# CORPORATE NETWORKING APPLICATIONS

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Digital connectivity and Integrated Services Digital Network (ISDN) functionalities offer ways to bring new voice, data, and video applications to corporate network users. ISDN virtual private networks allow both small and large corporations to offer these applications to their users. Corporate network telephone users can have station and messaging features that were previously available only to users on the same private branch exchange (PBX). Remote access to centralized computers from personal computers (PCs), and computing resources associated with local area networks (LANs), are now available over digital corporate networks. Videoconferences can be arranged on demand on corporate networks between domestic and international locations. This paper describes current applications of modern corporate networks, and discusses some emerging applications that can be realized by ISDN.

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## Introduction

Corporate networks have been the chief beneficiaries of ISDN. Because these networks were among the first to adopt digital switching, and to use digital private lines or digital virtual network services, their subsequent migration to ISDN generally has been simple. Because corporate networks contain clearly-defined communities of interest for voice, data, and video communications, the locations that should be upgraded to ISDN can be readily identified. In terms of economy and efficiency, corporate networking customers derive readily-identifiable benefits from ISDN applications.

ISDN applications are based on either its out-of-band signaling intelligence or on the 64 Kbps (kilobytes per second) digital transport it provides. ISDN signaling—over a combination of the 64 Kbps D channel of the Primary Rate Interface (PRI) and the Common Channel Signaling System No. 7 (CCS7) implemented in the AT&T network—is

**Panel 1. Terms and Acronyms in This Paper**

| | |
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| ANI | automatic number identification |
| AUDIX | audio information exchange |
| BN/CN | billing number/calling number |
| BRI | Basic Rate Interface |
| CO | central office |
| CPE | customer premises equipment |
| DCP | Digital Communications Protocol |
| DCS | Distributed Communications System |
| DID | direct inward dialed |
| DTE | data terminal equipment |
| FEP | front end processor |
| ISDN | Integrated Services Digital Network |
| LAN | local area network |
| LEC | local exchange carrier |
| MPDM | modular processor data module |
| PBX | private branch exchange |
| PC | personal computer |
| PRI | Primary Rate Interface |
| SDN | software defined network |
| SDDN | software defined data network |
| SNA | Systems Network Architecture (IBM) |

handled by messages transferred between ISDN call endpoints. These messages are used not only by the switches to make the basic call, but also to identify the location or station, the caller, and the answering station and individual. Today, customers use this information about switched calls to provide screening and security applications. ISDN signaling and switch processing together provide dynamic integrated access to the AT&T network. This call-by-call service selection capability available on PRI links is discussed in the paper by Ryva et al. in this issue.[1]

The 64 Kbps digital transport helps several switched digital data applications provide connectivity between personal computers, LANs, and host systems. Furthermore, other applications may be available over pre-ISDN digital networks that are enhanced or more efficient when ISDN is available. These applications are always available on both private line and AT&T's virtual private networks: the software defined network (SDN) and software defined data network (SDDN).

SDDN provides the digital data capability at 56 Kbps and higher in SDN. Data rates of 56 and 64 Kbps are widely available throughout the AT&T network. A 384 Kbps tariff has recently been filed, and a 1.536 megabytes per second (Mbps) tariff will follow. SDDN and voice calls can be made on a call-by-call basis on the same access channel, because their data characteristics are signaled to the AT&T network switch via D-channel signaling. They may also be automatically restored in less than 20 seconds without disturbing the data terminal equipment (DTE) interface when on a separate trunk group classified as SDDN. This is important for Systems Network Architecture (SNA™) applications to maintain cluster controller terminal sessions spanning trunking failures. (SNA is a trademark of International Business Machines, Inc.) SDN network management capabilities such as call screening, flexible routing, and periodic traffic reports, also are supported for SDDN[2]. As discussed in the introduction to this issue, corporate networks often are *hybrids* that mix and match private and virtual network capabilities in the most economical combination. The Definity® Communications System supports all the applications over any combination of private line facilities or SDN/SDDN, allowing customers full flexibility of network architecture.

### Applications Based On ISDN Intelligence

Perhaps the most commonly used ISDN applications are based on calling number or billing number delivery for calls delivered to customer premises equipment (CPE) over an ISDN PRI interface. Billing number [also called automatic number identification (ANI)] is available as an option with AT&T's Megacom® 800 service. This information is the basis for a variety of telemarketing and teleservicing applications described elsewhere this issue.[3] In the corporate network

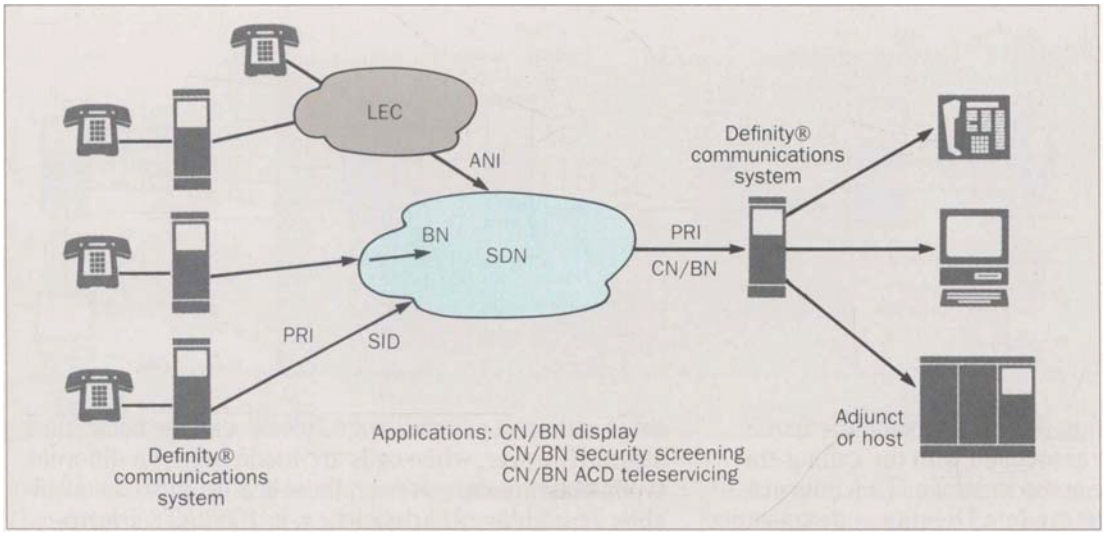


**Figure 1.**
**Calling/billing number delivery applications.**

environment, it is also possible to receive a billing number or calling number (BN/CN) with all calls originating on the corporate software-defined network.

To receive BN/CN, the customer location must have a PRI access to the AT&T network (see Figure 1). For calls from switched access locations, the local exchange carriers (LECs) will deliver the billing number associated with the calling location. This normally is a 10-digit number based on the North American dialing plan. It is transported through the AT&T CCS7 network, converted to a D channel information element in the ISDN setup message at the terminating 4ESS™ switch, and transmitted to the customer premises over PRI. If a location is directly connected to the AT&T service node over voice grade or DS-1 private lines, AT&T generates a 10-digit billing number for the calling location and passes it to the called PRI-connected destination. If the call is from a Definity® telecommunications system directly connected to the AT&T network via PRI, the system sends the 10-digit direct inward dialed (DID) number. Thus, the destination can always have a 10-digit number delivered with each SDN call to identify the caller's location, and in some instances also identify the calling station. (There are several delivery options associated with BN/CN delivery over PRI.)[4] The Definity system then passes the BN/CN information to the digitally-connected endpoint that is the call's destination. Three different protocols may be used for these connections: PRI, Basic Rate Interface (BRI), or the AT&T proprietary Digital Communications Protocol (DCP), AT&T's pre-ISDN station protocol that uses the 2B+D format of BRI.

One obvious application of BN/CN delivery is call screening at a display telephone. BN/CN could also be used in a computer security application where it can be compared to a list of numbers with authorized system access. It could also be used to speed up teleservicing applications. For example, handling calls from corporate locations that report an emergency could be speeded up by extracting information from a database keyed on BN/CN.

When calls are completed between Definity communications systems connected over PRI—or that use PRI to access SDN—it is possible to go beyond passing the calling number. In these cases (see Figure 2), the

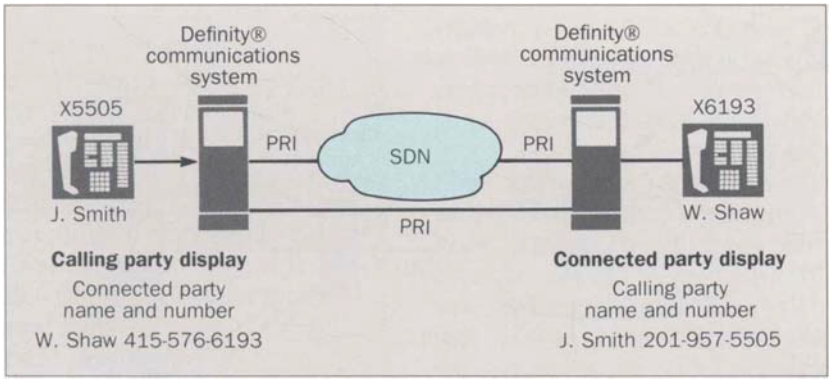


**Figure 2. Name and number display on end-to-end SDN calls.**

Definity system originating the call can send the name and 10-digit DID number associated with the calling station across the PRI in the setup message. This information is then passed by any tandem Definity systems—or by the AT&T CCS7 network—to the Definity system at the called location. When the incoming call is connected, either to the called station or to another station in the coverage path or transfer path, the name and number of the connected station is sent back to the originator.

This delivery capability can be used for the same screening, security, and teleservicing application as with the BN/CN. However, the calling and connected name provides a more convenient basis than BN/CN for visual screening. Access to the calling name makes it unnecessary to remember phone numbers to decide the disposition of the call. The calling parties also know the terminating point of their calls. For example, if someone wants to speak directly to the called party, but sees that the call has gone to coverage and is going to the audio information exchange (AUDIX) voice message system, time can be saved by dropping the call.

In the future, ISDN intelligence will be used in other corporate network applications. For example, ISDN standards are being expanded to include supplementary services. Today a rich set of station and attendant features are available on calls on the same switching system, such as call waiting, automatic callback, and leave-word calling (a pre-packaged "please call me back" message). However, when calls are made between different types of switching systems, these features are not available. To address this deficiency, in 1982 AT&T introduced the Distributed Communications System (DCS). It is available today using a pre-ISDN out-of-band signaling scheme to provide feature transparency between and among System 75, System 85, and the Definity communications systems. In the future, ISDN out-of-band signaling carried over PRI or CCS7 will be able to carry the information necessary to provide the same features for calls over the corporate ISDN that are available today on calls terminated on the same Definity system.

### Switched Digital Data and Video Applications

The user's advantage in switching a data or video application across the AT&T virtual switched network is the reduced cost of bandwidth for applications where full period connectivity is not required, or where additional bandwidth or back-up bandwidth is needed to supplement private line connections. With private networks, the reduced cost benefit extends to full-period connectivity applications, because there can be a significant savings in facility consolidation of data and voice facilities.

ISDN capabilities in both the AT&T network and the Definity switching system extend the applications that can be switched-based on higher speed transport

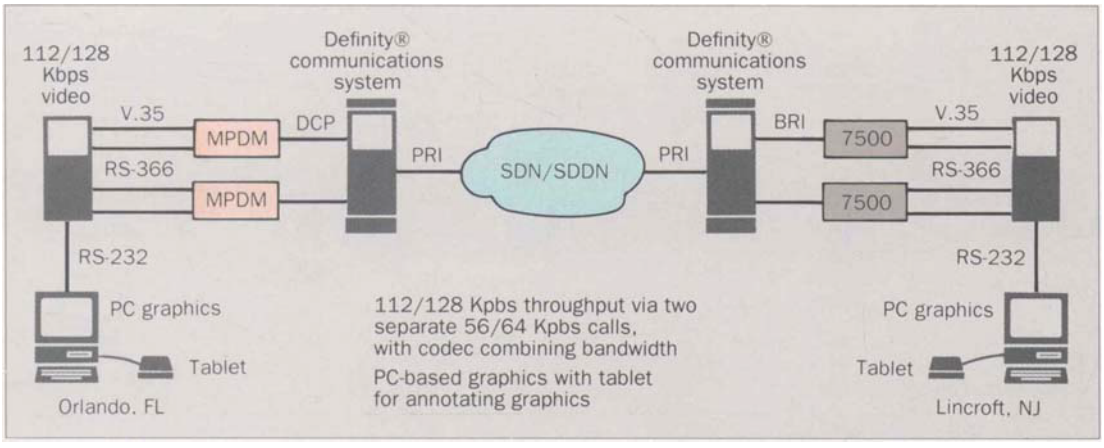


**Figure 3. Switched multimedia teleconferencing over SDN.**

(64 Kbps currently) and ISDN's rich signaling capabilities. These signaling and transport capabilities allow data and video traffic to mix with voice traffic on a call-by-call basis on the DS-1 access facilities to the private or virtual networks, resulting in the lowest possible access cost and inter-node transport costs to the users. The following data and video applications make use of these advantages.

### Switched Videoconferencing

Videoconferencing is a prime example of an application that can fully exploit both private line networks and virtual private networks. Widely dispersed groups of users need to confer with each other on an as-needed basis. Video codecs mix the signals from video, voice, and optional PC graphics—or overhead projector—for viewgraphs into a compressed synchronous data stream. This data stream is transmitted on an external interface, typically using the V.35 standard. Associated with this stream is an out-of-band dialing signal based on the RS-366 standard interface.

Video codec performance usually requires a synchronous signal bandwidth of at least 112 Kbps. This is attained via two separate synchronous signals at 56 Kbps or 64 Kbps, combining the signals in the codec. An example of such a configuration is shown in Figure 3. In that figure, the separate synchronous data and dialing signals terminate on a pair of modular processor data modules (MPDMs) connected to the Definity switch in Orlando, Florida, using the DCP. The remote video codec in Lincroft, New Jersey, is connected via a pair of AT&T ISDN 7500 data modules using the ISDN BRI protocol. This provides a 112 Kbps transport between the codecs, and also fully interworks endpoints behind the DCP and the open BRI interfaces. Users with primary rate access to the AT&T network switch can obtain dynamic access on the T1 bearer channels, with voice and video calls using the same bearer channels on alternate calls. By contrast, users without PRI access to the AT&T network switch must statically provision a trunk subgroup of at least two channels dedicated to switched 56 Kbps data. Users without access to a Definity/System 75/85 switch may be accessed by connecting their codecs to a pair of terminal interface units and then connecting to the AT&T network switch via the Accunet® switched digital service.

### LAN Interconnections

There are three opportunities for LAN synergies with Definity PBXs. LANs are usually interconnected over wide areas with bridges or routers using full-period private facilities. When private switched networks are

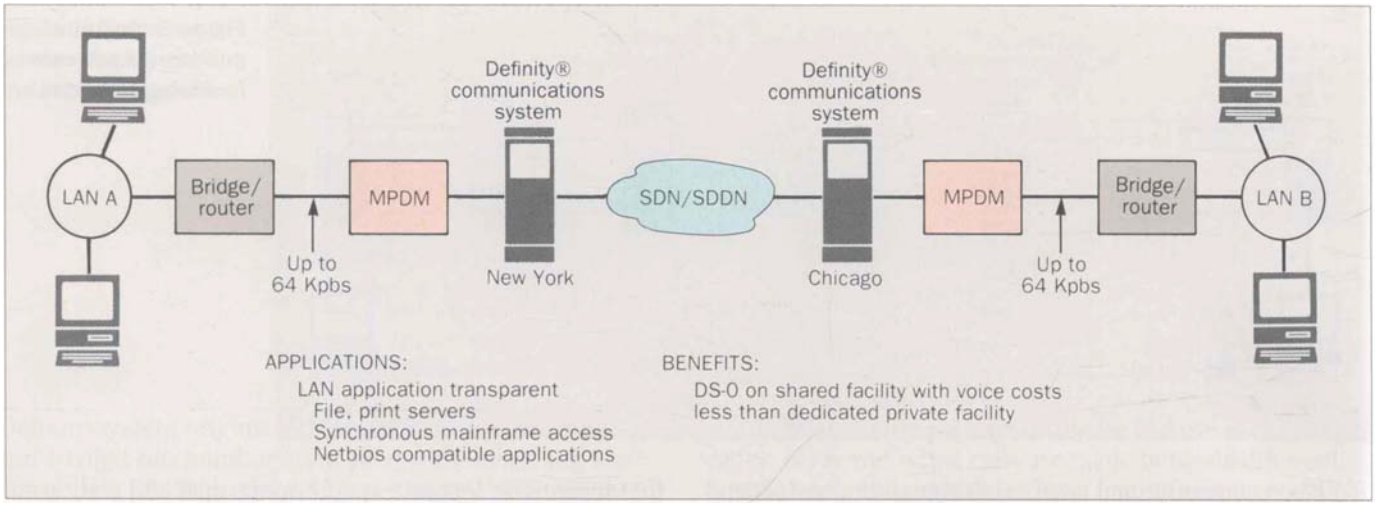


**Figure 4. LAN bridges/routers and SDN/SDDN networks.**



employed, the Definity PBX can provide on-demand bandwidths of 56 or 64 Kbps between the bridges or routers. When switched networks connect the Definity systems, additional bandwidth during peak traffic times—or back-up bandwidth during private facility outage over switched facilities—is a cost-effective alternative to additional private facilities. In either case, the bridge or router signals a bandwidth request to a Definity synchronous data module, either by dialing via an associated RS-366 interface (as with the video codec), or by asserting the data terminal ready lead in the V.35 interface, and having the Definity switch administered to dial a predetermined number. Once the connection is made, the LANs are transparently connected, effectively forming one functional LAN spanning the wide area. The bridges or routers filter all LAN packets so only those destined for the remote LAN travel across the link between them. This configuration is illustrated in Figure 4. The data modules and Definity switch connection, combined with the switched network, offers a low-delay, protocol-transparent connection with low error rates.

A second connection opportunity occurs when users remote from the LAN who wish to obtain occasional access to it and its resources become LAN peer members. Currently, an analog modem at the user's PC is needed to establish an analog public network connection to one of a bank of analog modems connected to a gateway server at the remote LAN. These remote modems are often connected to the analog network via central office (CO) dedicated lines. Critical data transfer rates are limited by the speed of the modems. Higher performance at lower cost can be achieved with the configuration shown in the upper part of Figure 5. Here, users who are located behind Definity switches use an AT&T 7400B asynchronous data module connected to their PC to establish a link at up to 19.2 Kbps via 64 Kbps digital facilities in switched or private networks. They connect to a remote Definity switch where a bank of 7400B data modules replaces the analog modems. This connection is established on a call-by-call basis with voice calls on the PRI facilities. The asynchronous data call is rate-adapted to the 64 Kbps bearer channel on the PRI facility.

This solution is possible only because of ISDN signaling and 64 Kbps data transport, and because the

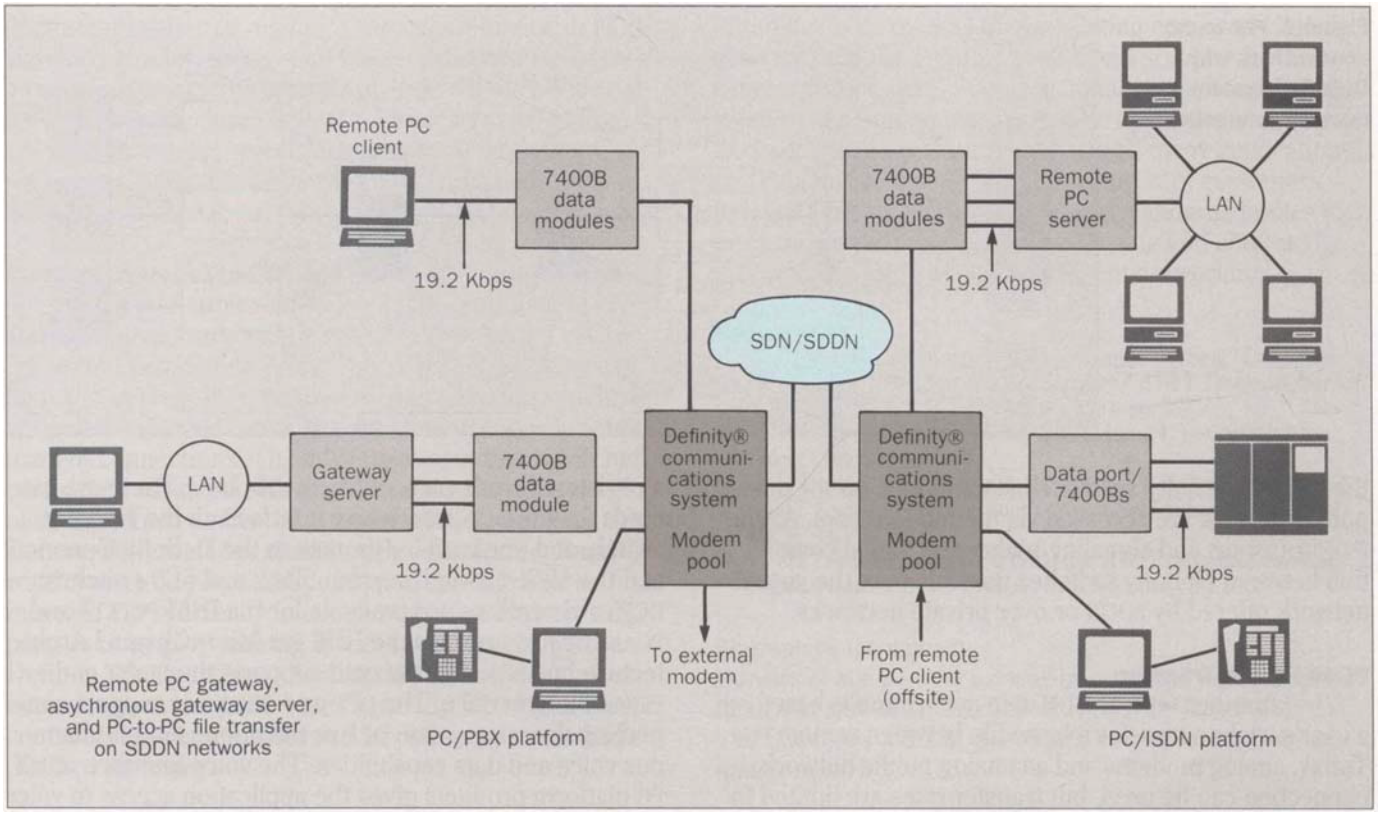


**Figure 5. Remote PC gateway, asynchronous gateway server, and PC-to-PC file transfer on SDDN networks.**

data modules fully emulate the analog modems. This leaves the user's PC packages and LAN gateways undisturbed. Users without access to a Definity PBX can still access the LAN gateway with analog modems dialing into modem pooling facilities on the Definity PBX associated with the LAN gateway. The modem pool converts the analog signal to digital signals. It is a shared resource, providing economies of scale because fewer expensive high-speed analog modems are used and dedicated CO access lines are avoided.

A third LAN opportunity arises to connect LAN users to remote asynchronous hosts. Currently, analog modems and dedicated CO trunks are used, with the same limitations on transfer rate and cost penalties as when dialing into remote LANs. The middle part of Figure 5 shows the alternate solution. The LAN user employs a terminal emulation package and a LAN asynchronous gateway to connect to a remote host via a bank of 7400B data modules that replace the analog modems. The dedicated CO lines are again replaced by digital ports on the Definity switch. Digital links over 64 Kbps bearer channels in DS-1 facilities interconnect the user at up to 19.2 Kbps to mating digital data modules in a hunt group at

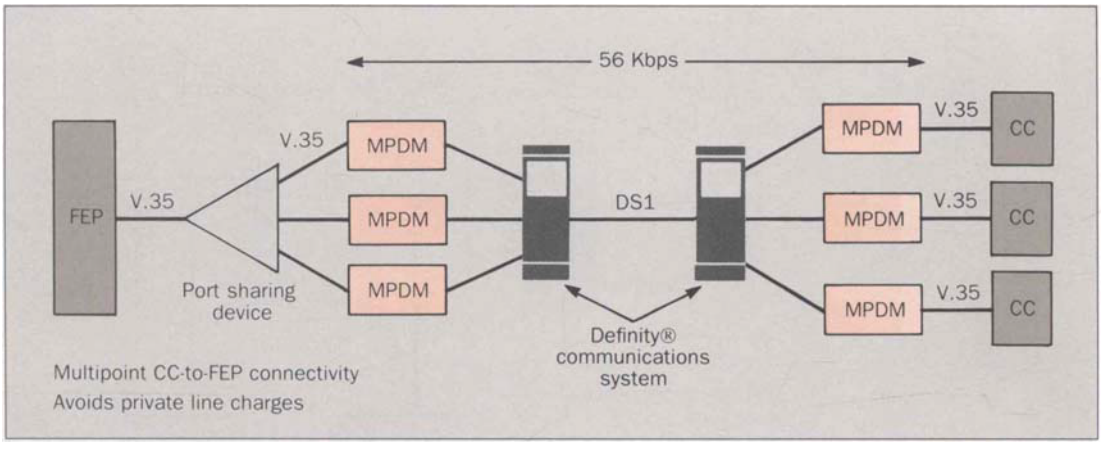


**Figure 6. FEP-to-CC connectivity with Definity® system permanent connections.**

the remote Definity switch. Host endpoints off the analog public network are accessed via the modem pool. Again, ISDN transport and signaling makes the digital connection between Definity switches possible over the virtual network offered by SDDN or over private networks.



**PC-to-PC File Transfer**

Another type of ISDN data application is based on a user's wish to transfer a large file between remote PCs. Today, analog modems and an analog public network connection can be used, but transfer rates are limited to about 9.6 Kbps. This means a file of about a megabyte might take 20 minutes to transfer. If the two users are members of LANs whose community of interest justifies a pair of LAN bridges and a dedicated private facility between them, transport time is no longer an issue. However, this solution is expensive when such a community of interest does not exist. An alternative solution for users with Definity PBXs and ISDN transport employs the AT&T PC platform products and a software package from an independent software vendor.

AT&T offers three PC platform cards for PCs running the MS-DOS® operating system, all having a common application interface available to software vendors developing write voice and data applications. (MS-DOS is a registered trademark of Microsoft, Inc.) There are two cards for the DCP proprietary interface on the Definity switch, and one card for the BRI on the Definity Generic 2 and the 5ESS® switch version 5E4.2 and 5E5 switches. DCP card versions are available for the IBM PC/XT® and PC/AT bus PCs and for the IBM PS2 MicroChannel Architecture bus PCs. The BRI card supports the PC/XT and PC/AT bus interface. The DCP and BRI cards support connecting the appropriate DCP or BRI phone for simultaneous voice and data capabilities. The voice interface on all PC platform products gives the application access to voice call management services and provides a high level interface to either the DCP or BRI protocols. The application accesses the voice interface via C-language library functions. The data interface is called the Expanded Interrupt 14 Interface. The application uses it to access data call management and data transfer services for both the bearer and signaling channels. The data interface is command-oriented and uses DOS BIOS Interrupt 14H.

Many applications vendors have chosen to port applications to the PC platforms. One in particular provides adaptive file compression via a proprietary protocol. When combined with ISDN 64 Kbps transport, it provides a net throughput of 64 to 120 Kbps over a 64 Kbps bearer facility. This is enough to send a 500 Kb

document in about a minute. When combined with ISDN signaling to allow call-by-call voice or data transport over a virtual network, this permits the 500 Kb file to be sent between PCs for about 20 cents. The lower part of Figure 5 illustrates this configuration. It will work equally well over private networks where 64 Kbps bearer channels are available.

### Cluster Controller-to-FEP and FEP-to-FEP Connections

Cluster controller-to-front end processor (FEP) and FEP-to-FEP connections are usually obtained over full-period private line links. The same connections can be made in Definity private networks by using synchronous data modules connected by administratively set permanent connections. The advantage of using a switched permanent connection is that the customer does not need additional dedicated private facilities, but uses time slots on DS-1 facilities shared with voice traffic. Bandwidths up to 64 Kbps can be supported. One way to increase FEP efficiency in using expensive high speed ports is to employ sharing devices on them, using the Definity private network to concentrate remote cluster controllers on the ports (see Figure 6). Up to four cluster controllers at remote sites can be connected to a single 56 Kbps FEP port.

### Conclusion

The Definity communications system and the AT&T network together provide a rich set of end-to-end applications that use ISDN intelligence and digital transport. ISDN is an overlay to the existing corporate digital network, and the Definity switch and SDN provide an easy migration path. ISDN functionality can be added one location at a time to match specific user needs for voice, data and video applications. Although many applications are available today, AT&T is working with customers, independent software vendors, and standards bodies to keep the stream of applications flowing and continually increase the value of ISDN intelligent networking.

### References


1. G. J. Ryva, B. T. Howard, J. A. Newell, and J. H. Sun, "Corporate Networking: Evolution and Architecture," *AT&T Technical Journal*, Vol. 70, No. 5, September/October 1991, pp. 2–13.
2. *SDDN Users Applications Guide*, AT&T, Issue 1, December 1990, Select Code 533-501-163.
3. D. E. Harvey, S. M. Hogan, J. Y. Payseur, "Call Center Solutions," *AT&T Technical Journal*, Vol. 70, No. 5, September/October 1991, pp. 36–44.
4. AT&T Technical Reference TR 41459, *AT&T Integrated Services Digital Network (ISDN) Primary Rate Interface*, July 1990.


Biographies (continued)

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*(Manuscript received April 8, 1991)*