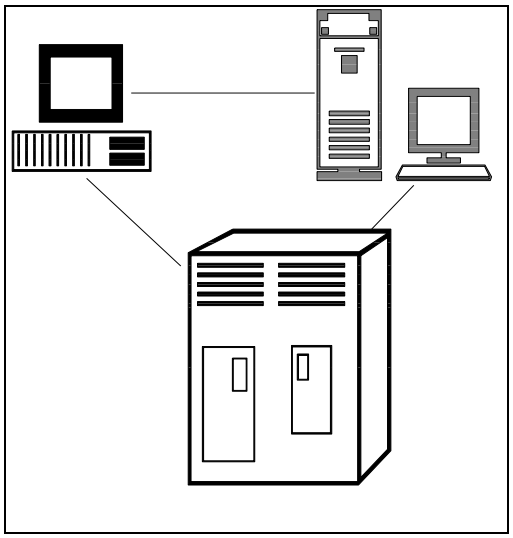
LOCAL AREA NETWORKING

What is a LAN?

Introduction

A network is a communication system that links computers and computer resources, no matter the physical distance. The resource may be a printer, plotter, or storage device.

In some cases an organization may already have personal, mini and mainframe computers and peripherals in place. A network provides a platform of tying these diverse systems together into a communications system.



Up to 1970s computing resources were often handled by centralized mainframe computer systems. The price of processing and storage was very high, and not many users benefited. The minicomputers became available which were considerably cheaper.

Eventually personal computers caused a shift in the 1980s, but their resources were not shareable i.e. useful information had to be spread among many computers, rather than being centralized.

Thus in mid 1980s PCs were wired together into NETWORKS of computers, and files were stored on centralized file systems for all users.

Difference between NETWORKS and MINI/MAINFRAME COMPUTERS

A network consists of many computers that access files and other resources from a central SERVER, but each computer (node or workstation) performs its processing (i.e. is intelligent). They are therefore called distributed processing systems (see Fig 1.1).
A minicomputer/mainframe system centralizes its processing, file access, and other activities. Terminals do not have processing capability (i.e. are dummy terminal). They are therefore called centralized systems.

Role of WORKSTATIONS and SERVER

Workstations attached to the server perform simple to complex tasks on their own. Each can access programs, files and other networks services by logging into the server.

The server is therefore left exclusively to handle file storage and retrieval, network management, user management and security.

Networks are today seen as company-wide computing PLATFORMS that provide the modular connectivity for different computer systems. This is a great advantage especially when an organization wants to expand from already installed capacity.

Role of Novell NetWare 4.0

Novell was founded to develop products for PC networks. Its objective is to eventually encompass corporate-wide level networking by allowing non-DOS systems (e.g. Apple Mackintosh, Unix workstations, OS/2, DEC and IBM mini and mainframe systems etc) to be connected. These should therefore be able to share resources irrespective of their operating system or communication protocols (e.g. IPX, TCP/IP etc). This is what is called distributed applications.

Why use Networks?

The most common reasons for establishing a computer network are as outlined below:

Program and file sharing there are many networkable versions of popular software packages, which cost much less than buying individually licensed copies. A database program is an ideal application for a network, since it can be accessible to many authorized users.

Network resource-sharing resources like printers, plotters etc can be shared by users, thus reducing costs

Economic expansion of PC base an organization may expand its number of computers by acquiring inexpensive diskless workstations

Electronic mail messages or documents can be sent to users or groups on the network.

Creation of work groups groups of users normally work in a given department or project. These can be assigned special directories and resources not available to other users.

Centralized management most resources of a network are centered on the server, making management easier.

Security security features ensure that files are protected from unauthorized users; authority comes from the supervisor

Access to other OS Novell NetWare allows workstations to connect with other operating systems

Enhancement of networks stimulate work group **corporate structure** structures which is in line with normal organizational structures

LAN TERMINOLOGY

A network consists of both hardware and software. The most common terminology to describe these are discussed below:

File Server

This is the computer that runs the network operating system (e.g. Novell NetWare) and offers network services to workstations (i.e. file storage, user management, security, common network commands, system manager commands). It must therefore be a high performance system using

80386 or 80486 microprocessor, high memory (at least 2 MB), and lots of disks space (at least 40 MB).

Workstations

These are the computers attached to a network and are also called nodes. These may be DOS-based PCs, Apple Mackintosh, OS/2 systems or diskless. Workstations are essentially inexpensive.

Network interface cards (NICs)

These provide the computer interface to the network and are dependent on the network cabling system e.g.

. ARCNET
. Ethernet
. Token Ring

This course is based on Ethernet networks.

Bridges

These are essentially NICs used to connect two networks with the same communication protocol. A server needs two NICs if it is to act as a bridge.

Gateways

Unlike bridges, gateways allow systems with different protocols to interconnect. Interoperability is a movement in the networking industry today that allows many types of operating systems and vendor products to share the same network cabling.

Shared resources and peripherals

These are peripherals (pieces of hardware) attached to the server which need not be duplicated for each workstation.

Media

This is the cable used to connect the server, workstations and other resources on the network.

There are three types of cables, viz.
- coaxial cable
- twisted pair
- Fibre optics - only used in high traffic data flows over long distances.

Ethernet LANs commonly use coaxial cables.

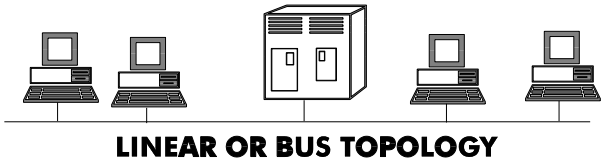
Selection of cables is based on:
- transmission speed
- cable length before need for booster (repeater)
- price

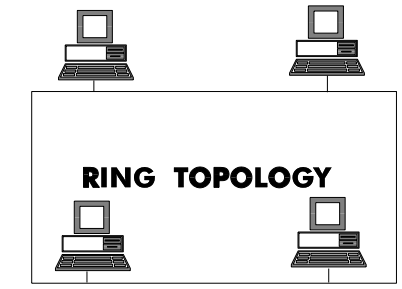
Network architecture

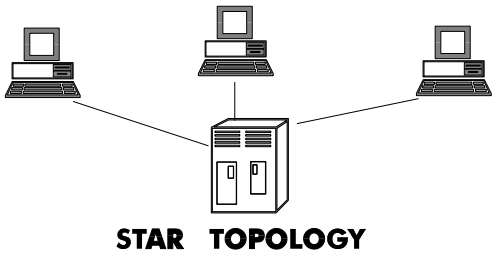
This defines the layout of the cabling system, workstation attachment, and communication protocols.

Topology

This is the description of the physical layout of cables from node to node. Examples of topologies are as follows:







- Linear this runs from one end to another with two distinct ends.
- Star Cable branches from a central box (i.e. concentrator) to the nodes.
- Ring this topology has the cable connected on both ends into a loop.

In reality, it is possible to have a linear topology appear zigzag, star appear linear etc. The most important consideration is how it transmits signals.

Communication protocols

These define how a message to be sent is prepared, how a communication channel is established, and how the communications are managed once underway. Protocols are the rules and procedures used on a network to establish communication between nodes.

Many Protocol standards exist, and computers, which use these different standards, cannot be easily connected together.
NetWare uses a form of protocol designed by Xerox, Internetwork Packet Exchange (i.e. IPX/SPX) but is moving towards the Open System Interconnection (OSI) protocol. The OSI model

promotes the development of products that can work together in a multivendor-networking environment.

Media Access Methods

The methods used when data packets are transferred from a workstation's memory to the physical network cable are referred to as the media access methods.

- The carrier sensing (CSMA) or token passing access method may be used, depending on the type of network interface card installed in the workstation and the topology of the network cable system.

- Carrier sensing or CSMA (Carrier Sensing Multiple Access) A node checks to see if the cable is in use before transmitting. Also referred to as the collision detection method.

Token passing. A node waits for a "token" to become available, which means it can transmit its packets. This assures that no other network is transmitting.

The collision detection method usually provides higher throughput on a cable system because a workstation can simply gain access to the cable whenever required. As long as network traffic is not heavy, collisions are unlikely to occur and the network operates at a high speed.

Token passing networks tend to be extremely reliable and maintain a constant speed, but that speed is often slower than networks using collision detection methods. The constant speed is due to the fact that only one station can use the token at once. In addition, a station cannot overuse the token, which would deprive other stations from accessing the cable.
If speed is the main requirement, a system using the collision detection method such as Ethernet may be appropriate. If reliability is important, a token passing scheme may be preferable.

Addressing Schemes

Each node on a network is given a special address. This address may be hard -wired by the manufacturer or selected by the user when changing switches on the card. In addition, each network has specific address, so if two or more networks are bridged together, a node's complete address consists of its network address plus its node address.

Packets

Information sent between nodes is "Packaged" according to the protocol rules. At each level, information is added to packets in the form of headers and trailer. This information may include the source and destination address, communications parameters, and synchronization information. Packets usually contain 512 bytes of data plus the header and trailer information.
If a message is broken into many small packets, they must be reassembled at the receiving station, which degrades performance. If packets are large, fewer packets are sent. Packet size on NetWare may be as high as 4202 bytes.

Thus when a user sends a message, an address is attached, and if the message is long, it is split into small packets. At the receiving station, the protocol reassembles and unpacks the message for the user's screen.

Range Of Networks

This Literally refers To the Distances That A Network Covers. The Common Ranges Are Given Below:

Local Area Network (LAN) A small network, 3 to 50 nodes, usually located within a group of buildings

Interconnected networks (Internetwork) Two or more networks connected together to form a company-wide network system

Metropolitan area network (MAN) This is an interconnected set of LANs within a specific area e.g. city

Wide Area Networks (WAN) this is a network that spans countries, and is characterized by some form of remote communications.

CABLING THE NETWORK

The cable used to connect networks is often referred to as the network media. You can classify the types of cable in terms of the following factors;

- Transmission speed
- Maximum Length
- Shielding against interference

The three most popular cable types are copper twisted pair, copper coaxial, and optical fiber.

Twisted Pair.
Two insulated strands of copper wire braided together and, in most cases, wrapped in a protective shield. The twisting reduces the electrical interference. Most telephone wiring is twisted pair, and has recently been used as a connection media for networks.

Coaxial Cable
This is commonly used in cable television networks. It consists of a copper core surrounded by insulation. A braided metal sleeve that helps block interference surrounds this in turn. The entire cable is then wrapped in a protective cover. There are several types of coaxial cable that may be either thick or thin. Long networks trunks can be designed with thick cable; however, it is more expensive that thin cable which has a shorter potential distance. The higher the transmission speed of Coaxial cables the shorter the potential distance.

Fibre Optic cable.

Fibre Optic cable transmits data signals with light. The modulated light passes through a glass core, which is surrounded by a reflective cladding. This assembly is in turn surrounded by a protective covering. Transmission rates for networks are usually in the range of 100 M bits per second.

Types of Networks

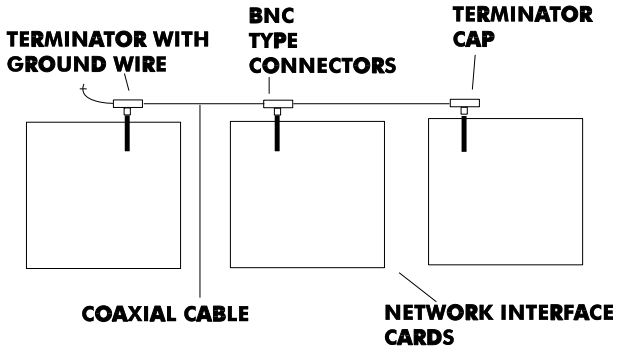
Network interface cards and cabling systems are usually designed around the specifications of the institute of Electrical and Electronics Engineers. The IEEE project 802 consists of a set of committees that defines several methods of controlling access to the physical transmission medium, four of which are listed below.

The 802.3 committee defines a family of carrier sensing standards such as CSMA/CD for Ethernet.
The 802.4 committee defines a token passing standard over a bus topology.

The 802.5 committee defines a token passing standard over a ring topology such as IBM Token ring.
The 802.6 committee defines high-speed fiber optic networks for campus-wide or metropolitan areas.

Ethernet Networks

Ethernet/Cheapernet networks have linear (also called bus) topology this consists of a single trunk of coaxial cable. A carrier sensing access method with collision detection (CSMA/CD) is used. Ethernet has a transmission rate of 10M bits per second.



There are two types of coaxial cable used in Ethernet: thick and thin. While thin cable is cheaper than thick cable, its maximum length is 185 meters. Thick cable permits longer cable runs of 500 meters.
Thin Ethernet is more frequently used in small LANs. Its is wired in cable segments from one workstation to the next to form a single linear trunk. The ends of each cable segment are fitted wit a BNC -type twist -on connector, which plugs into a T- connector on the back of the network interface card, as shown in the following figure. The farthest ends of the trunk are fitted with terminators. One of which is grounded.
Ethernet networks can also be built using twisted pair and fiber optic cable. Additionally, a combination of cable may be used. For example, fiber optic cable may be used to join two distant Ethernet networks wired with thin coaxial cable.

Arcnet Networks

Arcnet networks commonly use coaxial cable, but most interface card vendors now support the use of twisted pair, which is more practical for short distances. Arcnet networks are token passing with a bus topology, but hubs are used to distribute workstations in a star-like configuration. As with Ethernet coaxial cable, Arcnet segments are attached to cards and hubs using BNC-type twist-on connectors.
Both passive and active hubs are used to distribute workstations from a central point. Nodes can be connected up to 609 meters from an active hub and up to 30 meters from a passive hub. Passive hubs usually have four ports; active hubs usually have eight ports.
Arcnet workstations use a token passing scheme to access the network. However, the token does not travel in a physical ring but a logical one. Each workstation is assigned a number and the token passes to each workstation in the correct numeric order, even if the stations are not physically connected in that order.

Token ring networks.

Token ring networks are exactly what their name implies; A token passing access scheme is used on a ring topology. However, Token ring can take on the appearance of a star topology since station can branch from a central hub, or multistation access unit (MAU) Special shielded cable is normally used, but unshielded telephone - type twisted pair is also supported, Existing telephone wire makes an excellent media for Token ring. Token ring works at 4M bits -per second or 16M bits per second. The equipment required to run the faster Token ring is more expensive, and unshielded twisted pair wire cannot be used. The total length of the entire ring cannot exceed 366 meters and the maximum distance a station can be placed for a MAU is 100 meters using shielded twisted pair wire.

Expanding the Network

A local area Network is usually contained within a single building and built on one type of network card and cable. Expanding the network is often a simple matter of adding workstations. However a LAN has limits to the length of its cable and the number of attached workstation. Performance can degrade if too many workstations are attached.
The expansion of a LAN can be done in several ways:

A repeater can extend the distance of a LAN by boosting its signals to accommodate longer distances. A bridge may interconnect two LANs or dived and overloaded LAN into two separate trunks. A router is a bridge-like device that interconnects several Lands and provides the best possible routes for packets to follow when traversing the interconnection.

When you need to connect with workstations or LANs located on the other side of a campus or city, you can establish a metropolitan area network (MAN) using remote connections, such as telephone, microwave, or satellite connections. A remote connection is one requiring a connection other that a direct-connect cables. Remote connections may be established through the phone system or with microwave dishes and satellites. Connections range in size from a single user who needs to access the LAN from home to an entire LAN. The following methods can be used to establish remote connections:

- Point to point voice-grade telephone lines.
- Public data networks like Tymnet and Telenet with packet-switching techniques.
- High speed lines like Digital Data Service (DDS) and TI.

LAN to LAN remote connections
Wide area connections are made between LANs at remote locations so files can be shared and electronic mail can be sent to users at the remote sites. When remote LAN to LAN connections are made, a workstation on each LAN is usually dedicated as a remote bridge. The remote connection software is then run exclusively in the bridge.

Connections can be made to a minicomputer, mainframe, or other systems that use a different operating systems and protocols, thus forming a gateway.
Backbones are special high performance connections used to link servers in an internetwork. They are high- performance lines such as fiber optic or coaxial cables connected to interface cards that are separate from the one used to connect workstations. Workstations are never attached to the backbones. They can provide long-distance connections that provide high-speed links between servers.

Types of connections

The line speed of the connection usually determines what type of connection is used. Standard modems transmit at speeds of 2400 and 9600 baud, which is usually inadequate for LAN to LAN connections.

Packet Switched Networks.

Public data networks allow users to call into a worldwide communications network that provides high-speed, relatively inexpensive voice and data transmission capabilities. Such networks are operated by the government in many countries but are privately operated in the USA. The operator leases time on the networks. The services use existing telephone lines, microwaves, and satellite equipment.
A method called packet switching is used to transmit information, as opposed to circuit switching. Circuit switched lines are lines which remain open to service a single line until the caller hangs up. The lines may then be used to service another connection.
Packet switching shares connections between nodes with multiple users to optimize the line and reduce the rate. Voice and data are divided into packets that are transmitted constantly over the network. The receiving end must sort, reassemble, and distribute the packets to the appropriate callers.
An international standard called X.25 is used to access packet-switched networks. Because packet switched networks are non-dedicated, they can be accessed and used only when necessary.

Direct Digital Service lines.
These operate at speeds of up to 64 K bits-per-second DDS lines are highly reliable, using a synchronous protocol. They generally cost more to implement than X.25 methods, however, the increased speed may be necessary when LANs must transfer files or provide direct file access.
T1 and T3 links
These are high-speed digital lines used when high performance is required between remote sites. T1 transfer speeds of up to 2.048 M bits per second are available in the Europe. T1 can be used when immediate access to the most current information is required. T1 lines can also be subdivided into multiple channels that support voice, video, and data.
Newer T3 links can provide rates up to 44.736 bits- per-second. T3 rates are appropriate for corporations who need centralize their data processing facilities for mission-critical applications.

NOVELL NETWORKING STRATEGIES.

The goal of networking is to provide transparent access to the data and resources of any computing system from any other system. Transparency is made difficult by conflicting hardware and software standards, different media and protocol standards, as well as unique operating systems. Since it is unlikely that one networking or operating system will become an industry standard, only operating systems that allow users to integrate multiple standards can provide network computing solutions. Novell supports Media independence and a strategy it calls open protocol technology (OPT). Media independence allows NetWare to run over 30 different types of networks on more than 100 different network adapters. Open protocol technology allows NetWare to support DOS, OS/2, and Unix and Mackintosh computers on the same network.

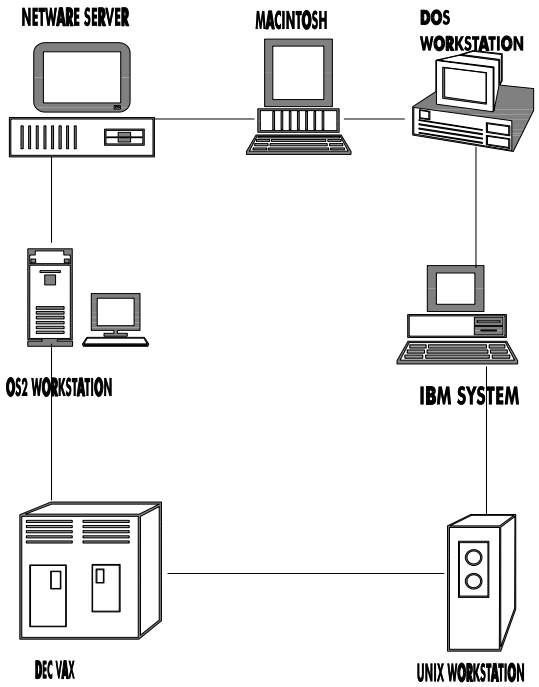
Open Protocol Technology

This provides a way to use multiple protocols on a network, which use different operating systems. OPT also provides a migration path to future protocol standards such as the Open Systems Interconnection model which was developed by the International Standards organization (ISO) When the OSI model is fully adopted, network hardware and software from a multitude of vendors will be able to connect into a network.

Media Independence

This allows NetWare to recognize network adapters made by different manufacturers. A bridge allows two or more networks to be joined into one inter-network. In this way, users on an Ethernet network for example can transparently connect with users on a Token Ring Network.

Transport Protocol Independence



This defines the rules for "transporting" packets of information from one workstation to another. They include the media access protocols. Transport protocols are a form of peer to peer communications between two systems. Novell's transport protocol is the Internetwork Packet Exchange (IPX), but other protocols that need to be taken into consideration when establishing a multi-vendor internetwork are:

. Apple computers
Apple Talk
. IBM's NetBEUI/DLC
. IBM's Systems Network Architecture (SNA)
. Industry standard TCP/IP
. Open Systems Interconnection (OSI) protocols

Protocol independence allows the use of more than one communication protocol on the same adapter and provides increased flexibility when designing a network. NetWare v3.12 is now protocol independent. The two components of NetWare's architecture that make this possible are open data- link interface and NetWare Streams.

Open data link Interface.

This specification is designed to allow NetWare to send and receive multiple protocols on the same adapter. It is an interim solution that provides a migration path to OSI. As an example, an adapter might support IPX/SPX, TCP/IP, and AppleTalk concurrently. At the bottom level are network interface cards that receive or send different protocol packets using a multiple link interface driver (MLID) The MLID then passes the information in the packet to the link support layer (LSL) The LSL is like a switchboard - it routes the packet information to the appropriate protocol stack.

NetWare Streams

This provides the same set of interfaces as the open data-link interface, but at a higher level that supports interprocess communications (IP) for server-based applications. NetBios, Named Pipes,

and AT&T's Transport Library Interface (TLI) are examples of protocol-dependent mechanisms that allow the remote processes of distributed applications to communicate.

Support for Industry supports.

Novell supports TCP/IP and OSI as part of its protocol independence strategy. Under TCP/IP, NetWare will include support for Telnet, FTP, SMTP, the R series utilities, and other recognized TCP/IP applications. In the OSI environment, Novell supports the most popular OSI applications protocols, such as X.400.

Novell also supports IBM's System Applications Architecture (SAA)

Client Server Protocol Independence

The NetWare Core protocol is a client -server model that delivers NetWare services to DOS and OS/2 users. Client server protocols define the rules that apply when a workstation (the client) makes a request from the server. Other client server protocols exist such as the Apple Talk Protocol (AFP) for Mackintosh systems and Sun Microsystems Network File System (NFS) for Unix clients. Novell now supports these.

NetWare SERVICES

NetWare services are the core of the NetWare Open Systems network. They include file, print, and security services among others.

File and Print Services

NetWare's file system allows multiple users to access shred files on NetWare server. Clients can be DOS, OS/2 Mackintosh or UNIX workstations. The file systems provide up to 32 terabytes of disk storage on volumes that can span multiple physical disk drives. In addition, NetWare's System Fault Tolerance (SFT) feature increases system reliability. SFT allows disks to be mirrored or an entire disk and controller to be duplexed.

Novell print services allow workstations to use printer attached to the server or attached to individual workstations. A workstation can become a print server and service print jobs from other workstations. In this way printer management can be distributed and print jobs can take place at printers closer to the users that initiate them.

Communication services

Novell provides a complete set of communications services for network users. Through LAN to LAN links, wide area networks can be constructed to allow users to communicate with other user, file servers, and resources on other networks. Remote links allow users to connect into a network from a workstation at a remote site.

Database Services

The following products are available:

. NetWare Btrieve is a key -indexed record manager that supports high-performance data handling for several management applications.

. SQL provides back-end database services for many front-end applications.

Store and Forward Services

When direct connections are established between LAN's messages can usually be sent from a workstation on one LAN to a workstation on another in real time. However, it may not be feasible to maintain a constant real-time connection between LAN's. In this case store- and -forward

messaging can collect messages and distribute them to users during an established communications session.
The NetWare Message handling system (MHS) collects and delivers messages to like and unlike systems on local and wide area networks.

Management Services
Management services allow users on large internetworks to access the services of any server. In addition, network managers can manage servers and workstations through the network. .

Distributed Directory Services
A distributed directory service keeps track of all network users, servers and resources on large internetworks. This information is kept in a global database. By accessing the database, users can determine which services they need and quickly access them, without regard to their location.

System Management.

Management can be distributed so that each network platform is managed on its own, or management can be centralized so it can be handled by a single management staff
Novell provides management products that enable network managers to manage all the NetWare Services.

Security management

There are additional improvements as follows:

Encryption Passwords are encrypted before crossing the cable to prevent unauthorized cable taps from determining a user's password.

Authentication when a user logs into a NetWare system, an identification key is assigned to the account. These keys are assigned dynamically for each login session and allow NetWare to confirm a user's identity each time a service or access to data is requested.

Authorization an authorization process must be completed before a user is granted services or data.

Open Architecture
A computing system with an open architecture is one that encourages the development of third party applications. Novell supports third-party development through open systems. This strategy ensures that a variety of useful and productive software is available to take advantage of NetWare and network computing.

Novell addresses five areas in its open architecture strategy.

Open server platforms
Typically, when a workstation runs an application from the server, it retrieves the entire application plus the data file from the server; then it runs the program in its own memory. It is often inefficient to transfer an entire program or data file to the workstation. A more efficient method is to deliver only the portions of the program and file the workstation actually needs.
A distributed application can split its workload between the file server and workstation. The "front end" of this arrangement is the workstation, where screen and keyboard activities are handled. At the "back end" is the server, where shared tasks such as disk input and output are handled.

Open API's

To encourage the development of software for a particular system, applications programming interfaces (API's) must be available. NetWare includes a well-defined set of interfaces that software developers can use to port or develop applications to wok in the distributed environment of a network.

Support for Industry Standards
Novell supports Industry standard interfaces such as the Mackintosh, OS2 and UNIX.

Application Portability
When Industry Standard API's are used, third-party software applications can be ported to other environments as well. Novell supports industry standard API's so developers can port the applications they develop to other environments as well, thus increasing their return investment.

Development Tools
Novell makes a complete set of development tools and support services available to developers. The two most important tools are:

NetWare Programmers Workbench

A set of tools developers need to create complete distributed application for NetWare. A developer's version of NetWare is included, along with a C network compiler, a C network compiler for DOS and OS/2, and a full set of API documentation.

NetWare Remote procedure calls

A set of tools designed to help developers in creating code necessary to extend applications procedure calls across the network to a server or client.

- In order to establish a conventional Ethernet network running NetWare , the following are the system requirements:

- File server i386 or i486 processor
  4 MB or more RAM
  40 MB or more hard disk
  MS-DOS 3.0 or later
  1 empty slot (16 or 32-bit)
  Other standard configuration

- Workstation(s) i8088 or i286 or i386 or i486 processor
  640 KB or more RAM
  1 empty expansion slot (8 or 16-bit)
  Other standard configuration

- Cables a) (Thick) Standard Ethernet coaxial cables (RG-11)

Transceivers with Transceiver cables (50 m) with DIX connectors (J1)
Terminators
Maximum trunk segment distance 500 m (up to 2500 m with repeaters)
Maximum number of nodes 100

OR

b) (Thin) Cheapernet cables (RG-58 A/U) with BNC T-connectors (J2)
In-built Transceivers on Network Interface Card (NIC)
Terminators
Maximum trunk segment distance 305 m (up to 600 m with repeaters)
Maximum number of nodes 30

- NIC 16-bit or 32-bit on File server e.g. NE2000/NE3200
  8-bit or 16-bit on Workstation e.g. NE1000/NE2000
  NB: These interface cards/boards come with software drivers

- Software NetWare Version 4.0 licensed for 10, 25, 100 or 250 users
  Other application software as required