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Module – 1 (Introduction)

Introduction to Client/Server computing - Driving forces behind Client/ Server, Client/ Server development tools, Development of client/server systems, Client/Server security, Organizational Expectations, Improving performance of client/server applications, Single system image, Downsizing and Rightsizing, Advantages of client server computing, Applications of Client/Server.

CLIENT SERVER COMPUTING

- Client/Server computing is new technology that yields solutions to many data management problems faced by modern organizations.
- The term Client/Server is used to describe a computing model for the development of computerized systems.
- This model is based on distribution of functions between two types of independent and autonomous processes: Server and Client.
- A Client is any process that requests specific services from the server process.
- A Server is a process that provides requested services for the Client. Client and Server processes can reside in same computer or in different computers linked by a network.
- When Client and Server processes reside on two or more independent computers on a network, the Server can provide services for more than one Client.
- A client can request services from several servers on the network without regard to the location or the physical characteristics of the computer in which the Server process resides.

- The network ties the server and client together, providing the medium through which the clients and the server communicate.

- The Fig. 1.1 given below shows a basic Client/Server computing model.

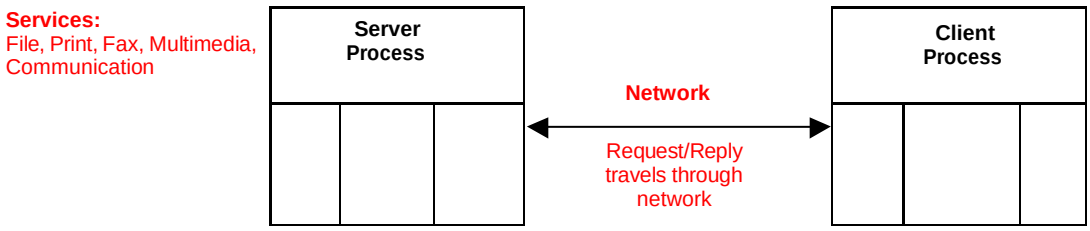

Fig.1.1: Basic Client/Server Computing Model

TYPES OF SERVERS

File Server

- All the files reside on the server machine. File Server provides clients access to records within files from the server machine.
- File Servers are useful for sharing files across a network among the different client process requesting the services.
- The server process is somewhat primitive because of tends to demand many message exchanges over the network to find the requested data.

The examples of File servers are:

- UNIX: Network File Services (NFS) created by Sun Micro systems.
- Microsoft Windows "Map Drive" e.g., Rivier College's "P-drive".
- Samba: An open Source/Free Software suite that provides seamless file and printservices to SMB/CIFS clients (i.e., Microsoft Windows clients).

Print Server

- This machine manages user access to the shared output devices, such as printers. These are the earliest type of servers. Print services can run on a file server or on one or more separate print server machines.

Application Server

- This machine manages access to centralized application software; for example, a shared database.
- When the user requests information from the database, the application server processes the request and returns the result of the process to the user.

Mail Server

- This machine manages the flow of electronic mail, messaging, and communication with mainframe systems on large-scale networks.

Fax Server

- Provides the facility to send and receive the Faxes through a single network connection. This machine manages flow of fax information to and from the network. It is similar to the mail server.

Directory Services Server

- It is found on large-scale systems with data that is distributed throughout multiple servers.
- This machine functions as an organization manager, keeping track of what is stored where, enabling fast and reliable access to data in various locations.

Web Server

- This machine stores and retrieves Internet (and intranet) data for the enterprise. Some documents, data, etc., reside on web servers.
- Such servers shares documents across intranets, or across the Internet (or extranets). The most commonly used

protocol is HTTP (Hyper Text Transfer Protocol).

- Web application servers are now augmenting simple web servers.
- The examples of web application servers are Microsoft's Internet Information Server (IIS), Netscape's iPlanet IBM's WebSphere, BEA's WebLogic and Oracle Application Server.

Database Server

- Data resides on server, in the form of a SQL database. Database server provides access to data to clients, in response to SQL requests.
- It shares the data residing in a database across a network. Database Server has more efficient protocol than File Server.
- The Database Server receives SQL requests and processes them and returning only the requested data; therefore the client doesn't have to deal with irrelevant data. The example of database server is: Oracle9i database server.

Transaction Servers

- It shares data and high- level functions across a network. Transaction servers are often used to implement Online Transaction Processing (OLTP) in high-performance applications.

- Examples areTP-Light with Database Stored Procedures like Oracle, Microsoft SQL Server etc.

- TP-Heavy with TP Monitors like BEA Tuxedo, IBM CICS/TX Series.

Groupware Servers

- Liable to store semi-structured information like text, image, mail, bulletin boards, flow of work.
- Groupware Server provides services, which put people in

contact with other people, that is because “groupware” is an ill-defined classification protocol differing from product to product.

- For Example: Lotus Notes/Domino and Microsoft Exchange.

Client/Server: Stateless or Stateful

stateless server

- A stateless server is a server that treats each request as an independent transaction that is unrelated to any previous request.
- The biggest advantage of stateless is that it simplifies the server design because it does not need to dynamically allocate storage to deal with conversations in progress or worry about freeing it if a client dies in mid-transaction.
- There is also one disadvantage that it may be necessary to include more information in each request and this extra information will need to be interpreted by the server each time.
- An example of a stateless server is a World Wide Web server. With the exception of cookies, these take in requests (URLs) which completely specify the required document and do not

require any context or memory of previous requests contrast this with a traditional FTP server which conducts an interactive session with the user.

- The Gopher protocol and Gopher+ are both designed to be stateless.

Stateful Server

- Client data (state) information are maintained by server on status of ongoing interaction with clients and the server remembers what client requested previously and at last maintains the information as an incremental reply for each request.
- The advantages of stateful server is that requests are more efficiently handled and are of smaller in size. Some disadvantages are their like state information becomes invalid when messages are unreliable.
- Another disadvantage is that if clients crash (or reboot) frequently, state information may exhaust server's memory.
- The best example of stateful server is remote file server.

Stateless vs Stateful Servers

- There are some comparative analysis about stateless and stateful servers.
- A stateful server remembers client data (state) from one request to the next.
- A stateless server keeps no state information. Using a stateless file server, the client must specify complete file names in each request specify location for reading or writing and re-authenticate for each request.
- Using a stateful file server, the client can send less data

with each request. A stateful server is simpler.

- On the other hand, a stateless server is more robust and lost connections can't leave a file in an invalid state rebooting the server does not lose state information rebooting the client does not confuse a stateless server.

Servers and Mainframes

From a hardware perspective, a mainframe is not greatly different from a personal computer. The CPU inside a mainframe was, however, much faster than a personal computer.

- . A mainframe was 'larger' in terms of:
  - The raw speed expressed in instructions per second, or cycles.
- The amount of memory that could be addressed directly by a program.
- Mainframes are the monstrous computer system that deals mainly the business functions and technically these giant machines will run MVS(Multiple Virtual Storage), IMS and VSAM(Virtual Storage Access Method) operating systems. There is a common believe that a mainframe is 'database'. There are many reasons behind this belief:
  - Many servers are either file or database servers running sophisticated database such as Sybase, Oracle and DB2.
  - These servers connect to the mainframe primarily to access databases.
  - Organisations use servers specifically to replace mainframe databases.
  - Organisations keep applications on the mainframe usually for better database performance, integrity and functionality.
  - Mainframes still serve the purpose in managing the

complex business rules of very large organizations and enterprises that are spread out over a very large area.

- But the increasing processing power of servers combined with their lower costs makes them the logical replacement to mainframe-based systems in the future.
- In the meanwhile, Client/Server networks will often find it necessary to connect to mainframe-based systems.
- This is because some data can only be found in the mainframe environment, usually because the business rules for handling it are sufficiently complex or because the data itself is massive or sensitive enough that as a practical matter it remains stored there.

A very natural question at this stage is: How do Client/Server Systems differ from Mainframe Systems?

- The extent of the separation of data processing task is the key difference.
- In mainframe systems all the processing takes place on the mainframe and usually dumb terminals are used to display the data screens. These terminals do not have autonomy.
- On the other hand, the Client/Server environment provides a clear separation of server and client processes, both processes being autonomous.
- The relationship between client and server is many to many.

Various other factors, which can have, prime considerations to differentiate the mainframe and Client/Server systems:

- **Application development:** Mainframe systems are over structured, time-consuming and create application backlogs.
-
- On the other hand, PC-based Client/Server systems are flexible, have rapid application development and have better productivity tools.

- **Data manipulation:** Mainframe systems have very limited data manipulation capabilities whereas these techniques are very flexible in the case of Client/Server systems.

- **System management:** Mainframe systems are known to be integrated systems but in the case of Client/Server systems only few tools are available for system management.
- **Security:** Mainframe systems are highly centralized whether as Client/Server systems are relaxed or decentralized.
- **End user platform:** Mainframe systems comprise of dumb terminals, are character- based, single task oriented and of limited productivity. On the other hand, Client/ Server systems are intelligent PC's with graphical user interface having multitasking OS with better productivity tools.

Client/Server Functions

The main operations of the client system are listed below:

- Managing the user interface.
- Accepts and checks the syntax of user inputs.
- Processes application logic.
- Generates database request and transmits to server.
- Passes response back to server.

The main operations of the server are listed below:

- Accepts and processes database requests from client.
- Checks authorization.
- Ensures that integrity constraints are not violated.
- Performs query/update processing and transmits responses to client.
- Maintains system catalogue.
- Provide concurrent database access.
- Provides recovery control.

Advantages

There are various advantages associated with Client/Server computing model.

(i) Performance and reduced workload: Processing is distributed among the client and server unlike the traditional PC database,

(ii) Workstation independence: Users are not limited to one type of system or platform.

(iii) System interoperability: Client/Server computing not only allows one component to be changed, it also makes it is possible for different type of components systems (client, network or server) to work together.

(iv) Scalability: This ability to change component system makes Client/Server systems especially receptive to new technologies in both hardware and software.

(v) Data integrity: Client/Server system preserves the data integrity, DBMS can provide number of services that protect data like, encrypted file storage, real time backup (while the database is being accessed),

(vi) Data accessibility (enhanced data sharing): Since the server component holds most of data in a centralized location, multiple users can access and work on the data simultaneously.

(vii) System administration (centralized management): Client/Server environment is very manageable. Since data is centralized, data management can be centralized. Some of the system administration functions are security, data integrity and back up recovery.

(viii) Integrated services:. Desktop user can use their desktop tools in conjunction with information made available from the corporate systems to produce new and useful information

(ix) Sharing resources among diverse platforms: Client/Server model provides opportunities to achieve open system computing.

(x) Reduced operating cost: Client/Server computing offers acash rediuction by replacing expensive large systems with less expensive smaller ones networked together.

(xi) Reduced hardware cost: Hardware costs may be reduced, as it is only the server that requires storage and processing power sufficient to store and manage the application.

(xii) Communication costs are reduced: Applications carry out part of the operations on the client and send only request for database access across the network, resulting in less data being sent across the network.

Disadvantages

There are various disadvantages associated with the Client/Server computing model.

(i) Maintenance cost: Major disadvantages of Client/Server computing is the increased cost of administrative and support personnel to maintain the database server.

(ii) Training cost: Training can also add to the start-up costs as the DBMS may run on an operating system that the support personnel are unfamiliar with.

(iii) Hardware cost: There is also an increase in hardware costs. This usually means purchasing a high-powered platform with a large amount of RAM and hard disk space.

(iv) Software cost: The overall cost of the software is usually higher than that of traditional PC based multi-user DBMS.

(v) Complexity: With so many different parts comprising the

entire Client/Server, i.e., the more are the pieces, which comprise the system the more things that can go wrong or fail. It is also harder to pinpoint problems when the worst does occur and the system crashes. It can take longer to get everything set up and working in the first place. This is compounded by the general lack of experience and expertise of potential support personnel and programmers, due to the relative newness of the technology.

Advantages of Client Server Network

1. Centralization

The main advantage of client server network is the centralized control that it is integrated with.
All the necessary informations are placed in a single location. This is especially beneficial for the network administrator since they have the full control over management and administration.

Whatever the problem that occurs in the entire network can be solved in one place. And also due to this, the work of updating resources and data has become way more easier.

2. Security

In client server network, the data is well protected due to its centralized architecture. It can be enforced with access controls such that only authorized users are granted access. One such method is imposing credentials like username and password. Moreover if the data were to be lost, the files can be easily recovered from a single backup.

3. Scalability

Client server networks are highly scalable. Whenever the user needs they can increase the number of resources such as clients and servers. Thus, increasing the size of the server without much interruptions. Even if the size gets increased, there is no hesitation about permission to network resources since the server is centralized. Therefore, very less number of staffs are required for the configurations.

4. Management

Since all the files are stored in the central server, it is rather easy to manage files. In client server network has the best management to track and find records of required files.

5. Accessibility

Irrespective of the location or the platform, every client is provided with the opportunity to log into the system. By this way all the employees will be able to access their corporate informations without needing to use a terminal mode or a processor.

Disadvantages of Client Server Network

1. Traffic Congestion

The primary disadvantage of client server network is the traffic congestion it undergoes. If too many clients make request from the same server, it will result in crashes or slowing down of the connection. An overloaded server creates many problems in accessing informations.

2. Robustness

As we all know client server networks are centralized. In case if the main server happens to undergo failure or interference, then the whole network will be disrupted. Therefore, client server networks lacks on the side of robustness.

3. Cost

The cost involved in setting up and maintaining the server is usually high in client server network as it does on the network operations. Since the networks are powerful they can be expensive to purchase. Hence, not all the users will be able to afford them.

4. Maintenance

When the servers are implemented, it is going to work non-stop. Which means it must be given proper attention. If there are any problems, it must be resolved immediately without any delay. Hence, there should be a specialized network manager appointed to maintain the server.

5. Resources

Not all the resources that is present on the server is acquirable. For an example, it is not possible to print a document on the web directly or edit any informations on the client hard disk drive.

Driving Forces Behind Client/ Server Computing

A rapidly changing business environment generates a demand for enterprise – wide data access, which, in turn, sets the stage for end user productivity gains.

Data access requirements have given rise to an environment in which computers work together to form a system, often called distributed computing, cooperative computing, and the like.

Client/Server computing is the most effective source for the tools that empower employees with authority and responsibility.

Client/Server computing has become more practical and cost-effective because of changes in computer technology that allow the use of PC-based platforms with reliability and robustness comparable to those of traditional mainframe system.

In fact, the accelerating trend toward system development based on Internet Technologies, particularly those supplied by Web, has extended the Client/Server model's reach and relevance considerably.

For example, to remain competitive in a global business environment, businesses are increasingly dependent on the Web to conduct their marketing and service operations.

Such Web-based electronic commerce, known as E-commerce, is very likely to become the business norm for businesses of all sizes.

There are various forces that drive the move to client/server computing. Some of them are:

(i) The changing business environment.

(ii) Globalization: The world as a market.

(iii) The growing need for enterprise data access.

(iv) The demand for end user productivity gains based on the efficient use of data resources.

(v) Technological advances that have made client/server computing practical like microprocessor technology, data communication and Internet, Database systems, Operating Systems and Graphical User Interface, PC-based and end user application software.

(vi) Growing cost and performance advantages of PC-based

platforms.

(vii) Enterprise network management.

2.2 DRIVING FORCES

Forces that drives the move to Client/Server computing widely can be classified in two general categories based on:

(i) Business perspective.

(ii) Technology perspective.

Business Perspective

Basically the business perspective should be kept in mind for obtaining the following achievements through the system:

- For increased productivity.
- Superior quality.
- Improved responsiveness.
- Focus on core business.

The effective factors that govern the driving forces are given below:

The changing business environment:Business process engineering has become necessary for competitiveness in the market which is forcing organizations to find new ways to manage their business, despite fewer personnel, more outsourcing, a market driven orientation, and rapid product obsolescence.

Due to globalization of business, the organizations have to meet global competitive pressure by streamlining their operations and by providing an ever-expanding array of customer services.

Information management has become a critical issue in this competitive environment; marketing fast, efficient, and widespread data access has become the key to survival.

The corporate database has become a far more dynamic asset

than it used to be,and it must be available at relatively low cost.

The dynamic information driven corporate worlds of today require data to be available to decision makers on time and in an appropriate format.

Because end users have become active in handling their own basic data management and data analysis, the movement towards freedom of data access has made Client/Server computing almost inevitable.

The Client/Server model's ability to share resources efficiently by splitting data processing yields a more efficient utilization of those resources.

It is not surprising that Client/Server computing has received so much attention from such a wide spectrum of interested parties.

Globalization

Conceptually, the world has begun to be treated as a market. Information Technology plays an important role in bringing all the trade on a single platform by eliminating the barriers.

IT helps and supports various marketing priorities like quality, cost, product differentiation and services.

The growing need for enterprise data access: One of the major MIS functions is to provide quick and accurate data access for decision- making at many organizational levels.

Managers and decision makers need fast on-demand data access through easy-to-use interfaces.

When corporations grow, and especially when they grow by merging with other corporations, it is common to find a mixture of disparate data sources in their systems.

For example, data may be located in flat files, in hierarchical or

network databases or in relational databases. Given such a multiple source data environment, MIS department managers often find it difficult to provide tools for integrating and aggregating data for decision-making purposes, thus limiting the use of data as a company asset.

Client server computing makes it possible to mix and match data as well as hardware.

In addition, given the rapidly increasing internet-enabled access to external data through the Internet's inherent Client/Server architecture, corporate Client/Server computing makes it relatively easy to mix external and internal data.

The demand for end user productivity gains based on the efficient use of data resources: The growth of personal computers is a direct result of the productivity gains experienced by end-users at all business levels.

End user demand for better ad hoc data access and data manipulation, better user interface, and better computer integration helped the PC gain corporate acceptance.

With sophisticated yet easy to use PCs and application software, end user focus changed from how to access the data to how to manipulate the data to obtain information that leads to competitive advantages.

Technology Perspective

Technological advances that have made Client/Server computing practical by proper use of the following:

- Intelligent desktop devices.
- Computer network architectures.
- Technical advances like microprocessor technology,

data communication and Internet Database system, operating system and graphical user interface.

- Trends in computer usage like:

(i) Standardization: Trend towards open systems and adaptation of industry standards, which includes:

  * de facto standard: protocol or interface that is made public & widely accepted. (e.g., SNA, TCP/IP, VGA)
  * de jure standard: protocol or interface specified by a formal standards making body. (e.g., ISO's OSI, ANSI C)

(ii) Human-Computer Interaction (HCI): trend towards GUI, user Control.

(iii) Information dissemination: trend towards data warehousing, data mining.

- PC-based end user application software together with the increasing power and capacity of workstations.
- Growing cost and performance are advantages of PC-based platforms.

The PC platform often offers unbeatable price/performance ratio compared to mainframe and minicomputer platforms. PC application cost, including acquisition, installation, training, and use, are usually lower than those of similar minicomputer and mainframe applications.

New PC-based software makes use of very sophisticated technologies, such as object orientation, messaging, and tele-communications.

These new technologies make end users more productive by enabling them to perform very sophisticated tasks easily, quickly, and efficiently.

The growing software sophistication even makes it possible to migrate many mission-critical applications to PCs.

The pursuit of mainframe solutions typically means high acquisition and maintenance costs, and chances are that

managers are locked into services provided by single source.

In contrast, PC hardware and software costs have both declined sharply during the past few years.

PC-based solutions typically are provided by many sources, thus limiting single- source vulnerability. However, multi-source solutions can also become a major management headache when system problems occur.

Enterprise Computing and the Network Management

If a business is run from its distributed locations, the technology supporting these units must be as reliable as the existing central systems.

Technology for remote management of the distributed technology is essential in order to use scarce expertise appropriately and to reduce costs.

All computing and communications resources are integrated functionally as a single, seamless system. To maximize productivity by providing universal, up-to-date information the technology requirements are that computing technology must be widely deployed.

All computers must be networked together in a consistent architecture such that computing and networking resources must be reliable, secure, and capable of delivering accurate information in a timely manner.

And all the applications must be flexible to user preferences and work styles i.e., applications must interwork with in a common framework.

Client/server technology gives cost-effective, logical, and consistent architectural model for networking that generalizes the typical computer model.

Client/Server can simplify network interactions that will give transparent interaction to the users.

See the Fig. 2.1 illustrated below:

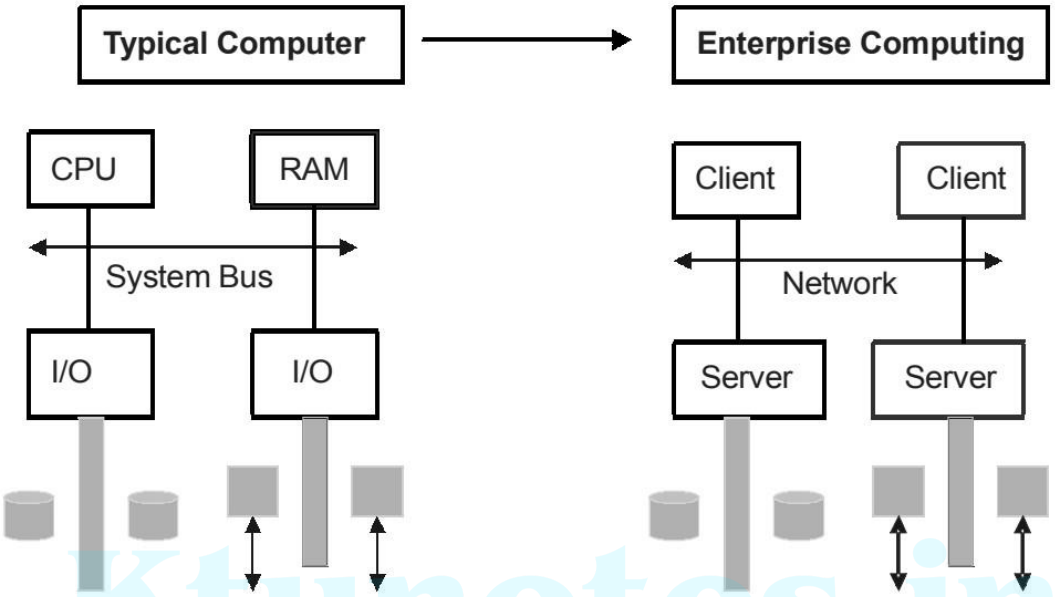

Fig. 2.1: Enterprise Computing

2.3 DEVELOPMENT OF CLIENT/SERVER SYSTEMS

2.3 DEVELOPMENT OF CLIENT/SERVER SYSTEMS

The development of Client/Server systems differs greatly in process and style from the traditional information systems

development methods.
For example, the systems development approach, oriented towards the centralized mainframe environment and based on traditional programming language, can hardly be expected to function well in a client server environment that is based on hardware and software diversity.

In addition a modern end users are more demanding and are likely to know more about computer technology than users did before the PC made its inroads.
Then the concerning manager should pertain their knowledge about new technologies that are based on multiple platforms, multiple GUIs, multiple network protocols, and so on.

Development Tools

In today's rapid changing environment, choosing the right tools to develop Client/Server applications is one of the most critical decisions. As a rule of thumb, managers tend to choose a tool that has a long-term survival potential.

However, the selection of a design or application development tool must also be driven by system development requirements.

Once such requirements have been delineated, it is appropriate to determine the characteristics of the tool that you would like to have.

Client/Server tools include:

- GUI-based development.
- A GUI builder that supports multiple interfaces (Windows, OS/2, Motif, Macintosh, and so on).
- Object-oriented development with a central repository for data and applications.
- Support for multiple database (flat file, hierarchical, networked, relational).

- Data access regardless of data model (using SQL or native navigational access).
- Seamless access to multiple databases.
- Complete SDLC (System Development Life Cycle) support from planning to implementation and maintenance.
- Team development support.
- Support for third party development tools (CASE, libraries, and so on)
- Prototyping and Rapid Application Development (RAD) capabilities.
- Support for multiple platforms (OS, Hardware, and GUIs).
- Support for middle ware protocols (ODBC, IDAPI, APPC, and so on).
- Multiple network protocol support (TCP/IP, IXP/SPX, NetBIOS, and so on).

There is no single best choice for any application development tool. For one thing, not all tools will support all the GUI's, operating system, middleware, and databases. Managers must choose a tool that fits the application development requirements and that matches the available human resources, as well as the hardware infrastructure.

Chances are that the system will require multiple tools to make sure that all or most of the requirements are met. Selecting the development tools is just one step. Making sure that the system meets its objectives at the client, server, and network level is another issue.

Development Phases

It is important that a marketing plan be developed before actually starting the design and development efforts. The

objective of this plan is to build and obtain end user and managerial support for the future Client/Server environment.

Although there is no single recipe for this process, the overall idea is to conceptualize Client/Server system in terms of their scope, optimization of resources and managerial benefits.

In short, the plan requires an integrated effort across all the departments within an organization.

There are six main phases in Client/Server system development.

(i) Information System Infrastructure Self-study

The objective is to determine the actual state of the available computer resources. The self-study will generate atleast the following.

- A software and hardware inventory.
- A detailed and descriptive list of critical applications.
- A detailed human resource (personal and skills) inventory.
- A detailed list of problems and opportunities.

(ii) Client/Server Infrastructure Definition

The output of Phase One, combined with the company's computer infrastructure goal, is the input for the design of the basic Client/Server infrastructure blueprint. This blue print will address the main hardware and software issues for the client, server, and networking platforms.

(iii) Selecting a Window of Opportunity

The next stage is to find the right system on which to base the Client/Server pilot project. After identifying the pilot project, we need to define it very carefully by concentrating on the problem, available resources, and set of clearly defined and realistic goals. The project is described in business terms rather than technological jargon. When defining the system, we must make sure to plan for cost carefully. We should try to balance the cost carefully with the effective benefits of the system. We

should also make sure to select a pilot implementation that provides immediate and tangible benefits. For example, a system that takes two years to develop and another three to generate tangible benefits is not acceptable.

(iv) Management Commitment

Top to bottom commitment is essential when we are dealing with the introduction of new technologies that affect the entire organization. We also need managerial commitment to ensure that the necessary resources (people, hardware, software, money, infrastructure) will be available and dedicated to the system. A common practice is to designate a person to work as a guide, or an agent of change, within the organization's departments. The main role of this person is to ease the process that changes people's role within the organization.

(v) Implementation

Guidelines to implementation should atleast include:

- Use "open" tools or standard-based tools.
- Foster continuing education in hardware, software, tools, and development principles.
- Look for vendors and consultants to provide specific training and implementation of designs, hardware, application software.

(vi) Review and Evaluation

We should make sure that the system conforms to the criteria defined in Phase Three. We should continuously measure system performance as the system load increases, because typical Client/Server solutions tend to increase the network traffic and slow down the network.

The network performance modelling is required to ensure that the system performs well under heavy end user demand conditions.

Such performance modeling should be done at the server end, the client end, and the network layer.

2.4 CLIENT/SERVER STANDARDS

Standards assure that dissimilar computers, networks, and applications scan interact to form a system.

A standard is a publicly defined method to accomplish specific tasks or purposes within a given discipline and technology.

Standards make networks practical.

Open systems and Client-Server computing are often used as if they were synonymous. It does not make long-term sense for users to adopt a Client/Server environment that is not based on standards. There are currently very few Client/Server technologies based on standards at every level. Proprietary Client/Server technologies (applications, middleware etc.) will always lock you into a particular supplier.

The existing costs are always high. Failure to appreciate the spectrum of technologies within the Client-Server model, will always lead to dysfunctional Client/Server solutions.

This will result in compromises in key areas of any company's Client/Server infrastructure, such as Usability, Security, and Performance.

There are quite a few organizations whose members work to establish the standards that govern specific activities. For example, the Institute of Electrical and Electronics Engineers (IEEE) are dedicated to define the standards in the network hardware environment. Similarly, the American National Standards Institute (ANSI) has created standards for programming languages such as COBOL and SQL. The International Organization for Standardization (ISO) produces the Open System Interconnection (OSI) reference model to achieve network systems communications compatibility.

Benefits of Open Standards

- Standards allow us to incorporate new products and technology with existing I.T. investments — hardware,

operating environments, and training, with minimum effort.

- Standards allow us to mix and match the 'best of breed' products. Thus databases and development tools, and Connectivity software become totally independent.
- Standards allow us to develop modular applications that do not fall apart because the network has been re-configured (e.g., change of topology, or transport protocol etc.), or the graphical user interface standard as changed, or a component-operating environment has changed.
- Standards maintain tighter security.
- Standards reduce the burden of overall maintenance and system administration.
- Standards provide faster execution of pre-compiled code.
- Standards prevent the database and its application and possibly others on the server from having their response time degraded in a production environment by inefficient queries.

2.5 CLIENT/SERVER SECURITY

A security threat is defined as circumstance, condition, or event with the potential to cause economic hardship to data or network resources in the form of destruction. Disclosure, modification of data, denial of service, and/or fraud, waist and abuse. Client/ Server security issues deal with various authorization methods related to access control. Such mechanisms include password protection, encrypted smart cards. Biometrics and firewalls. Client/Server security problems can be due to following:

- **Physical security holes:** These results when any individual gains unauthorized access to a computer by getting some user's password.
- **Software security holes:** These result due to some bug in the software, due towhich the system may be compromised into giving wrong performance.
- **Inconsistent usage holes:** These may result when two

different usages of a systems contradict over a security point.

Of the above three, software security holes and inconsistent usage holes can be eliminated by careful design and implementation. For the physical security holes, we can employ various protection methods. These security methods can be classified into following categories:

(i) Trust-based security.

(ii) Security through obscurity.

(iii) Password scheme.

(iv) Biometric system.

Emerging Client/Server Security Threats

We can identify emerging Client/Server security threats as:

(i) Threats to local computing environment from mobile code,

(ii) Threats to servers that include impersonation,

(iii) eavesdropping, denial of service, packet reply, and packet modification.

Software Agents and the Malicious Code Threat

Software agents or mobile code are executable programs that have ability to move from machine to machine and also to invoke itself without external influence. Client threats mostly arise from malicious data or code. Malicious codes refers to viruses, worms (a self-replicating program that is self-contained and does not require a host program. The program creates a copy of itself and causes it to execute without any user intervention, commonly utilizing network services to propagate to other host systems.)e.g., Trojan horse, logic bomb, and other deviant software programs. Virus is a code segment that replicates by attaching copies of itself to existing executables. The new copy of the virus is executed when a user executes the host programs. The virus may get activated upon the fulfilment of some specific conditions.

The protection method is to scan for malicious data and program fragments that are transferred from the server to the client, and filter out data and programs known to be dangerous.

Threats to Server

Threats to server may be of the following types:

(i) Eavesdropping is the activity of silently listening to the data sent over the network. This often allows a hacker to make complete transcript of network activity and thus obtain sensitive information, such as password, data, and procedures for performing functions. Encryption can prevent eavesdroppers from obtaining data traveling over unsecured networks.

(ii) Denial of service is a situation, where a user renders the system unusable for legitimate users by hogging or damaging a resource so that it can be used. The common forms of this, are:

- **Service overloading:** A server may be rendered useless by sending it a large amount of illegitimate service requests so as to consume up its CPU cycle resource. In such a situation, the server may deny the service request of legitimate requests.
- **Message flooding:** It is a process of increasing the number of receiving processes running over the disk of the server by sending large files repeatedly after short intervals. This may cause disk crash.
- **Packet replay** refers to the recording and retransmission of message packets in the network. Medium tapping can do this. A checker may gain access to a secure system by recording and later replaying a legitimate authentication sequence message. Packet reply can also be used to distort the original message. Using a method like packet time stamping and sequence counting can prevent this problem.

2.6 ORGANIZATIONAL EXPECTATIONS

As we have already discussed the advantages and disadvantages associated with Client/ Server computing, from the organizational point of view the managers are looking for the following Client/Server benefits.

- Flexibility and adaptability.

- Improved employee productivity.
- Improved company work flow and a way to re-engineering business operations.
- New opportunities to provide competitive advantages.
- Increased customer service satisfaction.

Flexibility and Adaptability

Client/Server computing is expected to provide necessary organizational flexibility to adapt quickly and efficiently in changing business conditions.

Such changes can be driven by technological advantages; government regulations, mergers and acquisitions, market forces and so on.

A company that can adapt quickly to changes in its market conditions is more likely to survive than one that cannot.

Multinational companies, whose widely dispersed offices must share information across often-disparate computer platforms, are especially well-positioned to benefit from the flexibility and adaptability offered by the Client/Server infrastructure.

Improved Employee Productivity

Client/Server computing opens the door to previously unavailable corporate data. End users can manipulate and analyze such data on an ad hoc basis by means of the hardware and the software tools that are commonly available with client server environments.

Quick and reliable information access enables end users to make intelligent decisions. Consequently, end users are more likely to perform their jobs better, provide better services, and become more productive within the corporation.

Improved Company Work Flow and a Way to Re-engineering Business Operations

Organizations that face problems with their internal data management typically favour the introduction of Client/Server computing.

Providing data access is just the first step in information management. Providing the right data to the right people at the right time is the core of decision support for MIS departments.

As competitive conditions change, so do the companies' internal structure, thus triggering demands for information systems that reflect those changes.

Client/Server tools such as Lotus Notes are designed exclusively to provide corporations with data and forms distribution, and work group support, without regard to geographical boundaries.

These workgroup tools are used to route the forms and data to the appropriate end users and coordinate employee work. The existence and effective use of such tools allows companies to re-engineer their operational processes, effectively changing the way they do the business.

New Opportunities to Provide Competitive Advantages

New strategic opportunities are likely to be identified as organizations restructure. By making use of such opportunities, organizations enhance their ability to compete by increasing market share through the provision of unique products or services. Proper information management is crucial within such a dynamic competitive arena. Therefore, improved information management provided by a Client/Server system means that such systems could become effective corporate strategic weapons.

Increased Customer Service Satisfaction

As new and better services are provided, customer satisfaction is likely to improve. Client/ Server systems enable the corporate MIS manager to locate data closer to the source of data demand, thus increasing the efficiency with which customer enquiries are handled.

2.7 IMPROVING PERFORMANCE OF CLIENT/SERVER APPLICATIONS

Client/Server-developed applications may achieve substantially greater performance when compared with traditional workstations or host-only applications.

(i) **Offload work to server:** Database and communications processing are frequently offloaded to a faster server

processor. Some applications processing also may be offloaded, particularly for a complex process, which is required by many users.

The advantage of offloading is realized when the processing power of the server is significantly greater than that of the client workstation. Separate processors best support shared databases or specialized communications interfaces. Thus, the client workstation is available to handle other client tasks. These advantages are best realized when the client workstation supports multitasking or atleast easy and rapid task switching.

(ii) **Reduce total execution time:** The server can perform database searches, extensive calculations, and stored procedure execution in parallel while the client workstation deals directly with the current user needs. Several servers can be used together, each performing a specific function. Servers may be multiprocessors with shared memory, which enables programs to overlap the LAN functions and database search functions. In general, the increased power of the server enables it to perform its functions faster than the client workstation. In order for this approach to reduce the total elapsed time, the additional time required to transmit the request over the network to the server must be less than the saving. High-speed local area network topologies operating at 4, 10, 16, or 100Mbps (megabits per second) provide high- speed communications to manage the extra traffic in less time than the savings realized from the server. The time to transmit the request to the server, execute the request, and transmit the result to the requestor, must be less than the time to perform the entire transaction on the client workstation.

(iii) **Use a multitasking client:** As workstation users become

more sophisticated, the capability to be simultaneously involved in multiple processes becomes attractive. Independent tasks can be activated to manage communications processes, such as electronic mail, electronic feeds from news media and the stock exchange, and remote data collection (downloading from remote servers). Personal productivity applications, such as word processors, spreadsheets, and presentation graphics, can be active. Several of these applications can be dynamically linked together to provide the desktop information-processing environment. Functions such as Dynamic Data Exchange (DDE) and Object Linking and Embedding (OLE) permit including spreadsheets dynamically into word-processed documents.

These links can be *hot* so that changes in the spreadsheet cause the word-processed document to be updated, or they can be *cut and paste* so that the current status of the spreadsheet is copied into the word-processed document.

Systems developers appreciate the capability to create, compile, link, and test programs in parallel. The complexity introduced by the integrated CASE environment requires multiple processes to be simultaneously active so the workstation need not be dedicated to a single long-running function. Effective use of modern CASE tools and workstation development products requires a client workstation that supports multitasking.

2.8 SINGLE SYSTEM IMAGE

Rapid changes have occurred in computer technology resulting in system of increased capabilities. This indicates that maximum resources are available to accepts all these new products. For the organizations using Client/Server systems the environment is heterogeneous whereas the users prime

concern to achieve the maximum functionality.

Every Client/Server system should give equal importance to the developers' and users' requirements. For the users, this means the realization of a single-system-image.

"A single- system-image is the illusion, created by software or hardware, that presents a collection of resources as one, more powerful resource." SSI makes the system appear like a single machine to the user, to applications, and to the network.

With it all network resources present themselves to every user in the same way from every workstation (See the Fig. 2.2, given below) and can be used transparently after the user has authorized himself/ herself once. The user environment with a desktop and often-used tools, such as editors and mailer, is also organized in a uniform way.

The workstation on the desk appears to provide all these services. In such an environment the user need not to bother about how the processors (both the client and the server) are working, where the data storage take place and which networking scheme has been selected to build the system.

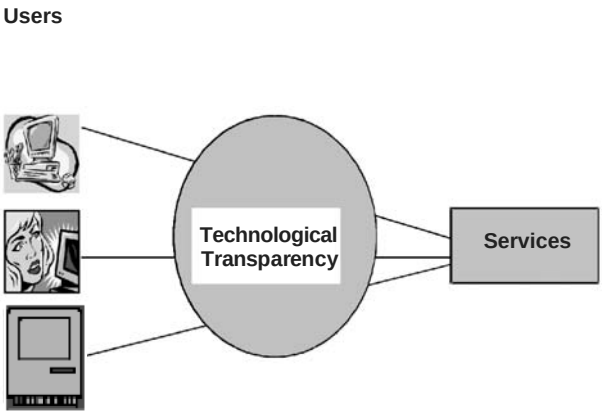

Fig.2.2: Single Image System

Further desired services in *single-system-image* environment are:

- Single File Hierarchy; for example: xFS, AFS, Solaris MC Proxy.
- Single Control Point: Management from single GUI and access to every resource is provided to each user as per their valid requirements.

- Single virtual networking.
- Single memory space e.g. Network RAM/DSM.
- Single Job Management e.g. Glunix, Codine, LSF.
- Single User Interface: Like workstation/PC windowing environment (CDE in Solaris/NT), Web technology can also be used.
- Standard security procedure: Access to every application is provided through a standard security procedure by maintaining a security layer.
- Every application helps in the same way to represent the errors and also to resolve them.
- Standard functions work in the same way so new applications can be added with minimal training. Emphasis is given on only new business functions.

Hence, *single-system-image* is the only way to achieve

acceptable technological transparency.

> *"A single-system-image of all the organization's data and easy management of change" are the promises of client/server computing.*

But as more companies follow the trend towards downsized Client/Server networks, some find the promise elusive. Security, scalability and administration costs are three of the key issues. For example, the simple addition of a new user can require the definition to be added to every server in the network. Some of the visible benefits due to *single-system-image* are as given below:

- Increase the utilization of system resources

transparently.

- Facilitates process migration across workstations transparently along with load balancing.
- Provides improved reliability and higher availability.
- Provides overall improved system response time and performance.
- Gives simplified system management.
- Reduces the risk covered due to operator errors.
- User need not be aware of the underlying system.
- Provides such architecture to use these machines effectively.

2.9 DOWNSIZING AND RIGHTSIZING

Downsizing:

The downward migrations of business applications are often from mainframes to PCs due to low costing of workstation. And also today's workstations are as powerful as last decade's mainframes.

The result of that is Clients having power at the cost of less money, provides better performance and then system offers flexibility to make other purchase or to increase overall benefits.

Mainframes are being replaced by lesser expensive PC's on networks. This is called computer downsizing. Companies implementing business process reengineering are downsizing organizationally. This is called business downsizing. All this would result in hundreds of smaller systems, all communicating to each other and serving the need of local teams as well as individuals working in an organization. This is called cultural downsizing. The net result is distributed computer systems that support decentralized decision-making. This is the client/server revolution of the nineties.

Rightsizing: Moves the Client/Server applications to the most appropriate server platform, in that case the servers from different vendors can co-exist and the network is known as the 'system'.

Getting the data from the system no longer refers to a single mainframe. As a matter of fact, we probably don't know where the server physically resides.

Upsizing: The bottom-up trend of networking all the stand alone PCs and workstations at the department or work group level. Early LANs were implemented to share hardware (printers, scanners, etc.). But now LANs are being implemented to share data and applications in addition to hardware.

2.10 CLIENT/SERVER METHODOLOGY

Many PC-based developers, particularly those who never knew of any other type of computer, believe that today's methodologies are not only wrong, but also unnecessary. They believe that prototyping based on rapid application development tools make methodologies completely unnecessary. Is this true? If yes, should the methodologies be thrown away? The answer to all these questions depends on the scale and complexity of the application being developed. Small applications that run on a single desktop can bebuilt within hours. The use of methodology in such cases can be waste of time.

However, bigger systems are qualitatively different, especially in term of their design process. Whenever, a system, particularly one involving a database, expands to include more than one server, with servers being located in more than one geographical location, complexity is bound to go up. Distributed systems cross this complexity barrier rapidly. We can say.

- Methodologies are important, and will continue to remain so for the construction of large applications.
- Distributed systems will need these methodologies most of all.
- Today's methodologies will have to change to meet the needs of a new generation of developers and users, accommodate the design of distributed systems, and yield friendly, maintainable systems.