ISDN DATA NETWORKING APPLICATIONS IN THE CORPORATE ENVIRONMENT

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(continued on page 120)

The introduction of the Integrated Services Digital Network (ISDN) into the public switched network holds the promise of combining multiple data networks and voice applications into a single, integrated digital network. This paper shows how these promises have been turned into reality at the headquarters of the McDonald's Corporation in Oak Brook, Illinois. ISDN service to McDonald's is provided by Illinois Bell Telephone via a central office implementation of the AT&T 5E4(2) software generic on the AT&T 5ESS® switch. Applications running on multiple data networks have been integrated into ISDN, resulting in improved performance and increased flexibility for the end user. This paper describes how these existing data networks have been integrated into ISDN and discusses the advantages of an ISDN network.

Introduction

In the fall of 1984, the McDonald's Corporation wanted state-of-the-art technology for their voice and data networks. At that time, the corporate Home Office, located in Oak Brook, Illinois, consisted of multiple buildings in a campus setting; the three primary locations were: the existing Home Office (The Plaza), the Lodge, and Hamburger University.® McDonald's was also planning to open a new Home Office in 1988. This new building (now completed and occupied) was to be the essence of McDonald's, i.e., a relaxed campus setting with the latest architectural designs, facilities, and a communications system with growth potential into the 21st century.

The Lodge and Hamburger University (and the new Home Office site) are approximately 1.5 miles from the Plaza building. Within this environment, McDonald's had over 15 separate voice and data networks that were becoming increasingly difficult and expensive to manage. (See Figure 1.) As a leader in their own field, McDonald's wanted a leading-edge technology to integrate numerous voice and data

Panel 1. Terms and Acronyms in This Paper

AMI	alternate mark inversion
ASCII	American Standard Code for Information Interchange
B channel	bearer channel
BRI	basic rate interface
CCITT	International Telegraph and Telephone Consultative Committee
CPE	customer-premises equipment
D channel	data channel
DMI Mode 2	digital multiplexed interface Mode 2 protocol
DSL	digital subscriber line
DTE	data terminating equipment
FAX	facsimile
FEP	front-end processor
ISDN	Integrated Services Digital Network
LAN	local-area network
LAPB	link access procedure for the B channel
LAPD	link access procedure for the D channel
NPSI	network packet switched interface
NT1	network termination Type 1
OA	office automation
PAD	packet assembler/disassembler
PBX	private-branch exchange
PC	personal computer
PRI	primary rate interface
RFP	request for proposals
RFS	remote file sharing
RJE	remote job entry
RTS/CTS	request-to-send/clear-to-send
SNA™*	systems network architecture
TA	terminal adapter
TCP/IP	transmission control protocol/internet protocol
TTY	teletypewriter
VTAM	virtual telecommunications access method
WATS	wide-area telecommunications service

* Trademark of IBM Corporation

networks into a single, manageable network. With these ideas in mind, McDonald's issued a request for proposals (RFP) in the fall of 1984. (Panel 1 is a list of terms and acronyms in this paper.)

At the same time, AT&T Network Systems (AT&T-NS) and Illinois Bell Telephone (IBT) were completing negotiations for a joint introduction of the nation's first ISDN—an open network, based on international standards as defined by the International Telegraph and Telephone Consultative Committee (CCITT),[1] that provides for the integration of voice and data on existing twisted-pair copper wiring.[2]

IBT responded to McDonald's RFP with a central-office-based ISDN proposal to integrate McDonald's multiple voice and data networks into a single information-transport network based on the evolving international standards for ISDN. ISDN offered the control and flexibility necessary to meet McDonald's evolving communication needs; in addition, the day-to-day job of operating, maintaining, and administering the network could be left to IBT. Furthermore, with open interfaces, McDonald's could have multiple, customer-premises equipment (CPE) vendors and a wide selection of equipment at a competitive cost.

Based on a competitive bidding process, McDonald's selected the IBT ISDN as the proposal with the best telecommunications network to meet their diverse and demanding requirements. This decision was based on the functionality provided by ISDN, the open, standard interfaces into the ISDN, and the economics derived from a single network to replace the multiple, existing voice and data networks.

The IBT central-office-based ISDN solution allows the separate McDonald's buildings to be integrated into a single telecommunications network easily. Additionally, an AT&T-NS network management system called NetPartner™ gives McDonald's the ability to monitor their ISDN network from a terminal on premises. With the NetPartner system, they can also test ISDN lines, check translations on ISDN or analog lines, change translations on either ISDN or analog lines, and file trouble reports with IBT maintenance personnel. With this system,

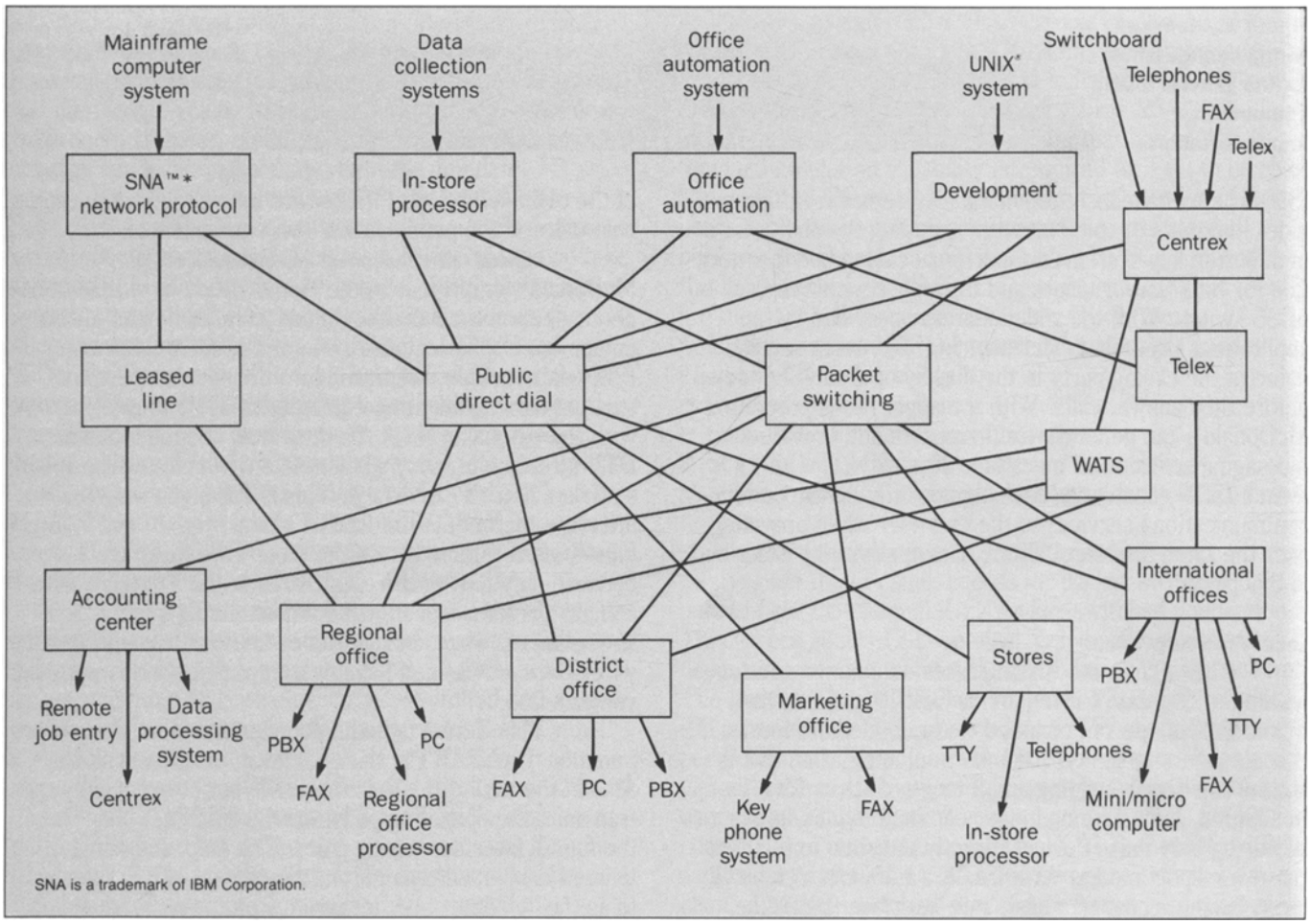

Figure 1. The communications systems of McDonald's Corporation before the implementation of the Integrated Systems Digital Network (ISDN).

McDonald's can concentrate on what they do best—selling high-quality fast food—while leaving the day-to-day operations and maintenance of a telecommunications network to IBT, a corporation with a long history of providing and maintaining reliable telecommunications service.

The partnership between McDonald's, IBT, and AT&T-NS has provided McDonald's with the first, fully functional, ISDN communications network in the nation. This network is the foundation of McDonald's information transfer, providing quick and easy access to the information necessary for McDonald's to maintain its leadership in the fast-food industry.

This paper focuses on the details of implementing data applications in an ISDN. It should be remembered that

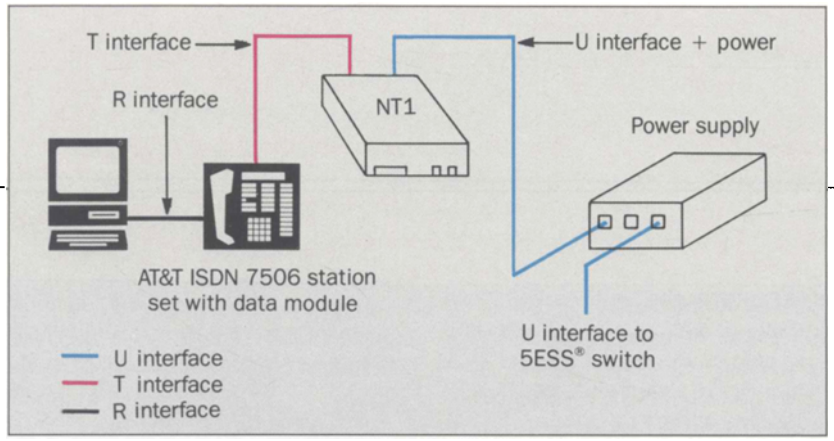

Figure 2. Premises wiring configuration for the general ISDN equipment implementation.

ISDN is simultaneously providing a voice network that provides hundreds of voice features including the ability for a multibutton key system and individual calling line identification for calls that originate and terminate within the same 5ESS switch. With the added features provided by the applications processor, McDonald's ISDN users see the name of the calling party in the display of their ISDN sets before they answer calls. With the applications processor, McDonald's can generate traffic reports and provide a messaging service and electronic directory. The 5ESS switch/ISDN capabilities have significantly enhanced telecommunications services to the end user while providing, over the same interface, all the data applications described in this paper.

Local-Area Networking

Local-area networking takes on a new definition within the context of ISDN. With ISDN, local-area networks (LANs) are not confined to the immediate locale. (Locale refers to the typical LAN implementation that is limited to a single building and a range of about 1500 feet.) In addition, LANs are no longer confined to just data or to accessing only those devices directly attached to the dedicated transport media. With ISDN, a LAN can include all users having access to a basic rate interface (BRI), the standard, open interface into the ISDN network that provides "2 B + D" access [two 64-kilobit per second (kb/s) B channels and one 16-kb/s D channel]. In the 5E4(2) software generic, the LAN function includes all users having access to a single 5ESS switch. As the ISDN capabilities of the 5ESS switch and capabilities of the public networks expand, the concept of local-area networking will merge with the concept of wide-area networking. In the 5E4(2) generic, wide-area networking requires the interworking of the 5ESS switch and ISDN with both the existing analog network and the public packet-switched network.

General ISDN Equipment Implementation. All McDonald's employees in the Home Office have ISDN telephone sets on their desks. Figure 2 shows details of the equipment implementation. The ISDN set will have an ISDN data module integrated into the set that permits existing data terminating equipment (DTE) to interface with the set via an RS-232C interface, the most common DTE interface in today's business environment. The ISDN set has a BRI "T" interface. This is the eight-wire ISDN interface that meets the CCITT standards.[1,3] (The T interface is often referred to as the "four-wire interface" because only four of the eight wires in the T interface are actually used for transmitting and receiving signals from and to the network. In addition to the four transmit/receive wires, two are defined for powering the set and two are as yet undefined.)

This T interface then connects to a network termination Type 1 (NT1) that resides in the wiring closet. Also in the wiring closet is the ISDN set power supply that transmits the operating power to the ISDN set over one of the four T interface wiring pairs. The unloaded, single, twisted copper-wire pair from the central office, referred to as the "U" interface, terminates on the network side of the NT1. (The U interface standard[3] specifies two pairs: one pair for transmit/receive and one pair for future use.) The U interface, a 160-kb/s AMI-coded signal, is terminated at the integrated services line unit on the 5ESS switch and has an effective range of approximately 12 kilofeet (kft). This range is a function of the wiring size and the number and length of any bridge taps.[4]

Each user's ISDN line is typically configured with one B channel for voice, one B channel for circuit-switched

data, and a D channel for signaling and packet-switched data. Each user's voice channel is typically configured for three call appearances (to handle three simultaneous voice calls on a single voice channel), call forwarding, hold, drop, conference, transfer, electronic directory, speed calling, message retrieval, call pickup, and time and date.

Office Automation System. With the introduction of ISDN, McDonald's decided to convert the existing coaxial-based office automation (OA) system to one that could take advantage of ISDN capability—namely, the ability to move users from location to location easily and to access the office automation system via switched ISDN access. McDonald's issued an RFP for a new office automation system to provide the traditional functionality, i.e., word processing, database management, graphics, spreadsheets, electronic mail, time management, etc., as well as the ability to interface to the ISDN. McDonald's selected an AT&T-Business Markets Group (AT&T-BMG) proposal based on AT&T 3B2/600 processors running RFS (remote file sharing) under UNIX® System V, Release 3.1.

The architectural implementation of the office automation system is shown in Figure 3. A McDonald's OA user accesses the OA system via either D-channel X.25 packet switching or B-channel circuit-switched data connections, depending on the BRI configuration. D-channel X.25 packet-switched access will be provided for most users. This access provides end-to-end throughput rates of 9.6 kb/s and is ideal for users who need quick, easy access to the OA system but do not use word processing on a full-time basis. Access to the system for full-time word processing is via B-channel circuit-switched connections operating at 19.2 kb/s. The 19.2-kb/s asynchronous RS-232C signal is rate-adapted to the 64-kb/s B channel by the ISDN set using Digital Multiplexed Interface Mode 2 protocol (DMI Mode 2).[5] In either case, the user accesses the OA system by dialing a four-digit number that is associated with specific ISDN lines on the OA system. The 5ESS switch searches for an open port on the OA system and completes the connection.

End-user DTE consists of either ASCII terminals or PCs. (PCs can be IBM, IBM-compatible, or Apple® Macintosh™ computers.) (ASCII stands for American Standard Code for Information Interchange.) ASCII terminals are connected to the ISDN set via the RS-232C interface. A communications package that has an ASCII terminal-emulation capability is required for PCs to be able to access the OA system. Optionally, a PC version of word processing can be run on the PC and files transferred between the PC and the OA system. The PCs connect to the ISDN set via an RS-232C serial interface. While there are many ASCII terminals and many PC terminal-emulation programs on the market, McDonald's needed equipment with the ability to:

- Process display attributes
- Support a 16-function key interface
- Support ISDN throughput rates of 19.2 kb/s
- Support RTS/CTS (request-to-send/clear-to-send) flow control
- Transfer files between PCs and the OA system.

On the OA side, access for packet-switched data users is via a B-channel X.25 packet-switched connection. This access allows 12 D-channel X.25 packet-switched users to terminate on a single ISDN line at the OA system. The multiple, logical channel support of X.25, up to 15 logical channels per D channel and up to 127 logical channels per B channel, allows for concentration of users onto a single access line. Because of the intermittent activity of each user, up to 12 users, each accessing at 9.6 kb/s, can be concentrated onto a single 64-kb/s X.25 B channel, with satisfactory throughput rates and response times. A D-channel packet-switched user dials a four-digit directory number associated with a specific 3B2/600 processor. The 5ESS switch then searches for an available logical channel on one of the B-channel packet-switched connections on that 3B2/600. Each 3B2/600 is capable of terminating as many as 40 simultaneous users depending on application. Approximately 40 percent of the 3B2/600 ports per each 3B2/600 processor are reserved for circuit-switched data access at 9.6 to 19.2 kb/s. The user concentration ratio for D-channel packet-switched access is typically 12 D-channel

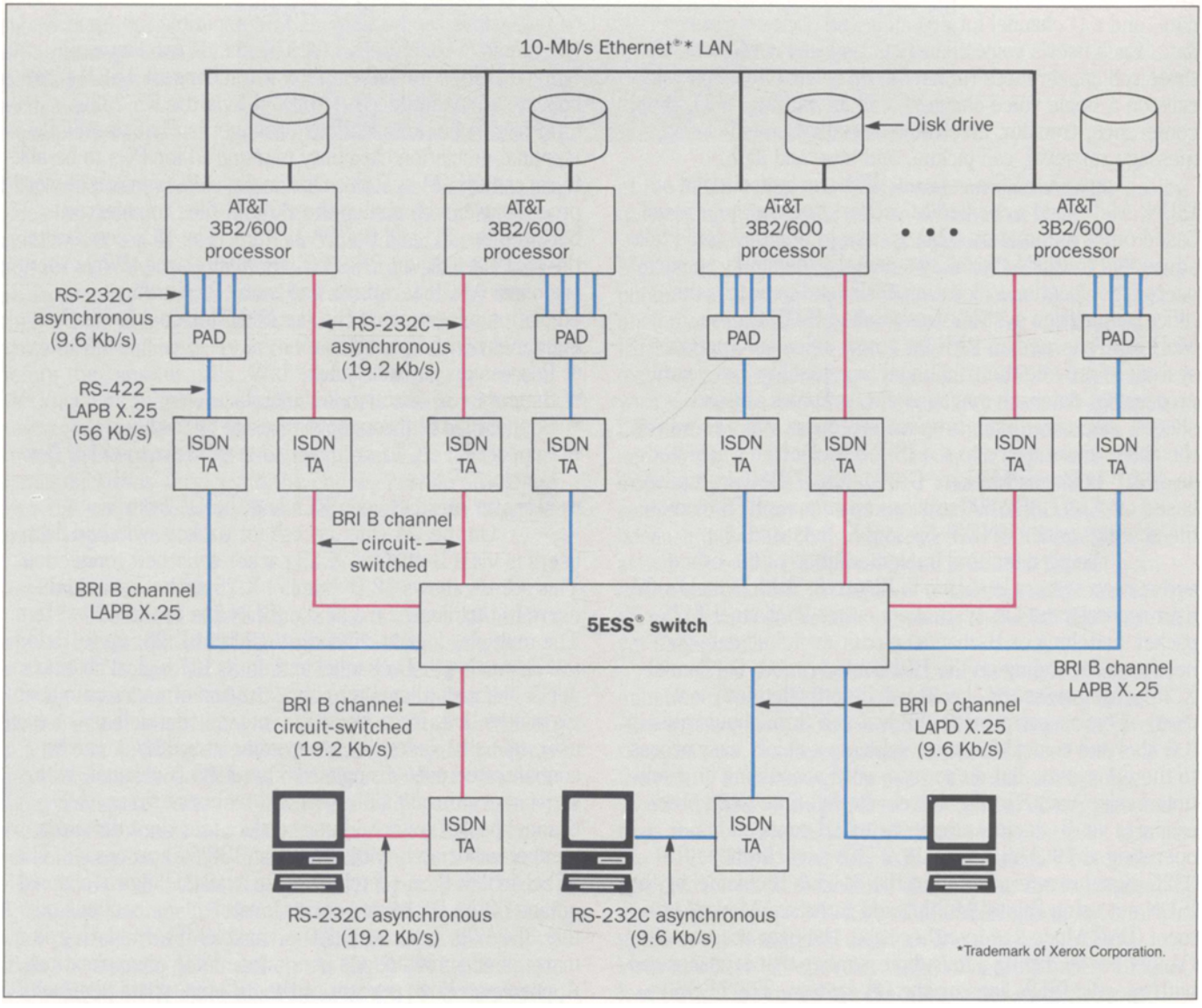

Figure 3. McDonald's office automation (OA) system with ISDN. A McDonald's OA user can access the system via either D-channel X.25 packet switching or B-channel circuit-switched data connections, depending on the BRI configuration.

X.25 users to 1 B-channel X.25 connection.

Circuit-switched access is nearly identical to packet-switched access from a user's perspective. A four-digit number that is associated with a specific 3B2/600 processor is dialed. The 5ESS switch will search for an available B channel on the ISDN lines terminating on that specific 3B2/600 and complete the connection if one is available. Each ISDN line is capable of simultaneously terminating two circuit-switched connections.

Further user concentration is gained by the fact that all users having access to the OA system are not connected simultaneously. Thus, the number of users assigned to a specific 3B2/600 is a function of the number of times per day a user logs on and the length of time a user stays on once they have logged on. This added concentration allows approximately a 3:2 contention ratio per 3B2/600 processor with no blocking or delays encountered.

Easy, quick access to hard-copy output is necessary for a successful office automation system. The printer implementation based on ISDN transport provides OA users with a convenient and effective method of obtaining hard-copy output. Individual laser printers are distributed throughout the office complex such that, on average, no employee is more that 25 feet from a printer. Each printer is connected to the OA system via an ISDN permanent virtual circuit or a B-channel circuit-switched connection. A 9.6-kb/s connection provides hard-copy output at the full rate of the laser printers (8 to 10 pages per minute). The UNIX-based OA system makes it possible to route the OA output to the nearest printer, whether that printer is attached to the same processor that the user is logged onto or is located on another processor. RFS provides the transparent connectivity between 3B2/600 processors.

Other benefits of this OA architecture based on ISDN include:

- Accessing multiple hosts and multiple applications easily
- Moving employees and their equipment from office to office quickly
- Having distributed processing coupled with file-transfer capability.

Access to other applications that reside on different host processors is available simply by dialing the appropriate four-digit address of the desired host. Other McDonald's applications that can be accessed in this way may reside on a Tandem X.25 host, on development hosts running the UNIX operating system, or on IBM systems. These applications are described later in this article.

It is common for employees to be moved from office to office. These moves and changes were time-consuming and costly with a dedicated OA system based on coaxial cable as the transport media. With the ISDN-based OA system, moves are easy. Users need only have their ISDN set and DTE moved to their new location. On arrival, their directory number and feature set can be defined to the ISDN line in their new office via the Net-Partner system. These moves take less than 24 hours (typically, less than 2 hours) as compared to the movement of coaxial cable that can take several days or weeks to plan and coordinate. Upon activation of the ISDN line in a new office, users can immediately access all applications by dialing the same four-digit directory number that is familiar to them. Employees can be moved without long lead times, minimizing losses in productivity.

The OA implementation also allows for easy implementation of distributed processing. A PC version of the office automation system is available that permits office automation documents to be generated and modified on PCs. These documents can then be uploaded from the PC to the OA system for final printing and distribution. Alternatively, files either created or existing on the OA system can be downloaded to the PC for further changes or for off-line storage.

If there is an OA processor failure, users can access backup versions of files by dialing the four-digit directory number of the backup processor where the previous day's backups are stored. Information entered at the time of the failure may be permanently lost, depending upon the type of failure; however, users will still have access, via the backup processor, to the files and information as they existed at the time of the latest backup, which

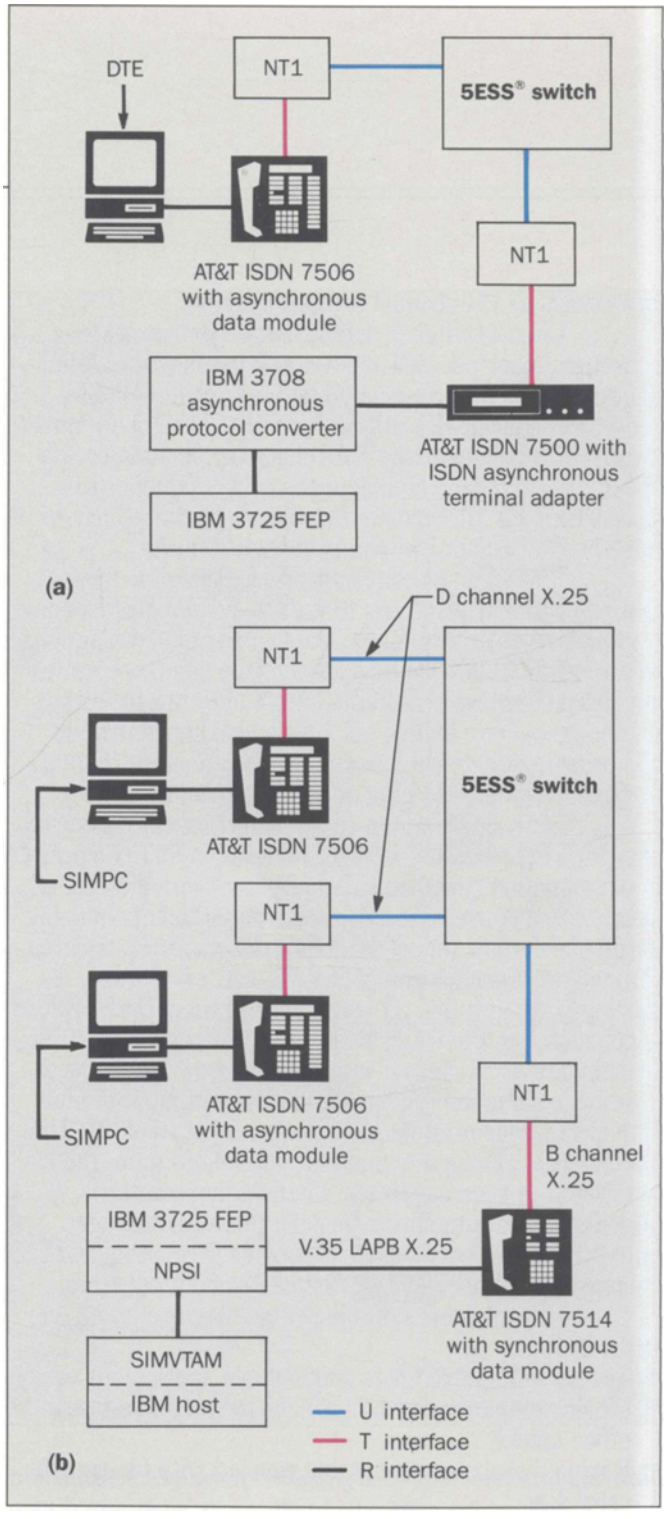

Figure 4. User access to McDonald's IBM host via ISDN. (a) asynchronous access; (b) RS-232C asynchronous access. SIMVTAM = a software package for asynchronous communication via NPSI.

is usually done every 24 hours.

During scheduled maintenance periods, information is not usually lost and access and functionality are transparent to the user. With the combination of RFS and ISDN, users are able to dial the directory number of a backup 3B2/600 in the OA system that has been loaded with backup files and continue with their normal work activities.

Access to IBM Host. To access the McDonald's IBM host via ISDN, users employ one of three methods:

- Asynchronous protocol converter (e.g., IBM 3708 asynchronous protocol converter).
- X.25 transport to IBM front-end processor (FEP) using NPSI software (still in trial stage only) (NPSI stands for network packet switched interface.)
- ISDN terminal adapters (TAs) that eliminate coaxial cable.

Access to the IBM host is via the IBM 3708 asynchronous protocol converter and asynchronous ASCII terminals or PCs running terminal-emulation software packages. Access to the asynchronous protocol converter is via D-channel X.25 packet-switched connections. (See Figure 4a.) A simulated IBM 3278-2 terminal display is presented to the terminal or PC user. With ISDN, users have higher bandwidths [9.6 kb/s versus 1200- or 2400-b/s (bits per second) modems] than with normal asynchronous protocol converter access. They also have easy access to other applications outlined in this article.

SIMWARE of Ottawa, Ontario, Canada provides an IBM VTAM host software package that accepts asynchronous communication via NPSI, the IBM implementation of X.25. (VTAM stands for virtual telecommunications access method.) (See Figure 4b.) SIMWARE's PC communications package called SIMPC™ (and MACSIMPC™ for the Apple Macintosh) provides a

full PC simulation of an IBM 3278-2 terminal. This software has been optimized for X.25 packet networks and is efficient. ISDN again allows the concentration of multiple, D-channel packet-switched users onto a B-channel packet-switched connection to NPSI at the IBM FEP. This application provides an emulation of IBM 3278 terminals and access to IBM networks and applications via the switched ISDN. This implementation provides great flexibility; a PC user can gain access to either the IBM host or the OA system simply by invoking a different PC communications package and dialing a different four-digit directory number.

The third ISDN-implemented access to an IBM host involves the replacement of the coaxial cabling that would normally run from a IBM 3278-2 terminal or a PC 3278-2 terminal-emulation card, such as the IRMA™ card, to an IBM cluster controller. (IRMA is a trademark of Digital Communications Associates.) An ISDN TA takes the 3278-2 SNA™ systems-network protocol and puts it onto a 64-kb/s circuit-switched B channel. (SNA is a trademark of IBM Corporation.) The ISDN TA looks like a cluster controller to the IBM 3278 terminal. The data stream is then switched through the network to a matching ISDN TA at the cluster controller. This ISDN TA appears as an IBM 3278 terminal to the cluster controller. This implementation allows for the elimination of remote cluster controllers and the centralization of all IBM cluster controllers at the IBM host location. This centralization permits greater utilization of the equipment. It also allows the IBM 3278 terminal to be physically located many miles from the local cluster controller. In remote applications where remote cluster controllers are eliminated, user performance improves because each user is connected to the host cluster controller via a 64-kb/s channel, whereas in a remote cluster-controller architecture, several users would be terminating on a remote cluster controller and their signals would be multiplexed across a single leased line at 9.6 to 56 kb/s.

PC Networking. Before the implementation of ISDN, much of the PC-to-PC communication at McDonald's was accomplished by "sneaker net." Sneaker net consists of copying information to be transferred onto a floppy disk and then physically carrying the floppy disks between PC users. With ISDN, PC-to-PC communication is much more efficient because of the increased transfer speeds available on a dial-up basis. Communications packages for MS-DOS® PCs have been available for PC-to-PC file transfer for some time. (MS-DOS is a trademark of Microsoft Corporation.) However, at transfer rates of about 600 b/s, the time required to transfer a large file [50 to 100 kilobytes (kbytes)] was beyond the threshold of acceptability. (600 b/s represents the average throughput on a DOS-PC-to-DOS-PC connection, using a 1200-b/s modem and existing McDonald's PC telecommunications software with the XMODEM file-transfer protocol.) With transfer rates of 9.6 kb/s and 19.2 kb/s on ISDN and file-transfer protocols designed to take advantage of the highly reliable ISDN, the time to transfer a file can be reduced by as much as 50 times. This is because of:

- Increased bandwidth of ISDN as compared to 1200-b/s modems
- More efficient file protocols of new communications packages
- Communications packages that can do real-time file compression/decompression.

Increased bandwidth allows about 10 times the throughput, more efficient protocols account for about 2 times the throughput, and real-time file compression accounts for a throughput improvement of about 1.5 to 3.0 times. (Thus, the total improvement is approximately $10 \times 2 \times 2.5 \cong 50$ times).

At the same time, ISDN makes the connection between PCs easy. The PC-to-PC connection is established on a demand basis by dialing a four-digit directory number. This provides great flexibility for the PC user, who can alternately be connected to another PC or to a host simply by dialing the appropriate four-digit directory number.

The key to PC-to-PC communications on ISDN is a file-transfer protocol that takes advantage of ISDN. Two protocols have been identified for file transfers:

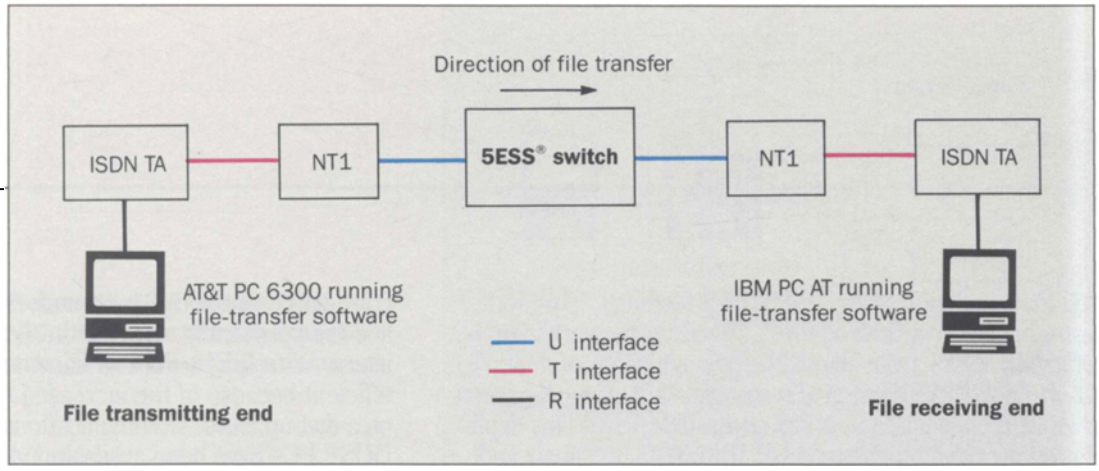

Figure 5. PC-to-PC communications via ISDN offer increased transfer speeds on a dial-up basis.

- YMODEM-G—implemented by Smartcom III™ and QMODEM. (Smartcom III is a trademark of Hayes Microcomputer Products.)
- HyperPROTOCOL™—implemented by HyperAccess.™ (HyperPROTOCOL and HyperAccess are trademarks of Hilgrieve, Inc., Monroe, MI.)

(See Figure 5.) Both YMODEM-G and HyperPROTOCOL provide end-to-end error checking. However, unlike popular transfer protocols such as XMODEM and Kermit, they do not wait for far-end acknowledgment before sending out the next block of data. These protocols inherently assume that data will be transferred error-free. If an error should occur, YMODEM-G identifies it and aborts the transfer; HyperPROTOCOL identifies the block of data with an error and retransmits from the beginning of that block.

In tests on ISDN D-channel X.25 packet-switched connections, YMODEM-G protocol has shown end-to-end throughputs of over 12 kb/s. HyperPROTOCOL, which has built-in, real-time file compression, has demonstrated throughputs ranging from 18 to 35 kb/s, depending on the file being transferred. Binary files are on the low side of the transfer range; text and database files are on the high side of the transfer range.

While communications packages that implement XMODEM (or "XMODEM-like" protocols) and Kermit protocols can be used on ISDN, they do not use the X.25 packet-switched connections efficiently. Throughputs tend to be in the 1.6- to 2.2-kb/s range. While this is better than connections through 1200-b/s modems, it still falls short of what is expected of a 9.6-kb/s connection. The inherent delays of these protocols due to end-to-end error checking and small block sizes (96 to 1024 bytes) result in reduced throughput.

When ISDN PC cards become available (cards that fit into the standard IBM PC XT slot and have a direct ISDN T interface), PC-to-PC file transfer should be routinely available at nearly the full 64 kb/s of the circuit-switched B channel. (Technical demonstrations have shown that a net throughput of 61 kb/s is achievable.) ISDN PC cards will be evaluated for use at McDonald's as they become available. Currently, all PCs are networked into ISDN via the PC serial port connected to the RS-232C asynchronous interface on the ISDN telephone sets. This limits all PC communications to a maximum of 19.2 kb/s. Thus, ISDN PC cards will be evaluated in light of their potential ability to increase transfer rates above those currently achievable with communication packages like HyperAccess running at 19.2 kb/s.

Facsimile. McDonald's uses facsimile (or FAX) systems to communicate with their regional and international offices as well as with their customers and service providers. This FAX network has been based on a CCITT Group III facsimile standard.[6] There is currently a centralized FAX service at McDonald's Home Office building. Since the move to the campus and the new building, the centralized facsimile function has been maintained by transferring FAX information electronically, when available, and via Group IV facsimile[7] when electronic transfer is not possible. This implementation is designed to reduce the amount of paper that is handled and facilitate the flow of information in a quick and responsive manner.

Group IV facsimile provides transfer of information at 56 or 64 kb/s as compared to maximum Group III facsimile rates of 9.6 kb/s. Thus, Group IV facsimile is much faster and provides much higher quality transfer images than Group III facsimile. The FAX implementation

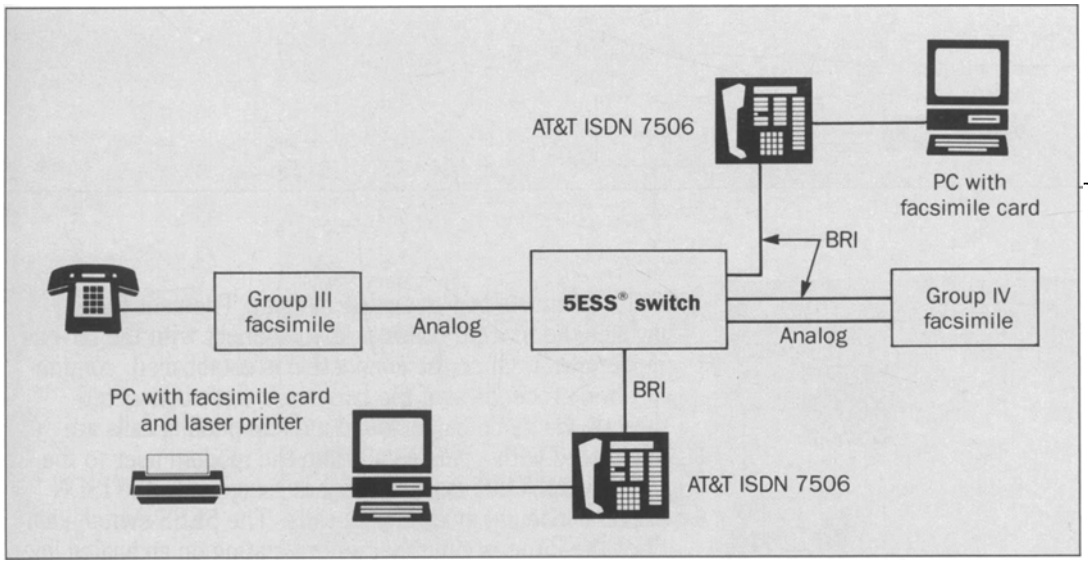

Figure 6. McDonald's facsimile system with ISDN.

is shown in Figure 6. A centralized FAX service from the Plaza building will continue. FAX traffic originating or terminating at the campus can be forwarded to the Plaza FAX service. When FAX information is available in electronic format, such as a document on the OA system, it will be transferred to the Plaza in electronic format. Eventually, this electronic file will be transferred to a PC-based FAX system that will convert the file into a Group III facsimile format and transmit it to the receiving Group III facsimile. With this implementation, information that is stored on PCs or host processors can be transferred via Group III facsimile without the use of paper copies. For information that does not exist in electronic format, paper copies will be transmitted to the Plaza via Group IV facsimile and then sent to the receiver via Group III facsimile.

Inbound Group III facsimile will terminate on the Group IV facsimile machines. The Group IV facsimile machines have dual-interface capability—one interface is a V.35, Group IV standard,[7] and the other an RJ-11 connector supporting Group III standards.

ISDN will support intercampus facsimile at Group IV rates and image qualities. By interworking the electronic information storage, such as in the OA system, with the PC-based facsimile service, the amount of paper handled is expected to decrease significantly. In addition, this implementation allows the continued use of a centralized facsimile service that keeps McDonald's costs and overhead at a minimum.

Electronic Publishing. McDonald's has implemented an electronic publishing system designed by Interleaf Inc. This system is based on an Ethernet TCP/IP network and X.25 gateways. (TCP/IP stands for transmission control protocol/internet protocol.) It also provides RS-232C interfaces to either local or remote devices that support RS-232C interfaces (e.g., ASCII terminals and PCs, including both IBM and IBM-compatibles as well as the Apple Macintosh). This allows ASCII terminal users, PC users, and remote file servers to access the electronic publishing system via circuit-switched or packet-switched connections. (See Figure 7.) Furthermore, users from different McDonald's locations in the Oak Brook area can all have access, via ISDN, to the electronic publishing system. Eventually, Group IV facsimile equipment will be supported as input/output devices using ISDN.

Access to the ISDN from External Locations

While the focus of this article has been on ISDN applications at the McDonald's Home Office, the ISDN implementation goes beyond this. There is full interworking with networks external to the ISDN network. This includes the existing analog network through the use of modem pooling and access to the public packet-switched network.

McDonald's will use both of these interworking capabilities to access their accounting center as well as the regional offices and company-owned stores. The company-owned stores have installed AT&T 6386 computers for collection of sales and inventory information. This information will be transferred on a routine basis to the regional offices and Home Office via X.25. Interworking

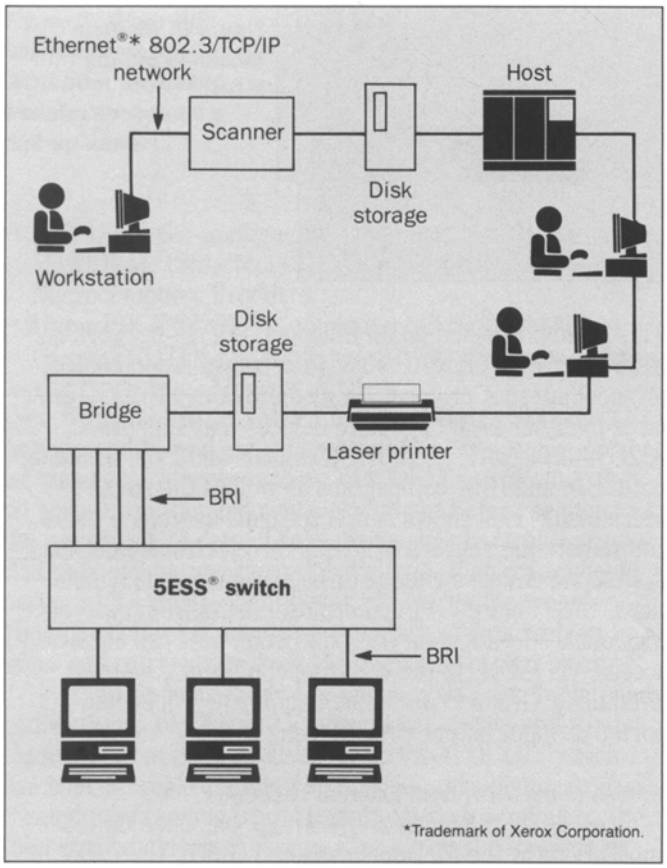

Figure 7. McDonald's corporate electronic publishing system using ISDN.

between the public packet networks and the 5ESS switch will allow flexible interchange of information among all McDonald's locations.

Modem pooling permits ISDN users to exchange information with modem users on the analog telephone network. The 5ESS switch modem-pooling implementation is shown in Figure 8. Outbound calls require a two-stage dialing sequence. An ISDN user first dials the modem pool and is connected to an analog modem. The user then invokes the modem commands to connect with the far-end modem user. Once the connection is established, communication proceeds as if the two users were connected directly via modems. Inbound modem pooling calls are completed with a single call from the modem user to the ISDN user. A directory number is assigned to the ISDN user for inbound modem pool calls. The 5ESS switch identifies the directory number as originating on an analog line and terminating on an ISDN line and automatically routes it through a modem pool that has been assigned for that directory number. This provides analog users with single-stage dialing access to ISDN users as well as to applications residing on host processors that have ISDN connectivity. This type of functionality will allow McDonald's employees to access applications from their homes as well as from remote sites, such as regional offices. However, transfer rates and delays will be a function of the modem speed, which is typically significantly slower than an ISDN-to-ISDN connection.

Other forms of interworking [e.g., switched 56-kb/s digital data service (DDS)] have been successfully tested and demonstrated and may be used where available and economically feasible to provide the connectivity required to support applications at McDonald's, e.g., voice-mail networking.

ISDN for National and International Levels

The initial focus on ISDN applications has been at the McDonald's Home Office in Oak Brook, Illinois. However, as ISDN becomes available in other McDonald's locations throughout the country as well as the world, it is McDonald's intention to consider ISDN for each of these regions, with the eventual goal of a world-wide ISDN network. This goal will be achieved in a steady, orderly fashion.

Initially the regional offices could be integrated into ISDN, either via central-office-based implementations as at the Home Office, or via digital PBXs (private-branch exchanges) that support ISDN standards and interfaces.

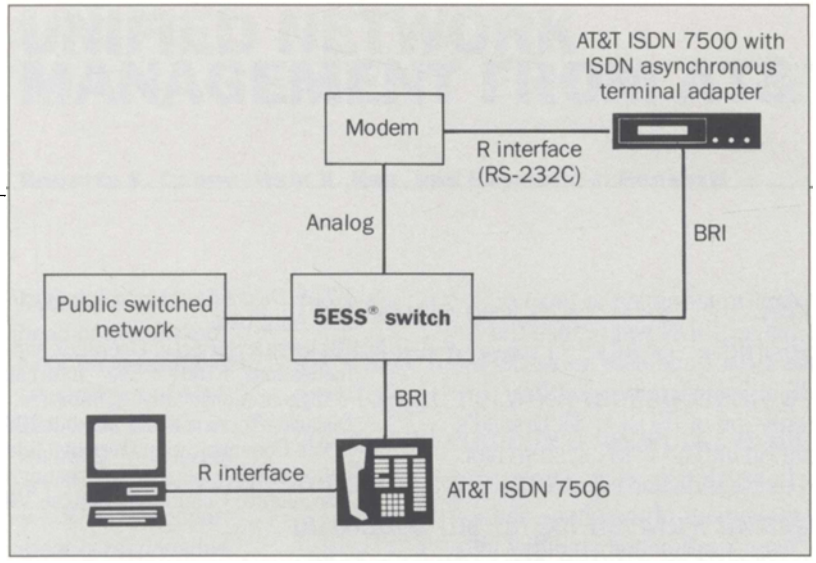

Figure 8. ISDN modem pooling.

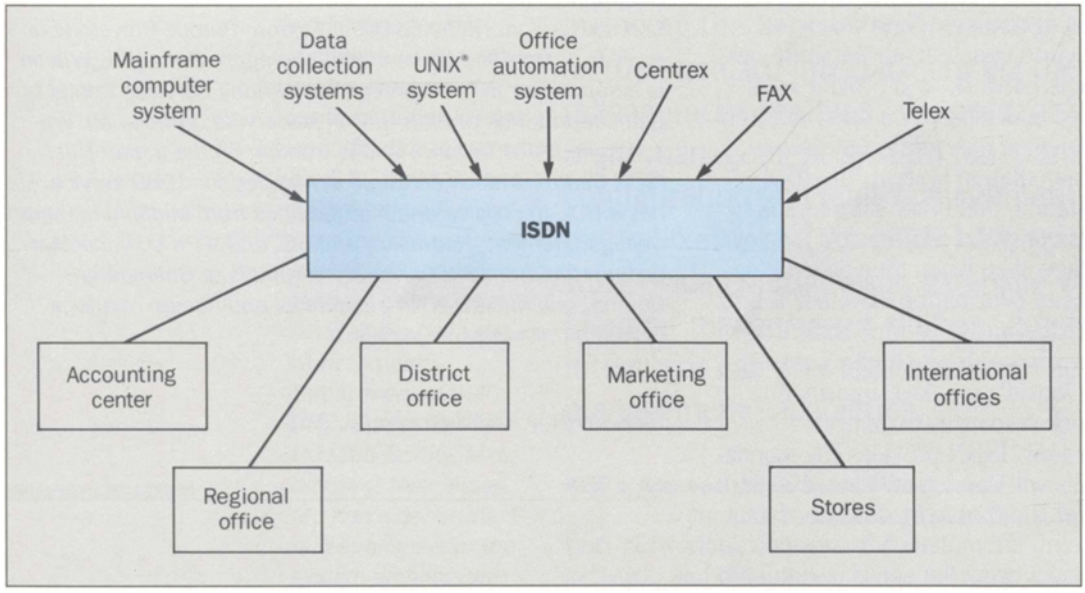

Figure 9. McDonald's integrated communications system. ISDN's single network provides easy access to information stored in databases on many different hosts and applications running on many different processors.

These ISDN implementations will be networked together via ISDN support from the interexchange carriers. With the support of the ISDN primary rate interface (PRI), end-to-end ISDN connectivity can eventually provide highly reliable voice, data, message, and image transfer between McDonald's corporate entities as easily as it does today within McDonald's Home Office. These capabilities include the delivery of calling line identification across the network, as well as voice and data feature transparency across the network.

In the pursuit of this goal, McDonald's Corporation, working with IBT and AT&T, is helping to drive the ISDN standards, both nationally and internationally. The McDonald's network, based on ISDN, will provide economical functionality to McDonald's employees, while providing a showcase for future corporate communications networks.

Summary

The McDonald's Corporation implementation of an Integrated Services Digital Network has provided a sin-

gle network for exchange of information in the form of voice, data, message, and image. ISDN will reduce the complexity of the McDonald's voice and data networks by consolidating most of the 15 individual networks that existed before the implementation of ISDN at McDonald's (see Figure 9). This integration into an ISDN system has made moves and changes a quick and simple process, requiring only the physical movement of the phone and data equipment to the new user location and an entry into the database connected to AT&T's 5ESS switch via a terminal located on McDonald's premises. No rewiring is required, nor is there a need to update many separate network databases. This "single network" can provide easy access to information stored in databases on many different hosts and applications running on many different processors. Access to the office automation system, the IBM hosts, the facsimile workstation, and other PC users is only a call away. This access provides McDonald's employees with the information they need when they need it.

Quick, easy access to information, whether it be voice, data, message, or image, provides McDonald's a competitive edge in their business. In the highly competitive industry of which McDonald's is a part, information transfer is essential for quick responses to an ever-changing business environment. ISDN provides the foundation from which McDonald's will develop an international communications network for the transport of voice, data, message, and image.

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Biographies (continued)

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