L7: Web Servers

Web Engineering

188.951 2VU SS20

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L7: Webservers

- Overview of web servers (hardware and server software)
- Web servers as part of internet architecture
- Serving static resources over the filesystem
- Dynamic resources through server-side scripting and HTTP

Learning Goals

- Understand the difference between web servers as hardware and software
- Place web servers on the map of broader scale of internet architecture
- Describe static and dynamic resources with respect to web servers and HTTP
- Ability to write a basic web server with JavaScript/Node.js

Recap: High Level Web Overview

- Servers wait for requests
- They serve web **resources**

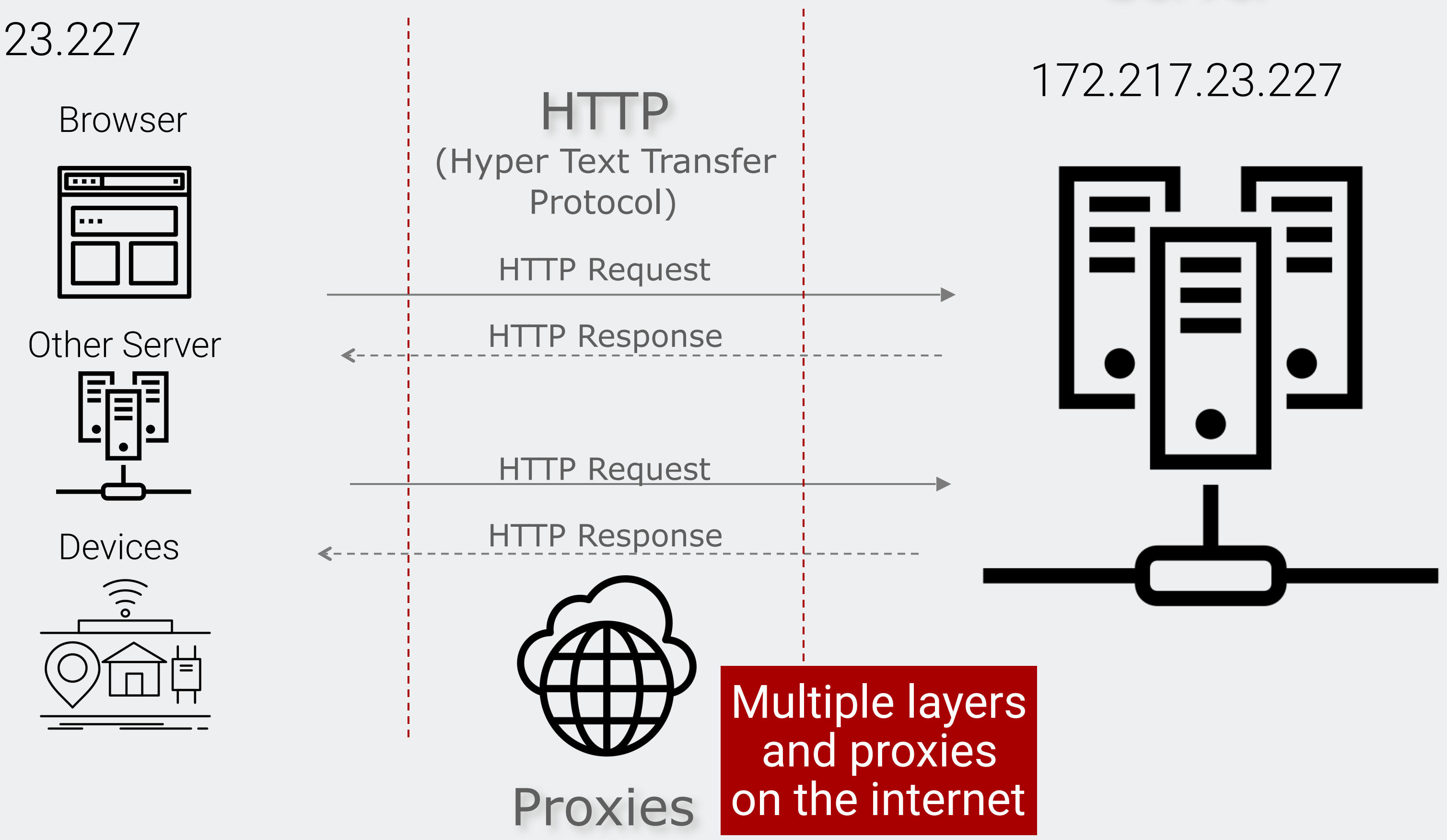
Client https://www.google.at

www.google.at —> 172.217.23.227

Domain Name System (DNS): Translating hostname to IP address

Server

172.217.23.227



Multiple layers and proxies on the internet

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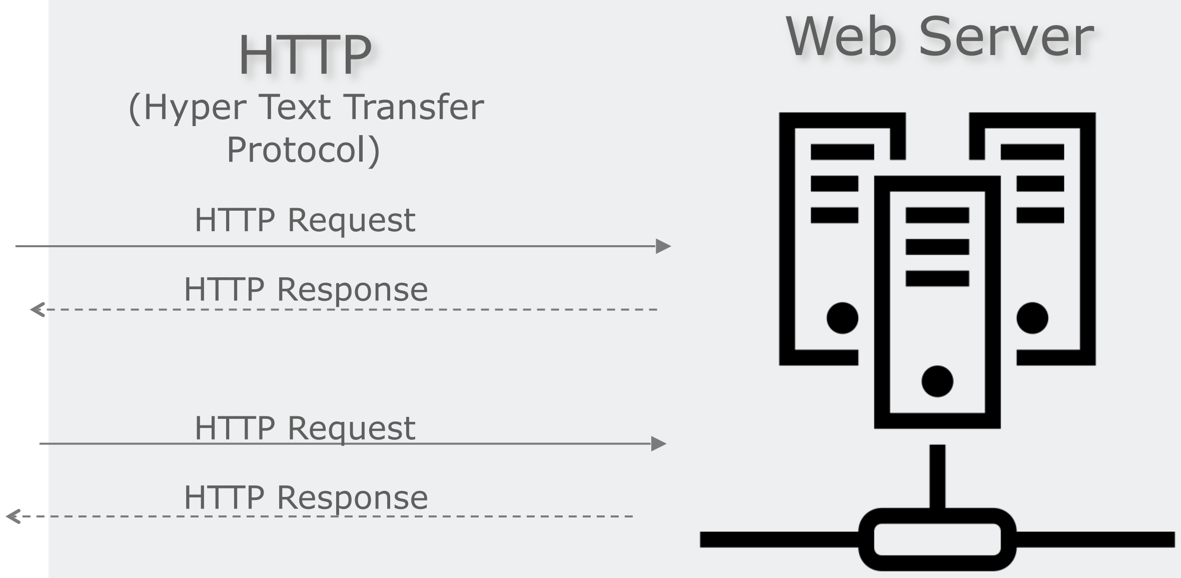
Icons by the Noun Project: Cattaleeya Thongsriphong, Flatart, Graphic Tigers, I Putu Kharismayadi

Web Server



"Web Server" is an ambiguous term:

1. **Hardware:** A computer ("server") connected to the internet (or any network)

2. **Software**: A program running on a computer/server that accepts HTTP requests over a specific port and answers with HTTP responses

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Web Server - Hardware

Hardware: A computer ("server") connected to the internet (or any network)

Properties of contemporary web servers

- Part of large data centres
- Latency is geographically dependent, so web servers are often geographically distributed (works through, e.g., DNS)
- Virtual servers: Physical servers can host many virtualized (web) servers

Can also be your own computer (localhost)

"Data Center" by Sean Ellis https://flic.kr/p/6UDnWP

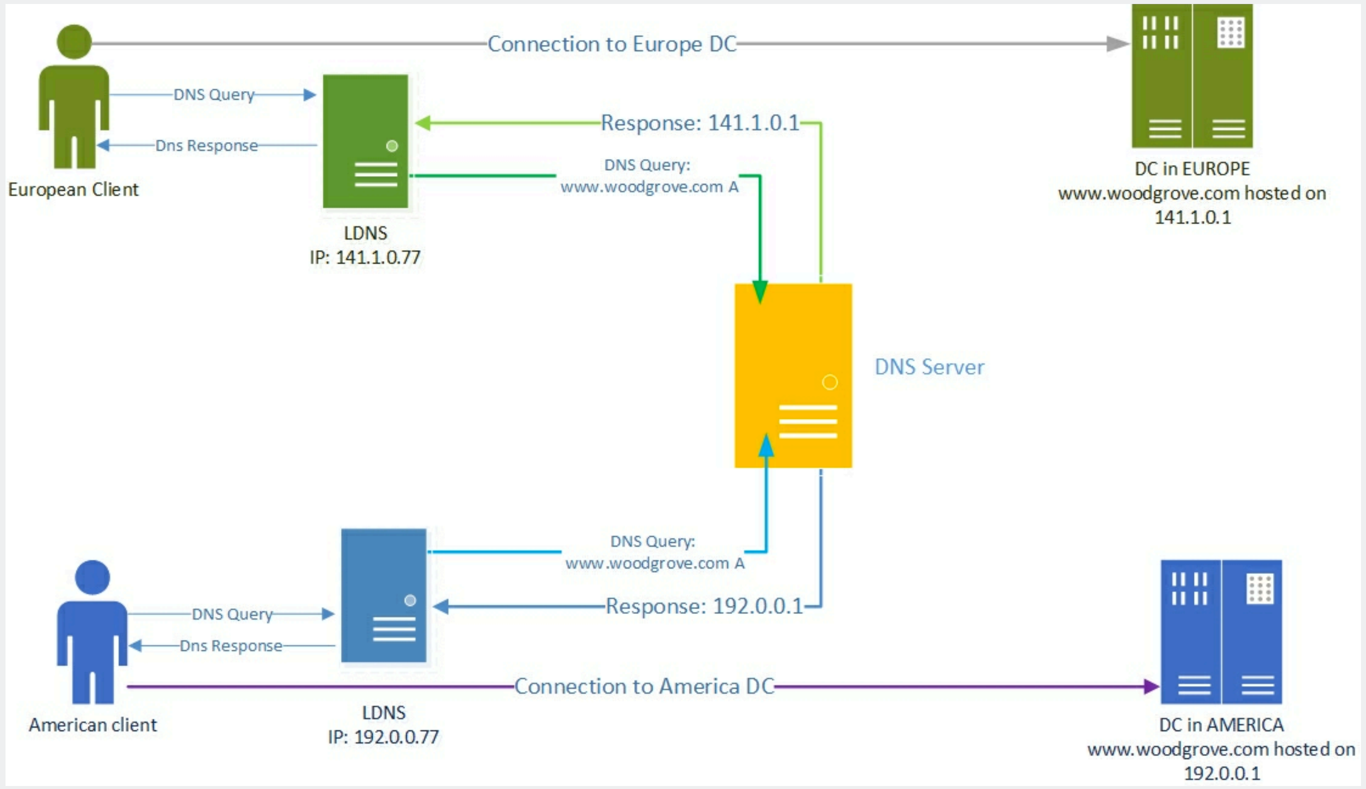
Web Server - Geo DNS

Geo-location based Serving through DNS:
Serving resources from geographically closer data centres

DNS: {Hostname, “Location”} —> IP

LDNS = “Local” DNS provided by the ISP

If not present in LDNS, contacts global DNS. They determine IP address to be returned based on policies regarding “location” features (e.g., IP address)



https://docs.microsoft.com/en-us/windows-server/networking/dns/deploy/primary-geo-location

Web Server - Virtual Servers and Containers

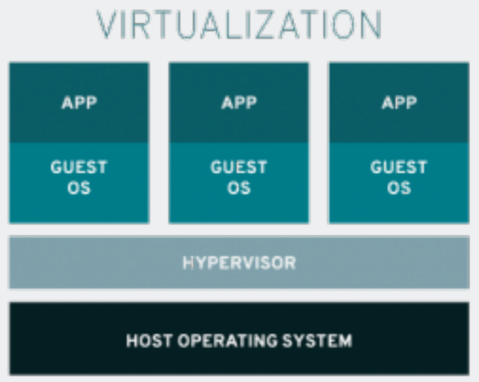
One physical server can host multiple **virtual servers** and/or **containers**

Virtual Machines

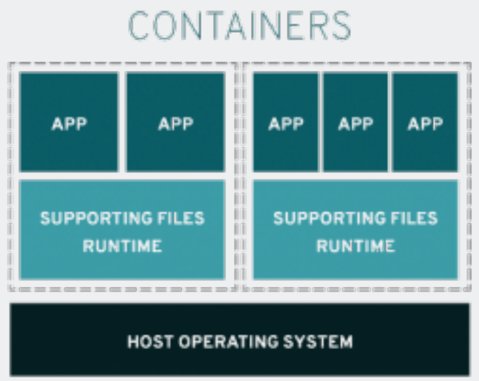
- Enables multiple virtual instances of different operating systems to run in isolation through technology called "hypervisor"
- Hypervisors divide physical resources so that virtual servers can use them and "translates" kernel operations

Containers

- Containers "feel" like virtual machines, but are not virtualized
- They provide lightweight process isolation (through cgroups) but share the Host OS kernel
- Beware that containers do not offer the same security boundaries



https://www.redhat.com/en/topics/virtualization



Web Server - Cloud

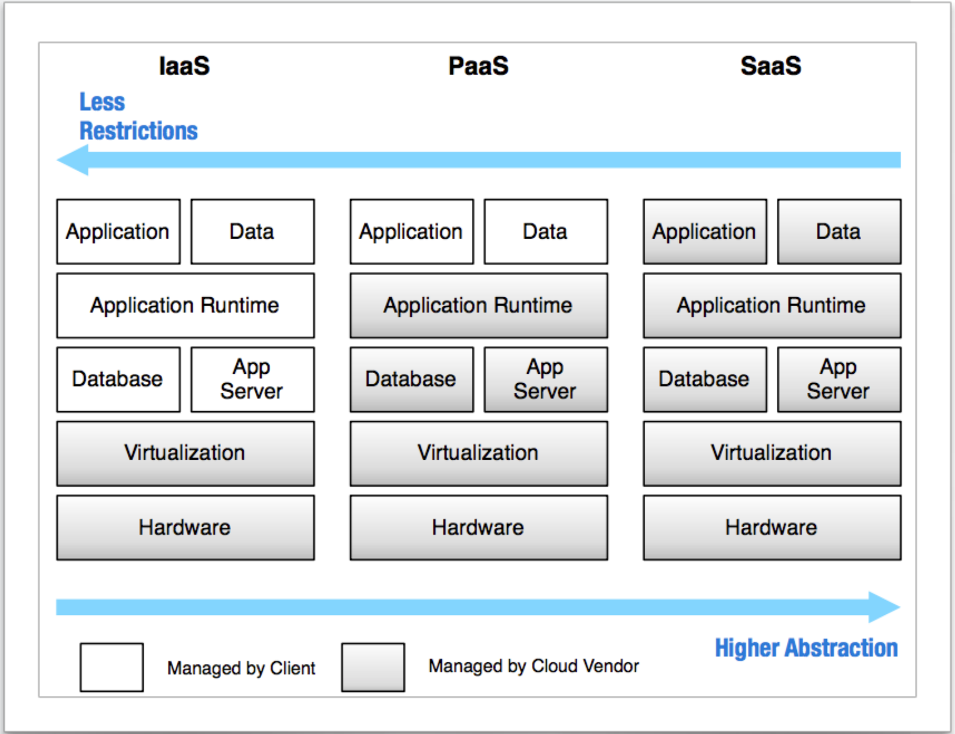
The “cloud” enables provisioning of computational resources over an API

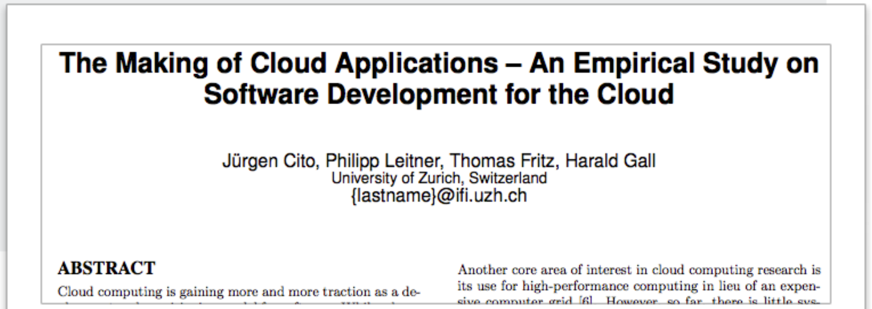
Infrastructure as a service (IaaS)

- API-driven infrastructure (web servers) at scale
- Provides the ability to write a script that automates retrieving new (virtual) server capacity
- Examples: AWS EC2, Google Compute Engine, …

Platform as a Service (PaaS)

- Managed application runtimes (e.g., web servers) that are built on top of IaaS for scalability
- Underlying infrastructure (server) is abstracted away, configuration can provide directives
- Example: Heroku, CloudFoundry, App Engine
  - Deploy web applications by providing directives on process to start or providing container




The Making of Cloud Applications – An Empirical Study on Software Development for the Cloud

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ABSTRACT

Cloud computing is gaining more and more traction as a de-

Another core area of interest in cloud computing research is its use for high-performance computing in lieu of an expen-

Jürgen Cito, Philipp Leitner, Thomas Fritz, and Harald C. Gall. 2015. **The making of cloud applications: an empirical study on software development for the cloud.** In Foundations of Software Engineering (FSE 2015)

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Web Server - Software

Web Server Software: A program running on a computer/server that accepts HTTP requests over a specific port and answers with HTTP responses

Web Server/HTTP Server

- Makes resources accessible over a URL and HTTP/S (standard ports 80 and 433)
- Starting a web server on local computer makes it accessible over
  - http://localhost
  - http://127.0.0.1
- Maps **path component** of URL to
  - static asset on the file server
  - dynamically rendered resources
- Often incorporates some functionality for caching and session handling

https://localhost:3000**/members/rackets?year=2020**

Path component + query parameters

Web Server - Static Assets

Serving static assets from the file system

- Web server automatically wraps static files with HTTP Response Headers
- Static assets directly map URL path to relative part of the file system
  - They cannot react to other part of the request (e.g., query parameter)
- MIME-Type is inferred through heuristics (e.g., file endings)
- Example of common static files in web servers
  - HTML, CSS
  - JavaScript (for use in browser)
  - Media (Images, Video, Audio, etc.)

Example:

- Static assets made available at path
  /var/www/public_html
  on the server
- If we determine [this is configurable]
  http://localhost/static/js/search.js
  to be a request for static assets we could return
  /var/www/public_html/js/search.js

Web Server - Dynamic Resources

Dynamic Resources

- Executing programs in a server side programming language on the server
- Dynamic resources can react to complete HTTP request (including header information)
    - Path and Query Parameters
    - HTTP Method (GET, POST, PUT, …)
    - Content Negotiation (`Accept: application/json`)
    - …
- System output is treated as the complete HTTP response (including headers)
- However, many programming languages offer library support for basic HTTP related functions and provide abstractions (e.g., for dealing with response headers)

Web Server - Examples

Apache/httpd with CGI (Common Gateway Interface)

- One of the earliest methods of providing dynamic scripting
- Live Example: https://github.com/web-engineering-tuwien/docker-cgi-python

nginx

- Reverse proxy and web server
- Online Tutorial: https://www.digitalocean.com/community/tutorials/how-to-configure-nginx-as-a-web-server-and-reverse-proxy-for-apache-on-one-ubuntu-18-04-server

Node.js Web Server

```
const http = require('http');

const requestListener = function (req, res) {
  res.writeHead(200);
  res.end('Hello, World!');
}

const server = http.createServer(requestListener);
server.listen(8080);
```