Volume 13, Number 2
February, 1992
ISSN 0270-7284

SNA Perspective

The single source, objective monthly newsletter covering IBM's Systems Network Architecture

Enterprise Network Management Part II: SNA Peer-to-Peer

This is the second of a two-article series on enterprise network management begun in the last issue of *SNA Perspective.* The previous article focused upon subarea SNA network management issues, provisions, directions, and implications.

This article focuses on five aspects of network management in distributed processing environments: client/server, APPN, IBM's LAN Network Manager, standards for LAN management, and OSF DME. We also look at the implications of IBM's January announcement of NetView/6000.

In part I, we noted that networked computing resources are the most valuable and yet the least well managed resources in today's enterprise. We then discussed various characteristics of NetView and subarea SNA network managment. SystemView and NetView are IBM's basis for integrated system and network management in complex interconnected environments. SystemView is a framework for integrated system and network management solutions for SNA, Open Systems Interconnection (OSI), and Transmission Control Protocol/Internet Protocol (TCP/IP) applications and their associated networks, and is integral to Systems Application Architecture (SAA). NetView is IBM's flagship system and network management product set and provides host-based, centralized network orchestration. NetView today works well in SNA subarea networks and reflects IBM's classical host-centric approach to SNA. In this article, we will focus on the network management requirements in distributed environments.

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3174 Part II: Hard Hit by Gateways

The challenges to the 3174 today are many. The first challenge was the introduction of the IBM PC ten years ago. These PCs were eventually enhanced to include sophisticated communication programs and sufficient PC horsepower to run the programs well at an affordable price. In addition came the proliferation of LANs and the emergence of client/server computing.

This article describes the current and anticipated functionality of the 3174 and SNA LAN gateways. We describe the changing environment the 3174 is facing and propose several possible changes ahead for the 3174.

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Client/Server Computing

The proliferation of price/performance-efficient workstations throughout the enterprise has given rise to workgroups that share computing resources such as applications, information, devices, and services. Resource sharing is often provided through LAN solutions. Client/server computing provides the means for a programmable workstation (PWS) to share resources both within the workgroup and throughout the enterprise.

Transparent resource sharing proceeds through the interaction of requesting clients and supplying servers. IBM's client/server computing direction generally positions client (requester) programs at the PWS and server (service-providing) programs at enterprise and departmental processors.

Services accessible by clients include:

- Backup/archive of workgroup and workstation data
- LAN system problem determination and management
- Software distribution and control
- LAN system user administration
- LAN system performance analysis
- User access control and security management
- Configuration and asset management
- Print services
- Distributed database
- Distributed files
- Distributed office functions
- Computer-integrated manufacturing (CIM)
- Distributed object integration
- Distributed processing

Three elements are necessary to meet user needs for a client/server interface:

- A consistent access procedure. Users require access to the above services in a consistent way, regardless of target application location or processing environment.
- A window interface. Users prefer windows and/or icons rather than a command line-based interface.
- A consistent look and feel. Users want a consistent way to interact with a wide range of applications running in a wider range of local and remote workstation, midrange, and host platforms.

Heterogeneity Hampers Network Management

Target application platforms often reside in local as well as remote processing environments. These environments are usually heterogeneous and abound in interprogram and network incompatibilities. To exacerbate matters, the wide array of routing and bridge products themselves provide solutions to these problems in an inconsistent way. The inevitable result has been the emergence of incompatible networked application environments that do not lend themselves to efficient or effective connectivity, or even consistent or reliable network management.

Client/Server Management Requirements

Network management requirements in a client/server workgroup and between this environment and enterprise processors should:

- Be vendor-independent
- Cover LAN, LAN-to-LAN directly, and LAN-to-LAN across WANs
- Manage heterogeneous environments
- Provide the following features:
  - Problem management. Manage network problems (unwanted changes) from their detection through to final resolution. This includes disciplines such as problem determination, problem diagnosis, problem bypass and recovery, problem resolution, and problem tracking and control.

- Performance and accounting management. Quantify, measure, report, and control the responsiveness, availability, utilization, and usage charges of network components.

- Configuration management. Control information that is necessary to identify physical and logical networked resources and their interrelationships.

- Change management. Plan and control the additions, deletions, and modifications of networked hardware, software, and microcode resources.

- Security management. Prevent unauthorized access to protected resources, authenticate peer entity and data origins, provide access control, provide for traffic flow confidentiality and integrity in connection-oriented and connectionless environments, provide selective field confidentiality, and ensure nonrepudiation throughout.

Each of the above requirements is a tall order to fill just in a straightforward subarea SNA network, let alone in a hybrid subarea/APPN network or a multivendor network using a combination of SNA, OSI, and TCP/IP.

APPN Network Management

Advanced peer-to-peer networking (APPN) SNA provides the basis for dynamic connections between distributed applications. Subarea SNA, on the other hand, is the classical SNA method whereby nonprogrammable terminals (NPTs) access host-resident applications. In subarea networks, the host applications control access and configurations. Application invocations and routing logic are predefined and must be manually redefined.

APPN is architected on the basis of Node Type 2.1 (NT2.1). APPN network node servers provide the basis for dynamic determination of remote application location, as well as dynamic calculation of end-to-end routing and intermediate node routing.

APPN Is Strategic...

IBM has introduced APPN for several of its major platforms: System/36 (1986), AS/400 (1988), ES/9000 under DPPX/370 (1990), 3174 establishment controller (1991), PS/2 with Network Services/2 (NS/2) (under OS/2 EE) (1991), OS/2 Version 2 Communication Manager (1991).

These successive implementations of APPN make it clear that IBM is committed to peer-to-peer networking across the entire range of its major SAA enterprise, departmental, and workstation platforms. In January 1992, IBM announced that it would license APPN network node to other vendors, to further increase its availability on a wide range of platforms.

It also appears inevitable that APPN network node will be provided on the RS/6000, which is IBM's principal Advanced Interactive Executive (AIX) platform. *SNA Perspective* believes that APPN will be supported on the RS/6000 because IBM has increasingly positioned the SAA and AIX platforms as interoperable. Furthermore, IBM announced last month that APPN will be supported on its new multiprotocol router, the 6611 (see *IBM Announcements* in this issue), which is based on an RS/6000 engine.

Clearly, APPN is IBM's SNA routing solution for distributed workgroup, client/server users. APPN functions as a peer SNA routing protocol set that can conceptually select from a range of possible underlying WAN and LAN data links transparently. APPN is potentially suitable for providing dynamic SNA peer connections over data link environments including but not limited to:

- Token ring
- Ethernet and IEEE 802.3 Carrier-Sense Multiple Access/Collision Detection (CSMA/CD)
- IEEE 802.4 Token-Passing Bus
- Synchronous Data Link Control (SDLC)
- High-Level Data Link Control (HDLC)

APPN is an evolving routing protocol set which is quite likely to include support for higher speed link environments to include:

- Fiber Distributed Data Interface (FDDI)
- IEEE 802.6 Metropolitan Area Network
- Integrated Services Digital Network (ISDN)
- Broadband ISDN
- ES/9000 Enterprise System CONnection (ESCON) optical fiber channel
- Gigabit LANs
- Synchronous Optical NETwork (SONET)

...But NetView Can't See It

Users and their increasingly distributed applications require the dynamic, peer-to-peer capabilities of APPN in concert with higher speed connections. A significant network management concern here is that, at present, host-resident NetView is not able to maintain awareness of a downstream dynamic network environment. That is, NetView network awareness is generated and maintained by static updates to its tables. Downstream fluctuations in the network due to the inherent APPN network node functions of dynamic directory, dynamic route selection and intermediate node route calculations, are simply not known to NetView on an ad hoc basis. It seems to *SNA Perspective* to be quite inconsistent to provide APPN network node functionality across the entire SAA platform set and yet not provide a commensurate capability to manage this dynamic environment.

What NetView Needs To Support APPN

Each of the following desirable capabilities are discussed in more detail below:

- NetView should intercept APPN topology changes automatically
- APPN management should include dynamic change management and dynamic performance and accounting management
- Configuration management in APPN should extend beyond boundary node
- APPN management should include dynamic automated operations, dynamic security management, and consistent implementations
- NetView should enable multitier APPN problem management disciplines
- SAA and AIX environments should consistently apply APPN-cognizant focal point, entry point, and service point logic

SNA Perspective believes that NetView and its supporting products should be able to intercept and record APPN network topology changes as they occur without operator intervention. Perhaps the mechanism to accomplish this would be to provide the capability for any APPN network node topology data unit (TDU) exchange resulting in network node local, cache, or network directory rewrites to update a NetView topology database. That is, one solution would be to architect a Management Services (MS) TDU capability wherein NetView or any other focal point, entry point or service point implementation could issue and capture MS TDUs generated by APPN network nodes and, in so doing, dynamically update its view of an entire APPN network. (Entry point, service point, and focal point are defined in part I of this series in the January issue.)

SNA Perspective believes that NetView and any other focal point products, as well as entry point products, should support a dynamic network management topology view at global, network node, end node, low-entry networking node, link characteristic (active, inactive, bandwidth), session, and conversation levels.

Furthermore, *SNA Perspective* believes that configuration management capabilities in an APPN managed environment should extend well beyond the boundary node (from the NetView perspective) level. Since user experience with token ring implementations suggests that source routing (the token ring bridge scheme) is reasonable through six bridges, perhaps six embedded topological tiers of view should be provided in a dynamic NetView/ APPN environment. *SNA Perspective* thinks that NetView and supporting products should enable multitier APPN problem management disciplines including problem determination, problem diagnosis, problem bypass and recovery, problem resolution, and problem tracking and control.

This APPN network management environment should also include the following features:

- Dynamic change management which enables awareness of additions, deletions, and modifications of networked hardware, software, and microcode resources on an ad hoc basis without the need for manual table updates.
- Dynamic performance and accounting management which incorporates awareness of the results of quantifying, measuring, reporting, and controlling the responsiveness, availability, utilization, and usage charges of network components into the network routing and session recovery decision process.
- Dynamic automated operations which would extend the current expert systems and automated management capabilities to include dynamic updating of knowledge-based, rule-based, inference engine tables as a function of topology changes in network node and associated resources.
- Dynamic security management.
- Consistent SAA and AIX implementations. APPN is integral to SAA and, as stated earlier, *SNA Perspective* believes that IBM will incorporate APPN capabilities into AIX.

The NetView interface on the enterprise processors is currently through Multiple Virtual Storage Subsystem Interface (MVS SSI), Virtual Machine Programmable Operator (VM PROP), and Virtual Storage Extended Operator Communications Control Facility (VSE OCCF). These and the other SAA runtime environments (OS/400 and OS/2) as well as the AIX runtime environments (ESA/AIX, AIX/6000, AIX PS/2) should consistently apply APPN-cognizant focal point, entry point, and service point logic. Perhaps LAN-resident APPN network node servers could function as local service points and present themselves upstream to APPN-cognizant NetView hosts as satellite focal points.

LAN Management

This section looks at IBM's LAN Network Manager and Heterogenous LAN Management (HLM).

LAN Network Manager

IBM announced LAN Network Manager Versions 1.0 and 1.1 as well as LAN Network Manager Entry in September 1990. There have been phased shipments of LAN Network Manager Version 1.0 since April 1991, but general availability will be in the latter part of March 1992. LAN Network Manager Version 1.1 and LAN Network Manager Entry are planned for availability in mid-December 1992.

These LAN Network Manager programs run under OS/2 EE and OS/2 Version 2. They enable management of multisegment IBM token ring and broadband/baseband IBM PC Networks as well as the IBM 8209 LAN Bridge that interconnects token

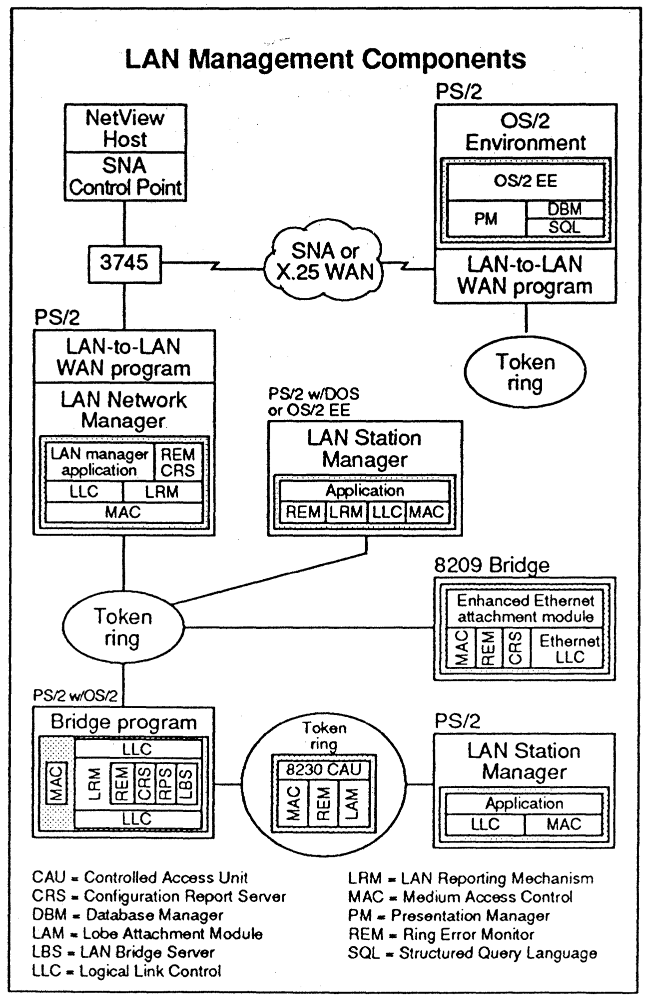

Figure 1

ring and Ethernet LAN segments. This environment is characterized in Figure 1 (see page 5). LAN Network Manager enables management of a LAN either centrally from a NetView host or locally through the operator interface at the LAN workstation. The operator interface is based on the SAA window-based presentation interface using OS/2 Presentation Manager. The OS/2 Database Manager provides a Structured Query Language (SQL)–based relational database environment within which to construct a LAN configuration database.

LAN Network Manager extends NetView LAN commands to support access to a set of LAN functions from NetView Version 2 Release 2 and onward. This begins to provide the basis for an enterprise-wide, NetView-orchestrated LAN/WAN management solution. LAN Network Manager Entry, in concert with NetView Version 2 Release 2 and onward, enable management of remote, single-segment token ring or broadband/baseband PC Networks. There is no user interface at the LAN Network Manager Entry station. These LAN network management products, while beginning to address LAN/WAN SNA network management, do not provide support for multiprotocol (SNA, OSI, TCP/IP) environments.

In June 1991, IBM introduced AIX NetView Service Point, which generates a gateway to NetView for management systems running on Unix platforms. The AIX NetView Service Point arrangement is shown in Figure 2. AIX NetView Service Point is supported on the RS/6000 POWERserver and POWERstation as well as on the SUN UNIX SPARCserver and SPARCstation. This UNIX platform for service point logic generates network management vector transport (NMVT) request units (RUs) from TCP/IP SNMP flows. In January 1992, IBM introduced NetView/6000, which is essentially an SNMP Manager with a user interface and communication to NetView (see Announcements section in this issue for more details).

These LAN/WAN network management approaches certainly fill specific niches. However, they do not provide the level of overall network management level of openness required by users increasingly operating in multivendor, multiprotocol environments. *SNA Perspective* believes that it will become increasingly important for IBM to provide transparent network management support for integrated SNA, OSI and TCP/IP networked applications. In September 1990, IBM formally expanded its Open Network Management (ONM) direction to encompass open, end-to-end management of heterogeneous networks.

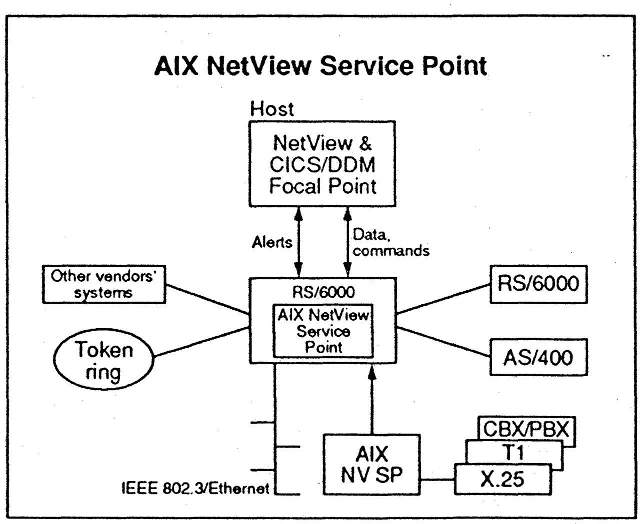

Figure 2

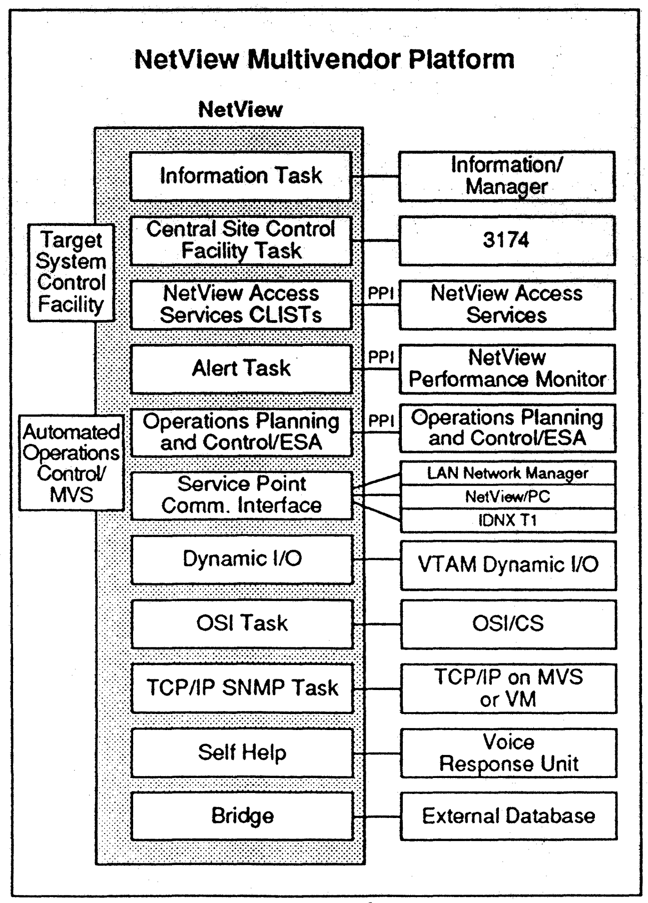

Figure 3

ONM specifically states it will support these mixed environments through the use of open management architectures for SNA, OSI, and TCP/IP. Figure 3 (see page 6) summarizes NetView support for SNA, OSI, and TCP/IP tasks.

Figure 4 expands on Figure 3 to include AIX NetView Service Point and non-IBM network management systems. Significantly, Figure 4 also represents the *SNA Perspective* viewpoint that NetView will be enhanced to support APPN as well as LU 6.2.

Heterogeneous LAN Management

Enterprise networks are increasingly characterized by multiple workgroup LANs interconnected by intersubnetwork WANs. Departmental LANs in turn support a mixture of media types and operating system environments. A typical mixture includes the coexistence of token ring and Ethernet/IEEE 802.3 LANs. Networks in Fortune 1000 corporations, government agencies, and universities tend to include mixed media LANs. The two major LAN management protocols considered for use in heterogeneous LAN environments are OSI Common Management Information Protocol (CMIP) (defined by the International Standards Organization (ISO)) and the Simple Network Management Protocol (SNMP) (defined by the Internet Engineering Task Force (IETF)).

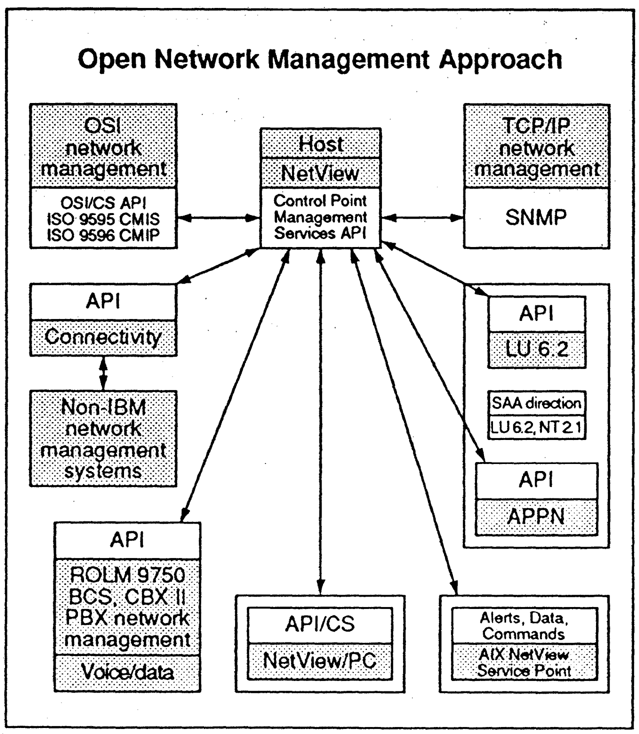

Figure 4

Enterprise networks are increasingly multivendor in nature. These also employ varying combinations of SNA, OSI and TCP/IP application and networking approaches. Bridge, router, and gateway solutions proliferate from an increasing number of vendors. These solutions themselves provide for heterogeneous networked application solutions in an inconsistent way. The inevitable result has been the emergence of incompatible networked application environments which do not lend themselves to efficient or effective connectivity, let alone consistent or reliable network management.

IBM and 3Com have addressed the problem of network management in a mixed LAN environment through cooperative development of an approach called Heterogeneous LAN Management (HLM). It is significant that IBM and 3Com have teamed up in this effort, as they are the leading vendors for token ring and Ethernet/IEEE 802.3 LAN adapters, respectively. Key to development of HLM was the issue of managing a LAN environment comprised of a mixture of operating system environments (such as DOS, OS/2, UNIX, etc.) in addition to addressing the problem of network management of a mixed media environment. HLM design goals are:

- To manage all types of end stations (such as workstations running DOS, OS/2, UNIX) in addition to concentrators, hubs, routers, bridges, and servers
- To provide an architecture to manage Ethernet and token ring LANs today with provision for additional LAN types tomorrow
- To provide minimal management services that can be supported by any network node, with extensions to support vendor and user extended management entities
- To be a standards-based architecture
- To provide application program interfaces (APIs) through which developers can create compatible network management software
- To provide specifications of what management data is accessible

The HLM base management protocol is specified by use of the OSI CMIP standard using a lower level logical link control (LLC) network service. The result is CMIP over LLC (CMOL). LLC is specified by IEEE 802.2 and is a frequently implemented data link sublayer. Essentially, LLC defines how command packets are generated and interpreted for support of logical link functions of one or multiple logical links. SNA, OSI, and TCP/IP traffic flows are all supported over LLC.

HLM base services are provided by an entity called the LAN Station Manager (LANSM). LANSM functions are provided by all HLM stations whether they are managing or being managed. These functions include:

- Discovery/registration
- CMOL processing
- Base-level Management Information Base (MIB) services
- Extended API support

CMIP and SNMP

It is interesting to note that several other vendors are pursuing SNMP as their preferred LAN network management approach. This is certainly due in part to increasing market acceptance of TCP/IP as well as to the relative simplicity and lower cost of SNMP as compared to CMIP. However, it is also important to consider the relative technical benefits of CMIP over SNMP (see Table 1).

Relative Merits of CMIP and SNMP

CMIP	SNMP
Excellent automation potential	Limited automation capability
Manager and agent well defined	Manager and agent not well defined
Rich access control	Agent cannot authenticate commands from manager
Event driven	Limited event-driven support; mostly manager polling
Rich monitoring and control	Limited monitoring; no scoping or filtering
Complex	Simple
Few current suppliers or implementations	Many suppliers and many products on market
Expensive	Inexpensive

Table 1

Clearly, Table 1 is a very limited comparison of CMIP and SNMP. However, *SNA Perspective* believes that IBM will continue to promote support of CMIP in the heterogeneous LAN environment through the 3Com/IBM HLM architecture and throughout the enterprise internetwork environment through the SAA SystemView direction. Nonetheless, it is highly likely that IBM will continue to support SNMP as well as CMIP on NetView.

Managing SNA, OSI, and TCP/IP

Open networking in today's environment requires that users be able to transparently access SNA, OSI, or TCP/IP applications in a consistent way. SNA remains IBM's proprietary network architecture and has certainly established itself as the predominant international *de facto* networking approach.

SNA Perspective believes that IBM will continue to support both subarea and APPN SNA, but will emphasize development of APPN. *SNA Perspective* further believes that APPN will be announced in NCP and VTAM by the third quarter of 1992. The network management implications of this projected capability for NetView are enormous. NetView must be significantly and immediately enhanced to recognize, process, and reconfigure its knowledge of the network on the basis of multiple APPN network nodes. Therefore, *SNA Perspective* believes that NetView will also be announced with APPN network node TDU processing and directory update capabilities during the third quarter of 1992.

IBM has also emerged in the past three years as a leader in development of consistent OSI networked applications running in SAA and AIX processing environments. *SNA Perspective* believes that IBM will integrate common APIs from programs into SNA and OSI services (see "SNA Directions: 1992 and Beyond" *SNA Perspective* December 1991). This projected integration will certainly require consistent and significant evolution of the network management product set including NetView, NetView/PC, LAN Network Manager, LAN Station Manager, the AS/400, and the RS/6000.

IBM has classically regarded OSI and TCP/IP as its strategic and tactical multivendor approaches, respectively. All of IBM's significant SAA and AIX platforms now support SNA, OSI, and TCP/IP. The introduction of the AIX NetView Service Point underscores IBM's commitment to providing a reasonable degree of network management transparency in these three environments.

IBM and the OSF DME

The greatest challenge in network management today is the lack of consistency in multiprotocol networks. Heterogeneous interconnection products (bridges, routers, and gateways) provide solutions to this lack of consistency, but they are themselves inconsistent with other interconnection product solutions. Further, major vendors are pursuing dissimilar "standard" approaches to network management in mixed environments.

Within the "standards" environment for network management, it is important to consider the activities of the Open Software Foundation (OSF). Perhaps the greatest OSF asset is that it is a collection of major vendors who, as a group, are developing a standard set of solutions collectively called the Distributed Computing Environment (DCE) and Distributed Management Environment (DME). These solution sets were developed through competitive bids in a request for technology (RFT) process. The OSF members then develop vendor- and protocol-independent products which conform to these environments.

The OSF view is that a DME should enable a heterogeneous networked computing environment to be managed in a uniform and efficient manner through a consistent user interface. The result should be that users would spend less time and effort managing their interconnected systems and focus more on their applications and work at hand.

The driving objective of the DME development process has been to identify a common framework for managing heterogeneous networked application environments. This framework defines APIs which are accessible by applications in order to invoke common management services, store/retrieve management information and exchange such information with managed objects located in local and remote processing environments. The DME user interface is conceptually defined to enable both a graphical and object-oriented interface as well as a character cell (nongraphical) interface.

Management tasks performed by DME management applications include:

- Remote initialization of network nodes
- Remote configuration of network nodes
- Interchange and manipulation of computing resource representations

DME computing resource representations are called managed objects. DME common management services include management communications, event management, event logging, and object management. These services also provide for intersystem interoperability.

The primary DME technologies were selected in September 1991. These are principally based upon Hewlett-Packard's OpenView systems and network management products and the object-oriented products of Tivoli of Austin, Texas.

In April 1991, IBM announced that it would license portions of HP's OpenView. This announcement was an evolutionary outgrowth of IBM's and HP's complementary submissions on DME to OSF. Specifically, IBM is licensing HP OpenView Network Node Manager and HP OpenView Network Management Server, which was part of HP's DME submission to OSF.

HP Network Node Manager is based on SNMP and allows a system administrator to configure, trouble-shoot, and monitor performance of a TCP/IP network from a single workstation. HP Network Management Server extends the functionality of HP Network Node Manager by using APIs based on OSI CMIP.

IBM has clearly and consistently stated that its support of openness is a primary objective. Furthermore, IBM has begun to position both SAA and AIX to absorb significant components of DCE and DME through OSF/1 and its successors. The networking and internetworking interconnection and management environments have become more complex during the past few years for all of the reasons stated above.

Conclusions

End users and network administrators share a clear requirement for a standard, technology-independent way in which to use and manage networked computing resources. NetView and its predecessor host products have traditionally provided reasonable levels of SNA network management hierarchically. Users, however, increasingly connect and share application resources in a distributed fashion. These processes occur on enterprise-wide levels in inter-LAN and LAN/WAN/LAN internetworked environments. The growing realities of networked applications require solutions that address not only SNA, but also multiprotocol environments based on SNA, OSI, and TCP/IP. *SNA Perspective* believes that IBM's alignment with DCE and DME is critical in providing effective and efficient solutions in these settings.

In summary, *SNA Perspective* expects that the likely development pathway from IBM for network management in distributed environments will be:

- Maintenance of NetView and supporting products for subarea SNA management
- Evolution of NetView APPN interoperability to address peer-to-peer SNA
- Continuing evolution of NetView capabilities in OSI CMIP and TCP/IP SNMP
- Incorporation of DME into NetView and its supporting SAA and AIX products
- Evolution of nonhost-resident SAA/AIX DME-supporting products ■

(continued from page 1)

3270 Terminals on the Decline

User productivity today usually requires more than a terminal and host-based applications can provide. Increasingly, traditional users of terminals find that they are performing functions that could be better performed on a PC. They are also finding that 3270 emulation provides sufficient, or even better, SNA connectivity than they have with a nonprogrammable terminal. LAN-based SNA gateways can provide that connectivity in addition to other benefits of being attached to a LAN.

Research by Dataquest Inc. shows a dramatic drop in new terminal sales over the past few years and finds that more PCs than terminals are now connected to 3174s (see sidebar on page 16). Much new establishment controller business has been to replace or consolidate existing controllers since newer controllers support more users, new features such as downstream devices, and new connectivity options including token ring, Ethernet, and ESCON.

Terminals and Standalone Emulators

IBM acknowledged the PC presence by letting the 3174 support coax-attached PCs and by the development of PC-based 3270 emulation software. Since the introduction of the early PC-based emulators—including, for example, IRMA in November 1982 and PCOX in June 1983—users wanting more than just a keyboard and a display have been able to transfer files to and from the host system and, by way of the same application program interface (API) used for file transfer, have been able to take advantage of a growing number of micro-to-mainframe applications. Emulators have also kept pace with terminals with respect to graphics, multisession support, windowing, and keystroke recording and playback. With some exceptions (e.g., the IBM 3276), 3270 terminals have been limited to Category A coaxial or twisted-pair connection to a controller. Emulators have also exploited remote connections (SDLC, BSC, QLLC) and, more recently, token ring attachment to a 3174 establishment controller or 3745 communication controller.

LAN-Based 3270 Gateways

In 1986, IBM, CXI, DCA, and others introduced LAN-based 3270 gateways. They were limited in scope—a total of five sessions when the gateway was coaxially connected to a 3274 cluster controller and up to 32 sessions for an SDLC or, in some cases, BSC connection. The session limitations for SDLC connections recognized the performance limitations inherent in running the gateway on a 6- or 8-MHz PC AT over a NetBIOS-based LAN. The use of coprocessors and, ultimately, of much faster PCs overcame many of the limitations, allowing 40-session multiplexed coaxial and 254-session SDLC and token ring gateways.

Today's SNA Gateways

More than a dozen vendors offer SNA gateway/client solutions. Each uses a client/server architecture in which one PC or dedicated network server is designated as the gateway (or communications server) and contains the physical connection to the host. Gateway and/or client platforms include DOS, OS/2, UNIX, XENIX, AIX, NetWare 3.11 and, for the Macintosh, System 7.

UNIX is much harder to support than the other platforms because there are several different UNIX implementations on various hardware platforms. CLEO and Rabbit Software dominate the small but growing market for UNIX-based micro-to-mainframe products. Their products provide similar functionality to the DOS and OS/2 products.

SNA gateways support a variety of host connections. However, as discussed below, they do not yet cover all the options available on 3174 establishment controllers.

Client workstations communicate with gateways over a LAN (token ring, Ethernet, ARCnet, token bus) using one of the many NetBIOS LAN protocols, Novell's IPX/SPX, or TCP/IP.

Most client workstations support the expected 3174 LU types (LU 1, LU 2 and LU 3). Some also support LU 0 and/or LU 6.2 (for APPC). The addition of these two LU types changes the gateway and client designation from 3270 to SNA. Some gateways support PU Type 2.1, necessary for host-independent LU 6.2-to-LU 6.2 communication.

Getting to the Host

The following eight types of host connections from SNA gateways are possible today:

1. SDLC link, over switched or permanent circuits, with a V.24/V.28 (EIA-232-D), V.35, or X.21 interface

2. X.25 link, using qualified logical link control (QLLC), with V.24/V.28 (EIA-232-D), V.35, or X.21 interface

3. Token ring, via a 3745 adapter, ES/9370 adapter, 3172 interconnect controller, or 3174-based token ring gateway

4. DFT-mode coaxial cable or IBM Cabling System, with a five-session limitation, via an IBM 3174, 3274, or equivalent

5. Multiplexed DFT-mode coaxial cable or IBM Cabling System, with a 40-session limitation, via an IBM 3174, 3274, or equivalent (appearing as an IBM 3299 Model 2 or 3)

6. Multiplexed DFT-mode coaxial cable, IBM Cabling System, or fiber-optic cable, with a 160-session limitation, via an IBM 3174 (appearing as an IBM 3299 Model 032)

7. Ethernet, via a 3172 or McDATA 7100 controller

8. Host channel, either bus-and-tag or ESCON

Most gateway vendors have products that provide host connectivity options 1, 3, and 4, although the fourth option is obviously quite limited in capacity. Some (including Attachmate and NSA) support SDLC adapters with built-in synchronous modems.

A number of vendors also offer option 2, mainly for the European market. There is also a very strong demand for an X.21 interface for both switched and nonswitched operation. Several vendors (including Eicon, Novell, and NSA) support V.35 adapters, which avoids the need for a V.28/V.35 converter for 56- and 64-kbit/s operation.

Rabbit Software's RabbitGATE II and Data Interface's DI3270 LAN Gateway also support option 5, as does Novell with its older NetWare SNA Gateway.

McDATA's 7100 can provide option 7, Ethernet host connectivity to gateways, by providing an Ethernet interface that looks like a token ring to the host. (McDATA has tested it with Attachmate and NSA gateways so far.) IBM's OS/2 EE supports SNA over Ethernet natively, using the connection provided by the 3172 with the Interconnect Enhancement feature and VTAM V3R4.

So far, no gateway vendors offer either options 6 or 8, although option 6 is an elementary extension of option 5. With a data rate of 2.35 Mbit/s, the Category A interface is usually adequate for the support of 160 sessions. Token ring alternatives make it unlikely that we shall see any gateways offering this option.

Channel adapters for PCs, including PS/2s, already exist. It is only a matter of time before the major SNA gateway vendors offer channel-attachment support, possibly including support for attachment to the ESCON channel director.

SNA Client-to-Gateway Connections

At its most basic, the client-to-gateway LAN connection operates as a replacement for the terminal-to-controller coaxial connection. However, given the flexibility of LAN connections and the multisession capabilities of today's SNA client workstations, the available connection options are anything but basic.

Whereas a multisession distributed function terminal (DFT), such as the IBM 3472-G, can be coaxially connected only to a single controller, a multisession SNA client workstation can, if necessary, use a different gateway for every session (and gateway selection can, moreover, be dynamic). Whereas a 3270 terminal may only be 1500 meters (about 5000 feet) from the controller, wide area LAN interconnection (via bridges or routers) allows SNA client workstations to be any distance from the gateway.

Although establishment controllers can provide access to up to eight hosts per data link, they do not offer the path redundancy for their locally attached devices that is available with two or more SNA gateways. When the controllers are acting as a token ring (or, in McDATA's case, Ethernet) gateway, their downstream PC-based clients do not have this limitation because they can connect to any gateway on the LAN.

SNA Client Workstation Characteristics

Gateway vendors have implemented SNA client workstation software in two different ways: (1) a split stack—LU or partial LU on the client workstation with a single PU on the gateway or (2) a full stack—PU and LU on each client workstation. Having a full SNA stack gives each client workstation the greatest connectivity flexibility. The disadvantage is increased memory use which can be a problem for DOS workstations. Memory use is less critical in Windows or OS/2 environments and vendors using the full stack approach (IBM, Attachmate) have made efforts to minimize memory usage. In both direct client-to-host communication over a LAN and peer to peer communication, the full stack has an advantage over split stack, providing direct communication instead of triangulated via the gateway (see figures 5 and 6 on page 13).

LU Type 2

Client workstation capabilities vary from one vendor to another.

Most DOS-based workstations provide crisp text-mode emulation of the four most popular screen formats (24x80, 32x80, 43x80, and 27x132, often referred to as Models 2 through 5) and take advantage of VGA or super VGA characteristics to display the three larger formats without the need for scrolling.

Treatment of the operator information area (OIA), or status line, reflects a variety of philosophies. Some vendors have taken the trouble to faithfully reproduce the special symbols used by the nonprogrammable terminals; others have abandoned the effort. Extra information, displayed continuously or invoked by keystroke, includes server name, local address, LAN connection messages, row and column number, etc.

Several vendors (Attachmate, DCA, IBM, Novell, and Rabbit) support the small market for APL (A Programming Language). All but IBM and Novell provide APL only as part of an extra-cost graphics package.

Most vendors now offer or are developing Windows-based workstations. IBM's Personal Communications/3270 can be customized for DOS or Windows. New functions are possible in a Windows environment and these are in great demand. Features such as cut-and-paste and dynamic data exchange (DDE) for passing data between the 3270 emulation software and other Windows applications are much sought after.

Support of multiple national languages is important for those vendors who do not wish to limit their sales to the U.S. IBM's support includes other alphabets, such as Greek and Cyrillic. Adoption of IBM's code page approach is now regarded as essential for display, keyboard, and printer support.

Split Stack and Full Stack Approaches

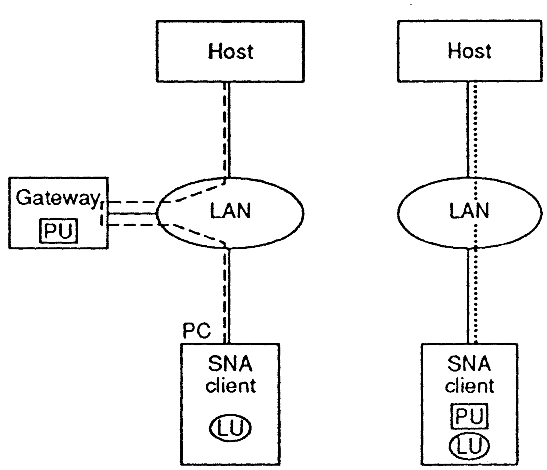

Figure 5

LU Type 1 and 3

Most 3270 client workstations can be configured to support one or more host-addressable printers, often with the option to redirect print requests to the LAN printer spool queue.

Given that host-addressable printers are not generally considered to be in a user's private domain, it is reasonable to allow the attachment of printers to the SNA gateway (directly or via the LAN spool queue). However, at the moment, printer data streams must be routed to a workstation for capture back to the LAN spool queue. Doubtless, gateway vendors are working on ways to eliminate this wasteful process, perhaps by incorporating printer LUs directly into the gateway software.

LU Type 6.2

The appearance of APPC applications has been slow. However, many large end users increasingly see APPC capability as a necessity and are developing applications to exploit it. Most gateway vendors have yet to introduce APPC support.

Most gateway vendors view IBM OS/2 Extended Edition (EE) as their standalone competition and have or are developing APPC support that is OS/2 EE-compatible rather than APPC/PC-compatible. This OS/2 EE-compatible support is not just for OS/2 clients but is also for DOS and Windows

Split Stack and Full Stack Approaches with APPC

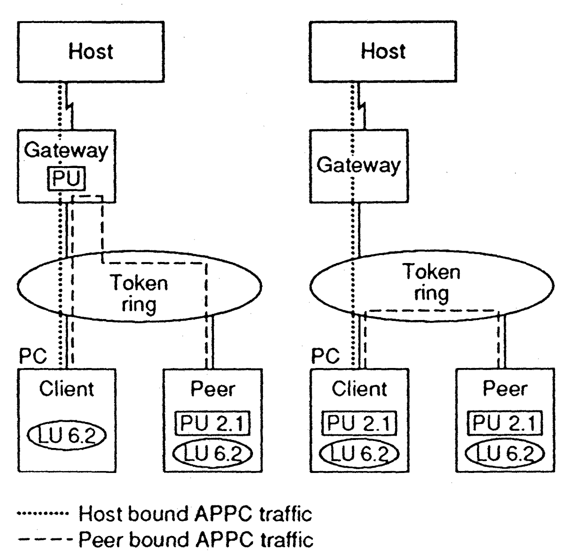

Figure 6

clients. It is becoming known as APPC/EE. IBM OS/2 2.0 does not have an Extended Edition with modules such as Communication Manager and Database Manager bundled in. Instead, these modules are available separately as Extended Services (ES), and APPC support will be provided by the Communication Manager ES. The level of APPC support will be equivalent to that provided by Network Services/2 including the CPI-C interface. Novell is one of the few exceptions, developing support that is APPC/PC compatible.

File Transfer

The host file transfer utility IND$FILE and the send and receive components of the 3270 emulation allow files to be transferred between the host and the client's local disk. This and the High-Level Language Application Programming Interface (HLLAPI) feature are available irrespective of whether the PC is attached to a 3174 or attached to an SNA gateway.

HLLAPI

HLLAPI and EHLLAPI applications interface to the LU via HLLAPI, bypassing the regular 3270 screen. HLLAPI provides a customizable graphical interface to the user. Another benefit of using HLLAPI applications is that they can be easily modified to manage changes in contrast to the considerable effort of modifying the host application.

Asynchronous Dial-In Support

A few vendors (Attachmate, Novell) provide asynchronous dial-in support for remote non-LAN–attached 3270 clients, either on the gateway itself or via a LAN-attached communications server. The advantage asynchronous dial-in to a gateway has over synchronous (SDLC) dial-in direct to the SNA network is that, in most cases, a gateway site is closer to the remote client than a site with a communication controller (37x5). The telephone toll charges are therefore less. Also, providing dial-in ports on a communication controller is much more expensive than providing ports for access to a gateway.

3174 Capabilities Not Yet In SNA Gateways

The following capabilities are not all equally desirable. However, most of them will probably be available on various SNA gateways in the next year or so.

- DSPU support via LAN or ISDN connection
- Printer authorization matrix (PAM)
- Between brackets printer sharing
- Intelligent printer data stream (IPDS) support
- Local format storage
- NetView support
- Response-time monitor
- APPN

DSPU support via LAN or ISDN connection

Some gateways, including IBM's, treat their client workstations as downstream physical units (DSPUs). Most do not. Full DSPU support would likely permit the use of downstream SNA gateways.

Printer authorization matrix

On a 3174, the PAM is used to associate display terminals with the printers or printer classes on which they are permitted to perform local-copy printing. Selection of a printer class allows display users to print on the first available printer that satisfies their needs. IBM documentation offers the simple example of "any printer with yellow paper."

A PAM may be specified at 3174 customization time or may be downloaded from the host. In addition to printer [class]/display relationships, it includes specification of printer type—i.e., host only, shared, and local only.

When an SNA gateway is coaxially attached to a 3174, its client workstations may direct local-copy printing to 3174-attached printers under the control of the PAM. For other than a coaxial attachment or, in any case, for LAN or workstation-attached printers, the absence of PAM support might cause problems for some installations. Most gateways do, of course, provide for local-copy printing, but *SNA Perspective* has not identified any that are PAM-compatible.

Between Brackets Printer Sharing

Only a few gateways already provide between brackets printer sharing. On a 3174, this capability applies to printers that are defined as shared. Host printer data streams are batched as work units, each of which corresponds, for example, to a user-requested report. Each work unit is defined as a bracket and is delineated by beginning and ending bracket indicators. Local-copy printing is permitted *between brackets*.

Although today's low-cost printers have eliminated most of the economic arguments for host/local printer sharing, it continues to be a requirement in some installations.

Intelligent Printer Data Stream Support

Graphics and font selection, sizing, orientation, and positioning are commonplace on printers, especially laser printers, used in conjunction with word processing, desktop publishing, and graphics applications on personal computers. IPDS offers the same capability for host-originated data streams. It is a safe bet that the leading vendors of SNA gateways and client workstations will offer this capability within the next year.

Local Format Storage

Actual 3174s provide this only for control unit terminals (CUTs). This is, however, a local restriction and is transparent to CICS, which is the host application subsystem with which local format storage is most commonly used. With the actual 3174, formats must be downloaded after the controller is IMLed (initial microprogram loaded). However, a gateway could be designed to save the formats to disk for subsequent reloading.

NetView Support

The 3174 can be configured as a NetView Entry Point, supporting the monitoring of events and alerts, the tracking of asset information (including Vital Product Data and Extended Vital Product Data), and the downloading of microcode (central site change management). The number of SNA gateway vendors offering NetView Entry Point support is increasing and includes CSI, DCA (OS/2 products only), Novell, and Rabbit Software.

Response-Time Monitor

This tool, which requires code in both the gateway and the client workstations, is important to SNA network administrators. It is the means by which they identify degraded performance and thus plan upgrade and configuration strategies. Most vendors are expected to offer this as a component of their NetView support.

APPN

In March 1991, IBM added both advanced peer-to-peer networking (APPN) end node and network node functionality to the 3174. This allows the 3174 to be a full APPN routing node, providing support for peer topologies and support for client/server applications. In January, though, IBM announced that it will license APPN network node, so gateways in the future may include this capability.

The Future of the 3174 and Gateways

When there is a requirement for nonprogrammable terminals, it is hard to beat the 3174 and its direct competitors. Moreover, there is still nothing like a channel-attached controller for sheer performance.

There is no doubt that market for nonprogrammable terminals is quickly shrinking. With it goes the *need* for the initial primary function of establishment controllers, even though they can also provide gateway functions for LAN-attached PCs. IBM has addressed the need for a low cost, limited connectivity, remote token ring LAN gateway with the 3174 model 90R TokenWay controller. But as a hardware architecture, it cannot compete well with the flexibility, openness, and rapid development of software gateways. The addition of the important remaining 3174 capabilities to these gateways is only a matter of time. Faster LANs coupled with faster server and workstation hardware should soon eliminate the performance advantage of the specialized controller.

SNA Perspective speculates that, although IBM will continue to enhance the 3174, there will be no direct follow-on product to it. IBM will undoubtedly continue to market the 3174 for many years while there is still demand.

Some of the unique 3174 functionality, such as coax terminal support, may be added into a future RS/6000-based product in a communications family started by the new 6611 multiprotocol router. IBM may also add coax terminal support capabilities to the 3172 to replace channel-attached 3174s. This would certainly provide sufficient coax support for the operator terminals in the computer room. The 3172 already provides the token ring LAN connectivity available with the 3174. However, the addition of coax support seems less likely to us, since IBM seems to prefer the 3172 to operate as only a LAN-level interconnect.

It would be a considerable effort for IBM to port some or all of the 3174 microcode from its proprietary processor to either the Intel microprocessor of the 3172 or the RISC processor of the RS/6000. However, this may prove more effective in the long run than continually coding new advances for both IBM's 3174 and gateway products. If 3174 microcode were ported to the 3172, then it would be a short stretch for any PC or communication server with an Intel microprocessor with the appropriate coax or asynchronous cards to then function like a 3174. That might be worth the effort. However, since the 3174 is a reliable technology and can serve users well into this decade, it is unclear when IBM will decide that an alternate solution is necessary.

What does the future hold for the SNA gateway? Besides filling in the remaining pieces of missing 3174 functionality described above, we can look forward to many new features and enhancements. *SNA Perspective* expects to see increased manageability by industry-standard network managers, APPN end node—and perhaps even licensed network node—support, and more support of native Ethernet SNA host connections. And we expect, in the not-too-distant future, 3270 over LU 6.2 on gateways. ■

More PCs than 3270 Terminals Attached to Controllers

Shipments

During 1990, for the first time, more personal computers became attached to 3270 controller ports than 3270 terminals, according to Dataquest, a San Jose, California market research firm (see Table below). The table is based on shipment numbers in the United States, which totalled about 1.3 million.

Devices Attached to 3174-type Controllers
1990 Shipments — United States

Displays and Printers	Type of Device	Displays Only
36%	PCs	45%
35%	3270 displays	44%
4%	LANs	5%
5%	Other (workstation, midrange)	6%
1%	Protocol converter (ASCII)	2%
20%	Printers	
100%		100%
1,300,000	Shipments in units	1,050,000

Note: Columns may not add to totals due to rounding.

Source: Dataquest

The percentage of PCs that appear to host applications as 3270 devices is actually even higher than these numbers indicate, for several reasons. The LAN number in the table counts the number of LANs rather than the number of devices that access the controller across those LANs. Further, these numbers include only devices on controller ports; they do not include devices which access applications other than through controller ports, such as PCs connected directly or LANs with SNA gateways connecting through 3745 communication controllers or 3172 LAN interconnect controllers.

This crossover between PCs and terminals happened in the same year, 1990, in which U.S. shipments of 3270 terminals dropped by an unprecedented 30 percent. Dataquest's preliminary 1991 figures also show a drop, though not as dramatic, in 3270 terminal shipments.

Installed Base

Dataquest also expects that during 1992 PCs will also outnumber 3270 terminals in the installed base of devices attached to controllers. At the end of 1990, just 50 percent of the *installed base* of eight million 3270-appearing devices on controllers were actually 3270 terminals from IBM or vendors of compatible products. ■

IBM Announcements

Router and New SNMP for RS/6000 Unveiled

On January 21, IBM made several strategic announcements related to multiprotocol network routing and distributed network management.

6611 Router

IBM's long-awaited multiprotocol bridge-router, the 6611, is based, as expected, on the RS/6000 architecture. Its functionality is analyzed in this month's *Architect's Corner.* The four-slot model 140 base price is $9,995 while the seven-slot model 170 has a base price of $18,640. Both models are scheduled to ship in June.

AIX NetView/6000

AIX NetView/6000 provides network management for the new router as well as for TCP/IP devices with SNMP agents. These are found extensively in environments such as UNIX and LANs. It also monitors all IP addressable devices.

Significant features include its OSF/Motif-based graphical user interface, a dynamic network discovery and mapping capability, and SNMP fault, performance, and configuration management features. AIX NetView/6000 replaces AIX Network Manager/6000.

Used with AIX NetView Service Point, it provides what IBM terms cooperative network management with NetView. Traps from SNMP agents are filtered and converted to SNA alerts by AIX NetView/6000 and then sent to NetView via AIX NetView Service Point. AIX NetView/6000 can accept commands from NetView and respond back.

This cooperative management is consistent with IBM's SystemView strategy. As OSF's DME technology is delivered, AIX NetView/6000 will be DME conformant.

IBM is working with other vendors so that their products can be managed by AIX NetView/6000, by supporting their SNMP MIBs. These MIBs will be shipped to users with AIX NetView/6000. Companies already participating in this Networking Services Vendor Enablement Program include Chipcom, Fibermux, Hewlett-Packard, Optical Data Systems, Network Equipment Technologies, Proteon, SynOptics Communications, Wellfleet, Xylogics, and Xyplex.

Slated for June availability, the AIX NetView/6000 is composed of two parts. The SNMP Manager license fee is $9,950 and the End User Interface license fee is $4,950.

Licensing APPN Network Node

In its press release on the 6611 and AIX NetView/6000, IBM included the following sentence: "IBM intends to license APPN network node support for use by other manufacturers." When asked, IBM stated that no further information is currently available. This statement of intention (not an official Statement of Direction) was meant to express officially what IBM sources have been openly discussing with users, consultants, and the press for several months.

SNA Perspective believes that IBM has not completed its project planning for developing a source code product nor has the company completed its pricing and marketing structure for it. Because of the importance of APPN (see *SNA Perspective* January 1992), we believe both this issues are receiving attention at the highest levels within IBM's Networking Systems line of business. ■

Architect's Corner

Baby Steps—SNA and Multiprotocol Routing

by Dr. John R. Pickens

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Dateline 21 January 1992

"IBM expands its network software
offerings by introducing the IBM
Multiprotocol Network Program (5648-
016), IBM's first multiprotocol,
multiport, bridge and router
software product supporting the new
IBM 6611..." IBM programming
announcement 292-017.

"IBM intends to license Advanced
Peer-to-Peer Networking (APPN)
network node support for use by
other manufacturers." IBM press
release.

"[Network Equipment Technologies
(N.E.T.) and IBM announce] an
agreement to license IBM's new Data
Link Switching technology to N.E.T."
N.E.T. press release.
```

In last month's *Architect's Corner,* I outlined a four-quadrant model for standards—proprietary/public-domain development on one axis by open/closed availability on the other axis. I ended the discussion with the rhetorical question "In which quadrant will SNA APPN routing emerge?" The wait was surprisingly short. The answer—proprietary-open. Even more interesting was the announcement of another architecture—data link switching.

In this month's column, I'll consider three questions raised by this announcement: How complete is IBM's multiprotocol routing? What will be the impact of open APPN routing? What is data link switching?

IBM's Multiprotocol Bridge/Router

Table 2 summarizes the protocol and feature content of IBM's initial router software release for the 6611 as described in the product announcement. For each routable protocol, both the end system and intermediate system connectivity options are shown. Connectivity for each type of bridging paradigm (source route bridging, transparent bridging, and source route transparent) is also shown. The mapping of SNA data link and NetBIOS/LLC2 to TCP is also shown.

IBM Router Support Matrix

	Ethernet	Token ring	Serial SDLC	Serial-HDLC-Bridge	Serial-PPP	X.25	Frame Relay-SNA	Frame Relay-PPP	DLS-Tunnel TCP
IP End System	●	●	–	–	●	○	–	–	–
IP Route	●	●	–	–	●	●	–	●	–
XNS ES	●	●	–	–	–	–	–	–	–
XNS Route	●	●	–	–	●	○	–	●	–
IPX ES	●	●	–	–	–	–	–	–	–
IPX Route	●	●	–	–	●	○	–	●	–
DECNet ES	●	●	–	–	–	–	–	–	–
DECNet Route	●	●	–	–	●	○	–	●	–
AppleTalk ES	●	●	–	–	–	–	–	–	–
AppleTalk Route	●	●	–	–	●	○	–	●	–
SNA EN	○	●	●	–	–	○	○	–	●
SNA Route	○	○	○	–	○	○	○	○	○
SR Bridge	–	●	–	●	●	–	–	●	–
T Bridge	○	○	–	○	○	–	–	○	–
SRT Bridge	○	○	–	○	○	–	–	○	–
SRTB Bridge	●	●	–	●	●	–	–	–	–
NetBIOS ES	●	●	–	–	–	–	–	–	●

● Supported ○ Not supported – Not applicable

DLS = Data Link Switching
EN = End Node
ES = End System
PPP = Point-to-Point Protocol
SR = Source Route
T = Transparent
SRT = Source Route Transparent
SRTB = 8290-type Bridge

Table 2

On the whole, the router feature content is a solid first step. With routable support for IP, XNS, IPX, DECnet, and AppleTalk, plus support for source route bridging, the product makes a respectable entry into this market. But significant holes exist—some expected, some not.

- No SNA routing (tunnels but no routes). As IBM has been discussing since last fall, the company chose to enter the multiprotocol router market with a product that does not route SNA. Rather, IBM tunnels SDLC and LLC2—the two primary data links for SNA—across TCP sessions. At least a clear direction is given that when SNA routing capability is offered, it will be based upon APPN network node (not subarea PU 4). I'd expect a new release of 6611 software which will include APPN network node sometime before mid-1993.
- Limited Ethernet/802.3 support. No generalized bridging for Ethernet end systems and no SNA data link switching services for Ethernet end systems. Given IBM's push in recent years toward accommodation of Ethernet (and other IEEE 802 standards) within IBM networks, this is surprising.
- Weak SNMP MIB support. Two SNMP MIBs were announced—MIB II and an IBM-proprietary MIB. But MIBs exist for many other functions—bridging, OSPF, DECnet, AppleTalk, token ring interface, Ethernet interface, point-to-point protocool (PPP), etc. Implementation of these MIBs is lacking.
- Weak X.25 support. Only the IP routing function is supported on X.25.
- Weak bridging function. Only token ring source routing is supported. Other than Ethernet-to-Token-ring translation bridging à la 8209, no support exists for Ethernet. No support for transparent bridging (IEEE 802.1D) nor the more recent source route transparent (SRT) extensions. These limitations restrict the applicability of the product's bridging function to existing token ring environments only. As a general mixed media bridge (IEEE 802 LAN, FDDI, etc.), the announced bridge function is sorely lacking.

Open APPN

A year ago, I predicted in this column that APPN network node would remain closed. Unfortunately, I made no caveat about the price of openness (i.e., license fee). Well, on this one, I have to eat my words. APPN is open.

(Editor's Note: We will be cooking up a banquet for our architect, with the main course to be that issue of SNA Perspective, *sliced in strips and sautéed in a white wine sauce.)*

I have a feeling that IBM will see significant interest in APPN network node licensing by communications and router vendors. This is a big step.

Data Link Switching

Data link switching is a tunneling architecture (see Figure 7). SDLC, LLC2, and NetBIOS are currently included. (Look for QLLC/X.25 in the future.) Data link switching basically fulfills one function—to enable transport of SDLC, LLC2, and NetBIOS/LLC2 traffic across IP internets using IP routing. Local termination of LLC2 and SDLC connections is necessary in this scheme because of the increased latency seen in IP routing environments. Local termination, which is not shown explicitly in the

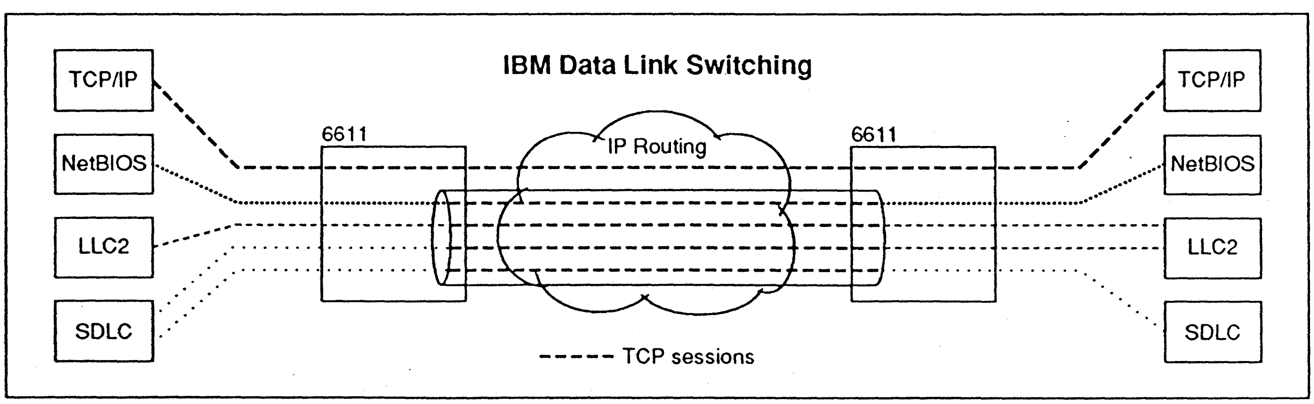

Figure 7

figure, internally terminates the 802.2 layer and locally acknowledges frames—handles the polling for SDLC and the "keep alive" for LLC2.

This keeps the connection timers from expiring. Note, however, that while data link switching can convert SDLC on one end of the tunnel to LLC2 on the other and vice versa, it can only connect NetBIOS traffic on one end to NetBIOS on the other. Further details are unavailable at present.

N.E.T.'s agreement to license data link switching from IBM hints that data link switching, like APPN, will be an open, proprietary architecture. I expect IBM to open data link switching. If this does occur, it will be in the context of other router vendors' tunneling schemes, which are not only proprietary but closed. It will be interesting to see whether, because of IBM's data link switching, these other vendors choose to open their schemes ("I'd rather fight than switch") or accept IBM's scheme as a *de facto* standard. The coming months will be interesting from the perspective of multivendor politics.

Conclusion

IBM's multiprotocol router, open APPN, and data link switching services are now on the playing field. Despite holes, weaknesses, and questions about detail, these moves represent credible steps and will ultimately benefit users, both by encouraging multivendor interoperability and by further justifying the needs and advantages of multiprotocol routing. By opening APPN network node, IBM has taken a big step toward eliminating the confusion between APPN and subarea SNA routing. Baby steps and big steps. ■

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