

# Networking and Cloud Computing

CS222 Spring 2024

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# Agenda

1. Introduction to Networking and Cloud Computing
  - a. Basic Networking Theories
  - b. Cloud Computing Models
  - c. Cloud Service Providers
2. Docker and Containerization
3. Next Steps

# Networking

# Different Ways of Viewing Things

There are two main ways of breaking down the different steps needed to achieve computer communication over networks.

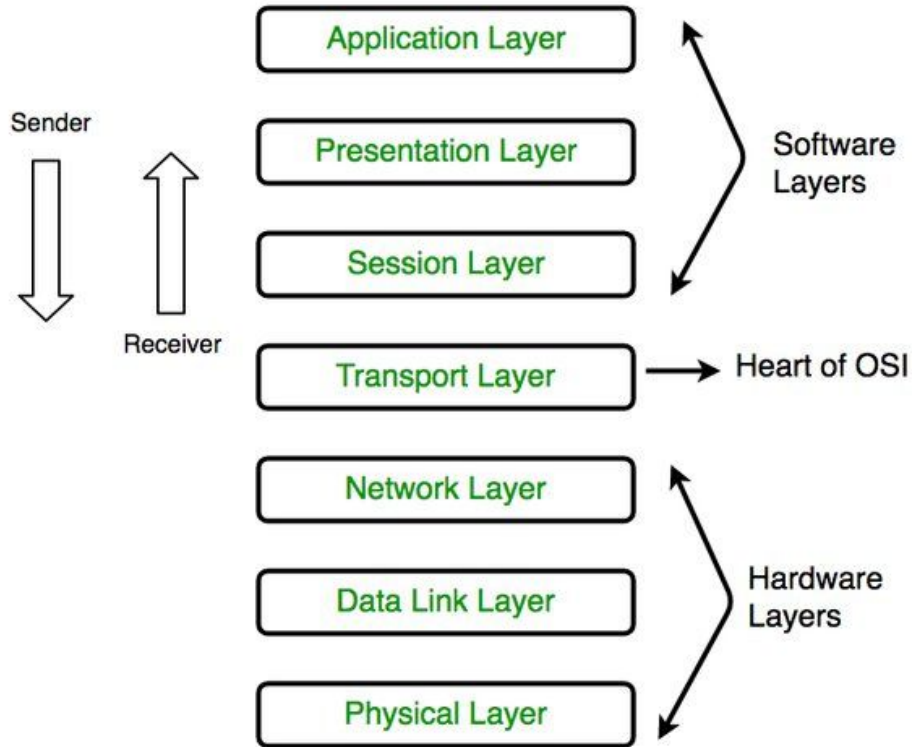
## 1. OSI Model

- a. Consists of 7 layers
- b. More comprehensive model of networked communication used for reference and education.

## 2. TCP/IP Model

- a. Consists of 4 layers
- b. More practical model, used in everyday life like the internet.

# Universal Standard for Communication



The OSI Model provides a “universal language” for communication over networks.

Each layer serves a specific purpose and operates independently of the others.

Layers communicate with each other using predefined protocols.

Each one can be thought of as an API - a pre-defined framework for communication.

# 7 Layers of the OSI Model

## Application

- End User layer
- HTTP, FTP, IRC, SSH, DNS

## Presentation

- Syntax layer
- SSL, SSH, IMAP, FTP, MPEG, JPEG

## Session

- Synch & send to port
- API's, Sockets, WinSock

## Transport

- End-to-end connections
- TCP, UDP

## Network

- Packets
- IP, ICMP, IPSec, IGMP

## Data Link

- Frames
- Ethernet, PPP, Switch, Bridge

## Physical

- Physical structure
- Coax, Fiber, Wireless, Hubs, Repeaters

<https://www.geeksforgeeks.org/open-systems-interconnection-model-osi/>

# TCP/IP Model

The TCP/IP model is a foundational framework for internet communications, guiding how data is shared across networks.

- IP Addresses (internet layer)
  - IP addresses are like home addresses but for devices on the internet. They ensure data reaches the correct destination.
- TCP protocol (transport layer)
  - TCP protocol (separate from TCP/IP model) as the delivery guarantee service of the internet. It ensures messages are delivered accurately and in order.
  - Three-Way Handshake: A protocol between devices to establish a secure connection before communicating.
- Data Transfer (internet layer)
  - How Data is Transferred Across the Network? Data is divided into smaller packets for transmission. Each packet contains source and destination IP addresses, along with a sequence number to ensure ordered delivery.
  - Packet Switching and Routing is the process of routing and transferring packets through a network. This approach enables multiple communications to coexist over a network, optimizing bandwidth utilization.

Phone  
App,  
Browser

## Application

- To allow access to network resources

TCP/UDP

## Transport

- To provide reliable process to process message delivery and error delivery

IP  
Addresses,  
Routing

## Internet

- To move packets from source to destination
- To provide internetworking

Wifi,  
Ethernet

## Network Interface

Responsible for the transmission for the between two device on the same network.

<https://www.geeksforgeeks.org/tcp-ip-model/>



# TCP vs UDP

## Transmission Control Protocol (TCP)

- Reliable: Ensures accurate delivery of data packets in the order they were sent.
- Connection-Oriented: Establishes a connection between sender and receiver before data transfer begins.
- Error Checking: Uses acknowledgments and timeouts to detect and retransmit lost or corrupted packets.

### Ideal Use Cases

Web browsing (HTTP/HTTPS)

Email (SMTP, POP3, IMAP)

File transfers (FTP)

NOTE: TCP is separate from TCP/IP model

## User Datagram Protocol (UDP)

- Unreliable: Does not guarantee order or delivery of data packets.
- Connectionless: Sends data without establishing a connection, minimizing overhead.
- Faster Transmission: Ideal for scenarios where speed is crucial and occasional data loss is acceptable.
- Simpler: Lacks sophisticated error recovery, making it lightweight.

### Ideal Use Cases

Streaming media (live broadcasts)

Online gaming

# Cloud Computing

# What is Cloud Computing?

Delivery of computing services over the internet, allowing for on-demand resource scaling.

Cloud Computing Models

IaaS, PaaS, SaaS

Cloud Service Providers

AWS, Azure, Google Cloud

# IaaS, PaaS, SaaS Explained

- Infrastructure as a Service (IaaS)
  - IaaS provides virtualized computing resources over the internet. In this model, cloud providers offer servers and storage storage.
- Platform as a Service (PaaS)
  - PaaS provides a platform allowing customers to develop, run, and manage applications without the complexity of building and maintaining the infrastructure typically associated with developing and launching an app.
- Software as a Service (SaaS)
  - SaaS allows users to connect to and use cloud-based apps over the Internet. Common examples include email, calendaring, and office tools (such as Microsoft Office 365, Google Drive).

# Overview of Major Cloud Providers

Features, strengths, and when to use AWS, Azure, or Google Cloud Platform (GCP).

- **AWS**
  - Amazon Web Services (AWS) is the market leader in cloud computing, providing a wide range of IaaS and PaaS services. Lots of services and use cases.
- **Azure**
  - Rapidly growing cloud service
  - It's also used for its integration with Microsoft's software and services (VSCode).
- **Google Cloud**
  - Google Cloud Platform (GCP) specializes in high compute offerings like big data, analytics, and machine learning. It provides scalable and flexible computing solutions. Very developer friendly.

# What should you start with?

→ Do you like Microsoft tools?

- ◆ Start out with Azure

→ Do you like Google Tools?

- ◆ Use Google Cloud

Or

→ Use AWS

all three offer free tiers or free starting modes that allow users to experiment with and test various services at no cost. These free tiers are designed to help users learn about the platforms, develop new applications, and host small-scale projects.

# Docker and Containerization

# What is Docker?

Docker makes it easier to create, deploy, and run applications. By packaging software into standardized units called containers, Docker enables these applications to run across different computing environments consistently.

## Why Docker?

- Consistency Across Environments
- Isolation
- Microservices Architecture
- Efficiency



# Core Concepts of Docker

- Images

- Read-only templates used to create containers. Instructions for how to run your code.

- Containers

- Runnable instances of Docker images. Containers can be started, stopped, moved, and deleted.

- Dockerfile

- A text document that contains all the commands a user could call on the command line to assemble an image. Similar to a makefile

# Docker in Cloud Computing

- Portability
  - Docker containers can be run on any system that supports Docker, making it easy to move applications across different cloud environments.
- Scalability
  - With Docker, it's straightforward to scale applications up or down as needed by simply adding or removing containers.
- Integration
  - Most cloud providers offer services that are specifically designed to manage and orchestrate Docker containers, such as Amazon ECS, Google Kubernetes Engine, and Azure Kubernetes Service.

# Getting Started with Docker

- Installation
  - Docker can be installed on various operating systems, including Windows, macOS, and Linux.
- Running Your First Container
  - Learn to run a simple Hello World application in a Docker container.
  - Map to a port on your computer and expose API endpoints using Docker

Fireship:

[https://youtu.be/cw34KMPSt4k?si=VI\\_PsVjncm-\\_\\_bok](https://youtu.be/cw34KMPSt4k?si=VI_PsVjncm-__bok)

Next Steps

# Where to learn more

- On campus;
  - CS 341 - Systems Programming (part of the UIUC CS track).
  - CS 438 - Communication Networks
  - CS 435 - Cloud Networking
- Cloud Service Developer Documentation
  - <https://docs.aws.amazon.com/>
  - <https://cloud.google.com/docs>
  - <https://learn.microsoft.com/en-us/azure/developer/>
- Docker
  - Youtube ( Fireship). ChatGPT, Docker Documentation (<https://docs.docker.com/>)