



Server Functionality in Detail

- The functions provided by the server in a NOS environment:
 - **Request Processing**
 - **File Services**
 - **Fax/Print/Image Services**
 - **Database Services**
 - **Communications Services**
 - **Security Services**



Request Processing

- Requests are issued by a client to the **NOS services software** resident on the client machine.
- These services format the request into an appropriate RPC and issue the request to the application layer of the client protocol stack.
- This request is received by the application layer of the protocol stack on the server.



File Services

- File services handle access to the virtual directories and files located on the client workstation and to the server's permanent storage.
- These services are provided through the redirection software implemented as part of the client workstation operating environment.
- **All requests are mapped into the virtual pool of resources and redirected as necessary to the appropriate local or remote server.**
- The file services provide this support at the remote server processor.
- In the typical implementation, software, shared data, databases, and backups are stored on disk, tape, and optical storage devices that are managed by the file server.

- To minimize the effort and effect of installation and maintenance of software, software should be loaded from the server for execution on the client.
- **New versions can be updated on the server** and made immediately available to all users.
- **Installation in a central location reduces the effort** required for each workstation user to handle the installation process.
- Because each client workstation user uses the same installation of the software, optional parameters are consistent, and remote help desk operators are aware of them.

- Sharing information, such as word processing documents, is easier when everyone is at the same release level and uses the same default setup within the software.
- Backups of the server can be scheduled and monitored by a trained support person.
- **Backups of client workstations** can be scheduled from the server, and data can be stored at the server to facilitate recovery.
- Tape or optical backup units are typically used for backup; these devices can readily provide support for many users.
- Placing the server and its backups in a secure location helps prevent theft or accidental destruction of backups.



Fax / Print / Image Services

- High-quality printers, workstation-generated faxes, and plotters are natural candidates for support from a shared server.
- **The server can accept input from many clients, queue it according to the priority of the request and handle it when the device is available.**
- Many organizations realize substantial savings by enabling users to generate fax output from their workstations and queue it at a fax server for transmission when the communication costs are lower.
- Incoming faxes can be queued at the server and transmitted to the appropriate client either on receipt or on request.
- In concert with workflow management techniques, images can be captured and distributed to the appropriate client workstation from the image server.
- **In the client/server model, work queues are maintained at the server by a supervisor in concert with default algorithms that determine how to distribute the queued work.**

- Incoming paper mail can be converted to image form in the mail room and sent to the appropriate client through the LAN rather than through interoffice mail.
- Centralized capture and distribution enable images to be centrally indexed.
- This index can be maintained by the database services for all authorized users to query.
- In this way, images are captured once and are available for distribution immediately to all authorized users.



Database Services

- Early database servers were actually file servers with a different interface.
- Products such as dBASE, Clipper, FoxPro, and Paradox execute the database engine primarily on the client machine and use the file services provided by the file server for record access and free space management.
- There are no facilities to execute procedural code at the server, to execute joins, or to filter rows prior to returning them to the workstation.
- This lack of capability dramatically increases the likelihood of records being locked when several clients are accessing the same database and increases network traffic when many unnecessary rows are returned to the workstation only to be rejected.

Database trends.

- **Flat Files: Sorting Physical Records** - These original implementations physically stored data columns and records according to the user view.
- **Hierarchical Databases: Adjacent Storage of Related Record Types** - could store related record types physically or logically next to each other.
- The developer explicitly references the index to get to the data of interest.
- Disadvantage is that only applications that access data according to its physical storage sequence benefit from locality of reference.

- **Relational Databases: Extracted Indexes and SQL**
- Relational database technology provides the current data management solution to many of the problems inherent in the flat-file and hierarchical technologies.
- The first relational products were introduced by ADR with Datacom DB and Computer Corporation of America with Model 204.
- Used extracted indexes to provide direct access to stored data without navigating the database or sorting flat files.

- The primary design objective behind SQL was to **provide a data access language** that could be shown mathematically to manipulate the desired data correctly.
- The secondary objective was to **remove any sense of the physical storage of data from the view of the user**.
- SQL uses extracted indexes to provide direct access to the rows (records) of the tables (files) of interest.
- Each column (field) may be used as part of the search criteria.
- SQL provides a very powerful data access language.
- Its algebra provides all the necessary syntax to define, secure, and access information in an SQL database.

- For the development of client/server applications, products should be implemented with support for the following products and standards:
 - ANSI SQL and IBM DB2 standards
 - A variety of front-end query products
 - C and COBOL SQL precompilers
 - Support for and compatibility with server NOS: NetWare, OS/2 (LAN Manager, LAN Server), Windows NT
 - Support for client Operating Systems: DOS, Windows, OS/2, Windows NT, Mac System 7, or UNIX

- The following DBMS features must be included in the database engine:
 - Performance optimization tools
 - Dynamic transaction backout
 - Roll back from, roll forward to last backup
 - Audit file recovery
 - Automatic error detection and recovery
 - File reclamation and repair tools
 - Support for mirrored databases
 - Capability to split database between physical disk drives
 - Remote distributed database management features
 - Maintenance of accurate and duplicate audit files on any LAN node

- In the client/server implementation, you should **offload database processing to the server**.
- The database engine should provide **support for stored procedures or triggers** that run on the server.
- The client/server model implies that there will be **multiple concurrent user access**.
- The database engine must be able to manage this access without requiring every developer to write well-behaved applications.
- The following features must be part of the database engine:
 - **Locking mechanisms to guarantee data integrity**
 - **Deadlock detection and prevention**
 - **Multithreaded application processing**
 - **User access to multiple databases on multiple servers**



OODBMS

- Object-oriented database management systems provide support for complex data structures: such as compound documents, CASE entity relationship models, financial models, and CAD/CAM drawings.



Communications Services

- Client/server applications require LAN and WAN communication services.
- Basic LAN services are integral to the NOS.
- WAN services are provided by various communications server products.



Security Services

- Client/server applications require similar security services to those provided by host environments.
- **Every user should be required to log in with a user ID and password.**
- If passwords might become visible to unauthorized users, the security server should insist that passwords be changed regularly.
- The enterprise on the desk implies that a single logon ID and logon sequence is used to gain the authority once to access all information and process for the user has a need and right of access.

- Because data may be stored in a less physically secure area, **the option should exist to store data in an encrypted form.**
- A combination of the user ID and password should be required to decrypt the data.
- New options, such as **floppyless workstations with integrated data encryption standard (DES) coprocessors**, are available.
- These products automatically encrypt or decrypt data written or read to disk or a communication line.
- The encryption and decryption are done using the DES algorithm and the user password.
- This ensures that no unauthorized user can access stored data or communications data.



The Network Operating System (NOS)

- The network operating system (NOS) provides the services not available from the client OS.
 - Novell NetWare
 - LAN Manager
 - IBM LAN Server
 - Banyan VINES
 - PC Network File Services (NFS)

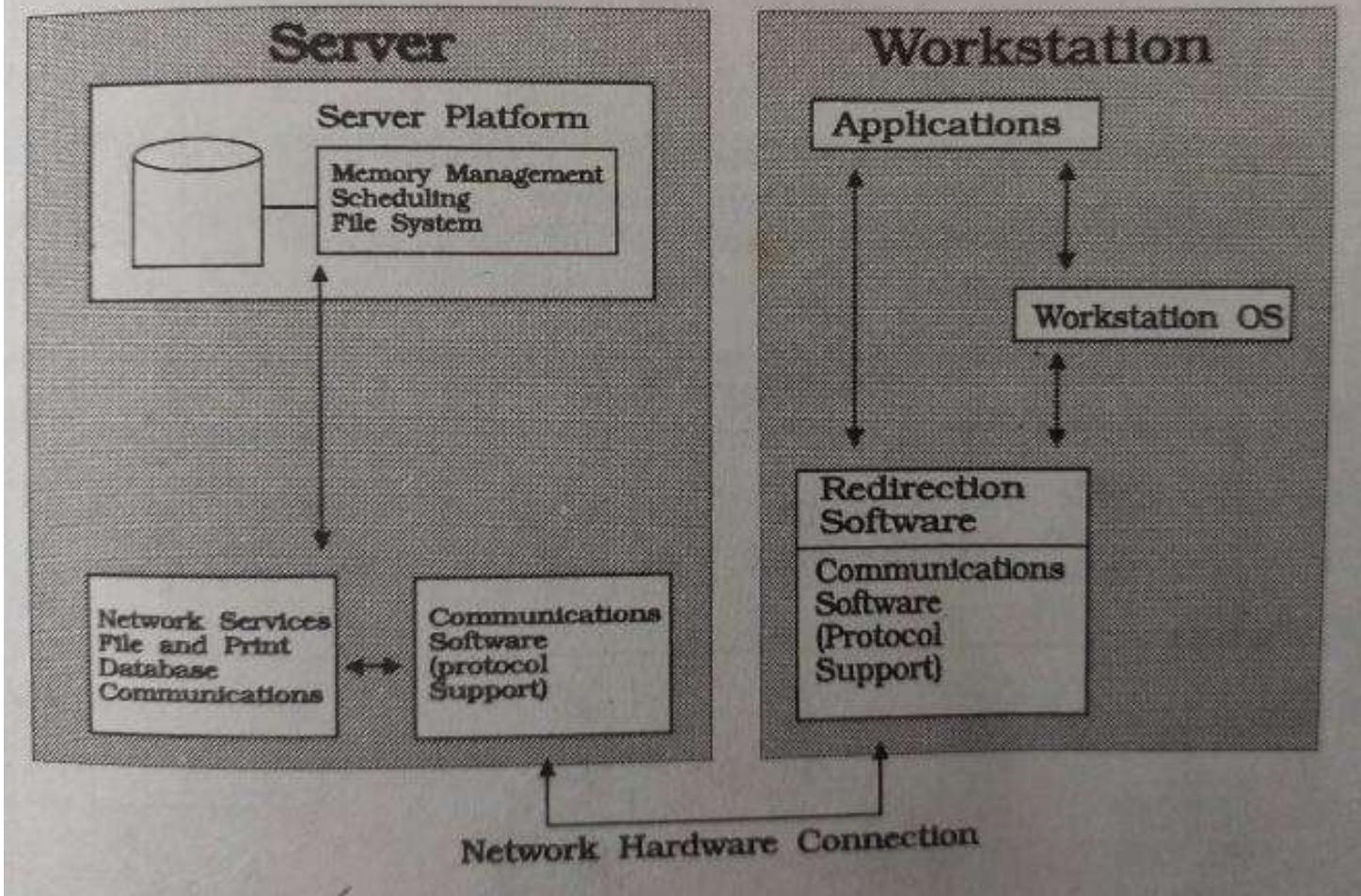


Novell NetWare

- NetWare is a family of LAN products with support for IBM PC-compatible and Apple Macintosh clients, and IBM PC-compatible servers.
- NetWare is a **proprietary NOS** in the strict sense that it does not require another OS, such as DOS, Windows, Windows NT, OS/2, Mac System 7, or UNIX to run on a server.
- NetWare provides the premier LAN environment for **file and printer resource sharing**.

- It had 62 percent of the market share in 1993.
- It is widely installed as the **standard product** in many organizations.
- ***NetWare is the original LAN NOS for the PC world.***
- It incorporates many of the ease-of-use features required for sharing printers, data, software, and communications lines.

NetWare Architecture



- Figure shows the major components of the NetWare architecture, illustrating client and server functions.

- Novell has committed to move NetWare to an open architecture.
- Through the use of **open protocol technology (OPT)**, Novell makes NetWare fully **network protocol independent**.
- Two standardized interfaces - **open datalink interface (ODI)** and **NetWare Streams** - enable other vendors to develop products for the NetWare environment.
- This facilitates its integration into other platforms.
- Figure 4.5 outlines the **NetWare open architecture**.

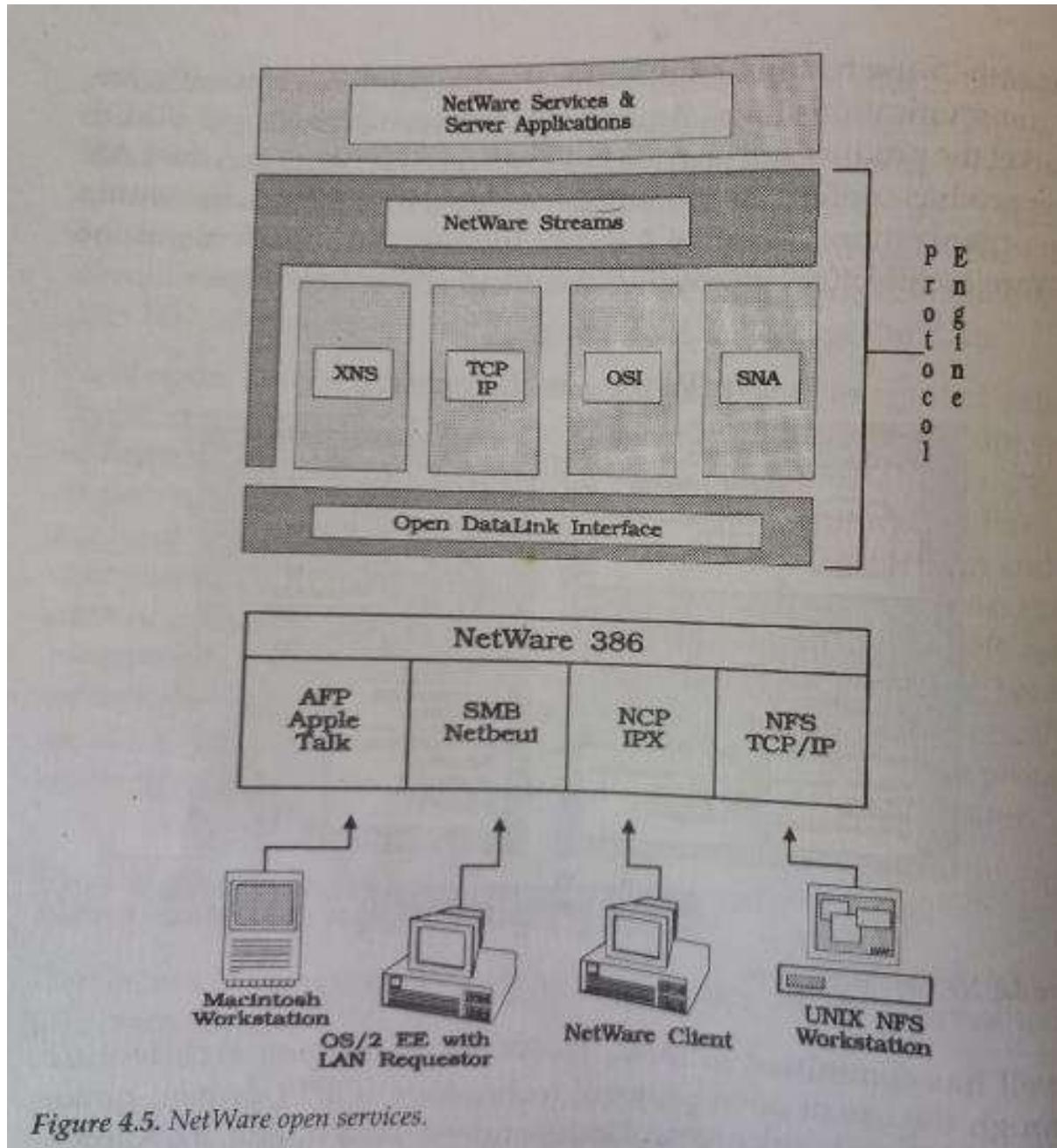


Figure 4.5. NetWare open services.

- NCP IPX- **Internetwork Packet Exchange** using Novell Netware OS
- NCP - Netware Core Protocol
- SMB – Server Message Block protocol
- Netbeui – NetBIOS Extended User Interface.
- XNS – Xerox Network Services.

- Client workstations can use Mac System 7, OS/2, DOS, Windows, Windows NT, NetWare, or UNIX NFS operating environments.
- OS/2, Windows NT, and UNIX servers may be installed on the same LAN as NetWare servers to provide support for products that require these platforms.
- Novell's goal is to provide **NetWare services totally independent of network media, network transport protocols, client/server protocols, and server and client operating systems, at each layer of network design.**

- Adv:
 - high performance
 - low resource requirements
 - relative ease of use
- Standard applications cannot run on the server processor, because NetWare does not provide compatible APIs.
- Instead, NetWare provides a high performance capability called a **NetWare Loadable Module (NLM)** that enables database servers such as Sybase and Oracle, and communications servers such as Gateway Communications provides, to be linked into the NetWare NOS.



LAN Manager

- **LAN Manager** and its IBM derivative, **LAN Server**, are the standard products for use in client/server implementations using OS/2 as the server operating system.
- **LAN Manager/X** is the standard product for client/server implementations using UNIX System V as the server operating system.
- Microsoft released its **Advanced Server** product with Windows NT in the third quarter of 1993.

- During 1994, it will be enhanced with support for the **Microsoft network management services** and **Banyan's Enterprise Network Services (ENS)**.
- Advanced Server is the natural migration path for existing Microsoft LAN Manager and IBM LAN Server customers.
- LAN Manager and Advanced Server provide client support for DOS, Windows, Windows NT, OS/2, and Mac System 7.
- Client workstations can access data from both NetWare and LAN Manager servers at the same time.

- LAN Manager supports **NetBIOS** and **Named Pipes LAN communications** between clients and OS/2 servers.
- **Redirection services** are provided to map files and printers from remote workstations for client use.
- ***Advanced Server also supports TCP/IP communication.***
- Microsoft has added **TCP/IP support** to LAN Manager 2.1 and Advanced Server along with NetView and Simple Network Management Protocol (SNMP) agents.

- **Advanced Server** provides *integrated support for peer-to-peer processing and client/server applications.*
- Existing support for Windows NT, OS/2, UNIX, and Mac System 7 clients lets application, database, and communication servers run on the same machine as the file and print server.
- This feature is attractive in small LANs.

- Microsoft has attempted to preempt the small LAN market with its **Windows for Workgroups (WfW)** product.
- This attacks the same market as NetWare Lite with a low-cost product that is tightly integrated with Windows.
- It is an attractive option for small organizations without a requirement for larger LANs.
- WfW can be used in conjunction with Novell for a workgroup wishing to use some WfW services, such as **group scheduling**.



IBM LAN Server

- IBM has entered into an agreement to resell and integrate the Novell NetWare product into environments where both IBM LAN Server and Novell NetWare are required.
- NetWare provides more functional, easier-to-use, and higher-performance file and print services.
- In environments where these are the only LAN functions, NetWare is preferable to LAN Manager derivatives.
- **The capability to interconnect to the SNA (Simple Network Architecture) world makes the IBM product LAN Server attractive to organizations that prefer to run both products.**
- Most large organizations have department workgroups that require only the services that Novell provides well but may use LAN Server for client/server applications using SNA services such as APPN(Advanced Peer-to-Peer Networking).

- IBM has priced LAN Server very attractively so that if OS/2 clients are being used, LAN Server is a low-cost option for small LANs.
- LAN Server supports DOS, Windows, and OS/2 clients.
- No support has been announced for Mac System 7, although it is possible to interconnect AppleTalk and LAN Server LANs to share data files and communication services.



Banyan VINES

- Banyan VINES provides basic file and print services similar to those of Novell and Lan Manager.
- VINES incorporates a facility called **StreetTalk** that **enables every resource in a Banyan enterprise LAN to be addressed by name**.
- VINES also provides **intelligent WAN routing** within the communications server component. These two features are similar to the OSI Directory Services X.500 protocol.

- StreetTalk enables resources to be uniquely identified on the network, making them easier to access and manage.
- All resources, including file services, users, and printers, are defined as **objects**.
- Each object has a StreetTalk name associated with it.
- **StreetTalk names** follow a three-level hierarchical format:
Item@Group@Organization.
- For example, a user can be identified as Psmith@Cerritos@Tnet.
- All network objects are stored in a distributed database that can be accessed globally.

- Novell's NDS is similar to StreetTalk in functionality.
- StreetTalk is less flexible but less complex to manage.
- One advantage of StreetTalk has over NDS is that StreetTalk **objects can have unlimited attributes available for selection**.
- To locate a printer with certain attributes, the command: "Locate a color laser printer with A4 forms on the 7th floor of Cerritos" finds and uses the printer with the desired characteristics.
- **VINES V5.5 offers ISDN and TI support for server-to-server communications over a WAN**, as well as integration of DOS, Windows, OS/2, and Mac clients.
- VINES does not support NFS clients.



PC Network File Services (NFS)

- NFS is the standard file system support for UNIX.
- PC NFS is available from **SunSelect** and FTP to provide file services support from a UNIX server to Windows, OS/2, Mac, and UNIX clients.
- NFS lets a client mount an NFS host's filing system (or a part of it) as an extension of its own resources.
- NFS's resource-sharing mechanisms encompass **interhost printing**.
- The transactions among NFS systems traditionally ride across TCP/IP and Ethernet, but **NFS works with any network that supports 802.3 frames**.
- SunSelect includes instructions for adding PC-NFS to an existing LAN Manager or Windows for Workgroups network using Network Driver Interface Specification (NDIS) drivers.

- With the increasing use of UNIX servers for application and database services, there is an increasing realization that PC NFS may be all that is required for NOS support for many workgroups.
- This can be a low-cost and low-maintenance option because the UNIX server is easily visible from a remote location.



Available Platforms

- Client/server computing requires that **LAN and WAN topologies be in place** to provide the necessary internetworking for shared applications and data.
- **Workstations in LAN Configuration**
- **LAN-to-LAN/WAN Configuration**
- **LAN-to-Host Configuration**
- **Enterprise-Wide**
 - **OLTP on a LAN**
 - **OLTP with UNIX**



Workstations in LAN Configuration

- This model is the most basic implementation providing the standard LAN services for file and printer sharing.



LAN-to-LAN/WAN Configuration

- **Routers and communication servers** will be used to provide communication services between LANs and into the WAN.
- In the client/server model, these connections will be provided transparently by the SDE (Systems Development Environment) tools.
- There are significant performance implications if the traffic volumes are large.
- IBM's LU6.2 (Logical Unit type 6.2 protocol) implementation in **APPC (Advanced Program-to-Program Communication)** and **TCP/IP** provides the best support for high-volume, LAN-to-LAN/WAN communications.

- DEC's implementation of **DECnet (Digital Equipment Corporation Networking architecture)** always has provided excellent LAN-to-WAN connectivity.
- Integrated support for TCP/IP, LU6.2, and IPX (Internetwork Packet Exchange) provides a solid platform for client/server LAN-to-WAN implementation within DECnet.
- Novell 4.x provides support for TCP/IP as both the LAN and WAN protocol.
- Internetworking also is supported between IPX and TCP/IP.



LAN-to-Host Configuration

- The lack of real estate on the desktop encouraged most organizations to move to a single device - using terminal emulation from the workstation - to access existing mainframe applications.
- It will take considerable time and effort before all existing host-based applications in an organization are replaced by client/server applications.
- The host can be used for enterprise database storage and for the provision of security and network management services.

- Mainframes are expensive to buy and maintain, hard to use, inflexible, and large, but they provide the stability and capacity required by many organizations to run their businesses.
- Only organizations who create an **enterprise architecture strategy and transformational plans** will accomplish the **migration to client/server** in less than a few years.
- Without a well-architected strategy, gradual evolution will produce failure.



Enterprise-Wide

- Information that is of value or interest to the entire business must be managed by a central data administration function and appear to be stored on each user's desk.
- These applications are traditionally implemented as **Online Transaction Processing (OLTP)** to the mainframe or minicomputer.
- With the client/server model, it is feasible to use database technology to replicate or migrate data to distributed servers.

- Wherever data resides or is used, the location must be transparent to the user and the developer.
- Data should be stored where it best meets the business need.



OLTP on a LAN

- Online Transaction Processing applications are found in such industries as insurance, finance, government, and sales - all of which process large numbers of transactions.
- The systems have high requirements for availability, data integrity, performance, concurrent access, growth potential, security, and manageability

- OLTP has traditionally been the domain of the large mainframe vendors—such as IBM and DEC—and of special-purpose, fault-tolerant processors from vendors such as Tandem and Stratus.
- *The client/server model has the capability to provide all the services required for OLTP at much lower cost than the traditional platforms.*
- All the standard client/server requirements for a GUI—application portability, client/server function partitioning, software distribution, and effective development tools—exist for OLTP applications.

- The first vendor to deliver a production-quality OLTP systems product is Cooperative Solutions with its **Ellipse product**.
- Ellipse provides all the necessary components to build systems with currency control and transaction rollback features.
- Ellipse currently operates with Windows 3.x, OS/2 clients, and OS/2 servers using the Sybase database engine.
- Novell is working with Cooperative Solutions to port Ellipse as a Novell NetWare Loadable Module (NLM).
- It provides a powerful GUI development environment using a template language as a shorthand for development.
- This language provides a solid basis for building an organizational SDE and lends itself well to the incorporation of standard components.



OLTP with UNIX

- UNIX has added many of the features found in other commercial operating systems such as VMS(Virtual Memory System) and MVS(Multiple Virtual Storage).
- There are now several offerings for OLTP with UNIX.
- Database services will be provided by a combination of AIX and MVS servers.
- (IBM's Advanced Interactive eXecutive, or AIX, is a series of proprietary UNIX-based operating systems built and sold by IBM).

- Client/server **TP monitor software** is becoming increasingly necessary now that client/server systems are growing to include several database servers supporting different vendors' databases and servicing tens, hundreds, and even thousands of users that need to access and update the same data.
- UNIX-based OTLP products are maturing to provide the same level of functionality and reliability as traditional mainframe-based IBM Customer Information Control Systems (CICS), yet at less cost and with graphical front ends.



The Server Operating System

- Servers provide the platform for application, database, and communication services.
- There are six operating system platforms that have the greatest potential and/or are prevalent today:
 - **NetWare**
 - **OS/2**
 - **Windows NT**
 - **MVS**
 - **VMS**
 - **UNIX**



NetWare

- NetWare is used by many organizations, large and small, for the provision of file, printer, and network services.
- **NetWare is a self-contained operating system.** It does not require a separate OS (as do Windows NT, OS/2, and UNIX) to run.
- Novell is taking steps to allow NetWare to run on servers with UNIX.
- Novell purchased USL and will develop shrink-wrapped products to run under both NetWare and UNIX System V, Release 4.2.
- The products will enable UNIX to simultaneously access information from both a NetWare and a UNIX server.



OS/2

- OS/2 is the server platform for Intel products provided by IBM in the System Application Architecture (SAA) model.
- OS/2 provides the **storage protection and preemptive multitasking services** needed for the server platform.
- Several database and many application products have been ported to OS/2.
- **The only network operating systems directly supported with OS/2 are LAN Manager and LAN Server.**
- Novell supports the use of OS/2 servers running on separate processors from the NetWare server.
- The combination of Novell with an OS/2 database and application servers can provide the necessary environment for a production-quality client/server implementation.



Windows NT

- With the release of Windows NT (New Technology) in September of 1993, Microsoft staked its unique position with a server operating system.
- NT provides the preemptive multitasking services required for a functional server.
- It provides excellent support for Windows clients and incorporates the necessary storage protection services required for a reliable server operating system.
- Its implementation of C2 level security goes well beyond that provided by OS/2 and most UNIX implementations.



MVS

- IBM provides MVS as a platform for large applications.
- The standard networking environment for many large organizations – SNA - is a component of MVS.
- IBM prefers to label proprietary systems today under the umbrella of **SAA (Systems Application Architecture)**.
- The objective of SAA is to provide all services on all IBM platforms in a compatible way.
- IBM provides support for the LAN Server running natively under MVS.
- MVS provides a powerful database server using DB2 and LU6.2.



OPENVMS

- NetWare supports the use of OPENVMS servers for file services.
- DEC provides its own server interface using a LAN Manager derivative product called Pathworks.
- NetWare supports the use of OPENVMS servers for file services.
- DEC provides its own server interface using a LAN Manager derivative product called Pathworks.
- Pathworks runs native on the VAX and RISC Alpha RXP.

- VAX OPENVMS support for database products such as RDB, Sybase, Ingres, and Oracle enables this platform to execute effectively as a database server for client/server applications.