Chapter-7

INTERNET AND INTRANET APPLICATIONS

7.1. General Applications: Email, WWW, Gopher, Online Systems

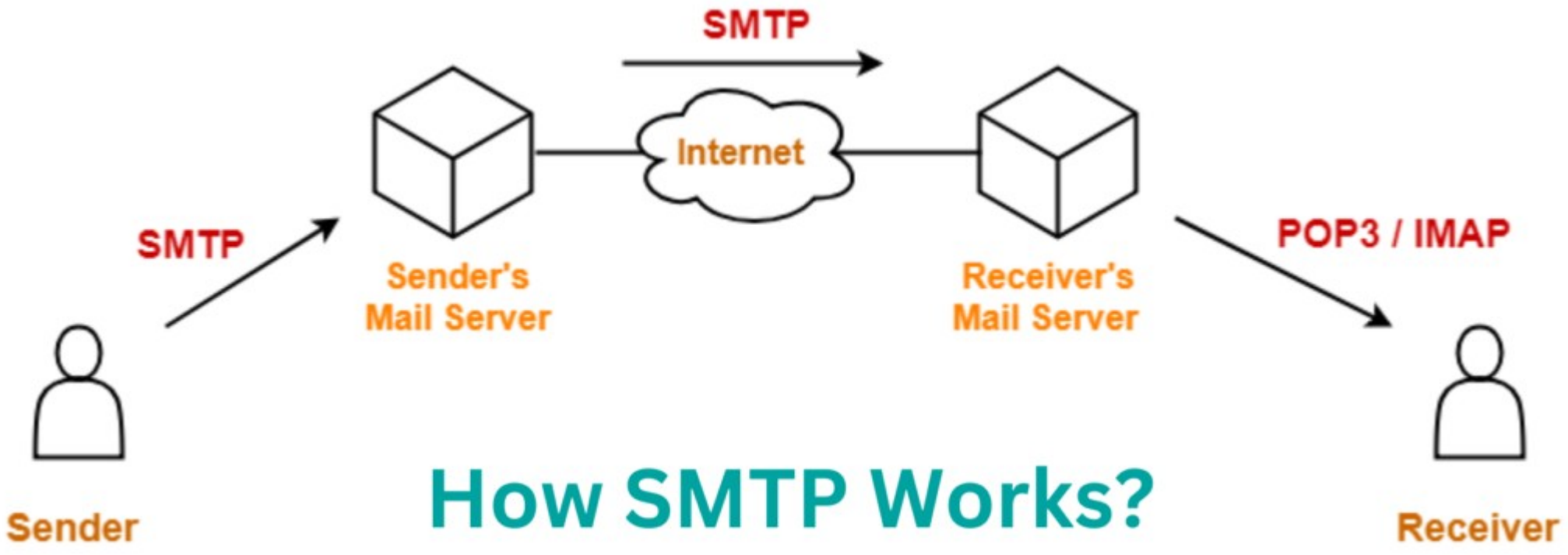
7.1.1 Email

- Internet e-mail functions through the use of Internet standards. Although many more standards actually apply to email, virtually all mail servers and email clients support at least the following basic set.
- SMTP (or RFC 5321) specifies the protocol by which email is transmitted
- RFC 5322 specifies the basic format for email
- POP3 and IMAP4 specify email retrieval protocols used by e-mail clients

1. SMTP (Simple Mail Transfer protocol)

- SMTP is an application layer protocol. Using a process called “store and forward”, SMTP moves our email on and across the networks. The client who wants to send mail opens a

  TCP connection to the SMTP server and sends the mail across the connection. The SMTP server is always o listening mode. As soon as it listens for a TCP connection on that port (25). After successfully establishing a connection the client process sends the mail instantly and the serve acknowledges it.
- SMTP is a formal protocol that defines the message transfer agent (MTA) client and the server in the internet. When the message arrives at the destination server, it then uses POP or IMAP to download the mail. Hence, SMTP is a message transfer agent and POP and IMAP are message access agent.
- SMTP protocol is of two types.
  - End to End Method
  - Store and Forward Method
- End to end method is used to communicate between different organizations whereas store and forward method is used within the organization.


SMTP
Internet
SMTP
Sender's
Mail Server
Receiver's
Mail Server
POP3 / IMAP
Sender
How SMTP Works?
Receiver

2. POP3 (Post Office Protocol)

- The POP (Post Office Protocol) protocol provides a simple, standardized way for users to access mailboxes and download m messages to their computers. When using the POP protocol all our e-mail messages will be downloaded from the mail server to our local computer.
- Its design assumes that the email client downloads all the available email from the server, deletes them from the server and disconnects. POP3 normally uses port 110.
- POP3 is a client/server protocol in which email is received and held for us by our internet server. Periodically, we check our mailbox on the server and download any mail. It deletes all the mail on the server as soon as the user has downloaded it.
- However, some implementation allows users or an administrator to specify that mail be saved for some period of time.
- POP was designed for, and works best in, the situation where you use only a single desktop computer. If we choose to work with our POP mail on more than one machine, we may have trouble with email messages getting downloaded on one machine that we need to work with on another machine; for example, we may need a message at work that was downloaded to our machine at home.

POP Workflow

- Connect to server
- Retrieve all mail
- Store locally as new mail
- Delete mail from server
- Disconnect

3. IMAP (Internet Message Access Protocol)

- IMAP is a protocol for retrieving email messages. The IMAP protocol is designed to let the user to keep their email on the server until and unless the user explicitly removes it. IMAP requires more disk space on the server and more CPU resources than POP as all the emails are saved on the servers. IMAP uses the port number 143.

  IMAP services:

- IMAP is designed for the situation where you need to work with your email from multiple computers. It supports multiple logins.
- We can create subfolders on the mail server to organize the mail we want to keep.
- Messages are displayed on your local computer but are kept and stored on the mail server -you can work with all your mail, old and new, from any computer connected to the internet.
- It allows facilities like read mail, flag mail for urgency and save draft messages on server.
- Access to messages without having to download from the servers or transfer messages from one to another computer.
- Supports for online, offline and disconnected access modes.

IMAP workflow:

- Connect to server
- Fetch user requested content and cache it locally, e.g. list of new mail, message
- Summaries, or content of explicitly selected emails
- Process user edits, e.g. marking email as read, deleting email etc.
- Disconnect

7.1.2 WWW (World Wide Web)

- The World Wide Web (abbreviated WWW or the Web) is an information space where documents and other web resources are identified by Uniform Resource Locators (URLs), interlinked by hypertext links, and can be accessed via the Internet. The resources of the Web are transferred via the Hypertext Transfer Protocol (HTTP), may be accessed by users by a software application called a web browser, and are published by a software application called a web server.
- Web resources may be any type of downloaded media, but web pages are hypertext documents formatted in Hypertext Markup Language (HTML). Special HTML syntax displays embedded hyperlinks with URLs which permits users to navigate to other web resources.
- In addition to text, web pages may contain references to images, video, audio, and software components which are either displayed or internally executed in the user's web browser to render pages or streams of multimedia content. Multiple web resources with a common theme and usually a common domain name, make up a website. Websites are stored in computers that are running a web server, which is a program that responds to requests made over the Internet from web browsers running on a user's computer. Website content can be provided by a publisher, or interactively from user-generated content. Websites are provided for a myriad of informative, entertainment, commercial, and governmental reasons.

7.1.3 Gopher

- Gopher is a TCP/IP application layer protocol used to distribute, search and retrieve documents over the Internet.
- The Gopher technology is based on a client-server structure, where a gopher client program is used to search gopher servers. These servers can store documents, articles, programs, and other information. Instead of hyperlinks, the gopher interface uses menus of links to other documents and programs.
- Gopher is designed to function and to appear much like a mountable read-only global network file system (and software, such as gophers, is available that can actually mount a Gopher server as a FUSE resource). At a minimum, whatever a person can do with data files on a CD-ROM, they can do on Gopher.
- A Gopher system consists of a series of hierarchical hyperlinkable menus. The choice of menu items and titles is controlled by the administrator of the server. Similar to a file on a Web server, a file on a Gopher server can be linked to as a menu item from any other Gopher server. Many servers take advantage of this inter-server linking to provide a directory of other servers that the user can access.

7.2 Multimedia and Digital Video/Audio Broadcasting Video/Audio Conferencing, Internet Relay Chat (IRC)

7.2.1 Multimedia

Multimedia is a field concerned with the computer – controlled integration of text, graphics, drawings, still and moving images (videos), animations, audio where every type of information can be represented, stored transmitted and processed digitally. The uses of multimedia are as follows:

- Industrial advertisement
- Entertainment
- Education
- Medicine
- Engineering Simulation

Classes of Multimedia Application: There are 3 classes of multimedia application. They are:

a. Streaming Stored Audio and Video – E.g., YouTube

b. Streaming Live Audio and Video – E.g., FB Live

c. Real time Interactive Audio and Video – Internet telephony, Video Conferencing.

a. Streaming Stored Audio and Video: The multimedia content has been prerecorded and stored on a server. User may pause, rewind, forward, etc.

First Approach: Using a web server

- A compressed audio/video file can be downloaded as a text file. The client (browser) can use the services of HTTP and send a GET message to download the file. The Web server can send the compressed file to the browser.
- The browser can then use a help application, normally called a media player, to play the file. The file needs to download completely before it can be played.

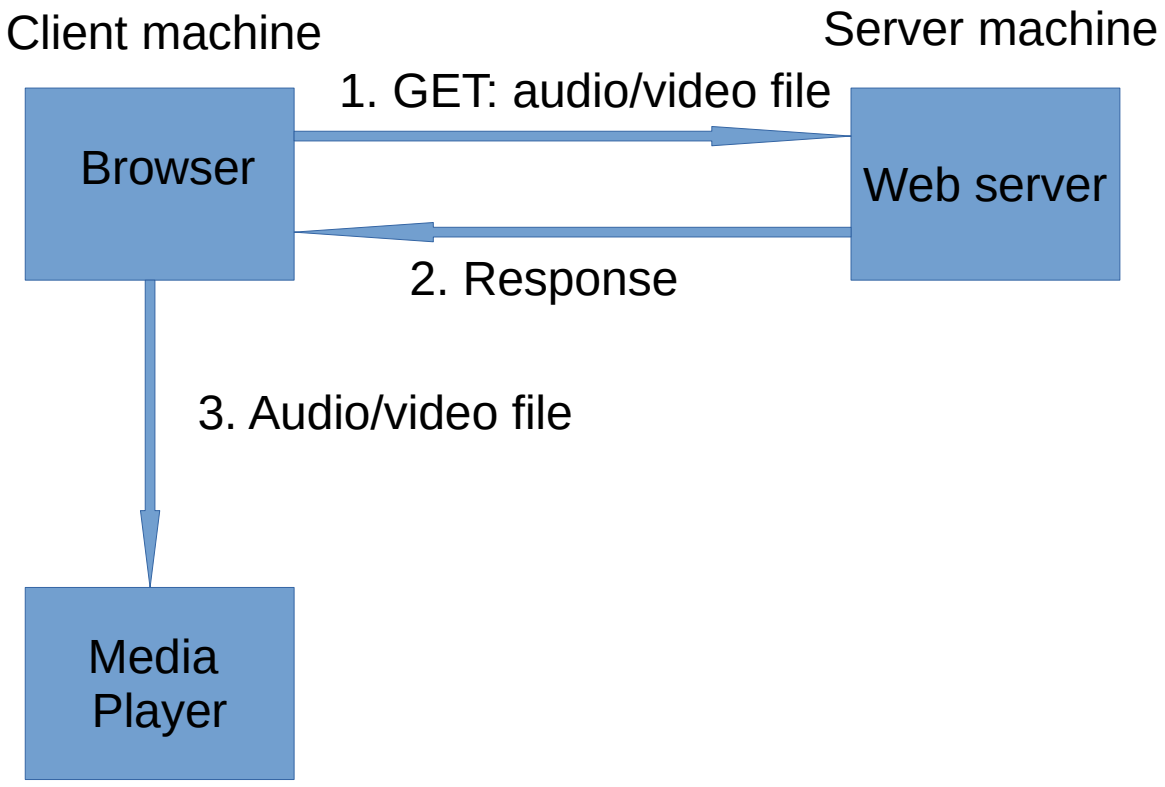


Fig: Streaming streamed audio and video using a web server

Second Approach: Using a Web Server with Metafile

- In another approach, the media player is directly connected to the Web server for downloading the audio/video file. The Web server stores two files: the actual audio/video file and a metafile that holds information about the audio/video file.
- The HTTP client accesses the Web server using the GET message.
- The information about the metafile comes in the response.
- The metafile is passed to the media player.
- The media player uses the URL in the metafile to access the audio/video file.
- The Web server responds.

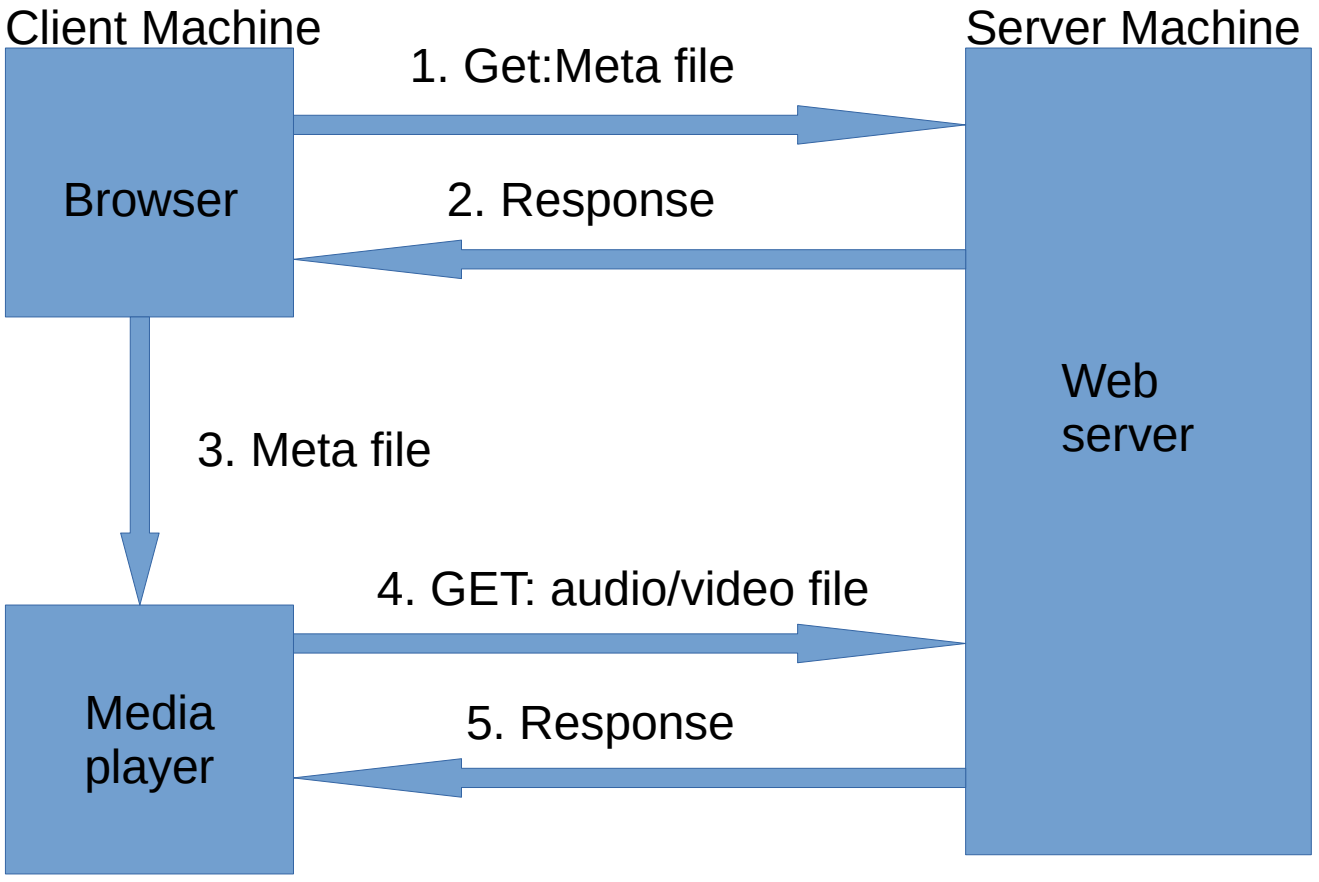


Fig: Streaming streamed audio and video using a web server with metafile

Third Approach: Using a Media Server

- The problem with the second approach is that the browser and the media player both use the services of HTTP. HTTP is designed to run over TCP. This is appropriate for retrieving the metafile, but not for retrieving the audio/video file. The reason is that TCP retransmits a lost or damaged segment, which is counter to the philosophy of streaming. We need to dismiss TCP and its error control; we need to use UDP. However, HTTP, which accesses the Web server, and the Web server itself are designed for TCP; we need another server, a media server.

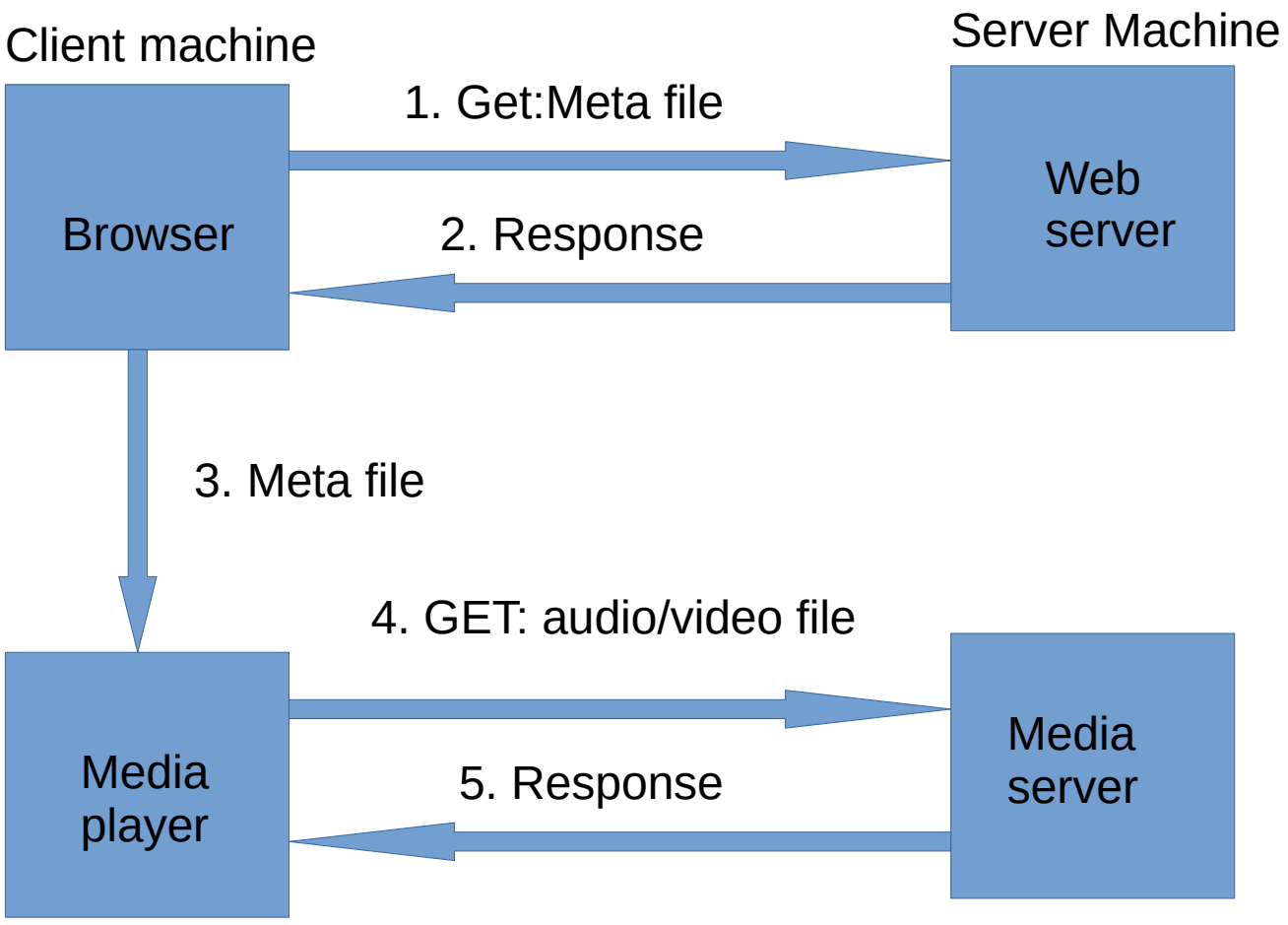
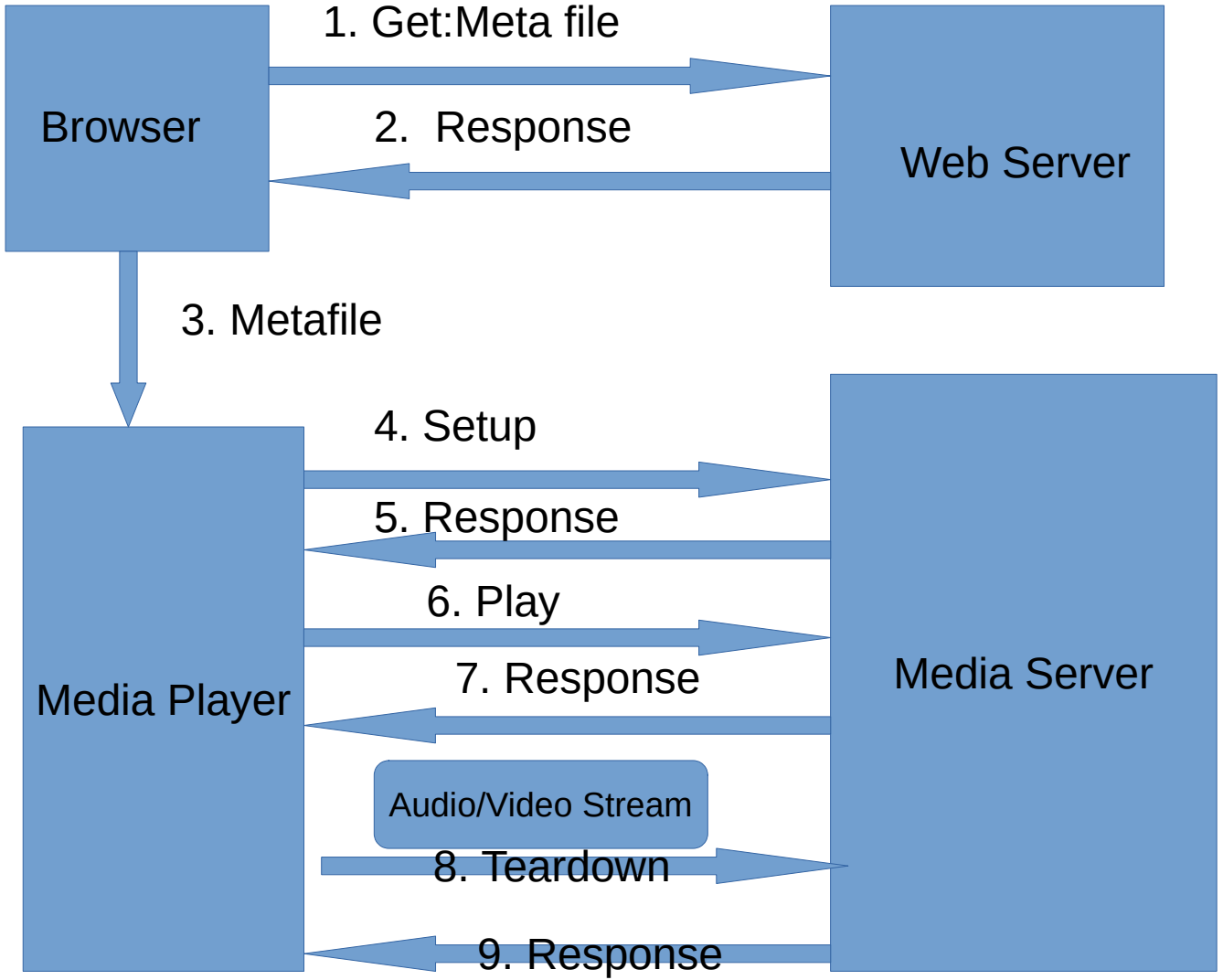


Fig: Streaming streamed audio and video using a media server

- The HTTP client accesses the Web server using a GET message.
- The information about the metafile comes in the response.
- The metafile is passed to the media player.
- The media player uses the URL in the metafile to access the media server to download the file.
- Downloading can take place by any protocol that uses UDP.
- The media server responds.

Fourth Approach: Using a Media Server and RTSP

- The Real-Time Streaming Protocol (RTSP) is a control protocol designed to add more functionalities to the streaming process. Using RTSP, we can control the playing of audio/video. Figure below shows a media server and RTSP.


Browser
1. Get:Meta file
2. Response
Web Server
3. Metafile
Media Player
4. Setup
5. Response
6. Play
7. Response
Media Server
Audio/Video Stream
8. Teardown
9. Response

- The HTTP client accesses the Web server using a GET message.
- The information about the metafile comes in the response.
- The metafile is passed to the media player.
- The media player sends a SETUP message to create a connection with the media server.
- The media server responds.
- The media player sends a PLAY message to start playing (downloading).
- The audio/video file is downloaded using another protocol that runs over UDP.
- The connection is broken using the TEARDOWN message.
- The media server responds.

b. Streaming Live Audio and Video

- Streaming live audio/video is similar to the broadcasting of audio and video by radio and TV stations. Instead of broadcasting to the air, the stations broadcast through the Internet.
- There are several similarities between streaming stored audio/video and streaming live audio/video. They are both sensitive to delay; neither can accept re-transmission.
- However, there is a difference. In the first application, the communication is unicast and on-demand.
- In the second, the communication is multicast and live.
- Live streaming is better suited to the multicast services of IP and the use of protocols such as UDP and RTP.
- Examples: Internet Radio, Internet Television (ITV), Internet protocol television (IPTV).

c. Real-Time Interactive Audio and Video

- In real-time interactive audio/video, people communicate with one another in real time.
- The Internet phone or voice over IP is an example of this type of application.
- Video conferencing is another example that allows people to communicate visually and orally.

7.2.2 Audio/Video Conferencing

a. Audio Conferencing

- Audio conferencing is where at least two individuals in various locations use technology like a conference bridge to hold an audio call.
- It aims at accomplishing communications and collaboration at the same time.

b. Video Conferencing

- When at least two individuals utilize digital platforms to communicate and collaborate with each other in order to accomplish a common goal adequately then it is known as a video conferencing.

Benefits of audio and video conferencing:

- Reduces Travel Costs: All business meetings happened face-to-face, which involved travel, expense and time. However, through audio and video conferencing an organization can save a lot of time and money.
- Keep connected to our employees: If we have employees working from home or out on the road, through audio video conference system we can stay in touch with them consistently.
- Increases productivity: If collaboration is done well, it can increase productivity essentially.
- Improves teamwork: If we have large teams or members of staff at various locations, video conferencing will assist to unite them. Employees can share data and collaborate to make a better-informed decision, which will prompt better working relationships internally.
- Effective communication: Not just would we be able to hear people's voices, through video conferencing we can likewise see the people we are communicating to, see their expressions, instant responses and body language.
- Training many people at a time: Organizations spend a lot of time and money on internal training programs. By using an audio video conference system, we can easily overcome such kind of situations and save a lot of time.

Components of Video Conferencing/ Technologies for Video Conferencing

- Camera
- Video display
- Microphone
- Speaker: to play audio received from remote locations
- Codec (Compressor/Decompressor)

Methods of Audio/Video Conferencing

- Point-to-Point Conferencing: A videoconference that connects two locations is known as point-to-point conferencing. Each site sees and hears the other sites at all times
- Multipoint Conferencing: A videoconference that connects to more than two sites through the use of a multi-poin control unit, or MCU is known as multipoint conferencing. Participants at all sites can hear one another at all times and see the site that is currently speaking.

Uses of Audio/Video Conferencing

- Presentations
- Virtual meetings
- Videoconference-based learning
- JIT (just in time) events
- Recruitment/search committees
- General meetings
- Project coordination
- Informal work sessions
- Alumni relations
- Question and answer session

7.2.3 Digital Video/ Audio Broadcasting

a. Digital Video Broadcasting

- Asynchronous Data Transmission: Data is transmitted without strict synchronization between different channels or time slots. This flexibility allows data channels to operate independently, and time slots are allocated based on the necessity of data transmission.
- Variable Data Rates: Individual data channels may have fixed data rates or may vary based on the requirements of the transmitted content. This variability allows for optimized data transmission based on content demands.
- Equal Forward Error Correction (FEC): Forward Error Correction techniques are employed uniformly across the data channels to detect and correct errors in the received data, ensuring reliability in transmission.
- Modulation Techniques: The system utilizes modulation techniques like Single Carrier Quadrature Phase Shift Keying (QPSK) or Quadrature Amplitude Modulation (QAM) for transmitting digital information. These modulation schemes are efficient for digital data transmission.
- Transmission Links: Digital video broadcast systems can use various transmission links for broadcasting:
- Satellite: Utilizing satellites for wide-area coverage and distribution of digital content.
- Cable: Transmitting content through cable networks.
- Terrestrial: Using terrestrial networks (such as antennas or towers) for localized or regional broadcasting.

Benefits of Such a System:

- Flexibility: The asynchronous nature and variable data rates provide flexibility in accommodating diverse content types and transmission needs.
- Reliability: The use of equal FEC across channels ensures error detection and correction, enhancing the reliability of data transmission.
- Adaptability to Various Platforms: By utilizing satellite, cable, or terrestrial transmission links, the system can cater to different geographical areas and audience preferences.
- Such a system is adaptable to varying data demands and transmission scenarios, offering reliability and flexibility in delivering digital content through different mediums.

b. Digital Audio Broadcasting

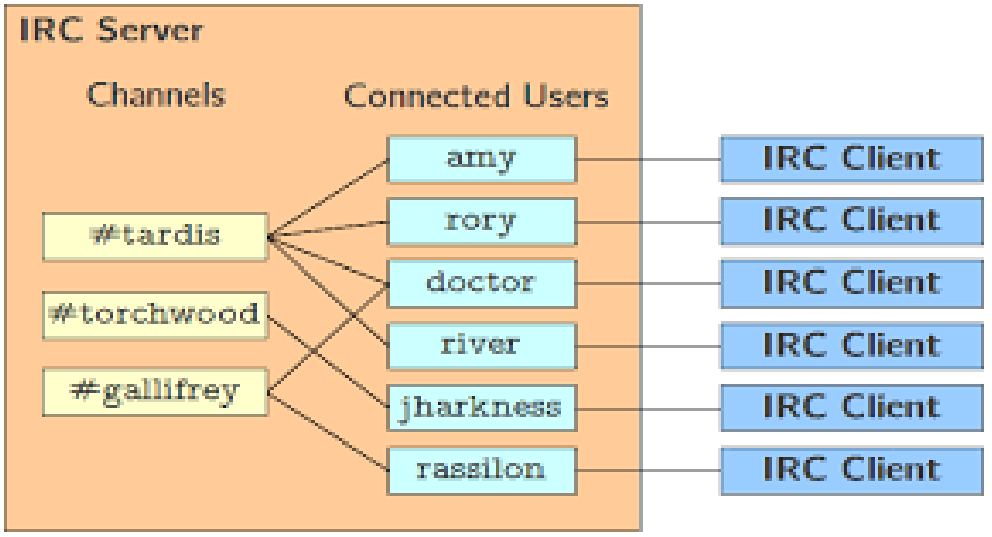
- Synchronous Data Transmission: Data transmission is synchronous, where the timing and data rates for each data channel are fixed and synchronized. This synchronization ensures consistent transmission across channels.
- Constant Data Rates: Each data channel maintains a constant data rate, providing a consistent and predictable transmission speed for the audio data.
- Fixed Time Slots: The time slots allocated for individual data channels remain fixed, implying a structured and predetermined allocation of time for each channel.
- Unequal Forward Error Correction (FEC): The system employs an unequal Forward Error Correction method across different data channels. This likely means that different levels or types of error correction techniques are applied to different channels based on their requirements or priority.
- Modulation Technique: DAB uses COFDM (Coded Orthogonal Frequency Division Multiplexing) as its modulation method. COFDM is known for its resilience to multipath interference and efficient use of bandwidth.
- Transmission Link: The primary transmission link for Digital Audio Broadcast is terrestrial, indicating that it's broadcast over land-based networks (such as antennas, towers, or ground-based transmitters).

Benefits and Implications:

- Consistent Quality: Synchronous transmission with constant data rates and fixed time slots helps maintain consistent audio quality across channels.
- Effective Error Correction: Using unequal FEC allows for customized error correction methods, addressing the varying needs of different channels for optimal error recovery.
- Terrestrial Transmission: Broadcasting via terrestrial links can provide localized coverage and reach specific geographical areas efficiently.
- Overall, a Digital Audio Broadcast system with synchronous transmission, constant data rates, fixed time slots, and COFDM modulation aims to ensure reliable and consistent transmission of audio content over terrestrial networks.

7.2.4 Internet Relay Chat (IRC)

- Internet Relay Chat (IRC) is an application layer protocol that facilitates communication in the form of text.
- The chat process works on a client/server networking model.
- IRC clients are computer programs that a user can install on their system.
- These clients communicate with chat servers to transfer messages to other clients.
- IRC is mainly designed for group communication in discussion forums, called channels, but also allows one-on-one communication via private messages as well as chat and data transfer, including file sharing.
- There are hundreds of IRC channels (discussion areas) around the world, hosted on servers, on which people type their messages to others on the same channel interested in the same subject.
- There are client IRC programs which provide graphical interfaces which make it easier for people log on and access active channels and send and receive the messages.
- IRC chat, at present, is not limited to two people, unlike earlier versions.


IRC Server
Channels
Connected Users
#tardis
#torchwood
#gallifrey
amy
rory
doctor
river
jharkness
rassilon
IRC Client
IRC Client
IRC Client
IRC Client
IRC Client
IRC Client

- The basic architecture of IRC is shown in the figure above.
- In the simplest case, there is a single IRC server to which multiple IRC clients can connect to.
- An IRC client connects to the server with a specific identity. Most notably, each client must choose a unique nickname, or “nick”.
- Once a client is connected, it can communicate one-to-one with other users. Additionally, clients can run commands to query the server’s state (e.g., to obtain a list of connected users, or to obtain additional details about a specific nick).
- IRC also supports the creation of chat rooms called channels for one-to-many communication.
- Users can join channels and send messages to the channel; these messages will, in turn, be sent to every user in the channel.

7.3 Broadband Communications, Policy, xDSL and Cable Internet

7.3.1 Broadband Communication

- Broadband communications are usually considered to be any technology with transmission rates above the fastest speed available over a telephone line.
- Broadband transmission systems typically provide channels for data transmissions in different directions and by many different users. For example, the coaxial CATV system is a broadband system that delivers multiple television channels over the same cable.
- In addition, it can handle data transmissions (primarily Internet access for home users) in an entirely different frequency spectrum.

Typical broadband communication systems include the following:

- ISDN (Integrated Services Digital Network): ISDN is implemented over existing copper telephone cables. The basic rate variety provides two channels of 64-Kbit/sec throughput that can be bonded to form a 128-Kbit/sec data channel. Primary rate ISDN provides additional bandwidth in increments of 64 Kbits/sec.
- ATM (Asynchronous Transfer Mode): Asynchronous Transfer Mode (ATM) is an International Telecommunication Union- Telecommunications Standards Section (ITU-T) that is used to transfer all the services like voice, data, or video. These services can be conveyed in a small fixed-sized packet called the cell. These cells are connected in a network that transmits the data asynchronously.
- Frame Relay: Frame relay is a protocol that defines how frames are routed through a fast-packet network based on the address field in the frame. Like ATM, frame relay is primarily used for corporate rather than home connections.

- DSL (Digital Subscriber Line): DSL is a whole family of high-bandwidth digital services that the telephone companies offer over copper telephone cable. Depending on the service, rates can reach into the multimegabit/sec rates.
- Wireless Communications: A variety of wireless broadband services are now available or under development, including satellite-based systems and terrestrial-based systems that are essentially fixed cellular systems. Broadband wireless uses microwave and millimeter wave technology to transmit signals from base stations to customers.

7.3.3 xDSL

- Digital Subscriber Line is a technology that utilizes high transmission frequencies to convert ordinary conventional phone line into high-speed data conductor.
- DSL technologies use sophisticated modulation schemes to pack data onto copper wires.
- They are sometimes referred to as last-mile technologies because they are used only for connections from a telephone switching station to a home or office, not between switching stations.
- DSL is a family of technologies that are used to transmit digital data over telephone lines.
- In telecommunications marketing, the term DSL is widely understood to mean asymmetric digital subscriber line (ADSL), the most commonly installed DSL technology, for Internet access.
- DSL service can be delivered simultaneously with wired telephone service on the same telephone line. This is possible because DSL uses higher frequency bands for data.

The different DSL technology are as follows:

- ADSL (Asymmetric DSL): Provides faster download speeds than upload speeds, suitable for typical internet usage where users consume more data than they upload.

- VDSL (Very High Bitrate DSL): Offers higher bandwidth capabilities compared to ADSL, enabling faster upload and download speeds.

- SDSL (Symmetric DSL): Provides equal upload and download speeds, ideal for applications requiring symmetrical data transmission.

- HDSL (High Bitrate DSL): Capable of transmitting data at higher rates but typically requires two copper lines for operation.

How xDSL Works:

- xDSL utilizes existing copper telephone lines to carry digital data, allowing simultaneous transmission of voice (telephony) and high-speed internet data.
- It works by using different frequencies to separate voice and data signals, enabling users to make phone calls while accessing the internet.

Advantages of xDSL:

- Availability: Widely available in areas where traditional telephone lines are present, offering internet connectivity without major infrastructure changes.

- Cost-Effective: Utilizes existing infrastructure, making it more cost-effective to deploy compared to laying new cables for broadband.

- Variety of Types: Offers different variants to suit various speed and bandwidth requirements.

7.3.4 Cable Ethernet

- Ethernet uses a communication concept called datagrams to get messages across the network. The Ethernet datagrams take the form of self-contained packets of information. These packages have fields containing information about the data, their origin, their destination and the type of data.
- The data field in each package can contain up to 1500 bytes. It is also provided with the sender address, the receiver address, the stamp indicating what the package's contents are.
- The commonly used network cables: Cat 5, Cat 5e, Cat 6, Cat 6a, Cat7 all have different levels of performance, and therefore to is necessary to buy or select the right cable for the right application.
- These network cables are used for connecting a variety of network elements from Ethernet switches and Ethernet routers to computers, servers and other network items - if there is an Ethernet interface, they can be connected using Ethernet cables.
- The Ethernet cables are available in a variety of lengths as patch cables, or the cable itself is available for incorporating into systems, buildings, etc.

Categories for Ethernet Cables:

- A variety of different cables are available for Ethernet and other telecommunications and networking applications. These network cables that are described by their different categories, e.g. Cat 5 cables, Cat-6 cables, etc., which are often recognized by the TIA (telecommunications Industries Association) and they are summarized below:
- Cat-1: This is not recognized by the TIA/EIA. It is the form of wiring that is used for standard telephone (POTS) wiring, or for ISDN.
- Cat-2: This is not recognized by the TIA/EIA. It was the form of wiring that was used for 4Mbit/s token ring networks.
- Cat-3: This cable is defined in TIA/EIA-568-B. It is used for data networks employing frequencies up to 16 MHz It was popular for use with 10 Mbps Ethernet networks (100 Base-T), but has now been superseded by Cat-5 cable.
- Cat-4: This cable is not recognized by the TIA/EIA. However, it can be used for networks carrying frequencies up to 20 MHz. It was often used on 16 Mbps token ring Networks.

- Cat-5: This is not recognized by the TIA/EIA. This is the network cable that is widely used for 100Base-T and 1000Base-T networks as it provides performance to allow data at 100 Mbps and slightly more (125 MHz for 1000Base-T) Ethernet. Cat 5 cable uses twisted pairs to prevent internal crosstalk, XT and also crosstalk to external wires, AXT. Although not standardized, the Cat 5 cable normally uses 1.5 - 2 twists per centimeter.
- Cat-6: This cable is defined in TIA/EIA-568-B provides a significant improvement in performance over Cat 5 and Cat 5e. During manufacture, Cat 6 cables are more tightly wound than either Cat 5 or Cat 5e and they often have an outer foil or braided shielding. The shielding protects the twisted pairs of wires inside the Ethernet cable, helping to prevent crosstalk and noise interference.

7.4 VoIP, FoIP and IP Interconnection

7.4.1 VoIP

- Voice over Internet Protocol (Voice over IP, VoIP and IP telephony) is a methodology and group of technologies for the delivery of voice communications and multimedia sessions over Internet Protocol (IP) networks, such as the Internet.
- The terms Internet telephony, broadband telephony, and broadband phone service specifically refer to the provisioning of communications services (voice, fax, SMS, voice-messaging) over the public Internet, rather than via the public switched telephone network (PSTN).
- Voice over IP has been implemented in various ways using both proprietary protocols and protocols based on open standards. VoIP protocols include: SIP (Session Initiation Protocol), RTP (Real-time Transport Protocol), Skype.

Advantages of using VoIP over PSTN:

- Cost reduction - low-cost phone calls.
- Convergence of data/voice networks – unification.
- Simplification and consolidation - centralized management.

Transmission of Voice using IP Networks

Step 1: Because all transmissions must be digital, the caller’s voice is digitized.

Step 2: Next using complex algorithms, the digital voice is compressed and then separated into packets; and using the Internet protocol, the packets are addressed and sends across the network to be reassembled in the proper order at the destination.

Step 3: During transmission on the Internet, packets may be lost or delayed, or errors may damage the packets. Conventional error correction techniques would request retransmission of unusable or lost packets, but if the transmission is a real-time voice communication that technique obviously would not work, so sophisticated error detection and correction systems are used to create sound to fill in the gaps.

Step 4: After the packets are transmitted and arrive at the destination, the transmission is assembled and decompressed to restore the data to an approximation of the original form.

VoIP Configurations

a. Dedicated routers :

- These devices allow us to use our traditional phone to place VoIP calls. They are connected to cable/DSL modems (or any high-speed internet source) and allow us to attach an ordinary telephone. Once configured, and with an appropriate VoIP provider and service plan, these devices require no special software or interaction with a computer.

b. Adapters (USB)

- These devices also allow us to use a traditional phone to place VoIP calls. They usually come in the form of USB adapters. They feature a standard modular phone jack to which we can attach an ordinary phone line. Once connected, our phone behaves as if it were connected to standard phone service.

c. Software-Controlled VoIP Applications

- There are many software applications (“softphones”) that allow you to place VoIP phone calls. Using an ordinary computer with a headset, microphone, and sound card. Software-based VoIP applications are quite attractive to consumers. They often already have most of the components. It can start at little to no cost

d. Dedicated VoIP phones

- A VoIP phone looks like an ordinary corded or cordless telephone. It connects directly to a computer network rather than a traditional phone line. It may consist of a phone and base station that connects to the internet. It may also operate on a local wireless network. Like the VoIP adapters mentioned above, dedicated VoIP phones also require a provider and service plan.

H.323 and SIP

- H.323 is an application layer protocol that is utilized for VOIP, and it is a common protocol for audio and video conferences. It is not used for other applications such as application/file-sharing or online games but simply for multimedia conferencing, which makes it simpler than SIP. It is a binary protocol in which messages are compressed to binary, which makes it appropriate for narrowband connections. The high level of interoperability of H.323 is one of its advantages. It contains some additional capabilities like NAT traversal, support for different addressing schemes, data conferencing, and load balancing. It also features mechanisms that ensure reliability by recognizing issues with network connecting equipment.

- SIP (Session Initiation Protocol) is an application layer protocol that is utilized for VOIP. It is utilized to control multimedia communication sessions and may be utilized for online games, fax over IP, instant messaging, video conferencing, and even file transfer. In addition to multimedia conferencing, SIP may be utilized for file sharing, online gaming, instant messaging, and other multimedia communications. In contrast, H.323 only concentrates on multimedia conferencing.

7.4.2 FoIP

- FoIP (Fax over Internet Protocol), also called IP Faxing, is a method of sending faxes over the Internet. FoIP changes the transmission medium of faxing in much the same way that VoIP (Voice over Internet Protocol) changes the transmission medium of a phone call. In both cases, data makes all or most of the trip between sending and receiving devices on a packet-switched network (usually the Internet), avoiding the long-distance phone lines of the circuit-switched telephone network. This reduces the cost of transmission and can be a more efficient setup for a business that already has access to Internet bandwidth.
- The FoIP setup is a lot like the VoIP setup, and you can even send IP faxes using a VoIP server. However, since a fax requires more bandwidth than a voice, a VoIP server doesn't automatically work seamlessly for transmitting faxes. It typically requires some modifications, which you can make by installing a piece of software. Some companies also make servers that are optimized for both VoIP and FoIP applications.

How FoIP Works ?

- FoIP, or Fax over Internet Protocol, enables the transmission of facsimile (fax) documents over the internet using IP networks instead of traditional phone lines. Here's an overview of how FoIP works:
- 1. Protocol and Standards:

  T.38 Protocol: FoIP typically uses the T.38 protocol, specifically designed for real-time fax communications over IP networks. T.38 standardizes the transmission of faxes over IP networks, ensuring reliability and interoperability.

  2. Process of FoIP Transmission:
- Fax to Digital Conversion: The analog fax document is converted into digital format by an Analog Telephone Adapter (ATA), fax server, or specialized FoIP software.
- Packetization: The digitized fax data is packetized into IP packets for transmission over the internet.
- T.38 Protocol Handling: If using T.38, the fax data is encapsulated within T.38 packets, ensuring error correction, real-time delivery, and reliability during transmission.
- Network Transmission: The packets containing fax data are transmitted over the internet using standard IP networking protocols (TCP/IP or UDP/IP), just like other data packets.
- Reception and Reconstruction: At the receiving end, the IP packets are reassembled and converted back to analog signals if necessary, recreating the fax document.

Key Components Involved:

- FoIP Gateway or Server: Responsible for managing the conversion of analog fax signals into digital packets and vice versa.
- Network Infrastructure: Utilizes existing IP-based networks (such as the internet or private networks) for transmitting fax data.
- Fax Machines or Software Clients: Initiates the fax transmission and receives the fax on the recipient's end.

Considerations and Challenges:

- Quality and Reliability: FoIP quality may vary based on network conditions, causing issues like packet loss or delays, affecting the reliability of fax transmissions.
- Interoperability: Ensuring compatibility and adherence to standards (like T.38) across different FoIP systems and devices for seamless communication.
- Security: Encrypting fax data to prevent interception or unauthorized access during transmission over the internet.

7.4.3 IP Interconnection

- Interconnection links networks so as to enable the customers of one operator to establish and maintain communications with the customers of another operator. Interconnection for Internet traffic over IP networks operates according to a different set of rules from telephony. However, an increasing proportion of telephone traffic is carried over IP enabled carrier networks. Such type of interconnection is known as IP Interconnection.

7.5 Datacenters and Data Warehousing, Packet Clearing House

7.5.1 Data Centers

- Data Center is a centralized repository, either physical or virtual, for the storage, management, and dissemination of data and information organized around a particular body of knowledge or pertaining to a particular business.
- It is the brain of a company and the place where the most critical processes are run.
- Example: The Government Integrated Data Center (GIDC) is a data center operated by Government of Nepal at Singha Durbar, Kathmandu.

Importance of Data Centers

- Data centers contain the devices that do the following:

a. Process our business transactions.

b. Host our website.

c. Process and store our intellectual property

d. Maintain our financial records

e. Route our e-mails

- Data center is the brain of any company because data centers enable the company to assist the business to:

a. Perceive the world (data connectivity)

b. Communicate (e-mail)

c. Remember information (data storage)

d. Have new ideas (research and development)

Components of Data Centers

a. Physical space

b. Raised flooring

c. In-room electrical

d. Standby power

e. Data cabling

f. Cooling

g. Fire suppression

Design Considerations

- The various design considerations of the data center can be categorized in five major headings:

1. Design Related Considerations

a. Design programming

b. Modeling criteria

c. Conceptual design

d. Detailed design

e. Mechanical engineering infrastructure designs

f. Electrical engineering infrastructure design

g. Technology infrastructure design

2. Energy Related Considerations

a. Energy efficiency

b. Energy use analysis

c. Power and cooling analysis

d. Low-voltage cable routing

3. Environment Related Considerations

a. Thermal zone mapping

b. Greenhouse gas emissions

c. Environmental control: Metal whiskers

4. Security Related Considerations

a. Fire protection

b. Security

5. Miscellaneous Considerations

a. Site selection

b. Modularity and flexibility

c. Computational fluid dynamics (CFD) analysis

7.5.2 Data Warehouse

- A single, complete and consistent store of data obtained from a variety of different sources made available to end users in a what they can understand and use in a business context is called data warehouse.
- A data warehouse is a:

  a. subject-oriented

  b. integrated

  c. time-varying

  d. non-volatile
- Collection of data that is used primarily in organizational decision making.

Benefits of Data Warehouse

- A data warehouse maintains a copy of information from the source transaction systems. This architectural complexity provides the opportunity to:

  a. Integrate data from multiple sources into a single database and data model.

  b. Mitigate the problem of database isolation level lock contention in transaction processing systems caused by attempts to run large, long running, analysis queries in transaction processing databases.

  c. Maintain data history.

  d. Integrate data from multiple source systems, enabling a central view across the enterprise.

  e. Improve data quality, by providing consistent codes and descriptions, flagging or even fixing bad data.

  f. Present the organization's information consistently.

  g. Provide a single common data model for all data of interest regardless of the data's source.

  h. Restructure the data so that it makes sense to the business users.

  i. Restructure the data so that it delivers excellent query performance, even for complex analytic queries, without impacting the operational systems.

  j. Add value to operational business applications, notably customer relationship management (CRM) systems.

  k. Make decision–support queries easier to write.

  l. Optimized data warehouse architectures allow data scientists to organize and disambiguate repetitive data.

Assignment

Difference between Data Centers, Data Warehouse and Data Mart

7.5.4 Packet Clearing House

- The Packet Clearing House (PCH) is a nonprofit organization that provides operational support and security infrastructure to critical internet resources, particularly focusing on the Domain Name System (DNS) and internet exchange points (IXPs). Here's an overview of the Packet Clearing House:

  Purpose:

- Internet Infrastructure Support: PCH offers services that aid in the stable and secure operation of essential internet infrastructure, including DNS root servers and IXPs.
- Technical Support: Provides technical assistance, capacity building, and operational expertise to internet service providers (ISPs), network operators, and organizations involved in internet infrastructure.

  Key Functions:

  1. DNS Root Server Operations: Operates and maintains authoritative DNS root servers, contributing to the global DNS infrastructure's stability and resilience.

  2. Internet Exchange Points (IXPs):

- Assists in establishing and supporting IXPs, which facilitate efficient interconnection between different internet networks, improving internet performance and reducing latency.

  3.Routing Security and Infrastructure:

- Works on initiatives promoting secure routing, including supporting the implementation of Resource Public Key Infrastructure (RPKI) to enhance routing security.

  4. Data Analysis and Research:

- Conducts research and analysis on internet infrastructure, internet governance, and related technical issues to support informed decision-making.

Contributions to Internet Stability:

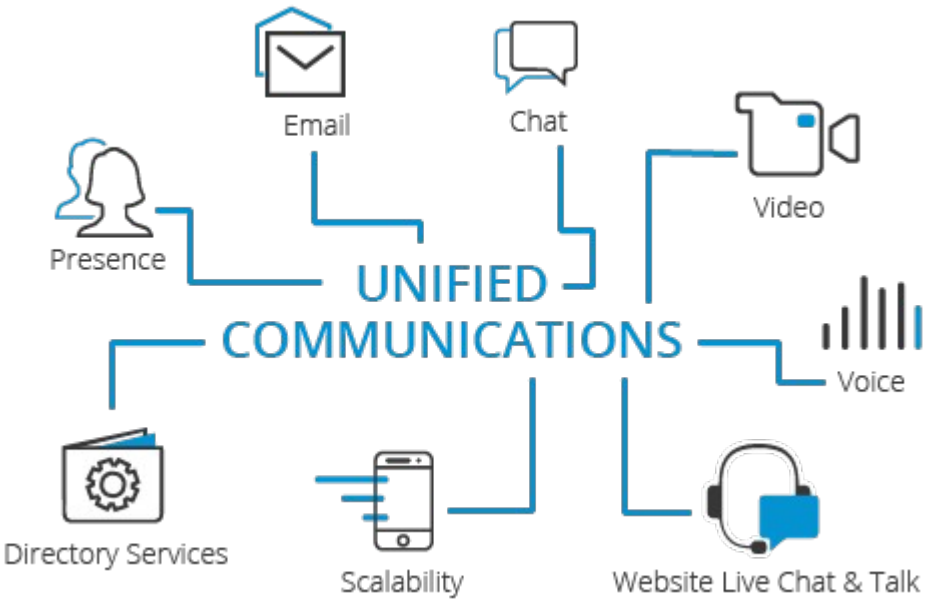
- PCH's activities contribute to the robustness, security, and reliability of the internet's core infrastructure, playing a role in ensuring global connectivity and stability.
- Collaboration and Partnerships:
- Collaborates with various stakeholders, including internet governance bodies, government agencies, regional internet registries (RIRs), and network operators to enhance internet infrastructure and security.

- Importance:
- PCH's efforts are critical in maintaining a resilient and secure internet infrastructure, providing essential support services that underpin the functioning of the internet globally.
- The Packet Clearing House's role in managing and supporting critical internet infrastructure is pivotal in ensuring the reliability, security, and stability of the internet's core elements, contributing to the overall functionality of the global internet ecosystem.

7.6. Unified Messaging Systems

- Unified Messaging (UM) is the integration of different electronic messaging and communications media (e-mail, SMS, Fax, voicemail, video messaging, etc.) technologies into a single interface, accessible from a variety of different devices.
- Importance of Unified Messaging System

  1. Reduces travel and administrative costs
  2. Lowers IT and other operational costs
  3. Better workforce collaboration
  4. Secure communication


Email
Chat
Video
Presence
UNIFIED
COMMUNICATIONS
Voice
Directory Services
Scalability
Website Live Chat & Talk

7.7 Fundamental of E-Commerce

- E-commerce is the technical term for buying and selling things through the electronic media. E-commerce relies on technology and digital platforms, including websites, mobile apps and social media to make buying and selling possible.

  7.7.1 Building Blocks (Components) of E-commerce

- E-commerce comprises of the following elemens:

  i. Website

  ii. Shopping Cart Software

  iii. Ecommerce Payment Methods

  iv. Payment Gateway

  v. Merchant Bank

  vi. SSL

7.7.2 Classification of E-Commerce Applications

i. Electronic Markets: The principal function of an electronic market is to facilitate the search for the required product or service. Airline booking systems are an example of an electronic market.

ii. Electronic Data Interchange (EDI): Electronic Data Interchange (EDI) is the electronic exchange of business documents in a standard, computer processable, universally accepted format between-trading partners. EDI is quite different from sending electronic mail, messages or sharing files through a network.

iii. Internet Commerce: The Internet (and similar network facilities) can be used for advertising goods and services and transacting one-off deals. Internet commerce has application for both business-to-business and business to consumer transactions.

7.7.3 Types of E-Commerce

i. B2B (Business to Business): The two businesses pass information electronically to each other. B2B e-commerce currently makes up about 94% of all ecommerce transactions.

ii. B2C (Business to Consumer): This is where the consumer accesses the system of the supplier. It is still a two-way function but is usually done solely through the Internet.

iii. C2B (Consumer to Business): Consumer to Business is a growing arena where the consumer requests a specific service from the business.

iv. B2E (Business to Employee): Business to Employee e- commerce is growing in use. This form of E-commerce is more commonly known as an ‘Intranet’.

v. C2C (Consumer to Consumer): The consumer lists items for sale with a commercial auction site. Other consumers access the site and place bids on the items. The site then provides a connection between the seller and buyer to complete the transaction.

- Note: Other types of e-commerce include Government to Government (G2G), Government to Consumer (G2C), Consumer to Government (C2G), Government to Business (G2B), Business to Government (B2G)

Scope of e-commerce:

i. Selling can be focused to the global customer
ii. Pre-sales, subcontracts, supply
iii. Financing and insurance
iv. Commercial transactions: ordering, delivery, payment
v. Product service and maintenance
vi. Co-operative product development
vii. Distributed co-operative working
viii. Use of public and private services
ix. Business-to-administrations (e.g., customs, etc.)
x. Transport and logistics
xi. Public procurement
xii. Automatic trading of digital goods
xiii. Accounting
xiv. Dispute resolution

Advantages of e-commerce:

i. Saves the cost and time of setting up and maintaining a physical store

ii. Provides customers the convenience of shopping from anywhere, anytime

iii. Maintains every business transaction detail, even the smallest one

iv. Makes the shop accessible to customers from all over the globe

v. Many customers can be simultaneously attended to

vi. Checks fraudulent transaction attempts

vii. Helps take business beyond the borders of your country or locality, offering you the potential for exponential growth

viii. Helps the merchant to offer a competitive price to the buyers, by giving discounts and other lucrative offers

ix. Provides money back guarantee for ensuring customer satisfaction

x. By linking to other affiliate sites, helps customers to find related things of interest

Disadvantages of e-commerce:

i. E-commerce lacks personal touch

ii. E-commerce delays goods

- E-commerce websites sometimes take a lot longer to deliver the goods into our hands.

iii. Many goods cannot be purchased online

iv. Anyone can set up an e-commerce website

- Since anyone can set up an e-commerce website, there is a problem of how to verify the store from where we are purchasing is genuine.

v. Security

- When making an online purchase, we have to provide at least our credit card information and mailing address. In many cases, e-commerce websites are able to harvest other information about our online behavior and preferences. This could lead to credit card fraud, or worse, identity theft.

7.7.4 Electronic Payment System

- E-Commerce or Electronics Commerce sites use electronic payment where electronic payment refers to paperless monetary transactions. Electronic payment has revolutionized the business processing by reducing paper work, transaction costs, labor cost. Being user friendly and less time consuming than manual processing, helps business organization to expand its market reach / expansion. Some of the modes of electronic payments are following.

  i. Credit card: When a customer purchases a product via credit card, credit card issuer bank pays on behalf of the customer and customer has a certain time period after which he/she can pay the credit card bill. It is usually credit card monthly payment cycle.

  ii. Debit card: Debit card, like credit card is a small plastic card with a unique number mapped with the bank account number. It is required to have a bank account before getting a debit card from the bank. The major difference between debit card and credit card is that in case of payment through debit card, amount gets deducted from card's bank account immediately and there should be sufficient balance in bank account for the transaction to get completed.

  Whereas in case of credit card there is no such compulsion. Debit cards free customer to carry cash, cheques and even merchants accept debit card more readily. Having restriction on amount being in bank account also helps customer to keep a check on his/her spending.

iii. Smart card: Smart card is again similar to credit card and debit card in appearance but it has a small microprocessor chip embedded in it. It has the capacity to store customer work related/personal information. Smart card is also used to store money which is reduced as per usage. Smart card can be accessed only using a PIN of customer. Smart cards are secure as they store information in encrypted format and are less expensive/provides faster processing. Mondex and Visa Cash cards are examples of smart cards.

iv. E-money: E-money transactions refers to situation where payment is done over the network and amount gets transferred from one financial body to another financial body without any involvement of a middleman. E-money transactions are faster, convenient and saves a lot of time. Online payments done via credit card, debit card or smart card are examples of e-money transactions. Another popular example is e-cash. In case of e-cash, both customer and merchant both have to sign up with the bank or company issuing e-cash.

v. Electronic fund transfer (EFT): It is a very popular electronic payment method to transfer money from one bank account to another bank account. Accounts can be in same bank or different bank. Fund transfer can be done using ATM (Automated Teller Machine) or using computer.

7.8 Concept of Grid and Cloud Computing

7.8.1 Grid Computing

- Grid computing is a computing infrastructure that combines computer resources spread over different geographical locations to achieve a common goal. All unused resources on multiple computers are pooled together and made available for a single task.
- For example, meteorologists use grid computing for weather modeling. Since weather modeling requires processing huge amounts of weather data, using a single computer is slow and time consuming. Due to this reason, meteorologists run the analysis of weather data over geographically dispersed grid computing infrastructure and combine the results.

Why is grid computing important?

Grid computing is important for several reasons:

- Efficiency: With grid computing, we can break down large, complex tasks into multiple subtasks. And multiple computers can work on the subtasks concurrently, making grid computing an efficient computational model.
- Cost: Grid computing works with existing hardware, which means we can reuse existing computational resources.
- Flexibility: Grid computing is not constrained to a specific location. Grid computing network can be set up spanning several regions. This enables researches from different geographical location to work collaboratively.

Characteristics of grid computing:

i. Large scale

ii. Geographical distribution

iii. Heterogeneity

iv. Resource sharing

v. Multiple administration

vi. Transparent access

vii. Dependable access

viii. Consistent/reliable access

ix. Pervasive/universal access

Advantages:

i. Can solve larger, more complex problem in short time.

ii. Easier to collaborate with other organization.

iii. Make better use of existing hardware.

Disadvantages:

i. Grid software and standards are still evolving.

ii. Non-interactive job submission.

Some challenges in grid computing:

- Data movement
- Data replication
- Resource management
- Job submission

Some grid applications:

- Distributed supercomputing: aggregate computational resources to tackle problems that cannot be solved by a single system. Examples: climate modeling, computational chemistry.
- High-throughput computing: Schedule large numbers of independent tasks. Goal is to exploit unused CPU cycles (e.g., from idle workstations). Examples: parameter studies, cryptographic problems.
- On-demand computing: Use grid capabilities to meet short-term requirements for resources that cannot conveniently be located locally. It is used to dispatch expensive or specialized computations to remote servers.
- Data-intensive computing: Synthesize data in geographically distributed repositories.
- Collaborative computing: Enable shared use of data archives and simulations.

7.8.2 Cloud Computing

- Cloud computing refers to the delivery of computing services—including servers, storage, databases, networking, software, analytics, and more—over the internet, often referred to as "the cloud."
- It is a model for enabling universal, on demand access to a shared pool of configurable computing resources, which can be rapidly provisioned and released with minimal management efforts.
- Key Characteristics:

  a. On-Demand Service: Users can access computing resources on-demand without the need for physical infrastructure setup, often paying for what they use (pay-as-you-go model).

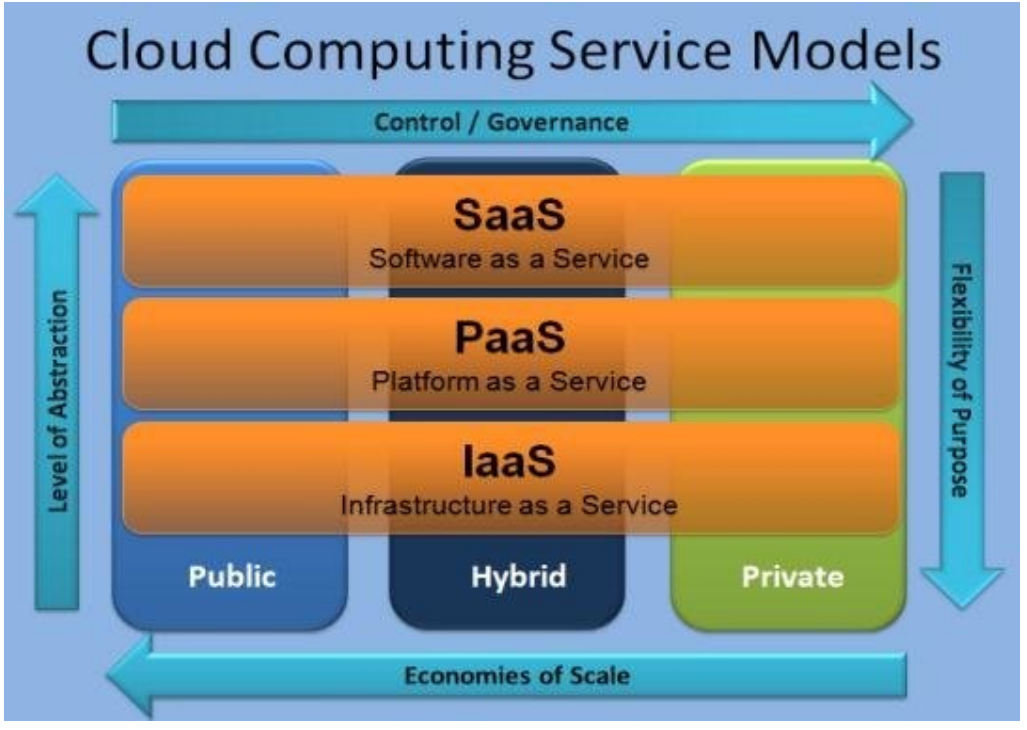
  b. Scalability: Cloud services offer scalability, allowing users to easily scale up or down their resources based on their needs, providing flexibility and cost-efficiency.

  c. Resource Pooling: Computing resources are shared and pooled among multiple users, enabling efficient resource utilization and cost-sharing.

  d. Self-Service Interface: Users can provision and manage resources through a web-based dashboard or API without direct intervention from service providers.

Cloud Computing Service Models

- IAAS (Infrastructure as a Service)
- PAAS (Platform as a Service)
- SAAS (Software as a Service)



1. Software as a Service (SaaS)

- Software as a service (SaaS) is a method of delivering applications as a service over the Internet. Instead of installing and maintaining software, we simply use the Internet to access it. This frees us from the hassles of software and hardware management.
- There are many types of software that lend themselves to the SaaS model. Typically, software that performs a simple task without much need to interact with other systems is best suited for SaaS. Customers who are not inclined to perform software development but have need of high- powered applications can also benefit from SaaS.
- Some of these applications include:
  - Customer resource management (CRM)
  - Video conferencing
  - IT service management
  - Accounting
  - Web analytics
  - Web content management
- Examples: Google Workspace, Salesforce, Microsoft

2. Platform as a Service (PaaS)

- Platform as a service (PaaS) is a cloud computing model that provides all the resources required to build applications and services completely from the Internet, without having to download or install software.
- PaaS services include application design, development, testing, deployment, and Hosting.
- Examples: Google App Engine, Mosso, AWS: S3

3. Infrastructure as a Service (IaaS)

- Infrastructure as a service (IaaS) is a cloud computing model that provides the hardware so that our organization can put whatever they want onto it.
- Rather than purchase servers, software, racks, and having to pay for the datacenter space for them, the service provider rents those resources.
- IaaS allows us to “rent” such resources as
  - Server space
  - Network equipment
  - Memory
  - CPU cycles
  - Storage space
- Examples: Flexiscale, AWS: EC2

Cloud Computing Deployment Models

1. Public Cloud

- A public cloud (also called external cloud) is a cloud computing deployment model, in which a service provider makes resources, such as applications and storage, available to the general public over the Internet. Public cloud services may be free or offered on a pay-per-usage model.

2. Private Cloud

- Private cloud (also called internal cloud or corporate cloud) is a marketing term for a proprietary company architecture that provides hosted services to a limited number of people behind a firewall.
- Advances in virtualization and distributed computing have allowed corporate network and data-center administrators to effectively become service providers that meet the needs of their "customers" within the corporation.

3. Hybrid Cloud

- A hybrid cloud is a composition of at least one private cloud and at least one public cloud.
- A hybrid cloud is typically offered in one of two ways: a vendor has a private cloud and forms a partnership with a public cloud provider, or a public cloud provider forms a partnership with a vendor that provides private cloud platforms.

Advantages of cloud computing:

a. Back-up and restore data:

- It is easier to back up and restore data once it has been stored in the cloud.

b. Mobility:

- Cloud computing allows us to easily access all cloud data via mobile.

c. Data security:

- The cloud provides many advanced security features that ensure data is stored and handled safely.

d. Reliability:

- We can always get instant updates about changes with cloud computing.

e. High speed:

- Due to faster deployment, we can get the resources needed for our system in less time.

f. Quick deployment:

- Cloud computing allows us to deploy applications quickly. When we choose to use the cloud, our entire system can be up and running in a matter of minutes.

Disadvantages of cloud computing:

a. Internet connectivity:

- In cloud computing, all data is stored in the cloud, and we access it via the cloud via an internet connection. We will be unable to access these files if your internet connection is poor. We don't have any other way to get data from the cloud, though.

b. Vendor lock-in:

- When transferring services from one vendor to another, organizations may run into issues. Because different vendors offer different platforms, moving from one cloud to another can be difficult.

c. Limited control:

- Because the service provider owns, manages and monitors the cloud infrastructure, cloud users have less control over the function and execution of services within the cloud infrastructure.

d. Security:

- Although cloud service providers adheres to the highest security standards when storing sensitive data, however, we should be aware that by using cloud technology, we will be sending all of our company's sensitive data to a third party, namely a cloud computing service provider. While sending data to the cloud, there is a chance that hackers will gain access to our company's information.