## **How the Web Works**

Chapter 2

Randy Connolly and Ricardo Hoar

Fundamentals of Web Development

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Internet
Protocols
Domain Name
System

Uniform Resource Locators



Hypertext Transfer Protocol

Web Browsers



Summary

Fundamentals of Web Development - 2<sup>nd</sup> Ed.

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A Layered Architecture

TCP/IP.

These protocols have been implemented in every operating system, and make fast web development possible.

Networking is it's own entire discipline.

Web developer needs general awareness of what the suite of Internet protocols does

### A Layered Architecture



Link Layer

- Responsible for
  - physical transmission of data across media (both wired and wireless) and
  - Establishing logical links.

It handles issues like packet creation, transmission, reception, error detection, collisions, line sharing, and more.

Much more to learn in Networking courses outside of web development.

Internet Layer

The Internet layer provides "best effort" communication.

Makes use of IP addresses

Internet Layer (IP)





IP Address

10.239.28.131

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IP addresses





Transport Layer (TCP)

• Ensures transmissions arrive in order and without error



**Application Layer** 

There are **many** application layer protocols. Web developers should be aware of :

- **HTTP.** The Hypertext Transfer Protocol is used for web communication.
- **SSH.** The Secure Shell Protocol allows remote command-line connections to servers.
- **FTP**. The File Transfer Protocol is used for transferring files between computers.
- **POP/IMAP/SMTP**. Email-related protocols for transferring and storing email.
- **DNS**. The Domain Name System protocol used for resolving domain names to IP addresses.



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### Name Levels



### Name Levels



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### Name Levels



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Types of Top Level Domains

- Generic top-level domain (gTLD)
  - Unrestricted. TLDs include .com, .net, .org, and .info.
  - Sponsored. TLDs including .gov, .mil, .edu, and others.
  - New TLDs.
- Country code top-level domain (ccTLD)
  - TLDs include .us , .ca , .uk , and .au.
  - Internationalized Domain Names
- arpa

### Name Registration



**Address Resolution** 



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Overview



Protocol

Recall that in Section 2.1, we listed several application layer protocols on the TCP/IP stack. FTP, SSH, HTTP, POP, IMAP, DNS, ...

Requesting

- ftp://example.com/abc.txt → sends out an FTP request on port 21, while
- http://example.com/abc.txt → transmits an HTTP request on port 80.

Domain

- The domain identifies the server from which we are requesting resources.
- Since the DNS system is case insensitive, this part of the URL is case insensitive.
- Alternatively, an IP address can be used for the domain

- The optional port attribute allows us to specify connections to ports other than the defaults
- Add a colon after the domain, then specify an integer port number.

Familiar concept to anyone who has ever used a computer file system.

The root of a web server corresponds to a folder somewhere on that server.

- On many Linux servers that path is /var/www/html/
- On Windows IIS machines it is often /inetpub/wwwroot/

The path is optional. However, when requesting a folder or the top-level page, the web server will decide which file to send you.

Query String



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Fragment

A way of requesting a portion of a page.

• Browsers will see the fragment in the URL, seek out the tag anchor in the HTML, and scroll the website to it.



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# Hypertext Transfer Protocol



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# Hypertext Transfer Protocol

- **Request headers** include data about the client machine.
- **Response headers** have information about the server answering the request and the data being sent



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### Hypertext Transfer Protocol Request Methods



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- 2## codes are for successful responses,
- 3## are for redirection-related responses,
- 4## codes are client errors,
- 5## codes are **server** errors.

### Hypertext Transfer Protocol (Some) Response Codes

200: OK

- 301: Moved Permanently
- 304: Not Modified
- 307: Temporary redirect
- 400: Bad Request
- 401: Unauthorized
- 404: Not found
- 414: Request URI too long
- 500: Internal server error



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Fetching a Web Page



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Fetching a Web Page – Load Times and Cascades

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**Browser Rendering** 

- Interpreting the entire HTML markup together with the image and other assets into a grid of pixels for display within the browser window is called rendering the webpage.
- Implemented differently for each browser (Firefox, Chrome, Safari, Explorer, and Opera)

### **Browser Caching**



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**Browser Features** 

- search engine integration,
- URL autocompletion,
- Form autocompletion,
- cloud caching of user history/bookmarks,
- phishing website detection,
- secure connection visualization,

and much more

**Browser Extensions** 

Can change what is shown to the end user. Newer challenge for web developers.

For developers, extensions like

- Firebug and
- Yslow

For the general public:

- Adblock
- Third Party Plugins



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**Operating Systems** 

- A **web server** is nothing more than a computer that responds to HTTP requests.
- Real-world web servers are often more powerful than your own desktop computer
- Webservers must choose an **application stack** to run a website. This application stack will include an
  - operating system,
  - web server software,
  - a database,
  - and a scripting language for dynamic requests

**Application Stacks** 

We will rely on the LAMP software stack , which refers to

- L inux operating system,
- A pache web server,
- M ySQL database, and
- P HP scripting language

Other stacks include WAMP, WISA, MEAN, ...

**Operating Systems** 

- Linux
- Windows

Web Server Software

- Apache
- Nginx
- IIS

Database Software

- MySQL
- PostgreSQL
- Sqlite
- Oracle
- IBM DB2
- Microsoft SQL Server
- MongoDB

Scripting Software

- PHP
- ASP.NET
- Python
- Node.js
- ...



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### Summary Key Terms

address resolution Apache Application stack application layer country code top-level domain (ccTLD) DNS resolver **DNS** server domain names domain name registrars Domain Name System (DNS) **FTP** four-layer network model

generic top-level domain (gTLD) **GET** request HTTP Internet Corporation for Assigned Names and Numbers (ICANN) Internet Assigned Numbers Authority (IANA) internationalized top-level domain name (IDN) Internet layer Internet Protocol (IP) **IP** address IPv4 IPv6 IAMP software stack

link layer MAC addresses MFAN software stack packet protocol port **POST** request protocol request request headers response codes response headers reverse DNS lookups root name server second-level domain SFTP



SSH subdomain TCP/IP (Transmission Control Protocol/ Internet Protocol) transport layer Transmission ControlUniform ResourceProtocol (TCP)Locator (URL)top-level domain (TLD)web serverTLD name serverWISA software stackUser DatagramProtocol (UDP)

