

# How the Web Works

## Chapter 2

# Chapter 2

**1** Internet  
Protocols

**2** Domain Name  
System

**3** Uniform Resource  
Locators

**4** Hypertext Transfer  
Protocol

**5** Web Browsers

**6** Web Servers

**7** Summary

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# Internet Protocols

A Layered Architecture

TCP/IP.

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

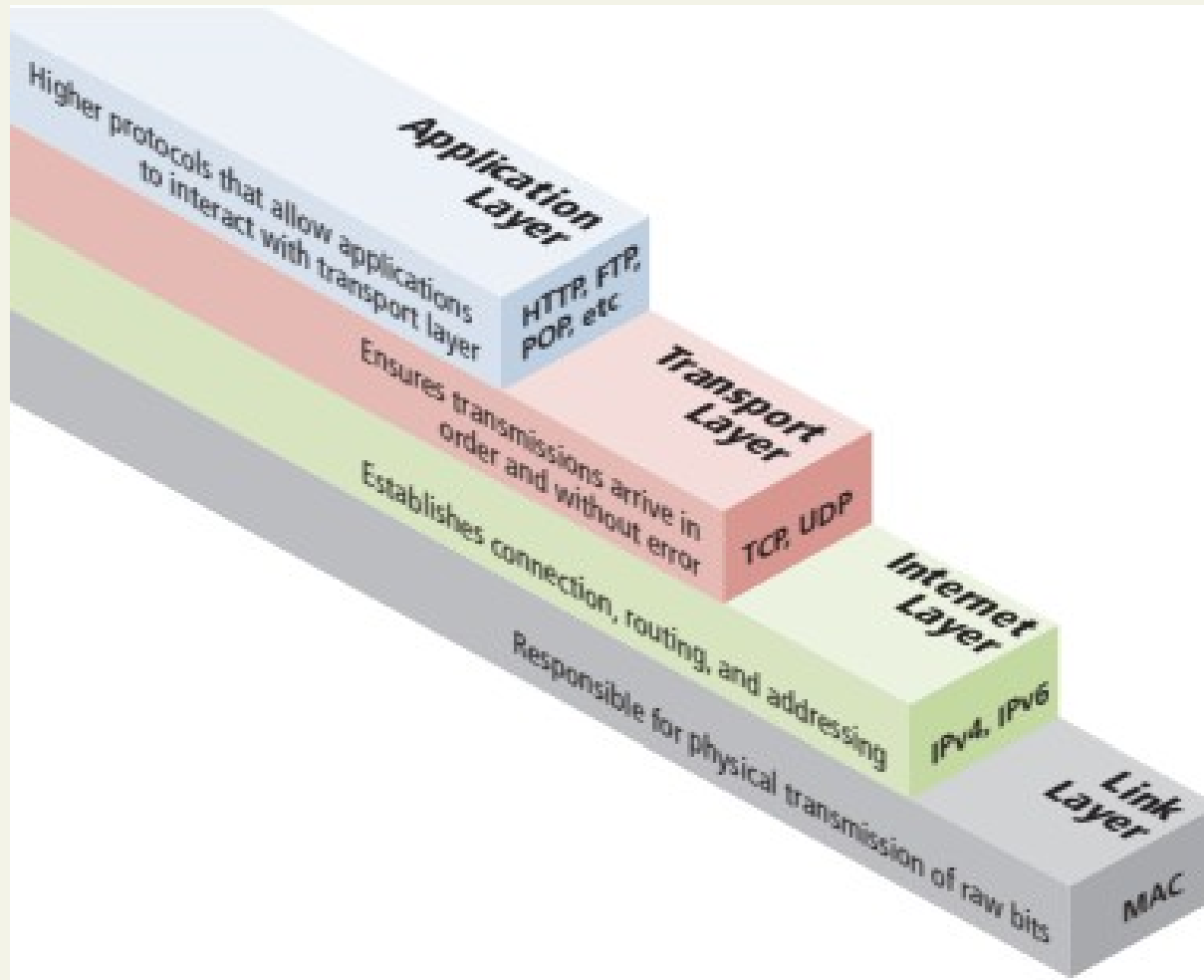
Networking is its own entire discipline.

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

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# Internet Protocols

A Layered Architecture



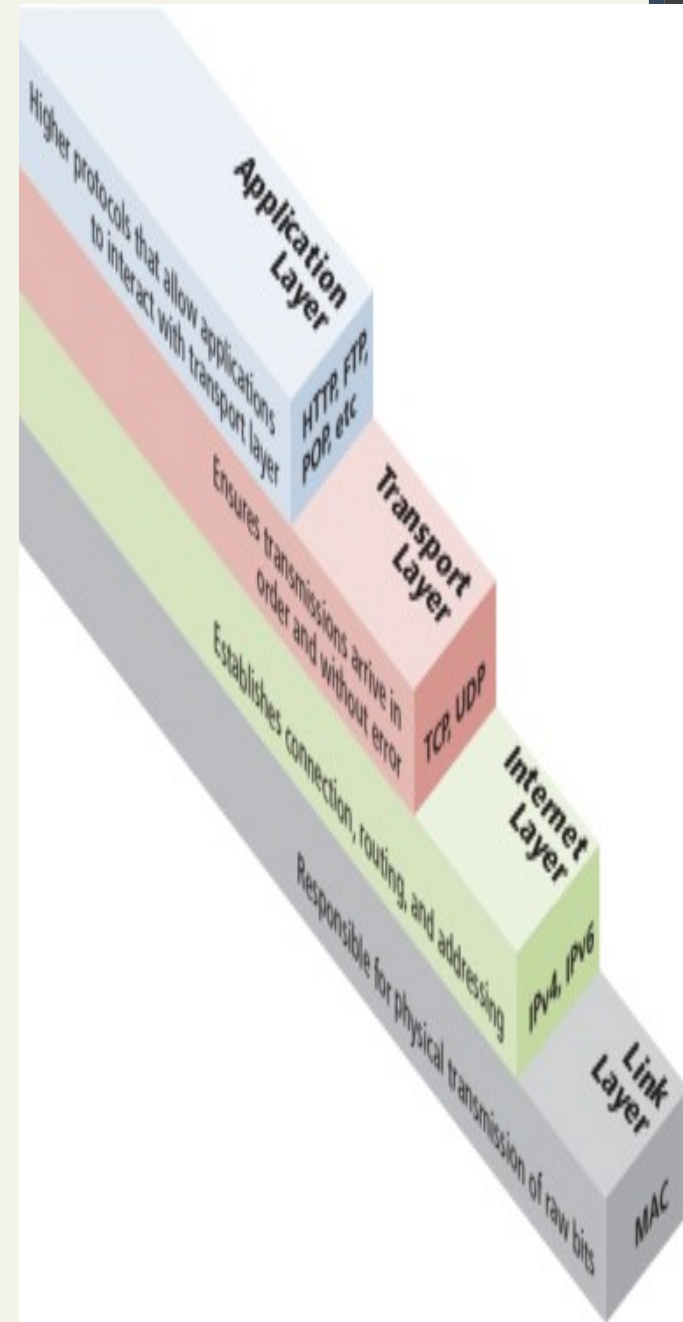
# Internet Protocols

## 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.

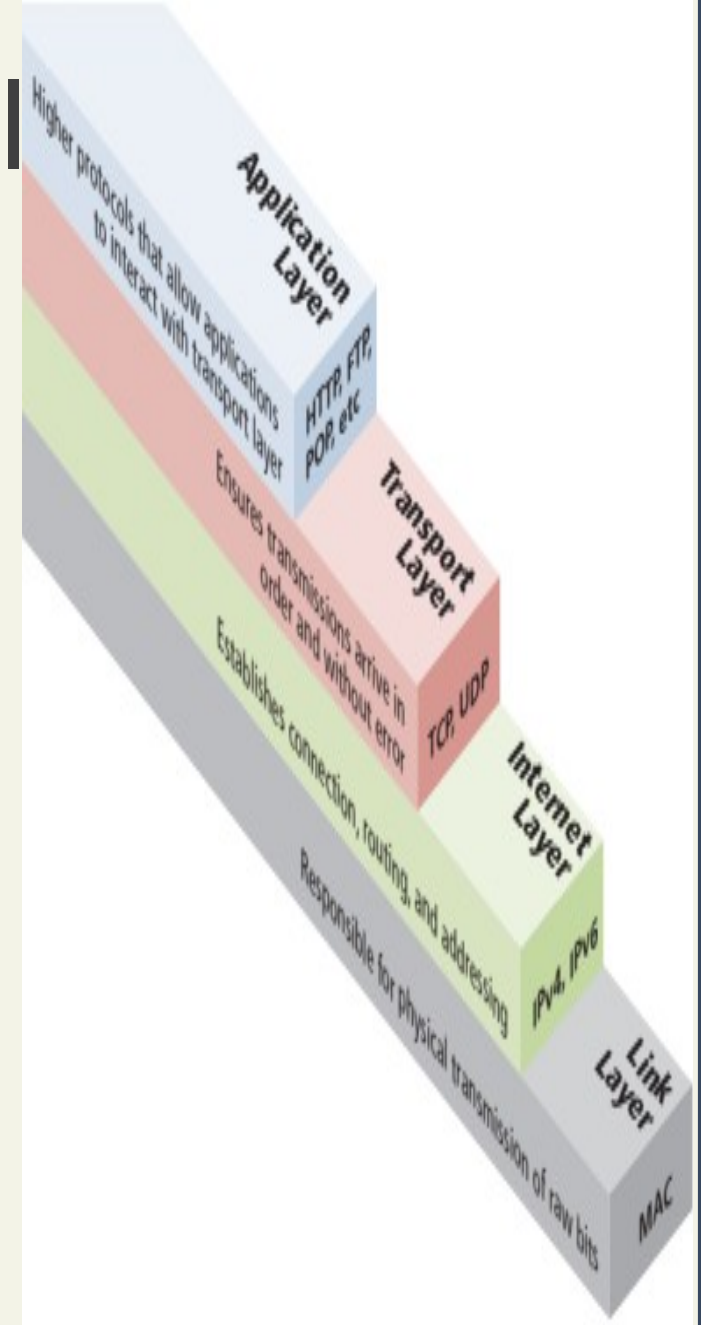


# Internet Protocol

Internet Layer

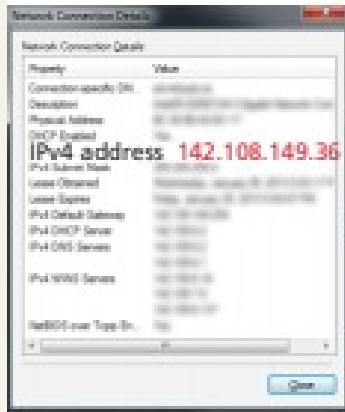
The Internet layer provides “best effort” communication.

Makes use of IP addresses



# Internet Protocols

Internet Layer (IP)



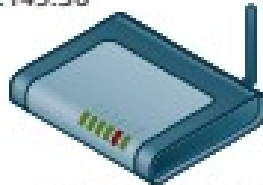
IP: 142.108.149.36



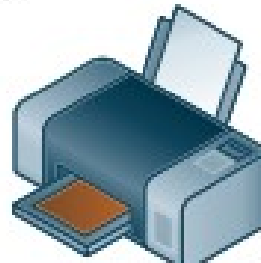
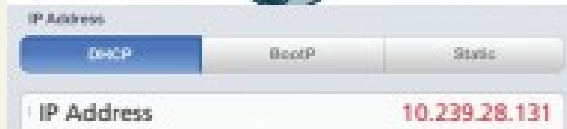
IP: 22.15.216.13



IP: 10.238.28.131



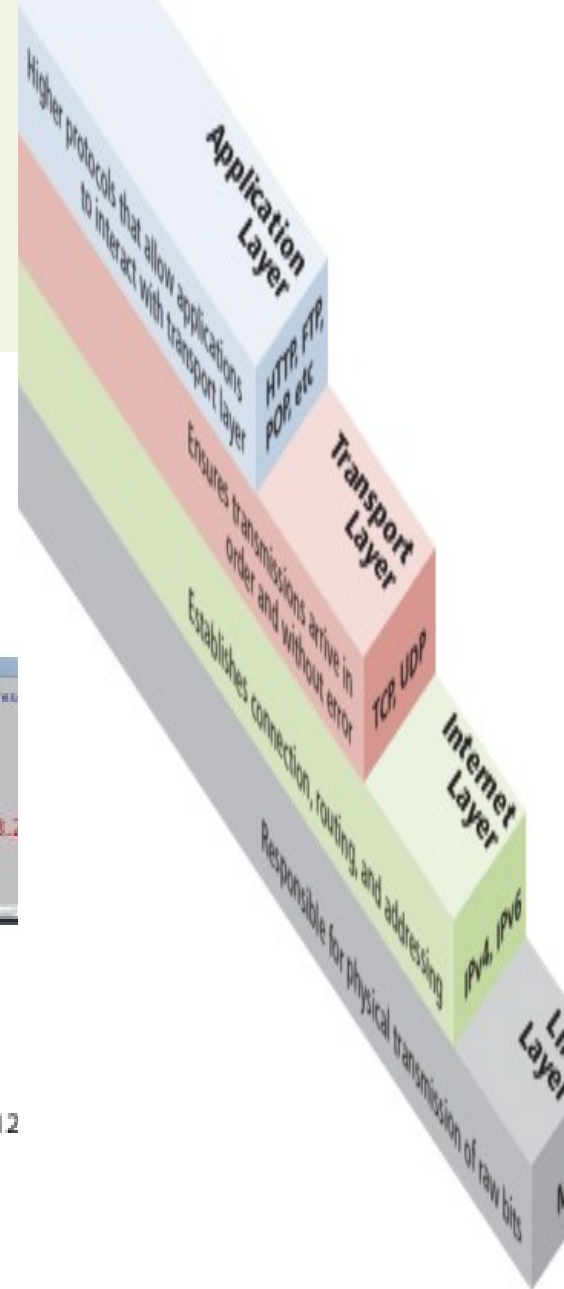
IP: 10.239.28.131



IP: 142.181.80.3



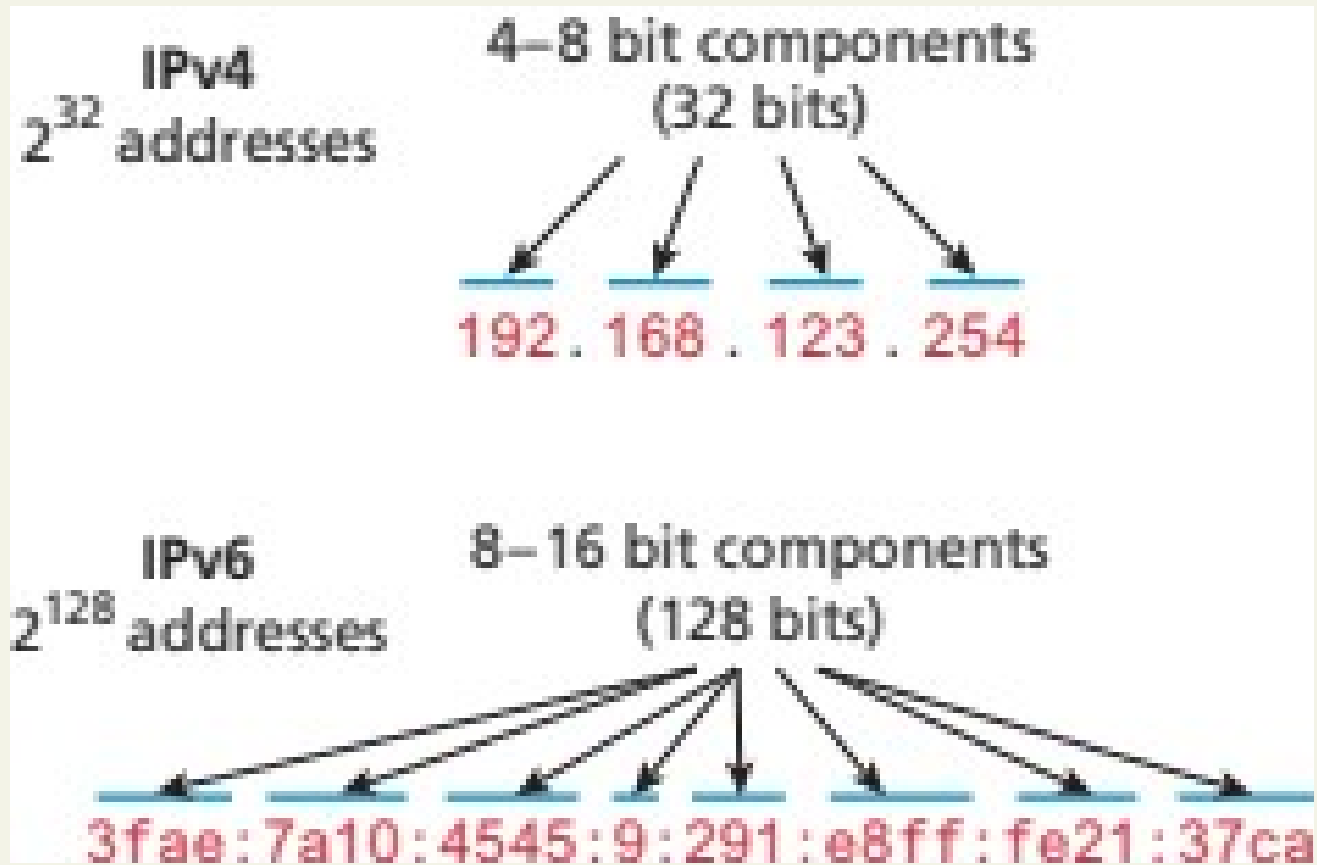
IP: 192.168.12





# Internet Protocols

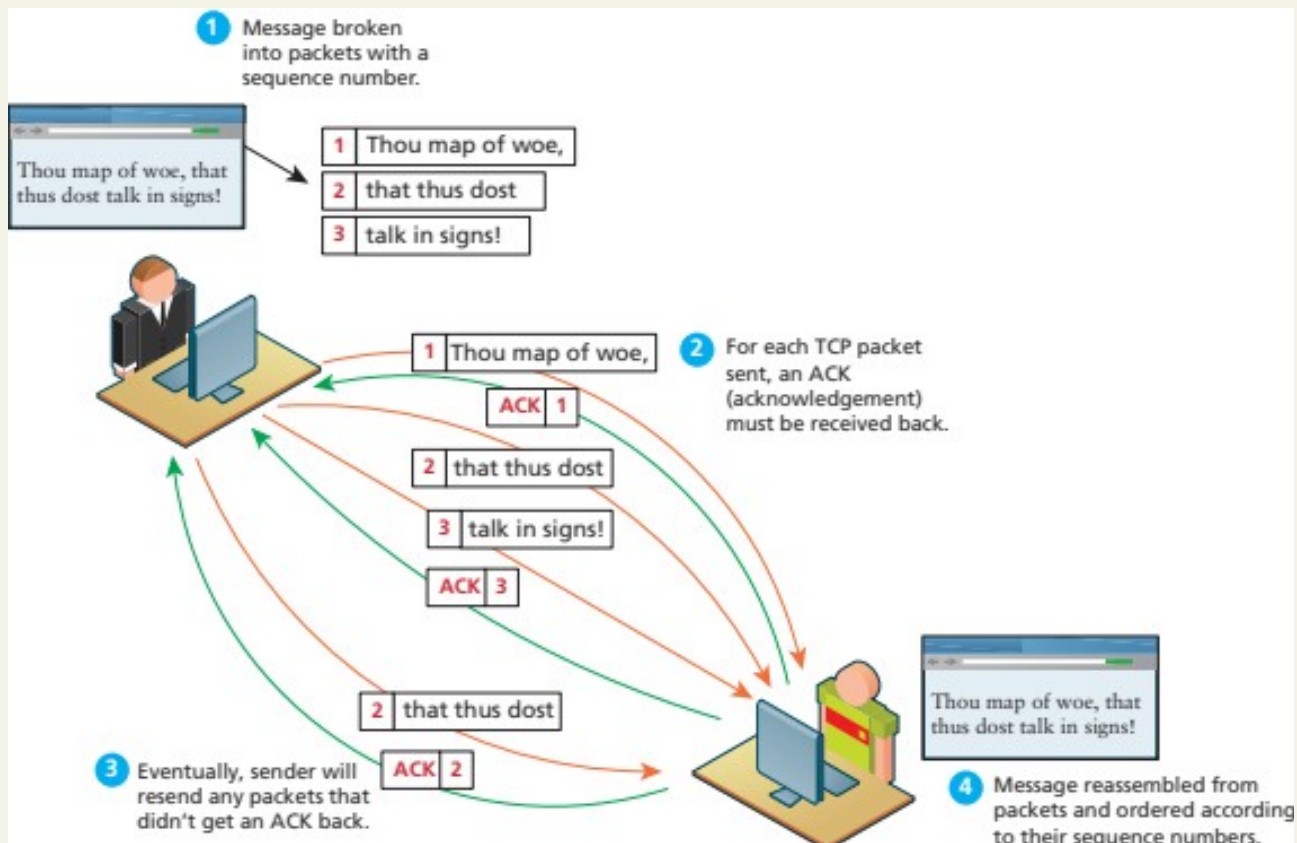
IP addresses



# Internet Protocols

Transport Layer (TCP)

- Ensures transmissions arrive in order and without error



# Internet Protocols

## 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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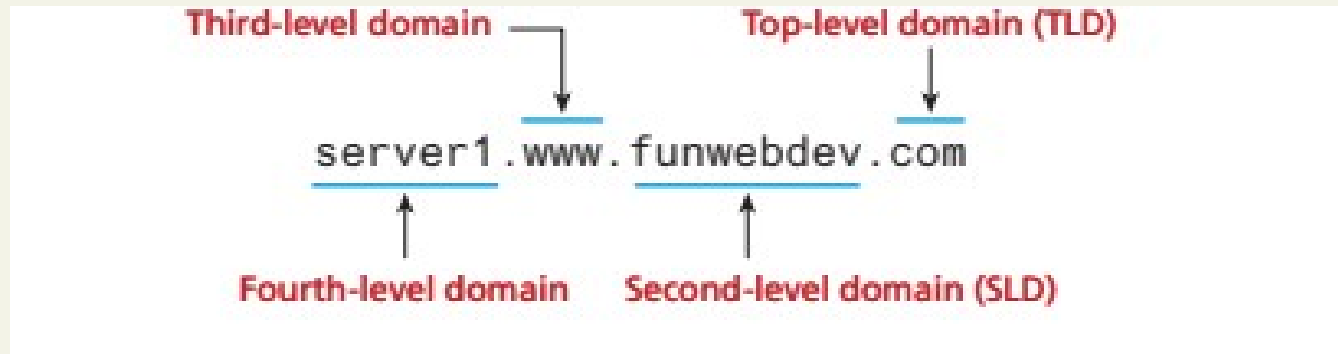
**6** Web Servers

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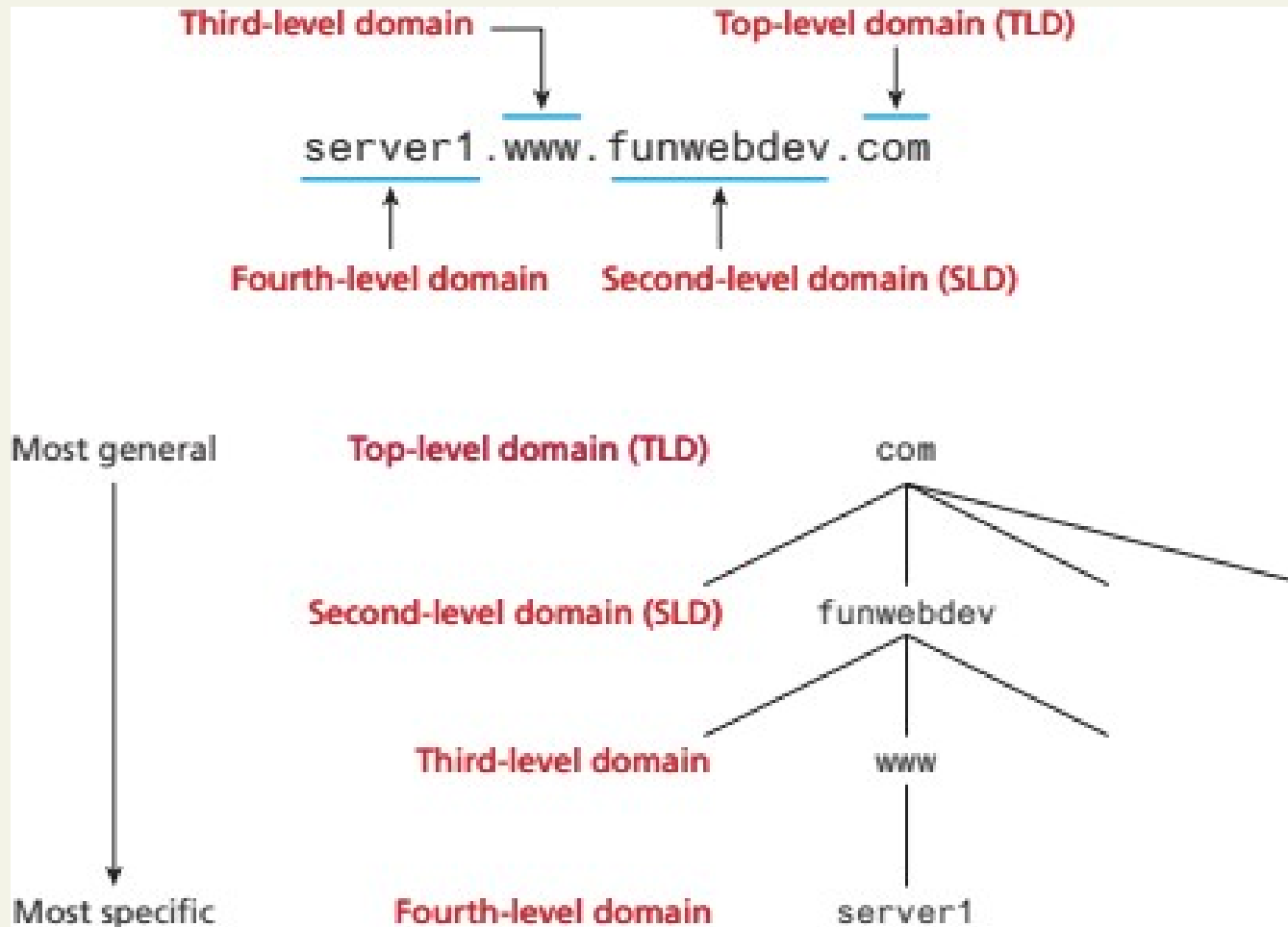
# Domain Name System

Name Levels



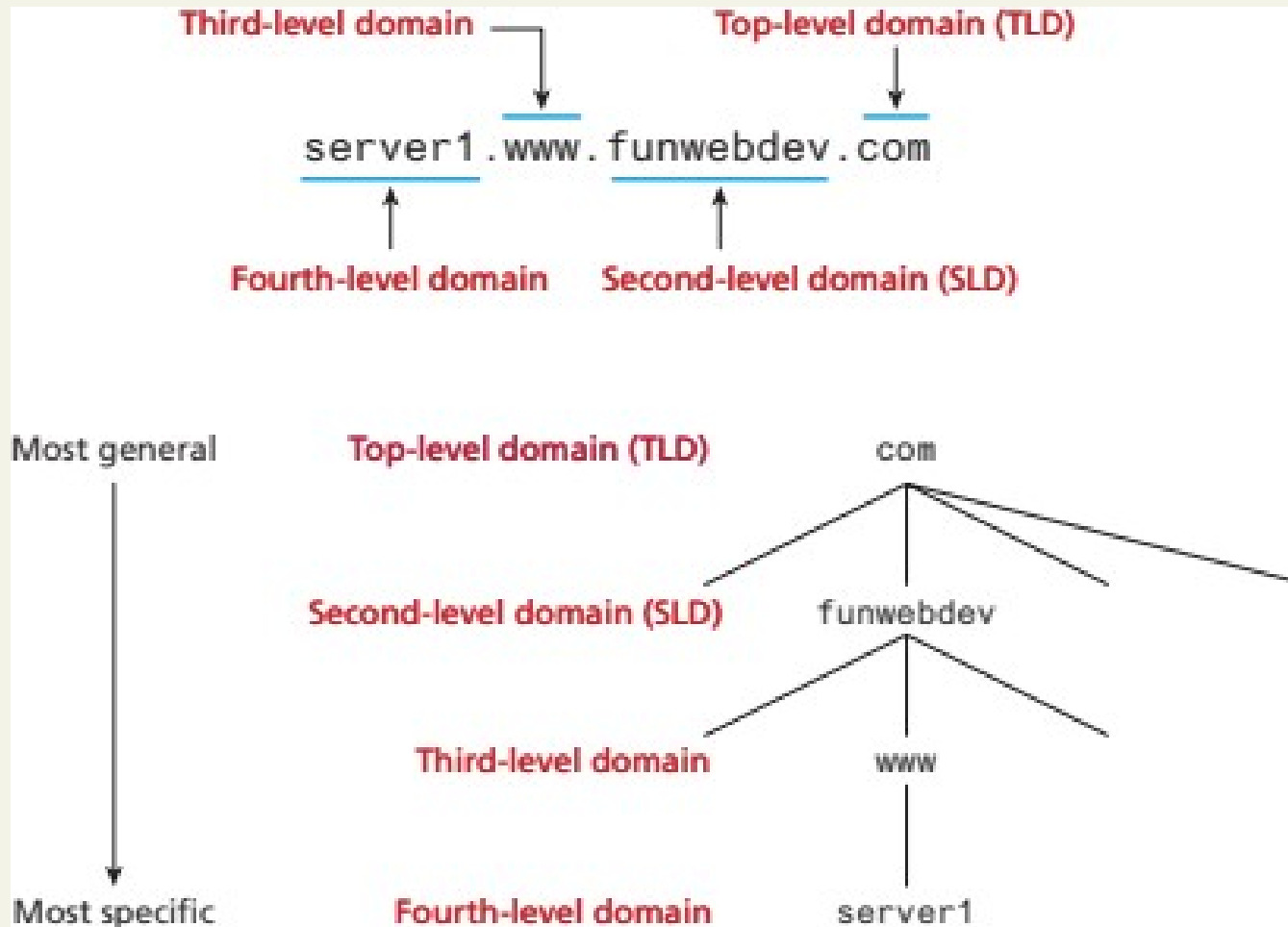
# Domain Name System

## Name Levels



# Domain Name System

## Name Levels



# Domain Name System

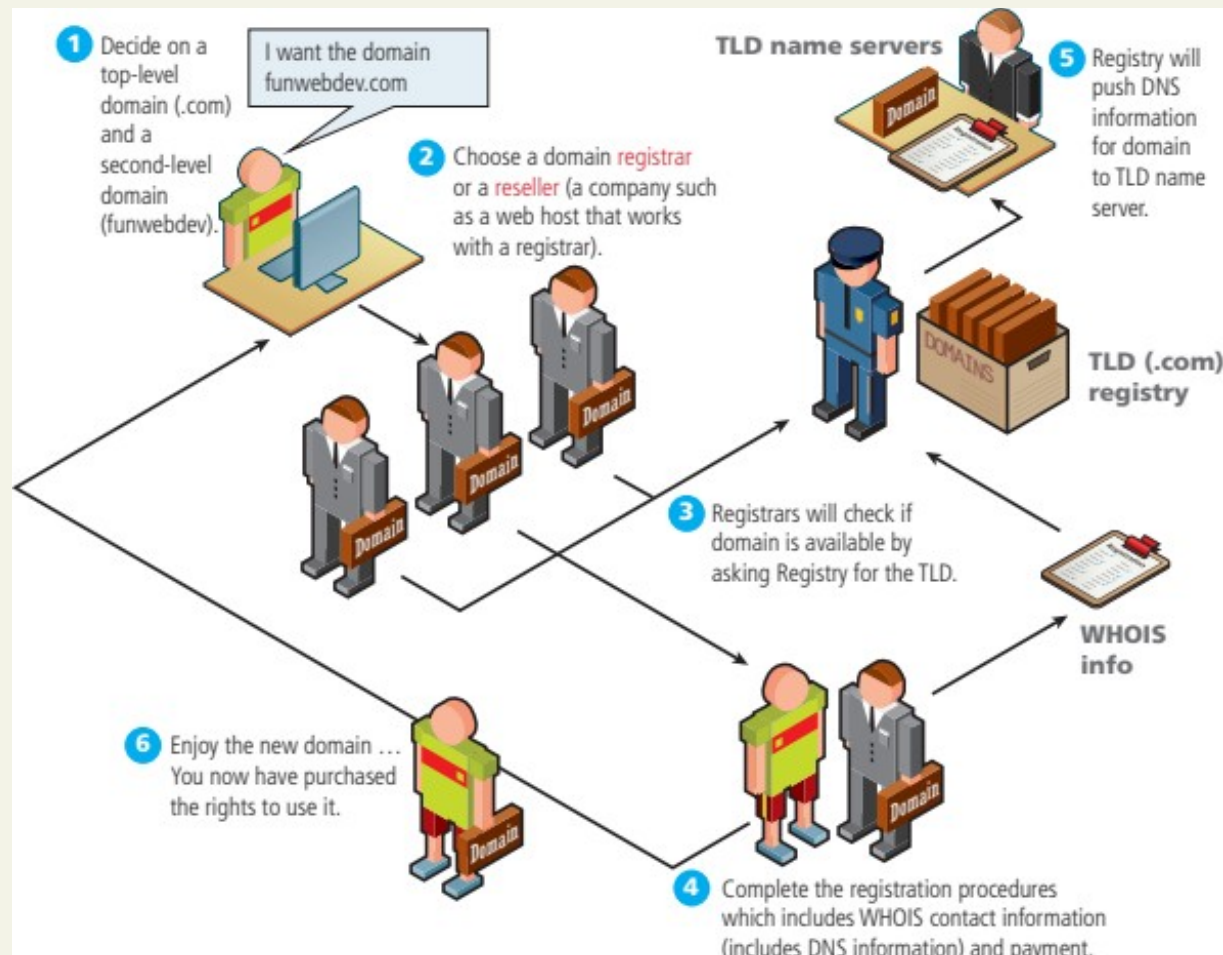
## Types of Top Level Domains

- 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 ( first assigned TLD. Used for reverse DNS lookups)
-



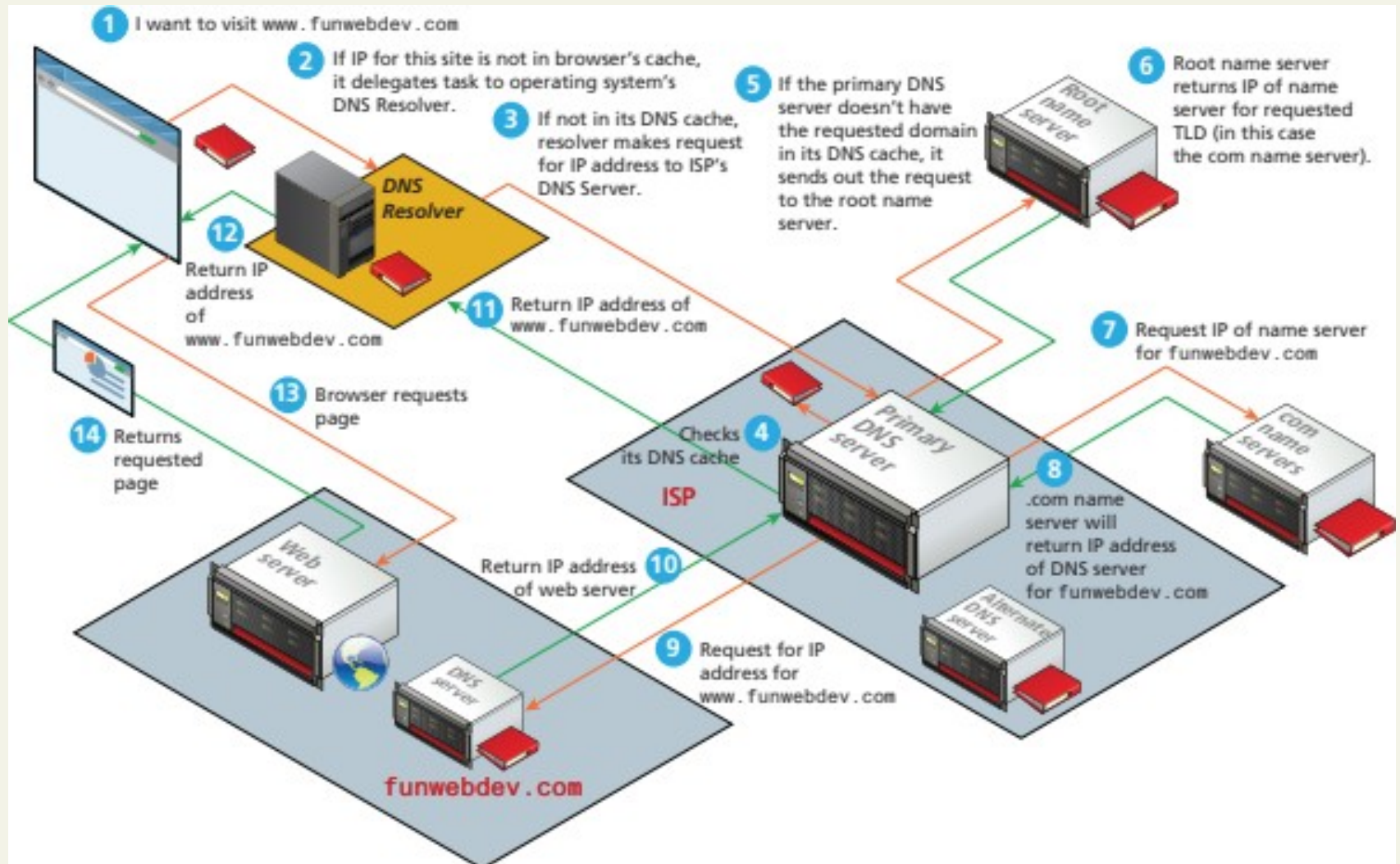
# Domain Name System

## Name Registration



# Domain Name System

## Address Resolution



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# Uniform Resource Locators

## Overview

`http://www.funwebdev.com/index.php?page=17#article`

The diagram shows the URL `http://www.funwebdev.com/index.php?page=17#article` with blue brackets underneath identifying its parts: `http` is the Protocol, `www.funwebdev.com` is the Domain, `/index.php` is the Path, `?page=17` is the Query String, and `#article` is the Fragment.

*Protocol*      *Domain*      *Path*      *Query String*      *Fragment*

---

# Uniform Resource Locators

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.
-

# Uniform Resource Locators

## 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
-

# Uniform Resource Locators

Port

- 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.
-

# Uniform Resource Locators

Path

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/`

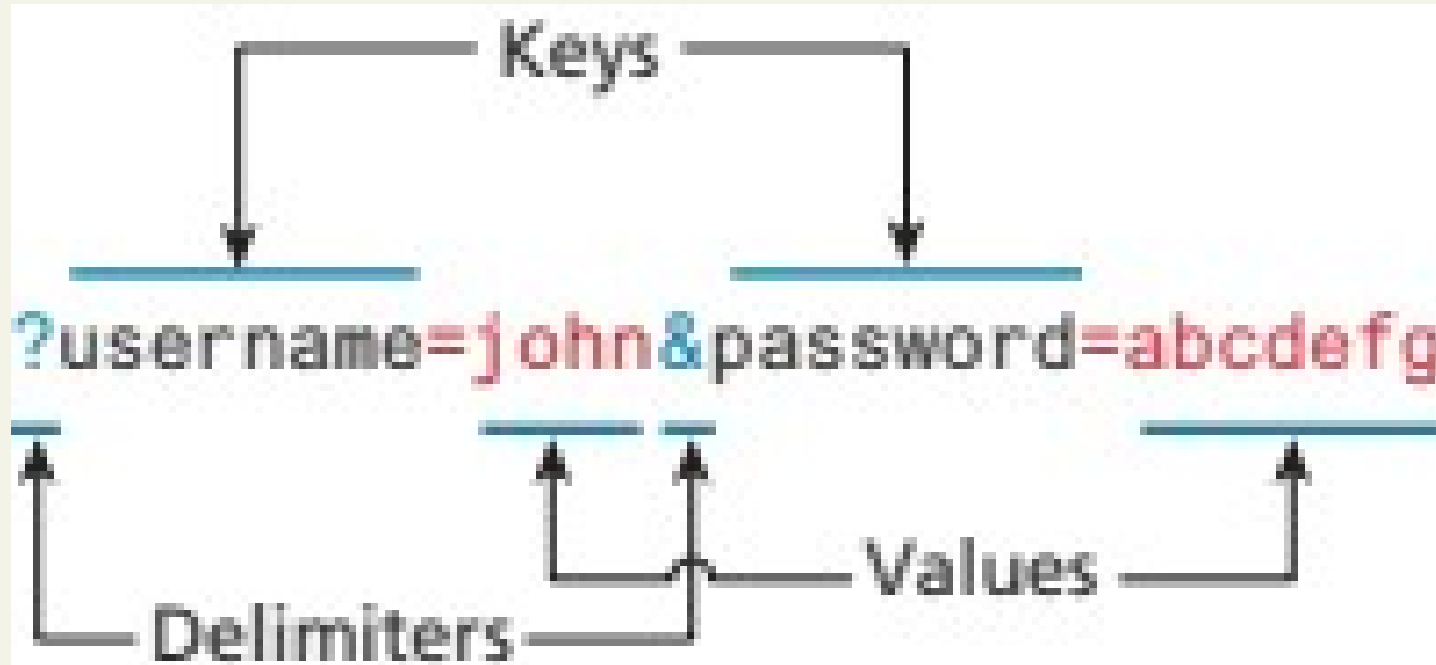
The path is optional. However, when requesting a folder or the top-level page, the web server will decide which file to send you.

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# Uniform Resource Locators

Query String



# Uniform Resource Locators

## 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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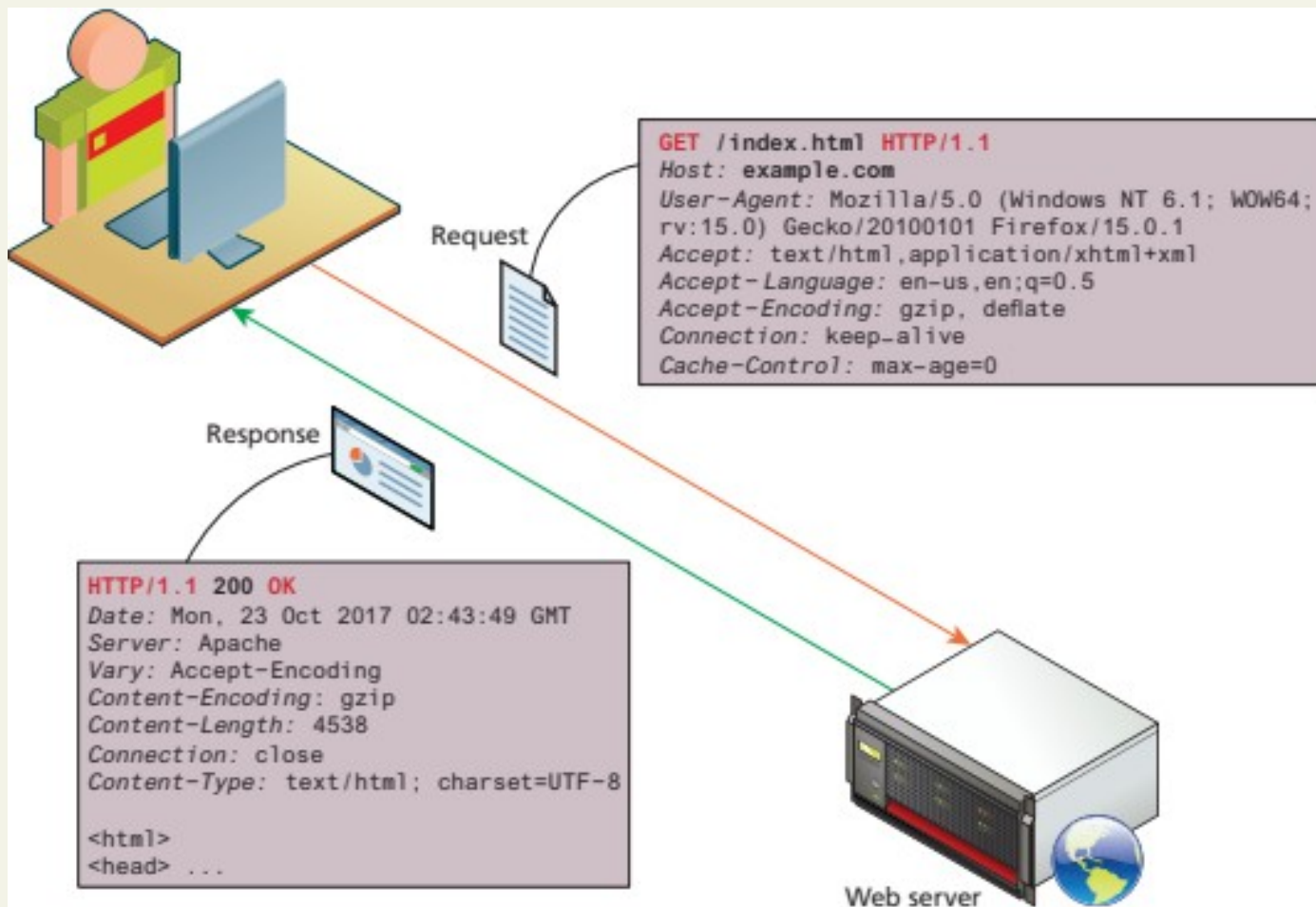
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# Hypertext Transfer Protocol

Headers

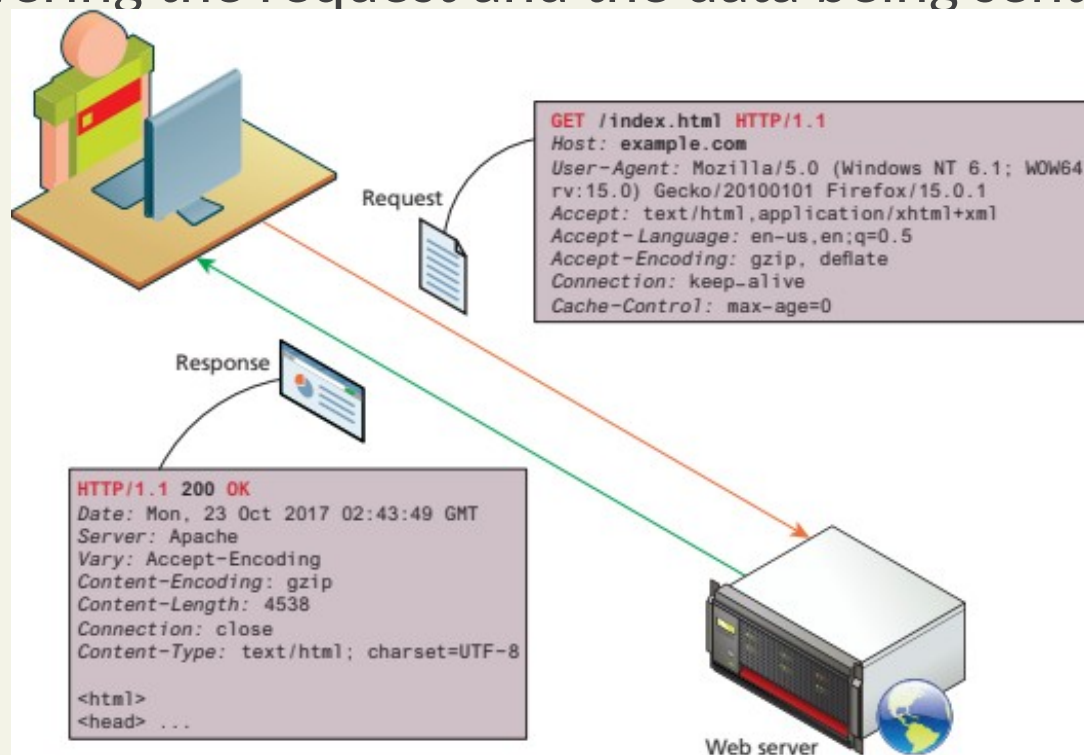
## Protocol



# Hypertext Transfer Protocol

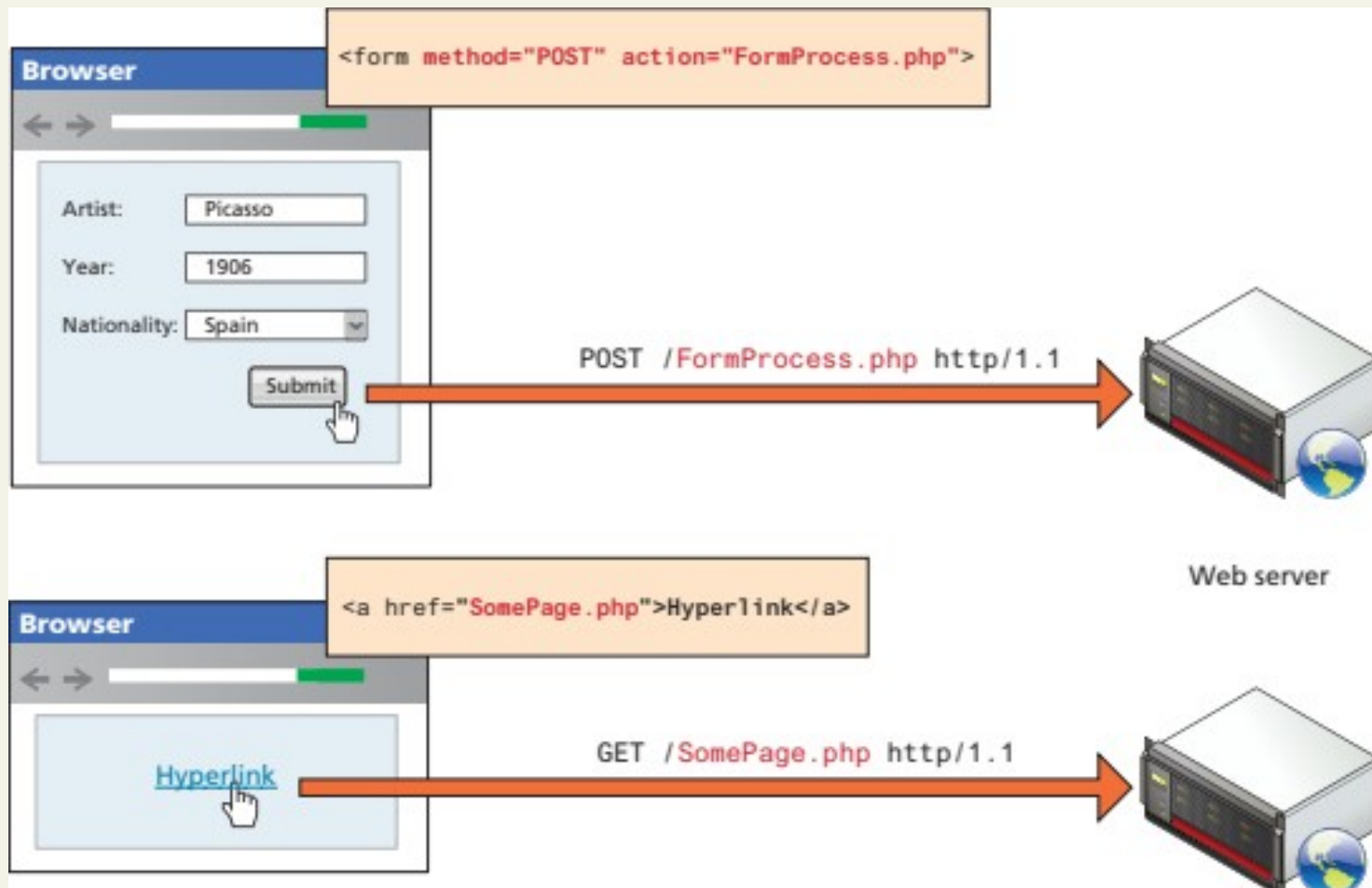
Headers

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



# Hypertext Transfer Protocol

Request Methods



# Hypertext Transfer Response Codes Protocol

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

# Hypertext Transfer (Some) Response Codes Protocol

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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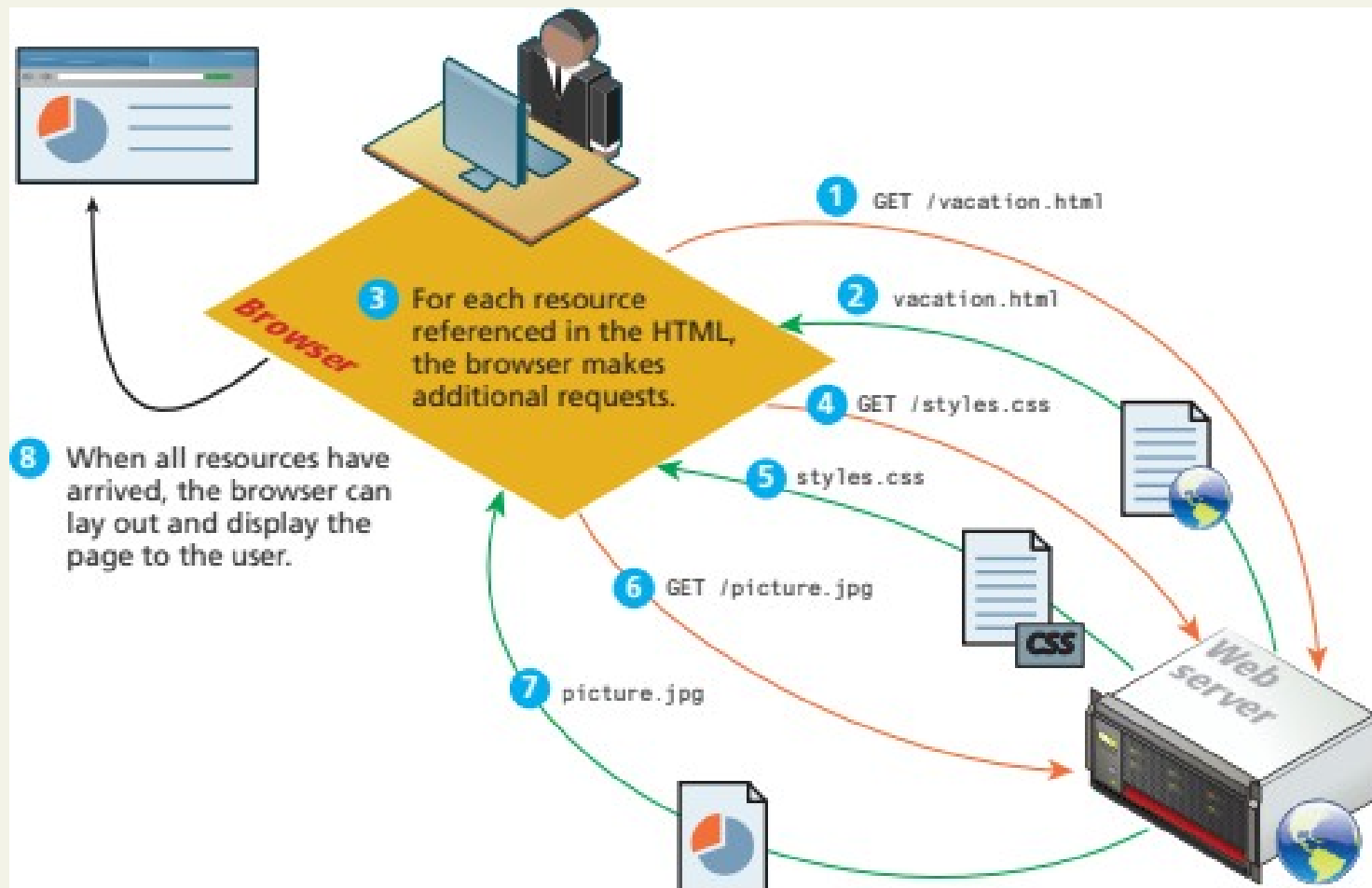
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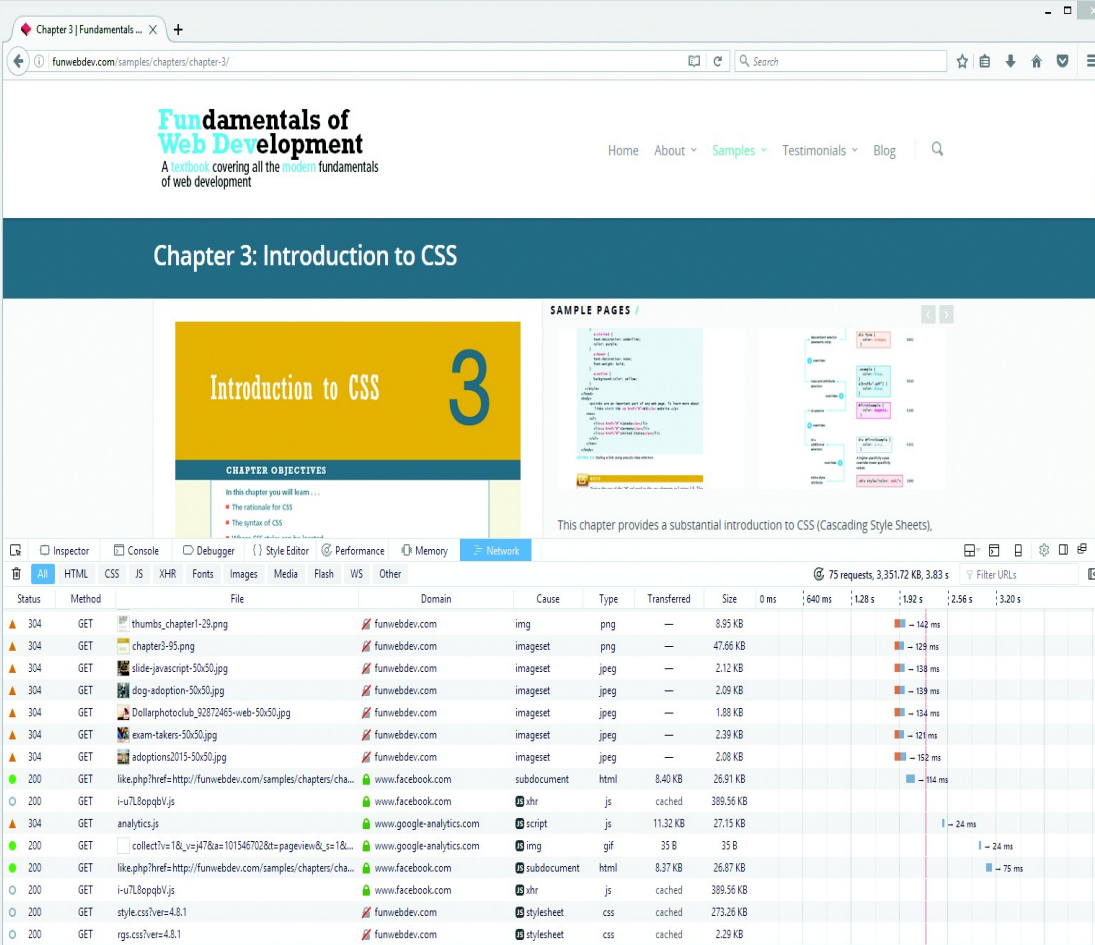
# Web Browsers

## Fetching a Web Page



# Web Browsers

## Fetching a Web Page – Load Times and Cascades



The screenshot shows a web browser window displaying the 'Fundamentals of Web Development' website. The page title is 'Chapter 3: Introduction to CSS'. The main content area features a large yellow banner with the text 'Introduction to CSS 3' and a section titled 'CHAPTER OBJECTIVES'. To the right, there are 'SAMPLE PAGES' showing various CSS examples. The browser's developer tools are open at the bottom, showing the 'Network' tab with a list of 75 requests. The requests are categorized by status, method, file, domain, cause, type, transferred, size, and time. The table below summarizes the data from the Network tab.

| Status | Method | File   | Domain                   | Cause       | Type | Transferred | Size      | 0 ms | 640 ms | 1.28 s | 1.92 s | 2.56 s | 3.20 s |
|--------|--------|--|--------------------------|-------------|------|-------------|-----------|------|--------|--------|--------|--------|--------|
| 304    | GET    | thumbs_chapter1-29.png                                     | funwebdev.com            | img         | png  | —           | 8.95 KB   |      |        |        | 142 ms |        |        |
| 304    | GET    | chapter3-95.png  | funwebdev.com            | imageset    | png  | —           | 47.66 KB  |      |        |        | 129 ms |        |        |
| 304    | GET    | slide-javascript-50x50.jpg                                 | funwebdev.com            | imageset    | jpeg | —           | 2.12 KB   |      |        |        | 138 ms |        |        |
| 304    | GET    | dog-adoption-50x50.jpg                                     | funwebdev.com            | imageset    | jpeg | —           | 2.09 KB   |      |        |        | 139 ms |        |        |
| 304    | GET    | Dollarphotoclub_92872465-web-50x50.jpg                     | funwebdev.com            | imageset    | jpeg | —           | 1.88 KB   |      |        |        | 134 ms |        |        |
| 304    | GET    | exam-takers-50x50.jpg                                      | funwebdev.com            | imageset    | jpeg | —           | 2.39 KB   |      |        |        | 121 ms |        |        |
| 304    | GET    | adoptions2015-50x50.jpg                                    | funwebdev.com            | imageset    | jpeg | —           | 2.08 KB   |      |        |        | 152 ms |        |        |
| 200    | GET    | like.php?href=http://funwebdev.com/samples/chapters/cha... | www.facebook.com         | subdocument | html | 8.40 KB     | 26.91 KB  |      |        |        | 114 ms |        |        |
| 200    | GET    | i-u7L8opqBV.js   | www.facebook.com         | xhr         | js   | cached      | 389.56 KB |      |        |        |        |        |        |
| 304    | GET    | analytics.js   | www.google-analytics.com | script      | js   | 11.32 KB    | 27.15 KB  |      |        |        | 24 ms  |        |        |
| 200    | GET    | collect?v=1&tid=UA-101546702-8&pageview&_sa=18...          | www.google-analytics.com | img         | gif  | 39 B        | 35 B      |      |        |        | 24 ms  |        |        |
| 200    | GET    | like.php?href=http://funwebdev.com/samples/chapters/cha... | www.facebook.com         | subdocument | html | 8.37 KB     | 26.87 KB  |      |        |        | 75 ms  |        |        |
| 200    | GET    | i-u7L8opqBV.js   | www.facebook.com         | xhr         | js   | cached      | 389.56 KB |      |        |        |        |        |        |
| 200    | GET    | style.css?vers=4.8.1                                       | funwebdev.com            | stylesheet  | css  | cached      | 273.26 KB |      |        |        |        |        |        |
| 200    | GET    | rgs.css?vers=4.8.1   | funwebdev.com            | stylesheet  | css  | cached      | 2.29 KB   |      |        |        |        |        |        |

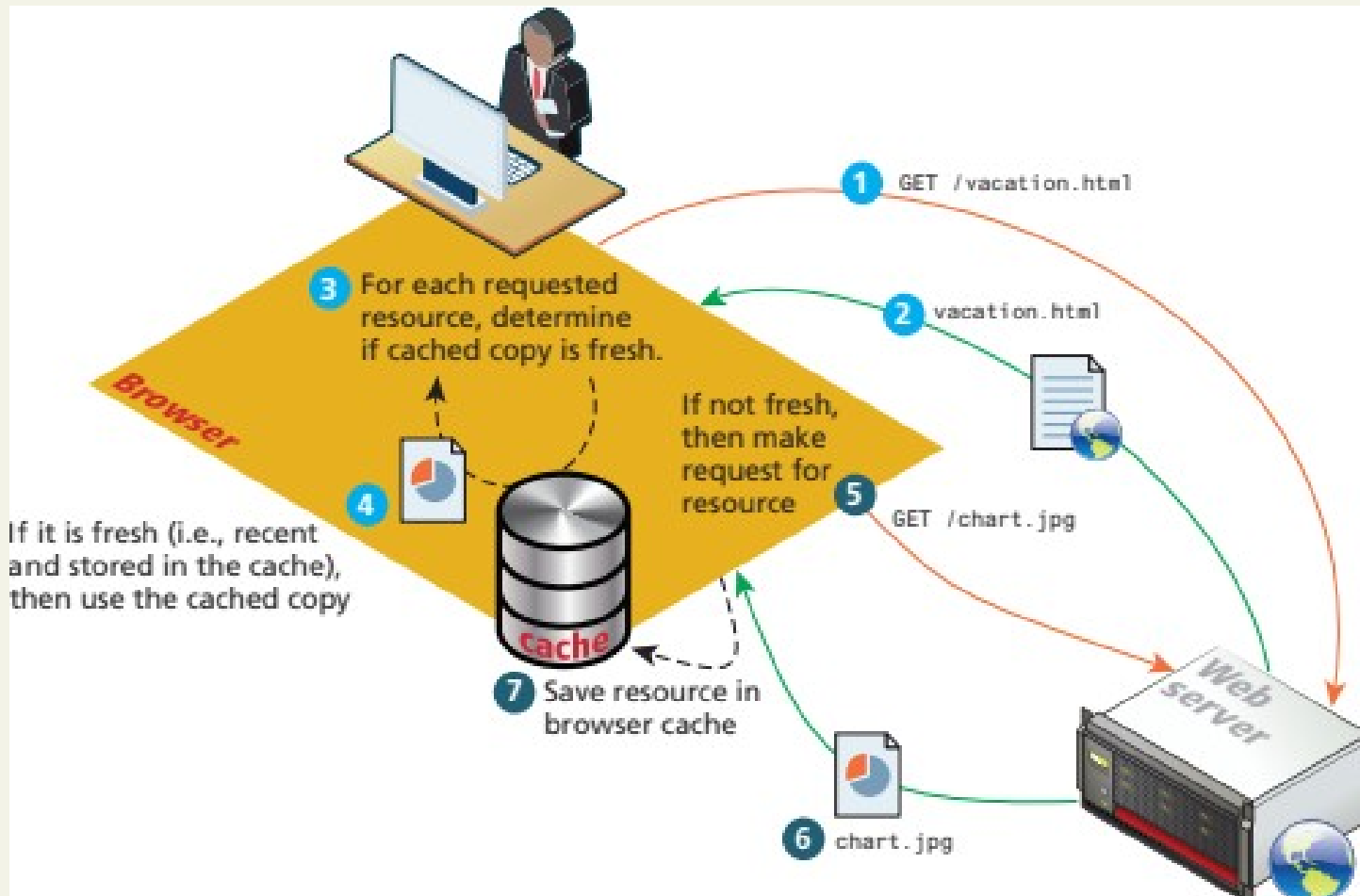
# Web Browsers

## 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)
-

# Web Browsers

## Browser Caching



# Web Browsers

## Browser Features

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

# Web Browsers

## 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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# Web Servers

## 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
-

# Web Servers

## 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, ...

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# Web Servers

Operating Systems

- Linux
  - Windows
-

# Web Servers

Web Server Software

- Apache
  - Nginx
  - IIS
-

# Web Servers

Database Software

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

# Web Servers

Scripting Software

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

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# Summary

## Key Terms

|                          |                             |                     |
|--------------------------|-----------------------------|---------------------|
| address resolution       | GET request                 | link layer          |
| Apache                   | HTTP                        | MAC addresses       |
| Application stack        | Internet Corporation for    | MEAN software stack |
| application layer        | Assigned Names and          | packet              |
| country code top-level   | Numbers (ICANN)             | protocol            |
| domain (ccTLD)           | Internet Assigned           | port                |
| DNS resolver             | Numbers Authority           | POST request        |
| DNS server               | (IANA)                      | protocol            |
| domain names             | internationalized top-level | request             |
| domain name registrars   | domain name (IDN)           | request headers     |
| Domain Name System       | Internet layer              | response codes      |
| (DNS)                    | Internet Protocol (IP)      | response headers    |
| FTP                      | IP address                  | reverse DNS lookups |
| four-layer network model | IPv4                        | root name server    |
| generic top-level domain | IPv6                        | second-level domain |
| (gTLD)                   | LAMP software stack         | SFTP                |

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# Summary

Key Terms (Continued)



# Questions?