[Unit 7: Internet and Intranet Applications]
Internet Technology (CSC-402)

Jagdish Bhatta

Central Department of Computer Science & Information Technology
Tribhuvan University

Internet and Intranet Systems Development

Email:

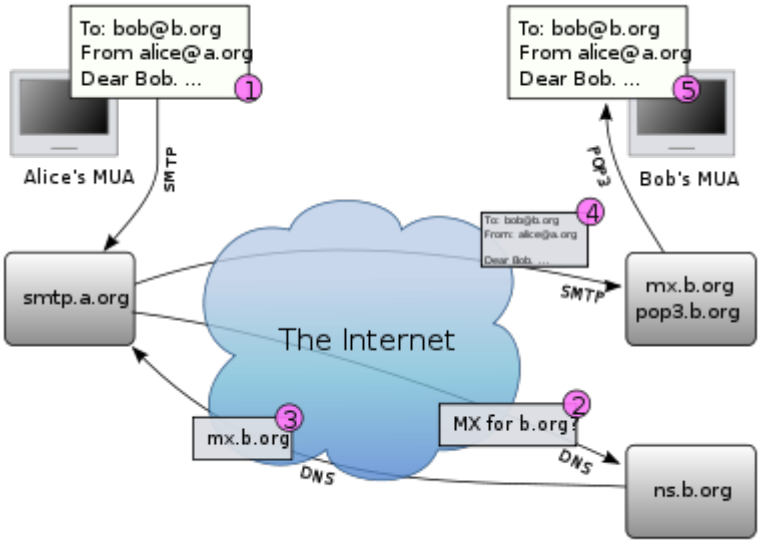
Electronic mail, also known as **email** or **e-mail**, is a method of exchanging digital messages from an author to one or more recipients. Modern email operates across the Internet or other computer networks. Some early email systems required that the author and the recipient both be online at the same time, in common with instant messaging. Today's email systems are based on a store-and-forward model. Email servers accept, forward, deliver and store messages. Neither the users nor their computers are required to be online simultaneously; they need connect only briefly, typically to an email server, for as long as it takes to send or receive messages.

An Internet email message consists of three components, the message *envelope*, the message *header*, and the message *body*. The message header contains control information, including, minimally, an originator's email address and one or more recipient addresses. Usually descriptive information is also added, such as a subject header field and a message submission date/time stamp.

Network-based email was initially exchanged on the ARPANET in extensions to the File Transfer Protocol (FTP), but is now carried by the Simple Mail Transfer Protocol (SMTP). In the process of transporting email messages between systems, SMTP communicates delivery parameters using a message *envelope* separate from the message (header and body) itself.

Operation Overview:

Following it shows a typical sequence of events that takes place when Alice composes a message using her mail user agent (MUA). She enters the email address of her correspondent, and hits the "send" button.



1. Her MUA formats the message in email format and uses the Submission Protocol (a profile of the Simple Mail Transfer Protocol (SMTP),) to send the message to the local mail submission agent (MSA), in this case smtp.a.org, run by Alice's internet service provider (ISP).

2. The MSA looks at the destination address provided in the SMTP protocol (not from the message header), in this case bob@b.org. An Internet email address is a string of the formlocalpart@exampledomain. The part before the @ sign is the *local part* of the address, often the username of the recipient, and the part after the @ sign is a domain name or a fully qualified domain name. The MSA resolves a domain name to determine the fully qualified domain name of the mail exchange server in the Domain Name System (DNS).

3. The DNS server for the b.org domain, ns.b.org, responds with any MX records listing the mail exchange servers for that domain, in this case mx.b.org, a message transfer agent (MTA) server run by Bob's ISP. A **mail exchanger record** (**MX record**) is a type of resource record in the Domain Name System that specifies a mail server responsible for accepting email messages on behalf of a recipient's domain, and a preference value used to prioritize mail delivery if multiple mail servers are available.

4. smtp.a.org sends the message to mx.b.org using SMTP.

This server may need to forward the message to other MTAs before the message reaches the final message delivery agent (MDA).

1. The MDA delivers it to the mailbox of the user bob.
2. Bob presses the "get mail" button in his MUA, which picks up the message using either the Post Office Protocol (POP3) or the Internet Message Access Protocol (IMAP4).

Message Format:

The Internet email message format is now defined with multi-media content attachments collectively called *Multipurpose Internet Mail Extensions* or *MIME*. Internet email messages consist of two major sections:

Header – Structured into fields such as From, To, CC, Subject, Date, and other information about the email.

Body – The basic content, as unstructured text; sometimes contains a signature block at the end. This is exactly the same as the body of a regular letter.

The header is separated from the body by a blank line.

Message Header:

Each message has exactly one header, which is structured into fields. Each field has a name and a value. Email header fields can be multi-line, and each line should be at most 78 characters long and in no event more than 998 characters long.

The message header must include at least the following fields:

- ***From*:** The email address, and optionally the name of the author(s). In many email clients not changeable except through changing account settings.
- ***Date*:** The local time and date when the message was written. Like the *From:* field, many email clients fill this in automatically when sending. The recipient's client may then display the time in the format and time zone local to him/her.

The message header should include at least the following fields:

- ***Message-ID*:** Also an automatically generated field; used to prevent multiple delivery and for reference in In-Reply-To:
- ***In-Reply-To*:** Message-ID of the message that this is a reply to. Used to link related messages together. This field only applies for reply messages.

Common header fields for email include:

- ***To*:** The email address(es), and optionally name(s) of the message's recipient(s). Indicates primary recipients (multiple allowed), for secondary recipients (Cc: and Bcc:)
- ***Subject*:** A brief summary of the topic of the message. Certain abbreviations are commonly used in the subject, including "RE:" and "FW:".
- ***Bcc*:** Blind Carbon Copy; addresses added to the SMTP delivery list but not (usually) listed in the message data, remaining invisible to other recipients.
- ***Cc*:** Carbon copy; Many email clients will mark email in your inbox differently depending on whether you are in the To: or Cc: list.
- **Content-Type:** Information about how the message is to be displayed, usually a MIME type.
- ***Precedence*:** commonly with values "bulk", "junk", or "list"; used to indicate that automated "vacation" or "out of office" responses should not be returned for this mail, e.g. to prevent vacation notices from being sent to all other subscribers of a mailing list. Sendmail uses this header to affect prioritization of queued email, with "Precedence: special-delivery" messages delivered sooner. With modern high-bandwidth networks delivery priority is less of an issue than it once was. Microsoft Exchange respects a fine-grained automatic response suppression mechanism, the X-Auto-Response-Suppress header.

- ***References*:** Message-ID of the message that this is a reply to, and the message-id of the message the previous reply was a reply to, etc.
- ***Reply-To*:** Address that should be used to reply to the message.
- ***Sender*:** Address of the actual sender acting on behalf of the author listed in the From: field (secretary, list manager, etc.).
- ***Archived-At*:** A direct link to the archived form of an individual email message

Message Body:

Most modern graphic email clients allow the use of either plain text or HTML for the message body at the option of the user. HTML email messages often include an automatically generated plain text copy as well, for compatibility reasons.

Advantages of HTML include the ability to include in-line links and images, set apart previous messages in block quotes, wrap naturally on any display, use emphasis such as underlines and italics, and change font styles.

Client/server applications for accessing mail

Messages are exchanged between hosts using the Simple Mail Transfer Protocol with software programs called mail transfer agents (MTAs); and delivered to a mail store by programs called mail delivery agents (MDAs, also sometimes called local delivery agents, LDAs). Users can retrieve their messages from servers using standard protocols such as POP or IMAP.

Mail can be stored on the client, on the server side, or in both places. Standard formats for mailboxes include Maildir and mbox. Several prominent email clients use their own proprietary format and require conversion software to transfer email between them. Server-side storage is often in a proprietary format but since access is through a standard protocol such as IMAP, moving email from one server to another can be done with any MUA supporting the protocol.

Accepting a message obliges an MTA to deliver it, and when a message cannot be delivered, that MTA must send a bounce message back to the sender, indicating the problem.

File name extensions:

Upon reception of email messages, email client applications save messages in operating system files in the file system. Some clients save individual messages as separate files, while others use various database formats, often proprietary, for collective storage. A historical standard of storage is the *mbox* format. The specific format used is often indicated by special filename extensions:

eml: Used by many email clients including Microsoft Outlook Express, Windows Mail and Mozilla Thunderbird. The files are plain text in MIME format, containing the email header as well as the message contents and attachments in one or more of several formats.

emlx: Used by Apple Mail.

msg: Used by Microsoft Office Outlook and OfficeLogic Groupware.

mbx: Used by Opera Mail, KMail, and Apple Mail based on the mbox format.

Types:

Web-Based Email (Webmail): This is the type of email that most users are familiar with. Many free email providers host their serves as web-based email. (e.g.: Hotmail, Yahoo, Gmail, AOL). This allows users to log into the email account by the help of a Internet browser to send and receive their email. Its main disadvantage is the need to be connected to the internet while using it. There exist also other software tools to integrate parts of the webmail functionality into the OS (e.g. creating messages directly from third party applications via MAPI).

POP3 Email Services: POP3 is the acronym for Post Office Protocol 3. It is a leading email account type on the Internet. In a POP3 email account, your email messages are downloaded to your computer and then they are deleted from the mail server. It is difficult to save and view your messages on multiple computers. Also, the messages you send from the computer are not copied to the Sent Items folder on the computers. The messages are deleted from the server to make room for more incoming messages. POP supports simple download-and-delete requirements for access to remote mailboxes (termed maildrop in the POP RFC's). Although most POP clients have an option to leave messages on the server after downloading a copy of them, most e-mail clients using POP3 simply connect, retrieve all messages, store them on the user's computer as new messages, delete them from the server, and then disconnect. Other protocols, notably IMAP, (Internet Message Access Protocol) provide more complete and complex remote access to typical mailbox operations. Many e-mail clients support POP as well as IMAP to retrieve messages; however, fewer Internet Service Providers (ISPs) support IMAP.

IMAP Email Servers: IMAP refers to Internet Message Access Protocol. It is an alternate to the POP3 email. With an Internet Message Protocol (IMAP) account, you have access to mail folders on the mail server and you can use any computer to read your messages wherever you are. It shows the headers of your messages, the sender and it is subject and choose to download only those messages you need to read. Usually mail is saved on the mail server, therefore it is safer and it is backed up on the email server.

MAPI Email Servers: Messaging Application Programming Interface (MAPI) is a messaging architecture and a Component Object Model based API for Microsoft Windows.

MIME: Multipurpose Internet Mail Extensions (MIME):

It is an Internet standard that extends the format of email to support:

- Text in character sets other than ASCII
- Non-text attachments
- Message bodies with multiple parts
- Header information in non-ASCII character sets

The basic Internet email transmission protocol, SMTP, supports only 7-bit ASCII characters. MIME defines mechanisms for sending other kinds of information in email. These include text in languages other than English using character encodings other than ASCII, and 8-bit binary content such as files containing images, sounds, movies, and computer programs. Mapping messages into and out of MIME format is typically done automatically by an email client or by mail servers when sending or receiving Internet (SMTP/MIME) email.

Gopher:

The **Gopher protocol** is a TCP/IP application layer protocol designed for distributing, searching, and retrieving documents over the Internet. Strongly oriented towards a menu-document design, the Gopher protocol presented an attractive alternative to the World Wide Web in its early stages, but ultimately failed to achieve popularity.

Gopher is a protocol system, which in advance of the World Wide Web, allowed server based text files to be hierarchically organised and easily viewed by end users who accessed the server using Gopher applications on remote computers. Initially Gopher browsers could only display text-based files before developments such as HyperGopher, which were able to handle simple graphic formats though they were never used on a widespread basis

as by this time the World Wide Web and its Hypertext Transfer Protocol (HTTP) were gaining in popularity, and had similar and more extensive functions.

Its central goals were,

- A file-like hierarchical arrangement that would be familiar to users.
- A simple syntax.
- A system that can be created quickly and inexpensively.
- Extending the file system metaphor, such as searches.

Gopher uses a server-client protocol to access and manage the files. Gopher clients use the TCP port 70 to connect to the Gopher servers. The server sends a list of files available, with each line having a standard code that identifies the type of file. It uses 0 for files, 1 for directories and 7 for search services. Other code parts include the selector string, which is the part that needs to be sent back to the server in order to get the requested resource, the server port name and the port number.

Gopher faced some serious competition from the Hypertext Transfer Protocol, or HTTP, since the linking could be done from directly within the documents instead of having to be done from the servers. HTTP also overtakes Gopher when it comes to displaying information, because unlike Gopher which only uses text, the HTTP protocol can present the information in any shape and with pictures.

The main advantage of Gopher is its simplicity. It assures compatibility between platforms, and the bandwidth usage is minimal. The fact that linking needed to be done directly by the servers was considered by some a cleaner approach.

The Gopher protocol is now obsolete and it's not used anymore. Due to its limitations, it lost the competition against the Internet. All files in the system were converted to be compatible with the HTTP protocol, and most of the Gopher servers are offline. The final hit for the Gopher was delivered in 2002 when a security breach related to Gopher was found in Internet Explorer, and Microsoft decided to retract its support for the Gopher protocol.

Multimedia and Digital Video/Audio Broadcasting:

Digital Video Broadcasting (**DVB**) is a suite of internationally accepted open standards for digital television. DVB systems distribute data using a variety of approaches, including:

- Satellite: DVB-S, DVB-S2 and DVB-SH
- DVB-SMATV for distribution via SMATV
- Cable: DVB-C, DVB-C2
- Terrestrial television: DVB-T, DVB-T2
- Digital terrestrial television for handhelds: DVB-H, DVB-SH
- Microwave: using DTT (DVB-MT), the MMDS (DVB-MC), and/or MVDS standards (DVB-MS)

These standards define the physical layer and data link layer of the distribution system. Devices interact with the physical layer via a synchronous parallel interface (SPI), synchronous serial interface (SSI), or asynchronous serial interface (ASI). All data is transmitted in MPEG transport streams with some additional constraints (DVB-MPEG).

Digital Video Broadcasting (DVB) is a set of standards that define digital broadcasting using existing satellite, cable, and terrestrial infrastructures. In the early 1990s, European broadcasters, consumer equipment manufacturers, and regulatory bodies formed the European Launching Group (ELG) to discuss introducing digital television (DTV) throughout Europe.

The main forms of DVB are summarised below:

DVB STANDARD	MEANING	DESCRIPTION
DVB-C	Cable	The standard for delivery of video service via cable networks.
DVB-H	Handheld	DVB services to handheld devices, e.g. mobile phones, etc
DVB-RSC	Return satellite channel	Satellite DVB services with a return channel for interactivity.
DVB-S	Satellite services	DVB standard for delivery of television / video from a satellite.
DVB-SH	Satellite handheld	Delivery of DVB services from a satellite to handheld devices
DVB-S2	Satellite second generation	The second generation of DVB satellite broadcasting.
DVB-T	Terrestrial	The standard for Digital Terrestrial Television Broadcasting.

Digital Audio Broadcasting:

Traditionally radio programmes were broadcast on different frequencies via FM and AM, and the radio had to be tuned into each frequency, as needed. This used up a comparatively large amount of spectrum for a relatively small number of stations, limiting listening choice. DAB is a digital radio broadcasting system that through the application of multiplexing and compression combines multiple audio streams onto a relatively narrow band centered on a single broadcast frequency called a DAB ensemble.

Digital audio broadcasting (DAB), also known as digital radio and high-definition radio, is audio broadcasting in which analog audio is converted into a digital signal and transmitted on an assigned channel in the AM or (more usually) FM frequency range. DAB is said to offer compact disc (CD)- quality audio on the FM (frequency modulation) broadcast band and to offer FM-quality audio on the AM (amplitude modulation) broadcast band. The technology was first deployed in the United Kingdom in 1995, and has become common throughout Europe.

It is an entirely new system for broadcasting and receiving radio stations. As the name indicates signals are broadcast in a digital format to enable CD quality to be achieved.

Within an overall target bit rate for the DAB ensemble, individual stations can be allocated different bit rates. The number of channels within a DAB ensemble can be increased by lowering average bit rates, but at the expense of the quality of streams. Error correction under the DAB standard makes the signal more robust but reduces the total bit rate available for streams.

Advantages of DAB over analogue systems:

- **Improved features for users:** DAB radios automatically tune to all the available stations, offering a list for the user to select from.
- **More stations:** DAB is not more bandwidth efficient than analogue measured in programmes per MHz of a specific transmitter
- **Reception quality:** The DAB standard integrates features to reduce the negative consequences of multipath fading and signarl noise, which afflict existing analogue systems.
- **Less pirate interference:** The specialized nature and cost of DAB broadcasting equipment provide barriers to pirate radio stations broadcasting on DAB.
- **Variable bandwidth**
- **Transmission costs:** It is common belief that DAB is more expensive to transmit than FM. It is true that DAB uses higher frequencies than FM and therefore there is a need to compensate with more transmitters, higher radiated powers, or a combination, to achieve the same coverage. A DAB network is also more expensive than an FM network. However, the last couple of years has seen significant improvement in power efficiency for DAB-transmitters.

Internet Relay Chat (IRC):

Internet Relay Chat is a method to broadcast and receive live, synchronous, messages. **Internet Relay Chat** (**IRC**) is a protocol for real-time Internet text messaging (chat) or synchronous conferencing. It is mainly designed for group communication in discussion forums, called *channels*, but also allows one-to-one communication via private message as well as chat and data transfer, including file sharing.

To join an IRC discussion, you need an *IRC client* and Internet access. The IRC client is a program that runs on your computer and sends and receives messages to and from an IRC *server*. The IRC server, in turn, is responsible for making sure that all messages are broadcast to everyone participating in a discussion. There can be many discussions going on at once; each one is assigned a unique *channel*.

IRC (Internet Relay Chat) is a real-time multi-user messaging system. Users connect to an IRC server and join one or multiple channels or enter into one-on-one chats with individual users. Users type in messages (up to a few hundred characters long, I'm not sure what the actual limits are) and send them to the channel they are in. Other people in that channel then receive the messages that everyone else has sent. The server is a central point of contact for the channel and serves as a relay for the messages from each user, thus the name. Additionally, servers can be chained together, relaying their traffic back and forth. Typically, an IRC client will render the conversations in a channel as an upward scrolling list of messages in

chronological order, with each message on one or several lines (depending on length) and prefixed with some username identifier and perhaps other information (such as a time stamp) depending on the individual configuration of the client.

Components of IRC:

Servers: The server forms the backbone of IRC as it is the only component of the protocol which is able to link all the other components together: it provides a point to which clients may connect to talk to each other, and a point for other servers to connect to. The server is also responsible for providing the basic services defined by the IRC protocol.

Clients: A client is anything connecting to a server that is not another server. There are two types of clients which both serve a different purpose.

User Clients: User clients are generally programs providing a text based interface that is used to communicate interactively via IRC. This particular type of clients is often referred as "users".

Service Clients: Unlike users, service clients are not intended to be used manually nor for talking. They have a more limited access to the chat functions of the protocol, while optionally having access to more private data from the servers. Services are typically automatons used to provide some kind of service (not necessarily related to IRC itself) to users. An example is a service collecting statistics about the origin of users connected on the IRC network.

Architecture of IRC:

An IRC network is defined by a group of servers connected to each other. A single server forms the simplest IRC network. The only network configuration allowed for IRC servers is that of a spanning tree where each server acts as a central node for the rest of the network it sees.

The IRC protocol provides no mean for two clients to directly communicate. All communication between clients is relayed by the server(s).

IRC Protocol Services:

This section describes the services offered by the IRC protocol. The combinations of these services allow real-time conferencing.

Client Locator: To be able to exchange messages, two clients must be able to locate each other. Upon connecting to a server, a client registers using a label which is then used by other servers and clients to know where the client is located. Servers are responsible for keeping track of all the labels being used.

Message Relaying: The IRC protocol provides no mean for two clients to directly communicate. All communication between clients is relayed by the server(s).

Channel Hosting and Management: A channel is a named group of one or more users which will all receive messages addressed to that channel. A channel is characterized by its name and current members, it also has a set of properties which can be manipulated by (some of) its members. Channels provide a mean for a message to be sent to several clients. Servers host channels, providing the necessary message multiplexing. Servers are also responsible for managing channels by keeping track of the channel members. The exact role of servers is defined in "Internet Relay Chat: Channel Management".

Broadband Communication:

The term ***broadband*** refers to a telecommunications signal or device of greater bandwidth, in some sense, than another standard or usual signal or device (and the broader the band, the greater the capacity for traffic).

XDSL:

XDSL Refers collectively to all types of ***d****igital* ***s****ubscriber* ***l****ines,* the two main categories being ADSL and SDSL. Two other types of xDSL technologies are *High-data-rate DSL (HDSL)* and *Very high DSL (VDSL)*.

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.

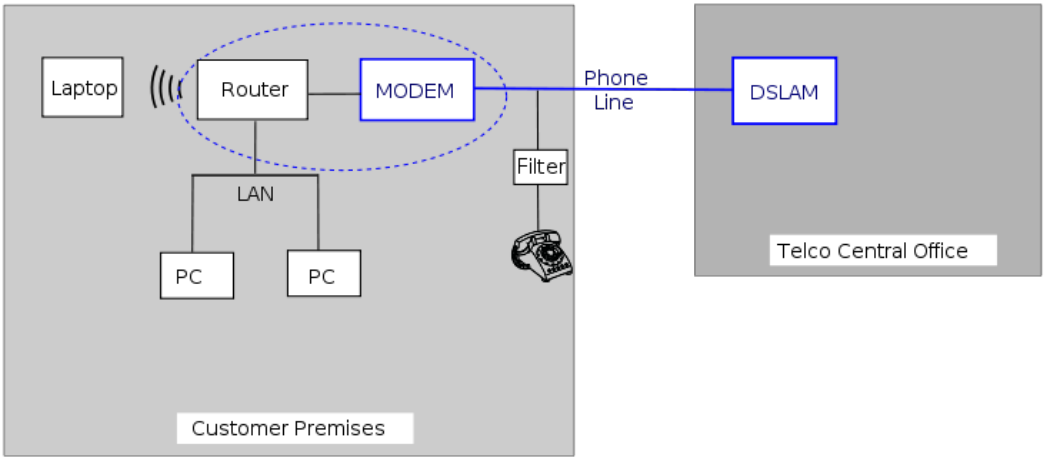
Digital subscriber line (**DSL**, originally **digital subscriber loop**) is a family of technologies that provide internet access by transmitting digital data over the wires of a local telephone network. In telecommunications marketing, the term DSL is widely understood to mean asymmetric digital subscriber line (ADSL), the most commonly installed DSL technology. DSL service is delivered simultaneously with wired telephone service on the same telephone line. This is possible because DSL uses higher frequency bands for data separated by filtering. On the customer premises, a DSL filter on each outlet removes the high frequency interference, to enable simultaneous use of the telephone and data.

The data bit rate of consumer DSL services typically ranges from 256 kbit/s to 40 Mbit/s in the direction to the customer (downstream), depending on DSL technology, line conditions, and service-level implementation. In ADSL, the data throughput in the upstream direction, (the direction to the service provider) is lower, hence the designation of *asymmetric* service. In symmetric digital subscriber line (SDSL) services, the downstream and upstream data rates are equal.

xDSL is similar to ISDN(***i****ntegrated* ***s****ervices* ***d****igital* ***n****etwork*) inasmuch as both operate over existing copper telephone lines (***p****lain* ***o****ld* ***t****elephone* ***s****ervice*) and both require the short runs to

a central telephone office (usually less than 20,000 feet). However, xDSL offers much higher speeds - up to 32 Mbps for upstream traffic, and from 32 Kbps to over 1 Mbps for downstream traffic.

Fig: DSL Connection



Benefits

- **High-speed data service:** DSL typically >10x faster than 56-kbps analog modem
- **Always on connection:** No need to "dial-up"
- **Uses existing copper wires:** Co-exists w/ POTS service
- **Reasonably priced today and getting cheaper**

Applications

- **High speed Internet access**
- **Multimedia, Long distance learning, gaming**
- **Video on Demand**
- **VPN**
- **VoDSL**

ADSL:

Asymmetric Digital Subscriber Line (**ADSL**) is a type of digital subscriber line technology, a data communications technology that enables faster data transmission over copper telephone lines than a conventional voiceband modem can provide. It does this by utilizing frequencies that are not used by a voice telephone call. A splitter, or DSL filter, allows a single telephone connection to be used for both ADSL service and voice calls at the same time. ADSL can generally only be distributed over short distances from the telephone exchange (the last mile), typically less than 4 kilometres (2 mi), but has been known to exceed 8 kilometres (5 mi) if the originally laid wire gauge allows for further distribution.

At the telephone exchange the line generally terminates at a digital subscriber line access multiplexer (DSLAM) where another frequency splitter separates the voice band signal for the conventional phone network. Data carried by the ADSL are typically routed over the telephone company's data network and eventually reach a conventional Internet Protocol network.

SDSL:

It is the Short for **Symmetric Digital Subscriber Line**, a technology that allows more data to be sent over existing copper telephone lines (POTS). SDSL supports data rates up to 3 Mbps. SDSL works by sending digital pulses in the high-frequency area of telephone wires and can not operate simultaneously with voice connections over the same wires. SDSL requires a special SDSL modem. SDSL is called *symmetric* because it supports the same data rates for upstream and downstream traffic.

ADSL Vs. SDSL

ADSL (Asymmetric Digital Subscriber Line) and SDSL (Symmetric Subscriber Digital Subscriber Line) are the two major groups when it comes to broadband internet connections. The most major difference between these two groups is in how much bandwidth they allocate to the user. Since SDSL is symmetric. It offers equal download and upload speeds to the user while, although the download speed is also very high for ADSL, the upload speed can be significantly slower.

The most major advantage that ADSL has is the ability to have the DSL and a telephone unit on the same two wires and they can be used simultaneously. This is because ADSL does not take up the entire bandwidth. SDSL uses the whole bandwidth and leaves no room for a telephone unit. The bandwidth for the telephone is allocated to the upload speed and explains the much higher bandwidth despite using the same two wires.

Cable Internet:

In telecommunications, **cable Internet access**, often shortened to **cable Internet** or simply **cable**, is a form of broadband Internet access that uses the cable television infrastructure. Like digital subscriber line and fiber to the premises services, cable Internet access provides network edge connectivity (last mile access) from the Internet service provider to an end user. It is integrated into the cable television infrastructure analogously to DSL which uses the existing telephone network. Cable TV networks and telecommunications networks are the two predominant forms of residential Internet access. Recently, both have seen increased competition from fiber deployments, wireless, and mobile networks.

Broadband cable Internet access requires a cable modem at the customer's premises and a cable modem termination system at a cable operator facility, typically a cable television headend. The two are connected via coaxial cable or a Hybrid Fiber Coaxial (HFC) plant. While access networks are sometimes referred to as *last-mile* technologies, cable Internet systems can typically operate where the distance between the modem and the termination system is up to 100 miles (160 km). If the HFC network is large, the cable modem termination system can be grouped into hubs for efficient management.

Downstream, the direction toward the user, bit rates can be as much as 400Mbit/s for business connections, and 100Mbit/s for residential service in some countries. Upstream traffic, originating at the user, ranges from 384kbit/s to more than 20Mbit/s. One downstream channel can handle hundreds of cable modems. As the system grows, the cable modem termination system (CMTS) can be upgraded with more downstream and upstream ports, and grouped into hubs CMTS for efficient management.

VOIP:

Voice over IP (**VoIP**, or **voice over Internet Protocol**) commonly refers to the communication protocols, technologies, methodologies, and transmission techniques involved in the delivery of voice communications and multimedia sessions over Internet Protocol (IP) networks, such as the Internet. Other terms commonly associated with VoIP are *IP telephony*, *Internet telephony*, *voice over broadband* (VoBB), *broadband telephony*, *IP communications*, and *broadband phone*.

Internet telephony refers to communications services —voice, fax, SMS, and/or voice-messaging applications— that are transported via the Internet, rather than the public switched telephone network (PSTN). The steps involved in originating a VoIP telephone call are signaling and media channel setup, digitization of the analog voice signal, encoding, packetization, and transmission as Internet Protocol (IP) packets over a packet-switched network. On the receiving side, similar steps (usually in the reverse order) such as reception of the IP packets, decoding of the packets and digital-to-analog conversion reproduce the original voice stream

Early providers of voice over IP services offered business models (and technical solutions) that mirrored the architecture of the legacy telephone network. Second generation providers, such as Skype have built closed networks for private user bases, offering the

benefit of free calls and convenience, while denying their users the ability to call out to other networks. This has severely limited the ability of users to mix-and-match third-party hardware and software. Third generation providers, such as Google Talk have adopted the concept of Federated VoIP - which is a complete departure from the architecture of the legacy networks. These solutions typically allow arbitrary and dynamic interconnection between any two domains on the Internet whenever a user wishes to place a call.

VoIP systems employ session control protocols to control the set-up and tear-down of calls as well as audio codecs which encode speech allowing transmission over an IP network as digital audio via an audio stream. The choice of codec varies between different implementations of VoIP depending on application requirements and network bandwidth; some implementations rely on narrowband and compressed speech, while others support high fidelity stereo codecs.

. Examples of the network protocols used to implement VoIP include:

- H.323
- Media Gateway Control Protocol (MGCP)
- Session Initiation Protocol (SIP)
- Real-time Transport Protocol (RTP)
- Session Description Protocol (SDP)

There are several advantages to using voice over IP. The biggest single advantage VoIP has over standard telephone systems is cost. In addition, international calls using VoIP are usually very inexpensive. One other advantage, which will become much more pronounced as VoIP use climbs, calls between VoIP users are usually free. Using services such as TrueVoIP, subscribers can call one another at no cost to either party.

How Does VoIP Work?

VoIP phone service (Voice over IP; also known as digital phone service, digital telephony, or broadband phone) replaces your phone line with a high-speed Internet connection. It's that simple.

While traditional telephone service compresses your voice into a frequency on a wire, VoIP compresses the sound of your voice into packets of data. In milliseconds, these data packets are sent over the Internet. When the data reaches the final destination, it is converted back to sound. If use VoIP to call someone on the traditional phone network (the "PSTN" or Public Switched Telephone Network), the VoIP call is converted to sound once it reaches the network and the call is routed normally. The difference is that you've paid a lot less for that call.

GSM VOIP (GOIP):-

It bridges the GSM services and the IP networks. The use of GSM Terminals together with VoIP Networks has significantly increased in the last years and continues to rise. GSM/VoIP Network configurations permit service providers to bypass the local Wired Public Switched Telephone Network (PSTN) in communicating with a GSM mobile handset. Thus, the excessive rates charged by telephone companies are avoided.

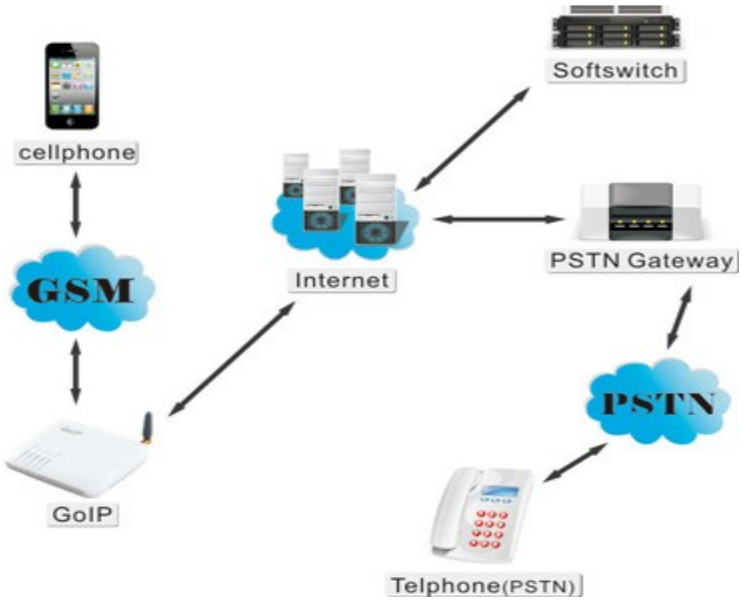
A VoIP GSM Gateway enables direct routing between IP, digital, analog and GSM networks. With these devices (fixed cellular terminals) companies can significantly reduce the money they spend on telephony, especially the money they spend on calls from IP to GSM. The core idea behind cost saving with VoIP GSM Gateways is Least Cost Routing (LCR).

Through least cost routing the gateways select the most cost-effective telephone connection. They check the number which is dialed as well as rate information which is stored in an internal routing table. Because several SIM cards and GSM modules are integrated within the VOIP GSM Gateway it is able to make relatively cheaper GSM to GSM calls instead of expensive IP to GSM calls.

VoIP GSM Gateways are IP-based systems that enable users to make cost effective calls from an IP phone to a GSM network through LCR (Least Cost Routing). The several SIM cards and GSM modules are integrated within the VOIP GSM Gateway. Often used in business and considered a method of significant savings over traditional telephony, VoIP GSM Gateways enables connections between IP, digital, analog and GSM networks.

The VOIP GSM Gateway is generally useful for the business enterprises or the users with the IP Telephone systems using VOIP enabled through SIP or H.323 protocol at the multiple locations who want to share the GSM Gateway connections. The VOIP GSM Gateway enables the VOIP users to make calls to the mobile phone networks at the reduced rates without needing to convert the call to ISDN, PSTN or any other traditional switching mode to use the traditional GSM Gateway equipment. The VoIP GSM Gateway normally enables both inbound and outbound VoIP and Cellular calls through one compact box.

Examples of some of the well known VoIP GSM Gateways suppliers include Hypermedia System, 2N Telekomunikace, Eurodesig BG, NovaTec, PorTech etc



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.

IP Interconnection is defined as that which comprises the physical and logical interconnection of carrier networks required to initiate, terminate and/or exchange Managed VoIP services traffic and associated features and functions. Standards for this type of interconnection invoke the well-known, structured approach to computer-to-computer communications known as the ISO Open Systems Interconnection Reference Model (the "OSI Model") as a means to explain individualized and composite functionality.

In order to understand IP Interconnection, one must first understand the concept of constructing a transmission unit (packet) by combining logical functions conducted by all layers, in a progressive manner, for transmission on one or more, physical interconnection link(s) between the parties' networks. Each layer of the receiving party's network then deconstructs the transmission unit, interpreting directives for it and passing the remainder upward to the higher levels for further processing.

IP Interconnection, then, is much more than just the physical continuity between two networks. It comprises the functional support for ALL layers of the OSI reference model according to standardized protocols and rules drafted to support the services in question, in this case, voice/video telephony-over-IP services traffic and associated features and functions.

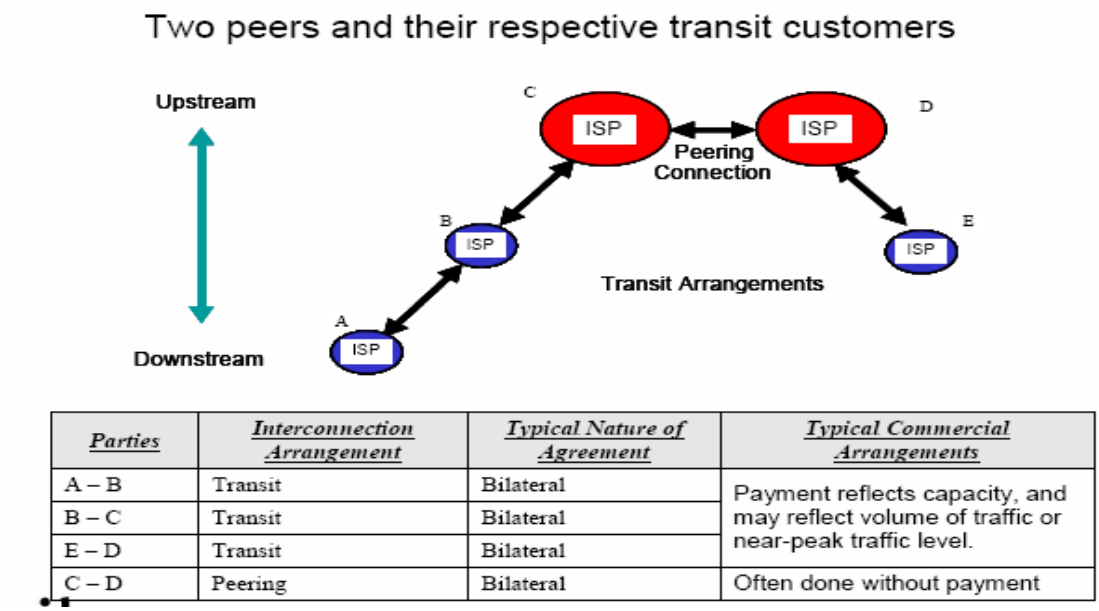
IP Interconnection will provide a significant reduction in the number of interconnection ports and facilities required to comprise ubiquitous interconnection.

The majority of connections between two IP-based networks today take place according to one of two basic interconnection models: **transit and peering.** Most readers are familiar with transit services, although not necessarily by that name: If you subscribe to an Internet access service, for example a DSL or cable broadband service, you are using transit. A transit service provider connects you, the transit customer, to the Internet for a fee. The service that a large Internet Service Provider (ISP) provides to a large business enterprise, or to a smaller or less well connected ISP, is on a larger scale but is not fundamentally different from your individual transit service.

Transit is an inherently asymmetric model. The transit provider (the ISP) carries traffic for the transit customer, but the transit customer is not under any obligation to carry traffic for the transit provider. The transit customer pays the provider, not the other way around.

With peering, ISPs exchange traffic for their respective customers (and for customers of their respective customers), but not for third parties. Peering is a substantially symmetric form of network interconnection.

Peering is an agreement between ISPs to carry traffic for each other and for their respective customers. Peering does not include the obligation to carry traffic to third parties. Peering is usually a bilateral business and technical arrangement, where two providers agree to accept traffic from one another, and from one another's customers (and thus from their customers' customers). Transit is an agreement where an ISP agrees to carry traffic on behalf of another ISP or end user. Transit is usually a bilateral business and technical arrangement, where one provider (the transit provider) agrees to carry traffic to third parties on behalf of another provider or an end user (the customer).



Parties	*Interconnection Arrangement*	*Typical Nature of Agreement*	*Typical Commercial Arrangements*
A – B	Transit	Bilateral	Payment reflects capacity, and may reflect volume of traffic or near-peak traffic level.
B – C	Transit	Bilateral	
E – D	Transit	Bilateral	
C – D	Peering	Bilateral	Often done without payment

Data Centers:

A **data center** or **computer centre** (also **datacenter**) is a facility used to house computer systems and associated components, such as telecommunications and storage systems. It generally includes redundant or backup power supplies, redundant data communications connections, environmental controls (e.g., air conditioning, fire suppression) and security devices.

IT operations are a crucial aspect of most organizational operations. One of the main concerns is **business continuity**; companies rely on their information systems to run their operations. If a system becomes unavailable, company operations may be impaired or stopped completely. It is necessary to provide a reliable infrastructure for IT operations, in order to minimize any chance of disruption. Information security is also a concern, and for this reason a data center has to offer a secure environment which minimizes the chances of a security breach. A data center must therefore keep high standards for assuring the integrity and functionality of its hosted computer environment. This is accomplished through redundancy of both fiber optic cables and power, which includes emergency backup power generation.

The "lights-out" data center, also known as a darkened or a dark data center, is a data center that, ideally, has all but eliminated the need for direct access by personnel, except under extraordinary circumstances. Because of the lack of need for staff to enter the data center, it can be operated without lighting. All of the devices are accessed and managed by remote systems, with automation programs used to perform unattended operations. In addition to the energy savings, reduction in staffing costs and the ability to locate the site further from population centers, implementing a lights-out data center reduces the threat of malicious attacks upon the infrastructure.

There is a trend to modernize data centers in order to take advantage of the performance and energy efficiency increases of newer IT equipment and capabilities, such as cloud computing. This process is also known as data center transformation

Three main elements of datacenters consist of:

1. hardware (servers, switches, routers, modems, and network utilities),
2. utilities required for environmental controls (including temperature control, humidity, Closed Circuit Cameras, and fire alarms),
3. Information security (such as using hardware and software and security procedures and the appropriate network design for this purpose to materialize)

Presently, the companies and the organizations use one of the three following methods to save their information and applications:

1. Use foreign datacenter services
2. Keep servers within their organizations
3. Use domestic datacenter services

In general, data centers can be broken down into three types- Internet **Data center (IDC)**, **Storage area network (SAN)** and **Enterprise data center (EDC)**.

- An Internet data center (IDC) is a facility that provides data and Internet services for other companies
- A Storage Area Network (SAN) is a network of interconnected storage devices and data servers usually located within an enterprise data center or as an off-site facility offering leased storage space.
- An Enterprise data center (EDC) is the central processing facility for an enterprise's computer network

Besides providing computing and storage resources on demand, another important aspect/role of Data Centre is to provide **data protection.** Therefore, Data Centers need to have strong **state-of-the-art backup and recovery and vaulting solutions** in place.

Data Warehousing:

Packet Clearing House:

Packet Clearing House is a non-profit research institute that supports operations and analysis in the areas of Internet traffic exchange, routing economics, and global network development. It has since grown to become a leading proponent of neutral independent network interconnection and provider of route-servers at major exchange points worldwide. PCH provides equipment, training, data, and operational support to organizations and individual researchers seeking to improve the quality, robustness, and accessibility of the Internet.

PCH works closely with the United States Telecommunications Training Institute (USTTI) to offer courses on telecommunications regulation, Internet infrastructure construction and management, domain name system management, and Internet security coordination, three times yearly in Washington D.C., in addition to the eighty to one hundred workshops PCH teaches on-location throughout the world each year.

Unified Messaging:

Unified Messaging 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. While traditional communications systems delivered messages into several different types of stores such as voicemail systems, e-mail servers, and stand-alone fax machines, with Unified Messaging all types of messages are stored in one system. Voicemail messages, for

example, can be delivered directly into the user's inbox and played either through a headset or the computer's speaker. This simplifies the user's experience (only one place to check for messages) and can offer new options for workflow such as appending notes or documents to forwarded voicemails.

Unified Messaging is an indistinct term that can refer to the typical definition of simple inclusion of incoming faxes and voice-mail in one's email inbox, all the way to dictating a message into a cell phone and the intelligent delivery of that message to the intended recipient in a variety of possible formats like text email, fax, or voice recording.

Unified messaging provides a number of benefits for users to manage their businesses with accessible, interfaced electronic communication systems, such as e-mail, voice, messenger services;

- **A single inbox.** Unified messaging can deliver all types of messaging and communication to a single inbox. The single inbox is easier for administrators to maintain, and provides flexibility for users to manage and interact with all of their communications.
- **Efficient communication.** Users can communicate more efficiently by having access to all communications at one time and being free to share, forward, or manage them in the way that's most convenient or effective for the given communication.
- **Cost savings.** Merging streamlines the communications administration and consolidates the infrastructure onto fewer physical servers, saving money for the enterprise.
- **Access from anywhere.** Unified messaging provides alternative methods of accessing communications. By merging e-mail, voice, and other communications, users can get voice messages in e-mail, have e-mail dictated over the phone, or access communications via the Web.

Fundamentals of e-commerce:

Traditional commerce:

- Mass-marketing and sales force-driven
- Difficulty to search for the best price and quality
- Information asymmetry – any disparity in relevant market information among parties in transaction

E-commerce:

In its broadest definition, e-commerce is digitally enabled commercial transactions between and among organizations and individuals, where digitally enabled means, for the most part, transactions that occur over the Internet and World Wide Web.

Commercial transactions involve the exchange of value (e.g. money) across organizational or individual boundaries in return for products and services. E-Commerce is a modern business methodology that addresses the needs of organizations, merchants, and consumers to cut costs while improving the quality of goods and service and increasing the speed of service delivery.

Ecommerce can be defined from different dimensions as;

- From a **communications perspective**, EC is the delivery of information, product/services, or payments over telephone lines, computer networks, or any other electronic means.
- From a **business process perspective**, EC is the application of technology toward the automation of business transactions and work flow.
- From a **service perspective**, EC is a tool that addresses the desire of firms, consumers, and management to cut service costs while improving the quality of goods and increasing the speed of service delivery.
- From an **online perspective**, EC provides the capability of buying and selling products and information on the Internet and other online services.
- From a **collaboration perspective**, EC is the facilitator for inter- and intra-organizational collaboration.
- From a **community perspective**, EC provides place for community members, to learn, transact and collaborate.

E-commerce Vs. E-business

E-business is the use of Internet and digital technology to execute all the business processes in the enterprise. E-business includes e-commerce as well as processes for the internal management of the firm and for coordination with suppliers and other business partners. E-business includes digital enabling of transactions and processes within a firm, involving information systems under the control of the firm.

For example, a company's online inventory control mechanisms are a component of e-business and online selling of company product is e-commerce.

Types of ecommerce:

Classified by the nature of market relationship – who is selling to whom

1. **Business-to-Consumer (B2C):**
- Businesses sell products or services to individual customers
- Example:
  Walmart.com sells merchandise to consumers through its Web site

2. **Business-to-Business (B2B)**
- Businesses sell products or services to other businesses
- Types include inter-business exchanges, e-distributors, B2B service providers, matchmakers and infomediaries.
- Examples:
  Grainger.com sells industrial supplies to large and small businesses through its Web site,
  Intel sells products to other business rather than customers.

3. **Consumer-to-Consumer (C2C)**
- Participants in an online marketplace can buy and sell goods with each other
- Example:
  Consumers and businesses trade with each other on eBay.com

Classified by technology used;

1. **Peer-to-Peer (P2P)**
- Use of peer-to-peer technology, which enables Internet users to share files and computer resources directly without having to go through a central Web server, in e-commerce
- Examples: BitTorrent and eDonkey.

2. **Mobile commerce (M-commerce)**
- Use of digital wireless devices to enable transactions on the Web

Unique features of ecommerce

The features the set e-commerce Technology apart from others used in traditional commerce are:

1. **Ubiquity** – internet/web technology is available everywhere: at work, home and elsewhere via mobile devices.
   - ✓ Marketplace extended beyond traditional boundaries
   - ✓ "Marketspace" is created, available 24/7/365

- ✓ Customer convenience increased, costs reduced.
- ✓ Ubiquity reduces *transaction cost* – the cost of participating in a market

2. **Global Reach** – the technology reaches across national boundaries, around the learth.
   - ✓ The potential market size is roughly equal to the size of the world's online population
   - ✓ The total number of users or customers an e-commerce business can obtain is a measure of its reach

3. **Universal standards** – there is one set of technology standards, namely internet standards that is shared by all nations around the world.
   - ✓ Promotes technology adoption
   - ✓ Reduces costs of adoption
   - ✓ Greatly lower *market entry cost* for merchants
   - ✓ Reduce *search cost* for consumers

4. **Richness** – Refers to the complexity and content of a message
   - ✓ Video, audio, and text messages are integrated into a single marketing message
   - ✓ The Internet has the potential for offering considerably more information richness than traditional media like printing press, radio, and television because it is interactive and can adjust the message to individual users

5. **Information Density** - Internet and Web vastly increase the total amount and quality of information available to all market participants
   - ✓ Information processing, storage and communication costs drop dramatically.
   - ✓ Accuracy and timeliness improve greatly.
   - ✓ Information becomes plentiful, cheap and accurate.

6. **Interactivity** – the technology allows active user involvement.
   - ✓ Enable two-way communication between merchant and consumer
   - ✓ Traditional televisions cannot ask viewers any questions or enter into conversations, and it cannot request that customer information be entered into a form
   - ✓ Interactivity allows an online merchant to engage a consumer in ways similar to a face-to-face experience on a global scale where consumers engage in dynamic dialog

7. **Social Technology** – the technology allows the persons to create communities of their own interest.
   - ✓ The Internet and e-commerce technologies have evolved to be much more social by allowing users to create and share content in the form of text, videos, music, or photos with a worldwide community.

- ✓ Using these forms of communication, users are able to create new social networks and strengthen existing ones

8. **Personalization/Customization** – the technology reaches allows personalized messages to be delivered to individuals as well as groups.
   - ✓ E-commerce technologies permit personalization by targeting of marketing message to specific individuals by adjusting the message to a person's name, interests, and past purchases
   - ✓ The technology also permits by changing the delivered product or service based on user's preferences or prior behavior
   - ✓ Potential customer reach extended.

Ecommerce Challenges:

Although using e-commerce offers organization a wealth of new opportunities and ways of doing business, it also presents managers with a number of serious challenges as given below

- **Unproven Business Models** - Many Internet business models are new and largely unproven to prove enduring sources of profit
- **Business Process Change Requirements** - Web-enabled business processes for e-commerce and e-business requires far-reaching organizational change
- **Channel Conflicts** - Using the Web for online sales and marketing may create channel conflicts with the firm's traditional channels
- **Legal Issues** - laws governing electronic commerce are still being written
- **Trust, Security, and Privacy** - Electronic commerce does not provide trust among buyers, sellers, and other partners involved in online transactions

Facebook: The New Face of E-Commerce ☺

- Do you use Facebook, and if so, how often? What has the experience been like?
- Have you purchased anything based on an advertisement on Facebook or by using a link provided by a friend? Or have you used Facebook Marketplace Feauture?
- Are you concerned about the privacy of the information you have posted on Facebook?

Ecommerce trends 2010- 2012

- Social networking continues to grow
- Social e-commerce platform emerges

- Mobile computing begins to rival PC
- Explosive growth in online video viewing
- Group Purchasing
- Continued privacy and security concerns

Concept of Grid and Cloud Computing:

Grid Computing:

grid computing is a computer network in which each computer's resources are shared with every other computer in the system. Processing power, memory and data storage are all community resources that authorized users can tap into and leverage for specific tasks. A grid computing system can be as simple as a collection of similar computers running on the same operating system or as complex as inter-networked systems comprised of every computer platform you can think of.

Grid computing is the federation of computer resources from multiple administrative domains to reach a common goal. The **grid** can be thought of as a distributed system with non-interactive workloads that involve a large number of files. What distinguishes grid computing from conventional high performance computing systems such as cluster computing is that grids tend to be more loosely coupled, heterogeneous, and geographically dispersed . Although a single grid can be dedicated to a particular application, commonly a grid is used for a variety of purposes. Grids are often constructed with general-purpose grid middleware software libraries.

Grid size varies a considerable amount. Grids are a form of distributed computing whereby a **"super virtual computer"** is composed of many networked loosely coupledcomputers acting together to perform large tasks. For certain applications, "distributed" or "grid" computing, can be seen as a special type of parallel computing that relies on complete computers (with onboard CPUs, storage, power supplies, network interfaces, etc.) connected to a network (private, public or the Internet) by a conventional network interface, such as Ethernet. This is in contrast to the traditional notion of a supercomputer, which has many processors connected by a local high-speed computer bus.

Grid computing combines computers from multiple administrative domains to reach **a common goal**, **to solve a single task**, and may then disappear just as quickly.

One of the main strategies of grid computing is to use middleware to divide and apportion pieces of a program among several computers, sometimes up to many thousands. Grid computing involves computation in a distributed fashion, which may also involve the aggregation of large-scale cluster computing-based systems.

The size of a grid may vary from small—confined to a network of computer workstations within a corporation, for example—to large, public collaborations across many companies and networks. "The notion of a confined grid may also be known as an intra-nodes cooperation whilst the notion of a larger, wider grid may thus refer to an inter-nodes cooperation".

Cloud Computing:

Cloud computing is the use of computing resources (hardware and software) that are delivered as a service over a network (typically the Internet). The name comes from the use of a cloud-shaped symbol as an abstraction for the complex infrastructure it contains in system diagrams. Cloud computing entrusts remote services with a user's data, software and computation.

There are many types of public cloud computing: Infrastructure as a service (IaaS), Platform as a service (PaaS), Software as a service (SaaS), Storage as a service (STaaS), Security as a service (SECaaS), Data as a service (DaaS), Test environment as a service (TEaaS), Desktop as a service (DaaS), API as a service (APIaaS).

Characteristics:

Cloud computing exhibits the following key characteristics:

- **Agility** improves with users' ability to re-provision technological infrastructure resources.
- **Application programming interface** (API) accessibility to software that enables machines to interact with cloud software in the same way the user interface facilitates interaction between humans and computers.
- **Cost** is claimed to be reduced and in a public cloud delivery model capital expenditure is converted to operational expenditure.[26] This is purported to lower barriers to entry, as infrastructure is typically provided by a third-party and does not need to be purchased for one-time or infrequent intensive computing tasks. Pricing on a utility computing basis is fine-grained with usage-based options and fewer IT skills are required for implementation (in-house)
- **Device and location independence**[29] enable users to access systems using a web browser regardless of their location or what device they are using (e.g., PC, mobile phone). As infrastructure is off-site (typically provided by a third-party) and accessed via the Internet, users can connect from anywhere.
- **Virtualization** technology allows servers and storage devices to be shared and utilization be increased. Applications can be easily migrated from one physical server to another.

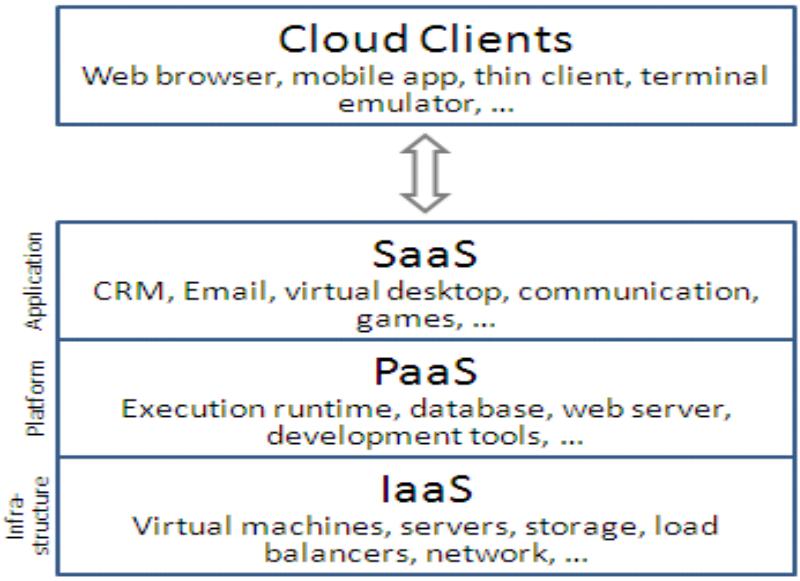
- **Multitenancy** enables sharing of resources and costs across a large pool of users thus allowing for:
    - **Centralization** of infrastructure in locations with lower costs (such as real estate, electricity, etc.)
    - **Peak-load capacity** increases (users need not engineer for highest possible load-levels)
    - **Utilisation and efficiency**
- **Reliability** is improved if multiple redundant sites are used, which makes well-designed cloud computing suitable for business continuity and disaster recovery.
- **Scalability and elasticity** via dynamic ("on-demand") provisioning of resources on a fine-grained, self-service basis near real-time, without users having to engineer for peak loads.
- **Performance** is monitored, and consistent and loosely coupled architectures are constructed using web services as the system interface.
- **Security** could improve due to centralization of data, increased security-focused resources, etc., but concerns can persist about loss of control over certain sensitive data, and the lack of security for stored kernels.
- **Maintenance** of cloud computing applications is easier, because they do not need to be installed on each user's computer and can be accessed from different places.

Cloud Clients:

Users access cloud computing using networked client devices, such as desktop computers, laptops, tablets and smartphones. Some of these devices - *cloud clients* - rely on cloud computing for all or a majority of their applications so as to be essentially useless without it. Examples are thin clients and the browser-based Chromebook. Many cloud applications do not require specific software on the client and instead use a web browser to interact with the cloud application. With Ajax and HTML5 these Web user interfaces can achieve a similar or even better look and feel as native applications. Some cloud applications, however, support specific client software dedicated to these applications (e.g., virtual desktop clients and most email clients). Some legacy applications (line of business applications that until now have been prevalent in thin client Windows computing) are delivered via a screen-sharing technology.

Cloud Service Models:

Cloud computing providers offer their services according to three fundamental models: Infrastructure as a service (IaaS), platform as a service (PaaS), and software as a service (SaaS) where IaaS is the most basic and each higher model abstracts from the details of the lower models.



Iaas:

In this most basic cloud service model, cloud providers offer computers, as physical or more often as virtual machines, and other resources. The virtual machines are run as guests by a hypervisor, such as Xen or KVM. Management of pools of hypervisors by the cloud operational support system leads to the ability to scale to support a large number of virtual machines. Other resources in IaaS clouds include images in a virtual machine image library, raw (block) and file-based storage, firewalls, load balancers, IP addresses, virtual local area networks (VLANs), and software bundles. IaaS cloud providers supply these resources on demand from their large pools installed in data centers. For wide areaconnectivity, the Internet can be used or—in carrier clouds -- dedicated virtual private networks can be configured.

To deploy their applications, cloud users then install operating system images on the machines as well as their application software. In this model, it is the cloud user who is responsible for patching and maintaining the operating systems and application software. Cloud providers typically bill IaaS services on a utility computing basis, that is, cost will reflect the amount of resources allocated and consumed.

IaaS refers not to a machine that does all the work, but simply to a facility given to businesses that offers users the leverage of extra storage space in servers and data centers.

Examples of IaaS include: Amazon CloudFormation (and underlying services such as Amazon EC2), Rackspace Cloud, Terremark and Google Compute Engine.

Paas:

In the PaaS model, cloud providers deliver a computing platform typically including operating system, programming language execution environment, database, and web server. Application developers can develop and run their software solutions on a cloud platform without the cost and complexity of buying and managing the underlying hardware

and software layers. With some PaaS offers, the underlying computer and storage resources scale automatically to match application demand such that cloud user does not have to allocate resources manually.

Examples of PaaS include: Amazon Elastic Beanstalk, Heroku, EngineYard, Mendix, Google App Engine, Microsoft Azure and OrangeScape.

Saas:

In this model, cloud providers install and operate application software in the cloud and cloud users access the software from cloud clients. The cloud users do not manage the cloud infrastructure and platform on which the application is running. This eliminates the need to install and run the application on the cloud user's own computers simplifying maintenance and support. What makes a cloud application different from other applications is its elasticity. This can be achieved by cloning tasks onto multiple virtual machines at run-time to meet the changing work demand. Load balancers distribute the work over the set of virtual machines. This process is inconspicuous to the cloud user who sees only a single access point. To accommodate a large number of cloud users, cloud applications can be multitenant, that is, any machine serves more than one cloud user organization. It is common to refer to special types of cloud based application software with a similar naming convention: desktop as a service, business process as a service, test environment as a service, communication as a service.

The pricing model for SaaS applications is typically a monthly or yearly flat fee per user, so price is scalable and adjustable if users are added or removed at any point.

Examples of SaaS include: Google Apps, innkeypos, Quickbooks Online, Limelight Video Platform, Salesforce.com and Microsoft Office 365.