Technology Reports

Data Decisions' technology reports are designed to give you the background you need to put your purchase decisions in perspective within the larger information processing picture. They tell you what products can and can't do—and explain how they'll fit into your overall operation. They also tell you what to look for when evaluating and purchasing products and how to install them with a minimum of interruptions and a maximum productivity increase.

The following technology reports include communication concepts and voice systems technology on topics such as PBXs, key/hybrid systems, teleconferencing, and call accounting and distribution systems.

For information on the technology of data communication systems, see the reports following the Technology Reports (400) tab in Volume 1.

Call Accounting Systems

An Introduction to Call Accounting, the Types of Systems Available, Guidelines for System Evaluation & An Overview of the Industry

■ INTRODUCTION

Telephone-related expenses are 1 of top 3 corporate expenditures today. They are also the easiest to manage, because of computer-based call accounting systems. These devices accumulate data in the form of call records, store them in various devices depending on the amount of call traffic expected, and process the data into information that can be effectively used to manage telephone usage. A very active and growing industry has developed around these devices, and this report will examine the basics of call accounting, how the systems work, and takes an in-depth look at the industry. It will also offer guidance on ways to get the greatest benefit from call accounting, as well as how to justify its cost to management.

■ THE NEED FOR CALL ACCOUNTING

Call accounting as a concept is not new. Telephone companies have for years been providing users with printed records of telephone calls, usually long distance. Business and residential users are accustomed to a printout of their toll calls. For residential customers, the basic method of printing out the calls as a list is acceptable, since most residences don't generate anywhere near the number of calls businesses make. However, larger users with hundreds and thousands of users have a much more difficult time determining the origin of a toll call with traditional telephone company billing methods. Since expense associated with long distance is the largest portion of most corporate telephone bills, a means of identifying them is essential for better management.

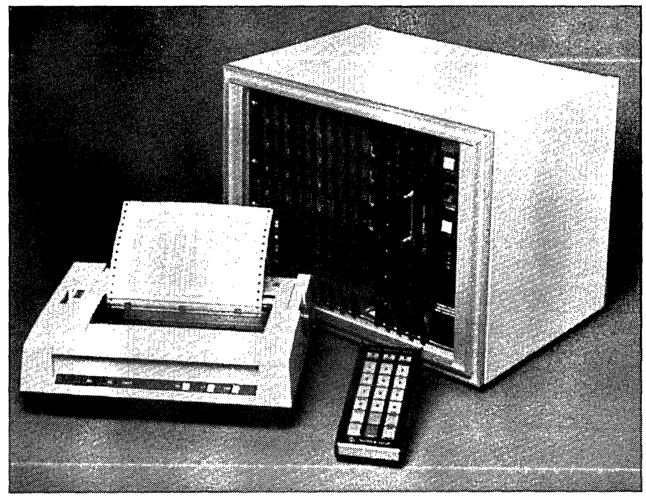
For years, the prevailing attitude toward the corporate telephone bill was simply, "Pay it." No questions asked. However, as telephone bills escalated rapidly during the late 1960s and into the early 1970s, the rubber stamp approach to phone bills no longer worked.

At that time, there were 2 specific ways business users could obtain some degree of outgoing call detail. The first was Centrex, which first appeared in the late 1950s, and features direct inward dialing and automatically identified outward dialing (AIOD). The latter feature generates an individual phone bill for each Centrex extension line, similar to a standard single business or residential line. Only long distance calls are identified, and calls are printed in sequential order. To obtain any overall picture of the corporation's expenses, users at one time had to get pencils and paper and prepare for hours and even days of manual computations to produce a usable document.

The other method of obtaining outgoing call details involved the hotel/motel industry. Arrangements were made with the local operating telephone company to receive a verbal message from telco long distance operators on "time and charges" for any toll calls made by guests. Each guest typically called either the hotel operator (if a manual cordboard-type system) or dialed a special number (if an automatic dial system) before placing a toll call. The guest room was identified, and then the call was placed. As soon as the call was completed, a special long distance operator designated for hotel/motel calling dialed the hotel and reported the time and charges for subsequent billing by the hotel. Frequently, hotels built in a special surcharge on top of the toll charges to boost the house's profits. Another device, still in use today, records the number of local calls made from hotel guest rooms. This unit is a **message registration system**, and typically uses mechanical registers, or counters, to indicate the number of local calls made by the guest.

□ Enter WATS

Wide Area Telecommunications Service first appeared in the



Summa Four MCX-8000

1960s, and achieved an enormously high level of acceptance by the business community. WATS had 2 specific problems: people thought WATS equalled "free telephone calling," and there was no individual call detail available on WATS calls. Of these 2 situations today, the former no longer exists, but the latter still persists. An interesting phenomenon occurred with the proliferation of WATS. Although there was the perception that WATS was saving users money, in reality it was making a fortune for the telephone companies. Phone bills were significantly higher for many companies after they installed WATS; after all, if the service is "free" people will use it. And indeed they did (and still do).

WATS has undergone numerous restructuring since the late 1970s. Today, it is exclusively a **measured rate service**, with a complex pricing scheme. There is no longer a high-priced high-usage version of WATS, such as the 240-hour option, which could cost as much as $1,700 per month. WATS is still, despite all the regulatory gnashing of teeth, the most popular discount long distance service ever offered, and, if properly controlled, can be very cost-effective.

□ Enter The Other Common Carriers

A small company called Microwave Communications, Inc started a revolution in the telecommunications industry by building a private microwave service between Chicago and St. Louis back in the early 1970s. Today, **MCI Corporation** is a multibillion-dollar firm, and the major long distance competition for AT&T. There are numerous other major long distance service providers who compete with AT&T for long distance revenues. Each claims to save more money than AT&T, which is generally true, but keeping track of bills generated by the OCCs can be a cumbersome job, especially in larger organizations.

□ The Divestiture Changes Everything

Once AT&T divested itself of its operating telephone companies, several important changes occurred which have had a tremendous impact on all telecommunication professionals. First,

Call Accounting Systems

life became much more complicated with multiple telephone organizations: one for local service, one for long distance, and several for equipment. Second, costs started rising at a faster rate than in previous years. Although AT&T Communications (the long distance provider) is now able to reduce its rates to become more competitive, costs for local service, which were always subsidized by long distance profits, have risen dramatically. Third, a new element in interstate and intrastate communications has surfaced, called Local Access and Transport Areas, or LATAs. Fourth, increased competition from the newly divested operating telcos and their unregulated equipment subsidiaries has made the whole business of running a telecommunications operation that much more confusing. These and other situations have made accurate information on telecommunications expenses absolutely essential. Call accounting systems fill this need so well that few businesses can do without them today.

☐ Abuse, Misuse, Etc

The telephone is truly a gateway to the world, and people spend millions of their company's dollars each year taking advantage of this capability. Misuse and abuse are 2 areas where telephone expense can be effectively controlled. Misuse implies a lack of information about the proper use of the communications systems, which usually can be corrected with some sort of training or education. Abuse, on the other hand, suggests the intent to use the system incorrectly, or to make calls that are not for business purposes. Calls to one's spouse, friend(s), or other nonbusiness individual **on a regular basis** are considered abuse. Calls to various "Dial-a" services, like Dial-a-Joke, Sports Line, and even the familiar Time and Weather can get abusive if not kept under control. Most typical business phone calls average about 3 to 4 minutes. Calls that are excessively long (usually over 15 minutes) do not necessarily indicate abuse, particularly if used for business purposes, but they could indicate a lack of communication skills on the part of the callers.

Another situation where a method of call tracking is valuable is companies that perform work for specific clients, and that want to charge back all costs associated with a specific client/project. Before call accounting systems were available, about the only way to allocate these costs was to use separate phone lines for each project, since the individual bills would include calls generated for the project in question. Centrex users did essentially the same thing, usually ordering additional Centrex lines for specific projects.

Businesses need timely and accurate information for effective decision making, and this need carries over into telecommunication. As business professionals have come to realize the critical importance of communication to the bottom line, they now acknowledge that telephone call detail makes good business sense.

■ TYPES OF SYSTEMS

Call accounting systems have traditionally been grouped into 1 of 2 categories; active and passive. Systems that simply gather information for subsequent processing into reports are called **passive**. Those which can be programmed to complete outgoing calls over the least-cost trunk line are called **active** machines. This latter group is now represented by only a handful or products, but is expected to prosper from the growth and success of specialized common carriers and resale carriers, who use LCR systems, extensively. Their use with PBX systems is expected to diminish, since PBXs can perform all the functions associated with active call routing systems at a fraction of the cost. In most PBX systems today, call routing is an integral feature, and is used extensively. Passive machines, conversely, are being installed at an ever-increasing rate. This surge of interest in call accounting equipment is the result of several factors, most notably the AT&T divestiture. The increased confusion end users now experience with multiple vendors, LATAs, and the proliferation in equipment has fueled the need for low-cost, yet sophisticated call accounting systems.

☐ Passive Systems

Prior to the development of a PBX software feature called **Station Message Detail Recording**, passive call accounting systems were connected to PBX station lines and trunk lines. The connection was, and still is, made by tapping onto each station/trunk line **tip and ring**. These are found at the **main distribution frame**, or **MDF**. The call accounting unit simply scans lines and goes into operation when it detects an off-hook condition. Information in the form of dialed digits and various electrical signals is accumulated in the call accounting system's storage facility for later processing into management reports. Raw data includes the following items:

- Station number originating call
- Time of call origination
- Date of call
- Dialed number
- Call duration
- Trunk line used
- Account code

This data can be processed into reports using one of several methods: 1) by call accounting system, 2) by separate report-generating software running on another computer, or 3) by service bureau equipped to process call records.

Since the mid-1970s, PBX systems and a growing number of key telephone systems have provided a special feature known as **Station Message Detail Recording**, or **SMDR**. This feature scans all outgoing call activities for the system and stores them on either

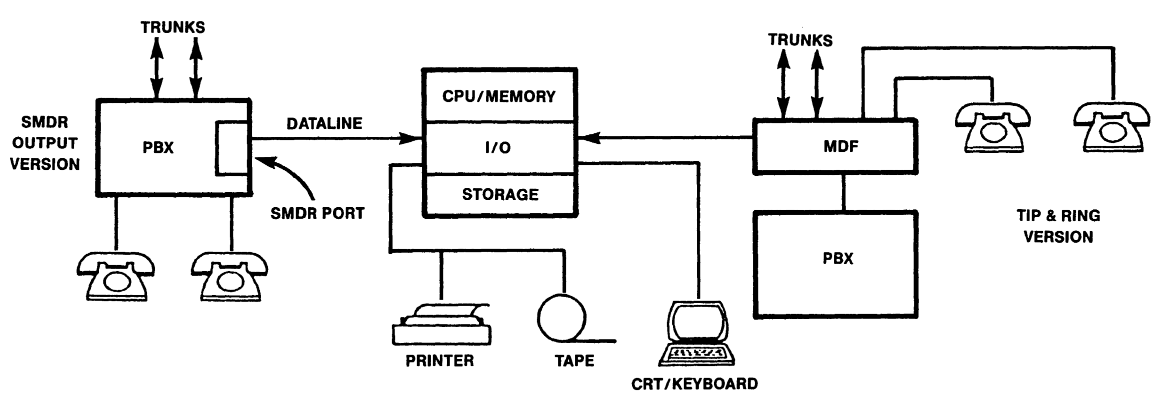


Figure 1 • Call Accounting System Configuration

Call Accounting Systems

hard disk or tape. An RS-232C interface connects the PBX to a call accounting system. The PBX dumps its SMDR records to the system for subsequent processing into reports.

When selecting a PBX or key/hybrid system with SMDR, check into the system's capabilities. Don't buy a system, for example, that provides trunk information by **trunk group only**. It is more beneficial if **individual** trunk usage statistics are provided by the switch.

Some PBX manufacturers offer the same report-producing capability normally provided by separate call accounting system. This usually involves a separate device that takes the SMDR output from the switch and generates reports. It can range anywhere from a microcomputer-based unit, such as the Rolm Insite, to a large system, complete with tape/disk drives, etc, such as the AT&T AP-16 Applications Processor. At this stage, the deciding factors become price, support, and software updating. Brand loyalty also enters here, although not so great a factor as it once was. Users today have no fear of being a multivendor shop.

□ Active Systems

Users with telephone systems that have no outgoing call routing features can obtain them with an active call routing system. Standard call accounting capabilities are usually included with these systems. To achieve the greatest possible savings on long distance calling, users must have a mix of communication facilities. Aside from WATS, there are numerous other long distance alternatives from which to choose. Any of these can save money over WATS, if used properly. Other services in regular use include tie lines and foreign exchange (FX) lines, each of which offers specific cost savings. The number of possible ways to complete a long distance call is enormous, particularly with the proliferation of specialized common carriers. It takes a system with a high degree of sophistication to handle this task.

An **active call routing system**, also known as a **least cost routing (LCR) system**, completes outgoing long distance calls over a variety of communication facilities based on a customer-arranged set of routing guides, called **routing tables**. Telephone users simply dial a standard access code, such as "8," into the system, followed by the destination phone number. The call will be completed over the lowest cost trunk line, and the system will record the information for inclusion in its summary reports.

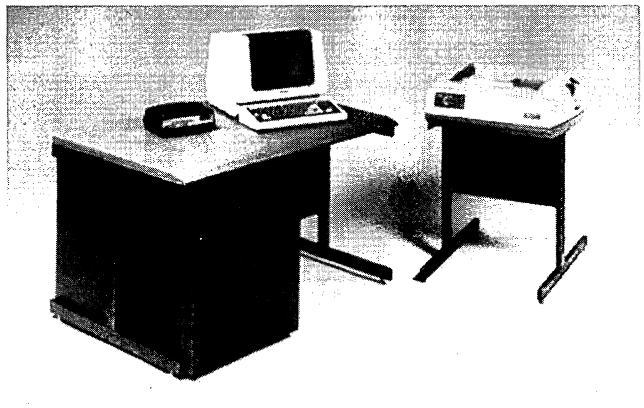
Several distinct call handling features are provided by LCR systems, including automatic route selection (ARS), queuing, priority calling, abbreviated dialing, remote system access, call duration tones, traffic simulation, authorization codes, and equal access routing.

Automatic route selection provides a series of customer-selected call completion routes, usually beginning with the lowest cost line, and ending with DDD, assuming it is provided as a last choice. Part of ARS is route advance, which shifts to the next outgoing line in the routing sequence, if the desired facility is in use. Most route selection systems **complete calls in one direction**. The outgoing call route is followed through to completion, rather than retrying the same facilities a second or third time. Greater cost reductions are possible in the few systems that retry specific facilities before switching to DDD, but the system overhead required to accomplish this can be substantial.

Queuing is an effective means of obtaining greater usage on discount rate trunk lines. It is generally available in 1 of 2 forms: **callback or standby**. If the desired trunk lines are in use, the caller can dial a code and hang up. The system places the caller into a queue for subsequent callback once the desired trunk is available. The other alternative, standby queuing, gives users the opportunity to wait online until a desired trunk frees up. The system can be programmed with variable queue durations, depending on how long users are prepared to wait for the lowest cost trunk line. Either method results in greater discount trunk usage, which translates into greater overall savings.

Priority calling is normally used with queuing. Certain users, based either on their rank or need for rapid call completion, are permitted to bypass others waiting in queue.

Abbreviated dialing makes it easier to dial frequently called numbers. It is available on virtually every PBX system, too.



National Applied Computer Technologies LCX 120

Remote system access gives users outside the system the ability to dial into the system over a dedicated phone line. After dialing a special access code, the user can then access the same features as anyone else on the system. This feature is also available on most PBXs as direct inward system access (DISA).

Call duration tones are "friendly reminders" to users who tend toward lengthy conversations. These can be set to various thresholds, depending on the company's preference.

Traffic simulation gives users the ability to selectively turn facilities on and off, change routing patterns, change time of day parameters, and test potential trunk rearrangements before placing an order.

Authorization codes can be used simply for accessing the system, or to track calls associated with specific clients and projects.

Equal access routing is a new development created by the AT&T divestiture. Users throughout the U.S. will eventually have the option of selecting their long distance carrier of preference. This will result in better communication service quality for OCCs, since local access lines from the carrier into the local telephone company will be the same as those provided for AT&T Communications. For residential users, this will simply mean a choice of AT&T or one of the other OCCs (not always an easy choice,

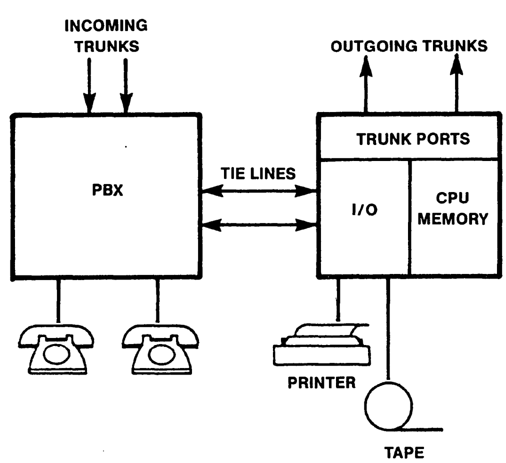


Figure 2 • Least Cost Routing System Configuration

Call Accounting Systems

based on the amount of promotional materials customers receive before an area gets equal access). Business customers will still need more choices for economical call handling, but call completion will be a bit more complicated with equal access. Special access codes have been developed to identify a particular carrier, and the LCR system will need to provide the correct carrier access codes prior to dialing the call. Only a few PBX systems have announced capabilities in this area. LCR systems will support these requirements the same as PBXs. Users in an equal access area should investigate this carefully with their LCR system supplier.

□ Personal Computer-Based Systems

Personal computer use has grown at an amazing rate. PCs are considered the devices most likely to be found in the automated office of tomorrow. Several companies have found PCs as an effective call accounting system for small to medium applications. Ideally, the system will have SMDR operating in the background, and another application running in the foreground for maximum efficiency. The price is very competitive, too, with complete systems currently ranging from under $6,000 to about $25,000, depending on the number of software applications selected.

□ Polling Systems

Companies with multiple locations can maximize the efficiency of SMDR at various locations by installing a polling device at corporate headquarters, or some other appropriate location, to poll SMDR data from remote PBX/key systems. Data is accumulated at each location and stored in either disk or tape, depending on the volume. A polling unit calls up each site on a scheduled basis, gathers all call records, and compiles them into reports. This creates a more efficient, centralized means of managing phone usage at large corporate locations, smaller regional offices, sales offices, etc. It reduces the capital outlay for hardware and software at multiple sites, and provides a higher level of control.

□ Call Accounting Service Bureaus

For those companies who don't want to invest in additional hardware and software for on-site call accounting and report generation, service bureaus are available. Call records are sent to the service bureau, which processes them into management reports. Several bureaus have polling capabilities to gather call data directly from various locations, rather than waiting for call records to arrive by mail. The cost is very competitive, and convenience is an important advantage.

□ Do It Yourself Systems

Some companies with large data processing departments have developed their own call detail software. For those who like to "build their own" it is possible to assemble the necessary components for a call accounting system. This is the exception rather than the rule, since there are so many cost-effective systems available today.

□ Centrex Call Accounting Systems

Although Centrex pioneered call accounting with its AIOD (automatic identified outward dialing) feature, it doesn't provide enough call detail for effective system management. In particular, it doesn't provide individual trunk call detail, only trunk group identification. Enhancements to Centrex are coming out everywhere, since the divested Bell operating companies (BOCs) are indeed bullish on centrex. Specific Centrex enhancements, like SMDR, have been available for several years, but new offerings promise even better service for these users. Centrex call detail has traditionally been provided on a magnetic tape supplied by the telco. Several call accounting manufacturers are investigating other approaches to gather Centrex call details. One method is to tie into the data link that connects the Centrex console to the telco central office switch. Based on the renewed interest in Centrex, there is indeed a bright future ahead for Centrex users.

■ CALL ACCOUNTING TECHNOLOGY

Call accounting system technology is simple and elegant. A microprocessor with memory, tape and/or disk storage units, I/O equipment for connecting to the associated phone system, a CRT/keyboard, and printer are all that's required in a typical system. Larger systems, particularly LCR models, need additional processing power. This is provided by a more powerful processor, usually a minicomputer. Most units are modular in construction, for ease of installation and maintenance.

The most popular device being selected for call accounting systems today is the IBM Personal Computer. Several firms have products built around the PC, and it is possible to have the PC running call accounting while handling another application concurrently, adding to its efficiency.

As with most computer systems, software is the key. In call accounting systems, an operating system is usually provided, plus the specific call processing application(s). Numerous programs are available today to generate management reports. A critical piece of software is the **V & H coordinates table**. This is used to price out long distance calls by determining the correct distance between call origination and termination points. The most important component in a call accounting system is the **call pricing tables**, which contain all pricing parameters. Users create various files and tables for their individual systems, and a **database manager** is often included to help keep track of all files. Some of the applications available today include:

Basic Call Accounting—prices out calls and sorts into reports with various levels: individual user, department summary, division summary, corporate summary.

Specialized Reports—identifies areas of misuse and abuse, frequently dialed numbers, calls exceeding a certain cost/time threshold, authorization code summary, account code summary.

Traffic Detail Reports—provides call details by individual trunk line, trunk groups; summary by WATS band, area code, exchange code; tie/FX/OCC trunk summaries.

Equipment Inventory—maintains current record of all telephone and data equipment; useful for verifying account billing with telephone company/interconnect company.

Maintenance/Trouble Reporting—keeps record of all trouble reports; verifies that work was completed.

Directory—maintains current listing of all company employees; usually has option of printing out hard copy if desired.

Network Analysis—assists management in designing optimum network configuration based on inputs from traffic detail summaries.

Financial Analysis—accepts inputs from system proposals for financial analysis; calculates cash flow, present values.

Cable/Wiring Inventory—tracks all cable and wiring plant in corporate locations.

Private Line Pricing—simplifies pricing of dedicated private lines by simply inputting area code and exchange code of each point on circuit, and selecting carrier.

ACD Optimization—provides means of designing best configuration of automatic call distribution facilities and hardware.

Shared Tenant Billing—used in multiple tenant communication environments where all communication are shared over a group of facilities; system generates bills for individual tenants, includes costs for hardware, toll calls, management fees, etc.

Most of the above programs have appeared in only the last 3 years. Users are much more conscious of their telecommunication expenses than ever before, and software developers will continue to introduce applications as needed.

Call accounting systems store variable quantities of call records based on the amount of storage provided. Older systems used **9-track tape** units for storing call records, and this method is still in regular use today, as well as cassettes and floppy disks. **Hard disk drives** store large volumes of call records, too, and can be accessed easily if the user wants to query the system.

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Many systems use a **combination of disk and tape** depending on user needs.

Connections to the associated telephone system, as mentioned previously, are usually 1 of 2 ways. The more traditional method, used before telephone systems had SMDR, is **connecting across tip and ring at the main distribution frame**. The advent of SMDR has simplified the connection to a simple **RS-232C port** on both the phone system and call accounting unit. A standard cable connects the 2 units. Data transmission rate is customer-selectable, usually between 1200 and 4800 bps.

LCR systems have different connections to an associated phone system. Depending on the degree of telephone system sophistication, the **call accounting function can be connected using either of the above methods**. The LCR function requires **outgoing trunks be connected to the LCR system, rather than the PBX/key system**. A group of **tie lines** connects the PBX/key system to the LCR system. All outgoing calls originate in the PBX/key system and are routed over tie lines into the LCR system, which then completes the calls over various trunks using customer-set routing parameters. If features like queuing are used, the tie lines are again used to pass signals between the LCR unit and the phone system.

Polling units reside between call accounting systems. They generally have a storage buffer that accumulates polled data until it can be transferred to the main storage device. At predetermined intervals, the poller calls up other call accounting units and requests their data. The call is usually made on a dial-up basis, using a standard modem and automatic calling unit. Sometimes the automatic calling is handled by the main call accounting unit. Polling is an efficient method of handling multiple locations without extensive hardware investments at remote sites. The main location must have sufficient processing power and storage to handle the number of call records anticipated during a typical month. The **call pricing database** is probably the most important part of a call accounting system. It needs to be updated whenever tariffs change. This is handled in several ways. The easiest way is to **send the user a new diskette with updated pricing tables. Remote database updating**, in which the call accounting firm calls up its system and remotely transmits new database files, is growing in popularity. Most manufacturers offer this service as an option.

□ How Does a Call Accounting System Work?

Once a user lifts the handset, the process begins, and doesn't end until the call is finished. Assuming the phone system has SMDR, the call data is stored within the system. At certain times, the switch dumps call records to the call accounting system, which stores the data on either disk or tape. If SMDR is not available, the call accounting system scans all station and trunk lines, looking for an off-hook condition. It then monitors the status of the station/trunk line, and keeps a record of all pertinent data for the call.

At certain intervals, the system generates management reports based on accumulated call records. Depending on factors such as the number of records stored, the speed of the CPU, and, most significantly, the printer speed, because report generation takes from a few hours to several days to complete. Some systems have a sophisticated man/machine interface that provides users with greater control over report selection, content, and frequency.

Pricing out a call is the most basic call accounting operation. Long distance calls are both time and distance sensitive, and the system examines both factors when calculating a price. The area code and local exchange code for originating and terminating locations are compared to a **V & H coordinate table**. Special numbers that identify the location of each area code/exchange are used to calculate the mileage between the 2 points. The call duration is also part of computing the cost. The system has software pricing tables, and uses the data gathered by the system to compute the correct cost.

The individual customer database is established prior to system installation. Changes to the database can be made either onsite by customer or remotely by the manufacturer. The call pricing database will also be updated as needed.

□ How Does an LCR System Work?

Aside from the call accounting portion of the system, the LCR unit is virtually invisible to the user. When originating an outside call, the user dials a specific access code, followed by the destination number. If a local call, the system completes it over local CO trunks. If a toll call, the system scans the digits of the phone number dialed, and compares them to a series of routing tables. The system then examines the user's class of service to determine such things as the type of queuing permitted, the maximum queue length, overflow to DDD after a preset time, insertion of call duration tones, and whether or not the call itself is authorized.

Once several initial tests are completed, the correct routing table is selected, and the system attempts to complete the call over the first choice. Assuming this circuit is available, the system sends the call through, and records all appropriate call data for the call accounting portion. If the circuit is not available, the system tries the next line in the table, and so on, until (1) all circuits are in use, or (2) overflow to DDD is available. Additional options like queuing come into play, which keep the caller in the system long enough to complete the call over the lowest cost line available. If the caller's class of service is high enough, overflow to DDD can be permitted. Some systems insert a special warning tone before overflowing to DDD, which gives the user a change to abort the call before the higher-cost facility is used.

One very important application for LCR systems is the **resale common carrier industry**. The big names in the specialized common carrier industry, MCI, GTE Sprint, ITT/USTS, SBS, and Allnet use LCR systems extensively to route subscriber calls. Resale carriers buy up bulk quantities of MCI, GTE Sprint, WATS, etc lines and resell long distance service at an additional discount over the larger carriers. LCR systems handle the complex routing requirements of both specialized and resale carriers efficiently, and provide detailed billing for subscribers.

There are 2 variations of LCR systems that bear mentioning. **TDX Systems** of Virginia developed a system called **Telemax** that performed LCR but with a different twist. A processing unit connected to both station and trunk lines at the user's location. All call processing functions were stored at the Telemax control center at TDX headquarters. A data link established between the processing unit and the control center handled the exchange of instructions based on specific customer call routing parameters. Unfortunately, if the data link failed, the system was out of service. The other variation of LCR was provided by a few of the prominent OCCs as an inducement to use their WATS-lookalike services. Both MCI and Southern Pacific Communications (now GTE Sprint Communications) had an **LCR option** in which long distance calls handled by the carrier were routed over different groups of discount-rate trunks using call routing features of the carrier's switching equipment. Users needed no specialized equipment on their premises. The carrier simply installed direct access lines from the customer into its switching system. The user then set up a special dial code for accessing the lines. The carrier's switching equipment completed the call over the lowest cost facility.

■ REPORTS—THE ESSENCE OF CALL ACCOUNTING

Call accounting systems are only as good as the information they provide. Most systems today have a significant cadre of reports available. Specialized reports can usually be developed on an individual basis, but are not generally needed. Reports are grouped into 3 general areas: 1) system management, 2) cost allocation, and 3) traffic analysis. Table 1 lists several reports provided by a typical call accounting system. Additional reports are provided by equipment inventory, cable and wiring inventory, directory, message center, and maintenance/trouble reporting programs. A tremendous amount of information is provided. If used properly, with management support, it can be an extremely effective tool in controlling costs.

■ JUSTIFYING CALL ACCOUNTING EQUIPMENT

Investing in a piece of equipment that will save money from its first day in operation makes a lot of sense. Call accounting systems

Call Accounting Systems

TABLE 1: CALL ACCOUNTING SYSTEM REPORTS

SYSTEM MANAGEMENT

Totals by Division
Totals by Department
Cost Center Summary
Extension Summary
Frequently Dialed Numbers
Excessively Long Calls
Excessively Expensive Calls
Operator-Assisted Calls
Credit Card Calls
Equipment Summary

COST ALLOCATION

Extension Summary
Department Summary
Division Summary
Total Company Summary
Summary by Client
Summary by Project

TRAFFIC ANALYSIS

WATS Activity by Band
WATS Activity by State
WATS Activity by Area Code
Non-WATS Activity for Band/State/Area Code
Non-WATS Activity by Exchange Code (FX Analysis)
Message Unit Summary (Depending on Metro Area Served)
Summary of DDD Overflow Calls
Incorrect Facility Report
Call Distribution Reports by Hour/Day
LATA Call Summary Report
Network Traffic Summary Report

can do just that. It's not unusual for a system to pay for itself within its first year of operation, just on savings alone. The most important ways for a call accounting system to pay for itself are:

Identify all telephone expenses—if users and managers know where their telephone dollars are going they can more effectively control them.

Identify abuse and misuse—if there are chronic problems among users regarding their calling habits, they can be quickly identified and corrected.

Effectively monitor employee productivity—if employees are required to use the phone as part of their work, their performance on the phone can be more easily tracked; this can translate to improved productivity and increased sales.

Design the most cost-effective network—the system can provide information that will assist in the design and implementation of a cost-effective communication network; it can also monitor the network's performance and identify adjustments necessary to fine-tune it.

Establish profit-making capability—while some companies will not choose this approach to telephone expense control, it is growing in popularity. Hotel/motel owners have been doing this for years, and the latest trend, shared tenant communication, is gathering momentum.

Aside from working with prospective call accounting system vendors, probably the best way to help justify a call accounting system is to **get advice from others who have installed their own systems**. Find out how they determined savings, how they used the management reports, what problems they had (and still have), and what their future plans are. Attempting to project telephone expenses in today's divested environment is risky business, since a decrease in long distance rates can easily be offset by a boost in local service rates. Once again, the call accounting vendor can probably provide assistance in this area, as can other users.

A few cautions are appropriate at this time. A typical passive system only records calling activities; it doesn't have any control over them. Most PBX systems, and even a few key/hybrid systems have LCR functions; therefore, a passive system will be sufficient for most users. Since call accounting systems are computer-based, they may have specific environmental requirements (heating, power, security), that must be addressed. If a polling arrangement is used, data communication line quality is critical so that call records are not lost during polling. The proliferation of systems and software for call accounting suggest that a conservative approach to software is appropriate. It's easy to acquire programs that will do 2 or 3 times as many things as are actually required. Most basic software has an adequate group of reports which should easily handle most applications.

■ THE INDUSTRY—GROWING PAINS

Call accounting systems for end users have been on the scene since the early 1970s. Originally, there were about a half dozen companies in the business; today there are over 60. There have been casualties along the way, though. Several companies have folded, others have merged with bigger companies, and product lines have been revamped.

The industry was quite healthy before the AT&T divestiture. New companies burst on the scene: hardware manufacturers, software developers, and service bureaus. Business was indeed booming.

All that came to a screeching halt toward the end of 1983 and through most of 1984. The divestiture changed virtually everything about telecommunication management. Uncertainty about the direction the industry would take made users hold off purchases of call accounting equipment. This brought the call accounting industry virtually to its knees until sales started returning during the latter half of 1984. Sales in 1985 are vigorous again, now that the transition through 1984 is over. Several new trends have emerged from the ashes of 1984 that spell the industry's direction in 1985 and beyond:

Software for IBM Personal Computer/PC-Compatibles—almost overnight the IBM PC and its clones have become the darlings of the call accounting industry. A year ago, there were only about half a dozen software packages for the PC in telecom management. Today, there are several dozen, and the number is growing rapidly.

Families of Telecom Management Software—telecommunication management is not just standard call accounting and traffic analysis—it is hardware management, personnel management, maintenance and repair, message management, and profit-making. To effectively handle these additional responsibilities, software developers have created integrated families of software.

Smaller Call Accounting Systems for Key/Hybrid Systems—call accounting systems traditionally were used in medium to large phone installations, since the savings potential was greater. There is a growing trend toward systems that connect to small key systems and PBXs ranging from 20 to about 70 stations. Systems will cost $4,000 or less, fully equipped, putting them within reach of a large number of prospects.

Other trends anticipated include an increase of integrated call accounting capabilities in major PBX product lines, over-the-counter call accounting systems, call accounting for 5 lines or less, increased reporting on inter- and intra-LATA calling, and improved call accounting for Centrex. Improvements in LCR features in PBX and key/hybrid systems point to the eventual disappearance of standalone LCR systems used with PBXs but

Call Accounting Systems

their use in specialized/resale common carrier networks is expected to continue unabated.

■ SUMMARY

Call accounting systems are a valuable addition to virtually any telephone system today. The industry's growth and the proliferation of hardware and software indicate a healthy future. There will undoubtedly be more post-divestiture gyrations within the industry, but they will benefit all concerned, particularly end users. Most PBX and key/hybrid system manufacturers are not interested in selling call accounting systems; they simply want to sell more phone systems. As end users need more information on communication expenses, the call accounting manufacturers will be there with solutions.

• END

Call Distribution Systems

An Introduction to Automatic Call Distributors, Uniform Call Distributors & Automatic Call Sequencers; With an Overview of the Industry & Planning Guidelines.

■ INTRODUCTION

Businesses that depend on the telephone for sales, particularly through incoming calls, need an efficient method of handling these calls. The more calls the company can handle, the more sales it will make. There are numerous specialized systems available to handle incoming calls—known under a variety of names—but generically referred to as **call distribution systems**. This report will examine the various types of call distribution systems, discuss planning considerations, and take a look at the current marketplace.

■ THE NEED FOR CALL DISTRIBUTION

Call distribution systems exist to **generate and protect revenues**. There is no better way to lose business than by making existing or new customers wait for their calls to be answered. Even if they have to wait, it is important to let them know their call is in the system, and will be answered soon. For many companies, the telephone is the primary way of conducting business. The spiraling cost of an in-person business sales call is so high that many companies are depending more on **telemarketing** for all or most of their sales activities. Incoming calls are a major part of any telemarketing operation, and the efficient and professional handling of these calls will ensure a successful sales program.

There are few communication systems on the market that justify their presence better than call distribution systems. The more efficiently a system completes incoming calls to people trained to handle them, the more satisfied the customers will be, and increased revenues usually are the end result.

Different incoming call requirements among companies have created a call distribution industry responsive to these needs. Several different types of systems are available, based on customer needs, and, while the cost for call distribution equipment can be quite high, the benefits more than justify the costs.

■ CALL DISTRIBUTION SYSTEM EVOLUTION

The high degree of sophistication in call distribution systems today is a far cry from the early systems. Companies with a need for answering a substantial volume of incoming calls had them handled by a switchboard operator, who routed them to a group of people assigned to answer them. The operator was solely responsible for determining who received the most calls, who received the complaint calls, and who received the "designated customer" calls. Quite a lot of responsibility for an individual. Problems with this approach include 1) uneven distribution of calls, 2) limited statistical information about call activities, and 3) training of new or relief operators.

The development of key telephone systems in the 1930s gave incoming call handling its next boost. Agents could view the status of several lines by observing various lamps and other visual signals. Incoming calls were still screened and connected by the switchboard operator, but calls could be handled by several different people picking up the same lines on their key telephones. While this method offered some improvements, there were still problems: 1) uneven distribution of calls, 2) limited statistical information, and 3) calls could be placed on hold and left on hold, upsetting customers.

AT&T introduced the first **automatic call distribution (ACD)** system, the 2A ACD in 1963. It served incoming calls to agents on a first-in/first-out (FIFO) basis. Calls were routed using a specific pattern, or sequence. The 2A supported up to 56 trunks, 60 agent positions, and was built around a crossbar switching system. A very large system, the 3A, also appeared in 1963, with a capacity of 198 trunks and 200 agents. It used step-by-step switching equipment. Ten years later, AT&T introduced its next ACD systems, the 2B and 4A. The 2B, based on crossbar switching, had a maximum configuration of 68 trunks and 70 agent positions. It could be networked into 3 systems for up to 180 agents using load balancing techniques among the individual systems. The 4A was the first example of **automatic call sequencing**. It supported up to 20 trunks and 15 agent positions, but alerted agents of call status via flashing lights in conjunction with key telephone sets. These systems handled calls fairly well, but they provided little or no management information to optimize system operation.

The **Carterfone Decision of 1968** helped open the door to the next generation of call distribution equipment. A **stored program controlled system**, with sufficient program memory, had the greatest potential as an ACD machine, and the first non-AT&T product was developed and installed by the Collins Radio Group of Rockwell International. It is known as the **Galaxy**, and is the most successful of any systems ever developed in the industry. It is also a **digital** ACD system, a revolutionary application for a technology that was slowly growing in popularity, despite being in the shadow of ubiquitous analog switching. Today, virtually every medium to large ACD system, as well as PBX, is digital. The Galaxy was indeed ahead of its time, and its introduction was a pivotal event. It was installed at Continental Airlines in 1973.

Additional ACD products entered the market over the next several years, slowly at first, but gradually picking up momentum into the 1980s. AT&T introduced ACD systems built around its 1ESS central office throughout the balance of the 1970s, and provided ACD enhancements to its PBX product lines as well. The major enhancements to ACDs during this period included extensive management information, improved call routing and queuing flexibility, and improved agent/supervisor terminals.

Today there are several different types of call distribution systems: **automatic call sequencers, uniform call distributors, and automatic call distributors**. Each has its own unique operating features, but all provide the same basic properties: **efficient incoming call handling and detailed management information.**

■ TYPES OF CALL DISTRIBUTION SYSTEMS

Two basic system types exist today: the **standalone machine** and **PBX system with integral ACD features**. Within the standalone category, 3 product types are available today.

Automatic Call Sequencers (ACS)—these devices connect to a key telephone system, answer incoming calls automatically, provide announcements as required, and place calls on hold. Status lamps located on the telephone instruments and wall-mounted modules flash at different rates, depending on the length of time the call has been on hold. The status lamps can be designed to change color as an additional reminder. Calls are then answered by whoever is available; there is no programmed call routing methodology.

Uniform Call Distributors (UCD)—incoming calls enter these

Call Distribution Systems

systems and are completed to agents with a predetermined sequence. There are 2 methods used: circular (round robin) and top-down. **Circular** begins at the last agent connected, and tries the next agent in order until a free agent is found. This provides a fairly even distribution of work, although the system cannot back up and make a second attempt at previous agents when they become free. The routing sequence is always in the same direction. **Top-down** routing places agents in a single sequence, and **always starts at the beginning of the list** when attempting to complete a call. Agents near the beginning of the routing list will handle more calls than those near the end. This method can work well if agents at the end of the list have other responsibilities, such as secretarial or clerical, in addition to answering calls. This method of call distribution is used on many PBX systems.

Automatic Call Distributors (ACD)—while this term is often applied to the industry as a whole, it describes the most sophisticated call distribution system. Incoming calls are completed to agents **who have been idle the longest**, ensuring a truly equitable distribution of work. The system scans all agent positions constantly, while monitoring the amount of time spent on each call. Various routing sequences can be used for normal conditions, such as circular or even top-down. But on those occasions when the system is looking for an open position and is searching in a particular direction, an opening in another area will trigger an immediate response from the system. It can complete calls **in any direction**, and **in any sequence** to ensure an even distribution. If multiple agent groups are available, and all agents in one group are busy, the system can **intraflow** to another group. If multiple ACD systems are in use, and all groups in one system are in use, the systems can **interflow** calls between individual ACDs. Most systems can be dynamically reconfigured by management as traffic conditions change. System performance statistics are available on a real-time basis, giving management a high degree of control over all aspects of the system. If, for example, an agent leaves the system for lunch, the supervisor can take the position "out of the system" and reconfigure other positions as required to ensure smooth call completion.

PBX systems can be purchased with varying degrees of ACD functionality, depending on the manufacturer. To date, most manufacturers offering an incoming call handling feature provide UCD. Some offer specialized agent telephones and supervisor terminals. A growing number of manufacturers offer call routing similar to "true" ACD service. It is advisable, however, to verify the call routing methodology with individual vendors, as some interpret UCD and ACD differently. Interestingly, a number of standalone ACD systems also provide PBX features.

■ ACD SYSTEM ELEMENTS

There are 4 basic elements to any call distribution system: incoming call routing, trunk lines, agent/supervisor positions, and management reports. Each plays a critical role in the smooth operation of an incoming call handling group.

□ Call Routing

Call distribution systems have incoming trunk lines, a switching element, and agent/supervisor positions. In most cases, the number of trunks is equal to or slightly greater than the number of positions available. This provides increased opportunities for incoming calls. The routing methodologies vary with the type of system. A typical sequence of events for an incoming call might look like **Figure 1**. More sophisticated systems offer 2 or more messages once a call is placed in a queue. This is reassuring to callers and keeps them on the line. Naturally some callers will not wait very long, unless they are calling on a toll-free 800 Service number, and this must be taken into consideration when designing the system. Aborted calls often mean lost business, so the system must be configured to handle the anticipated volume.

Perhaps the most important element in call routing is **queuing**. Much research has gone into the issue of queuing, as this has a tremendous impact on the eventual success or failure of the call distributor. Queuing **permits more calls to enter the system than it can actually handle**, which means more opportunities for revenues. Most systems use a first-in/first-out (FIFO) queuing

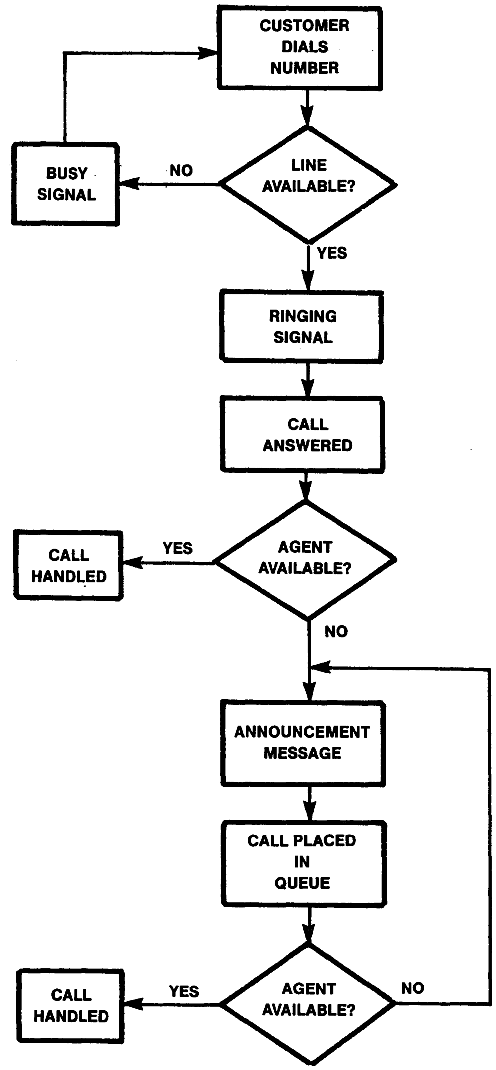


Figure 1 • Incoming Call Sequence

approach. The system's **ability to effectively distribute calls** is the other part of the equation. It is critical to successful completion of the largest number of calls, which has a direct impact on revenues.

Once a call is in the system, it is then routed to an available agent using one of the methods mentioned earlier. If a UCD system, calls are routed according to a predetermined pattern, either circular or top-down. If an ACD system, calls are completed based on which agent has been idle the longest, and a combination of the other methods can be used as well. In an ACS system, the system simply displays calls in the order of their appearance and subsequent answering by the system. Visual signals indicate which ones have been on hold the longest, and it's up to the individual agents to answer the calls.

True ACDs can be dynamically reconfigured based on traffic loads. Agent groups can be shifted, trunk groups can be reassigned, queue lengths can be varied, and system configurations can be modified according to the time of day, if required. Calls can be redirected to other agent groups, if positions are

Call Distribution Systems

available; this is called **intraflow**. The system supervisor channels traffic simply by entering specific commands to the system. In large multiple systems where traffic volumes can get extremely heavy, calls can be rerouted among different systems; this is called **interflow**.

☐ Incoming Trunk Lines

The number of trunk lines into the system will determine how many calls the system can handle, and the configuration of trunks is absolutely essential to a successful system. Depending on how the company wants to handle various geographic areas of the country, 800 Service lines are probably the best method. Advertising with 800 Service numbers has been shown to pull 20 percent more business than ads without them. The cost for 800 Service is very reasonable, with the basic monthly cost for 2 lines just under $80 per month. Companies have taken to 800 Service numbers that spell out specific messages, such as 1-800-ABC-CORP, to further distinguish them from their competition.

Other specialized lines, such as Foreign Exchange (FX), can be installed in a call distributor, if a more specific geographic area needs to be reached. Trunks are usually grouped in **gates**, or **splits**, for greater efficiency. A system can have a single trunk group, which is fine for smaller operations, but in larger installations multiple gates are usually the rule.

Depending on the needs of the business, outgoing trunks can also be used. if an agent needs to make an outside call for information, the system can be configured with various outgoing trunk lines the same as a standard PBX. Some larger systems will even provide sophisticated features like least cost routing.

☐ Agent/Supervisor Equipment

Virtually all call distribution equipment available today can operate successfully with standard single-line and key telephones. To increase agent/supervisor efficiency, however, most manufacturers provide their own proprietary station terminals. Critical functions are set up on designated buttons, special audible tones are provided to identify the type of call, and some terminals even have a visual display to further identify the call. Supervisor positions are usually modified agent terminals with additional features like the ability to monitor agent calls for training purposes. Most ACDs and even some UCDs include a CRT/keyboard for access to the system, particularly for up-to-the-minute performance statistics and the ability to dynamically reconfigure the system.

☐ Management Information Reports

Before computer-based call distributors appeared on the scene, system performance was literally up for conjecture. Very little information could be obtained, other than **peg counts** on certain switching events. The Rockwell Collins Galaxy changed all that. The system provided an extensive report package that gave management more information than ever thought possible. All call distribution systems provide management reports, and the variety and degree of sophistication in reports varies with the system's overall capabilities.

Managing an incoming call operation is one of the most difficult assignments in the telecommunication profession. Timely and accurate information is absolutely essential if the system is to handle calls quickly and efficiently. In traditional PBX systems traffic information is generally examined once or twice a month, although in larger installations it can be monitored on a daily and even hourly basis. Call distribution systems need to be monitored on virtually a minute-by-minute basis, because of the random nature of incoming calls. If changes in call patterns occur, the system administrator must know about them immediately if the system is to be reconfigured. Management reports are packaged into several generic groups.

System-Level Reports—Overall system performance is presented in these reports. They can be displayed on a screen or printed out. Information is provided for each gate on a half-hour or hourly basis. Typical reports include number of calls offered (calls that attempted to get answered by the system), number of

Rockwell Galaxy ACD

calls answered, number of calls queued, queuing duration, number of agents assigned, average call holding time (how long the call lasted), average time before call was answered by system, and average time for call to be answered and connected to an agent.

Agent-Level Reports—The system scans monitors factors like average time on a call, average after-call work time, and number of calls handled. Additional reports can be devised for improved staff planning or comparing the performance of individuals within a group as well as comparing groups.

Delayed/Queued Call Reports—This element monitors the number of calls queued, and presents information on the number of calls abandoned, queue lengths for individual gates, and number of calls in queue for specific time periods.

Trunk Usage Reports—Trunks represent approximately half the average investment in call distribution systems, thus the need for careful monitoring. Reports provide information on trunk occupancy, number of calls offered, number of calls abandoned, holding times per call on an individual trunk/trunk group basis, number of times all trunks in a group were busy, and any trunk outages. This information is essential to configure trunks in the best way for handling incoming traffic.

Diagnostic/Trouble Reports—Reports are available on most systems that indicate various system malfunctions. Systems can be queried on a real-time basis either on-site or remotely. System status can be displayed on a screen, if desired.

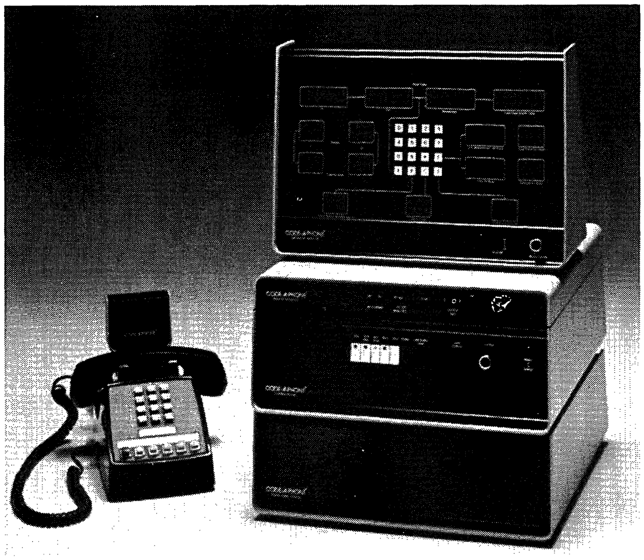
System Networking Reports—Some installations use multiple ACDs to handle large volumes of calls. A great deal of configuration flexibility is possible with multiple systems, and the number of gates, trunks, and agent positions is increased substantially. Specific information is needed, however, to handle these large operations. Incoming traffic can be interflowed among systems, and the decision to do this must be based on timely information about internal traffic flows.

Call Accounting Reports—Larger call distributors have call accounting capabilities that identify costs associated with outgoing calls. These costs can be charged back to a specific department, if necessary.

Trending/Forecasting Reports—Medium to large incoming call operations not only need current performance data, they need the capability to forecast staffing requirements in anticipation of specific situations. If a company is experiencing a steady growth in calls, a forecasting program can look at previous activities and make projections on future trunk requirements and staffing needs.

Management reports are a critical component of any call distribution system. Most have a basic group of reports, but the final decision on a system should be based in great part on the

Call Distribution Systems



Code-A-Phone Sequence I ACS

number and quality of reports available. Some systems permit the design of new reports, if a new application is determined.

■ SYSTEM PLANNING CONSIDERATIONS

Although call distribution systems can get very expensive, **hardware and software costs are only about 5 percent of the total investment**. As mentioned previously, trunk lines account for about 50 percent of the costs. The rest is for personnel. Thorough planning will result in a system that more than pays for itself.

Telecommunication professionals **must thoroughly understand their company's goals** in establishing an incoming call operation. It is important to **determine the approximate value to the company of a sales call obtained via an ACD**, because this will help determine the value of the ACD to the company.

Traffic engineering becomes a major consideration when implementing a call distribution system, because the cost for trunk lines is such a large portion of the overall system price. If the company is starting from scratch, the services of an experienced consultant are advisable, and the call distributor vendor will be able to provide additional design inputs. Call distributor traffic engineering is quite different than for standard PBXs, because it is impossible to determine when calls will be offered to a system. Past experience with similar situations is usually the best way to get an initial estimate on a trunk configuration. Once the system is installed, the trunks must be monitored constantly to determine what adjustments or rearrangements are needed. Special software programs are available that address the unique traffic engineering requirements of ACD systems. Most manufacturers can provide assistance, as can experienced ACD system consultants.

Determining the **personnel requirements** for an ACD operation is another complex issue. Initial staffing will probably include experienced managers, who can then hire and train agents. Consultants can again offer valuable assistance in this important area. Procedures must be developed and implemented. **Managing the operation** is also critical to the success of the company. Scheduling shifts, training new employees, handling problems, and developing job enrichment programs are all part of the business, aside from day-to-day operations.

Call distribution systems are probably the most difficult telecommunication system to plan for. Once the company's requirements are determined, it is probably advisable to obtain the services of an experienced ACD consultant to help develop a Request for Proposal (RFP). Since there are not many call distribution system manufacturers in any given size range, it will be fairly easy to narrow the field down to 2 or 3 vendors. From that point it is advisable to interview users of each vendor's recommended system to verify the system's performance and its ability to pay for itself.

The system's installation is only the beginning of the long-term planning effort. The system's impact should be projected over the company's financial expectations, so that it can make the greatest possible contribution to profits. Long-term plans should incorporate factors such as staffing, work areas, additional trunks, additional agent positions, projected effects of tariff changes, and even potential changes in economic conditions.

■ THE CALL DISTRIBUTOR MARKETPLACE

Until the advent of the Rockwell Collins Galaxy in 1973, the only source of ACD equipment was AT&T. Today, there are approximately 20 companies that provide incoming call handling equipment. This is in addition to PBX manufacturers, most of which also offer some sort of ACD/UCD functionality.

The ACD marketplace was approximately $175 million for 1983, and is expected to grow at an average rate of 12 percent. The number of companies entering the industry has risen somewhat over the past 5 years, but the unique nature of call distribution systems keeps the marketplace small and well-defined. Most companies in the business market to a specific size range, so it is fairly easy to identify prospective vendors for an application. Refer to the Survey Report on ACD Systems in **Section 1440** of this volume for details of the major systems available today.

Most call distribution systems made today are digital, and the trend toward integrating voice and data communication has not been lost on ACDs. While there has been limited activity to date on this aspect of the business, it is likely to increase dramatically in the next 2 to 3 years. Since most uses now operate from computer-based information systems, it is a logical extension of the ACD system to handle data communication concurrent with voice. Some of the larger airline installations are using this technology, but it will not be limited just to this application.

Call distribution systems have been the mainstay of airlines, hotels, and rental car companies. Today, virtually any organization that derives a portion of its revenues from telephone orders can benefit from an ACD/UCD/ACS system. The future of the call distribution industry is indeed bright.

• END

PBX Systems—The Office Connection

An Introduction to the Concepts of PBX Technology, the PBX System as the Key to Modern Office Communication, and Guidelines for Evaluating and Implementing Your Own System

■ INTRODUCTION

It is difficult to imagine an office without a telephone. The day is not far off when the same statement can be made in reference to a computer terminal. These 2 devices are the basic elements of what many are calling the automated office, or office of the future. Assuming that no individual office employees are islands, there is an intrinsic need to communicate. Tying together a diverse population of telephones, terminals, computers, printers, and other information devices into a harmonious system is a difficult job. Although a number of methods have been proposed to effectively connect these pieces together, by far the most popular and most likely solution is the PBX. It is only about 10 years since the advent of digital PBX technology. In the years that followed, the PBX evolved into a product that today has virtually unlimited potential for serving the business community. This report examines the various types of PBX technology available, alternatives to PBX communications, and offers guidelines for the selection and implementation of a PBX system.

■ COMMUNICATIONS IN THE OFFICE

There has been a tremendous increase in the use of computers at individual work locations. This trend is projected to increase throughout the 1980s and well into the 1990s. Both users and vendors are pushing for this development, which portends a future of greater efficiencies in completing work, with minimal reliance on paper. A blueprint for an automated office has been developed over the past decade, and includes the following objectives:

• **Minimize the use of internal memos and documents** which pass assignments or identify needs.

• **Eliminate the physical document file**, except where required by law, replacing them with electronic images and inquiries into computer files.

• **Service the information needs** of each clerical worker via computer access at that position.

• **Integrate existing computerized tasks**, such as word processing, into the system.

• **Provide high-powered, high-functionality management and professional workstations** to increase productivity at this level and to eliminate paper generated by these individuals.

It is easy, analyzing these objectives, to visualize an automated office as a group of **workstations** which have a functional desk workspace, a terminal for access to the office computer, and a telephone. The worker uses the phone for the person-to-person interactions with customers, suppliers, or co-workers which require direct dialog and uses the computer to generate messages (**electronic mail**) where conversation is not needed to where the other party is not immediately available.

Since paper is also a means of communication, it must be replaced or augmented by a similar means of communication. Telephones provide a partial solution, but voice communication lacks precision where complex information must be conveyed and fails where the parties cannot always be available concurrently for a conversation. Electronic mail or voice mail, based on a computer which accepts, stores, and delivers messages can be a solution, but only if the generation and acceptance of electronic messages is a second-nature function to the people involved. This comfort with the medium is typically available only if the staff finds it integrated with other familiar office functions and equipment, such as telephones.

A key issue in office automation is an economical method of providing communications at the workstation level. Some requirements which any proposed method must meet are:

• **Economics.** The number of workstations in a large office would be considerable. The cost of providing the telephone, the computer terminal, and the connection hardware must be small or the total cost of the automated office will be difficult to recover.

• **Noncompetition.** The voice and data connections cannot compete for a singular resource so that the use of one precludes the use of the other. Otherwise tasks which require both (a majority in the case of "service positions" such as account coordinator) cannot be performed.

• **Connectivity.** Both the voice and data connections must be switchable to access whatever resource is needed for the job at hand. They may not be required to switch such that both go to the same destination (a customer is an unlikely source of his own contract file).

• **Versatility.** There must be a means within the communication environment provided to support any communication method which the job requires. For example, store-and-forward voice messages may supplement telephone communication, but they cannot replace text-image electronic messages for the display of complex forms and documents.

• **Friendliness.** People will have to use the system in order for it to be effective. The means of use must therefore encourage use, not place artificial technical or functional roadblocks in the path of the average user. In particular, it must address "start-up rejection" which occurs when workers used to a pure manual system are introduced to an automated system which at first use appears complex and job-threatening.

All of the objectives above are not necessarily confined to a communication system; the application programs used in an office can be **unfriendly** as well. But the communication system must satisfy these goals within its own scope of operation or the applications built on it cannot possibly satisfy users. Many technologies have been proposed for the communication link of the automated office, some of which are at the leading edge of the communication field, or possibly beyond. The PBX is the most frequently mentioned technology of all.

■ PBX SYSTEM TECHNOLOGIES

Seen from a data communication or even total connection point of view, the automated office looks remarkably like a voice telephone system. Each workstation requires connection to a large universe of other workstations which may be within the business or outside of it. The image of a central switch which operates in the same way as a telephone central office or voice PBX is difficult to shake, especially since the terminal-to-computer needs of most computer systems are satisfied by the same host-central architecture. Because of the ubiquitous nature of telephone systems, telephone solutions come naturally to mind

PBX Systems—The Office Connection

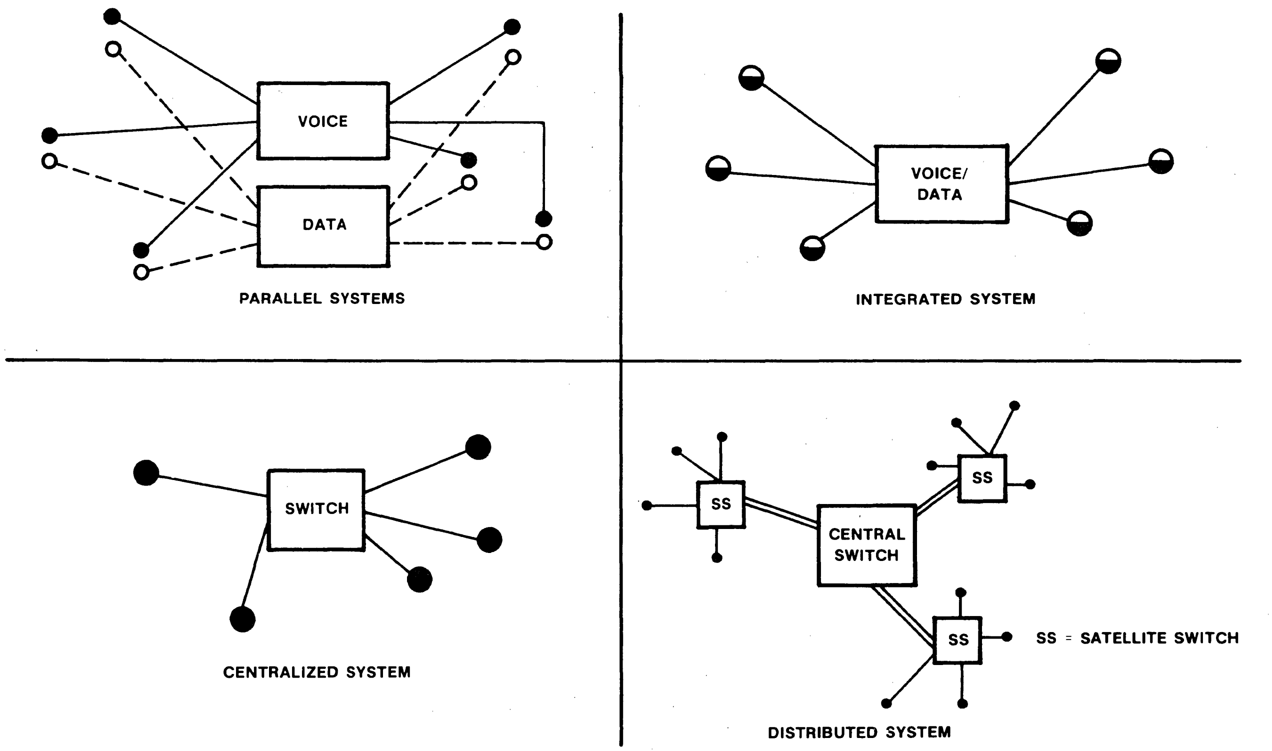


Figure 1 • PBX architecture alternatives.

when addressing connection problems. But telephone concepts are not the only way of addressing office connections. In the last several years, the idea of using a local communication network based on coaxial or fiber-optic cable has gained strength, supported by the DEC-Intel-Xerox ETHERNET and more recently addressed in the form of transmission standards by the **IEEE-802 Committee**. Local area networks, or LANs, based on cable have several attractive features, not the least of which is the sharing of resources on a single cable loop among perhaps hundreds or more users. PBX technology has likewise advanced, providing more features which are applicable to voice and data communication rather than simply to voice. Today's office user has many alternatives for basic communication support as shown in **Figure 1**, but they can be categorized in several ways to aid in their analysis.

• **Single-system versus parallel system.** Some office connection solutions require that the voice and data paths be, to a greater or lesser degree, separate and parallel systems. A local network solution which does not have voice capability, for example, may be teamed with a conventional voice PBX. Other systems will support voice and data from a single workstation over the same connection.

• **Central versus distributed.** Any communication switching and routing system needs intelligence to operate. The logic may be concentrated in a single central point (as it is with many PBXs) or distributed at the points of user connection (as it is with most cable-based LANs).

• **Old or new technology.** The fact that conventional voice systems can also carry data is attested to by the success of the telephone system. But analog voice paths are inefficient in data handling, and low-quality digital voice paths may transform the directives of corporate executives into something akin to the sounds generated by cartoon characters. Some PBX and LAN systems have an inherent capacity to switch information in a generally form-independent manner while others are optimized for one information structure, voice or data.

☐ Analog Voice PBX Systems

The first use of telephone-type switches for offices relied on the telephone system not only for the technology, but to some extent for the name—Private Branch Exchange. As the systems became less dependent on the plug-and-cord concepts, they became known as **PABX** systems, for **Private Automatic Branch Exchange**. Early telephone switches and PABXs were based on techniques to connect wires, to provide a continuous copper path through the switch. In these systems, a series of metallic crosspoints support the connection of subscribers. Modern analog systems have replaced the metallic crossbar contacts with computer-controlled electronic matrix circuitry and more modern reed-type switches, but the principle of a continuous path remains the same. The introduction of computer technology not only increased performance and reduced cost, it gave the systems a new name—**Computerized Branch Exchange**, or **CBX**. Since computerized systems make up nearly all the systems built today, the distinction between CBX and PABX has become less important, and the generalized term PBX is now common in referring to any private switching system. **Figure 2** shows the structure of an electromechanical switch.

In yet another form of analog switch, computer-controlled time division sampling methods divide the input voice waveform into "slices" which are of short duration but have the same amplitude (signal voltage) as the original voice wave at that point. This technique is called **pulse amplitude modulation (PAM)** and is not a truly digital system because the amplitude of the sample is still an analog (continuously variable) rather than a digital (having a finite number of discrete values) signal. Switching these **slices** is more easily done and requires less switch hardware, so this is the most economical form of analog PBX, especially for large numbers of lines. Since these systems use digital sampling techniques, they are sometimes called digital PBX systems. A time-division switch structure is shown in **Figure 3**.

PBX Systems—The Office Connection

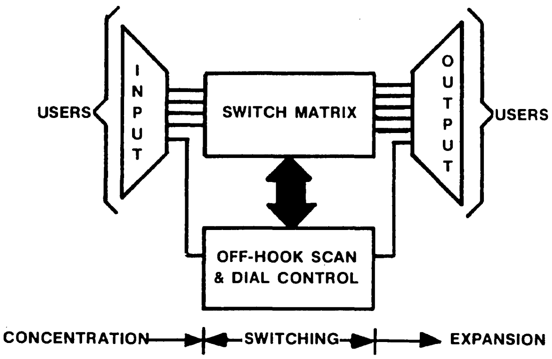


Figure 2 • basic electromechanical switch.

□ Digital PBX Systems

In digital systems, the switching matrix is replaced by a computer. Input (voice) information is **sampled** at a rate of about 8000 times per second and converted into digital data in a form sometimes called **pulse code modulation (PCM)**. The digital data is then switched using standard computer circuits and concepts and is reformed into the original signal upon exit through a reverse filtering process. Because the information in a digital PBX is already in a data form, these systems are inherently capable of handling **both voice and data**. Most modern units sample and encode information in the same way in which AT&T processes speech for its T-carrier voice channels (64K bps) and have the same 56K-bps potential data capacity as a single channel of a T-1 carrier.

□ Data PBX Systems

Many users are confused by the similarity in the terms **digital PBX** and **data PBX**. The digital systems are named for the type of **sample-and-switch** logic they employ while the data PBX, is named for its **processing specialty—data**. Most modern terminal devices operate at a rate of 9600 bps or less, and digital signals have only 2 possible states—one and zero. Digital data in its serial, transmittable form can be converted into 8-bit characters using inexpensive components. Because of these characteristics, it is possible to service and switch a data link with less resources than would be needed to sample and switch a high-quality voice circuit. This resource reduction translates into lower costs per connection, making the data PBX the least expensive of the PBX systems for switching of pure data.

□ Local Area Networks

The newest entry in local or office communication is the local area network. These systems generally use a coaxial cable with either a ring or bus structure (**Figure 4**) to connect multiple users via **tapes** or intelligent interfaces which may contain modems, microprocessors, or both. Each user requires an access point to the cable, although some systems can attach multiple terminals with a single unit. The intelligence in the access point, in cooperation with that in other access points and possibly with one or more **shared repeaters** or **gateways**, performs the switching and routing tasks. The cable itself may be used directly as a digital path (a **baseband** system) or digital data may be used to modulate a radio-frequency carrier similar to a television channel (**broadband**). Cable systems of either type offer the potential for much higher data rates than are common with the directly-cabled RS-232C systems or with the earlier PBX systems, but many users cannot take full advantage of this potential with existing terminal equipment. A more significant advantage of the cable system is low cost. For small user communities, a cable system can be acquired at far lower cost than a PBX system because the relatively expensive shared central resource of a PBX is not required in cable. In larger systems, however, the cost of the distributed cable environment increases directly with the number of ports, while the PBX per-port cost rises more slowly as the central resource cost is distributed further among users. LANs can carry voice data, but the high bandwidth required by voice and its need to preserve, at least in general, the intervals between the digital components to retain intelligibility makes cable voice a more difficult proposition.

Within each of the basic technologies described there are many variations in architecture and features, some of which may have significant performance impact on the users. As in all communication problems, the solution to which type of system to acquire lies in matching the features and characteristics of each to the business problems at hand, a task which is complicated by the fact that the **new** technology of local area networks is no less new (and confusing) to many data communication specialists than the **old** technology of the PBX.

■ INSIDE THE PBX SYSTEM

Figure 2 shows a functional block diagram of a PBX system. The actual switching process takes place in a function set called **concentration**, **switching**, and **expansion**. These names, and indeed the elements themselves, date from the development of mechanical relay switches. In these early PBX systems, a fixed number of **switching paths** existed, limiting the total number of conversations the switch could support. The concentration logic of the switch selected the input lines which were connected to the switching paths, and the expansion portion connected the switching lines to the proper destinations. **Figure 5** shows an example of this type of switching system. In such a system, scanning logic detected an input which was **off hook** and connected a control element to it for the purpose of receiving the dial pulses. These were then used to set switches in the concentration, switching, and expansion sections so that the caller was connected to the indicated output line. Switching mechanisms thus tended to be the limiting factor in switch capacity, and some switch technologies still operate economically only by restricting the number of lines switched.

PBX design, like the design of central-office switching equipment for the telephone system, has always been a balancing of the **cost** of the switch to the **level of service** it can provide. The problems facing switch designers relate not only to the capacity of the switch in number of lines, but to the number of simultaneous user connections which must be supported, sometimes called the

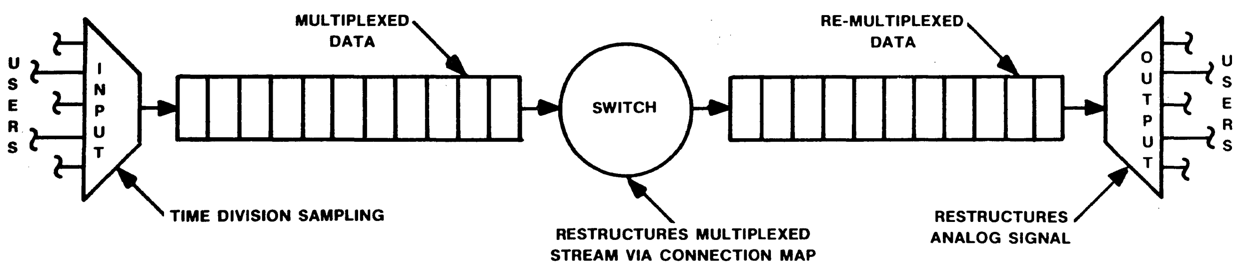


Figure 3 • a time division switch.

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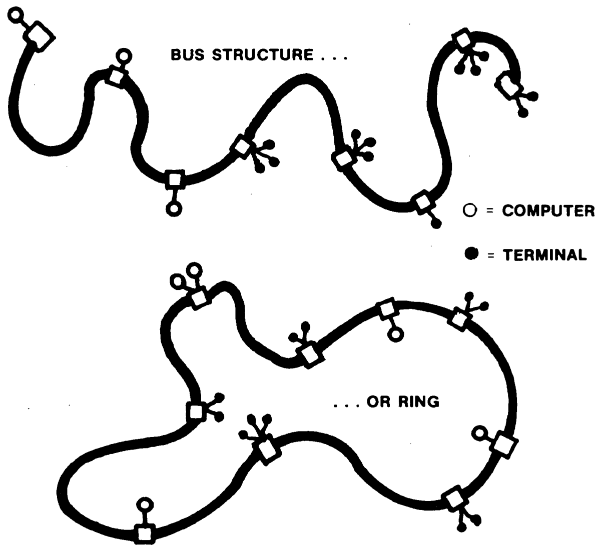

Figure 4 • LAN topology.

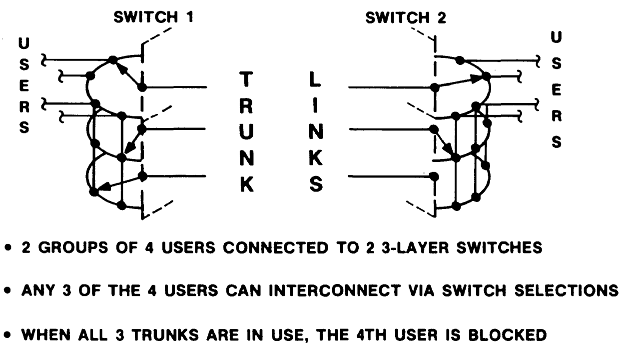

Figure 5 • a simple switch with fixed trunks and blocking.

number of simultaneous connections. Switches which cannot allow all users to connect at the same time are said to **block** users and are called **blocking switches**, while those which do not restrict cross-connects are called **nonblocking**. The need to limit the number of cross-connects in early switches relates to the relay systems used to connect subscribers. Since the relationship between the number of subscribers and the number of switching elements needed to fully connect them is exponential rather than linear, a relatively small switch might need thousands of relays just to allow all users to connect at one time. Since most phone exchanges do not find that even a majority of its users will simultaneously attempt connection, the cost of these relays cannot be justified. Data connections, however, have a characteristic known in PBX design as **long holding time**, meaning that the data calls can be lengthy. In addition, data normally utilizes only a small portion of the bandwidth available, while in most voice conversations, one party is speaking during the majority of the call. The implications of this difference, and the ability of the switching technology to exploit it, depends on the design of the switch.

□ PBX Generations

Like the computer industry, the PBX industry seems determined to accent product evolution by highlighting **generations** of equipment. PBX generations are unfortunately just as nebulous as computers, but the following is a guide of what to expect.

- **First generation systems** are continuous-path analog circuit switches, unlikely to be seen in new product offerings. Voice and data can be mingled in these switches only by converting the data to analog form through the use of a modem.
- **Second generation systems** are time-division switches which use digital sampling of the pulse amplitude modulation (PAM) variety. Some writers are calling these systems **first generation digital** PBX systems. The PAM switch can handle data without a modem, but the PAM technology cannot easily take advantage of the fact that data has only 2 signal states, one and zero. It thus tends to limit data speed to the sampling rate of about 8000 samples per second. An example is the AT&T Dimension.
- **Third generation systems** are those which employ true PCM digital time division switching. Many of these units have distributed architectures with digitizing performed at or near the user's point of attachment, local microprocessor concentrators, and one or more linked central switches. Since they switch data in digital form, it is possible to introduce data directly and at a very high efficiency. An example is the InteCom IBX.
- **Fourth generation systems** are typically data switching systems that can also handle voice communications. The most frequent design is based on one or more high-speed local area networks, supporting transport speeds from 10 million to 50 million bps. The LANs are dynamically allocated for voice and data requirements, as needed, by the switching controller. Digital station instruments digitize voice at the set, and multiplex voice and data signals over a single communications link with the switch. Two prominent examples of this technology are the CXC Rose and Ztel PNX.

□ Blocking & Time-Division Switches

When time-division switching is used, the inputs to the switch are electronically sampled by the **concentration/sampling** element. The rate of sampling required is determined by the highest frequency which must be passed by the switch, 4 KHz in the case of voice telephony systems. It can be shown mathematically that if **slices** of an analog signal can be taken at a rate equal to **twice its highest frequency component**, that signal can be reproduced accurately from the samples (**Figure 6**). Voice telephony then requires that 8000 samples be taken of each active input per second, certainly an easier task than maintaining continuity between input and output at all times. Each of these samples can be of very short duration, and if the sample **slice duration** can be made small enough a simple switching system can handle many lines. **Figure 2** shows how a time-division switch works. In theory, the number of lines which can be supported is based on the rate at which channels can be sampled and the number of **samplers** and switch paths built into the switch. Because some sort of matrix or multiple-level switching scheme is still needed when the number of lines exceeds the capacity of one **sampler** (or else phones on one sampler could not connect with phones on another), there may still be a limit to the nonblocking capacity. In practice, many time-division switches use computers for switching, making the speed of the computer the limiting factor. For example, if a computer **switching element** can switch 240,000 samples per second from input to output, it can service 240,000 divided by 8000 (the samples required per second per channel) or 30 channels. Parallel computers can multiply this figure with a much smaller incremental cost than that associated with banks of electromechanical relay switches, so practical nonblocking switches can be constructed using time-division technology.

□ Types of Time-Division Switches

We have already identified some types of time-division switches as fundamentally analog devices. These are the units which switch PAM-encoded waveforms, because the PAM pulses vary continuously in amplitude. But once we have a sample with a specific amplitude, we can divide the possible amplitude range of the signal into arbitrary units and code the amplitude of the sample by letting the number of units of its strength represent it. **Figure 7** shows an analog signal being sampled and digitally encoded. If 8 bits represent each sample, 256 possible amplitude values can be encoded, and the total representation of the voice signal will require 8000 (samples per second) times 8 (bits per sample) or 64K bps of digital capacity. Use of 4 bits would give 16

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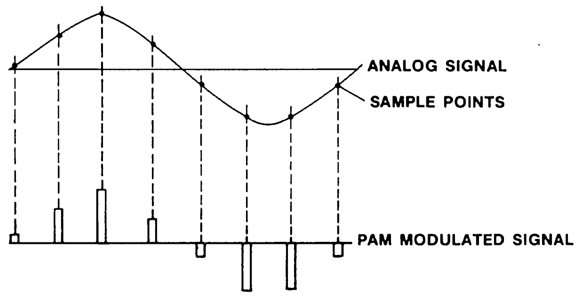

Figure 6 • pulse amplitude population (PAM).

possible amplitude values and require only 32K-bps capacity. Since the analog signal is now totally digital in its representation, this type of PCM system is often called (correctly) a **digital PBX**. The AT&T T1 carrier is also made up of PCM digitized data. Each T1 **frame** carries the samples for 24 channels, 8 bits each, and requires 192 bits. Another bit is added for error control, making the frame 193 bits long. Since voice samples must take place 8000 times per second, 8000 of these frames must be sent per second, or a total of 1.544M bps. This is the source of the familiar **1.544 megabit** rate T1 channels. Digitizing techniques other than the familiar PCM are available, the most popular being **delta modulation**, such as that employed by in the Harris Digital 400/1200 PBX systems. Delta modulation encodes the direction of change in the signal with each sampling rather than its amplitude. Supporters of delta modulation claim that it is less sensitive to channel noise, a fact which opponents accept but feel is unimportant in a controlled PBX environment.

There are many techniques for switching time-sample values by computer control. In some, each line sample is written into a control storage at a unique location, from which the output scanner removes it to deliver to the destination line. In others a computer-driven crosspoint matrix is used to associate an **input** time sample to an output slot. The former method is called **T switching** and the latter, **S switching**. Since multiple levels of switching are needed even here to handle many lines, it is common to **gang** T and S switch stages. Thus, a **TSST switch** consists of a T stage, a pair of S stages, and another T stage. A hybrid system called a **digital symmetrical matrix** or **DSM** combines both time and space switching concepts into a single device. DSM systems are presently limited in application by the constraints of DSM design, a set of limits which arise from trying to apply a circuit which contains both time and space techniques as a single switch element. The technology looks promising, however, and may appear in commercial products shortly.

□ Data in the Digital PBX

Any PBX which samples the input can, in theory, sample even the digital signals which are used in data transmission. Since the digital signal can be directly sampled, no conversion from digital to analog is required; that is, no modem is needed. In practice, some modifications are needed to handle data correctly since digital signals have **square corners** which contain very high frequency components and thus cannot be accurately reproduced with a sampling rate of 8000 per second if the data rate is high. PAM systems can be made to handle data by synchronizing the sample rate with the bit timing of the character if the data rate is 8000 bps or less. With PCM systems, it is possible to introduce data **around** the sampling logic as though it were already digitized (which it is). **Figure 8** shows the introduction of data into a digital PBX by bypassing the sampling logic.

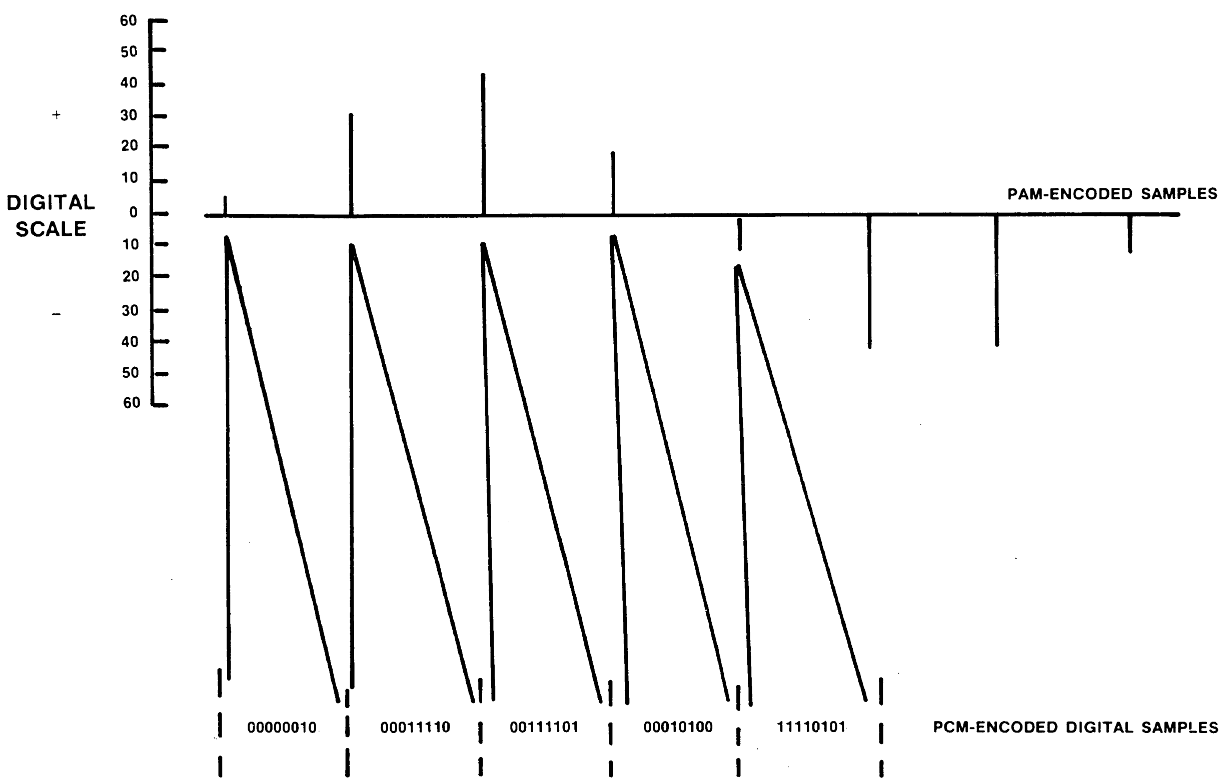

Figure 7 • digital pulse code modulation (PCM).

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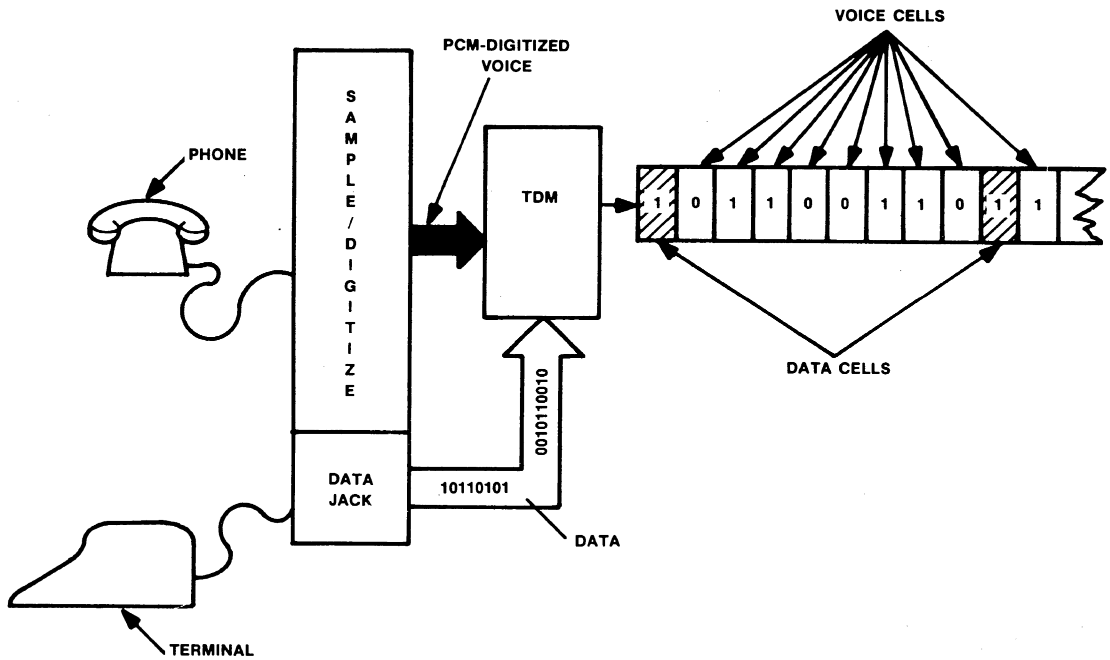

Figure 8 • digital data in a PCM-based digital PBX.

The ability of a digital PBX to transmit data directly is even more useful if the transformation of speech to the digital PCM pattern takes place at the telephone instrument rather than in the central PBX. This is because such remote encoding makes it possible for data and voice to be mixed **at the workstation**, an important feature in the satisfaction of the objectives of the automated office. In fact, if speech can be digitized using less than the 64K-bps sampling rate with satisfactory results, it is possible to simultaneously support voice and data from a single workstation over a **single circuit**. This is especially important in light of the efforts of the CCITT and AT&T to standardize on a 32K-bps speech digitizer. Many vendors have already provided **information stations** which provide users with access to both voice and data paths, **sharing** the PCM link to the PBX itself in various proprietary ways. New LSI technology for combining voice and data at the **workstation level** is now available and is appearing in new products. **Figure 9** shows a sample of a single-chip device which combines voice and data by using one extra bit per PCM frame on a single twisted pair to provide about 9600 bps of data capacity in addition to normal 64K-bps digitized voice. If 4 wires are available to the workstation (as they normally are in a PBX installation), the chip provides 64K-bps data and 64K-bps digitized voice.

□ Additional Applications

Because the digital PCM concept accommodates signals whose highest frequency component is 4 KHz or less, it can be applied to signals other than voice or data. Digital signals from nontraditional data equipment, such as digital facsimile, can be handled directly at rates to 56K bps. Examples of applications include intrusion detection, fire and smoke detection, environmental control, and process control. By routing these circuits through the PBX system, the need for multiple types of wiring and several points of control within the office or facility can be eliminated. Such central control of all information routes is a key element in control of an automated office. It also permits the integration of process and communication functions; an alarm level on a monitored line could be used to trigger a voice message to designated personnel or even generate a broadcast alarm message. The introduction of control circuits into a PBX is not unique to third-generation PCM systems; **Figure 10** shows the application of a PAM second generation PBX to an energy control and conservation system within a building.

■ FOCUS ON THE DIGITAL PBX

The theory of the digital PCM system and digital PBXs based on it has already been explained, making it possible to discuss the features of this technology from the user/economic perspective. In this way, these features can be discussed in terms of the benefits they may present to the user. Here are some of the key features of the digital PBX and their importance in office communication.

• **Small circuit size.** Digital technology makes it possible for the PBX to use smaller circuits to sample and switch data. This translates into a **greater capacity**, both in number of lines and in nonblocked capacity of the switch. While many users feel that a high-capacity nonblocking switch is overkill for PBX applications, most have no experience in the number of and duration of data calls which their office automation applications might generate. Does your CPU expect the inquiry terminals to be more or less continuously online? If it does, each terminal uses up a connection and the total terminal base may take up most of the simultaneous connect capacity of a blocking PBX system.

• **Distributed architecture.** The digital PBX lends itself to the distribution of functions. One dimension of this is the movement of per-connection tasks, such as digitizing, out toward the user. We have already covered the advantages of making the 64K-bps digital path which is internally associated with a channel available to the user as a data path. Another advantage of the movement of intelligence toward the connected user is the use of interface multiplexers or first-level concentrators to collect a region of users and concentrate them into one or more trunk lines to the central switch. This can permit a much larger connected geography without the use of multiple central switches. But a second dimension to distribution is its effect on reliability. The probability of an element failure taking the entire switch down is reduced by defining a hierarchy of intelligence such as that shown in **Figure 11**. Backup at any level can be theoretically achieved by paralleling the unit involved rather than an entire switch structure.

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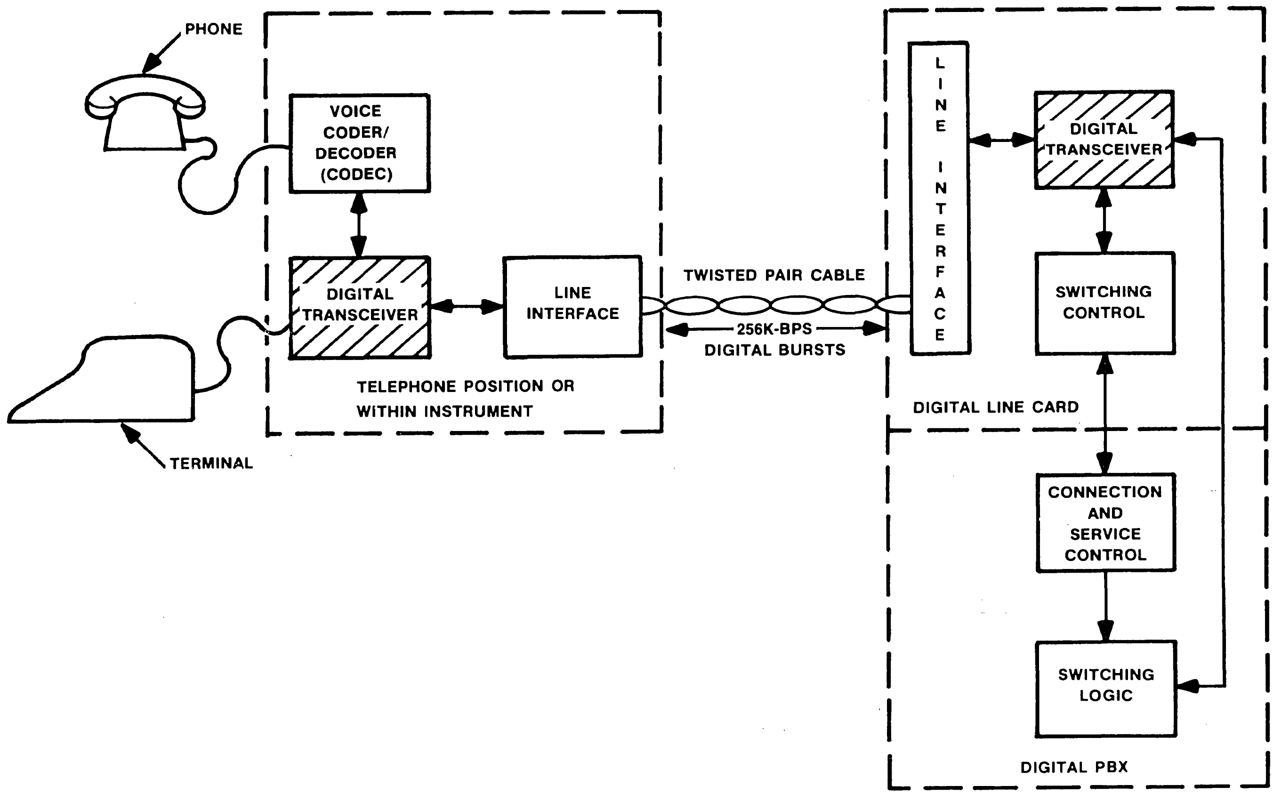

Figure 9 • a new voice/data chip.

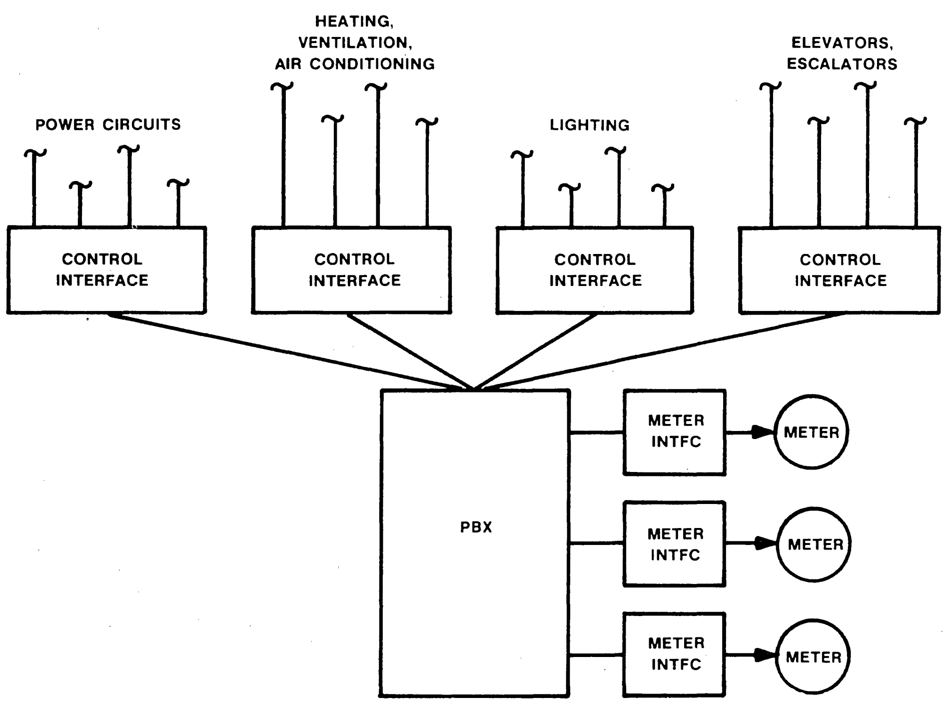

Figure 10 • a PAM PBX in an energy management application.

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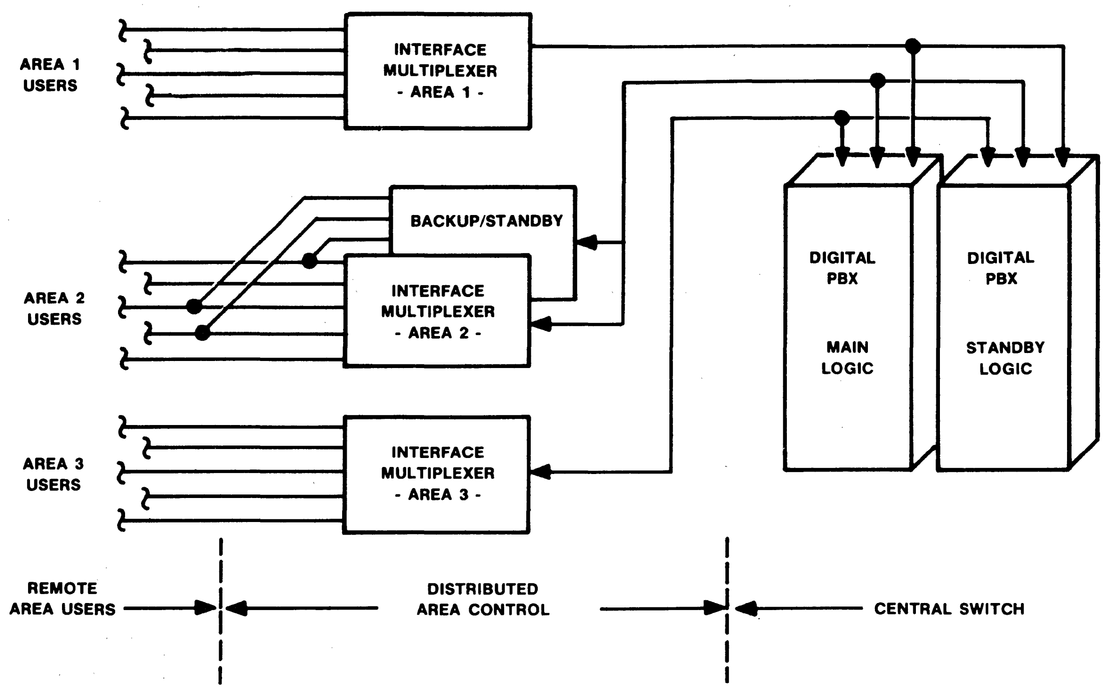

Figure 11 • parallel and distributed elements in a high-reliability switch.

• **Digital PCM encoding.** By converting voice into digital form, the digital PBX provides a switching system which can carry binary data efficiently without modems or add-on circuitry because it was designed to do so. The use of digital data on the link to the connection point makes it possible to share the same pair of wires for voice communication and data transmission even where the uses are simultaneous because the task of digitally separating the data while it is in digital form is relatively easy. This can be done by either using less than 64K bps for data as is done in the newer 32K-bps digitizing algorithms, or by employing a form of time multiplexing of voice and data together to produce a **composite digital frame** at a rate higher than 64K bps.

• **Integration of computer technology.** The high processing power of the digital PBX, and its distributed architecture, lend themselves to applications other than switching. Special services such as call forwarding may not be applicable to data communication in most cases, but other services such as closed user groups for connection security may be invaluable. In any case, could call forwarding to another host address help eliminate the frustrations of internal users resulting from a CPU failure?

• **High-speed trunk connection.** The similarity of digital PCM used in the PBX and the AT&T T-carrier system has already been discussed. This compatibility allows the attachment of T-1 level trunks to support voice circuits or data. For example, many large users are experimenting with T-1 as a connection between their offices and the local phone system, eliminating the multiple cables which can often be difficult to install. This scheme is particularly attractive when combined with the Centrex system to make office extensions numbers on a **private exchange** within the telephone system. Microwave T-1 attachment to private networks is also possible.

• **Attaching subscriber service processors.** A service processor is a device or unit which provides users of a PBX system with a special interface or service, as shown in **Figure 12**. They are particularly useful, and common, for connecting PBX-based asynchronous users to complex networks such as public packet or SNA. In that application they are often called **gateways** and made a part of a vendor-defined multidevice connection architecture with a proprietary name such as Northern Telecom's **OPEN World** and Rolm Corporation's **RolmNet**. The digital interface of a PCM PBX makes the attachment of such computer-based gateways easy, and makes user access to them almost transparent.

• **Use of existing wires.** Most offices are already wired for PBX/telephone systems, and most have 4-wire connection available to each position. Modern digital PBX systems can use these connections for transmission of voice and data at rates to 64K bps. Even where cabling doesn't already exist, the distributed architecture of the digital PBX makes it possible to construct a hierarchy of serving processors, which minimizes individual cabling by concentrating into interface multiplexers, then to central switches through trunk lines.

• **Internal message services.** Digital PBX systems often have the ability to provide message services in the form of data or voice message storage and forward. This may sound like a duplication of service with the electronic mail features offered by some office computer systems, but it has additional benefits to the user:

• **it replaces a computer-based system** which may be expensive or require excessive processing power to support.

• **voice message capability may be available**, expanding the scope of the service to those without data terminals.

• **it is available to any user of the PBX**, not just to users who have data access to the computer; this can be a key feature where some office positions have no requirement to attach to an internal system which has mail support.

• **it is available to outside users** who wish to communicate with personnel within the company without giving those **outsiders** access to company computers for electronic mail.

• **it can alert users to and deliver messages** even when the user is not connected to the computer; not all workstations will have constant access to a computer.

• **it provides message services** even when multiple computers may be used by any one workstation; leaving messages on 2 or more systems in the hope that the addressee will sign on to get them is inefficient and frustrating.

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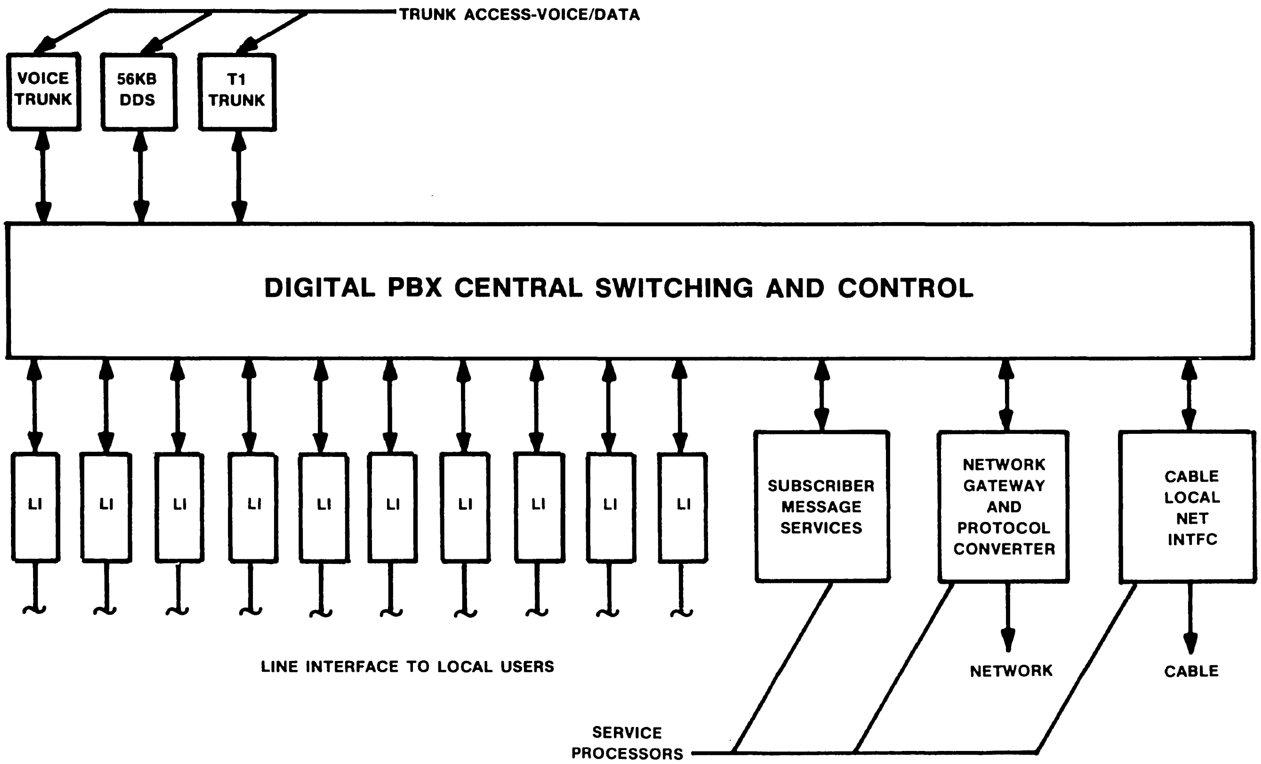

Figure 12 • service processors/gateways in a digital PBX.

■ THE DIGITAL PBX VERSUS THE LOCAL AREA NETWORK

One of the **hot buttons** of data communication today is the cable-based local area network (LAN). There are many solid reasons for its appeal; high transmission bandwidth, low per-attachment costs, support for very high data rates between users, and lower cabling costs. The cable network has taken a position competitive to the digital PBX as the hub of the automated office, and prospective buyers of office communication must consider it and its relative advantages and disadvantages.

Cable systems consist of a series of user attachment points, sometimes called **media access units or MAUs**, linked by coaxial or CATV-type cable. The linking cable may be continuously connected into a ring or may be open-ended in the manner of a bus, and the signals on the cable may be transmitted directly in baseband form or modulated onto an RF carrier much like a TV station as a broadband signal. Users essentially treat the cable as a multidrop line in that all share access to the common facility and require some method of usage arbitration to prevent constant interference.

Three methods of media control have become popular enough to be represented in today's marketplace; CSMA, token passing, and central station control. **CSMA** stands for **Carrier Sense Multiple Access**, and defines a system where stations simply send data when they have it, relying on low usage and listening first for other stations to minimize collisions. Some may detect collisions which occur once transmission has started, and these systems are said to have **Collision Detection**. The combination **CSMA/CD** is popular as the Xerox/DEC/Intel offering ETHERNET. Token passing refers to the circulation through the system of a **token** granting permission to send data. A station with data to send waits until the token reaches it, then removes the token and sends its data, regenerating the token afterward. In centrally controlled systems, a master cable controller allocates cable time to each station much the same way as a host computer controls a polled line.

Cable networks have not as yet taken over a significant portion of the data transmission within businesses. Part of the reason for this has been the lack of basic agreement on the structure and control of the cable network, particularly at the basic **link level**. Without any operative standards at the connection level, each cable vendor must either embrace a **compatible technology** of another (such as ETHERNET) or devise a proprietary method for control. Most, unfortunately, have chosen the latter course, and the result is a multiplicity of incompatible systems. Many users feel that the situation is still out of control, and prefer to delay any acquisitions of cable systems until solid standards exist. The Institute of Electrical and Electronic Engineers (IEEE) has formed a study committee, IEEE 802, for the establishment of a standard in the lower layers of the cable protocols (referencing the ISO reference model), but agreement has been hard to achieve and the **standard** actually **defines several alternatives**.

A second problem with the use of cable systems has been user confusion on the connection features offered. Many users expect the cable system to provide universal connectivity between their devices, including protocol conversion. Others expect a form of PBX-type calling service, including logical addresses and other features of switching systems. The ongoing debate over CSMA versus token passing and bus versus ring has tended to overshadow issues of usage in the trade press, leaving the user with a better understanding of engineering alternatives than of connection features.

The best starting point for users conducting a comparative evaluation of cable networks versus digital PBX systems is probably a comparison of basic architectures. Cable systems can be summarized architecturally as follows:

• **pure transmission systems** use broadband cable and frequency division multiplexing to give individual user pairs dedicated transmission paths. There is little provision for switching and connection support since the connection rules are

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established when the network is configured.

• **distributed, cooperative switching systems** use either broadband or baseband cable and have intelligent MAUs which work together to control data flow within the network, either by passing a token or by CSMA strategies. Here the transmission path is truly shared and must be arbitrated in some way.

• **centrally controlled systems** are typically broadband, where a cable controller provides supervision over the distribution of time allotted to each station and in general, controls the circuits. The MAUs are still intelligent devices in many cases, but act as slaves to the central control.

Users who can consider the pure transmission form of cable networks will probably have little difficulty making a choice between it and the digital PBX—the PBX will probably be significantly more expensive. In applications where a single cable is to share the transmissions between defined and fixed pairs of users, particularly computers, the broadband cable system in one of its forms is a very viable solution to communication problems. Cable systems can support very high data transmission rates, and the broadband modems needed for basic systems are inexpensive and reliable. Many users have installed such systems, and if their basic assumptions on the type of service needed were accurate they have generally been satisfied with the result.

Not all users can accept basic transmission services. If the devices in their application must cross-connect for various interactions rather than constantly support a single configuration, a degree of switching control is needed. This switching makes the application a candidate for PBX usage as well. The cable network offerings are so diverse that it is difficult to provide general rules for evaluating them against PBX systems, but here are some points to consider.

1. If the business already has a significant voice PBX requirement and if the equipment in place is old, replacement of it by a digital PBX with data communication capability may be less expensive than purchasing a new voice system and adding a data communication cable network at the same time.

2. If the number of data lines are small and there is no immediate need to replace existing voice systems, it is unlikely that digital PBX systems will be an economical solution.

3. Where very high data speeds are involved (over 56K bps), it will be difficult to find support in today's digital PBX product line. Cable networks may be the best solution.

4. Many terminals operating at medium to high speeds rapidly consume bandwidth. A 1000-line digital PBX may have a data bandwidth of 56M bps (1000 lines at 56K bps), far beyond that of a baseband cable system and probably difficult to support with most commercial broadband offerings.

5. Cable economy with the local area networks is most obvious when the users are clustered in computer or terminal rooms throughout a facility. Office automation users are not necessarily placed so conveniently, and the cost of winding a cable throughout a building to each current telephone position would send chills through most facilities managers. On the other hand, using a long local attachment to a cable MAU to connect a remote user may erode cost savings because both coaxial cable and RS-232C cabling are more expensive than telephone twisted pairs.

6. It is normally more difficult to provide basic centralized services such as call records, gateway access, access protection, and message storage by cooperative efforts of a distributed network than by operation of a central facility. If user needs for these services are high, the digital PBX is likely to serve best.

7. If you draw a map of your proposed cable network and find that it consists of multiple rings or busses connected with internet gateways and with redundant control points and access units, consider the possibility that you are pushing the technology a little too far. There are cable networks which can handle such configurations, but the application is clearly one where a PBX could be considered.

8. Be sure of your cable supplier. Digital PBX systems are available from companies with considerable field experience and large installed bases. If a part or extension is needed for such a system, it is probably going to be available. Who makes your cable alternative? What is their financial position? Can you get compatible equipment elsewhere? There is no cable network supplier today with the field experience or installed base of even one of the smaller PBX vendors.

A final point on the issue of cable versus digital PBX is that there is a good chance that the best way to utilize cable technology may be through the digital PBX system. Some of the vendors are already providing cable interfaces for their products as a part of their **open office system** concept. If you find that a cable system satisfies a short-term need, try to get one which is compatible with some of the PBX products, and if you cannot get a definition of a compatible cable attachment from your PBX vendor, consider one of the standard (IEEE 802 or de-facto ETHERNET) systems.

■ FEATURES VERSUS APPLICATIONS—WHAT'S IMPORTANT?

The features of digital PBX systems that most interest data communication users are likely to be those directly concerned with data transmission. Other features should be considered as well in the context of the automated office, because they create an environment which is more conducive to workstation productivity. Some features of this type are:

• **Message storage and delivery.** Much production is lost in the repeated attempts to contact persons who are not at their desks or are otherwise unavailable. In the automated office, this lack of availability may create the need for manual messages of the **while-you-were-out** style, a clear contradiction in the quest to eliminate paper flow. Computer storage of messages, whether in voice or data form, is valuable in helping to schedule the dialogs necessary in any business to resolve questions and make decisions. In the data context, messages may be used to schedule access to a resource. Broadcast form messages and messages with multiple addresses are especially valuable to alert users of a resource of a change in its status ("drive 2 is not available due to maintenance—expected availability 2 pm").

• **Paging.** Many automated offices use open floor plans which have cubicles for each workstation. Finding people in this environment can be difficult, and having a substantial portion of the organization searching for the people they must talk with is not much different from having them searching files for information. Paging helps locate people without requiring anyone to leave the work position (and probably cause others to begin looking for them).

• **Conference calling.** This is important for much the same reason that paging is useful. Many meetings do not require all the parties to be physically co-located, only that they can freely communicate. A conference call may get 3 or more decision makers together for a short discussion which otherwise might have waited days until a meeting could be scheduled.

In the area of data features, the prime issues relate to the way in which data is sent and the limitations on its speed and structure, but there are many other issues. Prospective users must determine how integrated the voice/data combination is within each PBX alternative as well as the specific features which apply to data. Here are some guidelines.

• Voice and data may coexist within the PBX, but there may be limits on how close to the user this coexistence comes. Ideally, a single connection (2, 3, 4, or more wires in a single cable) should carry both voice and data. If separate connections are needed, the cost may be excessive if all or many workstations are provided data terminals.

• Even where both voice and data share a cable, they may be alternating in use rather than simultaneous. By **alternating**, we mean that the workstation operator cannot have what appears to be a simultaneous data and voice conversation, not that the technology necessarily sends both at the same time. In some newer integrated voice/data technologies the information is time-division multiplexed; voice and data are transmitted in pulses at a higher speed than the 64K bps required, but are interleaved in some way to appear simultaneous to the user.

• Attachment of the terminal to the PBX may be an issue even if a

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single integrated path is provided. Digital PBX systems, as has already been noted, can accept data in digital form by introducing it after the voice has been digitized where the stream of information is digital. If digitizing occurs at the user connection (the telephone instrument or a special local adapter/connector), the terminal might plug directly into the digitized unit. In some PBX systems, there is a data connector on the back of the telephone unit. It is desirable that the attachment of the terminal be as easy as possible. It is also desirable that the substitution of a voice/data position for a voice-only position be possible at a low (preferably near-zero) cost.

• Data connections should have all of the forwarding features of voice connections, but should be immune from the incoming call signal and should be barred from connecting to a voice station.

• Connecting a computer or set of computers to a PBX may make sensitive applications available to internal subscribers or even to outside callers. Some form of connection security should be provided by the PBX to prevent unauthorized access, because not all computers will administer password protection. It may also be desirable to make attempts at unauthorized access an **alert** on the PBX call reports.

• Where data calls are made from the PBX out into the public phone system, least-cost routing may be desired if tie-lines are available, but if the line quality of the tie-line is low or if the long holding time of a data call makes the use of tie-lines inappropriate, it should be possible to inhibit LCR on the data calls.

• Computers may connect to the PBX in the same way in which workstations do, but there are advantages to optimizing a host access. No voice connection is normally required for computer connections, and the use of a service processor for protocol conversion may make it possible to connect a host via a network interface protocol such as X.25 or SNA. Cable network attachment or even a T1 interface may also be available.

• If transmission at rates above 19.2K bps is necessary, some form of high-speed interface will be required since the RS-232C interface is not suitable for high speeds. Popular interface alternatives are V.35 and RS-449. Be sure that the PBX supports the type of interface you have for the equipment, since interface conversion at higher speeds is likely to be expensive.

• Some PBX systems support an **information station** which consists of a small CRT display and a keyboard (perhaps with only numeric and function keys). This station can be used for automatic dialing and to receive messages or call status. In some applications, this type of unit can result in considerable increases in productivity by eliminating searches of phone lists or by allowing messages to be received by a person whose phone is in use. There is little compatibility among vendors on these information station interfaces, so be sure that your supplier has what you need.

• Open attachment architectures are becoming the vogue in digital PBX advertising, and the concept is worthwhile if it is properly supported. Be sure to find out exactly how all of the office units shown in the open system charts actually connect, and get the connection cost. Also find out if there are restrictions in the interface, manufacturer, model, or other areas.

■ EVALUATING DIGITAL PBX SYSTEMS

For users with specific and immediate purchase plans, generalized guidelines on the importance of digital PBX features may be helpful but unsatisfying. If you are evaluating a PBX purchase, the following checklist will help you match technical characteristics with your own needs.

• **Technology.** Units which are called **digital PBXs** may be the time-multiplexed Pulse Amplitude Modulation type or the Pulse Code Modulation/Delta modulation type. PAM systems are not strictly digital devices because the samples taken of the input are still analog signals, while PCM or Delta modulation systems are totally digital. PAM systems may be less expensive for users whose data communication needs are limited to low-speed devices and who do not expect to employ high-speed host or network attachment protocols from the PBX. For other users, especially those with growing needs for high-speed data exchange, the digital PCM or Delta system is preferred.

• **Blocking or Nonblocking.** Most true digital PBX systems are effectively nonblocking in that they do not limit the number of simultaneous user connections. If you are reviewing any systems which are blocking PBXs, be sure to find out what the capacity for simultaneous calls is. Sometimes vendors will express capacities in traffic-density units such as erlangs or CCS (100 call-seconds) which are useful primarily to telecommunication engineers. It is best to get a specific answer to capacity based on your own target configuration. Ask, "How many of my lines can be engaged in calls at any point in time?" and be sure that you know the difference between the number of calls and the number of stations active (normally 2 stations are active per call unless it is a conference call or an outside call).

• **Voice Data Support.** A PBX may support voice and data over separate lines, competitively over a single line, or simultaneously over a single line. If your applications require that a workstation operator be engaged in voice calls while using a terminal, simultaneous voice/data will not require separate lines for that use. If most of your operators will not use data or will use it in place of voice when it is used, competitive or duplicate-path systems may be less expensive.

• **Integrated Information Instruments.** Where voice and data can use the same line together or alternately, a single unit should provide for connection of a terminal and a phone to the line. The cost of this unit, both as a separate purchase and as an increment over a voice-only connection, affects the economics of giving each worker both voice and data capability. An ideal system would provide a combined unit at a price low enough to justify for all positions in the organization so that the addition of data capability at a workstation can be accomplished without incremental PBX cost. If you cannot justify the expense of universal voice/data connectivity, be sure that you know how much it will cost to add data to workstations and project the total cost of adding data capability as a function of data growth. A system which is cost-effective with predominantly voice traffic may become much less so as data terminations are added.

• **Modular Distributed Architectures.** Many digital PBX systems have modular architectures which permit the addition of groups of lines with little or no expansion of the central switching facility through interface multiplexer units or remote concentration units. This type of architecture allows users to grow from a relatively small to a very large system while keeping incremental cost per user nearly level. Modularity may also extend to the switching units themselves; some vendors are offering a hierarchy of switching systems which resemble AT&T's switching office structure in their flexibility. If you are expecting significant growth within 5 years, ask each vendor to plot the changes in your configuration (and their cost!) by year, and be sure that they take the request seriously. If you have any doubts, ask that the availability of upgrade as shown be made a part of any contract signed.

• **Interface Flexibility.** You cannot switch if you cannot connect. Be sure that the interface, speed, and protocol limitations of any system being evaluated are understood. Try to get the following specific questions answered.

1. What electrical interfaces are supported? (RS-232C, RS-422, RS-423, V.35, AT&T 303, T1, etc.) Be specific.

2. What transmission speeds are available, both synchronous and asynchronous? For synchronous support, can the PBX supply clock?

3. Are synchronous terminals supported as destinations for system messages or mail? (Probably not, but ask.) If not, will the system prevent incompatible transmissions which might lock the terminal?

• **Connection Security.** In a fully-switched PBX environment you may be exposed to application security problems, because any terminal could in theory access any computer. If your applications were used to having dedicated terminals which were physically secure, they might not provide any form of access protection. Will the PBX support closed user groups? Passwords for data access? Prevent connections between incompatible users?

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• **Special Services Processors.** Most digital PBX systems now support special features via an attached microprocessor-based service processor. One example of this service is a protocol converter gateway into a special network or transmission system. A popular gateway is the **X.25 PAD**, which gives users the ability to connect their terminals into public packet networks. If you are looking at gateway systems, be sure that the gateway meets the interface standard of the destination. For X.25, that means certification for connection to the public networks. In the case of SNA, find out what physical unit type and logical unit type are emulated by the PBX and check with the system programmers in the SNA host organization to be sure that the facilities are compatible with their system and with your planned use. Where the gateway connects to a special transmission facility, be sure to find out what interface is required. Cable networks, for example, may use a proprietary interface or a public or industry standard (such as ETHERNET).

• **Service, Support & Reputation.** PBX systems are important to most businesses and are therefore a poor place to gamble for minimal economic benefits. Be sure that vendors you consider have a good service organization, offer installation planning support, and can provide customer references.

■ ORDERING & INSTALLING A DIGITAL PBX

Deciding what to buy is only the **first step** in entering the world of the digital PBX—it still must be ordered, installed, and used. Digital PBX systems are normally large capital investments, so at an early stage in the deliberations, both legal and financial advice should be sought to insure your organization is protected and maximizes tax advantages for itself. Some things to look out for in this phase are.

1. **If you are considering leasing the PBX**, be aware that some leases (often called **closed-end** or **operating leases**) are more similar to rental agreements because your business does not own the equipment and is not entitled to a tax credit. While the cost of an operating lease may be lower, the long-term implications of the loss of tax credit and depreciation may be unfavorable. Check with your financial department.

2. **Be sure that your lawyer has reviewed** the portions of the **vendor contracts which deal with your rights** in the event that another party brings action against your vendor for infringement of patent rights or nonpayment of license fees. You should be guarded against any actions which might arise from such a dispute, and your attorney may want specific remedies spelled out. You may also want to be sure that no such proceedings have been filed.

3. **If you provide services to other organizations** from your PBX system, you should address in contract form the limits of your liability to them in the event of a failure. Your vendor may not consider them customers. In particular, avoid **consequential damages** clauses in agreements with these users. If you are using the PBX for security or fire protection, check with the insurance company and be sure that all codes are met.

When you have decided to place an order, the legal and financial advisors should begin the negotiations of the contract and the securing of financing. During this phase, the following points should be considered.

1. **Be sure that any key vendor commitments are written into the contract.** This is especially important where these commitments represent promises for modifications to the standard product, advance commitments for delivery of new features, specific performance promises, or growth and migration paths into new configurations. In general, try to address any key purchase issues, but don't get too complex—a 40-page contract may require months to negotiate.

2. **Get a firm delivery date**, but be sure you ask for the equipment well in advance of any firm need. In the first place, installation may require some time, and in the second place, there should be a shaking-out of the system to some degree before full installation and use.

3. **Be sure you know who is responsible for running wires and ordering phone lines**, and if your business has this task, be sure it is done in time. A failure on your part will excuse late delivery on the part of the vendor. Don't overlook electrical power and environmental issues—find out what is needed and get it done. You will almost certainly have the responsibility here.

4. **If you elect an open-ended lease** and are told that you can take the tax credit, be sure to get a form or statement to that effect.

As the installation date approaches, you will want to be sure that all of the preinstallation details are covered.

1. **Do you have the physical space prepared**, including environment, power, lighting, etc? Be sure that if any special plugs are used on the unit, the proper receptacles are installed. Many systems employ the Hubbel Twist-Lock plug, and it must be specially ordered and installed. Be sure that wiring complies with the local codes and that it is properly inspected and approved.

2. **Have a master plan drawn**, hopefully with the cooperation of the vendor, to show the location of each phone or other piece of equipment. **Figure 13** shows a sample of a portion of such a plan. When the gear arrives, you don't want to have to figure out where it all goes.

3. **If the instrument wiring is your responsibility**, find out exactly what type is needed, including some specific nomenclature (4-wire twisted 22 gauge with vinyl jacket) and if possible, a manufacturer/supplier recommendation. Check this with the local building inspector, and be sure your plan to route the wire is acceptable. The compliance with local codes here is your responsibility.

4. **If new extension numbers are to be assigned** on the system, make up new phone lists. It may be a good idea to give data-only connections such as computer ports numbers in a special range so that they are not dialed accidentally. Note the numbers on your master plan and put a label at each physical location indicating the number of the extension to be placed there. If any special equipment such as a data terminator is to be installed, note that both on the master plan and on the label.

5. **Ask the computer operations and programming personnel** to be sure that any changes in the system or application software needed to support the PBX data connection are made and the new versions ready to be tested and installed. If user IDs or passwords are to be needed, get them assigned and distributed to the people involved.

6. **Consider having one or more operators trained in advance** of installation so they can help others over the early confusion. Also, set up a **hotline** for internal users who have questions. Also, consider seminars to train your internal users. Try to get the vendor to help with these.

7. **Have a meeting with the vendor about a week before installation** to review the procedures to be followed and to validate the satisfaction of your preinstallation responsibilities.

When the equipment is delivered, assign a user coordinator to work with the vendor in getting everything installed and checked out. Parallel testing a system such as a PBX is pretty much impossible, so you will have to certify its operation with a few new circuits. Here are some tips.

1. **If you can, install an outside line and connect it to the new equipment.** In the first stages of the installation, connect new internal service to the system and check it out as much as possible.

2. **Give installation priority to the voice system** unless you have unusually critical data requirements. Chances are, your present data connection technique will serve, but you will not operate without telephones.

3. **Cut over to the new system over a weekend**, preferably a long weekend. Have a team of people check all the phones and mark any problems on a trouble log and on a note at the instrument. Leave each user whose unit is malfunctioning a note stating that the problem is being resolved; provide both an estimate of correction time and an interim solution.

4. **Make up a list of problem extensions and their alternates** and give it to the switchboard operator as a temporary amendment to the new phone list.

5. **Have a team of vendor and user personnel circulate** on the

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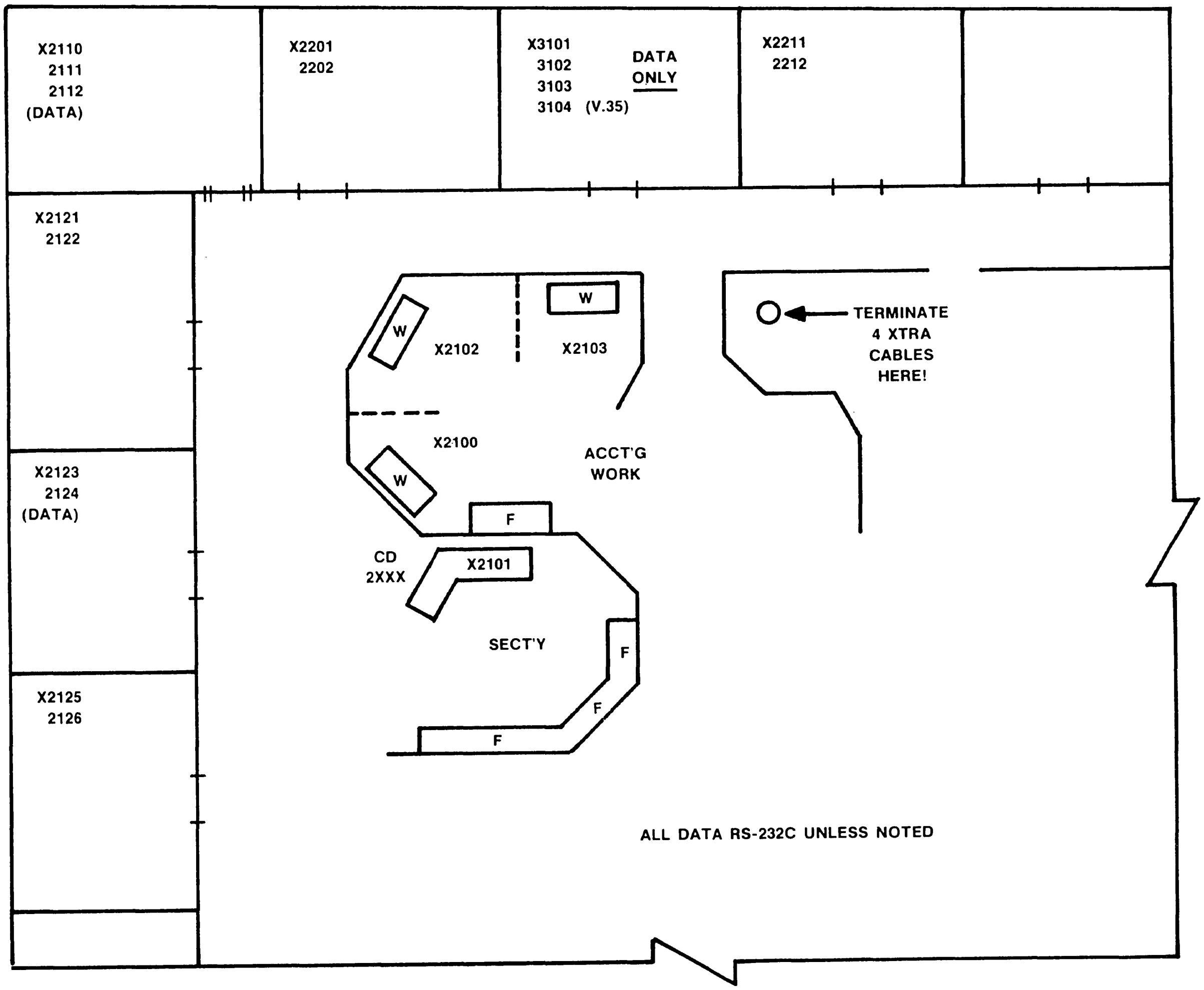

Figure 13 • a user's master floor plan.

first few days of installation to detect and correct problems.

6. **When data cutover is ready, have the computer operations personnel install the new software off-hours to check it out,** and when it is ready, cut over the data connections. Be sure to monitor the new system for failures, delays, or security problems.

Sometimes the installation of a new piece of equipment is a good time to schedule other tasks which might be unnecessarily disruptive if they were done alone. Some things to look at.

1. **Assigning a new set of passwords and user IDs** for the computer systems to introduce some structure and uniformity.

2. **Running cables for phone extensions** expected to be installed later.

3. **Instituting new procedures for the telephone system,** such as phone coverage, message taking, alternate contact points.

4. **Establishing a structured phone number** so that a portion of the number identifies the department and a certain base value is always the general contact point within the department for questions. For example, all accounting numbers might be of the form "4XXX" and "4000" might be the accounting information number.

■ LOOKING INTO THE FUTURE

The expansion of digital technology has continued to accelerate, and there is little doubt that many changes and improvements in the digital PBX can be expected. Semiconductor manufacturers are already beginning to produce chips to increase performance and cut both costs and space required. Here are some trends you can expect in the growth of the digital PBX.

• **Look for higher speed data support.** 64K bps will soon be universally available and rates to T1 (1.544M bps) will become more common. Simultaneous voice and data over one cable from a workstation will become the rule.

• **Gateway processors will become more important,** not only to custom protocols such as X.25, but to specialized transmission media such as cable LANs and to special devices such as digital facsimile. These improvements will make the digital PBX even more important to the automated office.

• **Specific directions in office automation will be provided** as giants such as AT&T and IBM lead the field. Both of these companies have an interest in office automation which extends beyond the data communication aspects.

• **The growth of smaller specialized PBX companies** like CXC and Ztel will be cut short by a major industry shakeout that will

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take place over the next 2 years. The major players will include AT&T, GTE, NEC, Northern Telecom, and IBM/Rolm.

• **The Information Station concept will expand to replace the conventional business telephone** with a small keyboard and screen. This will supply traditional features such as abbreviated dialing and display of call progress messages but will also extend to services such as phone listing lookup, text message entry, storage, and delivery, and even calculator replacement.

Disputes over the superiority of the digital PBX or the cable LAN will probably not be settled in the near future, but it seems inevitable that technical progress will integrate all of the office technologies into a single and more effective unit in the satisfaction of business goals, making debates on the relative quality of each component as unnecessary as debates over whether marketing or accounting is the key to corporate success.

• END

Key/Hybrid Telephone Systems

An Introduction to Electromechanical, Electronic & Hybrid Key Systems, the Industry & System Planning Guidelines

■ INTRODUCTION

The most frequently used business telephone system is the key system. There are more of them in use than any other type of communications equipment. Their appeal to users is a blend of flexibility, reliability, low cost, and abundancy of features. The industry has grown dramatically in the past 10 years, to where today it is one of the most hotly competitive areas in the telecommunications industry. While a PBX more often steals the show with its numerous sophisticated data and voice integration features, key systems continue to forge ahead, providing better service, improved ease of operation, and better management controls. This report focuses on the key system industry; its evolution, the technologies, key players, and the significant trends. It also discusses how to plan for a successful system installation.

Key telephone systems satisfy the communications needs of small- to medium-sized businesses at a minimal price with a high degree of reliability and flexibility. A typical key telephone system has the ability to connect 2 or more telephone lines on 1 or more specialized telephone sets. Each **key set** can access some or all of the telephone lines. Intra-company communication is usually handled by an **intercom** line. Additional devices such as **external bells, buzzers, automatic dialers, handsfree units, and toggle switches** provide greater ease of use. Key systems of today include both **electromechanical** and **electronic** products. Although there are millions of electromechanical units still in operation, the trend is toward **electronic** key systems.

Hybrid System—TIE Ultracom CX

■ BACKGROUND

Traditional key telephone systems date back to the early part of the 20th century, but didn't begin to achieve any structure or momentum until the introduction of 1A service in 1938 by the Bell System. The next upgrade to key service came in 1953 as 1A1, which featured the familiar flashing lamp. The next major development in key equipment occured in 1963 with the now ubiquitous 1A2 system. This built on 1A1 by putting all major components into plug-in units that connected to a prewired housing, or **key service unit (KSU)**. Most electromechanical key systems today are 1A2, models which have achieved an outstanding record for service and longevity.

The Carterfone Decision of 1968 opened the door to non-Bell telephone equipment, which has grown into the multibillion dollar **interconnect telephone industry**. Early interconnect key systems were manufactured by Iwatsu, Toshiba, and Telephone Interconnect Equipment (now TIE/communications). These companies built key systems that had several important features not available with Bell 1A2, such as automatic button restoration, multiline conferencing, and tone and voice station paging. Perhaps the most popular feature of these systems was music-on-hold. But the most important message was a new financial option: users could **purchase** their telephone systems. For the first few years, these fledgling companies had to claw and scrape to build market share. AT&T finally acknowledged their presence in 1973 by announcing ComKey, a modified 10- and 20-button key system that offered the same features as the interconnects, plus a new Two-Tier payment plan. Customers still couldn't own a Bell-provided system, but the Two-Tier plan gave them the feeling they were, and it helped the company compete successfully.

The increased use of microprocessors in PBX systems during the middle and late 1970s found its way into the key system marketplace. **Electronic key systems** began appearing around 1978, and with increasing frequency in the early 1980s. On the surface they appeared the same as a typical electromechanical telephone, but that's where the similarities ended. All internal operations were under control of a stored program, the same as most PBX systems; PBX-like features were available; and station equipment required only a few pairs of wires, rather than the familiar 25- or 50-pair cables.

Another type of telephone system that first appeared in the late 1970s was the **hybrid**, so named because it could be configured to function like either a multibutton key system, a PBX, or a combination of both. The first of these was the AT&T Horizon, which was followed by similar products from manufacturers like NEC, Iwatsu, Toshiba, and ITT. These systems were all microprocessor/stored program controlled, and had a large number of features that often rivaled their PBX counterparts.

The telephone system industry in the under-100 line range is perhaps the **most active** market segments. Systems can range from 2 lines and 2 phones to 30 trunks and 100 stations. There are thousands of key systems users, a growing number of hybrid users, and competition for market share is intense. Prices can range from about $1,000 to $20,000 and there is substantial flexibility for price adjusting throughout the various products. The ease of installing a key system makes it an extremely popular part of an interconnect telephone company's product line. Most systems can be installed and literally forgotten—their quality is high and they are easy to service. It's not unusual for an interconnect to carry products from at least 2 key system manufacturers, since some vendors specialize in products at different line sizes. The interconnect company must have a product line that can accommodate just about any size system, to satisfy user needs.

■ KEY SYSTEM TECHNOLOGY

Electromechanical key systems are built around the **key service unit (KSU)**, which functions as the equipment cabinet. **Key telephone units (KTU)** plug into the KSU to provide access to phone lines and other features. Users can configure an unlimited number of lines into a key system simply by adding more KSUs. Phone lines are connected to the KSU via a 400-type line card.

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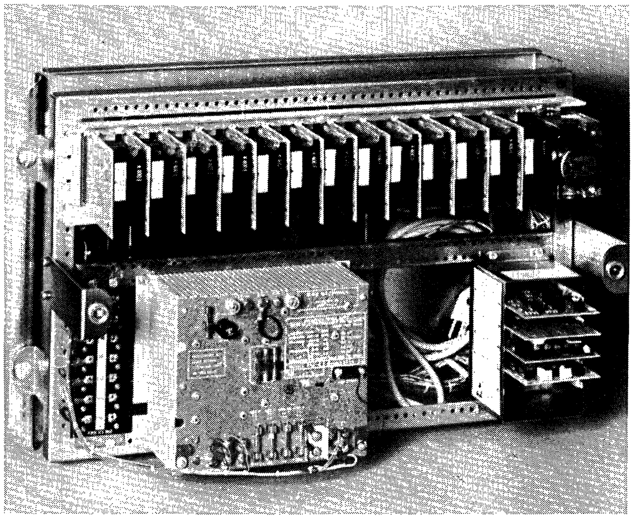

1A2 Key Service Unit—ITT K-512A

This provides the electrical connections, relays, and signaling necessary to make the line available on a key tèlephone. An **interrupter** flashes station lamps at different rates when there is an incoming call or a call is placed on hold. The **power supply** provides DC current to the KSU. For intercommunication, there are usually 2 types of methods, **manual or dial signaling**. A manual intercom requires a 401-type KTU, which provides a simple talk path between 2 or more phones. Separate signaling devices are added to permit 1 user to alert another of a call. A dial intercom is frequently used if there are 4 or more users that have a need to intercommunicate. A single dedicated talk path is provided on each phone, with a 1- or 2-digit code for dialing stations. Most **dial select intercoms** accommodate either 9 to 18 codes, with some units available that can support up to 36 dial codes. Older dial intercoms required a separate equipment cabinet, which made them somewhat more difficult to service. Dial intercoms manufactured today, however, have all components mounted on a plug-in card that fits into the KSU. A special card is required for **music-on-hold**, a feature made popular by interconnect companies. Other cards are required for **paging system access** and **automatic ringdown lines**.

Cabling requirements for electromechanical key systems are substantial. Aside from multiple **connecting blocks** that connect outside lines to the KSU and station equipment, the telephones themselves require at least 25 pairs of wires per set. While a standard telephone uses only a single pair of wires for communication, a key phone typically requires 4 pairs for each line appearance. A pair each is required for speech, lamp, signaling, and hold. More pairs are required for intercom lines and special circuits. It is easy to use up available pairs on a 25- or 50-pair cable with a fully loaded key system. Since each pair must be connected by hand, installation is slow, usually 1.5 to 2 hours per station.

Station equipment is available in a variety of line sizes, ranging from the familiar 6-button set up to modular units that can support as many as 120 buttons, typically built into flush-mounted desk units. A ubiquitous **hold button** is provided. Other buttons are used for outside lines, intercom, signaling, or private line access. External buttons, buzzers, and switches are available for specialized applications, giving users substantial flexibility. Speakerphones, automatic dialers, call diverters, and answering machines can be added for further variety.

When interconnect systems appeared on the scene in the early 1970s, they had 5 specific features that the interconnects hoped would set them apart from Bell phones, and, hopefully, translate into sales. The 5 included **automatic button restoration, multiline conferencing, tone and voice signaling, music-on-hold, and direct station selection with busy lamp field**. They were referred to as **square** systems because each station had the same configuration of outside lines and intercom buttons. It took the Bell System about a year to get the message, and the result was **ComKey**, a family of products built around existing components with additional features. The systems sold well, and many are still in use today. These systems represented the highest level of sophistication acheived for electromechanical key equipment.

■ ELECTRONIC KEY SYSTEM TECHNOLOGY

If PBX systems were making greater use of microprocessors and stored programs, why not key systems, too? As with a PBX, an electronic key system has a central processor, stored program, some type of switching matrix, wide range of features, and skinny-wire connections to stations. Physically, they look like a conventional key system with separate pickup buttons for all outside lines, separate buttons for intercom, and a hold button. Lines can be accessed by depressing the desired button, and intercom calls are made by dialing the desired extension number. The direct station selection/busy lamp field (DSS/BLF) unit for an attendant is still there. But that's where all similarities end.

Stations are connected usually by 2 pairs of wires, **regardless of the number of lines picked up on the set**. This makes installation substantially easier than electromechanical key systems. Numerous features are available, like **call forwarding, calling number display on a station, do not disturb,** and **speed calling**. Specialized features like **station message detail recording (SMDR)** and **automatic route selection (ARS)** are available on some models. A few models have, or are planning to add, **data communications** capabilities. Telephone sets usually have their own built-in microprocessor, and offer **integral speakerphones** for ease of use. Each manufacturer has its own line of proprietary stations for use with the system. All components are housed in a small floor- or wall-mounted cabinet, and uses plug-in circuit boards for system functions.

■ HYBRID SYSTEM TECHNOLOGY

Although these systems exhibit features common to both key systems and PBXs, they are more like PBXs in design and operation. System architecture is either centralized or distributed, and switching is built around either TDM/PAM or TDM/PCM principles. Many have nonblocking switching matrixes, and several are digital switches, with the potential to handle integrated voice and data communications. Systems typically support up to 120 stations and 40 trunks, but a few can approach 300 stations. Attendant consoles look just like PBX consoles, and function the same. Standard single-line 500 and 2500 telephones can be used, as well as proprietary station instruments. These **multibutton electronic telephones** can be programmed to operate like key telephones in specific applications. It is possible to have a system with all standard telephones, all proprietary telephones (this is what the manufacturers prefer, naturally), or a combination. Costs for an electronic telephone can range from \$150 to about \$500, compared with \$50 to \$80 for a standard phone. The reason for going with electronic sets is the abundance of features, usually 3 to 4 times as many as with a single-line phone. Depending on user needs, the additional features may not really justify the additional cost. One important factor in the hybrid's favor, however, centers on price. Comparing a PBX with a hybrid system—identical configurations—yields a **significant savings in favor of the hybrid**. Of course, if the application is projected to expand beyond the growth limits of the hybrid, the hybrid should not even be considered.

□ Strengths & Limitations

Electromechanical key systems are alive and well. Some industry analysts have projected their eventual demise, and this may happen by the end of this century, but in the meantime, there's still a lot of business out there. Their cost has risen to the point where it no longer makes sense to lease them monthly from such companies as AT&T Information Systems, which took over the installed base of electronmechanical systems from the Bell operating companies. AT&T-IS would prefer to sell its Merlin electronic key system, the Horizon hybrid, or even its new System

Key/Hybrid Telephone Systems

75 PBX. If traditional 1A2 is the choice, however, most interconnect companies will be happy to provide a system. More cable is required, which today translates to additional expense. Installation takes longer, also contributing to costs. Maintenance, on the other hand, should be minimal, as 1A2 equipment is extremely rugged, and should generally outlast electronic systems. Fewer features are available than with electronic equipment, and any changes must be hard-wired. 1A2 is virtually universal; any type of equipment that supports 1A2 can be connected into any existing 1A2 system. Some of the major manufacturers of 1A2 have signaled their intent to pull out of the business; the most prominent is AT&T and its Western Electric unit. In spite of these developments, it's still hard to beat the flexibility and cost of 1A2.

Electronic key and hybrid systems are definitely the wave of the future. Numerous features, increased flexibility, ease of cabling, programmability, and diagnostic routines all enhance their value. Stations look more attractive. Expansion in the field is easy; usually by adding more circuit boards and stations. The use of proprietary telephones, however, locks a user into a particular vendor. Troubleshooting requires electronic testing equipment, and repairs usually involve replacing circuit boards. System diagnostic programs help, but test sets are an absolute must. Extensive training is required for both installing an electronic system and understanding how to properly use all the features. Static electricity and radio interference can cause problems with the system's integrated circuits. More spare parts are required for an electronic key system than 1A2. Pros and cons for hybrid systems are essentially the same as electronic key systems.

■ THE KEY SYSTEM MARKETPLACE

There are over 40 companies in the U.S. actively engaged in manufacturing key and hybrid telephone systems. Most specialize in a particular market segment, but there are a few who provide systems for any application. The major players are AT&T, ITT, Comdial (which acquired Stromberg-Carlson key equipment), NEC Telephones, Iwatsu America, TIE/Communications, Toshiba Telecom, Executone, American Telecom, and Northern Telecom. The largest market shares are held by AT&T, Comdial, ITT, TIE, Iwatsu, and NEC, but the market is very competitive, and the other players are working aggressively to increase their share.

Two of the largest players, AT&T and Comdial, are getting out of the 1A2 business to concentrate on electronic systems. This may be premature, considering the vast numbers of 1A2 systems still in the field. AT&T, which got a late start in the electronic key system business, is pushing its Merlin, a small modular unit that handles up to 8 lines and 20 stations. The system can be installed by a user with only a screwdriver. It is expected that Merlin will gradually be expanded as AT&T phases out its involvement with 1A2. TIE, NEC, and Iwatsu have considerable experience with electronic key systems, and should continue to set the pace for the industry. Other companies appear periodically with an electronic key system, but their ability to penetrate the market is limited by the extensive presence of the market leaders.

1A2 Key Telephone—ITT 20-Button Model 2831

Electronic Key System—AT&T Merlin

Some companies pursue a different avenue in marketing their products. A particularly significant opportunity is Centrex, which typically is heavily configured with key equipment. Systems have been developed that work "behind" Centrex, providing specialized features not normally available. This market may, however, dry up within 2 years as Centrex undergoes extensive feature enhancements.

The next direction for the key system market is office automation. Voice communication is the most frequent application for a key system, but the need to support data communication cannot be overlooked, especially with the proliferation of personal computers. Expect 1985 to be a year of increased digital key system announcements, with electronic telephones designed to accept RS-232C terminal interfaces. Although digital systems are faster and more efficient than analog systems, the analog system can still support limited data communications with modems and other suitable interfaces.

■ EVALUATING & SELECTING A SYSTEM

The rules for deciding on a key system are essentially the same as for a PBX. There are probably more alternatives available for key systems than PBXs, and this could add to the confusion. Depending on the size of the prospective installation, no more than 4 or 5 vendors should be solicited for bids. Specifications for the system should be drawn up on a Request for Proposal (RFP), with specific issues of installation, training, maintenance, and availability of spare parts spelled out clearly. Most vendors will offer both purchase and lease options, but check out the leasing plans carefully; find out who provides the package. Check out other installations the vendor has in the area to make sure these users are satisfied with the vendor's performance. The competitive nature of the key/hybrid business affords some room for price adjusting, but cost should not always be the deciding

Key/Hybrid Telephone Systems

factor. New electronic systems have lots of features, many of which won't be needed. Electronic telephones provide access to these features, but their cost is several times a standard 2500 telephone. Electronic systems provide greater flexibility for user applications, but this flexibility doesn't always come cheaply. Once the decision has been made, and the agreements signed, stay in close contact with the vendor to make sure the installation schedule is maintained. Once the system is in operation, exercise it for a few days to uncover any bugs, before signing the certificate of acceptance. Training is very important with electronic systems. Some vendors will train the user's entire staff, but this is fast becoming the exception. Today, the vendor trains 1 or 2 employees from a company, who then train other employees. The system database is critical to the success of a system. In most cases, the vendor should gather all pertinent data and take care of the necessary system programming. Some vendors require the user to gather station information for the database; this should be determined early in the RFP process. While there are numerous elements in the acquisition of an electronic key/hybrid system, the many improvements in today's systems should result in a relatively trouble-free installation.

• END

Shared Tenant Services—Smart Buildings Are Here

An Introduction to Shared Tenant Communications, The Technologies Involved, The Issues & The Impact on Building Development

■ INTRODUCTION

Shared Tenant Service is the provision of integrated communication and information services to building tenants on a shared basis. Most office buildings today offer environmental services, electricity, security, maintenance, and other administrative services. In the last 5 years, however, a trend has been developing to augment these traditional office services with telecommunication and data processing functions, and the increasing acceptance of these factors by building developers and managers points to perhaps the fastest growing area of the telecommunication industry today.

The development of "smart" buildings is a recent phenomenon, and suggests a future office environment in which the office worker has available an extensive array of information services, such as telephone service, voice and text messaging, teleconferencing, and resource sharing, all provided by the landlord. Developers and building managers who embrace this exciting concept are indeed "smart."

A developer of office buildings automatically plans for such services as heating, air conditioning, electricity, maintenance, security, and the usual administrative functions of leasing and building management. Since the objective in building office space is to have it fully leased and occupied, it is a major challenge to compete with other new and established office complexes without an additional competitive edge. Shared tenant service is the key factor in today's hotly competitive market for selling/leasing office space. **Where tenants have traditionally assumed the responsibility for satisfying their communication and information processing requirements, they now can obtain these same services from the landlord, in addition to the other services they have come to expect.**

Methods of Providing Shared Tenant Service

Several considerations must be examined to plan a shared tenant system. First, is the building new or existing? if new, the job of integrating shared services is much easier to implement. The early stages of the building's design should be planned with the intent of supporting the additional facilities requirements of information systems. The marketing program of the new building should include the services and benefits anticipated from the information services. The additional costs for the services should be developed, since the overall package price should still be competitive with other offices in the area. The increased administrative burden expected from becoming an information service provider should be evaluated carefully. Sufficient planning up front will make the difference in a successful venture (translated: 100 percent of space rented).

If the building is existing, additional considerations come into play. The number of tenants and their existing and planned communications/information services must be examined. The system installed in the building must be able to support at least 50 percent more than the current number of tenants to be a viable candidate. Space for the new system must be located, and if there's a space crunch management will have another major problem. If there's a sufficient number of users in the building, the switching system will require a minimum floor area of 1,500 to 2,000 square feet, not to mention any additional management office space to handle the administrative duties associated with the system. If the building is at least 75 percent occupied, a suitable area for the operations center may be difficult to find. Cabling will probably exist throughout the building, but there will be no standardization of this critical element. Some offices will have large 25-pair or 50-pair telephone cables while others will have skinny 2-pair or 4-pair wires. Wherever computer systems are located there will be a wide selection of cabling facilities, ranging from standard copper wires to coaxial cables and possibly fiber optic cables. This cable "soup" presents a significant problem to a landlord who wants to enhance a building. Does all the existing cable get pulled out, or does all new cable get installed beside the old? The introduction of computer-based information systems translates into additional air conditioning requirements. Security will have to be reinforced, as will fire protection and control. If the new equipment is installed on an upper floor, is there sufficient floor loading to support the additional weight? These and other issues will have to be addressed when retrofitting an existing building.

The cost for upgrading an existing building or planning a new building with integrated information services is substantial, and many developers cannot afford the initial cost. Some of the nation's largest developers have formed interesting partnerships or arrangements with information system providers to share the load. Other cooperative ventures have sprung up over the last 3 years to offset the start-up costs of shared services. Several different methodologies have appeared which address the potential opportunities.

One approach is the **developer forming a shared tenant service subsidiary**. Obviously only the largest developers have the financial resources to form this type of company, and 2 excellent examples are Multinet Communications Corporation (MCC), Dallas, TX, a subsidiary of Triland International, also of Dallas, and LinCom, a unit of Lincoln Property Company, again from Dallas. Both companies have numerous projects either under construction or on the drawing boards that are built around shared tenant services.

Another method is for a **communication company to form a shared tenant services subsidiary**. Naturally, since communication services are the cornerstone of an intelligent building, it makes sense for a major communications firm to expand its sights into this highly lucrative market. Satellite Business Systems (SBS) formed a company, SBS Real Estate Communications (RealCom) to provide shared services. RealCom functions as the planning/management element, and secures the communication equipment from other sources. "Other" sources happens to include Ameritech, Inc, 1 of 7 AT&T regional operating units formed by the divestiture of AT&T. Ameritech provides the hardware expertise, installation, maintenance, and other support services, and RealCom provides the planning and management functions. RealCom's connection to SBS doesn't hurt, either, since SBS has become 1 of the top 5 voice and data facilities carriers in the U.S. Its expertise in satellite communication will be extremely valuable to the entire venture, since satellite links represent an effective alternative to local telco lines, an area that has generated much activity since the divestiture.

Suppose a large corporation is **sufficiently diversified that it can provide the complete range of shared tenant services itself**. One example of this is United Technologies, which with its Otis Elevator, Carrier Air Conditioning, U.T. Communications Co, U.T. Integrated Office Services Division, and U.T. Building Systems Co, provides services to buildings it owns as well as develops. In some cases, it also teams up with other firms that specialize in specific areas. Another firm with expertise in many of the key areas of shared services is Honeywell, with market leadership in building control systems, a major presence in the computer systems industry, and a growing telecommunication business nationwide. Another company to watch for is IBM. The company's recent purchase of Rolm Corporation gives it a powerful switching system to tie various building operations together, its office systems expertise is superior, its communication expertise (with its controlling interest in SBS) is extensive, its management skills are second to none, and its

Shared Tenant Services—Smart Buildings Are Here

financial resources are enormous. The company, as is its usual procedure, has not jumped immediately into the fray; it is watching and waiting. Based on the progress of shared services during 1985, expect IBM to make its move before the year's end.

How about **joint ventures**? Take 2 or more companies, the best in their respective fields, pool their talents and resources for the benefit of each, and couplings such as United Business Communications and its Isacomm subsidiary, and Olympia & York, Toronto, are created. The end result is OlympiaNet, a $100 million venture that will provide shared tenant services to the hundreds of Olympia & York properties worldwide. Another venture viewed with great interest is ShareTech, Parsippany, NJ, a partnership of AT&T Information Systems and United Technologies Building Systems Company, Hartford, CT.

In the American spirit of free enterprise, there are **several new companies whose business is shared tenant service**. Included in this entrepreneurial group are Electronic Office Centers of America, Chicago, IL; Planning Research Corporation, McLean, VA; and TEL Management, Dallas. Take expertise in building development, communications, office systems, and building management, and the foundation is there for a successful enterprise.

One of the newest, and perhaps, the most innovative approach, is that of **systems integrator**, a company that gathers the resources needed to support a shared tenant operation, and provide the overall management for its opertion. Such a venture is General Electric Information Services Company (GEISCO), which recently formed a Tenant Services unit. GEISCO signed agreements with 3 major information system providers—Wang Laboratories, MCI Telecommunications, and InteCom, Inc—to provide the key components of the service. Through its Integrated Communications Services Operation (ICSO) in Atlanta, GEISCO intends to be a "single-source provider and integrator" of tenant service through its nationwide network of 60 service centers.

Although the industry is relatively new, there are already a growing number of firms actively involved in shared tenant services. What about the traditional providers of telephone service, the Bell Operating Companies? Theirs is an interesting dilemma. While their parent organizations, the 7 regional holding companies, busily form separate subsidiaries to address the shared tenant market, the BOCs are gradually finding other ways of entering the business. One important factor in their favor is **Centrex, the original shared tenant communications service**. Where industry analysts were predicting the demise of the central office-based service a year ago, today it has entirely new prospects for long-term survival. Shared tenant service is one of the key reasons for this revival. Another issue for BOCs is the provision of communication services that function outside the nebulous border called "basic service." As soon as a BOC talks about a service that offers extra value to the end user, such as a messaging service, the regulators cry "foul." The resale of local service for shared tenant applications is the issue at hand. Several BOCs have petitioned their state boards of public utility commissioners to approve this proposal. What is being viewed as a test case involves Southwestern Bell Telephone Co, St. Louis, MO. So far, the Texas Public Utilities Commission has denied the company's request for regulation of local service for shared use. Southwestern Bell has proposed that shared tenant service providers be required to use switching equipment that blocks the sharing of local lines by tenants. This means each user, or tenant, would have to obtain local lines directly from the telco, rather than share a pool of facilities provided through the reseller (landlord). If the Texas PUC reverses its decision, the way will be set for increased regulatory activity in other states for this same ruling. So the BOCs have a number of ways they can increase their participation in the shared tenant service industry. The year 1985 will be a pivotal one for the BOCs indeed, and favorable rulings will further crowd the business.

Shared Tenant Service Technologies

While there are several ways shared tenant service can be developed and provided, it's important to know just what is involved in this industry from a technology perspective. Numerous components must be integrated for a truly comprehensive information environment.

The traditional building functions like heating, air conditioning, electricity, lighting, and security, are usually associated with separate systems. The primary system associated with shared tenant communications is the PBX system, or more specifically, **a PBX system that can be partitioned into multiple systems, each with its own unique operating characteristics**. Fortunately, most digital PBX systems on the market today can be partitioned into as few as 2 or 3 to as many as 1,000 separate units. Some systems can support multiple attendant consoles, such that each tenant can have its own front desk operation and answer its own calls. Depending on the size of the building, the expected number of tenants, and the expected number of phones, a wide variety of systems is available to the developer or systems integrator.

Partitioning is accomplished by software, which gives the PBX the flexibility of assigning different extension numbers within the same system, accepting various Direct Inward Dialing (DID) number groups, and routing outgoing calls over a pool of facilities or separate facilities for each tenant. The software in effect sets up numerous **classes of service** for each tenant, giving each user its own identity for billing purposes, as well as preventing a user in one company from dialing into another user's system.

The manufacturer most actively pursuing the shared tenant application is InteCom, Inc, Richardson, TX, maker of the IBX family of digital switches. InteCom has been the "system of choice" for more shared tenant applications than any other, so far, but that doesn't necessarily make for one-sided decisions on the part of developers. Other major manufacturers like Rolm, Northern Telecom, and United Technologies Lexar have been selling systems to developers, too, but have not yet achieved the "presence" InteCom has. InteCom has developed a shared tenant version of the IBX, called the S-80/T, which has the capability of 1,000 user partitions. It has extensive voice and data integration capabilities, the ability to interface with various IBM communications protocols, and sophisticated outgoing call routing features. It's an expensive switch, and requires a full-time organization to keep it running smoothly, but its capabilities as a total system are significant, and the company is marketing the switch everywhere possible to secure a strong market position. Possibly the only other system available that has the partitioning capabilities of the IBX is Centrex.

Centrex, as stated earlier, is the original multitenant communication system. During the service's development in the 1950s, one of the key design issues was the problem of partitioning, and how to prevent users from one Centrex from dialing another's system. Ultimately this was resolved through the use of **classes of service**, the same technique used by today's PBXs. Centrex has been the number one choice of users with several locations in the same geographical area, such as a large city, since the same central office can service all locations. The system can be set up so that a uniform dialing plan is established, or different dialing arrangements can be made, depending on the business's requirements. Centrex at one time was the glamor service offered by the Bell System, but in recent years it has fallen somewhat from grace, particularly with the rapid development of highly sophisticated digital PBX systems with hundreds of features and the ability to switch voice and data communications simultaneously. Now that the Bell Operating companies are divested, they have had to find a way to effectively utilize Centrex, or else discard it altogether. Fortunately, Centrex development has been proceeding at a rapid pace in the last 18 months, and numerous features thought to be available only in smart PBXs are now becoming available with Centrex. Integrated voice and data communication are already in use in some areas of the country, albeit on a trial basis, but the direction is clear: Centrex is on the comeback trail. The rapid acceptance of shared tenant communication has further spurred the resurrection of Centrex. Already there are contracts for Centrex-equipped buildings in both Indiana and Illinois Bell territories; more are likely in the coming year.

What has made Centrex turn around? First of all, the original Federal Communications Commission (FCC) proposal to charge a flat $6 per Centrex line was modified to $2 per line on lines installed before July 27, 1983 and $6 per line afterwards. The BOCs responded by adjusting their rate schedules for Centrex downward, to absorb the FCC-mandated increases. Second, the BOCs started working overtime to bring out new features for

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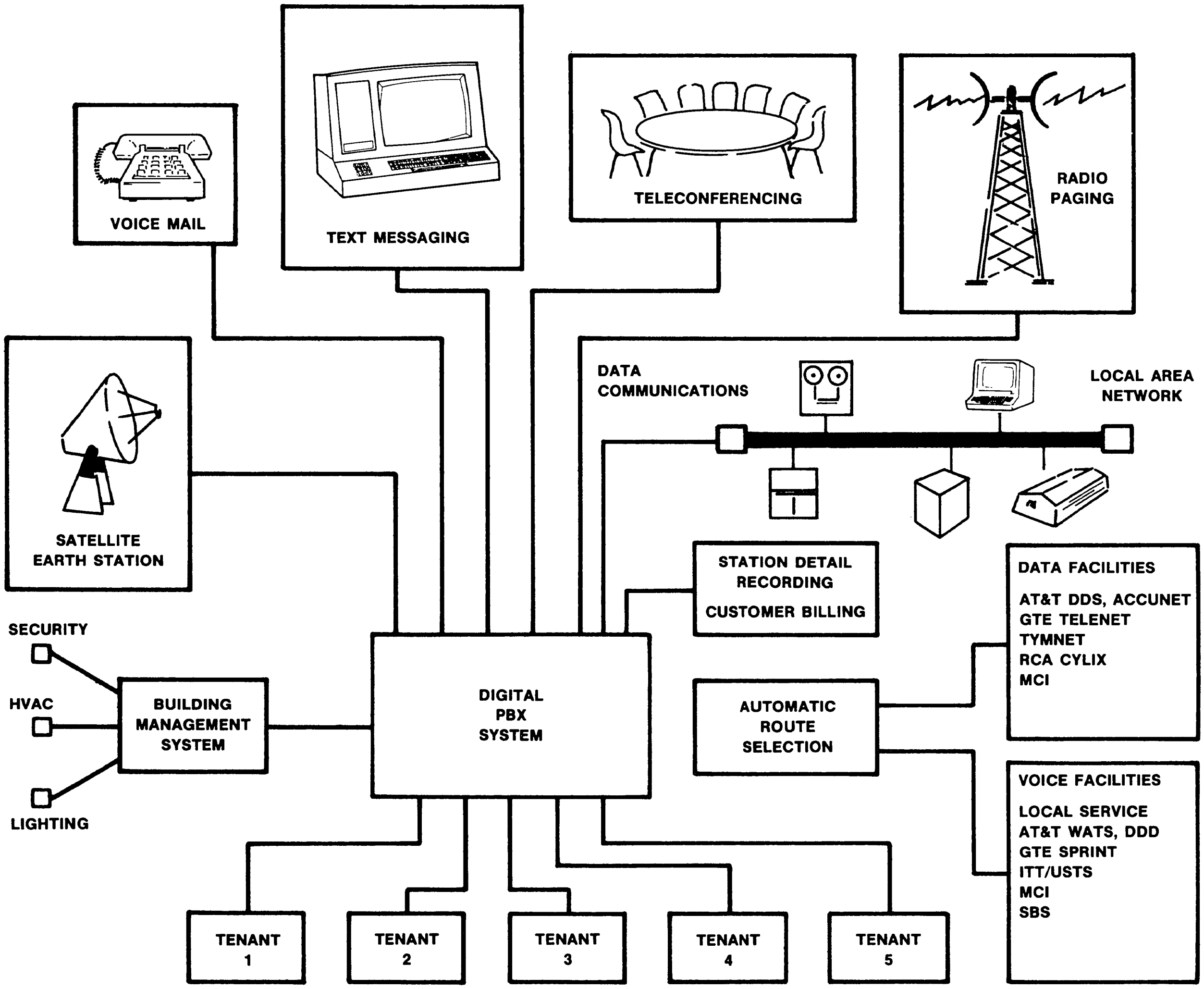

Figure 1 • communication services available through shared tenant digital PBX system.

Centrex, which they have successfully done. Third, Centrex, being a central-office-based service, requires no equipment installed in the customer's site. Additions or reductions of Centrex service do not penalize the user with regard to investment required—users pay only for what they need. (This premise is one of the cornerstones of the whole shared tenant business.) Building wiring is the responsibility of the telco, and system downtime is rare. The user gets a system to satisfy communications requirements, without the responsibilities (and headaches) of operating a separate system. **Centrex is definitely the service to watch** in the shared services industry.

The issue of **cabling**, rendered moot with Centrex, is a major consideration with most shared tenant operations. The idea of a universal communications outlet, into which virtually any kind of information systems can be connected, is closer to reality in a shared tenant system. The key to providing this capability is getting the information out to the user, which is why cabling is so important. Most buildings run electrical wires separately from telephone. Computer cables, such as coaxial, run separately from both of those. Add all this activity up over several years with numerous tenants coming and going, and areas of the building designated for running cable will probably look like a maze. The logical way to prevent this is to run a specific type of cable throughout the building, **as it's under construction**, and maintain that same cabling philosophy. Several major companies have offered cabling methodologies that appear to address these unique requirements. IBM's Cabling System is designed for high-speed intra-office communications using twisted-pair wire. It also paves the way for future IBM office communication products, such as its long awaited local area network (LAN). AT&T, not to be outdone, certainly has a wealth of experience in cabling buildings, and offers its Information Systems Network (ISN) as a means of connecting various office elements together.

Whatever the major information systems providers say, an intelligent building should have a uniform cabling plan. The shared system is located in a more or less central area, and major cable runs feed each floor of the building. After these runs, or risers, are terminated on each floor, primary and secondary feeder runs are routed to each tenant. Termination blocks are located in each company's office(s) to route cable to each user work area. If it's done correctly, there should be a uniform number or wires or facilities available to each user. Office rearrangements can be made much easier with a distributed cabling approach. Office areas built around modular partitions and wall units, with built-in cable raceways, make the business of relocating offices a relatively simple (and low cost) matter.

Shared Tenant Services—Smart Buildings Are Here

What is the typical cabling scheme for a shared tenant building? Depending on the extent of information flow and types of communication, anything from 4-pair twisted-pair to fiber optic cable or coaxial cable can be used. The best method right now is 4-pair station cable, which, when coupled with a digital PBX and digital station terminal, provides an entirely acceptable high-speed data communication channel for most voice and data communications requirements. Most major digital PBXs have digital telephones that can provide an RS-232C or RS-422 interface in the back of the set. The user then simply connects a data terminal or Personal Computer to the interface and uses the PBX to process both voice and data calls. The future probably rests with fiber optic cables, however. These pencil-thin wires have an extremely large bandwidth, and can support more communications requirements than most users will probably ever need. The trick with fiber optic cable is the connector—the method of splicing into the main feeder cable. The techniques for fiber cable interconnections are rapidly improving, and by the time shared tenant developers need the increased bandwidth, the technology will be ready. While the ideal user connection is a single port that provides a gateway to various information services provided by the landlord, the more likely arrangement for the near future is a combination—both twisted-pair and fiber optic cabling. Coaxial cable will also be part of this plan, although not as frequently as fiber optic. Its cost per foot is high, and the expected enhancements to fiber optic cable will no doubt bring its price down significantly, making it and twisted pair the cables of choice. It's possible to envision an office with the usual number of electrical outlets, and perhaps 2 other outlets—one using twisted pair for voice and data integration, and the other using fiber optic cable for functions like video transmission.

When considering the cabling plan, the use of a **local area network (LAN)** should not be overlooked. LANs are high-speed digital pathways that provide a high level of resource sharing. Although LANs provide the ability to connect a wide variety of terminal devices, they do not have the switching capabilities of PBXs. What may ultimately happen is a mix of PBX and LAN facilities, depending on anticipated customer needs. Several PBX manufacturers have announced LAN interface, in particular, Ethernet. What all this says is the PBX will most likely be the information switching hub of the intelligent building.

Communication within the smart building will be taken care of by the PBX, but communication outside the office becomes the **province of carriers, both telco and specialized**. Aside from the local telephone company, developers have numerous choices for long distance service. The toughest part of setting up a shared communication system is **selecting the optimum mix of facilities**. The usual portfolio of services includes DDD, WATS, and WATS-like services provided by companies like MCI, SBS, ITT, and GTE Sprint. Data communication facilities like AT&T Information Systems Net 1000, and GTE Telenet and Tymnet packet-switched public data networks, can also be tied into the overall facilities plan. Using the sharing capabilities of the PBX, a mix of local, long distance, and data facilities can be configured. these can then be shared by all tenants, resulting in a lower overall cost per user. It is basically the same method **resale carriers** use to provide competitive rates for long distance services. Other specialized facilities, such as leased lines, satellite circuits, and T-1 digital lines, can be implemented to augment the system's total capabilities.

There is a growing trend in the communication industry to **bypass local communication lines**, as these facilities are expected to increase substantially over the next few years as a result of the AT&T divestiture. Developers planning on a large (100,000 square feet or more) building with several tenants should investigate this technology as an alternative or adjunct to local lines. Local lines connect end users to facility providers, whether they are telcos or specialized/resale carriers. In the past, these circuits were cost-subsidized by inflated revenues for long distance service. now that the divestiture has dissolved that relationship, telcos are raising local loop prices to more accurately reflect their true cost. This of course translates to big increases for end users. Several methods of bypass have been identified. One is the use of **microwave** to provide direct links to the specialized carrier. Microwave, however, is limited by its line-of-sight requirement. If the distances involved are substantial, multiple microwave towers must be erected, increasing the cost. Another alternative is the use of **satellites** to beam communication signals from one location to another via earth stations. This technique is called digital termination service (DTS), and offers great potential if the volume of transmissions is sufficient to justify the initial investment in equipment. A third possibility is **cable television**. Currently, cable TV operators are using their systems for television only, but there is tremendous capacity for additional information flow if cable companies can be convinced to take the gamble. The key factor in cable's favor is its availability. Making the connection from a business location to the CATV head end is a fairly routine matter these days, and CATV operators have all their transmission facilities in place; the only additional connection needs to be with communication carrier(s). A fourth possibility growing in popularity is **cellular radio**, which currently concentrates on providing mobile telephone service. The high level of transmission quality and capacity represents an interesting alternative to the methods mentioned previously. Most major U.S. cities either have or are in the process of establishing cellular service. The bandwidth available and the switching capabilities of cellular radio make it a viable and relatively low-cost method.

Developers may decide initially to provide services a more traditional way: obtaining local loops from their telco. They should not wait too long, however, to begin evaluating and implementing alternative connections to their facilities carriers. Rates will continue to creep upward, and these increased costs will have to be passed back to tenants. If there's one sure-fire way to make tenants jump ship, it's raising the rent. In a shared tenant services building, **the rent includes costs for communications and information services**.

Having a complex mix of communication facilities is acceptable, but with no control over the use of these facilities, chaos usually results. Most PBXs on the market today have 2 features called **Automatic Route Selection (ARS)** and **Station Message Detail Recording (SMDR)**, that make the PBX so critical an element in an intelligent building. Obtaining the lowest cost for a telephone call in the U.S. requires a **combination** of facilities. ARS is a programmable routing facility that completes outgoing calls over facilities that result in the lowest net cost per minute. The landlord must program the PBX to route calls over the most cost-effective outgoing trunk lines. Once that is done, the system must be constantly monitored to ensure the calls are being completed with minimal delays, and that the routing patterns selected are working properly. While all this is going on, users must be billed for phone calls, and this is where SMDR comes in. Also a software function within the PBX, SMDR captures call data on each internal and external call. This raw data is then processed into numerous reports, some for monitoring system operation, and others for billing tenants. **These 2 PBX features, ARS and SMDR, literally turn the intelligent building developer or manager into a small utility**. All facilities in the switch are available for use by all tenants, the same as in a telco central office. Most major carriers have special tariffs that grant substantial discounts for large quantities of facilities. Assuming the intelligent building developer/manager has sufficient communication usage, these discounts can be passed on to tenants as lower long distance charges than they would pay on the outside. In addition, these discounts can provide a healthy profit for the developer/manager. After all, resale carriers are doing the same thing, and the formula works very well.

Since most tenants will have data processing requirements, consideration must be given to the internal and external communication these systems will require. The intelligent building's capabilities to support the diverse datacom requirements of its tenants will have a marked impact on its ability to attract and retain tenants. Most digital PBXs support asynchronous and synchronous communication to 19.2K bps and 64K bps, respectively. Interfaces such as RS-232C and RS-422 are generally supported, and digital telephones that connect terminals over voice lines are available in most systems. PBX ports should be able to connect into various computer systems, either through a traditional front end or some other communications access method. The PBX literally functions as an **information traffic cop**, ensuring completion of all service requests. The rapid growth of personal computers says that the

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likelihood of one or more tenants using PCs is high, therefore, a system should be installed that provides a dependable interface for PCs, regardless of manufacturer. Ease of access to outside databases, like the Source, CompuServe, and Dow Jones Information Service, is important to users, and the PBX must have sufficient facilities to support the demand. Internal communication among computer users is particularly challenging, since there are numerous activities users perform, such as file transfers, messaging, and communication with databases. Depending on the complexity of communication, a local area network may be required to augment the PBX, with the PBX functioning as a gateway into the LAN, a bridge from the LAN to the outside, or some other combination.

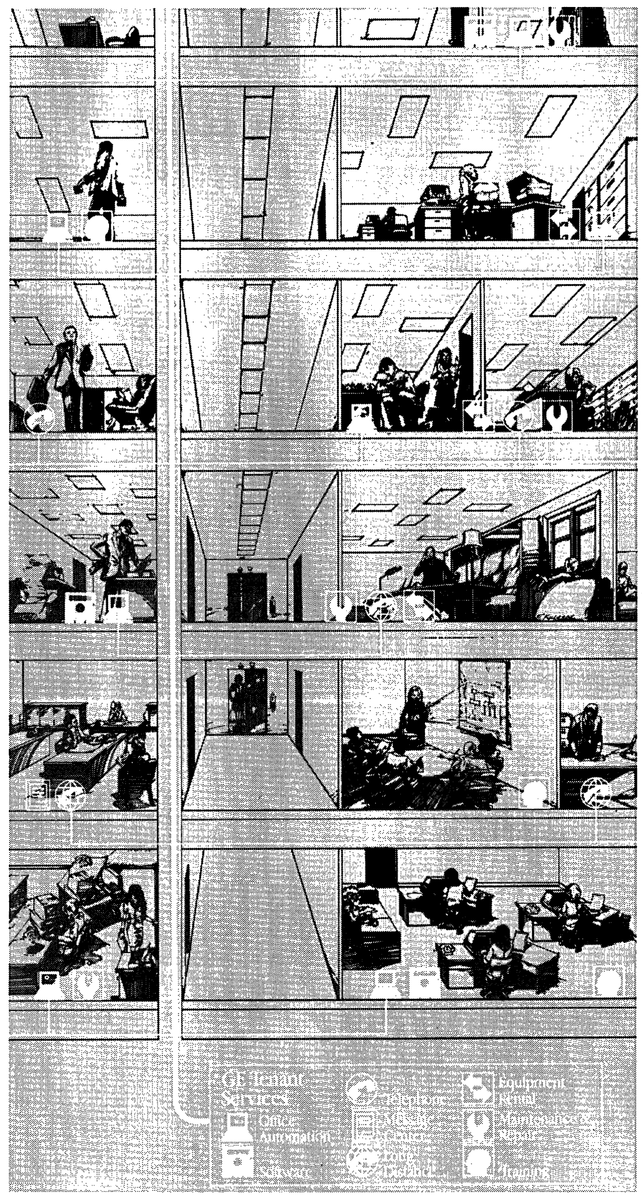
Since the PBX will provide shared telecommunication services, **consideration must be given to the prospect of providing data processing services within the building**. This of course will be much more difficult, especially if tenants come from different operating environments, e.g., an IBM or Burroughs shop. Developers should carefully investigate the costs involved in providing data processing services in the building, since many tenants will probably want to use their own systems. Conversion of files and records from one computer environment to another is usually difficult, and correspondingly expensive. Since it is much easier to provide the communication support among information systems, it makes sense for developers to avoid providing DP services, unless one of the tenants is very large, and the opportunity for additional (and profitable) value-added services is high.

Building Construction & Management

Intelligent office buildings requires that additional elements be considered in the planning, architectural, and construction phases. Most traditional building components such as electricity, environment control, lighting, security, and maintenance require a minimal allocation of space, since it is expected their operation will be largely unattended. **A centralized information center, however, will require specialized quarters** since it will be fully staffed. Space for the equipment, and offices for administrative and support personnel will have to be provided. If the building is new, it can be easily integrated into the total package. If shared tenant service is to be retrofitted, locating space for the center may pose a real problem. Assuming this issue can be resolved, sufficient space should be allocated for the switching equipment; various peripheral units like disk and tape drives, printers, and data communication devices; and administrative offices for managers, analysts, technicians, and clerical personnel.

The switching equipment will probably need its own room; provisions for power supplies, air conditioning, fire protection, security, lighting, and storage must be made. Depending on the equipment selected, a raised floor may be required. Process cooling equipment will help maintain the proper operating temperature/humidity for the switch. Standby power equipment, ranging from batteries to Uninterruptible Power Systems (UPS), should be provided to ensure continued operation. If the building has an internal sprinkler and fire detection system, it should optimized for the switching center. Security for the information center will be essential, since numerous customer records will be stored there, as well as a large investment in highly specialized equipment. There should be sufficient room for expansion, preferably by at least 50 percent. Offices built around floor-to-ceiling walls will not be as easy to relocate as movable partitions. These and many other considerations must be evaluated when designing the facility.

Buildings with the typical array of environment/support operations traditionally had no real need for any sort of **disaster recovery plan**. If a power outage occurred, alternative sources restored power, which maintained operation of other functions. Communication facilities, usually the responsibility of the telephone company, were quickly restored to normal operation. An intelligent building needs a more detailed action plan in the event of a disaster. Aside from the expected backup power supplies, restoration of a large sophisticated PBX system is not usually an overnight affair. A system supporting many users must have its operating programs backed up on tape or disk at an alternate location, or locked up in a fireproof safe. Programs running complex traffic routing tables, SMDR records and



formats, and overall system administration functions are simply not that easy to reproduce on a real-time basis, therefore, they must be duplicated and stored in a safe location. Usually, the supplier keeps copies of all software programs and files at its service location. The PBX supplier must have the ability to respond in a major disaster, and this should be spelled out in the contract. Alternate sources of telephone instruments should be in the area, as should sources of cable.

Administering the system and its various services requires a decision as to the extent of internal management. The trend appears to be **total management of the systems and facilities**. Since communication and information services are to be provided by the landlord, the landlord is now assuming the role of **information utility**. This means establishing service, disconnecting service, moves and rearrangements, billing, maintenance, complaints, and system analysis and planning will be handled by the landlord, or an organization under contract to the landlord for this function. Maintenance is perhaps the most

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important of all these, since users are concerned that their systems operate smoothly, and if there is an outage or problem, that it gets corrected quickly. In a large office complex, with 20 or more users, as is typical of an intelligent building, this means a full-time staff should be in place to provide maintenance and technical support. while this effort can certainly be made in cooperation with system manufacturers, a more personalized approach by an in-house staff will enhance the overall image of the building, as well as provide more responsive service. Most PBX systems today have extensive internal diagnostics, and outages can usually be traced to a faulty circuit board. Replacement of these components is a simple matter. Remote diagnostics provide an additional benefit to the prospective intelligent building developer. If the developer has several properties to be built, separate systems can be installed in each building, and a centralized maintenance and support operation can be established. Some systems even have the ability to operate remote switching modules off a main switch. This keeps the initial investment lower than if separate systems are installed, while maintaining all available system features.

Services Available To Tenants

Aside from telephone service, intelligent buildings promise a significant number of management services designed to improve tenant productivity while keeping costs under control. Traditional **voice communication** will be the primary service offering, with the latest in technology and sophisticated features available. Outgoing calls will be routed over a variety of long distance carriers, and costs will be lower through sharing these resources. Integrated data communication will be supported through the PBX, if desired. This will keep cabling requirements to a minimum, yet provide more networking possibilities. The provision of **data communication** is the other key feature of an intelligent building. The switch should be able to support a wide variety of communication methods, and offer gateways to specialized networks like SNA, X.25, and local area networks. Some PBXs have the ability to interface with building management and control systems, the kind that control lighting, HVAC, and security. This makes the PBX an even greater asset to the developer, as it provides for a higher level of management control.

Additional services are available that increase the value of an intelligent building, not to mention the PBX. Various types of **messaging** can be developed for tenants. Depending on the PBX selected, text and/or voice messaging can be provided. The PBX can become an internal message center, and users can enter and receive messages on a display terminal, a telephone instrument specifically designed for messaging, or on standard telephones. **Text messaging** can be integrated with outside information services, such as The Source, to extend messaging capabilities nationwide, and even worldwide. Formating, editing, and routing of messages is controlled by the PBX. Specialized station instruments with integrated displays can handle messaging functions the same as a display terminal, yet cost substantially less. **Voice messaging** is a fairly new technology, and shows lots of promise. Messages to one or multiple users are entered through a standard telephone, with commands to the system typically handled by touching specific dial codes on a tone-dial pad. Systems prompt the user with prerecorded voice messages. The day is not far off when a user will be able to send and receive messages using a combination of these features.

If a tenant wants to hold a meeting with other locations in the company, a **teleconference** is an effective and low-cost alternative to travel. Conferences can be either audio, video, or a combination of both. **Audio teleconferencing** is growing in popularity among large corporations, and there's no reason why it cannot also benefit smaller companies, too. **Video teleconferencing,** while highly desirable because of its visual aspect, is more expensive than audio teleconferencing. Depending on the number of tenants anticipated, the developer will find it advantageous to consider providing at least audio conferencing facilities; perhaps a separate conference center included in the rent or available on a per-use basis. Video conferencing, on a real-time basis, is very expensive because the communications facility requires a very large bandwidth to support video signals. This, plus the cameras, switching equipment, and auxiliary facilities puts the cost for providing a video conferencing room in the hundreds of thousands of dollars. A developer might also want to investigate conference services available through major hotel chains, such as Hilton and Holiday Inn. A linkup with one of these organizations may be the answer for a moderate-cost conference system. Included in the conference package should be the ability to support transmission of graphic information, typically handled by facsimile devices or telewriters. Scheduling the room will be the responsibility of the landlord.

Executives on-the-move need to be reached immediately if there's an urgent need for their services. Perhaps the most effective way of contacting these individuals is through **radio paging**. Users typically have the familiar "beeper" which signals them to call their offices. This capability can be another value-added feature of an intelligent building, either by adding the radio transmitting equipment to the building's facilities, or providing access to a radio common carrier for its services.

While the number of communication and information management services available to the tenant is impressive, there are additional services a landlord can offer to attract tenants. Included in these are space planning facilities, management system training, temporary office clerical/administrative help, mail and delivery services, travel services, copier services, and even day-care and exercise facilities. With all the opportunities available to developers in the shared tenant services market, what goes into the decision to plan an intelligent building?

Issues In Shared Tenant Services

Why develop a smart building? To the **developer**, it means the opportunity to sell or lease more office space, achieve higher occupancy levels, and enjoy higher profitability. For the **tenant**, it is literally a bonanza. Lower equipment costs, lower maintenance costs, single-source shopping for communication and information services, reduced risk of obsolescence due to equipment being leased, increased flexibility since building is designed to support wide range of requirements, paying only for what is needed, and access to sophisticated technology not otherwise available all add up to a healthy environment for many businesses.

Who should be involved in shared tenant services? Aside from developers and real estate entrepreneurs, landlords of large buildings and office parks, building contractors, corporations that are constructing new office complexes, communications consultants, and entrepreneurs eager to become involved in a promising, profitable venture are excellent prospects to enter the business. How about typical intelligent building tenants? Large organizations that usually can afford their own computer and communication facilities are going to be more difficult to sell on an intelligent building since it may duplicate what they already have, or they may feel the intelligent building's capabilities inferior to their own. Small- and medium-sized companies who want to utilize sophisticated technologies but cannot afford the initial investment are ideal candidates for an intelligent building, since these services are usually provided as part of the rent. Since they pay only for what they use, they have greater flexibility in selecting the proper mix of services, and if they want to experiment, their risk is minimized. Smaller firms need to feel competitive with their larger counterparts, and the ability of intelligent buildings to support increased information requirements will attract a large number of aggressive, entrepreneurial firms that need to move quickly but without making a large upfront investment. Smaller regional offices of large companies may decide to occupy an intelligent building, particularly if they are opening up a new territory, expanding operations, or trying to control costs. As more intelligent buildings become available, they will become an important office space alternative to large corporations with numerous field offices.

Venturing into the shared tenant industry has its share of opportunities and risks. Based on the progress made to date, it appears that the investment is indeed steep, but the risk is acceptable and the potential for profit is high. Startup costs for an intelligent building, aside from the usual design and construction costs, must be increased to accommodate the communication and information systems required. These costs include the PBX, facilities into the switch; station equipment and cable; power supplies; system planning, installation, and training; equipment

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room construction; salaries for administrative/technical/clerical staff; and numerous other costs. If there are many tenants (over 50), the switch/facilities costs will probably spiral into the millions of dollars. On top of that, monthly recurring costs for facilities, salaries, maintenance support, and other administrative expenses will have to be considered. The initial investment for a fairly large (250,000 square feet) intelligent building will be approximately $10 to $15 per square foot ($2,500,000 to $3,750,000). This assumes approximately 35 tenants with an average of 50 telephones each. Industry analysts project that profits from an intelligent building can be as high as $25 per square foot per year. This means the developer or landlord can reduce rents or keep them stable, in order to attract more tenants, as well as retain existing ones. Assuming the developer/landlord is able to provide efficient management of the intelligent building, the risks are minimized. Other potential problems arise from situations such as bill collecting, employee turnover, shortage of qualified technicians, lack of shared tenant management expertise, potential regulatory bottlenecks, inability to provide desired services, and maintenance problems. Still, the prospect of success is high, and the time is right for development of smart buildings, before the marketplace becomes saturated.

Convincing a prospective tenant to lease space in an intelligent building will be both a simple and difficult task. Simple because there is more value to the user in being a tenant. There are sophisticated telecommunication services, messaging services, conferencing capabilities, single-source management of all resources, and the ability to pay for just what is needed. There is the prestige that comes with being a tenant in a smart building. There is the opportunity to maximize productivity while minimizing the investment. Lots of excellent reasons. If that's the case, why will some organizations decide against a smart building? Perhaps cost, especially if there is a substantial jump in per-square-foot rates from their former space to the new building. Perhaps fear of technology. A highly sophisticated PBX system, local area networks, integrated messaging, and teleconferencing may seem too sophisticated for a more conservative organization. Perhaps fear of a loss of control over what the organization chooses for its communication and information requirements. If this is now the province of the landlord, it might alienate prospective tenants used to handling their own systems. The success of the entire project will depend heavily on how the building is marketed. Some areas of the U.S. are better than others for building development. The "better" cities will probably have little difficulty supporting the development and proliferation of intelligent buildings, while other cities may not be supportive at all. It is really a function of the developers in the area, and how well they know their marketplace. Intelligent buildings will represent one of the most effective ways of attracting new business to a city, thus they should be welcomed by developers and city officials alike.

Planning for A Shared Tenant System

In any project involving a shared tenant system, a sufficient amount of planning and research is required. Research should focus on what the prevailing rental rates are in the area, any other intelligent buildings existing or planned, various types of communication systems, communications facilities available, and of course the issues of obtaining the necessary financing for the project and designing/construction/managing the building.

If the building is to be retrofitted, a thorough examination of the existing tenants and their communication requirements, both present and future, must be conducted. An inventory of all voice and data communications equipment must be taken. Interviews should be conducted with all tenants to determine their communication and information requirements for the next 2 to 3 years, since the system selected should have the flexibility to support each tenant's communication needs. It is critical to determine each tenant's desire for enhanced communications services, such as messaging and teleconferencing, before investing in the technology. Finally, determine if tenants **want** to have someone else handle all their communications equipment and systems.

If the building is new construction, it won't be as easy to determine the communication requirements of tenants if they have not been identified as yet. The best way to approach this is to survey the overall market area to develop a profile of the "typical" prospective tenant needs. From this, it makes sense to limit the initial offering to voice communication, shared facilities, and data communication support. Other features and services can be added later. If the tenant prospect list can be expanded to a nationwide focus, more innovative and forward-thinking prospects can be identified. Discussions with consultants experienced in shared tenant systems will be beneficial, too.

Further research should be conducted into the telecommunication marketplace. PBX systems range widely in price, and the type of system selected will have a tremendous impact on the success of the entire venture. Costs for facilities must be determined, because there are both installation and monthly recurring charges to deal with. Costs for various data communication components must be added to the plan, including modems, multiplexers, local area networks, protocol converters, and testing devices. The costs for cable are critical to the project, particularly the requirement for fire-retardant cable. Some cities require it, others don't, but it adds to the overall cost of the job. Other auxiliary systems, such as message centers, conference equipment, and paging systems, must be added to the overall package.

The next step is to develop a business plan for the intelligent building. It should include plans for voice and data communication services, specialized services such as teleconferencing, marketing plans to identify and sell prospective tenants, and the method of managing the complex, in addition to all the other aspects of managing a large office building. Cost projections must be made, and should include rent estimates, capital expenditures, communication expense, personnel expense, and consulting fees, in addition to numerous other financial reports. An intelligent building is much more sophisticated than a typical office building, literally functioning as its own information utility.

There are many PBX systems on the market today, each with its own special array of features. But there are so many similarities among PBXs, **it is difficult to determine the differences**. For a prospective shared tenant system developer/operator, the key areas of concern are (1) system capacity (number of stations, trunks, and user partitions), (2) data communication support, (3) voice communication features, (4) Automatic Route Selection (ARS) capabilities, (5) Station Message Detail Recording (SMDR) capabilities, and (6) administrative capabilities. Once the requirements of the current tenants are determined, or the projected needs for the new building and its tenants have been established, a Request for Proposal (RFP) should be developed to define the requirements of the system and those who will use it. It should specify the timetable for construction of the new building, or plans for retrofitting the existing one. Make sure the system has the capability to expand at least 50 percent beyond its initial configuration, as user requirements tend to increase as people get more comfortable with the system. Bidders' conferences are desirable during the initial phase of the RFP cycle especially if there are no other intelligent buildings in the area. Investigate the PBX manufacturer carefully, since the fate of numerous tenants is at stake. Poorly designed systems will probably cost the developer tenants, and the word could spread throughout the area, placing a negative label on the building. Determine if the bidder has any other shared systems installed and if possible, visit at least one of them. Once a bidder is selected, monitor the progress of the installation closely, especially as the system cutover nears. Obviously, numerous other activities are to be taking place during the entire building development project, but the communication systems are critical to the building's (and owner's) success.

Facilities selection is as critical to the building's success as the PBX. Usually a mix of services is desirable, because some carriers have better rate schedules than others in certain areas of the country. If the building is existing, it will be much easier to make a determination of the number and type of facilities required. Going from numerous separate communications entities to a single shared resource is a major design challenge, and the advice of a telecommunication consultant experienced in facilities engineering and design will be worth the investment. If a professional consultant is employed in the project, make sure access to traffic engineering programs is available to achieve a

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higher level of accuracy. Depending on the amount of data communication traffic, there are several alternatives available. Most carriers today can provide both voice and data communication facilities, but the datacom facility is dependent on factors such as transmission speed, synchronous or asynchronous transmission, switched or dedicated lines, point-to-point, multipoint or (multidrop) communication, real-time or message-switched (store-and-forward) operation, type of terminal equipment, time of day, communication protocol required, and throughput. Local communication loops, as mentioned earlier, are expected to increase in price steadily, and state regulators will impact the acquisition of local lines for shared tenant service. The opportunities for becoming a "utility" are abundant and the risks, significant, but based on the successes so far, appear to be achievable.

Managing the operation takes careful planning, since there will be numerous additional activities, besides maintenance and collecting rent, for the landlord. Becoming an information provider, as well as a provider of space, means a high level of management involvement with both the manufacturers and carriers, as well as the tenants. Sophisticated billing systems will be required, since costs will include charges for long distance calls, local calls, data calls, communication equipment, telephone instruments, operator services (if desired), message center calls, maintenance, and administrative expenses. If there are many tenants, customer service will become a major part of the intelligent building's daily operations. This group will need to be skilled in discussing the information requirements of tenants, solving problems, providing training, planning for enhanced features, handling complaints, collecting bills, and providing a smooth-running profitable operation.

The Future

Intelligent buildings are perhaps the most significant development in the real estate industry in many years. For the telecommunication industry, they represent a highly efficient use of technology to improve business productivity while controlling costs. It is called the most significant and fastest growing segment of the communication industry today, and based on the rapid development of the market and products that can operate in it, this is indeed a true statement. The future office building will have an extensive list of information resources available to tenants, and the time is right to take advantage of this lucrative opportunity.

• END

Teleconferencing—A Potentially Economic & Powerful Alternative to In-Person Meetings

An Introduction to Teleconferencing Technologies & Trends, With Guidelines for Successful Teleconferences

■ INTRODUCTION

Bringing 2 or more communicators in dispersed locations together electronically is the essence of teleconferencing. Whether the parties are human or mechanical, the goal remains the same: link the parties together so that information is exchanged. The idea of multiple communicators bridged together is not new; people have been conducting conferences over the telephone for years. In just the past 10 years, however, an entire industry has developed to support the growing demands of business to make timely decisions, announce new products, improve productivity, and save time and money doing all of them. Teleconferencing has proven itself an extremely important aid to business, and this report examines the industry and the technologies involved, discusses the techniques for planning and conducting electronic meetings, and provides a list of organizations actively involved in the industry.

■ WHY USE TELECONFERENCING?

One of the most beneficial, and most often overlooked, services available from telephone companies is the conference call. Normally set up by special conference operators, this service is an effective low-cost way to get several distant parties talking to each other. Transmission quality, regardless of distance, is usually excellent. Why, then, has it infrequently been used over the years? Most likely, it is because the feeling existed (as it still does today) that **business can be conducted better in person**. The cost for gathering business people in meetings today is quite high, considering transportation, lodging, meals, actual meeting expenses, and nonproductive manager time. If there was a way to eliminate all these extra costs, perhaps some sort of alternative to the face-to-face meeting could be considered. Teleconferencing appeared to be the answer. Thus, the first plausible justification for an electronic teleconference was **travel cost displacement**.

While this is indeed a usable argument for teleconferencing, there are today more substantive ones favoring its use. The most important of these is **improved user productivity**. Studies have shown that a typical audio teleconference (using telephone lines) accomplishes all elements of a meeting in an average of 45 minutes. Participants need not relocate to another area for the meeting, unless there are several involved in the conference who work at the same facility. In this case, a conference room suitably equipped for the conference call is an effective solution. Getting issues resolved quickly is often difficult to accomplish in face-to-face meetings, but these same issues can be handled much easier if interpersonal contact is eliminated. Once the "personal" aspects of a meeting (eye contact, body language, speech techniques) are removed, there is usually nothing else but the reason for having the meeting in the first place.

Teleconferencing helps **speed the decision process**. If several managers are required to approve a decision, and each is located in a different geographical area, the decision can be made faster by conferencing all parties together. Important issues can be discussed, additional information can be presented, the decision can be made, and implementation responsibilities can be delegated. The high-speed pace of today's business world demands rapid decision making, particularly with respect to a company's competitive position. Teleconferencing, when used properly, is absolutely essential in the decision-making process.

Time and money always seem to be highly in demand, but invariably short in supply. Teleconferencing has proven itself as a **time-saver and money-saver**. Just as people depend on the telephone to get information, ask questions, discuss ideas, and resolve problems, they are learning to depend on teleconferencing. It brings people together on a timely basis, gets things accomplished on time, and improves productivity while controlling costs.

■ TELECONFERENCING APPLICATIONS

Numerous applications have been developed for teleconferencing. It is an effective solution, provided users can be convinced of its value and benefits. The most frequent use for teleconferencing is **meetings with participants dispersed over a geographical area**. Regardless of the subject matter, if a company can connect all the right players via a teleconference, the objective will usually be achieved.

Since teleconferencing can be conducted on a point-to-point or point-to-multipoint (broadcast) basis, potential opportunities are numerous. One application that is growing in popularity is the **new product announcement**. Typically, a company with a new product or service has several avenues in which to alert its prospective customer base. Choices include traditional newspaper, magazine, radio, and television advertising, and direct mail. Some of the more innovative methods include electronic mail and teleconferencing. Imagine the value to a prospective end user of attending a video conference in which questions can be asked of the new product's creators-live-rather than reading a press release or other documentation, or perhaps speaking with company representatives who may not have the depth of understanding desired by the users. Several major telecommunication and computer manufacturers have invested, very successfully, in video conferences, including Datapoint and Rolm Corporation. Several large hotels in specific areas have mobile earth stations installed for receiving the broadcast signal from a satellite. Their equipment is then connected to a conference system that displays the picture on a large screen, while a voice communication link to the broadcast origination point is established.

Several major hotel chains have added teleconferencing to their list of services. Since conventions and meetings are important sources of revenue for hotels, companies such as Holiday Inn and Marriott Corporation are investing in earth stations and video facilities to attract business. Specially outfitted conference rooms are available in major cities that can provide full-motion video conferences plus full audio communication and even hard copy equipment, such as facsimile terminals, for additional backup.

Education has been a major application for teleconferencing. Colleges and universities around the country have used **closed-circuit television** to conduct classes for over 20 years. With added voice communication to the broadcast point, it represents an efficient low-cost method of teaching large numbers of students, particularly for high-volume classes in core subject areas like accounting and mathematics. One of the leading proponents of teleconferencing is the **University of Wisconsin-Extension**, which has developed a state-wide audio teleconferencing system. Dozens of parties can be connected on a single conference call, if desired. Video conferencing facilities in the state have been greatly expanded in the past 5 years, too. **Penn State University** has been using closed circuit television to teach basic accounting for well over 20 years, and the use of CCTV has spread to other colleges in the university, as well.

A major trend developing in the U.S. is the integration of communication and information processing facilities into office

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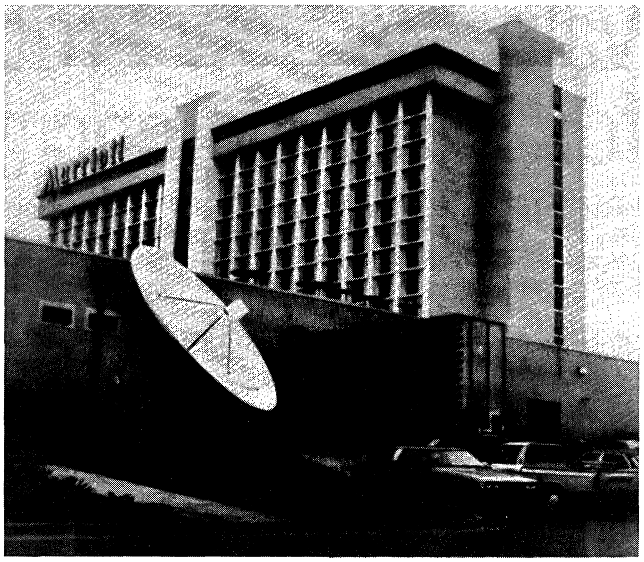

Hotel Video Conference System.

buildings. The phenomenon is called **shared tenant service**, and is built around the premise of sharing information services by each building tenant, resulting in lower costs for everybody. Teleconferencing is one of the key services to be provided in these "smart buildings." With the appropriate facilities, individual tenants can establish teleconferences from their offices, using the building's conference bridging equipment. Or they can utilize a separate audio/video teleconferencing room specially designed for conferences. Since the cost for this kind of service will be shared by tenants, the actual cost to each tenant will be far less than if each contracted for the service separately.

There is expected to be an increase in **international teleconferencing**, particularly with the development and installation of high-speed data communication links between continents. These services will typically be provided by satellites. With more companies establishing an international presence, teleconferencing is a natural. The cost of video teleconferences is still fairly high for international conferences, but audio conferences are expected to increase in volume with improvements in international telephone service.

■ TRENDS IN TELECONFERENCING

Video conferencing is destined to be the star of teleconferencing over the next 5 to 10 years, particularly with costs for equipment and transmission facilities expected to drop dramatically. Audio conferencing will build on its already large following. Increased efforts will be made to educate people in the use of teleconferencing, since most people are simply not aware of its many benefits. This will be done on both a national and grass-roots level. Major companies will build teleconference facilities at corporate locations. Teleconferencing will become as much a part of the corporate culture as the personal computer is today.

Currently, the cost for transmission time on a satellite ranges from $700 to $1,000 per hour, not counting the cost for the earth station and its associated connecting facilities. Within 2 to 3 years, these costs are expected to plunge to about $150 to $300 per hour. (**See Figure 1**.) The present cost for a video codec, which converts the analog broadcast signal to digital for transmission, ranges from $80,000 to $115,000. These costs are expected to fall around $10,000 to $20,000, particularly with improvements in video compression technology. The price for T1 digital communication lines is expected to drop further. Since first introduced for end-user applications, the price has dropped several times, to where the hourly rate is about $300 to $400 per hour, or about 25 percent of their previous levels. The cost for earth stations has fallen significantly. Increased use of the Ku band for satellite communications results in smaller and more efficient stations, which also translates into lower costs. It is likely that an earth station which today costs $30,000 to $40,000 will be available for half that amount in 2 years. The cost to build a self-contained video teleconferencing room about 2 years ago was as much as $500,000. Currently, a fully equipped room, with multiple cameras and screens, costs between $100,000 and $200,000. These costs will continue to drop over the next 3 to 5 years, making it much easier for companies to have their own teleconference facilities. Portable teleconference systems, a fairly recent development, can be built for as little as $100,000, depending on the degree of sophistication desired. Audio teleconferencing equipment, such as the AT&T Quorum system, has been reduced in price as much as 28 percent in the past 6 months. The cost for teleconferencing is coming down to the point where there will be no excuse for "We can't afford it." The real challenge is getting people to use it.

	1983	1984
New York to London	$10,000	$2,000
San Francisco to New York	$ 2,000	$1,100

(for public rooms)

Figure 1 • Reductions in Videoconferencing Costs in Only One Year (costs per hour)

International teleconferencing is expected to increase over the next several years, bringing the world community even closer together. Global decision making will be possible with television quality in most areas of the world, so long as an earth station and video equipment are available. Satellites have proliferated to such an extent that it is possible to communicate with virtually any point on the earth.

■ TELECONFERENCING TECHNOLOGIES

There are 3 fundamental components in teleconferencing: **terminal equipment**, whether a desktop speakerphone for an office or a full-motion video transmission system; a **conference bridge**, which connects multiple parties together for the conference; and the **transmission facilities**, which provide the linkup between participants. The most critical factor of all is transmission, which is determined by 2 factors: bandwidth and distance.

The information capacity of a communication line is a function of its **bandwidth**. (**See Figure 2**.) The greater the bandwidth, the more information can be transmitted. For analog facilities, bandwidth is measured in cycles per second, or Hertz (Hz), defining the range of frequencies that can be transmitted. Digital transmission line capacity is measured in terms of bits per second, or bps. Most audio teleconference calls are conducted over voice-grade lines, since they are ideal for voice transmission, and their cost is very reasonable. Video conferences, particularly full-motion, use digital lines with very high transmission speeds to support the large bandwidth required.

Standard voice communication requires a bandwidth of only 2700 Hz, and commercial AM radio audio broadcasts use only about 5000 Hz. Television requires about 6M Hz (megahertz, or millions of cycles per second), or approximately 1,500 voice channels. Digital compression systems can squeeze that signal down to 1.5 million bps, which is the same as a standard T1 digital channel. This is another reason for the increased interest in T1; it supports video transmission besides regular data communications. More sophisticated digital signal compression equipment reduces the bandwidth requirement for video to half a T1 line, or about 768K bps. This permits the simultaneous transmission of video, voice,

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System	Analog Bandwidth	Digital Bit Rate
Voice Conference (Telephone grade)	2700 Hz	64K bps
Voice Conference (Broadcast grade)	5000 Hz	80K bps
Electronic Blackboard (AT&T)	2700 Hz	1.2K bps
Analog Facsimile (2-6 minutes)	2700 Hz	—
Digital Facsimile (30 seconds)	2700Hz	4.8K bps
Slow-Scan Video (9 to 35 seconds per frame)	2700 Hz	—
Full Motion Video (Compressed)	—	1.5K bps
Full Motion Video (Non-Compressed)	6 MHz	—

Figure 2 • Bandwidth Requirements. Where a specific system uses analog or digital facilities almost exclusively, other entry is left blank.

data communication over the same T1 line, further enhancing its value. The cost for T1 lines is high, which limits their use for most prospective end users. T1 costs are expected to decrease over the next few years, bringing this important communication service within the reach of more users.

The other component of facilities cost is **distance**. Terrestrial, or land-based, facility costs are distance sensitive, whereas satellite facilities are typically distance insensitive, and their quality is as good as terrestrial lines. Another important factor is availability. Land-based lines typically take several months to be installed. T1 lines can take as long as 9 or more months for installation. Satellite links, especially when an earth station is available, can be used almost immediately, particularly when the earth station is receiving signals from another location.

Although these facilities deal in longer distances, short-haul requirements can be addressed, too. Voice-grade lines for locations in a city or metropolitan area are sufficient for audio conferences, but video conferences present a different set of problems. Bandwidth is needed, and wideband lines provided by common carriers are usually too expensive for short distances. Alternatives to this include microwave, cable TV, and fiber optic systems. These particular technologies are also popular choices among companies choosing to **bypass** the local telephone company. Within office buildings, local area networks (LANs) can be used because of their large bandwidth. Satellite facilities can also be used, but within a small geographic area, the cost for ground stations can get prohibitive, compared to the alternatives available.

The second major component in a teleconference is the **conference bridge**, which interconnects the participants. The bridge can be as simple as a conference circuit in a PBX system, which can typically handle 6 or more conversations with good sound quality. More sophisticated conference bridges have been developed to produce satisfactory communication for 30 or more users. Several companies have appeared over the past 10 years that set up conference calls. This is of course aside from the familiar operator-assisted conference call that has been available from telephone companies for years.

The third element in a teleconference call is the **terminal equipment**. This market has experienced tremendous growth over the past 10 years. In the audio area, several manufacturers have developed conference telephone instruments that sit on a desk surface, with the ability to support up to 30 or more speakers in the same room. For best results, however, audio conferences should be limited to 10 participants per room. In the video area even more activity has taken place. Codecs (devices which convert analog signals to digital) have been improved to the point where data speeds under 1.5M bps can still provide acceptable, albeit fuzzy, video quality transmission. Cameras and video screens have improved continuously, and control systems for running the call are extremely easy to use. Earth stations and their associated equipment are lower in cost than ever before, and it is increasingly simple to erect an earth station. Adjunct equipment, such as facsimile for hardcopy documents, and graphic support devices for transmitting visual images in real-time, add greatly to the overall effectiveness of the conference call.

■ TELECONFERENCING SYSTEMS

There are 5 distinct types of teleconferencing systems: audio, graphic, slow-scan video, full-motion video, and computer conferencing. The most frequently used method is audio; the least-used, full-motion video. Based on current and projected usage patterns, it is likely that audio conferencing will remain the most popular choice, but slow-scan and full-motion video are likely to stage major increases in user installation during the next several years, as costs for the various components decrease. (**See Figure 3**.)

TECHNOLOGY	USING NOW	PLAN TO USE	PROJECTED INCREASE IN USERS
Audiographics/Fax	121	72	59%
Slow-Scan TV	56	138	246%
Digital (Compressed Video)	22	95	431%
Analog (Full-Motion) Video	91	111	121%
Computer	64	110	171%
Totals	354	526*	

*Some checked more than one category
Source: Colorado Video

Figure 3 • Teleconferencing Trends. Figures represent number of companies using technology.

□ Audio Teleconferencing Systems

Perhaps the most ubiquitous audio conference device ever invented is the **speakerphone**. The most popular of these is the **Type 4A**, sold by telephone companies and interconnects for over 15 years. It uses 2 units, 1 for the speaker, and the other for a combined control unit/microphone. Quality is generally good, but acoustics of the unit create the familiar "barrel tone" effect which often draws complaints from users. This can be reduced or eliminated through better sound dampening in the room or reducing the distance between the speaker and the microphone. This unit is ideal for conferences with up to 5 people in the room.

Larger conference units, usually referred to as **group conference** phones, are designed for groups of 10 to 20 people. The unit sits in the center of a table and uses an omnidirectional microphone. Individual microphones can also be attached for increased ease. Audio systems are designed for 1 speaker at a time, since that is the most effective way to assure that the messages is sent and received. Some systems are **voice-switched**, which directs the system's resources to the party speaking, while reducing the levels at other microphones. Others are manually controlled via 1 of 2 methods: the moderator operates a control panel that activates individual microphones, or each user activates a "push-to-talk" switch. Either method works well, provided the meeting is properly planned, and all participants understand the

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rules for speaking.

Most audio systems available today are modular, with separate speakers and microphones. One unit, the PC-50 from Precision Components, is a portable system with 2 microphones and integral telephone for setting up a call. It is well suited for meetings with up to 10 people, and has been marketed through operating telephone companies for over 10 years. AT&T Information Systems offers the Quorum teleconferencing systems, a complete product line of conference bridges, microphones, speakers, and amplifiers. Audiences from under 20 people to classrooms and medium-sized auditoriums can easily be supported by Quorum. The conference bridge allows 14, 21, or 28 locations to join in the call, and costs from $31,000 to $36,000. The Quorum group audio teleconferencing terminal (GATT) controls the conference call, and costs $6,300. Part of Quorum is a unique omnidirectional microphone, a 30-inch vertical shaft that sits in the center of the conference table. The unit compensates for echo problems and speakers can be clearly heard for distances of up to 12 feet. Darome Corporation makes a family of conference bridge systems as well as desktop speaker/microphone units. Shure, a major manufacturers of microphones and audio equipment, has the ST6000 Corporate Link, with distinct components ranging from the control unit to several types of microphones, speakers, and interfaces for video conference systems. It can connect to any type of analog communications line, as well as satellite facilities.

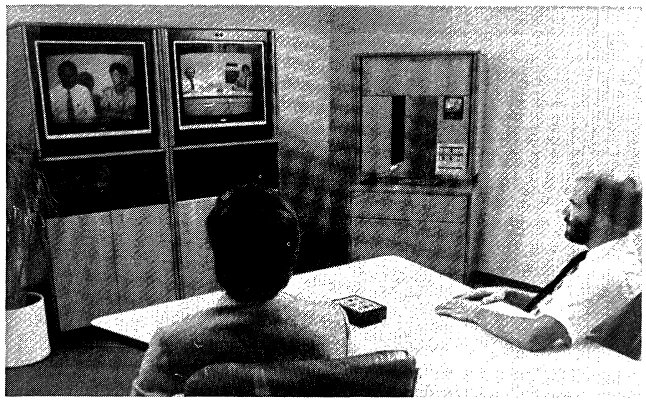
Audio conferences have several important strengths and limitations. On the plus side, they can reduce travel expenses, are faster to set up than face-to-face meetings, require only standard voice telephone lines, are shorter and generally more organized than regular meetings, produce decisions faster, and stimulate greater participation and commitment to the objectives and goals of the meeting. On the negative side, they are more demanding and, consequently, more tiring to the participants. They can be distracting to one's concentration, especially if audio quality is poor. Teleconferencing is perceived as appropriate for only certain types of meetings, and indeed this will probably remain true to a large extent. Most experts agree that teleconferencing will not replace face-to-face meetings, but it will be a frequently used alternative. Perhaps the biggest problem for audio conferencing is user acceptance of its value. The best way to overcome user resistance is to promote the benefits of the service regularly, citing successful examples of its use.

□ Graphic Teleconferencing Systems

Since pictures are indeed worth a thousand words, the addition of visual messages greatly enhances the value of an audio teleconference. Costs for slow-scan and full-motion video can be highly prohibitive, thus the availability of **graphic equipment** that provides a cost-effective bridge between standard audio and full-scale video. Graphic systems permit users at 2 or more dispersed locations to create pictures, graphs, and other basic information on a visual screen, and store, display, and transmit them in real-time. The sophistication of the visual message is not as complex as with full-motion video, and standard voice-grade telephone lines can be used for transmission. Graphic systems are usually backed up with an audio link. This means that 2 telephone lines will be required for the conference; 1 for the voice link and 1 for the graphic system.

Three different types of audiographic systems are available: telewriters, facsimile, and slow-scan video. Slow-scan is included here because of the way images are transmitted, but will also be treated as a separate category because of its unique nature.

Telewriters permit the creation of pictures, words, numbers, graphs, tables, etc in 1 location and the visual results displayed in other locations on a television monitor. They permit flexibility in developing the graphic message, differing from facsimile and slow-scan which require a new visual image to be transmitted. The transmission rate is only about 1200 bps, which means the modems at each end need only be industry standard units. Image quality is generally good, and the systems are easy to set up. An interesting alternative to voice-grade lines for a telewriter is packet-switched network, such as GTE Telenet. Telewriters have not achieved the glamor of video systems, particularly full-motion, but they should not be overlooked.



Portable Video Conference System from Pierce-Phelps.

Perhaps the most well-known and publicized telewriter is the **AT&T Gemini Electronic Blackboard**. It is rather expensive (about $400 per month plus a video monitor), and uses what appears to be a standard blackboard as the sending device. Whatever is drawn on the blackboard is transmitted to a remote monitor as an electronic image. The remote site can also have a blackboard for adding and deleting elements in the picture. These changes appear on monitors at both sites. Erasing can be performed on a selected basis, and the entire screen can be erased at the touch of a button. Gemini requires a separate voice line for the image; a second line is required for audio signals. The system can be set up in a broadcast mode, where 1 blackboard sends signals to multiple remote monitors. AT&T also has several graphic tablets that can be used for generating a visual image.

Telewriters operate on the same basic principle. Each point on the writing surface is represented by a **series of x and y coordinates**. When the surface is touched, a signal encoder sends the coordinates of the point to the remote monitor. The appropriate point on the monitor lights up. If lines or other shapes are drawn, the encoder sends a string of coordinates to the monitor, duplicating the image.

Telewriters, particularly the Gemini, provide a useful support function to an audio teleconference, but have their drawbacks. While the writing surface can be the size of a 3x5 feet blackboard, the area at the receiving end is only the size of a 25-inch monitor. This creates potential resolution problems, especially with detailed charts and tables. It takes practice to effectively use a telewriter. If 2 units are in use, and 1 party wants to make changes in an image drawn by the other, it can be very difficult to determine the proper place to start on the writing surface.

Facsimile systems are used for transmitting graphs, charts, letters, and other supporting documentation over a standard telephone line. Depending on the type of transceiver used, the speed of transmission will vary from about 6 minutes to under 30 seconds, and this will have a definite impact on the speed of the meeting. A major advantage for facsimile is its ability to send documents to remote locations, which can be used for reference. The document quality is generally very good, but varies according to resolution.

There are 4 different classes of facsimile terminals that correspond to CCITT. Recommendations Groups 1, 2, 3, and 4. Typically, the unit cost increases with transmission speed and resolution. Quality, however, does not deteriorate. Three classes operate over standard telephone lines, transmitting at 4 to 6 minutes, 2 to 3 minutes, or 30 seconds. A fourth class transmits over high-speed digital lines at speeds as high as 56K bps, sending messages as fast as 3 seconds per page.

Facsimile is a valuable adjunct to a conference call, whether audio or video, but it can be rather expensive for conference calls alone. The best application for facsimile is the transmittal of documents in preparation for the teleconference; it can be used during the

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conference call, but the transmission speed will probably create an undesired break in the meeting's flow, so it should be used judiciously.

☐ Slow-Scan or Freeze-Frame Video Systems

Another effective method of transmitting visual images electronically is **slow-scan, or freeze-frame video**. In slow-scan, snapshot is taken of the image, whether a picture, graph, chart, CRT display screen, or other nonmoving information, and scanned line-by-line for subsequent transmission. Where a typical full-motion video system scans a scene 60 times per second, a slow-scan system takes as long as 60 seconds to scan single picture or frame. Once the frame is received, it can be viewed as long as required on the remote monitor. When a new image is transmitted, the previous one is erased. Slow-scan images are not transmitted in real-time, as with a telewriter. The image is scanned by the system, encoded for transmission, and received at the remote location where it is slowly painted on the screen. If a change in the image is needed, it must be rescanned after the changes are made. Picture quality is directly related to transmission speed. The faster the speed, the higher the resolution. Slow-scan equipment is relatively inexpensive, and requires only standard voice-grade lines. Unlike telewriters, which use several components, a slow-scan unit is entirely self-contained. The video signal is encoded to an analog signal in the device, making is much easier to set up than a telewriter. Pictures can be transmitted in either monochrome or color, and portable systems are available.

☐ Computer Conferencing

Relatively new, in comparison to other conferencing techniques, computer conferencing **typically operates parallel to audio, graphic, and video teleconferencing**. It is not normally interactive. Messages are sent from one computer user to another on essentially a store-and-forward basis. This means users do not have to be online at the same time, and can conduct conferences virtually anywhere, and at any time. The usual operation has the sender developing a message and sending it to a central storage facility for future retrieval. The receiver simply logs on to the message center and retrieves the message. If this sounds similar to electronic mail, it is. Although not a real-time system, it affords a bit more privacy and less exposure, particularly for sensitive issues, than real-time conferencing. Some industry experts foresee a day when computer conferencing becomes an important part of office communication, especially when integrated with audio and video conferencing. The major need is for more sophisticated user terminals that can handle the functions associated with various methods of teleconferencing.

☐ Full-Motion Video Systems

Long considered the quintessential form of teleconferencing, full-motion video provides video and audio transmission between 2 or more parties on a real-time basis. It is the most expensive method of all, and the most realistic. The quality is comparable to standard broadcast television. The high costs associated will full-motion video are gradually declining, bringing the service within the budgets of a growing number of companies. For example, there are currently about 100 full-motion video conference rooms in the U.S., and this is projected to grow to about 400 by the end of 1985. This costs for video compression devices are decreasing, as are transmission facilities. Satellite transmission, which is ideally suited for video, has also dropped substantially in cost. The future indeed looks bright for video conferencing.

A typical video teleconference has transmit and receive locations. If both locations transmit and receive, they utilize transceivers. The equipment used is similar to a television studio, including camera(s), switching equipment, cables, and connections to the transmission medium. The television signal produced is sent to as satellite-transmitting antenna called an **uplink**. Whether fixed or transportable, the uplink transmits the signal to any of the satellites currently in geosynchronous orbit above the earth. The transmission must be scheduled with the satellite provider, because the satellite is normally used for a wide variety of transmissions. Receiving sites are usually meeting rooms, conference rooms, or training centers at locations also equipped with earth stations, now called **downlinks**. In most cases, the picture portion of the video conference is 1-way. Audio conference support can be 2-way. In cases where 2-way video is desired, multiple screens must be installed at all conference locations.

Video transmission uses huge amounts of bandwidth. For example, the color television signal generated by a video camera requires a 90M bps transmission link. This is impractical for all but the major broadcasting companies. A means of compressing this signal bandwidth is necessary to bring down the cost for transmission facilities. Codecs (coder-decoders) are used to convert the analog picture signal to a digital signal for transmission and then back to analog for user viewing. Rapid progress has been made in codecs and video compression techniques, so that today a satisfactory full-motion picture requires only about 748K bps. As recent as 1981, this requirement was 3M bps, and there are codecs today that can produce video at speeds as low as 56K bps. The growing availability and acceptance of high-speed T1 digital communication lines has brought full-motion video within the range of more businesses than ever before. With a bandwidth supporting 1.544M bps, and a suitable codec, a user can simultaneously transmit a video signal and use the remaining bandwidth for low- to medium-speed data and even voice transmission. As data transmission speeds decrease, however, full-motion video picture quality also declines. As there are continued advances in video technology, the day is not far off when users will be able to experience full-motion video at their workstations, as well as all other automated office features.

Several video compression techniques are used. The oldest form is **differential pulse-coded modulation**, also known as **interframe coding**. It is preferred by NEC and the British firm GEC McMichael. The value of each **pixel** (picture element) of succeeding frames is compared, pixel for pixel, with preceding frames and only the differences in value are transmitted. In situations with minimal motion, picture quality is good. However, when movements speed up, the picture can appear jerky and often blurred.

Another technique is **intraframe coding**, which differs from interframe in that processing is performed on each picture frame. Groups of frames in rectangular clusters, called segments of cells, are scanned and the digital values encoded. An intraframe algorithm processes the pixel segment, compresses the digital data, and transmits the results segment by segment. Since the compression technique is applied frame by frame, regardless of scene changes, intraframe coding is relatively motion-independent. Picture frame quality, however, is slightly less than interframe coding when used with low-motion scenes.

A third type of compression is a combination of interframe and intraframe techniques. Developed by Compression Labs, the inventor of intraframe coding, the new technique is called **differential transform coding**. It uses intraframe coding to process segments, and then interframe coding from one frame to another. According to the company, picture quality normally obtained at 1.544M bps transmission speeds can be obtained at 768K bps, with improved picture stability as well.

Other manufacturers are stretching the technological limits of compression even further. Firms like Avelex Corporation and Widcom Corporation produce codecs that provide acceptable motion at speeds of 56K bps. Even slower speeds like 19.2K bps will provide limited motion which can be useful in specific situations.

☐ Conference Rooms—Are They Really Needed?

When AT&T introduced Picturephone service in 1964, it was greeted with fascination but little interest. Only a few very large companies ever set up their own Picturephone conference rooms, because the overall cost was too prohibitive. Several years ago, AT&T resurrected Picturephone in the form of public conference centers, called **Picturephone Meeting Service (PMS)**. Recent changes in the industry have prompted AT&T to close down 6 of its 11 PMS rooms, but that doesn't mean AT&T is in any trouble. Rather, it anticipates even greater success through its 1.544M bps Accunet digital transmission service, the price of which has been declining steadily. This service will make video conferencing possible for many companies in 1985 and beyond. Connections with numerous foreign countries are making AT&T the preeminent

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source for international teleconferencing.

Video conference rooms can be very expensive. For example, a year or so ago a PMS room, completely outfitted, ranged from $250,000 to about $400,000. Today it is possible to build a video conference room for around $100,000. Portable video systems are available for around $50,000 to $75,000. For those who do not want to invest in a complete facility, several major hotel chains, such as Holiday Inn, Hilton Hotel, and Marriott Corporation, provide video conference rooms in major cities on their premises. For limited applications, this alternative is perhaps the best solution of all. A growing number of Fortune 500 companies have built, or are planning to build their own video conference networks, connecting multiple corporate sites. Atlantic Richfield, for example, inaugurated its own private network, ARCOvision, in September of 1983, at a cost of approximately $17 million. The firm designed and installed its own network facilities, conference rooms, and internal operating procedures.

Aside from the costs associated with the studio equipment and codecs, transmission facilities have been a big stumbling block to video conferencing. These costs, as mentioned earlier, are coming down quickly. The most cost-effective alternative to leasing transmission facilities is to create a private network. Satellites make this possible, and the costs associated with earth stations and renting out satellite transponder time have dropped considerably in the last 2 years. Satellite communications has great promise, especially for small to medium businesses. As the cost for an earth station comes down to $10,000 and below, it will no longer be the stuff of dreams to have a satellite connection. For shorter distances, such as within a city, microwave, fiber optics, and even lightwave communications can effectively bypass local telephone company lines. Major communications carriers have plunged heavily into satellite transmission for video conferencing, and some will even provide assistance in the design of a conference room. Satellite Business Systems and American Satellite Corporation are 2 such examples. Both can provide full-motion video at speeds of 1.544M bps or less. American Satellite's Flex Stream service, for example, can integrate voice, data, and video over the same signal.

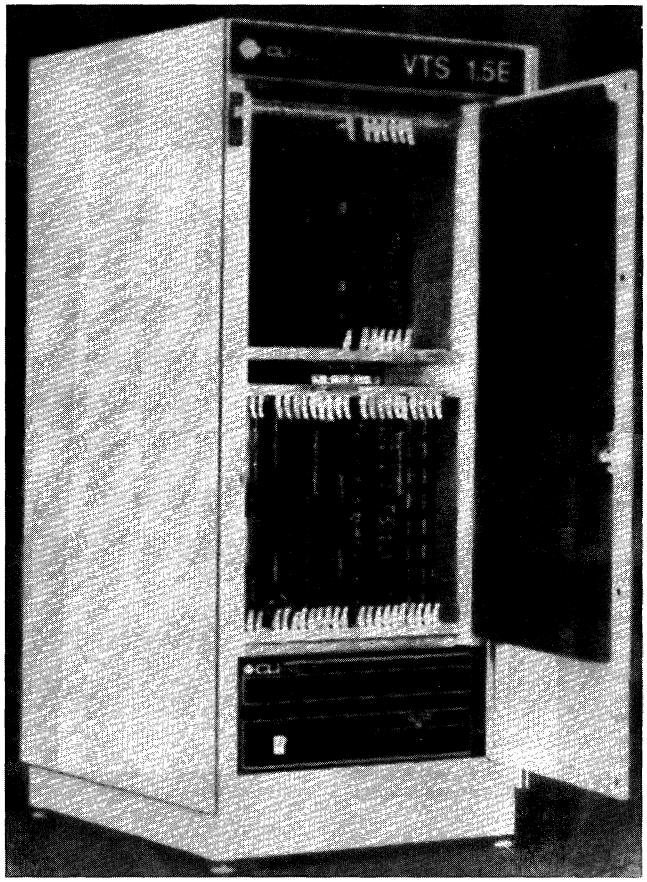
■ PLANNING FOR TELECONFERENCING

There are 2 key elements in successful teleconferencing: equipment and personnel. The right equipment will achieve the desired results, with a reasonable investment. However, if individuals do not use the system, or if they use it incorrectly, it will not be successful. In actual practice, the personnel factor is often the more difficult of the 2 to achieve.

□ Hardware Considerations

In most companies, the telecommunications department will be responsible for designing and implementing teleconferencing systems. It is essential to determine the specific applications for teleconferencing, the potential number of locations involved, the number of people involved at any given location, time factors such as time zones and conference duration, as well as an understanding of the company's overall corporate objectives. It is understood that **teleconferencing will not be the primary means for conducting meetings**. Face-to-face conferences still are the most popular method of accomplishing business, and may continue as such. But a well-planned teleconference will accomplish as much work, in less time, and for less money, than a face-to-face meeting. Usually, all it takes is 1 or 2 successful teleconferences to start the ball rolling.

The first consideration in hardware is the need for audio, video, or both. Usually, since an audio conference is far less expensive than a video meeting, it is advisable to try this method first. If only a few individuals are present at each location, the conference can be set up by the telephone company conference operator or a conference operator or a conference bridging service like that offered by the Darome Connection. Some conference calls can even be established through the company's PBX system. The equipment needed at each location is a telephone, or perhaps a speakerphone if there will be a few people present. For larger numbers of participants, more sophisticated audio equipment is required. If any supporting documentation is required, such as charts or graphs, reports, etc, they should be distributed in



Compression Labs VTS 1.5E Codec.

advance of the meeting, along with a meeting agenda.

If graphics are required in a real-time situation, such as a planning meeting for a new product, graphics units like the AT&T Gemini can be used. Slow-scan video is another alternative. Both can be used with a moderate investment because they require only standard voice-grade telephone lines for transmission. Connections can be made on a dial-up basis for ease of setup, but the quality of the connection can vary greatly, affecting picture quality. Very little operator intervention is required, which keeps the entire process simple and holds costs down.

Video conferencing is the most expensive in terms of hardware. Typically, there will be a dedicated room for the conference center, multiple cameras, a control room, facilities center for the equipment, and accommodations for the speakers, such as tables, chairs, easels, lights, microphones, and switching controls. When designing the control units, for example, care should be taken to make the switching methodology as simple as possible for users. If there are multiple cameras focused on the speakers, the person responsible for controlling the conference equipment should be able to switch back and forth among cameras and monitors by the touch of a button. If the video conference is between 2 locations, there is no requirement to develop a network. However, if there are more than 2 locations planned for the network, the telecommunication department will have to design a network that can handle the multilocation requirements.

Hardware manufactured expressly for video conferencing is limited. Cameras, monitors, and switching units are generally off-the-shelf products modified for the application. Video codecs and specialized audio systems are the only products that fall into

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this category. Codecs are perhaps the most important element in video conferencing, because their ability to compress video signals without sacrificing picture quality is the key to implementing a successful operation.

The actual conference room may have to be designed from scratch, rather than modify an existing conference room. Factors such as room lighting, room shape and size, acoustics, power outlet location and type, ambient noise levels, and cable routing are critical in building facilities conducive to video conferencing. Instead of building a new room or remodeling an existing one, a portable system costing thousands of dollars less, may be the solution. Equipment used in the portable system may be reused in the event a separate conference room is justified.

□ Personnel Considerations

Building the most lavishly appointed video conference room will not guarantee its success. Users must be convinced of the room's value to their business productivity. They must be advised of other companies' successes with teleconferencing, and **top management must support the program**. Unless the company is big enough to fund a separate department to handle teleconferencing (and few are), the telecommunication department is ideal for getting the program underway. It can determine the best type of conference service for the user requirement, whether audio or video, and can get the best deal in terms of cost since the department knows the carriers and major hardware vendors.

Whether an audio or video teleconference, several important activities must take place for a meeting to be successful.

- There should be a chairperson appointed for the meeting. This individual will establish and maintain the meeting's pace, and will ensure that all participants are heard.
- An agenda of the meeting must be distributed to all participants in advance, along with any other pertinent reports, tables, charts, etc.
- Visual cues in a video conference send messages as effectively as verbal ones. In an audio conference, this information is not available, so the moderator must encourage all participants to offer their comments, if for no other reason than to make sure they are awake.
- All participants should be introduced at the start of the meeting, which helps everyone to relax.
- Participants should be advised of any limitations with the medium in use, as well as the best methods of using the equipment. In audio conferences, it is good practice for speakers to identify themselves before speaking.
- Make sure each participant knows how to rejoin the call, in the event of a disconnection.
- Structure the meeting so that each subject is summarized and the outcome agreed upon before proceeding to the next item.
- The trappings of power and one's position are not physically evident in an audio teleconference, which can help promote a livelier discussion. Video conferences do not have this limitation, however, and it is the moderator's responsibility to see that all participants are heard, regardless of their rank.

Getting started in teleconferencing can often be made much easier with help from companies experienced in teleconferencing and specialized consultants. These organizations know the hardware, but more importantly, they know how to deal effectively with people during a teleconference, and this is the key to a successful program.

■ TELECONFERENCING—A BRIGHT FUTURE

Teleconferencing is an idea whose time has finally come. It is easy to have a teleconference, and the cost is cheap. At the other end of the spectrum, it can cost millions of dollars and be exceedingly complex. But the overriding need is for effective ways to improve productivity, and in this capacity teleconferencing is an excellent alternative. In terms of saving time, it can't be beat. For getting things accomplished quickly and efficiently, few methods do as good a job. So why is there no teleconferencing boom?

Old habits die slowly. Travel is one of the "perks" made available to company personnel. Teleconferencing can conceivably eliminate a large portion of this luxury. The annual sales conference simply would not be the same over a television screen. Teleconferencing will not replace travel in all cases, but it has proven itself time and again an effective alternative. For the past 5 to 10 years, little or no equipment was available for teleconferencing; or what was available was far too expensive for most prospective users. However, all that is changing rapidly. Costs for teleconferencing equipment have dropped significantly, especially in video conferencing. A large assortment of audio systems is now available to satisfy virtually any application. Costs of high-speed transmission facilities have dropped enough to bring video conferencing into a growing number of companies. Satellite communication is the big success story in video. For $10,000 or less, a user can buy a receiving station for all types of video. Prominent hotel chains have taken video conferencing and built it into a major source of revenues.

Although there are presently more companies who do not use teleconferencing than those who do, it is expected this situation will completely reverse itself by the end of the decade. It is a technology with an exceedingly bright future, and a brighter one for those who use it.

■ TELECONFERENCING VENDORS

For further information on teleconferencing, the following list of vendors has been developed. After each company name, the products and services provided by each are listed.

American Satellite Corporation • 1801 Research Boulevard, Rockville, MD 20850-3186 • 301-251-8333 • video conference service • conference room facilities • consulting.

American Video Teleconferencing Corporation • 2949 Long Beach Road, Oceanside, NY 11572 • 516-763-1150 • graphic equipment • video equipment • consulting.

Arus Corporation • 1305 Conkling Avenue, Utica, NY 13501 • 315-793-8500 • conference bridge.

AT&T Communications • 295 North Maple Avenue, Basking Ridge, NJ 07920 • 201-221-2000 • communication services.

AT&T Information Systems • 100 Southgate Parkway, Morristown, NJ 07960 • 201-898-8000 • audio equipment conference bridges • graphic equipment • conference room facilities • audio/video conference service • consulting.

Avelex Corporation • 310 Bonifant Road, Silver Spring, MD 20904 • 301-384-8060 • codecs • video equipment.

Bonneville Satellite Corporation • 165 Social Hall Avenue, Salt Lake City, UT 84111 • 801-237-2450 • audio equipment • video equipment • video conference service consulting.

Buscom Systems, Inc • 490 Gianni, Santa Clara, CA 95050 • 408-988-5200 • audio equipment.

CEAC, Inc • 1500 East Conesuh, Union Springs, AL 36089 • 205-738-2000 • conference bridges.

Center for Interactive Programs, University of Wisconsin—Extension • 728 Lowell Hall, 610 Langdon Street, Madison, WI 53703 • 608-262-4554 • audio conference service • consulting.

Centro Corporation • 2029 Century Park East, Los Angeles, CA 90067 • 213-203-8033 • graphic equipment • video equipment.

Colorado Video • P.O. Box 928, Boulder, CO 80306 • 303-444-3972 • video equipment • consulting.

Compression Labs, Inc • 2305 Bering Drive, San Jose, CA 95131 • 408-946-3960 • codecs • video equipment.

Comsat Telesystems, Inc • 2721 Prosperity Avenue, FairFax, VA 22031 • 703-698-4300 • audio equipment.

Comtech Telecommunications Corporation • 45 Oser Avenue, Hauppauge, NY 11788 • 516-231-5454 • video equipment.

Confer Tech International, Inc • 240 Park Center, 8795 Ralston Road, Arvada, CO 80002 • 800-525-8244 • audio equipment • conference bridges.

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Connex International • 12 West Street, Danbury, CT 06810 • 203-797-9060 • audio conference service.

Contech • 30 Plaza Drive, Westmont, IL 60559 • 312-789-0888 • conference bridges.

Cross Information Corporation • 934 Pearl, Suite B, Boulder, CO 80302 • 303-444-7799 • computer conferencing • consulting.

Dacon Electronics, Inc • 8 Industrial Avenue, Upper Saddle River, NY 07458 • 201-825-4640 • audio equipment • conference bridges.

Darome, Inc • 711 East Diggins, Harvard, IL 60033 • 815-943-5481 • audio equipment • conference bridges.

Darome Connection, Inc • 8 West Street, Danbury, CT 06810 • 800-243-0991 • audio conference service.

Dasa Corporation• 15 Stevens Street, Andover, MA 01810 • 617-475-4940 • audio equipment.

Decisions and Designs, Inc • 8400 Westpark Drive, McLean, VA 22101 • 703-821-2828 • graphic equipment • video equipment.

GEC Video Systems • 8260 Greensboro Drive, Penthouse A, McLean, VA 22102 • 703-821-1400 • codecs.

Hilton Communications Network • 9880 Wilshire Boulevard, Beverly Hills, CA 90210 • 213-278-4321 • video conference services.

Holiday Inn HiNet • 3796 Lomar Avenue, Memphis, TN 38195 • 901-362-4505 • video conference services.

Hughes Aircraft Co. Industrial Products Divisions • 6155 El Camino Real, Carlsbad, CA 92008 • 714-438-9191 • graphic equipment • video equipment.

Infolink Corporation • 1925 Holste Road, Northbrook, IL 60062 • 312-291-2900 • graphic equipment.

Intelect, Inc • 840 Moowaa Street, Honolulu, HI 96817 • 808-845-6611 • audio equipment • conference bridges.

Interand Corporation • 3200 West Peterson Avenue, Chicago, IL 60611 • 312-478-1700 • graphic equipment.

Inter-Continental Hotels Intelnet Videoconference Service • 111 East 48th Street, New York, NY 10017 • 212-906-1506 • video conference service.

International Data Control Corporation • 2373 Stevenage Drive, Ottawa, ON K1G 3W1 • 613-733-4440 • conference bridges.

ISACOMM • 1815 Century Boulevard, Atlanta, GA 30345 • 800-554-3365 • video equipment • video conference service • conference room facilities • consulting.

Kellogg Corporation • 5601 South Broadway, Littleton, CO 80121 • 303-794-1818 • audio conference service • consulting.

M/A Comnet, Inc • 1350 Piccard Drive, Rockville, MD 30850 • 301-258-8858 • video conference service • conference room facilities.

Marriott Teleconference Network • 1 Marriott Drive, Washington, DC 20058 • 202-897-9000 • video conference service.

McCurdy Telecommunication Products, Inc • 1051 Clinton Street, Buffalo, NY 14206 • 716-835-3587 • audio equipment • conference bridges.

Microdyne Corporation • P.O. Box 7213, Ocala, FL 32672 • 904-687-4633 • audio/video equipment • consulting.

Misar Industries • 17192 Gillette Avenue, Irvine, CA 92714 • 714-540-2477 • video equipment.

NEC America, Inc Broadcast Equipment Division • 130 Martin Lane, Elk Grove Village, IL 60007 • 312-640-3792 • video equipment • codecs • conference room facilitis • communication services.

Netcom International • 702 Union Street, San Francisco, CA 94123 • 415-921-1441 • video conference service.

Northern Telecom Canada, Ltd Analog & Radio Transmission Division • 9300 Trans Canada Highway, St Laurent, PQ H3C 3S1 • 514-331-9611 • conference bridges.

Northern Telecom, Inc • 1001 East Arapaho Road, Richardson, TX 75081 • 214-234-5300 • audio equipment.

Optel Communications • 322 8th Avenue, New York, NY 10001 • 212-741-9000 • graphic equipment.

Participation Systems, Inc • 50 Cross Street, Winchester, MA 01890 • 617-729-1976 • computer conferencing.

Pierce Phelps, Inc • 2000 North 59th Street, Philadelphia, PA 19131 • 215-879-7171 • audio equipment • video equipment • consulting.

Precision Components, Inc • 1110 West National Avenue, Addison, IL 60101 • 312-543-6400 • audio equipment.

Positron Industries, Inc • 184 North Main Street, Champlain, NY 12919 • 514-731-3715 • audio equipment • conference bridges.

Pulsecom Division Harvey Hubbell, Inc • 2900 Towerview Road, Herndon, VA 22071 • 703-471-2900 • audio equipment • conference bridges.

Resource Management Consultants • 43 Birch Street, Derry, NH 03038 • 603-434-2210 • audio equipment • video equipment • consulting.

Robot Research • 7591 Convoy Court, San Diego, CA 92111 • 714-279-9430 • video equipment.

Satellite Business Systems • 8283 Greensboro Drive; McLean, VA 22102 • 703-442-5000 • video conference service • communications facilities.

Sears Communications Network, Inc • 95 West Algonquin Road, Arlington Heights, IL 60005-4401 • 312-952-3000 • audio/video conference services.

Shure Brothers • 222 Hartrey Avenue, Evanston, IL 60204 • 312-866-2400 • audio equipment • conference bridges.

Talos Systems, Inc • 7419 East Helm Drive, Scottsdale, AZ 85260 • 602-948-6540 • audio equipment • graphic equipment.

Telco Systems, Inc • 1040 Marsh Road, Menlo Park, CA 94025 • 415-324-4300 • audio equipment • conference bridges.

Telecom Canada • 160 Elgin Street, Room 1150, Ottawa, ON K1G 3J4 • 613-567-3748 • audio/video conference services • communication services.

Teleconferencing Systems International • 41 Martin Lane, Elk Grove Village, IL 60007 • 312-255-3990 • audio equipment.

TeleMedia International • 1425 Market Street, Suite 205, Denver, CO 80202 • 303-534-8456 • consulting.

Telephonic Equipment Corporation • 17401 Armstrong Avenue, Irvine, CA 92714 • 714-546-7900 • audio equipment • conference bridges.

TeleSpan • 50 West Palm Street, Altadena, CA 91001 • 818-797-5482 • consulting.

Tellabs, Inc • 4951 Indiana Avenue, Lisle, IL 60532 • 312-969-8800 • audio equipment • conference bridges.

Teltrend, Inc • 620 Stetson Avenue, St. Charles, IL 60174 • 312-377-1700 • audio equipment • conference bridges.

Tori International • 12700 Nicollet South, Minneapolis, MN 55337 • 612-894-5128 • audio/video conferencing equipment.

Uni-Tel, Ltd • 1792 Birchmount Road, Scarborough, ON M1P 2H7 • 416-291-3131 • audio equipment • conference bridges.

VideoStar Connections, Inc • 3390 Peachtree Road, Atlanta, GA 30326 • 800-241-8850 • audio equipment • video conference service.

Video Systems • 12530 Beatrice Street, Los Angeles, CA 90066 • 213-870-1231 • video equipment.

Vidicom Video Communications Division of L.D. Bevan Co • 742 Hampshire Road—Suite D, Westlake Village, CA 91361 • 805-497-2685 • audio equipment • graphic equipment • video equipment.

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Virginia A. Ostendorf, Inc • P.O. Box 2896, Littleton, CO 80161-2896 • 303-797-3131 • consulting.

Vitalink Communications Corporation • 1350 Charleston Road, Mountain View, CA 94043 • 415-968-5465 • video conference equipment • video conference service • consulting • communication services.

Wescom, Inc • P.O. Box 1458, Downers Grove, IL 60515 • 312-985-9000 • conference bridges.

Westell, Inc • 7630 Quincy Street, Willowbrook, IL 60521 • 312-789-0888 • audio equipment • conference bridges.

Western Union Video Conferencing Service • One Lake Street, Upper Saddle River, NJ 07458 • 201-825-5000 • audio equipment • video conference service • conference room facilities.

Widcom • 1500 Hamilton Avenue, Campbell, CA 95008 • 408-377-9981 • codecs • video equipment.

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