Connectivity: The IBM Way

Overview

Coming up with ways to make IBM computers talk to other IBM computers and non-IBM computers for that matter is quickly shaping up to be one of the great challenges of the late 20th century. Next to deciphering IBM data communications philosophies, other 20th century discoveries were measly by comparison. Unlocking the secrets of the atom, for instance, was a laughable challenge. Uncovering the human genetic code contained in DNA was a yawner.

Building new architectures that will permit its products to talk to one another has been no less a challenge for IBM. For the past couple years IBM has been addressing problems of its incompatible processor lines, incompatible architectures, incompatible operating systems, and diverse marketing strategies. IBM has responded to these interconnectivity challenges by throwing acronyms at them. First there was SNA, followed more recently by LU6.2, also known as APPC, DDM, and SAA. IBM's most recent addition to the list is SAA or Systems Application Architecture, which is supposed to solve problems created by some other famous IBM acronyms like MVS/SP, SSP, and DOS, all incompatible operating environments. Most of the issues addressed by these communications offerings focus on one area: connectivity, surely the computer industry buzzword for the late 1980s. It's certainly on the minds of the IBM user community. In a recent Datapro survey, in fact, *Datapro 70* subscribers surveyed said micro-to-mainframe connection issues were their No. 1 area of interest.

Connectivity is surely an area of top interest among IBMers, particularly since it may be having an impact on IBM's sagging bottom line. For two years running, IBM earnings were down. In the 1986 IBM annual report, IBM placed much of the blame for the poor showing on disappointing mid-range processor sales. To improve its confused mini and supermini situation, IBM has been pelting the market with hundreds of hardware/software offerings in this segment. System/36 and System/38-related announcements at the National Computer Conference in June 1986, for instance, marked one of the biggest announcement barrages in IBM's history. At the show, IBM announced products designed to make it easier for IBM S/3X users to access System/370 and IBM PC environments. The October 1986 announcement of the new 9370 line added to the confusion, although initial response to the new 370-compatible supermini has been encouraging for IBM. The 9370 was announced to bring the System/370 operating environment to the departmental level and address basic architectural incompatibility problems of the System/36 departmental mini. Finally, IBM announced in April the Personal System/2 (PS/2), a new generation of personal computers that is destined to play a big role in distributed processing within large corporate environments. A key indication of this role is contained in the new PC operating system, Operating System/2 (OS/2), which will accommodate much larger PC memories, an advanced relational data base system, intersystem communications, connectivity, and terminal emulation. OS/2 will come in two packages delivered at different times, OS/2 Standard Edition and OS/2 Extended Edition. OS/2 Standard Edition, which will not contain communications and data base support, will be generally available by first-quarter 1988. Users interested in communications support will have to wait for OS/2 Extended Edition. IBM said Extended Edition availability information will not be announced until fourth-quarter 1987.

Many of IBM's problems at the mid-range level have been exacerbated by the crafty folks at Digital Equipment Corporation, currently riding high atop the success of the VAX line and the DECnet connecting architecture. While IBM people are figuring out how to make incompatible mid-range computers talk to each other, Digital already offers highly regarded departmental products that are fully compatible. For instance, the 11 VAX 8000 system models introduced since January 1986 all use a common I/O architecture, run the same operating system, and connect to the same peripherals. Digital's communications product, DECnet, supports both IBM's SNA communications protocols and ISO Open Systems Interconnect (OSI) protocols. This lets Digital products feel at home in multivendor environments, particularly IBM environments. And unlike ▷

In the old days, companies like IBM could sell computers by bragging about their phenomenal price/performance. But nowadays it takes good connections. Specifically, users are demanding that computers from a single vendor, as well as products from different vendors, be able to talk to one another. Within the last couple years, IBM has tried to respond to these demands with dozens of connectivity products. If successful, such products will make it possible for IBM's diverse lines of personal computers, minis, superminis, and mainframes to talk to one another. Ultimately, IBM hopes to achieve a unified product strategy. All this is easier said than done, of course, especially when one considers the utter size of the IBM hardware base and the variety of incompatible products IBM offers. To make sense of IBM's new connectivity offerings—if that's possible—Datapro has prepared a new report. The report examines IBM's new statement of direction regarding connectivity and reviews many of the major connectivity products. The article reviews IBM's strategies based on revelations announced to date and analyzes product offerings for PC-to-mainframe links, mini-to-mainframe links, and connectivity in the multivendor environment. For additional information on some of the topics covered in this report, also refer to *Datapro Reports on Data Communications* and *Datapro Reports on PC Communications.*

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IBM's many offerings for interconnecting hardware and software applications, Digital offers one transparent system interface for all its products. DECnet has been called one of the most advanced networking architectures around and a system that's available now. IBM users, on the other hand, will have to wait for IBM to respond to the Digital challenge with a single unifying product of its own. IBM people are currently telling users the IBM solution will be well worth the wait. The solution may well be the newly unveiled SAA in addition to elements of LU6.2, which will both be examined a bit later.

It Started with SNA

IBM's strategic communications product for the last 13 years has been Structured Network Architecture or SNA, a layered architecture that defines how information is shared and transported among IBM products. Since IBM continues to be the dominant force in the mainframe world, it's not surprising that SNA is now the dominant networking standard and the *de facto* standard for data communications. Other vendors that hope to compete in multivendor environments, by necessity, offer products supporting SNA protocols and gateways.

When SNA was introduced in 1974, it outlined a primarily hierarchical communications approach typically between centralized mainframes and dumb terminals. Gradually, the nature of the computing universe is beginning to change. While the mainframe is still king in many large organizations, computing power is becoming less centralized. The concept of departmental computing and the proliferation of intelligent desktop systems has brought computing power to the end-user level. In many instances, MIS departments have encouraged the trend towards end-user computing to help reduce the programming backlog. Whether planned or otherwise, as a leading seller of personal computers, IBM itself has done more than perhaps any single vendor to encourage the idea of distributed processing. Just as it has done in other computing fields, IBM has made the IBM PC the standard for others to follow, if only because it has sold so many.

The allure of distributed computing has created a demand among end users for peer-to-peer communications among intelligent distributed systems that takes advantage of the native intelligence of PCs, workstations, and departmental machines. This, in turn, has created immense problems for IBM and its imposing SNA networking standard. Fortunately, SNA is a living, breathing standard that's adaptable to change. In response to industry trends, IBM has been moving SNA to a concept called SNA/Low Entry Networking (LEN). The concept will let vast networks of PCs and departmental systems communicate on a peer-to-peer basis without having to go through a System/370 host and related communications equipment. Much of this approach is based on LU (logical unit) 6.2 and PU (physical unit) 2.1. LU6.2 is often used interchangeably with Advanced Program-to-Program Communication (APPC). In the world of SNA, a logical unit can be an end user accessing the system through a terminal or it can be an application program. A PU represents a single device within the network. Users taking advantage of the LU6.2 protocol will communicate with other personal computers or workstations or minis on the network to access common applications without passing through a host. The protocol together with PU2.1 brings PCs within the mainstream of processing and allows programs to talk to each other as equals. The LU6.2 protocol will make peer-to-peer communications possible between PCs and System/36s or 38s and 370 mainframes. LU6.2 was the first step away from the otherwise hierarchical framework that long characterized SNA, a long-standing user complaint.

LU6.2 could also be the beginning of a solution to the micro-to-mainframe link problem. Up to now, most PCs trying to communicate with an IBM 370 host have had to pretend to be 3270 "dumb" terminals, since System/370 machines were primarily designed to only recognize interaction from 3270-type devices. When PC users running a spread-sheet program like Lotus 1-2-3 found it necessary to access a mainframe data base for spread-sheet data, third-party vendors led by Digital Communications Associates (DCA) have obliged with hundreds of 3270 emulation products that allow PCs to download and upload mainframe data. DCA, marketer of the famous Irma board, currently leads the market. While the 3270 emulation approach continues to be the most basic way to access mainframe data, it's considered inefficient at best. PC users are forced to conform to the screen-by-screen transfer approach of 3270-type communication. This approach becomes particularly problematic when multiple PCs conduct file transfers while emulating 3270s. The central mainframe sitting in the middle of all this can get sluggish and could even be brought down.

IBM brought an added dimension to the LU6.2 APPC standard with the announcement of the Token-Ring Network in 1985 and subsequent enhancements announced through 1986. The token-ring uses a new version of APPC called Advanced Program-to-Program Communications for the IBM Personal Computer (APPC/PC). The product provides an SNA APPC application programming interface to the network and allows for program-to-program communications over the Token-Ring Network and synchronous data link control (SDLC) links. (SDLC is the standard SNA protocol for implementing synchronous communications paths.) IBM's long-anticipated Token-Ring Network also provides still another way to link PCs, and System/36 departmental computers to System/370 host applications. IBM PC users on the ring can access System/370 host applications through an IBM 3725 Communications Controller directly attached to the network. System/36 computers attach to the Token-Ring using a dedicated IBM PC AT equipped with an IBM Token-Ring Network PC Adapter II card. Besides IBM connectivity, IBM has assured users that the Token Ring Network uses an open architecture that will permit non-IBM devices to attach to the Token Ring. (The earlier IBM PC Network, a broadband local area network introduced in 1984 for interconnecting IBM PCs, is now positioned as a departmental LAN, while the Token Ring is being called an "enterprise-wide" LAN.)

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IBM Rolls Out SAA

While IBM offerings let users access data and share resources among its varied product lines, they don't fully overcome problems arising from incompatible machines using incompatible architectures. For this problem, IBM has come up with still another solution called Systems Application Architecture (SAA). According to IBM, SAA will be a new framework for developing applications that will work on all of IBM's varied hardware and software operating environments spanning the IBM PC, System/36 and 38, 9370, and 4381 minis and supermins, and 3090 mainframes. It will mean programmers can write applications for one system architecture, such as the System/36 and be assured that the application will run on a 3090 mainframe or PC. With the announcement of the IBM PS/2 personal computer line, IBM revealed the new OS/2 PC operating system will be the first participant in SAA.

Announced PC support is surely a step in the right direction, but don't expect SAA to solve application development problems by tomorrow or even next week. Similar to SNA, first unveiled in 1974, IBM assured customers that SAA would be a constantly evolving product. For the moment, SAA is less a product than a statement of direction. It currently consists of four elements: a Common Programming Interface, Common Communications Support, Common User Access, and Common Applications. To implement this architecture in any meaningful way will take several years and the writing of many lines of new code overlaid on top of existing communications products.

Common User Access defines end-user interfaces used within SAA applications and environments. Common Programming Interface identifies common standard languages including Cobol, Fortran, and C. It also identifies a procedure language based on the existing REXX language; a data base interface based on ANSI-defined SQL X3.135 and IBM's SQL; a query interface based on Query Management Facility; a presentation interface based on Graphical Data Display Manager; an applications generator based on elements of Cross System Products interfaces; and a dialogue interface based on extensions to the interface found in EZ-VU.

Common Communications Support will include the LU6.2 protocol, PU Type 2.1 nodes, X.25 protocol, SDLC, the IBM Token-Ring Network, Document Interchange Architecture (DIA), SNA Network Management Architecture, 3270 Data Stream, Document Content Architecture, Intelligent Printer Data Stream, and SNA Distribution Services (SNADS).

IBM System/36 and System/38 Connectivity

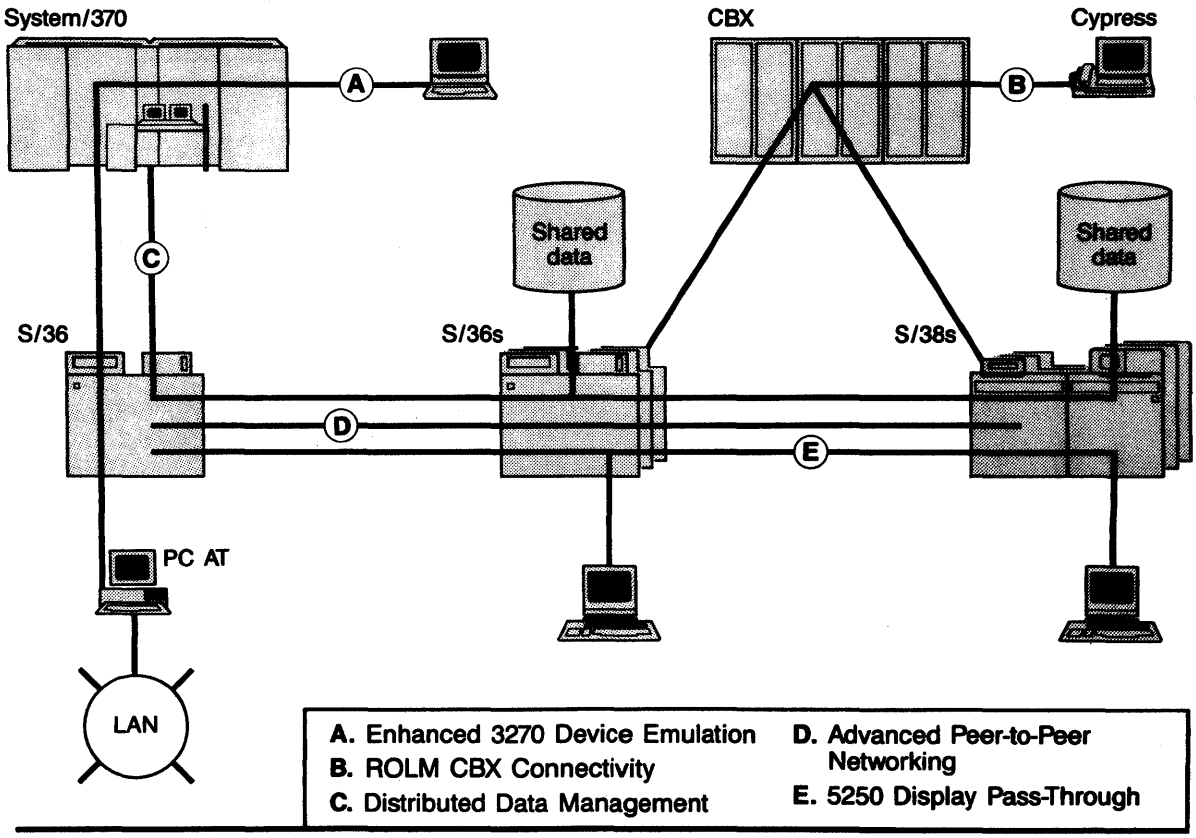

Figure 1. This IBM-prepared drawing describes how new mid-range connectivity products announced last year connect S/3X processors with S/370 mainframes and IBM PCs.

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The fourth area, Common Applications, outlines IBM's plans to develop common applications among SAA environments. IBM will focus first on office applications and later on industry-specific applications. IBM is also encouraging software vendors and users to develop applications using SAA products. Areas being defined in this category now include document creation, document library, personal services and mail, and decision support.

Since it will take a while before SAA is implemented in any meaningful way, IBM users will have to contend with dozens of strategic IBM connectivity products that are available now. As the accompanying charts and tables show, IBM has introduced products tailored for specific environments and hardware, while other products are tailored to work in all IBM environments and also link IBM products with non-IBM products. What follows is a rundown of IBM communications products and how they implement specific communications requirements. Specific sections cover micro-to-mainframe connectivity and mini-to-mainframe connectivity. A final section covers IBM in the multivendor environment. This section reviews what IBM has done to make it possible for non-IBM vendors to communicate and interact within IBM environments and vice versa. Table 1, appearing at the end of this report, summarizes major offerings and indicates when they were first announced.

Micro-to-Mainframe Connections

More than any other product, the PC has helped to distribute computing power throughout organizations. Users can now carry out many business and scientific functions using intelligent PC workstations equipped with powerful software tools. When this desktop intelligence became available, users found they could be less dependent on the corporate mainframe. Of course, users were soon to discover that such sophisticated tools did not make them *independent* of the mainframe. Many users found they still needed to access the vast centralized mainframe data base for useful and up-to-date information. Once they obtained the mainframe data, PC users could manipulate financial and statistic data using spread-sheet packages or could do program development or engineering and design functions at their PCs and intelligent workstations without further burdening the mainframe. This kind of distributed processing fueled the market for mainframe link software and emulation products of every variety. PC users needed products to perform the simple transfer of data from the mainframe and more sophisticated products that could access mainframe files and format the mainframe information in a structure useful to the PC user. Since most computing organizations use IBM mainframes, third-party IBM mainframe link products have naturally been the most numerous on the market.

IBM PC Communications Products

Advanced Program-to-Program Communications for the Personal Computer

IBM Attachment/370+

IBM System/370 to IBM Personal Computer Enhanced Connectivity Facility

IBM Token-Ring Network

IBM PC 3270 Emulation Program, Entry Level

IBM PC 3270 Emulation Program Version 2.0

IBM PC 3270 Emulation Program Version 3.0

NetView/PC

PC/Host File Transfer and Terminal Emulation Program

Server-Requester Programming Interface (SRPI)

Chart 1

Many users trying to access IBM mainframe data are using IBM PCs or one of the many PC clones. When IBM introduced its Personal Computer in 1981, it soon set the standards for PC-level computing in the business world. The almost universal acceptance of the IBM PC in business computing once again made IBM a winner in a newly emerging market, while also unleashing vexing problems dealing with the whole field of data communications and product connectivity. Of course, IBM has a way of turning problems into delicious opportunities. These opportunities may be lurking inside IBM's new line of PS/2 personal computers and later releases of the new OS/2 operating system. Unlike the first generation of IBM PCs, it is abundantly clear that the company plans to make PS/2 and OS/2 the cornerstones of its intrasystem connectivity plans. Its SAA participation will make it easier for programmers to port applications across other IBM systems. Users will also find it easier to share data on different IBM systems using facilities based on SQL.

Products that make it easier to access the mainframe, of course, not only help the micro-to-mainframe user, but ultimately help IBM. For IBM, the mainframe remains the most important product because it brings in the most income. It also remains the center of corporate information residing on vast data bases. Helping to get its products to talk to its mainframe data bases and make use of powerful mainframe resources could only help keep the mainframe at the center of the IBM universe.

Before IBM could truly implement distributed processing environments involving IBM PCs, minis, and mainframes, the giant has had to overcome difficulties with incompatible processor lines and the SNA hierarchical communications structure, two problems that have hindered progress in the connectivity area. In the meantime, IBM has offered dozens of products to circumvent these constraints to implement micro-to-mainframe communications.

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Three Roads to the Mainframe

IBM implements micro-to-mainframe connectivity using three primary approaches: via a collection of 3270 emulation products, through Advanced Program-to-Program Communications products that rely on the LU6.2/PU2.1 protocols, and through the IBM Token-Ring Network, which can also use elements of LU6.2. (Refer to Chart 1 and Table 1.) These connectivity approaches will now be thoroughly incorporated into IBM's new generation of personal computers, the Personal System/2, and the new PC operating system, OS/2, which as noted, will be delivered in stages beginning next year.

Of all the PC-to-mainframe communications options available to date, the terminal emulation approach has proved to be the most popular among users. This approach has been largely dictated by the master/slave communications architecture of IBM's SNA framework. Invariably, the old IBM approach involves a big mainframe at the center of a network populated with dumb terminals. The dumb terminals, such as the ever popular 3278 or 3279, interact with the host through cluster controllers such as the IBM 3274 and the more recent 3174. This hierarchical-type communications architecture means that PC users wishing to access and transfer files from the mainframe have to install an emulation device to make the mainframe "think" it's talking to a 3270 device. Many third-party vendors continue to sell board-level emulation products as well as software to make it possible to download and upload mainframe data. A software component is usually necessary to format the mainframe data in a form that's useful to the PC. IBM 3270 terminal emulation products may be classified as communications-attached or controller attached, depending on the type of terminal they emulate. Popular products such as DCA's Irma and Forte's 3278 and 3279 emulators mimic the operation of cluster terminals and are controller attached. Other products such as pcPath line products from Pathway Design and BlueLynx Remote from Techland are designed to emulate a 3174, 3274, or 3276 and are attached to the host through communications lines.

IBM entered the emulation market with several products of its own. The IBM PC 3270 Emulation Program Version 2.0 provides IBM System/370 host connectivity for PCs attached to the IBM PC Network and the IBM Token-Ring Network using the IBM 3278/3279 Emulation Adapter, the IBM SDLC Adapter, or the IBM Series/1 PC Connect.

The IBM PC 3270 Emulation Program Version 3.0, announced in April 1986, provides additional connectivity options. The new version lets IBM PCs emulate 3270 devices using the Token-Ring Network attached to the IBM 3725 Communications Controller. In this configuration, a PC can be used as a standalone workstation, a network gateway station, or a network station.

When configured as a standalone workstation, an IBM PC using the IBM PC Emulation Program Version 3.0 can emulate the IBM 3274 Control Unit, an IBM 3278 or 3279 Display Station, and an IBM 3287 Printer. In this configuration, each IBM PC appears to the 3725 and the IBM System/370 as a control unit with a display and printer attached. This configuration provides a direct connection via the Token-Ring Network with no intervening gateway station.

When configured as a gateway station on the network, the IBM PC connects to the Token-Ring Network attached to the 3725. The gateway emulates the IBM 3274 Control Unit; emulation of a display and printer is optional. When attached to the gateway, other IBM PCs are configured as display and printer only. Up to 32 sessions can be supported through a gateway station. A session is either a display or a printer, configured and activated on the gateway or network station.

The PC 3270 Emulation Program Version 3.0 gateway station may also be configured to support network stations attached to the PC Network. The gateway station from the PC Network can be attached to the Token-Ring Network for access to the 3725.

A major addition to IBM PC-to-mainframe link offerings emerged in June 1986 when IBM announced the PC Enhanced Connectivity Facilities, which include the Server-Requester Programming Interface (SRPI). The new offerings allow IBM PC users to access host files, disk space, and printing facilities. Additional facilities include virtual disk, virtual file, and virtual print features. The virtual disk facility lets PC users access mainframe disk space to store PC data in PC formats. Virtual file lets users access host files as though they were local files. Virtual print lets PC users direct output to the host printer. SRPI provides a consistent interface for development of applications that require coordination among System/370 hosts and PCs. Menu-driven programs allow PC users to query and extract data from System/370 hosts, transfer files between hosts and PCs, and issue host commands from PCs. PC users can use the products to access Database 2, Structured Query Language/Data System, extracted Data Language/1 data, VSAM files, CMS files, and sequential files. The Enhanced Connectivity Facilities require an S/370 host running MVS/XA with TSO/E or VM/SP. The products work with IBM PCs, XTs, ATs, and the 3270-PCs.

The emulation approach has its obvious problems. To gain access to mainframe level files and data, an intelligent device such as a PC or workstation has to play "dumb" and act as an interactive terminal. Secondly, file transfer programs installed on multiple PCs can bog down cluster controllers and communications controllers that were designed for less burdensome interactive communications. Response time can be slow and overall mainframe performance seriously degraded.

Peer-to-Peer Soon to Appear?

A better approach would be the implementation of peer-to-peer type networks. IBM is trying to move in this direction while people at Digital boast they already have highly workable peer-to-peer solutions contained in DECnet. So-called peer networks support data communications among intelligent machines that may include PCs, workstations,

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supermicros, minicomputers, or mainframes. With the exception of the mainframe, such machines can carry out processing chores at local, departmental, or remote levels. Some devices may be used as file servers or other special purpose in a network. Rather than concentrate computing intelligence within a single large host, the old IBM approach, peer networks composed of many intelligent processing nodes distribute processing throughout an organization.

Moving to a peer-to-peer style approach is surely a big change in direction for IBM, particularly since the long-standing, host-controlled network approach encourages mainframe sales, still IBM's big-ticket product. For instance, when a medium-sized IBM mainframe got bogged down with too many interactive terminal users, IBM's solution was to move the account up to a bigger mainframe. IBM has been moving away from this approach, particularly in the face of competitive pressures from other vendors and complaints from users. In establishing a strategy for distributed processing involving PCs, minis, and mainframes, IBM has been putting much of its muscle behind its LU6.2 peer-to-peer protocol. LU6.2 is slowly emerging as a new standard for implementing distributed peer-to-peer processing. LU6.2 establishes a communications pipeline through SNA, making it possible for intelligent devices such as PCs to communicate directly with other PCs, minis, or mainframes without having to go through a mainframe host.

LU6.2 is independent of the other seven LUs defined by SNA. To understand its new significance in an IBM data communications universe calls for knowing some SNA basics. IBM's SNA, of course, defines the master plan for linking IBM hardware products and sharing resources. It's composed of seven layers that describe different communications functions ranging from basic physical and data link connections all the way up to transaction services. While these various layered functions are important in IBM hierarchical networking, another major aspect of SNA takes on overriding importance in any discussion of LU6.2. This concerns how IBM represents participating devices in an SNA network. Such devices and programs are referred to as *network addressable units (NAU).* NAU types include LUs, PUs, and the System Services Control Point (SSCP). LUs and PUs were defined earlier. In a conventional hierarchical SNA network, the SSCP provides a central point for establishing connections, for route selection, and for controlling information flow. To get where they want to go, PUs and LUs must pass through this centralized SSCP point.

Although a PU represents a physical device, the PU itself is not really a physical device. It's actually a portion of a control program that defines a collection of services that a mainframe or communications device in the network may perform. A PU addition gaining attention for its peer networking capabilities is PU2.1, which is often mentioned in conjunction with LU6.2. A PU2.1 node is significant because it does not have to come under strict SSCP control. Instead, Type 2.1 nodes can establish direct, peer-to-peer communications without mainframe intervention.

SNA communications occur within *sessions* established between NAUs. A session is a logical, two-way connection between two NAUs over a specific route for a specific period of time. While SNA defines sessions that can occur between SSCPs and PUs, LUs, and other SSCPs, LU-to-LU sessions are of immediate concern to this discussion. IBM now defines seven types of sessions between logical units. A given logical unit can participate in only one type of session. This means the names of session types can also be used to identify the type of logical units. Generally, lower-numbered LUs describe very basic communications between relatively unsophisticated terminal devices. An LU2, for instance, describes a session between a host application and an IBM 3270 display terminal. Middle-level sessions describe communications at the applications program level. LU6 describes Intersystem Communications (ISC) sessions between applications programs. LU6.2, a derivative of LU6, defines APPC. LU6.2 or APPC establishes sessions between an applications program in an intelligent terminal, often referred to as a PU2.1 device node, or sessions between two PU2.1s that need not go through a host. While LU6.2 sessions can be supported by many PU types, they are best supported by PU2.1 nodes, since 2.1-type nodes support connection with other PU2.1 nodes in a peer-to-peer relationship in addition to supporting mainframe connections in the standard hierarchical manner.

APPC implemented through LU6.2 and PU2.1 represents the future direction for IBM distributed processing and should alleviate problems associated with inefficient 3270 emulation schemes. For the moment, however, it's far from a universal standard, although more vendors are announc-

IBM Mini Communications Products

Advanced Peer-to-Peer Networking

Advanced Program-to-Program Communication

Distributed Data Management

Enhanced 5250 Emulation Program, Version 2.1

5250 Display Station Pass-Through

IBM 5209 Model 1 3270-5250 Link Protocol Converter

IBM System/36 Local Area Network Token-Ring attachment

IBM 3274 Remote Controller and 3174 Controller

Rolmbridge 5250 Link Protocol Converter

SNA/Low-Entry Networking

Chart 2

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ing support for LU6.2. In the meantime, 3270 emulation will remain popular since it is native to SNA.

A major implementation of LU6.2 involves the IBM Token-Ring Network. With the 1985 announcement of the Token Ring, IBM announced Advanced Program-to-Program Communication for the IBM Personal Computer (APPC/PC), a licensed program that supports LU6.2/PU2.1 program-to-program communications over an IBM Token-Ring Network and SDLC communications links. APPC/PC became available in March 1986. APPC/PC provides a peer-to-peer protocol that supports multiple conversations between applications running an IBM PC and a System/370 running CICS/OS/VS Version 1 Release 7. It also supports the System/36, System/38, Series/1 running Realtime Programming System Version 7.1, or another IBM PC. APPC/PC provides the applications programming interface to allow a user-written program to communicate between sessions on the two links, but does not provide direct connectivity between sessions on the IBM Token-Ring Network link and sessions on the SDLC link.

APPC/PC works with the IBM PC, PC AT, PC XT, and the IBM Portable. For SDLC configurations, hardware should be outfitted with a minimum of 185K bytes of memory. Token-ring only configurations require at least 195K bytes of memory, and SDLC and Token-Ring configurations

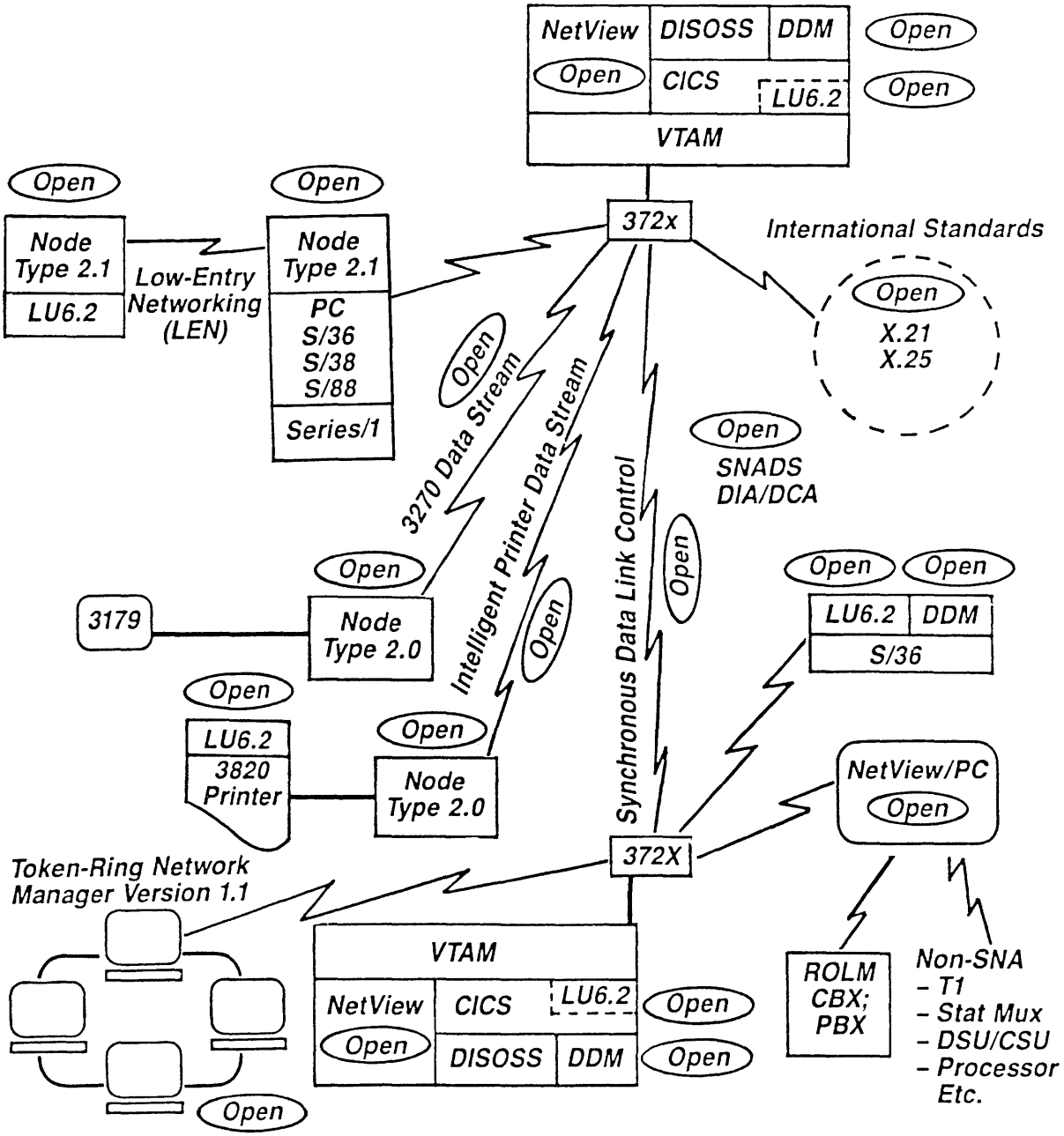

Figure 2. The master framework for IBM recently announced Open Communication Architectures is described in this IBM-prepared illustration.

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require at least 208K bytes of memory. APPC/PC also requires an IBM Token-Ring Network Personal Computer Adapter and adapter handler program or an SDLC adapter. An additional 7K bytes of memory is required for the Token-Ring PC adapter handler program.

The new PS/2 personal computer products together with OS/2 will also support LU6.2 and the Enhanced Connectivity Facilities interface. Additionally, OS/2 will support DFT, SDLC, the IBM Token Ring and PC Network LAN, IBM Netbios, IEEE 802.2 LAN, and asynchronous protocols. Terminal emulation support will include 3270, 3109, and Digital Equipment VT100. New data base management support will be consistent with IBM's DB2 and SQL.

The Mini-to-Mainframe Connection

With the announcement of new PC and supermini hardware that fits into IBM's new connectivity framework, the company hopes to regain much needed momentum in the mid-range market and prop up a badly sagging bottom line. To improve its position here, IBM has been trying to bring a more consistent, unified strategy to bear, a big departure from the way IBM has attacked this area in the past.

Evidence of the old IBM approach is scattered throughout an incompatible mid-range product mix. Products include the System/36 and System/38 departmental systems, the 4361 superminis, the Series/1, the System/88 fault-tolerant system, and now the 9370, a System/370-compatible supermini. In offering so many alternatives, IBM has targeted products to specific market segments, which the company claims has helped customers acquire application-specific solutions at the best price/performance available. While IBM has broken its markets into segments, competitors such as Digital have offered office systems that emphasize product line consistency and networking capabilities.

Faced with pressures from mini vendors and complaints from users concerning incompatible architectures and operating systems, IBM is now pursuing a single product line approach with a vengeance. In the last few years, IBM has announced dozens of system connectivity products to connect IBM PCs and mini products with each other and to connect departmental systems to System/370 host mainframe environments. (Refer to Chart 2 and Table 1.)

In recent years, many of IBM's departmental office system strategies have centered around the System/36 departmental system. The System/36 has long been the major offering for entry-level departmental computing for the non-data processing professional as well as more experienced users. The product line offers hundreds of applications packages for data processing, word processing, and office management. The System/36 can be the departmental host in a PC-based office system configuration. PC users can use the central S/36 host for exchanging information, resource sharing, file storage, and many other functions. The implementation of SNA Low-Entry Networking, the IBM Token-Ring Network, Distributed Data Management, and SAA, all recent IBM connectivity products and directions, will make it easier for users to communicate with other S/36s, S/38, and S/3370 mainframes.

Despite all these products, many users believe the System/36 is just not powerful enough to implement departmental solutions involving PCs. A S/36 already handling office applications may not have the capacity to serve as a host for several attached PCs. The current S/36 product line features a main memory capacity ranging from 128 kilobytes to 7 megabytes, and can handle up to 72 local workstations and up to 64 remote workstations. Additionally, the S/36 uses a processor architecture and operating system that's not consistent with System/370 mainframe environments. A transparent application interface architecture such as SAA would alleviate the incompatibility problems between S/370 systems and S/36s, but it will take some time to implement. Because of these complications, the System/36 is used primarily as a standalone departmental machine for many users.

IBM 9370: The 'Mini-Mainframe'

IBM addressed long-standing user complaints about S/36 with the 1986 announcement of the 9370 "mini-mainframe," a four-model departmental system that extends the traditional S/370-based MIS environment to the office environment. The 9370—really a System/370-compatible supermini—runs under VM/SP, VM/IS, VSE/SP, and IX/370 operating systems (MVS/SP is only offered on the two high-end models). The 9370 features a communications processor and can be attached to the IBM Token Ring and to non-IBM LANs including Ethernet. These connectivity options, in addition to its consistent S/370-style architecture, offer the beginnings of a two-tier networking approach involving architecturally compatible IBM mainframes and 9370 superminis on the top layer connected to IBM PCs and non-IBM hardware at the bottom.

While the 9370 addresses many architectural compatibility issues, it does not appear that IBM plans to abandon its System/36 or 38 users. Recent S/36/38 hardware and software announcements appear to reinforce the view that IBM will continue to support both System/36 connectivity ap-

IBM/Multivendor Communications

Advanced Program-to-Program Communications

API/Communications Service and NetView/PC

Structured Network Architecture (SNA)

IBM Token-Ring Network NETBIOS operating system

Open Communication Architectures

Open Network Management

Systems Application Architecture

Chart 3

Connectivity: The IBM Way

proaches and will also support new 9370 strategies for users who need to access mainframe applications.

IBM dramatically augmented System/36/38 connectivity options with the announcement of new products at the 1986 National Computer Conference. The products let departmental systems communicate with each other, and with System/370 mainframes through the Token-Ring Network, and through Rolm's CBX.

Major mid-range connectivity offerings announced to date include:

- System/36 Advanced Peer-to-Peer Networking
- System/36 Token-Ring connectivity
- The IBM 5250 Display Station Pass-Through
- Distributed Data Management
- The IBM 5209 Model 1 3270-5250 Link Protocol Converter
- The Rolmbridge 5250 Link Protocol Converter
- The IBM 3174 Display Station Controller
- 3270 Device Emulation enhancements
- PC Support/36 enhancements

S/36 Plans Take Shape

Advanced Peer-to-Peer Networking (APPN), now a new feature of the S/36 System Support Program, is the initial implementation of IBM's SNA Low-Entry-Networking (LEN) strategy. APPN allows users to communicate across a network of interconnected System/36s and S/38s on a logical, point-to-point basis without the need for a central SNA host. APPN supports SDLC leased lines, X.25 networks, and the IBM Token-Ring Network. In addition, the System/38 is able to function as an end node in APPN.

The IBM 5250 Display Station Pass-Through function permits users to pass through a System/36 to sign on to a System/38 and use System/38 applications. Distributed Data Management (DDM) provides increased connectivity among the System/36, System/38, and IBM System/370-based processors using IBM's Customer Information Control System/Virtual Storage (CICS/VS). Users can sign on to any system in a network of System/36s and System/38s and have access to data stored anywhere in the network.

The IBM 5209 Model 1 3270-5250 Link Protocol Converter allows IBM 3270 devices to be attached to an IBM System/36 or System/38, either locally or remotely and concurrently to an IBM System/370 host through a 3174/3274 Control Unit. The end user can "hot key" between active display sessions on the IBM System/36 or System/38 and the IBM System/370 host. Users have full access to DisplayWrite/36, Personal Services/36, and Personal Services/38. Installed 3270 users can access IBM System/36 or System/38 applications and IBM System/370 applications from a single workstation.

The Rolmbridge 5250 Link Protocol Converter, jointly developed by IBM and Rolm, is a networking product that supplies switched data connection for asynchronous terminal and printer devices connected through a Rolm CBX II to a System/36 or System/38 host. The 5250 allows asynchronous devices, such as Rolm Desktop products, other asynchronous display terminals, printers, and personal computers with terminal emulation software to appear as 5250 displays and printers. Up to 14 workstations connected to a CBX can be attached simultaneously to System/36s or System/38s by the Rolmbridge 5250.

The new 3174 controller and 3274 remote controller allow 3270-type devices to be used as System/36 displays or to let them pass through a System/36 to a System/370 host. Additionally, IBM 3270 Device Emulation was enhanced to allow an IBM PC or other workstations emulate IBM 3278 or 3279 displays and communicate through a System/36 with larger host systems, such as System/370 mainframes.

System/36s can communicate with other S/36s, IBM PCs, and S/370 systems through the IBM Token-Ring attachment, an option announced in April 1986. Connection to the Token Ring requires an IBM PC AT which is used as a dedicated communications controller for the S/36. Up to two S/36 Token-Ring attachments are supported.

The 9370 Era Begins

As noted earlier, as extensive as the S/36 offerings are the mini processor line does not provide a true migration path to IBM 370 architectures. To address this problem, IBM is now delivering the 9370 line of superminis, thought to be replacements for the old 4361 supermini processor line. The 9370 line is being marketed much like the S/36, but with some fundamental differences. Unlike the S/36, which uses an incompatible SSP operating system, the 9370s operate under System/370, mainframe-style operating systems.

While the 9370 is 370 compatible, the product line is packaged like a typical minicomputer using rack enclosures. A system includes rack-mounted storage and tape devices and integrated communications subsystems. The compact line runs on standard 120/220 VAC power and does not need a computer room environment, making it easy to bring the 9370 into a typical office environment.

Similar to the S/36, operating system software is packaged for the non-DP professional. IBM is calling its VM/IS version of VM/SP the "preferred vehicle" for departmental and end-user computing. The load-and-go style package allows personnel with little DP experience to load the software in minimal time. VM/IS features several optional functions tailored to specific environments such as office professionals, engineering/scientific, program development, relational data bases, networking, and communications.

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In the communications and connectivity area, the 9370 features several controller functions. The Workstation Subsystem Controller lets users attach up to 32 PCs, 3270 terminals, and printers as well as attachment capabilities for OEM devices using the Serial Original Equipment Manufacturer's Interface (SOEMI). The entry-level 9370 system can handle two workstation controllers and the largest processor can handle up to 12 controllers.

The 9370 uses four communications control devices, which include the Telecommunications Subsystem Controller, ASCII Subsystem Controller, IBM Token-Ring Subsystem Controller, and IEEE 802.3 Local Area Network Subsystem Controller. All four subsystems are based on the same communications processor card, plus one or more communications adapter cards and the appropriate microcode for the specific subsystem. The Model 9373 supports up to two of these controllers, the Model 9375 supports up to four, and the 9377 accommodates up to 12.

The Telecommunications Subsystem Controller supports 9370 attachments to public networks and lets users attach to TTC2 display devices. The telecommunications subsystem together with its Multi-Protocol Two-Line Adapter supports TTC2, BSC, SDLC, and HDLC (X.25 Level 2) protocols. According to IBM, the maximum number of lines supported by one Telecommunications Subsystem Controller depends on the combination of protocols and line speeds selected and the number of I/O slots available.

The ASCII Subsystem Controller supports up to 16 ASCII devices operating at 50 bps to 19.2K bps in full-duplex mode either on local lines without modems or on switched and leased communications lines with modems. Three modes of operation—ASCII support, ASCII/3270 conversion, and ASCII/3270 transparent mode—are available. In ASCII mode, all attached ASCII devices appear to software as native devices; this mode is supported by the Unix-based IX/370 operating system.

The IBM Token-Ring Subsystem Controller provides access to a 4M-bps IBM Token-Ring Network compatible with the IEEE 802.5 standard for interconnecting information processing equipment. The network uses the IBM cabling system, including Type 3 specified telephone media for physical interconnection. It employs a token-ring access protocol for network traffic control.

The IEEE 802.3 Local Area Network Subsystem Controller is used for communicating with other 9370 Information Systems, other vendors' systems, and workstations using the IEEE 802.3 standard or the Ethernet local area network. This controller supports a network with a transmission speed of 10M bps using Carrier Sense Multiple Access with Collision Detection (CSMA/CD).

The 9370 can also communicate with a Rolm CBX through a communications processor with an asynchronous adapter connected to a Rolm DataCom Module (DCM) or Data Terminal Interface (DTI).

IBM and Multivendor Communications

It's become something of an industry truism: When IBM introduces a major product such as the IBM PC or announces a new statement of direction such as SAA, an IBM *de facto* standard eventually comes out of it. With a dominant share in most markets it enters, IBM invariably sets the standards for an entire industry to follow. This reality can be a boon for vendors producing compatible IBM systems and more than a major annoyance for vendors trying to compete and coexist in a Big Blue world. Now that much of the talk in the industry has turned to connectivity issues, IBM once again hopes to use its considerable influence to set standards here and control market directions to its advantage. In 1986, IBM put this thinking to work with the announcement of Open Communication Architectures, the cornerstone in its new openness policy. According to this new statement of direction, announced in September 1986, IBM plans to open up many of its key communications architectures and protocols to third parties, making it possible to attach non-IBM systems to IBM networks of host systems. IBM followed this announcement with the October unveiling of the 9370 supermini computer line, which it has positioned as an open system supporting third-party hardware and software efforts. Additionally, IBM delivered more pieces of its Token-Ring Network, which has also been positioned as an open system. Finally, IBM has joined other vendors in supporting the Open Systems Interconnect standard, an international effort for implementing connectivity standards for linking incompatible hardware from various vendors using a standard communications network. With all these announcements, IBM, of course, hopes to play a big role in connectivity issues, bring some new marketing direction to its scattered PC and mid-range offerings, and perhaps stymie the recent marketing success of Digital Equipment. (Refer to Chart 3 and Table 1.)

IBM got off to a strong start in this direction with the Open System Architecture announcement. The products delivered with the announcement will let non-IBM computer equipment, PBXs, and IBM's Token-Ring Network tie into an SNA network management system. IBM backed up this intention with the announcement of NetView/PC, a personal computer version of the System/370 mainframe version of the product providing network management support for these various products. NetView/PC communicates with NetView on the mainframe. Additionally, IBM stated it would further open up its SNA architecture to let vendors and users design and build products that would work on an SNA network. IBM architectures and protocol specifications that will be made available to third parties include LU6.2 and Type2.0 nodes, Type2.1 nodes, LEN, LU2.0 SNA Distributed Services, DIA, DDM, SDLC, the IBM Token-Ring Network, and IBM's implementation of public data network standards, X.21 and X.25.

A key interface in the new open communications architecture is Application Programming Interface/Communications Services (API/CS), which is contained in NetView/

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PC. API/CS will allow third parties and users to design software to link their equipment to an SNA network. NetView/PC also extends support for the DDM and LU6.2 protocols to the PC world. When originally announced in June 1986, DDM was designed to let System/36 and System/38 users access files contained on S/370 systems. The LU6.2 component allows program-to-program communications between NetView/PC contained on an IBM PC XT or AT and a mainframe host running CICS and DDM.

A short time after announcing its new open communications architecture, IBM began to take the lid off its 370 mainframe architecture with the announcement of the 9370 supermini line, a scaled down version of its mainframe architecture. IBM took steps to open up its 370 architecture by making it compatible with non-IBM standard industry interfaces for the first time. Users of the 9370 will be able to access an Ethernet LAN through the processor's communications subsystems. The Ethernet connection will be supported through the Transparent Service Access Facility residing in VM/SP, one of four operating environments available on the 9370. The Serial Original Equipment Manufacturer's Interface (SOEMI) will be available through the 9370 workstation controller. SOEMI can support Multibus and Unibus, making it possible to connect hardware from outside vendors.

On the LAN front, IBM promised to make its Token-Ring Network an open architecture that will accommodate both IBM and non-IBM attaching devices. By encouraging openness, IBM hopes to make its strategic LAN product a universally accepted standard. The Token Ring already conforms to the IEEE 802.5 standard and the European Computer Manufacturers Association (ECMA) Standard 89 for token-ring baseband LANs. To make it possible to attach third-party devices to the Token Ring, IBM has made Texas Instruments an authorized supplier of semiconductor adapter components required to attach non-IBM devices to the Token Ring. The TI TMS380 Token-Ring Local Area Network adapter chip set consists of three processors and two interface chips for mounting on a circuit card.

To make it possible to allow non-IBM systems to talk to IBM systems and vice versa, IBM has thrown its support behind the ISO Open Systems Interconnect. The OSI standard will make it possible to fully connect systems from different manufacturers. For this reason, OSI is expected to become an important national and international standard in the years to come, while IBM's dominant SNA standard is expected to coexist with OSI and continue to remain the major *de facto* standard. By supporting OSI, IBM has acknowledged that many IBM user sites operate as multivendor environments that include products from IBM and companies like Digital, Unisys, Honeywell, and others. While many competing vendors provide gateways to SNA, a number don't. OSI will make it possible for users of both IBM and non-IBM systems to meet on a common ground. Although IBM has endorsed the OSI standard, analysts believe IBM is primarily interested in making it easier for non-IBM users to enter the IBM world rather than the reverse. Is it any wonder why they call IBM Big Blue?

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TABLE 1—IBM Connectivity Rundown: A Brief History

The following chart provides a listing of some recently announced IBM products that play a significant role in connectivity strategies. Products are listed in the order they were originally announced.

PRODUCT	DESCRIPTION
August 1984	
PC Network	Links IBM PCs in broadband local area network.
October 1985	
IBM Token-Ring Network	Local area network that supports attachment of most IBM PCs, industrial computers, Series 1, System/36, and System/370 machines.
IBM Asynchronous Communications Server Program	Lets IBM PCs on Token-Ring Network or PC Network access ASCII applications via switched communications lines.
Advanced Program-to-Program Communication for the IBM PC (APPC/PC)	Provides an SNA APPC (LU6.2, PU2.1) application programming interface for the IBM PC; allows program-to-program communications over Token-Ring Network and SDLC links.
April 1986	
IBM PC 3270 Emulation Program Version 3.0	Enhances 3270 emulation in Token-Ring Network; IBM 3725 Communications Controller can now be directly attached to Token-Ring Network.
May 1986	
PC/Host File Transfer and Terminal Emulation Program	Supports IBM PC communications with an IBM SNA host through an IBM 3708 Network Conversion Unit or an IBM 3710 Network Controller.
IBM Attachment/370+	Allows users to communicate from an IBM PC product with any System/370 mainframe running MVS or VM.
NetView	IBM mainframe network management package that consolidates several previous offerings.
June 1986	
Advanced Peer-to-Peer Networking	Allows users to communicate across a network of interconnected System/36s and System/38s without the need for a central controlling IBM SNA host.
5250 Display Station Pass-Through	Lets users pass through a System/36 to sign onto a System/38 and use System/38 applications.
Distributed Data Management	Permits System/36 users access to data residing on another S/36, S/38, or S/370 processor using CICS/VS.
IBM 3274 Remote Controller and 3174 Controller	Allow 3270 type devices to either be used as System/36 displays or to pass through a S/36 to a S/370 host.
Rolmbridge 5250 Link Protocol Converter	Provides integrated switched data connection between ASCII terminal devices and System/36s and System/38s.

Connectivity: The IBM Way

TABLE 1—IBM Connectivity Rundown: A Brief History (Continued)

PRODUCT	DESCRIPTION
June 1986	
IBM System/370 to IBM Personal Computer Enhanced Connectivity Facilities	Gives PC users access to host files, disk space, and printing facilities on System/370 machines.
Server-Requester Programming Interface (SRPI)	Makes it easier for IBM PCs to extract data and services from IBM System/370 host processors.
September 1986	
Open Communication Architectures	Details IBM plans to publish documentation to allow users to integrate non-SNA and non-IBM network components into an SNA network management environment.
Netview/PC	A collection of packages that extend SNA network management functions to the IBM PCs.
October 1986	
IBM 9370 Information System Processors	Supermini processor line brings System/370 mainframe architecture down to the departmental level.
March 1987	
Systems Application Architecture	Outlines framework for a new architecture that will allow applications written for one IBM hardware environment to be easily transportable to other hardware environments, overcoming hardware and software incompatibilities across strategic IBM product lines.
April 1987	
IBM Personal System/2	New generation of IBM personal computers.
OS/2 Extended Edition	Part of new PS/2 operating system that will contain connectivity and intersystem communications support; IBM has yet to announce a delivery date.