CLIENT SERVER COMPUTING

- **UNIT II: Client, Servers and Operating Systems–The Anatomy of a server program–Needs of Client/Server from an OS–Servers capability–Client anatomy–Client and server Trends – Client OS and Server OS.**
- TEXT BOOK:
- Robert Orfali, Dan Harkey& Jeri Edwards, "Client/Server Survival Guide", Wiley INDIA Edition, 3rd Edition, 2011.
- Prepared by : B.Loganathan

Clients, Servers & OS : The Anatomy of a Server Program

- The role of a server program is to serve multiple clients who have an interest in a shared resource owned by the server.
- A typical sever program done :
- i) **Waits for client-initiated requests**: The server program spends most of its time passively waiting on client requests. The server must always be responsive to its clients and be prepared for rush hour traffic when many clients will request services at the same time.

- ii) **Executes many requests at the same time** : The server program must do the work requested by the client promptly. The server program that does not provide multitasking will run the risk of having a client hog all the system resources. The server must be able to concurrently service multiple clients while protecting the integrity of shared resources.
- iii) **Takes care of VIP clients first**: The server program must be able to provide different levels of service priority to its clients. For example, batch job in low priority while OLTP-type for high priority clients.

- **iv) Initiates and runs background-task activity**: The server program must be able to run background tasks triggered to perform routine task unrelated to the main program's thrust. For example, a task to download records from the host database during non-peak hours.
- **v) Keeps running**: The server program is typically a mission-critical applications. If the server goes down, that impacts all the clients depend on its services.
- **vi) Grows bigger and fatter** : Server program seem to have an uncontrollable appetite for memory and processing power. The server must be upwardly scalable and modular.

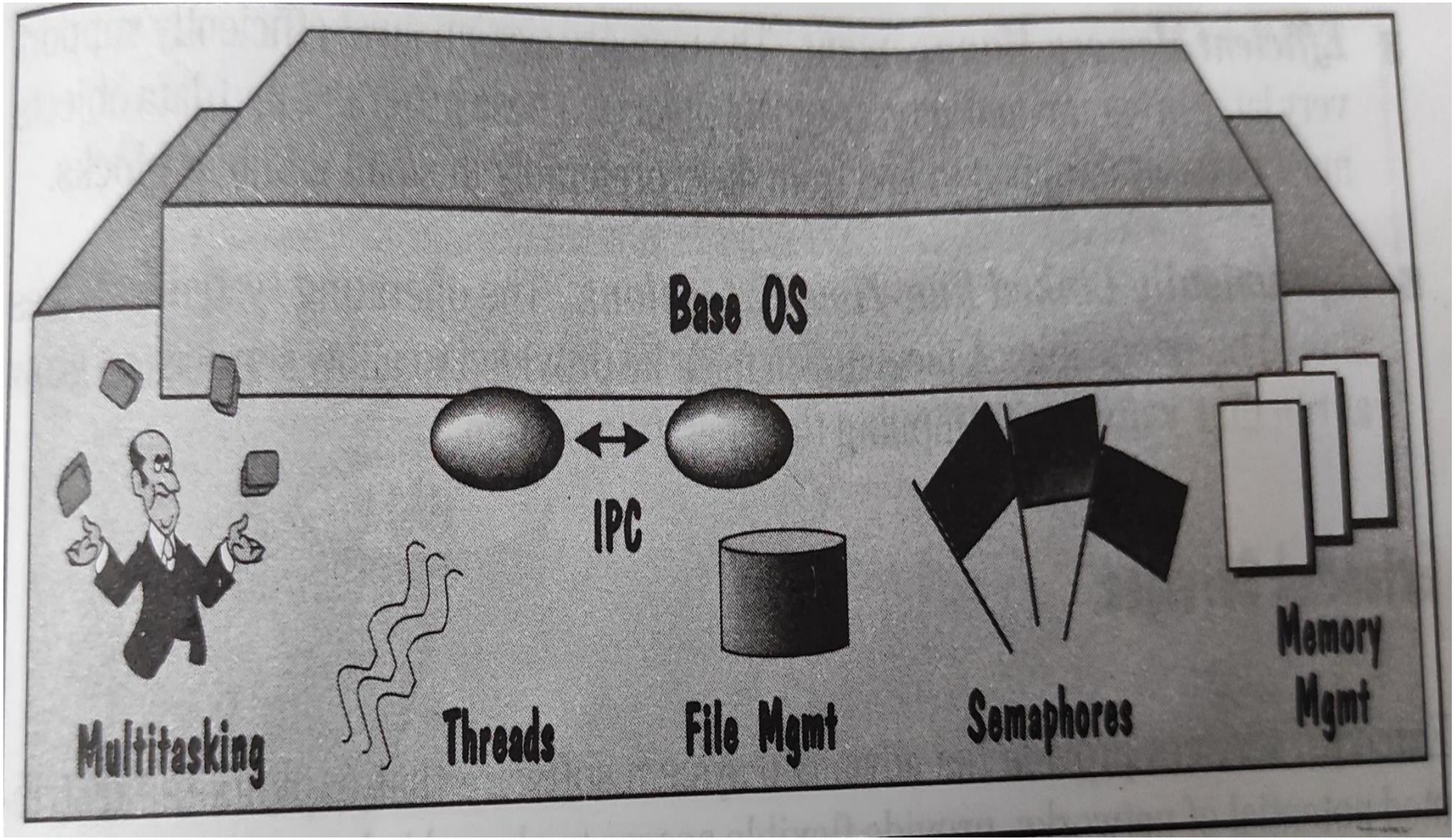
Needs of Server from an OS

- In distributed computing environment, the operating system functions are either base services or extended services. The base services are part of the standard OS, while the extended services are add-on modular software components that are layered on top of the base services.
- Extended services are usually provided by more than one vendor.

Base Services

- The server programs exhibit a high level of concurrency. Task management is best done by multitasking operating system.
- Multitasking is the way to simplify the coding of complex applications that can be divided into a collection of discrete and logically distinct, concurrent tasks.
- It improve the performance, throughput, modularity and responsiveness of server programs.

Servers requirement from OS



- Operating System requirements:
- i) **Task Preemption** : An OS with preemptive multitasking must allot fixed time slots to each task. Without preemptive multitasking, a task must voluntarily agree to give up the processor before another task can run.
- ii) **Task Priority** : An OS must dispatch tasks based on their priority. This feature allows server to differentiate the level of service based on their clients priority.
- iii) **Semaphores** : An OS must provide simple synchronization mechanisms for keeping concurrent tasks from bumping into one another when accessing shared resources. These mechanism is called semaphores.

- iv) **Inter-Process Communications (IPC)** : An OS must provide the mechanisms that allow independent processes to exchange and share data.
- v)**Local/Remote Inter-process Communication**: An OS must allow the transparent redirection of inter-process calls to a remote process over a network without the application being aware of it.
- vi) **Threads** : Threads are used to create very concurrent, event-driven server programs. Each waiting event can be assigned to a thread that blocks until the event occurs. Other threads can use the CPU cycles productively to perform useful work.

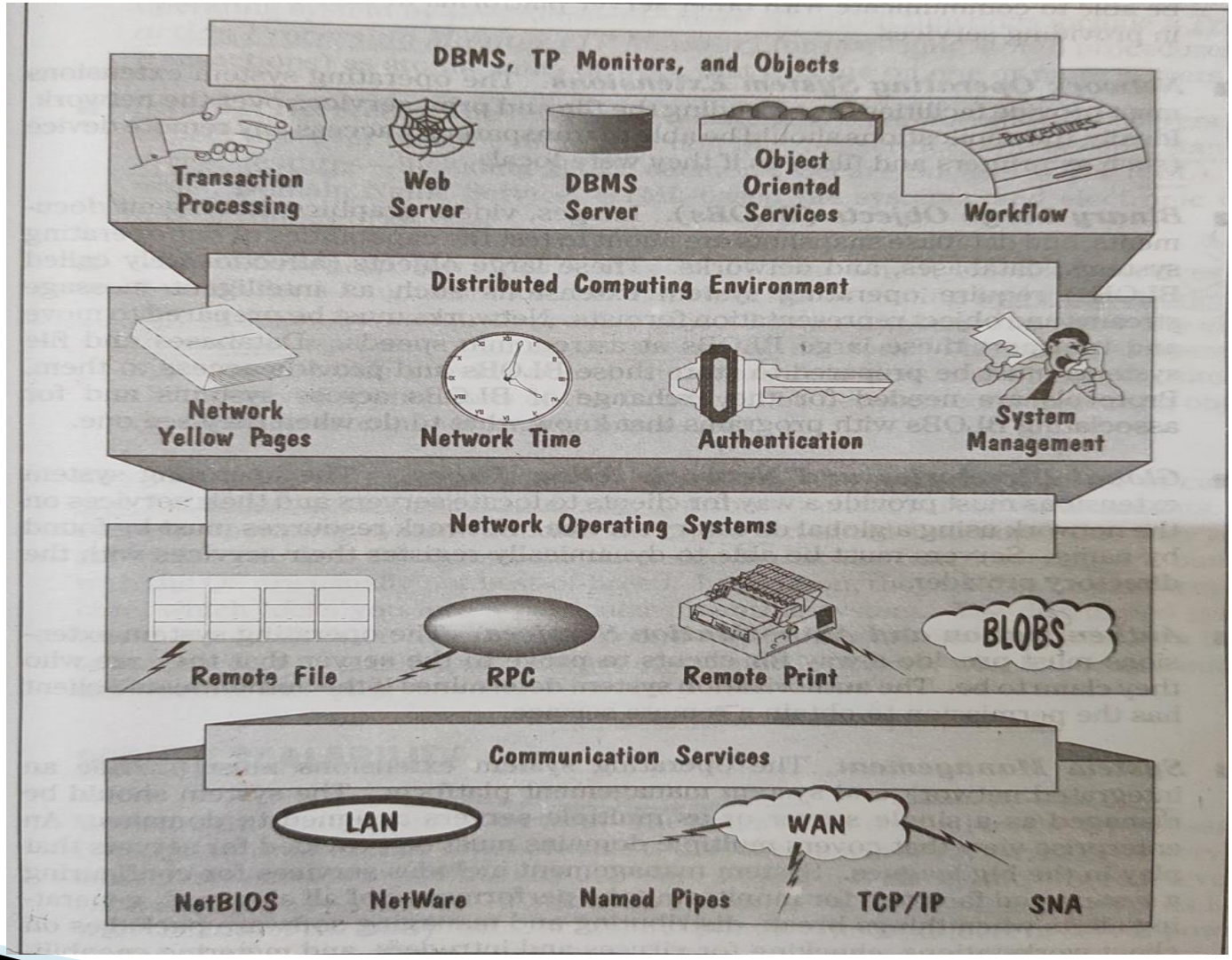
- **vi) Inter-task Protection** : The OS must protect tasks from interfering with each others resources. Protection also extends to the file system and calls to the operating system.

- **vii) Multiuser High-Performance File System** : The file system must support multiple tasks and provide the locks that protect the integrity of the data. The file system must support a large number of open files without too much worse in performance.

- **viii) Efficient Memory Management** : The memory system must efficiently support very large programs and very large data objects. These must be easily swapped to and from disk.

- **ix) Dynamically Linked Run Time Extensions :** The OS services should be extendable. A mechanism must be provided to allow services to grow at run time without recompiling the operating system.

Extended Services



- Extended services provide the advanced system software that exploits the distributed potential of networks, provide flexible access to shared information and make the system easier to maintain.
- i**) Ubiquitous communications** : The OS extensions must provide a rich set of communications protocol that allow the server to communicate with the greatest number of client platforms.

- ii) **Network OS extensions** : The OS extensions must provide facilities for extending the file and print services over the network. The applications should be able to transparently access any remote device.

- iii) **Binary large objects (BLOB)** : Images, videos, graphics, intelligent documents and database are about to test the capability of OS in networks. These large objects (BLOBs) require OS extensions such as intelligent message streams and object representation formats. Network must be prepared to move and transport these large BLOBs at astronomic speed.

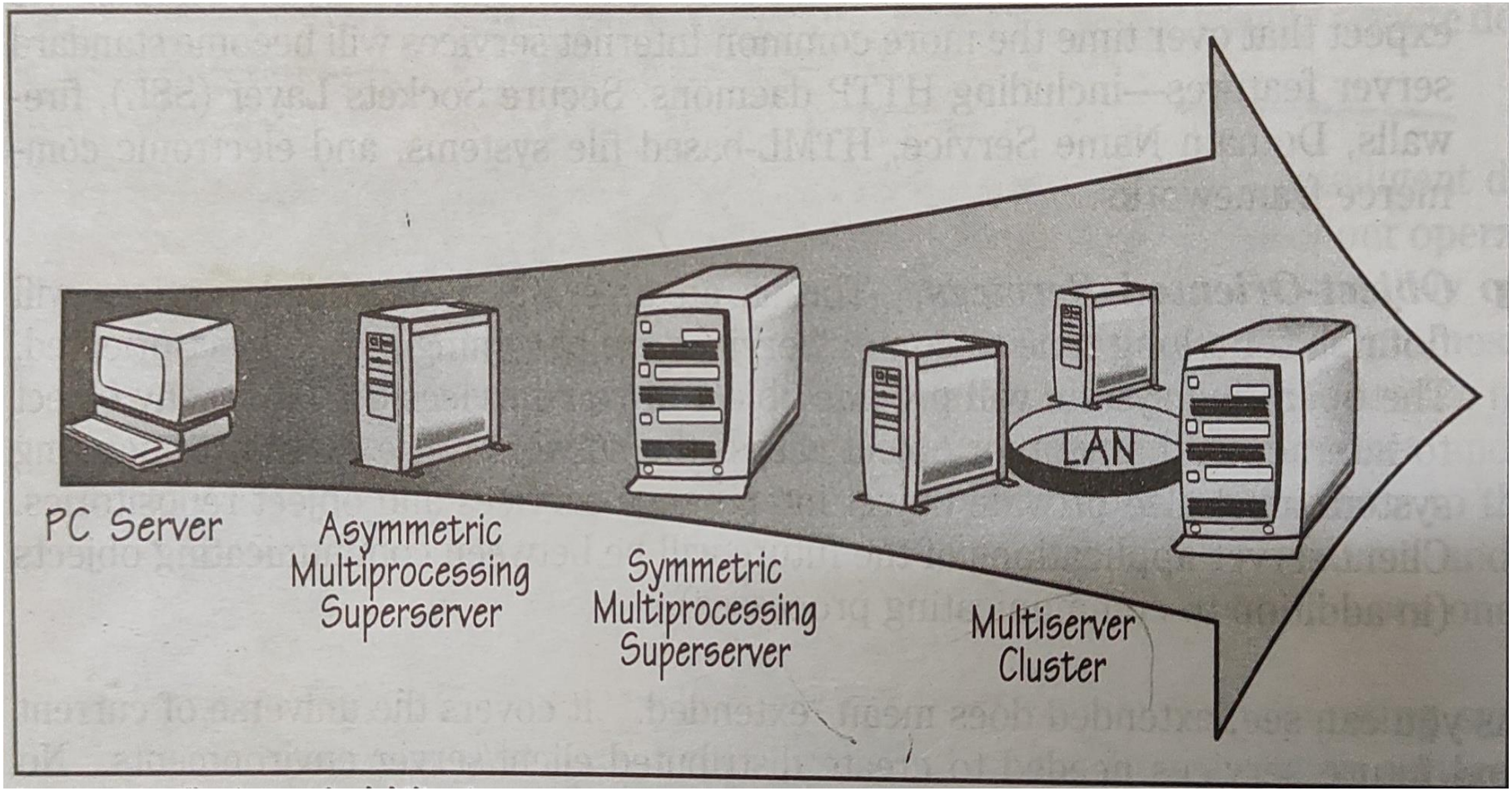
- iv) **Global directories and network yellow pages** : The OS extensions must provide a way for client to locate servers and their services on the network using the global directory service.

- v) **Authentication and authorization services** : The OS extensions must provide a way for client to prove to the server that they are who they claim to be. The authorization system determine if the authenticated client has the permission to obtain a remote service.

- vi) **System management** : The OS extension must provide an integrated network and system management platform. System management includes services for configuring a system, facilities for monitoring the performance of all elements, generating alert when things break, distributing and managing software packages on client work stations, checking for viruses and metering capabilities for pay-as-you-use resources.
- vii) **Network time** : The OS extensions must provide a mechanism for clients and servers to synchronize their clocks.
- viii) **Database and transaction services** : The OS extensions must provide a robust multiuser Database Management System (DBMS). This DBMS support SQL for decision support and server-stored procedures for transaction services.

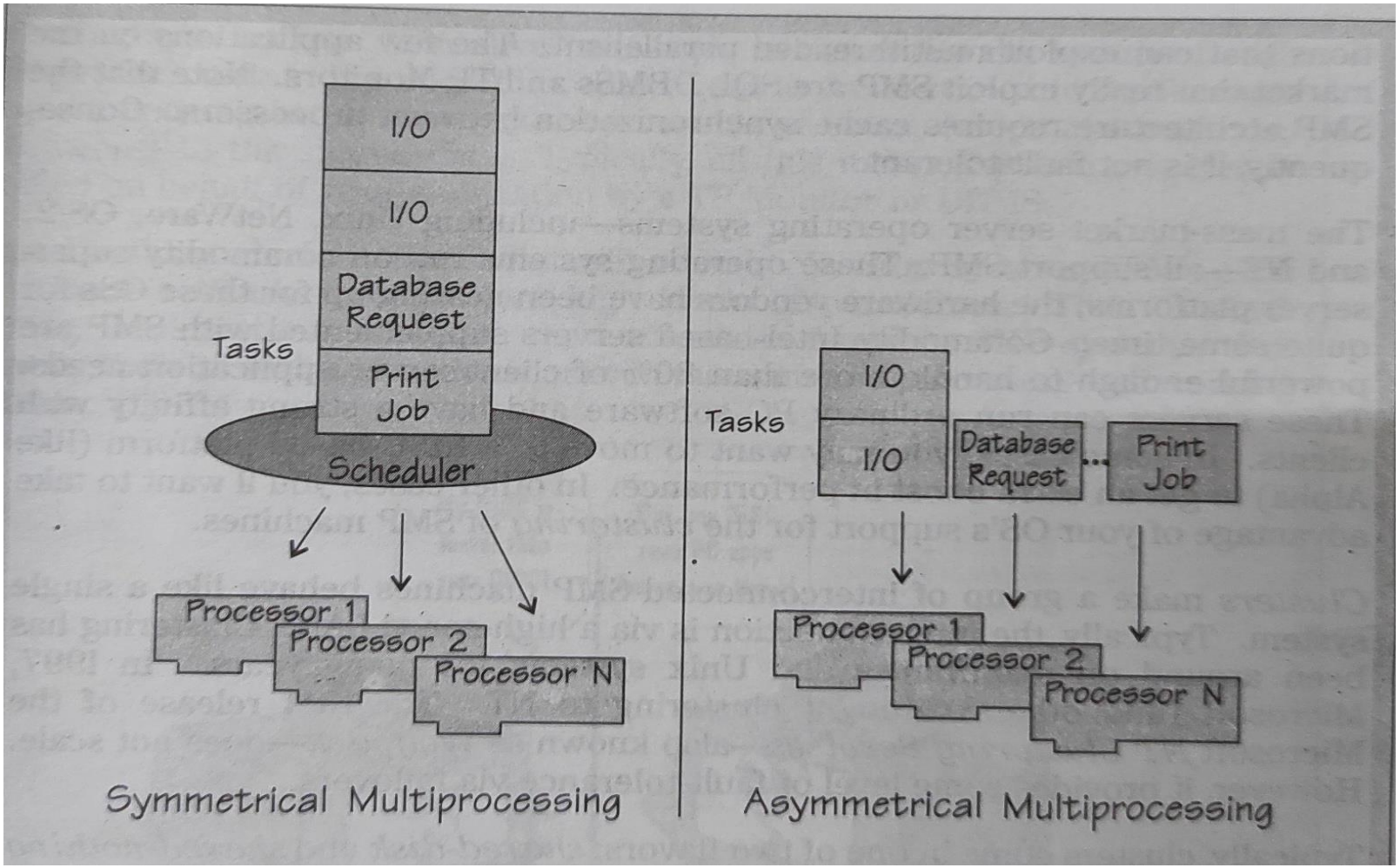
- ix) **Internet services** : The internet is a huge growth opportunity for servers. Internet services will become standard features including HTTP domain, Secure Socked Layer (SSL), firewalls, Domain Name Service (DNS), HTML based file system and electronic commerce frameworks.
- x) **Object oriented services** : The OS provide object broker services that allow any object to interact with any other object across the network. The extended OS must also provide object interchange services and object repositories.

Server Scalability



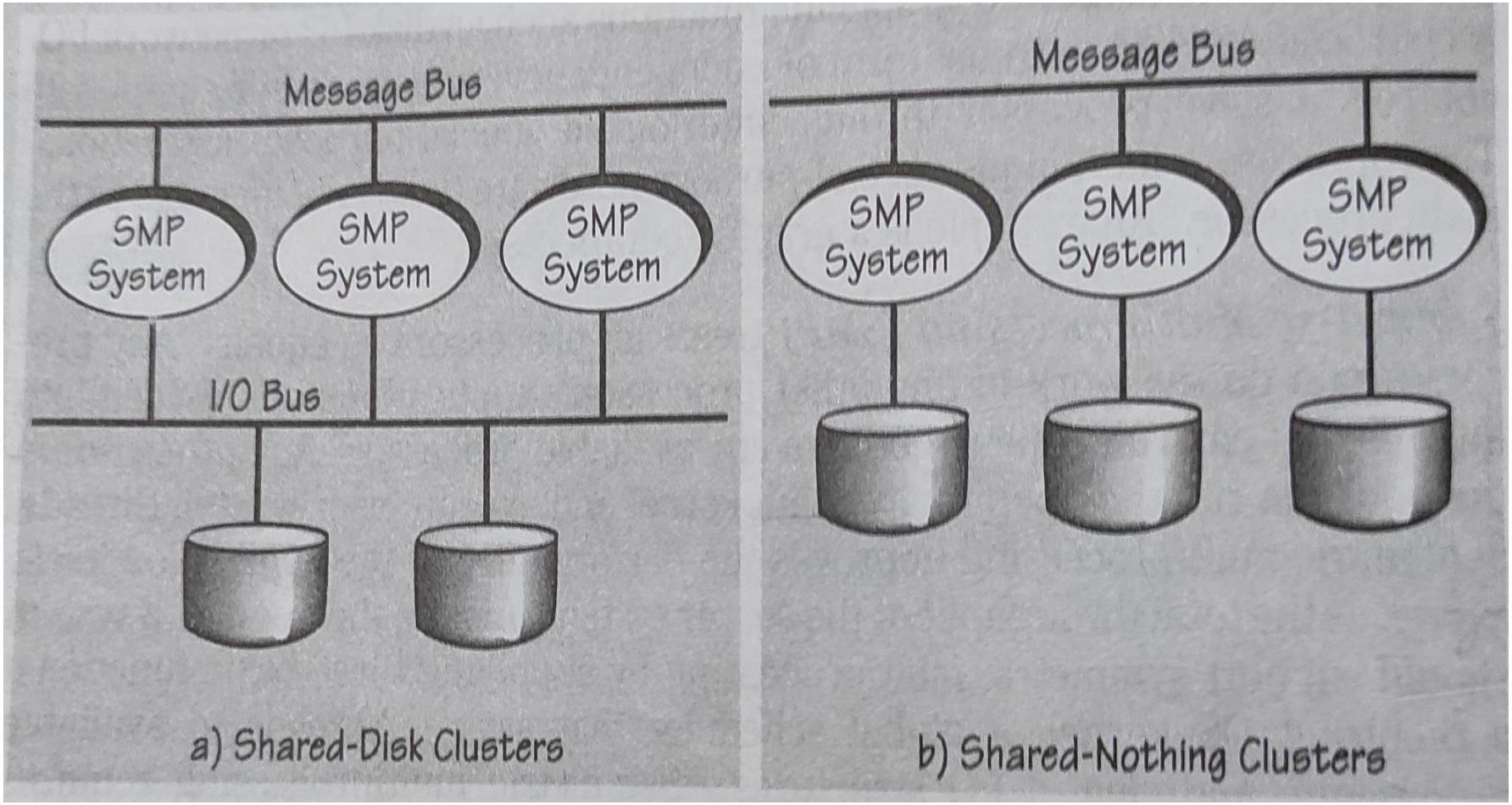
- The diagram shows the different level of escalation in server power. It starts with a single PC server with the top-of-the-line processor and I/O power.
- The next level of server power is provided by super servers populated with multiprocessors. If the power is not enough, divide the work among different servers.
- Multi-server clusters are used in environment that require more processing power. It is upwardly scalable. When we need more processing power, we can add more servers or the existing server machine can be traded up to the latest generation of super server machine.

Multiprocessing Super Servers



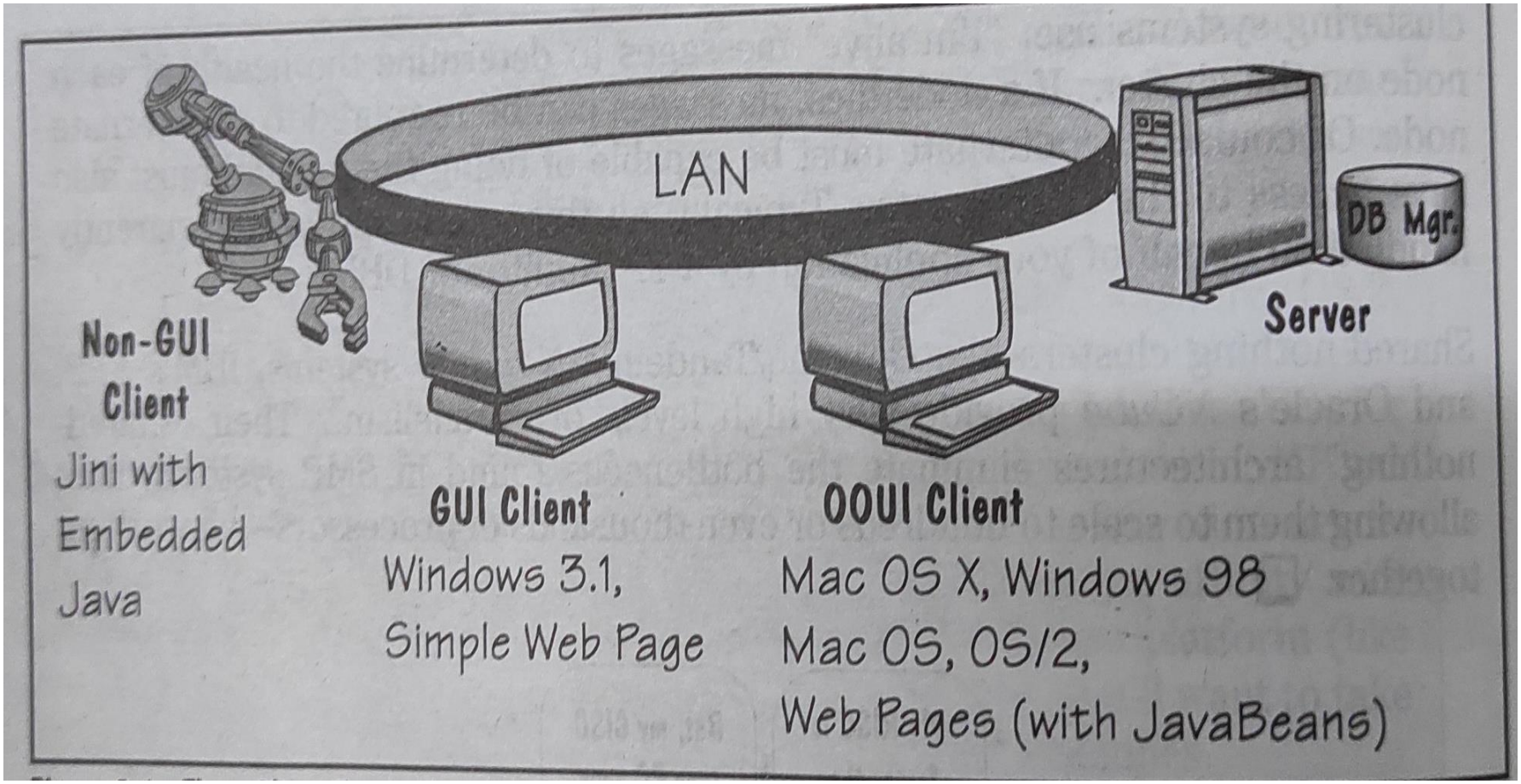
- **Multiprocessing super servers comes in two flavors** : Asymmetric and Symmetric.
- i) **Asymmetric multiprocessing** : It imposes hierarchy and a division of labor among processors. Only one designated processor, the master that controls slave processors dedicated to specific functions such as disk I/O or network I/O.
- ii) **Symmetric Multi-Processing (SMP)** : It treats all processors as equal. Any processors can do the work of any other processor. Applications are divided into threads that can run concurrently on any available processor. SMP improve the performance of the application as well as the total throughput of the server system. SMP supported OS are Unix, NetWare, OS/2 and NT.

Clustering Architecture



- Clusters make a group of interconnected SMP machines behave like a single system. Clustering has been around on main frames and Unix systems for many years.
- Clusters come in one of two flavors : Shared-disk and Shared-nothing. So in both cases, some form of high speed LAN is used for intercluster communications.
- In shared-disk clusters, clusters provide high availability and any failures are contained within a single node. Cluster system use “I am alive” message to determine the health of each node on the cluster. If a node dies, messages can be re-routed to an alternate node. The alternate must be capable of doing the job and also have access to the shared data.
- Shared-nothing clusters provide very high level of parallelism. The shared-nothing architecture is used to eliminate the bottlenecks found in SMP system.

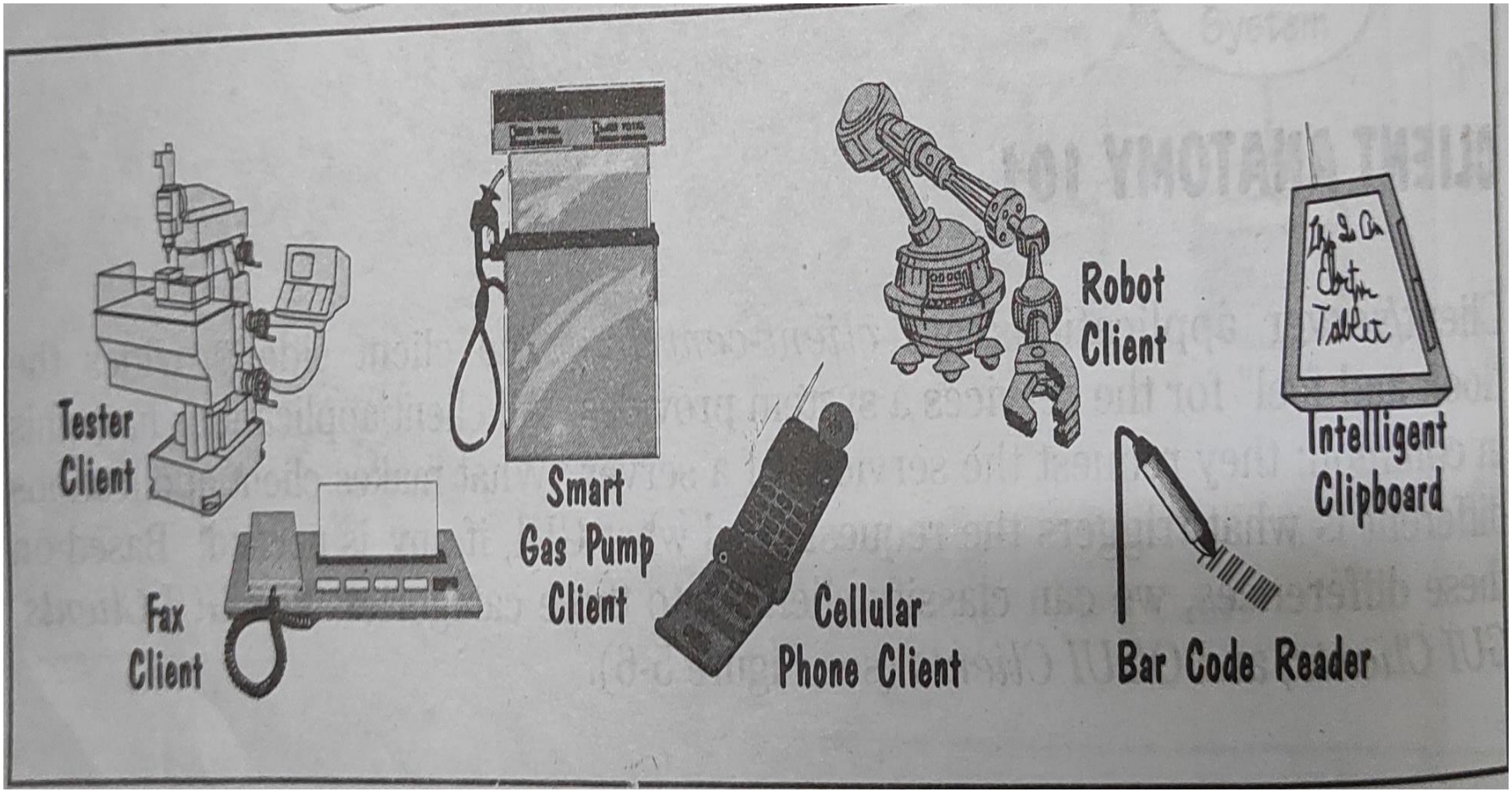
Client Anatomy



- Client/server application are *client-centric*. The client side provides the “look-and-feel” for the services a system provides.
- Classification of Client into three categories : Non-GUI Clients, GUI Clients and OOUI Clients.

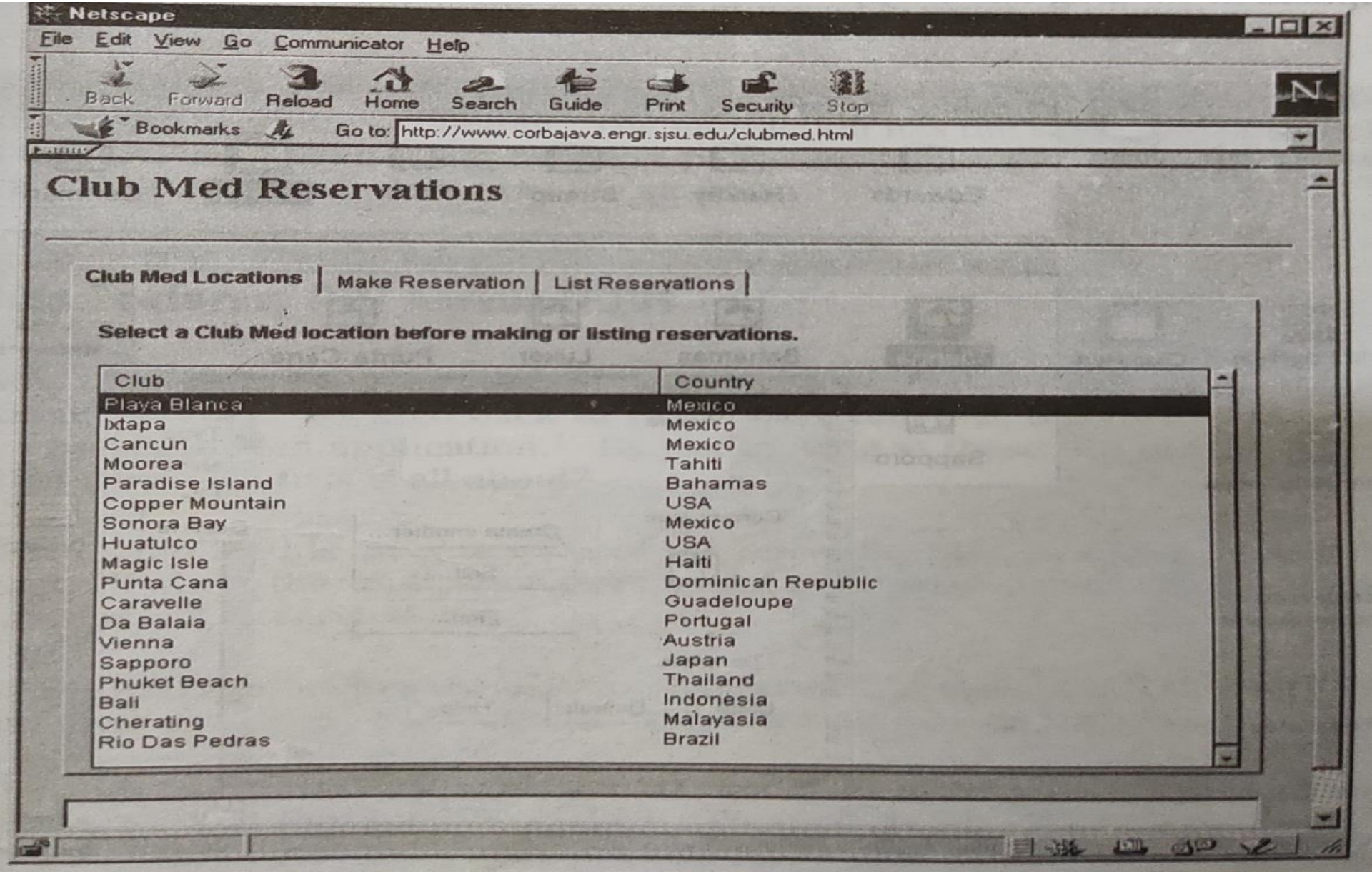
- **a) Non-GUI Clients** : It generate server requests with a minimal amount of human interaction. Non-GUI fall into two sub-categories :
- i) Non-GUI clients that do not need multitasking: Examples are automatic teller machines (ATM), barcode readers, cellular phones, fax machines, smart gas pumps and intelligent clipboards. These clients may provide a simple human interface.

Non-GUI Clients



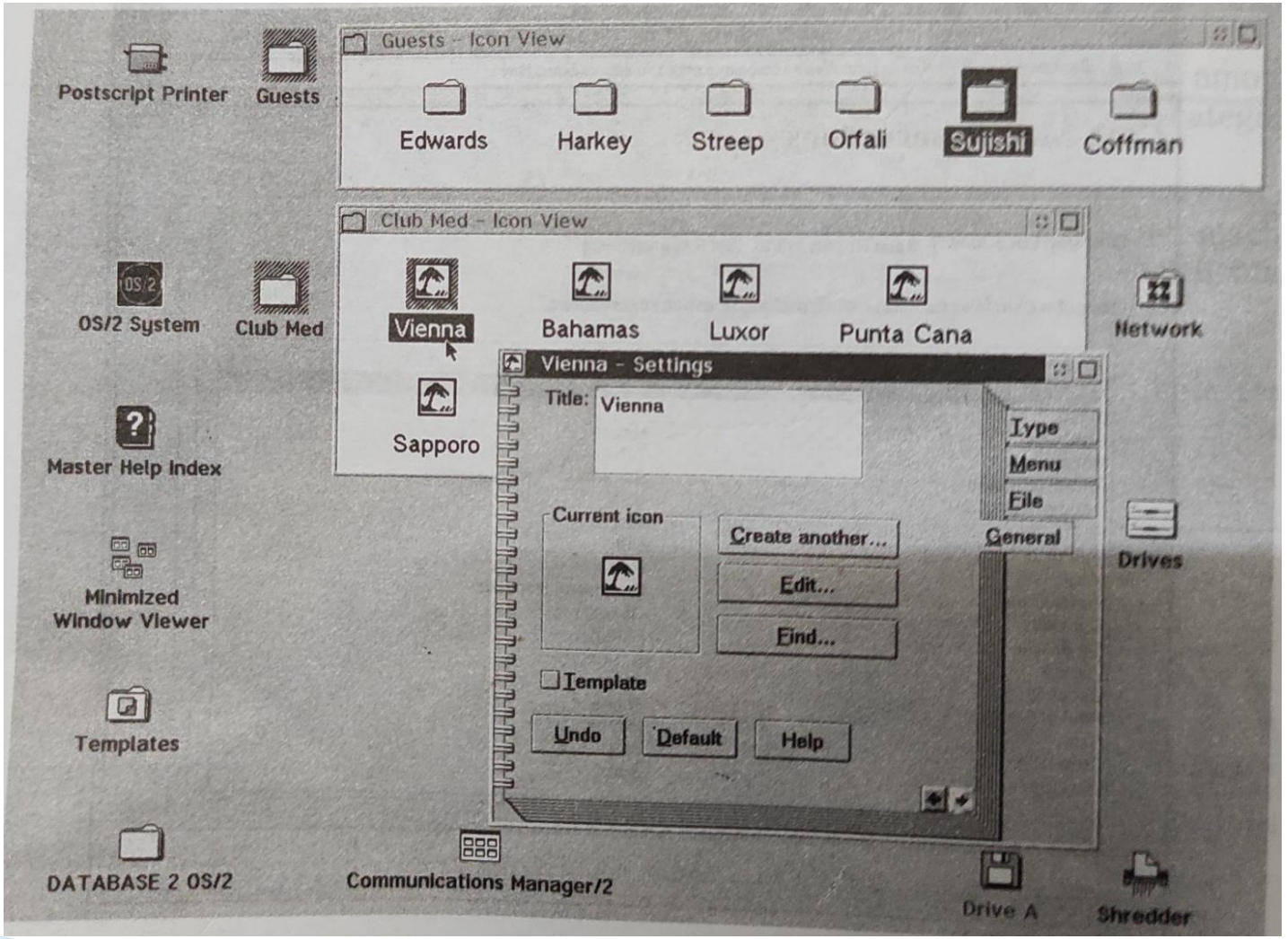
- ii) Non-GUI Clients that need multitasking : Examples are robots, testers and daemon programs. These clients often require real-time, event-driven multitasking services.
- **b) GUI Clients** : These are applications where occasional request to the server from a human interacting with GUI. These make good frond-end clients to database servers.
- GUI client applications are graphical renditions of the dialogs. GUI replace the old green-screen with graphical dialogs, color, menu bars, scroll boxes, pull-down and pop-up windows (Diagram).

GUI Clients


Netscape
File Edit View Go Communicator Help
Back Forward Reload Home Search Guide Print Security Stop
Bookmarks Go to: http://www.corbajava.engr.sjsu.edu/clubmed.html
Club Med Reservations
Club Med Locations | Make Reservation | List Reservations
Select a Club Med location before making or listing reservations.
Club
Country
Playa Blanca Mexico
Ixtapa Mexico
Cancun Mexico
Moorea Tahiti
Paradise Island Bahamas
Copper Mountain USA
Sonora Bay Mexico
Huatulco USA
Magic Isle Haiti
Punta Cana Dominican Republic
Caravelle Guadeloupe
Da Balaia Portugal
Vienna Austria
Sapporo Japan
Phuket Beach Thailand
Bali Indonesia
Cherating Malayasia
Rio Das Pedras Brazil

- **Object-Oriented User Interface (OOUI) Clients** : OOUIs are used by information workers doing multiple, variable tasks whose sequence cannot be predicted.
- Examples are executive and decision-support applications, multimedia-based training systems, system management consoles and stockbroker workstations.
- OOUI desktop objects need to communicate among themselves and with external servers by necessity, real-time, interactive and high concurrent.
- Example are OS/2 Workplace Shell, NextStep(Mac x), Mac OS and Windows 98.

OOUI Clients



- The desktop can contain multiple workplaces running concurrently (Above diagram). Each workplace may be running parallel dialogs, called modeless dialogs over parallel sessions with the server.
- Information is displayed to the user in the foreground windows, while background tasks are constantly moving information to and from servers. For example, first page from a multimedia document is displayed in a window while a background task is busy pre-fetching the rest of the document from the server.

GUI Vs OOUI

Table 5-1. GUI Versus OOUI.

Feature	Graphical User Interface (GUI)	Object-Oriented User Interface (OOUI)
Application Structure	A graphic application consists of an icon, a primary window with a menu bar, and one or more secondary windows. The focus is on the main task. Ancillary tasks are supported by secondary windows and pop-ups. Users must follow the rigid task structure (and may get trapped in a task). An application represents a task.	A graphic application consists of a collection of cooperating user objects. Everything that you see is an object. Each object is represented by an icon and has at least one view. Objects can be reused in many tasks. The application's boundaries are fuzzy. The user defines what's an application by assembling a collection of objects. These objects may come from one or more programs and are integrated with the desktop objects the system provides (like printers and shredders). The users can innovate and create their own "Lego-like" object collections.
Icons	Icons represent a running application.	Icons represent objects that may be directly manipulated.
Starting an Application	Users start applications before selecting an object to work with.	Users open the object on the desktop, which causes a window view of the object to be displayed.
Windows	Users open a primary window and then specify the objects they want to interact with. The same window can be used to display other objects.	A window is a view of what's inside an object. There is a one-to-one relationship between a window and an object.
Menus	Menus provide the primary method for navigating within an application.	Each object has a context menu. You navigate within an application or across applications by directly manipulating objects. The desktop functions as one big menu; icons represent the objects that you can manipulate.
Active Application Visual	Icons represent minimized windows of active applications.	Icons are augmented with the *in-use* emphasis to represent an active object.
Direct Manipulation	An application may provide direct manipulation on an ad hoc basis.	Objects are created, communicated with, moved, and manipulated through drag-and-drop manipulation.
Creating New Objects	Objects are created in an application-specific manner, usually through some form of copy mechanism or using the menu choices: new or open.	A templates folder contains a template for every object type. To create a new instance of an object, drag its template to where you want the new object to reside.

GUI Vs OOUI (continued)

Table 5-1. GUI Versus OOUI. (Continued)

Feature	Graphical User Interface (GUI)	Object-Oriented User Interface (OOUI)
Actions	Choose object; then choose action from menu bar.	In addition to choosing actions from menus, a user can drag objects to icons to perform operations; for example, dragging a file to a printer icon.
Containers	Text-based list boxes provide the primary form of containment.	In addition to list boxes, OOUIs provide container objects, including folders and notebooks. These in turn can contain other objects. Actions performed on container objects affect all the objects inside them.
Focus	Focus is on the main task.	Focus is on active objects and tasks.
Who Is in Control?	Control alternates between the user and the application.	All the applications behave the same and the user acts as the conductor. Think of the user as the visual programmer of the desktop.
Product Examples	Windows 3.X, Motif, and simple Web pages.	NextStep/Mac OS X, Mac OS, Windows 98, OS/2 Workplace Shell, and Web pages that take advantage of Java 2 JavaBeans.

Client Need From An OS

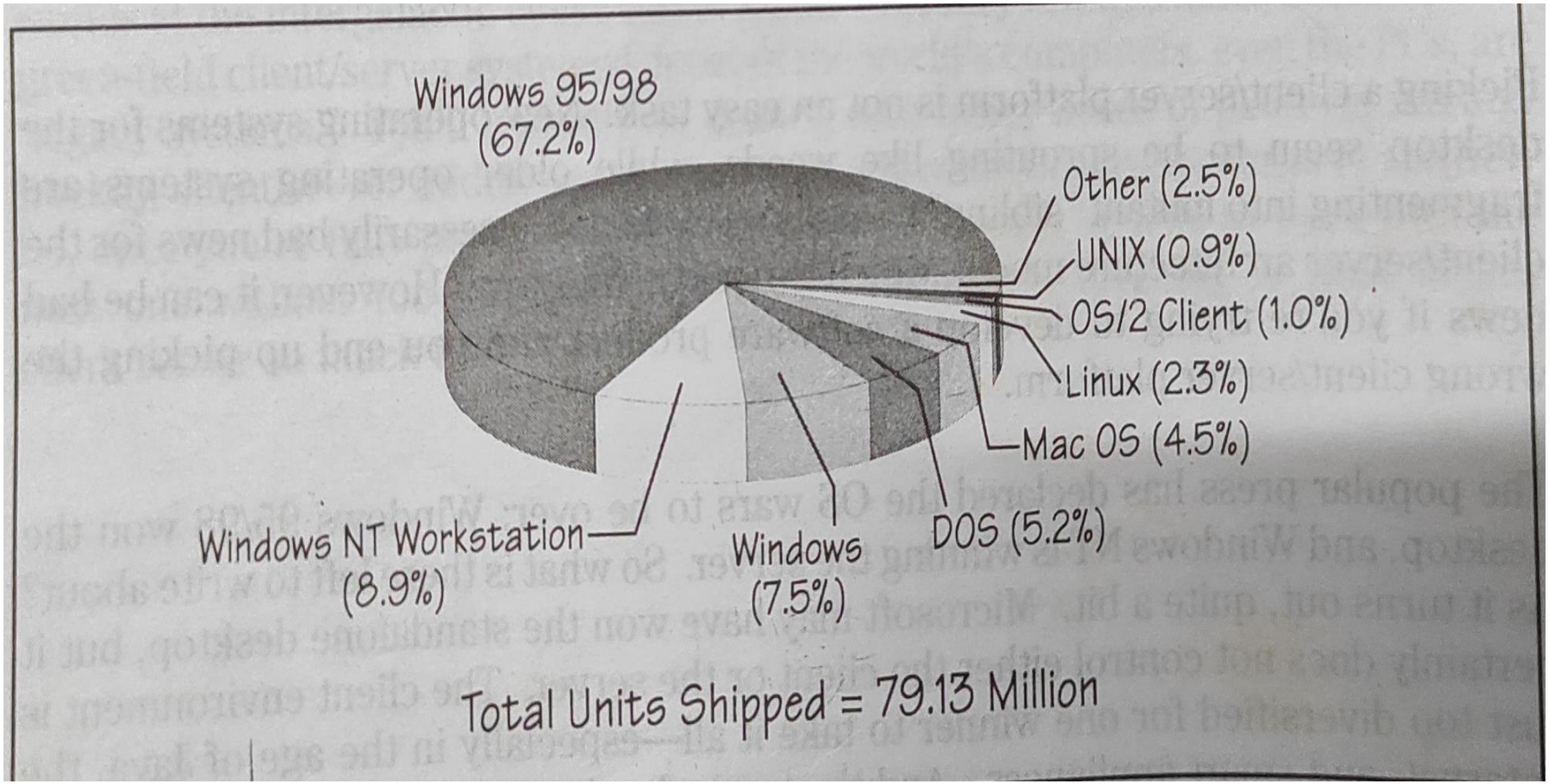
Table 5-2. What Does a Client Need From an OS?

Requirements From an OS	Non-GUI Client		Simple GUI Client	OOUI Client
	Without Multitasking	With Multitasking		
Request/reply mechanism (preferably with local/remote transparency)	Yes	Yes	Yes	Yes
File transfer mechanism to move pictures, text, and database snapshots	Yes	Yes	Yes	Yes
Preemptive multitasking	No	Yes	Desirable	Yes
Task priorities	No	Yes	Desirable	Yes
Interprocess communications	No	Yes	Desirable	Yes
Threads for background communications with server and receiving callbacks from servers	No	Yes	Yes (unless you like the hourglass icon)	Yes
OS robustness, including intertask protection and reentrant OS calls	No	Yes	Desirable	Yes

Client OS Trends

- Trends in the client industry are :
- i) *The desktop is becoming more fragmented*: The move from 16 to 32-bit Operating System is fragmenting the desktop. Microsoft has five competing OS : Windows CE, Windows 3.X, Windows for Workgroups, Windows 95/98 and NT Workstation.
- Mac OS has its dedicated following among the Internet crowd and Linux is becoming more attractive every day. The following diagram shows the total client OS shipment in 1997.

Client OS Shipments



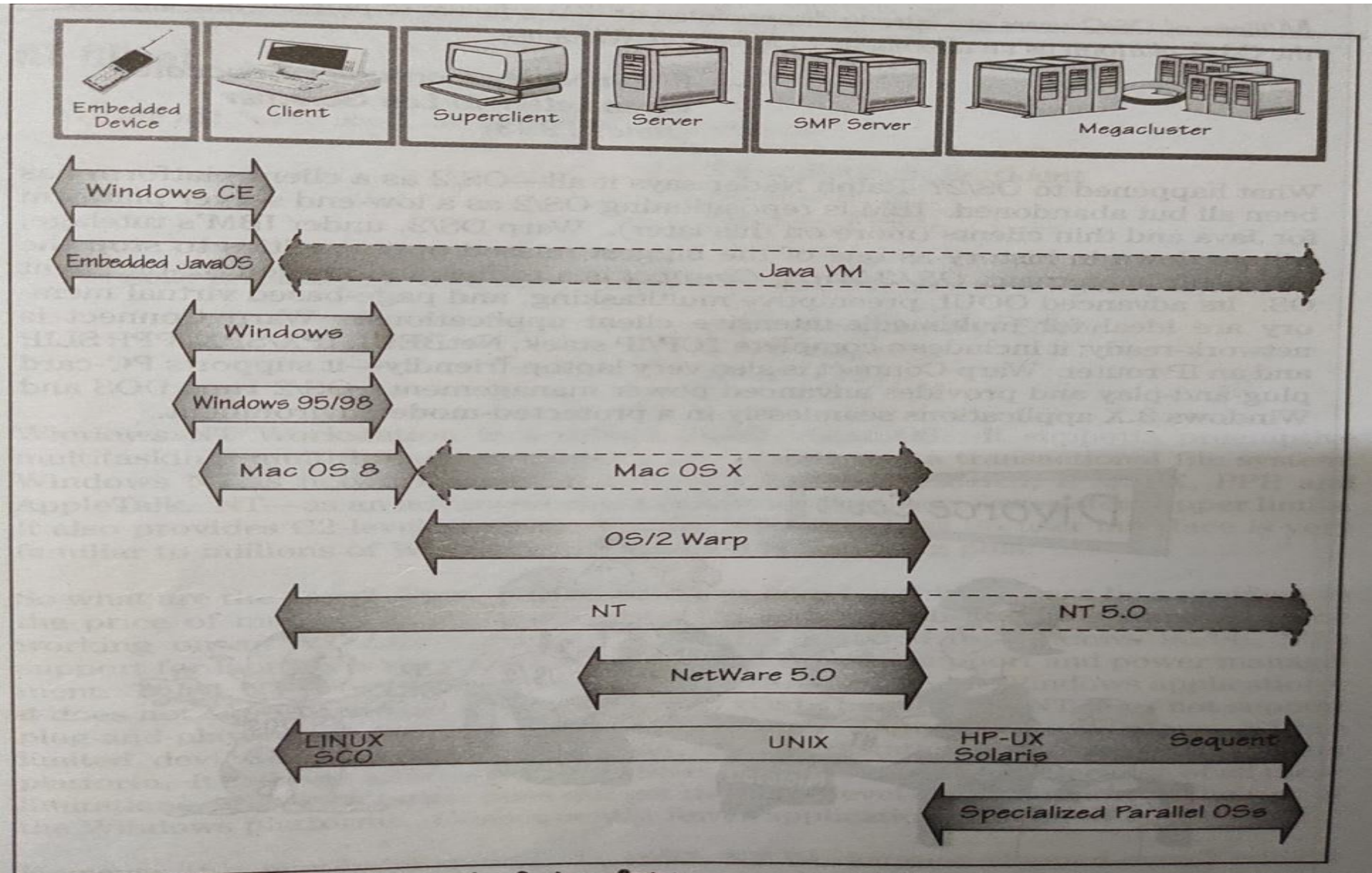
- ii) *The universal client is really a Web browser*: Microsoft does not own the standards for the intergalactic client. The Internet community owns these evolving standards. The java VM is an operating system for Web mobile code and it is lives on top of existing OS.
- iii) *There will be a huge demand for super-fat PCs :* These are ordinary PCs that act as both clients and servers.
- iv) *There will be a huge demand for ultra-thin PCs* : These minimalist PCs are centrally managed via a server.

- v) *Shippable places will become the new desktops*: The desktop is no longer a single monolithic place. We have multiple places to choose from and able to run these places either from our Web browser or from more specialized place viewers. Internet portals will serve as "home place" and also dispensers of shippable places.
- vi) *Embedded clients will be everywhere* : Millions of little network nodes will be installed in fuel injectors, copy machines, crock-pots, refrigerators, televisions, telephony devices and ATMs. These nodes require microcontrollers and OS with a small footprint that can run some form of client/server middleware.

Client Operating System

- The following diagram shows the today's client platforms and it is mostly belongs to Microsoft. The only other competition on the desktop comes from Mac OS and Linux. The OS/2 is no longer a serious player.
- Java OS/VM may eventually become a formidable competitor especially in the area of Internet applications, Web TVs and embedded clients.
- The client OS and the browser will simply provide a player for running Web content.

Client OS

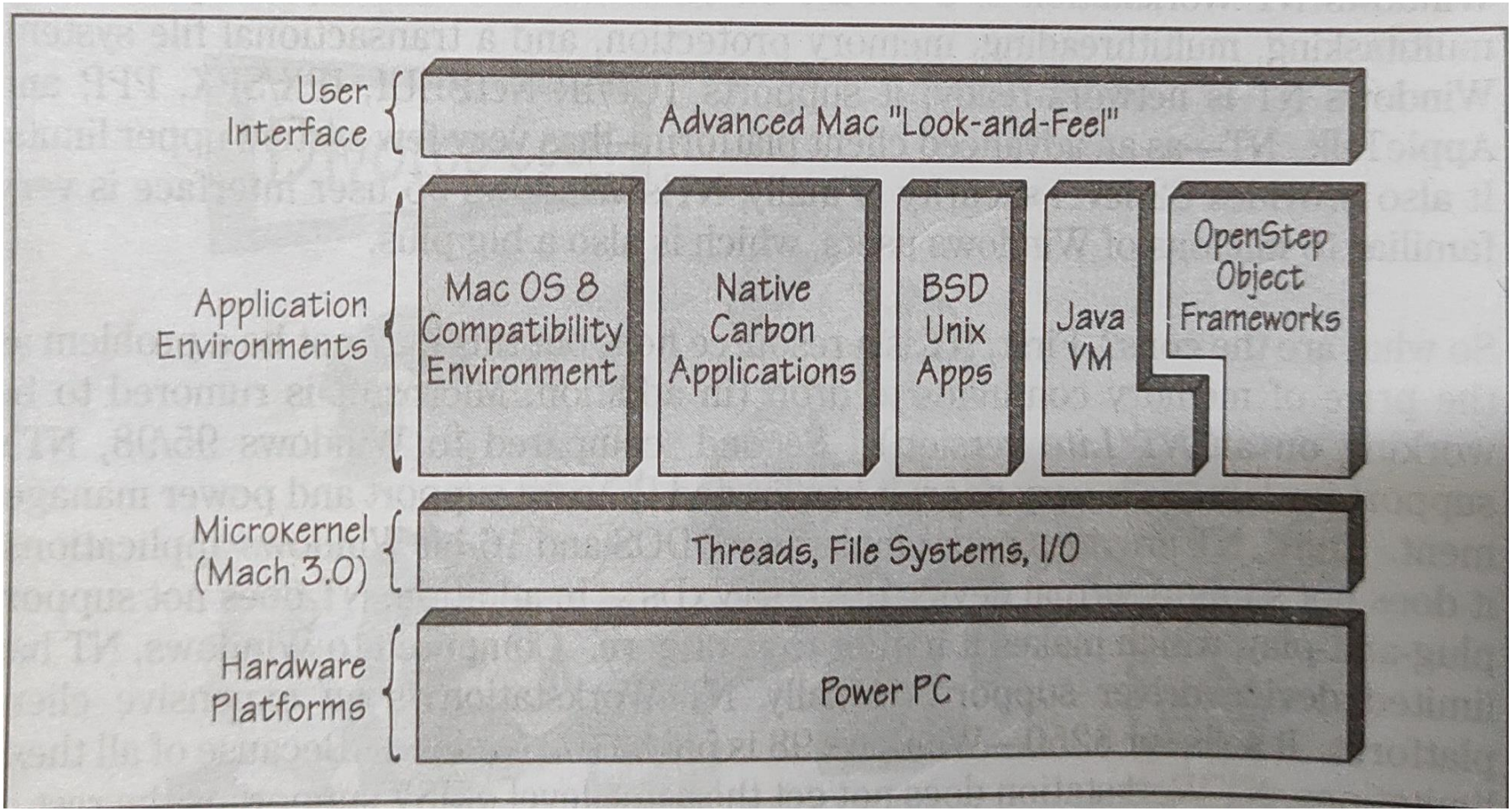

Embedded Device
Client
Superclient
Server
SMP Server
Megacluster
Windows CE
Embedded JavaOS
Java VM
Windows
Windows 95/98
Mac OS 8
Mac OS X
OS/2 Warp
NT
NT 5.0
NetWare 5.0
LINUX
SCO
UNIX
HP-UX
Solaris
Sequent
Specialized Parallel OSs

- For client/server computing to unleash its potential, the industry is moving to 32-bit client platforms with full multithreaded support, robust memory management and preemptive multitasking.
- Microsoft has declared NT to be the successor to Windows 95 on the desktop. Apple is in the process of moving its user base from Mac OS to Mac OS X.
- **OS/2 Client :** IBM is repositioning OS/2 as a low-end server platform for Java and thin clients. OS/2 Warp Connect is a robust and proven 32-bit client OS.

- OS/2 Warp Connect is advanced OOUI, preemptive multitasking and page-based virtual memory are ideal for multimedia-intensive client applications.
- Warp Connect is network-ready and it includes TCP/IP, NetBEUI, IPX/SPX, PPP, SLIP and IP router.
- Warp Connect is also very laptop-friendly and it support PC-card plug-and-play provide advanced power management.
- **NT Client** : Windows NT Workstation is a robust 32-bit client OS. It support preemptive multitasking, multithreading, memory protection and transactional file system.

- Window NT is network-ready and it support TCP/IP, NetBEUI, IPX/SPX, PPP and AppleTalk.
- Microsoft is also adding conversion features in NT 5.0 (called Windows 2000) that will make it easier to migrate from Windows 98.
- **Mac OS X** :
- The Mac with 10 – 15 million users, is a key player on the desktop. Apple's weapon to win the client is Mac OS X, a modern OS that is a synthesis of Mac OS 8.5 and NeXT's OpenStep 4.2.
- Mac OS X inherits from NeXT a modified microkernel and BSD 4.4 Unix layer, allowing it to run most Unix applications (Diagram).

Mac OS


User Interface
Advanced Mac "Look-and-Feel"
Application Environments
Mac OS 8 Compatibility Environment
Native Carbon Applications
BSD Unix Apps
Java VM
OpenStep Object Frameworks
Microkernel (Mach 3.0)
Threads, File Systems, I/O
Hardware Platforms
Power PC

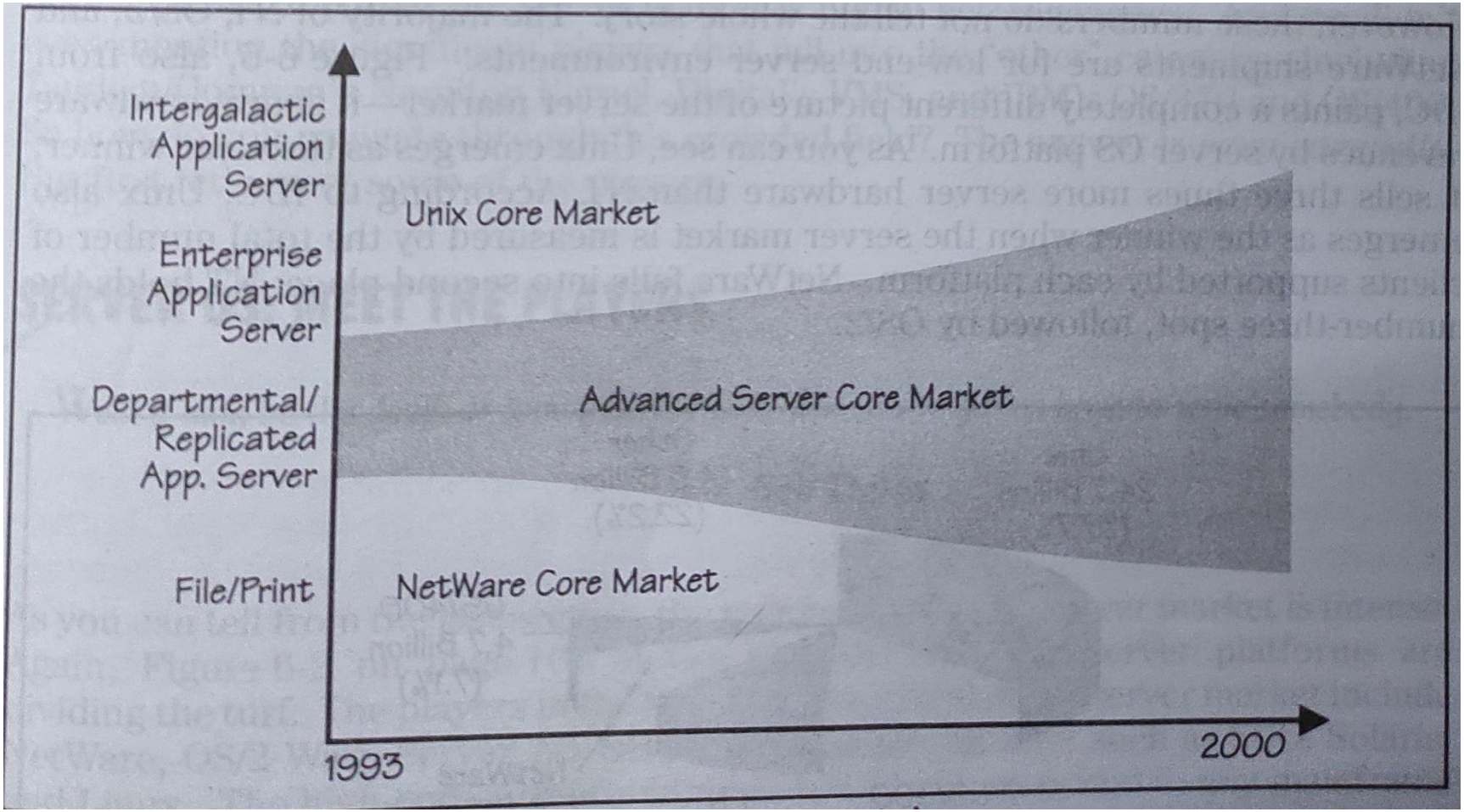
- Mac provide memory protection, threading and preemptive multitasking. It is fully compatible with Java VM that support pure Java and Java Beans.

- **Linux OS** :
- Linux is “free Unix” that people use with their web servers. It is one of the fastest growing client operating system. It is an Open Source community operating system.
- Any Intel base Unix application will run on Linux without modification. The community of Linux technologies provide excellent free support.

Server OS Trends

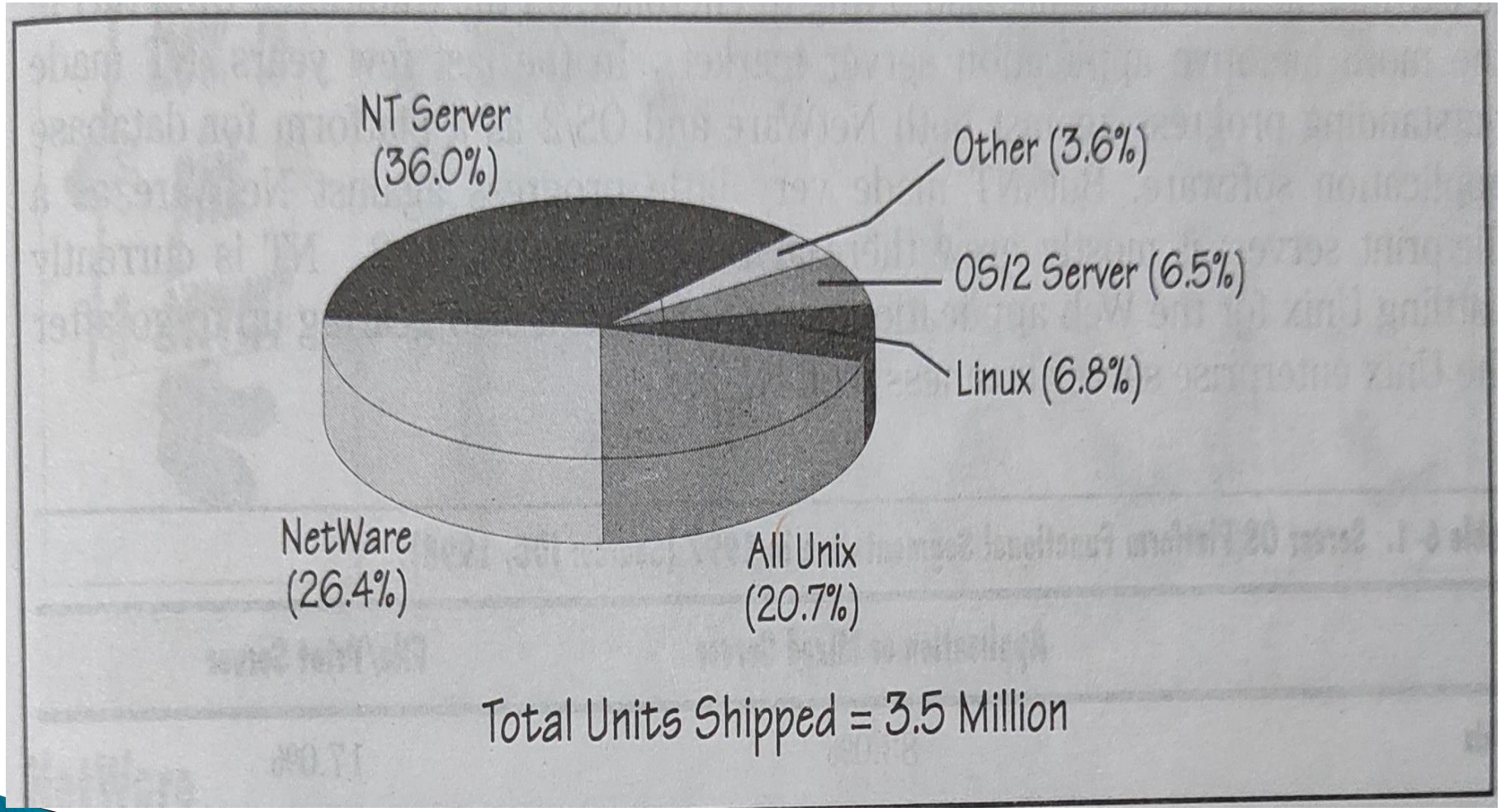
- According to IDC (International Data Corporation), Server OS sales are going though the roof. The fastest growing category is called application servers.
- The following diagram shows where application servers fit in the scheme. They started from the department and are now spreading in two directions : 1. downward into the space held by NetWare servers and 2. upward into the space held by Unix servers.

Application Server Market



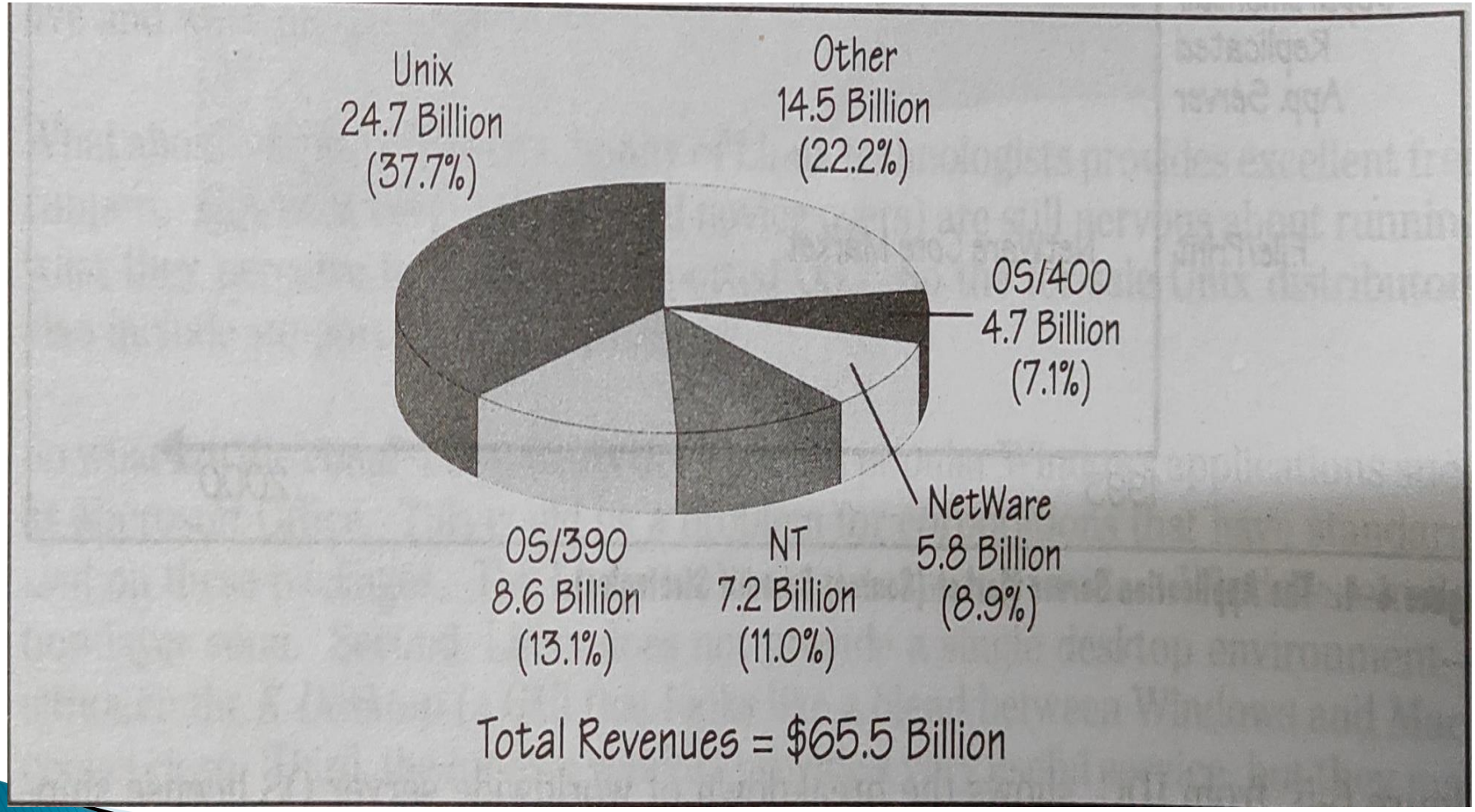
- The following diagram shows the worldwide server OS license shipment in 1997.
- The numbers show that NT server shipment 1.2 million server (36%).
- The Unix and Linux combined sold 9,62,000 server licenses.
- Netware was a third with 9,24,000 server licenses.
- The OS/2 sold 2,18,000 server licenses.

Server OS Shipment



- The majority of NT, OS/2 and NetWare shipments are for low-end server environments.
- The following diagram shows the completely different picture of the server market.
- Unix emerges as the clear winner. It sold three times more server than NT.
- NetWare falls into second place and NT hold the number followed by OS/2.

Hardware Revenue By Server OS



- The following Table shows that Unix is primarily used as an application server platform.
- In contrast, 50% of NT server licenses are used for departmental file/print servers.

- In last few years, NT made outstanding progress against both NetWare and OS/2 as a platform for database application software.

- NT is currently battling Unix for the Web application server market.

Server OS Functional Segmentation

Table 6-1. Server OS Platform Functional Segmentation in 1997 (Source: IDC, 1998).

	Application or Mixed Server	File/Print Server
Unix	83.0%	17.0%
Windows NT	46.0%	54.0%
OS/2 Warp Server	31.8%	68.2%
NetWare	18.0%	82.0%

Server Operating System

- The players in the low-to-medium end of the server market include NetWare, OS/2, NT server and Unix on Intel such as SCO, Solaris and Linux.
- The high-end belongs to Unix clusters and to any mainframe or super-mini that can act as a server to PCs.
- The most formidable competitors at the very high-end are the RISC mainframe vendors that can provide massively parallel computing, scalability and fault tolerance.

NetWare

- The largest server installed base belongs to Novell's NetWare. It is a very fast, effective, well-supported file server that support OS/2, Mac and Windows clients.
- NetWare is a well-managed server platform. More that 5,000 applications run on it including the major DBMS.
- Cons of NetWare 4.X: 1. limited memory protection, 2.lack of memory management and does not provide virtual memory 3. No support for preemptive multitasking, 4. Do not support full SMP.

- NetWare 5.0 fixes all the cons of previous versions. It support native SMP, preemptive multitasking and virtual memory management.
- NetWare 5.0 provide one of the fastest and most secure Java VM. It allow our Java programs to be directory-enabled. It support Enterprise JavaBeans and CORBA.
- So, developers will be able to use standard Java tools to create their server-side beans on the NetWare platform. NetWare 5.0 is a great platform for writing server-side Java code.

NT Server

- NT Server provide file/print server support, built-in Internet server, disk mirroring, and SMP.
- NT 4.0 support DCOM ORB, enhanced security, multiprotocol routing, better SMP support and ISDN communications.
- NT 5.0 introduces a network directory, enterprise-level security, enhanced clustering, built-in Object Transaction Monitor (MTS) and message queue facility (MSMQ).

- NT is a good application, database and file/print server platform. It comes from the PC LAN tradition, which means that it is easy to install, manage and configure.
- NT programming environment familiar to programmers versed in MS tools. It is tight coupling with windows environments.
- Cons of NT : 1.It does not scale well and Its SMP engine support only four processors. 2.NT 4.X does not provide an enterprise directory server. 3. NT security is really a work-in-process. 4. NT add-ons MTS,MSMQ and Active Directory are all based on MS COM object model.

- **OS/2 Warp Server** :OS/2 is also an excellent application server for departments. IBM introduced Warp Server with LAN server is a very fast file and print server.
- Warp Server provides an OOUI user interface for easy installation, configuration and system management. It also provide disk mirroring, remote administration, remote software distribution, backup server and software metering.
- IBM release OS/2 Warp Server code named 'Aurora'. It include a built-in SMP engine, journaling file, support single European currency, super fast Java engine and an improved Web server.

Unix

- Unix is function-rich operating system and it is scalable from the desktop to the supercomputer. It is close connection with Universities make it a great incubator of new ideas.
- Unix standards have become Internet standards such as mail, FTP, TCP/IP and domain name service.
- Unix vendors have always been at the forefront of client/server computing. It is also a well-regarded choice for database server.

- **Cons of Unix : There is dozens of Unix variants on the market. Unix is a hardware-independent operating system and application should be able to run on any machine from PC to supercomputer. This sever scalability has two things:**
- **1. *Lack of binary compatibility* : Unix not support binary standards. Its applications must be recompiled to be ported from platform to platform.**
- **2. *Functional differences among the Unixes* : There will always be differences among the Unixes. Vendors like to sell products and functional differences are required to avoid relentless.**

Thank you