The Evolution of LAN Operating Systems

In this report:

Editor's Note
The network operating system (NOS) is the key component in most local area networks (LANs). This report provides an overview of the evolution of LAN operating systems, plus a look at the three leading NOSs on the market.

Report Highlights
End-user computing, from the early 1980s to today, has evolved from unconnected mainframes, minicomputers, and PCs to networks of devices providing peer-to-peer communications. Likewise, servers on LANs have evolved to what is today known as the client/server computing model.

This evolution has resulted in the popular acceptance of LANs by the business community. The proliferation of LANs has brought to the forefront the importance of the software that provides the basic network features and functions—the network operating system (NOS). LAN operating systems are the key network component and now drive many LAN purchase decisions.

A lively battle is now being waged for dominance in the LAN operating system market. Novell, with its ubiquitous NetWare, is the undisputed market leader. Software giant Microsoft has launched a challenge with its OS/2 LAN Manager product. LAN Manager, initially licensed as an OEM product to several LAN vendors (IBM, 3Com, and Ungermann-Bass, among others), has been a disappointment. Microsoft has since changed its strategy—it is marketing LAN Manager directly and plans a massive assault on Novell's leadership position. Meanwhile, Banyan's VINES has won popular acclaim but only a small market share.

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Server Evolution and Client/Server Computing

Computing resources in the early 1980s existed as unconnected personal computers (PCs) on end-user's desks or as centrally located mainframes connected only to each other. The local area network (LAN) revolution brought the PCs into peer-to-peer communication with each other and eventually brought even the mainframes into the LAN. These

LANs used servers[1] to bring printer sharing and local file access to end users.

The earliest servers consisted of software slapped onto the cheapest hardware platform available; they were designed for printer sharing and generally were not even dedicated to that task. The dedicated but still PC-based server was a step up. Today's high-performance servers are generally resident on dedicated platforms with workstation or minicomputer[2] engines, giving network managers more MIPS, faster processing, multitasking operations, and other performance and reliability advantages.

As business needs changed, network architectures evolved to serve those needs. The distributed server brought faster response time to the network's users and less stress to the internet infrastructure (bridges, routers, etc.) as end users directed more requests to local servers and fewer requests to central mainframes. Of course, distributed servers do increase the network management burden because there are more devices to manage.

This LAN proliferation irrevocably altered the way PC users thought of their desktop machines, but it did not really alter the way that mainframes were used in the corporate internet. The mainframe, even as the 1990s begin, is still seen as the core of the corporate information strategy, the mainstay of application management and information dispersal.

The final step in server evolution—called the client/server computing model—carries the server to its logical ultimate role as the primary focus of information dispersal in the internet. Users in a client/ server computing environment can access information stored anywhere in the internet, providing an entirely new information infrastructure.

Rise of Client/Server Computing

In the client/server computing model, the server and its clients share the computing role between them. The server performs database access and intensive computing tasks (the back-end processes), and the client performs the display and user interface tasks for those calculations (the front-end processes). In a standard server model, the server receives a database request and transports a copy of the entire database to the requestor. This clogs the network and raises security concerns. In the client/server computing scenario, only results are transmitted, conserving network bandwidth. The client/server computing model allows each device to contribute what it does best and distributes the computing load throughout the network.

Each part—both server back end and user front end—can be developed, migrated, and serviced separately. The parts are developed so as to optimize a particular function, either database retrieval or information display, so that each device in the network can be used most effectively. Both the use of computing resources and the use of corporate funds are leveraged with low-cost, high-MIPS server platforms and a preserved investment in hardware, software, and training.

The client/server computing model helps bring essentially flat networks into a more hierarchical framework for easier and more effective management. As networks grow in size, segmenting managed resources into logical management domains allows managers to automate some tasks, zero in on problem areas faster, and spend time analyzing and planning rather than just fire fighting.

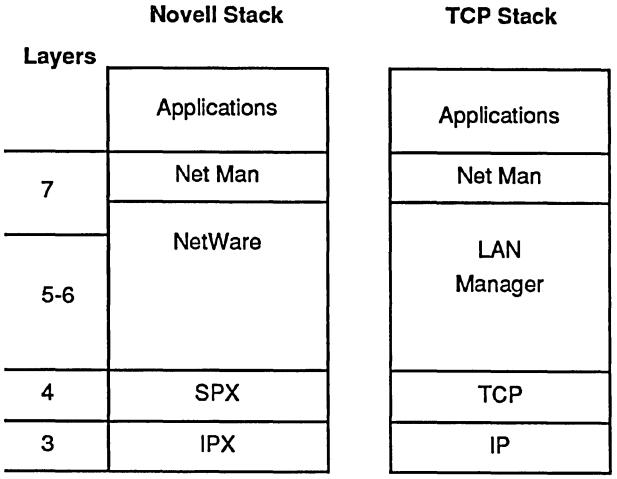
The software entities that manage server operations are called network operating systems (NOSs). In the same way that a device operating system manages the interface between a device's basic functions and its user applications, the NOS manages the interface between the network's underlying transport capabilities and the applications resident on servers. To manage a network, especially a modern network containing distributed servers, you need a powerful and effective network operating system.

LAN Operating Systems

Network operating system software resides at the equivalent of the OSI Reference Model's Session and Presentation Layers, with some Application Layer functions thrown in. Figure 1 shows where the typical NOS fits in some popular protocol stacks, using Novell's NetWare and Microsoft's OS/2 LAN Manager[3] as examples.

NOSs evolved primarily to solve an existing problem: giving multiple users access to a PC LAN's servers. Because the earlier mainframe- and

Figure 1.
The NOS in the Network Software Stack



minicomputer-dominated networks did not stimulate the development of servers, they did not depend heavily on NOSs. The evolution of the NOS was intimately tied to the market success of the PC LAN.

The NOS has now moved beyond the confines of the purely or primarily PC LAN. In the typical hybrid internet, the NOS now regulates every user's access to information.

Server Architectures

As servers become the major platform for disseminating information in the corporation, the NOS becomes a critical tool in the network management arsenal. The following list shows the critical management needs in server design.

What Must a Server Deliver?

- Reliability
- Maintainability/upgradability
- Performance
- Services blind to user's
  - –Device OS
  - –Transport protocol
  - –Upper layer protocols

Reliability and performance are clear needs in any network that carries mission-critical applications. If the server is the repository of critical applications, the network manager must be able to move users, services, and the hardware platforms themselves to new locations quickly and easily.

The ability to deliver services to any client device, regardless of its device operating system, is a clear necessity in a multivendor, multiplatform network environment. But users want more—including the ability to access servers using multiple transport protocols (Layer 4 in Figure 1) and multiple high-layer software (electronic mail, remote terminal access, directory services, etc.) protocols.

The NOS gives servers a chance to offer users uniform presentation of offerings. Figure 2 shows an end user and a server, both running their respective portions of Microsoft's OS/2 LAN Manager. The internal server engine should not affect the server's capability to offer software services to end users of DOS or any other operating system. In Figure 2, this particular end user has a TCP stack for transporting the packet containing the request; the server has front-end processing for both TCP and OSI packets. Another server might handle SNA and DECnet, for example.

Management in the NOS

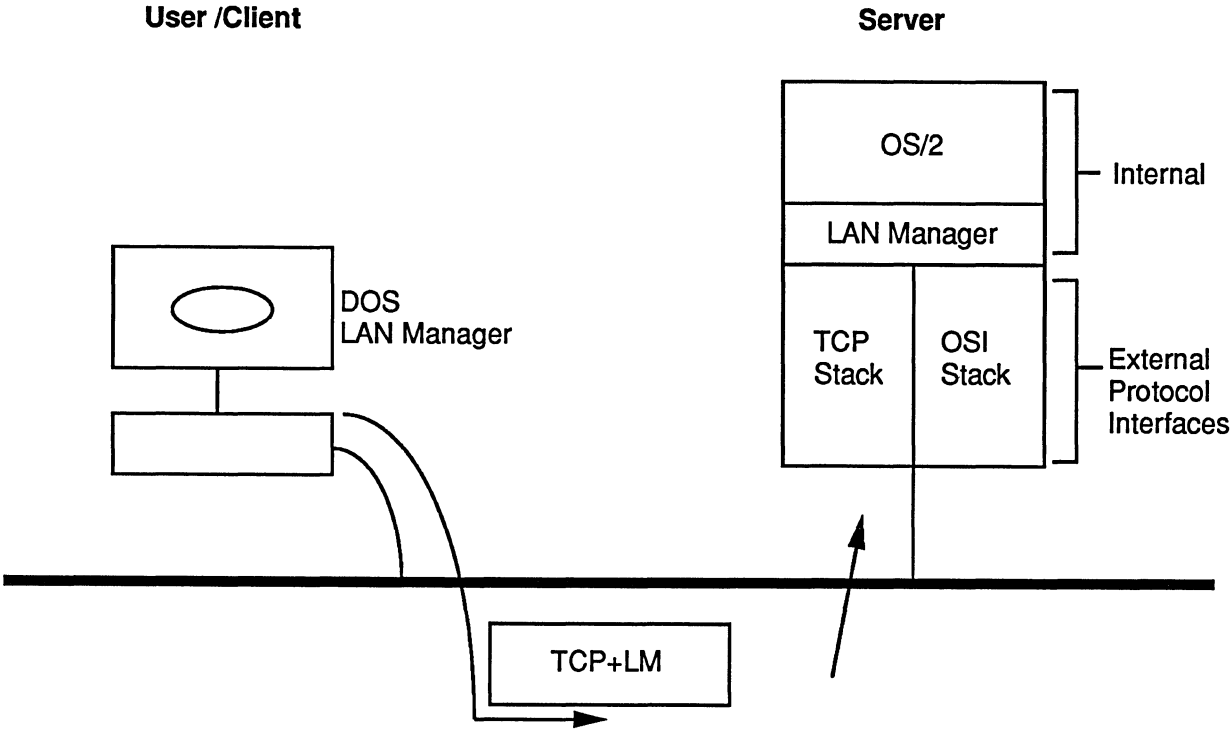
In PC LANs, and small- to mid-sized LANs in general, a NOS is seen as primarily a server management tool. However, having an effective LAN operating system is an even more valuable asset to an internet manager. A single-server interface—which an operating system provides—eliminates an entire *class* of software incompatibility problems in the internet. In addition, an effective LAN operating system with management capabilities can isolate the remaining software problems to the server itself.

The general principle of good internet management is to embrace layer management—as the OSI model requires—so that problems at a particular layer are resolved or contained at that layer or the layer immediately above. The operating system can contain some problems at the layer it manages and prevent them from proliferating to the application or network layers and therefore out into the internet.

NOS Market Issues

Now that we have looked at NOS management capabilities in general, we need a marketplace road map.

Figure 2.
Client/Server Operations



The most popular LAN operating system today is Novell's NetWare. Both IDC of Framingham, MA, and Dataquest of San Jose, CA, believe that NetWare's installed base accounts for almost three quarters of the total LAN operating system installed base. The most recent version, NetWare 386, runs on servers using the 80386 and 80486 chip and, if the appropriate add-on software is present, it can be accessed by end-user computers using the MacOS (Macintosh), DOS, UNIX, and OS/2 device operating systems.

Microsoft's[4] OS/2 LAN Manager uses a server engine running OS/2 as its device OS but is designed to be accessible to users running other device OSs. With LAN Manager available from over 40 OEMs, most network managers can buy this NOS from their existing LAN supplier. (In addition, Microsoft now sells its version of OS/2 LAN Manager directly.) Each OEM's version contains slightly different features, allowing varying levels of interoperability with other products. AT&T's LAN Manager/X, for instance, is a UNIX version of OS/2 LAN Manager that allows devices running with DOS, OS/2, or UNIX operating systems to access the server. Microsoft's basic LAN Manager is available for devices running under DOS or OS/2.

LAN Manager, as a relatively recent entrant into the marketplace, has a relatively small installed base. Dataquest's projections see it moving into second place within five years, however, a figure few independent analysts dispute. LAN Manager, because its multiple licensees also have the right to make custom modifications, may eventually find market troubles in the incompatibilities among its many flavors. Since LAN archrivals 3Com and Ungermann-Bass are both LAN Manager licensees, for example, they need to differentiate their versions to establish a competitive advantage for their customers.

IBM's entry, OS/2 LAN Server, is also based on Microsoft's OS/2 LAN Manager, but with major modifications. IBM and Microsoft recently deepened their long-term technical alliance by announcing LAN Server's coming migration to code

compatibility and a common set of APIs with Microsoft's LAN Manager. Users can expect to treat LAN Server as a subset of LAN Manager through the 1990s.

Now that we have a road map, let us take a more detailed look at the three top LAN operating systems: NetWare, LAN Manager, and VINES.

NetWare

The most recent NetWare version—named NetWare 386 because it is optimized for 80386 microprocessor performance—eliminated many major shortcomings of earlier versions, primarily by making it easier to add new users and new servers. Each server can theoretically serve up to 250 users, although users requesting complex tasks will reduce that maximum number considerably. NetWare's key features are as follows.

NetWare Features

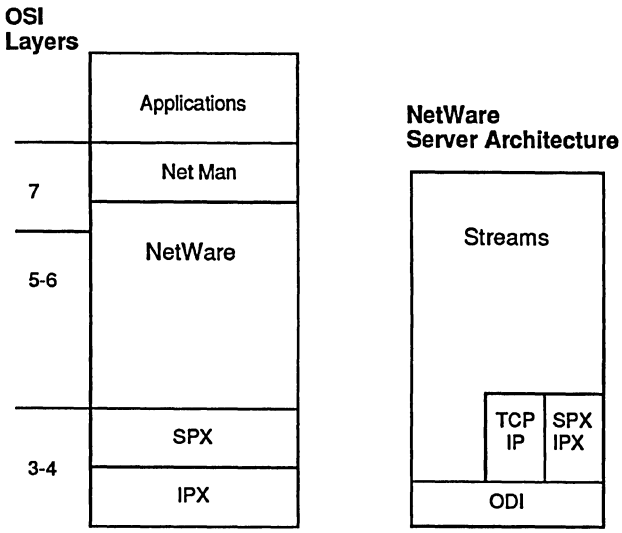
- Centralized administration possible
- Extended File Salvage
- Fault tolerance: hot fixes, disk caching
- High-performance file system
- Supports multiple transport protocols

NetWare servers can use dynamic memory allocation and a high-performance file system to speed performance, while centralized administration improves security and boosts the efficiency of the management staff. Novell has a message handling system (MHS) for electronic mail subsystems and NetWare SQL as a database manager.

NetWare's Extended File Salvage could be a considerable boon in small networks: a server actually recovers only the space allocated to "deleted" user files when it runs out of free space. Thus, users with second thoughts may be able to get their discarded files back if the server's memory is not heavily loaded. Of course, the manager of a *Fortune* 100 internet will probably never have enough server memory to waste in saving deleted files for careless end users. This is clearly a powerful feature only for underused servers.

The server engine's architecture is based on UNIX' Streams and the Open Data Link Interface (ODI) codeveloped by Novell and Apple Computer. Figure 3 shows how the parts of the NetWare architecture fit together. Streams can now encompass the TCP/IP stack, AppleTalk Filing Protocol (AFT), Sun's Network Filing System (NFS), and Server Message Block (SMB) and LAN Requestor software. Novell has announced that NetWare will eventually be capable of supporting X.400 electronic mail and other OSI protocols, including the TP4 transport protocol.

Figure 3.
NetWare Server Architecture



LAN Manager

If you peruse LAN Manager's various features in the following list, you will see many of the same selling points that NetWare claims. Fault tolerance, a high-performance file system, and centralized administration are all important to network managers, but they are not unique to LAN Manager.

LAN Manager v. 2.0 Features

- Centralized administration
- HPFS
  - –Fault tolerance
  - –Disk mirroring
  - –Hot fixes
- Domain Server
- Security
  - –Access control lists
  - –Audit trails for charge-backs
- Named Pipes
- Peer services

LAN Manager's more interesting features include the domain concept, Named Pipes, multitasking and multiprocessing operations, and the ability to audit specific Named Pipes. A network manager sets up a domain of servers and can then act on them as a group; this automates moves, adds, and deletes of users, applications, and security authorizations. Multiprocessing operations put multiple processors to work within one server. In LAN Manager, one processor will be devoted to certain operations—disk I/O, for example—and all disk read/write requests will be automatically routed to that processor, leaving the second processor free for other work.

Named Pipes is a powerful LAN Manager tool. A pipe is a Presentation Layer entity that allows process-to-process communication; it is created for a specific communication and disappears when the communication is complete. A Named Pipe is a permanent logical structure that gives users the opportunity to redirect interprocess communication in regular ways. Once a Named Pipe is listed in a server directory as a shared resource, it can be accessed by any user who needs it. Named Pipes gives developers a simple, generic, high-level interface for their API development. Managers can create scripts to automate their audits of Named Pipes for departmental charge-backs.

Peer services are becoming more important in segmented, workstation-oriented networks, which are typically the larger networks with the most complex topology. If a workstation can act as a nondedicated server to peers for a single low-level function—fetching mail, perhaps—while still acting as a standalone device for its end user and as a client to other dedicated network servers, the network's efficiency increases. Multiprocessing, especially the symmetrical form, helps a server's manageability by removing the processor as a potential I/O performance bottleneck. In symmetrical multiprocessing, the processors share the load equally; the asymmetrical form dedicates each processor for certain tasks so they cannot load-share dynamically.

VINES

VINES' primary niche is the large, complex network, so until recently Banyan was actually leading rather than responding to user needs. Only in the past three years has buyer understanding been equal to the tasks that Banyan designed VINES to accomplish.

VINES Features

- Fault tolerance
  - –Disk mirroring, hot fixes
- High-performance file system
- Security features
- Extensive peer services
- Symmetrical multiprocessing
- Global name service

VINES performs especially well compared to its rivals in networks with large numbers of users and servers and heavy traffic. It is particularly easy for network managers to add, delete, and move users and server offerings. In small networks, VINES can be slower than NetWare, and it definitely requires more memory in user devices.

One great VINES selling point—and a key to the "large networks" design goal—is StreetTalk, a global naming service. A global naming service, such as the CCITT/ISO X.500 Directory Service standard, provides a "yellow pages"-type service for all network users. Users log on to the network with a globally known logon name and access list, so they can access servers anywhere in the network. In networks without a global naming service, moving users, servers, or services puts a significant work load on network management staffs.

Neither NetWare nor LAN Manager compare favorably with VINES in this instance. NetWare 386 is not slated to have a global naming service until late 1990, and users frequently cite this lack as a major source of dissatisfaction. In NetWare, LAN Manager, and LAN Server, users log on to an individual server, not the network as a whole, so network managers must create scripts to log a particular user onto more than one server at a time. If the user or the server moves or if the access rights to any server or service changes, the script must be changed. If the server moves and 50 user scripts must change, significant management effort is wasted. In most cases, the users will experience a time delay during which they cannot access the moved server—a serious matter if the server contains mission-critical applications!

Banyan has moved recently to modify VINES so that it will support rival Microsoft's LAN Manager NOS protocols and APIs. The two companies are swapping technical specifications for the NOS code so they can build future applications that will run on both NOSs. Banyan will be first out with a LAN Manager protocol stack in VINES, allowing its NOS to support mail, print, filing, and other LAN Manager APIs (application programming interfaces), as well as the Named Pipes interprocess communications facility. The VINES StreetTalk facility will provide network management information on both VINES and LAN Manager nodes. The new version is expected to ship by late 1990.

References

[1]A server is a software entity (with a generic or dedicated hardware platform) that delivers specific services to end-user devices. Refer to other DP reports for in-depth coverage of server technology.
[2]Frequently referred to as superservers.
[3]"LAN Manager" in this report refers to Microsoft's NOS, not an identically named IBM network management package.
[4]The original LAN Manager was codeveloped by 3Com for Microsoft. ■