H1 Networking Operating Systems

H1.1 Introduction

A networking operating system is one which allows hosts to intercommunicate using operating system support. Thus, networking is built into the operating system, and not just an add-on. Many early versions of operating systems from Microsoft, including DOS and Microsoft Windows Version 3, had networking as an add-on to the operating system, thus proved unreliable and difficult to setup. Recent versions of Microsoft Windows have successfully integrated networking, and also support mixed, or hybrid networks. The most successful networking operating systems are:

- **Microsoft Windows.** The de-facto standard PC operating system which supports many applications. It supports a client/server architecture and also peer-to-peer architecture. Windows NT/2000 provides a robust networking technology.
- **Novell NetWare.** A PC-based system which provides an excellent file server support and a print server. It has been enhanced to provide corporate networks using NDS.
- **UNIX.** A robust and well-tested networking operating system which supports most of the industry-standard protocols. UNIX tends to run on high-powered workstations.

H1.2 Microsoft Windows

Windows NT has provided an excellent network operating system. It communicates directly with many different types of networks, protocols and computer architectures. Windows NT and Windows 95/98 have the advantage over other operating systems that they have integrated network support. Operating systems now use networks to make peer-to-peer connections and also connections to servers for access to file systems and print servers. The three most used operating systems are MS-DOS, Microsoft Windows and UNIX. Microsoft Windows comes in many flavors; the main versions in current use are:

- Microsoft Windows 3.xx – 16-bit PC-based operating system with limited multi-tasking. It runs from MS-DOS and thus still uses MS-DOS functionality and file system structure.
- Microsoft Windows 95/98 – robust 32-bit multi-tasking operating system (although there are some 16-bit parts in it) which can run MS-DOS applications, Microsoft Windows 3.xx applications and 32-bit applications.
- Microsoft Windows NT/2000/XP – robust 32-bit multi-tasking operating systems with integrated networking. Networks are built with NT/2000 servers and clients. As with Microsoft Windows 95/98 they can run MS-DOS, Microsoft Windows 3.x applications and 32-bit applications. In this chapter, Windows NT/2000 will be simply referred to as Microsoft Windows.

H1.2.1 Novell NetWare networking

Novell NetWare is one of the most popular systems for PC LANs and provides file and print server facilities. The protocol used is SPX/IPX. This is also used by Windows NT to communi-

cate with other Windows NT nodes and with NetWare networks. The Internet Packet Exchange (IPX) protocol is a network layer protocol for transportation of data between computers on a Novell network. IPX is very fast and has a small connectionless datagram protocol. Sequenced Packet Interchange (SPX) provides a communications protocol which supervises the transmission of the packet and ensures its successful delivery.

NetWare uses the Open Data-Link Interface (ODI) standard to simplify network driver development and to provide support for multiple protocols on a single network adapter. It allows Novell NetWare drivers to be written without concern for the protocol that will be used on top of them (similar to NDIS in Microsoft Windows). The link support layer (LSL or LSL.COM) provides a foundation for the MAC layer to communicate with multiple protocols (similar to NDIS in Windows NT). The IPX.COM (or IPXODI.COM) program normally communicates with the LSL and the applications. The MAC driver is a device driver or NIC driver. It provides low-level access to the network adapter by supporting data transmission and some basic adapter management functions. These drivers also pass data from the physical layer to the transport protocols at the network and transport layers.

H1.2.2 Microsoft Windows networking

Networks must use a protocol to transmit data. Typical protocols are:

- IPX/SPX – used with Novell NetWare, it accesses file and printer services.
- TCP/IP – used for Internet access and client/server applications.
- SNA DLC – used mainly by IBM mainframes and minicomputers.
- AppleTalk – used by Macintosh computers.
- NetBEUI – used in some small LANs (stands for NetBIOS Extended User Interface).

Novell NetWare is used by many organizations to create local area networks of PCs. It uses IPX/SPX for transmitting data and allows access to file servers and network printing services. TCP/IP is the standard protocol used when accessing the Internet and also for client/server applications (such as remote file transfer and remote login).

A major advantage of Microsoft Windows is that networking is built into the operating system. Figure H1.1 shows how it is organized in relation to the OSI model. Microsoft Windows has the great advantage of being protocol-independent and will work with most standard protocols, such as TCP/IP, IPX/SPX, NetBEUI, DLC and AppleTalk. The default protocol is NetBEUI.

There are two main boundaries in Microsoft Windows and NDIS and TDI. The Network Device Interface Standard (NDIS) boundary layer interfaces to several network interface adapters (such as Ethernet, Token Ring, RS-232, modems, and so on) with different protocols. It allows for an unlimited number of network interface cards (NICs) and protocols to be connected to be used with the operating system. In Microsoft Windows, a single software module, `NDIS.SYS` (the NDIS wrapper), interfaces with the manufacturer-supplied NDIS NIC device driver. The wrapper provides a uniform interface between the protocol drivers (such as TCP/IP or IPX/SPX) and the NDIS device driver.

IPX/SPX and AppleTalk

Novell NetWare networks use SPX/IPX and are supported through Microsoft Windows using the NWLink protocol stack. The AppleTalk protocol allows Windows NT/2000 to share a network with Macintosh clients. It can also act as an AppleShare server.