Upgrade | Both | The protocol the sender wants to switch to |

# WWW: HTTP: Caching

- HTTP has built-in *caching* support.
- How to determine that a previously cached copy of a page is the same as the page would be if it was fetched again?
  - The first strategy is page validation (step 2). The cache is consulted, and if it has a copy of a page for the requested URL that is known to be fresh (i.e., still valid), there is no need to fetch it anew from the server.
  - The second strategy is to ask the server if the cached copy is still valid. This request is a conditional GET (step 3).
  - Both of these caching strategies are overridden by the directives carried in the Cache-Control header (e.g. no-cache).
- Other caching issues: proxy caching, caching effect, ……

# WWW: HTTP: Caching



# WWW: HTTP: Experimenting with HTTP

- In most UNIX shells and the command window on Windows (once the telnet program is enabled).

  telnet www.ietf.org 80

  GET /rfc.html HTTP/1.1

  Host: www.ietf.org

  # Comment line:

  #A blank line following the last header is mandatory.

# WWW: HTTP: An Example

The start of the output of *www.ietf.org/rfc.html*.

telnet www.ietf.org 80>log

GET /rfc.html HTTP/1.1

HOST:www.ietf.org

close

```
Trying 4.17.168.6...
Connected to www.ietf.org.
Escape character is '^]'.
HTTP/1.1 200 OK
Date: Wed, 08 May 2002 22:54:22 GMT
Server: Apache/1.3.20 (Unix) mod_ssl/2.8.4 OpenSSL/0.9.5a
Last-Modified: Mon, 11 Sep 2000 13:56:29 GMT
ETag: "2a79d-c8b-39bce48d"
Accept-Ranges: bytes
Content-Length: 3211
Content-Type: text/html
X-Pad: avoid browser bug

<html>
<head>
<title>IETF RFC Page</title>

<script language="javascript">
function url() {
 var x = document.form1.number.value
 if (x.length == 1) {x = "000" + x }
 if (x.length == 2) {x = "00" + x }
 if (x.length == 3) {x = "0" + x }
 document.form1.action = "/rfc/rfc" + x + ".txt"
 document.form1.submit
}
</script>

</head>
```

# WWW: The Mobile Web

Difficulties for mobile phones browsing the web

1. Relatively small screens preclude large pages and large images.
2. Limited input capabilities make it tedious to enter URLs or other lengthy input.
3. Network bandwidth is limited over wireless links, particularly on cellular (3G) networks, where it is often expensive too.
4. Connectivity may be intermittent.
5. Computing power is limited, for reasons of battery life, size, heat dissipation, and cost.

# WWW: The Mobile Web

- **WAP** (Wireless Application Protocol): failed
- Increasingly used approach: run the same Web protocols for mobiles and desktops, and to have Web sites deliver *mobile-friendly* content when mobile
  - W3C is encouraging this approach in several ways. E.g. standardize best practices for mobile Web content
- **XHTML basic**: stripped-down version of HTML
- a complementary approach is the use of *content transformation* or *transcoding*. a computer sits between the mobile and the server, transforms pages to mobile friendly, e.g. reduce image size.

# WWW: The Mobile Web: XHTML Basic

The XHTML Basic modules and tags.

| Module | Req.? | Function | Example tags |
|---|---|---|---|
| Structure | Yes | Doc. structure | body, head, html, title |
| Text | Yes | Information | br, code, dfn, em, h*n*, kbd, p, strong |
| Hypertext | Yes | Hyperlinks | a |
| List | Yes | Itemized lists | dl, dt, dd, ol, ul, li |
| Forms | No | Fill-in forms | form, input, label, option, textarea |
| Tables | No | Rectangular tables | caption, table, td, th, tr |
| Image | No | Pictures | img |
| Object | No | Applets, maps, etc. | object, param |
| Meta-information | No | Extra info | meta |
| Link | No | Similar to <a> | link |
| Base | No | URL starting point | base |

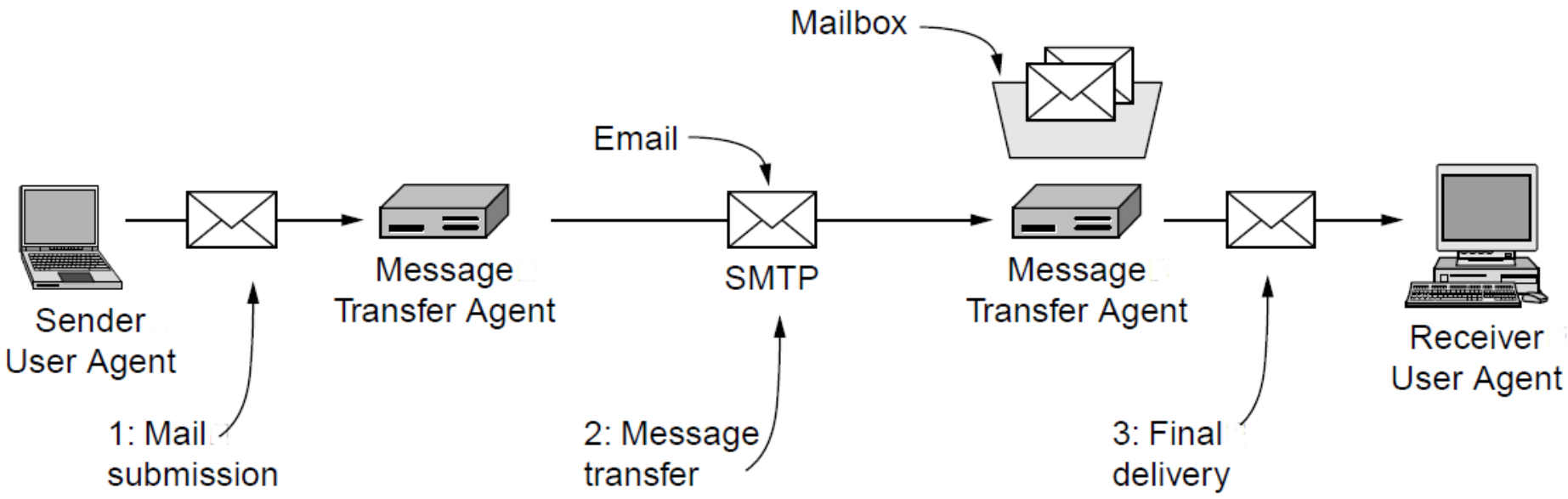
# WWW: Web Search

- Web search companies
  - Google, Bing
  - Baidu
- How does web search works?
  - How to find web pages? Web crawling
  - How to store web pages? Hard disks
  - How to process web pages? Indexing techniques
  - How to make profit from web search? Advertising
  - ……

# Email

- Architecture and Services
- The User Agent
- Message Formats
- Message Transfer
- Final Delivery

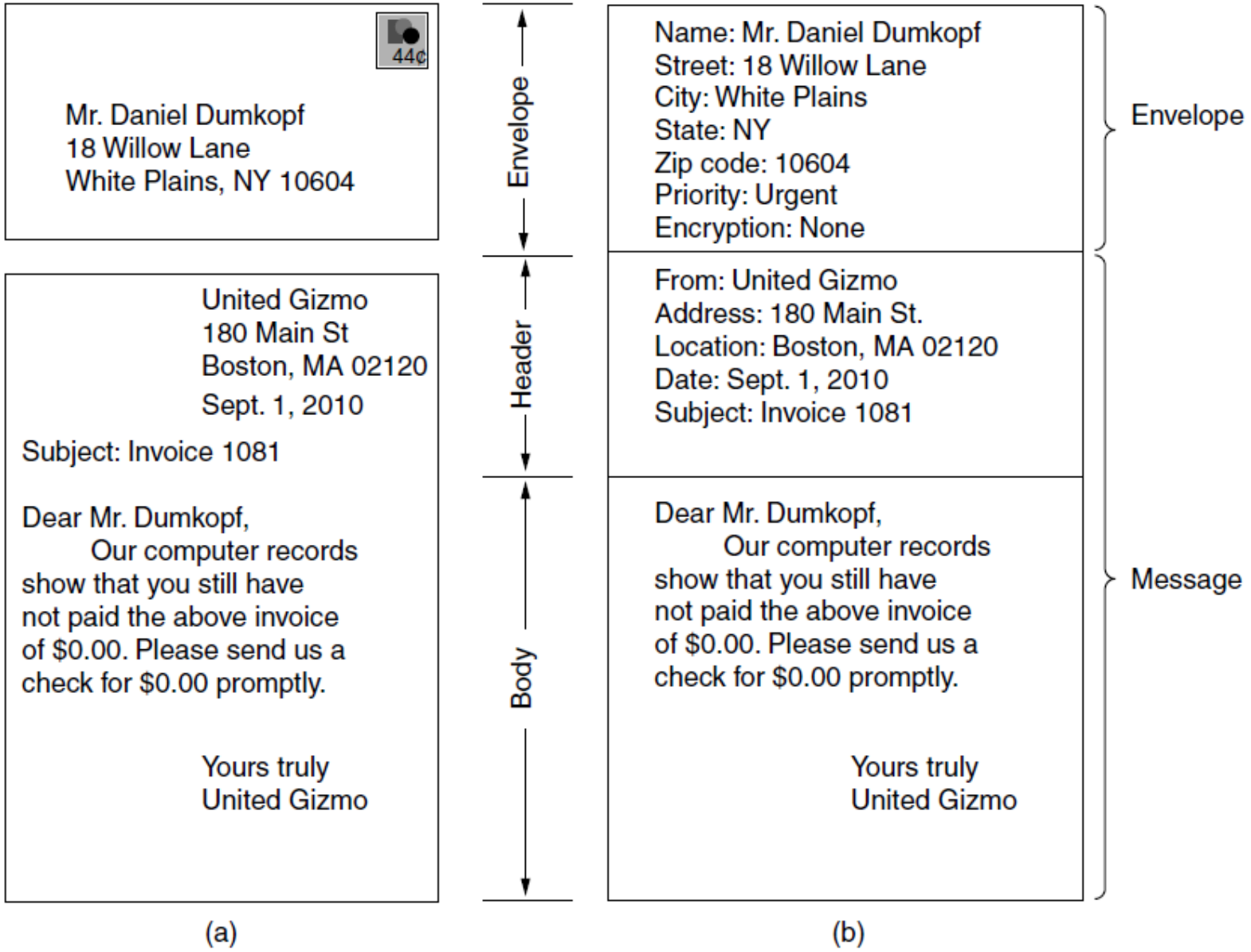
# Email: Architecture and Services



# Email: Architecture and Services

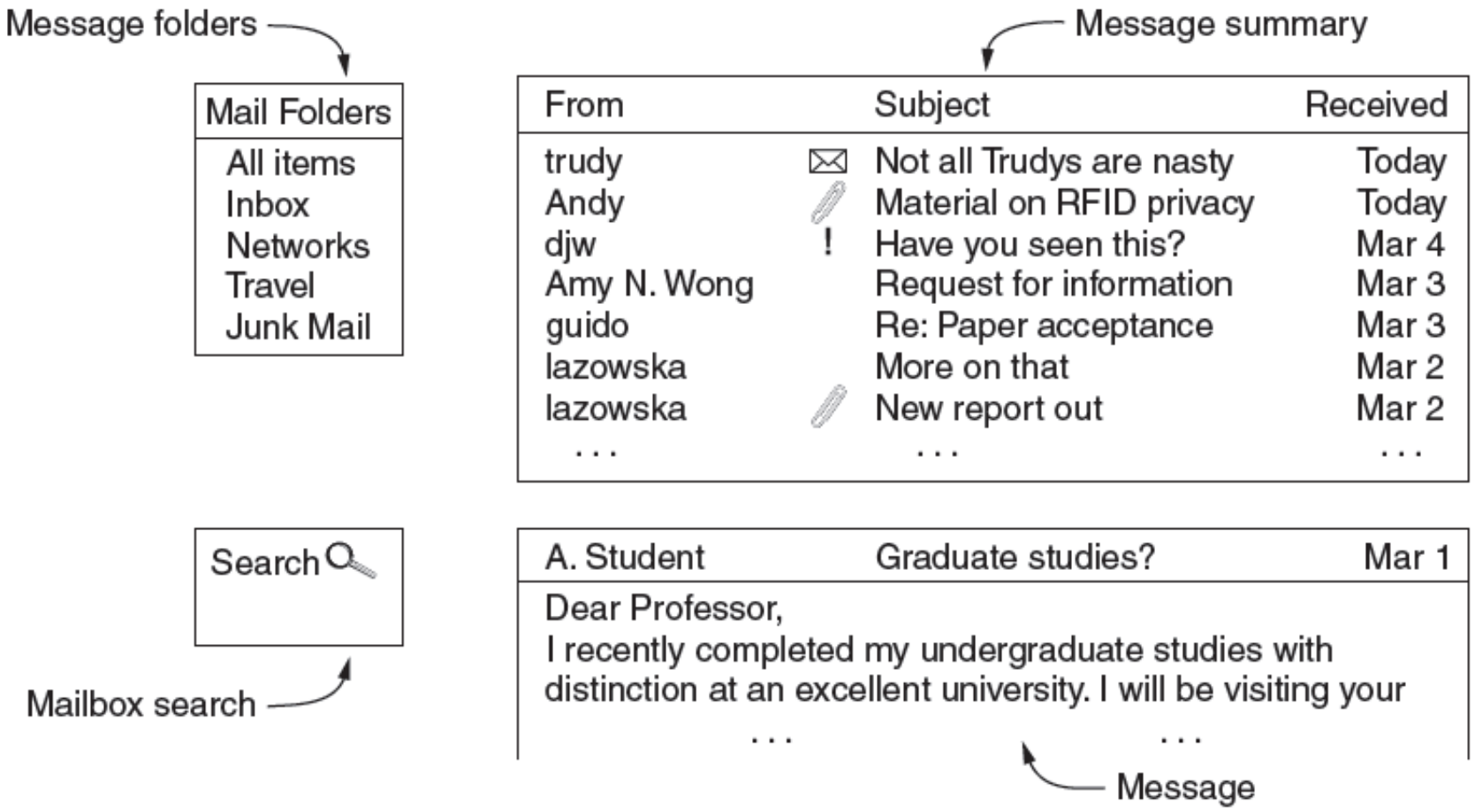
- Basic functions of email systems:
  - Composition: creating messages and answers
  - Transfer: moving messages from the originator to the recipient.
  - Reporting: telling the originator what happened to the message
  - Displaying: displaying emails.
  - Disposition: What the recipient does with the message after receiving it.
- Additional functions of email systems
  - Forwarding email, Mailing lists
  - Carbon copies, blind carbon copies
  - High-priority email, Secret email
  - Mailboxes
  - …

# Email: Architecture and Services



# Email: User agent

## Typical elements of the user agent interface



# Email: Message Formats

- Two kinds of Message Formats
  - RFC 5322 – The Internet Message format
    - Envelop fields vs message fields
    - ASCII message format
  - MIME (Multipurpose Internet Mail Extensions) message format

# Email: Message Formats: RFC 5322

RFC 5322 header fields related to message transport.

| Header | Meaning |
|---|---|
| To: | E-mail address(es) of primary recipient(s) |
| Cc: | E-mail address(es) of secondary recipient(s) |
| Bcc: | E-mail address(es) for blind carbon copies |
| From: | Person or people who created the message |
| Sender: | E-mail address of the actual sender |
| Received: | Line added by each transfer agent along the route |
| Return-Path: | Can be used to identify a path back to the sender |

# Email: Message Formats: RFC 5322

Some fields used in the RFC 5322 message header.

| Header | Meaning |
|---|---|
| Date: | The date and time the message was sent |
| Reply-To: | E-mail address to which replies should be sent |
| Message-Id: | Unique number for referencing this message later |
| In-Reply-To: | Message-Id of the message to which this is a reply |
| References: | Other relevant Message-Ids |
| Keywords: | User-chosen keywords |
| Subject: | Short summary of the message for the one-line display |

# Email: Message Formats: MIME

- MIME – Multipurpose Internet Mail Extensions
- Problems with international languages:
  - Languages with accents (French, German).
  - Languages with non-Latin alphabets (Hebrew, Russian).
  - Languages without alphabets (Chinese, Japanese).
  - Messages not containing text at all (audio or images).

# Email: Message Formats: MIME

## Message headers added by MIME.

| Header | Meaning |
|---|---|
| MIME-Version: | Identifies the MIME version |
| Content-Description: | Human-readable string telling what is in the message |
| Content-Id: | Unique identifier |
| Content-Transfer-Encoding: | How the body is wrapped for transmission |
| Content-Type: | Type and format of the content |

# Email: Message Formats: MIME

MIME content types and example subtypes.

| Type | Example subtypes | Description |
|---|---|---|
| text | plain, html, xml, css | Text in various formats |
| image | gif, jpeg, tiff | Pictures |
| audio | basic, mpeg, mp4 | Sounds |
| video | mpeg, mp4, quicktime | Movies |
| model | vrml | 3D model |
| application | octet-stream, pdf, javascript, zip | Data produced by applications |
| message | http, rfc822 | Encapsulated message |
| multipart | mixed, alternative, parallel, digest | Combination of multiple types |

# A multipart message containing enriched and audio alternatives.

```
C: From: alice@cs.washington.edu
C: To: bob@ee.uwa.edu.au
C: MIME-Version: 1.0
C: Message-Id: <0704760941.AA00747@ee.uwa.edu.au>
C: Content-Type: multipart/alternative; boundary=qwertyuiopasdfghjklzxcvbnm
C: Subject: Earth orbits sun integral number of times
C:
C: This is the preamble. The user agent ignores it. Have a nice day.
C:
C: --qwertyuiopasdfghjklzxcvbnm
C: Content-Type: text/html
C:
C: <p>Happy birthday to you
C: Happy birthday to you
C: Happy birthday dear <bold> Bob </bold>
C: Happy birthday to you
C:
C: --qwertyuiopasdfghjklzxcvbnm
C: Content-Type: message/external-body;
C:          access-type="anon-ftp";
C:          site="bicycle.cs.washington.edu";
C:          directory="pub";
C:          name="birthday.snd"
C:
C: content-type: audio/basic
C: content-transfer-encoding: base64
C: --qwertyuiopasdfghjklzxcvbnm
```