Library Use in the US of Computers, Networks, and Broadband: an evolution, a retrogression?

B.R.I.E. / Berkeley Roundtable on the International Economy,
University of California, Berkeley
Institute of International Studies
Working Paper 59
September 1992

Jack Kessler
kessler@well.sf.ca.us

Introduction

The concern here is to assess the use by US libraries of computer network telecommunications technology. This library use can be viewed as a specific application, in the information fields, of the general capacities promised by the US Internet and other networked telecommunications systems.

A brief history of the libraries' encounters with the technology thus far is presented. Some analysis is made, then, of the library applications, both as intended and as actually performed. Conclusions are drawn, finally, regarding the libraries' responses, thus far and perhaps in the near future, to the changing technology: conclusions about both the libraries and the technology. Statistics will show that library applications have been and will continue to be a large and increasing factor in US telecommunications traffic. The suggestion also will be made, however, that information principles and professionals drawn from traditional library disciplines will have a central role in emerging non-"library" applications as well.

There are difficulties within the current numbers, however. The most significant of these is the question of the number of users. Patterns of use change. The dime-novel lending library user of the 1800's cannot blindly be equated with the online data-searcher of the 1980's, nor can the rare book scholar-user be equated, in any given period, with the schoolchild doing her homework using her local library as a warm, convenient study hall. Different users use libraries in different ways, and, over time, shifting use patterns can disguise trends. Aggregate use figures, even compared over time, can cloak shifts among different library resources, and massive shifts toward and away from library use altogether can be entirely overlooked.

The suggestion here is that library use during the last several decades has made just such a massive shift, in this case away from traditional concepts of "the library". The catalyst for this shift has been the computer. The irony is that the computer has been developed to provide precisely the type of access to information promised by traditional library work. Today, developments like high-capacity networks and broadband communications offer physical access to data to average users on a level never dreamed of by the inventors of the paper-and-cardboard book or the library card catalog. And yet intellectual access to that data appears to be impeded, by its lack of organization and by the inability of average users to find useful information within it.

Ineffectual hand wringing too often characterizes the response of the profession traditionally concerned with the organization and provision of information, the library community. It also too often is the reaction of "information-overloaded" users. It perhaps is the result of the recent history of the interaction between libraries and the computer.

1.00 History and underlying quantities

1.10 The 1970s: millions of books

The problem of the 1970s for libraries was the same problem which libraries always had confronted, that of documenting the existence of large physical collections of paper books and journals. The information sought by users was contained in books and journals, there were a great many books and journals, and librarians occupied themselves as they always had with indexing and classifying these myriad materials so that they might be retrieved for a user easily.

The computer arrived in libraries during the 1970s much as it arrived in most businesses: through the back office. A typical business-office progression for computer applications of the time was from the desk of the assistant bookkeeper to the desk of the bookkeeper to a systems office that handled little more than general accounting functions. The computer was considered a calculating machine -- a device for adding, substracting, multiplying and dividing numbers -- and logically was connected, in the minds of its proponents as well as others, with financial accounting functions. Nowhere, in the 1970s, was there made the serious suggestion that managers might use computers for decision-making. The "what-if" scenario was in its infancy. The ideas that the computer might store information, might be used for communications, and might one-day change the entire organization, were for the most part far away.

One non-financial computer application that did arise in the 1970s, however, was inventory control. Businesses with large inventories of plant, equipment or merchandise – particularly those with inventories characterized by large numbers of units and large turnover activity, like merchandisers and parts suppliers, rather than those with just large amounts of a unit -- immediately saw the application of early computer capacities to inventory control. It was easy to make the association: any records kept in large amounts of numbers on ledgers seemed appropriate for the computer/calculating machine, so payroll, sales and credit history, taxes, and inventory control made the shift from ledger sheet to tape or disk early on.

Libraries were not unlike businesses, in that they too had back offices and accounting departments. It was in those back offices, in larger libraries, that computers made their first appearances, for accounting functions much as they had in general business offices. Book warehousing, however, was a major activity of the traditional library, so the transfer of inventory control to the calculating machine was a logical next step for libraries as it was for inventory-heavy businesses. Acquisition and circulation functions were tied to inventory control, so records of both "vendors" and "customers" quickly became tied to the inventory tracking system in libraries, just as they did in general merchandise businesses.

The more difficult next step for both businesses and libraries, though, was to use the information stored on the computer more actively. This was a giant conceptual step for both types of institution. Resistance came both from short-sighted individuals who protested that the static, essentially-archival information already was as used as it could be, and from individuals with perhaps greater vision but less courage who resisted by asserting that information use, much less decision-making, always had been and therefore always would be characterized by an irrational component, not necessarily devoid of but definitely not the product of mechanical number-crunching. The transition occurred, but it was not a smooth one.

Early business accounting applications merely transferred hand-entry procedures to the computer: computer spreadsheets looked like ledgers, computer payroll records looked like payroll books. Individual, independent functions initially each had their own, separate application -- reflecting prior, pre-computer, office arrangements and procedures -- with relatively little effort made to combine or relate one function to another, using the computer. This was as true of libraries as it was of other computer users.

The arguments against extending computer applications into decision-making finally were defeated in the general business-context by the "what-if" scenario, the leading sales argument for computer marketers of the 1970s, which said that a manager now could project and weigh alternative futures much more easily using the computer. The ability this gave junior managers who had learned computer techniques -- to dazzle senior managers with numerical analyses of business problems, and then become senior managers themselves no longer in need of junior management for collecting and processing information -- contributed greatly to the managerial revolutions of the 1970s and 1980s in US business.

Libraries also used the "what-if" scenario, and were as susceptible to its use as a sales-pitch in the 1970s as were other computer users. Library managers gradually, reluctantly, embraced the idea that financial decisions, at least, might be aided by looking at computer-generated alternatives. But the real library automation advance of the time, to the full use of computer capacities by libraries, came in the production of lists.

The generation of lists -- lists of books, of authors, of journal titles, of subject classifications, of borrowers, of potential donors -- has a time-honored role in the history of libraries. The earliest library records were simple lists of collection contents. (The earliest "catalog cards" were notes written on the backs of playing cards, in inventories made during the French Revolution of noblemen's "liberated" book collections.)[1] Bibliography, a primary activity of modern librarians, although it can extend to detailed analysis, begins and often ends with a list of books. Reference work, another traditional library activity, all too often consists merely in the provision to users of lists of sources.

Cataloging and classification, still taught as the fundamentals of the professional education, have been two basics of library activity. "Cataloging", traditionally defined, has been the making of a list of books. "Classification", also traditionally defined, has been the maintaining of a list of the categories under which those books are to be organized within the library. The provision and interpretation of both to the user -- of the list of books in the library and of the list defining their organization -- has been an essential part of traditional library service.

Libraries were not the only computer users who grafted their old procedures onto computer applications during the 1970s, in the process neglecting to develop the full potentials of the new media. Business users who simply transferred hand-entry ledgers to computers were taking the same route. The difference for the library perhaps was the vested interest that the librarian had in the production of the list itself. The business ledger was but one of a number of tools designed to secure the ultimate business goal of profit. The production of lists, however, was itself the primary goal of the librarian's activity. As such, the suggestion here is that the mystique of lists to a great extent blinded librarians during the computer revolution which was to

[1] Lucien Febvre and Henri-Jean Martin. *L'Apparition du livre*. Paris: Editions A. Michel, 1958), trans. by David Gerard as Geoffrey Nowell-Smith and David Wootton, eds. *The Coming of the Book.* (London: NLB, 1976).

take place in the 1980s and 1990s, a revolution dependent largely upon the ability to see entirely new applications of traditional activities, and entirely new activities themselves.

During the 1980's, businesses discovered the virtues of marketing their information systems, in some cases independently of their traditional activities, and in a few cases so successfully that the new marketing replaced the traditional activities. One notable example among many others of the latter was telemarketing, which revolutionized retail and in many cases entirely replaced traditional storefront marketing, in a process very much the product of the 1970s' computerization of office records and the development of information systems. Libraries' difficulties in making this same sort of transition stemmed largely, it will be seen, from their close association with a tool -- the list -- rather than with the end product of the process of which they were a part. The knowledge gained by the user was less important to the librarian than was the provision of various library lists. The great improvements in the potential for list making brought by the computerization of the 1970s may well have been a distraction which impeded further improvements in library computerization during the 1980s and 1990s.

1.20 The 1980s: millions of records

Just as the library computerization problem of the 1970s had been that of documenting the existence of collections, so the overriding problem of the 1980s became that of coping with the vast amount of documentation information produced by the 1970s' efforts. The lists were put on the computers during the 1970s. By the 1980s the lists were too long, and there were too many lists.

The first great 1980s development, beyond the mere data-loading of the 1970s, was the elaboration of relational databases and other techniques designed to take advantage of the more advanced features of computerization. Cross-referencing, indexing, and authority control, among other traditional functions of library lists, began to be automated.

Cross-referencing was accomplished in the eras of handwritten and printed lists with physical indicators, such as signs on bookshelves and additional cards in a card catalog, indicating that a user should check some other place, and written indicators, the famous "see" and "see also" references -- understood by every librarian, misunderstood by many users -- sketched into every library list. Computers in the 1980s came to be used for making such cross-referencing automatic, more and more "invisible" to the user. Programming established links

between one entry and another, such that if a user consulted the first entry, other related entries automatically would be produced.

Indexing, likewise performed and used by hand in previous eras, was automated during the 1980s. Both the assignment of index terms and the retrieval of documents using those terms were transferred in large part from human indexers and searchers to computer systems. Some of the most fruitful explorations of artificial intelligence and expert systems applications were begun during this period, with the investigation of automated procedures for building term-indexing systems from full texts, in library contexts.

Even authority control, a hallowed province of the library professional -- who thereby alone could dictate whether an entry under "Twain, Mark" or "Mark Twain" or "Clemens, Samuel" was correct -- became more and more the realm of the automated system. Great thesauri and thesaurus-building procedures were elaborated, interestingly as much to satisfy the exacting demands of precise, dumb, "garbage-in/garbage-out" automated systems, as to assist professionals in managing the rapidly-growing mass of library lists.

The point of greatest significance for us here, however, is that work in the 1980s, in library computer applications, still consisted primarily in the refinement of the procedures for handling lists. Questions were not asked, too often or too loudly, about the wisdom of this concentration upon lists: whether they were a good way of structuring the functions to be offered to the library user, and whether there might be any completely different alternative. At the beginning of the decade there were few enough online lists to be analyzed. It was only by the end of the decade that the problems of the growth of a multiplicity of lists, and the growth of each list so that huge retrievals from it became unmanageable, began squeezing out other problems in the priorities of information retrieval systems design.

One of the other great computer developments of the 1980s was the emergence of computer-to-computer communications. Libraries took advantage of these innovations. Initially great "bibliographic utilities" were established: regional consortia of libraries wanting to pool their efforts in book and journal cataloging. Online catalog records, essentially duplicating the paper card catalog records which had preceded them, were assembled at giant centers possessing large-capacity computers, and then distributed to member libraries, for a fee, for tape-loading into member library online catalogs.

Online union catalogs -- large databases containing the bibliographic records of several member libraries -- also were assembled during the 1980s. Again, this was an extension of a traditional effort. The printed union catalogs of great collections such as the Library of Congress, and printed national bibliographies such as those of the major western European nations, had long been the prized possessions of any major library collection. These had been the results of monstrous efforts, occupying the work of compilers over many years, similar to the decades of effort which went into compiling the Oxford English Dictionary. Now computer capacities not only had made such an effort far more manageable, but computer communications were making it continually updateable, in theory at least.

An even more significant product of 1980s library computer work, than either bibliographic utilities or online union catalogs, however, was the development of the online public access catalog, or "opac". Few ideas have caused greater revolutions within the library profession. At first the idea was simply, hesitantly, to share the library staff's own internal computerized holdings records -- part of their acquisitions system -- with the users. In the UC Berkeley case, a few terminals connected to the back office computer were set up next to the main card catalog.[2] There were few ideas initially that the former ever would entirely replace the latter. The automated system, however, quickly was found often to be more accurate and always to be more up to date than the card catalog alternative. The automated system also enjoyed the additional allure of being "new". Gradually the new system became more popular than the cards. More accurate, more up to date, and already the instrument of necessity for the professionals at the library, the online system inevitably became the instrument of choice for the users as well.

Both bibliographic utilities and online catalogs demanded more standardization work, which saw literally an explosion in effort during the 1980s. Standards for "MARC", or "Machine Readable Cataloging", were developed by various agencies at all levels and in several countries. Default formats like the US Library of Congress' "LC MARC" or the British Library's "UKMARC" or the European "UNIMARC" only painfully emerged from a babble which included "CATMARC" (in Catalonia), "IBERMARC" (in Madrid), and "ICEMARC" (in Reykjavik). Authorities work also made great, painful strides, the lists adopted by default from the Library of Congress in the US meeting enthusiastic rejection by non-US users. Throughout,

[2] For MELVYL's early history, see Clifford A. Lynch, "From telecommunications to networking: the MELVYL online union catalog and the development of intercampus networks at the University of California." in *Library Hi Tech*, Issue 26, 7(2), pp.61-84.

the emphasis of standardization work in the 1980s was on finding one single "best" way of doing things, to use the centralization which seemed at the time to be the great advantage being offered to libraries by computerization.

A final revolutionary 1980s change was the gradual extension of the "opac" to remote users. Traditional card catalogs had been valued for themselves alone only by librarians: to users they had been merely an adjunct to a search for a book or journal – they were located in the library near the loan desk, and were consulted only "on the way" to retrieving the desired end-product book or journal. In public, school and special libraries such card catalogs might rarely be consulted by anyone but the professional librarian. During the middle of the decade, however, the development of the "pc" marketing concept -- the packaging of small portions of computer power and the selling of it to consumers -- suggested to the managers of opacs that the digital signals coursing through the channels within their system might be sent out over telephone lines, using modems, to remote "PCS". So the "public access" online catalog became accessible to a "public" which extended far beyond its own library building walls.

Perhaps the 1980s development of greatest significance for the library profession itself, however, was the advance of information retrieval techniques. As online lists extended and proliferated, the problem of using them to retrieve "relevant" documents became more and more acute. Large lists yielded too much. Cross-referenced lists yielded even more. Users searching for manageable amounts of information increasingly became distressed with what came to be called "information overload".

Initial efforts to manage information retrieval yielded even greater "overload" problems. The earliest information retrieval systems tried to improve searching using "Boolean" logic. Various descriptors -- author names, title words, subject terms – were tied to documents in databases, and searches were conducted by matching query descriptor terms with document descriptor terms using Boolean connectors: descriptors "x 'or' y", "x 'and' y", "(x 'or' y) 'and' z", and so on. Various problems surfaced, however. Users had trouble with Boolean formulas. The Boolean "and", which yields a set smaller than either individual descriptor -- "x 'and' y" is smaller than "x 'plus' y" -- conflicted with users' own logic, which equates "and" with "plus" and yields sets larger than either descriptor. The greatest problem was that of the "null set and overload": Boolean searches tended to retrieve either too much or nothing, particularly as

databases grew in size. Users increasingly became impatient with retrievals of 300 or 400 items when 3 or 4 were all they had sought.[3]

Later efforts in the 1980s tried at least to rank information retrieval outputs, according to the relevance of an item to the user. This was done again by matching descriptor terms, but this time ranking retrieved documents according to their degree of match with the original query. Terms even could be weighted according to their degree of importance for either the query or the document, in some models. Probability theory and signal theory were used to refine and in some cases redefine retrieval work. Gradually, some far-sighted individuals realized that a theory was being evolved which might be applied to information retrieval generally, a problem far broader than the retrieval of books from lists which had been the traditional concern of librarians.[4]

Information retrieval efforts in the 1980s were dogged, however, by two problems that continue to plague them in the 1990s. The first is the problem of relevance. Even for precise scientific literatures the mere occurrence of a particular descriptor term in either a query or a document is not necessarily indicative of its contents. That a paper entitled "Theory of Relativity" might have something to do with quantum mechanics is not a revolutionary idea to a modern thesaurus, but in 1905 an information retrieval system might not have made such a connection so easily.

Even less obvious are connections between term descriptors in queries and words used in the title, abstract or even text of the sought-after document. There is great variety in usage in such terms even within the same human language and even in a scientific context. So much greater, then, were the problems of linguistic precision and, ultimately, meaning and relevance, in information retrieval involving non-scientific languages. Librarians traditionally have avoided indexing or classifying fiction by subject for such reasons: non-fiction often can be thus characterized, but how to describe the subject matter of Shakespeare's "Hamlet" with a few index terms, or how to design an information retrieval search engine which would be able to find a Gertrude Stein poem containing the word "rose" by its subject? Occasional forays into multilingual indexing and retrieval further highlighted the linguistic problem. "Aspects humains", a precise term corresponding to a multitude of card catalog entries in a French legal

[3] William S. Cooper, "Getting beyond Boole." in *Information Processing and Management*, vol. 24, no. 3, pp.243-248, 1988.
[4] see Gerard Salton, *Automatic Text Processing: the transformation, analysis, and retrieval of information by computer*, (Reading, Mass.: Addison Wesley, 1988), and writings by Salton generally.

context, means nothing or certainly nothing at all similar when translated literally, as it usually is, into "aspectos humanos" in Spanish or "human aspects" in English. The story goes that, "The flesh was willing but the spirit was weak", once was translated into Russian and came back into English as, "The meat was good but the whiskey was bad".[5] Information retrieval based upon language terms has had its problems.

A major difficulty, however, was that information retrieval work in the 1980s confined itself largely to use of the lists which had proliferated early in the decade. Great refinements were made in the ability to use one list to improve the searching of another. Several of the techniques described above enable sophisticated users to improve searches within very large lists. Thesauri and authority lists and standardization such as MARC were used to discipline list contents so that several lists might be combined, and so that some searching might take place across several different lists. The search paradigm, however, still was that of the era which preceded the computer, that of the consultation of lists.

But gradually, toward the end of the 1980s, possibilities began to emerge for the use of computer network information that had only been science fiction dreams a few years before. Not only were all the relational and communication aspects of the technology vastly increased and made more generally accessible, but entirely new applications came slowly within reach. Libraries discovered that their own concern with providing access to bibliographic information quickly was being outdistanced by the availability of fulltext online. Just as the library community felt it at last was coming to grips with at least the problems, if not the solutions, to information overload of bibliographic citations, suddenly the full texts which lay behind the citations began coming online. Commercial and professional services were offering fulltext. CD-ROMs were appearing which carried fulltext. Library opacs, the original bearers of the bibliographic universe, began loading fulltext and making it available directly to remote dial-in users.

The information retrieval difficulties of using bibliographic data, already complicated, became immeasurably more so with fulltext. The difficulty with which bibliographic searches had been organized and standardized -- by massive, continuous efforts such as those which supported the MARC formats and AACR, the Anglo-American Cataloging Rules -- were greatly exceeded by the challenges of standardizing the full texts themselves: brave attempts to do so --

[5] A story first heard by this writer from Michael Buckland.

like that of the Text-Encoding Initiative,[6] using markup languages like SGML, Standard Generalized Markup Language -- were begun, but reached only a very narrow section of the academic community by the early 1990s, and were not yet applicable at all in the rapidly-expanding commercial fulltext marketplace. In the 1980s, though, at least the possibility that principles of information retrieval designed for bibliographic lists might in fact work for the texts themselves, a possibility considered only theoretically before, at last was becoming generally amenable to research and testing.

In addition to the somewhat logical extension of bibliographic searching to fulltext searching, though, came various types of non-text online access. The realization at last had arrived that many things besides text might be digitized. Digitization of visual images and digitized sound made headway. Old ideals of truly multimedia access to information began drifting more into reach than they ever had been before.

This convergence, in the late 1980s, of information previously stored and used on different media types, put the library community in a quandary from which it has not yet emerged. The beginnings of a major reaction against the new technologies were sown when the card catalogs -- the primary tool of the profession for nearly one hundred years -- were threatened and ultimately replaced by the computers, during the 1970s and early 1980s. Now a more serious threat had appeared: that to printed books and journals, the very commodities which many librarians -- and many library users and library funding sources -- felt libraries were in the business of purveying. A few brave attempts were made early on to distinguish the print medium from the text that it contained, and to assert that the province of librarianship, documentation, and of the new "information science" might concern at least as much the latter as the former.[7] The battle raged, however, on library staffs, in budget sessions, at professional meetings, and most of all at academic library schools, and remained still unresolved at the end of the decade.

How much more serious, at that time, was the reaction to the more extreme idea that libraries might concern themselves not only with text that was not in books and journals but with

---

[6] Association for Computers and the Humanities, Association for Computational Linguistics, and the Association for Literary and Linguistic Computing, *Text Encoding Initiative: guidelines for the encoding and interchange of machine-readable texts.* eds. C.M. Sperberg-McQueen (e-mail: U35395@uicvm.cc.uic.edu, u35395@uicvm.bitnet) and Lou Burnard (e-mail: lou@uk.ac.ox.vax, lou@vax.ox.ac.uk), doc. no. TEI P1, Draft: version 1.0, 15 July 1990. An online listserv e-conference is maintained for discussion of TEI issues: subscription to it is the best way of becoming acquainted and staying current with TEI issues.

[7] F. Wilfrid Lancaster, *Toward paperless information systems*. (New York: Academic Press, 1978).

information that was not even text. The idea, suggested seriously but not taken seriously yet by the profession, was that many of the organization and retrieval principles applied to printed textual materials might prove useful for non-printed and non-textual materials as well: maps, museum objects, satellite data -- the idea, at any rate, was that these soon might be digitized and might one day require some close attention in their organization and access.[8]

1.30 The 1990s: millions of texts

The 1990s dawned, then, in library and information studies as in other fields, before the problems of the 1980s had been solved. In 1990 and 1991 much active work was being done in the library schools to improve or replace the Boolean information retrieval systems of the 1980s, much improved theory was being applied to the problems of information overload of bibliographic lists, inherited from the 1970s, and great effort was being put in, in the profession and in the libraries, to applying computer, database, CD-ROM, and computer network technologies. The only problem was that, as before, the work was a little late.

The library computerization problem of the 1970s had been that of documenting the existence of printed book and journal collections. The problem of the 1980s had been that of coping with the great online lists which had appeared as a result of the 1970s' work. Just when the 1990s began addressing the problem of lists better, then, a new problem appeared. In place of lists there now increasingly were the original sources, the items to which the abbreviated entries in the bibliographic lists made reference.

Online fulltext is the most obvious example. By this writing (Spring, 1992) hundreds of sources characterized loosely as "fulltext" are available online, and many thousands more are in preparation.[9] Fulltext comes in various forms already, ranging from commercial databases to electronic conferences and journals to fully electronic libraries such as those planned for San Francisco and for the new Bibliotheque de France.[10] The commercial publishing markets, newly inspired by the success of the US "BabyBells" at shaking off their legal restrictions, are preparing for an entirely new era of commercial publication of fulltext via the network media. The most exciting, and most intimidating, source of online fulltext, though, is the coming flood of local loading: the ability now of anyone with a personal computer to publish whatever they

[8] Michael K. Buckland, *Library Services in Theory and Context*. 2d ed. (New York: 1988).
[9] Jack Kessler, *Directory to fulltext online resources 1992*. (Westport, Conn.: Meckler, forthcoming).
[10] *Bulletin des Bibliothe`ques de France*, t.36, no.5, 1991.

wish to whomever they wish, and as broadly as they wish, over the networks. This last is the dream of centuries of publicizers, near to being realized in the multitude of bulletin board and file transfer applications which have begun to crowd the networks: it is the nightmare of librarians, who have devoted those same centuries to helping people find and filter information, and now must reinvent their techniques for a networked world.

Less obvious than online fulltext, however, are all the other types of digitized information that increasingly are available. Maps, charts, diagrams, pictures, photographs, physical objects such as those stored in galleries and museums and warehouses, sound, touch, nearly any sensation which might be perceived by a human may be digitized and replicated in some form or another. This was a known fact to science fiction in the 'fifties and to information theory in the 1970s. But it is becoming a real-life implementation in the 1990s. As it becomes so, digitization presents real problems and challenges to those whom, like librarians, would like to organize, index and cross-reference common bodies of textual and non-textual images. What is the common reference point for a digitized image of Rembrandt's "The Last Watch", a digitized sound recording of Kenneth Clark discussing the same painting, and a digitized text of Horst Janson's description of it? It has been difficult enough to formulate separate description standards for art photographs, sound recordings, and printed texts; will it be possible to "unify" such standards into one which will serve all three, particularly so that the single unified standard will be useful for multimedia retrieval and manipulation of the visual, sound and printed texts?

Many challenges and problems attend this new flood of fulltext and images of the 1990s. Outstanding among them are those of its organization and the retrieval of its meaningful information by users. These are the same efforts that librarians, chiefly, undertook in dealing with information when it was contained in printed books and journals. Librarians also, in the early days of computerization, during the 1970s and 1980s, many times led the way in organizing and retrieving information then newly online. The question now becomes, however, whether they will be able to transfer their skills and experience to the broadly digitized formats of the 1990s. Information use in the 1990s not only no longer deals with the librarian's traditional tools, like the card catalogue and the flat-file booklist, but it also no longer is concerned with the traditional library medium, the printed book and journal.

The implications of such a radical departure from traditional information media extend far beyond the impact upon librarians and libraries. One effect, for example, is the problem of

designing an entirely new user interface, to replace that of the human user making inquiries of a human librarian, and perhaps even of a human eye scanning a printed page. Much work is being devoted to improving computer screens, both in their color and resolution and in their icon and inquiry formats, as for now at any rate the "vdt", or "Video Display Terminal", screen appears to be the site at which most user-system interaction is taking place. The latest adventures in the technologies, such as those of "virtual reality" -- in which computer simulations replace much of the visual, auditory and tactile sensations upon which users rely -- are being looked to for clues as to the future of multimedia presentation. Commercial ideas, such as that of the ubiquitous computer -- that computers, through miniaturization and declining costs, shortly will become omnipresent and unobtrusive in the workplace and home -- provide clues as to the usage patterns of online information that can be expected in the near future.[11]

Another 1990s question involves the role of the human intermediary/navigator: will this role diminish as user interfaces improve, or will it expand, as the interfaces are found lacking and users turn to human helpers in desperation? Still another issue addresses the potential tragedy of the self-destruction of the old medium, as much because of neglect and distraction of professionals now entranced by the new media, as it is the result of the acid paper problem that is its most immediate cause.

Many solutions have been proposed and already are under development, for these and other 1990s information questions. The technology continues to evolve at a pace that promises quick solutions to many of the user interface questions. High capacity networks such as the recently authorized US NREN, and high-resolution television such as that now being produced in Japan and in the US, promise much potential for improving the attractiveness and general quality of the transmissions that the user sees.

Standardization work continues and has increased, with large international efforts being devoted to formulating communications formats (like Z39.50),[12] text-encoding formats (TEI),[13] and standards in nearly every conceivable computer and networking field. One of the great

[11] Mark Wieser, "The Computer for the 21st Century.", in *Scientific American*, vol.265, no.3 (September, 1991), pp.94- 105, also, Andrew Pollack, "The Latest in Computer Couture.", in *The New York Times* (West Coast Edition), (March 19, 1992), p.C1.

[12] Z39.50 is a standard for telecommunications protocols for the exchange of networked information, being developed and promoted by an international effort. The best means of finding out about and keeping up with this rapidly-changing process is to subscribe online to the Z39.50 Implementor's Discussion Group list, by sending the e-mail message "subscribe Z39.50IW <your first name><your last name>" (without the quotes) to LISTSERV@NERVM.BITNET.

[13] TEI -- the Text-Encoding Initiative: see note 6, above.

challenges of the decade will be the extent to which such standards, worked out with such painful and meticulous care, largely by the academic community, will survive the transition to a networked world of commercial and private applications. Much effort is being devoted to preservation, as well. The acid-paper problem at last has struck home, as the collected wisdom of most of the 19th and all of the 20th centuries literally crumbles, used or not, on shelves in libraries, archives, businesses and government centers. It remains to be seen whether any adequate work will be done to preserve these records for the 21st century historian.

A few solutions already are emerging which are unique to the 1990s. Cooperative cataloging, for example -- the copying of the bibliographic records of one library, such as the Library of Congress, by another -- which spawned the massive bibliographic utilities of the 1980s such as OCLC, RLIN and WLN, may be dying a rapid death. Libraries have realized that networks such as the Internet now can give them easy access to each other's records. Regional consortia -- smaller, and hopefully much cheaper, versions of the 1980s giants -- are being negotiated to unite groups of libraries which wish to circumvent the large utilities' fees or policies. Optical character recognition algorithms are getting increased use for document retrieval, particularly in legal libraries where materials are nearly all textual and moreover are comparatively uniform in format and presentation. International network access, finally, is becoming a practical reality. 60 British library opacs were made easily available to the US Internet in March of 1991, bringing the total of Internet-accessible library opacs to over 200 by fall of 1991. (A user-friendly gateway, mapping the Internet's older TCP/IP to the UK's newer standard, was established. The UK previously had been available but only via a more complex, lower capacity gateway.) By fall of 1991, catalog usage and copy-cataloging negotiations had spanned the Atlantic.

Several unique 1990s problems likewise have emerged. One among these is the problem of archiving new media formats. If an historical record is to be preserved, some sample of the work of the 1990s must be archived, somewhere. But how to archive a multimedia presentation? What to do to preserve a 1990s virtual reality experiment for the enjoyment of 21st century historians? While printed text was largely still the means of communication, up into the 1980s, it still was relatively easy to preserve the communication even though the printed text at some point had been digitized: some printed version of it simply could be stored somewhere. Digitized images and sounds and touch sensations, and their combination into complex multimedia

presentations, are more difficult to store. The algorithms used to recognize and combine them are more complex than are those used for text. The hardware used in the process is more arcane and less likely to be operable by a 21st century technician. The entire problem is made vastly more complicated by the fact that much new media is designed to be interactive with the user. "Feedback relevance" increasingly is essential to the operation of even the simplest information retrieval systems: but how to record an event that relies on the participation of the user to make it happen? The dusty old machines operating on long-forgotten principles which one can find in a "Musee Mecanique " are not the point; rather it's the self-destructing mechanisms of conceptual "happenings" artists like Jean Tinguely[14] -- once they're over, they're over, they were unique and by definition could not be duplicated – which come to mind. The 21st century may have a hard time reconstructing what the 1990s were about, even using its digitized records.

The most crucial aspect so far, however, of 1990s development in library and information work, appears to be the arrival of the commercial market. The unleashing of the US BabyBells in Fall of 1991, added to the enormous work already done by the European PTTs, has provided a critical mass which may at last push the enormous commercial publishing industry, in the US, Europe and Asia, over into the use of electronic networks for distribution. This is a move which has been bitterly resisted in many quarters, a resistance which the move's proponents say is nothing more than the last gasp of the dying print medium, trying to protect its own monopolies.[15]

It took only two months for a wave of joint ventures and product and service demonstrations to be announced by the BabyBells, after the reversal of Judge Greene's restriction of their entry into information. In many cases the products and services were old, now outmoded, items dusted off quickly once the possibility of marketing them at last had been realized. But the catch-up process will occur rapidly. Joint ventures with industry leaders can fill the gap while leaving start-up risks largely in the other partner's hands, and in the current recession there is no lack of work-hungry engineers happy to show a giant firm like Ameritech or US West how they can develop their own in-house information systems.

---

[14] K.G. Pontus-Hulte'n, *The Machine: as seen at the end of the mechanical age*. (New York: Museum of Modern Art, 1968).

[15] Much animated discussion of these "BabyBells" events and issues has taken place in the popular press. A good discussion may be retrieved from the PACS-L e-conference archive (see note #28, below).

The significance for libraries and information service of this 1990s entry of the BabyBells, and of the associated entry of the commercial publishing market, into the world of networked information, is the flood of new information that it will produce. Whatever are the current figures on US library usage (see appendix), it seems safe to assert that they do not approach the service to the entire US consumer population rendered by the BabyBells and the commercial publishing industry. If the publishers succeed in purveying their wares, through greatly increased-capacity pipelines such as that promised by NREN, and over the vast distribution systems represented by the US telephone network, the flood of information usage will be far greater than anything ever envisaged by library designers in the past. If the entertainment industry adds its efforts on top of that, as appears to be the promise of universal digitization, ISDN, and numerous projects already under way in Hollywood, the flood may well deluge the networks, the users, and anyone attempting to organize or, possibly, to use it.

The challenge is to organize the flood. Natural organization will be achieved with saturation points, business fall-offs, failures, bankruptcies and recessions. It would be preferable if some sort of control might mitigate the worst excesses of these natural business checks. The question is whether the traditional information-organizers are up to the task in the case of these new media. Librarians only just succeeded in capturing their old lists on computers by the end of the 1970s, and information scientists had barely got going on really using those lists on computers before the 1980s had ended. In both cases the efforts came late: the communications boat was already leaving the dock, and it seemed as though the librarian or information scientist was the last to get on board. Now, in the 1990s, networked multimedia information seems about to descend upon an unsuspecting public in amounts massive enough to flood the public, bankrupt many providing firms, drown any efforts to preserve older media forms and the texts which they contain, and generally wreak a havoc in education, government, business and consumer in-baskets which will make the "information overload" cries of the 1980s appear laughable. If "reading the morning mail" was a problem in the 1960s, how are users to cope with the mail and the voice mail and the e-mail and the e-conferences, electronic bulletin boards, videotext, e-journals, and virtual reality decision-and-entertainment choices of the 1990s? Who will provide the standards, the filters, the navigation and the guidance this time around?

2.00 Distinctions made and not made -- analysis

Whoever is to be the standards-setter and navigator in 1990s information, they must be able to make two sets of crucial distinctions: 1) they must have a clear idea of the product which they are purveying, and, 2) they must have a clear idea of the client to whom they are purveying it. No business ever succeeded without knowing its product and its customer well. Few professionals stay solvent without maintaining standards and contacts with their clients. No industry or profession can protect its practitioners from the necessity of such knowledge for long: industries and professions that do produce the chimney sweeps and knife-grinders of the next generation.

2.10 The thing

2.11 The book or the record or the text?

The traditional library profession appears to have at least three separate products in mind when the question, "what are you offering", is asked:

1) The physical item in the collection -- the book or journal or archived letter or object -- is the first of the librarian's concerns. Great attention is given to the exact physical description of the item in some library quarters. Much devotion, and much budget, have been put into the preservation and conservation of physical items;
2) The bibliographic record of the physical item -- the card catalog record, or now the MARC record -- is a universe unto itself for many librarians. There is much preoccupation with the catalog and with cataloging -- its quality, its exact standards, its use by other librarians and by users -- so much so that interest in the books, journals and objects thereby represented at times appears to recede in importance;
3) The text contained in the physical item -- text in the loosest sense as including words, charts, photographs, maps -- the informational content of the item: a library product being shaken loose from its association with either the bibliographical record or the physical item by the current media revolution.

2.12 Confusion of goals

The quandary in which librarians now find themselves is largely the product of confusion of the three products mentioned above. Not that each of the three does not have its own rightful place in the world of libraries and information. If information is contained in books and journals, or for that matter CD-ROMs and computer disks, all these physical items must continue to be collected and preserved. They likewise must be cataloged and classified, and their informational content made available for access by users.

But great confusion seems to occur over the distinction between the text, as defined above, and the physical item (book, journal, object) or its bibliographic description. Much of the library failure to understand the problems and potential of computer applications described above stems from this confusion between text and the physical item in which it is contained or the bibliographic record which describes it. Computer designers have been perfecting systems that easily can contain and purvey text, but librarians have been looking no further than the use of these systems for containing records. Text in their minds has been equated with the traditional physical item, and the idea of its separation has been literally unimaginable. Users, on the other hand, appear not to care in what medium the text is contained, and so now go around libraries to other providers, like online resources, when the text they seek is more conveniently found and used elsewhere than in the library's physical items.

2.20 The users

One strategy, adopted in industry and in government but less perfectly among the professions, for determining the changing needs of clients, customers, and users, is to ask the user. Librarianship has considered itself a profession. This perhaps explains why librarians, like doctors and lawyers and accountants, have a reputation at least for not often asking their clients how their profession should be conducted. Such aloofness is sustainable only so long as the basic need for the profession exists. The alchemy, bloodletting, and scriveners' professions -- all once thriving and respectable -- no longer thrive. Some alchemists made the switch to modern science, however, a few blood letters became nurses or doctors, and some scriveners learned to type. The suggestion here is that those who didn't might have asked and listened better to their users. To the extent that librarians face such a fundamental revolution in the needs and demands of their

users, caused by the invention of online access to information previously best obtained in libraries, the profession might do more to survey and study its users.

2.30 Library and Information Service

An alternative approach to that which emphasizes library books and records and, for that matter, buildings, might be one which focuses on the function that the library is meant to perform. Michael Buckland's early concepts of "library service",[16] and his expanded idea of "information service",[17] answer the need for at least a theoretical recasting of traditional library activities in a more useful modern mold.

Buckland's intention is to free his profession from an unnecessary association -- in its own mind, and in the minds of outsiders -- with only one or two aspects of its general activities. The tendency to associate librarians with library buildings -- as doctors are not associated with hospital buildings, nor lawyers with courthouses -- is one product of the lack of clarity in this area. So long as the public, and information professionals themselves, persist in associating the term "librarian" only with "the person who works in the library building" -- rather than with some socially-useful function, as are doctors and lawyers and other professions -- librarians will find it difficult to extend their training and talents in finding and organizing information outside of the realm of finding and organizing information only in books, and users will be deprived of all the assistance which such training and talents in finding and organizing information might render. Similar associations in librarian and non-librarian minds link the profession exclusively to printed books, or to paper media, or to bibliographic citations rather than to the text that they describe and the function that the profession performs.

Buckland's suggestion is that a broader concept of information service might serve to broaden the exposure of traditional professional library information-handling techniques, which he firmly believes might be useful outside the traditional book library. To this may be added the observation that the networked world outside the traditional book library is badly in need of precisely the information-handling techniques practiced upon book-held information by librarians: techniques of classification, cataloging, indexing, abstracting, cross-referencing,

[16] see M.K. Buckland, note 8, above.
[17] Michael K. Buckland, *Information and information systems*. (New York: Greenwood Press, c.1991).

retrieval and organization -- to aid in the current problems of "information overload" and the general inability to find anything on the networks. It seems to be a marriage made in heaven, but both groom and bride -- whichever is which – are having difficulty finding their respective ways to the altar.

3.00 The effect of distractions

The indictment offered here, of the incapacities of librarians thus far in grasping the full potential of new computer and networking technologies, is perhaps no worse in the case of librarians that it is in the case of other professions and occupations in their own applications. The librarian's concern for physical books rather than for their contents, and for the making of lists, have parallels, for instance, in the many research questions of the medical profession: in both cases the activity is intended to serve a final product, and in both cases the end product -- getting information to users and making patients well -- is not necessarily served. The time for concern certainly arrives when the activity not only does not serve the end product but impedes its achievement. If medical research becomes so specialized, so arcane, and so expensive, that patients in fact are getting sicker as a result, perhaps the basic organization of medical research requires attention. Just so, if librarians' concern for physical books and for lists of bibliographic records becomes so distracting that they no longer get information to their users well, or get it there less efficiently than do their competitors from other fields, librarians may suffer the fate of a doctor who makes her patients sicker, or of the scrivener who offers her products to a typewritten world.

It might be best to view libraries' future plans for the computer and the networks in just such a skeptical light, to assess whether library plans for the application of the technology will serve library means or library ends. The term "technological determinism" now is in common use, to describe those whose sheer fascination for the buttons and knobs and glowing lights of the electronic technologies blinds them to the difficulty of applying the technology toward some ulterior motive. In the library case the ulterior motive is informing the user. It might be well to examine the current library technology program asking, throughout, the question, "Will this improve the provision of information to the user?"

3.1 Capacities, in the library context -- the current picture

3.11 Computer capacities

Computers -- laptops, PCs, minis, mainframes -- and local area networks are as omnipresent in libraries now as they are in most organizations in the US. Their presence is subject to the usual qualifications of budget and organizational style: less wealthy and more old-fashioned organizations have fewer, wealthier and newer or more up-to-date organizations have more. One suspects that the usual qualifications govern certain characteristics of their use: users may be primarily younger staff, although older staff may adapt to some functions better and may possess more computers or computer access by virtue of seniority; and back office-front office differences in style of use may be similar to those which exist in business and government settings (differences in use of in-house versus off-the-shelf software, in intensity of use, in use of laptops versus mainframes, and others).[18]

Library applications, moreover, conform to usual organizational computerization patterns: payroll and accounting functions normally are fully computerized, internal e-mail and e-communications (bulletin boards, organization-wide announcements, etc.) are struggling to get established, client records and any other numerical records most likely now are found on a computer, even a very small laptop, in most US libraries.

One difference to be found is in the great importance which inventory control still has in libraries, compared to many other organizations. This situation is not so different from the practice of auto parts suppliers, mass merchandisers (such as wholesalers or department stores), and other organizations for which inventory control is critical. Even a larger or wealthier library which makes its online inventory -- its bibliographic record catalog -- available to the public, as most who can now are doing, is not that different from commercial telemarketers who do the same thing: for both, an exact, standardized description of the item is important, up-to-date information regarding stock status is crucial, and access -- quick and easy information retrieval ability within the database -- is critical.

A further dimension is added, however, with the addition to the library picture of fulltext, and of digitized representation of the information contained in other objects (maps, photographs,

[18] Lee Sproull and Sara Kiesler, *Connections: new ways of in the networked organization.* (Cambridge, Mass.: MIT Press, c.1991).

"regalia"), as now is the common case with tape and CD-ROM loading into at least the larger opacs. A parallel exists in the practice of commercial telemarketers, who increasingly unify videotext, television, telephone, and online computer capacities to show not only abbreviated descriptions of their items -- corresponding to the librarian's bibliographic records -- but now also the full, very often moving, images of the items which they offer. In both cases questions mentioned above, of the design of the user interface and of the continuing necessity for human intermediaries and navigators, are raised. Commercial telemarketers would dearly love integrated multimedia presentations that might be piped in directly to customers' homes over the telephone lines; and they would love to eliminate the human telephone operators who currently handle orders. To the extent that they succeed in realizing either goal -- both are not far from being realized -- their success may create similar opportunities for libraries to purvey the "full" contents of their products directly to their own publics.

The looming problem for libraries, however, is competition, from the very publishers who currently use libraries as a middleman for reaching certain segments of the public. Librarians in the type of electronic library envisaged for the SF Public Library and the Bibliotheque de France may well be able, shortly, to show their patrons the full texts, and complete, high resolution, images of the contents of their collections, via computers, local area networks, and HDTV within the reading rooms of the library. But the broad public appeal of such a service will be questionable if commercial publishers are doing the same for potential library patrons in the privacy and comfort of their own homes. This aspect of the coming uses of technology by libraries appears now to be linked inextricably to questions of remote telecommunications.

3.12 Telecommunications capacities

The use by libraries of computer telecommunications capacities gradually has expanded, to include today four basic applications areas: resource sharing, "opacs" and information servers, professional services, and user services.

3.121 Telecom: Resource sharing

Libraries currently use telecommunications heavily for cooperative cataloging. When a new book or journal is added to a library collection, the option exists either to make up an

original catalog record for the item or simply to copy that record from some other reliable source. The standards for such records are elaborate. The "US MARC -- Machine Readable Cataloging" format, which specifies the fields, sub fields, and many other elements of such records, occupies three large loose-leaf binders of material for its basic text alone.[19] "AACR2 -- Anglo-American Cataloging Rules (2nd edition)",[20] the parallel standard for the content of the fields and sub fields put into MARC in the US and UK, is itself a complex, hefty volume. Beyond these two basic tools exist many long and complex lists used by the library profession for determining call numbers, subject headings, authoritative name forms, and other library cataloging features, all of them necessary if records are to be useful in the highly cross-referenced catalogs used in modern libraries. All this has meant that original cataloging is an elaborate and labor-intensive and therefore expensive activity.

The idea occurred to librarians, early in this century, of copying catalog records from some central, rigorous, authoritative source. In the US case, the Library of Congress distributed its own cataloging cards and its MARC format, for copying and use by US libraries, and the structure of these records became the default US standard. With the arrival of computerization, this distribution spawned the rise of distribution centers, designed to assume some of the load being carried by the Library of Congress. The three most notable centers were one in the northwestern states, the Washington Library Network, which became WLN, another in Ohio, the Ohio Colleges Library Center, which became OCLC, and a national consortium of major academic libraries, the Research Libraries Group, now RLG. These centers grew, developing cooperative cataloging involving member libraries as well as the Library of Congress, adding account service facilities for members, and finally mounting independent databases and services of various types on their large computers, until they became today's giant "bibliographic utilities". In 1991, the largest such utility, OCLC, handled 2,736,793 online inquiries per day, from its 13,847 member libraries, for its databases of over 21 million bibliographic records (see appendix).

Distribution methods of the bibliographic utilities have evolved along with the technology: from the original paper cards, to tape distribution, to disk formats, and finally to

[19] Network Development and MARC Standards Office, *USMARC format for bibliogaphic data: including guidelines for content designation*. (Washington, D.C.: Cataloging Distribution Service, Library of Congress, 1988-).
[20] Joint Steering Committee for Revision of AACR, *Anglo-American Cataloging Rules*. eds. Michael Gorman and Paul W. Winkler. 2nd ed. 1988 revision. (Ottawa: Canadian Library Assoc., Chicago: American Library Assoc., 1988). pp.677.

online access. At this point any US library which has a computer, even a back-office laptop for simple accounting, either has purchased or is about to acquire a modem for gaining access to online copy cataloging. The large utilities, moreover, offer dedicated terminals and service contracts to any library not inclined, yet, to plug in its own computers. Recently both OCLC and RLG's RLIN have become available over the Internet, and even through local library online catalog interfaces, so that today any user with password access can reach the utilities from any modem-equipped pc or laptop.

Just as it now is easier for the giant utilities, such as OCLC, to reach their users, however, so it also is easier now for their users to reach each other. There now are nearly 250 online catalogs available over the Internet. All of these display records behind which a MARC record lurks somewhere: the user-oriented screen displays which a normal Internet user sees all are assembled from an underlying record which is kept in a format which is strictly uniform across systems -- in the US, a USMARC format using AACR2. The possibility now exists, then, and is being actively explored in many US library quarters, of cutting out the giant bibliographic utility as an unnecessary middleman: f forming smaller consortia, for bibliographic record resource sharing via the Internet, which would avoid the utilities and their fees. Group contracts of the "I'll show you my records if you'll show me yours" variety are being considered by libraries for their cooperative cataloging. (Although the contents of a MARC record may be protected by copyright, the US MARC format is not -- it is a government publication, being the product of the Library of Congress, and is exempt -- so that a library could share US MARC records which are its own work product.)

The potential problems with this latest development are legion. The economics of substituting local cataloging costs for the fees of the large utilities could be self-defeating, and the effort to enforce the rigorous standards of US MARC and AACR2 could be seriously diluted by decentralization. But there nevertheless is great appeal for small libraries, which have the most trouble with the utilities' fees, and for unique libraries -- those which contain highly-specialized collections, so that communication with the few other libraries which resemble them is all the copy-cataloging which they would feel they might need -- in at least exploring the idea of cooperative cataloging via Internet-based consortia. The net effect of such developments would be a significant increase in network traffic. Any reduction in traffic to and from the large utilities would be greatly exceeded by the rise in traffic among libraries which heretofore either

hadn't used the utilities or hadn't used them to their full capacities, and by the inefficiencies of the new uses, which in large part would be duplicating each others' and the large utilities' efforts.

There also is much talk among libraries of "resource sharing" via telecommunications for Inter-Library Lending, and, within that at this point, to the faxing of needed documents from one ILL point to another. Much theoretical talk has been devoted to making ILL faxing a non-stop, invisible stream: from the remote library's database through directly to the local user's terminal, manipulated behind the scenes by the ILL department but never producing a printed physical copy which must be handled by ILL personnel. One interesting by-product of such a faxing system could be the online capture and storage of digitized information as it is faxed, "killing two birds with one stone" in a sense. The usual logistical problems -- of arranging for users' e-mailboxes when their machines are offline, of marrying incompatible computer formats (Unix to DOS to Macintosh, and so on), of training ILL personnel -- thus far have prevented much actual implementation. RLG, one of the major utilities, now offers a fax service, but this operates only between ILL offices, and not yet out to the library user.[21] The greatest problem appears to be the difficulty of using the awkward fax equipment at the sending end: fax machines are no better designed for bound books' fragile spines and bindings than are photocopiers.[22] There may be a tendency to wait until the newer fax formats are available, until new OCR procedures are developed, and, perhaps, until more data is online so that physical scanning will be unnecessary.

3.122 Telecom: "Opacs" and information servers

A second area of application, in which improved telecommunications techniques and capacities have created an expansion in traditional library functions, has arisen in the rapid development of "opacs", or "Online Public Access Catalogs".

The "opac" rapidly has become much more than just a traditional library book-and-journal cross-referenced list, of the type initially inherited from the previous paper card catalog era. Rapidly now, library systems offices are adding local activity calendars, general information features, and, increasingly, tape and cd-rom loaded commercial databases to the original catalog records offerings. Much of this development has been primarily the result of expanded computer capacity. As memory storage and accessibility have improved, so has the tendency of library

[21] The reference is to RLG's fax-based "ARIEL" ILL system, which was being tested in 1991.
[22] This advice from RLG "ARIEL" fax/ILL users.

systems departments to expand their horizons. But much of this development also has resulted from the increased visibility and flexibility -- or demands for flexibility -- brought about by making the "opac" service more available to users' demands via telecommunications.

The variety of information offered by the central system has greatly expanded as a result of telecommunications. Information resources which previously were housed in local departments -- medical databases kept in public health departments, chemical reference materials kept in a science area, humanities resources kept in their respective place -- now, through central loading on the library "opac", are reaching new and greatly expanded publics outside their traditional areas.

In some cases the "library" online service has become the major electronic face shown by the institution to the outside world, and, as such, has been enhanced to reflect that importance. The University of California's "MELVYL", for example -- originally merely a union catalog of bibliographic records from the several regional campus libraries -- now offers an immense range of services, including two versions of its main book catalog, one of its serials catalog, six online indexes to journal articles of various types, and telnet access, via an Internet connection which is becoming increasingly "invisible", to twenty-six other library opacs/information systems, plus the two major bibliographic utilities, OCLC and RLIN. The Colorado library consortium, CARL, has gone even further, now offering access to twenty-one separate local library systems, seven indexes and other services, eight "information databases", "invisible" telnet access to ten Internet library systems, and seventeen "news" services. At Oxford, in England, the library online service even has been used to wreak a version of poetic justice upon an unsuspecting institution: that ancient university, which felt itself so embarrassed during the 1950's by the publication of the fantasy tales of the wizard Gandalf, in its Professor JRR Tolkien's *Lord of the Rings* trilogy,[23] now is known to the entire outside electronic world as "uk.ac.oxford.gandalf-pacx".

In addition to expansions of variety -- among the resources of both the home institution and the outside Internet – there have been enormous expansions in the size and capacities of given "opac" services. Online catalogs which once contained 3 million records now contain 12 million. Search features, which used to accommodate simple author and title and subject searches only, now offer complex Boolean search capacities: "post-Boolean" research even promises ranked retrievals and probabilistic methods, bringing search results more closely in line

[23] J.R.R. Tolkien, *The Lord of the Rings*. (London: Allen & Unwin, 1954-5) (Boston: Houghton Mifflin, 1954-6).

with user profiles and desires[24]. Search engines now being tested, like Thinking Machine Corp.'s "WAIS" (Wide Area Information Server),[25] promise users -- and telecommunications capacities -- a new generation of library service in which a single plain language query will be sent out over the networks to dozens of online resources, generating initial retrievals which, in turn, via relevance feedback procedures, will generate even more queries. To these improvements, advances and increases must be added innovations like fulltext, imaging and multimedia, all of which, to the extent that they will become available in the general market, will be adopted as additions and extensions of present online library services. All this means telecommunications network traffic, increasing exponentially and rapidly.

This evolution of the library "opac" from bibliographic record list to full public information service may have occurred only by default: there perhaps was a need, and no one else was doing it. But the fact that librarians -- or a library function -- developed the information service, points out the central role which the traditional printed-books-and-journals library profession might have, if it succeeds in divorcing its interest in providing information from its preoccupation with the media in which the information is contained. Apparently only the library professionals who set up MELVYL had the right combination of interests in public service, information, and computer systems to establish what has become UC's primary public information service. Other activities and departments specialized in slices of the pie -- others had computers and systems and information, and still others had an interest in providing their information to the public -- but none grasped the whole in such a way as to develop an "opac" which then in fact went public and evolved into a full-service information provider.

3.123 Telecom: Professional services

In a third area, that of providing and obtaining services useful to their own profession, librarians also have developed online telecommunications resources which are growing quickly.

---

[24] W.S. Cooper and M.E. Maron, "Foundations of probabilistic and utility-theoretic indexing", in *Journal of the Association for Computing Machinery*, vol.25 no.1, pp67-80 (1978), and Salton (1988), note 4 above.

[25] WAIS -- Thinking Machines Corp.'s "Wide Area Information " -- currently is one of the most promising software solutions to finding information in multiple resources on the Internet. It is an implementation of the Z39.50 communications protocols, with several useful "front-end" features -- like plain language searching, relevance feedback, and an attractive user interface -- added in. The software is free, and is freely distributed over the Internet. More details, and a subscription to his newsletter, "WAIS-discussion digest: Forum on Wide Area Information Servers and Electronic Publishing", may be obtained from Brewster Kahle via e-mail to the following address: brewster@quake.think.com.

The three functional capacities of the Internet – electronic mail, file transfer, and interactive connectivity -- each have spawned developments in this professional services area.

Libraries perhaps are no more or less developed or undeveloped in their use of e-mail than are other organizations.[26] For all the enthusiasm and publicity devoted to it, e-mail has yet to win broad acceptance as a dependable substitute for printed mail and the telephone, particularly as printed mail has been enhanced with special delivery services and fax, and the telephone has been enhanced with voice-mail. This despite certain advantages of e-mail: for example the numerous software features available in centralized mail systems, such as those provided by unix, which would not be available or would be expensive to acquire for a local pc; or the easy linkage between e-mail and various other computer and network functions such as windows and ftp and telnet, indicating that perhaps full e-mail use may have to wait until users become more securely wedded to other computer and network functions in their daily work; or the store-and-forward e-mail characteristic, which makes it more convenient than telephones and places it at least on a par with voicemail. ISDN implementations and storage innovations may in fact do a great deal to unify the various forms of both spontaneous and considered communication now carried over fax, phone, and e-mail. In the meantime, e-mail use and these various other electronic mail techniques slowly are catching on in libraries as in most places.

Electronic conferences, however, seem to be blossoming and growing rapidly wherever e-mail has been implemented and mastered by a few librarian users. These e-conferences tailor e-mail to offer opportunities for the type of general networking, exchange of specific inquiries, debates, announcements and information, so necessary to sustain any profession. Used loosely, the term "e-conference" might cover a range of possibilities, from Usenet groups to casual bulletin board services, to topics in an Interest group service like the WELL, to the more formal and highly-structured e-conferences like PACS-L. One list of current library-related professional e-conferences, only those which are highly structured and active, already contains 36 entries.[27]

The largest and most successful library e-conference currently is PACS-L, the "Public Access Catalog Systems List", maintained by an editorial team at the University of Houston. It

---

[26] Various popular press journals and periodicals carry stories, time to time, alleging contending that "the information revolution isn't what it's cracked up to be". These stories are hard to refute. The mere presence of e-mail in an organization does not guarantee its use, and it is hard to monitor that use -- certainly without infringing upon the users' confidentiality -- even for volume of usage, not to speak of content and quality.

[27] Charles W. Bailey, "Library-Oriented Conferences and E-Serials (Revised)", available from the PACS-L archive or from author Bailey direct via e-mail to: LIB3@UHUPVM1.BITNET.

currently reaches nearly 4000 subscribers in 40 countries, uses LISTSERV software for account housekeeping chores, sponsors several electronic journals, maintains user-accessible archives of its postings, and sends 5-10 postings to each user's e-mailbox daily. Subject matter ranges from requests for help with a new CD-ROM player's procedures to job listings to appeals for bibliographic help to debates about the broadest aspects of the profession. Recent discussions on PACS-L have contributed much to the withdrawal of a Lotus 123 information product which PACS-L contributors felt invaded privacy, to the effort to pass a new US constitutional amendment defining information and privacy of information, to the passage of federal legislation to build the NREN (National Research and Education Network), and to the development of site-licensing for commercial databases (the latter, broad, animated discussion involving practicing librarians, academics, and commercial database vendors themselves).

Another library-related use of the e-conference technology -- and here the term is used loosely to include both "bulletin board" style conferences, which require users to dial-in for messages, and true conferences like PACS-L, which send messages out to the user -- is its use tied to actual physical conferences. Various pre- and post- conference activities, as well as bulletin-board-type functions during the physical conference itself, can be carried out on an associated electronic conference.

As one example, The Faxon Corporation, an important library service provider, sponsored just such a conference in Reston, Virginia, to take place April 29-30, 1991. Beginning the preceding January, however, Faxon announced, on the networks, the establishment of a parallel e-conference, in which the topics to be discussed at the physical conference were arranged in discussion groups, open to participation by paying attendees under the direction of general editors. Network announcements specified, "People unable to attend the conference on site have the option of registering for the electronic conference". The e-conference served to publicize the physical conference, to reach participants who were not able to attend the physical conference, and to prepare the discussions that were to take place later in Reston.[28]

---

[28] The best information -- most complete and most up-to-date -- on the Faxon e-conference and many other topics discussed here may be obtained by constructing a string-search of the PACS-L archive, as follows:

```
mail to listserv@uhupvm1.bitnet
the message (no subject)
// Database Search DD=Rules
//Rules DD   *
Search Faxon in Pacs-l
Index /*
```

It is interesting to speculate on the differences -- advantages and disadvantages -- between a physical and an electronic conference. Attendees rarely have time to visit all the sessions they'd like to see at a physical conference: the electronic conference affords them that opportunity. Remarks, "papers" often go unheard or unread amid the noise and distractions of a physical conference: an electronic conference provides better assurance that a paper will be read in its full detail. And yet electronic conferences also provide much opportunity for precisely the informal "corridor gossip" which is so much an important part of any physical conference: the spontaneity of the e-mail medium, much criticized for other reasons, here may be a significant advantage of the e-conference format. E-conferences likewise have great ease of administration and distribution: accessing the views of others, disseminating one's own views, trading opinions back and forth, becomes a relatively-easy matter of pushing the right buttons in an e-conference: the same access and opinion exchange is far more limited at a physical conference. Physical conferences do feature the "warm bodies" and travel allowances which e-conferences do not: but insofar as the substance of the conference and not the politics are at issue (which admittedly may not be very far in some cases), the physical presence of attendees may not be as important as one might think, and travel allowances, increasingly in a recession-laden and telecommuting world, may not be as attractive an advantage as they have been.

File transfer, a second of the three main user functions available on the US Internet, also has been developed for professional uses by librarians. Great archives are being assembled by the various e-conferences which serve the profession. Already the PACS-L online archive is the best source for librarians to use to find current information on library aspects of current developments like ISDN, imaging, online copyright issues, or the National Research and Education Network.[29] Other listserv archives may be consulted for recent discussion of nearly any subject of interest to the profession. These conference archives still for the most part function using an awkward e-mail procedure. But the network file transfer protocol, ftp, also provides a convenient and very quick method for reaching large remote files, for those who have access to it. Archives like that of library policy statements and NREN legislative history, held at

---

This search can be refined further with Boolean commands ("Faxon and conference"), and qualifiers ("Pacs-l Since 1/1/91"). The file that you will receive, usually in a few minutes, will contain topics and reference numbers. You then re-send the above message exactly as it appears, only this time for "Index" substituting "Print all of 4390, 7744, 8321" (without the quotes), where the numbers are the reference numbers from the previous message which you would like to read. You will be sent the full texts of those postings, again in a few minutes, via e-mail from PACS-L.

[29] see note #28, above.

the Electronic Freedom Foundation,[30] or that of WAIS, the Wide Area Information Server project, held at Thinking Machines Corporation[31], or the extensive archive of all sorts of library and information materials maintained by the Apple library,[32] all now are easy to reach and use via the networks. Increasing professional use of these and similar resources mean increasing telecommunications traffic by librarians and libraries.

Finally, increased professional use of various interactive mechanisms available on the networks also is adding to library telecommunications traffic. Remote login and telnet sessions by library and information professionals -- available for their investigation, development and testing of new network applications -- account for much professional network use already. Professional training and education, insofar as that must be obtained with hands-on use of the new resources, accounts for another significant portion. Newer network applications suggest even more professional telecommunications use. Techniques like Internet Relay Chat promise increased traffic among professionals in all categories, as its potential for holding multi-party interactive conversations online -- like low-cost international telephone conference calls, only with ascii-text verbatim transcripts being simultaneously produced at all locations -- is realized for professional communication, in the library and information professions as in others.[33]

3.124 Telecom: User services

It is in a fourth area, however -- that of the provision of general online services direct to users, rather than among librarians or via other professional uses such as cataloging, inter-library lending, or even the provision of public access cataloging -- that library applications will make their presence felt most heavily by the networks.

3.1241 Telecom: user services -- opacs

"OPACs, it already has been observed, rapidly are changing, from the traditional book-and-journal finding-aids which they were in the era of the paper card catalog, into full-service information servers presenting fulltext and much other original, non-bibliographic, information.

---

[30] On the US Internet, via anonymous ftp to ftp.eff.org.
[31] On the US Internet, anonymous ftp to think.com. Also see note #25, above.
[32] On the US Internet, via anonymous ftp to apple.com.
[33] Internet Relay Chat -- "IRC" -- is a relatively-new technique on the networks -- already supported by a vast variety of internationally-based network hosts -- about which not much yet has been written, on or off the nets. Interested parties might e- mail to Wayne Christopher at faustus@ygdrasil.berkeley.edu.

It remains to be seen whether the centralized, integrated, campus information server -- benefiting from a single pooling of online design talent and using a single or small number of online command languages -- as represented currently by the most advanced "opac" services like Melvyl and CARL, will endure in the advancing era of decentralized processing and inter-networking. For now, though, opac-derived information servers are becoming a leading source of telecommunications traffic generated by library users over the networks (see appendix for statistics of one OPAC's Internet use).

3.1242 Telecom: user services -- e-journals

Electronic journals also are establishing themselves quickly on the networks. Some now are under the supervision of excellent and demanding editors: a few now even are refereed, a process which takes a few months as opposed to the years which sometimes pass before a refereed paper journal article appears in print. The following is a selection of just those e-journals currently available which appear relevant to the library community:[34]

ACQNET (The Acquisitions Librarian's Electronic Network)
ALCTS NETWORK NEWS (Association of Library Collections & Technical Services)
Consortium Update (SPIRES)
Current Cites (Annotated Citations About Computer Technology and Librarianship)
Hot Off the Tree (HOTT) (Excerpts and Abstracts of Articles about Information Technology)
IRLIST Digest (Information Retrieval Research)
Newsletter on Serials Pricing Issues
Public-Access Computer Systems News
The Public-Access Computer Systems Review

There are many other e-journals in addition to these for librarians: they cover, it would seem, every conceivable interest, although more appear every week.[35]

[34] From Charles Bailey's list (see note #27, above).

[35] The leading online directory of e-journals currently is maintained by Michael Strangelove: send the following e-mail message to listserv@uottawa.bitnet --
GET EJOURNL1 DIRECTRY
GET EJOURNL2 DIRECTRY

The idea of an e-journal may be subject to the same objection suggested here to the online bibliographic record: that both are matters of trying to graft products of the old paper-and-cardboard technology onto the new electronic media. In the one case the old product was the paper catalog card, in the other the paper journal or newspaper. Both were structured under conditions which forced prose to be short, and articles to be self-contained and argued "logically" -- interpreted then as linearly -- to a conclusion. Such restrictions do not pertain to electronic media, which more easily can manage great variations in length, and actually specialize in cross-referencing and linking different items. Electronic media thus can provide opportunities for feedback and conceptual leaps literally not possible in the use of linear printed text. To some extent electronic media may be underused or misused in carrying merely digitized print journals.

3.1243 Telecom: user services -- e-libraries

Currently the most exciting application of computer telecommunications capacities to library problems, however, is the idea -- now at last being realized -- of the electronic library. The idea is to make available, to some "public", information in a digitized format which might be accessible electronically at the user's place of business, in her own home, or somewhere besides a "library" building. Information providers of various types -- from the MELVYL service at the University of California, to bibliographic utilities like RLIN and OCLC, to the new Bibliotheque de France and the new San Francisco Municipal Library system -- all are working on various notions of providing such an e-library service.[36]

Perhaps the best initial e-library candidates are the giant tape-loading services which already have assembled extensive archives of digitized texts. The Oxford Text Archive currently is the leader among these. There, over 1000 fulltext files – texts ranging from various versions of *Beowulf* to Robert Louis Stevenson's *Kidnapped* in Serbo-Croatian -- currently are available on tape to users worldwide for reasonable fees.[37] Other groups have undertaken the job of keying in public domain text by hand, in mammoth, voluntary efforts taking on aspects of a social crusade. Still other groups are taking more careful approaches, emphasizing the scholarly, high-quality rendering of heretofore-printed texts into online form. At Rutgers University, for example, the

[36] (See note #10, above.)
[37] The Oxford Text Archive catalog may be obtained by e-mail from listserv@brownvm.bitnet, with the message GET OTALIST FORMAT (for a formatted file, easily read on a screen) or GET OTALIST SGML (for a tagged file, read with sgml software). E-mail inquiries about OTA can go to archive@uk.ac.oxford.vax.

Center for Machine-Readable Texts in the Humanities has assumed responsibility for guaranteeing to scholars that their online texts will be authoritative, scholarly versions containing the latest conventions for markup and retrieval techniques, following the mandates of the international Text Encoding Initiative (an effort in which they join the Oxford Text Archive).[38] All of these e-library efforts aim at traditional library users rather than at librarians -- at the scholars directly rather than at the folks who traditionally have assisted them in finding materials -- and in this respect deserve to be called libraries themselves.

The bibliographic utilities have not ignored these developments. RLG's RLIN service has branched out, installing many new indexing databases in addition to their traditional academic library collection bibliographic listings. OCLC as well has loaded the many R.H. Wilson & Co. library databases. There seems little to prevent both these services from loading fulltext and other data as well, and purveying it direct to users, perhaps but not necessarily through their traditional library clients.

The potential for such extensive use of telecommunications for serving library users has not gone unrecognized by libraries themselves. The entire premise of the new Bibliotheque de France is that electronics, and specifically telecommunications, might be put at the service of library users, to reach a broader spectrum of the user population than ever has been reached before. If France is able to unify its efforts to improve its national library service, and ISDN, and its immensely successful Minitel service, one could imagine a functioning national French library service making use of telecommunications on a scale only being dreamed of today.

The same dreams are being dreamt, on a less grandiose scale and perhaps for different reasons, by smaller, as energetic, and perhaps a bit more desperate library systems than that of the Bibliotheque de France. In San Francisco, one of the worst budget crises in the city's history has driven the public library community to pin all of its hopes on the development of a sophisticated, public-oriented electronic system.[39] As with the Bibliotheque de France, construction of a new central library building is only a part of the overall concept. More central to the idea, and more important to its promoters, is the provision of information to the users via telecommunications in the new systems. A not unimportant element, particularly in the San Francisco case, is the perception at least that telecommunications might realize great savings for

[38] (See note #6, above.)
[39] (See note #10, above.)

the system in providing library service. If San Francisco really will be able, cost-effectively, to serve its Chinese and Filipino and Latin American communities in their own homes, perhaps in their own languages, via telecommunications, and the Bibliotheque de France will be able to serve the treasures formerly housed, almost secretly, in the old Bibliotheque Nationale, to the French general public via Minitel or its more sophisticated ISDN-based successors, the networks will have acquired an intensive user base, from the traditional library community, of enormous proportions.

Like e-mail and the e-conference, however, the electronic library idea is more of a service to be performed than a physical resource to be located "somewhere". Unfortunately, like the e-journal, the e-library idea suffers somewhat from its association with ideas from the past, and much effort is given, like that above, to trying to identify current institutions that might "become" e-libraries. The point of electronic communication, however, is that it appears that nearly any institution might become an e-library, to the extent that that institution might facilitate "access" by "users" to electronic "texts". Whether the "text" is a keyed-in ascii version of Jack London's *White Fang*, in fact although unimportantly "located" on Project Gutenberg's disk memory in Illinois or a digitized satellite image of Mars "located" in Project Sequoia's database at UC Santa Barbara, or a scanned image with accompanying unicode words and sound of a Guillaume de Machaut manuscript music composition "located" in the Bibliotheque de France's database in Paris, the e-library is or can be the organization which tells the user that such a "text" exists, and assists the user in obtaining and using it.

This new possibility of e-libraries, directly the result of the recent and ongoing revolution in telecommunications, is not without its complications. Without standards, without organizing principles and filters and good user interfaces, the massive provision of such information could have an effect opposite to the one intended. Users overwhelmed by information in such amounts simply might not use it. Worse, access to the information might become more and more the province of only the elect -- those inclined, well-educated, and perhaps wealthy enough to use it -- exacerbating the widening split currently being felt acutely most places between haves and have nots: "Knowledge is power", goes the saying, and providing so much knowledge online to only a few could substantially overweight various power balances.[40] (During the last century French public libraries became, ironically, bastions of knowledge that in fact were breached only

[40] Bryan Pfaffenberger, *Democratizing Information*, (Boston: G.K. Hall, 1990).

by the wealthier classes of French society.[41]) The point to be made here, however, is not that information of this type should or should not be made available, nor that it might be made available electronically in one way rather than another, but only that the agent of its availability – the organization telling users that the information exists and assisting them in obtaining and using it -- is the e-library. Whether this organization will bear any resemblance to – much less direct descendance from -- the old printed-book-and-journal library, remains to be seen.

3.1244 Telecom: user services -- commercial publishing

There are no guarantees, however, that users' use of the networks for obtaining information will be confined to the organized, disciplined channels being developed for them now by the library and information communities. Commercial publishers, from the business news journals and wire services who already have experimented with services like Dow Jones and Dialog, to traditional print publishers who may still be dragging their feet hoping to delay the inevitable, all are vitally -- some bitterly -- aware of the potential of the new medium. The technical problems largely have been removed. It now is technically feasible for quite useful online fulltext and other data to be loaded from the publisher and purveyed directly to the public via the networks. The problems which remain tend to be those of logistics and marketing: who will pay, and how much, and how will copyright be protected? One senses, though, that once the essential marketing question is answered -- by the identification of a sizeable public willing and able to pay for the services -- that most of the other logistical problems quickly will be resolved or simply will disappear.

The entry of the commercial publishers into the telecommunications networks received a major boost in the fall of 1991, with the freeing of the US "BabyBells" -- the US telephone companies -- from the court restrictions that theretofore had prohibited them from entering the "information business". Just since fall, then, many numerous agreements, projects, and joint venture arrangements have been undertaken to bring this new commercial telephone network capacity into the online information world directly. The suggestion here is that this will make it far easier for commercial publishers -- news organizations, book and journal publishers -- to find online avenues for the dissemination of their materials to the reading public.

---

[41] Jean Hassenforder, *De'veloppement compare' des bibliothe`ques publiques en France en Grand-Bretagne et aux Etats-Unis dans la seconde moitie' du XIXe sie`cle (1850-1914),* Paris: Cercle de la Librairie, 1967).

3.1245 Telecom: user services -- local-loading

More promising even than online use of commercial publishers' materials, though, is the development of an even more vast source of online user material to be made available by providers who can only be called users themselves. At the very lowest level of this new medium, in other words, can be found individuals who with little expense and the greatest of ease can use the networks for broadcasting whatever material they wish, to an enormous number of other people.

This is the phenomenon of "local loading". It refers to the ability of any computer user with a modem to load whatever she or he deems of interest to the outside world onto a local laptop and then, via the modem, both advertise and transmit her material to great numbers over great distances using the telecommunications networks. The simplicity of these publication techniques far outstrips the simplest publication steps necessary for print, television or radio media: the investment simply is a laptop, a modem, and a personal knowledge of e-mail, telnet, and perhaps ftp: any intelligent individual with perhaps US$500 to spend and some free time now can do it. Publication of material by local loading has only just begun, already it is an enormous load on the telecommunications networks, and one senses that this beginning still is very small compared to what is coming.

3.1246 Telecom: user services -- online reference work

One answer to the flood of online information which seems to be promised by the commercial market and local loading might be to get the librarians back into the process directly. To the immense work already being done on expert systems and user interfaces and filters for controlling the impending flood of online information, might be added online reference work: the use by information professionals of the telecommunications networks for rendering the same sort of assistance, in finding and using information, which was rendered over the reference desk of the traditional paper book and journal library.

To some extent this is being done now. Oxford, and others on the Internet, and the University of Metz and La Villette libraries on Minitel, all provide for e-mail between users and librarians. Some experiments have been made with real-time, interactive reference service: the ability of a user to contact a librarian mid-session -- while in the act of conducting an opac

search, for example -- in such a way that the librarian can "see" the search in progress and render immediate assistance.

Expansion of these efforts would involve an even greater use of the telecommunications networks by the library community. Online reference work, via e-mail or ftp or even interactively, could become a necessity if even the milder predictions of online "information overload" are realized. The elaboration of systems for providing this service could create the most broad-reaching and intensive use of telecommunications thus far envisaged for the library and information community.

3.13 Broadband capacities

Both the previous history and the current practice of libraries with regard to computers and their networks point to greatly increased needs for capacity, for both the storage and the transmission of data. The suggestion also is made here, however, that libraries -- or their future library service equivalents -- will be vitally necessary to organize and manage the enormous quantities of currently "non-library" data which shortly will be online. Someone will have to tell users what is out there and how to get and use it, and that someone -- be they called "information broker", "information specialist" or whatever, and until the development of robotics, user interfaces and expert systems vastly more intelligent than anything so far seen -- will be the future equivalent of the paper-and-cardboard era's "librarian".

For both reasons, then, it might be useful to consider any increase in volume of data stored and transmitted electronically as being within the province of "libraries'" use of electronic technology. In what follows, the various types of digitized data thus far imagined are categorized and classified as to their potential uses. Each of these, it will be seen, is a potential client for broadband transmission, if only by virtue of the greatly increased amounts of data that its transmission will demand. Library and information disciplines currently are theorizing and to some extent experimenting with each of the following types. They, or someone, will need to do much work if these types are to be organized and made truly accessible to users.

3.131 Greater volume of lists

There will be, to begin with, a greater volume of lists. This perhaps regrettable tendency to make lists, inherited from previous non-electronic eras, shows no sign of slowing just yet.

Online there now are many lists, and lists of lists, and lists of lists of lists. One already can search through seemingly endless bibliographies, catalogs, and indexes, few of which yet are equipped with sophisticated search engines -- one reaches or retrieves the enormous file, and simply begins to page down through its contents, page by page -- and very few of which yet are equipped to connect directly to other resources.

There are exceptions. Minitel provides a simple but useful "MGS", "Minitel Guide des Services" index that allows nearly-keyword access to its myriad offerings.[42] A good Internet example is the series of convenient "front-ends" -- Libtel, Hytel -- which have cropped up to provide access to various flat-file lists of Internet online catalogs[43]. Other examples from the Internet are numerous "information directories", like McGill University's Archie service, or the Internet Resources Directory, now mounted by CARL and other opacs[44]. Perhaps the most elegant search engines are those provided by individual online catalogs -- MELVYL's is a prime example -- or the promising service offered by WAIS and the growing number of Z39.50 implementations[45].

The exceptions, however, prove the rule. Most online lists have grown precipitously, without benefit of software "front-ends" or "search engines" which really are up to the task of managing them. It is distressingly easy to add entries to a computerized list using word processing or database programs. This is being done in many places now continuously, with as yet unknown impacts of such growth on potential list uses, particularly on telecommunications uses. To take one example, one of the best and oldest online library lists is that of "Internet-Accessible Library Catalogs & Databases", compiled and maintained by Dr. Art St. George at the University of New Mexico. Two years ago this was a fairly short and simple list of library names and addresses, with brief descriptions of access procedures: the entire list could be obtained via a single e-mail request and scanned in a few pages on a user's computer screen. But as of April, 1991, this list had grown to over 7000 lines of text -- nearly 300 pages of typical computer screens -- and had been broken up into four separate files for e-mail communication. This sort of exponential growth is typical of all the online lists, from the catalog records of MELVYL and the Yale Library to lists of Usenet user groups or the Internet Resources Guide:

---

[42] The "MGS" option selected from within the "3614" kiosk, either on Minitel in France or via "F3614" from Minitel in the US. Free Minitel software for US users is available from (voice) (914) 694-6266.
[43] (See note #28, above.)
[44] (See note #28, above.)
[45] See MELVYL -- telnet to melvyl.berkeley.edu -- or see note #25, above, regarding WAIS.

they all have grown, well past the point of being easily transferred via telecommunications and perhaps past the point of being easily used by the users.

E-mail and "ftp" of such vastly increased and increasing numbers of lists, themselves of vastly increased and increasing lengths, is a potential burden on the telecommunications network directly the result of library and information work. The essence of the Internet, and of the international telecommunications "Matrix"[46] which it represents, is that of participation on networks of a multitude of users accessing a multitude of resources. If it were only a few users using a few resources, however large those resources might be, one wouldn't need a network: a single, large-capacity, dedicated line and system, or the US mail, might be sufficient. Broadband capacities on the "networks", however, implies many users reaching for many resources. The prevalent organizing principle for this sort of information for now, for better or for worse, is the indexing list. Broadband communications planners would do well to anticipate continued growth and multiplication of online indexing lists, insofar as broad-based inter-networking networks – in terms both of uses and resources -- are contemplated.

3.132 Greater volume of data, from various sources:

In addition to the indexing lists, however, there also is a rapidly increasing volume of information data that will be transmitted via the networks, in formats and using techniques that will require vastly increased telecommunications capacities. There are numerous sources for this increased information flow, only a few of which are listed here:

3.1321 Fulltext

The most immediate demand for increased telecommunication capacity is coming from the online fulltext field. Online fulltext may be viewed, in its narrowest incarnation, as merely the digitized -- normally using ascii -- representation of text which formerly had been presented in printed form. Once again, the danger of such a narrow view is that the products of an old technology might be grafted crudely onto a new technology's "platform", ignoring and to some extent wasting the unique characteristics of the new resource. But that is what is happening for now, initially. Books and journals are being keyed in -- increasingly, with benefit of improving

[46] John Quarterman, *The Matrix: computer networks and conferencing systems worldwide.* (Digital Press, Digital Equipment Corp., c.1990). Quarterman (p. xxvi) himself gives credit to William Gibson's science fiction novel *Neuromancer* as having been the origin of the use of the term "The Matrix" to describe the world networks.

optical character recognition techniques and algorithms, they will be scanned in -- to digital formats for distribution online. This is the original source of most of the "tape-loading", "CD-ROM " loading, and "full-text" services already available on the Internet.

At the same time there is much online fulltext, again narrowly conceived, which might have been issued as printed text but simply hadn't before it came online: its publishers have realized the advantage of online access, even if they haven't entirely taken advantage yet of online search and retrieval and other capacities. This is increasingly the case for the commercial and professional databases, such as those offered by Dialog, Westlaw, Medline, Lexis and Nexis: fulltext resources of these types vary greatly in the degree to which they offer more than simply the ascii version of what otherwise would be a printed text.

The significant point for telecommunications, of all these "online fulltext" manifestations of the old "printed" text, is the enormous increase in data volume that they represent. During the 1970s and 1980s, libraries only got a start at loading and exchanging bibliographic data -- short, abbreviated entries describing the represented work -- but nevertheless quickly became among the largest users of the online networks. If and to the extent that libraries, or others, now load the full ascii texts of the works themselves into this process during the 1990s, the load upon the networks will be expanded many times. The bibliographic description of Tolstoy's *War and Peace* occupies less than a single page of printed text: the novel's full printed text runs to nearly 1400 pages.

3.1322 Preservation

Another problem which looms for library and information work may have a great impact on telecommunications capacities. As information makes its rapid and enthusiastic jump into the digitized online world, during this decade, one important relic of the previous paper-and-cardboard era is in danger of being left behind entirely: namely, all the printed records of the civilization of the 19th and 20th centuries.

This would not be so bad or so unique a difficulty was it not for the problem of the acidic paper on which all of these records were printed beginning early in the 1800s. Such paper was used uniformly, for books, journals, business records, government documents, and personal correspondence, throughout the world for nearly 200 years. Now it is all turning yellow and crumbling into ashes, whether it is used or not. In major research libraries, which up until now

have been able to collect only a small selective portion of society's printed records, figures of 20, 30 and 40 percent are estimates of the damage and destruction of the total collection already wrought by the acid-paper problem. The spectre haunting the world's libraries is that the historian of the year 3000, looking back, will be able to discover much recorded history from before 1800, recorded as it was on acid-free paper, and much since the year 2000, recorded in easily-duplicated digitized formats, but nothing -- no business records, no government documents, no books, no journals, no letters, nothing -- for the years 1800-2000.[47]

The true threat comes less from the acid-paper problem, for which there are solutions, than from the distraction, for the library and information professions as well as for others, of the new online and computerized techniques. The ease with which new data may be handled online has inclined information workers to underestimate or ignore the rising problem of preserving existing acid-paper records. The little work that is being done has done little more than reveal the looming enormity of the problem. The Bibliotheque de France alone, which is swept up currently in one of the largest automation and online communication library projects, also faces the problem of preserving 1.6 million book volumes in need of deacidification and reinforcement, 1 million in need of rebinding, and over 1 million volumes and 260 million journal pages in need of immediate reproduction to prevent their complete loss: all this in addition to the problem of repairing books damaged in the impending move from the Bibliotheque Nationale.[48]

Digitized imaging appears to be a key to the preservation effort: a key both to making the texts more available to the public, as the French President has demanded of the Bibliotheque de France, and to protecting the old containers they now come in from the depredations of public handling. At the Bibliotheque de France, an older target of 300,000 now has grown to 415,000 existing titles, of texts which are to undergo some sort of retrospective imaging conversion initially. More significant -- because more easily realized -- is that new texts submitted to the depot legal for copyright might henceforth be required in image as well as print formats. A computer-accessible "phototheque" of imaged texts is to be developed. Digitized multimedia

[47] The Commission on Preservation and Access may be reached, for their numerous publications and general information about the preservation problem, as follows:

Commission on Preservation and Access
1400 16th Street NW, #740
Washington, D.C. 20036
Telephone: (202)939-3400
Fax: (202)939-3407
E-mail: CPA@GWUVM.BITNET

[48] Jean-Paul Oddos of the Bibliothe`que de France, in *Bulletin des Bibliothe`ques de France*, t.36 no.4 (1991).

presentations, which both preserve texts and make them available in integrated formats, are being planned. All of this creates information -- digitized images, derived from book, microform, photograph or other formats -- which increasingly may be stored, retrieved and used efficiently, although there is much work yet to be done, but which also will generate far greater volumes of data transmission for library telecommunications networks. Digitized images -- even low resolution, low gray-scale, black-and-white depictions of mere printed text, much less high resolution color images of photographs and paintings -- require many times more communications capacity than do their ascii bibliographic descriptions.

The suggestion here is that conversion and preservation of existing materials -- particularly materials of the last two centuries which happen to have been printed on acid-paper -- is a looming time-bomb in the entire question of online access and communication capacities, and not just for libraries. It appears that full realization of -- and funding to solve -- this problem will come late. When it does, there may be an unparalleled "balloon" need for capacity, communication and access if the effort to preserve some part of these deteriorating 19th and 20th century print materials is to succeed.

3.1323 Increasingly-interactive access

Over and above discussion of particular types of online fulltext materials -- new information, old information -- which will require vastly increased telecommunications capacities, looms the question of types of access to those materials. The networks currently offer, basically, three means of user access, with a potential fourth looming in the wings. These are:

1) E-mail. The traditional store-and-forward, packet-switched type of communication so easily handled now by modern systems;
2) File transfer ("ftp" on the US Internet). This eases the user's, although not necessarily the system's, burden in transmitting large amounts of information in one package;
3) Interactive connectivity ("telnet" on the US Internet). Increasingly this is the solution both for the use of very large databases and of sophisticated search engines, neither of which can be easily transmitted to the user's site, either electronically or otherwise.

To these might be added, shortly, an entirely new dimension in online access:

4) Interactive Relay Chat. To some extent an extension of interactive connectivity, only this time not between a user and an essentially-passive large database, but between and among users, and with online services specifically designed to be highly interactive.[49]

These four access techniques might be viewed as a progression, with online access having traveled from early "store-and-forward-only" days to a future involving greatly-increasing interactivity in whatever communications occur. This developmental scenario is one calling for greatly-increasing telecommunications capacity: a multitude of highly-interactive connections, all trying simultaneously to provide users access to a vast and growing multitude of online resources, is an entirely different universe of telecommunications capacity than was that of the more manageable beginnings of store-and-forward e-mail.

3.1324 Communications among institutions

The demands for online lists, fulltext, preservation of old text, and various forms of increasingly-complex access to all these resources will not occur, furthermore, within single institutions alone. The key to solving most of the problems, and to using most of the resources, will be telecommunications among different institutions, true "inter"-networking. Whatever capacities are required for access to preservation efforts, for example -- digitization of images in high resolution color, perhaps, and their coordination for multimedia presentation with associated text (ascii or simply bit-mapped) and sound – this access will have to be made available over telecommunications networks. The era has long since passed when a single institution -- a national library, a major academic collection -- felt smug and self-sufficient enough to conduct its own internal operations in isolation from the outside world. To the extent that the outside information world will need contact with libraries, and the world outside the information professions will need help in organizing data, telecommunications capacity will be the key to any of the functions described here.

3.1325 International access

A further impact on telecommunications capacity will be felt by the increase in international online access. Already the library community is engaged in a certain amount of

[49] (See note #33, above.)

exploration of international network resources. This has not yet, however, been built into any organized work routine. The potential for doing so quickly, however, is enormous. Within cataloging, already an expensive item on library budgets, multi-lingual international cataloging easily is the most expensive item: the personnel required for this very labor-intensive activity are among the most highly-trained and most expensive on the library staff. As libraries discover, however, that international bibliographic records may be retrieved easily and for free via the Internet -- already there are several Spanish, Mexican, French, Chinese, and German libraries on the networks, and of course the other US libraries all will have multilingual catalog entries useful to the library making the inquiry -- international consortia to share MARC cataloging records will arise, as they now are arising among cataloging departments within the US.

All the usual problems of international activity, then -- conflicting standardization norms, many additional layers of regulatory activity, duplication in the market -- will add to telecommunications traffic and demand for capacity as the activities described here expand beyond national borders. Multi-lingual access alone, for example -- most network activity now is in English -- will add duplicate texts and records and finding devices to those which exist now: "CJK", or "Chinese, Japanese, Korean", cataloging is only one of the more exotic current examples -- the French CNRS' "Pascal" database offers multi-lingual indexing in up to ten languages, and one expects that European, Asian, and African users will demand an increasing response by the networks to their own linguistic preferences. All this means more network data.

3.1326 Professionals

Information professionals already are the bane of existence of many systems managers: the "experiments" conducted on systems can produce great drags on capacities and efficiency. An information professional presumably knows where to poke, or tweak, or twist, to find a system's weakness: the more often this is done -- for the "benefit" of the system or otherwise -- the greater the short-run headaches for the system manager.

One can expect this activity to increase. System designers thus far have been primarily concerned with hardware and software of systems. Users' needs have played a significant, but secondary, role. There have not been that many users, after all: certainly not in the US, where the general public still does not have real access to the networks. But if this is about to change, as has been suggested here -- if the general US public is about to gain entrance to the networked

world -- so also will a new generation of information professionals wishing to cater to the needs of that public. Advertisers, marketers, distributors, pollsters, consultants of various types, brokers and navigators making their living from helping people find things on the networks: these are people who ultimately may increase network efficiency, but there is an equally-great chance that their activities, at least initially, will add greatly -- proportionately far greater for this group than for normal users -- to the demands on the networks for capacity.

3.1327 Users -- intellectual access

The users' level of ability and interest, with respect to networked information, does not stand still. One can expect an increase, as the networks become more readily available, and more sophisticated, and better-tailored to access by the average user. One important and much-underestimated aspect of this access is the extent to which the average user intellectually can understand the information provided by the networks, both the information sought and network-specific information. There are barriers to such understanding with any medium: literacy is only one of a number of such problems associated with obtaining access to the information in printed books -- radio and television overcome this particular barrier.

One interesting question is whether the intellectual access barriers of networked electronic media will be higher or possibly lower than those of print and other media. Initially they appear higher, but perhaps this is only because the network-specific information which must be mastered, at this stage in the technology's development, still is so great. As this "threshold" is lowered -- by user-friendly "front-ends", increased sophistication and apparent simplicity of workstations, and other means – there could be a great increase in usage, as average users discover that they in fact have "intellectual access" to the information which the networks can convey. For the networks can convey more than just printed text, and make it -- and printed text -- more easily used by users. If attractive colors, interesting sounds, and images -- in addition to printed text -- all will be available on the networks, via increasingly-"invisible" procedures, great increases in user demand and usage may result merely from the fact that users will find that they "understand" networked information better than some other. Average users currently still have more difficulties reaching and understanding networked information than they do information printed in books and journals; but they have even less difficulties with radio, television, and

video games – as networked media make these latter techniques readily, "invisibly", available, they may see unparalleled increases in their usage.

3.1328 Imaging and color

The increased use of imaging and color will increase the load on the networks, and the demand for broadband and other techniques for providing such capacities. Libraries' use of both is expanding rapidly, particularly as online fulltext increases and, with it, the need to carry associated images, and especially as the need for preservation of existing collections becomes more critical.

3.1329 Relational work

The techniques themselves for gaining access to and using online information may generate increased network use. As online resources multiply, and as they grow larger, the need for making cross-referenced, relational, use of them increases. It no longer is enough to "login" to one resource, consult it, "logout", and then "login" to another: already users demand the ability to "login" to several resources simultaneously, using the information they contain together, either online or at their workstations. "Windowing" programs at the latter are evidence of this need; increasingly, software that can operate the entire network like a giant relational database -- like Thinking Machines' WAIS programs -- will be demanded. Ultimately -- if those who design hypertext programs are correct, and apparently-random "browsing" is to be a key activity of network searching -- such relational ability may be an essential characteristic of any database or other resource, and certainly any finding tool or search activity, on the networks. A user would rather gather all her resources together and work with them simultaneously, than look at just one at a time, if she can manage it; and relational work on the networks quickly is developing tools which will enable her to do this.

3.134 Analytical access

One of the greatest failings of the networks so far -- that it still is so hard to find anything on the "nets" -- likewise will spawn additional layers of information which will add to the demand for network capacities. Entire superstructures of indexing and other access information will be needed, certainly if the general public is to use the networks adequately. A few of these

are examined above: the IP "e-mail" addressing system, which now offers so little information, must be expanded if we are to be able to discover and analyze who is using the networks and for what purposes, and fulltext, sound and imaging, and other formats all will require "headers" and reference "tags" which have yet to be developed. Generally there is a need for the development of indexing terms and systems to accompany every piece of networked information, to assist in providing access: indexing terms and systems which largely do not exist yet today. As with other techniques, these eventually may result in a reduction of the time and network capacity required for a given use; but, again, such individual reductions will be more than overtaken by the increased overall network use made possible by the increased access. Once it's easier to find and use things on the networks, more things will be sought and used.

3.135 Two key questions

There are many questions involved with the effect on network capacity of these various developments. Two among them which appear to be crucial are the effect of "front-end" software systems and the current debate on compression versus fiber optics.

3.1351 Front ends

Relational abilities offered by network software will not necessarily increase network traffic in their own use. "Front-ends" which download database entries -- via the networks – for manipulation in users' workstations, would load network communications channels more than would the same manipulations performed upon the remote database mainframe, using the workstation as a terminal; but the downloading and workstation manipulation could greatly reduce telecommunications connect-time, while also relieving the load on the mainframe. There is no guarantee, however, that users equipped with such elegant programs in fact will economize in their online use -- the cost of the online connection would continue and be a disincentive, but this cost may be negligible or at least marginal for many online uses -- so that increased relational access to the networks could impose a double load: users will increase their communications use together with their manipulation at their own workstation.

Neither is there any guarantee, moreover, that such "relational" functions will be performed at the workstation rather than online, or that the overall attractiveness of such functions will not generally be an incentive to increased telecommunications use. One can

visualize software which performs searches and manipulation from multiple sources online as well as one which does so offline: the latter might be more economical of network resources, but the former might stay in touch better with the resources during their retrieval and analysis. Might not search software be designed which simultaneously analyzes retrieved results and searches, via relevance feedback, for improved search sets, all from multiple online sources? If such software is on the workstation, the telecommunications load might be lessened; if it is on the network, the load might be very much more. Either way, the attractiveness of the network medium to users would be greatly enhanced, and overall network telecommunications traffic greatly increased.

3.1352 Compression versus fiber

A second key "capacity" question is the race between compression and fiber optics. A leading debate in the US information community now is over whether and to what extent expensive fiber optics-based systems will even be necessary, at this point, to carry the flood of digitized information -- text, images, sound, multimedia -- which appears to be looming. One leading participant, Mitchell Kapor, is of the opinion that the long-dreamed-of refinements of "ISDN", or "Integrated Services Digital Networks", which would integrate all these, now may be achieved with existing copper-wire technologies, without waiting for optical fiber technologies to arrive.[50] The answer appears to reside in improvements to compression algorithms, which already can squeeze ascii text down into space one-half its normal reading size, and can take images further, compressing to six and seven times smaller without loss of the original image.

There may be additional improvements to compression without image loss. Image loss itself presents an interesting question, though, for proponents of compression point out that there already has been "image loss" by the time the human eye "sees" an image -- vast arrays of the light spectrum simply can't be detected by the eye, and others are lost according to the vagaries of lighting and atmosphere and perhaps even mood in the viewer's particular situation -- so that "loss" due to compression may not be the question, so much as the sustainable level of all such loss, for the purpose for which the image is intended.

[50] Kapor's strong but well-informed opinions on the subject have been delivered in US Congressional testimony and numerous conference appearances and e-conference postings. Much of his material may be obtained by anonymous ftp to ftp.eff.org.

A dot-matrix printer's version of ascii text, for example, might represent significant "image loss" compared to that same text produced by a laser printer: yet the former may be just as "useful" for some purposes as the latter -- more so, if produced quickly and inexpensively as against the slower and more costly process of the laser. Just as the art historian's "threshold of acceptability" of 1200 pixels per inch for black-and-white images[51] might be far greater than that needed for a slide librarian's reference chart, so that same art historian's need for image quality might be greater than the parallel need for the same image by a newspaper editor: in both latter cases, an image compressed with a certain amount of "image loss" might be perfectly sufficient.

There is a certain amount of practicality which might be injected, as Kapor perhaps is doing, into the current, seemingly-endless, debates about network capacities. Fiber optics are desirable, but are they really necessary to get us started? High-resolution imaging and perfect compression are desirable, but might not lower resolution and better compression with some image-loss be useful as well, for some purposes? The suggestion here is not that the quest for perfect solutions be abandoned, but only that work on less-perfect, interim solutions be pursued as well: they often are the key to achieving perfection, and in the meantime they might be useful. They might do much to help us manage network capacities while we await the perfect solutions.

3.20 The relevance of applications

Does all this capacity serve the library purpose of getting information to the user? Will information system users become "better informed" as a result of the efforts and approaches described above? Will they be "library" users?

An assessment of the impact of an innovation, upon an organization like the library, can have both an internal and an external aspect. The internal question is whether and to what extent the innovation changes the internal structure and mechanisms of the organization. Are old activities redefined or abandoned? Are new activities introduced, perhaps along with new personnel to undertake them? There is a substantial literature in organization and management theory which attempts to define this internal aspect of the effects of telecommunications innovation.[52]

---

[51] Michael Lesk, "Image Formats for Preservation and Access", in *Information Technology and Libraries*, vol.9 no.4 (December, 1990) pp.300-308, and the report to which Lesk makes reference.

[52] (See note #18, above.)

The external question, on the other hand, is whether and to what extent the innovation changes the position of the organization with respect to its outside "market". Any organization might be viewed as holding a place in a "market": a professional has her "clients", a corporation has its "customers", a library has its "users", and all three types of organization have their "competitors". In the library case, "competitors" might include comic books, "pulp" paperbacks, television, video games: any information source not available in or through the library. Librarians have been reluctant to view themselves as competing in a "market", but their exposure to competing information sources today, in telecommunications and elsewhere, should force them to realize that there is a "market" out there to be served.

Shifts in relation to these "externalities" -- shifts in "market" position -- can have dire consequences for the organization. A shift which expands an established market, or finds a new market, or a wealthier or more enthusiastic market, can help an organization: it also can so overburden existing resources as to cause the organization to collapse from within. A shift which contracts an established market, concentrates organizational attention upon a diminished variety of markets, or focuses upon a less-wealthy market, can hurt the organization: it also can allow an organization to discipline itself, perhaps to weather "hard times" in its external markets generally.

The question posed most forcefully by the recent impact of technological innovation on the library is just such an "external" question. The "internal" reorganization of libraries as a result of automation has been dramatic, and promises to become moreso. But the effect of telecommunications, in altering the position of the traditional library with respect to its "market", promises even greater drama.

To some extent, telecommunications is expanding the markets of libraries, enabling them to reach more users, offering more library services. The capacities of the global networks, and of various new digitization techniques, were discussed above in this regard. Libraries which fail to keep up -- which fail to offer users the telecommunications services which they demand, or which try to do so but collapse through having over-extended their resources -- will find the distance between them and their "markets" growing greater as a result of these innovations.

But there is another threat, one not fully appreciated by libraries. There is competition in the library marketplace now. Other organizations can offer information to users via the networks now, efficiently and inexpensively -- at least in theory -- so that users may find it more

convenient and perhaps even more affordable one day soon to consult network resources rather than the library. This is not yet the case in the US, where network access still is limited to very few users; but it may soon become so, as the networks expand rapidly toward general public use -- and it already is the case in France, where the public can use the omni-present Minitel for as little as 15 US cents per minute.

Have library efforts in the automation and telecommunications areas expanded library "markets", then, or contracted them, by being too little, too late, or off the point? Are libraries better able now to serve information to their users as a result? Have libraries improved their position with respect to their own marketplace? What role will they have to play in the information future? These are unanswerable questions as yet, but they deserve at least asking now. To the extent that libraries wish to survive in an electronic age which stores, finds and uses information very differently than it did when it was stored on paper, the library's own self-interest dictates that it ask and answer such questions. To the extent that the age itself will require professionals to help find things, to help navigate, in the new information sources, others besides librarians also will need to find these answers. One distinction which may help is that made here between the librarian's traditional perceived task of "listing things" and the library user's somewhat different perception of the librarian's task of "finding things".

3.21 Listing things

It is the contention here that libraries thus far have been distracted, in automation, by their traditional tendency to manufacture lists. The production of lists is the antithesis of the capacity of computers. The computer specializes in finding relationships: certainly it uses lists, but its best talent does not lie in producing them, rather a computer can find the relationship between an item on one list and that on another and make this relationship evident to the user. To use computers to generate lists begs the question which the computer was designed to solve. Nevertheless it has been to this purpose that librarians have dedicated much of their computer automation activity up until now.

It has been suggested here that this myopia has had historical roots: roots in the list activity that produced card catalogs, bibliographies, and booklists throughout proceeding centuries of librarianship. Yet the great dream of the card catalog -- that the cards might be used for cross-referencing -- was realized during the 1980s, with the development of the relational

database, and librarians still are making lists. The "online catalog" of the 1990s usually has powerful cross-referencing capacities. But all too often these become buried, both because they are poorly presented in the user interface (a better name than "Boolean" should have been invented) or they are buried under the inexorable pressure of adding to the ever-expanding book-list. Retrievals which once found seven "relevant" items eventually found seventy, and were deemed to have been improved: but they now find seven hundred -- or repeatedly bring the system to a halt -- and the usefulness of the system which produces them is being diminished.

3.22 Finding things

Telecommunications removes the necessity of assembling individual collections and lists so large as to be unusable. There is no need, any longer, to compile massive databases which list "all" books or "all" periodicals such that a single retrieval will find "everything" available on a subject, if that retrieval will take forever to do, will bring the system "down" more often than not, or will find so much more than the user needs that she gets frustrated and ceases to use the system at all. There are other systems available now, via telecommunications. If she can't use a particular library easily -- on the networks now just as with physical libraries before -- a user will go elsewhere.

Librarians might improve their thinking about networks if they were to reorient that thinking away from listing things and more toward finding things. If they were to begin to view the networks -- the US Internet, Bitnet, Minitel, EARN, and the others, with all their e-mail, file transfer, and telnet capacities -- as a giant "finding aid", similar in function but emphatically not in structure to the cross-referenced card catalogs of the past, the importance of assembling and listing the physical contents of the most complete collection might recede, as it should in a networked telecommunications age. A user needing information can find it now online in Western Australia or in Scotland or in India -- increasingly so as fulltext and other new features are added in these locations -- instantaneously and very inexpensively, from her workstation in California or Italy or Nigeria via the networks. There is less need now for the library near her home to acquire and make lists of copies of the information that might be out in Perth or Aberdeen or Bangalore.

The need, rather, is for help in finding things. This task is no easier than it has been in the past for librarians superintending collections of physical books. The aids which existed then --

classification systems, subject-heading thesauri, standardized title pages and book formats -- were elaborate and invaluable, but nevertheless required interpretation and, basically, aid in navigation. Users might have understood them but didn't want to: users never are as interested in library systems as are librarians -- what users want is the information. The situation today on the networks is the same. Network enthusiasts propound the merits of various protocols and interfaces and strategies that are elaborate and invaluable but largely are irrelevant to average information-seeking users. The need for interpretation and navigation still is there, perhaps more so now that there are many more resources than ever before to be found.

3.23 Using things found

Finding things, and using them, often has been more the concern of the user than of the librarian in the past, it is suggested. If access in its many forms has been greatly improved via telecommunications, perhaps a shift of focus -- more toward finding and using information and away from collecting and storing it -- is in order for the profession. Not that the problems of collection and storage have been solved or are less severe: the acid-paper problem alone promises great increases, shortly, in the need for attention in these areas as well. But the most pressing need of the new telecommunications technology is for navigators: professionals who appreciate the structure and the procedures and the eccentricities of the global information "matrix" now being assembled, and can turn these to account in providing the immense capacities of telecommunications to information users.

This is a concept of library service, rather than one of libraries.[53] It emphasizes function rather than form: professional activities rather than professional status, performance rather than the elegant old buildings that used to house the performers.

This is a service already being offered in the business and professional communities, in the US and elsewhere. Professional "information brokers" -- many but not all of them trained librarians -- already command respectable hourly fees for assisting and undertaking searches of online databases for clients. Clients for such searching skills already include corporations, doctors, lawyers, and accountants, and gradually government agencies, professors on academic campuses, and libraries themselves.

[53] (See note #8, above.)

Library service, as thus defined, is very much a product of telecommunications innovations. Without telecommunications the library was to a great extent an institution that sat waiting for its patrons to come to it. Now telecommunications is creating the ability of its patrons to get to their information without "walking over to the library". Telecommunications also, however, is creating the ability of librarians to get out to their patrons. If they don't, someone else will.

Conclusion:

The development of library use of the networks over the past 15 years is an example of organizational response to technological change. There has been a response within the library community to telecommunications innovation, and the response has been positive, not just a reaction. But the response has become sidetracked, somewhat, by the imposition on the new technology of certain tasks and tendencies better-suited to the old technology which it replaced.

The old library task of producing lists is one of these anachronistic tendencies. Libraries have been so weighted down with the challenge and responsibility of "cataloging" their millions of items, according to the greatly increased capacities of the new electronic media, that they perhaps have failed to devote adequate attention to developing "uses" for that cataloging.

Cataloging is a traditional, pre-electronic network, library activity, derived from a time when the librarian's function was to provide lists of books in collections. So librarians have been distracted from fully exploiting their new electronic medium by a sense of professional responsibility, derived from an earlier era and in fact rendered somewhat obsolete by the new medium. With computers and networks one doesn't have to make endless lists. The computer can do that itself from the individual entries made during daily activities. Librarians thus are freer now to think of new, creative uses to which the relational abilities of computers and the communications abilities of networks might be put. Librarians to some extent have failed to do this: they still are stalled back at step one, using both computers and networks only to make larger and longer lists.

The exceptions to this prove the rule. Highly imaginative work is being done to synthesize the plethora of lists that has sprouted on the networks. Access to bibliographic records and to the texts that they represent is being developed in new and unique ways, taking advantage of wide area network concepts, relevance feedback theories, and some of the latest ideas of

information science and artificial intelligence. Still, most library activity on the networks consists primarily of the assembly of long book-lists, an extrapolation of a traditional professional activity in fact somewhat retrograde from the bibliographic analysis and sophisticated cross-referencing and indexing work of the generation of technology which immediately preceded the current one. This may be because of a general failure, thus far, of libraries to respond to the new capacity with a change in their organizational structure.

The current library dalliance with information technology will not be a failure, if only because the technology needs librarians so badly. No one can find anything on the networks, already. There is no indexing, no abstracting, and no cross-referencing. The most sophisticated users already complain of an inability to navigate the channels of their own creation. And this situation will increase, vastly, with the addition of essentially new media, resulting from the implementation of broadband, digitization, imaging, fulltext, and, most of all, the global inter-relationship of all the various, developing, "networks". All this will require navigators to aid the users, until the perfect day when all users are infinitely knowledgeable about all the systems, or all the systems are infinitely knowledgeable about all the users, both of which days long have been promised, and neither of which seems to be arriving soon.

These navigators may not develop from the traditional library profession, however, because of the failure to adapt suggested here. They may be drawn from other ranks, from computer science, from general research, or simply from the numbers of helpful, systems-minded individuals who have emerged to assist fellow users in using the networks to find things: every organization has one of these, and they may band together to form a new profession of "information brokers", absent the development of the same function from the library or some other pre-existing professional community.

The information-finding activity in which they will engage already involves the transfer of very large volumes of data. With the advent of online fulltext, those volumes will multiply to yield amounts many times larger. The addition of imaging and other digitization applications and forms will multiply these volumes yet again. Added to all this is the geometric increase in both the number of applications and the number of users of networked library functions, which climbs precipitously month by month. Uses which did not exist two years ago today reach tens of thousands of users all over the globe. Such various, increasing volumes of use make library applications a good subject of study for anyone interested in the telecommunications networks

generally, and anyone interested in the coming implementation of increases to their capacity, such as that promised by broadband.

Appendix

Statistics of Library use of the Networks (essay)

An essay appears here because there really are not any comprehensive statistics on either Internet or other network usage, yet. The only satisfactory "tag" which exists to trace usage to users and to particular types of use has been the IP e-mail addressing scheme, which provides addresses like "192.132.30.2", or "uk.ac.oxford.gandalf-pacx": this system is not yet of sufficient sophistication to enable researchers to identify the number of individual users attaching themselves to these addresses, much less the nature and duration of their use.

There is some hope that the CCIT X.500 directory work being done in several quarters[54] will yield at least a means of identifying network users: something better than the current one-line address, which could be that of a single user or of a campus or corporation of 100,000 users. For now, however -- like so much else about the networks -- our ability to understand them, certainly through statistics, is lagging behind rather than leading actual network growth.

We still can obtain a sense of the enormity of the networks' growth, and of the growth of library activity within it – at least of traditional library activity -- by examining the current size of library network uses, and comparing them with what we know of current network statistics overall. What follows is only an indication, then, of work that might be done in this regard. It does illustrate the significant use of the networks already being made by libraries to support a few of their traditional activities.

What follows, however, does not address libraries' and librarians' involvement in some of the network-intensive innovations that are imminent in the information field. Full-text, imaging, and multimedia -- to name only three -- all are innovations currently under development that will vastly increase the involvement of libraries, and of the information professions, in online and network activity. The statistics that follow can give some idea of the enormity of merely the bibliographic activity that until now has taken place on the library networks. The consequences of installing the complete texts -- not to speak of the accompanying images and sounds -- corresponding to the bibliographic references already online, have only begun to be imagined.

[54] The best source for a description of online network directory efforts would be a subscription to CNIDIR-L, the Coalition for Networked Information's e-conference devoted to the subject. Send to LISTSERV@UNMVM.BITNET the following e-mail message: SUBSCRIBE CNIDIR-L <your first name><your last name>.

Neither do the following statistics, moreover, address the newer activity of librarians, and of other information professionals, in assisting in the navigation of all these systems by the users. The most significant network activity of librarians will be, as it has been in the past with books, to help users of all types navigate this new medium in search of resources. Statistics for these new navigation activities thus far remain hidden in the current maelstrom of networked information growth. One hopes that they too will emerge once the dust has settled. In his time, Melvyl Dewey felt that his system would be so easy to understand as to be obvious to any book user. Today we should accept that there is only so much that expert systems and user interfaces will be able to do. Users will need navigators.

The statistics presented here are arranged in three sections, according to the following scheme:

A1.00 The Library Context

The general US picture: how many libraries, how they have been spending their money.

A2.00 Established Uses

Some examples of library use of the networks to support traditional activities.

A2.10 Cataloging: one "technical services" activity

A2.11 OCLC

A2.12 RLIN

A2.20 Catalogs: one user-oriented activity

A2.21 MELVYL

A3.00 Expanding Uses

Some new statistics indicating extensive, and expanding, library use of the networks.

A3.10 MELVYL on the Internet: one system's experience so far

A3.11 Others on the Internet: information systems

A3.12 Others on the Internet: users?

A1.00 The Library Context in the US

Some appreciation of the context within which US library and information statistics appear is needed before those statistics are presented. The US is a large country, blessed still with a large economy and a highly literate population, and is in possession of many libraries.

Before facile comparisons are made, then, between the US national experience and national efforts in other countries possessing far fewer or far more of these blessings and resources, it is a good idea to appreciate the tremendous US size differences. Size brings both advantages and disadvantages: there are economies of scale, but also problems of coordination to be reaped from large size. Any reader wishing to compare the following US statistics to her own situation would do well to remember, for example, that the experience of a country of 251 million people may not necessarily be directly applicable to a country of 50 million or of 1 billion people.

(The following statistics are derived from The Bowker Annual. Library and Book Trade Almanac 36th Edition 1991, and The Bowker Annual of Library & Book Trade Information 26th Edition 1981, ed. Filomena Simora. New Providence, NJ: R.R. Bowker, 1991, 1981.)

	1990	**1980**	**%**
Some gross, aggregate statistics:			
Population in US	251,394,000	220,415,000	14%
Total Number of US Libraries	30,871	28,665	8%
Public Libraries	14,893	14,653	2%
Academic Libraries	4,593	4,618	-1%
Armed Forces Libraries	489	485	1%
Government Libraries	1,735	1,260	38%
Special Libraries	9,051	7,649	18%
Libraries in US regions	110	113	-3%

Note to the above: There is not room here for adequate speculation upon the vagaries of these numbers, or on their real significance for our assessment here of libraries' online presence. The problems of defining "library" units, like the problems of defining "population", are well discussed in their respective literatures. The numbers are presented here merely for comparative purposes: comparisons to other national experiences, with the caveat regarding national size mentioned above, and comparisons over time, as both sets of numbers are derived from Bowker's similar statistical approach at the beginning and at the end of the decade. These gross numbers do not present, however, changing patterns of use within the libraries: if a massive shift from book-reading to remote online-fulltext reading were to take place it would not show up directly here.

	1990	1980	%
Public Library Acquisitions:	$854,203,736	$382,736,238	123%
(Surveys: 6389 libraries in 1990, 8037 in 1980)			
Books	69.5%	75.0%	-7%
Other print materials	0.9%		
Periodicals	10.2%	8.5%	20%
Manuscripts/archives	0.1%		
*AV materials	7.4%	6.3%	17%
*AV equipment	0.6%		
*Microform	1.8%	1.5%	19%
*Machine-readable materials	0.5%		
*Preservation	0.9%	1.5%	-37%
*Database fees	1.4%		
*Unspecified	6.8%	7.0%	-3%
Total for "automation" group	19.4%	16.3%	19%

Note to the above: This table is perhaps more interesting than the previous one, for what it possibly shows about changing library use patterns. A new group of statistical categories has appeared in 1990, which was not present in the 1980 survey figures, and which loosely might be categorized as an "automation" group: these are budget categories into which the many new expenditures of computerization and networking might have been fitted by beleaguered library managers. Viewed as a group, they have increased dramatically. So, however, have expenditures for periodicals, less a problem here than for academic libraries, below.

	1990	1980	%
Academic Library Acquisitions:	$1,338,619,065	$372,995,794	259%
(Surveys: 3156 libraries in 1990, 2413 in 1980)			
Books	35.80%	43.5%	-18%
Other print materials	1.30%		
Periodicals	48.00%	34.6%	39%
Manuscripts/archives	0.21%		
*AV materials	1.62%	2.6%	-38%
*AV equipment	1.03%		
*Microform	2.25%	2.3%	-2%
*Machine-readable materials	0.53%		
*Preservation	3.00%	5.5%	-45%
*Database fees	1.61%		
*Unspecified	4.55%	11.4%	-60%
Total for "automation" group	14.59%	21.8%	-33%

Note to the above: Expenditure changes during the past decade for US academic libraries have been far more dramatic than for their public library counterparts. Again, there has been an appearance of a whole new group of "automation" categories, although their overall significance appears to have receded as a percentage of the total. One explanation seems to reside in the vast increase in "periodicals" expenditures, reflecting both an increase in underlying price and the decline of the US dollar's international purchasing power during the decade, which has saddled US academic library budgets with their greatest crisis of the 1990s:

the periodicals acquisitions -- merely maintaining past levels without adding new subscriptions -- have so eaten into general acquisitions budgets that expenditures on automation, on books, and on non-acquisitions items all have been hurt.

Another possible factor, however, is the distinct advantage that academic libraries enjoy over others, in having other non-library campus computing resources on which to rely. If all the hardware, software, training classes, and general support provided by the surrounding campus to the academic library and its users were included in the above figures, the "automation" group of expenditures might be many times higher, and the academic library might be viewed as being that much deeper in its financial hole, albeit that much more efficient in the provision of its library service.

	1990
Special Library Acquisitions:	$188,378,678
(Survey: 2814 libraries in 1990)	
Books	30.77%
Other print materials	3.78%
Periodicals	39.68%
Manuscripts/archives	0.86%
*AV materials	1.64%
*AV equipment	1.08%
*Microform	2.31%
*Machine-readable materials	1.73%
*Preservation	2.70%
*Database fees	12.16%
*Unspecified	3.29%
Total for "automation" group	24.91%

Note to the above: A useful comparison might be drawn between these 1990 figures for "special" -- non-academic, non-public, non-school (i.e. corporate, professional) -- libraries, and those for their academic and public counterparts. Although periodicals loom large in this special library accounting as well, the "automation" group forms a far more significant part: nearly one fourth of total special library acquisitions expenditure, compared with 19% for public libraries and under 15% for academic libraries. Again, the "disguise" element, of academic libraries' reliance upon their general campus for much automation support, must be considered. But it would seem logical that special libraries -- in law firms, large corporations, research institutions -- might spend more on automation, particularly database searching for "time-value" information, than their public and academic counterparts.

	1988	1979	%
Academic Library Total Expenditures:	$2,770,075,000	$1,502,064,000	184%
(NCES surveys: 3438 libraries in 1988, 3000+ libraries in 1979)			
Salaries and wages	52.4%	47.3%	11%
Collection	32.2%	28.8%	12%
*Equipment	3.0%	1.1%	159%
*Preservation	1.2%	1.7%	-27%
*Postage	0.3%		
*Telecommunication	0.6%		
*Online database searches	0.6%		
*Contract computer services	2.5%		
*All other	7.2%	8.2%	-12%
Total for "automation" group	15.4%	11.0%	140%

Note to the above: These final "total expenditure" figures provide the financial context within which the "acquisition expenditure" figures discussed above appear. Total expenditures for academic libraries only are presented, because academic libraries are those apparently most severely hurt by trends in periodicals costs, and are the libraries showing the least percentage increase in "automation" acquisitions among those presented here. It appears here that automation expenditure has in fact loomed large in the overall total. Once again there are new categories to consider. But it appears that some money that might have gone to salaries and wages or to "the collection" as traditionally defined, has gone to the type of automation expense which supports network and online access.

One problem:
US Book Production and Average Prices:

	1989	1979	%
Book title production	53,446	45,182	18%
(1989, 1979, hard and trade paper, books and editions)			
Book title imports	7,315	5,458	34%
(1989, 1979, hard and trade paper, books and editions)			
Avg volume price: all hardcover	$40.61	$23.96	69%
Avg volume price: hardcover under $81	$30.08	$19.63	53%
Avg volume price: trade paperbacks	$17.16	$7.21	138%

Note to the above: The periodicals expenditure problem for US libraries already has been made apparent. Already, periodicals subscriptions are being canceled massively in the current library financial crisis. As CD-ROM and online versions of periodicals become more accessible -- as they are produced, as librarians discover and understand them, and as their pricing and access policies settle into place -- one can expect to see even more cancellations of their printed versions.

Perhaps the most significant unanswered question for US libraries today, then, is whether and to what extent their book expenditure problem might also be addressed by automation. Beyond the questions of the storage and retrieval of book-medium information, the above figures present the problem of the cost of acquiring new information held in book form. These prices

have gone up and will continue to do so. At the same time, access, via the networks, to CD-ROM and online fulltext versions of these books -- as they are produced, and as librarians discover and understand them -- is becoming less and less expensive, like most things in the computerization and online world. A break-even point may be reached. Online access soon may offer libraries an irresistible alternative to the book acquisition portion, as well as the periodicals acquisition portion, of their severely hamstrung expenditure budgets.

A2.00 Established Uses

The money which US libraries of all types has in fact spent on automation -- on computers, on software, on training – has found its way eventually into several major applications, of online network technology, to traditional library functions. Once again, this does not address non-traditional areas such as network systems design and navigation, which have yet to be organized in a manner susceptible to statistical analysis. The traditional library applications already on the networks, however, already form a significant and growing part of network traffic.

A2.10 Cataloging

The listing and cross-referencing of items in a large collection -- books and periodicals, and to some extent objects such as those found in museums and slide collections -- has been a central purpose of library work throughout its history. Cataloging also has been a major expense item in library budgets, so efforts to share catalog records among different libraries have a long history in the profession. When the potentials of online network technologies first became apparent, in the 1970s, one initial obvious application which occurred to librarians was the transfer to the networks of the job of assembling and distributing shared cataloging records. Initial small, local, consortium efforts mushroomed into giant "bibliographic utilities", which now transfer massive amounts of data on a daily basis over the networks. Some statistics for two of the largest such bibliographic utilities are presented here.

A2.11 OCLC

The Ohio College Library Consortium -- one of those original, small, local shared cataloging efforts -- grew, through a combination of management, vision, and being in the right place at the right time, into today's giant "OCLC": an organization now of over $121 million in

assets and generating over $87 million per year in revenues. From a total of 54 member libraries in Ohio in 1971, OCLC has grown to serve 13,847 libraries in 46 countries.

The following figures are taken from the OCLC Annual Report for 1990/91:

	1991	**1990**	**%**
Participating libraries	13,847	11,337	22%
Dedicated terminals/workstations online	12,460	10,940	14%
Items cataloged online	21,700,000	22,100,000	-2%
Items cataloged by tapeloading	13,200,000	5,800,000	128%
Catalog cards ordered	77,000,000	94,000,000	-18%
Online inter-library loan transactions	5,395,120	4,909,035	10%
Cataloging records added to database	1,930,000	1,910,000	1%
Location listings in database	404,000,000	365,000,000	11%
Catalog records distributed on tape	37,400,000	41,000,000	-9%
Average daily transactions	2,736,793	2,712,319	1%
Average transactions per second	66.45	65.26	2%

Several items of interest appear in these figures. The decline in "catalog cards ordered" illustrates the ongoing shift of US libraries from traditional paper cards to online media for their cataloging work. The fact that 77 million paper cards still were ordered in 1991, however, also indicates the potential for automation and online activity that still resides within the library community. The decline in "catalog records distributed on tape" also may indicate a similar technological shift: this figure may indicate the extent to which US libraries are relying more on telecommunications and less on older tape-loading procedures for transferring records of the type offered by OCLC.

Translating OCLC's reported figures into measurable impact on the networks, our primary interest here, requires the making of some assumptions. OCLC reports 2,736,793 "average daily transactions" during 1991. A typical catalog record might contain as few as 4000 bytes of information -- for minimal-MARC cataloging -- or as many as 15,000 bytes for more detailed work. An OCLC "transaction" might include between 5 and 15 records. These assumptions yield the following table:

	minimum (?) avge. record size/count	**maximum (?) avge. record size/count**
OCLC transactions/day	2,736,793	2,736,793
avge. bytes/record (?)	5,000	15,000
avge. records/transaction (?)	5	15
bytes/day	68,419,825,000 (68Gbytes)	615,778,425,000 (615Gbytes)
bits/day	547,358,600,000 (547Gbits)	4,926,227,400,000 (5Tbits)
NREN @3Gbits/sec	3,000,000,000	3,000,000,000
OCLC hours/day on NREN	3.0	27.0
OCLC hours/day on NREN, even assuming the ability to achieve 50% compression of records during transmission:	1.5	13.5

In OCLC, then, there is a single library and information work network use which alone, if its current use patterns were maximized, could consume an appreciable portion of the latest US national network pipeline capacity. OCLC would not be using a single port, and the US national network would not serve OCLC via a single pipeline; nevertheless, 1.5 to 13.5 use-hours per day would make OCLC a significant network user.

A2.12 RLIN

OCLC is not alone in its work of providing shared cataloging to libraries that can be channeled over the networks. RLG – the Research Libraries Group – a consortium of academic libraries, maintains in its RLIN system the following files, which had the following files sizes on March 16, 1992:

(This information is available online daily from RLIN.)

Bibliographic and CitaDel files:

AMC	353,662
BKS	44,972,156
EIP	1,010,596
HTE	6,071
MAP	219,310
MDF	28,038
REC	1,260,463
SCO	978,738
SER	3,425,965
VIM	173,758

Authority files:	
AAT	19,449
NAF	4,765,691
SAF	284,740
Special databases:	
AVERY	119,543
AVERY REF	44,036
CONSPECTUS	8,608
ESTC	342,673
SCIPIO	111,900
RIPD	4,232

Use of this enormous database falls into the same large orders of magnitude, as does OCLC usage. RLIN use figures for February of 1992 show a grand total of 1,253,075 searches by all users, and the monthly average during the six months ended February 1992 was 915,400, so that, using the average figure of 1 million searches per month, the following table, similar to that derived above for OCLC network traffic, might be obtained:

	minimum (?) avge. record size/count	**maximum (?) avge. record size/count**
RLIN transactions/day	33,333	33,333
bytes/record (?)	5,000	15,000
records/transaction (?)	5	15
bytes/day	833,333,333 (833Mbytes)	7,500,000,000 (8Gbytes)
bits/day	6,666,666,667 (7Gbits)	60,000,000,000 (60Gbits)
NREN @3Gbits/sec	3,000,000,000	3,000,000,000
RLIN hours/day on NREN	0.04	0.33
RLIN hours/day on NREN, even assuming the ability to achieve 50% compression of records during transmission:	0.02	.17

Neither RLIN nor OCLC need limit their activities only to shared cataloging. Both utilities, and others like them, possess the skilled staff, quality control experience, database capacity, and market presence to play pivotal roles in the development of new network applications, like fulltext, imaging and multimedia. At the same time, the availability of their traditional product -- MARC catalog records -- on the Internet now means that their own members increasingly will be tempted to form smaller, perhaps less-expensive, specialized consortia, cutting out the giant "utility" as an unnecessary middleman. Whether the combination of such trends portends either

increase or eclipse, however, the bibliographic utilities today constitute no mean or statistically insignificant presence in the communications possibilities of the networks.

A2.20 Catalogs

Actual individual library "catalogs", moreover – the resource fed and sustained by the shared cataloging services of the utilities described above -- constitute an area of network use which, already significant, also is about to undergo transformations which could increase its network usage many times. The "online catalogs" which initially merely automated the old paper card catalogs, quickly became "online public access catalogs", or "opacs", with the advent of network telecommunications. Already this activity -- remote dial-in use of online bibliographic catalogs for traditional library catalog use -- is generating large volumes of network traffic. As with the bibliographic utilities, however, most "opacs" are considering -- many already are implementing -- new applications such as full text and features of true "inter-networking" which will add greatly to present traffic. This is an area in rapid change at the moment, for which there are no precise statistics. Consideration of one example, however, and the suggestion of the wide range of additional examples which either are accompanying the first or soon are to follow, at least can indicate the enormity of the network use patterns that are developing here.

A2.21 MELVYL

The MELVYL catalog at the University of California is untypical of online library catalogs now available on the networks in several respects. It is a union catalog -- a combined record of the holdings of several different units of its institution -- rather than simply a catalog of a single physical collection. It also has added many services, to its traditional cataloging activities, which other online catalogs have yet to develop. MELVYL is, in addition, one of the oldest online library catalogs, and currently is one of the most advanced. MELVYL's statistics nevertheless can give a good indication of where large library collections in the US and elsewhere are headed, in terms of their automation and their consumption of online resources. To the extent that large collections -- like those of the Bibliotheque de France, the Library of Congress, or larger academic institutions -- might come to dominate an online library world, the experience of MELVYL is highly relevant.

The following are some of MELVYL's collection figures as of March 17, 1992 (this data may be obtained by entering the command "show cat book stats" from within the MELVYL system):

broken down by location

BOOK STATISTICS - 03/17/92	**TOTAL RECORDS: 6,642,866**
BERKELEY	3,135,285
LBL	21,883
Earthquake Engin.	7,571
LOS ANGELES	2,670,996
General Library	2,751,314
NRLF	804,566
Giannini	0
RIVERSIDE	791,667
Govt. Studies	57,004
SAN DIEGO	1,282,750
Moffitt	135,334
Central	1,007,066
Law	164,403
Biomedical	56,687
Transportation	112,478
Documents	126,018
Water Resources	42,515
Undergraduate	68,511
Scripps	57,160
DAVIS	1,115,233
SAN FRANCISCO	221,993
Main	964,237
SANTA BARBARA	1,065,184
Law	66,460
SANTA CRUZ	641,571
Health Sciences	84,536
SRLF	819,137
HASTINGS LAW	44,388
IRVINE	855,911
CAS	31,265
Main	793,746
CSL	786,004
Medical Sciences	62,165
CRL	257,922

broken down by form of record

CATALOG FORM STATISTICS -- 03/17/92

Books	6,265,869
Dissertations	297,403
Government Documents	772,433
Analytics	53,374
Non-Books	376,997
Maps	66,173
Music Scores	196,904
Sound Recordings	89,831

periodicals (a separate file within the MELVYL system) --

PERIODICAL STATISTICS - 03/17/92 TOTAL RECORDS: 811,895

BERKELEY	335,896	NRLF	71,330
General Library	229,619	RIVERSIDE	34,912
Moffitt	1,034	SAN DIEGO	46,528
Govt. Studies	19,092	Central	41,534
Grad Theol Union	7,840	Biomedical	4,994
Law	8,539	Undergraduate	662
Transportation	3,973	SAN FRANCISCO	13,104
Water Resources	2,151	SANTA BARBARA	52,723
Other Affiliated	1,731	SANTA CRUZ	23,883
DAVIS	74,412	SRLF	70,030
Main	67,213		
Health Sciences	8,881	CSL	47,344
IRVINE	31,933	CRL	39,983

Main	29,089	CAS	4,070
Medical Sciences	4,996	CSU	39,061
LOS ANGELES	213,504	GETTY	9,795
General	153,509	STANFORD	190,390
College	1,507	USC	64,851
Law	9,541		
Biomedical	15,841		

All of these numbers represent bibliographic records only. These records are available 24 hours per day, 7 days per week, and are in nearly constant use by MELVYL's own university community, as the following use statistics will show (the following data may be obtained by entering the command "show weekly stats" from within the MELVYL system):

MELVYL SYSTEM WEEKLY STATISTICS
For: 03/07/92 through 03/13/92

1.0 GENERAL STATISTICS (includes all databases)

1.1 System load

1.1.1 Total sessions:

Location	Library	Remote	Total
Berkeley	13,635	7,470	21,105
Davis	28,623	3,822	32,445
Irvine	15,473	4,165	19,638
Los Angeles	6,038	2,595	8,633
Riverside	7,172	942	8,114
San Diego	11,120	3,799	

14,919
San Francisco 7,481 554
8,035
Santa Barbara 7,149 1,484
8,633
Santa Cruz 11,072 1,588
12,660
LBL 311 588
899
LLL 6 350
356
Other - UC 530 98
628
CSL 278 0
278
CSU n/a 9
9
Other - Non-UC n/a 12,376
12,376
------- ------

108,888 39,891
148,779

1.1.2 Active users

Average number of active users in a 2 minute interval:

12-2 a.m.	17	8-10 a.m.	119	4-6 p.m.	284
2-4 a.m.	6	10-12 a.m.	263	6-8 p.m.	168
4-6 a.m.	3	12-2 p.m.	301	8-10 p.m.	150
6-8 a.m.	19	2-4 p.m.	360	10-12 p.m.	71

Maximum of active users in a 2 minute interval:
For MELVYL on 03/09/92 at 15:20:41 total number of users: 455

1.1.3 FIND commands

Number of FIND commands issued by location:
Location Library Remote
Total
-------- ------- ------

Berkeley	42,729	30,178	72,907
Davis	106,873	14,408	121,281
Irvine	51,953	13,217	65,170
Los Angeles	18,747	8,603	27,350
Riverside	26,465	2,625	29,090
San Diego	31,915	10,982	42,897
San Francisco	26,851	3,346	30,197
Santa Barbara	24,434	4,664	29,098
Santa Cruz	37,961	5,613	43,574
LBL	820	1,342	2,162
LLL	19	904	923
Other - UC	1,318	294	1,612
CSL	741	0	741
CSU	n/a	76	76
Other - Non-UC	n/a	35,560	35,560
	370,826	131,910	502,736

Average number of FIND commands per hour:

12-2 a.m.	164	12-2 p.m.	4,149
2-4 a.m.	57	2-4 p.m.	4,761
4-6 a.m.	70	4-6 p.m.	3,489
6-8 a.m.	271	6-8 p.m.	1,965
8-10 a.m.	1,730	8-10 p.m.	1,742
10-12 a.m.	3,535	10-12 p.m.	830

Peak hourly load of 5,493 FIND commands occurred on 03/09/92 at 2 pm

1.1.4 Records Displayed

Number of Records Displayed by location:

Location	Library	Remote	Total
Berkeley	399,026	282,401	681,427
Davis	795,529	147,144	942,673
Irvine	395,314	140,376	535,690
Los Angeles	151,936	95,999	247,935
Riverside	184,148	25,342	209,490
San Diego	325,855	133,771	459,626
San Francisco	311,218	21,780	332,998
Santa Barbara	202,617	47,414	250,031
Santa Cruz	295,870	45,345	341,215
LBL	5,651	27,207	32,858
LLL	71	20,691	20,762
Other - UC	10,064	2,939	13,003
CSL	4,888	0	4,888
CSU	n/a	209	209
Other - Non-UC	n/a	336,298	336,298
	3,082,187	1,328,644	4,410,831

Average number of records displayed per hour:

12-2 a.m.	2,381	12-2 p.m.	61,573

2-4 a.m.	628	2-4 p.m.	72,003
4-6 a.m.	877	4-6 p.m.	54,355
6-8 a.m.	3,624	6-8 p.m.	32,116
8-10 a.m.	24,752	8-10 p.m.	28,850
10-12 a.m.	52,225	10-12 p.m.	12,418

Total number of Records Displayed
4,410,831

Peak hourly load of 83,960 records displayed occurred on 03/10/92 at 2 pm

MELVYL's use pattern just for bibliographic records -- taken from these figures which, although only for the latest peak-season week, still indicate the gross magnitude of network use potential from this rapidly increasing service -- might be translated into online network usage as follows:

	minimum(?)avge. daily use	maximum(?)avge. daily use
records displayed: 7 days	4,410,831	4,410,831
MELVYL records/day	630,119	630,119
bytes/record (?)	2,000	10,000
bytes/day	1,260,237,429 (1Gbyte)	6,301,187,143 (6Gbytes)
bits/day	10,081,899,429 (10Gbits)	50,409,497,143 (50Gbits)
NREN @3Gbits/sec	3,000,000,000	3,000,000,000
MELVYL hours/day on NREN	0.06	0.28

Several appreciable differences exist between MELVYL's network use and that of bibliographic utilities like RLIN and OCLC. The bibliographic records transmitted by MELVYL, for instance, usually are not full MARC records -- the highly-technical, and detailed and elaborate, basic information record used by information professionals -- but truncated versions of those MARC records, designed so as to present a satisfactory "user interface" to an untrained user. MELVYL likewise lacks the ability to transmit appreciable quantities of compressed records to its users: RLIN and OCLC might make compression/decompression software available at local user terminals, either by requiring it or distributing it or by installing it in their own dedicated

workstations. Even their ability to use compression might be hampered by their increasing exposure to untrained, public use via Internet connections. But unless heroic assumptions are made about standardization of compression software and user sophistication, it seems unlikely that the normal pc-equipped, dial-in user of an online catalog like MELVYL will be able to take advantage of compression soon.

MELVYL, then, merely as one library online catalog serving traditional library catalog functions (among nearly 250 currently online on the US Internet), already is generating significant network telecommunications traffic.

A3.00 Expanding Uses

Online library catalogs like MELVYL, however, are not staying merely with their traditional bibliographic record activities any more than are the bibliographic utilities. As rapidly as time and budget will allow, MELVYL and other library systems are adding features like fulltext, independent databases of various types, campus information services, and even e-mail facilities. On many library systems now, both in the US and in Europe, any user can send and receive messages to and from the library staff, and some systems support a full and elaborate Internet connection, with all the increased network communications traffic which that implies.

A3.10 MELVYL on the Internet

A3.101 outbound

Perhaps the most interesting online catalog "added" feature, for purposes here, is the "use" command service, in operation on MELVYL and increasingly present on other library services, which sets up an invisible US Internet telnet session for MELVYL users, connecting then to an array of outside services. Currently, for example, via MELVYL's "use" command a user can reach RLIN and OCLC, two dozen other library services like those at Stanford, Harvard, and Yale, and one in Mexico, and several other online databases. The MELVYL user need not master the mysteries of "telnet": all she does is enter "use harvard" while in MELVYL, and the system establishes the telnet connection for her.

The following present one current week's worth of statistics for the MELVYL "use" command, in this case "outbound" sessions

from MELVYL users to the following resources:

MELVYL SYSTEM WEEKLY STATISTICS
For: 03/07/92 through 03/13/92

Number of USE commands issued by system:

Boston University	123
Brookhaven	36
Cal Poly, San Luis Obispo	24
Carnegie Mellon University	55
Claremont College	9
Cleveland Free-Net	1,003
CARL	285
Dartmouth College	210
DRA LC	0
GLADIS	715
Harvard	86
ITESM, Monterrey, Mexico	10
Northern Regional Lib Facility	734
NASA	305
OCEAN Information Center	79
OCLC EPIC	42
ORION	194
Pennsylvania State University	60
Princeton	193
Rennselaer Polytechnic Institute	38
RLIN	500
Stanford University	607
Triangle Research Libs. Network	0
University of Michigan	28
University of New Mexico - Gen. Lib	57
University of New Mexico	11
University of Tennessee	40
University of Delaware	39
University of Maryland	31
Virginia Polytechnic Institute	51
Yale	52
Other	25

Total number of USE commands 5,609

"USE" is a relatively-new and much under-used feature on MELVYL, as are its equivalents on other library systems. Increased use will depend on increasing user-sophistication, on the removal of various communications "bugs" which still exist

(reconciling different terminal emulation and screen-formatting conventions still presents problems), and on the development of various techniques to help the user cope with the varying command languages on the different systems to which she is connecting. It is perhaps too early to assess such true user inter-networking via library systems statistically. The suggestion is, however, that if MELVYL's own usage statistics, presented above, were projected upon the "USE" Internet connection numbers, which appear to be growing rapidly -- if MELVYL users begin using MELVYL for consulting both MELVYL records and the records and services of all these other Internet-available institutions -- the development of a considerable growth engine for networked information and telecommunications use, one of far greater capacity than anything seen so far, may be underway.

A3.102 inbound

The question then necessarily arises whether non-MELVYL users are using the Internet to seek out MELVYL? If a single online library service is generating such great network use among its own community, one wonders whether there are other online communities, outside MELVYL's, which have developed similar library telecommunications resources or at least have an interest in using them?

No more powerful or dramatic illustration of the presence of library and information systems on the networks, then -- both their current presence and their future potential -- may be provided than that obtained by scanning MELVYL's new "Internet use" statistics. These log users who "dialled in" to MELVYL from a given Internet "IP" address during a given period. The statistics are not able to account for the deficiencies of the Domain Name System, discussed elsewhere in this paper: a single "IP" address in what follows may be a machine in Berkeley to which a user has dialled from Mongolia, or it may be a "gateway" machine in Princeton through which all the users in the entire UK must come in order to reach MELVYL, or it may in fact be a machine in Mongolia. There is no way of distinguishing which of these users are UC students, faculty and staff, so generalizations may not yet be made about divisions in use between "system" and "non-system" users.

But the immense variety of addresses in the table which follows still is very impressive. There are few parts of the world -- certainly of the networked world -- which do not appear. "YALE-Spine.edu", "ILAN-HAIFA-1.net", "MURDOCH-UNIV.edu"

(Australia), and "UNINEWCASTLE.net" obviously are not local California IP addresses, and probably are not UC faculty or students. One of the favorite stories at MELVYL is of the professor at a Norwegian university who confesses that he finds it easier to call MELVYL over the Internet to do research than to trudge across the street to his university library in Norway *A2.

This variety, in the use already of this one information system, is the best indicator of the explosive potential of library networked information: one can hardly imagine the usage figures to be generated by the full development of this potential -- imagine if all the other users at each of the following IP addresses suddenly were to discover the utility of this resource and begin dialing in, and then imagine the sudden appearance of ten, or one hundred, times this number of IP addresses.

(The following information may be retrieved by entering "show in stats" from within the MELVYL system.)

Summary terminal usage data for Networks February 1992

INTERNET ADDRESS	NETWORK OR HOST NAME	SEARCHES	RECORDS DISPLAYED	IN USE HRS:MINS
13.	XEROX.com	5	246	0:19
15.	HP-internet	81	681	1:24
16.	DEC-internet	0	0	0:12
18.	MIT.edu	221	2,104	11:44
26.	MILnet	27	120	2:24
31.	UCOP.edu	0	0	0:01
35.	MERIT	638	2,631	18:35
36.	STANFORD.edu	232	1,426	22:38
38.	Unknown	5	8	0:11
128.2.	CMU-net	227	1,986	

5:12
128.3. LBL.arpa 5,060 50,590
217:32
128.5. FORD.net 8 80
0:48
128.6. RUTGERS.edu 341 4,276
19:37
128.8. UMD.edu 55 417
1:51
128.9. ISI-net 106 1,013
2:29
128.18. SRI.arpa 38 385
1:11
128.32. Berkeley.edu 69,943 803,740
2723:07
128.36. YALE-net 1 1
0:02
128.39. NTA-net 57 198
5:25
128.42. RICE-net 6 47
0:13
128.48. UCDLA-net-B 1,033 16,427
82:42
128.49. NOSCethernet 173 2,392
6:26
128.52. MIT-ai-net 8 717
1:53
128.54. UCSD.edu 28,545 311,961
1136:21
128.55. MFE-net 4 6
0:09
128.59. COLUMBIA.edu 124 666
4:47
128.60. NRL-ether.net 7 98
0:41
128.61. GAtech.edu 11 194
0:11
128.62. MCC-net 0 0
0:01
128.63. Unknown 1 19
0:17
128.82. ODU.net 62 501
2:51
128.83. UTAUSTIN.net 386 2,744
40:44
128.84. CORNELL.edu 25 493

0:29
128.86. JANET-net 235 4,282
13:21
128.89. BBN-enet 0 0
0:01
128.91. UPENN.edu 6 56
0:47
128.93. INRIA-net 0 0
0:01
128.95. WASHINGTON.edu 978 6,023
41:23
128.96. BELLCORE.com 24 186
0:39
128.97. UCLA.edu 37,353 375,412
1702:50
128.99. NORTHROP.com 6 25
0:08
128.100. TORONTO.edu 4 39
1:21
128.101. UMN.edu 28 174
2:05
128.102. AMES.arpa 20 133
3:08
128.103. HARV-fiber.net 61 482
1:28
128.104. WISC-herd 234 423
5:27
128.105. WISC.edu 9 72
0:52
128.109. NCSU.edu 441 6,587
22:23
128.110. UTAH.edu 424 3,350
22:19
128.111. UCSB.edu 4,865 46,438
190:53
128.112. PRINCETON.edu 84 930
4:45
128.113. RPI-net 126 697
2:44
128.114. UCSC.edu 63,905 555,966
2612:42
128.115. LLL.arpa 4,536 45,298
190:31
128.118. PSU.edu 75 628
5:45
128.119. UMASS.edu 11 16

0:21
128.120. UCDavis.edu 54,790 534,141
1952:17
128.121. CSC.org 0 0
0:01
128.122. NYU.edu 46 389
3:50
128.123. NMSU.edu 3 75
0:11
128.125. USC.edu 1,480 13,887
86:40
128.128. WHOI.edu 8 140
0:22
128.130. Unknown 26 62
0:37
128.135. U-CHICAGO.edu 86 1,100
3:01
128.136. Unknown 0 0
0:06
128.137. GENNET1.com 13 101
0:52
128.138. COLORADO.edu 2 16
0:04
128.139. ILAN-net 10 27
0:42
128.140. EMORY-inet 0 0
0:03
128.141. CERN-lan 5 16
0:39
128.143. VIRGINIA 61 663
2:47
128.145. NYSER-net 2 16
0:26
128.146. OHIO-state.edu 281 2,251
9:55
128.148. BROWN-univ.edu 23 215
0:44
128.149. JPL-net 32 1,159
2:33
128.151. UR-net 66 400
2:32
128.152. Unknown 1 2
0:19
128.153. CLARKSON.edu 12 71
0:51
128.155. LARC-net 70 1,048

2:25
128.163. UKY.edu 60 241
1:29
128.164. GWU-gate.net 6 30
0:24
128.165. LANL.gov 510 7,199
22:50
128.169. UTK.edu 29 137
0:50
128.171. HAWAII.edu 1,814 12,039
102:31
128.172. VCU-lan.edu 13 698
1:03
128.173. VA-TECH 21 166
0:34
128.174. UIUC-campus-b 679 5,130
34:04
128.175. UDEL.edu 61 131
1:11
128.180. LEHIGH.edu 25 149
1:30
128.181. TEKTRONIX.net 0 0
0:01
128.182. PSC.edu 0 0
0:09
128.183. GSFC-net 49 160
3:23
128.184. DEAK-inet 208 1,257
10:01
128.186. FSU.net 0 0
0:01
128.187. BYU.edu 34 331
2:25
128.189. BC-net 42 537
5:06
128.192. UGA.net 44 474
3:32
128.193. ORSTATE.edu 118 840
5:14
128.194. TAMU.net 71 442
3:04
128.195. UCIics-net 887 12,359
37:06
128.196. UNIV-ARIZ.edu 536 7,483
21:40
128.197. BU.edu 20 165

0:47
128.198. CU-Colospgs.edu 0 0
0:01
128.200. UCI.net 75,004 746,893
3511:55
128.204. AlbNYnet.edu 9 92
4:59
128.205. UBUFFALO.edu 212 2,181
9:32
128.206. MONET.net 23 161
15:03
128.210. PURDUE-ccnet 22 508
0:49
128.212. ISC-net 8 2
0:30
128.214. FU.net 581 7,075
27:26
128.220. JHU-net 6 0
0:22
128.223. UOREGON.edu 140 1,830
5:15
128.226. BINGHAMTON.edu 18 337
0:41
128.227. UF-net 3 23
0:28
128.228. CUNY.edu 14 103
1:03
128.230. SYR-Univ.edu 80 708
4:50
128.231. NIH-net 31 362
1:53
128.233. Unknown 3 16
0:12
128.235. NJIT 133 2,471
4:09
128.237. CMU-SEI-net 0 0
0:01
128.238. POLY-U-net 2 18
0:03
128.240. Unknown 0 0
0:04
128.248. UIC.edu 102 1,311
10:31
128.249. TMC.edu 1 7
0:10
128.250. UNIMELB.edu 0 0

0:06
128.252. WASHINGTON-U 81 722
4:51
128.253. CCS-net 31 498
1:16
128.255. UIOWA.edu 2 11
0:54
129.1. BGSU.edu 9 72
0:29
129.2. UMD-BOGON-net 2,494 13,442
120:15
129.6. NBS-net 3 3
0:23
129.7. UH-net 4 15
0:31
129.8. CSUFresno.edu 506 5,464
21:13
129.10. NORTHEASTERN-net 1 4
0:01
129.12. Unknown 14 152
1:13
129.13. LINK-net 0 0
0:02
129.15. UOKNOR.edu 1 0
0:09
129.16. CTH-net 9 141
1:41
129.18. NEXT-net 1 57
0:09
129.21. RIT.net 9 42
0:30
129.22. CWRU-net 385 3,023
18:14
129.24. UNM-cdcn 129 911
3:54
129.25. DREXEL.net 7 3
0:50
129.28. ETA-lan.net 5 5
0:05
129.29. USMA.net 0 0
0:01
129.31. Unknown 0 0
0:02
129.32. TEMPLE.edu 19 32
0:19
129.33. IBM-Almaden.net 8 70

0:51
129.34. IBM-Watson.com 4 20
0:12
129.46. QUALnet 88 699
2:21
129.49. SUNY-sb.net 12 88
1:23
129.55. LINCOLN-mi.net 41 466
1:00
129.59. VANDERBILT.edu 18 185
1:40
129.60. Unknown 6 47
0:10
129.62. Unknown 0 0
0:03
129.63. ULOWELL.edu 2 4
0:04
129.64. BRANDEIS.net 145 2,351
3:07
129.65. CALPOLY.edu 2,126 17,324
120:32
129.66. ASN-net 0 0
0:01
129.67. Unknown 24 720
1:10
129.69. RUS-net 21 202
0:48
129.70. Unknown 3 7
0:06
129.71. WVNET.edu 62 1,905
4:33
129.74. NOTRE-DAME 25 157
1:17
129.78. SYD-net 35 646
1:33
129.79. INDIANA.net 53 1,168
2:50
129.81. TULANE.edu 1 2
0:06
129.82. CSU-net 10 84
0:25
129.89. MILW-ipnet 116 1,331
5:13
129.93. HUSKERnet 129 1,733
6:54
129.97. UWnet 15 177

0:53
129.99. NAS.net 6 155
0:10
129.100. UWO-net 5 41
0:33
129.101. IDAHO.engr-net 65 114
1:42
129.105. NWU.edu 114 1,154
3:59
129.106. UTHouston.edu 1 0
0:01
129.107. UTARLINGTON-net 130 9,673
14:03
129.108. OTS.net 1 1
0:19
129.110. UTDallas.edu 40 288
1:35
129.112. UTSWMED-net 18 182
0:55
129.115. Unknown 3 1
0:09
129.117. THENETMN 0 0
0:04
129.118. TTU.net 136 907
22:07
129.120. UNTexas.edu 45 1,016
3:30
129.122. PRIME.net 0 0
0:01
129.123. USU-net 0 0
0:01
129.125. RUG-net 11 110
0:46
129.126. KODAK.com 0 0
0:01
129.127. ADELAIDE-UNI.edu 12 42
0:45
129.128. U-ALBERTA.edu 8 25
2:06
129.130. KSUnet 26 99
0:47
129.132. ETH-ETHER.net 6 13
0:25
129.137. UN-OF-CINCI.edu 4 23
0:16
129.142. DE.net 64 284

1:55
129.143. BELWUE-net 1 0
0:05
129.170. DART.ether-net 78 308
9:32
129.171. MIAMI.net 28 584
4:35
129.172. ROK-net 1 56
0:02
129.173. DAL-net 397 584
9:15
129.174. MASO-net 37 698
2:37
129.177. BERGEN-net 429 3,466
18:07
129.186. CYCLONE-net 24 641
1:51
129.187. BAVARIAN-net 5 8
0:10
129.188. MOTOROLA.com 7 17
0:11
129.189. ICOnet-ORC 15 53
0:17
129.192. Unknown 0 0
0:02
129.193. TRW-ed-net 23 704
1:30
129.194. UNIGE-CENTER.net 60 312
1:46
129.197. Unknown 3 4
0:38
129.206. HD-net 82 1,097
2:34
129.210. Unknown 92 591
3:49
129.212. Unknown 12 155
0:22
129.217. Unknown 0 0
0:01
129.219. ASU.net 1,755 12,083
136:46
129.221. Unknown 0 0
0:01
129.237. JAYHAWK-net 155 2,174
8:12
129.240. UIOnet 29 333

0:52
129.241. UNITnet 86 641
6:09
129.244. KEH-net 305 1,545
11:48
129.245. PAC-BELL.com 13 82
0:16
129.252. SCAROLINA-net 28 331
1:47
130.13. USWEST-net 0 0
0:01
130.14. NLM-ether 31 601
2:01
130.15. QUEENSU-net 14 81
1:11
130.17. CSUStan.edu 45 1,131
2:23
130.18. MSSTATE.edu 85 678
3:17
130.20. PNL-net 4 144
0:13
130.21. PRIME-CV.net 8 144
0:18
130.33. SARNOFF.net 59 105
0:21
130.39. TIGERlan 31 213
1:06
130.43. APPLE-net 15 88
0:45
130.44. AMS-net 2 1
0:04
130.46. DTRC-B1-net 59 1,235
1:05
130.49. U-PITT.edu 9 255
14:07
130.50. RISC.net 0 0
1:37
130.56. ANU-net 1 21
0:02
130.57. EXCELAN.net 0 0
0:03
130.58. SWARTHMORE.edu 5 7
0:34
130.60. UNIZH.net 8 58
0:11
130.62. MIPS.net 21 479

0:51
130.63. YORKU-net 28 346
4:09
130.64. TUFTS-net 17 60
1:03
130.65. SJSU-net 134 710
2:57
130.68. MSCnet 0 0
0:01
130.69. UTOKYO-net 0 0
0:03
130.70. USL.net 2 92
0:28
130.71. STOLAF.edu 13 58
0:38
130.75. Unknown 0 0
0:01
130.82. UNISG-net 29 219
0:57
130.83. Unknown 12 797
1:03
130.85. UMBC-net 4 1
0:55
130.86. CSUSac.edu 1,261 12,977
67:08
130.88. Unknown 6 46
1:00
130.92. UNIBE-net 8 31
0:25
130.95. UWA-net 1 46
0:01
130.99. 3M-net 0 0
0:05
130.100. Unknown 3 4
0:21
130.101. UAKRON.edu 0 0
0:01
130.102. UQ-net 3 37
0:04
130.108. WRIGHT-STATE.net 0 0
0:01
130.111. UMAINE-SYS.edu 262 1,576
10:12
130.113. MCMASTER-net 3 7
0:06
130.115. Unknown 2 36

0:11
130.118. GEOMEN.net 76 2,165
6:10
130.123. Unknown 7 6
0:17
130.127. CLEMSONU.net 0 0
0:11
130.130. UOW-net 0 0
0:04
130.132. YALE-Spine.edu 74 951
3:56
130.133. Unknown 1 12
0:10
130.149. TUB-net 5 160
0:27
130.150. CSUnet-ip 5,178 41,884
231:55
130.157. SONOMA-STATE.edu 977 14,958
59:59
130.159. Unknown 0 0
0:01
130.160. UA-net 42 406
1:12
130.161. DUT-lan.net 13 122
1:05
130.166. CSUN.net 375 3,824
32:00
130.167. STSCI-net 0 0
0:01
130.179. UMANITOBA.edu 52 298
2:38
130.182. CSULA-net 70 811
3:21
130.184. RAZOR.net 93 635
2:49
130.191. SDSU-net 2,059 24,668
92:07
130.194. MONASH-net 246 839
6:09
130.195. VUW-net 2 1
0:03
130.199. YAP-net 6 208
0:18
130.202. ARGONNE-net 83 755
2:05
130.206. IRIS-net 258 1,160

10:53
130.207. GIT.net 0 0
0:02
130.212. FOG.net 1,627 13,134
62:12
130.215. WPI-net 6 22
0:27
130.216. Unknown 3 2
1:26
130.221. AERO-net 27 1,417
0:52
130.223. UNIL-net 31 136
2:05
130.225. Unknown 13 64
0:30
130.231. Unknown 17 18
1:43
130.232. TURBO.net 6 20
0:13
130.233. HU-net 7 19
0:19
130.234. Unknown 2 11
0:05
130.235. LU.net 32 161
2:01
130.237. KTH-lan.net 7 31
0:26
130.238. UU-net 0 0
0:02
130.239. UMU-net 2 48
0:22
130.240. LUTH-net 7 10
0:08
130.252. TANDEM-net 2 0
0:01
130.253. DENVERU-net 21 324
0:53
130.254. Unknown 18 193
0:42
131.1. ICO-net 0 0
0:01
131.18. Unknown 0 0
0:01
131.74. Unknown 0 0
0:01
131.91. FAU-net 0 0

0:15
131.94. FIU-net 138 1,307
3:22
131.95. USM-net 1 53
0:11
131.96. Unknown 1 233
0:30
131.104. UOGUELPH.net 0 0
0:01
131.105. SM-ALC.net 33 232
3:05
131.107. Unknown 1 0
0:01
131.108. CISCO-system 0 0
0:02
131.111. Unknown 36 615
22:14
131.114. PISA-net 1 4
0:16
131.118. MINC-net 3 5
0:20
131.119. BARR-net 0 0
0:02
131.120. NPS-net 42 317
3:49
131.121. NADN-net 0 0
0:04
131.123. KENT-state.edu 10 55
0:15
131.128. URI.edu 2 2
0:02
131.130. UNIVIE.net 107 867
6:55
131.131. CONTEL-WTP.net 17 113
0:18
131.144. PEACH-net 53 499
4:07
131.146. MDC-SJ-net 0 0
0:01
131.152. UNIBAS.net 4 19
0:04
131.154. Unknown 1 4
0:18
131.156. NIU-net 0 0
0:02
131.162. AU-net 0 0

0:07
131.169. DESY-net 48 193
4:12
131.170. RMIT-net 0 0
0:01
131.172. LATROBE.net 110 503
3:18
131.173. UOS-net 2 0
0:01
131.174. NU-net 23 76
0:46
131.175. CILEA-net 71 228
3:01
131.177. Unknown 1 12
0:10
131.178. ITESM 8 7
1:10
131.179. UCLA-cs 497 8,921
17:16
131.181. QUT-net 0 0
0:01
131.183. UTOLEDO.edu 15 122
1:07
131.185. Unknown 0 0
0:01
131.193. UIC-ISN-net 24 255
0:48
131.194. Unknown 5 17
0:32
131.202. UNB-IP.net 81 206
3:45
131.203. DSIR-net 0 0
0:01
131.204. AU-net 3 10
0:06
131.210. UW-PARKSIDE.net 6 65
0:41
131.212. UMNdul.net 36 380
1:23
131.215. CALTECH.edu 2,018 19,970
78:28
131.216. NEVADA.edu 571 1,303
5:51
131.217. TASUNI-net 3 13
0:02
131.220. UNI-BONN.net 1 2

0:05
131.225. FERMILAB-net 24 451
0:48
131.229. Unknown 8 41
0:11
131.230. SIU-net 16 250
0:57
131.231. Unknown 0 0
0:04
131.236. ADFA-net 16 94
0:34
131.239. THINK-net 42 199
2:58
131.243. LBL-ip-net2 416 3,644
19:33
131.246. RHRK-LAN.net 258 2,943
12:24
131.252. PDX-net 67 1,191
2:15
132.64. IL1.net 45 493
2:00
132.66. IL3-net 9 89
0:30
132.68. ILAN-TECHNION-1.net 0 0
0:01
132.72. IL9-net 35 612
4:11
132.74. ILAN-HAIFA-1.net 10 52
0:29
132.76. IL13-net 0 0
0:15
132.156. Unknown 0 0
0:01
132.161. Unknown 31 453
1:39
132.162. OBERLIN.edu 18 167
0:29
132.170. UCF-net 7 10
0:09
132.174. OCLC-net 11 178
0:32
132.178. IDBSU 19 150
0:58
132.180. Unknown 0 0
0:01
132.192. Unknown 59 342

1:13
132.194. CUDENVER.edu 6 5
0:45
132.198. UVM-net 22 104
0:21
132.199. UNIR-lan 1 4
0:06
132.201. SBC.net 0 0
0:01
132.204. UMONTREAL.edu 140 1,277
5:52
132.205. CONCORDIA.net 42 699
6:22
132.206. MCGILL-CA.net 297 1,724
10:30
132.207. POLYTECHCA.edu 0 0
0:04
132.225. Unknown 0 0
0:02
132.230. FDN-net 4 55
0:34
132.235. OHIOU-net.edu 1 340
0:16
132.239. UCSD-subnets 17,415 187,035
649:48
132.241. CSUChico.edu 238 1,522
15:57
132.248. REDUNAM.net 8 25
0:23
132.249. SDSCLAN-net 126 1,497
6:41
132.254. ITESM-MEXICO.net 129 1,445
10:04
133.3. Unknown 2 23
0:37
133.5. Unknown 1 2
0:01
133.9. Unknown 5 142
0:08
133.24. Unknown 1 4
0:04
133.138. JAPANB-INET138 72 1,202
1:57
133.164. Unknown 1 19
1:44
134.2. TUE.net 138 3,436

9:03
134.7. CUT-net 29 201
0:43
134.9. OCF-net 9 12
0:06
134.10. REED-net 19 118
0:33
134.24. CERF-net 18 101
0:42
134.28. Unknown 3 7
0:19
134.29. MSUS-net 791 9,795
17:10
134.34. KISS-net 0 0
0:01
134.48. MARQUE-net 5 7
0:16
134.50. ISU-net 38 314
1:45
134.59. Unknown 16 143
0:38
134.68. IUPUI.edu 0 0
0:01
134.69. OXY.edu 275 1,847
8:53
134.71. CSUPom.edu 33 223
1:21
134.75. KREO-net 5 117
1:29
134.76. Unknown 108 884
2:15
134.83. Unknown 3 37
0:24
134.87. BCnet-2 45 488
2:50
134.88. Unknown 0 0
0:06
134.91. UNIDUI-lan 0 0
0:02
134.95. UNI-KOELN.net 1 5
0:03
134.96. UNISB-lan 1 3
0:04
134.99. Unknown 0 0
0:01
134.102. Unknown 21 151

0:54
134.105. MPIS-lan 3 18
0:14
134.106. Unknown 2 0
0:05
134.108. Unknown 1 7
0:05
134.114. NAU-net 0 0
0:02
134.115. MURDOCH-UNIV.edu 3 3
0:07
134.118. Unknown 0 0
1:06
134.120. Unknown 29 327
2:44
134.121. WSU-net 119 1,300
3:35
134.124. MOR-net 100 709
3:23
134.126. JMU-net 28 146
1:35
134.129. NODAK-net 4 22
0:17
134.130. ACHSE.net 159 3,423
13:25
134.139. CSULB-IP.edu 175 1,467
6:47
134.148. UNINEWCASTLE.net 320 1,343
6:44
134.153. Unknown 105 327
2:39
134.154. CSUHayward.edu 245 1,796
9:31
134.155. RUMEL-net 63 210
5:43
134.161. UNI-net 0 0
0:05
134.172. IG-net 6 16
0:17
134.173. CLAREMONT.edu 1,809 17,654
87:55
134.174. LMA-net 45 367
2:18
134.186. TDC-net 40 362
1:07
134.187. TEALE-net 1 5

0:35
134.193. UMKC-net 66 350
1:47
134.197. UNR-DOM.net 456 4,873
21:17
134.198. UOFSCRANTON.edu 1,175 11,080
22:09
134.202. Unknown 1 6
0:09
134.205. Unknown 1 17
0:16
134.214. Unknown 2 2
0:01
134.223. GRUMMAN.lan 0 0
0:01
134.231. GALLAUDET.net 8 27
0:18
134.241. MASS.net 5 27
0:30
134.250. SUSC-net 47 152
1:38
134.252. SNL-netC 1 2
0:01
136.145. CUN.edu 35 132
2:31
136.159. U-CALGARY.edu 76 1,142
3:06
136.165. Unknown 3 150
0:15
136.167. BC-net 0 0
0:01
136.168. CSUB-net 184 1,702
7:46
136.176. BRADLEY-net 5 11
1:04
136.177. GEO.net 0 0
0:13
136.183. Unknown 0 0
0:01
136.199. UNI-TRIER.net 0 0
0:12
136.200. DWR-net 122 1,660
3:39
136.242. CUAS-net 0 0
0:02
136.244. Unknown 29 106

0:46
137.22. CARLETONS.net 183 1,567
7:50
137.28. UWEC.net 23 2,087
2:43
137.43. UCD.net 5 22
0:12
137.48. UNOMAHA.edu 7 128
0:42
137.52. NOVA-net 3 37
0:09
137.53. OHSU.net 8 27
0:14
137.56. KUBnet-B 1 3
0:02
137.66. MN-SUPER-net 24 469
1:51
137.67. NWAC-net 9 6
0:16
137.79. Unknown 3 15
0:08
137.82. UBC-net 289 1,849
9:56
137.92. CANBERRA-UNI.edu 0 0
0:05
137.99. UCONN.edu 3 0
0:02
137.111. MACQUARIE.net 42 142
1:07
137.120. Unknown 0 0
0:01
137.122. Unknown 22 35
0:23
137.131. SCRIPPS-BIG-net 46 332
2:15
137.132. Unknown 58 1,659
5:07
137.134. Unknown 9 90
0:15
137.142. Unknown 3 3
0:10
137.145. CALI-net 0 0
0:01
137.146. COLBY-net 7 26
0:36
137.147. TRL-net1 2 2

0:04
137.149. UPEI-net 0 0
0:05
137.150. HSU.net 2 0
0:48
137.151. FUL-net 244 2,893
9:41
137.154. UWS-net 0 0
0:01
137.159. Unknown 75 800
3:23
137.165. WILLIAMS-net 19 593
1:45
137.168. Unknown 4 45
0:17
137.189. Unknown 41 739
1:52
137.190. WEBER-net 17 28
0:58
137.197. UNMC-net 34 119
0:57
137.204. Unknown 4 25
0:27
137.205. Unknown 8 261
0:22
137.208. Unknown 9 93
0:27
137.216. Unknown 7 19
0:18
137.226. ACHSES-net 24 291
0:20
137.229. ALAKA-net 45 294
1:35
137.238. Unknown 29 283
1:30
137.249. FAC-com 0 0
0:01
138.9. UOP-net 354 4,172
22:53
138.15. NEC.com 13 58
0:16
138.23. UCR-net 12,160 131,049
509:06
138.28. KENYOUN.net 76 873
4:36
138.38. Unknown 12 34

0:29
138.47. Unknown 2 65
1:10
138.67. CSM-net 11 462
1:08
138.73. Unknown 0 0
0:13
138.74. Unknown 15 329
1:44
138.75. LINCOLN-lan-1 39 862
1:55
138.77. UCQ-net 7 37
0:38
138.80. NTU-net 10 41
0:23
138.87. Unknown 5 149
0:21
138.96. FNET-SOP-B.net 9 109
0:45
138.108. Unknown 5 181
0:08
138.110. Unknown 40 226
1:48
138.119. UNBSJ-IPnet 2 9
1:15
138.202. USFCA-net 212 1,570
7:59
138.232. Unknown 9 14
0:12
138.234. Unknown 37 246
2:12
138.236. GAC-net 1 7
0:02
138.237. TCU-net 2 142
0:30
139.67. EIU-UCAN-net 103 189
4:07
139.82. Unknown 5 14
0:34
139.91. FORTH-net 6 52
0:49
139.102. INDSTATE-net 75 1,289
7:59
139.104. DISNEY.net 10 74
0:25
139.121. SAIC.net 27 461

1:27
139.127. SUNYHSCSYR-net 0 0
0:01
139.135. Unknown 2 5
0:06
139.140. BOWDOIN.net 19 167
1:24
139.147. LAFAYETTE-net 2 25
0:13
139.174. Unknown 8 35
0:28
139.182. CSUSB-net 83 873
3:49
140.77. ENS-LYON.net 55 237
0:47
140.78. Unknown 4 30
0:05
140.88. BETHEL-edu 20 273
1:22
140.92. Unknown 7 129
0:11
140.96. Unknown 0 0
0:07
140.103. Unknown 12 239
0:18
140.104. CARROLL-net 0 0
0:04
140.105. TRIESTE-net 16 233
0:32
140.109. Unknown 28 273
10:07
140.112. Unknown 4 7
0:12
140.113. Unknown 197 663
6:49
140.114. Unknown 24 92
0:47
140.115. Unknown 39 367
3:15
140.117. Unknown 10 32
1:15
140.120. Unknown 2 26
0:17
140.123. Unknown 7 12
0:26
140.146. Unknown 2 17

0:34
140.147. LOC.net 19 525
1:45
140.148. UDLAP.net 866 2,962
45:59
140.158. LAMAR-net 13 52
0:22
140.160. WNU-edu 70 285
4:46
140.164. CNR-NA.net 10 32
0:22
140.174. Unknown 0 0
0:05
140.180. PU-DORM.net 3 60
1:26
140.181. GSI-DE.net 3 100
0:27
140.184. Unknown 1 3
0:12
140.192. Unknown 2 8
0:11
140.198. MARICOPA-net 18 161
1:13
140.209. STTHOMMN-net 20 166
0:39
140.214. MP-REC.net 73 974
5:47
140.221. Unknown 10 69
0:15
140.225. STKATE-net 21 43
0:40
140.226. Unknown 10 51
0:24
140.228. ONU-net 6 7
0:28
140.232. CLARKU.edu 11 18
0:34
140.233. Unknown 41 477
2:08
141.108. Unknown 3 24
0:13
141.109. X.net 16 123
0:31
141.112. Unknown 19 49
0:51
141.117. Unknown 104 578

1:53
141.138. Unknown 95 285
2:24
141.165. Unknown 0 0
0:53
141.166. UOFR-net 18 131
0:17
141.201. Unknown 226 1,098
7:40
141.209. CMICH-net 291 1,127
8:27
141.210. OAKLAND-net 7 138
0:41
141.211. UM-net1 134 842
6:03
141.218. Unknown 2 3
0:07
141.222. SKIDMORE-net 7 30
0:15
141.225. MEMST-net 89 608
4:00
141.233. UWOSH-net 20 248
0:47
141.248. GASD-net 183 2,374
20:40
142.3. Unknown 4 19
0:09
142.4. Unknown 0 0
0:13
142.23. Unknown 0 0
0:05
142.31. Unknown 0 0
0:10
142.32. Unknown 20 84
0:41
142.66. Unknown 38 1,091
4:51
143.43. Unknown 5 404
1:29
143.44. Unknown 60 370
1:49
143.48. CSHLAB2.edu 2 3
0:03
143.50. Unknown 3 36
0:07
143.89. Unknown 22 155

1:00				
143.105.	Unknown	11	278	
0:50				
143.107.	USP-ANSP.net	0	0	
0:04				
143.108.	ANSP-net	14	33	
0:27				
143.117.	Unknown	3	33	
0:46				
143.132.	Unknown	3	35	
0:23				
143.169.	Unknown	122	566	
15:45				
143.197.	Unknown	35	535	
1:52				
143.207.	Unknown	0	0	
0:01				
143.229.	Unknown	27	361	
2:10				
143.233.	Unknown	21	334	
3:07				
144.13.	Unknown	12	87	
0:39				
144.30.	Unknown	42	95	
0:47				
144.37.	Unknown	424	2,920	
22:19				
144.38.	Unknown	0	0	
0:01				
144.90.	Unknown	4	10	
0:54				
144.91.	Unknown	54	305	
1:51				
144.92.	Unknown	2	33	
0:26				
144.96.	Unknown	4	106	
0:11				
144.110.	Unknown	20	76	
0:37				
144.125.	Unknown	2	6	
5:01				
144.126.	Unknown	1	3	
0:07				
144.171.	Unknown	0	0	
0:02				
146.83.	Unknown	13	40	

1:08				
146.88.	Unknown	1	10	
0:19				
146.96.	Unknown	15	116	
0:51				
146.97.	Unknown	6	10	
0:06				
146.154.	Unknown	27	53	
0:37				
146.163.	Unknown	1	40	
0:13				
146.169.	Unknown	12	52	
0:20				
146.202.	Unknown	241	1,853	
9:51				
147.8.	Unknown	58	298	
3:56				
147.9.	Unknown	0	0	
0:01				
147.11.	Unknown	39	288	
0:50				
147.26.	Unknown	16	52	
0:46				
147.28.	Unknown	30	97	
1:08				
147.32.	Unknown	19	143	
3:15				
147.52.	Unknown	123	1,812	
5:26				
147.92.	Unknown	15	167	
1:32				
147.96.	Unknown	39	773	
2:08				
147.126.	Unknown	10	123	
0:19				
147.162.	Unknown	27	436	
2:47				
147.171.	Unknown	8	25	
0:28				
148.59.	Unknown	9	55	
0:08				
148.81.	Unknown	1	8	
0:02				
148.85.	Unknown	72	608	
1:31				
148.201.	Unknown	2	35	

0:06				
149.4.	Unknown	24	72	
0:21				
149.31.	Unknown	15	0	
0:21				
149.130.	Unknown	3	8	
0:07				
149.137.	Unknown	6	67	
0:39				
149.152.	Unknown	20	183	
0:53				
149.171.	Unknown	5	63	
0:43				
149.175.	Unknown	13	189	
0:42				
150.105.	Unknown	13	129	
0:18				
150.128.	Unknown	6	70	
0:12				
150.145.	Unknown	4	19	
0:13				
150.188.	Unknown	1	1	
0:23				
150.203.	Unknown	29	196	
1:35				
150.212.	Unknown	172	1,211	
5:09				
150.216.	Unknown	3	38	
0:19				
150.252.	Unknown	15	65	
0:39				
151.159.	Unknown	33	216	
0:48				
152.1.	Unknown	128	473	
6:27				
152.2.	Unknown	42	699	
2:57				
152.10.	Unknown	4	4	
0:39				
153.18.	Unknown	3	42	
0:12				
153.106.	Unknown	6	18	
0:04				
155.68.	Unknown	6	250	
0:33				
155.135.	Unknown	72	760	

3:27
192.4.13. MRE-merlot.net 37 73
0:43
192.5.14. RAND-net 330 1,592
5:09
192.5.23. Unknown 23 44
0:33
192.5.65. NPRDCTRCFnet 102 1,705
7:06
192.5.166. GAT-net 17 504
0:22
192.9.9. SUN-BARRnet 22 387
1:15
192.12.10. THENETDFW.net 3 117
0:37
192.12.12. SANTAFE-net 4 41
0:15
192.12.69. UA-CS-net 6 77
0:47
192.12.72. Unknown 0 0
0:01
192.12.216. STEVENS.tech-net 2 17
0:14
192.20.225. Unknown 10 70
0:19
192.20.239. ATT-MD.com 40 372
0:54
192.31.112. TRINCOLL.net 24 101
0:38
192.31.146. UCR.edu 137 1,443
6:54
192.31.153. SALKnet 1,744 18,071
59:57
192.31.215. MONTANA.net 71 647
15:15
192.33.4. NYSERlan 29 345
2:37
192.33.12. Unknown 37 251
1:20
192.33.156. Unknown 11 162
0:51
192.35.44. GECRD-ISO.net 31 332
1:28
192.35.49. Unknown 1 10
0:09
192.35.226. UCDLibraries.edu 6,560 35,484

367:55
192.35.236. Unknown 25 1,025
0:18
192.41.245. IIT.edu 34 190
0:58
192.42.75. Unknown 26 352
2:27
192.42.82. SCRIPPS.edu 584 3,008
13:46
192.42.94. Unknown 29 214
1:52
192.42.113. SARA-net2 125 1,400
2:41
192.42.142. ICASE-net 25 273
0:50
192.42.201. Unknown 7 65
0:08
192.42.239. FIT-net 27 287
1:19
192.48.33. HAC-GATE-net 31 203
0:19
192.48.153. SGI-net 55 688
0:59
192.48.211. SEATTLEU-net 22 300
0:30
192.52.218. UNIONCOLLEGE.edu 13 41
0:28
192.54.81. CARL-net 3,779 41,035
413:48
192.54.130. WCC-net 0 0
0:06
192.54.238. Unknown 100 651
3:40
192.55.87. USD-net 330 3,137
13:34
192.55.228. Unknown 2 56
0:11
192.55.229. USCOLO.net 5 81
0:11
192.55.234. YSU-net 21 229
1:27
192.58.150. AIP.net 23 122
0:25
192.58.194. BNR-GATE.net 15 193
0:55
192.58.204. GRID.net 19 377

0:45
192.58.221. UCB-LOCAL.edu 46,261 377,179
1512:14
192.65.81. SIPLAN.net 0 0
0:01
192.65.129. Unknown 13 68
0:31
192.65.131. SIAM-lan1 11 65
0:34
192.65.218. DRA-STL.net 78 381
2:58
192.65.245. MWC.net 485 5,851
17:16
192.67.99. Unknown 76 697
3:59
192.67.131. Unknown 6 186
0:27
192.67.165. ASUHYPER.net 13 57
2:20
192.68.161. NOAA-PMEL.net 19 245
1:01
192.68.223. Unknown 498 4,612
39:19
192.70.169. Unknown 12 75
0:12
192.70.225. Unknown 549 4,671
29:24
192.70.249. Unknown 335 3,882
14:35
192.70.253. COLO-COLLEGE.edu 25 113
1:06
192.73.48. UMT-net 29 64
1:00
192.73.61. Unknown 824 9,228
31:26
192.73.63. STX-net 29 679
3:02
192.73.75. Unknown 13 25
0:19
192.73.220. GORDIAN-net 61 443
2:06
192.74.137. STD-net 76 597
1:41
192.75.10. PFC-net 328 725
11:32
192.75.14. Unknown 3 4

0:05
192.75.64. Unknown 9 87
0:21
192.75.156. Unknown 163 1,660
6:26
192.75.177. Unknown 462 3,987
15:13
192.76.183. Unknown 996 7,174
31:27
192.76.239. Unknown 141 1,832
3:16
192.77.116. Unknown 15 60
0:55
192.77.143. Unknown 23 32
1:01
192.80.10. CRC-net 2 2
0:02
192.80.56. Unknown 3 34
0:11
192.80.94. Unknown 12 136
1:48
192.82.109. IGC-net 25 198
1:31
192.82.111. UCDAVIS1.edu 121 724
4:05
192.82.113. TACOM-lan 16 143
0:50
192.82.120. Unknown 32 468
1:20
192.83.166. Unknown 36 537
2:53
192.84.12. Unknown 1,071 9,556
34:49
192.84.136. Unknown 3 20
0:07
192.84.225. Unknown 18 112
0:29
192.84.231. Unknown 7 51
0:24
192.88.122. Unknown 15 466
12:29
192.88.144. Unknown 8 111
1:10
192.88.240. Unknown 4 10
0:29
192.92.77. Unknown 0 0

0:11
192.92.124. Unknown 16 151
34:35
192.93.2. Unknown 2 34
0:13
192.93.100. Unknown 29 126
1:09
192.94.29. Unknown 24 211
0:37
192.94.119. Unknown 26 222
1:19
192.100.16. Unknown 27 177
1:32
192.100.81. Unknown 152 2,174
5:10
192.100.94. Unknown 28 1,303
1:39
192.101.147. Unknown 75 792
2:33
192.102.5. Unknown 11 28
0:35
192.102.94. Unknown 42 348
0:42
192.102.249. Unknown 150 1,161
5:50
192.103.20. Unknown 527 6,650
28:33
192.103.41. Unknown 34 365
1:24
192.104.1. Unknown 137 601
4:35
192.104.173. Unknown 20 89
0:36
192.104.174. Unknown 6 51
0:10
192.107.39. Unknown 130 321
4:28
192.107.180. Unknown 58 196
1:53
192.108.16. Unknown 3 8
0:13
192.108.106. Unknown 78 419
2:34
192.108.246. Unknown 53 786
1:46
192.111.214. Unknown 16 243

1:07			
192.112.50.	Unknown	178	1,768
9:32			
192.124.98.	Unknown	27	305
1:18			
192.124.116.	Unknown	16	187
1:46			
192.131.1.	Unknown	1,476	11,935
64:07			
192.131.98.	Unknown	44	560
1:18			
192.131.127.	Unknown	26	144
1:46			
192.131.253.	Unknown	43	497
1:33			
192.133.72.	Unknown	188	992
4:35			
192.133.129.	Unknown	74	716
2:09			
192.135.131.	Unknown	52	1,008
4:00			
192.135.238.	Unknown	24	225
1:09			
192.138.161.	Unknown	204	1,830
8:35			

A3.11 Others on the Internet

To the already-enormous picture presented by MELVYL's network presence, then, must be added the whole of which it is but a part. Nearly 250 library and information services like MELVYL currently may be reached via the Internet. Most represent smaller library book collections; some represent larger. Most still are only catalogs, offering fewer other services than does the MELVYL system currently; a few offer more. The potential, then, is not only for the many thousands of US libraries which are not yet Internet-accessible to become so -- all of them are "automating" in one form or another, and the addition of telecommunications capacity is a rather small marginal addition to the automation expense, and is becoming smaller -- but also for those libraries to add the community bulletin boards, fulltext databases, and other "non-catalog" features which MELVYL and other large systems already are offering.

The following is one of the leading lists of Internet-

accessible library systems. As each of the resources shown here attain usage figures which approach those of MELVYL, we can expect demands for network communications capacity far in excess of anything heard today. The MELVYL system is only one entry in the long list which follows.

(The following file -- its full, newly-updated versions, which include connection addresses and details -- can be obtained via the Internet per the following instructions:

"The Catalog is accessible by using FTP and will shortly be available as a package for Bitnet users. Two versions of the Catalog may be retrieved using FTP: ascii and Postscript. A WAIS version will appear shortly on those hosts with WAIS servers. To retrieve either of the two versions, FTP to ariel.unm.edu, login as anonymous and "cd" to the directory "library" There you'll find the files "internet library" (ascii) and "library ps" (Postscript). Mark Resmer's LIBTEL script also reflects this most recent release of the Catalog.")

Internet - Accessible Library Catalogs & Databases
April 16, 1991

Dr. Art St. George, University of New Mexico
Dr. Ron Larsen, University of Maryland
Edited by Carlos Robles, CERFnet

Catalogs & Databases Accessible Without Charge

ALABAMA
Auburn University
CALIFORNIA
California State University, Fresno
California State University, Long Beach
Cal Poly State University, San Luis Obispo
Occidental College's Automated Library System (Oasys)
The University of California, MELVYL(Catalog
University of California, Berkeley - GLADIS
COLORADO
Colorado Alliance of Research Libraries - CARL
CONNECTICUT
Yale University

DELAWARE
University of Delaware Libraries DELCAT
FLORIDA
Florida's State University System
GEORGIA
Emory University
Georgia State University
HAWAII
University of Hawaii
ILLINOIS
Northwestern University "LUIS"
University of Chicago
The University of Illinois at Chicago
University of Illinois/Urbana-Champaign
INDIANA
Purdue University
The University of Notre Dame Library
IOWA
Iowa State University
The University of Iowa Libraries
KANSAS
The University of Kansas Library
MAINE
University of Maine System Library Catalog
MARYLAND
AIM (Access to Information about Maryland)
John Hopkins University Library
UMCAT (Online Catalog for UM Libraries)
MASSACHUSETTS
Boston University "TOMUS"
Harvard University
MICHIGAN
The University of Michigan
Michigan State University Libraries
Wayne State University
MINNESOTA
The University of Minnesota Library System--LUMINA
MISSISSIPPI
Mississippi State Library
MISSOURI
University of Missouri
NEBRASKA
The University of Nebraska Libraries
NEVADA
University of Nevada, Las Vegas
NEW HAMPSHIRE

Dartmouth College
Dartmouth Dante Database
NEW JERSEY
Princeton University Library
Princeton University Online Manuscripts Catalog
NEW MEXICO
The University of New Mexico
University of New Mexico General Library
University of New Mexico Medical Center Library
New Mexico State University
NEW YORK
Cornell University
New York University
Rensselaer Polytechnic Institute
State University of New York at Binghamton
OHIO
Case Western Reserve University
Kent State University
Ohio State University
University of Dayton
University of Toledo
Wright State University
OKLAHOMA
The University of Tulsa
OREGON
University of Oregon
PENNSYLVANIA
University of Pittsburgh
Pennsylvania - Miscellaneous Online Resources
RHODE ISLAND
Brown University
SOUTH CAROLINA
Clemson University
TENNESSEE
University of Tennessee, Knoxville
University of Tennessee, Memphis
Vanderbilt University
TEXAS
Southern Methodist University
Texas A&M Library System
UT Arlington Library System
UT Austin Library System UTCAT
University of Texas at Dallas
UTAH
University of Utah Marriott Library
VERMONT

University of Vermont
VIRGINIA
The Old Dominion University Library
University of Virginia
Virginia Polytechnic Institute and State University
Virginia Commonwealth University Library System
WISCONSIN
Marquette University Libraries
University of Wisconsin Library Catalogs

Catalogs & Databases Accessible For a Charge

CALIFORNIA
Research Libraries Information Network

International Catalogs

AUSTRALIA
Australian Defence Force Academy
Australian National University's Library
Deakin University Library
CANADA
University of Alberta
University of Calgary
The University of New Brunswick
Queen's University Libraries Kingston, Ontario, Canada
University of Saskatchewan Libraries
University of Toronto
GERMANY
University of Konstanz
ISRAEL
InterUniversity Computerized Catalog System--ALEPH
MEXICO
Instituto Tecnologico y Estudios Superiores de Monterrey
Library of the Universidad de las Americas, Puebla
NEW ZEALAND
Victoria University of Wellington
THE UNITED KINGDOM
Aberdeen University
Aberystwyth University
Aston University
Bangor University
Bath University
Queens University Belfast
Birmingham University
Bristol University

Brunel University
Cambridge University
City of London Polytechnic
City University
Cranfield Institute of Technology
Dundee University
Dundee College of Technology
Durham University
East Anglia
Edinburgh University
Edinburgh University Online Library Information System - EULOLIS
Essex University
Glasgow University
Heriot-Watt University
Hull University
Kent University
Lancaster University
Leeds University Libraries
Leeds University Libraries Circulation System
Leicester Polytechnic
Leicester University
Liverpool University
London University - Central Libertas Consortium
London University - British Library of Political and Economic Science (LSE)
London University - Imperial College of Science, Technology and Medicine
London University - Kings College
London University - Queen Mary and Westfield College
London University - University College
Loughborough University
Manchester University
Newcastle University
NISSPAC
Nottingham University
Open University
Oxford University
Polytechnic of Central London
Polytechnic South West
Reading University
The Royal Greenwich Observatory
The Rutherford Appleton Laboratory
St. Andrews University
St. Andrews University Circulation System
Salford University
Sheffield University

South Bank Polytechnic Vax
South Bank Polytechnic Geac
Southampton University
Stirling
Strathclyde University
Surrey University
Sussex University
Swansea University
Thames Polytechnic
University of Manchester Institute of Science and Technology
University of Wales College of Cardiff
Warwick University
York University

Other Online Resources

Bulletin Boards
Agriculture
Business/Economics
Health/Nutrition
Law
Miscellaneous
Natural Resources
Newspapers
Space/Science
Sports and Recreation
Other Federal Government or Related BBS

Campus-Wide Information Systems

Appalachian State University
Columbia University
Cornell CUINFO
MIT TechInfo
New Mexico State University NMSU/INFO
North Carolina State University Happenings!
NYU ACF Info Sytem
PNN - Princeton News Network
University of Arkansas
University of New Brunswick, Canada, Info
University of New Hampshire's Videotex
University of New Mexico UNMINFO
University of North Carolina at Chapel Hill INFO

A3.12 Others on the Internet: users

The library and information systems world thus far described, finally, is only a part of the US Internet, which itself is only one part of the networked world. There are many uses of scientific databases and e-mail on the Internet which do not appear in the material normally defined as "library and information systems". Just so, Minitel and various X.25 and OSI networks extend the world of "The Matrix" more broadly than that covered by the US Internet.

US Internet statistics nevertheless can provide some idea of the phenomenal growth of use of network technology. If library and information systems, already a large factor, are participating in any significantly-parallel way in the growth curves which follow, they certainly will be leading consumers of communications capacities in the years to come. If their growth rates in fact exceed those of other network users, as is suggested here, both the networks and the library and information communities perhaps should prepare for an entirely new world in information communication.

(The information which follows may be obtained by e-mailing the message, "send rfc1296.txt-1", without the quotes, to the e-mail address, "nis-info@nis.nsf.net".)

Database: INFO - Merit-NSFNET Information Server

Network Working Group M. Lottor
Request for Comments: 1296 SRI International
Network Information Systems Center
January 1992

Internet Growth (1981-1991)

Abstract

This document illustrates the growth of the Internet by examination of entries in the Domain Name System (DNS) and pre-DNS host tables.

DNS entries are collected by a program called ZONE, which searches the Internet and retrieves data from all known domains. Pre-DNS

host
table data were retrieved from system archive tapes. Various
statistics are presented on the number of hosts and domains.

Scope of the Study

A problem with counting hosts and domains on the Internet is
defining
what the Internet really is. Finding host entries in the DNS
does
not necessarily indicate that the host is reachable from the
Internet. Many companies have mail gateways between the
Internet and
their local nets, thus disallowing direct access. However, some
of
these companies advertise all their hosts, and some advertise
only
the gateway. Are these hosts on the Internet or not?

Furthermore, many domains in the DNS are just mail-forwarding
(MX)
entries for off-Internet (such as Usenet) sites. Are these
domains
really part of the Internet and should they be counted in an
Internet
size study?

For the purposes of this study, a host has been defined as a
[name(s),IP-address(es)] grouping discovered from the DNS. This

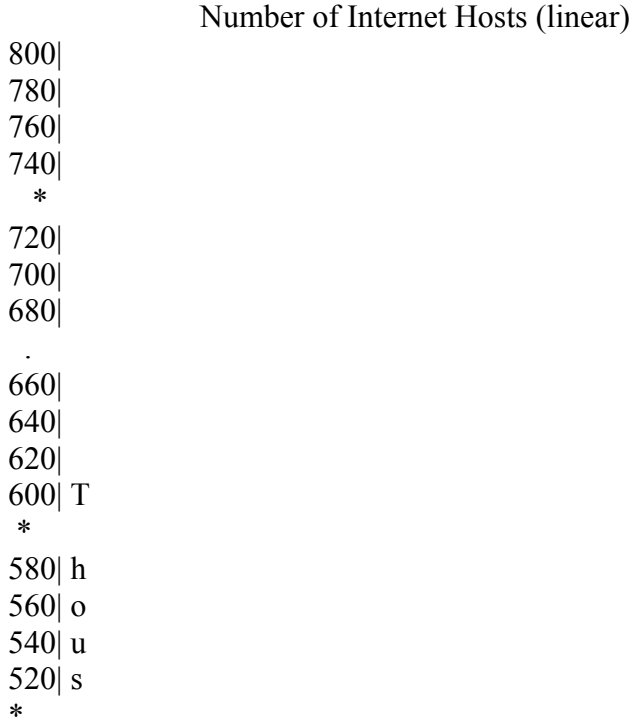
prevents us from counting a host with multiple names or
addresses
more than once. However, this does not consider whether the
host is
directly accessible or not. When ZONE counts the number of
domains
it includes all domains referenced by an NS record in the DNS,
thus
including MX-only domain sites in the final results.

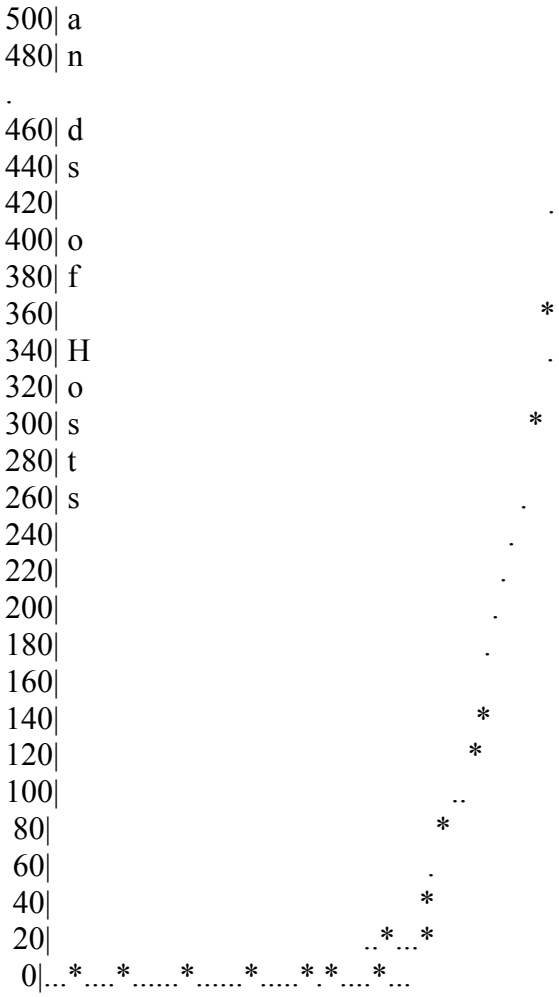
Number of Internet Hosts

The chart below shows the number of IP hosts on the Internet.
These
are hosts with at least one IP address assigned. Data was
collected

by ZONE except where noted. The following two sections are graphs of
the data in this chart.

Date	Hosts	
08/81	213	Host table #152
05/82	235	Host table #166
08/83	562	Host table #300
10/84	1,024	Host table #392
10/85	1,961	Host table #485
02/86	2,308	Host table #515
11/86	5,089	
12/87	28,174	
07/88	33,000	
10/88	56,000	
01/89	80,000	
07/89	130,000	
10/89	159,000	
10/90	313,000	
01/91	376,000	
07/91	535,000	
10/91	617,000	
01/92	727,000	





---

8 8 8 8 8 8 8 8 8 9 9
9
1 2 3 4 5 6 7 8 9 0 1
2

Date

"*" = data point, "." = estimate

This graph is a linear plot of the number of Internet hosts.

Distribution of Hosts by Top-level Domain

This chart shows the number of hosts per top-level domain (top 40 only) on 1-Jan-92. The percentage listed is the increase since 1-Oct-91. Large variations are probably due to problems and

variations
in the collection process; these figures are not meant to be authoritative, but serve as reasonable estimates.

243020 edu 13% 13011 fr 4% 1791 dk 4% 357 be -5%
181361 com 12% 12770 nl 21% 1662 es 15% 334 gr 14%
46463 gov 13% 12647 ch 10% 1506 kr 9% 308 br 26%
31622 au 19% 11994 fi 15% 1111 nz -16% 284 mx -5%
31016 de 20% 10228 no 9% 1016 tw n/a 207 is 0%
27492 mil 26% 8579 jp 6% 929 za n/a 146 pl 97%
27052 ca 22% 4109 net -49% 784 pt n/a 127 us 25%
19117 org 10% 3324 at 19% 484 sg 251% 25 tn 0%
18984 uk 139% 2719 it 197% 448 hk 78% 24 hu 71%
18473 se 34% 2020 il 14% 374 ie -7% 6 arpa 0%

Note to the above: the initials stand, loosely, for domains located in a particular country, and correspond to the last letters of an e-mail address, e.g. "athena.berkeley.edu", or "class.org", or "well.sf.ca.us". The first few categories -- "edu", "com", "gov", etc. generally are US-based domains. As always, there are riddling exceptions: "us" also contains US-based domains, there is no way of equating user #1479 in "gov" -- which may be a solitary, isolated, hacker – with user #12231 in "uk" -- which may be one of the world's greatest and largest research institutions, nor can one ensure that all the users of a "fr" domain are dialing in to that domain from locations in France. "The Matrix" tends to dissolve national as well as other boundaries.

This "statistical essay" has been offered as a substitute for general network telecommunications statistics that do not yet exist. This technology is too new -- or at least its application by users is too new -- to have generated overall usage patterns which can be obtained or analyzed with any great degree of certainty. Moreover the technology is changing rapidly. Three years ago there were barely 50 library services on the US Internet, few librarians much less users knew of their existence, and all they offered were typed records which duplicated the paper catalog cards which they had replaced. Today the total of networked library services is 250, the total is increasing rapidly, librarians use the services intensively and users are

discovering them, and talk is being heard of imaging and audio being added to banks of services which already have expanded far beyond the duplicated card catalog. In such an unsettled, changeable environment, statistics of a "slice-in-time" or even of a "previous trend" become of highly questionable value.

Instead of a neat, comprehensive statistical picture, then, this "essay" has attempted to present what figures do exist in their respective contexts: a single online library information service, the other online library services of which it is a part, the yet broader library community of which they all are a part, which has yet to but shortly will "go online", and finally the online world, itself expanding rapidly, which will be trying to accommodate, among so much else, this vastly increasing library and information service demand. There are many pieces missing in this puzzle. But assembling what pieces we can identify now may give us some insight as to the shape of future network services, and it may be useful as we go along toward that future.

Notes:

A1. The best source for a description of online network directory efforts would be a subscription to CNIDIR-L, the Coalition for Networked Information's e-conference devoted to the subject. Send to LISTSERV@UNMVM.BITNET the following e-mail message: SUBSCRIBE CNIDIR-L <your first name><your last name>.

A2. As reported in the _DLA Bulletin_, which may be read online from within the MELVYL system by entering SHO DLA BULLETIN (then enter "14.6" for this particular item). One suspects that the snow level and winter temperature in Norway might have something to do with this particular professor's liking for MELVYL, although he says it's response time.

.

Library Use in the US of Computers, Networks, and Broadband:
an evolution, a retrogression?

Index

by Jack Kessler
kessler@well.sf.ca.us

3.1310 broadband
3.1300 broadband capacities
3.1329 browsing
2.3000 Buckland, Michael
3.1230 bulletin board systems
3.1220 CARL
3.1310 CARL
1.1000 cataloging
3.1210 cataloging, decentralisation
3.1325 cataloging, international
1.2000 Catalonia
1.2000 CATMARC
1.2000 cd-rom
3.1321 cd-rom
3.1243 Center for Machine-Readable Texts in the Humanities
3.1325 Chinese, Japanese, Korean catalogin
3.1325 CJK cataloging, Chinese/Japanese/Korean
1.1000 classification
1.2000 Clemens, Samuel
3.1325 CNRS, Centre National de la Recherche Scientifique
3.1220 Colorado Library Consortium
1.3000 commercial databases
1.2000 commercial fulltext
1.3000 commercial information market
3.1100 commercial publishers
3.1244 commercial publishers
1.3000 communications formats
3.1100 competition, for libraries
3.2000 competition, in library market
3.1352 compression algorithms
3.1100 computer applications, in libraries
3.1100 computers in libraries
2.1200 confusion of goals, by libraries
3.1241 Consortium Update (SPIRES), e-journal
1.3000 cooperative cataloging
3.1352 copper-wire technologies
3.1210 copy cataloging
3.1230 copyright
1.2000 cross-referencing
3.1241 Current Cites, e-journal
3.1210 decentralisation of cataloging
3.1210 dedicated terminals
1.2000 descriptors
3.1322 de'po^t le'gal (France)
3.1244 Dialog
3.1321 Dialog

3.1351 front-ends
3.1230 ftp, file transfer protocol
3.1310 ftp, file transfer protocol
3.1323 ftp, file transfer protocol
1.2000 fulltext
1.2000 fulltext
1.3000 fulltext
3.1100 fulltext
3.1321 fulltext
1.3000 galleries, objects on networks
1.2000 garbage-in, garbage-out
1.3000 gateways
3.1210 group contracts, for networked information
1.3000 high resolution television
1.3000 Hollywood
3.1241 Hot Off the Tree, e-journal
1.2000 human aspects
3.1329 hypertext
3.1310 Hytel
1.2000 IBERMARC
1.2000 ICEMARC
3.1210 ILL, Inter-Library Lending
3.1352 image loss
3.1322 imaging
3.1324 imaging
3.1352 imaging
3.1328 imaging and color
1.2000 indexing
3.1340 indexing
Conclusion information brokers
3.1300 information brokers
3.2100 information brokers
3.1310 information directories
1.2000 information overload
3.1246 information overload
1.2000 information retrieval techniques
1.2000 information science
2.3000 information service
3.1300 information specialist
3.1352 Integrated Services Digital Networks, ISDN
3.1327 intellectual access
3.1323 interactive access
3.1323 interactive connectivity
3.1323 Interactive Relay Chat
1.3000 intermediary, librarian as
3.1325 international cataloging

3.1325 international online access
3.1210 Internet
3.1230 Internet
3.1310 Internet
3.1323 Internet
3.2100 Internet
3.1230 Internet Relay Chat
3.1310 Internet Resources Directory
3.1210 Inter-Library Lending
3.1324 inter-networking
1.1000 inventory control
3.1100 inventory control, in libraries
3.1340 IP e-mail addressing system
3.1230 IRC, Interactive Relay Chat
3.1323 IRC, Interactive Relay Chat
3.1241 IRLIST Digest, e-journal
3.1230 ISDN, Integrated Services Digital Networks
3.1230 ISDN, Integrated Services Digital Networks
3.1243 ISDN, Integrated Services Digital Networks
3.1352 ISDN, Integrated Services Digital Networks
1.3000 Judge Greene
3.1352 Kapor, Mitchell
3.1246 La Villette
3.1210 laptops
1.2000 LC MARC
3.1321 Lexis
Conclusion librarians, role of
1.2000 librarianship
1.2000 Library of Congress
3.1210 Library of Congress
3.1220 library professionals, role in information
2.3000 library service
3.2100 library service, rather than libraries
3.1310 Libtel
1.2000 linguistic precision
3.2100 listing things, as a library function
Conclusion lists, traditional library function
1.1000 lists, traditional library function
1.2000 lists, traditional library function
1.2000 lists, traditional library function
3.1310 lists, traditional library function
3.1230 LISTSERV archives
3.1230 LISTSERV software
1.3000 local loading
3.1245 local loading
3.1220 Lord of the Rings

1.3000 OCR, optical character recognition
1.3000 Online Computer Library Center
3.1210 Online Computer Library Center
1.3000 online fulltext
3.1321 online fulltext
1.2000 online public access catalogs
3.1220 online public access catalogs
3.1246 online reference work
1.2000 online union catalogs
1.2000 opacs
1.2000 opacs
3.1220 opacs
3.1241 opacs
3.1310 opacs
3.1220 opacs, as "electronic face" of the institution
1.3000 optical character recognition, OCR
3.1352 optical fiber
3.0000 over-specialization, of librarians
1.2000 Oxford English Dictionary
3.1243 Oxford Text Archive
3.1220 Oxford University
3.1246 Oxford University
3.1230 PACS-L
3.1210 paper cards
3.1325 PASCAL scientific database
1.2000 pc marketing concept
3.1322 photothe`que
3.1230 physical conferences, and e-conferences
2.1100 physical documents, containing texts
3.1220 plain language query
3.1220 post-Boolean search capacities
1.3000 preservation
3.1322 preservation
3.1220 probabilistic methods
1.2000 probability theory
3.1230 professional training and education
3.1326 professionals, load on systems from
3.1243 Project Gutenberg
3.1243 Project Sequoia
3.1326 public access, in US
3.1230 Public Access Catalog Systems List, PACS-L
1.2000 public access online catalog
3.1243 public libraries in France
3.1241 Public-Access Computer Systems News, e-journal
3.1241 Public-Access Computer Systems Review, e-journal
1.3000 publishing industry