Parul® University

Computer Networks

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Computer Science & Engineering

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DIGITAL LEARNING CONTENT

CHAPTER-9

Application Layer

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DIGITAL LEARNING CONTENT

Unit-5 Application Layer

❖ **Topics to be covered:**

- **DNS**
- **DDNS**
- **Telnet**
- **Electronic mail**
- **FTP**
- **World Wide Web**
- **HTTP**
- **SNMP**
- **Bluetooth**
- **Firewall**
- **Cryptography**

Application Layer Functions

- This layer is helpful to interact with user.
- This provides services to user to use network.
- It provides user services like user login, naming to network devices network, formatting messages, e-mail, transfer of files etc.
- It is used for error handling and recovery of the transferred of the message.
- It provides services by using different Protocol
- FTP
- Telnet
- SMTP

Application Layer Functions

- DNS
- HTTP

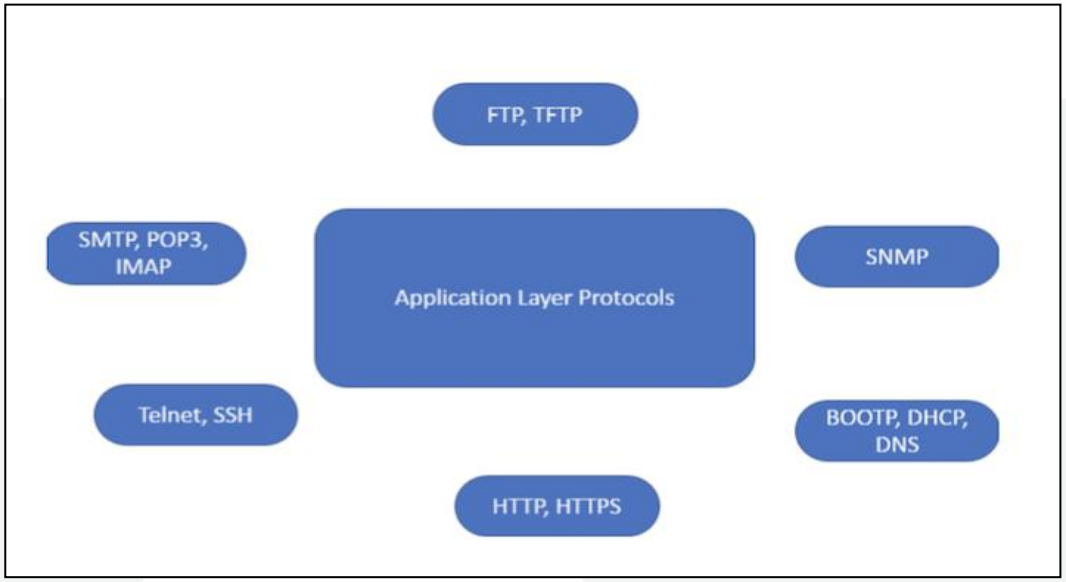

Figure: 5.1 Application Layer Protocol

(https://study.com/academy/lesson/application-layer-protocols-types-uses.html)

DNS (Domain Name Space)

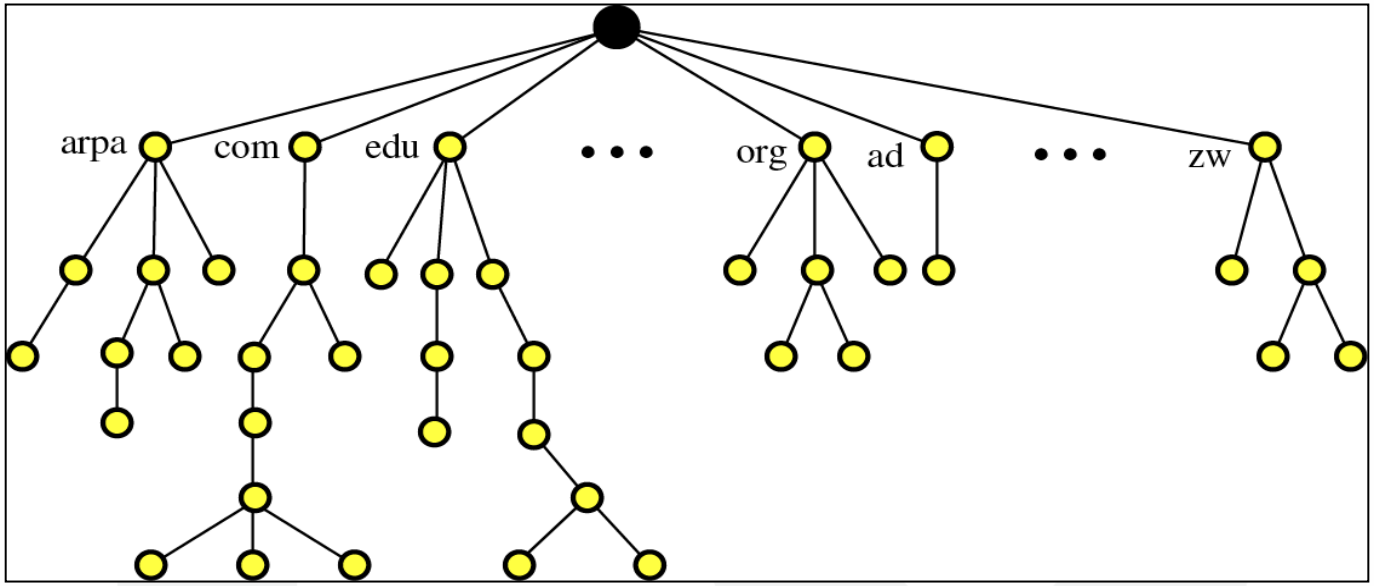

Figure: 5.2 Domain Name Space

Working of Existing DNS

DNS translates domain names to IP addresses.

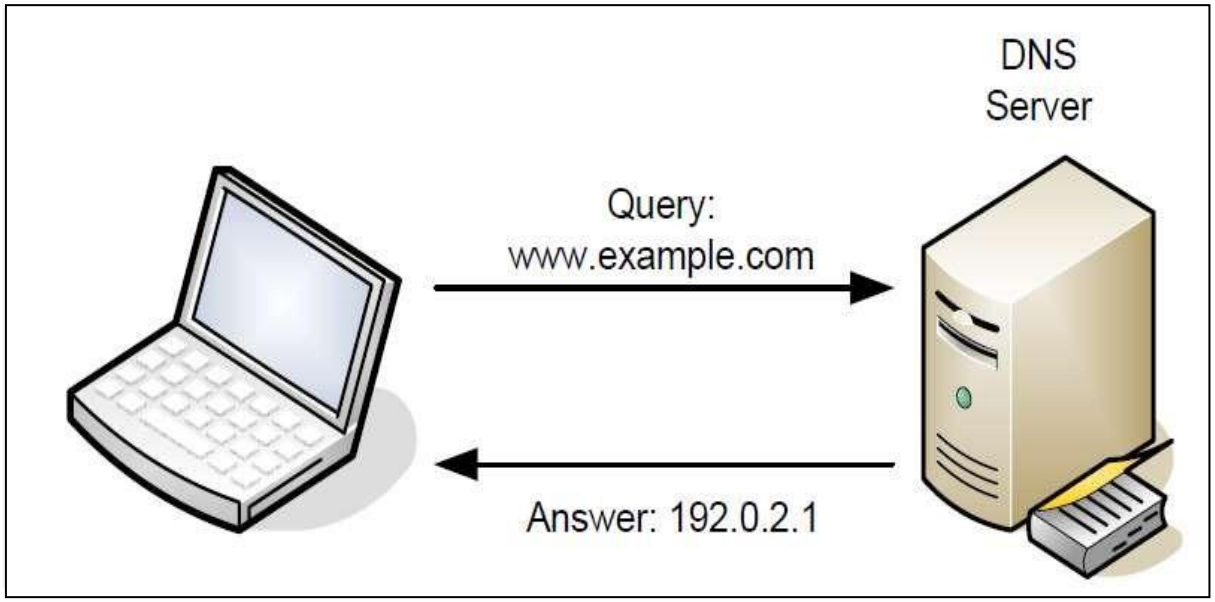

Figure: 5.3 DNS working

(https://www.dnsexit.com/Direct.sv?cmd=how-dynamic-dns-works)

DOMAIN NAMES

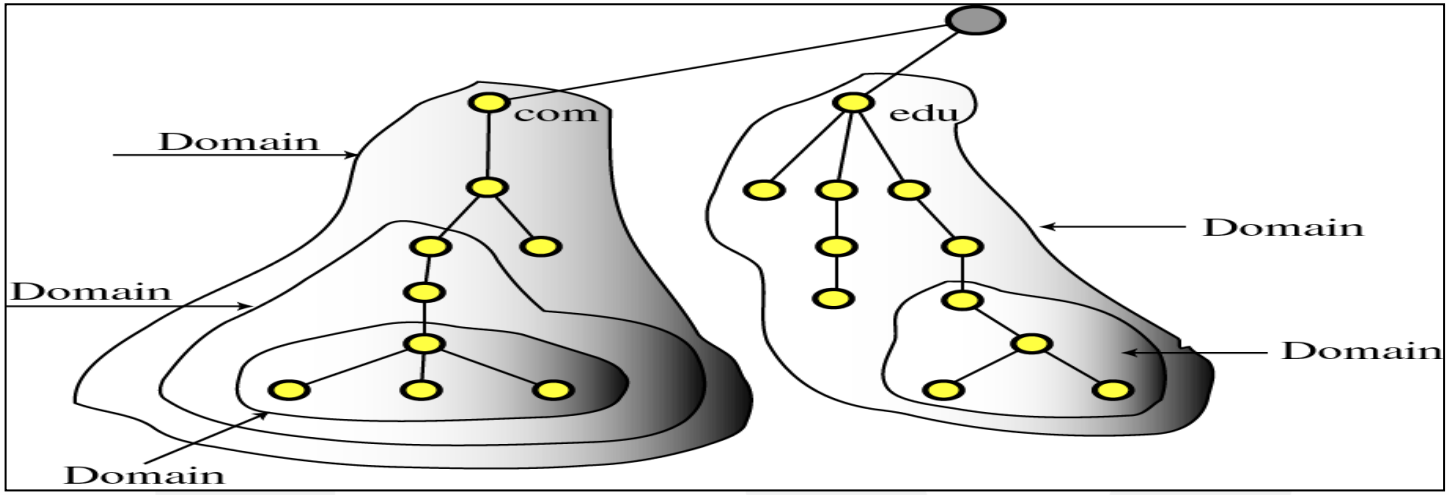

Figure: 5.4 Domain names

(https://silo.tips/download/chapter-25-domain-name-system-copyright-the-mcgraw-hill-companies-inc-permission)

DISTRIBUTION OF NAME SPACE

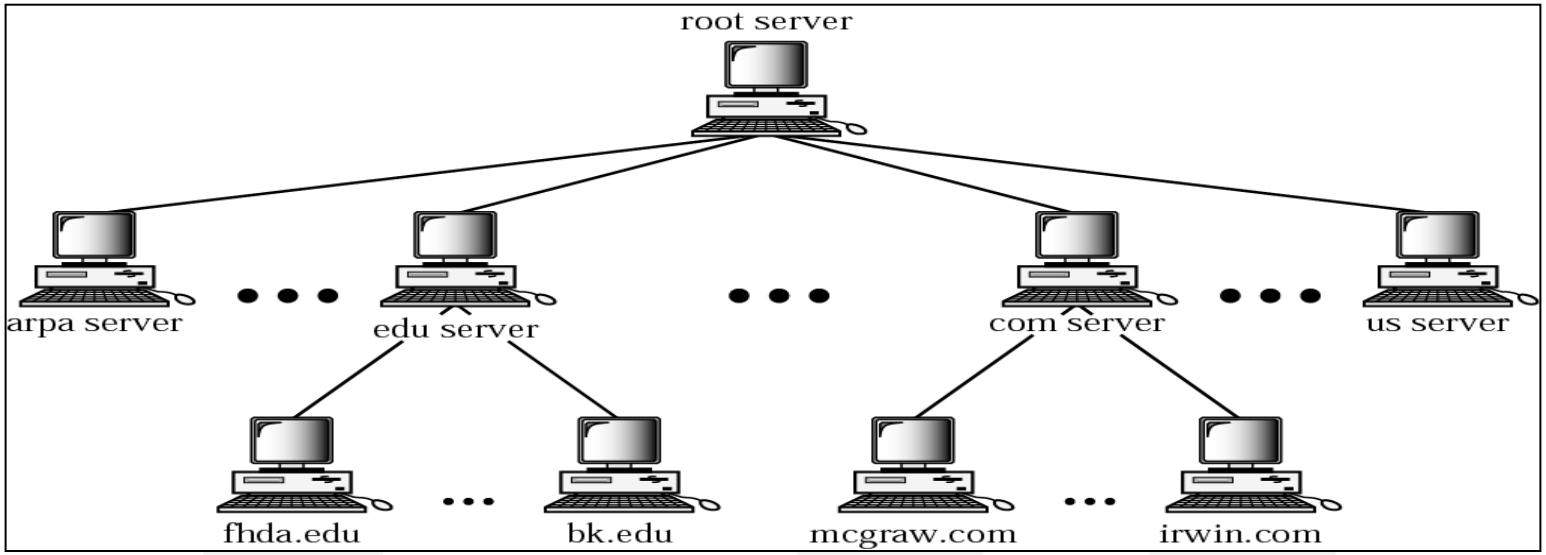

Figure: 5.5 Distribution of name space

ZONES AND DOMAINS

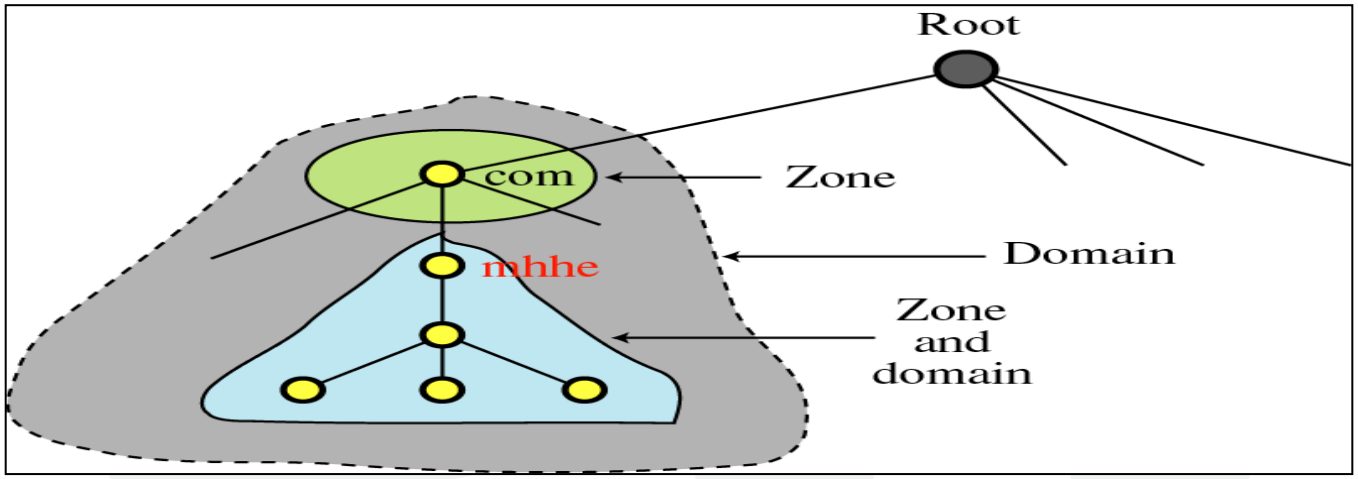

Figure: 5.6 Zones and Domains

A primary server loads all information from the disk file; the secondary server loads all information from the primary server. When the primary downloads information from the secondary, it is called zone transfer.

DNS IN THE INTERNET

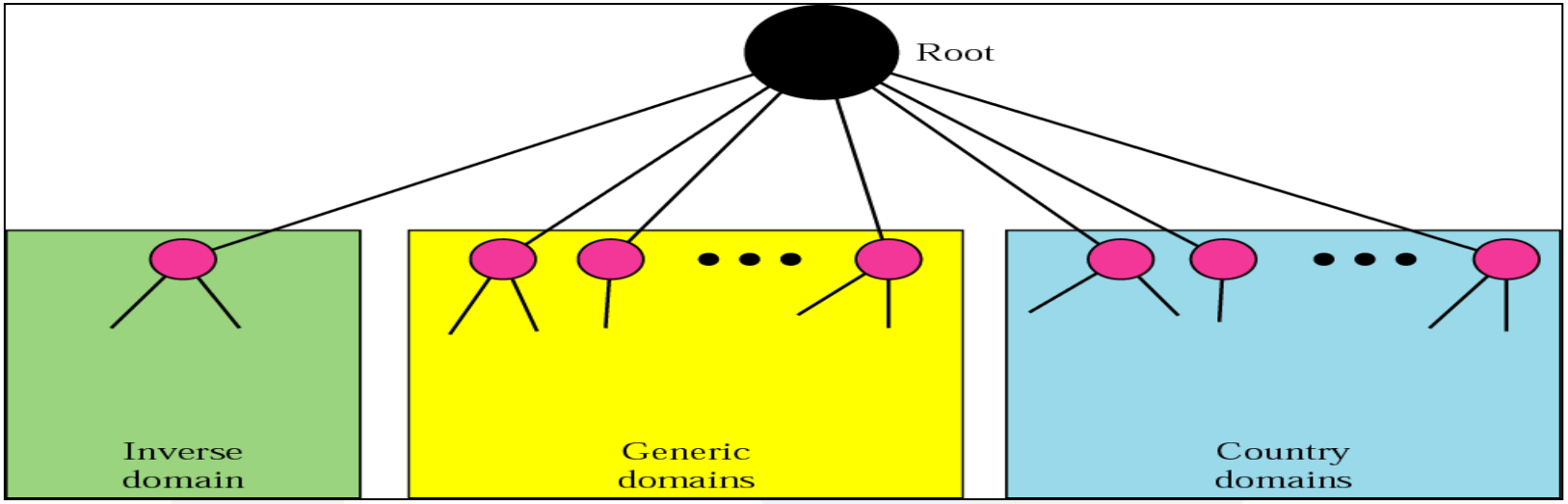

Figure: 5.7 Different Domain types

(https://silo.tips/download/chapter-25-domain-name-system-copyright-the-mcgraw-hill-companies-inc-permission)

GENERIC DOMAINS

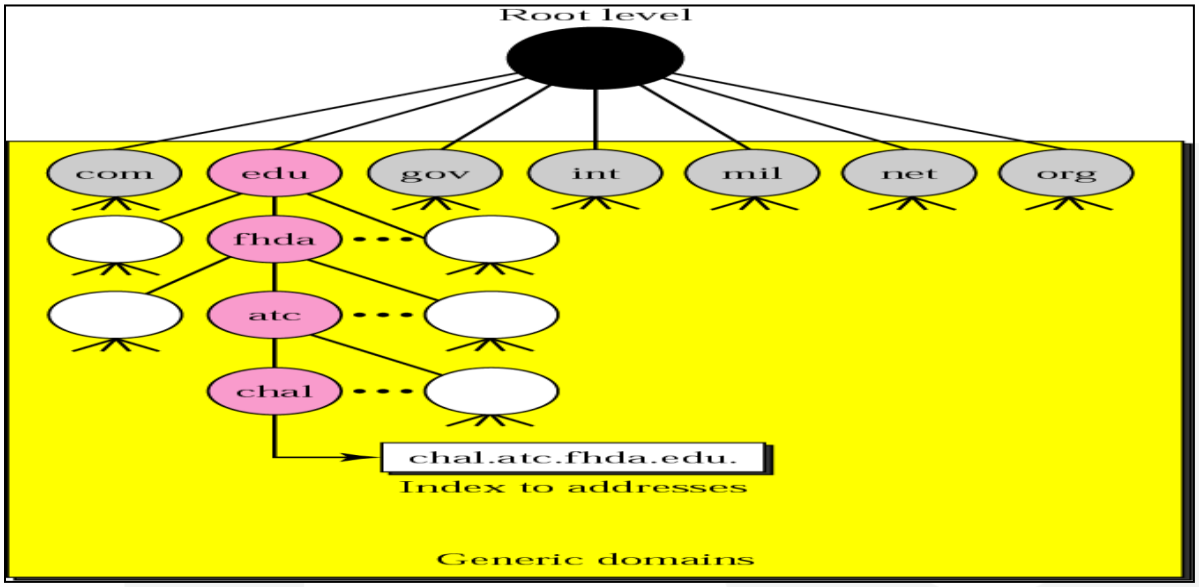

Figure: 5.8 Generic domain

(https://silo.tips/download/chapter-25-domain-name-system-copyright-the-mcgraw-hill-companies-inc-permission)

COUNTRY DOMAINS

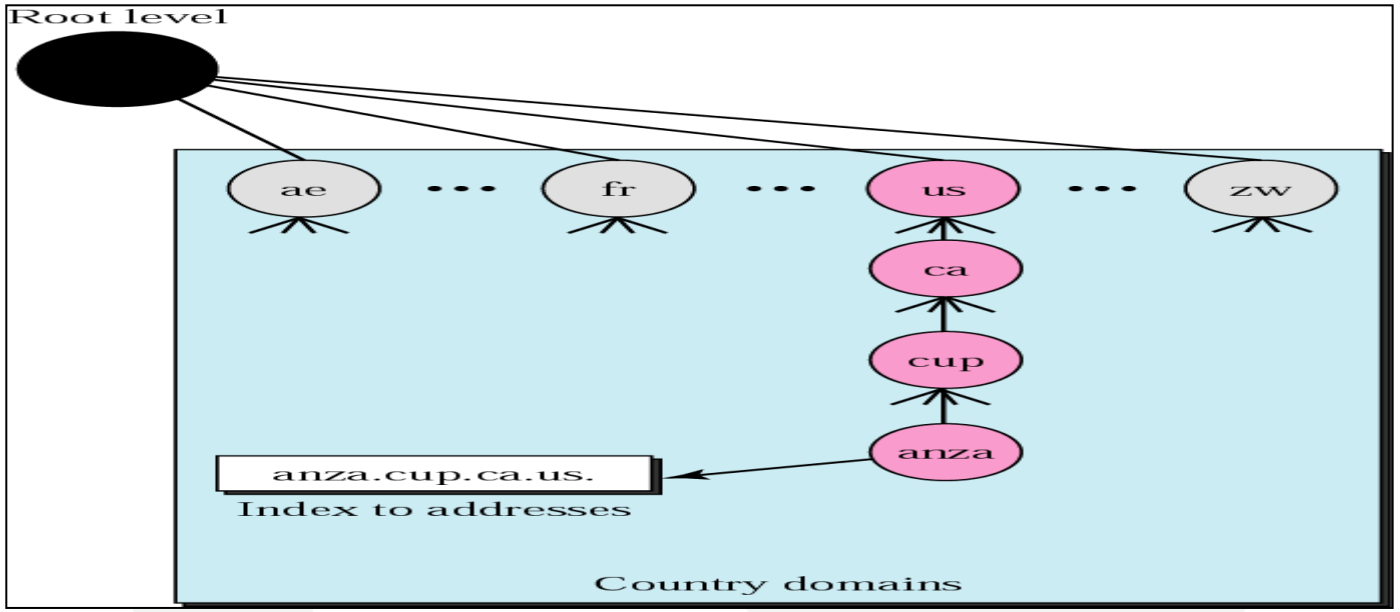

Figure: 5.9 Generic domain

(https://silo.tips/download/chapter-25-domain-name-system-copyright-the-mcgraw-hill-companies-inc-permission)

INVERSE DOMAIN

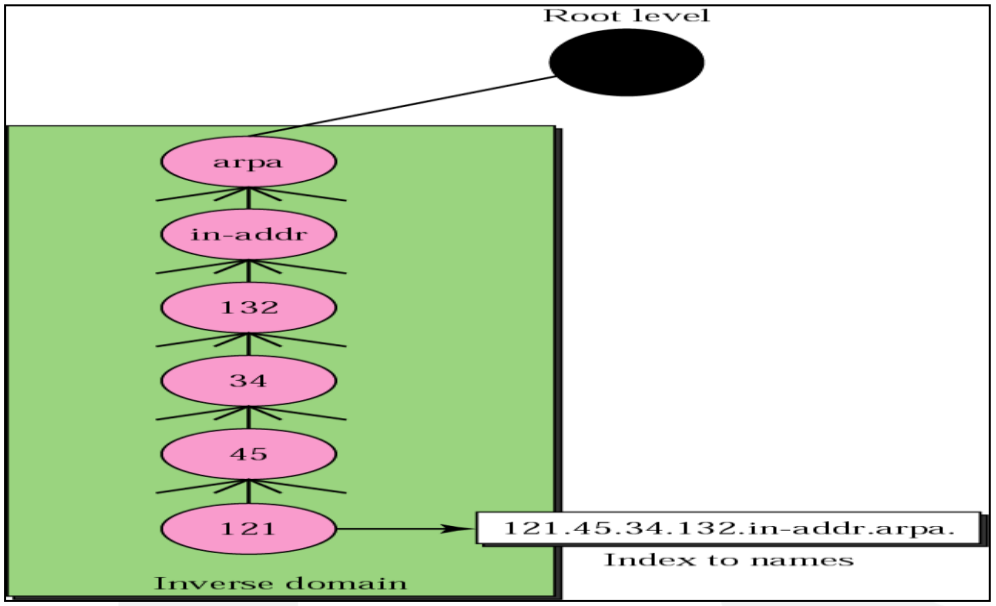

Figure: 5.10 Inverse Domain

DNS can use the services of UDP or TCP using the well-known port 53.

DDNS

- **Dynamic DNS** (**DDNS**) is a method of automatically updating a name server in the Domain Name System (DNS), often in real time, with the active DDNS configuration of its configured hostnames, addresses or other information.
- As the IP address changes frequently the domain names must be remapped in DNS.

- DYNAMIC DNS comes into play when a internet user cannot afford a static IP address from ISP.
- Enables to update DNS server.

Working of DDNS

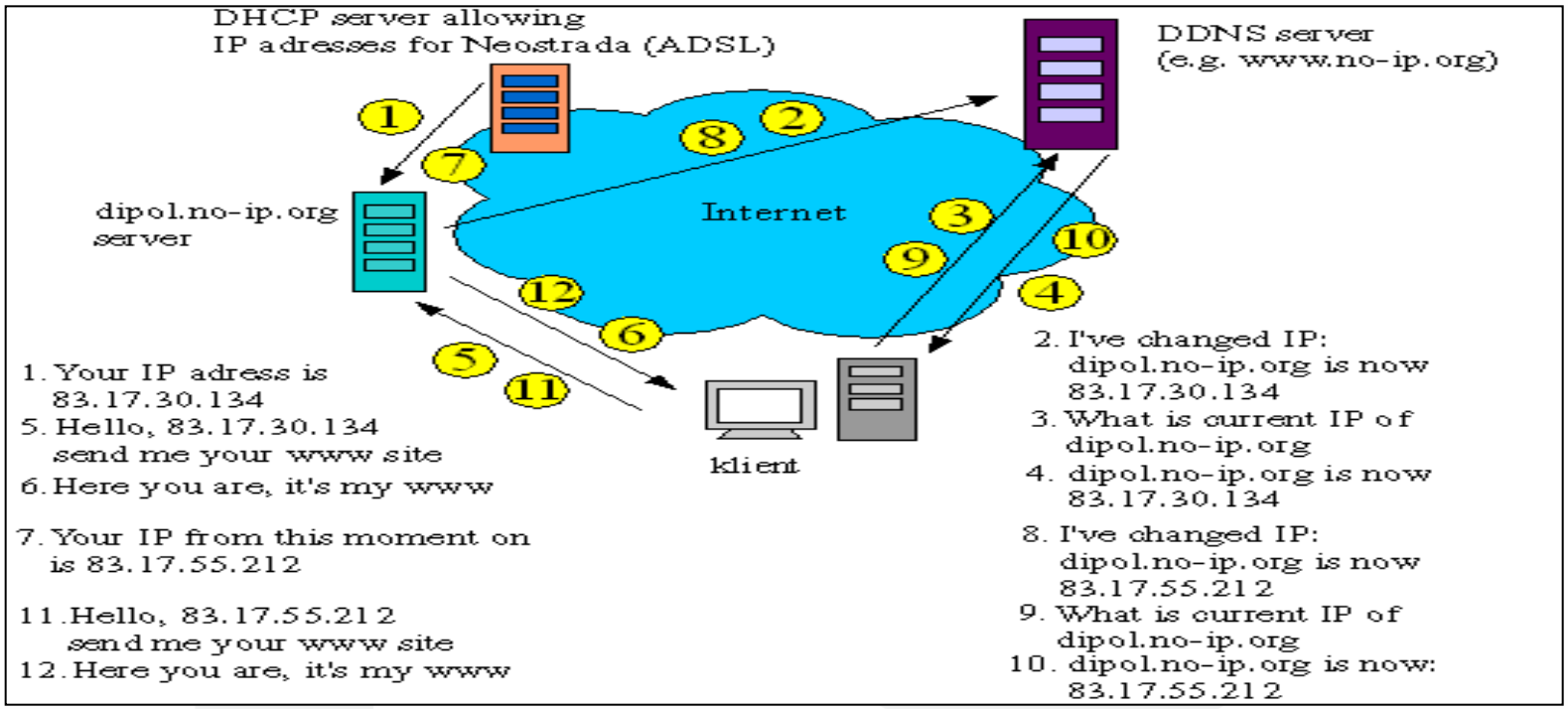

Figure: 5.11 Working of DDNS

(https://www.slideshare.net/praneetha523/ddns-32624941)

Telnet

TELNET is general-purpose client-server application programs.

Telnet provides a connection to the remote computer in such a way that a local terminal appears to be at the remote side.

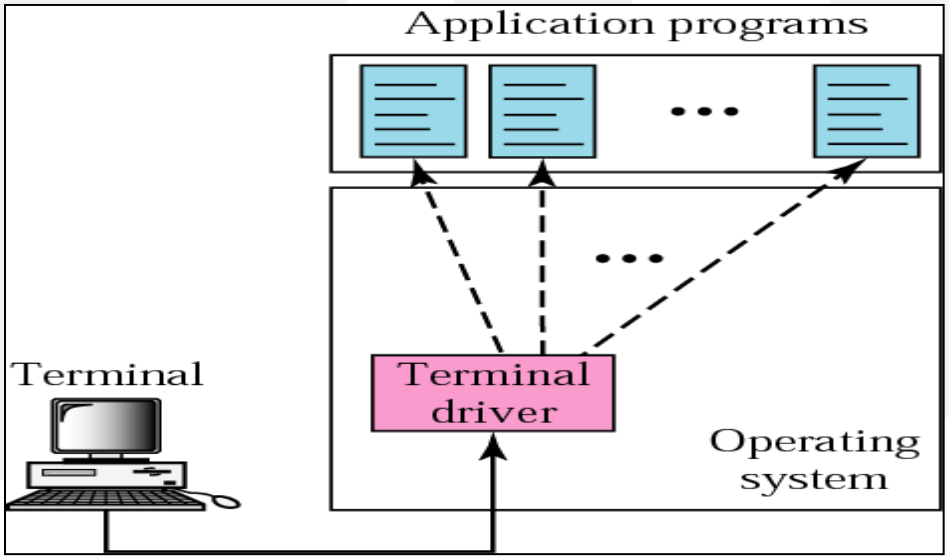

Figure: 5.12 Local login

(https://www.javatpoint.com/computer-network-telnet)

Conti..

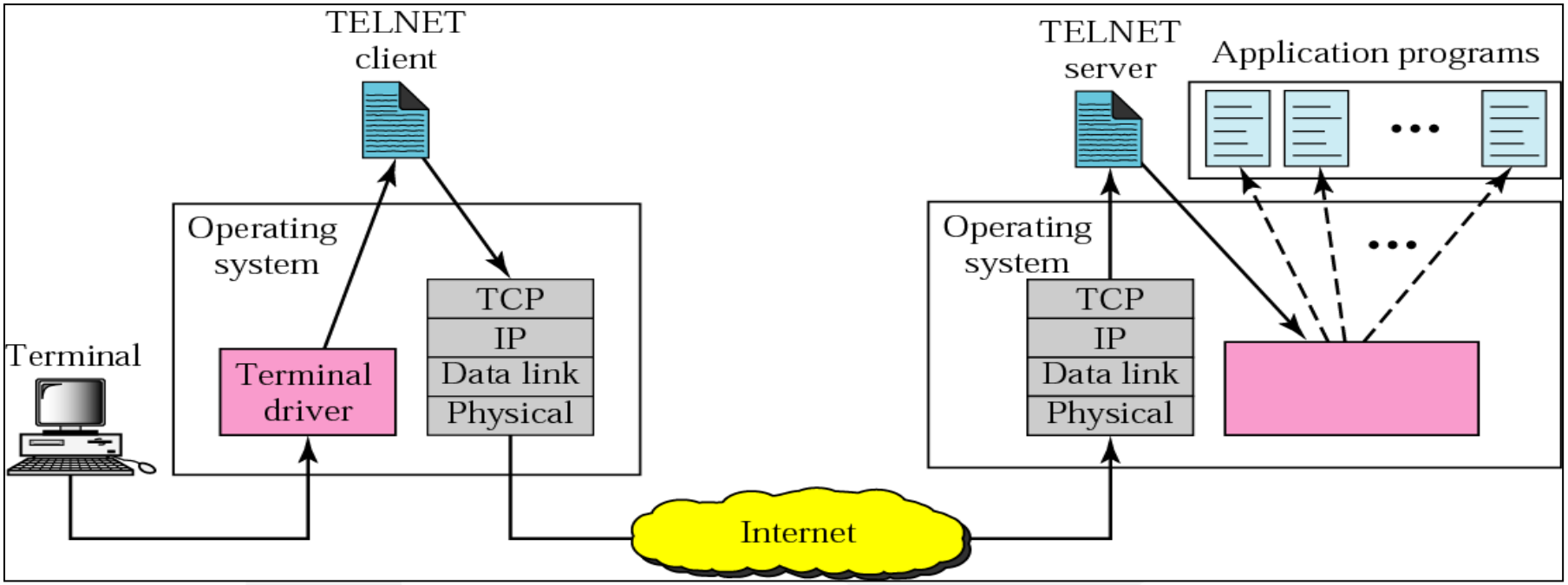

Figure: 5.13 Remote Login

(https://www.javatpoint.com/computer-network-telnet)

ELECTRONIC MAIL

- E-mail is asynchronous communication in which people can read and send messages in convenient way.
- Morden E-mail has many advance features:

✓ Message with attachments
✓ Hyperlinks
✓ Embedded photos
✓ HTML formatted text

- High level view of internet mail systems are:

- User agent
- Mail Server
- Simple mail transfer Protocol

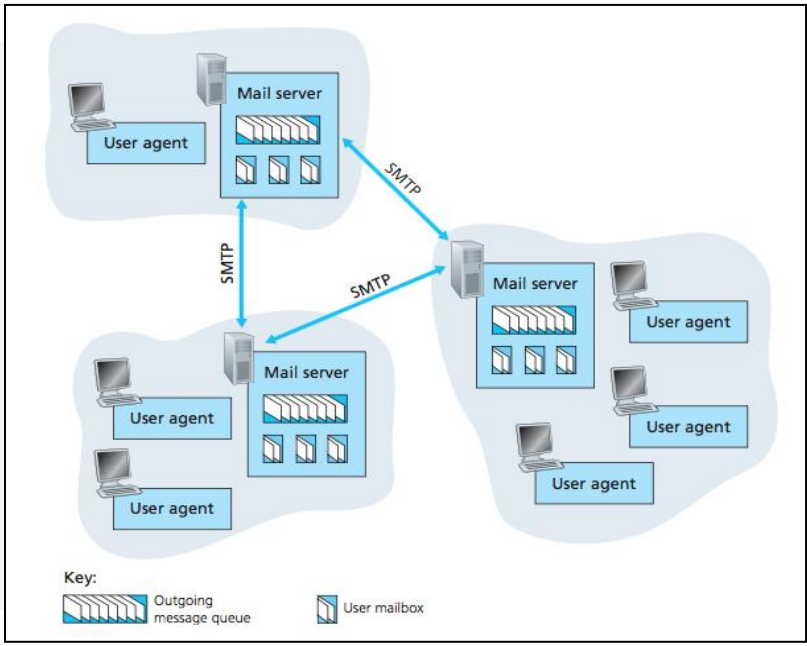

Figure: 5.14 E-mail

ELECTRONIC MAIL

- **User Agent**
- User agent are able to read ,send, reply to, compose e-mail.
- E.g. Apple mail and Microsoft Outlook

- **Mail Box Server:**
- Mailbox is contain incoming messages of users.
- Message queue of outgoing mail messages.

- **SMTP:**
- It is principal that working on application layer protocol working between server and send email-messages.
- Client: sending mail to server
- Sever: receiving mail from different mail server

SMTP

- SMTP transfers messages from senders' mail servers to the recipients' mail servers.
- It restricts the body (not just the headers) of all mail messages to simple 7-bit ASCII.
- If receiving end mail server is down, message remain as sending end mail server and wait for next attempt.
- To illustrate the basic operation of SMTP, let's take a common scenario. Suppose Alice wants to send Bob a simple ASCII message.

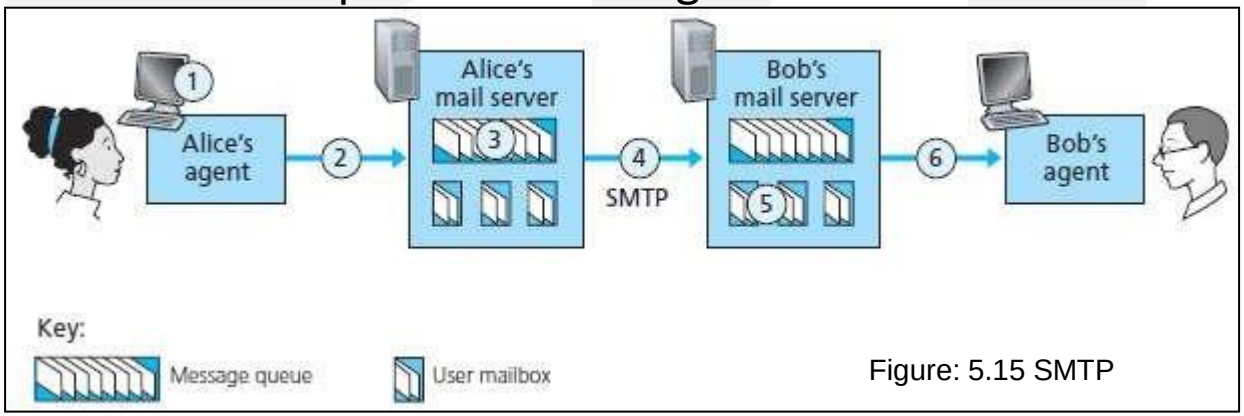

Figure: 5.15 SMTP

(https://www.dialwebhosting.com/blog/email-hosting/what-protocols-send-receive-email-with-the-mail-server)

Conti..

1. Alice invokes her user agent for e-mail, provides Bob's e-mail address (for example, bob@someschool.edu), composes a message and instructs the user agent to send the message.
2. Alice's user agent sends the message to her mail server, where it is placed in a message queue.
3. The client side of SMTP, running on Alice's mail server, sees the message in the message queue. It opens a TCP connection to an SMTP server, running on Bob's mail server.
4. After some initial SMTP handshaking, the SMTP client sends Alice's message into the TCP connection.
5. At Bob's mail server, the server side of SMTP receives the message. Bob's mail server then places the message in Bob's mailbox.
6. Bob invokes his user agent to read the message at his convenience.

Electronic Mail

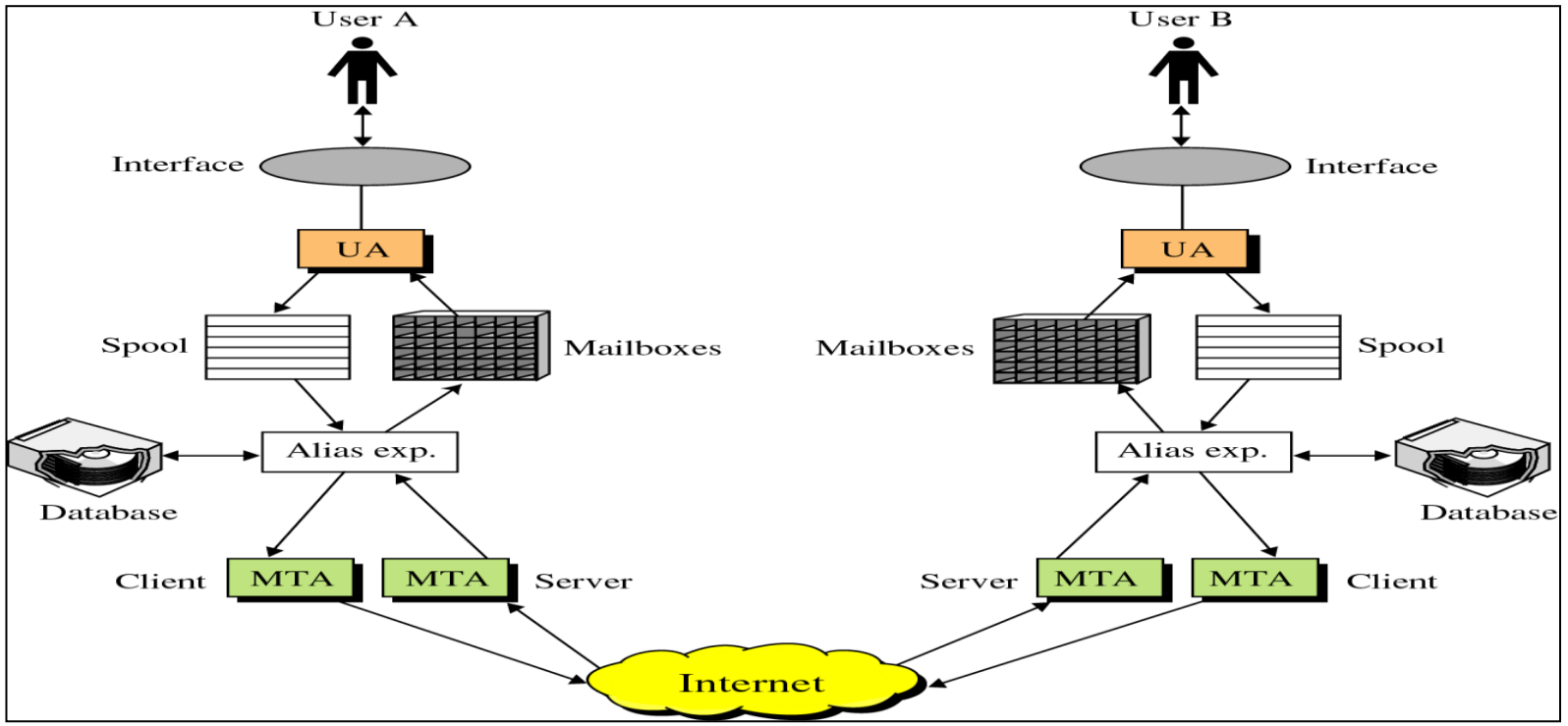

Figure: 5.16 E-mail architecture

(https://www.slideshare.net/alibefkani/smtp-protocol)

MAIL TRANSFER PHASES

1. Connection establishment
   connection establishes between MTA client and MTA server

2. Message transfer

3. Connection termination

SMTP CONCEPT

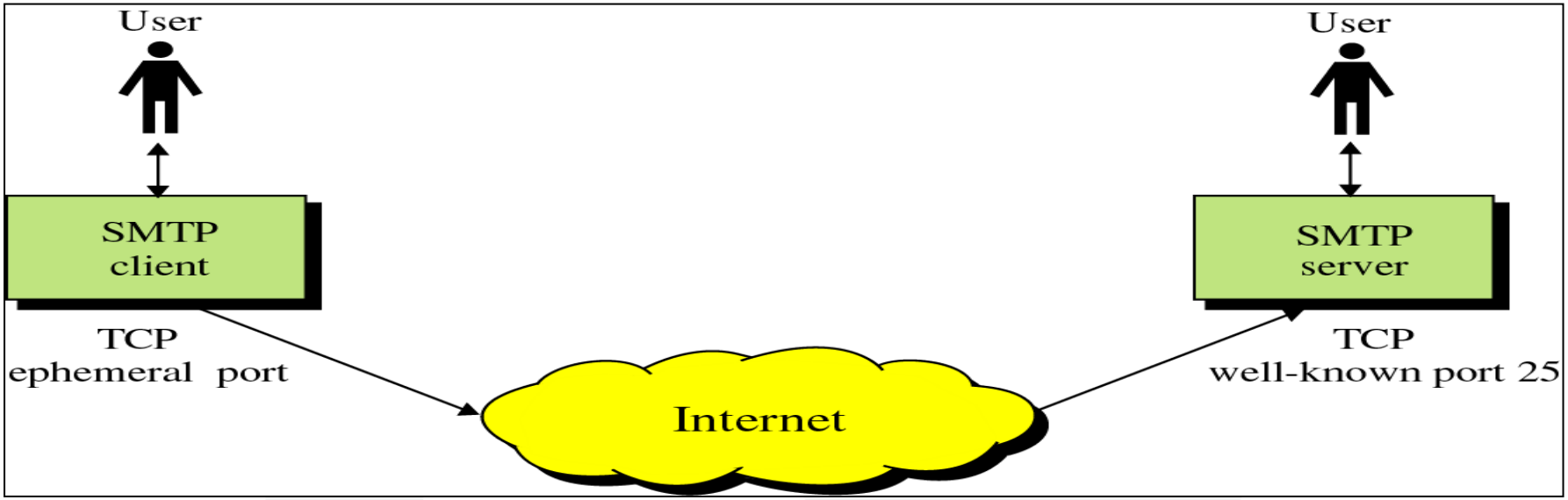

Figure: 5.17 SMTP over Internet

UAs and MTAs

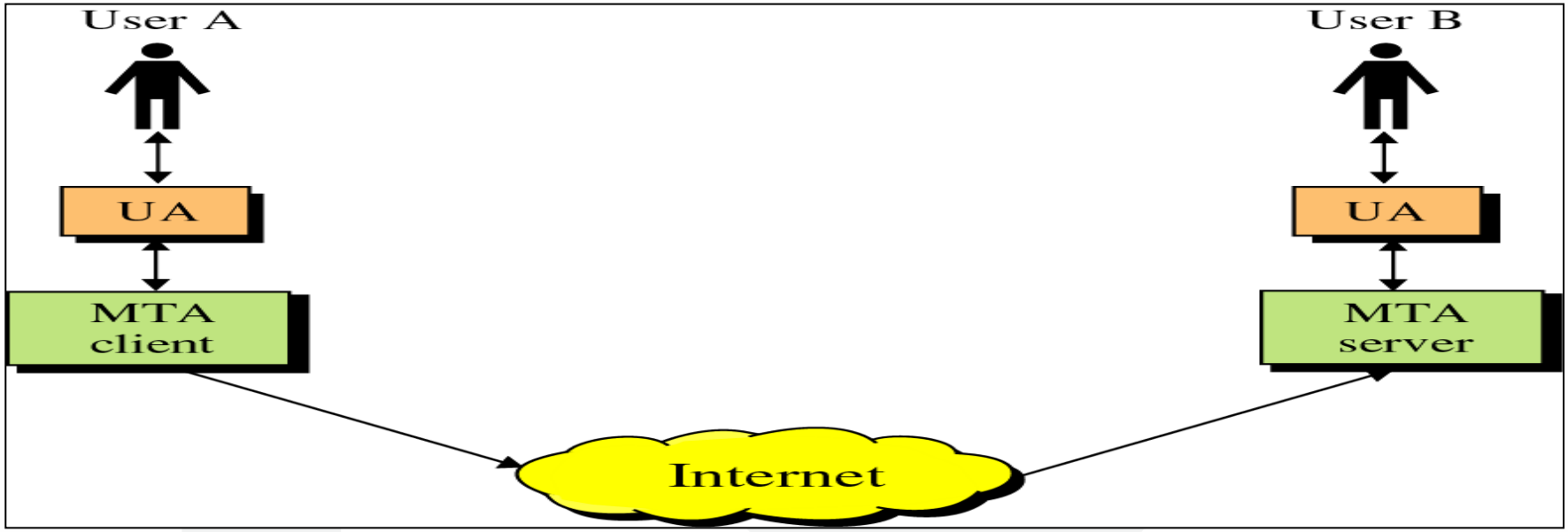

Figure: 5.18 UAs and MTAs

Relay MTAs

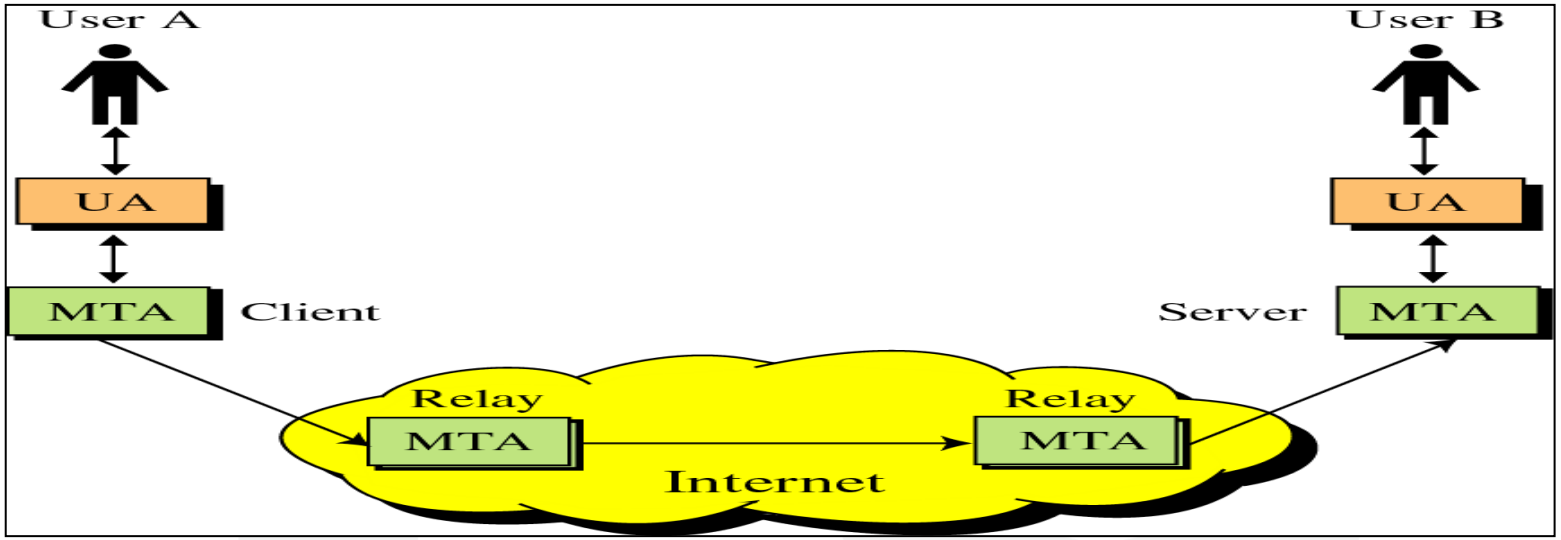

Figure: 5.19 Relays MTAs

(https://www.javatpoint.com/simple-mail-transfer-protocol)

Mail gateway

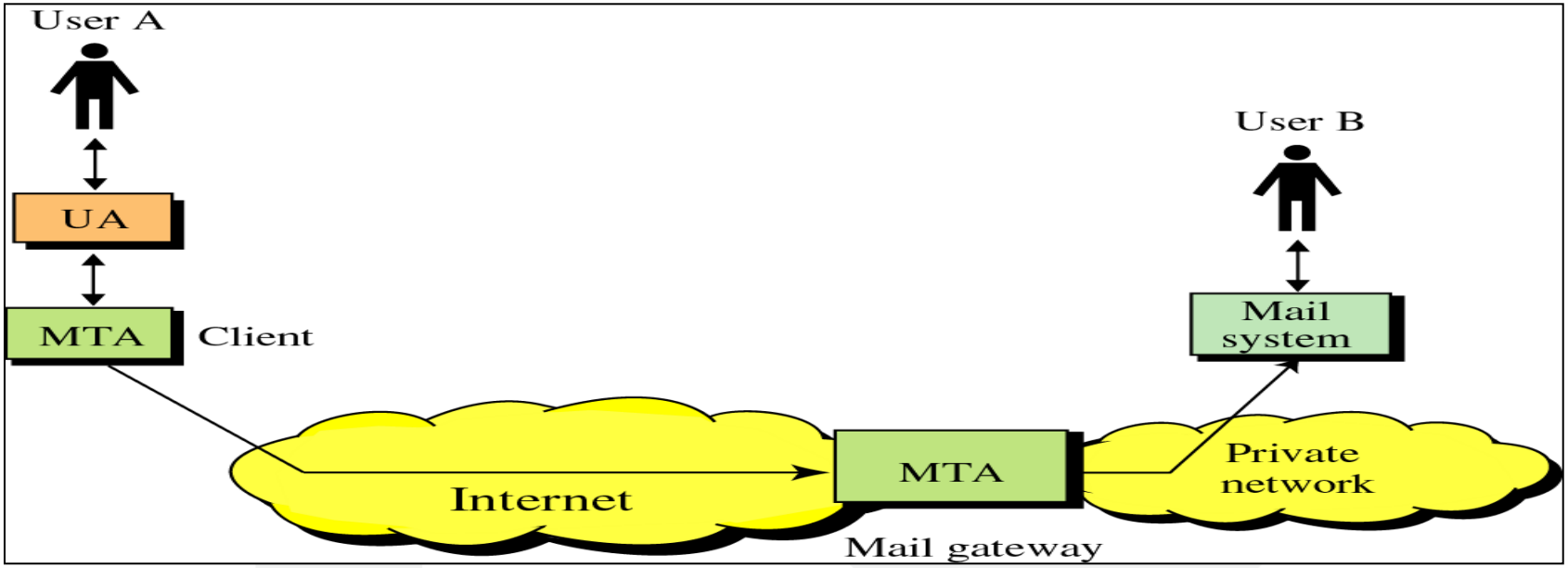

Figure: 5.20 Mail gateway

(https://www.javatpoint.com/simple-mail-transfer-protocol)

E-Mail Delivery

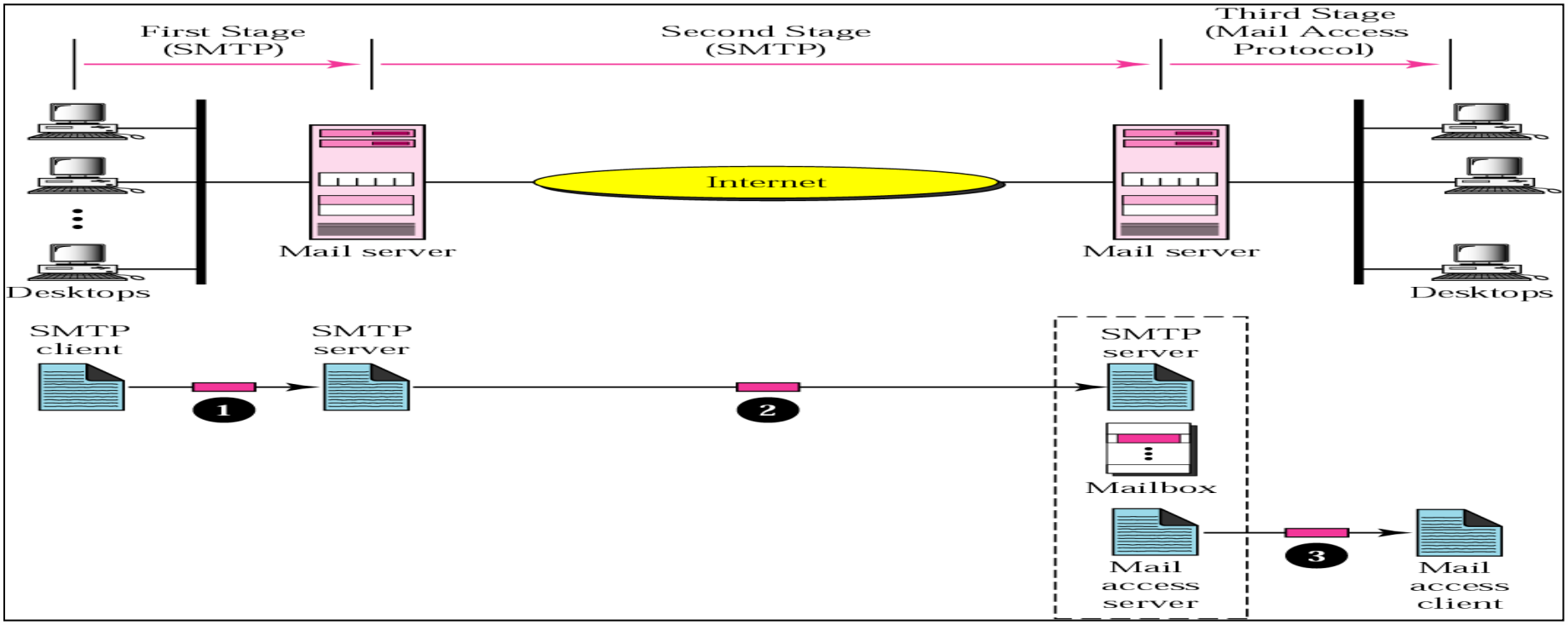

Figure: 5.21 E-mail Delivery

(https://silo.tips/download/chapter-25-domain-name-system-copyright-the-mcgraw-hill-companies-inc)

Email Address

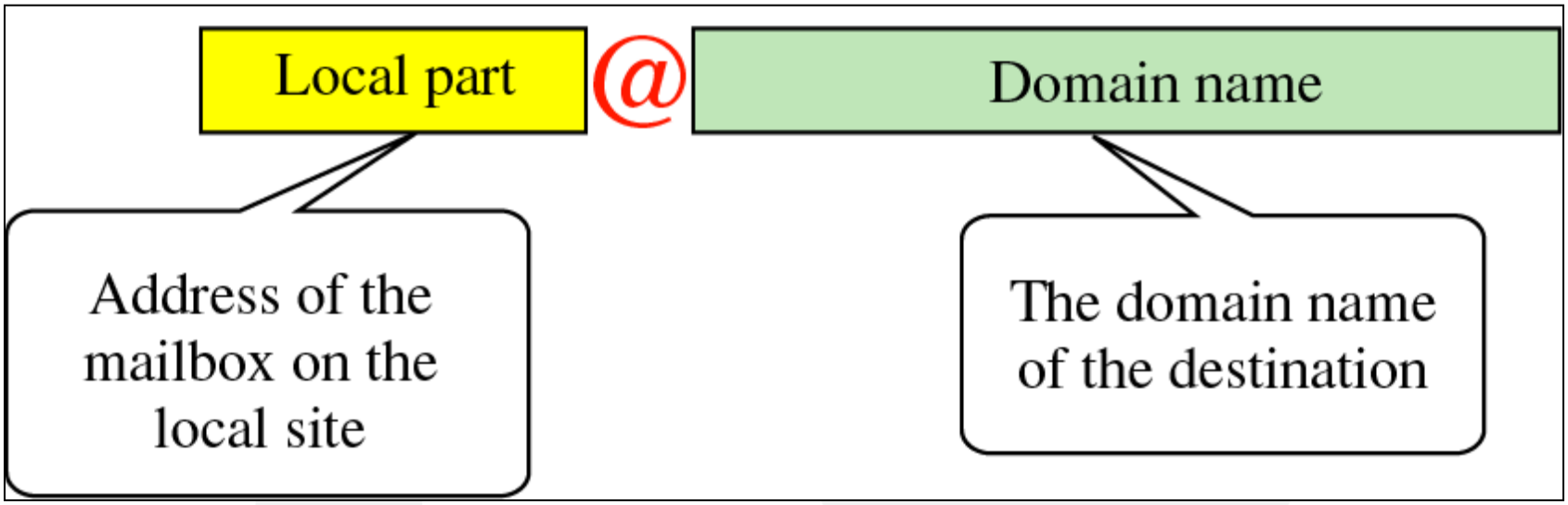

Figure: 5.22 Structure of E-mail Address

(https://silo.tips/download/chapter-25-domain-name-system-copyright-the-mcgraw-hill-companies-inc)

MAIL ACCESS PROTOCOLS: POP3

Post Office Protocol

- POP3 is an extremely simple mail access protocol.
- POP3 begins when the user agent of the client opens a TCP connection to the mail server of the server on port 110.
- POP3 is designed to delete mail on the server as soon as the user has downloaded it.
- POP can be thought of as a "store-and-forward" service

Conti …

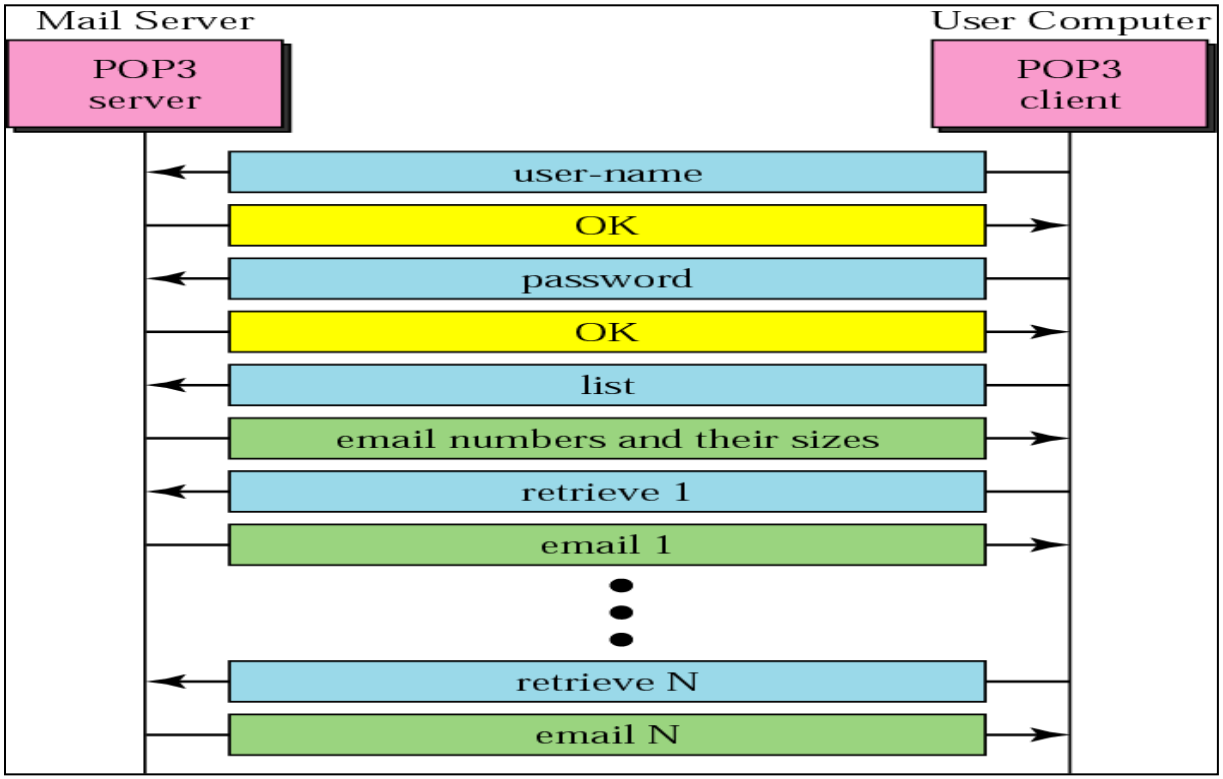

Figure: 5.23 POP3 client server

POP3

- With the TCP connection established, POP3 progresses through three phases: authorization, transaction, and update.
- During the first phase, authorization, the user agent sends a username and a password to authenticate the user.
- During the second phase, transaction, the user agent retrieves messages; also during this phase, the user agent can mark messages for deletion, remove deletion marks and obtain mail statistics.
- The third phase, update, occurs after the client has issued the quit command, ending the POP3 session; at this time, the mail server deletes the messages that were marked for deletion.

MAIL ACCESS PROTOCOLS: IMAP

- POP3 protocol does not provide any means for a user to create remote folders and assign messages to folders.
- An IMAP server will associate each message with a folder; when a message first arrives at the server, it is associated with the recipient's INBOX folder.

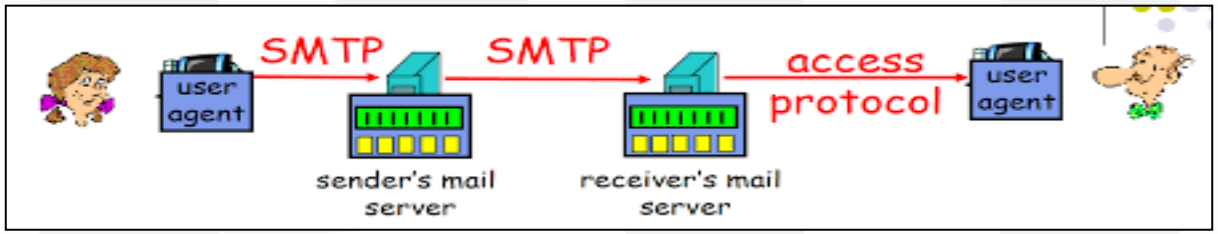

Figure: 5.24 IMAP

- The IMAP protocol provides commands to allow users to create folders and move messages from one folder to another.
- IMAP also provides commands that allow users to search remote folders for messages matching specific criteria.

FTP(File Transfer Protocol)

FTP uses the services of TCP. It needs two TCP connections. The well-known port 21 is used for the control connection and the well-known port 20 for the data connection.

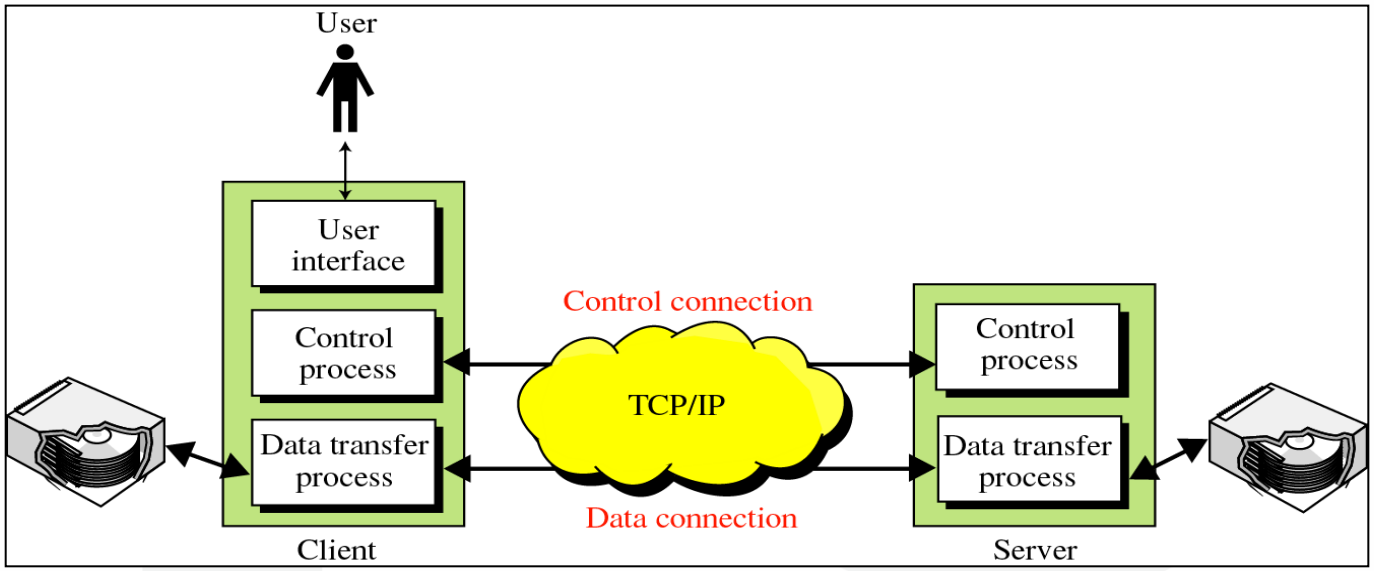

Figure: 5.25 FTP protocol

Conti..

- FTP uses the services of TCP. It needs two TCP connections. The well-known port 21 is used for the control connection and the well-known port 20 for the data connection.
- FTP uses client-server architecture.
- FTP promotes file sharing by remote computer for reliable transfer of data.

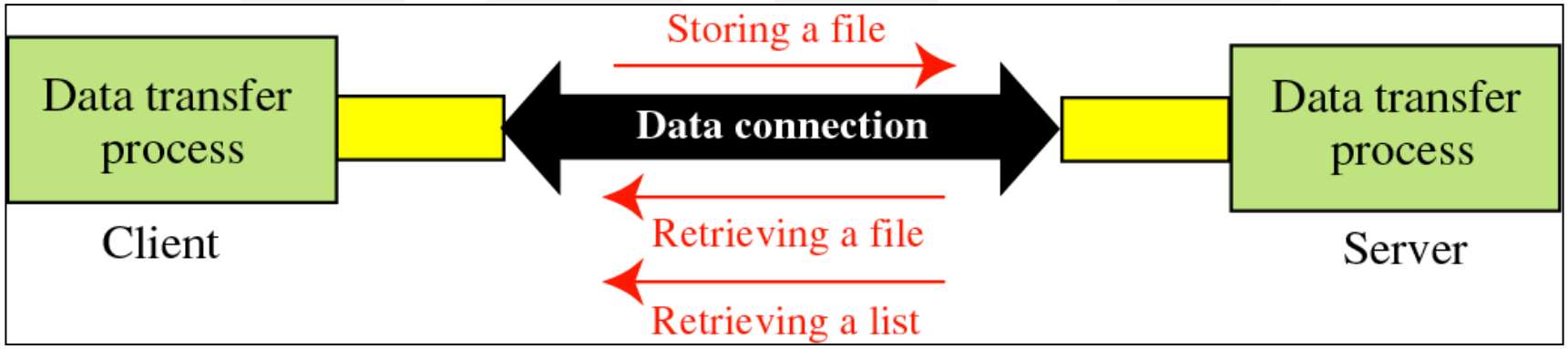

Figure: 5.26 Data transfer using FTP

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World Wide Web(WWW)

- In 1990,internet was used only by academics, researchers, students.
- WWW arrived as new application by Tim Berners Lee in 1994.
- WWW is information where other documents and other resources are identified by URL, Hyperlinks accessed by internet.
- User can demands it when they want unlike TV shows and Radio

Conti..

- Web pages consists of objects like .jpeg, applet file ,HTML file ,audio file.
- Web pages consist base file as HTML file and that consists several referenced objects.

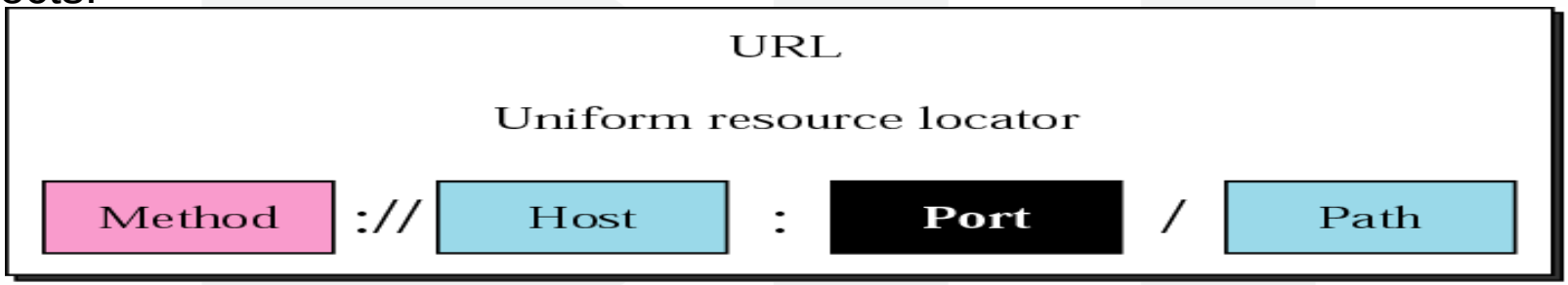

Figure 5.27 URL

Each object is addressable by Uniform Resource Locator(URL).
e.g.

https://www.javatpoint.com/java-awt

Host name Path name

Browser Architecture

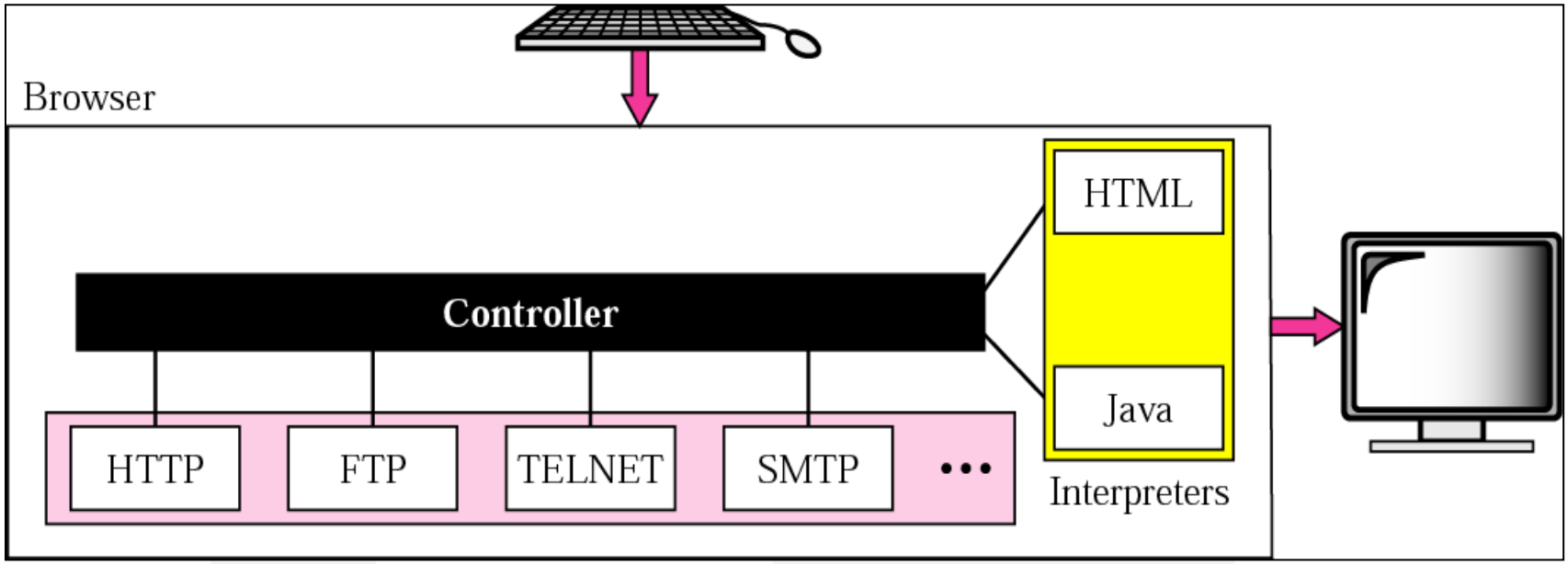

Figure: 5.28 Browser Architecture

(https://silo.tips/download/chapter-25-domain-name-system-copyright-the-mcgraw-hill-companies-inc-permission)

Categories of Web documents

:

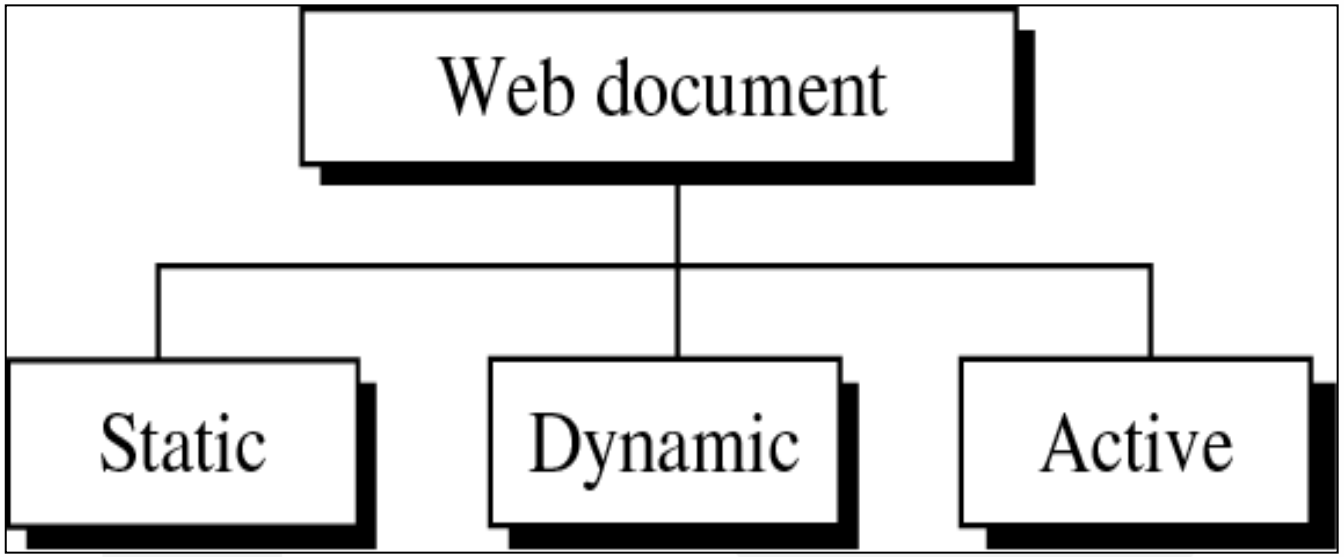

Figure: 5.29 Types of Web Document

(https://silo.tips/download/chapter-25-domain-name-system-copyright-the-mcgraw-hill-companies-inc-permission)

Static document

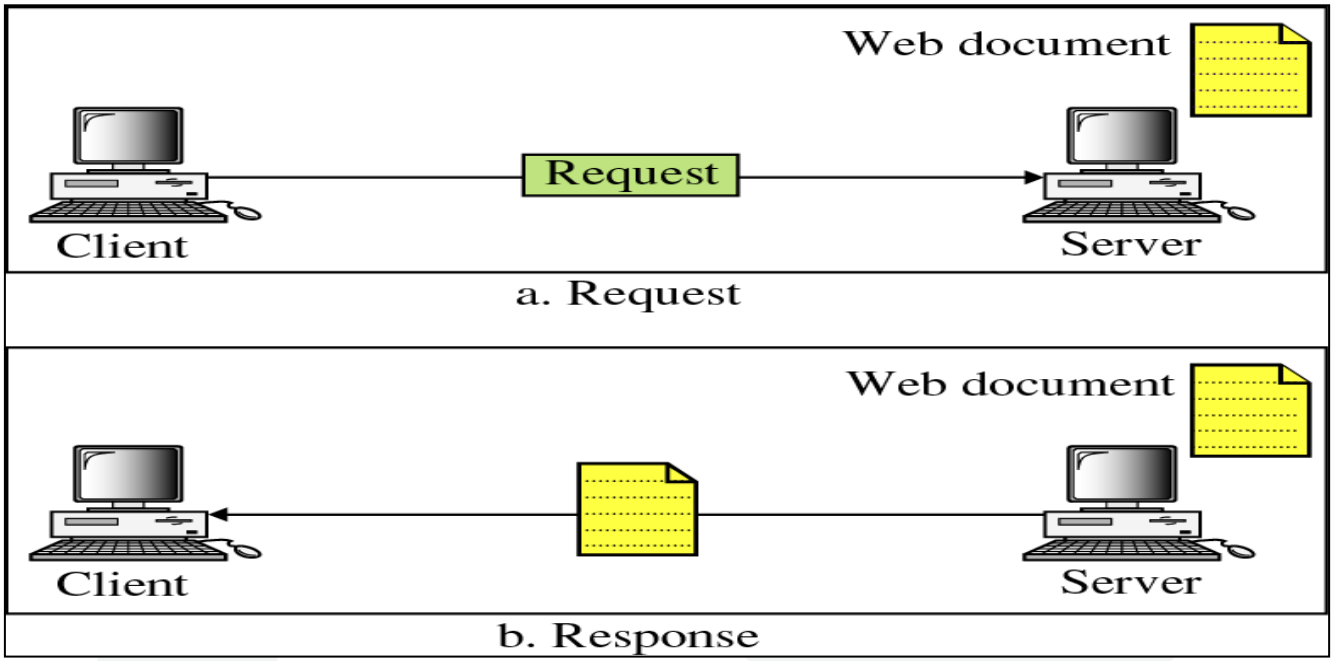

Figure: 5.30 Static Document

Dynamic document

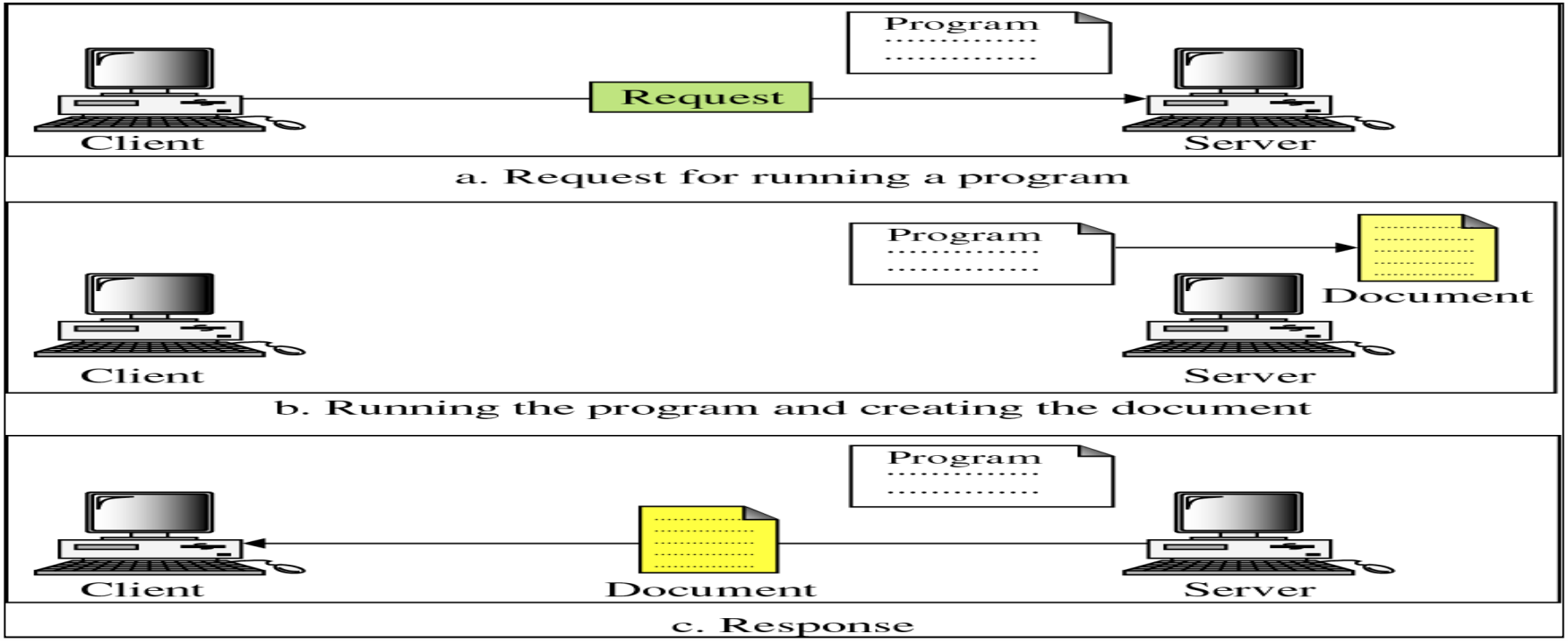

Figure: 5.31 Dynamic Document

(https://silo.tips/download/chapter-25-domain-name-system-copyright-the-mcgraw-hill-companies-inc-permission)

HTTP(Hyper Text Transfer Protocol)

- HTTP uses the services of TCP on well-known port 80.

- HTTP implemented in two programs:
- Client program
- Server program

- HTTP defined structure of messages and how web client and web server exchange the information(message).

Conti..

- **Client :**
- It is a browser that request,receive,display web object through HTTP protocol
- e.g. PC ,mobile

- **Server**
- web Server send web objects as response to the client.
- e.g. Apache web server

HTTP transaction

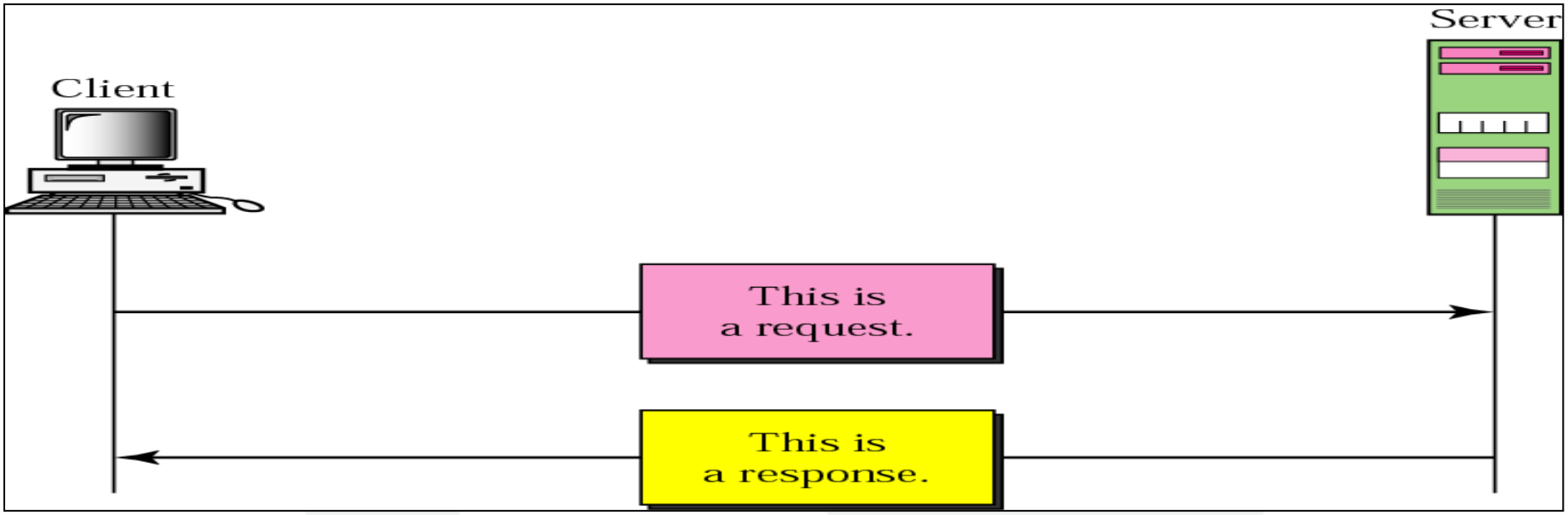

Figure: 5.32 HTTP Transaction

(https://www.javatpoint.com/computer-network-http)

Conti..

- Client initiates TCP connection to server by using port no 80.
- Server can accept connection request or reject.
- After accepting connection HTTP messeges is exchanged client(browser) and server(web server).

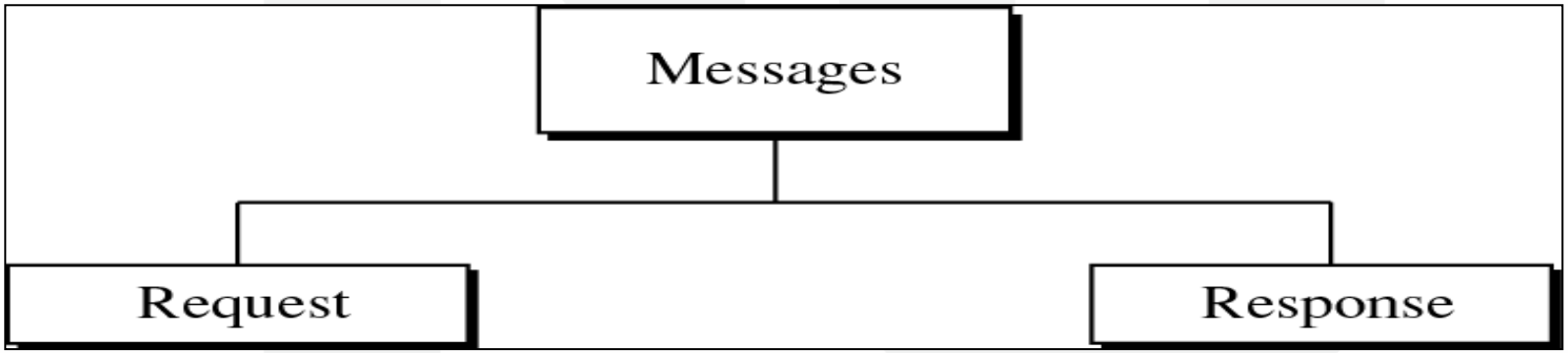

Figure: 5.33 Types of messages

(https://www.javatpoint.com/computer-network-http)

Conti..

- HTTP is stateless protocol no any client information is store.
- HTTP connection types
- **Non persistent HTTP**
- **Persistent HTTP**

Request message

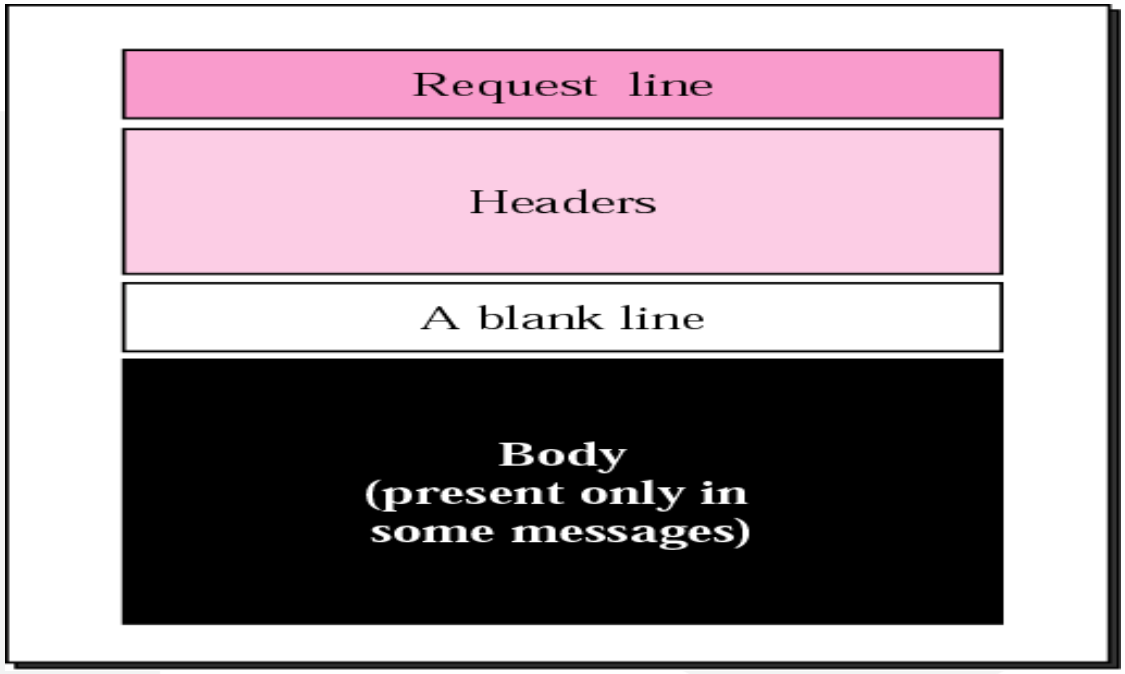

Figure: 5.34 Request message

(https://www.javatpoint.com/computer-network-http)

Simple Network Management Protocol(SNMP)

- SNMP defined by IETF(Internet Engineering Task Force).
- This manages internet devices like routers,switches,servers,workstations ,modems.
- This devices are mostly used for network management.
- It provides basic operation to monitor the internet.
- SNMP uses concept of **manager and agent.**
- Manager controls number of agent
  E.g. servers, routers.
- Manager sending the request to network device called agent.
- **Agent** is a one kind of router that runs on SMTP server.
- **NMS:** it executes applications which monitor and mange devices. Generally run on manager.

Simple Network Management Protocol(SNMP)

- SNMP defines the format of packets exchanged between a manager and an agent.
- It reads and changes the status (values) of objects (variables) in SNMP packets.

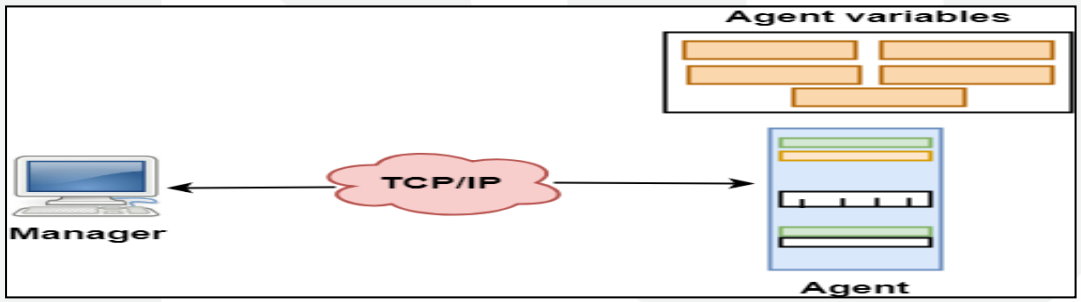

Figure: 5.35 SNMP

- All objects managed by SNMP are given an object identifier. The object identifier always starts with 1.3.6.1.2.1.

(https://www.javatpoint.com/simple-network-management-protocol)

Firewall

- A Network Firewall is a system or group of systems used to control access between two networks -- a trusted network and an untrusted network -- using pre-configured rules or filters.

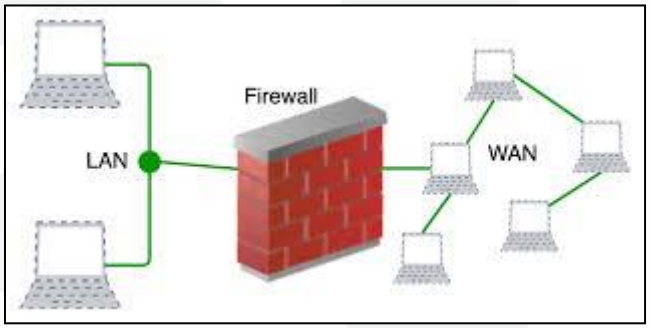

Figure: 5.36 Firewall

Firewall is device that provides secure connectivity between networks (internal/ external).

(https://www.geeksforgeeks.org/introduction-of-firewall-in-computer-network/)

Why we need firewall ?

- To protect our network & its resources from malicious users & accidents that originate outside of our network.

Figure: 5.37 Need of Firewall

(https://www.slideshare.net/nisargamin6236/firewall-and-its-types-and-function)

Conti…

- It is used to implement and enforce a security policy for communication between networks.
- A firewall may be a hardware, software or a combination of both that is used to prevent unauthorized program or internet users from accessing a private network or a single computer.
- All messages entering or leaving the intranet pass through the firewall, which examines each message & blocks those that do not meet the specified security criteria.

Conti...

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Types of Firewall

1.Hardware Firewall
2.Software Firewall

1. Hardware Firewall:

- It is physical device.
- It resides between modem and computer.
- It is fitted into broadband router it being used to share internet connection.
- Protects entire network.
- It is more expensive and hard to configure.
- E.g. Cisco pix,Netscreen .

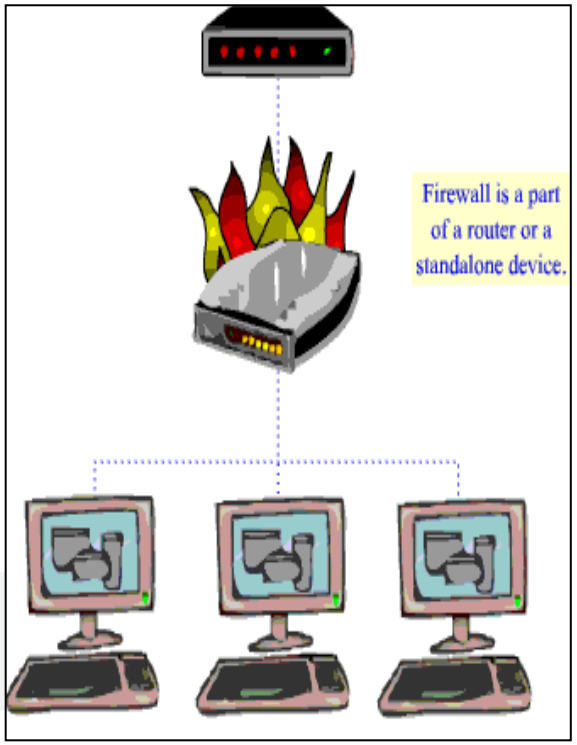

Figure: 5.37 Hardware Firewall

(https://www.slideshare.net/nisargamin6236/firewall-and-its-types-and-function)

Types of Firewall

2. Software Firewall

- It is software application.
- It is installed into the computer system that you want to
- protect.
- It is protect single computer.
- less expensive

e.g. Norton internet security
MacAfee internet security

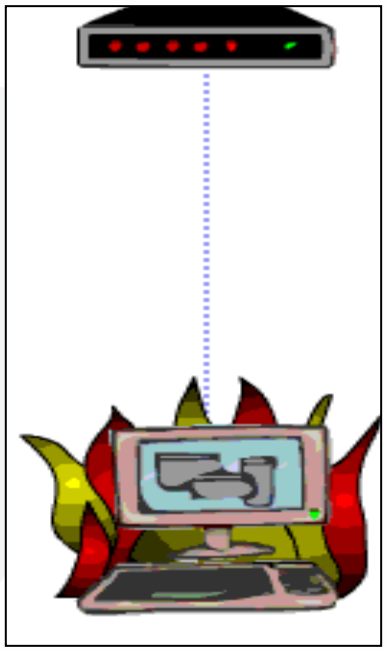

Figure: 5.38 Software Firewall

(https://www.slideshare.net/nisargamin6236/firewall-and-its-types-and-function)

Bluetooth

Bluetooth technology is a short-range wireless communication technology that is simple, secure, and everywhere.

- Bluetooth uses a radio technology called frequency-hopping spread spectrum.
- Supports data rate of 1 Mb/s(originally).
- The Bluetooth specifications are developed and licensed by the Bluetooth Special Interest Group (SIG).

Conti..

The key features of Bluetooth technology

- Less complication
- Less power consumption
- Available at cheaper rates
- Robustness.

Bluetooth Application Areas

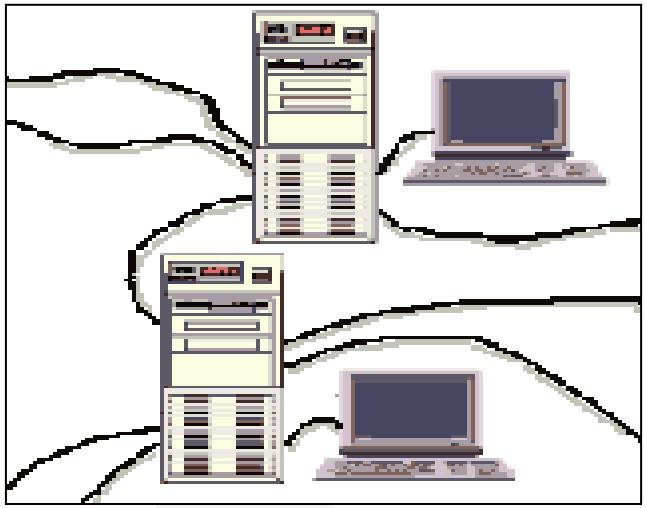

Figure: 5.39 Bluetooth

1. Data and voice access points
   Real-time voice and data transmissions.
2. Cable replacement
   Eliminates need for numerous cable attachments for connection
3. Ad hoc networking
   Device with Bluetooth radio can establish connection with another when in range

Piconet

- Two or more Bluetooth units sharing the same channel”
- Basic unit of Bluetooth networking (ad hoc fashion)
- Master and one to seven slave devices (3-bit address)
- Master determines channel and phase (synchronise)
- Star network, with the master as the centre node
- Two piconets may exist within radio range of each other
- Difference piconet will randomly collide on the same frequency (Frequency hopping is not synchronised between piconets)star network

Scatternet

When connecting two piconets the result will be a scatternet.

- Device in one piconet may exist as master or slave in another piconet
- Allows many devices to share same area
- Makes efficient use of bandwidth

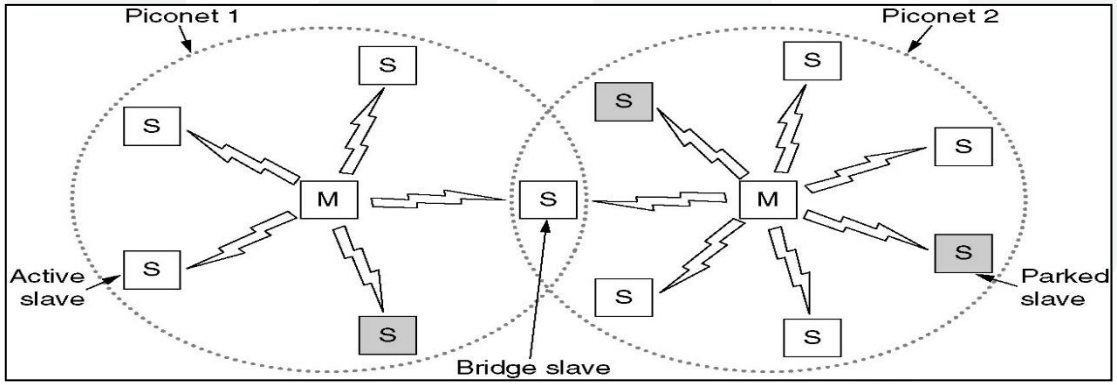

Figure: 5.40 Scatternet

(https://www.ques10.com/p/30668/explain-piconet-and-scatternet-explain-bluetooth-p)

Bluetooth layers

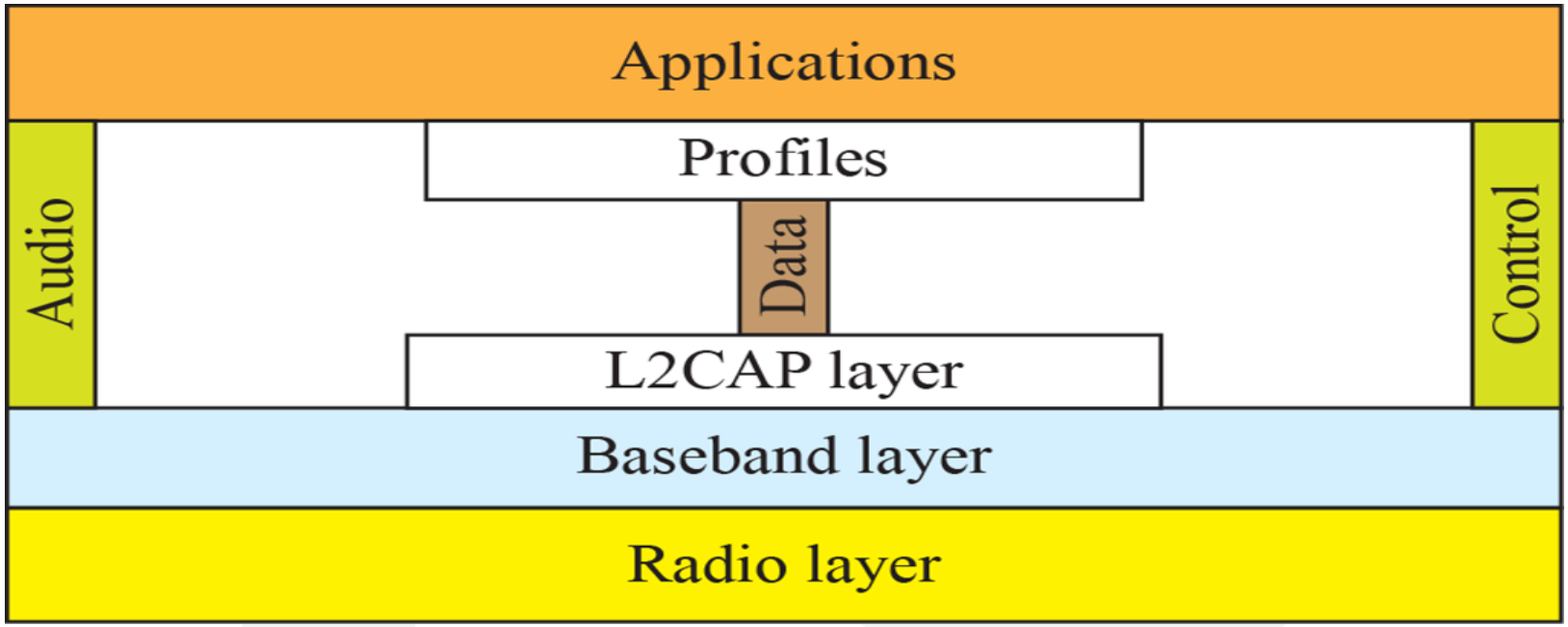

Figure: 5.41 Bluetooth layers

(https://www.slideshare.net/anamikagarg1253/bluetooth-43396683)

Conti..

- **Radio Front End (RF)**

  Defines characteristics of RF, frequency bands, channel arrangements & receiver sensitivity level.

- **Logical Link Control & Adaptation Protocol (L2CAP)**

  For transporting bigger data products to higher layer

- **Service Discovery Protocol (SDP)**

  Defines procedures for Discovering services of other devices. Determining the characteristics of those services.

Conti..

- **Link Manager Protocol (LMP)**
  - PICONET, master slave role assignments and link configuration.
  - Security configuration by device authentication using secret key.
- **RFCOMM**
  - Provides transport capabilities for high level services.
- **Object Exchange Protocol**

- Is a specification for Object data exchange over IR(InfraRed links).
- Examples for using OBEX include exchanging business cards and synchronizing calendar applications.

Cryptography

- Cryptography is the process ordinary plain text into unintelligible text and vice-versa.

Figure: 5.42 Cryptography

- Cryptography is used to protect the data as well as communication by using codes. So, that can be received by only intended person who want to receive the data.
- Cryptography is not used protection of data but it is used for authentication.
- Cryptography is process of converting plaintext(original data) into cipher text.

(https://www.123rf.com/photo_124422478_cryptography-related-flat-icon-isolated-on-white-background-trendy-flat-style.html)

Objectives of Cryptography

- **Cryptography is used for following objectives**:
- Confidentiality
- Authentication
- Non-repudiation
- Integrity

DIGITAL LEARNING CONTENT

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