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ABSTRACT

This collection of papers addresses the impact of rapidly changing telecommunications technology on libraries. A brief introduction by James L. Divilbiss sets the stage for the following papers: (1) "Making Sense of New Technologies and New Legislation" (Joseph Ford); (2) "Selection and Use of Telecommunications Consultants for Library Automation" (Rodney B. Perry); (3) "Modeling Library Communications Traffic" (John C. Kountz); (4) "Telecommunications for Libraries" (Richard W. Boss); (5) "A Collection of Books" (Herbert P. Crane); (6) "Telecommunications in the Office" (Michael A. Flavin); (7) "Electronic Mail Services in the Library and Information Center Community" (Dennis Oliver); (8) "Packet Radio for Library Online Catalogs" (Edwin B. Brownrigg); (9) "Narrowband Teleconferencing" (Joan Maier McKean); and (10) "Establishing a Data Communications Network: A Case Study" (Deborah K. Conrad). (THC)

TELECOMMUNICATIONS: MAKING SENSE OF NEW TECHNOLOGY AND NEW LEGISLATION

Edited by

JAMES L. DIVILBISS

Graduate School of Library and Information Science
University of Illinois at Urbana-Champaign

TELECOMMUNICATIONS MAKING SENSE OF NEW TECHNOLOGY AND NEW LEGISLATION

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of Data Processing, April 14-16, 1984

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INTRODUCTION

For twenty years this series of Clinics has explored nearly every aspect of library automation. Telecommunications has often been mentioned at these Clinics because automation projects of any scope nearly always involve pieces of computer equipment separated by more than a few feet. Whether the application is cataloging, public access, reference, or interlibrary loan, communication lines are usually an inescapable part of the system.

In the past few years it has been much harder to think of telecommunications as something tacked onto a completed system design. Partly this arises from new technology such as fiber optics, intelligent terminals, electronic mail, and packet switching and partly it arises from a greatly changed business climate. New forms of business such as value added networks, specialized common carriers and the entire giant interconnect industry have created so many new ways of accomplishing telecommunications tasks that the selection of the best way has become exceedingly difficult. And, of course, a complex situation was made simply chaotic with the divestiture of the Bell System in January of 1984.

While the divestiture of the Bell System and rapidly changing telecommunications technology have had great impact on the entire business community, our concern here is with their impact on libraries. As Joseph Ford Makes clear in his paper, libraries made up only about 0.5% of the private line revenue of the old Bell System and thus libraries do not have significant clout in the marketplace. Economic relief may ultimately come from technological advances but in the short run, legislative relief is the answer.

Many readers of this book will undoubtedly feel that the nuts and bolts of telecommunications technology are someone else's responsibility, a view that was certainly valid when all telecommunications services and products came from a single supplier, the Bell System Today, even small library systems have telephone lines, modems, terminals, and computers, all from different suppliers. In this situation, the failure of the system can generate an orgy of finger pointing unless the system user has some understanding of the constituent parts. In her paper, Debby Conrad makes a persuasive case that a librarian *can* master the details that spell the difference between a shaky system and an economical, smoothly running system.

In his paper, Richard Boss stresses that competing turnkey systems cannot be truly compared unless the associated telecommunications costs are included. (The system with the lowest *initial* cost may require heavy, continuing telecommunications expenditures.) For any system that extends beyond a single building, the configuration options are numerous and will probably be more numerous next year. The issue is complex, of extreme economic significance and is very capably addressed by Boss

Finally, there are certain to be cases where libraries feel they must have outside technical assistance in reaching a telecommunications decision Rodney Perry has been in that position and in his paper sets forth very clear guidelines for deciding on the desireability of using a consultant, choosing a consultant and working with a consultant

J L DIVILBISS
Editor

JOSEPH FORD

Executive Director
CAPCON

Making Sense of New Technology and New Legislation

Introduction

I would like to discuss what I believe to be one of the critical issues of the 1980s for libraries. Thanks to Dean Charles Davis and Professor J.L. Divilbiss of the University of Illinois Graduate School of Library and Information Science for identifying the issue and developing this Clinic.

As I said, telecommunications may well be the key technical and economic issue of the 1980s for libraries. No other resource at our disposal challenges us so much to make good decisions, and no other issue will reward our efforts if we do well, nor punish us so much if we fail to act.

The telecommunications resources we use have allowed us to develop much of the library data processing we use and rely on. Yet, in another sense, much of the telecommunications plant, or facilities that we use, are the traditional copper wires—of limited capacity but nearly unlimited distribution. Typically, libraries have leased this capacity and created private networks that link us together, to our branch locations, and to the bibliographic utilities. Library telecommunications also includes the use of the value-added packet-switching networks such as Telenet (General Telephone Electronics), Uninet (United Telecom Communications), and Tymnet (Tymshare Inc.), for dialing into information services such as Dialog and Bibliographic Retrieval Services, and to a lesser extent into OCLC or between individual libraries or branch locations.

In the last ten years, libraries have become dependent on telecommunications, particularly leased-line dedicated circuits, as we have adapted resource-sharing technology to library technical and public services. While we have learned to rely on certain kinds of service from our telecommunications industry, that industry has been preparing for a profound change in its structure, and in the types of telecommunications products and services it offers its consumers. The evidence of coming change has been apparent for several years, perhaps even longer to industry experts. Now the change is upon us, and it is apparent that much of what we rely on today will be changed dramatically in the near future, perhaps in the next two or three years. Much change has already occurred, but even more profound developments are coming.

Bases of Change

I believe we can name three major reasons for the changes now underway. They are: (1) the divestiture of AT&T, (2) the development of telecommunications and computer technology, and (3) the emergence of competition in the telecommunications industry.

These three forces are interlinked. It is difficult to differentiate between them—as with all very large-scale changes, many details and forces merge or blend with one another. The emergence of competition is clearly related to the AT&T divestiture, for example.

Background of the AT&T Divestiture

As we are aware, the old monolithic American Telephone and Telegraph Company (AT&T) has been changed unalterably. Since 1 January 1984, we have had a new AT&T, which retains some portions of the old predivestiture AT&T such as the Long Lines Division (now called AT&T Communications), and equipment sales (now called AT&T Information Systems). Gone from the AT&T family, however, are the old local operating companies such as Illinois Bell and Chesapeake and Potomac Telephone Company. The AT&T local operating companies have been divested and are now organized into seven regional holding companies. These regional holding companies—NYNEX, Bell South, Bell Atlantic, Ameritech, Pacific Telesis, Southwestern Bell, and U S. West—are still in the telecommunications game. In addition, there are approximately 1500 other local telephone companies in this country.

Despite the apparent suddenness of the divestiture, it did not spring out suddenly on 1 January 1984. In fact, there is a thirty-five year history of Federal actions, primarily brought by the U.S Department of Justice, which led toward the divestiture. Some of the critical dates in this chronology are 1949, 1956 (when AT&T agreed to a Final Judgement that precluded its participation in computer sales, among other things); 1969 and 1974 when one or another proceeding was introduced into court against AT&T, or an AT&T competitor was upheld in seeking access to AT&T markets. In 1982, AT&T and the Department of Justice announced an out-of-court settlement by which AT&T would accomplish the complex undertaking of dividing its assets, and becoming eight completely separate organizations.

It is important to note that with AT&T divested of its former monolithic structure, we now have a much more competitive marketplace, with more companies offering service. Indeed, some of the former AT&T operating companies have announced their entry into markets formerly denied to them by virtue of the Final Judgement of 1956. In addition to the divested AT&T companies, the new AT&T and the other telecommunications companies such as MCI have all been engaged in developing and marketing products and services which it is hoped will benefit the users. With this competition has come substantial technical, economic and regulatory change. We can expect, furthermore, the rate of change to accelerate in the future.

Technical Aspects of Telecommunications Change

Let us look at the technology of library telecommunications. In one technical sense, much of what we use in the library community might be called POTS—Plain Old Telephone Service. It is not universally true, but most of the library telecommunications environment is oriented around voice-grade, copper-wire plant, particularly in local exchanges.

Telecommunications switches, the devices that link individual subscribers' lines to complete either local or long-distance calls, have become more sophisticated as they have been computerized. In this country, whether the plant is fully computerized or not, the facilities work together very, very well. Nevertheless, much of the present local-exchange telephone technology is low-speed, voice-grade, low-technology telephone service. Consider that the device which links many computer devices to telephone lines—the modulator-demodulator, or "modem"—is needed to emit or receive tones in the range of human hearing that the telephone system has been designed to support. While our computer devices use binary (or digital) codes which offer very high transmission capacity, much of the telecommunications system still uses analog techniques and facilities which are inherently of lower capacity.

A critical economic and regulatory factor for libraries is that this type of voice-grade service is about to be affected drastically by new tariff structures which may double library telecommunications expenses in the next two years or sooner. The reasons for these new price structures are many and varied, but the primary thrust of increased prices for the type of telecommunications libraries use comes from the local telephone companies, those that operate and maintain local telephone exchanges and lines. The local exchange companies claim, perhaps with some justification, that their costs have always been higher than the prices they had us pay, but that in the past they had subsidies from the long-distance services to pay for local deficits. The breakup of the monolithic Bell System effectively terminated the cross-subsidization of local service. The subject of the Bell breakup is important to our discussion of economics in library telecommunications, and I will return to this later.

First, let us look at what the future may offer in telecommunications technology. In the early 1980s, a European telecommunications standards group called CCITT—Consultative Committee on International Telephone and Telegraph—put forward a concept of a completely digital telecommunications system. That is, the CCITT proposed that virtually all long-distance telecommunications transmission and reception would be in a binary digital code. If telephone service is called POTS, this might be termed PANS—Peculiar and Novel Services. The concept that CCITT put forward is being called ISDN—Integrated Services Digital Network. ISDN would have an enormous capacity, and by digitizing all transmission, could mix voice, computer data and video in a single switching and carrier package. The standards necessary for the adoption of ISDN are in preparation, and they are expected to be completed by the end of 1984. Some ISDN-compatible terminal equipment may be available by 1986. When ISDN becomes commercially available to end users, we will have enormous telecommunications capabilities which will terminate wherever there is sufficient demand.

Let us understand, however, that the costs for an ISDN conversion will also be enormous. We should also understand that the library community is a very small part of the total telecommunications market, and that very high-capacity telecommunications facilities will be difficult to justify for many of us. That is to say, there are several economic issues we face.

Telecommunication Futures: Economic

Economically, there are literally billions of dollars involved in current telecommunications products and services. AT&T estimates that its private line business in 1983 alone was $2.14 billion. The library portion was estimated at less than $10 million, or something under 0.5 percent. Dr. Walter Bolter, the American Library Association's consultant on telecommunications issues, once noted that libraries' use of private-line service was so slight a portion of AT&T's total private line business that our payments could disappear from an AT&T financial report as a rounding error.

Clearly, library telecommunications, whether leased-line or value-added network, represents only a fraction of the total telecommunications market In many respects, however, our use of telecommunications cannot be judged on economic grounds alone, because our uses transcend purely economic issues. But, as providers of information, libraries' activities which depend on telecommunications will be captives of higher prices.

I have already discussed the potential impact of proposed new tariffs for our type of private-line service With local telephone loops increasing in price by as much as 400 percent in some states, and with the cost of new, high-speed technology likely to be very expensive, we should be asking ourselves some critical questions. How can we adapt? How can we continue to provide service in the face of very large price increases? How can we adapt to services which will be very capital-intensive, and whose costs will exceed our capabilities to pay?

I believe we will adapt to new telecommunications by entering into creative technical partnerships, by looking to stronger institutional ties, and by taking advantage of shared activities.

Telecommunications Future: Technical

Let me share with you some probable developments in telecommunications which will affect all of us. These ideas are not a prognostication, but a simple description of probable future technology.

In the Integrated Services Digital Network environment, all telecommunications will be digital, using various transmission media. Such telecommunications standards as AT&T's T-1 carrier will travel by mixed-medium, mixed-architecture transmission channels. Probable choices for the telecommunications architecture include digital microwave radio, satellite, coaxial cable, and light-guide fiber optics. Significant problems remain to be solved, however, before any higher-speed communications can be implemented at the local exchange level.

As we noted earlier, much of the local telecommunications plant is not capable of high-speed transmission. The problem of moving data from hub locations to end users has been called the "last-mile problem."

While there are a number of possible techniques for handling the "last-mile problem," some of them will represent a direct threat to the telecommunications industry. For example, a system called Digital Termination Service (DTS)—digital microwave radio—is being tested in the Washington areas at this time. Local Area Networks (LAN)—various coaxial cable or wire pair systems for use in transmitting data in local settings—have been much discussed recently. In addition, a number of other, probably unfamiliar, delivery organizations are interested in providing local telecommunications capabilities. These include local electrical utilities, and the local cable television systems. These types of telecommunication systems will simply "bypass" the local telephone company facilities.

Another type of facility being discussed is the "wired campus," which as its name implies, is a local network which links the buildings on a university campus. The University of Pittsburgh is one institution which has made a commitment to a campus-wide local network. Yet another possibility is the "smart building," wherein the actual structure of a building will contain the telecommunications logic controls for all the tenants in the building.

Clearly, the choices for future telecommunications systems are many and varied, and we will be challenged to make good choices in our use of the systems. And, again, we will likely find ourselves making alliances in the future to be able to use and afford new telecommunications technology.

Legislative Issues

In order for us to arrive in the future, we must survive the present, and we are aware that price increases threaten us immediately. Let us turn now to a brief review of the legislative relief from massive price increases the library community sought in the 98th Congress.

As an opening statement, let me note that recent reforms or amendments to the Communications Act of 1934—the basic telecommunications law—have not fared well in Congress. In the 97th Congress, Congressman Wirth of Colorado introduced legislation which might have eased the burden of telecommunications increases for libraries. The bill was withdrawn after, among others, Congressman Corcoran of Illinois moved to block the bill coming out of committee.

In the 98th Congress, elected in 1982 and due to expire this fall, legislation was introduced in the Senate (S. 1660) and House (H.R. 4102) which, in the amended Senate version, would specifically have prevented price increases from affecting libraries. We should thank the American Library Association, particularly Eileen Cooke and Carol Henderson of the ALA Washington Office, for having worked long and hard on an amendment to this legislation, and to Senator Larry Pressler for having sponsored it. Despite the best efforts of the library community, S. 1660 was not reported out of committee, and therefore is effectively dead for this Congress. While we can hope that the House and Senate will [illegible]ok kindly on our needs in the future, there is no hope for direct legis[illegible] in the current year (1984).

Yet, there is little doubt in my mind that we need some type of relief. In January I had the opportunity to speak with representatives of AT&T, the Federal Communications Commission, and the U.S. Senate, all within a few days. Each group recognized our problem, and each group suggested that we look to one of the other groups to help us solve it When everyone suggests that we look elsewhere for help, then I believe we must look to the legislative or regulatory sectors for short-term assistance with increasing prices While our long-term solutions may be technical, libraries must have help to overcome the short-term price increases we are all facing at this time.

We do not wish to conclude with the idea that our outlook is hopeless. Your interest has brought you here for this Clinic, to hear speakers knowledgeable in the many areas of telecommunications important to libraries. You have an opportunity to learn about telecommunications and its challenges We in the library community have friends in Congress, we are organized and our professional concerns transcend economics. We can accomplish a great deal when we work together to face a challenge, and the changing nature of telecommunications is certainly a challenge. I believe we can and must rise to it

RODNEY B. PERRY
Associate Director
Rochester Public Library Monroe County Library System

Selection and Use of Telecommunications Consultants for Library Automation

Introduction

Data communications for library automation systems have emerged rapidly as a major consideration for library systems personnel, automation planners and library managers. The consequences of wrong choices in data communications are at least as serious as those for wrong choices regarding automation of library operations. Libraries installing automation systems, however, must make decisions in order to operate. It is an area where libraries should seek the best available help to assist them in clarifying options and reducing uncertainties. This article will describe the factors involved in selection and use of telecommunications consultants, particular focus will be given to Requests for Proposals (RFPs) and the characteristics of telecommunications for library automation which play a part in the selection and use of consultants. The Monroe County Library System (MCLS) in Rochester, New York is used as a primary example.

Telecommunications Needs for a Library System

In 1983 MCLS, a federated public library system of nineteen municipalities, contracted with Geac for installation and maintenance of an integrated library system. Circulation and database management are the first phase with planned future phases of acquisitions, media booking and an online catalog contingent on funding. Funding for the first phase is available in Monroe County's capital program and is sufficient for purchase of the computer equipment, software rights and data communications equipment necessary to serve thirty-five libraries. Operating costs of equipment and software maintenance for the computer system will be shared among the member libraries based on usage of the system. MCLS will pay telephone line costs for connecting the participating libraries. Under this cost-sharing arrangement, MCLS had the obligation to cover both equipment and operating costs for data communications.

The problem for MCLS in 1983 was to design a data communications network that would provide the lowest possible operating and capital costs within funds available in separate capital and operating budgets. An additional factor was the requirement that Geac agree to any added equipment, including telecommunications equipment, because of its contractual guarantee of response time. In the initial stages importance was attached to having a single supplier (Geac) be responsible for computer and telecommunications equipment.

MCLS had received from both Geac and the telephone company (Rochester Telephone Company—an independent) proposed designs for telecommunications. Geac's design, while technically sound, was conservative in consideration of response time and system performance needs; Rochester Telephone's design carried a high operating cost. It became clear that the answer to MCLS's telecommunications needs was not at hand.

MCLS faced several problems that highlighted the need for help in telecommunications:

1. lack of staff expertise in data communications,
2. lack of time for staff to gain the necessary knowledge due to the conflicting priority of planning for system operations, and
3. an apprehension about a rapidly changing area.

Regarding this apprehension, it is relevant that MCLS was pursuing a turnkey approach independent of the county's data processing center. Installation of a turnkey system does not provide the reassurance that comes from ties to a parent institution's computer services. Despite the skills and interests of automation vendors in providing a successful installation, installation of a turnkey system often jeopardizes any bureaucratic umbilical between the library and the parent institution. There may be, in fact, additional red tape attached by the parent institution.

The needs cited above were immediate and appeared soluble with a straightforward solution. They were technical and economic in nature—not political or organizational. Their possible solutions did not appear to be more than a matter of assembling the right elements to get the proper financial and performance picture. MCLS had the opportunity to address these problems because unspent funds allocated for telecommunications were available and could be used to hire a consultant.

Analysis and Substantiation of Need

Libraries may not be so fortunate as MCLS and may need to liberate funds in more direct competition with other functions. The following steps should by included in analysis and substantiation of the necessity for consultant services:

1. Review carefully the alternatives to using a consultant, or at least spending money for one. Is someone available in the parent institution? Could a local university or business provide free or subsidized consultant help? (If the help is free, will the job receive adequate attention?) Can a staff member be assigned to learn the area? Has the automation vendor been consulted thoroughly and forcefully on the issue? Have the telephone company's sales consultants been used? Has the nature of the telecommunications need been analyzed carefully to be sure the potential payback is significant?
2. Check the parent institution's purchasing authority for the procedures and limitations on hiring a consultant.
3. Analyze the library's needs by discussing the situation with people in the area who work in telecommunications. Describe the problem and solicit advice or background information. Find out what to watch for.
4. Discuss the library's situation informally with several consultants to determine if they can meet the needs. Combine this information with that gathered from area telecommunications personnel to determine if a consultant would be doing what library staff could do Would a consultant be paid only to borrow your watch and tell you the time?
5. Remember that effective use of a consultant is time consuming and requires responsibility on the part of the library to be sure a useful product is provided.

Requests for Proposals

The most common first formal step in engaging a consultant is preparation of the Request for Proposal It may be required by government agencies to assure equal opportunity to all prospective consultants.

Required or not, preparation of an RFP is a useful process to force a focus on goals and a definition of needs The RFP should establish the objectives of the project, specify the results of the project (what is the consultant required to produce?), and explain what is relevant to the consultant project (what does the consultant need to know about the library and the terms of the consulting project?) As a result of the RFP, a consultant should have a sufficiently clear idea of the library and its problems to respond with a summary of how and at what cost the consultant would address the problem

The RFP for library automation-telecommunications should also provide basic information for any consultant who may be very skilled in data communications but unfamiliar with library applications of data processing "Geac" or "CLSI" may not provide enough information to some consultants, whereas "interactive transmissions operating on polled block-mode asynchronous terminals attached to an XYZ/23 minicomputer" will provide a common technical ground to all.

Because the RFP is a device to communicate *unique* needs and requirements it should be prepared without borrowing from or piecing together other documents, including other RFPs This practice, hazardous at best in the preparation of automated system RFPs, would be disastrous due to the variables in telecommunications needs It is, on the other hand, very useful to seek out other RFPs for use in developing a focus on the library's needs and expectations from a consultant

Another essential aspect of achieving clear communication of the library's needs in the RFP is direct, simple and clear writing

Information in the RFP

The RFP should include the following information

1. *A description of the local situation and problems to be addressed.* Include the computer equipment to be used, its technical specifications, the database size, transaction types and volume as well as any other background of technical or organizational information that gives a picture of the library's current status Remember that a prospective consultant may not be familiar with library automation or with the library
2. *A description of the expected product* Whether the expected product is a report, cost study, review of options, an installed system, a negotiated contract, etc , the RFP should be very specific so that misunderstandings can be avoided Topics to be addressed should be specifically stated, as should, if relevant, topics to be omitted
3. *A requirement that the consultant describe the work method and steps to be used* How will the consultant go about producing the required product? To whom will the consultant talk about what? Where will the consultant visit? What status reports will be delivered? The RFP should not prescribe a work method as a condition to be met, but should include relevant factors that would help the consultant establish a proposed work method

4 *A requirement for information on what consultant staff will work on the project–their background, qualifications, level in the consultant organization and estimated time to be spent on the project.* This information should help prove that the consultant has the ability to do the work specified as well as provide the library with a basis for judging the level of skill applied and the accuracy of the quoted price.

5 *A description of the schedule of the work, showing various stages.* The consultant should be given the option to propose an alternative schedule. The library should attempt to be flexible and realistic about its expected time requirements because a two-month delay in the schedule might enable a good consultant to accept the job.

6 *Specify financial information requirements.* In how much detail is budget information to be provided? Is a single lump sum satisfactory or is a detailed breakdown by stage and activity of the project necessary? How are variations from budget to be handled? When are payments to be issued? Specify also the method the consultant may use to determine the total fee. There are at least ten methods of paying consultants.[1] These include.

—flat fees, which are used when there is little "open-ended" work in the project—the consultant is paid *X* amount of dollars for the work described Consultants may include a cushion in flat fees;
—bracket fees, which state that a consultant will be paid an amount per hour or day, not to exceed a certain upper limit This method is beneficial to the library in case the problem definition is unclear or the project requires flexibility for adjustments during its course; and
—per diem fees could be used when the library needs a consultant on a short-term basis

Regardless of the fee determination basis, most government or public agencies would establish a contract which fixes the terms and limit of payment

7 *Request information on the terms regarding access to the consultant outside the confines of the specified project.* Can the consultant be contacted for information on a related matter that is not a part of the consultant's scope of services? Will there be charges for these contacts? How are extra topics inserted into the work? Coverage, perhaps informally, of this area will help protect the consultant from feeling pressured to give free advice and help the library understand the extent to which support is available from the consultant

8 *Describe in some way the size of the job as viewed by the library.* Often this is done by stating the maximum budget for the project, the advantage is that the consultant has a target and a sense of scope, the disadvan-

tage is that the library will see fees clustered near one cost area. If the budget figure is not used, some statement may be necessary to indicate the library's expectation of the scope of the work.

9. *Require that the consultant describe other work that is similar and relevant to the project.* The consultant should be asked to describe why and how the experience on other jobs qualifies him or her to perform well in this job. As with evaluation of a job candidate, excessive generality or lack of relevance should be viewed with caution. It may also be helpful here to ask the consultant to list particular areas of knowledge, skill and experience

10 *A description of whether subcontracting and joint ventures will be allowed and how they will be handled.* Who is the prime consultant and who is responsible for the quality of the work? This type of joint venture arrangement may be particularly effective in telecommunications for library automation systems because of the separate knowledge required.

11 *Specify the method and process by which proposals will be evaluated, including the criteria on which selection will be based.* Overspecification of criteria will, however, leave little room for the more subjective aspects of evaluation or could lead a consultant to frame the proposal around evaluation criteria instead of the project content. In addition, overspecification could lead to challenges by unsuccessful consultants To digress: in my opinion, there should be an affirmative attempt to specify that selection will be based on content, not volume of proposals Proposals should indicate an understanding of *this* problem, not other problems or generic problems Proposals should clearly show a consultant's view and understanding of the issues involved and describe the treatment, consistent with this view, of the same or related issues in other projects As a practical matter, a consultant may be reluctant to specify a view on an issue for fear of rejection. Also, major consultants get many RFPs and have had to set up standard responses—often produced by word processors—so that time can be spent on existing projects If a response is considered voluminously irrelevant to the RFP but chosen anyway, protection must be obtained by establishing a very clear understanding of what problems and issues the consultant is to address

12 *Define terms that may be ambiguous, not in common use, or that relate to political or administrative units*

13 *Describe conditions applying to any contract or other document that will be developed between the library and the successful consultant*

14 *Establish a procedure and schedule for submission of written questions* When the questions are gathered, list, answer, and send them out to all who received the RFP Do not name names If telephone conversations

are held, be cautious about giving out any information that would benefit one consultant only

The Importance of Flexibility

Specific issues to which MCLS requested attention were the evaluation of proposed networks and suggestion of alternatives, equipment and operating costs, response time at varying levels of activity, the cost comparison of purchase or lease, the availability of equipment and service, the guarantee of support or acceptance by Geac, and flexibility for growth in functions, volume and number of participants.

Flexibility should be stressed as a basic element of any telecommunications plan, and a consultant must understand this. Flexibility is required not only for the proposed growth of functions, participants and volume on the system but also for changes in data communications methods and changes in rate structures. Integrated library systems are installed in phases, the telecommunications structure must be planned to adapt to these phases At the same time, technology and rates are changing in a field without uniform technical standards and with fierce economic competition Any data communications plan for a library system must include contingent strategies for adjustment at predicted phases of library system development or telecommunications charges

After all this material on RFPs, it should be noted that an RFP may not be needed to make a good selection of a consultant. Many consulting engagements have been successful without an RFP starting them off (and probably many engagements have been made less fruitful because of the limits established by RFPs) Required or not, however, the focus on goals and needs for consultant assistance provided by an RFP is the most important aspect Also, it should be pointed out that the RFP content as described here could require an amount of time in preparation that either the need or potential number of bidding consultants does not warrant. Be sure that the effort spent on the RFP is equal to the degree of need and that enough consultants are interested in bidding to make elaborate evaluation mechanisms appropriate

Three final suggestions on RFPs

1 Seek help locally in preparing it, especially if RFPs are new to you A faulty RFP can result in a poor consulting engagement
2 Do not over-rely on a complex set of conditions and a rigid problem statement, leave open the opportunity for unique areas of investigation and unique solutions This openness resulted in a consulting engagement that spawned OCLC [2]

3 Do not expect a lot of responses that dazzle you on every aspect of the RFP. If one does, be suspicious. Library automation data communications is a new area for library experts, an unfamiliar area for data communications experts, and a tough one for both given the volatility and high stakes in both fields.

Library Automation & Telecommunications

Some of the areas in which libraries may need telecommunications consultant help for library automation installation are listed below:

—A basic orientation to telecommunications for library automation
—Local installation problems, rates, routes, network structures and transmission methods, locally available products, voice and data integration.
—Selection of equipment and design of the most efficient network.
—Telecommunications system management· purchasing, maintenance, monitoring of performance, cost of projections, dealing with the telephone company.
—Review of available options for telecommunications. alternate technologies and their local status for both immediate and future installation.
—F[illegible]al planning for telecommunications covering the variables in bot[illegible]e library and data communications areas
—Development of models based on variables affecting automation and telecommunications planning.
—Building and space planning, including wiring of buildings.
—Analysis of automation vendors or bibliographic utilities in relation to telecommunications factors.
—Adaptation of a library automation system's capability to meet local capabilities and needs, including equipment, software and interface factors.

Telecommunications as a Local Matter

Telecommunications for libraries is first and foremost a local matter The library planning to select a telecommunications consultant seeks expertise in a rapidly changing technical and economic field that is affected by widely varying local conditions. Rates, technical capabilities and available technologies (including alternates such as microwave) all vary depending on the local geographic area, and the "local" area's complexity and uniqueness is compounded by the variability of telecommunications factors in the parent institution and library itself.

The University of California is grappling with this problem:

> The long-haul part of the network, while expensive and complex, can be implemented without overwhelming technical difficulty
>
> The local networks of the system are another matter altogether At present, we are engineering special-purpose, custom solutions for each terminal cluster We are trying to develop a series of building blocks to handle local distribution problems, but much of the technology is only now becoming available in the marketplace
>
> The capabilities we seem to need have much in common with tactical military data communications systems [3]

Telecommunications Beyond the Local

While local variability predominates certain aspects of telecommunications planning and installation, national developments create an unstable base. Deregulation, technical advances, economic competition, voice and data integration, local area network developments and alternate technologies destabilize yet control local level activities.

At the same time, library automation is changing rapidly There is an increase in the number and type of systems available, many of them microbased. Integrated systems are including micros for selected functions, and the separation of systems into regional components is being contemplated.[4]

In library automation there are three major technical forces at work *Hardware* is separating functions, making it possible to distribute functions out to local sites. *Software* is restraining that distributive tendency, particularly if large databases are to be effectively managed and used. *Telecommunications* is adding a volatility to the opposing forces of hardware and software

Because of the complex and volatile set of factors and interrelationships described above, the selection of a consultant is difficult. The knowledges and skills for local considerations are different from those for national considerations The knowledges and skills for telecommunications applications are different from those for library applications. Because of the rapid growth of automation system installation and the recent rise of telecommunications solutions arrived at independent of vendors, consultants specializing in this area with the appropriate mix of skill and experience are rare

A List of Telecommunications Consultants

How can a list of telecommunications consultants be compiled? There are eleven types of consultants or consultant firms[5] ranging from the large firm (e.g., Arthur D Little) to individuals between jobs In between are medium size firms of ten to fifty consultants, small groups of two to ten consultants (25 percent of all consultants work in this size company), individuals (about 50 percent are in this group), management firms (e.g., Peat, Marwick), professionals in particular fields, internal consultants within a company, university affiliated consultants, research firms and public agencies

Consultant names for a particular project can be obtained by advertising in trade journals, contact with local people in the field ("word of mouth"), professional associations (e.g., ALA and LITA), directories such as Gale Research Co.'s *The Consultants and Consulting Organization's Directory* and *Telecommunication Systems & Services Directory*, state library agencies, regional library networks or consortia, and the yellow pages. Major national associations include: Association of Consulting Management Engineers (New York City); Data Processing Management Association (Park Ridge, Illinois); Independent Computer Consultants Association (St. Louis); and Institute of Management Consultants (New York City) Additional names can be gathered by a review of trade journals (including nonlibrary) for news reports of other consultant studies.

Probably the most important aspect in determining appropriate sources of consultant names is the type of problem you have Do you want to address the local aspects of telecommunications (rates, routes, supplies, local planning etc)? Do you want to address the technical issues of the connection of a library system to telecommunications? Do you want to do long-range planning for telecommunications? The sources and geographic area of search would vary by the need you identify; a local installation problem suggests local people with perhaps little or no library automation experience, a library system problem suggests library automation experience with perhaps less experience in telecommunications (library consultants and system vendors are, however, rapidly paying more attention to telecommunications issues), long-range planning suggests a guru type

Selection of the Consultant

Selection of the consultant involves the following steps and factors

1. Development of an orderly system for rating consultant proposals It should be based on the needs that have been identified and indicate the relative importance of the various needs
2. Application of this rating system to the consultants' proposals indicating relative strength between consultants Focus here not only on consultants' qualifications but also on the understanding of need, the

content and relevance of the response to the needs, and the degree to which an individual, perhaps unique, project is proposed

3 Interviews with the consultants, especially to obtain understandings on both parts of the library's needs and consultants' ability to meet them. Be careful that you do not give a particular consultant any new information of substance that is not given to others.

4 Interview with references about consultants' performance, particularly in areas of similar problems. The consultants' statements about their prior experience should be verified

5 Costs and proposed budget. You should know from your parent institution the degree to which lowest cost needs are to be balanced against quality of product Also determine from the parent institution the degree to which negotiations on costs can be conducted with a single consultant, it may be possible for a consultant to reduce the scope of services or method of inquiry to bring a proposal within a budget. (Specifying the budget amount in the RFP would tend to eliminate opportunity for this because most fees specified would be close to but under budget)

6 Consider any informal constraints that may exist, such as the credibility, or lack of it, a local person would have vis à vis a person from outside the area You may need to be prepared to deal with the application of informal constraints that may hinder the selection of the best person

7 Trust your hunches as to the degree of confidence and rapport you can establish with the consultant Determine how the consultant's style would fit your needs does the consultant have a hands-off, hands-on or hold-your-hand style? Which do you want? Which do you need?

Once a consultant is selected, the library may establish a contract with the consultant This contract will specify the product, price, schedule, and clarify other administrative matters as well as include general terms and conditions for the work. Contracts should specify the areas of investigation that must not be omitted from the project and should include by reference the consultant's proposal.

More relevant to the affirmative productive aspect of any consulting project (as opposed to the protective value of a contract) is the "psychological contract," which is an understanding between the library and consultant staff of what the parties expect to gain [6]

Management of the Consultant Project

Two articles by Michael Malinconico do a fine job of surveying the management of consulting projects, particularly the establishment of project objectives and communication structures[7] Additional considerations include the following:

1. Provide the consultant with access to the necessary people, including those specified in the RFP. The consultant and the people he is to talk with should understand the degree of authority the consultant has and the extent, if any, he can act as the library's agent. Key points of information should be documented by the consultant and by the persons providing it.
2. The consultant should be fully briefed on the revelant areas regarding the project. This is particularly important in telecommunications for library automation because a combination of extensive knowledge and skill in both areas is unlikely. Also, focus should be placed here on any local consultants or political realities that would have an effect on the consultant's possible recommendations. (These areas may not appear as obvious in advance; routine reporting sessions may identify them.)
3. Be sure no assumptions are being made in areas where the consultant may be unfamiliar. Remember you may be working with a telecommunications expert or a library automation expert but not both.
4. Determine whether the consultant is a "paper person" or a "talk person." Good consultants may not deal extensively in writing and their reports may be quite brief If you expect a great deal of information to be transmitted verbally, you may wish to plan some way of documenting it
5. Establish regular progress reporting times to be sure the project is on course

MCLS Consultant Selection and Report

MCLS, in selecting a consultant, purposely chose a local expert in telecommunications with major local telecommunications contacts. The primary need was to determine the most cost efficient network that was practical to install Prompt and straightforward handling of the matter with Geac was also a priority: we wanted the issue to be solely telecommunications and not possible Geac modifications (That issue may come later)

The consultant's recommendation was to take advantage of the lack in the Rochester Telephone's rates of the use of timed message units A conventional business line will be left connected 24 hours a day at the business line monthly rate. The cost advantage over leased lines is about $15,000 per year. Telephone company sources estimate that this rate structure will be changed in 1987, at which time the network will be changed. The benefits, other than cost savings, are the temporary "holding action" nature of the network and the ability to install lines at the same cost regardless of library location For these benefits, MCLS can live with dual vendors (automation and telecommunications)

Benefits of a Consultant

A consultant can provide many benefits, including the following:

1. the provision of technical knowledge and experience to be applied to the making of decisions,
2. an "insurance policy" to reduce the risk of decisions;
3. a teacher to help the library learn about its needs and solutions;
4. a catalyst for self-learning;
5. a savings in time;
6. leverage with the telephone company, suppliers, automation venders, the parent institution;
7. a source for the resolution of disputes regarding the telecommunications components of the system, and
8. for MCLS, a plan that is flexible and adaptable.

Final Recommendations

This article has covered some of the important factors in obtaining and working with a consultant in the area of telecommunications for library automation. Some factors have applied specifically to problems that are unique to this single area of consulting, while others are applicable to all sorts of consulting ventures Five major recommendations for libraries surface:

1. Clarify and plan for the library's needs carefully with particular attention paid to the types of consultant experience required at different stages or levels of need
2. Place a premium on flexibility
3. Obtain telecommunications knowledge and skills inside the library.
4. Accept the notion of "planned clutter" in automation [8]
5. Don't expect simple and easy answers from a consultant, responsibility for decisions and results rest with the library

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JOHN KOUNTZ
Associate Director
Library Automation
California State University

Modeling Library Communications Traffic

It exudes a state of euphoric glee—i.e., our system at work! The most recent episode of this situation comedy (called "free enterprise") was entitled: "It works, it's reliable and cheap—so let's dump it!"

Thus, it can be argued that the world's only working reliable economical telecommunications system was scrapped to satisfy the desires of a handful of entrepreneurs. Basically, individuals who had discovered that a string of radio transmitter/receiver combinations, once installed, could make money because such devices require very little attention—if done right—and would nearly run forever—just add electricity!

The telephone company, "Ma Bell"—or whatever name satisfies—knew this for years But being a one-company monopoly, the telephone company used the high profit from their radio transmitter/receiver installations to subsidize their local service—their "direct-to-you" end user service The result was an orderly system in which the component parts were orchestrated and did work with amazing reliability and economy. The court ordered divestiture of the telephone company into seven regional firms, plus a radio transmitter/receiver or long lines company. This latter company, once integrated into the system, became merely a competitor with the entrepreneurs who had fostered the legislative and court movement in the first place. The result is an option for the user One can "save" money on long distance telephone service by opting for MCI or Sprint or Allnet, or pay a modest price for premium service by simply using the original long lines division of the telephone company.

And, as the situation has evolved, the cost is at an absolute premium for poor service from the now independent local telephone companies in each region as they attempt to understand and bill in harmony with their local operating expenses. An absolute premium means cost increases to the user of up to 400 percent. Concurrently, Bell Telephone, Western Electric and AT&T with their technical requirements for quality telephone service, have been shelved. By virtue of the Carterfone decision (an earlier assault on Ma Bell), and current electronic technology, one can inflict any number of substandard telephone-like toys on himself.

The episode of the telephone in America has just begun. As people throughout the world could, and will indicate, it is better and cheaper to go there in person or to write a letter than to fight the telephone. Perhaps the common experiences with telephones will one day draw the nations together in a way no political rhetoric or armed aggression has produced over the centuries.

Imagine diplomats having something in common—their respective national telephone services. Imagine diplomatic table talk such as: "Ah, Kim, I see the Chinese couldn't stop the retreat from North Korea, and now that area is independent again."

"Yes, Hakim. They were using Sprint, and just as the order to charge was given, the line went dead! I think the same thing happened to the Russians in Poland....Is it true Vladimir?"

"Nyet! Similar result, different reason We thought we could save money on long distance calls, but those fools didn't mention the local operating company connect charges. And, to top it all off, CP Poland purchased Japanese remote hand sets, but didn't buy extra batteries. Very bad result. We ordered curfew, but no one could hear the order because of multi path and dead batteries. On top of that we had to pay the Krakow phone company for access and connect time at prime rates—dogarai!"

You see, there may be a benefit in all of this, but probably none for the library of your choosing. And, now that the die is cast, there exists an uphill struggle in library's collective future should the field pursue subsidies similar to those provided for book-rate mail service, or relief from the new tariff structures beginning to emerge.

Notwithstanding the individuals attracted to money who did this for librarians and the legislative, political and economic games which are molding the results, one does have at his/her disposal a few tools, it is hoped that will help them minimize their expenditures for such services And, more probably, will enable one to know what is required and how to ask for it

First, before delving into detail, all must be aware in the instance of telecommunications that time is money, as is time of day, distance and quality of service And while no canonical form can be developed to permit one to get the most from their telecommunications dollar in all instances, a simple guideline can be proposed—"leastest is cheapest"

Then watch out for simple guidelines. Explicit in them is a whole group of implicit meaning. To make real the prospective "leastest is cheapest," one shall have to have done his/her homework, which may include becoming political on the home front and as technical as possible with practically everyone else And if one personally is not up to the political or the technical, one should hire people who are. Librarians, like it or not, are in the information business· telecommunications is the most important tool at their disposal now and will be with increasing emphasis in the years to come.

The telecommunications business is a technical business. As Perry has instructed earlier at this conference, select technologists wisely—unless one is an electronic engineer with a law practice, one shouldn't try to do it himself Even if Martha at the Fangschlyster Public Library writes an article on "How We Did It Well"—don't! The Martha article will kill the budget, credibility and service It is not a field for amateurs. And, integral with this litany, be sensitive to gadgets which are—and in greater abundance—touted as "the solution." There is no current library capable of implementing and operating its own telecommunications system using existing staff If it did it would no longer be a library. Enough conjecture—the doxology is over—let's get ready for modeling telecommunications traffic with a quick overview of some telecommunications concepts.

What are we dealing with? Well, it's neither smoke signals nor semaphor; but the objective is the same. So let's look at what this communication is For example, communications could be the logical and electrical interconnection between two or more devices: logical, since these are computer gadgets, and once they are connected they should do something; electrical, since the signals passed between them will be electromagnetic (smoke signals and waving flags do not do it this season). How these devices are connected determines how they work and how much time they take to do what they do. There are many ays to connect computing devices to each other. For lack of a better approach, how about reviewing them along historical lines (which, in terms of complexity, the early history will be the simplest approach). As a serendipitous "by product," one will find from this review that most of the complexity arises from building more and more housekeeping chores into the equipment, thus relieving the operator of a variety of responsibilities ranging from decoding to redialing.

The original Morse code, hardwired point-to-point (see fig 1) has some interesting characteristics

—Operator encodes and decodes
—Only one message in one direction at one time (half duplex)
—Distance limited (signals absorbed by the media)

—Speed of transmission limited to human response (10 milliseconds at best)
—Subject to environmental contamination (mechanical switches)
—Requires an operator at each terminal.
—Requires preestablished schedule so operators are ready at each terminal.
—One step up from dixie cups and strings (uses wire and switches).
—Secure communications.
—Limited primarily to point-to-point traffic.

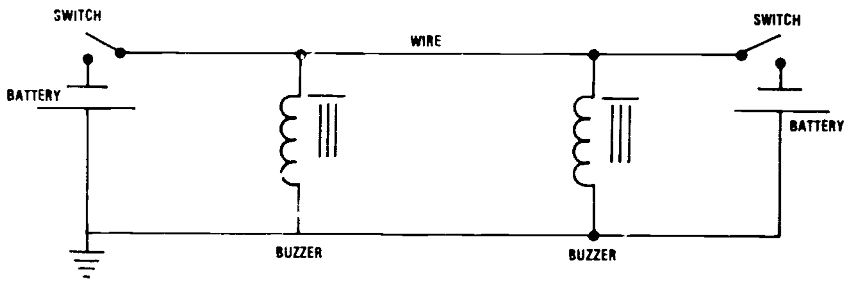


Fig. 1 The Basic Communications Circuit

It is this basic telecommunications system that can be found in essentially the same configuration with, of course, a substitution of technology here and there, on practically any ocean-going vessel, and in practically any "underdeveloped" country. In fact, basic point-to-point interconnection is found between terminals and computers. In keeping with modernism and use of polyester materials, some of the components have been "brought up-to-date," and most of the characteristics have been changed. But there has been no change to the objective nor to the basic interconnection concept

Today's "interconnect" (see fig 2) has these characteristics.

—Operator, when needed, keyboards and reads information
—Operator may not be required
—Can send and receive simultaneously (full duplex)
—Distance is unlimited (wherever a radio signal or light beam can go).
—Speed of transmission limited by electronic sensing devices (typically speed of light)
—Environmental contamination minimized (it's solid state)

—No schedule required
—Is not limited to point-to-point traffic.
—Security of communication is not so secure.
—One could not afford one personally.

So far the basic "what" of a network has occupied us, but what about the signals—the information that goes through? Well, how about digressing for a minute to examine the part that figure 1 had, but lost in figure 2. For example, the requirement for operators to run the network on a schedule while providing the necessary coding and decoding services. A simple review of terminology will help to eliminate operators, required standards and protocols, and aid in understanding.

So let's start with a "bit." Usually the machine one is dealing with can handle so many bits-per-second, while the communications man deals in "baud" which is a contraction of Jean Maurice Émile Baudot's last name. This fellow was a pioneer French telegrapher (one of the people required to operate the system in figure 1 and who became tired of it).

The term "baud" means the maximum rate of signal transfer-per-unit-time relative to the shortest pulse time used by the apparatus to be connected. For example, if the machine creates a pulse of 0.0135 seconds, then the maximum rate of signal transfer is the reciprocal of 0.0135 second—74.2 or 72.2 baud. Thus for a 100 word-per-minute teletypewriter to convert words-per-minute to bits-per-second, he/she needs to consider that there are five information pulses-per-character for the subject teletypewriter. In addition, each character must include a "start" pulse (another 0.0135 seconds) and a "stop" pulse of 0.019 seconds (1.42 times the information pulse). Thus, each character of five bits consumes 0.1 seconds (6 × 0.0135 + 0.019) for a 50 bit-per-second rate. Obviously there is a difference between baud and bits!

Typically the baud rate is the maximum signal rate for the transmission devices, while the bit rate is the number of information bits actually transmitted—the net of overhead or protocol signals. So most of us are interested in bytes. In any event the signals and their rates are a tremendous improvement over the idea—"one if by land and two if by sea!"—that all traditionally associate with signalling.

Similarly, the way communication is handled has changed vastly and can have an impact on the budget. Therefore, some additional concepts are required. They can be presented in a more painless way as in figure 3.

There are three communication channel types and two operating modes, the essence of which can be implemented in a variety of ways. "Simplex," is just that unidirectional communications—one-half duplex, or as the telephone company may call it, a two-wire circuit, which permits one to transmit or receive, but not at the same time. One must stop talking

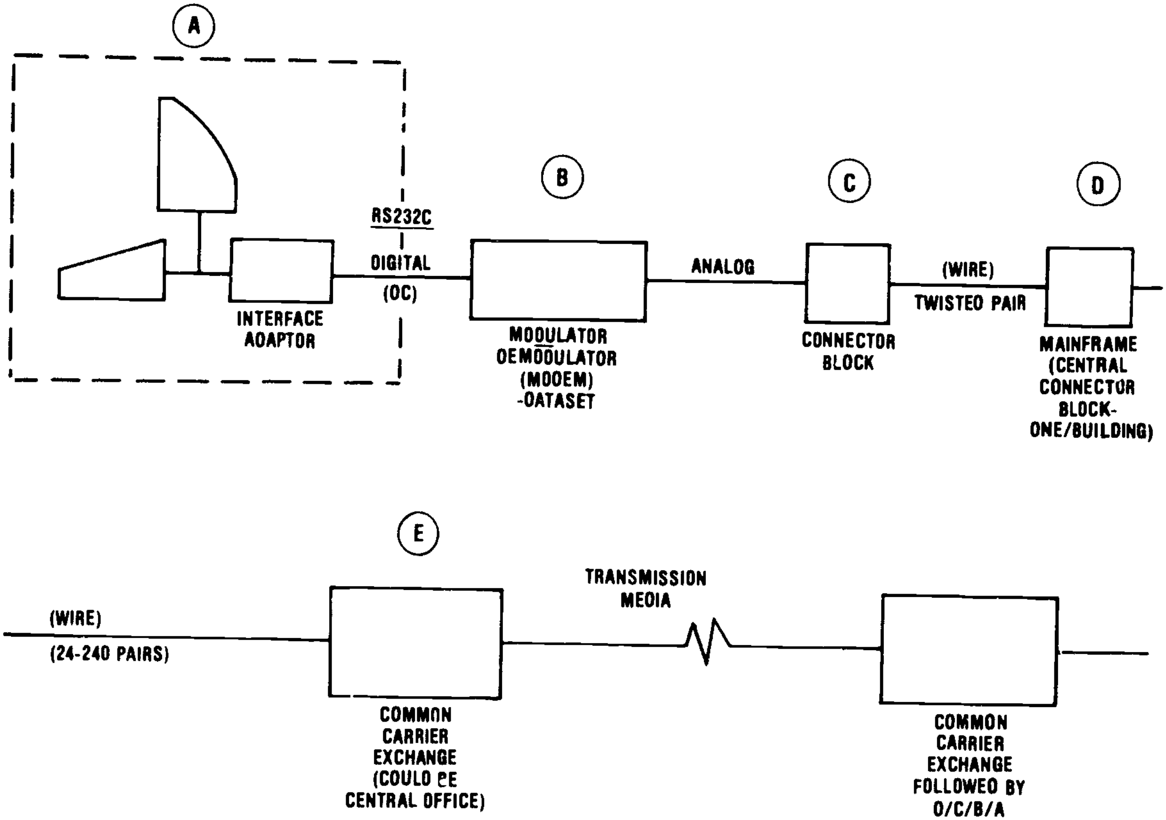
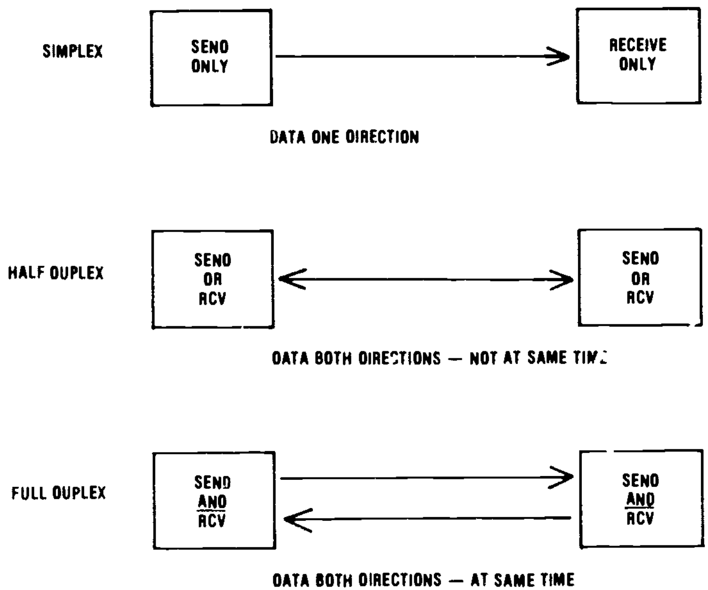


Fig. 2. The Computer Circuit



COMMUNICATION CHANNEL TYPES

ASYNCHRONOUS — DATA CHARACTER FRAMED BY START/STOP BITS (INEFFICIENT)

SYNCHRONOUS — DATA CHARACTER FRAMED BY TIME — NO START/STOP BITS (REQUIRES SYNCH PULSES PERIODICALLY)

Fig 3 Some Concepts of Communications

before he can hear the other person. Full duplex permits one to talk and listen at the same time, but requires two circuits. The two operating modes are:

Asynchronous—sends one character at a time if at a terminal. Thus one can send what he wants, when he wants, as fast as the line permits (remember baud) or as slow as need be: However, what is gained in convenience is paid for in efficiency because the overhead of start/stop bits consumes a large percentage of the connect time.

Synchronous—maintains a synchronized clock at both ends of the line with the signals being decoded correctly as they are framed between clock pulses. While more efficient, since there are no character framing start/stop bits, this mode requires sending everything at the same speed and synchronizing clocks with transmissions containing strings of "synch" pulses.

Within this framework there are codes—the familiar ASCII, BCDIC and EBCDIC and, the unfamiliar Baudot, Sitor, Amtor, Tor (7 bit) and Autodin (8 bit). There are also message formats which touch on protocols. One such format is shown in figure 4. Error detection and correction schemes also abound in number and variety and range from mathematical schemes to repetition of each character (echo back). These require twice the amount of time a simple transmission of the data would take since eac[illegible]racter is sent back to the originator (a scheme internal to most CR[illegible] terminals visually) with the operator doing the correcting. Finally, there are data encryption techniques to ensure the security of the information being transmitted.

Because "least is best" for communications, an awareness of these topics, so very briefly covered above, can keep one out of high rent arrangements. It is advised that a little reading be done if one wishes to go into details. But the majority get hooked with what's available, or at least we did when Ma Bell ran the show

But Ma Bell doesn't run the show any more. Consider the above topics for review, as the terms *bypass*, *gateway* and *open system* become prominent in the months to come.

And now the modeling. Armed with the brief vocabulary above, let's see what a model is. Well, a model should consist of the acquisition of quantitative data about an object in such detail and with such identified relationships as to permit one to change the relationships and/or the quantities, and examine the impact of such changes (modeling) before one does do it for real and has to feel the impact of the real changes. Following are some ideas of computer applications in the library. So, model the

S		S		E		S		E		E
O	PP	P	Address	O	Originator Address	T	Text	T	Trace & Time	O
M				A		X		X		T

SOM — Start of Message (character)

SP — Space (character)

PP — Message Priority

ADDRESS — Message Routing

EOA — End of Address (character)

ORIGINATOR — ID of Source

STX — Start Text (character)

TEXT — The Information

ETX — End Text (character)

TRACE & TIME — Terminal ID for Transmitter & Receiver

— Input message sequence number

— Output message sequence number

— Time Received — mm/dd/hr/min)

— Time Delivered — (mm/dd/hr/min)

EOT — End of message

Fig 4. Typical Data Communications Format

communications traffic for circulation control, excluding file maintenance for patron records and the brief bibliographic descriptors used in the circulation of library materials. The use of the word "circulation" shows the conviction that OCLC, or the bibliographic utility of a libraries persuasion, will take care of cataloging.

Basically, for this model, twelve functions are required to support "online" circulation control. These are enumerated in figure 5. Seven of these functions deal directly with the circulation function itself, two deal with interlibrary loan, and three deal with user and item file maintenance.

Function	Transaction	Message (fields)	Bytes
Charge	validate user	XMIT (AC)	32
		RCV-GO (AE)	64
		RCV-NG (AEH)	124
	validate item	XMIT (AB)	32
		RCV-GO (ADI)	305
		RCV-NG (ADH)	255
Discharge	validate item	XMIT (AB)	32
		RCV (ADHI)	365
Place Hold	validate user	XMIT (AC)	32
		RCV-GO (AE)	64
		RCV-NG (AEH)	124
	enquire item	XMIT (ADJK)	206
	fetch item	RCV-GO-STACK (AF)	507
		RCV-GO-HOLD (AH)	78
		RCV-NG (AH)	78
Trap Hold	validate item	XMIT (AB)	32
	route item	RCV-GO (ADHI)	365
Place ILL	validate user	XMIT (AC)	32
		RCV-GO (AE)	64
		RCV-NG (AEH)	124
	enquire item	XMIT (ADJ)	205
		RCV-GO-STACK (AF)	507
		RCV-GO-LOCAL (AH)	78
		RCV-GO-DONOR (AFEHI)	720
		RCV-NG (AH)	78
		RCV-NG-DONOR USE (AFEHI)	720
Trap ILL	validate item	XMIT (AB)	32
	route item	RCV-GO (ADHI)	365
Renew	validate user	XMIT (AC)	32
		RCV-GO (AE)	64
		RCV-NG (AEH)	124
	validate item	XMIT (AB)	32
		RCV-GO (ADI)	305
		RCV-NG (ADH)	255
Department Loan	validate user (1 5000 item)	XMIT (AC)	32
		RCV-GO (AE)	64
		RCV-NG (AEH)	124
	validate item	XMIT (AB)	32
		RCV-GO (AD)	195
		RCV-NG (ADH)	255
Enter Bad Guy	validate user	XMIT (AEE)	46
		RCV-GO (AEH)	124
		RCV-NG (AH)	78
Clear Bad Guy	validate use	XMIT (AEE)	46
		RCV-GO (AEHI)	434
	clear	XMIT (ACLB)	2,4
		RCV-GO (ABLHI)	588
		RCV-NG (AH)	78
Item Enquire	validate item	XMIT (AD)	195
		RCV-GO (AF)	507
		RCV-NG (AH)	78
User Enquire	validate user	XMIT (AEE)	46
		RCV-GO (AGDH)	1,136
		RCV-NG (AH)	78

Fig 5 Central Circulation Communications

Internal to these functions, assume also that there are twelve data elements which are logically combined to form the functions (see fig. 5). Each of these data elements contain from 1 to 168 characters (see fig. 6). The frequency or percent of occurrence of these functions-per-unit-circulated is shown in figure 7. The combination of these data elements into messages and subsequently into dialog is shown in figure 8 for the "charge" function. Having determined the types, frequency and size of the messages, it is then possible to apply these factors to a hypothetical data communications system.

Four examples of these combinations are shown in figures 9 through 12. The hourly multiplier numbers represent, in the examples indicated, library measured statistics for the activities which have been prorated by the percentage of occurrence for the functions comprising those activities in figure 7. Because communications is a two-way street, both transmitting and receiving data rates are shown.

It is interesting that the old adage about it being better to give than to receive doesn't work in the world of telecomputing—at least for circulation control—because for each library initialized action, the library receives more than it gives. Which serendipitously suggests two communications channels—a high speed and a low speed one. But, the model assumes a supercomputer is handling everything for everybody. Should these libraries "talk" to each other, then that receiving rate becomes the transmitting rate. And low-speed communications channels mean little rate. They mean little anyway because the communication channels provided will probably be the same speed regardless of how much information will be chosen to send down to them.

Bauds are the speed which the connection or circuit will support with ASCII being the code used for transmission. Baud rates, or the speed at which a device can function, are usually standardized by the manufacturer. Thus, a selection of standard values is usually provided for on the typical terminal. We are going to use the asynchronous mode of transmission.

So look at some of the examples. The first is the Bakersfield, California figure (see fig. 9). The peak-received-data-rate-in-bits-per-second is 149.52, net of character framing bits. And because it will be using asynchronous ASCII, it is easier to use characters/second (most tables are set up that way). With the use of standard baud rates eighteen or nineteen characters/second, a 300 baud line will be more than adequate.

For the Northridge example (see fig. 12) one can apply the same arithmetic, and discover that the line required will be 1200 baud; the same as required for Los Angeles (see fig. 11) in a typical situation. However, at their communications traffic peak a 2400 baud line will be needed for both Long Beach (see fig. 10) and Los Angeles.

	Field (source)	Data Elements	Characters
A	Preamble (keyboard/generated)	Message Type	1
		Function Code	2
		Library ID	4
		Terminal ID	1
		Date/Time	10
		subtotal	18
B	Level 1 Item (label)	Book ID	10
		Library ID (for book)	4
		subtotal	14
C	Level 1 User (badge)	Patron ID	9
		Library ID (for users)	4
		Status	1
		subtotal	14
D	Level 2 Item (keyboard/file)	Citation	62
		Edition	47
		Call Number	68
		subtotal	177
E	Level 2 User (keyboard/file)	Patron ID	9
		Name	32
		Zip Code	5
		subtotal	46
F	Level 3 Item (keyboard/file)	Citation	62
		Edition	47
		Call Numbers (5 max.)	340
		Copies (10 max.)	30
		Statuses (1 per copy)	10
		subtotal	489
G	Level 3 User (keyboard/file) Patron (all data elements)		168
H	CRT Comment (system generated from function & transaction type & user or item status)		60
I	Ticket Printer (system generated from function & transaction type & user or item status)		110
J	Cut Off Date/Time (keyboard)		10
K	Queue Type (date or time based)		1
L	Amount (keyboard by supervisor)		6

Fig 6 Online Data Elements (Interactive Processing)

Function	% Used for Calculation
Charge	100.0
Discharge	99.9
Place Hold	2.0
Trap Hold	2.0
Place ILL	1.2
Trap ILL	1.2
Renew	14.9
DPT. Loan	8.9
Enter Bad Guy	1.4
Clear Bad Guy	1.4
Item Enquire	2.9
User Enquire	1.5

Fig. 7. Percentage Occurence of Circulation Control Functions

So now the peak data rates have been determined (characters are easier than bits—but bits are more impressive). And now one can call the communications people and tell them what the line requirements are for a given data type, how they are to be encoded in a certain way, etc. One can also study the transaction types and note by batching certain ones how the speed of the required line is reduced. This is what models are for—to tinker and optimize.

Why, because "leastest is cheapest" which leads to the pricing structure of telecommunications circuits regardless of who is providing what. And, as mentioned earlier, pricing for telecommunicating is based on four factors: time—how much is consumed and when; type—private line or dial line; quality—how much conditioning is used and/or bandwidth; and distance—how far the impulse travels through how many changes.

Function:

Charge

Transaction Type	Message Type	Message Fields/Bytes (Ex-Protocol)	Max. Bytes/Transaction
validate user	transmit	Preamble/18 Level 1 User/14	32
	receive (go)	Preamble/18 Level 2 User/46	64
	receive (no go)	Preamble/18 Level 2 User/46 CRT Comment/60	124
validate item	transmit	Preamble/18 Level 1 Item/14	32
	receive (go)	Preamble/18 Level 2 Item/177 Ticket Printer/110	305
	receive (no go)	Preamble/18 Level 2 Item/177 CRT Comment/60	255

Fig 8

Site Level	Traffic		Bytes		Hourly Multiplier	XMIT/Hour	RCV/Hour
Bakersfield I (quarter)	Charge (all media, RBR and renew)	Patron validate	XMIT	32	30 00	960 00	
		GO	RCV	64	29 58		1,893 12
		No Go	RCV	124	0 42		52 08
		Item validate	XMIT	32	75 00	2,400 00	
Peak		GO	RCV	305	73 50		22,417 50
Month October		No Go	RCV	255	1 50		382 50
Day Tuesday; Hour 11 am	Place Hold	Patron validate	XMIT	32	1 00	32 00	
		GO	RCV	64	0 99		63 36
		No Go	RCV	124	0 01		1 24
Avg items/patron 2 5 1		Item enquire	XMIT	205	0 99	202 95	
		Go-Stack	RCV	507	0 23		116 61
Nominal chg period 2 wks		Go-Hold	RCV	78	0 75		58 50
Annual Circulation		No Go	RCV	78	0 01		0 78
(1974-75) 63,334	Place ILL	Patron validate	XMIT	32	0 90	28 8	
Annual hours open 4,082		GO	RCV	64	0 89		56 96
		No Go	RCV	124	0 01		1 24
		Item enquire	XMIT	205	0 89	182 45	
		Go-Stack	RCV	507	0 01		5 07
		Go-Hold (local)	RCV	78	0 21		16 38
		Go-Donor	RCV	720	0 66		950 40*
		No Go	RCV	78	0 01		0 78
	Clear Bad Guy	Patron validate	XMIT	46	0 42	19 32	
		Go	RCV	434	0 42		182 28
		Clear	XMIT	214	0 42	89 88	
		Go	RCV	588	0 415		241 08
		No Go	RCV	78	0 01		0 78
	Item Enquire	Item validate	XMIT	195	1 00	195 00	
		Go	RCV	507	0 99		501 93
		No Go	RCV	78	0 01		0 78
	Patron Enquire	Patron validate	XMIT	46	6 00	276 00	
		Go	RCV	1,138	5 88		6 691 44
		No Go	RCV	78	0 12		9 36
			TOTALS:	**Hourly**		**4,386.40**	**33,644 17**
				Peak per second.		**2 44**	**18.69**
				Peak bits per second		**19.52**	**149.52**

XMIT Transmit from library
RCV Receive in library
*Two messages received one at initiating site, one at donor site

Fig 9

Site Level	Traffic			Bytes	Hourly Multiplier	XMIT/Hour	RCV/Hour
Long Beach V	Charge	Patron validate	XMIT	32	112 00	3,584 00	
(semester)	(all media, RBR and renew)	GO	RCV	64	110 43		7,067 52
		No Go	RCV	124	1 57		194 88
		Item validate	XMIT	32	560 00	17,920 00	
		GO	RCV	305	548 00		1[illegible]7,384 00
Peak		No Go	RCV	255	11 20		2,856 00
Month October							
Day Monday	Place Hold	Patron validate	XMIT	32	10 00	320 00	
Hour 1 pm		GO	RCV	64	9 86		631 04
		No Go	RCV	124	0 14		17 36
Avg items/patron 5 1		Item enquire	XMIT	205	9 86	2,021 30	
		Go-Stack	RCV	507	2 47		[illegible],252 29
Nominal chg period 3 wks		Go-Hold	RCV	78	7 30		569 40
		No Go	RCV	78	0 09		7 02
Annual Circulation (1974-75) 785,071	Place ILL	Patron validate	XMIT	32	10 00	320 00	
		GO	RCV	64	9 80		627 20
Annual hours open 4,134		No Go	RCV	124	0 20		24 80
		Item enquire	XMIT	205	9 80	2,009 00	
		Go-Stack	RCV	507	0 30		152 10
		Go-Hold (local)	RCV	78	0 10		7 80
		Go-Donor	RCV	720	9 30		13,392 00*
		No Go	RCV	78	0 10		7 80
	Clear Bad Guy	Patron validate	XMIT	46	7 84	360 64	
		Go	RCV	434	7 84		3,402 56
		Clear	XMIT	214	7 84	1,677 76	
		Go	RCV	588	7 76		4,562 88
		No Go	RCV	78	0 08		6 24
	Item Enquire	Item validate	XMIT	195	20 00	3,900 00	
		Go	RCV	507	19 80		9,937 20
		No Go	RCV	78	0 40		31 20
	Patron Enquire	Patron validate	XMIT	46	8 40	386 40	
		Go	RCV	1,136	8 32		9,468 16
		No Go	RCV	78	0 08		6 24
			TOTALS:	Hourly:		32,499.10	221,605 49
				Peak per second:		18.06	123.11
				Peak bits per second:		144.48	984 88

XMIT Transmit from library
RCV Receive in library
*Two messages received one at initiating site, one at donor site

Fig 10

Site Level	Traffic		Bytes		Hourly Multiplier	XMIT/Hour	RCV/Hour
Los Angeles IV (quarter) Peak Month April Day Wednesday Hour 1 pm Avg items/patron 2 5 1 Nominal chg period term Annual Circulation (1974-75) 506,145 Annual hours open 4,875	Charge (all media, RBR and renew)	Patron validate	XMIT	32	120 00	3,340 00	
		GO	RCV	64	118 32		7,572 48
		No Go	RCV	124	1 68		208 32
		Item validate	XMIT	32	300 00	9,600 00	
		GO	RCV	305	294 00		89,670 00
		No Go	RCV	255	6 00		1,530 00
	Place Hold	Patron validate	XMIT	32	6 00	192 00	
		GO	RCV	64	5 92		378 68
		No Go	RCV	124	0 08		9 92
		Item enquire	XMIT	205	5 92	1,213 60	
		Go-Stack	RCV	507	0 24		121 68
		Go-Hold	RCV	78	5 68		443 04
		No Go	RCV	78	0 01		0 78
	Place ILL	Patron validate	XMIT	32	30 00	960 00	
		GO	RCV	64	29 58		1,893 12
		No Go	RCV	124	0 42		52 08
		Item enquire	XMIT	205	29 58	6,063 90	
		Go-Stack	RCV	507	0 30		152 10
		Go-Hold (local)	RCV	78	1 18		92 04
		Go-Donor	RCV	720	27 60		40,032 00*
		No Go	RCV	78	0 30		23 40
	Clear Bad Guy	Patron validate	XMIT	46	10 00	460 00	
		Go	RCV	434	10 00		4,340 00
		Clear	XMIT	214	10 00	2,140 00	
		Go	RCV	588	9 99		5,874 12
		No Go	RCV	78	0 01		0 78
	Item Enquire	Item validate	XMIT	195	25 00	4,875 00	
		Go	RCV	507	24 50		12,421 50
		No Go	RCV	78	0 50		39 00
	Patron Enquire	Patron validate	XMIT	46	50 00	2,300 00	
		Go	RCV	1,138	49 30		56,103 40
		No Go	RCV	78	0 70		54 60
			TOTALS.	**Hourly**		**31,644 50**	**221,013.24**
				Peak per second.		**17 58**	**122.54**
				Peak bits per second		**140 64**	**980 32**

XMIT Transmit from library
RCV Receive in library
*Two messages received one at initiating site, one at donor site

Fig 11

Site Level	Traffic			Bytes	Hourly Multiplier	XMIT/Hour	RCV/Hour
Northridge III	Charge	Patron validate	XMIT	32	100 00	3,200 00	
(semester)	(all media, RBR and renew)	GO	RCV	64	98 80		6,310 40
		No Go	RCV	124	1 40		173 60
		Item validate	XMIT	32	300 00	9,600 00	
Peak		GO	RCV	305	294 00		89,670 00
Month May		No Go	RCV	255	6 00		1,530 00
Day Monday	Place Hold	Patron validate	XMIT	32	9 00	288 00	
Hour		GO	RCV	64	8 87		567 63
		No Go	RCV	124	0 13		16 12
Avg items/patron		Item enquire	XMIT	205	8 87	1,818 35	
		Go-Stack	RCV	507	0 35		177 45
Nominal chg period		Go-Hold	RCV	78	8 50		633 00
2 wks		No Go	RCV	78	0 02		1 56
Annual Circulation (1974-75)	Place ILL	Patron validate	XMIT	32	3 80	115 20	
315,849		GO	RCV	64	3 55		227 20
Annual hours open		No Go	RCV	124	0 05		6 20
4,329		Item enquire	XMIT	205	3 55	727 75	
		Go-Stack	RCV	507	0 04		20 28
		Go-Hold (local)	RCV	78	0 14		10 92
		Go-Donor	RCV	720	3 33		4,795 20*
		No Go	RCV	78	0 04		3 12
	Clear Bad Guy	Patron validate	XMIT	46	4 20	193 20	
		Go	RCV	434	4 20		1,822 80
		Clear	XMIT	214	4 20	898 80	
		Go	RCV	588	4 14		2,434 32
		No Go	RCV	78	0 06		4 88
	Item Enquire	Item validate	XMIT	195	10 00	1,950 00	
		Go	RCV	507	9 80		4,968 60
		No Go	RCV	78	0 20		15 60
	Patron Enquire	Patron validate	XMIT	46	7 00	322 00	
		Go	RCV	1,138	6 90		7,852 20
		No Go	RCV	78	0 10		7 80
			TOTALS:	**Hourly:**		**19,113 30**	**121,278.73**
				Peak per second		**10.62**	**67.38**
				Peak bits per second		**84 96**	**539 04**

XMIT Transmit from library
RCV Receive in library
*Two messages received one at initiating site, one at donor site

Fig 12

Please note that how much time is used or is required to be used depends on what is being communicated and how fast it must be communicated. These, in turn, are a function of the quality of the line used.

Returning to the four examples, and assuming a conditioned, private line was rented, it would cost four times as much to handle the communication traffic from a large campus as it would to handle that for a small campus This is the cost of quality.

And, to digress and review the relative cost of line quality, at a nominal fifty bits-per-second the cost-per-mile-per-month let's say is *x* cents Then, the cost for 150 bits-per-second would be 4*x* and the cost for one megabit-per-second (the "T1" circuit) would be 800*x* And, naturally, there will be a library or two somewhere that will require the high speed, "T1" channel!

An alternative to one "T1 channel" might be several channels of lower quality, and that's what models are for. In this instance, more lines mean more monthly access charges. Others will review the Centrex/PBX/E-PABX situation and the rate increases targeted for them. They resemble the confusion in rate changes and in the regulations surrounding telecommunications in general At least librarians will be able to spot the trouble spots before they explode, by understanding how a simple check-out transaction can be translated into a specification for a communication line

RICHARD W BOSS
Senior Consultant
Information Systems Consultants Inc

Telecommunications For Libraries

The term *telecommunications* encompasses the electronic transmission of voice, data and video information from one, location to another, and includes all physical equipment, software and procedures used in transmitting and receiving that information. Libraries' approaches to telecommunications are undergoing rapid change because of rising telecommunications costs, emerging technologies and the changing needs of libraries

Changing Needs

Librarians' needs are changing most significantly in the area of data communications-telecommunication between terminals and computers and among computers During the 1980s, increasing numbers of remote terminals are being linked to computers as libraries implement patron access catalogs, more consortia install shared automated systems, and use of remote databases continues to grow.

The special data communications needs of libraries are complicated by the fact that most local library systems are minicomputer based, whereas most bibliographic utility, commercial bibliographic service, and remote database vendors' systems are configured around mainframe computers Minicomputers and mainframes communicate differently, the former normally use asynchronous transmission, the latter synchronous. Most of the literature on data communication emphasizes synchronous transmission.

Synchronous transmission requires a mechanism at each end of the communications channel to synchronize the transmitter and receiver An asynchronous system uses "dumb" terminals which the computer recognizes by identifying the p`.t of the computer into which the signal is directed. Synchronous transmission uses the telecommunications media more efficiently than asynchronous transmission, but the terminals and communications equipment are usually more expensive.

There is another significant difference between the communications requirements of mini- and mainframe-based systems. Mini-based systems usually involve communications over relatively short distances (fewer than 100 miles)—often, in fact, distances of only a few hundred feet. Users generally require a limited number of linkages rather than a complex, multinode telecommunications network. The remote terminals linked to a mainframe computer are often widely dispersed, with many over 1000 miles distant from the central computer.

When there is a need to access a minicomputer from more than a few hundred feet away, the options are limited by the fact that there is no standard communications protocol for minis. A turnkey vendor may sell a library or consortium an automated library system which permits resource sharing among those who share the computer, but it will probably not offer the capability to interface or electronically link the system with other mini-based systems in the area. It also may not offer the software support which enables the dumb terminals to be used to access remote mainframe-based systems such as Auto-Graphics, Baker & Taylor, Brodart, BRS, Dialog, Dun and Bradstreet, Ebsco, Faxon, OCLC, RLIN, UTLAS, etc. Most of the interfaces which are offered either transfer information from the screen of a terminal of a bibliographic utility system through the printer port and into a local system, or support dial access to a remote database service through a VAV (Value Added Network) which provides special protocol conversion support.

Communications protocols were developed for mainframe computers because the manufacturers had enough users with numerous terminals distant from their mainframes to require sophisticated data communications. IBM's dominant position in the industry led to it setting the de facto industry standard No industry-wide protocols exist for microcomputers, but most now have software packages which allow them to function as intelligent terminals to mainframe computers.

Because of the mix of requirements experienced by libraries, a great deal of work needs to be done to meet their changing needs in the area of data communications. This would be true even if costs and technologies were stable

Changing Costs

Costs are changing even more rapidly than needs In early 1984 the Federal Communications Commission, Congress, and the courts were grappling with the final details of the AT&T divestiture. Despite the unsettled state of the industry, it was clear that costs would rise. While the news media have emphasized the purchase of telephone equipment, the right to own a telephone is not an effect of divestiture. It came about several years ago as the result of earlier deregulation. It will continue to be possible to lease equipment at rates which are close to the current averages through 1985.

Businesses—including libraries—which leased telephone equipment from a local Bell Company are now customers of AT&T Information Systems (AT&T = IS). Under divestiture, all existing equipment leased from a Bell operating company (BOC) now belongs to AT&T-IS. The agreements made with a BOC will continue to be honored by AT&T-IS. A business customer can choose to purchase the existing equipment, or new equipment, from AT&T-IS or from any one of several competitors. Not all existing equipment will go up for sale at the same time, but by late 1985 all customers will have been given the opportunity to purchase their existing systems. No customers will be required to buy their existing systems; however, after 1 January 1986 there will be no long-term protection against future increases in lease rates or maintenance charges.

Rate changes are a potentially greater concern because they affect libraries' operating budgets rather than their capital budgets. Direct-dial long distance charges are actually expected to drop because long-distance revenues will no longer be used to subsidize local calling. The expected intense competition between AT&T and other long distance companies such as MCI, Sprint, and TDX may also force prices down.

The area of dramatic price increases will be local dial-up service and leased or dedicated line service. This will affect voice and data transmission because both are presently moved mainly over telephone lines. Most video transmission uses alternative transmission media The average bill for a business user of the telephone system will rise by 50 percent if no steps are taken to change the pattern of use of telecommunications facilities.

Local dial-up services will increasingly be converted to measured service, with rates for limited use of the telephone system comparable to those which now prevail, but with extra charges for calls in excess of a monthly minimum and for time in excess of a monthly minimum. For most libraries, this will affect only voice communication because data and video communication are generally over leased or dedicated lines.

Leased or dedicated voice-grade telephone lines have been the mainstay of data communication. In the past, the rates for such lines have been between $4 and $11 per mile per month for limited distances and substantially less for interstate lines These rates are now expected to rise 60 percent or more It will, therefore, be more important than ever to maximize the number of terminals sharing a single local telephone line This can be done using special hardware that is already available. In most cases the choices will be under the control of individual libraries.

The bibliographic utilities and other remote services present a more difficult problem for libraries because they are accessed through special networks. OCLC, for example, has over 260 leased lines serving 5400 terminals in libraries across the United States. Because the OCLC system is configured around mainframes, the telecommunications network operates synchronously at speeds of 2400 bps and is designed to work exclusively with a custom protocol. Each multidrop circuit services an average of twenty-five terminals. Under the old tariff structure, annual telecommunications billings to OCLC were $6 5 million; under the new tariff, the figure is expected to increase to more than $11 million. It will require a major overall system redesign to limit the amount of the increase. While this may be regarded as an appropriate role for the utility, it is of great interest to the libraries because, were OCLC to change the network in such a way as to make existing terminals and modems in libraries unusable on the new network, the libraries would have to replace $23 million worth of hardware.

New Technologies

The anticipated rise in telecommunications costs has stimulated interest in telecommunications technologies other than the telephone system, but it did not spawn them. Most of the emerging technologies have been under development for more than a decade and are now maturing sufficiently to be seriously considered. Among the alternative technologies are microwave, satellite and cable television. Within a building, the emphasis is on LANs (Local Area Networks), which use coaxial or fiber optic cable to move information.

It should not be assumed that whatever is technologically feasible can be implemented. It typically takes fifteen years from the time that something is technologically feasible until it is in widespread use. There are numerous obstacles to the adoption of a new technology: economics, marketing priorities, and legal and attitudinal constraints. These will be discussed in the context of the specific technologies.

In order to deal with the changes in needs, costs and technologies, librarians will have to develop a basic knowledge of telecommunications. The next section seeks to provide a minimum foundation.

Transmitting Information

Any telecommunications medium distorts the information transmitted over it. A distinct signal suffers degradation as it is transmitted. As the transmission speed increases, the distortion becomes greater; and as the distance of the transmission increases, the signals also fade.

In addition, "noise" is introduced by external influences on the line. At high transmission speeds, the strength of the noise becomes comparable with that of the signal and errors will occur in the interpretation of the information being tramsmitted. In all electronic circuitry, there is also a steady continuing background of internal random noise, known as "thermal noise." As the atoms in the communication medium vibrate, they send out electromagnetic waves resulting in a chaotic jumble of electromagnetic waves of all frequencies that provide additional interference to all electronic communication.

If the signal being transmitted fades too much, it becomes irretrievably mixed with the thermal noise. Once this occurs, the two streams can never be separated. And if the signal is amplified, the noise will be amplified with it. If the information is transmitted too quickly or too far, the signal drowns in the noise. To avoid significant distortion in transmissions over long distances, lower speeds must be used. Voice transmission is not significantly affected by these limitations, but data and video information are affected because the amount of information to be transmitted makes it important that high transmission speeds be achieved.

Analog *v.* Digital Transmission

There are basically two different ways in which information of any type can be transmitted over telecommunications media—"analog" and "digital." This distinction applies not only to the type of transmission, but also to the basic characteristics of the medium through which the communication is made Most telephone lines are designed to carry analog transmissions In an analog transmission a continuous range of frequencies is generated. A basic signal is always present and information content is transmitted as variations in the nature of that signal. Light, sound, radio waves, and the signals passing along telephone wires are all described in terms of frequency. The signal at a given point oscillates rapidly just as the string of a musical instrument oscillates when plucked. The rate of oscillation is referred to as the frequency and is described in terms of cycles per second

Normally the sound—or light—reaching the senses does not consist of one single frequency but of many frequencies or a continuous band of frequencies all traveling together. The human voice is a jumble of different frequencies The same is true of the electrical and radio signals of telecommunications Usually there is not one single frequency but a collection—or band—of frequencies occupying a given range.

Digital transmission, on the other hand, consists of a pattern of pulses. There is no continuous signal but rather an intermittent pattern of presence or absence of signals A stream of bits—ON/OFF pulses—is transmitted noncontinuously, in the same manner that data is handled in computer circuits. It is possible to transmit such data at an extremely high bit rate, except over voice-grade (analog) telephone lines or other analog media. Some phone lines have been designed specifically to carry digital data. However, these exist in only a few areas. For most data communication using analog phone lines devices known as modems are used to convert the digital data signals into analog signals for transmission over the analog lines.

Any communications medium—wire pairs, high-capacity coaxial cables, microwave radio links, satellites, and new transmission media, such as fiber optics—can be designed as either an analog or digital medium. If the path is designed to be analog, it will use amplifiers to maintain the signal strength. If the path is digital, it will use repeaters to regenerate the bit patterns and pass them on. A repeater is a power-driven device that detects the bits being sent and then retransmits them with their original strength and sharpness. It catches the bit stream before it is submerged in noise and separates it from the noise by creating it afresh. Consequently, very high transmission rates can be achieved provided that the repeaters are sufficiently close together to catch the bit pattern before it degenerates into noise. On a communications line, the repeaters can be small, inexpensive, solid-state devices.

Bandwidth

The different physical media used for telecommunications vary widely in their transmission capacity. A coaxial cable, for example, can transmit far more information than a simple pair of wires. Analog lines, such as most telephone lines, can handle differing data transmission rates depending on the characteristics of the modems used. A medium's capacity is described in terms of "bandwidth."

Bandwidth refers to the range of frequencies that a channel can transmit. Bandwidth is quoted in "Hertz" or cycles per second; or more commonly in kilohertz (kHz), the number of thousands of cycles per second, or megahertz (mHz), the number of millions of cycles per second.

The bandwidth of a regular analog telephone channel is about 3 kHz and it normally transmits frequencies from about 300 to 3400 hertz, the range needed for transmitting the human voice. Special techniques can be used to raise the frequency base to high frequencies over 8000 kilohertz but this does not change bandwidth which remains at 3 kilohertz. Bandwidth indicates nothing about the frequency of the transmission; it indicates only the range of frequencies the medium can accommodate.

The capacity of a channel for carrying information is proportional to its bandwidth. A channel with a bandwidth of 30 kilohertz can carry ten times as many bits of computer information per second as a channel of 3 kilohertz. If the speed of transmission is doubled, the time taken to relay the information is halved. Doubling the speed doubles the frequency and also doubles the bandwidth used.

Video transmission requires substantially greater capacity than data transmission and, therefore, is usually accomplished over coaxial cable in a limited area and over microwave and satellite transmission media when long distances are involved.

Telephone Lines and Linkages

The great advantage of the public telephone network for data transmission is its widespread availability. There are telephones virtually everywhere, and wherever there is a telephone, a data transmission device can be connected to the line. However, since the phone system was originally designed to transmit the continuous frequencies of the human voice, it uses an analog signal necessitating the use of modems or other devices to transmit digital data.

There are two common methods of establishing a telephone linkage—dial access and the use of a leased or dedicated line. Almost all voice communication employs dial access, while much communication involves either use of a leased line connecting a single terminal to a single computer or the sharing of a leased line among a number of terminals using multiplexing techniques to link them to a single computer. Video transmission also relies on leased lines when telephone lines are used.

Dial Access

The dial access or dial-up approach is normally used for voice communication. It can also be used for data transmission The telephone line can be used for voice communication when not in use for data transmission.

All dial-up telephone service is publicly switched. In other words the lines are switched through public exchanges or central offices to make temporary connections.

Dial access is appropriate for situations where a specific terminal-computer linkage is of relatively short and infrequent duration—i.e., entailing only a few dozen transactions a day. The efficiency of dial access, however, is reduced by the same limitations that apply to regular telephone traffic—peak period loads that make connections difficult to establish and restricted transmission speeds.

Until recently, a major advantage of using dial-up telephone facilities for terminal-computer linkage was economic. Most such installations are within local areas where relatively short distances are involved and local calling rates apply. However, this situation is changing as telephone companies revise their pricing structure and charge business and institutional users by the minute for local telephone calls. Costs are expected to rise further as local rates are restructured to absorb the loss of revenue from long-distance traffic attendant upon the breakup of AT&T. The cost of local dial-up service is expected to increase 60 percent or more between early 1984 and the end of 1985.

Certain technical aspects of dial access of dial access linkage limit the extent to which techniques to increase the speed of data communications—and thus lower the costs—can be applied. Transmission speed, which is usually expressed in "baud"—one baud being one signal element per second—is the major factor. With voice-grade telephone lines and regular modems, the practical upper limit is 1800 baud. Higher speed modems are available. They achieve faster data transmission by encoding more data bits in a baud. For example, a modem operating at 1200 baud, but encoding two bits in a baud, effectively transmits data at 2400 bits per second (bps). Some modems will transmit data over voice-grade lines at 4800 and 9600 bps. A penalty is paid for the very high speed in increased error rates and modem costs. Consequently it is common to limit transmission speeds over voice lines to 4800 bits per second. Unfortunately, the "dumb" terminals used in most local library systems mandate the use of a particular type of modem in dial-up mode effectively limiting the speed of transmission to 1200 bps.

Leased Lines

A leased line may be permanently connected via the local telephone company switching office; but it would not be connected to the switching gear and signaling devices of that office. On the other hand, an interoffice leased connection would use the same physical links as the switched circuits. It would not, however, have to carry the signaling that is needed on a switched line.

Other Types of Telecommunications Lines

Although in many parts of the United States phone companies offer Dataphone Digital Service (DDS) as an alternative to voice-grade analog lines with pre-1984 tariffs, there were virtually no cost savings to be realized through using DDS even though modems are not required on equipment attached to such lines. However, they offer greater reliability and better performance There is some evidence that digital phone service will be more attractively priced in the future.

Data communications can be handled through lines other than telephone line Telegraph lines, which have a much lower speed of transmission than voice-grade telephone lines, may be permanently connected, or they may be dialed like a telephone line, using a switched public network. Telex is similar; it exists throughout most of the world, permitting transmission at 50 bits per second. Telex users can set up international connections to other countries. Some countries have a switched public network that operates at a somewhat higher speed than Telex, but at lower speed than the telephone lines. In the United States, the TWX network offers speeds up to 150 bits per second. All of these communications lines are designated "subvoice grade" because they are slower than telephone lines.

Advantages of Leased Lines

Given the changes in dial access pricing structures and the number of transactions per remote terminal per day (300 or more), most libraries can justify leasing a line. The cost now varies from $4 to $11 per month per mile, but it can be expected to rise dramatically in the next few years.

There are some real advantages in using leased lines that are permanently connected

1 If it is to be used for more than a given number of hours per day, the leased line is less expensive than the dial-up or switched line. If it is used for only a half an hour per day, it is more expensive. The "break-even point" depends on the actual charges, which, in turn, depend on the mileage of the circuit, but it is likely to be of the order of an hour to three hours per day.
2 Leased lines can be specially treated or "conditioned" to compensate for the distortion they exhibit. Through conditioning, the number of data errors can be reduced or, alternatively, a higher transmission rate can be achieved. The switched connection, on the other hand, cannot be conditioned beforehand, because it is not known what path the circuit will take. A switched link established when dialing on one occasion is likely to follow a quite different physical path from that obtained by dialing at another time, and there are a large number of possible paths. Modems are now available that condition dynamically and adjust to whatever connection they are used on These devices enable higher speeds to be

obtained over switched circuits but they are expensive. The common carriers charge extra for conditioning.

3. Conditioned leased lines can often transmit information at a higher rate. Switched voice lines usually carry telephone company signaling within the bandwidth that can be used for data. Consequently, data transmission machines must be designed so that the data does not interfere with the common carrier's signaling. With some machines, this also makes the capacity available for data transmission somewhat less than that over a leased line. A common rate over a switched line in the 1960s was 1200 bits per second, whereas 2400 bits per second was common over a specially conditioned, leased line. Because of improved modem designs, it is probable that in the 1980s speeds of 3600 bits per second over switched lines and 9600 bits per second over conditioned, leased lines will become common. Already some modems transmit at higher speeds than 3600 bits per second over public voice-grade lines.

The cost advantage of switched lines will dominate if the terminal has only low usage

Value Added Networks

Value Added Networks (VANs) such as Telenet, Tymnet and Uninet lease multiple lines from the telephone companies at substantial discounts and resell the capacity in smaller chunks for data communication. Most users dial up into a local node of a VAN and then pay for the time they use at an hourly rate of $5 to $7 per hour. The rate structures are such that only communication over state lines or distances of more than 200 miles are cost effective VANs provide more than discounted telecommunications lines, however They add value by introducing network controllers which provide protocols for communicating among various systems. Most libraries using the BRS, Dialog and SDC database services access these systems with an asynchronous terminal through a VAN which converts the protocol to the synchronous one used by the host computers.

Simplex, Half-Duplex and Full-Duplex Lines

The lines in a telecommunications system may transmit in one direction only or in both directions There are two types of lines which can handle transmissions in both directions. those capable of transmitting in both directions at the same time and those capable of transmitting in only one direction at a time According to their directional transmission characteristics, lines are classified as simplex, half duplex or full duplex. In North America these terms have the following meanings.

simplex lines transmit in one direction only,
half duplex lines can transmit in either direction, but in only one direction at a time; and
full-duplex lines transmit in both directions at once.

Thus, one full-duplex line is equivalent to two simplex lines or two half-duplex lines used in opposite directions. A full-duplex line is often referred to simply as a duplex line. If data is relayed in half-duplex mode, there must be a pause at the end of a transmission to allow a reversal in line direction before a reply can be transmitted and received. The delay during which the direction of the transmission is reversed, is called the line turnaround time. For full-duplex transmission two channels would be used—one transmitting in each direction.

Simplex and half-duplex data transmission require two wires to complete an electrical circuit. Usually a four-wire circuit is needed for full-duplex transmission. There is, however, an ingenious way to build what is, in effect, a four-wire circuit out of two wires—the bandwidth of the lines is split into two separate frequency bands, one of which is used for transmission in one direction and the other for transmissions in the opposite direction. This is referred to as line splitting and produces an "equivalent four-wire" circuit. Although the technique uses only two wires it works as though there were four wires of half the bandwidth. This approach permits full-duplex operation on two-wire circuits. Data transmission machines often have specific requirements as to whether they require a two-wire or four-wire circuit.

Public telephone lines in North America are half-duplex in operation. It is only with leased telephone lines that the user has a choice between half duplex and full duplex. In North America, full-duplex lines generally cost 10 percent more than half-duplex lines.

In North America, simplex lines are not generally used because, even if information is being sent in only one direction, control signals are normally required to be sent back to the transmitting end

Many data transmission links use half-duplex lines thus allowing the movement of transmittal control signals and the occurrence of two-way "conversational" transmissions. On some systems full-duplex lines provide more efficient use of the lines at little extra line cost. A full-duplex line often costs little more than a half-duplex line. However, data transmission machines that can take advantage of full-duplex lines are more expensive than those that use half-duplex lines. Half-duplex transmission is, therefore, more common at present, although this situation might well change

Communications Hardware

In the past libraries have leased hardware voice communication from the local telephone company and data comm ations hardware from the same source that provides other computing hardware. However, it is likely that in the future libraries will seek to deal directly with firms specializing in telecommunications equipment. In that case, care must be taken to ensure that all hardware will be compatible and that selections anticipate future as well as current needs. This section describes the major hardware options.

Telephones

Most installed telephones are equipped with a rotary dial, but for several years subscribers have had the option of "touch-tone" or push button equipment which sends electronic pulses suitable for communicating with computer equipment. Rotary equipment is less expensive to lease or purchase. The lease rate for rotary equipment supplied by AT&T is set at $1.50 per month through the end of 1985, while touch-tone equipment is priced at $2.85 per month. urchase existing equipment is $19.95 and $41.95 respectively. The touch-tone approach has the advantage of providing access to the various long distance services such as MCI. After dialing the telephone number of a computer, the touch-tone equipment can be used to enter an account number. The typical purchaser can recover the investment in purchased equipment in less than two years. The purchaser assumes financial liability for maintenance when the equipment is owned.

Private Branch Exchanges

When the number of lines at a location exceeds sixteen it becomes practical to consider a Private Branch Exchange (PBX), a switching device for both internal and external calling. Recently, the manufacturers of such equipment have started to offer models which can accommodate both voice and data communication. While this equipment is available from AT&T, the majority of recent installations have featured equipment from a number of smaller vendors. The cost is usually $1000 to $2000 per line. The cost per line drops when hundreds of lines are supported.

Modems or Data Sets

As previously described, many of the communication lines over which data are sent are designed for analog transmission—not digital. If computer data is to be sent over such analog lines and there is no PBX with digital capability, it is necessary to convert the digital bit stream into an analog signal using a modem or data set

A modem converts the bit stream that leaves the computer into a range of frequencies suitable for transmitting over the analog communication line; then, at the other end of the line, a similar modem converts this range of frequencies back into a bit stream that replicates the original data stream. The modem tailors the signal to fit into the range of frequencies that the communication line handles without undue distortion of the signal. Modems range in price from a few hundred to several thousand dollars depending on the data rate for which they are designed.

Most telegraph lines and most wideband lines of higher capacity than telephone lines are analog. Similarly, most of the microwave radio links spanning North America operate in analog, not digital, mode. These links, therefore, must also employ modems when they transmit digital signals. If microwave links or any other communication facility were designed specifically for data transmission—as may happen in the future—they would be digital in operation, with digital repeaters, and thus would not require modems.

Multiplexers

Terminals located in groups at remote sites may be "multiplexed" on a single line using data terminal equipment designed to combine the transmissions of multiple terminals into one composite signal. Several terminals may be connected to a single multiplexer and at the other end of the line over which the signal is transmitted an identical multiplexer reconstitutes the original input from each terminal. In the case of a minicomputer, the equipment routes the signals to the appropriate ports of the computer or to yet another multiplexer. Neither terminal equipment nor the computer hardware or software need be changed when multiplexing is undertaken. Either dial-up or leased lines may be used with multiplexers. Most multiplexers have built-in modems.

There are several multiplexing techniques, the most cost effective of which is usually statistical multiplexing. A statistical multiplexer uses a small microprocessor and a buffer memory so that data can be stored temporarily during periods of peak activity. This permits more terminals to share a line because the "stat mux," as it is often called, smooths out the traffic flow. It allocates the shared line in such a way that up to eight terminals, each operating at 1200 bps, can share a single 1200 baud voice-grade telephone line transmitting at 2400 bps. Another term now more commonly used by manufacturers of this high capacity equipment is *data concentrator.*

Stat muxes typically cost from $2,500 to $10,000 each depending upon the number of terminals they handle and whether they include a built-in modem. A rule of thumb is to budget $2000 per terminal. The special modems required for use with data concentrators may cost as much as $6000 a pair.

It is possible to network stat muxes or data concentrators. For example several terminals at a branch library may share a multiplexer that is connected to another multiplexer through a pair of modems. In turn the second multiplexer connects with yet another multiplexer. Several other terminals may also come into the third multiplexer directly and all may share a single line to the central processor. The multiplexer at the central site splits all the transmissions among the appropriate ports of the computer.

The advantage to concentrating terminals is realized when the costs of the individual telephone lines (if any) from the terminals to the multiplexers, the telecommunications hardware and the shared multiple line charges are added up and found to be less than the cost of the larger number of individual telephone lines and modems

Multidrop Concentrators

Related to the data concentrator is the "multidrop concentrator." This device allows a single telephone line to connect individual terminals or clusters of terminals which are multidropped—i.e , configured with nodes at several points along the telephone line rather than just at each end. The multidrop concentrator at the central site—a processor—would poll or communicate with all of the node concentrators in round-robin fashion. Unlike the polling techniques used in synchronous communication, intelligent terminals are not required. The cost of a multidrop concentrator is $3500 or more and the node concentrators cost up to $2500 each.

Port Concentrators

Another related piece of telecommunications hardware is the port concentrator or intelligent port selector. It allows one computer port to communicate with several terminals, not just in dial-up situations, but also when leased lines are used. As a transmission comes in, it is directed to any vacant port rather than to a port preassigned to that particular terminal Unlike the other multiplexing devices discussed, a port concentrator does require some changes in the computer system software.

Non-Telephone Options

The thinking on the design of data communications systems is changing No longer are telecommunications networks seen as being composed of one communications medium Development is moving toward a multimedia approach which combines telephone with one or more other media such as satellites—cost effective for distances in excess of 700 miles, microwave and cable television—for local transmission, and Local Area Networks (LANs) for short distances. Implementation of multimedia data linkages is likely to be hampered by high start-up costs and by FCC regulations which require that data communications applications using media other than the telephone lines be licensed.

Satellites

Satellite channels offer very high speed and capacity because the frequency is in the billion cycles-per-second range. Satellite channels also provide low error rates because they are not subject to atmospheric interferences.

In order to utilize a satellite for voice, data or video communication, the user must have a connection to the central office of the satellite communications vendor The local telecommunication loop as it is called usually utilizes local telephone lines to transmit the voice or data to the terrestrial (earth-based) station. Video is usually sent to the terrestrial station over a specialized cable linkage or by microwave.

The major costs in establishing a satellite circuit are those of the terrestrial stations which exchange signals with the satellite, the central office facilities and the satellite itself.

The cost of an earth station capable of both transmitting and receiving is approximately $70,000. The satellites cost millions of dollars each to build and place into orbit. Because capacity is limited there is great competition for access to the facilities. Lease costs for a satellite transponder—capable of supporting the equivalent of 1000 telephone lines—begin at about $13 million per year. A single 56-Kbit (56,000 bits per second) circuit costs at least $10,000 per month.

Since the satellite is in orbit 22,300 miles above the earth, it will always appear stationary vis-à-vis the ground station and the signal always travels approximately the same distance. The cost of using the channel is, therefore, the same whether the sites being connected are Washington and Los Angeles or Washington and Baltimore. It is generally not cost effective to use satellite communication for distances shorter than 700 miles because telephone lines or microwaves involve lower fixed costs and thus lower rates

Microwave

Microwave communication is the most common form of terrestrial or earth-based long distance transmission for voice, data and video A single microwave transmission can carry 600 to 1800 voice channels. Using space as the transmission medium, microwaves are beamed from an origination point at which many individual messages have been collected by telephone lines, cable or other means. Because transmission of the microwave beam requires a straight, uninterrupted line-of-sight path, the transmitting towers are sited on hills or tall buildings to minimize interference. Usually towers are placed no more than thirty miles apart. Greater distances are not practical because the curvature of the earth causes the message stream to go into space rather than remain earthbound.

When transmission volume is high and distances exceed twenty-five miles, microwave usually is less expensive than telecommunication options which require the laying of special cables. This is particularly true when right-of-way must be obtained for cables. However, atmospheric interference is a factor; rain can cause severe transmission problems with microwave communications. Moreover, in metropolitan areas where many short microwave links exist, the available spectrum is becoming crowded and further installations are not possible.

The cost of constructing a single line-of-sight microwave tower is approximately $50,000. Maintenance costs are approximately $250 per channel per year. It is normally not practical to construct a microwave network for a group of libraries because the transaction levels are not high enough to offset the high start-up costs. It is sometimes possible to utilize excess capacity in existing fire, police or educational microwave systems. The major risk of this arrangement is that the excess capacity may eventually be claimed by the original users and service to the libraries discontinued. It must also be kept in mind that telephone lines or other linkages between the libraries and the microwave facilities will represent a major ongoing cost

Cable TV

There has been considerable interest in the use of cable television systems for data and video transmission. As with telephone lines the cables can be used to transmit data exclusively or intermingled with other information

Cable as a communications medium offers high capacity, speed and relatively widespread availability However, to install a cable system specifically and solely to link a number of sites which wish to exchange voice, data or video communications is prohibitively expensive except in very localized, high volume situations It involves getting the cable to all of the locations and the installation of equipment to link the telephone, computer system and or video facilities to the cable network.

Voice communication is rarely transmitted over cable television facilities There is currently only one cable television company which has provided a cable-based data communications system—Manhattan Cable

The company provides cable-based data communications to 200 high-volume banking and financial customers through an installation of only seventeen miles of cable. Each account contributes at least $200,000 a year to Manhattan Cable's revenue. Applications for licenses to use cable in this way have been filed in only four other communities

The use of cable for video is widespread. Libraries have been relatively successful in having cable facilities and access provided as part of the franchise agreement between a community and a cable company.

There is not yet enough experience to permit judgment of whether or not cable is a viable alternative for voice and data communication, but claims have been made by enthusiasts that if voice and data communication were to piggy-back on a cable television system, the costs could be reduced 10 to 40 percent below that of current telephone communications.

There are, however, constraints, especially with regard to the use of cable television systems for data communication. The medium must be capable of two-way/interactive communication. At the simplest level, a terminal operator needs to transmit a search request and be able to receive the results of the search—i.e., to transmit a message requesting that an item be placed on hold and to receive confirmation that the message has arrived. In practical, economic terms such capabilities are only available on cable television systems which have been designed as two-way systems. Only 1 percent of the U.S. communities which have cable television have such two-way services. Even in installations with this capability, library use of a cable channel for data communications requires that the system have spare channels not currently devoted to other applications. The majority of installed systems do not have spare capacity although most recently awarded franchises do have a number of unused channels.

Should a library be in a situation in which both of these requirements are met, the way is still not clear for the use of cable as a data communications medium because most cable companies are not yet interested in supporting data communication Factors such as company priorities and economics will be keystones in determining the future of the medium. Until cable companies are convinced that data communication will be profitable and within their technical capabilities, little will happen. At present, no library in the United States is using cable as an operational system for data delivery.

While cable has the potential to offer better and cheaper channels for data transfer, quality control can also be a problem—some systems do not offer satisfactory performance.

Local Area Networks

There has been a great deal of promotion of Local Area Networks—i.e., the wiring of a building or contiguous buildings to permit voice, data and video systems to be plugged in and interconnected. The most widely advertised systems are Ethernet, Xerox's X10, and Wangnet. While Ethernet is now supported by 34 companies, the claimed compatibility is nothing more than an undertaking by the equipment manufacturers to stay out of one another's way; equipment from different vendors can share the channel but cannot exchange information. Xerox's LAN is supported by only a few companies and Wangnet can only accommodate that company's hardware.

The cost of an interface between any piece of equipment and Ethernet is now $950, but this may drop to $300 or $400. If a new building is prewired, there can be cost savings for connecting compatible pieces of equipment without having to lay new cables.

Transmission media for local area networks include twisted-pair wire, baseband and broadband coaxial cable, and fiber optics cable. The most popular are the two types of coaxial cable. In baseband systems the information is encoded as a digital signal that is transmitted directly; only one signal can be present at any instant, and the signal uses the entire bandwidth. When used for data communication, a baseband system can have a data rate of 50 megabits per second; broadband can support 200 megabits per second. A broadband system permits several information signals to be present simultaneously.

Baseband systems—the type most widely marketed as LANs—are no[illegible]ly limited to 1.5 miles and can support hundreds of nodes. The cable costs are 10 to 15 cents per foot plus installation. Broadband techniques can support distances of up to 200 miles at cable costs of 15 to 25 cents per foot plus installation. A number of college campuses are planning the installation of broadband systems for voice, data and video communication.

Fiber Optics

Fiber optic cables are beginning to appear in short distance, high-capacity communications situations. Fiber optics is the technology of producing glass or plastic cables through which light can pass for long distances with only a slight loss of intensity. A laser is used as the light-producing medium. It is possible to transmit much more information in the form of light than as electrons through conventional copper or coaxial cables of comparable diameter.

In the next ten years fiber optic cable is expected to displace both conventional telephone lines and coaxial cables in high volume communications environments. Microwave, now usually used for high traffic communications over distances of 25 to 700 miles, is also expected to be affected by the growth of fiber optic systems

Video Communication, a Special Case

The distribution of video has been very limited outside the commercial television industry due to lack of adequate transmission facilities. While available telephonic communications systems will support voice and data communication in a reasonable and cost-effective manner, they do not provide adequate facilities for video communications.

The appropriate medium for video communications requirements will continue to be provided by a cable system separate from the telephone system. The system may be a cable television system or a LAN, and it may be dedicated to video communications or shared with voice and data communications.

As was mentioned earlier, there are two types of cable systems available—baseband and broadband. The baseband offers a fraction of the capacity of a broadband and can be carried as a "channel" on a broadband system. Baseband systems can be compatible with broadband systems and may be useful in intrabuilding networks. However, broadband cable systems are superior for multibuilding networks when video distribution is contemplated. As a general rule, a broadband single 1.5-inch coaxial cable with a 300 mHz signal will support thirty video circuits. A video channel requires a 6 mHz bandwidth.

Evaluation of Near-Term Options

Because of the changing needs of libraries and changes in the costs of telecommunications, librarians managing automated systems will need to periodically reexamine their telecommunications approaches. If a library's telecommunications costs are more than $1000/month or have risen more than 20 percent in the past year, a review should be undertaken. In the near-term this will consist of reevaluating the use of telephone systems, in the longer term it will involve the examination of other technologies. The following rules of thumb are valid at the present time:

1. If terminals are within 2000 feet of the computer, direct connections using line drivers are generally most cost effective.
2. When terminals are remote from the computer, but widely scattered, direct connection through telephone lines with modems may be cost effective. Normally, dedicated leased lines are more cost effective than dial-up lines.
3. If the remote terminals are concentrated at a small number of sites, if there are more than twenty-five remote terminals; or if telecommunications costs are more than $1500 per month, it is quite likely that the use of statistical multiplexing will be more cost effective than modems.

4. If there are more than fifty remote terminals, it may be possible to network statistical multiplexers to realize even greater cost savings.

Some libraries may be able to reduce ongoing telecommunications costs by up to 90 percent by investing in the telecommunications hardware discussed in this paper. The "payback" period—the time required to recover the capital outlay for telecommunications hardware—may be as short as two to three years.

While a library may wish to have the vendor of its computer system review and modify its telecommunications it is not mandatory that it do so. Virtually all telecommunications hardware requires no changes in software. A library may choose to retain an expert in telecommunications if its vendor does not appear to have appropriate expertise or if the vendor's prices for a telecommunications analysis are too high.

The vendor should be notified of planned changes in the telecommunications system as should the telephone company(ies). Despite frequent protests by vendors and telephone companies, they may not prohibit the use of telecommunications equipment purchased from other sources.

Interfacing Computer Systems

The interfacing or electronic linking of various computer systems will increase libraries' need for telecommunications, but telecommunications will not be a major obstacle to such interconnections. The dominant issues will be technological, economic and political. Hardware, software and database design will have to be made compatible or interconnection standards will have to be adopted. The cost of interfacing will have to be worth the perceived benefits. Most of all, the various competing vendors will have to be persuaded that interfaces to other systems—even those of competitors—are a requirement of the library community. When these issues have been successfully addressed there will be a wide range of choices for actually transmitting the information.

HERBERT P. CRANE
President
Ameritech Communications

A Collection of Books

Thank you for inviting me to speak to you today. I am aware that this is an important group of people. You provide a valuable—no, an invaluable—service to society You preserve literacy, aid research and keep people intellectually alive.

Thomas Carlyle remarked that the true university is a collection of books. He could not, of course, have foreseen the range of services libraries provide today—films, audio- and videotapes, microfiche, and computerized access to information of every kind.

Data processing is important today and it is the wave of the future. Literacy today is not defined only in the conventional sense. It also means *computer* literacy.

This annual Clinic was one of the first anywhere to recognize the long-term influence data processing was to have on the public sector. When these Clinics were begun, others were seeing data processing merely as a remarkable tool for business and research. The library industry looked ahead and saw what everyone knows today—that data processing is also a remarkable tool for just about *every* aspect of our lives The home, business, recreation, and the school all benefit from data processing.

The University of Illinois at Urbana-Champaign—our host for this Clinic—has, as you may know, one of the largest data facilities of any educational institution in the entire country. And the three campus libraries constitute the largest such facility—with nearly 6 million volumes—of any state university The library also provides access to an even larger pool of books through its Library Computer System (LCS) database

As president of Ameritech Communications, I have an intense personal and professional interest in data processing and transmission. Ameritech is the parent institution for sixteen companies. They are:

—Five Bell telecommunications companies that handle our traditional regulated service—Illinois Bell, Indiana Bell, Michigan Bell, Ohio Bell, and Wisconsin Bell.
—Their five communications sales and service subsidiaries. These subsidiaries provide a common delivery system to meet business customer needs. That's where the distribution channel is the sales force, the equivalent of one-stop shopping for business customers.
—And we have six other Ameritech subsidiaries. Some of them handle unregulated services, while others provide regulated services that are outside the boundaries of the Bell telecommunications companies.

You are probably already familiar with several of our subsidiaries. Ameritech Mobile Communications provides cellular telephone service. We have one system in operation in Chicago. We have been in business only five months and already we have nearly 7000 subscribers—that was our projection for the first year. So we are moving ahead to expand the system to accommodate the demand. Later this year we will have cellular service available in Detroit, Cincinnati and Milwaukee.

Another subsidiary, Ameritech Publishing, was formed to consolidate directory advertising. In addition, Ameritech Credit Corporation provides financing for business customers who want to lease rather than buy their telecommunications equipment. Ameritech Services gives operational and technical support to the five Bell telecommunications companies.

Another subsidiary, Ameritech Communications, supports the telecommunications company equipment subsidiaries. It currently has equipment contracts with TIE, NEC, Ericsson, AT&T Technologies, and General Datacomm Industries.

Ameritech Development Corporation completes our family. In a way, Ameritech Development may be thought of as our research arm—it helps us expand our research and development capabilities so we can continue to improve our product and service offerings.

We are not in the business of data processing. We are in the business of *transmitting* data We do business in one of the most data-intensive sections of the country. I should point out that Ameritech is not in competition with you We are in the business of *transporting* information. We do not compile information. You have the databases and we provide the facilities to access those databases.

Our corporate headquarters are in Chicago and our territory covers the surrounding five-state area—though we are not limited to these boundaries. As Chairman Bill Weiss said, we are just beginning to explore the possibilities.

There is no question that Ameritech is in a business that can be of significant assistance to librarians not just today, but also—and especially—in the future. In March of last year (1983), *Business Week* ran an article that suggested that for a variety of reasons—e.g., the soaring costs of energy, buildings and published materials—technology threatens to make the printed word obsolete. I doubt very much that this will ever happen. It is possible, of course, but books are too much a part of our lives to ever be abandoned completely. What *will* happen, without a doubt, is that technology will make books more readily available along with information in other forms.

The same *Business Week* article predicts that libraries will become much smaller. But they will provide access to far more information through electronic hookups to remote computer databases and computer-controlled regional library networks.

The books to which the computer provides access must be located somewhere, so there will be large libraries, but it will become less necessary for every library to stock the books every kind of user may need. It will not matter where the material is located, because it will be economically accessed remotely. The Southeastern Library Network, for example, links 260 libraries from Virginia to Louisiana. Across the country 2400 libraries are tied into the Online Computer Library Center whose central database is in Ohio. It lists more than 7 million published works. These and similar systems are a tremendous resource for students, scholars and those who engage in research of any kind.

Your business and mine find a common ground here. You are interested in communicating the content of your resources to those who find it useful. We can provide the facilities over which that content can be transmitted, transferred and transported. Ameritech has a wide-ranging vision of its own future. We see all sorts of business opportunities to build on our core business. That core business is our communications network. The network is an arrangement of switching systems, transport facilities and support systems which we use to provide service within our areas of operation. It includes the facilities we use to interconnect with the various interexchange or long-distance companies. Our five-state network contains some 14 million access lines, more than 1200 separate switching systems and millions of circuit miles of interoffice trunks.

These elements form an extremely complex arrangement which makes it possible for our customers to communicate and transfer information among themselves. Since our network is also linked to nationwide and worldwide networks, it is also possible to reach millions of others around the world.

The network is a strong national resource. It can provide every communications and information service known in the world today including, in many locations, full-motion video. And it is being continually modernized. Our Ameritech companies will spend $1.7 billion in 1984 to expand and modernize our network—some $500 million of that for fiber optics and digital switching and transmission systems. We will spend another $170 million for additional electronic switching equipment.

Today, two-thirds of all our customers and about 80 percent of the Ameritech region's major businesses, including our largest data users, can receive 56 kilobits service from the existing copper wire facilities without special conditioning. The data transport capabilities and service range of our wire-based access lines are also being advanced through digital systems.

There are, as I have said, more than 1200 switching systems serving Ameritech customers today. These have been the object of a widespread modernization effort, based on the deployment of stored program technology. The operation and service capabilities of these systems are controlled by a digital computer with an internally stored software program, though the information switched by these systems is in analog format.

Computer-controlled switching systems currently serve more than two out of every three Ameritech customers, or some 10 million access lines. In most of our major market areas, which are home to the large business customers who generate about 80 percent of our revenues, the percentage is even higher. The software for our most widely used system is entering its ninth generation of development, so we have achieved a sophisticated level of feature availability. With each new generation we are able to add new features which allow us to operate these systems more efficiently and to offer new services to our customers.

We are also moving ahead to install digitally based lightguide—or fiber optics—systems between our switching centers. Lightguide systems transport information over glass fibers as extremely brief pulses of laser light. They are well suited to the digital world. Though they use cables usually less than one-half inch in diameter, these systems offer significant increases in transmission capacity. Lightguide is also an interference-free transmission medium and is compatible with emerging digital switching systems. Because lightguide is interference free, it has lower error rates than other means of transmission. It permits the transmission of large amounts of data with a high degree of reliability and is particularly suited to library applications.

We are proud that much of this information age technology—i.e., stored program control, digital interoffice transmission, lightguide, digital switching—was pioneered by the Ameritech operating companies through field trials and leading edge applications. Our people were part of the process through which these technologies were perfected. They not only understand the technology, but they have played a hands-on role in putting it to work for our customers.

Long term—1986 to 1990—we are laying the groundwork for an even more sophisticated digital network called the *Integrated Services Digital Network*, or ISDN. ISDN is a conceptual framework that includes a set of standards for serving evolving customer needs via a network capable of carrying voice data and video services in a common, integrated and flexible manner. It is a totally digital network with all of the efficiencies of end-to end digital connectivity. The network defined by ISDN, functions as an all-purpose communications pipeline. It provides the customer with a circuit capacity which the customer can allocate to voice, data or video. That allocation can be changed as the customer's needs change, day to day or minute by minute.

ISDN standards are still in development Yet the basic elements of the ISDN—end-to-end digital connectivity, customer control of information transport capacity, and flexibility of interconnection with the network—are well within our capabilities. The local packet network is another capability which will help us to achieve that goal. A packet network allows voice and data traffic to share the same access lines and trunks. It provides efficient data transport for both small and large data communications customers, including data processing intensive industries and major information providers such as libraries.

A packet network also provides connections between multiple terminals and mainframe computers. Traffic from low speed terminals is packaged and multiplexed—or combined with packages from other users—on to high-speed facilities. Once on the network, packetized data can be routed to the desired destination and, once there, separated from packets originated by other customers, reassembled in sequence, and delivered.

Ameritech, through the operating company subsidiaries that offer communications equipment, will soon be offering state-of-the-art data products to complement their current lineup of electronic business equipment and network communications systems. So Ameritech can now offer its customers a total communications package including network services as well as voice and data systems The new product line includes data network management systems, digital and analog data sets, video display terminals, printers and integrated voice and data systems

As you can see from all this, Ameritech is moving ahead with dispatch in the new world of telecommunications brought about by the breakup of the Bell System. Our companies have the advantage of operating in a densely populated marketplace Our facilities in place make it possible for our growth to be low-cost This will provide a distinct advantage

Unfortunately, we still operate in an environment that is partly unregulated and yet still partly regulated We at Ameritech are aggressively promoting regulatory changes that will permit us to operate as a competitive enterprise should—basing our prices on cost and allowing them to be driven by market demand.

The fact is—and history teaches us this—that regulation of our industry was instituted in order to prevent the possible abuses of monopoly. Well, monopoly does not exist any more. And neither does the reason for regulation

It is hoped—not just for the sake of our companies and our stockholders, but for the sake of our customers—that the trend toward deregulation will continue and will accelerate, until we will some day achieve what is best for the industry—total deregulation.

MICHAEL A. FLAVIN
Executive Director
Business Communications Divisions

AT&T Information Systems Laboratories

Telecommunications in the Office

Many activities are underway to apply technology to the office to achieve improved productivity. This paper discusses advances in telecommunications technology and how they can be applied to the office environment. Trends in technology are discussed but predictions are avoided. Earlier, scientists and engineers have succumbed to the temptation to predict the future with poor results. Thomas Tredgold, in 1835, said, "any general system of conveying passengers—at a velocity exceeding 10 miles per hour or thereabouts—is extremely improbable." This railroad engineer failed to foresee the bullet train traveling from Tokyo to Osaka at over 100 miles per hour.

In 1903 Simon Newcomb said, "quite likely the most effective flying machine would be one carried by a vast number of little birds." Near the beginning of this century, one of the country's most eminent scientists, the secretary of the Smithsonian Institution, said he was certain man would never fly. *The New York Times* agreed with Professor Newcomb in an editorial. Presumably the Wright brothers did not read the *Times*. One week later they succeeded in raising "Flyer 1" from the sands of Kitty Hawk.

Innovators predict the future at their own risk. Even Wilbur Wright predicted slow progress toward flying when, in 1908, he revealed, "I confess that in 1901, I said to my brother Orville that man would not fly for 50 years." Notice that all these predictions tend to be negative. It is typical to underestimate the rate of technological achievement.

It is our knowledge that the pace of technological change is quickening. In the late 1800s, agriculture occupied 50 percent of the work force.

Industrial occupations were high. Service was low and information activities accounted for a mere 5 percent

Then came the big boom in industrialization in the late 1800s and early 1900s. Agriculture sank to 28 percent of the work force. Industry now consumed over half the work force Service and information had begun to grow

In our time less than 3 percent of the work force is engaged in growing food—and we feed half the world That is real productivity On the other hand, over half the work force now deals with information in some fashion such as programmers, teachers clerks, secretaries, accountants, stock brokers, managers, and of course, librarians The broad perception is that they are not dealing with information very effectively—The Information Explosion

TABLE 1
DISTRIBUTION OF THE WORK FORCE

	Stage 1 *Mid-1800s*	*Stage 2* *Early 1900s*	*Stage 3* *Now*
Agriculture	50%	28%	3%
Industry	36%	53%	27%
Service	9%	10%	14%
Information	5%	10%	56%

In 1979 the single most common occupation in the United States became that of clerk Clerks now outnumber laborers In fact, this segment of U S history can be characterized by the transition from farmer to laborer to clerk

As librarians you are undoubtedly aware of the information explosion Currently information in science and technology is growing at a rate of 13 percent per year—i e., the information doubles every 5.5 years. About enough time to complete an MS degree John Naisbitt, author of *Megatrends*, foresees an increase of 40 percent per year That means information will double in twenty months. Another way to put it is, information will quadruple during the time it takes to get a bachelor's degree The implications to those of you who are teaching is staggering. This can be even more threatening to the working professional Technical obsolescence is a very real threat Hence, I see a growing market for continuing education

Consider that by the end of 1982 there were more computers than people in the world There were over 5 billion computers on earth—including the big ones in the accounting departments and research labs, and the little computers in cars, games and calculators. By one estimate there will be over 8 million computer terminals in U.S. homes before the end of this decade.

What is driving this explosion of computers? It is spectacular progress in microelectronics—the first key technology of the "information age." It began with the invention of the transistor at Bell Labs in 1947. The first transistor was a rudimentary device but it worked. That set the stage for a microelectronics explosion. Today we can put the equivalent of hundreds of thousands of transistors into one cornflake-sized chip of silicon. That means that each of these chips has all the intelligence of a room-sized computer of the 1950s. As the size comes down so does the cost. In fact, every year for the past twenty years—on average—the computing power of silicon chips has doubled and their cost has been cut in half

To give an idea of the magnitude of that progression, one economist (Edward Steinmuller, Stanford University) points out that had air travel progressed as fast, the Concord would carry half a million passengers, fly at a speed of 20 million miles an hour—and the cost of a ticket would be one penny

Our latest microprocessor at AT&T Information Systems is the Western Electric 32000. The chip is smaller than a man's fingernail, yet contains 150,000 transistors It has as much computing power as some of today's minicomputers that are the size of file cabinets--but it costs much, much less So microelectronics is giving us the ability to make computers very small and cheap

When computers talk to each other, they speak digital—the second key technology of the information age. Digital systems have two main advantages—simplicity and speed. Nothing could be simpler than a single bit of information—a one or a zero—represented as the presence or absence of a pulse in a series of pulses This simplicity means that, in general, digital systems cost less, and their use results in reliable, high-quality services and systems

In addition, digital components are what give computers their terrific speed For instance, in the split-second it takes for a club to strike a golf ball, a Western Electric Digital Signal Processing chip can perform a few hundred thousand complicated arithmetic operations

So in the first two technologies we've got the microelectronics hardware and the digital systems to process a lot of information very quickly But how will all this information travel from here to there?

The third key technology is photonics. In electronics, metal wires carry information as pulses of electricity. In photonics, glass fibers carry information as pulses of light. Light pulses are a perfect match for digital systems. In fact photonics is so promising that in 1982 the Bell System installed more than 15,000 miles of glass fiber—twenty-five times more than the year before. Just one of those photonic systems (e.g., in Pennsylvania) contains more glass fiber than the systems of all domestic non-Bell companies combined.

The light comes from tiny light-emitting diodes or lasers smaller than grains of salt. The lasers turn on and off millions of times each second, sending pulses of light through fibers made of ultra-pure glass. These fibers form "superhighways."

Speaking of the speed of lasers, one of Bell Laboratories' latest achievements in laser technology is a laser that emits flashes of light that last thirty femtoseconds—10^{15} seconds. That is the shortest amount of time ever measured. Let me put that into perspective. In one second a beam of light can travel most of the way to the moon. In thirty femtoseconds a beam of light can travel only about one-tenth the thickness of a human hair. Someday a version of this laser might become the light source for lightwave communication systems. A laser so incredibly fast would be able to transmit enormous amounts of pulsed information.

The three technologies I have described—microelectronics, digital systems and photonics—give us the hardware to process and move enormous amounts of information with great speed and efficiency.

The fourth technology—software—is the glue that holds all the hardware together It is what tells the hardware what to do. Software has a lot in common with phonographic records In fact, software is to hardware as a record is to a stereo system. Just as which record you pick determines what music you hear, software is what gives products and services their unique features Software makes it possible to customize services to meet individual needs.

In order to meet the Bell System's enormous appetite for software, today about half the people in Bell Labs develop software Human designers need the computer's help—some of the solid-state circuits we are designing are so complex that it would take a human being a whole lifetime to design all the electronic connections by hand. Herein may be a clue to dealing with the information explosion. Designers are equipped with computer tools which allow them to deal with vast amounts of detailed information One major advantage of the computer tool is that it brings any inconsistency to the designer's attention That makes it very difficult to make an error

Then there are the key technologies of the information age Digital systems based on microelectronics are proliferating. Not only are they prevalent in computers and telecommunications but they are becoming common in automobiles, microwave ovens and washing machines Photonics offers a new form of intercommunication Software is becoming a buzzword It made a big splash in arcade games. Now it is featured on the cover of *Time* magazine along with the youthful millionaires who wrote it.

In January 1983, AT&T announced a new system called DIMENSION, System 85. The system basically is a premises-based switching system called a PBX. It can connect a telephone to others in the same complex or switch it to various trunk lines across the country. Since it is a digital system it can conveniently handle data to and from computers.

One capability pioneered by System 85 is simultaneous voice and data Voice is encoded into digits at the telephone instrument. Thus the voice can share wires with digital data. This allows a terminal user to independently use a telephone while communicating with a computer. But even for voice only, there are some new capabilities.

Combining voice and data also simplifies the wiring of the building. We use a simple outlet as the universal connector for System 85. It allows the user to move a telephone conveniently. Furthermore, the same jack can be used for computer terminals and printers (see fig 1).

The telephone designed for System 85 converts voice to digits. The data can be used to drive the forty character display. For example, a secretary who answers a phone for several people can see who is being called and who is calling. This allows the secretary to answer the call in a personalized way and she need not push any buttons. A lamp at the bottom of the phone indicates messages are waiting Thus, whenever a person returns to their office they can tell they have messages. With a telephone like this. messages can be retrieved automatically.

When an executive returns to his office he can use the display to see who has called and can return the calls by a single button push. If he wishes to answer the call, he can simply touch the "return call" button When the executive is in the office, he or she can also see who is calling and decide whether to answer or no

Simultaneous voice and data can be extended to the knowledge worker by means of a keyboard—i.e , a CRT Data Terminal The terminal functions both as a telephone and a computer input device The bottom line on the screen emulates the forty character display on the digital telephone. Thus while the terminal is being u[illegible]gnals about incoming calls and messages can be seen The termin[illegible]quipped with a touch-tone dial However, when using the terminal one can dial from the keyboard. The screen indicates the sequence for keyboard dialing. Holding the break key is equivalent to going off-hook. The system responds with the word "dial" instead of dial tone When one has dialed the digits and hits the return key, the screen indicates the progress of the call—e g., ringing followed by

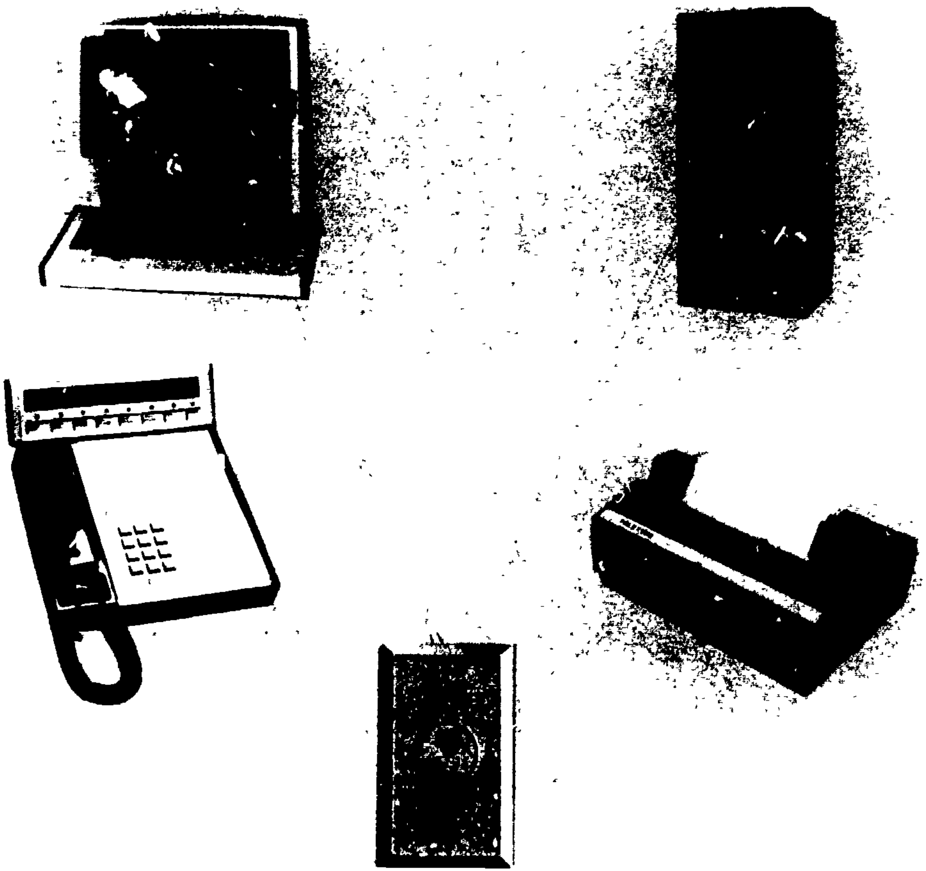


Fig 1 System 85 Uses a Single Phone Jack to Access Phones, Computers Printers

answer, or perhaps busy. The terminal coordinates the handshake with the computer In particular, it sets the data speed to be consistent with the computer port you have reached. This capability is available to any terminal on the system, not just AT&T terminals.

There are several modes in which the data terminal can be used. First, it can directly contact a host computer. Second, it can contact a special host called the "application processor" (AP) for office features such as electronic mail. Or third, it can use the "application processor" as an intermediary to allow communication with various computers. In particular, the AP can make a terminal emulate an IBM 3270 terminal to an IBM host.

The Application Processor can perform a range of functions beyond terminal emulation. Examples are message center, office management and programming. When a phone isn't answered, the call is diverted to a message center attendant. The attendant takes the message and types it on the terminal for storage on the "application processor."

The Office Management System provides a range of functions. It interfaces terminals on one side and communications on the other. For test preparation it has a word processing type of editor. The editor has niceties such as a spelling checker, a punctuation checker and even a sexist language checker. Forms are a mainstay of the office so they have their own editor. A simple programming language, OPL, is provided so work can be customized. Of course, electronic mail is included, as is a calendar/reminder service. A major element is a file system.

There is a menu of alternatives available on the office system The mail function provides a range of utilities. Creation of mail is eased by provision of text editors. Addressing is simplified by having a directory and an address book. The directory is available for general use. The directory is searched alphabetically, depending on the set of letters you type. All entries that start with those letters are displayed and you select one. It automatically becomes an address for mail. The address book is a personal directory. Names can be created for individuals or groups you frequently address. Mnemonics can be defined as preferred. A mnemonic can refer to a single individual or a group When a mnemonic is selected, a copy of the mail is addressed to the one or more individuals in the group. Mail can be sent with a range of priorities or mailing can be scheduled. Confirmation of delivery can be requested.

For example, a daily report can be stored in a host computer At a given time the report can be retrieved and sent to anyone in the department. A simple six-line program can do it.

The computer on the desk is becoming commonplace. It is indeed a valuable tool However, its true potential won't be achieved until it is networked to other computers The data needed is always somewhere else. The data is needed in a form in which it can be used without transcribing it. Thus, computer networking needs to be integrated. Telecommunications is a force toward integration. Surely, no one wants more than one terminal in their office. Not only can't the space be spared, but also no one needs to learn different sets of routines for different applications. Again, telecommunications is the catalyst of integration. System 85 is an example of the facilities that are becoming available. The same fundamentals apply to most needs: single terminal access to a wide array of computers distributed nationwide or worldwide.

New technology is rapidly being converted to applications which affect our daily lives. In particular, telecommunications is rapidly exploiting new technology. The most dramatic impact is being seen in the office place.

DENNIS OLIVER
President
International Electronic Mail Service, Inc

Electronic Mail Services in the Library and Information Center Community

In the beginning, libraries were not leaders in the use of new technology. Upon graduation from library school twelve years ago, a new professional had the experience of not being able to find a job because his combination of computer programming and library science did not match any of the scores of job descriptions within the library community of a very large North American urban center. Two universities, four community colleges, seven public library systems and scores of special libraries in various corporate headquarters had a minimal need for computer or technological expertise, although virtually all of these institutions were aware of the burgeoning information explosion and were participating in an active continuing education program from a well-reputed library school. Many organizations were planning for or at least thinking about the impact of technology in what was then being described as the "information age" in visionary articles in the professional literature, and several were beginning to commit resources to automation, at least in their planning budgets.

Today all of those institutions are using computers for a variety of library tasks and most of them have at least one or more people responsible for introducing new technology into the library environment. These library systems are in Toronto, a city endowed with one of the highest per capita expenditures for library services in the continent. The graduate was the author. Where just a few years ago there were no opportunities for the technologically-oriented graduate, there are now openings in every kind of library.

This anecdote underscores two key points—the rate of introduction of new technology into the library community has been very high, and the process of introducing new technologies is extremely dynamic. What library today does not have access to machine-readable cataloging, online reference services, automated acquisitions or circulation control systems? Literally every participant in this Clinic comes from an institution that has access to one or more of these services.

Within the last fifteen years the library and information center community has pioneered the implementation of several new technologies. Bibliographic utilities and online reference services are two examples of large-scale, state-of-the-art computer systems that have been designed and implemented expressely for library and information center use. A few years ago a close friend who was then developing new systems for Tandem Computers mentioned his extreme surprise at the scale and sophistication of OCLC's application requirements. Like many people in high-technology industries he was surprised that libraries could innovate and that the applications that were being implemented were on such a large scale. The low-profile and quasi-public image that libraries traditionally project is not in harmony with technological pioneers at the forefront of the information sector

Early Use of Telecommunications in Libraries

And yet, there are communities that implemented online circulation systems before local banks or retailers had automated their systems. Telecommunications applications are equally prevalent within the library and information center community Dedicated communications lines to bibliographic utilities and local systems are common. Dial-up access to online reference services is so successful that many new companies have been started and the number of services and databases available is growing rapidly. New companies are providing research and information brokerage services, both augmenting and replacing traditional library services.

When Fred Kilgour was establishing the concept of a bibliographic utility and a public Dialog system was still a gleam in Roger Summit's eye, the most advanced technology most libraries were using was the typewriter, the photocopy machine, and in Canada (as constant as the staff lounge and gossip), the electric tea kettle. Well-endowed central branches and reference collections might have had microfilm or microfiche collections, and some universities were experimenting with computer-based systems. Most of the automated library systems then in use were off-line, batch-processing, punch-card based systems

The early use of telecommunications in libraries was largely limited to TWX machines in dedicated networks and interlibrary loan applications Although by no means universal, many libraries had access to a main branch or cooperative system that would send interlibrary loan queries to other institutions. It was sometimes necessary to mail the requests to a central branch or regional center after they had been thoroughly documented from the originating library's local bibliographic resources. The regional center would then route the request to various resource centers using the TWX network One and a half decades ago, this was the only form of telecommunications that most libraries were using.

A Short History of Electronic Mail

It is important to establish our perspective on electronic mail in a historical context. Telex and TWX services are a direct derivation of the telegraph. On 24 May 1844, Samuel Morse demonstrated to members of the U.S. Congress and a gathering of officials and friends the first public telegram transmission, inaugurating a new age of communication technology. The first electronic message consisted of the quotation: "What Hath God Wrought!"—a quotation from the Book of Numbers chapter 23, verse 23 secretly selected for the occasion by Annie Ellsworth, daughter of the U.S Patent Commissioner. This auspicious choice of quotation has been underscored by Joe Ford in his keynote address to this conference. Other speakers at this Clinic have described efforts to establish control over vital telecommunications technology. As we wrestle with telecommunications complexity and the numerous choices we must make, especially in this era of deregulation and technological change, it is sobering to realize that in the middle of the last century Samuel Morse could not find a buyer for his invention because there was no commercial market application.

Today, 140 years later, electronically communicated messages and information are an integral part of world civilization. The synergistic interaction of computers and electronic communication create an environment in which virtually any kind of information transfer is possible. The increasing importance of electronic communications to individuals and organizations has resulted in thousands of companies, services, products, and options for electronic mail and messaging. However, this explosion of choice has also resulted in confusion, incongruency and unconnectedness. This twentieth-century tower of electronic Babel is both boon and bane, sometimes a channel but often a barrier to effective library communication

John Kountz has described the basic elements of the telegraph with his illustration of brother Tom at the backhouse and a coded signal over an electric wire. Using special wires strung between public offices, telegraph technology revolutionized commerce, journalism, warfare, and human perspective The telegraph was the first tenuous copper wire through the global village

In the United States, Western Union became a quasi-utility, sharing with the U.S. Postal Service an official mandate to deliver mail. In most other countries telegraph services were subsumed as part of the PTT, the official government department with monopoly control over post, telephone and telegraph facilities for that country.

As electro-mechanical technology was developed during the last century it gradually became possible to provide customers with dedicated machines with a unique number (or address) and to route calls through a switching center. Messages could then be electronically delivered directly to recipients equipped with their own telex machine. Telex is still the most common form of electronic mail, with over 3 million machines and numbers installed worldwide.

Using the five-level baudot code and operating at 6.6 characters per second in uppercase letters, the reliable telex machine can be found in virtually every country and continues to be a mainstay of business communications. The power of the telex is the worldwide availability and accessibility of the technology and service, combined with a high degree of reliability.

The maturation of the more sophisticated 7-bit code known as ASCII (American Standard Code for Information Interchange) enabled the transmission of a more extensive set of characters, including lowercase letters and special symbols. TWX service was introduced by AT&T shortly after World War II. TWX machines, also called teletypes, teletypewriters (or TTY), are still a common form of electronic mail in the United States. TWX service is available only in the United States and Canada.

Although TWX machines have a larger character set than telex machines, they still operate at relatively slow speeds—about 10 characters per second—and require a dedicated line. In recent years, Western Union and other international record carriers have made it possible for volume customers to access the telex and TWX services at higher speeds and in a dial-up mode through voice-grade telephone lines, although users are still charged for the delivery of messages at the slower network speed.

In addition to becoming a domestic U.S. communications standard, ASCII TTY communications protocols were adopted for computer communication by most major computer companies except IBM. ASCII communication codes were adopted as an ad hoc standard for general-purpose, dial-up terminal access. Today there are other, more specialized and higher-speed protocols and technologies for computer communications, but ASCII remains a basic standard for a wide range of computer and electronic mail services.

When computer operating systems that could execute several programs simultaneously were developed and it became possible for several user jobs to time-share the same computer system resources, it also became necessary for the various jobs (users) to communicate with the central console (operator), to request tape loads and other special handling. When systems began supporting several users at remote locations—particularly end users involved in interactive applications—the operating systems were enhanced to enable the users at remote sites to type and exchange general-purpose messages with the console operator.

But if a user could send messages to the computer operator, why not to other system users? Many time-sharing services and large operating systems evolved primitive messaging capabilities that enabled users to talk directly with other users or leave messages in a mailbox for a recipient to read at their convenience. These services became quite diverse in their operating characteristics and capabilities, but their utility led to the development of other, more sophisticated electronic mail services.

Computer-Based Message Systems (CBMS), have become so specialized that entire computers are now devoted to the electronic mail application. No longer competing for resources on large general-purpose mainframe computers with many different applications, CBMS and the electronic mail applications they support have become a new industry, blending computer and telecommunications technology in ways that impact modern society and its institutions, including libraries.

Electronic Mail in Libraries

In the library context, electronic mail and messaging services are becoming more prevalent in a variety of ways. The bibliographic utilities have moved closer to electronic messaging through the implementation of interlibrary loan subsystems. Originally limited to shared-cataloging applications, bibliographic utilities have been pressured to provide more functional capability, and interlibrary-loan messaging systems have been a natural result.

The trend toward increasing generalization and functionality of the systems we use has been referred to by previous speakers. This has been the case with online circulation and reference services as well as with bibliographic utilities, systems for other vertical markets, and personal computers. When users become familiar and comfortable with the systems they are using, they inevitably want more general-purpose capabilities. Rising user expectations should not be a surprise to the participants in this Clinic.

In the last few years there have been many developments in the application and implementation of electronic mail services in the library and information center community. Experiments with Telemail and Comet and the American Library Association's ALANET—implemented with the ITT Dialcom service—are examples. Several months ago Roger Summit announced that Dialog was developing a general-purpose electronic mail system (EMS), as well as a private packet-switched network

The CLASS OnTyme Network

In 1980, CLASS (the Cooperative Library Agency for Systems and Services) began receiving requests from the special library community for an electronic mail capability that could be used to exchange ILL data with other special libraries. Unlike public and academic libraries, these institutions were not traditionally included in dedicated TWX networks and many are not users of bibliographic utilities.

CLASS is a multitype membership-based library network operating under a mandate to achieve complete cost-recovery within five years of its inception. It was therefore important for the organization to examine and implement new services that could be used cost-effectively by any library. Electronic mail was an excellent opportunity to diversify the range of services being provided to members.

A cursory review of potential systems revealed the wide range of possible options that were available for EMS in the library community. It was necessary to select a service based on some rational subset of desirable features. There were several criteria used to select an EMS service for resale:

1. *Cost.* Most libraries have limited budgets. The cost had to be as low as possible and commensurate with good service and capability levels. It was vital that the service be as inexpensive as possible and also widely available, preferably through a local telephone call and a packet-switched network.
2. *Capability.* Although the specific application was for interlibrary loan data, an electronic mail service should be general enough to accommodate other kinds of applications, including the transmission of reference questions, contract negotiations, and committee reports. The system had to be effective with any kind of textual data.
3. *Flexibility.* It is important that an electronic mail system be responsive to changing user requirements. It should be possible either for the user or for the service supplier to alter the features and characteristics of a system that is intended for general communications. OnTyme was selected partly because it was a new product and the company personnel evinced a willingness to make the changes and enhancements their users wanted.

A closer examination of the service alternatives included demonstrations, cost-comparisons and negotiation with prospective vendors. Several options were immediately excluded because of cost and time factors. It was not practical to obtain a dedicated computer facility or to implement the EMS application on the CLASS minicomputer system. The OnTyme service from Tymshare was selected because it met the primary selection criteria and the company was interested in working with the library application and a resale agency CLASS and Tymshare were geographically close and personal communication was relatively easy. OnTyme was a new product that had not proven itself and was originally the responsibility of Tymnet, the Tymshare subsidiary that operates the packet-switched network.

Within a few months CLASS had established the first general-purpose EMS network for libraries and was meeting the requirements of the special libraries that had requested the service. CLASS became the first organization to resell electronic mail and acted as a secondary value-added network. Public libraries began to replace more costly dedicated TWX networks.

One of the most interesting aspects of managing the electronic mail network was the discovery of applications that were completely different from those originally intended. Information brokers began to use the service to communicate both with their customers and with their stringers and researchers at remote locations. Book jobbers began to use the system to accept and acknowledge orders. Publishers began to use the service to receive copy from authors and editors. Professional associations began to use the service to transact association business electronically, avoiding the time constraints and costs of using the post office and playing telephone tag

Another interesting consequence of the introduction of electronic mail was third-party resale of CLASS OnTyme. First the Pacific Northwest Bibliographic Center (PNBC) and then the Bibliographic Center for Research (BCR) began to resell OnTyme services originally provided through CLASS, becoming in effect, tertiary value added networks

Other speakers at this Clinic have mentioned the critical role that telecommunications play in the library and information center context. Electronic mail is not yet a complete replacement of the telephone, regular mail, telex or other forms of communication. But electronic mail can be an effective alternative for traditional communications, and can be a powerful tool in time and information sensitive applications.

Videoconferencing, interactive computer conferencing and the telephone are communication technologies that, along with electronic mail, will continue to influence the way in which we organize our work and deliver our services

EDWIN B BROWNRIGG
Director
Division of Library Automation
University of California

Packet Radio for Library Online Catalogs

The Problem of Wiring

The advent of online catalogs in libraries has resulted in a problem that could not have been foreseen when most library buildings were built—the need for wiring to transmit data between terminals and the online catalog. This problem is particularly serious in older libraries, where there are insufficient conduits, false ceilings are rare, and one faces the prospect of running cables through marble floors.

Installing such wiring can be costly. The experience of the University of California demonstrates that the cost of installing terminals in quantities of eight to ten may range from $8,000 to $12,000, not including staff costs. Even if the wiring for data communications makes up only half of this figure ($4000 to $6000), it is evident that the wiring can cost as much as or more than the terminal itself.

In addition, it can take months to arrange to install the wiring, and further, new wiring must be installed when the terminal is moved to a new location, making it costly and time-consuming to relocate online catalog terminals.

Packet Radio Technology

The University of California Division of Library Automation (DLA) is exploring packet radio technology—the marriage of radio and packet-switched telecommunications—as one solution to this costly problem. With packet radio, wireless terminals are possible—i.e., radio transceivers take the place of the usual data cables. A packet radio unit consists of a radio transceiver and a microprocessor that, when connected to a terminal or microcomputer, allows the device to send and receive data

Using packet radio for transmitting data to and from an online catalog avoids the expense of installing a cable for each terminal, and it also makes the terminals far more portable. Unlike terminals that communicate across a cable, a packet radio terminal can be installed very quickly.

Packet switching is widely used to route data through complex, long-haul telecommunications networks. It involves breaking the data to be transmitted into chunks called packets. The address of the data's destination is added to each packet, and the packet is then routed through the network until it reaches its destination.[1]

In a packet radio network in which a group of terminals are all communicating with a central computer's base station, the data packets, each tagged with an address, are broadcast by the base station to all terminals in the area. A terminal will recognize and accept only packets that bear its address. Packetized data makes sense in a radio-based terminal system not only because it is necessary to address data to the proper terminal, but because a number of terminals must contend for the broadcast channel across which they communicate with the base station. Breaking the data into packets makes possible the use of communications protocols that will avoid most data collisions, and will recognize collisions when they occur and retransmit the data packet.

A packet radio system operates simultaneously on one or, at the most, two radio channels or frequencies. This distinguishes it from cellular radio (a technique that is beginning to be used for mobile telephones), in which a large pool of frequencies is maintained with each caller allocated a frequency for the duration of the call's existence within a cell.[2] Packet radio has more in common with some recently announced hybrid systems such as Motorola, Inc.'s portable computer system, which features a handheld computer that can communicate with a remote computer by radio over a single pair of frequencies.[3] However, there are substantial differences in the two systems—Motorola's system has a hierarchical design that relies on centralized control and does not allow communication between terminals or portable computers except by passing the message through a central site. It is also designed to cover larger geographical areas than those covered by typical packet radio networks.

A BRIEF HISTORY OF PACKET RADIO

Military Activities

The military has been interested in packet radio for over a decade, primarily as a battlefield communications network that can be deployed rapidly, can quickly adapt to rapidly moving nodes (such as a terminal mounted on a truck or an aircraft), can avoid single points of failure, and is robust in the face of jamming or other interference. The development of packet radio began in the early 1970s with the University of Hawaii's ALOHA packet radio network, a watershed in the development of modern telecommunications protocols. The ARPANET, a large-scale wire- and satellite-based packet communications network developed by Bolt Beranek and Newman for the Department of Defense's Advanced Research Projects Agency (DARPA), had already been in operation for several years by then (the ARPANET was established in 1969). The ALOHA network was initially a single-hop system using no repeaters in which various devices such as terminals, minicomputers and graphics processors communicated via radio with a central computer. The protocols developed for the ALOHA network were later redefined and adapted for many other systems (see reference 4 for a description of the ALOHA network).[4]

After the ALOHA project, DARPA sponsored the development of a multihop packet radio network called the PRNET in the San Francisco Bay Area. The U.S. Department of Defense (DOD) is now working with second- and third-generation systems, and operates a number of testbed systems, such as the Fort Bragg Packet Radio Network. These feature very sophisticated, high-throughput, highly robust designs and equipment intended to support major networks under the most adverse circumstances; consequently, they are quite expensive.[5]

Amateur Packet Radio Activities

At the other end of the packet radio spectrum are amateur radio operators who have been experimenting for some years with very low cost, low-throughput systems. The first amateur packet radio network in North America was established in 1978 in Vancouver, British Columbia, after the Canadian government, seeking to encourage the use of packet radio, allocated a set of frequencies (221 to 223 MHz and 433 to 434 MHz) for packet and digital transmissions. The Vancouver Amateur Digital Communication Group (VADCG) soon began to produce and sell a packet radio terminal node controller (TNC)—i.e., a microprocessor combined with memory that allows a terminal or microcomputer to communicate via radio with other similarly equipped devices.

In 1980, in the United States, the FCC legalized ASCII transmissions, and in 1982 it removed many of the remaining restrictions on radio data communications. Since then, the Tucson Amateur Packet Radio Group (TAPR) has established a network and is now marketing its own TNC. Both the VADCG and TAPR TNCs can transmit at a data rate of up to 1200 bits per second using on-board modems (they can operate at somewhat higher speeds using external modems). These boards perform modulation in an audio subcarrier and do not include error correction. The digital side of the TNC includes a 6809 microprocessor operating at 3.6 MHz, a Western Digital HDLC chip, and a single-chip 1200-baud modem from EXAR. The board also includes 32K of ROM and 8K of RAM. Since the TNC is designed for use by ham operators, there is no radio on-board; most ham radios can be adapted fairly easily for use with the board.

Today there is much interest within the amateur radio community in packet radio. Amateur packet radio networks now in operation range from these local networks in Vancouver and Tucson to a national network that uses a system of repeaters. Several conferences on Amateur Radio Computer Networking have been held, and the Amateur Radio Research and Development group has issued preliminary protocol standards for packet radio networks.[6]

SPECIAL CONSIDERATIONS IN APPLYING PACKET RADIO TO ONLINE CATALOGS

The application of packet radio to library automation involves several unique considerations not well addressed by the current state of the art. First, current systems and the communications protocols developed for them have been designed to handle symmetric data rates: equal amounts of information are received and transmitted between any one station and another. Many library automation systems such as online catalogs, however, are highly asymmetric—about two or three characters are received by the host computer for every thousand characters it sends out to the terminal.

A second consideration is cost and its relation to the performance and reliability of the system. It may be possible to take advantage of the asymmetric data rate to achieve a compromise between the sophisticated and expensive military system and the inexpensive but somewhat unreliable amateur system. For example, one could use less expensive transmitters in the terminals where data speed is not crucial, and achieve a high data rate in the other direction by placing a high-quality transmitter in the online catalog's base station and sensitive receivers in the terminals. This would provide high performance while keeping costs to a minimum.

Finally, there is a special consideration involving repeaters and routing. It is unclear whether the ultimate library packet radio system will have to incorporate repeaters—devices that receive and rebroadcast a signal, making it possible to communicate over long distances. In many applications, one is concerned with networks that are limited geographically—

i.e., a building or a campus. If repeaters are used it will be necessary to explore different approaches to routing. Some compromise should be possible between the military system (in which the routing must adapt very quickly to fast-moving vehicles, node failures, and other drastic changes in network topology) and the amateur systems (in which the topology is extremely stable and there is not much concern for automatic selection of alternate routes)

DESIGNING A PACKET RADIO SYSTEM FOR LIBRARY AUTOMATION

The task of designing a packet radio network for a library automation application involves two basic questions: (1) What is the best way to share and manage a broadcast channel? (2) How should data be routed in a packet radio network large enough to require repeaters? A number of technical issues must be addressed in answering these questions. These issues are discussed briefly below.

Physical Characteristics of a Packet Radio Network

The first major issue involves choosing the right blend of transmission frequencies, transmitter power, modulation techniques, and antenna configurations for a given situation.

Frequencies

Unless one is transmitting at less than one-tenth of a watt, the broadcast frequencies must be allocated and licensed by the FCC. Virtually all packet radio systems operate at high frequencies which require line-of-sight transmission. The propagation characteristics of the frequency used will determine the cost of the transceivers. The frequency allocations will determine system bandwidth (capacity).

Modulation Techniques

This area encompasses two issues. The first is the method used to encode digital data into an analog signal so that it can be transmitted over a radio channel. This function is generally performed by a modem of some sort. It is important here to choose an encoding scheme that minimizes interference and maximizes bandwidth use. Some possible methods are

—frequency shift keying (FSK), in which a slight variation in frequency indicates whether a bit is a "0" or a "1";
—quadrature phase shift keying (QPSK), in which wavelengths at different phases represent different combinations of bits; and

—pulse code modulation (PCM), where binary digits are conveyed as the presence or absence of a pulse.

The second issue involves the method used to encode the analog signal into an analog carrier (the broadcast channel). Possible methods include frequency modulation (FM), amplitude modulation (AM), and frequency modulation using a single sideband (FM/SSB).

An alternative that involves both of these issues would be to use spread spectrum techniques which are very resistant to interference. Because interference tends to occur sporadically—either in short bursts, or centered around a frequency—spread spectrum acts to spread the data as widely as possible in order to minimize the amount of data destroyed by these bursts. Spread spectrum techniques can be applied either just before the digital signal is converted to analog, or as an extra input when the signal is encoded into the radio channel.

At the digital-to-analog stage, spread spectrum can be applied by incorporating pseudo-noise into the digital signal. Pseudo-noise is a stream of bits generated by a random number generator. For every bit of data to be transmitted, the encoding device will intermix a certain number of random bits into the data stream. The device receiving the data would use the same random number algorithm and the same starting point, allowing it to separate the actual data from the random bits. Spreading the data out in this manner reduces the probability that short bursts of interference will destroy data.[7]

At the analog-to-radio-carrier stage, spread spectrum can be applied by switching very rapidly among a number of different broadcast frequencies (called frequency hopping), with each frequency selected at random. Spreading the data across a broad spectrum of frequencies reduces the chance that interference on a specific frequency will destroy data.

While spread spectrum is ideal for library packet radio because of its great resistance to interference, the cost may be too high, and there are complex problems of synchronization between the stations that must be resolved. FCC licensing may also be a problem with spread spectrum modulation, although the FCC has recently indicated that it may deregulate the use of spread spectrum techniques.[8]

Transmitter Power

Transmitter power will determine the geographic area that the system can cover reliably, and the relationship between transmitter power, antenna configuration, cost of the transmitter, and the sensitivity (and hence the cost) of the receivers In addition to propagation in open atmosphere, one must consider the ability of the radio signal to penetrate into buildings

Antenna Configurations

Selection and configuration of antennas will depend upon the application. For indoor applications, long-wire antennas could possibly be run along the ceilings and up elevator shafts for the base station, and simple polarized antennas could be used on the terminal radios. For very short distances, infrared light is an interesting possibility. For interbuilding communications, a vertical nondirectional antenna might be used for the base station, with a vertically polarized yagi antenna of short length for the terminal cluster node station.

PROTOCOLS FOR A SHARED BROADCAST CHANNEL

The usual protocols for managing a shared broadcast channel are either some variant of ALOHA (standard or slotted), or Carrier Sense Multiple Access/Collision Detection (CSMA/CD).[9]

In standard ALOHA, transmission is done at any time, and the receiver sends an acknowledgment to the sender for each packet it receives. The sender detects problems if, after a given time interval, it has not received an acknowledgment from the receiver. The sender then delays for a random interval and retransmits. In slotted ALOHA, transmissions may only begin at the beginning of a time interval or "slot"; errors are detected in the same manner as in standard ALOHA. (This has implications for packet length size distributions if it is to make effective use of the channel.)

In the CSMA/CD protocol, the transmitter first listens to the channel to see if it is in use, and also listens while it is transmitting to detect collisions. In a network with repeaters (i.e., where every terminal cannot hear every other terminal), attempts to listen for collisions can be dangerous. A source node may be unable to hear a collision occurring at a destination node, or may "hear" a collision locally that the destination node cannot hear. There is also a problem, but a less serious one, in sensing if the channel is busy. There are a variety of proposals to resolve this such as transmitting a busy tone at higher power than standard data transmission, but they are all fairly complex. Another variant is straight CSMA, where the transmitter tests the channel to see if it is clear, but does not listen while it is transmitting. With CSMA, collisions are detected only when the receiver does not acknowledge a packet.

Simple ALOHA may be sufficient for terminal-to-base-station transmissions, given the low data rates for this channel. There are well-known analyses of all of these protocols in cases where the data rate is symmetric, but the extent to which asymmetric data rates affect these analyses is not entirely clear.

Routing and Repeaters

A packet radio network with no repeaters, in which a node can directly communicate with every other node, is called a "full broadcast network." In a full broadcast network, the network level protocol is fairly simple since there is no issue of routing. The simple act of transmission causes the message to be routed to any node that wishes to receive it.

Routing is only an issue if the network is large enough to require repeaters. Networks that require repeaters for end-to-end communications are called "semibroadcast networks." In semibroadcast packet radio networks, routing algorithms will be necessary in order to control the repeating of packets. A basic issue in routing is the choice between the virtual circuit approach or the datagram approach.

In the virtual circuit approach, once a route between sender and receiver has been established (by one of several different methods), that route is used for the duration of the transmission. The packets are sent and received in order. The virtual circuit approach has the advantage of being efficient once a route has been located, but it can also be time-consuming to identify and find another route if the established route is interrupted by, for example, an equipment failure. Virtual-circuit-type routing methods that select a wide path rather than a single set of repeaters can alleviate this, but such methods are difficult to implement.

In the datagram approach, each packet is considered an individual entity, and packets may travel in the network independently of the other packets in its data stream. Datagram methods frequently involve broadcasting packets throughout much of the network, rather than along a specific route, so that some packets will arrive at their destination via roundabout routes, and the same packet will often be broadcast a number of times. The datagram approach allows packets to be received out of sequence, and offers more flexibility and adaptivity than the virtual circuit approach. However, datagram routing methods can be fairly inefficient—i.e., requiring a great deal of system bandwidth to cope with the increased amount of traffic.

Routing in very large semibroadcast networks seems to be an intrinsically difficult problem, and remains an active area for research.

INTEGRATING A PACKET RADIO NETWORK WITH THE BACKBONE NETWORK

Packet radio is primarily a local technology. At the University of California, for example, we are viewing it as a means of providing access to the online catalog in certain campus buildings, or perhaps on an entire campus. Therefore, it must be tied to a more traditional long-haul backbone network—at DLA, the network linking the campuses across the state to the DLA computer center in Berkeley. The nature of this interconnection is somewhat dependent on the architecture of the long-haul network in question, and this section is oriented toward DLA's long-haul TCP/IP-based packet switching network described in reference 1, although many of the same considerations arise in connecting packet radio networks to any long-haul network.

The simplest means of integrating a packet radio network with a long haul network is to keep the existence of the packet radio network hidden from the long-haul network by simply plugging the packet radio network into the RS-232 interfaces on a terminal access controller (TAC), and having the packet radio network appear to the long-haul network as a group of terminals. While conceptually simple, this approach creates a mass of wiring and extra hardware at the TAC, since data from the terminals will have to be de-packetized and fed into the RS-232 interfaces, only to be re-packetized by the TAC. Also, it does not allow many of the sophisticated routing features that would be available if it were treated as a local-area network and became a formal part of the internet. Finally, it means that all users of the packet radio network must appear to the long-haul network as terminals, even when they are using computers, preventing computer-to-computer communication.

A second approach would still treat the packet radio network as an "invisible" network—i.e., not part of the internet. It involves building a specialized interface into the TAC in order to eliminate the extra cabling and RS-232 interfaces, and perhaps allowing the TAC to support terminals that appear to be passing data through an X.25 packet assembler/disassembler (PAD). This can in many ways be viewed as a more elegant version of the first method.

The final approach is to treat the packet radio network as an actual network in the internet. This is the most complex but also by far the most flexible approach. It involves two tasks. First, a gateway must be put in place between each packet radio network and the nearest interface message processor (IMP). Building such gateways is not trivial, as they implement a substantial amount of logic and protocol.[10]

The second consideration in treating a packet radio network as a true network arises in the end-to-end protocols that must be used. In order to gateway to the internet, the packet radio network must run standard Department of Defense Internet Protocol (IP) above whatever network-level protocol it uses. In addition, the higher-level protocols that are understood on an end-to-end basis throughout the network (normally TCP and TELNET) must be used on top of IP. The implication here is that either a packet radio TAC must be developed (providing TCP and

TELNET for packet radio clients) or each packet radio must effectively function as a "host" on the network, implementing TCP IP itself It might be possible to take both approaches a TAC or terminal server for simple terminals, with the option that intelligent hosts, such as personal computers, on the packet radio network could run TCP IP themselves and communicate directly with the gateway, allowing them to talk to hosts that are not on the local packet radio network. Some argument could be made for incorporating the packet radio TAC into the base station, possibly by modifying a standard TAC

NOTE This paper is a recapitulation of an article by Edwin Brownrigg ... a *Information Technology and Libraries* 3(Sept 1984) 229-41

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JOAN MAIER MCKEAN
Program Analyst
National Oceanic and Atmospheric Administration

Narrowband Teleconferencing

In the search to find new services to offer, new roles to fill, new functions to perform, and new needs to address, libraries are also sensitive to the *value-added opportunities*. What initiatives are taken must be done with the smallest possible increment of capital invested or operating budget. One such opportunity exists—narrowband teleconferencing. *Narrowband* refers primarily to electronic impulses sent over a twisted pair of copper wires—the familiar telephone system; *teleconferencing* refers to simultaneous communication of two or more parties using some electronic or radio wave form of signal transport.

Most people think of teleconferencing as the full-color, full-motion interaction on the "McNeil-Lehrer Report" or similar broadcast (broadband) television programs. The cost associated or the complex production techniques required are not considered at all. If one does investigate broadband teleconferencing, the cost and complexity are so overwhelming as to chill any latent enthusiasm for the result. It is not so much that people don't want to teleconference; but, unless they are part of large corporations which have adopted it into the corporate culture and use it by management fiat, they have had little opportunity to try it, much less budget for it.

Enter the people's university—the library. This institution has assets representing significant investments already in place which are prerequisites to teleconferencing—groups teleconferencing with groups—not merely one individual per site speaking into a handset. Public libraries are dedicated to serving *all* the public and are organized into systems, meaning that normal business channels of communication are well defined; they frequently host programs of public interest, have parking and restroom facilities, and are usually located along public transportation arterials or major highways Support functions such as online literature searching and business reference services are in place. If these services are well used, their clientele represent an obvious market for teleconferencing. It is a service which the business journals have hyped but which few small businesses have attempted to integrate into their daily routine due to the perceived high up-front costs. In addition to conferences, a strong secondary role for teleconferencing is teleteaching which permits professionals and small businesses to take training without the accompanying high cost of travel. Libraries always have had a strong if understated role in adult education. Teleteaching is a logical extension of this historic role

Since campus networks are already in place (the most noteworthy being under the auspices of Educom) the focus of this paper is on *public* libraries as sites for teleconferencing. Special libraries will follow the lead of their corporate or institutional structures. A curious exception to that pattern occurred in the late seventies when the U.S. Department of Education sponsored eight education-oriented telecommunications projects. One of these, Talinet featured the use of slow scan television and facsimile to demonstrate the efficiency of delivering sophisticated reference services to five remote public libraries in the Rocky Mountain Region—being impacted by the energy boom. Other libraries in the network included twelve federal scientific/technical libraries and a group of libraries in Maine headed by the state library. That network called Talimaine still operates. The lessons learned in this landmark experiment sponsored by the University of Denver Graduate School of Library and Information Management and the Federal Library Committee are documented in a series of reports available from ERIC Although sharing information resources rather than teleconferencing per se was the goal of the experiment, the organizational protocols, the budgeting, the need for more standardized equipment, and the difficulties of multitype institutions attempting to cooperate across regional boundaries are all factors to be dealt with today as they were then

Two promising developments have occurred in the hardware used during the Talinet experiment. The most important breakthrough in slow scan television is the development for the Defense Department of highly compressed video—which allows a moving image to be transmitted over a telephone line, a miracle created with microprocessors which code the picture so that it can be sent in electron streams and reassembled at the destination This technology, which is also referred to as the 56 Kilobyte-per-second Transmission, has reawakened interest in the Picturephone of the mid-sixties, which required more than one hundred telephone lines to create a picture, making the invention impractical except in rare circumstances Widcom, Inc , Campbell, California, has announced a VTC-56 desktop coder decoder called the PVS Personal Videoconferencing Station Introduced in 1985 for $17,500, it consists of a desktop console with speaker, color camera, two color monitors, a copy stand in color graphic transmission, and a keyboard/drawing pad to control the system.

Although the highly compressed "video-phone" service is not yet in mass production, it, like cellular radio, was only a dream a few years ago. It promises to revolutionize the way people communicate much like the personal computer and the work processor have revolutionized office work.

Along with compressed video has arrived another adaptation of this technique—the store-and-forward option in facsimile devices. Since 1978 the cost of sub-minute fax has dropped 50 percent and the hardware has become increasingly sophisticated in its options. Store-and-forward is particularly useful to libraries because items requested on interlibrary loan can be stored into the fax during the day and set to be transmitted at night when the telephone rates are lowest. This means that storing can be done in a batch mode by inexpensive personnel and forwarded automatically. The receiving machine tends itself. Most machines also print out the cost of the transmission as well for better budget control.

The slow scan hardware, in short, is due for a big change. The only question is how fast will the change occur and when should a library contemplate purchasing or leasing such equipment It is similar to the dilemma of when to jump into the microcomputer market. It is important to recognize that the *skills* organizationally and individually to use either technology once acquired do not become obsolete Nor is it possible to acquire these skills off-the-shelf or by intravenous injection. It takes *work*! Using teleconference hardware, while not so difficult as mastering a microcomputer, does take effort and dedication because there are many factors in success almost outside of the control of the individual site. It is not very different from using audiovisual equipment and dealing with those well-known gremlins

For those convinced that teleconferencing is a service for their library to offer, the conventional wisdom is to recommend a market survey The underlying assumption here is that the target population understands and recognizes instantly the product or service being surveyed In teleconferencing this is a rash assumption, unless the library is prepared to offer full-motion, two-way, interactive video The profile of narrowband teleconferencing has been very low, almost out of sight. For this reason the keynote is to *start small* and have the patience to allow the service to *evolve*. How then does one proceed to set up the service in a tentative yet positive way? The least expensive and the most familiar route is to install a speaker phone—one which will sit in the middle of the table in the staff meeting room The library director should begin using it for short staff meetings with other librarians in the system How is it possible to sell a service if one is not an enthusiastic user? A speaker phone of this type can be rented for less than $25 per month and does not require an acoustically modified room

If the audio conferences are useful and accepted into the normal course of library business, the next step is to add a visual dimension with facsimile—preferably sub-minute fax. These machines are now available for as little as $100 per month and can serve a variety of library support functions as well as to back up audio teleconferencing On a metropolitan telephone exchange, faxed messages are usually cheaper than surface courier or the U S mail Fax allows for less formally prepared messages—forms printed with felt-tip pen rather than typed, for example.

The machines themselves have logging devices and printouts The speaker phone and fax machine together provide a powerful organizational tool for the entire library system and for interfacing with other systems Planning can proceed in a natural manner in a series of short timely meetings as opposed to having people be away for hours or whole days from their normal duty stations for such meetings.

If this simple form of teleconferencing works well as an administrative device for the library, it is possible then to make it available to patron groups on a fee basis It is not recommended that more specialized devices such as slow scan TV or Telewriter CRTs or stylus writers be installed unless there is sufficient volume of clientele to justify these additions. Moreover, these are rapidly changing technologies that have not reached their maturity or potential Leasing is probably the best course of action even for fax equipment

Another adjunct to audio teleconferencing that can be had very reliably for low cost is the video letter—actually taping a meeting on color video tape at all sites, then sending the tapes via overnight mail This technique both reinforces the meeting while it is still fresh on the minds of the participants, tends to keep people more alert during the meeting, and archives the meeting. The units with the built-in recorder playback and monitor all in one are admirable for video-letter usage as they transport easily and are very easy to operate The video letter simulates broadband capability at a fraction of the cost.

In short, it is possible to test the administrative advantages of teleconferencing in a library setting with minimal cost In fact, some soft cost saving may actually accrue through better use of staff time and more productive time spent in meetings Teleconferencing has an important side effect—if a meeting is not well planned and well run, it becomes apparent immediately to the participants For this reason it is best to have short but well-planned meetings with handouts prepared in advance but also available for faxing. It is desirable to have someone ready to exit the meeting to obtain documents when the need for such arises during the meeting. It is not recommended that the expense of slow scan or compressed video be undertaken until all of the advantages of audio teleconferencing backed up by fax are fully understood, used and endorsed by the library staff. Then they will be in a position to promote the service.

There is a growing body of literature on teleconferencing. Recommended first reading includes:

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Robert Johansen. *Teleconferencing and Beyond: Communications in the Office of the Future*. McGraw-Hill, 1981, 185p.

Newsletters

Telcoms Teleconferencing Newsletter, Center for Interactive Programs, University of Wisconsin—Extension, Madison, Wisconsin, monthly. Circa 16 pages per issue. Note. C.I.P. also sponsors several conferences and workshop per year on teleconferencing.

Telescan, The Digest of the Center for Learning and Telecommunications, Ammerican Association for Higher Education, Washington, D.C. Bi-monthly. Circa 12 pages per issue.

One of the most experienced installers of teleconference equipment outside of AT&T is Pierce-Phelps Company of Philadelphia which has actual mockup teleconference rooms outfitted with the latest off-the-shelf equipment. They stock the Mizar, a system of voice-activated, computer-driven video cameras and monitors, such that the speaker can view both himself and the speaker(s) at the remote sites. This system, however, still requires broadband transmission, but would adapt to narrowband compression techniques. It is very expensive as well.

One final note—teleconferencing can be a low budget, high payoff adjunct to the library both for in-house use as well as patron use. It can bring groups into the library that previously made contact. It can open new educational opportunities for both library staff and patrons. Best of all, it places the library on the threshhold of a new era of long distance communication, personal networking, and group productivity. One of these days, when the video-phone is a cost-effective reality, libraries will wonder how they ever did without it.

DEBORAH K. CONRAD
Automation Consultant
Lincoln Trail Libraries System

Establishing a Data Communications Network: A Case Study

This paper is a description of the Lincoln Trail Libraries System (LTLS) Data Communications Network which was developed without the support of our computer system vendor by nontechnically oriented librarians. In order to explain some of the determining factors which resulted in the development of the Lincoln Trail automated circulation/online catalog system and the decision to develop our own telecommunications network without the support of the computer vendor, this paper will begin with a description of Lincoln Trail, its membership and a very brief overview of the history of the automation project.

Lincoln Trail is one of the eighteen library systems that serve libraries in the state of Illinois. It is a cooperative library agency which encompasses a nine-county region in east central Illinois. This region is 5,902.5 square miles in area and has a population of 439,108 people. The population density is 74 persons per square mile, compared to 205 per square mile statewide. Six of Lincoln Trail's nine counties have population densities below 48 persons per square mile. Its membership consists of forty-seven public libraries, five academic libraries, twenty-four school libraries and twenty-five special libraries. Of the forty-seven public library members, only 6 percent serve populations over 25,000. Thirty-nine public libraries (87 percent) are located in communities with under 10,000 residents, and 83 percent of the libraries are in communities with fewer than 5,000 residents. Thirty-four public libraries have an annual tax income under $30,000. Due to the fact that the majority of the public, academic and school libraries are located in low population density areas, their property tax bases are limited. Property tax levies are the funding source for these libraries. The result is that these libraries' expenditures are geared toward traditional library services and programs. Therefore, it has been the role of Lincoln Trail to support the establishment of innovative library services and to assist the libraries in maximizing their use of funds.

One of the primary responsibilities of any of the Illinois library systems is the processing of interlibrary loan requests both within their individual boundaries and between systems. In order to meet that responsibility, Lincoln Trail developed an in-house collection of books in order to fill the majority of interlibrary loan requests generated by member libraries. However, it would be impossible to maintain a large enough collection to fill all the requests from this collection. Therefore a union card catalog was established at the system headquarters. This union catalog was composed of card sets submitted by member libraries when they acquired new titles in their collections. All libraries were to notify system headquarters staff when titles were withdrawn from their collections. Interlibrary loan requests that could not be filled from the Lincoln Trail collection were then searched in the union card catalog and routed to the holding library. Lincoln Trail established a delivery system to route requests and interlibrary materials.

In 1976, a survey was conducted to determine the use of the Lincoln Trail collection and the completeness of the union catalog. This study showed that of the total collection, 65 percent had never been used, 19 percent had been used once, 8 percent had been used twice, and only 10 percent had been used more than twice. At the same time it was discovered that 20 percent of the interlibrary loan requests had not been filled within five weeks of submitting the request. A major problem in routing requests was the inability to determine circulation status. The study revealed that the system libraries were not keeping up with updating the union catalog. Lack of access to the union catalog by both the libraries and their patrons was also a hindrance.

Based on these results, it was decided to examine alternative methods for improving interlibrary loan service. In 1977, following a report submitted by a committee of the Lincoln Trail Board of Directors, it was decided to replace the union card catalog with an automated catalog circulation system and to invite member libraries to input their holdings and use the computer to record and process their circulation transactions. Lincoln Trail would then have current accurate data about the libraries' collections and would be able to route requests for on-shelf items. Members would also be able to search the system for Lincoln Trail holdings. In response to Lincoln Trail's invitation to participate in the computer database, seven public libraries and one academic library agreed to enter their collections into the database and use the computer system for circulation. Excluding the collections of the University of Illinois and Eastern Illinois University, these libraries represented 62 percent of the titles held in Lincoln Trail. The largest library has an annual circulation of 1 million items, an income over $1 million, a collection of over 200,000 items and a staff of twenty-four librarians The smallest library has an annual circulation of 21,118 items, an annual income of $15,258, a collection of 20,000 items, and a staff of one librarian It was our intent to use this very diverse selection of eight libraries as a demonstration to the other system members that automation could be an efficient alternative to traditional circulation methods for any type or size library In order to do that, it was necessary to ensure that the costs of automation be kept at as low a level as possible. This was particularly important because of the limited funds available to our members.

The three cost factors identified as having the greatest impact on participating libraries were equipment maintenance, retrospective conversion and data communications. The maintenance charges for the central site were divided among the online libraries based on their previous year's circulation. Lincoln Trail underwrote their share of the maintenance until they had completed their retrospective conversion. Each library would be responsible for their individual terminal maintenance. Lincoln Trail provided a subsidy to the libraries based on titles input which helped defray some of the retrospective conversion costs. During this initial phase it was assumed the computer vendor would provide the technical expertise to minimize communications costs.

Following the selection of the computer system, the project coordinator requested the assistance of the vendor in evaluating the equipment requirements for the eight libraries and received an estimate on the number of terminals needed by each library. The proposal stated that each terminal would require a separate telephone circuit and included a recommendation that Lincoln Trail contact the telephone company to get price quotes for line charges. While the central computer equipment was being installed, the project director called the local telephone company to obtain approximate costs for telephone lines to each of the eight libraries. The average cost was $350-$500 per month per library. It was felt that this would be unacceptable to the majority of the libraries and posed a serious threat to the success of the project. The telephone company offered the assistance of an Illinois Bell marketing representative Following several meetings, the telephone company presented three possible telephone line configurations These configurations were all based on multidrop lines with several libraries sharing a single long line circuit to which they would be connected with much shorter tail circuits The costs were considerably less than the original price estimate for a single line for each terminal connected to the central computer Using the information obtained from the telephone company, the project coordinator contacted the computer vendor. The vendor responded that neither the hardware nor the software were capable of supporting multidrop communication. Since the Lincoln Trail staff had no previous experience with data communications or computers, the information provided by the vendor was accepted without questions. Only two libraries out of the eight had the financial resources to absorb the estimated telephone costs. Since the original purpose for the installation of the computer was the development of an online union catalog, the participation of only two libraries was totally insufficient.

At the point when it was felt there were no alternatives, we received the aid of our largest academic library, the University of Illinois. At the same time that Lincoln Trail was beginning its automation project, the University of Illinois was implementing the Library Computer System (LCS) at both the Urbana campus and the two Chicago campuses. It had already been decided to expand LCS to include other academic libraries in Illinois. They were faced with even greater telecommunications charges than Lincoln Trail since that computer system was to be based in Chicago and participating libraries were located throughout the state. Therefore, the Lincoln Trail computer coordinator contacted the University Computer Services offices and requested information on how the data communication network for LCS was being planned. In response, we received information about telephone service which could be ordered through the State of Illinois. The state had contracted with Illinois Bell for a data circuit service called TELPAK, a service which provided discounted line charges. Any telephone line less than ninety miles long was a flat $90 per month. The furthest library was just under ninety miles from Lincoln Trail headquarters. It was decided to order all the telephone circuits with the exception of those located in Champaign and Urbana through TELPAK. The $90 per month charge was within the budget limits acceptable to the libraries.

Terminal equipment was then ordered from the computer vendor. The terminals which were ordered were to be used for data entry. None of the eight libraries had been OCLC users and the funds for contracting with a retroconversion service were not available. This meant each library would be required to manually key in all the bibliographic data contained on their shelflist cards. Realizing that under the best of circumstances this would be time-consuming and labor-intensive, the initial equipment specifications were for terminals operating at a minimum of 1200 baud or 120 characters per second in order to provide sufficiently rapid response time. After placing the first equipment order, Lincoln Trail was informed that the main computer and modems were incapable of a rate faster than 30 characters per second. Not having any alternatives, the timetable for data entry was revised to allow more time. The telephone lines were ordered to support 300 baud, two-wire service.

Before the terminals were installed, the vendor notified Lincoln Trail of a new communications device which had been added to their product line—eight-channel multiplexers. The multiplexers would enable a library to operate a maximum of eight terminals using one telephone line, all at thirty characters per second. Although the purchase price and monthly maintenance charge were high, two libraries decided to purchase the multiplexers in order to decrease telephone line costs.

Following the installation of the terminals and multiplexers a series of events took place that were critical to the decision to discontinue relying on the computer vendor for data communications needs. Six months after the terminals were in place, an analysis was conducted to compare the actual rate of data entry with the rate that had been projected. Even after making allowances for the slower transmission speed, the actual rate was much too slow. This was accounted for in two ways—terminal failure and central processing unit (CPU) downtime. The CPU downtime was resolved by having a complete set of spare parts placed at Lincoln Trail. The terminal downtime was a more difficult problem. When a terminal failed, the unit was shipped to the computer vendor. Instead of the unit being replaced immediately with an equivalent terminal, the library had to wait for the original terminal to be repaired and returned. This process could take up to four weeks during which time data entry was curtailed or discontinued, depending on how many terminals were still in place. Although Lincoln Trail felt that this was an unacceptable situation, maintenance was being paid to the computer vendor and there was no known alternative method of repairing the equipment.

Shortly after the analysis was conducted, the multiplexers began to fail. Again, when the unit failed it had to be shipped back to the vendor for repair. This was a serious problem because without the multiplexer, none of the library's terminals were operable. The multiplexers were located in two of the largest libraries with many titles to input. The project coordinator requested a copy of the operating manual in an attempt to do some on-site troubleshooting. This was not successful because no one on staff was familiar with data communications protocols and the equipment had been modified, making the manual inaccurate.

Another factor which resulted in the decision to develop our own network was the formation of an Illinois consortium of higher education institutions. Its purpose was to negotiate discounted pric[illegible]ll types of computer equipment and suppli[illegible]. As an affiliate of [illegible]rsity of Illinois, Lincoln Trail was able to become a member of [illegible]rtium and we began to compare consortium prices with those charged by the vendor. The difference was significant.

Finally, the vendor announced that the computer hardware could be upgraded to support 120 characters per second transmission. This necessitated the upgrade or replacement of terminals and multiplexers. It was decided to proceed with upgrading the central computer and to evaluate alternative sources for terminals and multiplexers.

By doing some cost comparisons it was determined that the terminals purchased from the computer vendor were five times the discounted price available through the consortia. Taking into account the purchase of a pair of modems, the consortium price was still 50 percent less. It was estimated that twelve months of vendor maintenance totaled the entire replacement price of a new terminal purchased through the consortium and that difference would become more dramatic over time, since the vendor's maintenance charges increased 10 percent annually. It was decided to discontinue purchasing simple keyboard display terminals from the vendor, discontinue vendor-supplied maintenance, and upgrade all the terminals transmission speeds. The libraries would pay Lincoln Trail a much reduced maintenance charge which would be used to purchase spare equipment. It was also decided to return the multiplexers for a credit on the central site maintenance and replace them with units that could be repaired locally.

As was stated previously, there was no one on staff with prior data communications experience. Therefore it was decided to purchase exactly the same type of terminal as that marketed by the vendor since it was known they interfaced with the computer. In addition, these terminals could be repaired locally at reasonable cost. Journal articles that reviewed and compared multiplexers were obtained and, based on these reviews and recommendations from the university's computer services office, it was decided to purchase units manufactured by a local company. These units were inexpensive and could be easily upgraded to accommodate more terminals without requiring total replacement of the multiplexers. The manufacturer was willing to perform on-site maintenance and provide replacement units if necessary.

The first step was to upgrade all the telephone lines to allow faster transmission rates. We then replaced all the terminals which could not operate at a faster speed. In order to upgrade the terminals that could operate at a faster speed, the modems were replaced. Although this was an expensive undertaking, money would be saved on maintenance charges and data entry rates increased.

It was at this stage that the first major problem was encountered. Prior to this, terminal equipment supplied by the computer vendor had been installed by their service personnel. The principles of installing terminals were understood by the staff, but not the actual method of installation. Since the computer and modems all required RS-232 connectors, this meant Lincoln Trail staff now had to know what wires on the data cable were soldered to what pins of the RS-232 connector. The pin assignments varied with the terminal model The vendor terminals had been modified so that they required nonstandard pin assignments The terminals connected to the multiplexers required still another pin setting. The off-the-shelf terminals required a third arrangement. Since the principles of RS-232 were not understood, the logic for why some pins were used in certain settings was not understood. In a trial-and-error method, several terminals were installed. However, it was extremely time-consuming and frustrating for both the libraries waiting to have the terminals installed and the staff trying to install the equipment. If the equipment did not work at installation, the staff had no way of knowing if it was the terminal, the modem or the telephone line. Multiplexers caused even greater confusion. The problem was solved by the project coordinator who installed one terminal in each type of situation, trying different pin assignments until one worked. A chart was then made which outlined the color wire that needed to be soldered to each pin for different types of terminals. Although the wire colors have no real function in establishing the communications connection, it was a simple means for the staff members to remember how to install a terminal.

There is another kind of connection that needs to be made before the communications link is complete. The cable that carries the incoming and outgoing data between the modem and the telephone line needs to be properly attached to the telephone interface device. Each data circuit consists of four wires—two for incoming data and two for outgoing data. Typically, the telephone interface consists of a small box at which point the four wires terminate. Each wire is color coded and is wrapped around a screw in the interface box. Each screw has a symbol next to it which indicates the color wire from the modem's data cable that needs to be placed on top of the incoming telephone wire. Supposedly, if the person installing the terminal correctly matches up the colored wires the connection is made. This connection needs to be made at both the terminal site and the central computer. Unfortunately it was not that simple.

There are four different telephone companies in Lincoln Trail's nine-county area Each of the four telephone companies uses a different type of termination box although the principles are the same for all four types. Two of these companies provide service to areas that are primarily rural and therefore have had very little experience installing data circuits. This resulted in servicemen from the telephone companies being unfamiliar with the proper installation of the termination box therefore making the color coding unreliable This complicated the situation for the Lincoln Trail support staff responsible for installing the equipment and slowed down the installation process.

Rather than waste time trying to bring logic to an illogical situation, the project coordinator contacted the multiplexer manufacturer. The multiplexer manufacturing representative recommended the purchase of a telephone handset with test leads in place of the standard cord. The leads could be held up to a pair of termination screws and if there was a tone from the computer it could be heard over the telephone. Then the LTLS staff member would then know what wires from the modem to connect to what terminating screws.

Based on this success, we began to rely less on guesswork and more on the advice of local vendors. Also, on recommendations from local business and representatives from the University of Illinois, we began to develop a supply of professional tools with which to install the equipment and troubleshoot equipment failure. We stopped soldering connections and bought a terminal installation kit which allowed the Lincoln Trail staff to perform the installation quickly and be assured of better connections. The soldering procedure had involved two staff members and frequently the connections were not solid. We began to buy data cable in 500-foot reels which was sold to the libraries on a per-foot basis when they had equipment to be installed. One library purchased a printing terminal which they wanted to have connected to the central computer. This required an entirely different pin configuration than any of the previous terminals. After contacting the vendor who sold us the terminal installation equipment, we leased a breakout box for an afternoon. The breakout box told us exactly what pins need to be connected and the terminal was operating in less than two hours. As the staff spent more time working with the equipment, they began to want more information about the basics of data communications. The multiplexer manufacturer sent a service representative to give a presentation on the basics of telephone service and troubleshooting telephone problems. In addition, two videocassettes which explained the basics of RS-232 and the operations of a breakout box were leased. Staff members were then able to read and understand the equipment manuals before installation and decide how they needed to be configured.

As we became more successful in installing and maintaining data communications equipment, the network became more sophisticated. We now have many different brands of video terminals and printing terminals in our libraries. The choice of terminal depends on the application and availability of local service. With the divestiture of AT&T we became concerned about the stability of TELPAK, and began recommending that all libraries with more than one terminal consider the purchase of a multiplexer. We now have multiplexers ranging in size from sixteen-port units to two-port units. The largest libraries recover the costs for the multiplexers in ten months while the two port units reach the break-even point in fifteen months. We are currently installing microcomputers in smaller member libraries. The microcomputers will be used to record circulation transactions on a floppy disk which will be downloaded via a WATS line on a daily basis.

Telephone and equipment costs have dropped over the past two years. In 1981 telephone costs were $1270 per month to support twenty-eight terminals. In 1984 telephone costs ar [illegible] per month to support eighty terminals. With the exception of laser scanner terminals and lightpen terminals, all equipment is maintained locally All malfunctioning equipment is replaced or repaired within twenty-four hours.

There are still two outstanding problems—i.e., dealing with local telephone companies and setting up a consistent procedure for each type of equipment in the field. Of the two, the telephone service has been the longest-lasting problem. As stated earlier, there are four telephone companies in our area. Because all of the service originates in Champaign, the telephone service is ordered through Illinois Bell. Until 1 January 1984, whenever there was a problem with a telephone circuit we had to call Illinois Bell. Then the Illinois Bell staff had to contact the local company where the library was located and work with their staff in correcting the problem. One telephone line was out of service for five days while Illinois Bell and the local company tried to determine the problem. Finally an Illinois Bell representative traveled to the local company switching center and discovered the problem—the circuit had been disconnected. It was back in service five minutes after the problem was discovered. Of seven data circuits installed in 1983, five were installed incorrectly and required at least one return visit before the problem was resolved. Since January 1984 we have faced even more confusion. For some circuits we call Illinois Bell, for others we call AT&T. When we contact AT&T with a problem, they are sometimes slow about contacting the local telephone company to dispatch servicemen. The second largest library was without telephone service for three days because the local telephone company dispatched only one repairman where two are required to thoroughly test a line. When he could not find a problem the account was closed even though the problem was not resolved It required three more calls before two servicemen were dispatched. Again, they found the problem in less than thirty minutes and the library could begin using the system immediately afterward In response to this, we have been purchasing more sophisticated multiplexers and modems that have greater testing capability. With this equipment we can perform a number of tests at Lincoln Trail before calling the telephone company resulting in faster response from the telephone company.

Because there is such a wide range of equipment in the field, both local library staff members and Lincoln Trail staff members were experiencing trouble spotting problems simple enough to be repaired either at the library or at Lincoln Trail. In response to this, we are now completing a checklist specifically for each brand of terminal and multiplexer used at Lincoln Trail. Each library will receive a copy of the checklists for the equipment which they own. These checklists outline steps they can perform to try to correct the problem. Lincoln Trail will have a different checklist consisting of steps to take after the library staff has tried to resolve the problem. It is hoped that this will be a simple, consistent method of determining causes for equipment failure, thereby enabling us to resolve the problem in a timely fashion.

Although the network has expanded over the past three years and member libraries have saved money on telecommunications, equipment and maintenance, we do not feel that we have the perfect solution. Over the next year we will be investigating more sophisticated methods of eliminating or reducing data communications charges. Some methods that are being considered include shared lines with other state or local agencies, more effective use of dial access for smaller libraries and cascading multiplexers. It is very likely that we will have to sacrifice some response time for lowered costs, but if TELPAK is discontinued this will be our only choice.

If someone were to ask me if the original decision to forego vendor support of our equipment and data communications needs was the correct decision, I would have to reply that it was very appropriate for us at that time. First, there was an operations staff responsible for maintaining and running the computer. It was a logical extension of their job descriptions to include equipment installation and maintenance. This meant it did not require hiring additional staff. Second, because member libraries are small and have limited funding, it was absolutely essential that costs be kept at a minimum. By taking advantage of price discounts from local vendors and state purchasing plans, we were able to ensure that libraries could afford to automate. By having equipment maintained and repaired locally, maintenance costs were kept at a minimum and equipment downtime eliminated. Because we were not limited to the vendor's product line, we were able to buy more flexible, powerful data communications equipment that was suitable to a wide range of libraries. Finally, although Lincoln Trail staff members did not have sophisticated technical backgrounds, we were able to locate people in the area who did have the knowledge we required. At that time the staff of the computer vendor did not have the skills we needed. A major disadvantage was the amount of time we spent obtaining the expertise to maintain the network. The end result has been a computer system that will be used by twenty-three libraries within the next year—almost 25 percent of our members. It has become a viable option for all types and sizes of libraries and has allowed all of them to consider automation in their future.

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