Introduction to Web Technologies

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The Internet is a network of networks

- The Internet is the descendant of ARPANET (Advanced Research Projects Agency Network) developed for the US DoD
- The initial goal was to research the possibility of remote communication between machines
- Critical step was development of the TCP/IP protocol (1977)
  - TCP Transmission Control Protocol
  - IP Internet Protocol
- Vinton Cerf’s postcard analogy for TCP/IP:
  - A document is broken up into postcard-sized chunks (packets)
  - Each postcard has its own address and sequence number
  - Each postcard travels independently to the final destination
  - The document is reconstructed by ordering the postcards
  - If one is missing, the recipient can request for it to be resent
  - If a post-office is closed the postcard is sent a different way
  - Congestion and service interruptions do not stop transmission
The first connection between two hosts

Image Ref: http://www.computerhistory.org
The Internet grew extremely rapidly!

Data Ref: http://www.isc.org/

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The World Wide Web operates over the Internet

- We often use the phrases “the WWW” and “the Internet” interchangeably, however they are different entities.
- The WWW is a service that operates over the internet.
- The concept of the WWW combines 4 ideas:
  - hypertext
  - resource identifiers (URI, URL)
  - client-server model of computing (web servers/browsers)
  - markup language (HTML)
- These were the brainchild of Tim Berners-Lee from CERN who released his first browser in 1991.
- All clients and servers in the WWW speak the language of HTTP (HyperText Transfer Protocol)
We can *generate* content dynamically

- There are several benefits to dynamically generating content:
  - We don’t have to store loads of pages
  - The content is completely up-to-date
  - **We can respond to/interact with the user**
  - Every site that involves a transaction (eg. Google, Amazon, NED) is generating dynamic content
Web servers serve content on request across the network

- The web server is responsible for:
  - accepting requests for content described by the URL
  - checking whether access is permitted and requesting authentication if necessary
  - sending (or serving) the content back to the browser
- A web server is the machine and the process serving content

- The most popular web server software now is:
  - Apache is an open source web server (Unix/Mac OS X/Win)
  - Microsoft IIS is the main Windows web server (Win only)
Browsers and servers communicate via **HTTP**

- *HyperText Transfer Protocol* (**HTTP**) is the standard protocol for transferring web content.
- The server *listens* on port 80 waiting for connections.
- The web browser connects to the server, and sends a *request*.
- The server *responds* with an error code or the web content.
The server runs a program to generate the web content

- This program gets run *every time* the given URL is requested
- The server passes the HTTP request details to the program
- The program returns the web content or an error code

Each web server interacts with the programs differently:
- Apache uses the *Common Gateway Interface (CGI)*
- Microsoft IIS uses *Active Server Pages (ASP)*
Browsing the web uses the client-server model

- The *client-server model* involves networked interaction between:
  - a *client* – in this case the web browser
  - a *server* – in this case the web server

- Dynamic content is generated on the *server side*

- The advantages of server side are:
  - We are not running programs on low-powered client computers
  - Typically the data you want to present is on server side
  - The client will restrict program functionality for security

- The disadvantage of server side are:
  - The server requires lots of processing power
    *particularly when there are many simultaneous clients*
  - The client side is often quite powerful anyway
  - Lots of information may need to be passed back and forth
The CGI client-server interaction
A web service is an application accessible over the Internet

- Web services emerged amidst a lot of hype
- A web service is a network accessible interface to application functionality, built using standard internet technologies.
- Powerful new way to build software systems from distributed components
- In other words, if an application can be accessed over a network using protocols such as HTTP, XML, SMTP etc. then it is a web service.
Web services use the client-server model

• Recall the CGI client-server model
• In the case of a user looking at a webpage
  • the *client* is the web browser
  • the *server* is the web server (and programs running on it)
• On the WWW information is always returned to the client in the form of a webpage (HTML).
• The key to web services is that they return information in a programmatic form (ie: they can return a string, float, array, object, just like an function).
• In the final stage of a chain of web services, the information may be presented to the user e.g. a webpage may be generated.
The Web service-client interaction

Server
Web Service

Result
Query

Client/Server
CGI

HTML
Query

Client
Browser

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Example web services

- Stock price quotes
- Amazon web services
  - provides access to the entire Amazon database of books/prices
  - you could aggregate prices for multiple online bookshops
- Google web services
  - originally just access to Google search engine results
  - people used to do this *manually* anyway – screen scraping
  - now extended to other services, e.g. Google maps
- And lots of astronomy/VO applications
  - Andreas will show some examples this afternoon
The HyperText Markup Language

- HTML marks up the structure of a document for publishing on the WWW
- It tells the browser how to interpret and display the document
- Different browsers interpret things differently (!)

- There are two main standards: HTML 4(5) and XHTML 1.0
- These are developed by W3C
  - W3C the World Wide Web Consortium
- All HTML documents should declare which standard they are using
Hello world!

```html
<!DOCTYPE HTML PUBLIC "-//W3C//DTD HTML 4.01//EN" "http://www.w3.org/TR/html4/strict.dtd">

<html>
  <head>
    <title>My first HTML document</title>
  </head>
  <body>
    <p>Hello world!</p>
  </body>
</html>
```
The basic unit of HTML is the *element*

- HTML includes element types to represent paragraphs, hypertext links, lists, tables, images, etc.
- Each element consists of three parts:
  1. start tag e.g. `<title>`
  2. content e.g. `my homepage`
  3. end tag e.g. `</title>`
- A *tag* is an element name enclosed in angle brackets.
- Some elements have no content e.g. `<br>` or `<hr>`
- Elements may have associated properties (*attributes*)
- Attributes and their values appear inside the start tag e.g. `<div id="section1">`
You only need a small set of elements to create a website

<table>
<thead>
<tr>
<th>Element: start/end tags</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;html&gt; &lt;/html&gt;</td>
<td>Starts and ends a HTML document</td>
</tr>
<tr>
<td>&lt;title&gt; &lt;/title&gt;</td>
<td>Text that appears in the title bar</td>
</tr>
<tr>
<td>&lt;head&gt; &lt;/head&gt;</td>
<td>Information about the document</td>
</tr>
<tr>
<td>&lt;body&gt; &lt;/body&gt;</td>
<td>The main part of the document</td>
</tr>
<tr>
<td>&lt;p&gt; &lt;/p&gt;</td>
<td>A paragraph</td>
</tr>
<tr>
<td>&lt;hr /&gt;</td>
<td>A horizontal line</td>
</tr>
<tr>
<td>&lt;br /&gt;</td>
<td>A line break</td>
</tr>
<tr>
<td>&lt;a href=&quot;url&quot;&gt; &lt;/a&gt;</td>
<td>A link</td>
</tr>
<tr>
<td>&lt;img src=&quot;url&quot; /&gt;</td>
<td>An image</td>
</tr>
<tr>
<td>&lt;!-- comment --&gt;</td>
<td>Comments that are not displayed</td>
</tr>
</tbody>
</table>
You only need a small set of elements to create a website

<table>
<thead>
<tr>
<th>Element: start/end tags</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><code>&lt;div&gt;</code> <code>&lt;/div&gt;</code></td>
<td>A section in the document</td>
</tr>
<tr>
<td><code>&lt;span&gt;</code> <code>&lt;/span&gt;</code></td>
<td>An inline section in a document</td>
</tr>
<tr>
<td><code>&lt;ul&gt;</code> <code>&lt;/ul&gt;</code></td>
<td>An unordered list (bullet points)</td>
</tr>
<tr>
<td><code>&lt;ol&gt;</code> <code>&lt;/ol&gt;</code></td>
<td>An ordered list</td>
</tr>
<tr>
<td><code>&lt;li&gt;</code> <code>&lt;/li&gt;</code></td>
<td>A list item</td>
</tr>
<tr>
<td><code>&lt;table&gt;</code> <code>&lt;/table&gt;</code></td>
<td>Encloses a table</td>
</tr>
<tr>
<td><code>&lt;tr&gt;</code> <code>&lt;/tr&gt;</code></td>
<td>A row in a table</td>
</tr>
<tr>
<td><code>&lt;td&gt;</code> <code>&lt;/td&gt;</code></td>
<td>A cell within a row</td>
</tr>
<tr>
<td><code>&lt;pre&gt;</code> <code>&lt;/pre&gt;</code></td>
<td>Enclosed text that stays in its raw format</td>
</tr>
</tbody>
</table>
CSS was introduced into HTML 4.0 to solve a problem

- We have focused on the structural aspects of HTML
- In fact that is what HTML was originally designed for
  - `<table>` = “This is a table”
  - `<p>` = “This is a paragraph”
- Layout was the job of the browser
- As the WWW exploded, more people started writing documents
- The two major browsers (Internet Explorer and Netscape) added new HTML tags and attributes to the original HTML specification e.g. `<font>`
- It became hard to separate *structure* and *presentation*
Formatting before CSS was inefficient

- Before CSS all formatting had to be included as attributes in HTML tags

```html
<font face="Verdana, Arial" size="+1" color="blue">
Hello, World!
</font>
```

- There are several disadvantages to this way of doing things
  - Information occurs in many locations → redundancy → errors
  - Updating multiple occurrences of information is time-consuming
  - Formatting information is hard-coded in HTML document
  - HTML elements can describe format/presentation and content/structure

- Other formatting tags you might be familiar with are `<b>` (bold), `<i>` (italics)...**we do not recommend using these**
Hello World! the CSS version

- To reproduce the previous HTML using CSS we need two files
  1. A HTML page (e.g. mypage.html) containing this

```html
<head>
  <link href="css/mystyle.css" rel="stylesheet" type="text/css" />
</head>
<body>
  <p>Hello, World!</p>
</body>
```

2. An accompanying style sheet file (e.g. mystyle.css)

```css
p {
  color: blue;
  font-size: small;
  font-family: Verdana, Arial, sans-serif;
}
```
HTML and CSS should be validated

- The W3C site provides tools for validating your website
  - they check what standard you claim to be using
  - then check all the syntax in your document complies with that standard
- The validators are free and easy to use, so there is no excuse!
- http://validator.w3.org/
- http://jigsaw.w3.org/css-validator/
References

- http://www.computerhistory.org
- HTML: http://www.w3.org/MarkUp/
- HTML: http://www.w3schools.com/html/
- XHTML: http://www.w3.org/MarkUp/2004/xhtml-faq
- XHTML: http://www.w3schools.com/xhtml/xhtml.html.asp
- CSS: http://www.w3.org/Style/CSS/
- CSS: http://www.csszengarden.com/