Introduction to Computer Networks & Cyber Security

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Course Description

- Entry level to understand the basics knowledge of :
  - Computer Networks
  - Cyber Security
  - Distributed System (Virtualization concepts and cloud computing)
- in order to help students how to deal with the computer networks and protect their devices from threats

Learning Outcomes

- **Know about**
  - Computer networks basic Terminologies and classifications
  - Network protocols
  - Cyber security and security goals
  - Methods of attacks and risks
  - Attacks mitigation and encryption
  - Distributed System
  - Types of Distributed System and examples
  - Cloud computing service models and deployment models
- Enhance students skills by doing some practices on some topics

Course Duration and Evaluation

- **Duration**: 9 hours
  - 3 Lectures (9 hours)

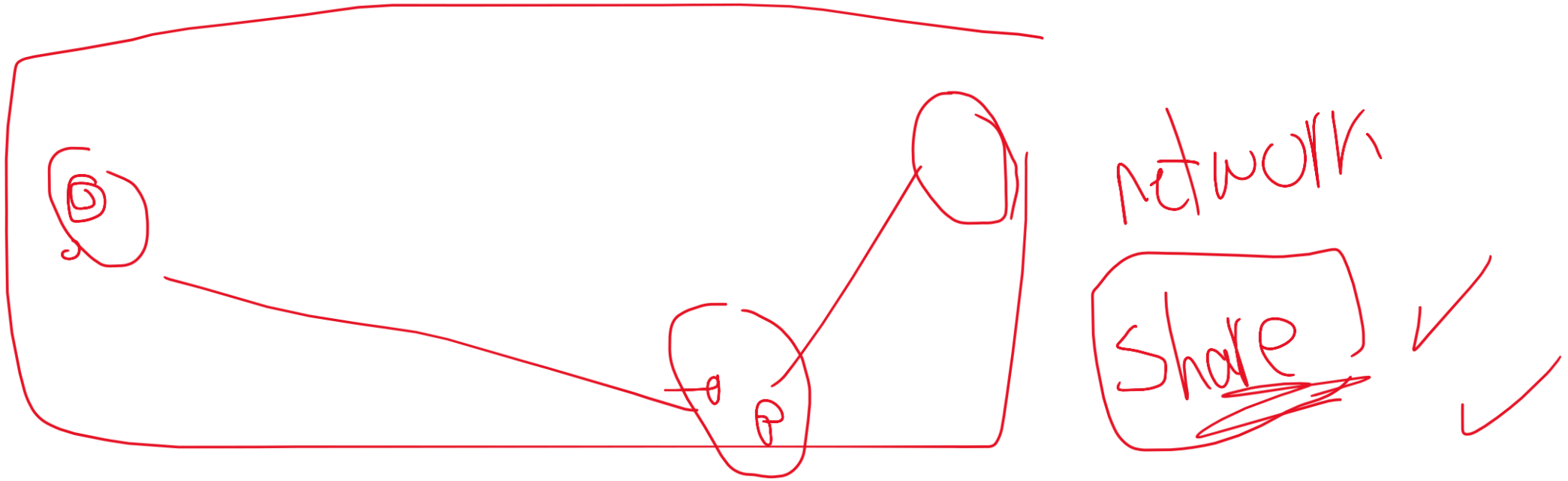
- **Evaluation Criteria:**
  - Participation and exercise completion (40%)
  - A comprehensive exam after finishing all the main conceptual courses (60%)

Course Topics

- **Session 1 (Network Essentials)**
  - Computer Networks Definition and Basic Terminologies
  - TCP/IP Protocol Suite
- **Session 2 (Cyber Security Essentials)**
  - Information Security Goals
  - Risks & Threats
  - Security Defenses
  - Encryption
- **Session 3 (Distributed System)**
  - Distributed Systems overview
  - Types of Distributed System
  - Distributed System Examples
  - Cloud computing

Course References

- **Essential Computer Science " Paul D. Crutcher,Neeraj Kumar Singh,Peter Tiegs"**
- Cisco CCNA (200-301) Cert Prep: 1 Network Fundamentals and Access
- CompTIA Network
- Data and Computer Communications " William Stallings 10th Edition"
- TCP/IP Protocol Suite "Behrouz A. Forouzan 4th Edition"
- Understanding IPv6 "Joseph Davies 2nd Edition"
- Distributed Systems "van Steen, Maarten, Tanenbaum, Andrew S."
- https://maharatech.gov.eg/enrol/index.php?id=22
- https://maharatech.gov.eg/enrol/index.php?id=37


network
share

Session 1 (Network Essentials)

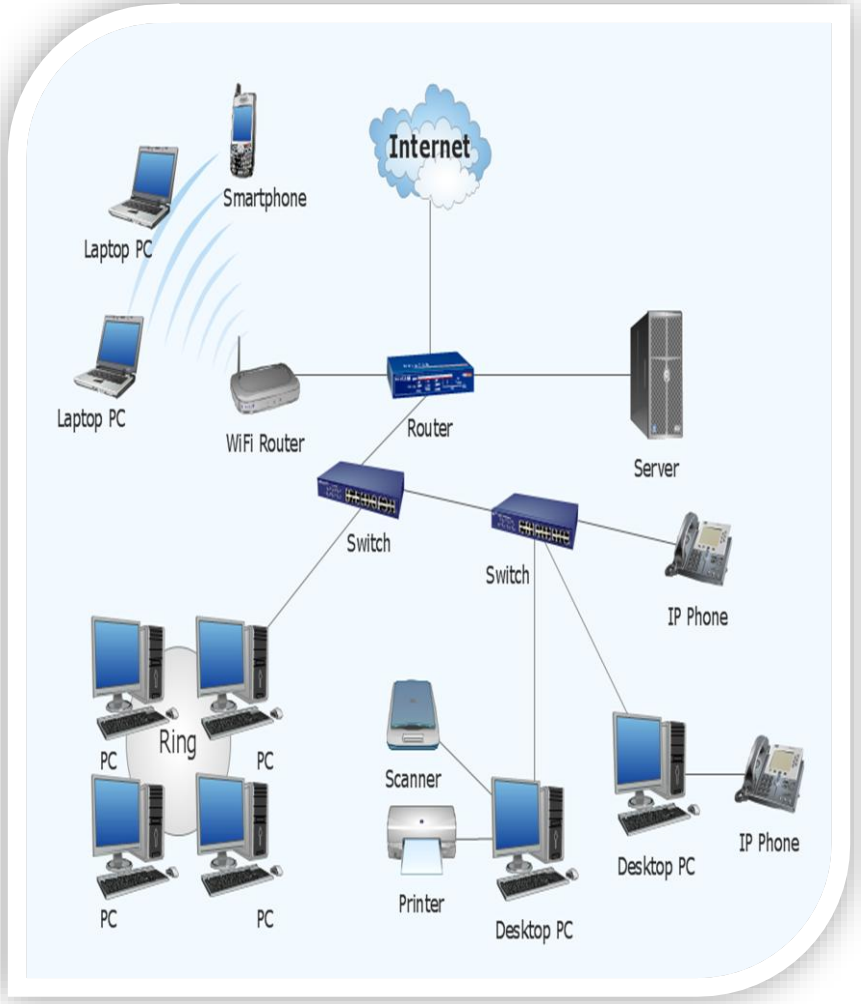
- **Session Outlines**
  - **Computer Networks**
    - Definition and Basic Terminologies
  - **TCP/IP Protocol Suite**
    - Application Layer
    - Transport layer
    - Internet layer
    - Network Access Layer (Physical Layer /Datalink Layer)

Session 1 (Computer Networks Definition)

- **Computer Network :**
  - a collection of computers, and other devices, or peripherals connected together through connecting media to perform certain task such as :

    Share Resources

- **Resources can be :**
  - File Sharing
  - Devices Sharing
  - Software Sharing with multi-user licenses.
  - Voice and Video calls
  - Shared Internet Access



Session 1 (Network Elements)

- **Hardware**
  - **Devices**
    - Computers – Printers –Phone – Routers - Switches
  - **Medium**
    - Wired -Wireless –Satellites
- **Software**
  - **Messages**
    - Information that travels over the medium such as **Mails-WhatsApp….etc**
  - **Protocols**
    - Governs how messages flow across network such as **http –https-FTP-RDP**

Session 1 (Network Basic Terminologies)

- **NIC (Network Interface Card)/network adapter or LAN adapter.**
  - a hardware that enable the device to directly access the network
    - **Internal NIC** (plugs into the motherboard directly)
    - **External NIC**(Wireless and USB based)

- **Mac address:**
  - Physical Address, **Unique** address **over the world** burned on the NIC card
- **IP address :**
  - logical address, identify each device on an IP network layer.
- **Protocols**
  - Communication rules that all entity must agree on http –https- FTP-RDP

Session 1 (Network Basic Terminologies)

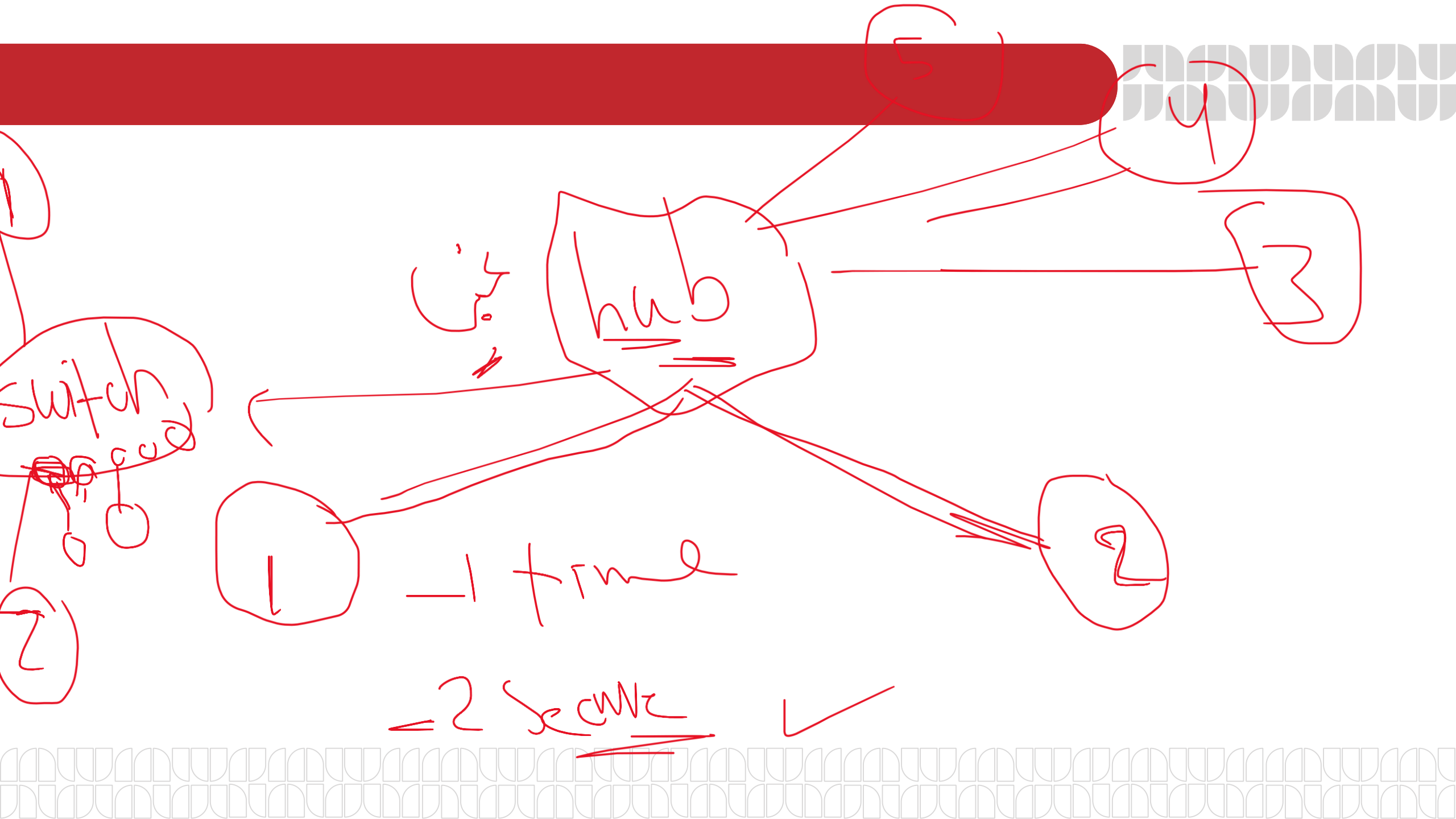
- **Hub**
  - Allow different nodes to communicate with each other at the same network(**Slow the network**)

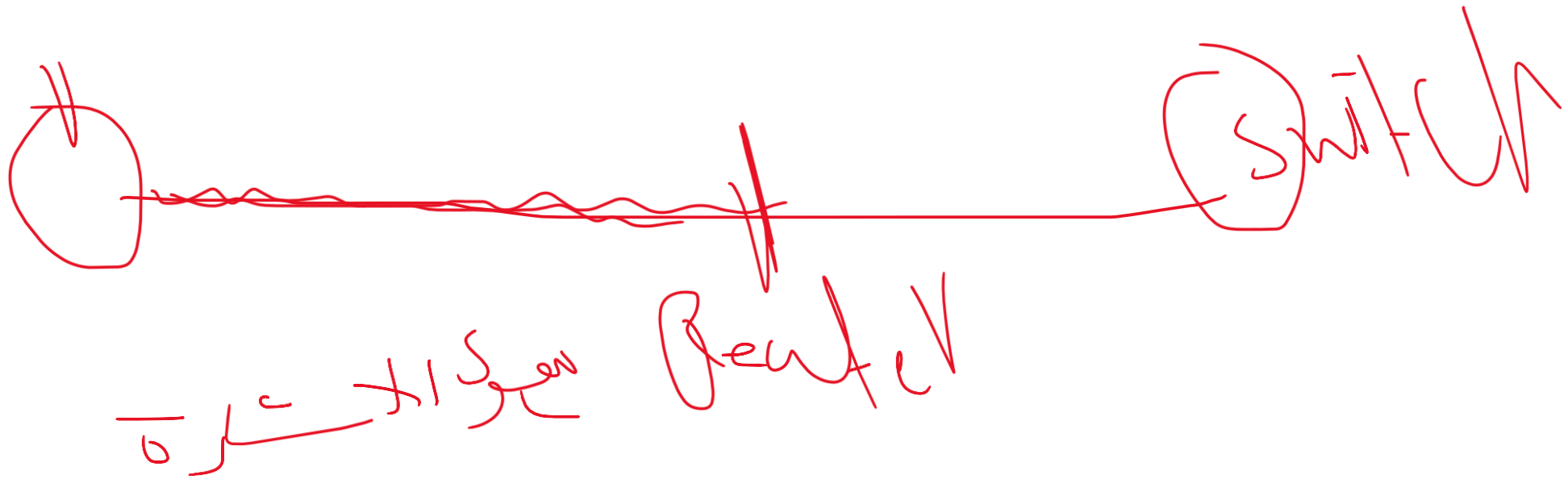
- **Repeater**
  - **Regenerate** the signal over the **same network** before the signal becomes too weak or corrupted

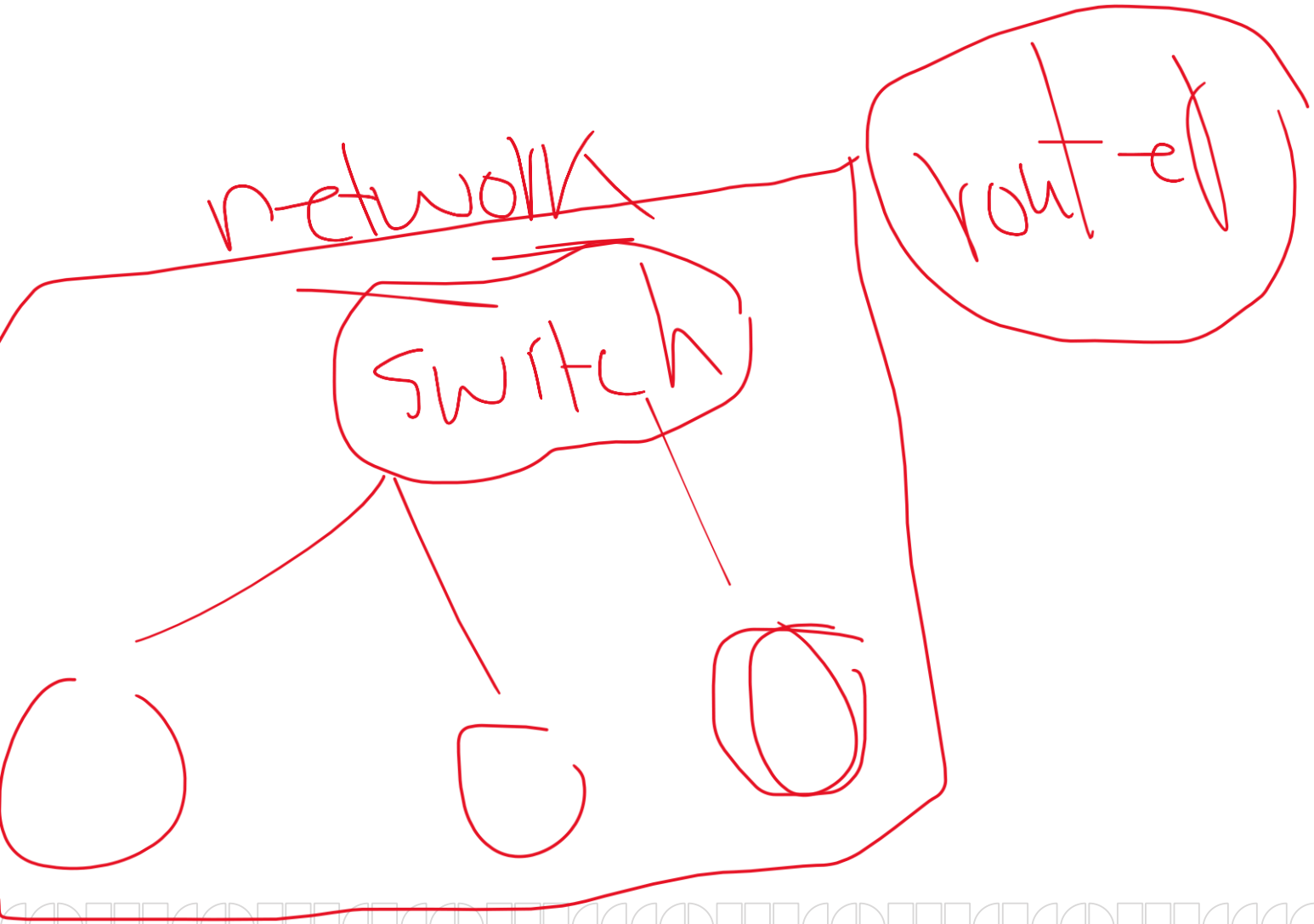
- **Access point (AP)**
  - allows other Wi-Fi devices to connect to a wired network. An AP is a physical location where Wi-Fi access is available.

- **Switch**
  - Allow **different nodes** to communicate with each other at the **same network** and time **without slowing each other**

- **Router**
  - Allow **different networks** to communicate with **each other**


5
4
3
hub
switch
2
1
2
1 time
2 secs




network
router
switch


network
switch

Networks Classifications

According to network topology

- How the computer are connected

According to Covered Area

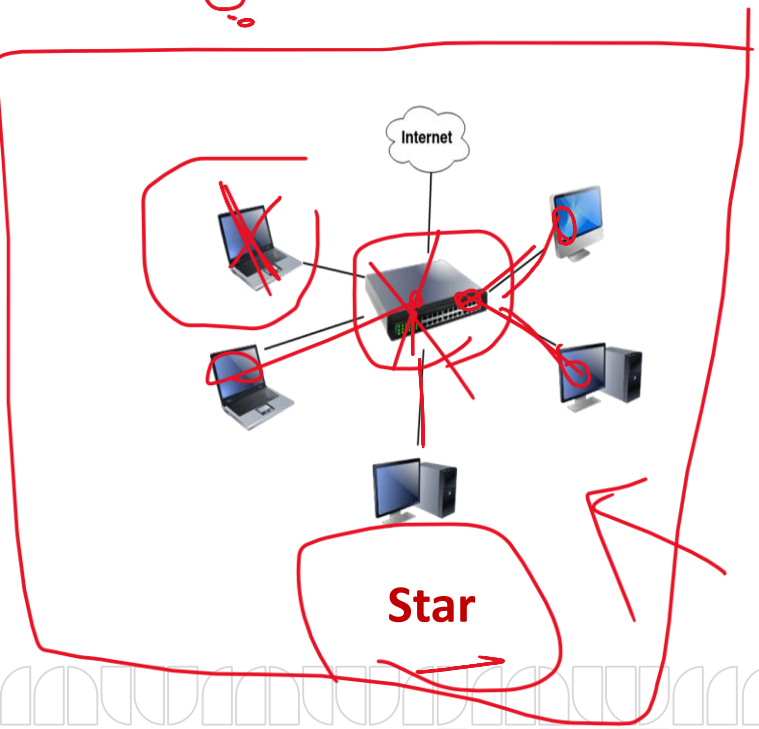
- How large is the network

According to network model

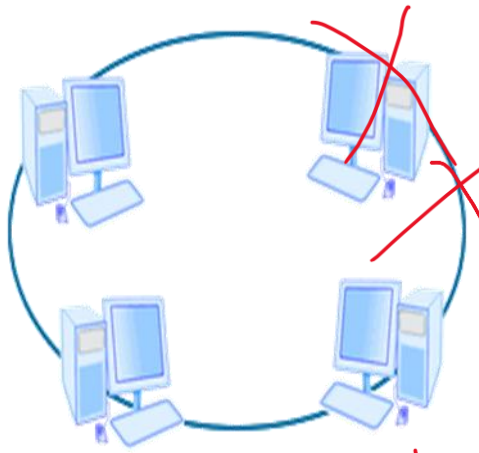
- What type of model

Session 1 (Network Topology)

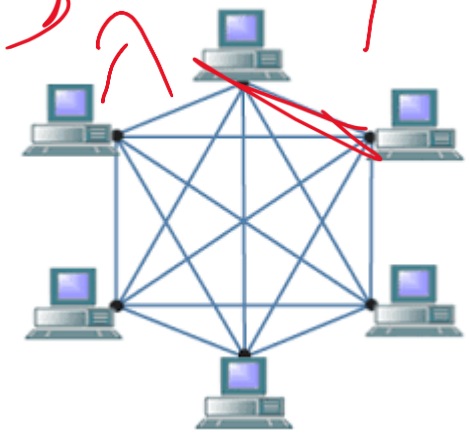
- **Network Topology**
  - **how devices are connected (shape)** and how **message** flow **from one device to another device**, Each topology has its own **advantages and disadvantages**



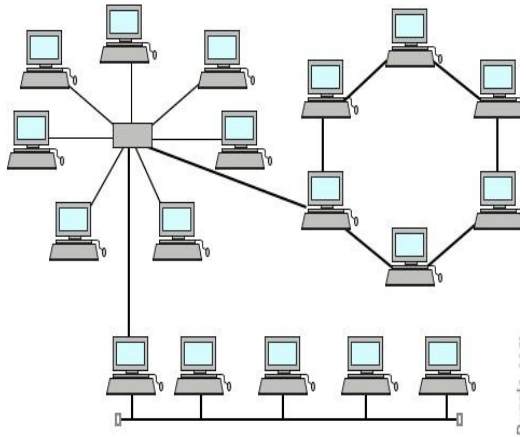
Star



Ring



Mesh

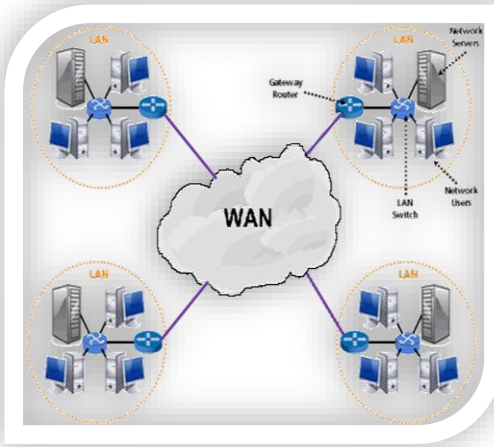


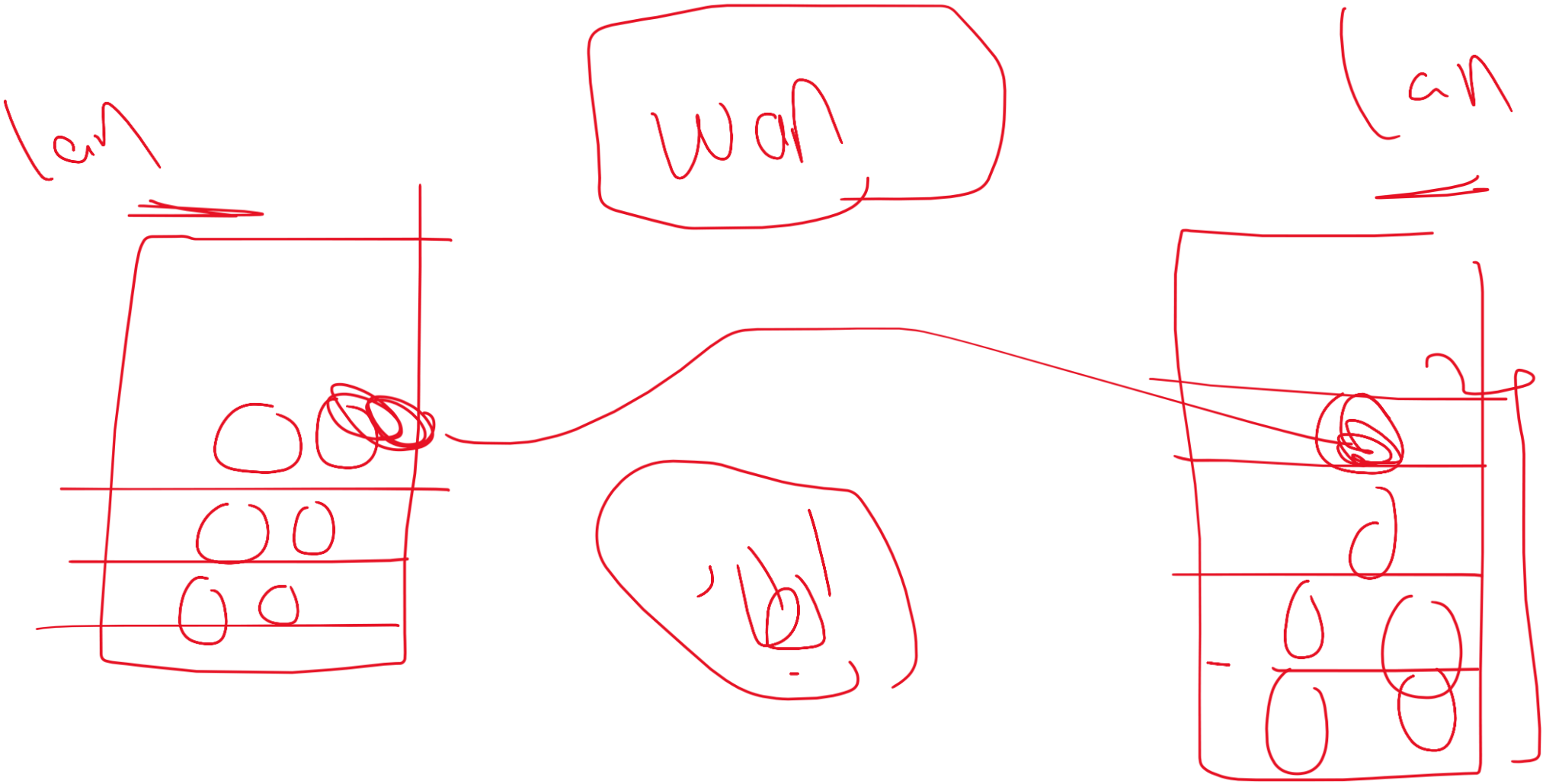
Hybrid

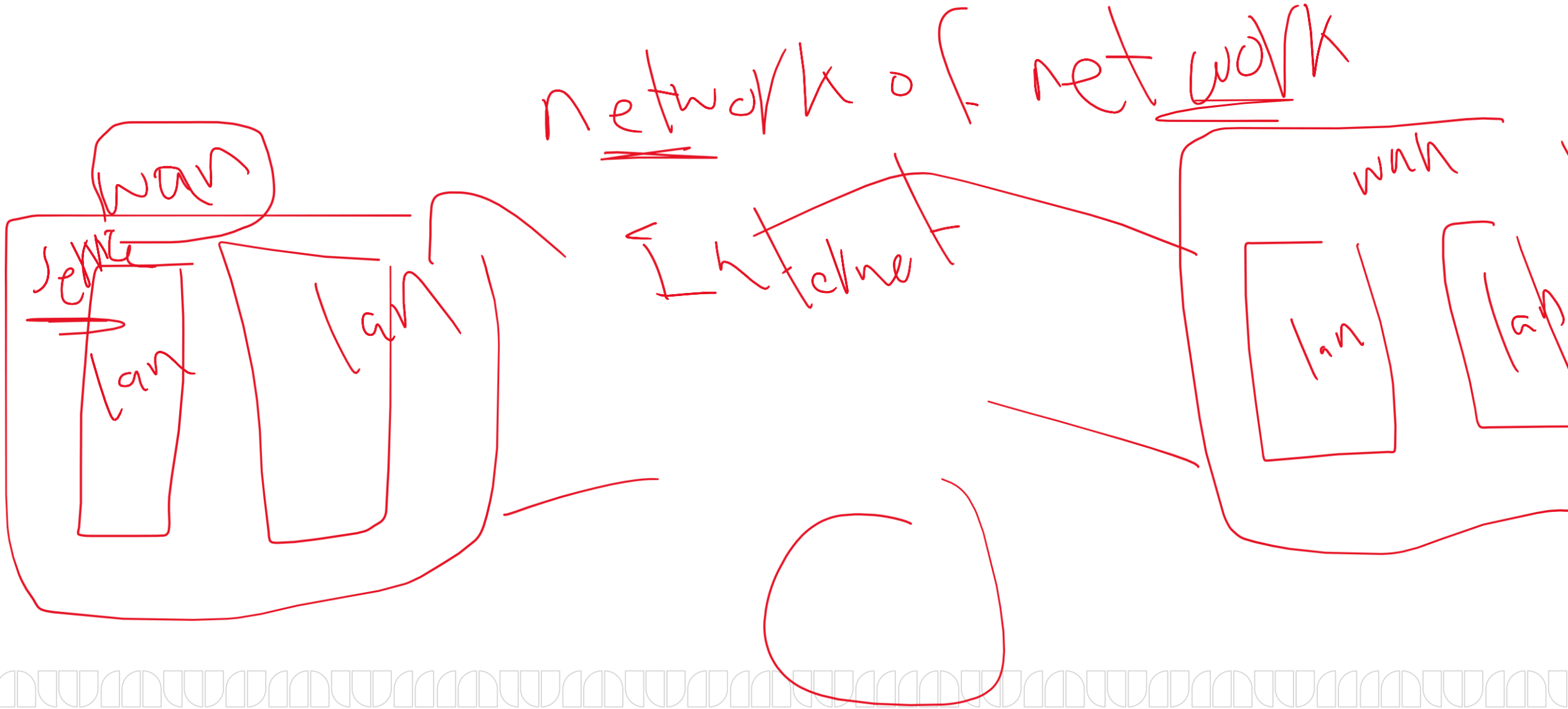
Session 1 (Network Covered Area)

- **Local Area Networks (LAN)**
  - a group of computers connected in **small geographical** area such as school, university campus or **office building (100-1000 M)**
    - Allow users to share files and services
    - **High speed** of communications
    - Under **administrative Control**

- **Wide Area Networks (WAN)**
  - A WAN is a group of computers connected in **Large geographical** area such as country
    - WAN can **contain multiple smaller networks**, such as LANs or MANs.
    - **Very low Speed**
    - Under your **ISP Administrative control** example of WAN is **Internet**

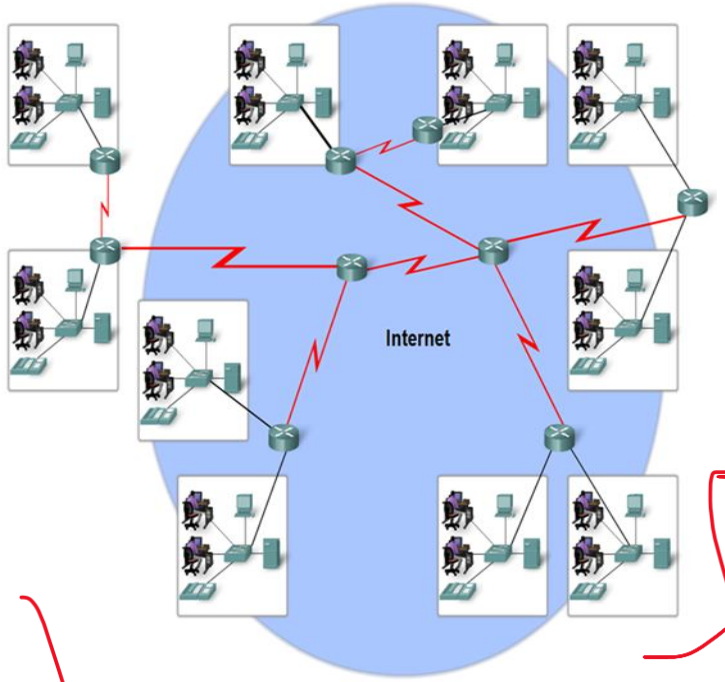


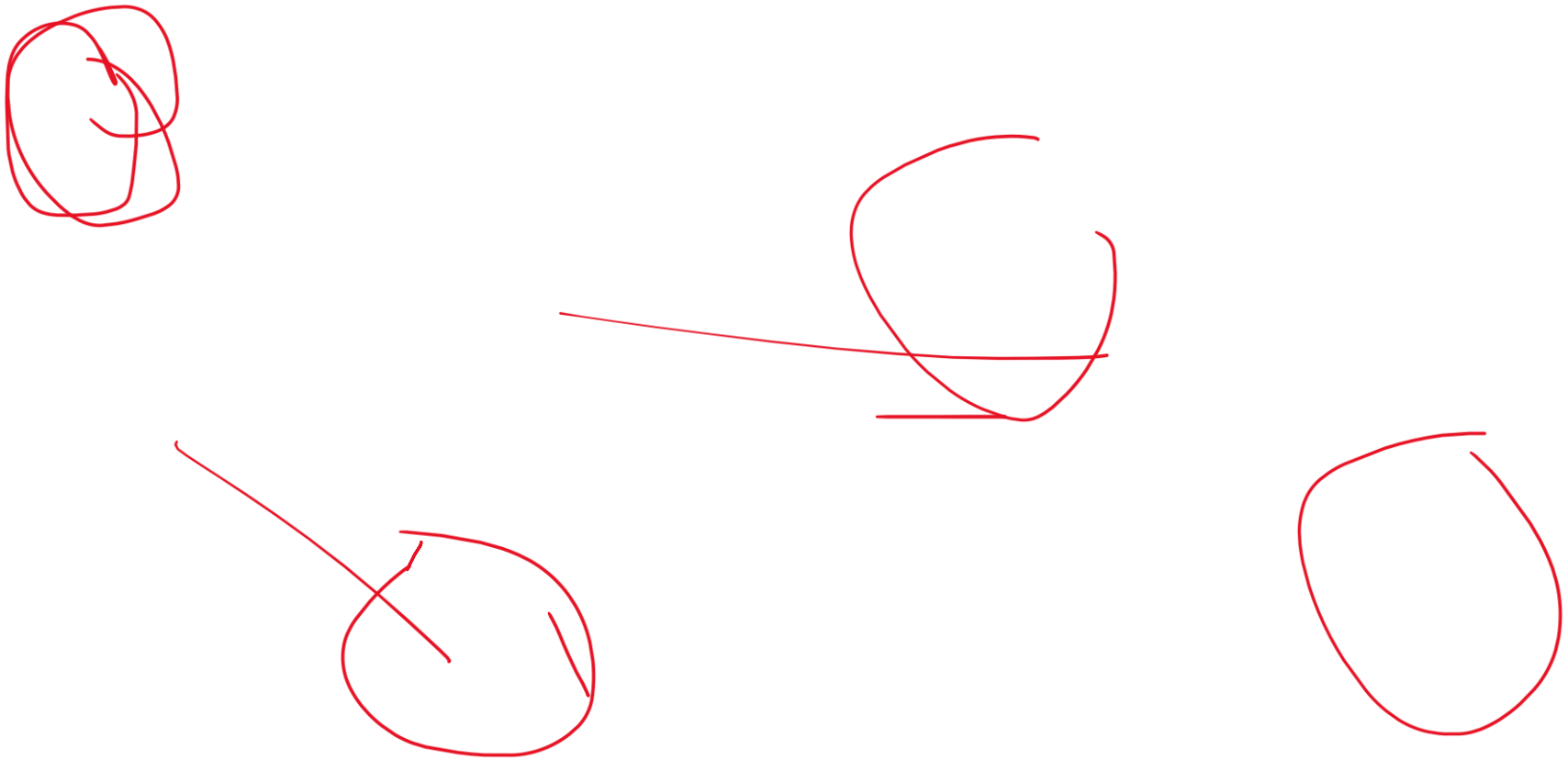

lan
wan
lan


network of network
Internet
wan
lan
lan
wan
lan

Session 1 (Internet)

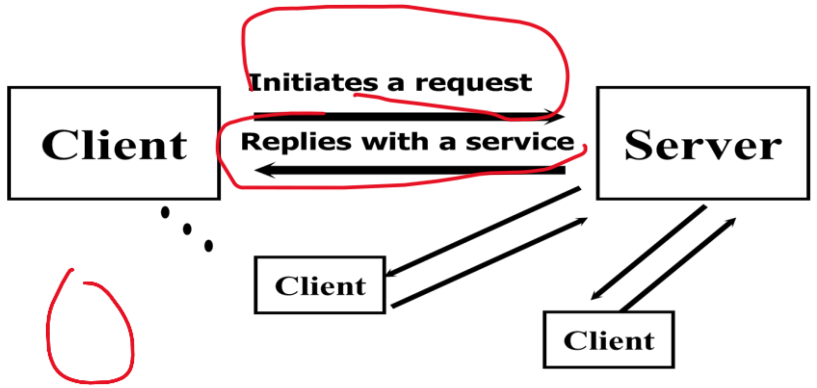
- **The internet**
  - is defined as a global mesh of interconnected networks
- **No one actually owns the Internet**
  - Many Orgs, ISPs, Companies, Govs own pieces of Internet Infrastructure.
    - ISOC: Internet Society
    - IETF: Internet Engineering Task Forum
    - **ICANN: Internet Corporation for Assigned Names and Numbers**

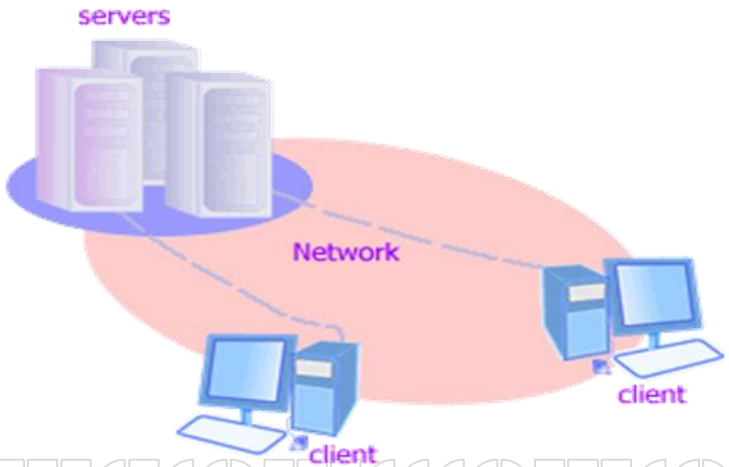


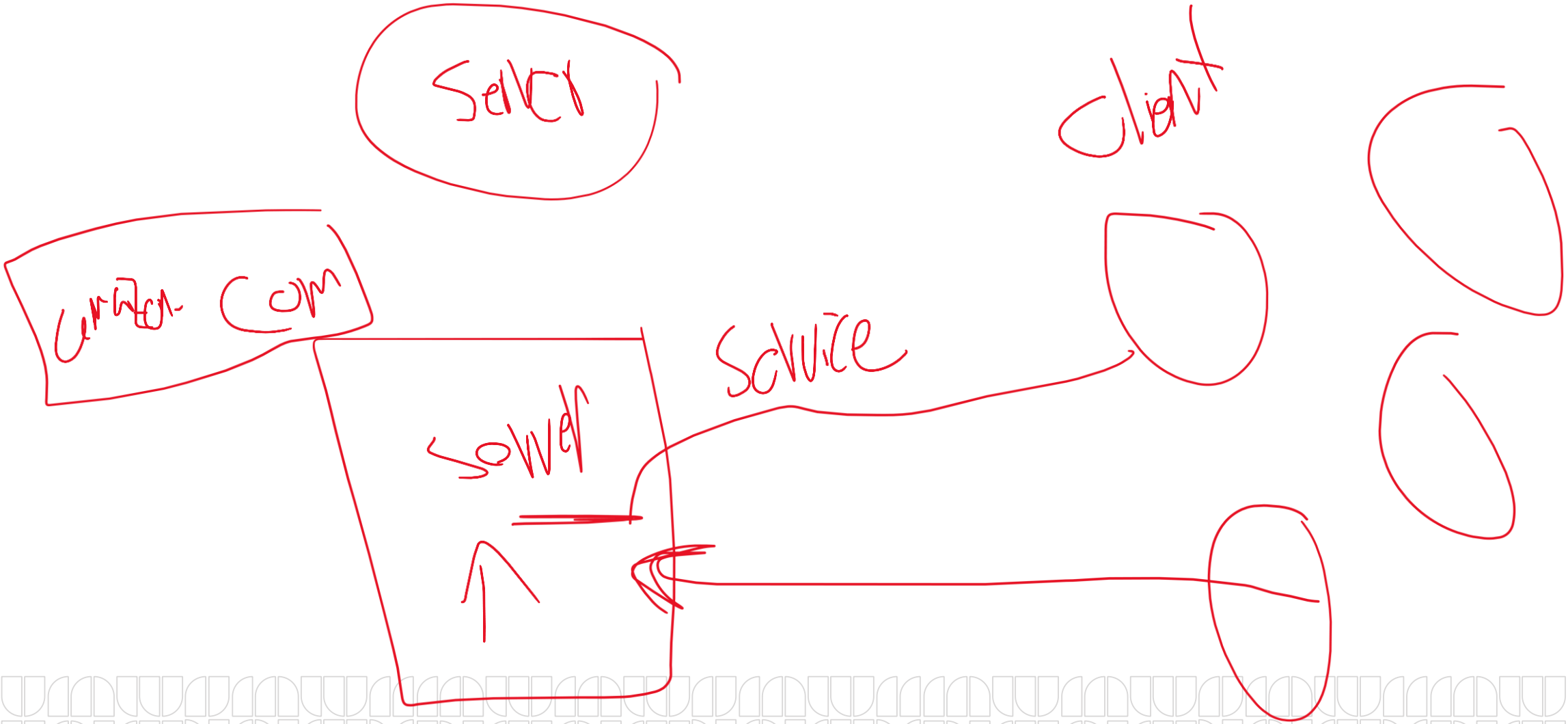


Session 1 (Network Models)

- **Peer to Peer Networks**
  - **No dedicated resources** to present specific service
  - Easy to work with
  - All nodes are the same (**equal to use the resources**)
- **Client/Server Networks**
  - Some nodes (**SERVER**) are dedicated to present services to other nodes (CLIENTS)
  - **Server is more powerful**
    - Mail Server
    - Web Server
    - File Server
    - Print Server



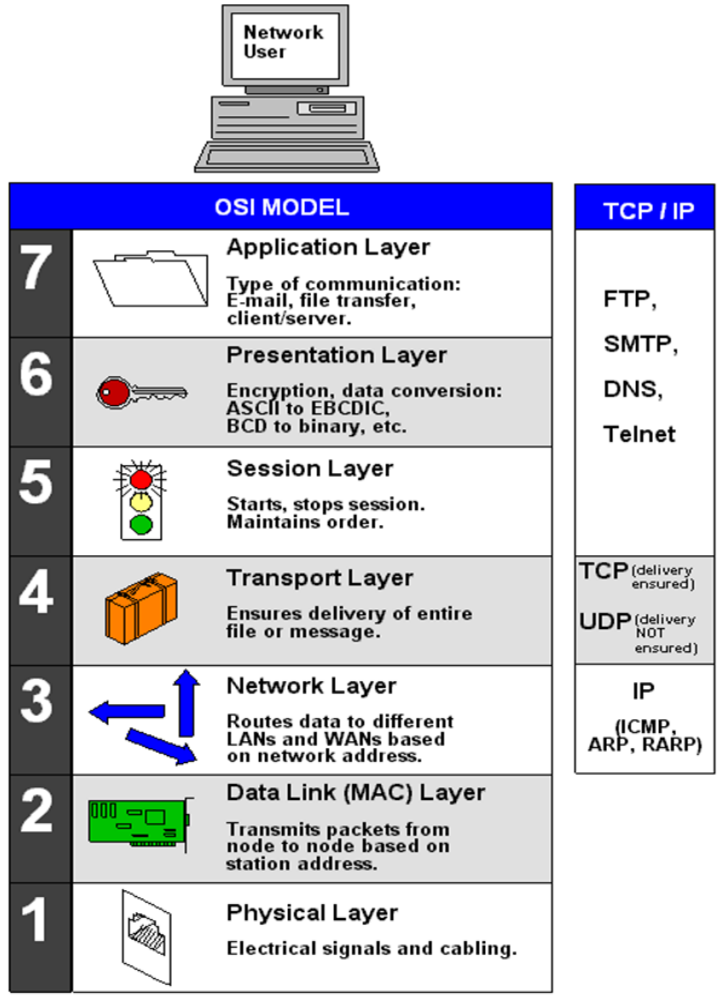



client
service
server

Session 1 (TCP/IP Protocol Suite)

- **Why we need Protocols ?**
  - To communicate **efficiently**
  - Enable data to flow from one NIC to another
  - **Control the messages** and the messages quantity in the network.

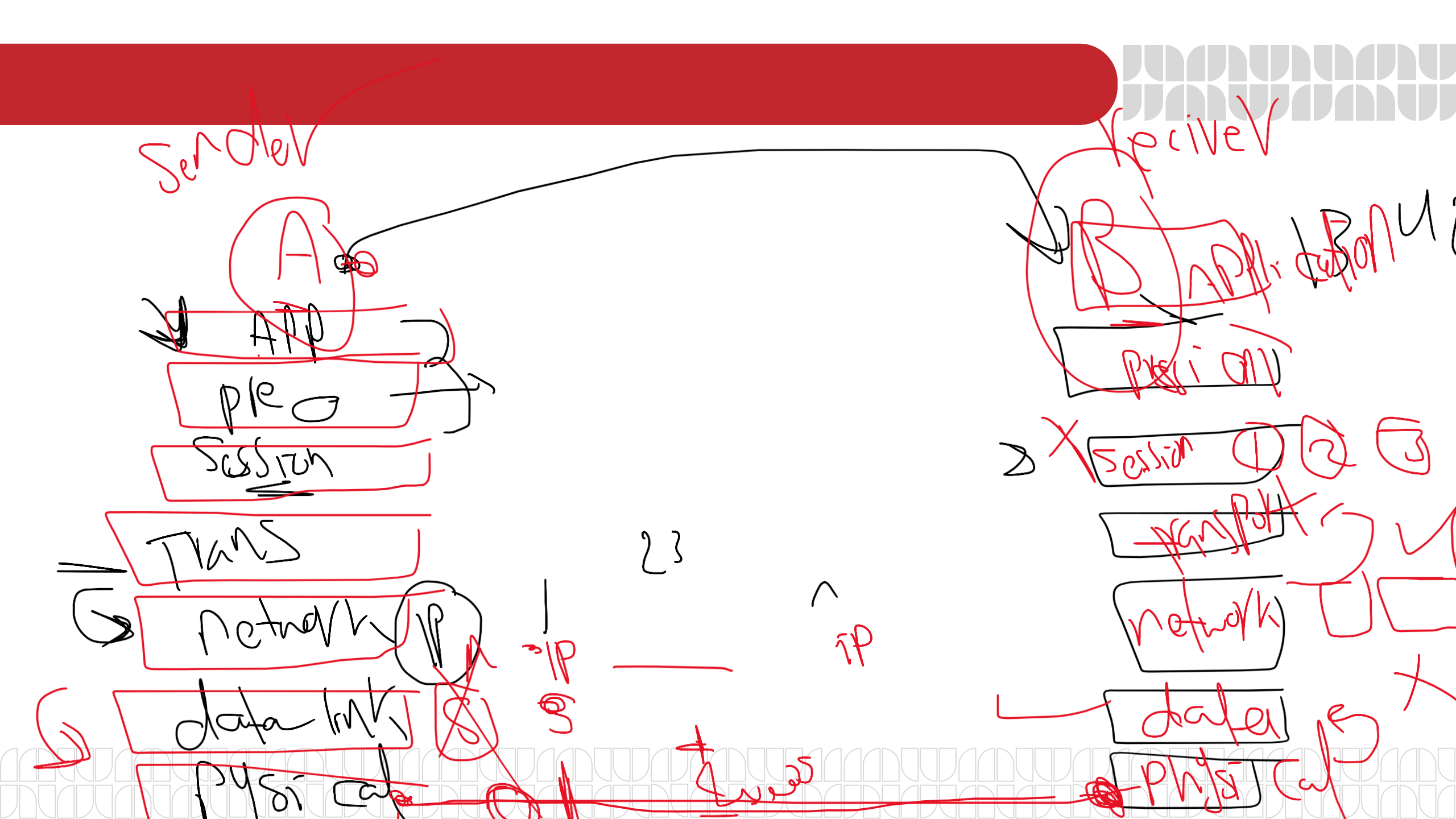
- **OSI Reference Model**
  - **OSI**: Open Systems Interconnect
    - was defined by ISO in 1983
      - Give developers universal concepts so they can develop protocols
      - The OSI reference model breaks this approach into **layers**.




PC
Laptop
iSO
model
dell

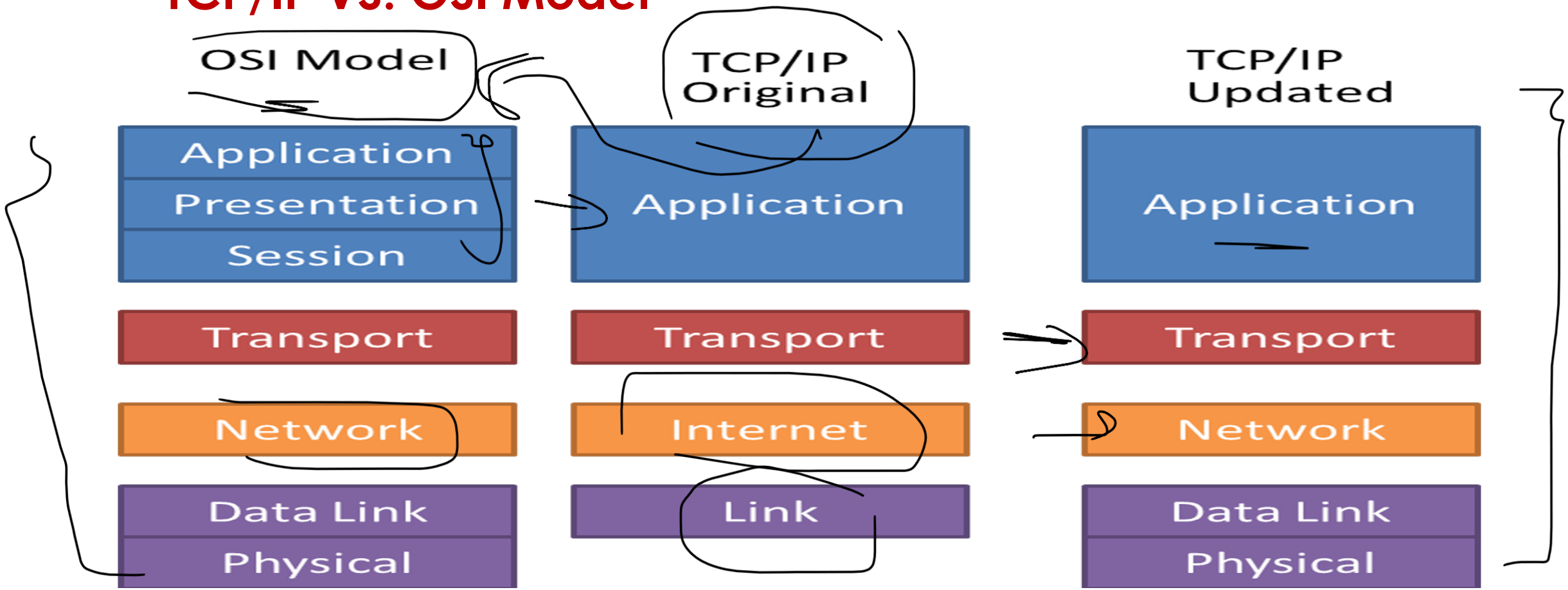
Session 1 (TCP/IP Protocol Suite)

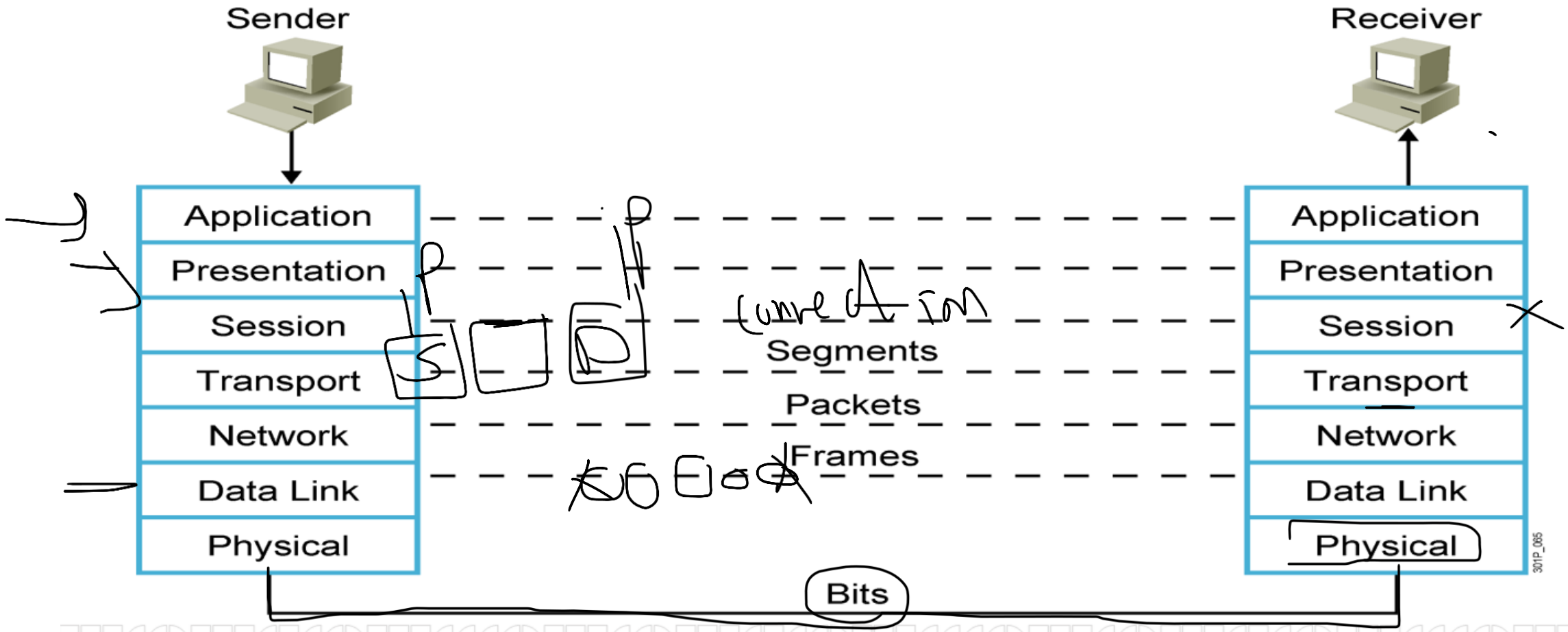
- **TCP/IP (Transmission Control Protocol/Internet Protocol)**
  - **Open Standard Protocol**
  - **Cross Platform** (default protocol for all modern operating systems)
    - Microsoft Operating Systems
    - LINUX Operating Systems
  - **Not tied to one vendor**
  - **Direct access to the Internet**(TCP/IP is the internet protocol)
    - Now internet use TCP/IP v4
    - Next version TCP/IP v6
  - **Routable**


Sender
A
APP
PRE
Session
TRANS
network
IP
data link
physical
23
IP
IP
Receiver
B
Application
Presentation
Session
network
data
physical

Session 1 (TCP/IP Protocol Suite)

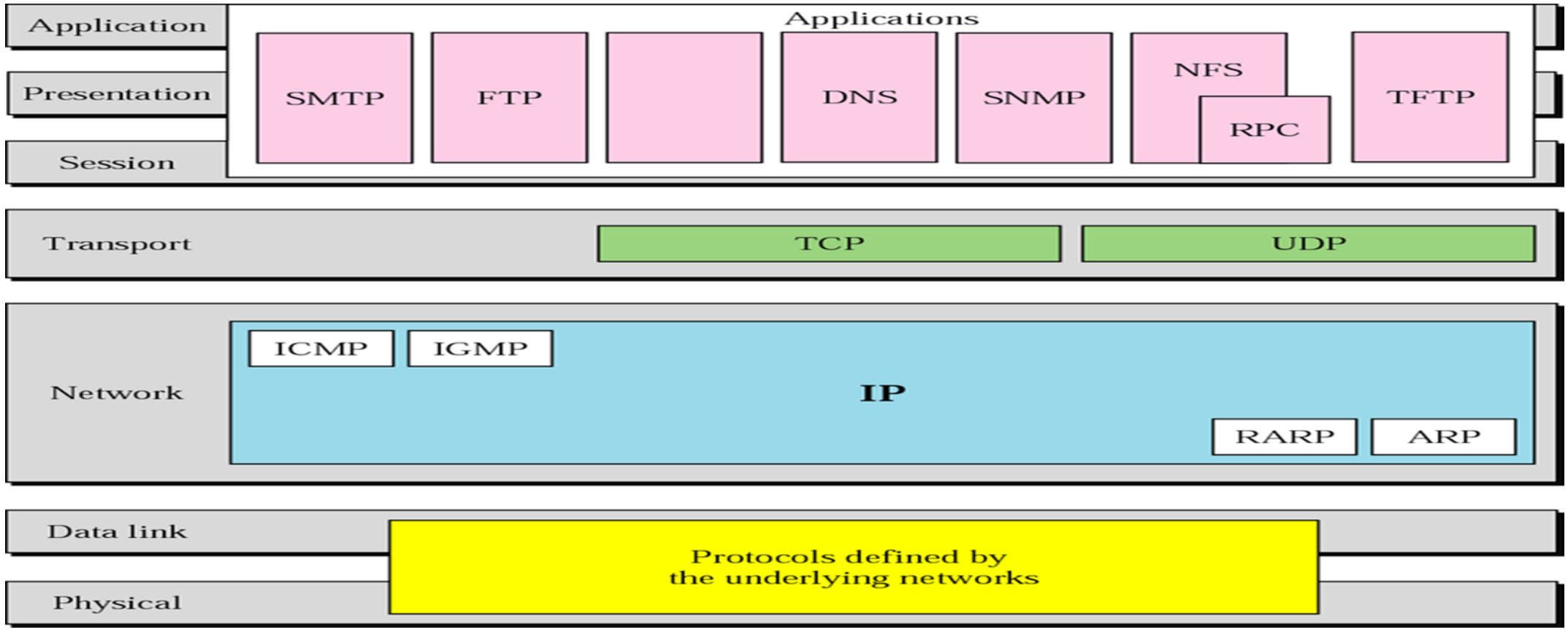
- **TCP/IP VS. OSI Model**




Sender
Receiver
Application
Presentation
Session
Transport
Network
Data Link
Physical
Application
Presentation
Session
Transport
Network
Data Link
Physical
Segments
Packets
Frames
Bits
301P_065

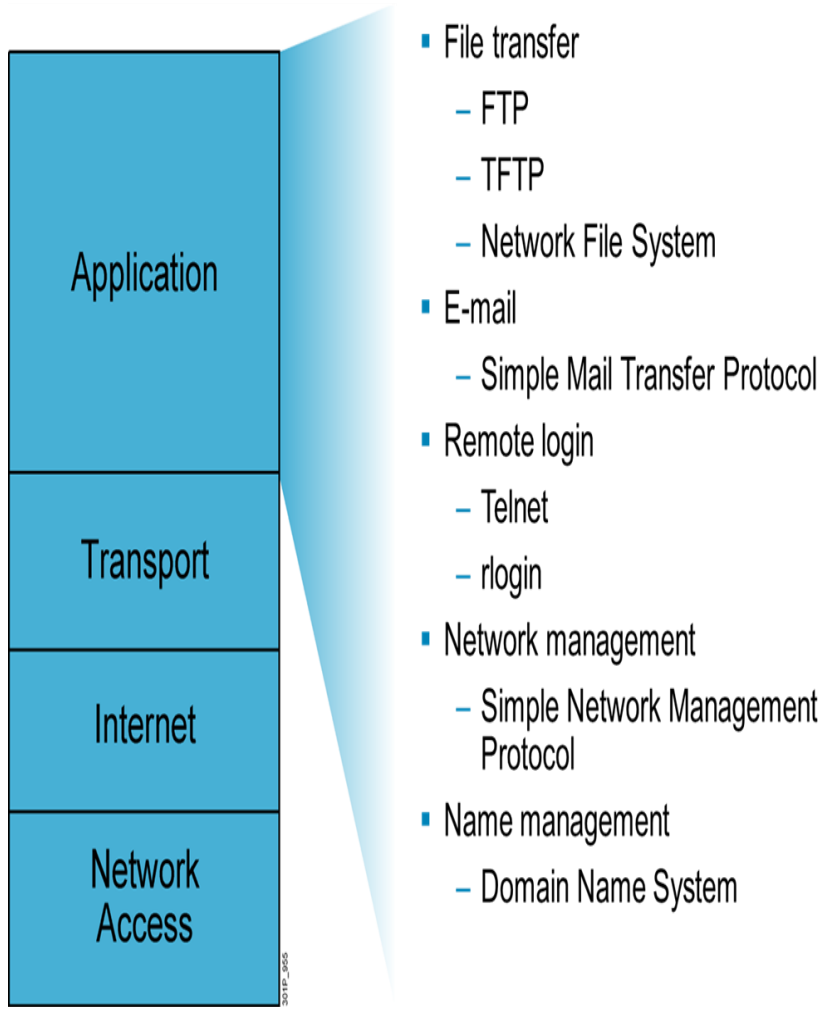
Session 1 (TCP/IP Protocol Architecture)

- Some Protocols in TCP/IP Suite



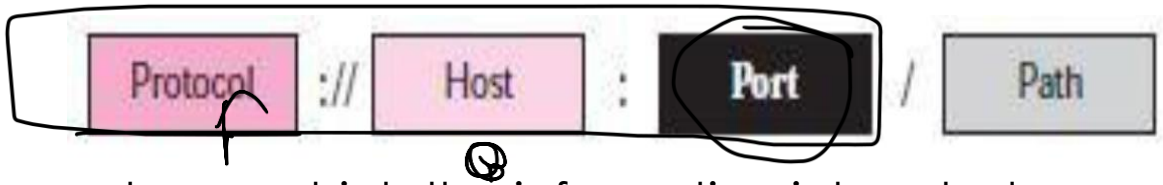
Session 1 (TCP/IP Protocol Architecture)

- **Application Layer**
  - Communication between processes or applications
  - Internet Services (Client/Web Server)
    - The World Wide Web: HTTP
    - Naming Service: DNS
    - File Transfer: FTP
    - Telnet Service
    - Electronic Mail service: IMAP, POP3, SMTP



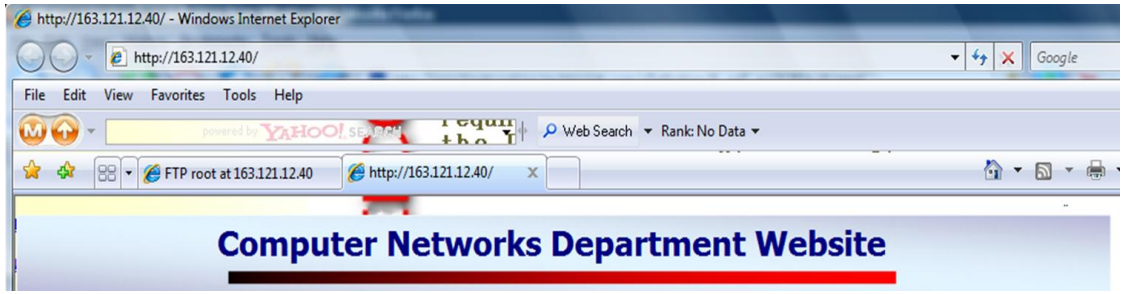
Session 1 (TCP/IP Protocol Architecture)

- **URL is Universal Resource Locator**



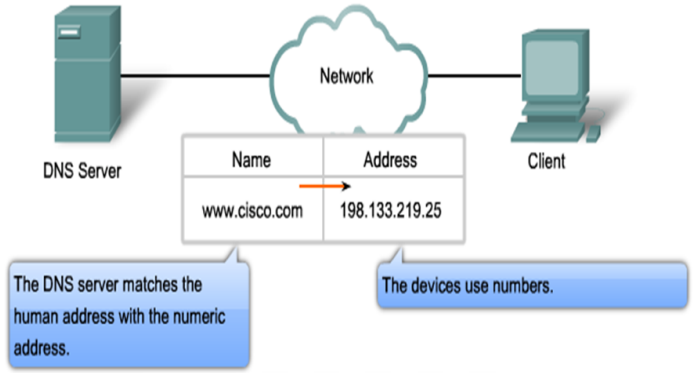
  - **Protocol** : HTTP, HTTPS or FTP
  - **Host** : is the domain name of the computer on which the information is located .
  - **Port:** The URL can optionally contain the port number of the server
  - **Path**: is the pathname of the file where the information is located.

- **HTTP (Hyper Text Transfer Protocol)**
  - Supports the delivery of web pages to the client

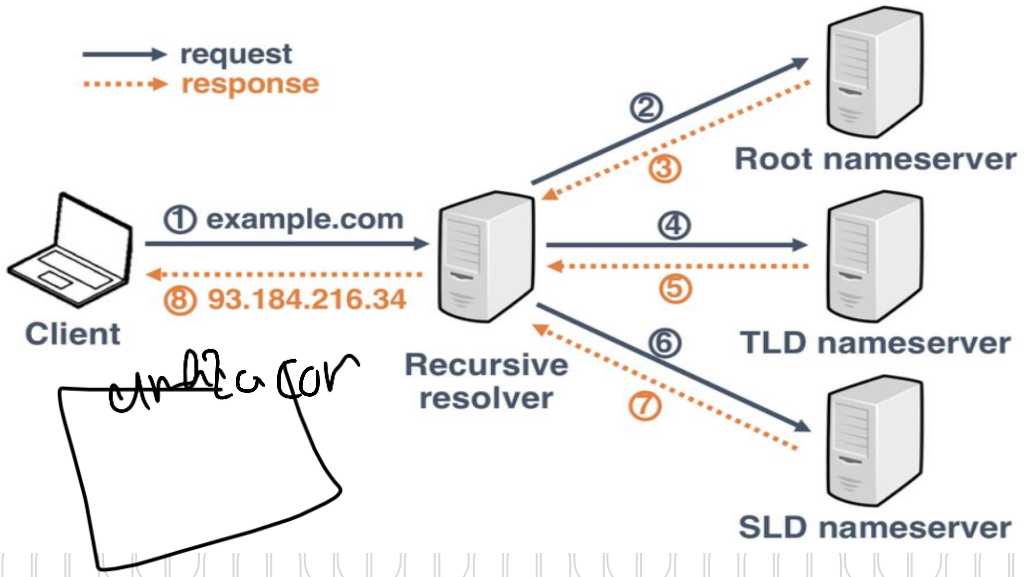


Session 1 (TCP/IP Protocol Architecture)

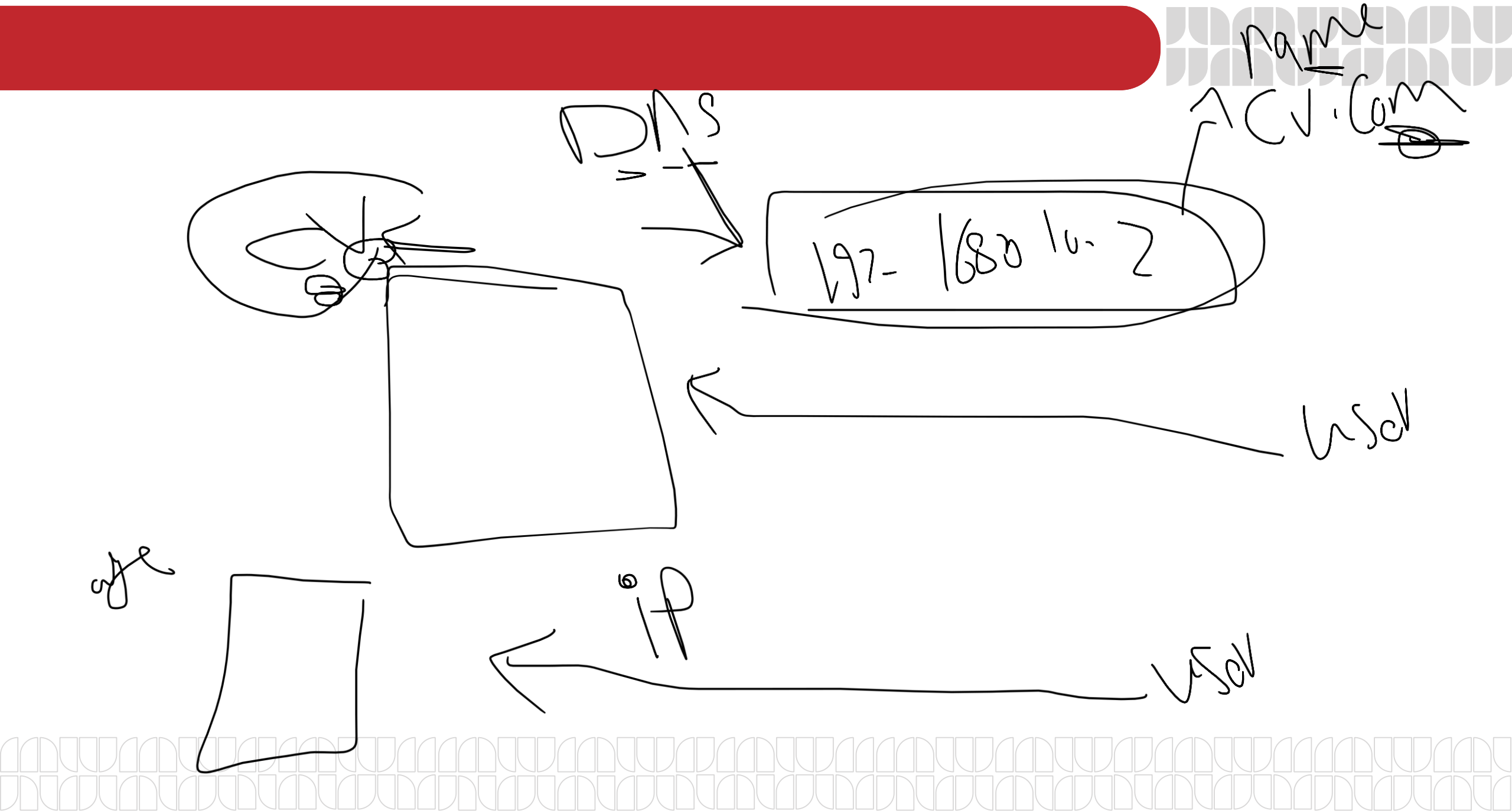
- **DNS** (Domain Name Servers)
  - A way to translate human-readable names into IP addresses
- How the client get the website
  - 1- check the cash
  - 2- check the hosts file
  - 3- Ask DNS server
- List of Top Level Domains (TLDs)



Domain Name	Assigned To
com	Commercial organization
edu	Educational institution
gov	Government organization
mil	Military group
net	Major network support center
org	Organization other than those above
country code	A country

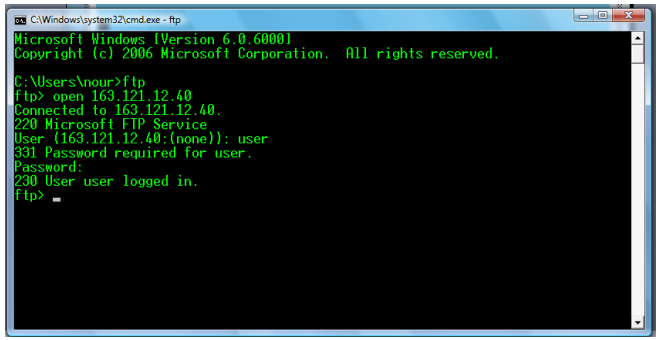


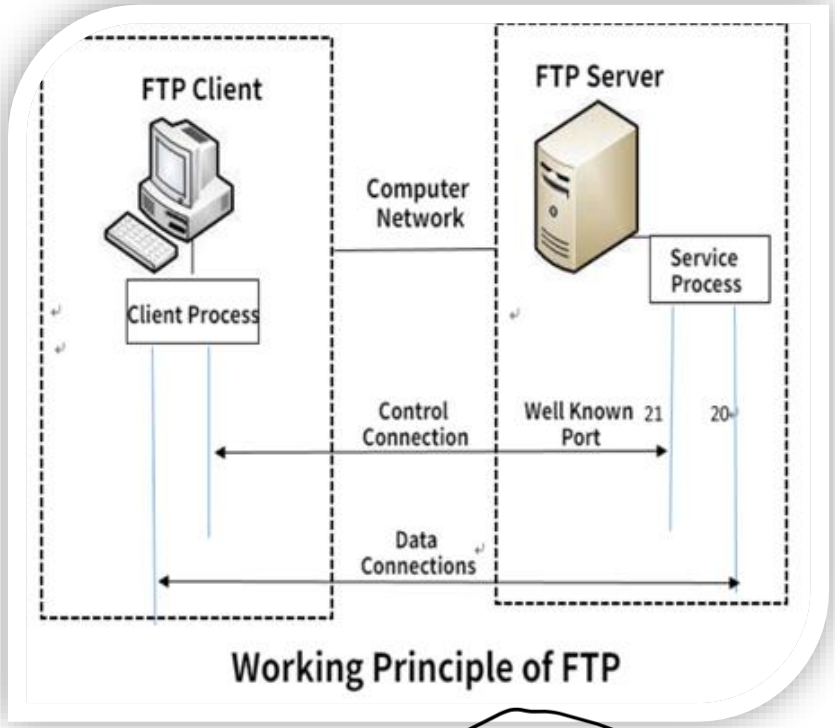
c/windows/system32/drivers/etc/hosts


name
CV.com
DNS
192.168.10.2
usb
ip
usb

Session 1 (TCP/IP Protocol Architecture)

- **FTP** (File Transfer Protocol)
  - a transmission protocol that provides reliable data transfer between hosts
  - FTP Client
    - Use Internet Browser as FTP client.
    - Using MS Windows built-in FTP client
    - Third party programs "cute FTP"





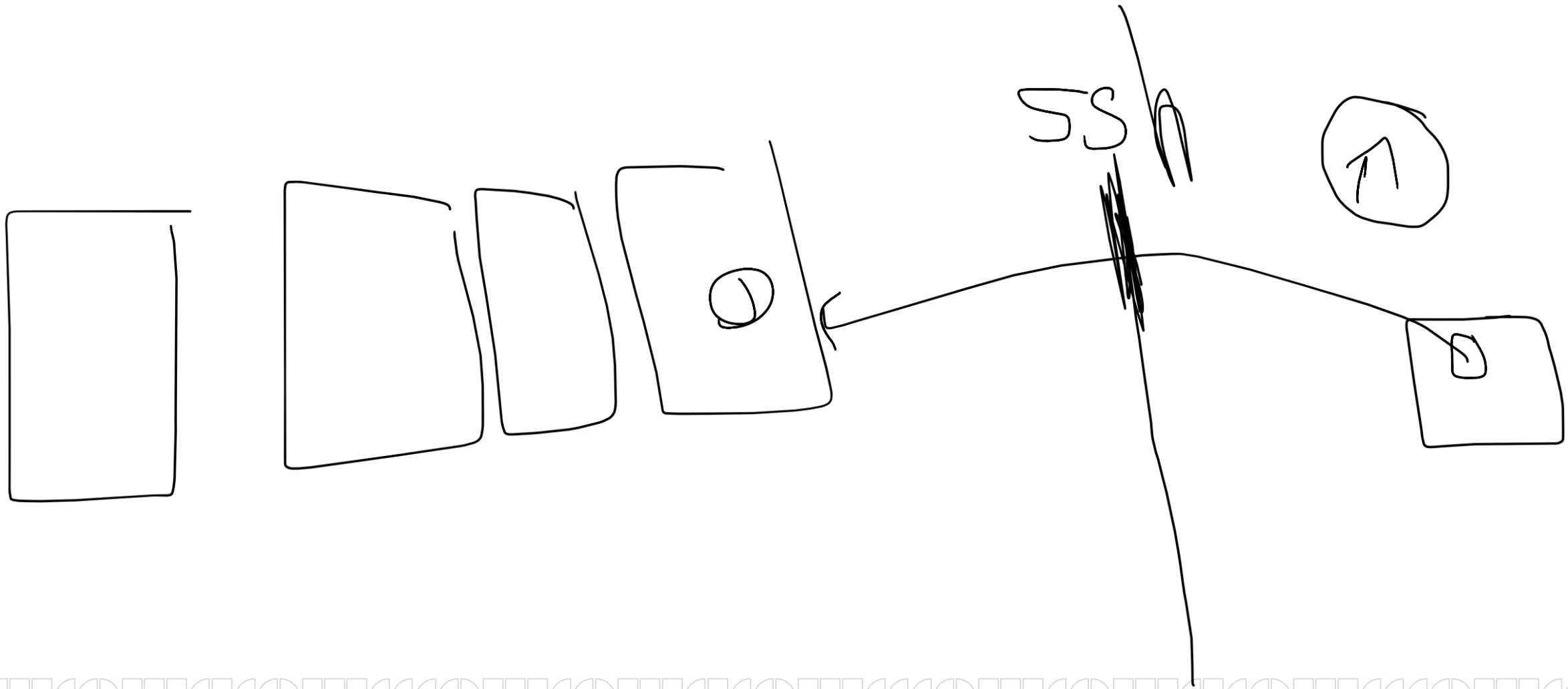
Session 1 (TCP/IP Protocol Architecture)

• Telnet /SSH or RDP

- Telnet/SSH is a user command and an underlying TCP/IP protocol for accessing remote computers.
- **Telnet/SSH**, an administrator can access someone else's computer remotely
- **Remote Desktop Protocol (RDP)** is a Microsoft proprietary protocol that enables remote connections to other computers,

Telnet VS SSH

SSH(Secure Shell)	Telnet
Runs on port 22	Runs on port 23
Very Secure Protocol	Not Secure Protocol
Only major protocol to access	Joint abbreviation
Difficult to decrypt	No data encryption
All popular Operating System	Linux , Windows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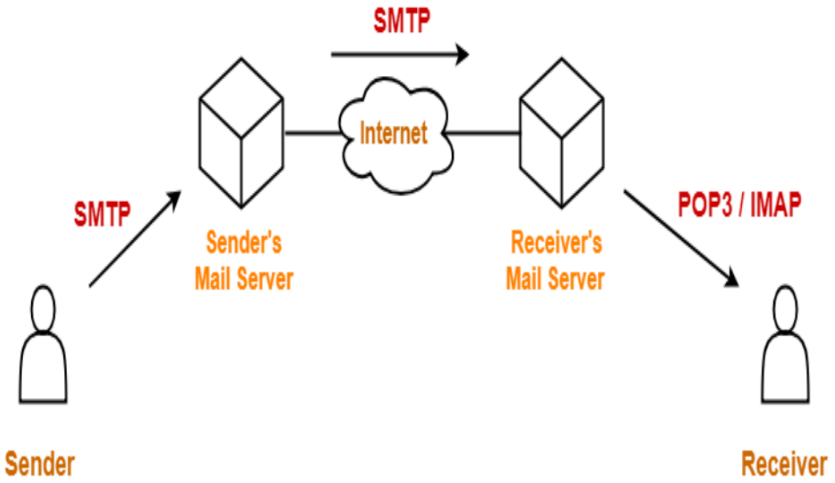
Session 1 (TCP/IP Protocol Architecture)

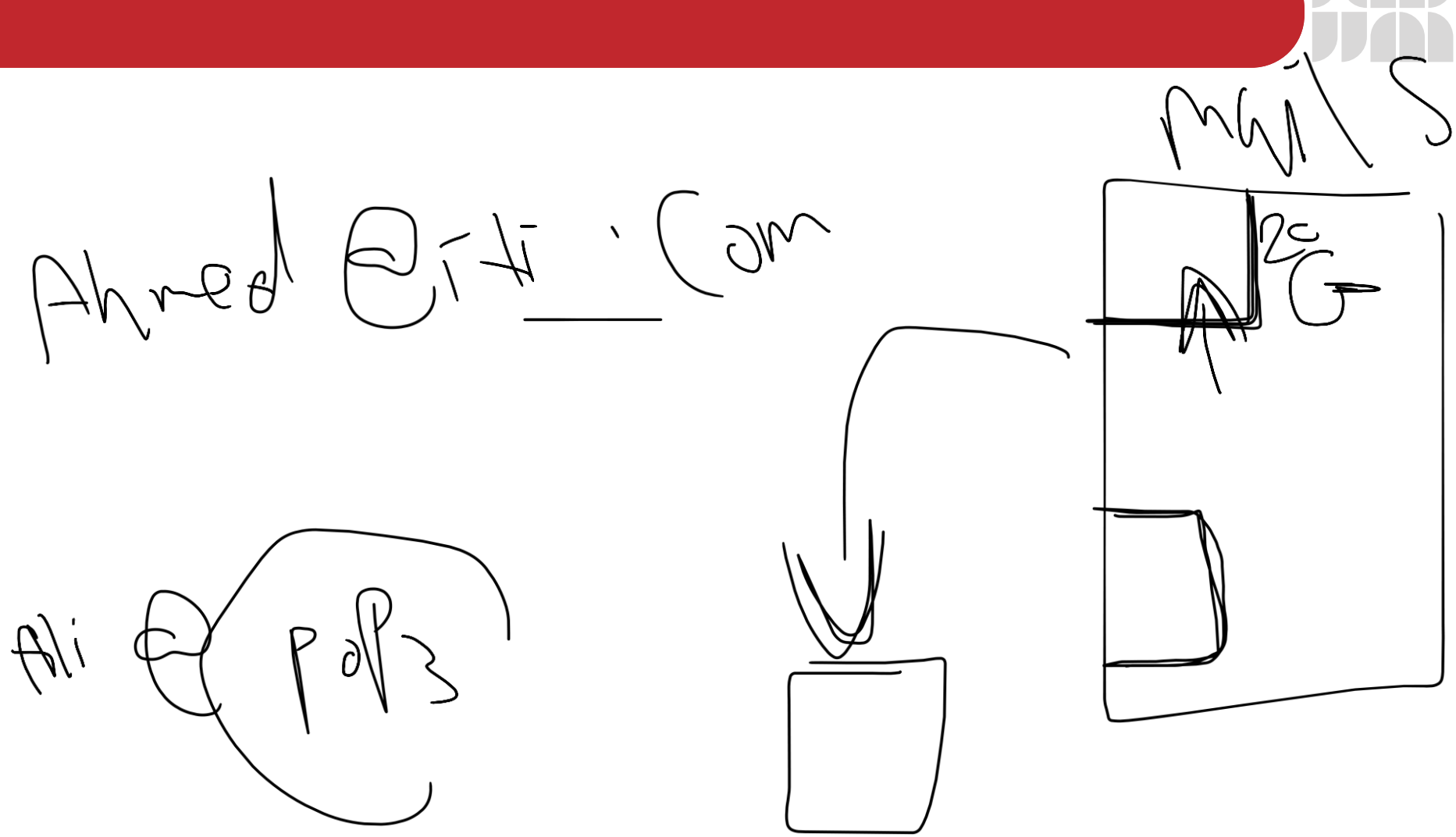
• Mail Server and Clients

- **Mail Clients**
  - **Web based :** Hotmail ,gmail
  - **Non web based :** Microsoft Outlook



• Mail Protocols

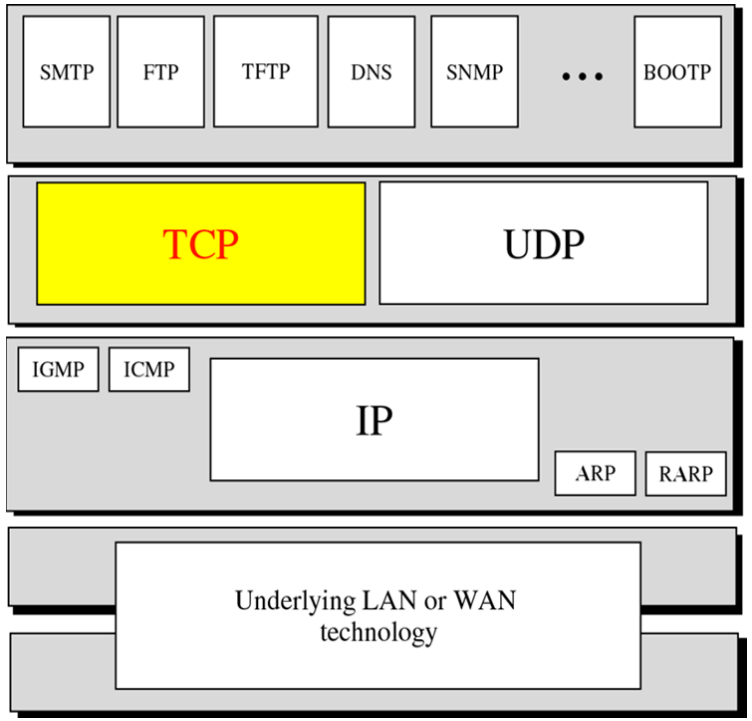
- **SMTP (send mail transfer Protocol)**
  - send messages back and forth to other Mail Servers or Email Clients
- **POP3 "Post Office Protocol version 3"**
  - the Email Client contacts the Mail Server to collect email messages
  - Download messages on the hard disk
  - can work Offline
  - Keep the user's quota on the server
- **IMAP4 "Internet Message Access Protocol version 4"**
  - Retrieve only message header


Mail Server
Ahmed@ti.com
2c
Ali
POP3

Session 1 (TCP/IP Protocol Architecture)

• Transport Layer

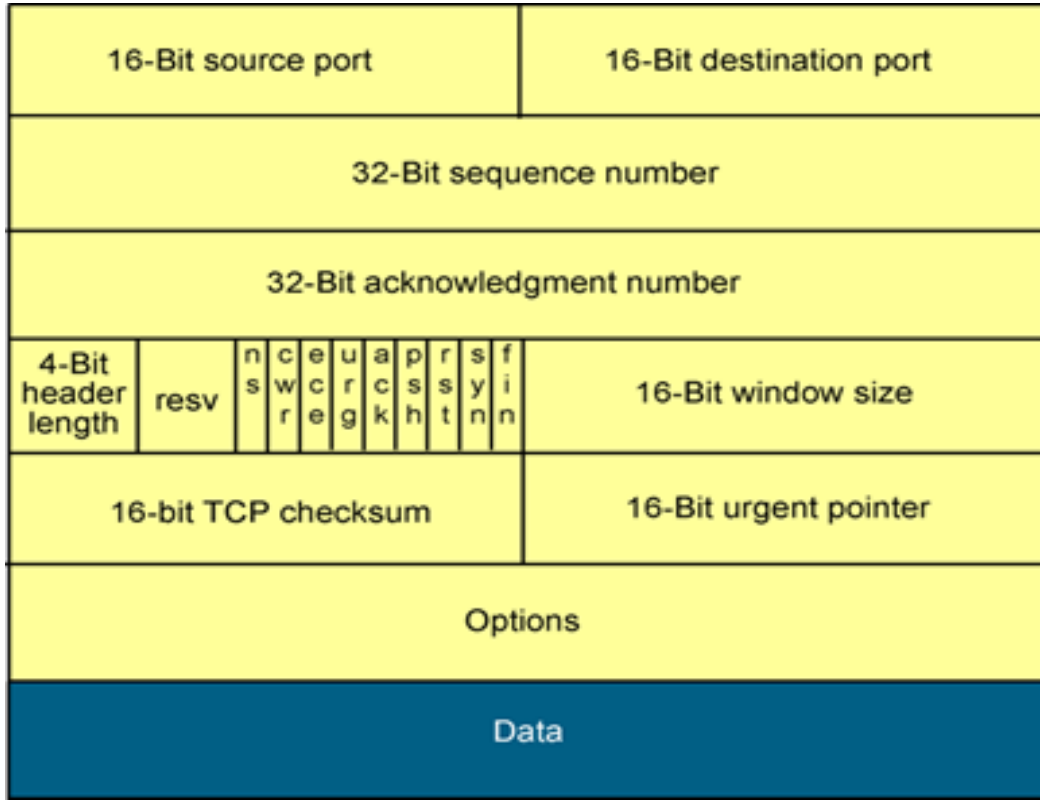
TCP Transmission Control Protocol)	UDP User Datagram Protocol
Reliable (Acknowledgement)	Unreliable (Best –Effort delivery)
Connection oriented (synchronization)	Connectionless (no notification)
Full duplex	Full duplex
Error control(Error checking(checksum)	Perform very limited error checking
Data-recovery features	Has no Data-recovery features
E-mail File sharing Downloading	Voice Streaming Video Streaming



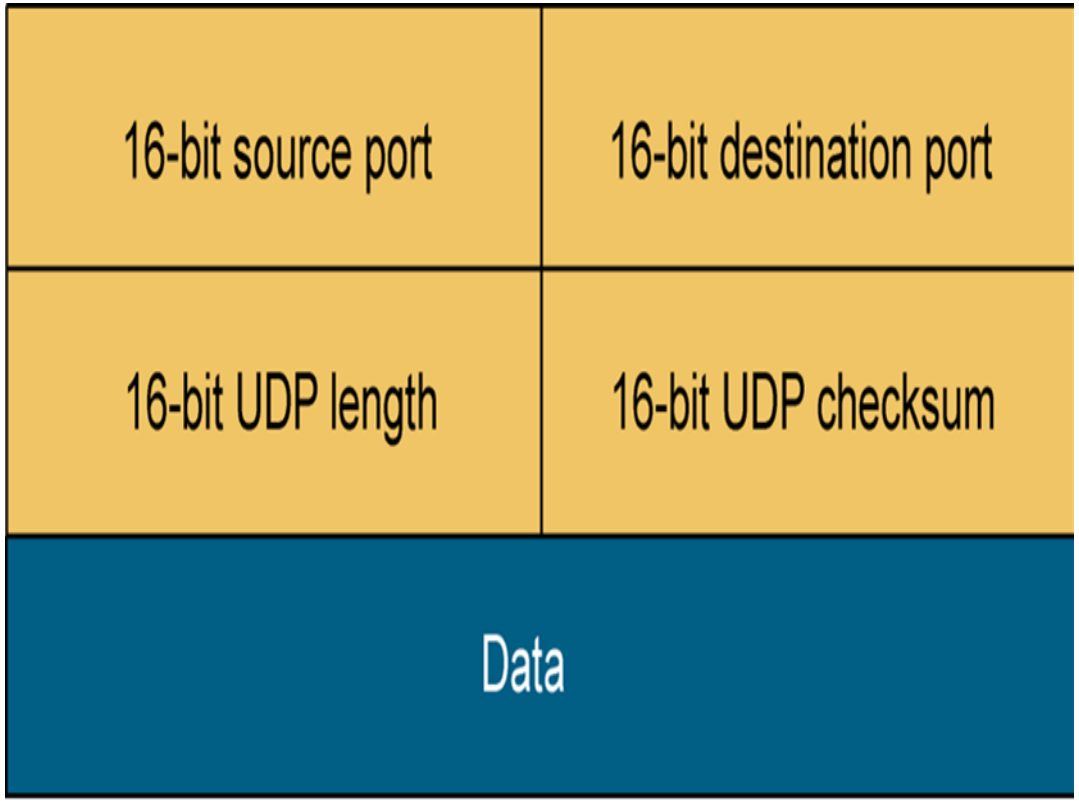
9:15 : 11:45

2 12:30 : 2:45

TCP Header vs UDP Header



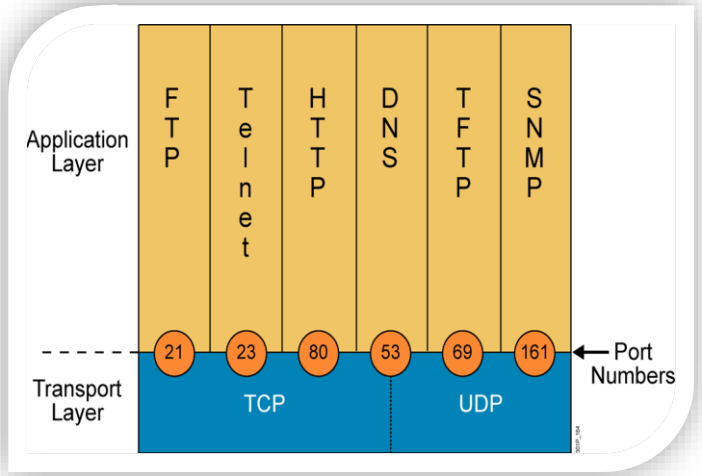
TCP Header

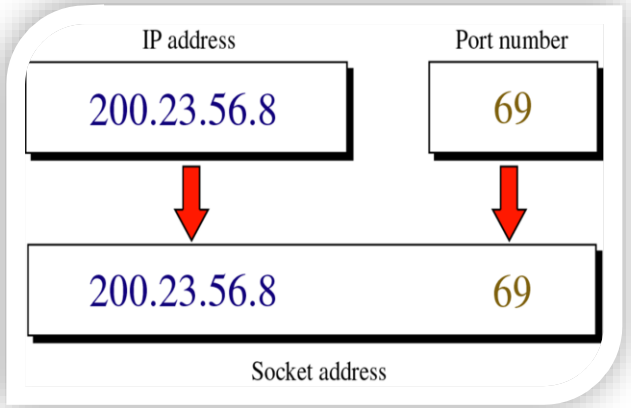


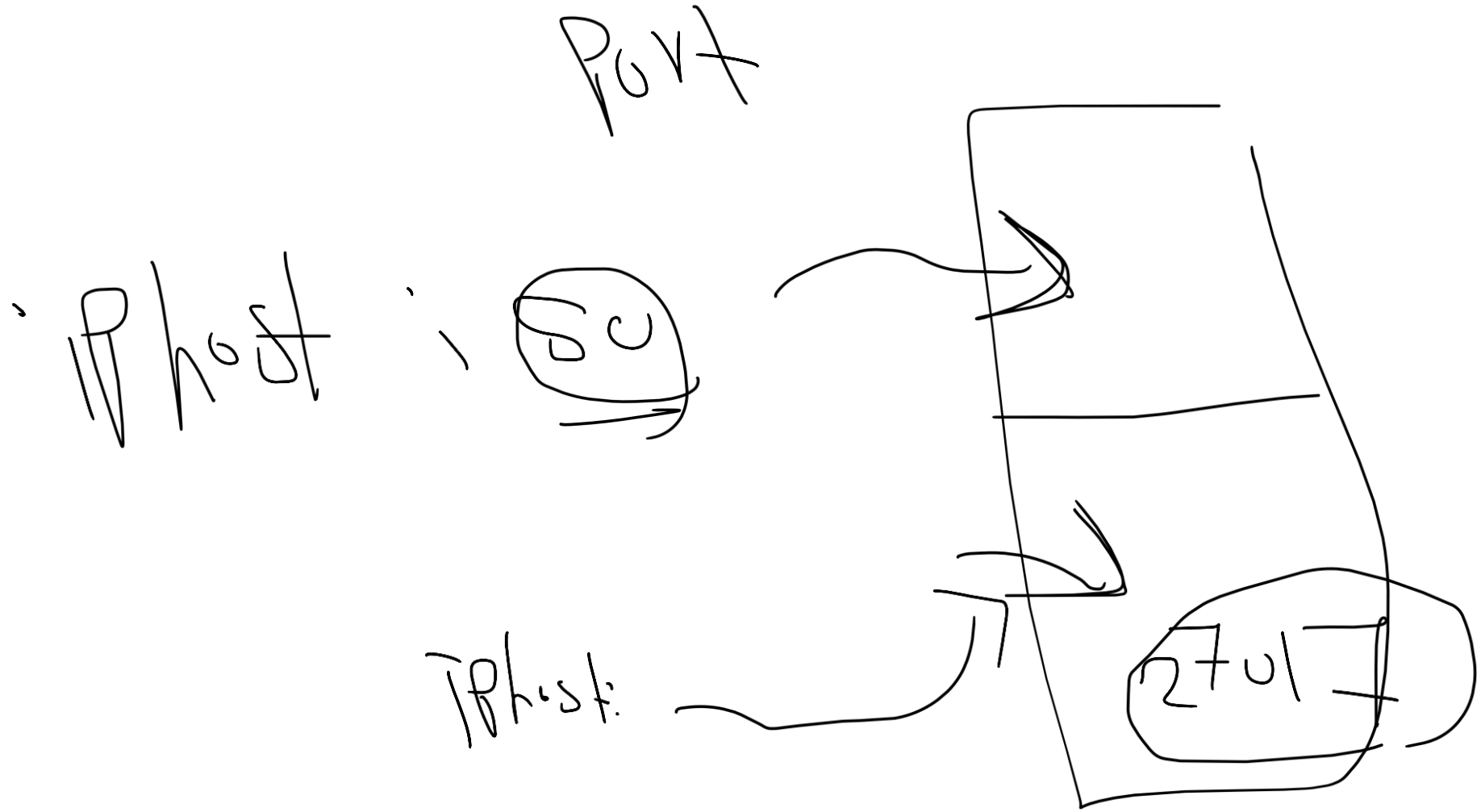
UDP Header

Session 1 (TCP/IP Protocol Architecture)

- **Transport Layer addressing (Port Numbers.)**
  - (ICANN) controls the port numbers.
  - **Well Known ports**
    - permanent used numbers.
      Range from 1 to 1,023 are assigned and controlled by ICANN
  - **Registered ports**
    - Range from 1,024 to 49,151 not assigned or controlled by ICANN
    - designated for use with a certain protocol or application but can be registered at ICANN to avoid duplication
  - **Dynamic ports**
    - Range from 49,152 to 65,535 are neither controlled nor registered

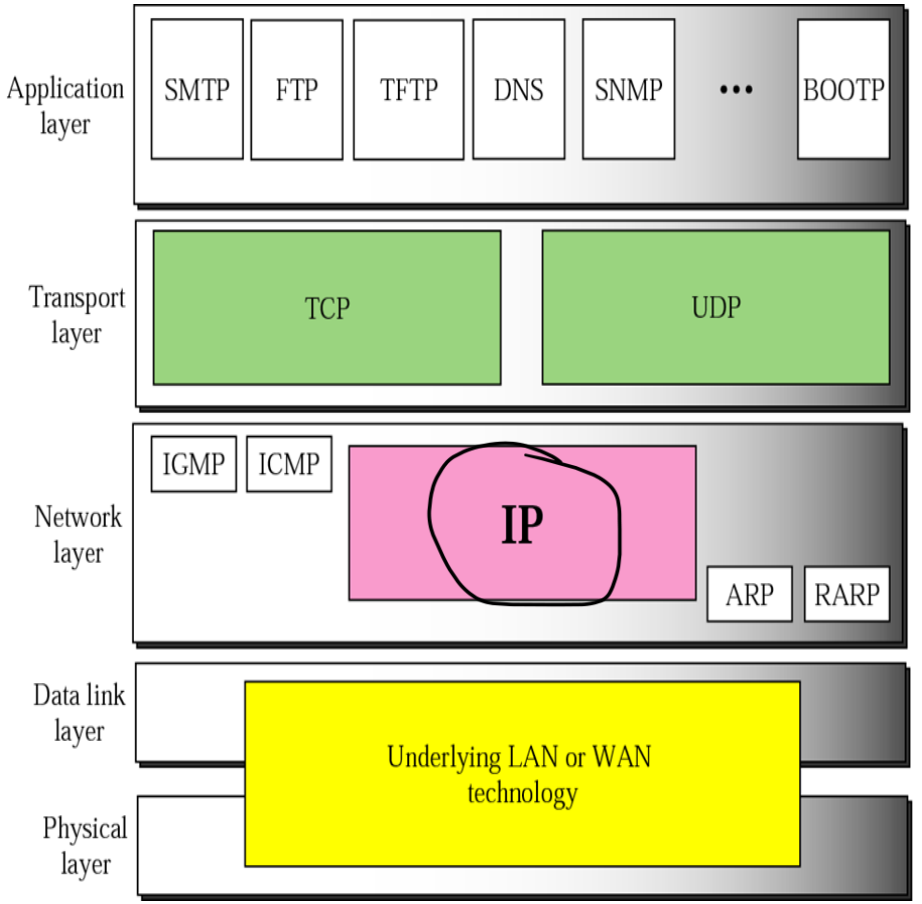




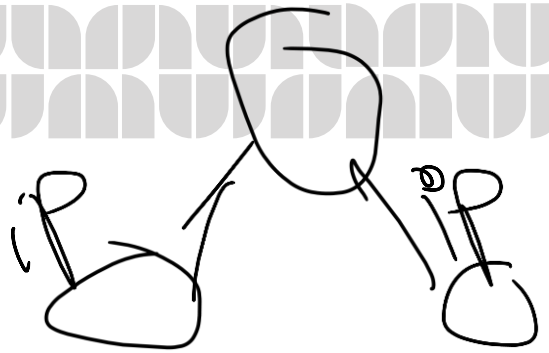

Port
IPhost : 80
IPhost:
2701

Session 1 (TCP/IP Protocol Architecture)

- **Internet / Network protocol Layer (IP Layer)**
  - Provides **connectivity** and **path selection** between two hosts (Source to Destination)
  - **Routing** of data (Provide mechanism to transmit data over **independent networks** that are linked together)
  - Logical addressing IPV4 , IPV6



Session 1 (TCP/IP Protocol Architecture)



- **Internet Protocol (IP V4)**
  - Some times we called it the **logical address**
  - Every host (computer, networking device, peripheral) must have **a unique address at the same network**
  - The IP address **32 bit** divided into **4 octets** each octet 8 bit

1 octet = 8 bit each represents from 0 to 255 separated with dots

	Example			
An IP address is a 32-bit binary number	10101100	00010000	10000000	00010001
For readability, the 32-bit binary number can be divided into four 8-bit octets	10101100	00010000	10000000	00010001
Each octet (or byte) can be converted to decimal	172	16	128	17
The address can be written in dotted decimal notation	172.	16.	128.	17

- **The address space of IPv4 is 2^{32} or 4,294,967,296**

Session 1 (TCP/IP Protocol Architecture)

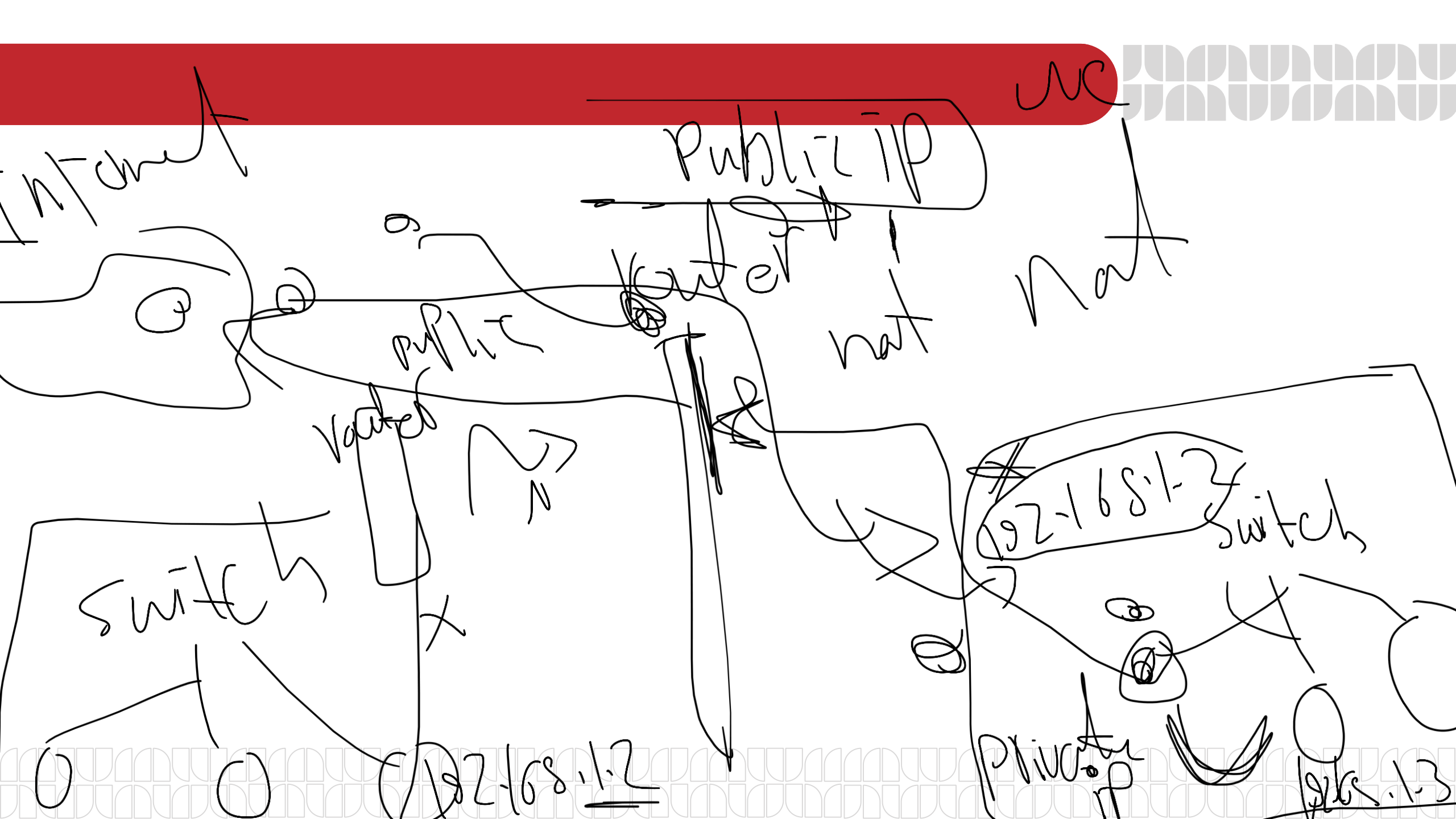
PUBLIC IP ADDRESSES (Real IP)

Class	Public IP Ranges
A	1.0.0.0 to 9.255.255.255 11.0.0.0 to 126.255.255.255
B	128.0.0.0 to 172.15.255.255 172.32.0.0 to 191.255.255.255
C	192.0.0.0 to 192.167.255.255 192.169.0.0 to 223.255.255.255

Private IP Addresses (Local IP)

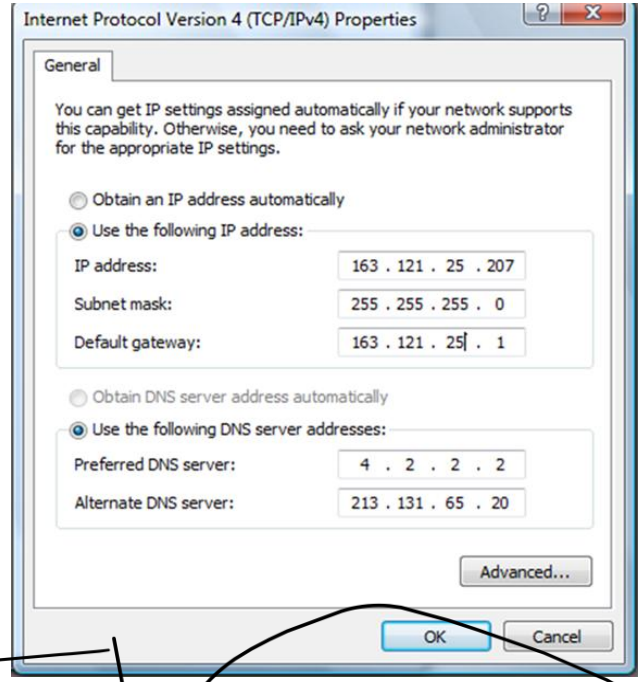
Class	Private Address Range
A	10.0.0.0 to 10.255.255.255
B	172.16.0.0 to 172.31.255.255
C	192.168.0.0 to 192.168.255 255

- **Nat** is used to Translate the private IP address to public IP addresses.


Internet
Public IP
VC
router
public
nat
nat
routed
192.168.1.2
switch
192.168.1.3
switch
192.168.1.2
Private IP
192.168.1.3

Session 1 (TCP/IP Protocol Architecture)

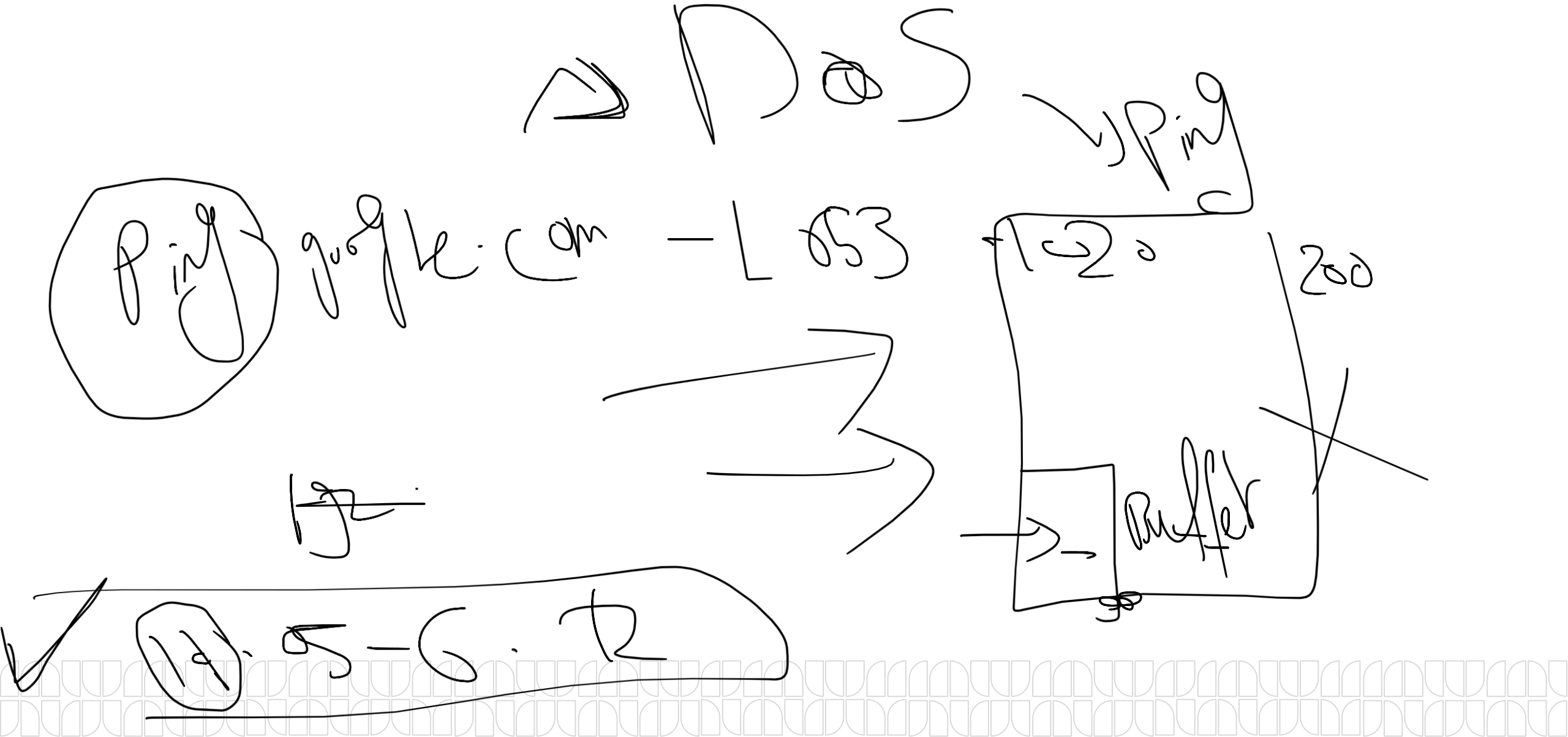
- **How to assign IP address to device**
  - Manually
  - Automatic (By DHCP)
  - APIPA (Random /Rang : 169.254.X.X)

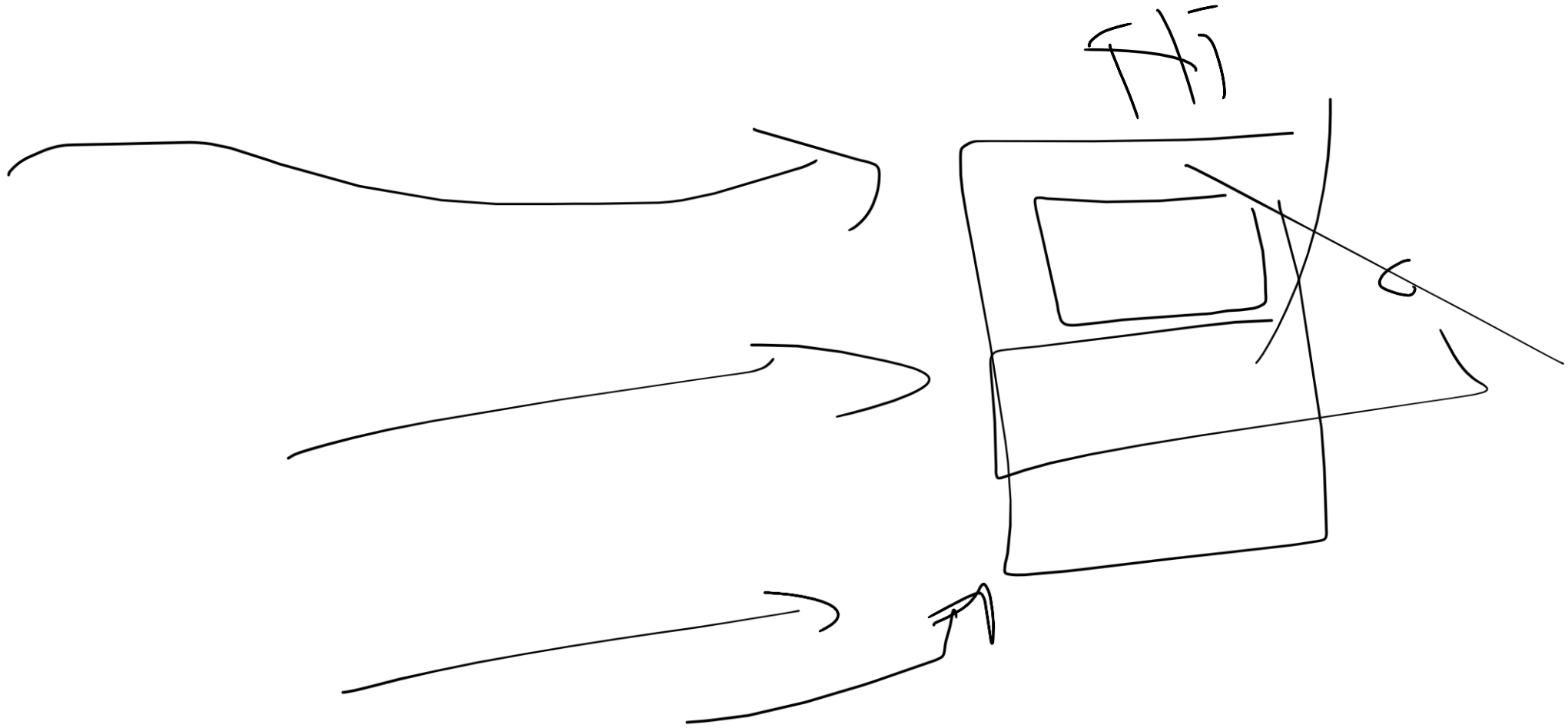


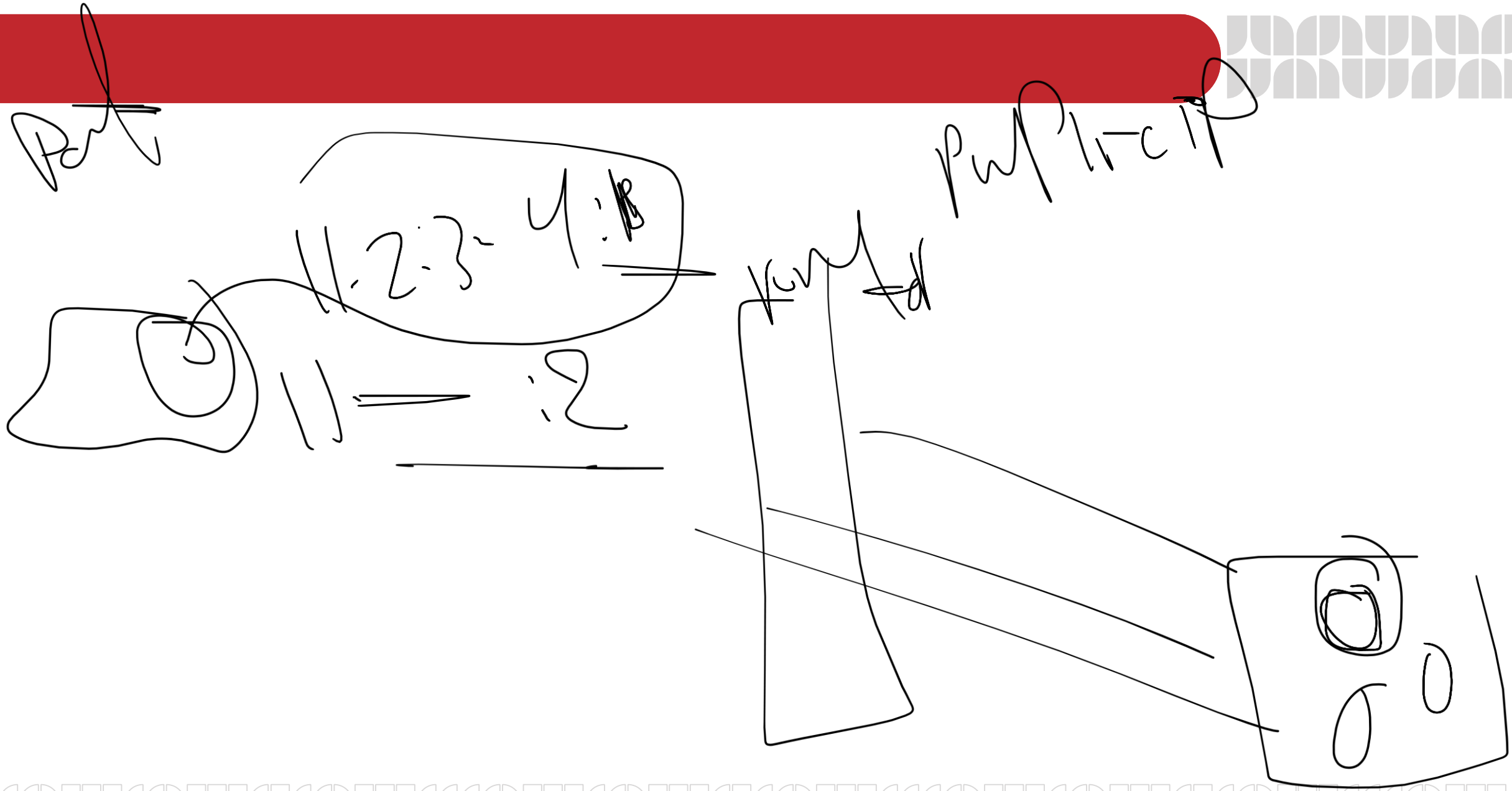
- **To find your private IP**
  - **Ipconfig - Ipconfig /all - Ipconfig /release - Ipconfig /renew**
- **ICMP (Ping) To test connectivity between Hosts**
  - **Ping IP**
  - **Ping URL**
  - **Ping IP -l -n -t**


ip
dhcp
ip
ip
ip


mac
NIC
tha

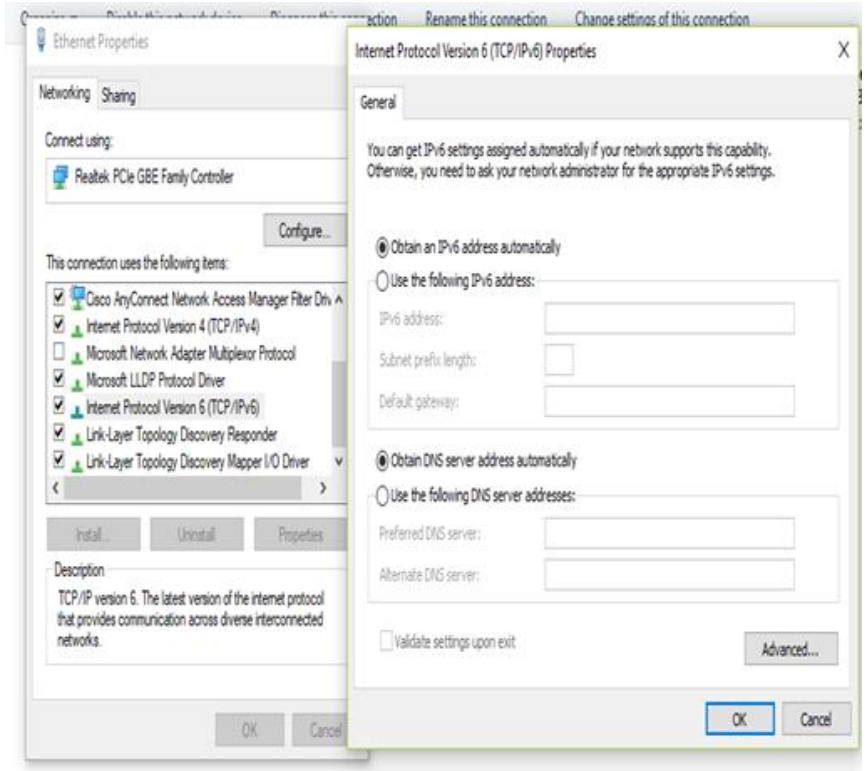

DoS
ping google.com -l 65
ping
120
200
Buffer





Session 1 (TCP/IP Protocol Architecture)

- **Internet Protocol (IP V6)**
  - **128-bit address**, provides approximately (340,282,366,920,938,463,463,374,607,431, 768,211,456) = approximately 340 undecillion, or 340 billion billion billion billion billion, addresses)
  - Represented as eight groups, separated by colons, of four hexadecimal digits. The full representation may be simplified by several methods of notation;



2001:0db8:0000:0000:0000:8a2e:0370:7334

=

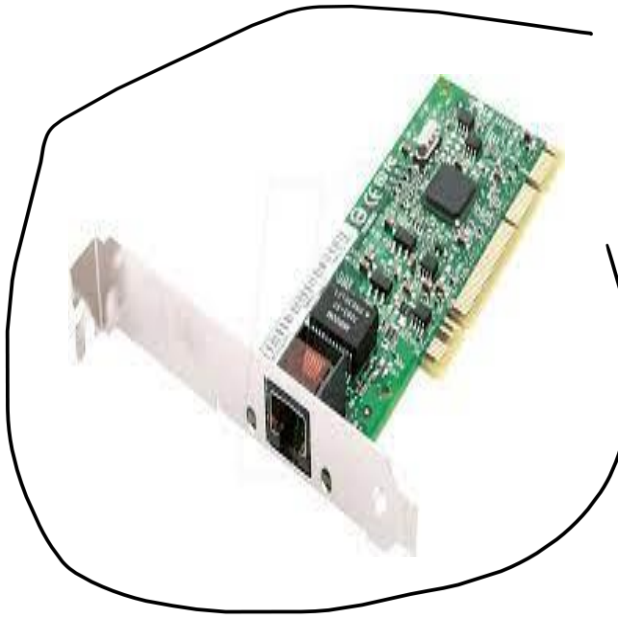
2001:db8::8a2e:370:7334

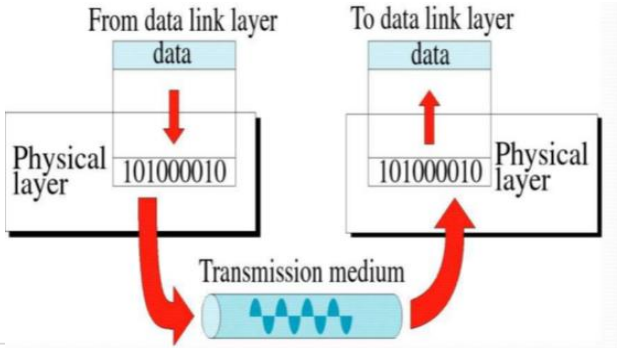
Session 1 (TCP/IP Protocol Architecture)

- **Internet Of Things (IOT)**
  - Aims **connect all devices to the existing Internet infrastructure**.
  - "things" that **sense and collect data** and send it to the internet.
  - (Eg:- coffee maker, A.C, Washing Machine, Ceiling Fan, lights , any thing) having sensors can be connected with internet.
- **PRACTICAL APPLICATIONS:-**
  - Smart Homes -Smart Cities-Energy - Environment monitoring- healthcare-Management

Session 1 (TCP/IP Protocol Architecture)

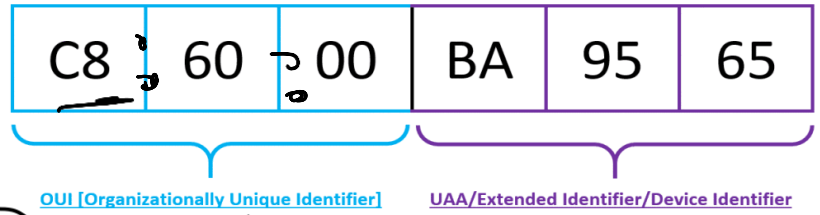
- **Network Access Layer**
  - **Datalink Layer**
    - Logical interface between end system and network
    - Error notification.
      (FRAMES, MEDIA ACCESS CONTROL)
    - Hop to Hop addressing
    - Error detection Mechanism (detects damaged or lost frames)
  - **Physical Layer**
    - defines the electrical, mechanical, Transmission medium
    - movements of individual **Bits** from one node to next



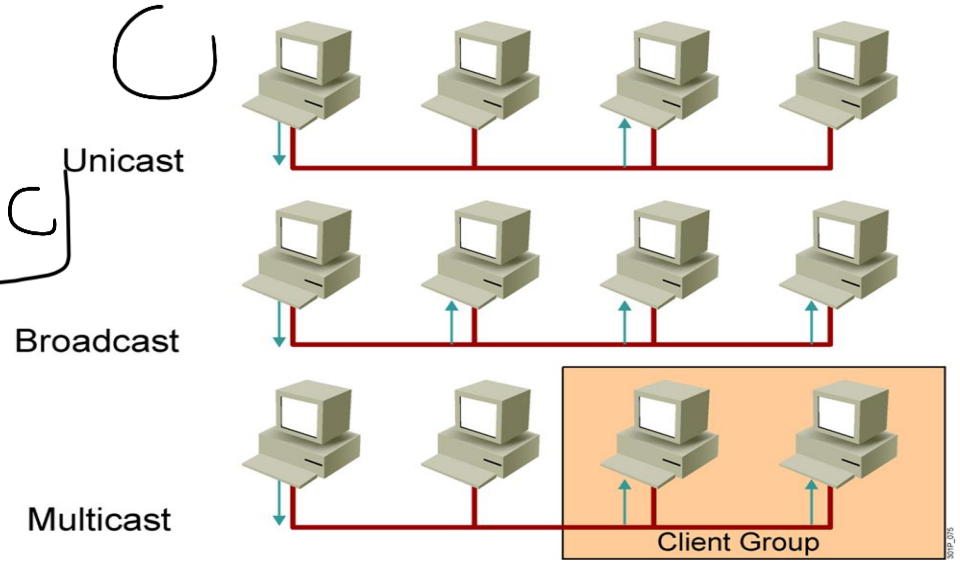


Session 1 (TCP/IP Protocol Architecture)

- **Physical Addresses (Mac)**
  - Physical Address **burned on the card**
  - **Unique address over the world**
  - **48-bit (6-byte)** written as **12 hexadecimal digits**;
  - every byte (2 hexadecimal digits) is separated by a colon



  - Physical addresses can be either
    - **Unicast**
    - **Multicast**
    - **Broadcast**



  - To check your physical address: -
    - **Ipconfig /all**
    - **GetMac**

Session 1 Practices

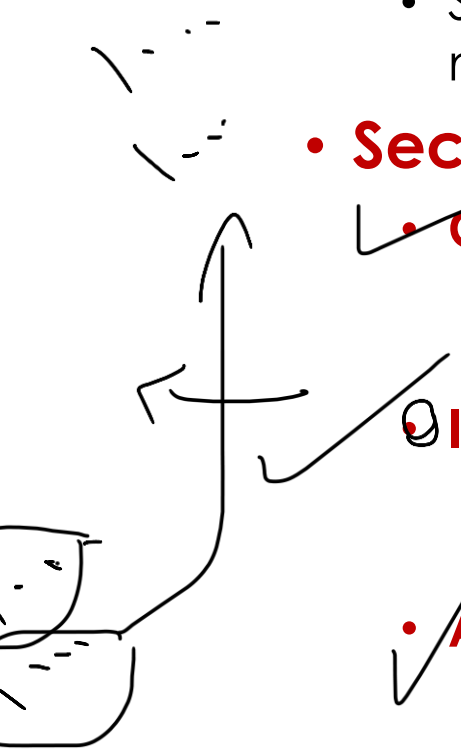
- **Find your mac address**
  - Ipconfig /all
  - Get mac
- **Find your real IP addresses**
  - https://www.whatismyip.com/
- **Find your private IP addresses**
  - Ipconfig
  - Ipconfig /all
  - Ipconfig /release
  - Ipconfig /renew
- **Find current session and ports on your device**
  - Netstat -n
  - Netstat -a
- **Find The IP of the domain Yahoo.com**
  - Nslookup Yahoo.com

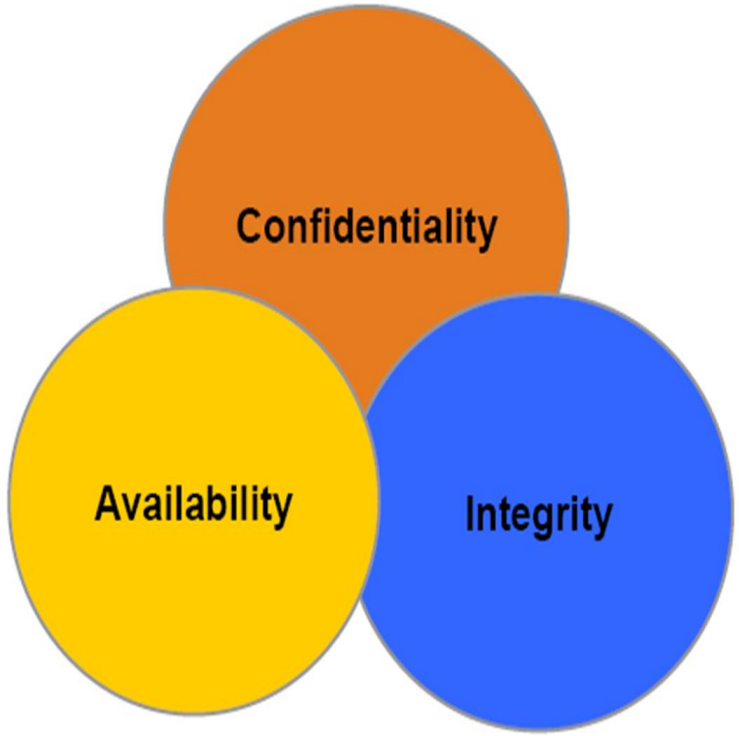
Session 2 (Cyber Security Essentials)

- **Session Outlines**
  - **Information Security Goals**
    - Confidentiality
    - Integrity
    - Availability
  - **Risks & Threats**
    - Threats & Vulnerabilities
    - Attackers methodology & Methods
    - Malware Types
  - **Security Defenses**
    - Firewalls (Static & Dynamic firewalls)
    - IDS /IPS
    - VPN
    - Proxy
    - Next generation Firewalls
  - **Encryption**
    - Symmetric & Asymmetric Key Cryptography
    - Digital Signatures /Digital Certificates

Session 2 (Security Goals)

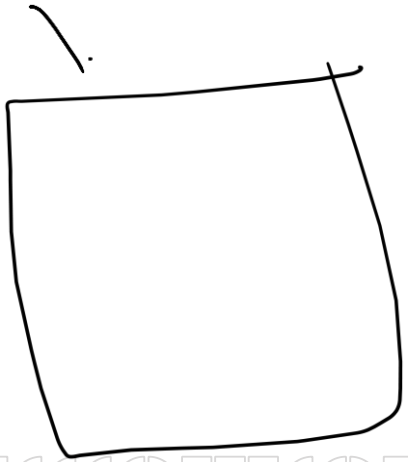
- **Cyber Security**
  - protect systems, networks, programs, devices and data from cyber attacks
  - Security is a **shared responsibility** that each person must accept when they connect to the network.
- **Security Goals Technically Defined**
  - **Confidentiality**
    - Ensuring that information is **not** revealed to **unauthorized** persons
  - **Integrity**
    - Ensuring **consistency** of data and it should be possible to **detect any modification** of data
  - **Availability**
    - Ensuring that **legitimate** users are **not denied** access to information and resources





Session 2 (Risks & Threats)

- **Focus of Security is Risk**
- **Risk = Threat x Vulnerabilities**
- **Vulnerability** is the **degree of weakness** which is found in every network and device.
- **Threats** is A person, thing, event or idea which **poses danger to an asset** in terms of that asset's confidentiality, integrity, availability or legitimate use
- **It's impossible** to totally eliminate risk & There is NO simple solution to securing information
- **Security 99.9 % Not found Why ?**
  - New technologies / applications
  - New Vulnerabilities
  - the difficulties in defending against these attacks (cost)

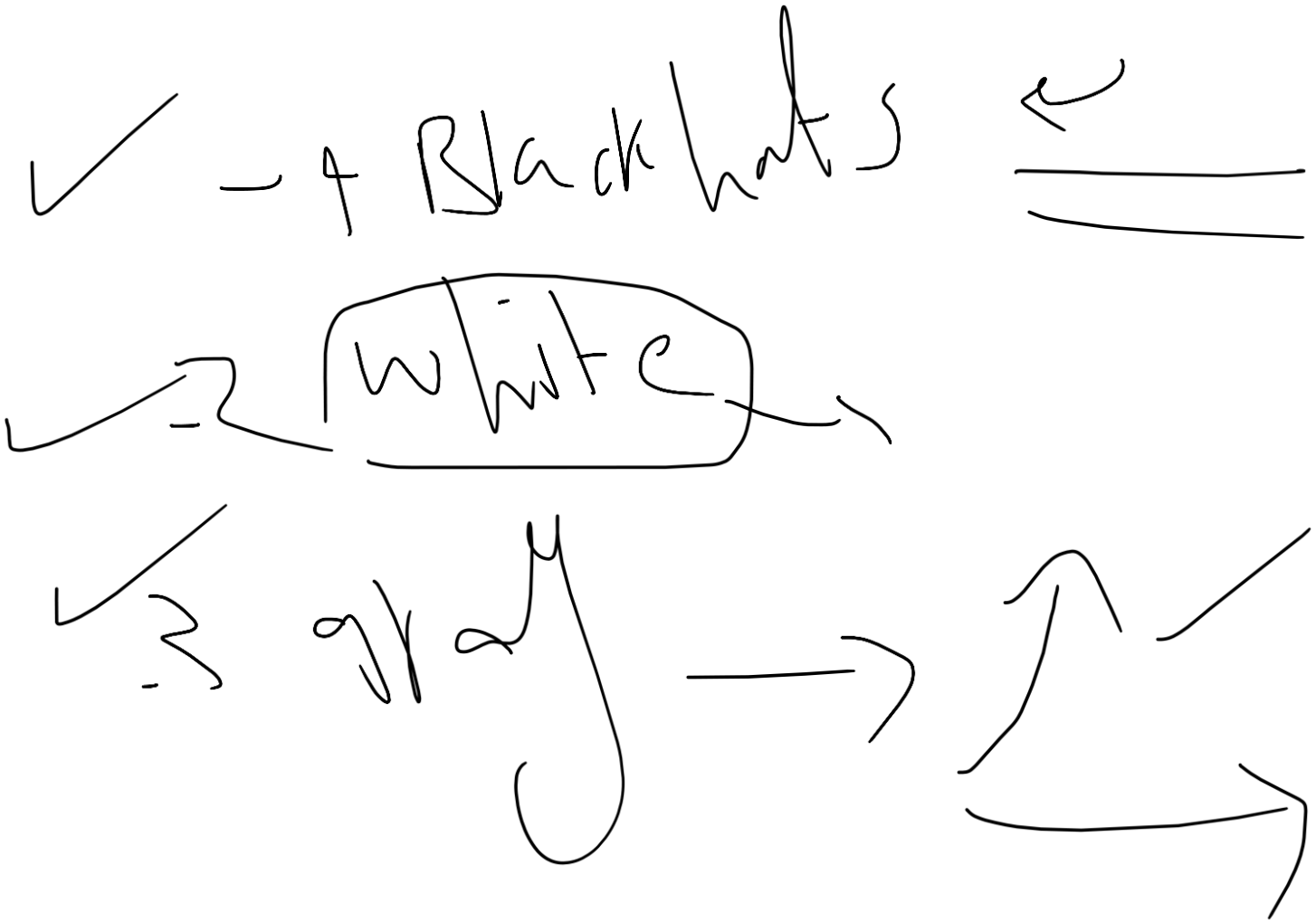


Session 2 (Attackers Methodology & Methods)

- **Attack:** Any attempt to **destroy, expose, alter, disable, steal or breaking into the information** or **breaking the systems** or **gain unauthorized access** to or **make unauthorized use** of an asset

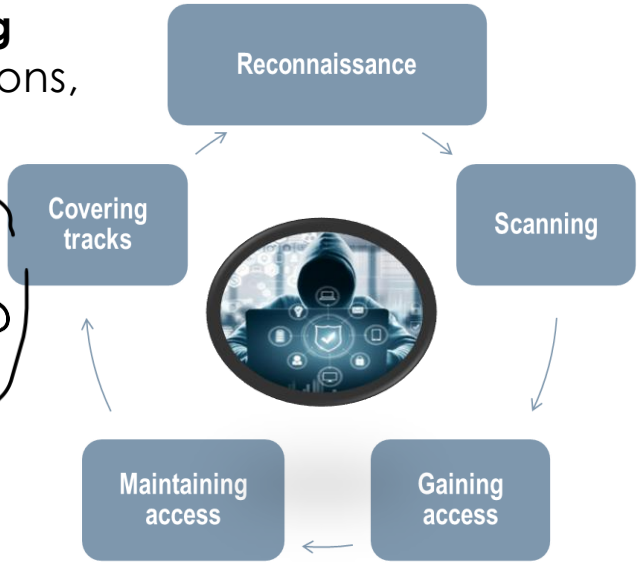
- **Passive Attack**
  - **Difficult to detect**, because the attacker isn't actively sending traffic (malicious or otherwise)
  - Example: An attacker capturing packets from the network and attempting to decrypt them

- **Active Attack**
  - **Easier to detect**, because the attacker is actively sending traffic that can be detected.
  - An attacker might launch an active attack in an attempt to access information or to **modify data on a system**.


Black hats
white
grey

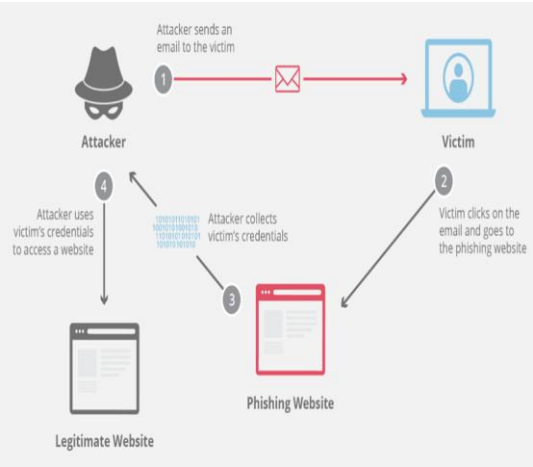
Session 2 (Attackers Methodology & Methods)

- **What does a Malicious Hacker Do?**
  - **Reconnaissance**
    - where an attacker seeks to gather **as much information as possible** about a target to launching an attack.
  - **Scanning**
    - the hacker **scans the network with specific information gathered during reconnaissance**. Scanning for open ports, operating systems, applications,
  - **Gaining Access**
    - the true attack phase. The hacker **exploits the system**.
  - **Maintaining Access**
    - the hacker tries to retain his '**ownership' of the system**.
    - Sometimes, hackers harden the system from other hackers.
  - **Covering Tracks**
    - activities undertaken by the hacker to extend his misuse of the system without being detected. Hackers can **remain undetected for long periods.**



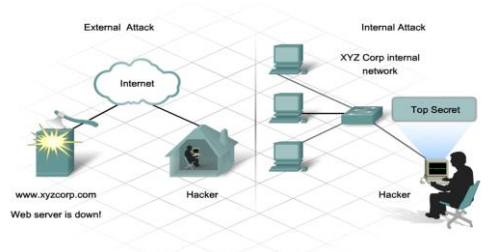
Session 2 (Attackers Methods)

- **Social engineering**
  - the ability of something or someone to influence the **behavior of a group of people**. Like tricking someone to **disclose information or taking action.**



- **PHISHING ATTACK:**
  - A **fake web page** which looks exactly like a popular website such (facebook, twitter, Gmail , paypal , bank page) to persuade you to **enter information** identity such as username , passwords and credit cards details
  - the hacker records the username and password and then tries that information on the real site.

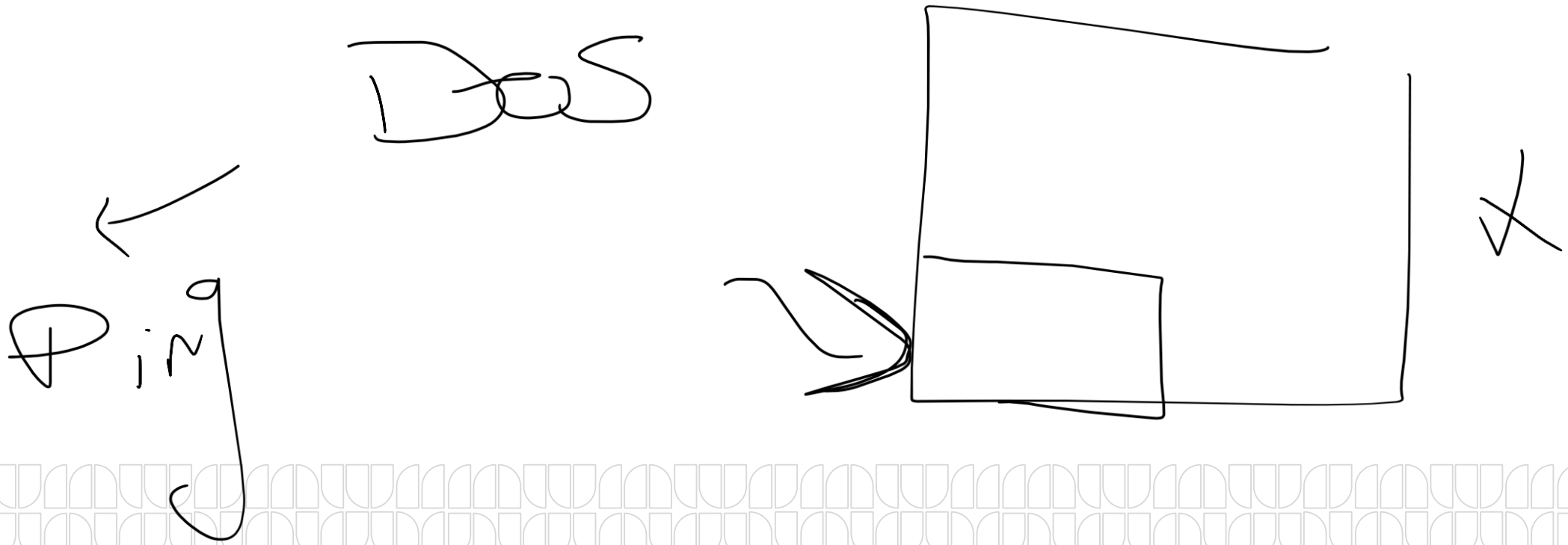
- **HIJACK ATTACK**
  - a hacker **takes over a session between you and another individual** and **disconnects the other individual** from the communication. You still believe that you are talking to the original party and may send private information to the hacker by accident.



- **Insider Attack**
  - involves **someone from the inside**, such as a dissatisfied employee, attacking the network.

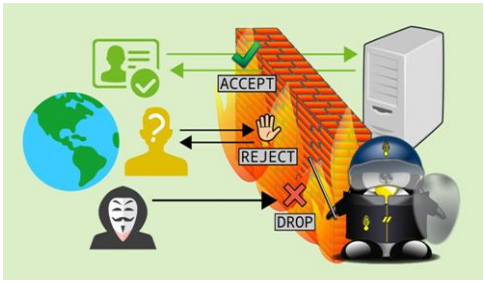
Buffer Overflow attack

DoS



Session 2 (Attackers Methods)

- **SPOOF ATTACK**
  - the hacker **modifies the source address** of the packets he or she is sending so that they appear to be coming from someone else. This may be an attempt to bypass your firewall rules.



- **PASSWORD ATTACK**
  - An attacker **tries to crack the passwords** stored in a network account database or a password-protected file.
    - **Dictionary attack**
    - **Brute-force attack**
    - **Hybrid attack.**

Session 2 (Malicious Software (Malware types)

• Backdoor or Trapdoor

- **Secret entry point into a program** ,Have been commonly used by developers
- Can't be removed or scanned and the only way is to uninstall sw or format the system

• Trojan Horse

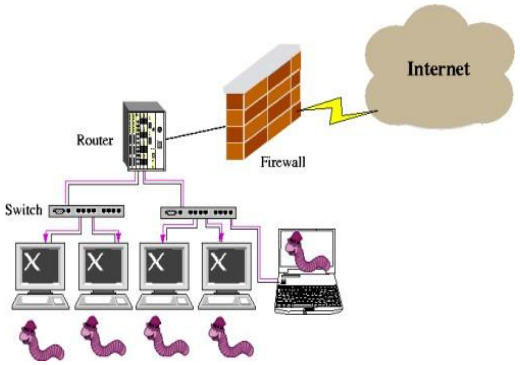
- program with **hidden side-effects which is usually superficially attractive** eg game, software upgrade etc .
  - allows attacker to **indirectly gain access** they do not have directly
  - used to **propagate a virus/worm** or install a backdoor
  - Open some ports or pass some malicious files

• Viruses

- A virus is **malicious software that is attached to another program** to execute a particular unwanted function on a user's workstation.
  - Both **propagates itself** & Carries code to make copies of itself

Session 2 (Malicious Software (Malware Types)

- **Worms**
  - **Replicating but not infecting program** Typically spreads over a network Using users distributed privileges or by exploiting system vulnerabilities Widely used by hackers to **create zombie pc's**, subsequently used for further attacks, especially **DOS**
  - Major issue is lack of security of permanently connected systems

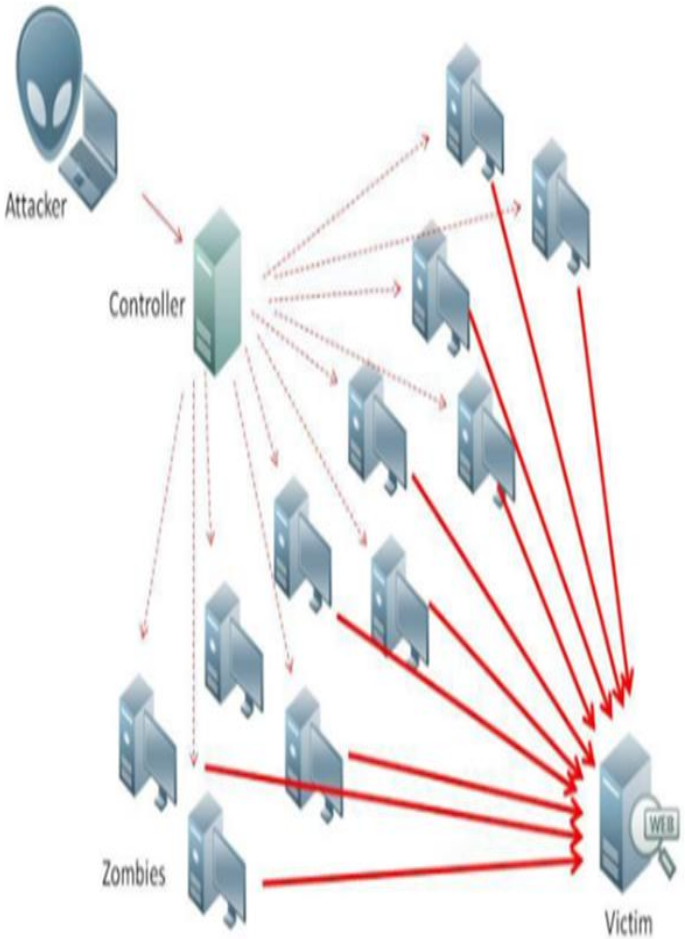


- **Zombie**
  - Program which secretly takes over another networked computer then **uses it to indirectly launch attacks**
  - Often used to launch distributed denial of service **(DDoS**) attacks

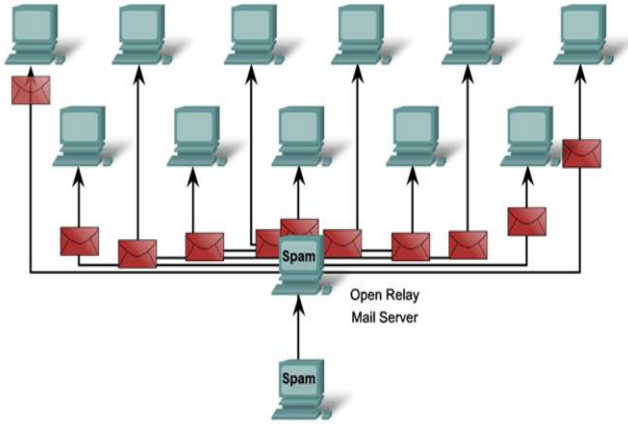
- **Ransomware**
  - Malware that locks a computer or device or **encrypts data** (Crypto ransomware) on an infected endpoint with an **encryption key ,only the attacker knows the key** the data unusable until the **victim pays** a ransom (usually cryptocurrency, such as **Bitcoin**).

Session 2 (Malicious Software (Malware Types)

- **DoS Attack**
  - Denial of service is about **without permission knocking off services**, for example through crashing the whole system.
  - This kind of attacks are easy to launch and it is **hard to protect a system against them.**
  - Consume host resources
    - **Memory**
    - **Processor cycles**
  - Consume network resources
    - **Bandwidth**
      - Dos Attack (Ping of Death)
- **DDoS Attack**
- A **distributed denial of service attack** uses **multiple machines** to prevent the legitimate use of a service.
  - TCP SYN flood



Session 2 (Malicious Software (Malware types)

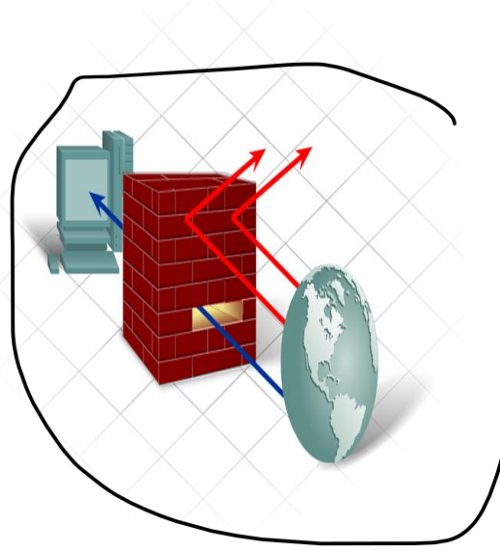


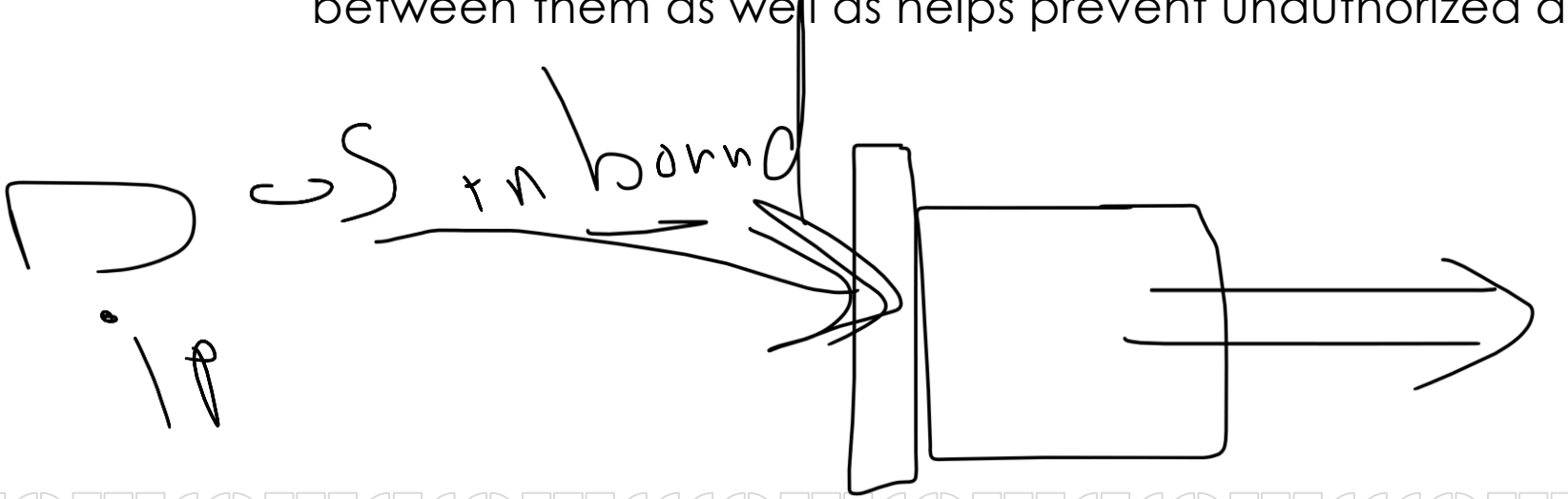
- **Spam**
  - Spam is a **serious network threat that can overload ISPs**, email servers and individual end-user systems. A person or organization responsible for sending spam is called a spammer. Spammers often make use of unsecured email servers to forward email. Spammers can use hacking techniques, such as viruses, worms and Trojan horses to take control of home computers.
- **Spyware**
  - Spyware is **any program** that **gathers personal information** from your computer **without your permission** or knowledge. This information is sent to advertisers or others on the Internet and can include **passwords** and **account numbers**.
- **Tracking Cookies**
  - Cookies are a **form of spyware** but are **not always bad**. They are used to record information about an Internet user when they visit websites

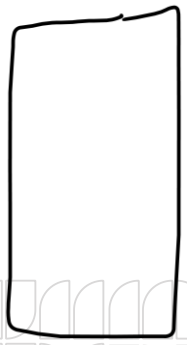
Session 2 (Attacks Mitigation)

Firewall

- A Firewall is one of the most effective security tools available for **protecting internal network users from external threats**.
- A firewall resides between two or more networks and controls the traffic between them as well as helps prevent unauthorized access

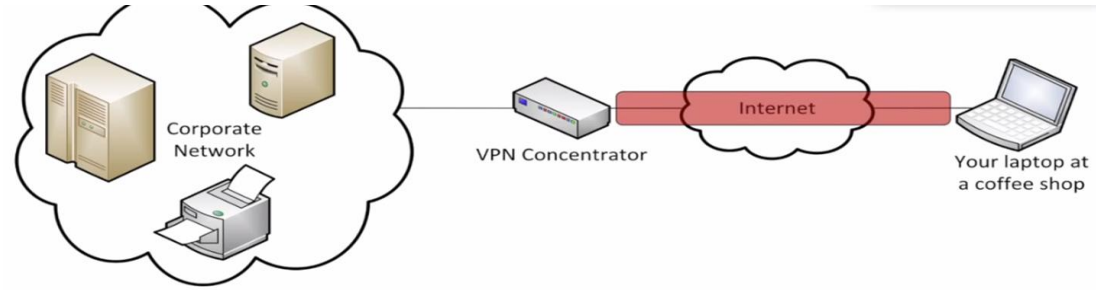






Session 2 (Attack Mitigation)

- **Proxy Server**
  - A computer system (or an application program) that **intercepts internal user requests and then processes that request on behalf of the user**
  - **Goal** is to **hide the IP address** of client systems **inside the secure network**
- **VPN**
  - It **Tunnel the traffic between the Two Sides of Network**
  - **Kinds:**
    - **Remote Access VPN**
    - **Site to Site VPN**

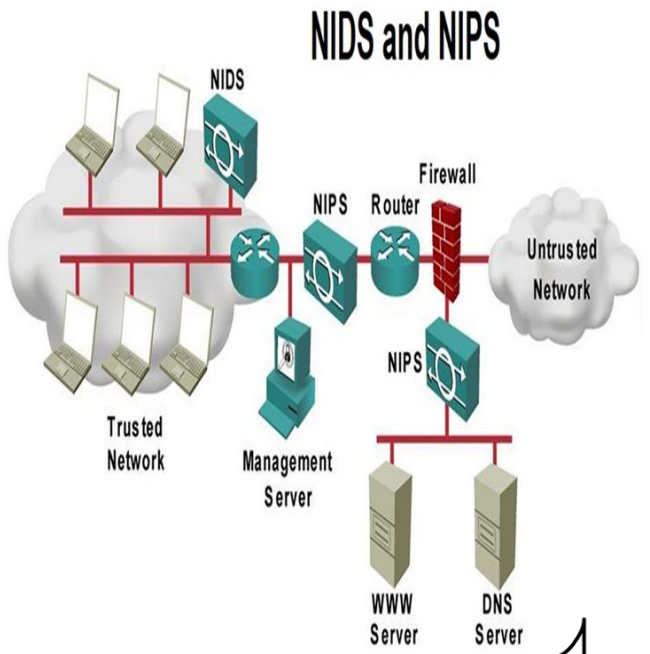



Proxy
6.3.4.5
5.5.6


VPN
virtual Private net
VPN
VPN
10.5.7.2

Session 2 (Attack Mitigation

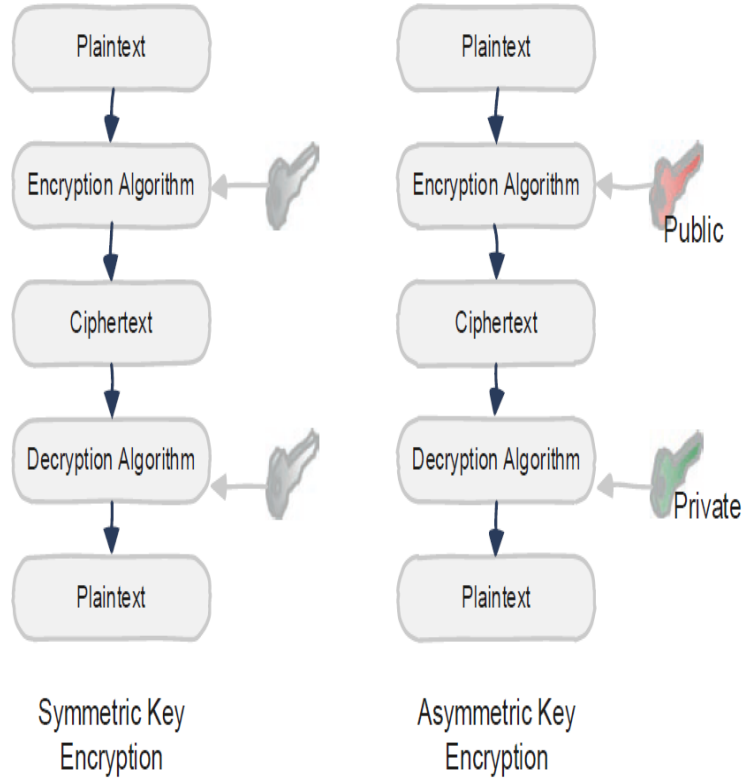
- **Intrusion Detection and Prevention Systems**
  - **NIDS:**
    - Watch the **Network Traffic and if there is Intrusion** it **Detects** that there **is Bad traffic Flow**.
    - it **send alarms** and logs
  - **NIPS:**
    - **Stops** the traffic if it detects that there is intrusion
  - **Signature-based:** look for the **perfect match**
  - **Anomaly-based:** Built a **based line of what is normal**
  - **Behavior-based:** **observe and report**
- **Next generation Firewall (NGFW)**
  - is,a "deep-packet inspection firewall that moves beyond port/protocol inspection and blocking to **add application-level inspection, intrusion prevention, and bringing intelligence from outside the firewall."**



Session 2 (Encryption)

• Encryption

- converts the original representation of the information, known as **plaintext**, into an alternative form known as **ciphertext.**
- Unencrypted data, called plaintext, is sent through an encryption algorithm to generate a ciphertext. **A key is used for encryption**.
- In **symmetric encryption**, the **same key both encrypts and decrypts data.** (Not secure)
- In **Asymmetric encryption** Uses **two keys**, **one for encryption (public key)**and **the other for decryption (private key).**



Session2 Practices

- How to use your local firewall to block a port and stop DOS attack from a zombie device

Session 3 (Distributed Systems)

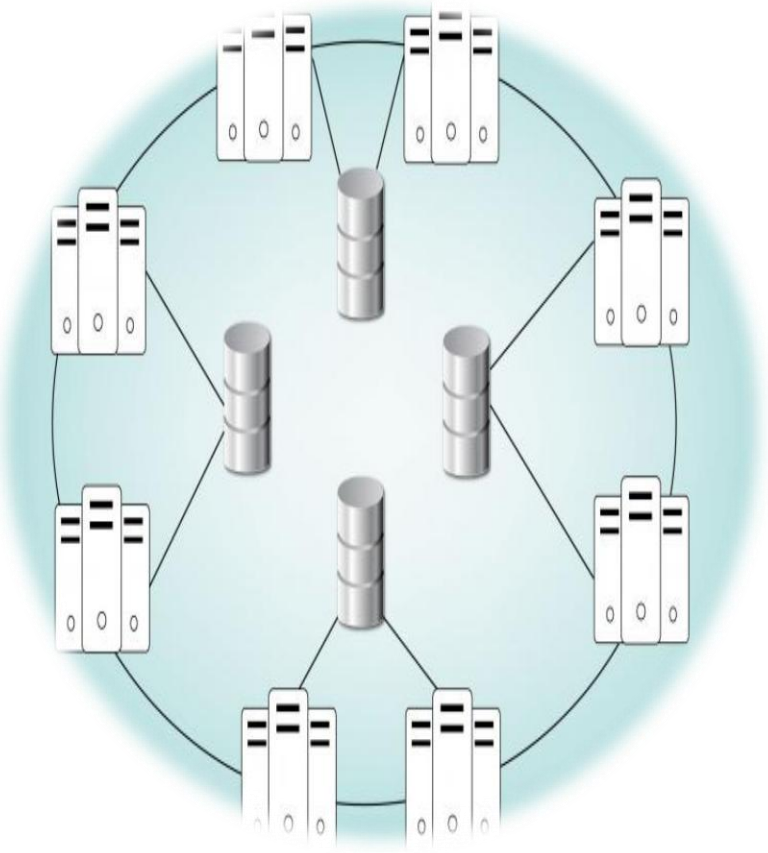
- **Session Outlines**
  - **Distributed Systems overview**
    - Definition and Basic Terminologies
  - **Why build a distributed system?**
  - **Types of Distributed Systems**
    - The 4 Distributed Systems architecture
  - **Distributed System Examples**
  - **Cloud computing**
    - Cloud computing service models
    - Cloud computing deployment models

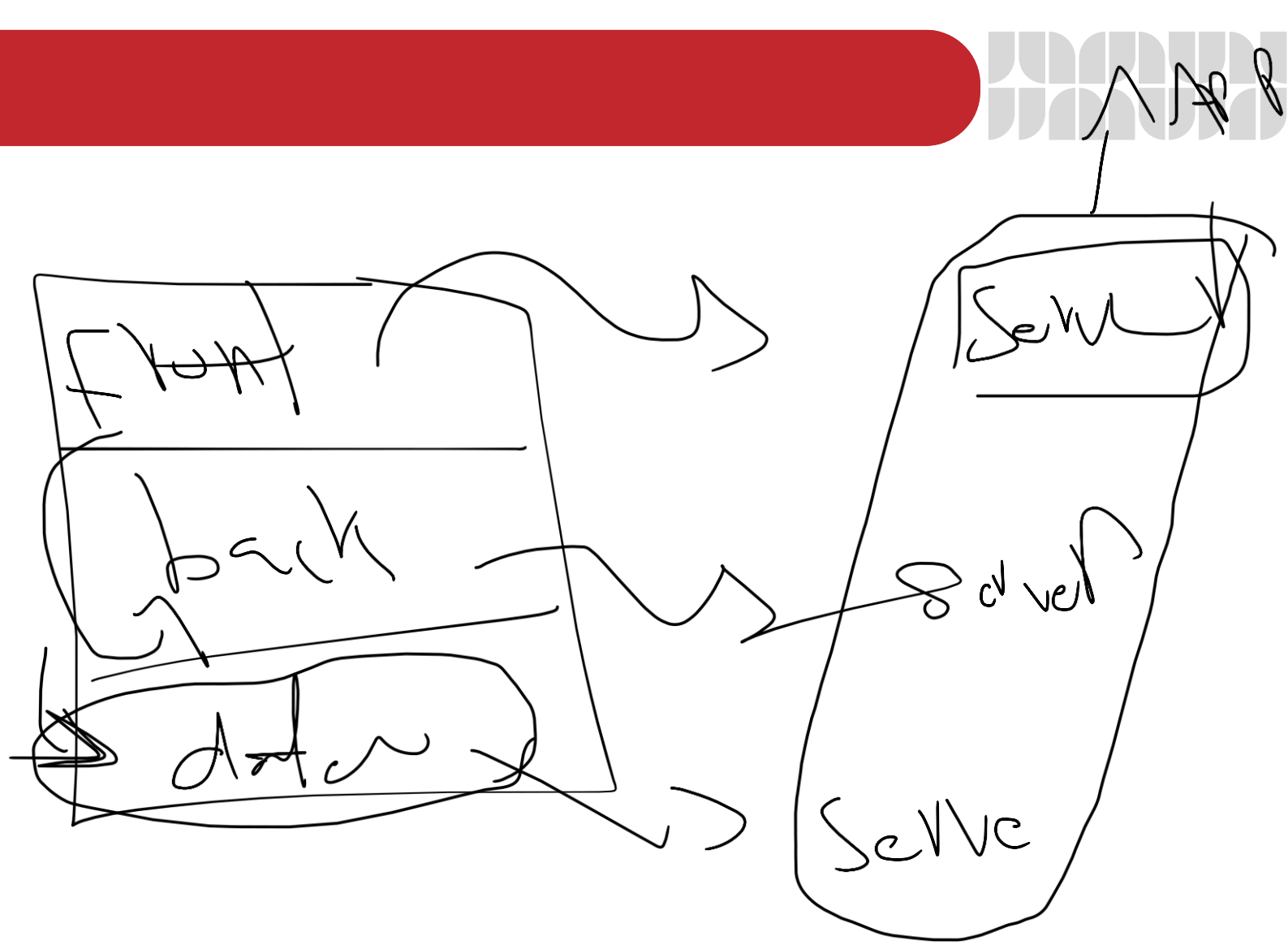
Session 3 (Distributed System)

Distributed Systems

- Is a **group of computers** working together as to **appear as a single computer** to the end-user.

- Is a collection of **independent components** located on **different machines** that share messages with each other in order to **achieve common goals**.

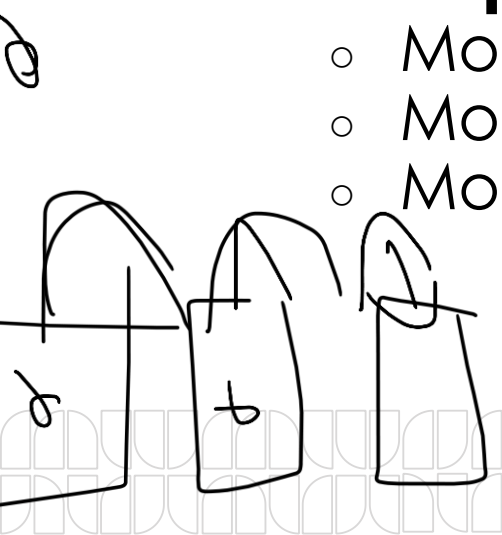


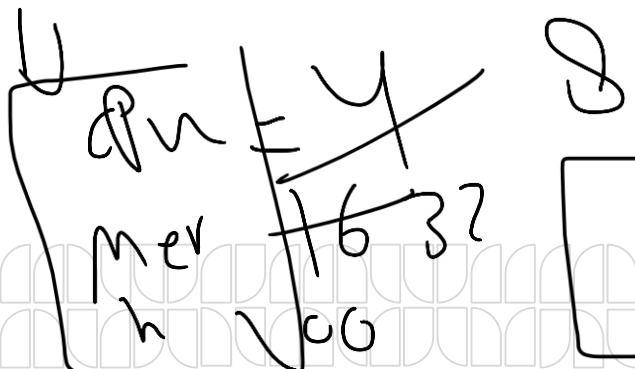


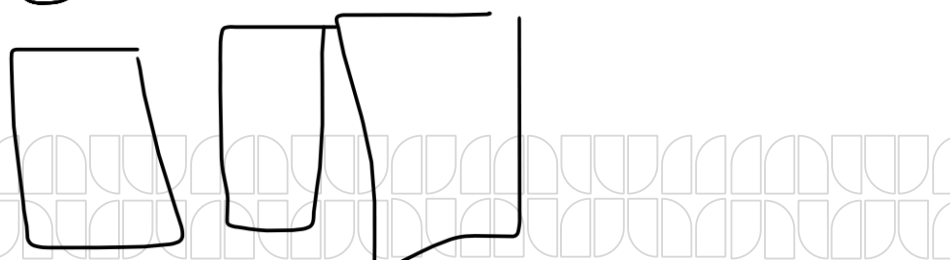
Session 3 (Distributed System)

- Centralized system VS Distributed system
- **Centralized system:** State stored on a **single computer**
  - Simpler
  - Easier to understand
  - Can be faster for a single user

- **Distributed system:** State divided over **multiple computers**
  - More robust(can tolerate failures)
  - More scalable (often supports many users)
  - More complex

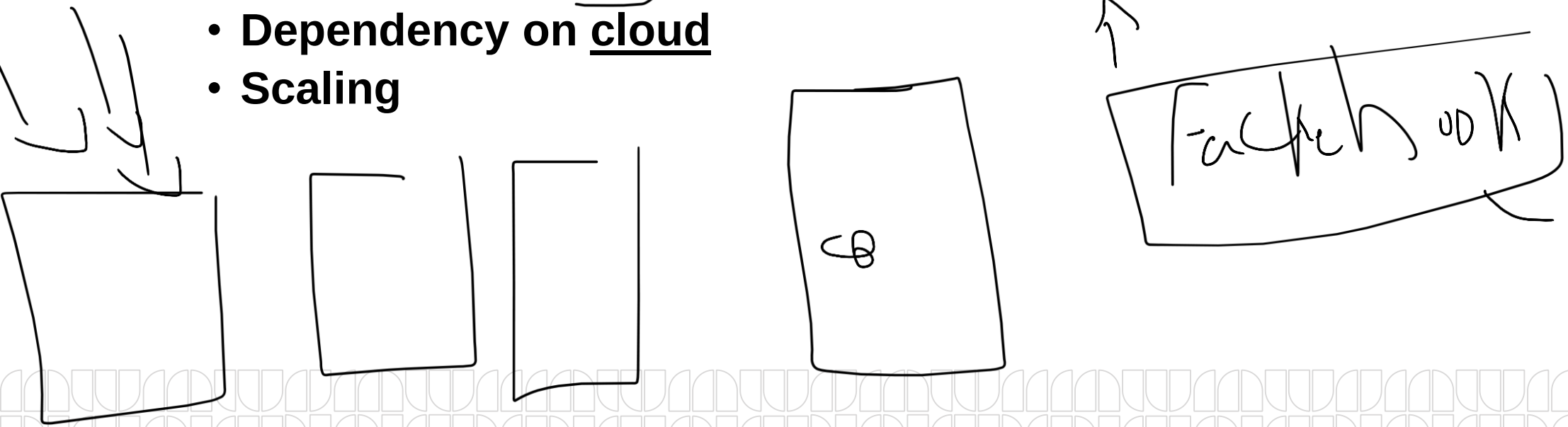






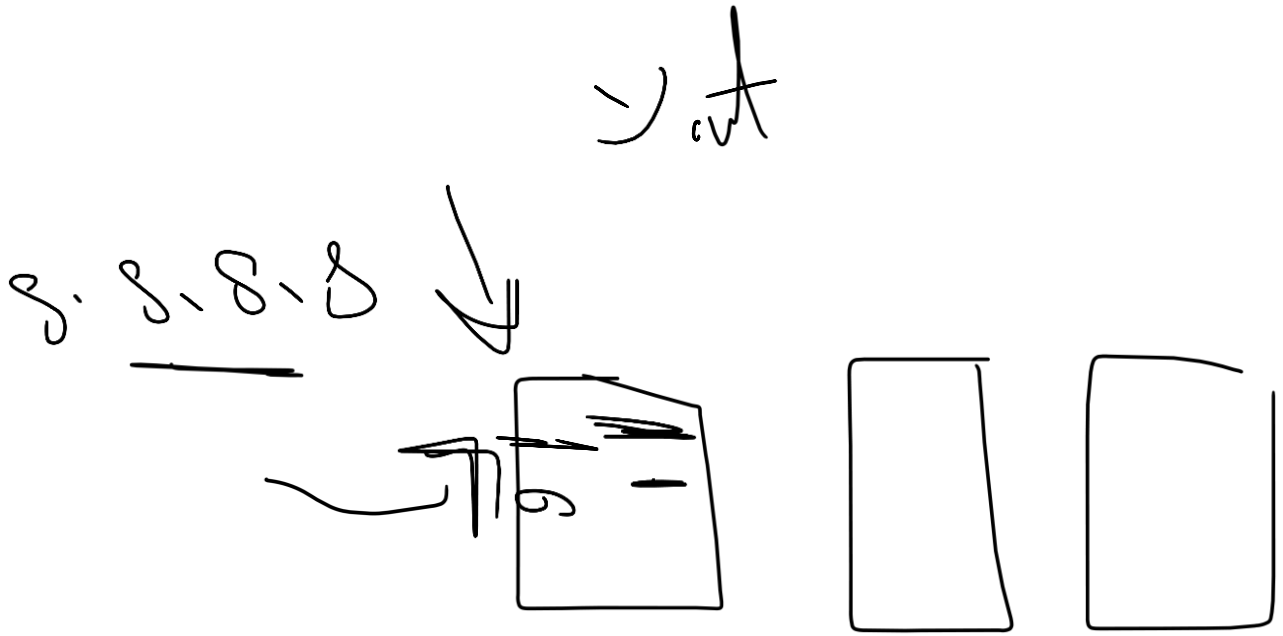
Session 3 (Distributed System)

- **Why build a distributed system?**
  - **One interface** to the end-user.
  - **Performance**
    - maximize resources and information while preventing failures
  - **Reliability**
    - if one system fails, it won't affect the availability of the service
  - **Dependency on cloud**
  - **Scaling**



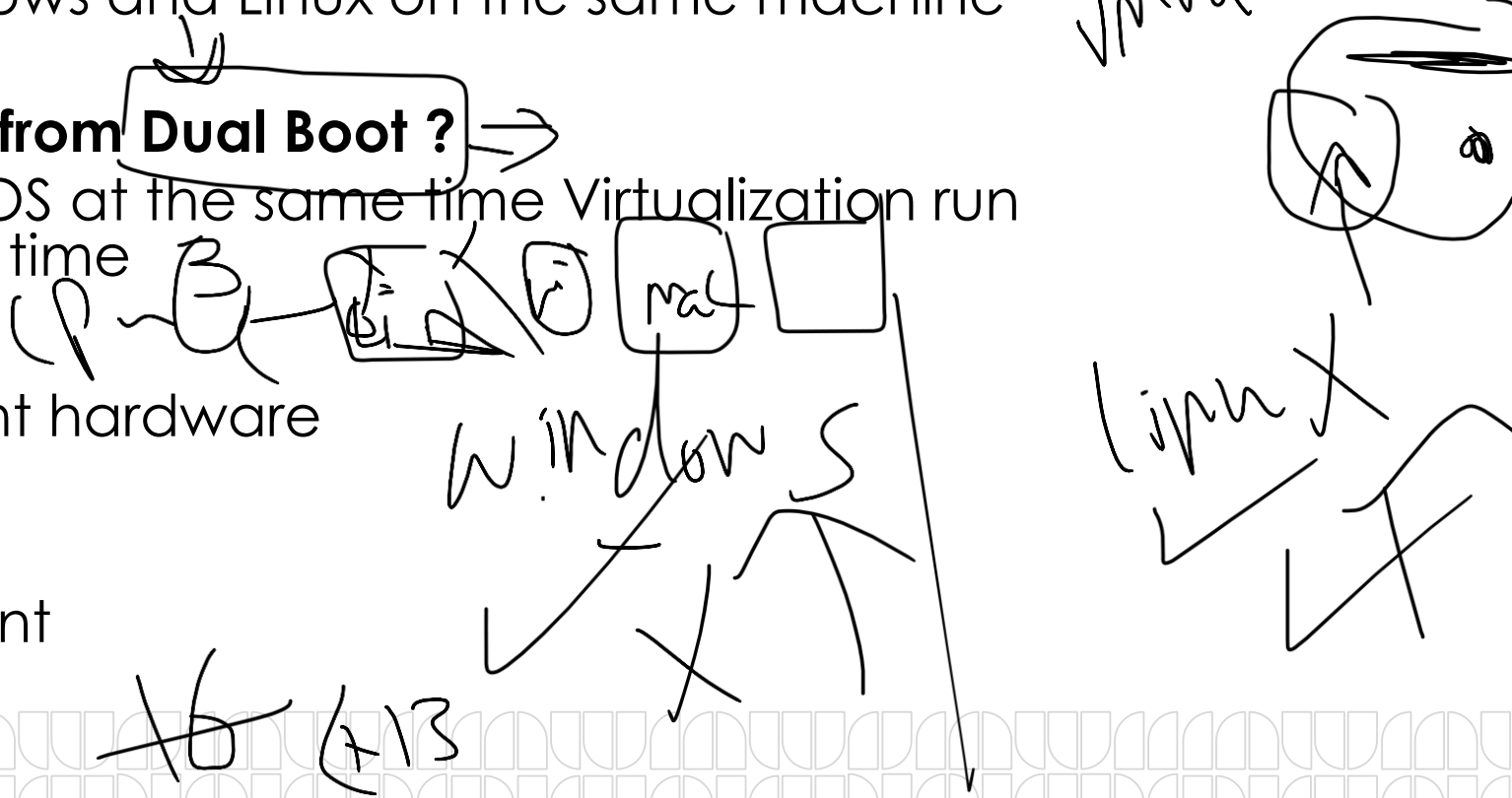
Session 3 (Distributed System Examples)

- **Domain Name System (DNS)**
  - Distributed lookup table of hostname to IP address
- **Facebook & Google use distributed systems extensively**
  - Massive scale
  - Fast enough
  - Very reliable
- **Cloud Computing**
  - Virtualization



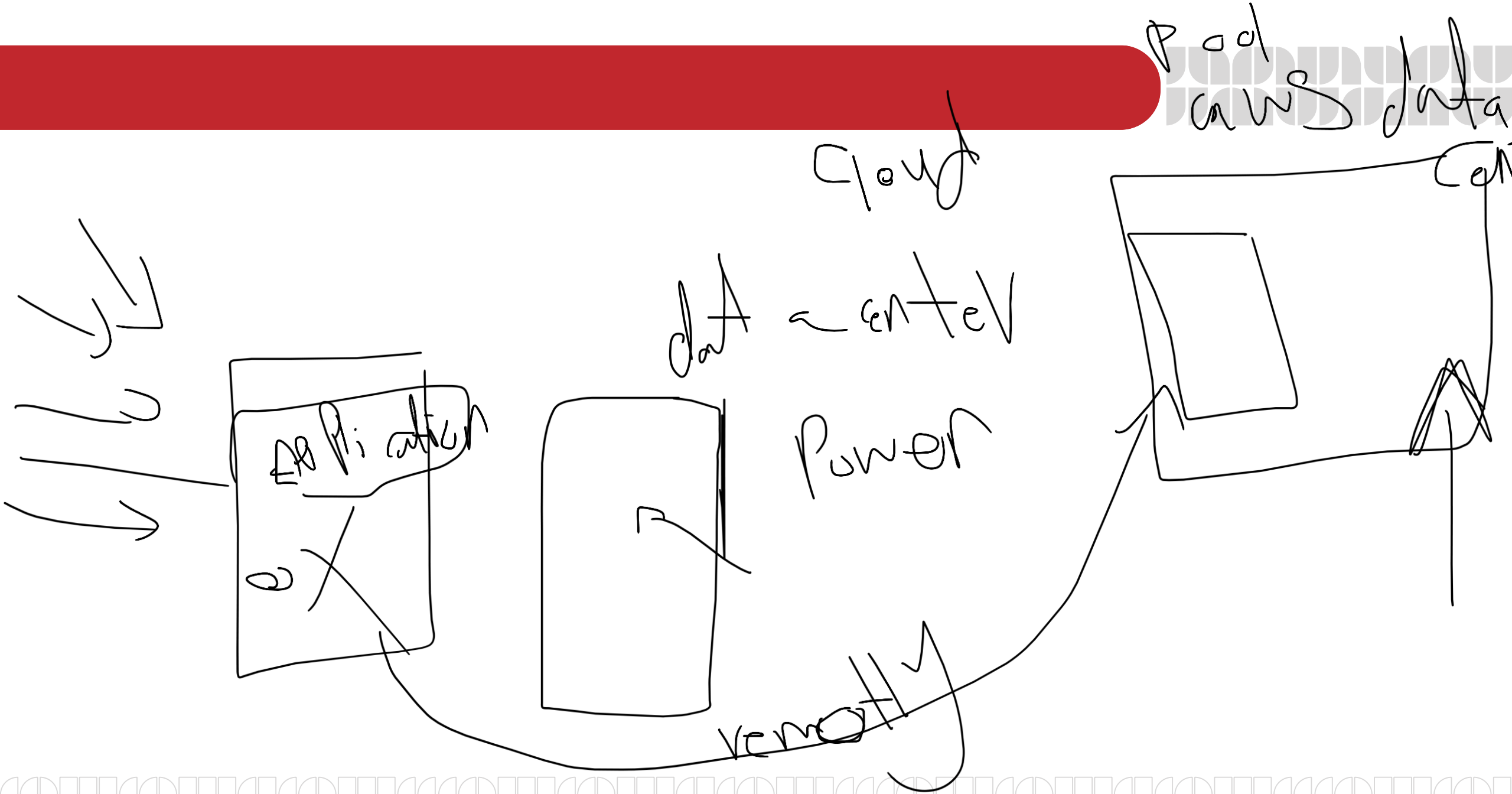
Session 3 (Virtualization)

- **Virtualization**
  - Is a technology that **run multiple same or different operating systems** which is completely isolated from each other **at the same time on the same machine**
  - Example: run both windows and Linux on the same machine
  - **Virtualization is different from Dual Boot ?**
  - Dual Boot run only one OS at the same time Virtualization run multiple OS at the same time
- **Virtualization Benefits**
  - Consolidation of different hardware
  - Redundancy
  - Migration
  - Centralized management



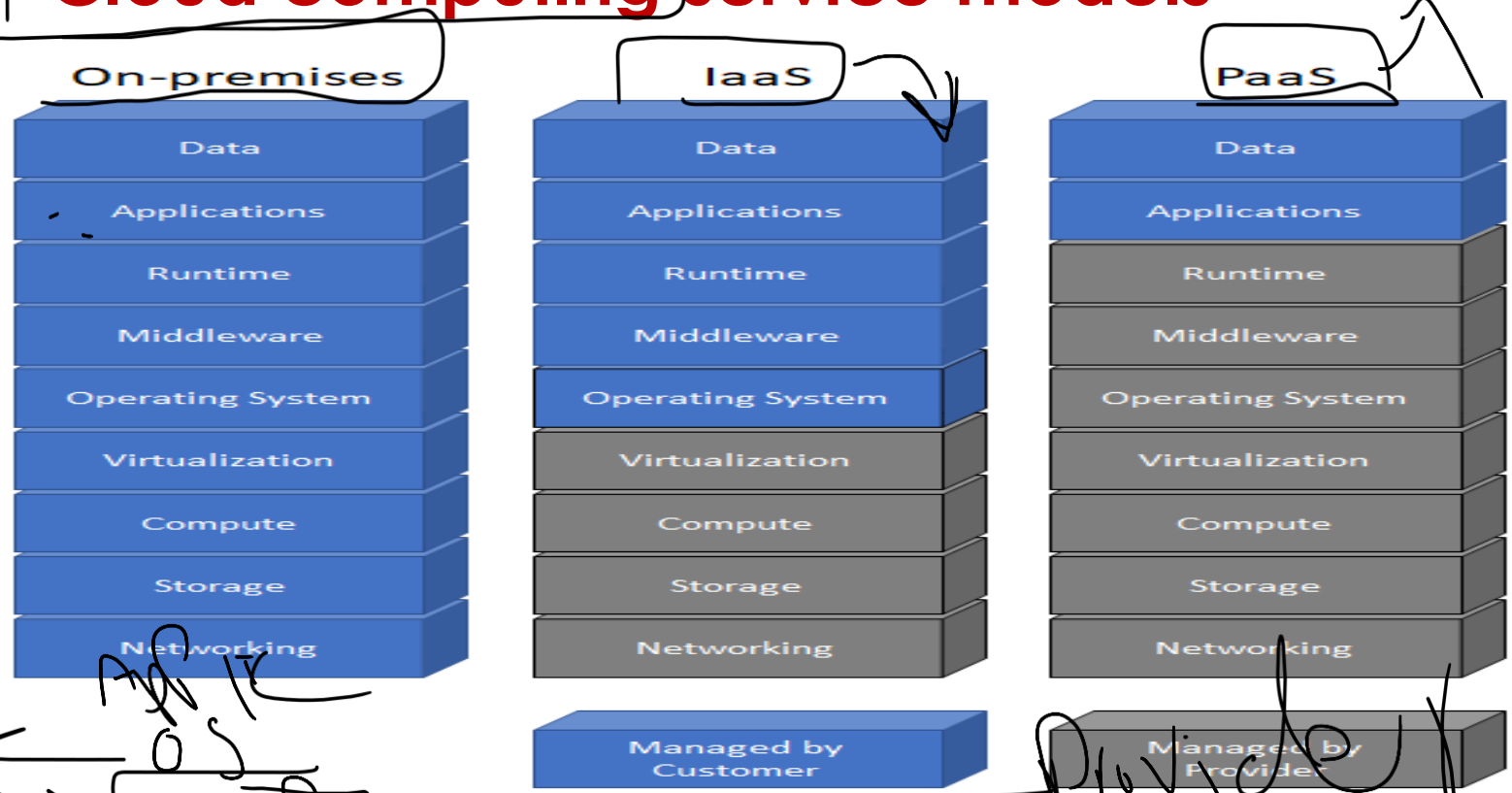
Session 3 (Cloud computing)

- **Cloud computing**
  - A **pool of resources** that can be **rapidly provisioned in an automated, on-demand manner.**
- **Value of cloud computing is :**
  - Economies of scale
  - Elastic enough to scale with the needs of your organization.
  - Cost and operational benefits
  - Easily accessed by users no matter where they reside


Cloud
data center
Power
remotely

Session 3 (Cloud computing service models)

- Cloud computing service models

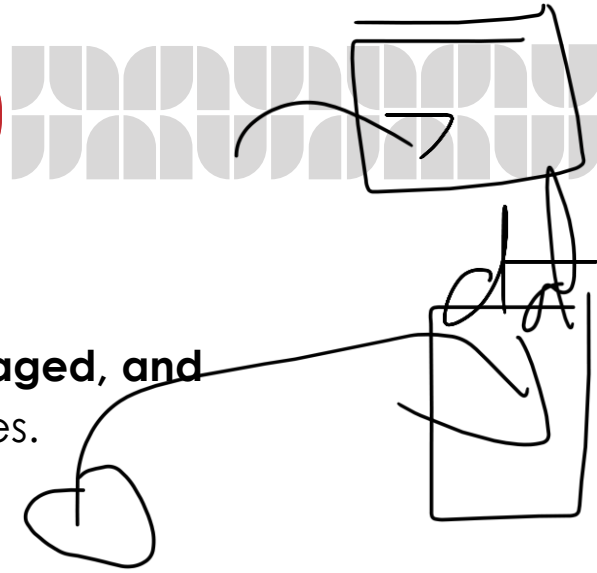


Session 3 (Cloud computing service models)

- **Software as a service (SaaS).**
  - Customers are provided access to **an application** running on a cloud infrastructure.
  - but the customer has no knowledge of, and does not manage or control, the underlying cloud infrastructure.
- **Platform as a service (PaaS).**
  - Customers can **deploy supported applications** onto the provider's cloud infrastructure,
  - but the customer has no knowledge of, and does not manage or control, the underlying cloud infrastructure.
  - The company owns the deployed applications and data, and it is therefore responsible for the security of those applications and data.
- **Infrastructure as a service (IaaS).**
  - Customers can provision **processing, storage, networks, and other computing resources**, and **deploy and run operating systems and applications.**
  - the customer has no knowledge of, and does not manage or control, the underlying cloud infrastructure. The customer has control over operating systems, storage, and deployed applications, along with some networking components (for example, host firewalls).
  - The company owns the deployed applications and data, and it is therefore responsible for the security of those applications and data.

Session 3 (Cloud computing deployment model)

- **Public.**
  - A cloud infrastructure that is open to use by the general public. **It's owned, managed, and operated by a third party** (or parties), and it exists on the cloud provider's premises.
- **Private.**
  - A cloud infrastructure that is used exclusively by a single organization. **It may be owned, managed, and operated by the organization or a third party** (or a combination of both), and it may **exist on premises or off premises.**
- **Hybrid.**
  - **A cloud infrastructure that comprises two or more of the aforementioned deployment models**, bound by standardized or proprietary technology that enables data and application portability (for example, fail over to a secondary data center for disaster recovery or content delivery networks across multiple clouds).
- **Community.**
  - A cloud infrastructure that is used exclusively by a **specific group of organizations**



Session 3 Practices

- Use the Vmware Workstation tool to host the two different OS on your machine

Thank You