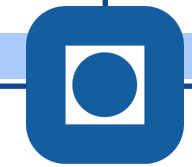
# Network Protocols and Services




**TTM4175 - Introduction to Communication Technology and Digital Security**

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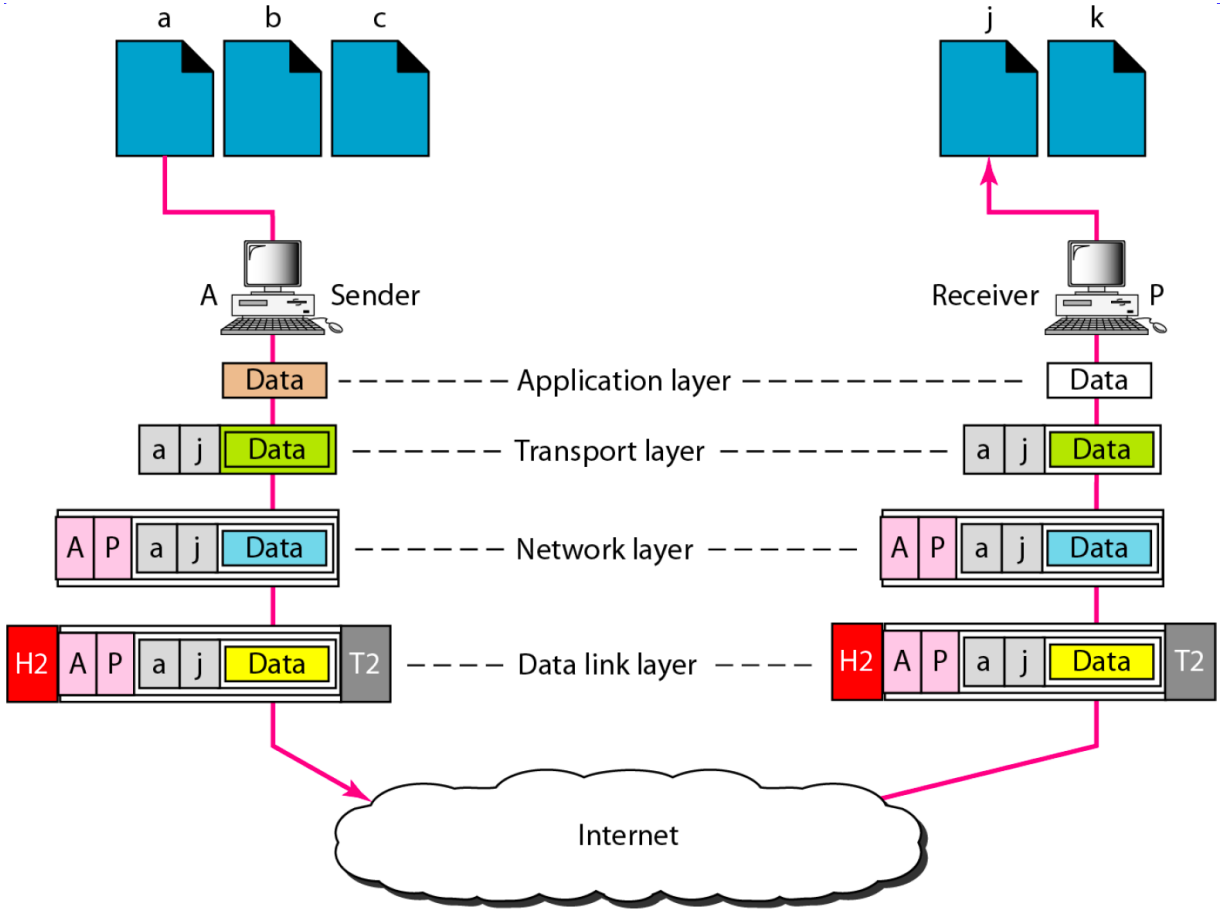
# TCP/IP

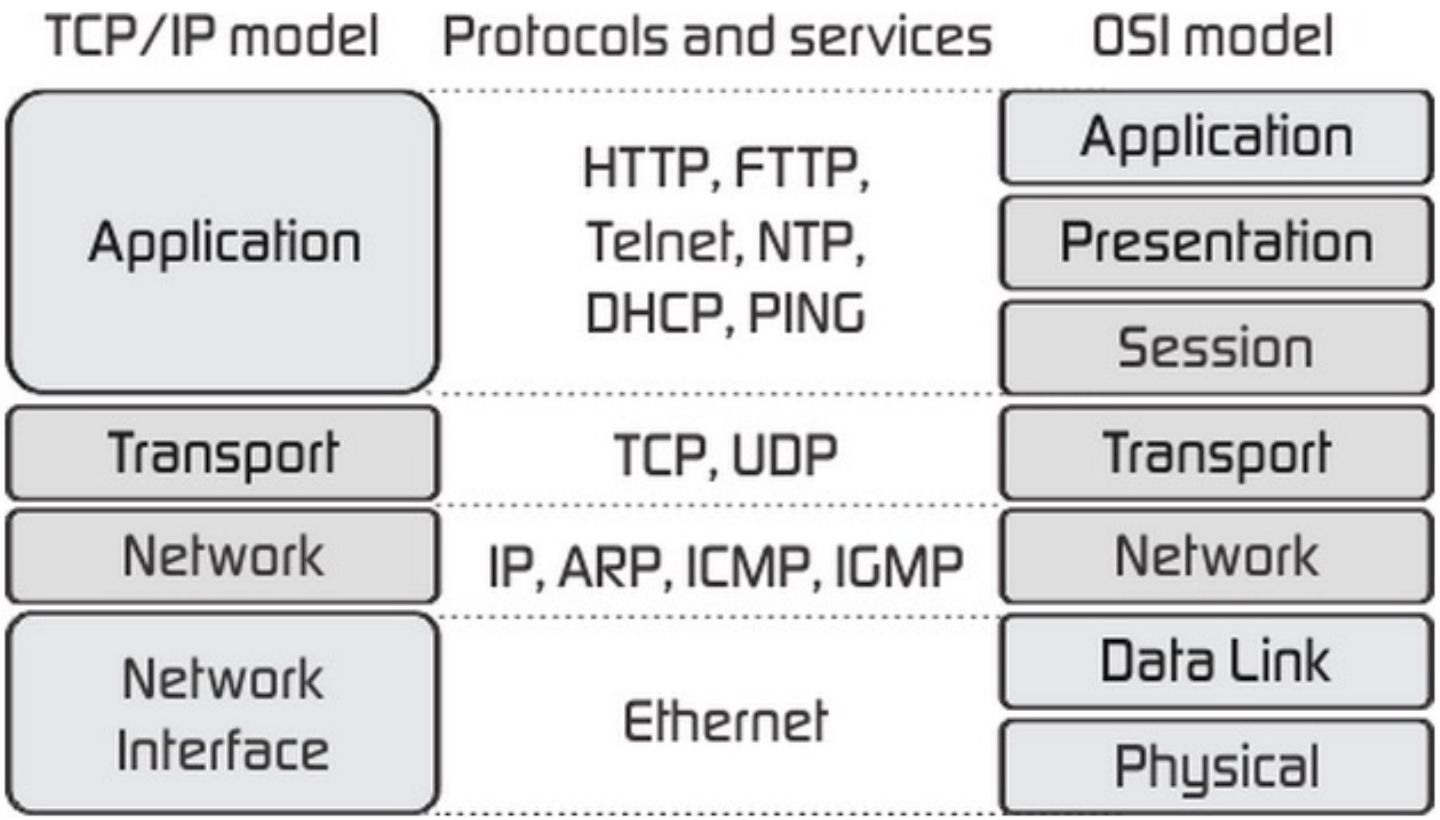
- TCP stands for Transmission Control  Protocol.
- IP stands for Internet Protocol.
- A set of protocols to support network communicatin
- OSI: for research purpose, as a guidline
  - TCP/IP as a practical model

# TCP/IP Layers

- To realize communication in computer network, we need:
  - IP address, MAC address, and port address
- In TCP/IP:
  - each layer take care of each of these addressing:

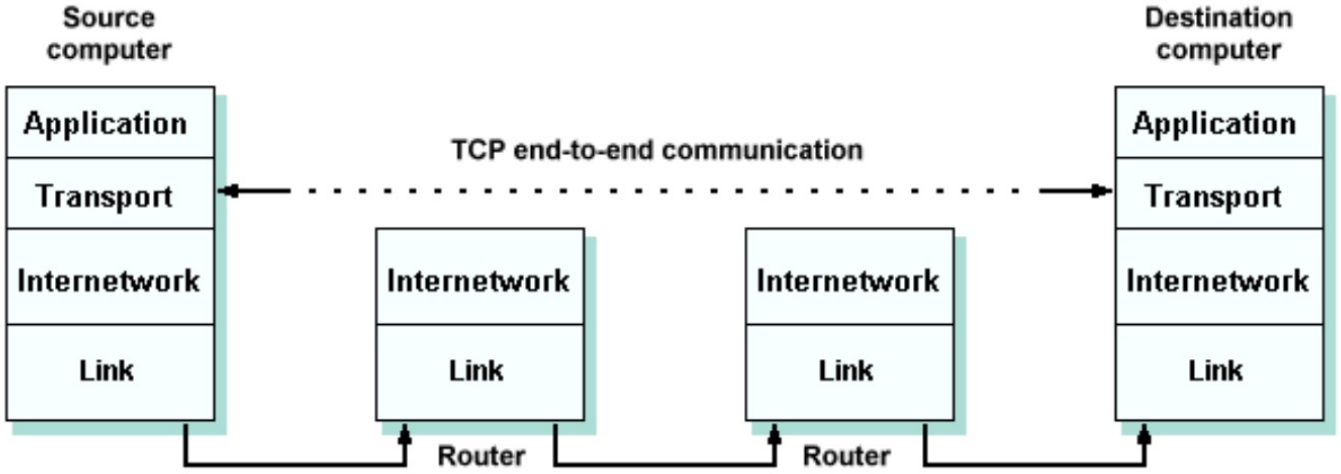


# Layering: TCP/IP vs. OSI



# Transport Layer: Services and Protocols

- Services
  - segmenting upper-layer application data
  - establishing end-to-end operations
  - sending segments from one end host to another end host
  - ensuring data reliability
  - providing flow control



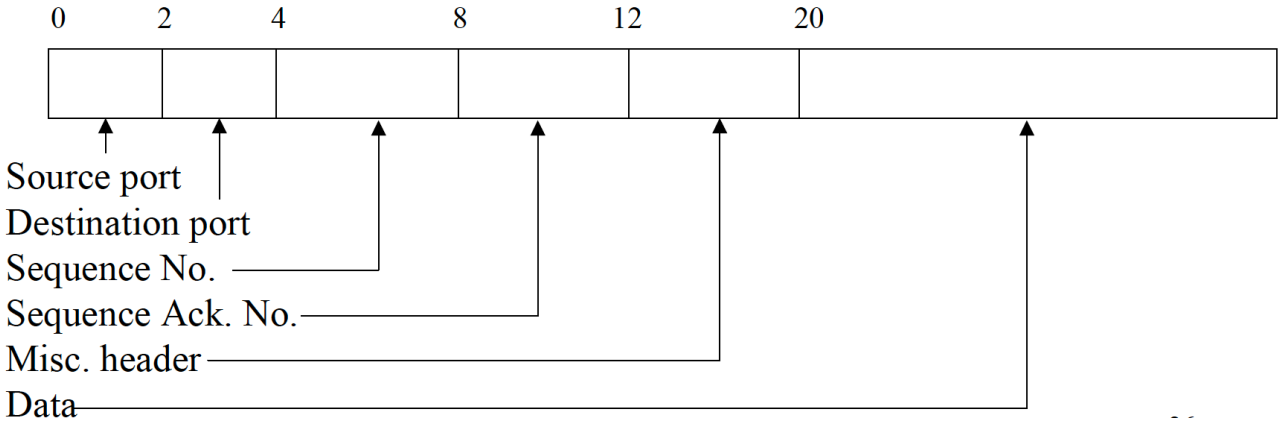

- Protocols
  - TCP and UDP

# TCP

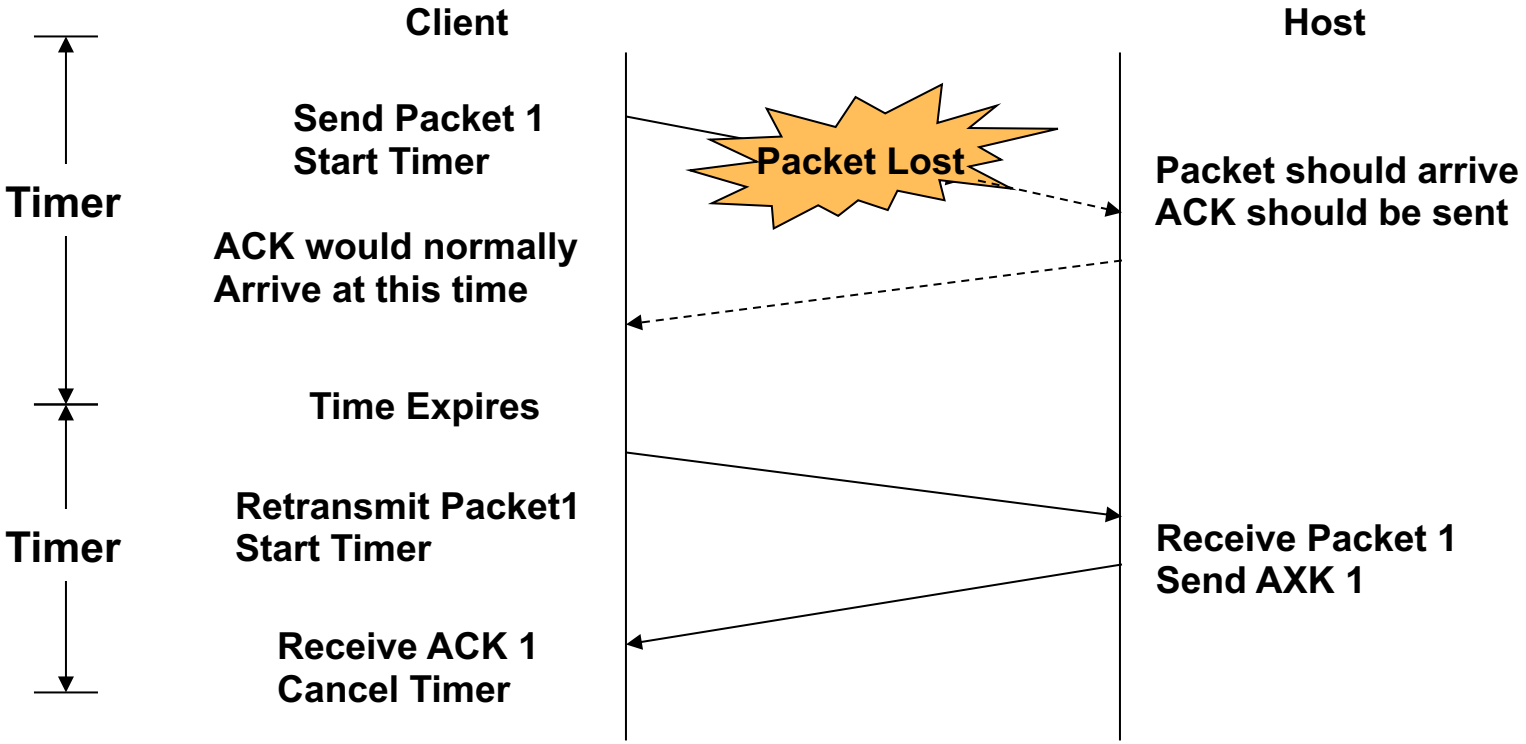
- Reliable, *full-duplex*, *connection-oriented*, *stream* delivery
  - data is guaranteed to arrive, and in the correct order without duplications
    - or the connection will be dropped
  - imposes significant overheads
- Before sending data: TCP requires that the computers communicating
  - establish a connection (connection-oriented protocol).
- Applications:
  - HTTP, FTP, and many other protocols
  - saves the application a lot of work: reliability checking at TCP layer

# TCP – Cont'd

- TCP: support for sending and receiving arbitrary amounts of
  - data as one big stream of byte data (IP is limited to 64Kb).
  - TCP breaks up the data stream into separate IP packets.
- Packets:
  - numbered, and reassembled on arrival, using sequence and sequence acknowledge numbers.
- TCP also specifies port numbers
  - → there are 65,536 different TCP ports (sockets)
- Structure of a TCP packet



# TCP Data Transfer

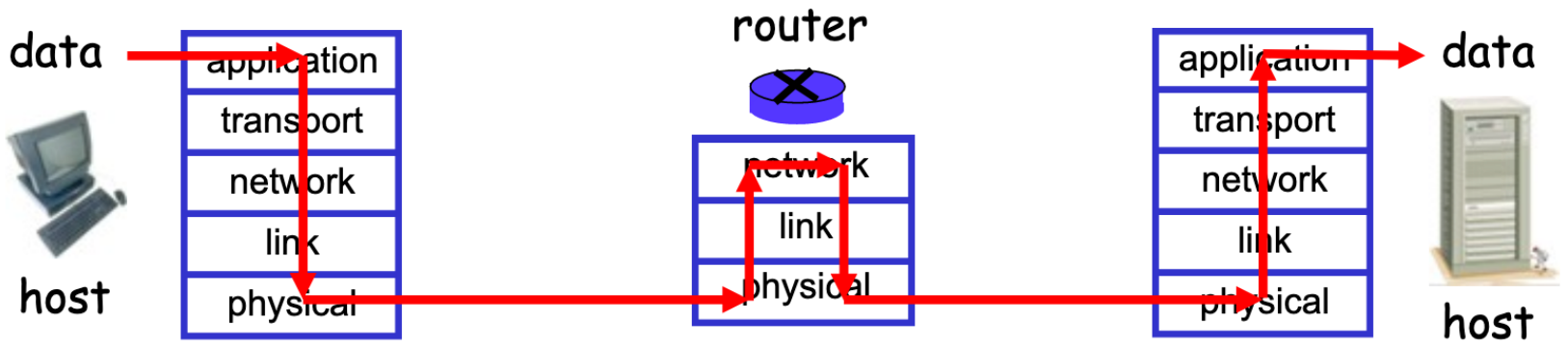


# UDP

- It stands for User  Datagram Protocol.
  - also built on top of IP
  - allows for port number specification: 65,536 ports.
  - connectionless protocol, without any error detection facility.
  - only supports data transmission from one end to the other, without any further verification. => very fast
- As compared to TCP:
  - TCP highly reliable, UDP  is less reliable
  - TCP is slow, UDP is generally faster
- Adds to packet:
  - packet length + checksum: guard against corrupted packets
- Still unreliable:
  - Duplication, loss, out-of-orderness possible
- Applications:
  - where packet loss is better handled by the application than the network stack
  - VOIP
  - most online games
  - video Conferencing

# IP

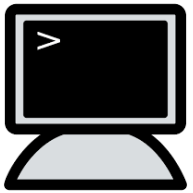
- Responsible for end to end transmission
- Sends data in individual packets
- Maximum size of packet is determined by the networks
  - fragmented if too large
- Unreliable
  - packets might be lost, corrupted, duplicated, delivered out of order



# Internet Application Protocols

- On top of TCP/IP, several services have been developed in order to homogenize applications of same nature:
  - Hypertext Transfer Protocol (HTTP)
    - the foundation of data communication for the World Wide Web.
    - *hypertext*: structured text uses hyperlinks + texts.
    - default port: 80
  - FTP (File Transfer Protocol)
    - to transfer files between two machines connected to the Internet.
    - default port: 21
  - Telnet (Terminal Protocol)
    - allows a user to connect to a remote host in terminal mode.
    - default port: 23
  - SMTP (Simple Mail Transfer Protocol)
    - defines a basic service for electronic mails.
    - various ports
  - SNMP (Simple Network Management Protocol)
    - allows the management of the network.
    - default port: 161 or 162





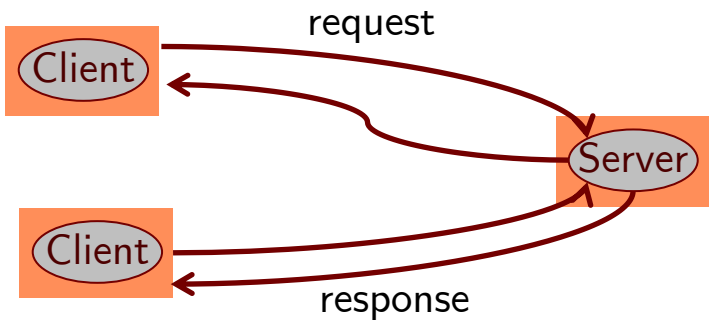


# Servers

- Server

  A computer/system that provides resources, data, services, or programs to other computers, known as clients, over a network.

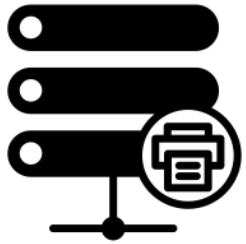
- Many types of servers: web servers, mail servers, and database servers
- Working of server
  - a device must be configured to listen to requests from clients on a network connection.



# Popular Servers - 1

- File Server
  - stores and distributes files
  - clients or users may share files stored on a server.
  - centrally storing files:
    - easier to backup
    - fault tolerance solutions

- Print Server
  - for management and distribution of printing functionality
  - rather than attaching a printer to every workstation
    - a single print server responds to printing requests from clients



# Popular Servers - 2

- Application Server
  - runs applications in instead of client computers running applications locally
  - often runs **resource-intensive applications**: shared by a large number of users

- DNS Server
  - provides name resolution to client computers.
  - converts names into IP addresses.
  - is a widely distributed database of names and other DNS servers.

# Popular Servers - 3

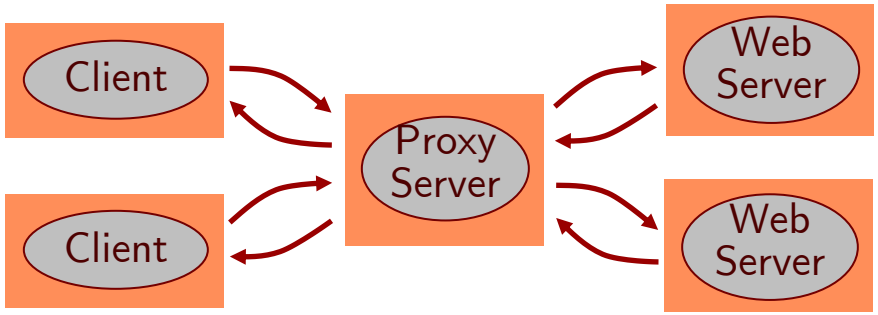
- Mail Server
  - receives emails sent to a user.
  - stores them until requested by a client on behalf of said user.
  - rather than requiring every client to have its own email subsystem

- Web Server
  - a kind of application server
  - hosts programs/data requested by users across the Internet.
  - responds to requests from browsers running on client computers for web pages, or other web-based services.
  - common web servers: Apache web server, Microsoft Internet Information Services (IIS) server, and Nginx server

# Popular Servers - 4

- Database Server
  - amount of data used by companies is staggering.
    - much of that data is stored in databases.
  - Databases:
    - to be accessed by multiple clients at any given time.
    - can require extraordinary amounts of disk space.
    - locating such databases on servers?
  - Database servers: run database applications
  - Common database servers: Oracle and Microsoft SQL Server

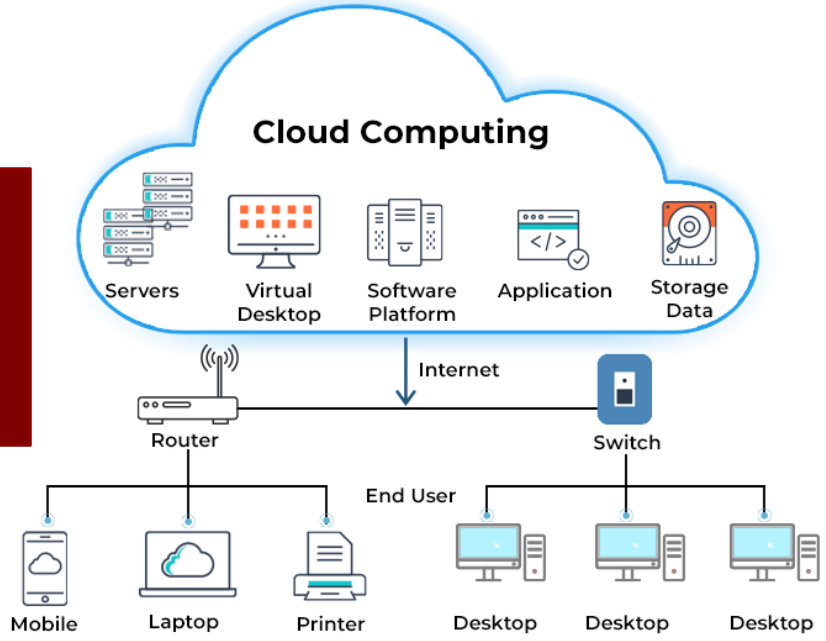
- Proxy Server
  - acts as an intermediary between a client and a server.
  - is often used to isolate either the clients or servers for security purposes.
  - neither the client nor the server needs to directly connect to each other.



# Cloud Computing

- Analogous to electricity distribution grid
  - plug to outlet, consume electricity, and pay
  - hide the internal mechanisms from the end-user
- Definition:

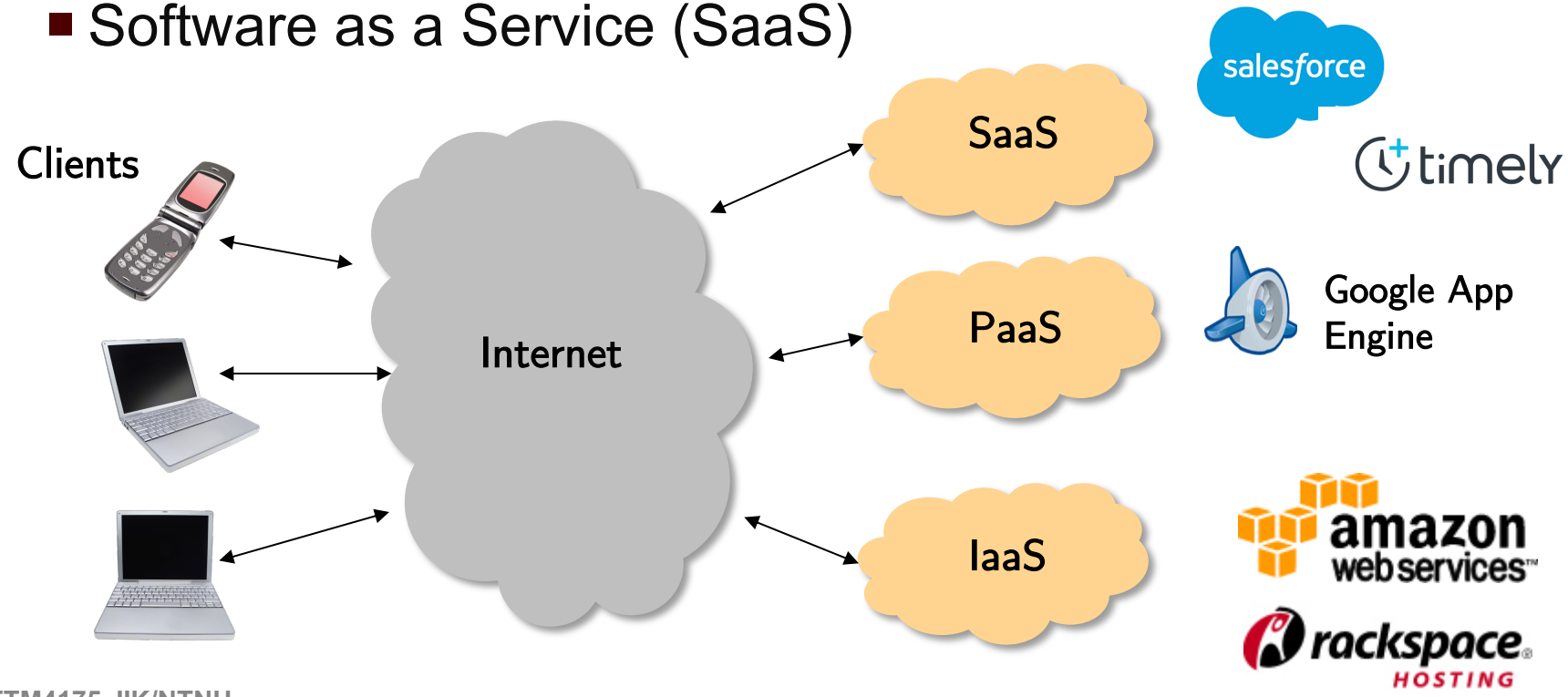
Cloud computing is the delivery of computing services—servers, storage, databases, networking, software, etc.—over the Internet based on a "pay-as-you-go" model




- Common between definitions:
  - pay-per-use
  - the illusion of infinite resources
  - self-service interface
  - abstracted or virtualised resources

# Cloud-based Services - 1

- Three classes of cloud; viewed as a layered architecture:
  - Infrastructure as a Service (IaaS)
  - Platform as a Service (PaaS)
  - Software as a Service (SaaS)

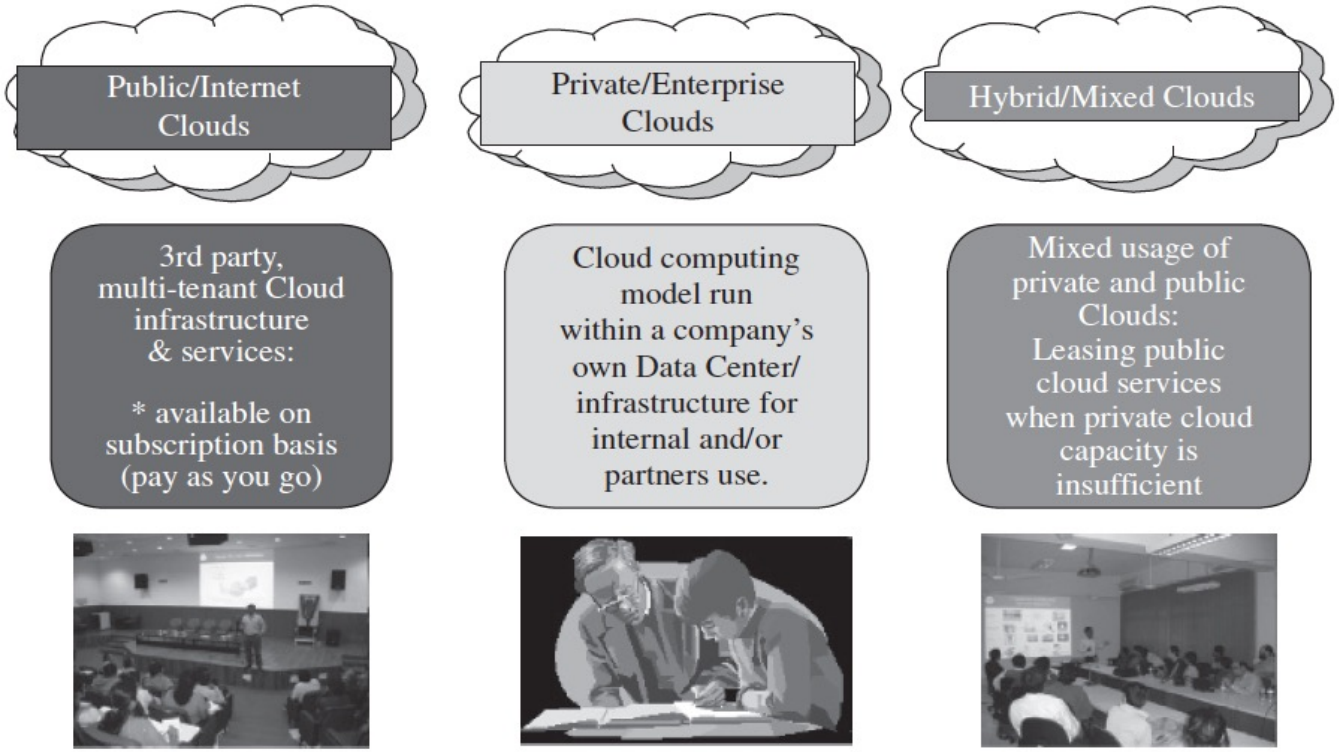


# Cloud-based Services - 2

- IaaS
  - offering virtualized resources (computation, storage, and communication) on demand
  - several choices of OS and a customized software stack
  - **e.g., Amazon EC2**: offering VMs with a software stack customizable like an ordinary server
- PaaS
  - offering an environment to create and deploy applications
  - no need to know low-level technical config., e.g., number of processors or amount of memory
  - offering multiple programming models and specialized services, e.g., data access and authentication
  - **e.g., Google AppEngine**: for developing and hosting Web apps written in Python or Java

# Cloud-based Services - 3

- SaaS
  - applications reside on the top of the cloud stack
  - accessed by end users through Web portals
  - desktop apps such as word processing as a service in the Web
  - **e.g., Salesforce.com**: offering business productivity apps (CRM)
- Deployment models:



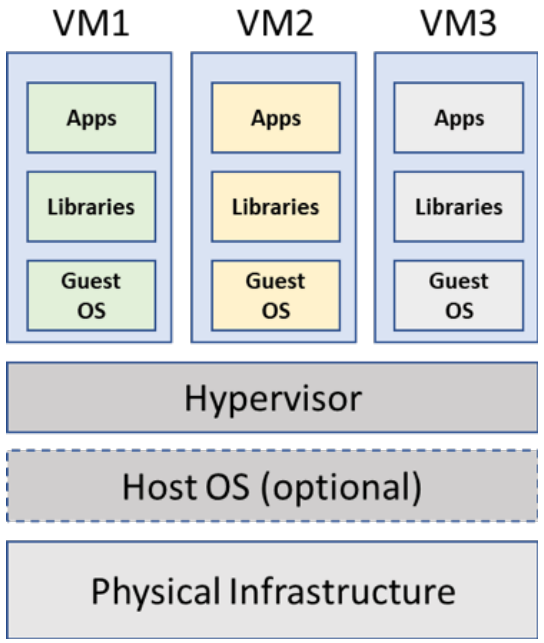
# Cloud in Our Everyday Life?

- Online Data Storage: Dropbox, GoogleDrive, OneDrive
- Antivirus Applications: Avast CloudCare, ESET Protect Entry
- Education Applications: Udemy, IBM Cloud for Education
- E-Governance applications: Skatteetaten
- Healthcare applications: Google Health, Helseboka
- Entertainment applications: PlayStation Now, Steam Cloud


# Virtualization

- Definition

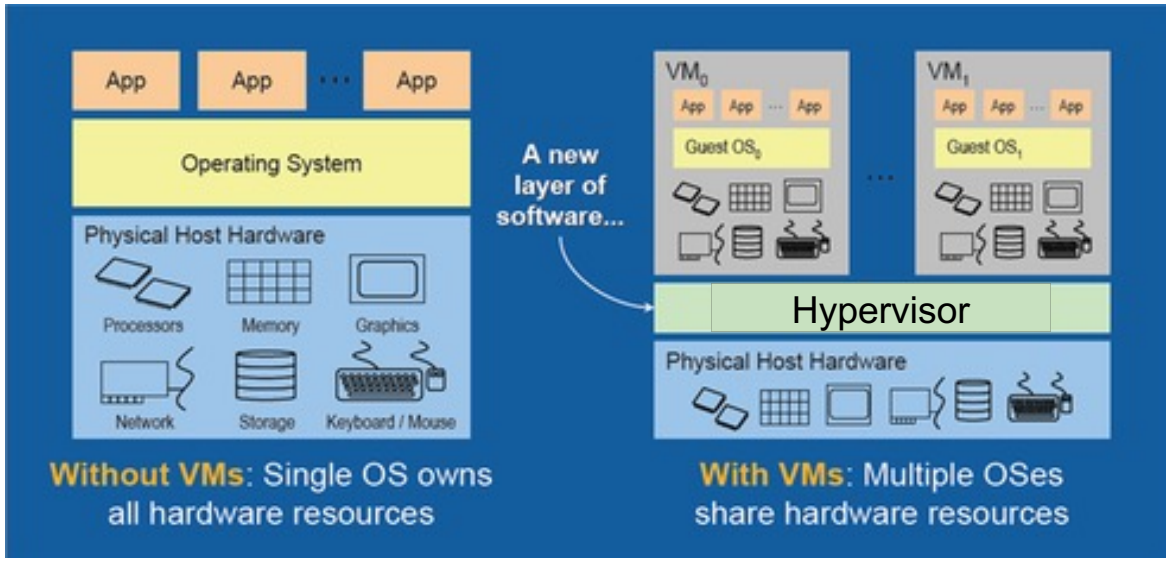
A way to create multiple virtually simulated instances over the computer hardware to utilize your system's underlying resources fully.




- Hypervisor:
  - allows to share storage, memory, processor, etc. among multiple separate virtual computers
  - virtual machine (VM): has its dedicated operating system which uses a part of the system's hardware resources for operation.

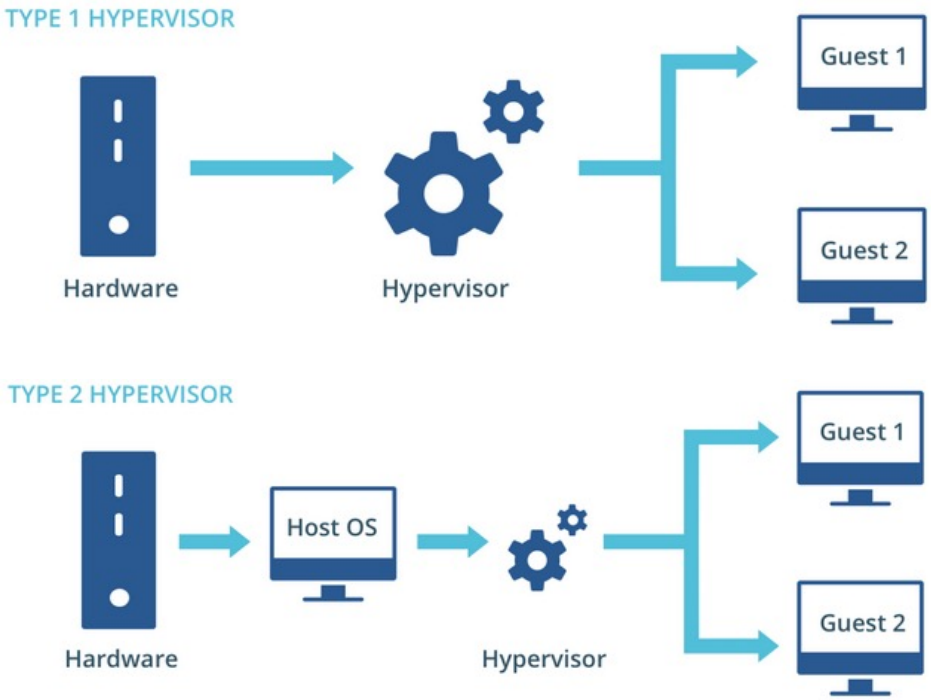
# Virtualization in Cloud Computing

- A foundational element of cloud computing
  - enables multiple users to share a single physical instance of a resource at a time.
- **Virtual Machine?**
  - emulation or a virtual representation of a physical device that can execute multiple operating systems (OS) on the same computer with a different OS.
  - OSs installed using the virtual machine are known as the *guest OS*.



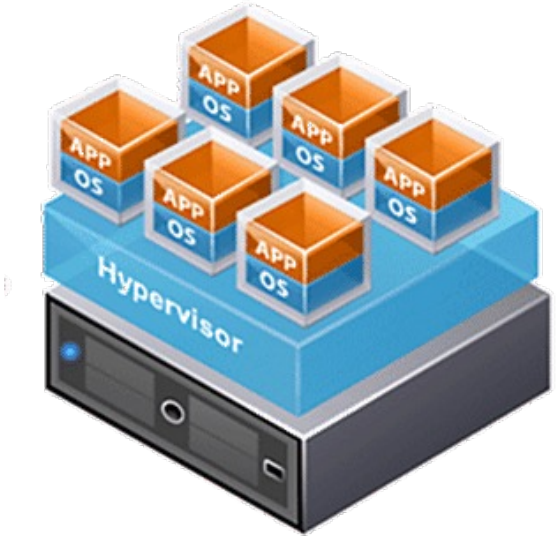
# How Does Virtualisation Work?

- Through hypervisor
  - allows to create a virtual layer over the hardware system.
  - acts as a connection between the physical system and VMs to ensure the proper access of the hardware resources.
- Types of Hypervisor
  - Type1 (Bare Metal)
    - interacts directly with the hardware resources.
    - replaces the host OS.
  - Type2:
    - runs as a software application on the host OS.
    - coordinates with the VMs for hardware resource management.

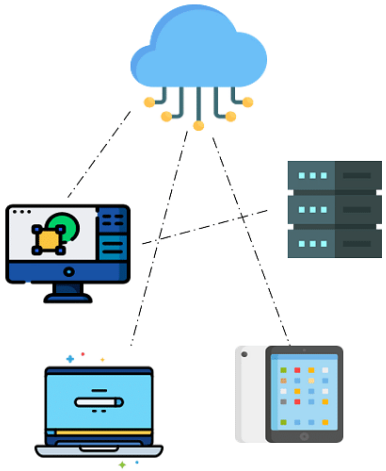


# Types of Virtualization - 1

- **Server Virtualization?**
  - the process of using software to divide physical hardware into separate unique virtual servers
  - once divided: independent virtual servers can be used for a multitude of tasks
  - each virtual server: able to host a different OS without any compatibility issues

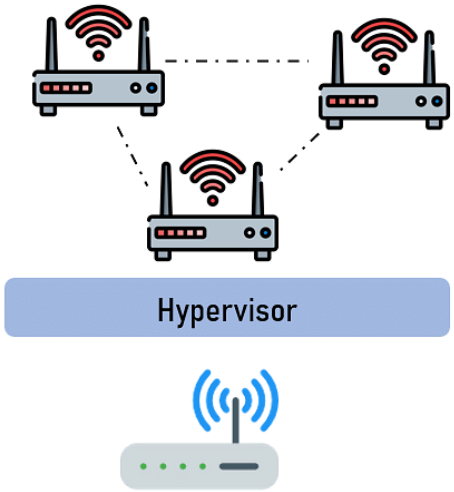



- **Application Virtualization**
  - the application runs without the need of installing it into the system.
  - applications: run on a virtual environment



# Types of Virtualization - 2

- **Network Virtualization**
  - creating a virtual instance of the network
  - It forms the abstraction of the hardware components and functions (e.g., switches, routers, etc.)
  - simplifying network management




- **Storage Virtualization**
  - enables all the storage devices to be accessed&managed as a single storage unit pool for better maintenance.

# Summary

- TCP/IP
  - Specifications
  - Differences between TCP and UDP
- Internet application protocols
- Popular server types
- Cloud Computing
  - Three classes of Cloud
  - Cloud in our everyday life
- Virtualization
  - How it works
  - Types of virtualization