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The Application of Minicomputers to Problems of Information Retrieval

Although minicomputers can be used in many types of information retrieval facilities, this paper deals primarily with bibliographic reference retrieval systems. There are two main reasons why it is attractive to consider using a minicomputer for on-line applications: (1) the relatively low cost and (2) the hardware and software provided.

Definition

It is perhaps appropriate at this stage to consider what is meant by a minicomputer as there is now a considerable overlap in size and capability between the upper end of the minicomputer range and the lower end of many ranges of mainframe machines. Several minis are now available with a memory of 256K bytes and at least one can have a one megabyte memory. Similarly, the range of peripherals that can be handled has grown and it is not uncommon for a mini to handle several 30 megabyte disk drives. All this is far removed from the mini of the mid-1960s which might be equipped with up to 16K of core store and have backing store of one 64K disk plus a tape drive. Another significant change has come in the word sizes used. A few years ago virtually all minis used a 12-bit word whereas now 16-bit words are common, and there is now a minicomputer with a 32-bit word. However, we can identify certain basic attributes that distinguish a mini from mainframe machines. First, there is the price. While a large configuration can be expensive, most minis can be obtained with 16K for less than $20,000 and, perhaps equally important, the store size can be increased by small increments, typically 4K or 8K. Second, they are able to handle a relatively large number

of peripherals and often have a capability for many effectively simultaneous I/O transfers facilitated by the hardware techniques employed. Third, a majority of present-day minis are provided with software and hardware that are particularly suitable for real time applications.

This is not meant to be a definitive description of a minicomputer, but it does serve to give some terms of reference for considering the role of minicomputers in information retrieval. Many definitions of minicomputers have been given,[1] and a glance at a list of minis available will show the wide range available and the considerable diversity in size, price and performance.[2] For the rest of this paper I intend to exclude what might perhaps be better described as midis and only deal with machines of up to, say, 128K. After all, there are many IBM 370 installations considerably smaller than a maximum configuration Interdata 7/32 with its 1 megabyte of 32-bit word 750ns store.

Minicomputers in Information Retrieval

It also seems appropriate to define information retrieval: this paper will deal in general with the retrieval of bibliographic citations, although this will not necessarily exclude the possibility of retrieving abstracts or even full text. In fact this is the area of information retrieval where it is arguably most difficult to employ minicomputers successfully. The problem is, of course, that the size of data bases used will tend to be larger than in many other areas, and its actual size and rate of growth is likely to be unpredictable.

There are two basic types of bibliographic information retrieval: current awareness and retrospective. The first of these, current awareness, can be easily handled on a mini since, whether the products be individual notifications, special interest bulletins or whatever, the amount of material to be handled at any time is relatively restricted. For example, a typical issue of an Inspec tape will contain 5,000 records. In fact minis are rarely used for this type of application, although they are successfully used by the Canadian Defence Scientific Information Service[3] and by the British Food Manufacturing Industries Research Association,[4] who have recently installed a minicomputer to handle all library operations including SDI, other current awareness services and retrospective searches. Minis are probably best suited to continued dedicated use for a task, and most current awareness services are intermittent in nature. Consequently they tend to be run as a batch job on a mainframe machine—either in-house or a bureau machine.

We are then left to consider retrospective searching. For batch searching even a very small mini could be used for searching large data bases provided an overnight turnround could be accepted. For instance, a 12K PDP 8/L with

only a 64K disk and one tape deck can search 2,000 or 3,000 Inspec records per minute. Provided one was prepared to swap tapes every five to ten minutes, a search of a data base containing 1 million records could be made overnight. However this does not seem a very promising application and it is in the provision of real-time retrospective searching facilities that minicomputers have an important role to play.

This is not to say that a conventional on-line search package could be successfully implemented on a mini except with a relatively small data base. Nevertheless there are areas where, given a sufficiently large volume of use, a dedicated mini would make economic sense. Certainly a relatively modest configuration could be used with a data base of 50,000 references. For example, the RIOT system at Culham Laboratory,[5] which does run on a large computer, uses less than 40K of store and one 30 megabyte disk pack to provide on-line searches of data base containing 40,000 specially selected references and provides a typical response time of 3-4 seconds with its worst time being 20 seconds. However it is probably true that in most cases where a data base of this size is appropriate, then the traffic on the system is likely to be low, making the provision of a dedicated machine an unnecessary luxury.

An extension of this approach is to use a mini with a recent subset of a large data base which will hopefully answer many queries directly and, for those searchers requiring full retrieval from the whole data base, provide a means by which they can interactively arrive at an optimum search profile which can be used for a subsequent batch search—perhaps overnight on the same hardware. Although some of these possible applications may be valid in certain circumstances, it is probable that the most useful role for minicomputers in a bibliographic retrospective search system is when they are used in conjunction with other hardware. The types of application can be considered in four broad areas: (1) as a front-end preprocessor, (2) in a switching network, (3) as a central facility in a hybrid system using microform, and (4) as a central facility in conjunction with specialized storage devices.

Front-Ending

Many on-line computing systems use a minicomputer to connect user terminals and perhaps other peripherals to the mainframe. The advantages of this are basically: (1) it removes load from the mainframe by handling such matters as user identification, command syntax and spelling validation and, often, file editing; (2) the operating system on the mainframe consequently need have less facilities—notably much less complicated I/O software can be used, and (3) it is possible to alter the mainframe configuration or even

change to a different make of machine without altering the user-image of the system.

Similar advantages can apply to using a mini to front-end a mainframe used for information retrieval. Particularly important is the provision of a stable user-image and the ability to handle a range of terminals that may not only be used with the IR machine and may therefore have varying characteristics. For example, it is desirable that systems should be able to cater for terminals operating in half-duplex and full-duplex as the methods used for suppression of passwords on half-duplex printers (e.g., IBM 2741) are ineffective on Teletype–compatible video terminals and vice-versa. The effectiveness of a front-end mini is such that not only is a much more efficient and usable system provided, but sometimes a financial saving can be made in that the cost of the mainframe can be lower because a smaller configuration can be used.

Switching Network

In many different areas there is a strong move toward the network concept[6] and, naturally, minicomputers are used for message handling within these networks. Networks arise for a variety of reasons. Some, like SITA, are essentially for message carrying, the purpose being to provide quick, reliable communication facilities at minimum cost.[7] Others, notably ARPA, are aimed at making powerful computing facilities more widely available.[8] Many networks exist, but at present only a relatively small number of information retrieval systems may be accessed via a network. Perhaps the best known example is the National Library of Medicine's MEDLINE which is available over the Tymshare network.[9] However, while TYMNET can handle a variety of terminals operating at a range of speeds, it is still basically a communications network as it merely passes on the message it receives and carries out the necessary code and speed changes.[10] An example of a network provided solely to enable access to an information retrieval facility is that now being proposed by ESRO to provide dial-up access throughout Europe to their RECON service based in Frascati, Rome.[11] Here the remote minis would be able to provide more specific functions and regulate the output to the type of terminal being used.

Perhaps the most valuable application of minis in a network is when they are used to provide access to a range of mainframes all providing on-line search facilities on different data bases.[12] Such a facility (by conversion and buffering of data) would be capable of accepting the many different types of terminal devices actually available to users. It could also provide a simplified

standard dialog which would make all the various systems provided look the same to the user, obviating the need for separate training in the use of each different system. It is arguable that systems used with this dialog would be powerful enough to meet most user requests: where a user does not find the information he requires, he would be encouraged to consider making use of the full power of the facilities provided by the system operator and, of course, he would be offered the opportunity of using the original dialog as soon as he had selected a data base.

The principal advantages of this sort of information retrieval network may be summarized as follows:

1. It allows the user to access several retrieval systems using only one terminal—whatever that terminal may be.
2. It increases the potential audience for on-line systems—particularly when access is possible over the TELEX network.
3. It gives the user the option of searching several data bases. If selection of multiple data bases for searching can be achieved automatically the system will, in effect, be offering one large, integrated data base. This may well be a simpler solution when attempted at retrieval time, rather than if an attempt is made to create an integrated data base.
4. All the retrieval systems made available may be accessed using the *same* stable user image. (A possibility is that future retrieval systems could be developed more easily as the designer could, by initially designing for users of the network, delay implementing a special user dialog.)
5. It makes central accounting possible.
6. By using remote multiplexing, considerable savings can be made in line costs.

Microform Systems

There are a number of factors which have a major influence on the cost and usability of an on-line retrieval system. Three of these are: (1) storage of information within the system, (2) transmission of information to the user, and (3) display of information in an acceptable and attractive form. A technology is now emerging which shows potential as a means of mitigating the effect of these factors. Microforms have been in use in libraries for many years, but it is only recently that the possibility of selecting and displaying frames under computer control has become a reality.

The most widely known terminal is the Image Systems CARD terminal which holds 750 conventional fiche. This has been used in several

bibliographic retrieval systems, notably by Intrex and by CID in Luxembourg. Other terminals employing higher reductions (150X) are the Microform Data Systems Terminal which holds 50 ultrastrips, each containing 2,000 A4 page images, and the Automated Microform Terminal now under development by the Marconi Company.[13] This will hold 150 ultrafiche, each containing 3000 A4 page images. At Inspec (with support from the Office for Scientific and Technical Information) we have been evaluating at Marconi AMT and find that storing 6000 A5 pages, each containing a complete citation with abstract, gives a very acceptable display. The user's query is formulated on a Teletype connected to a PDP 8 which carries out the searching. However, the full text is not stored on the computer and on finding a match in the search file the appropriate coordinates are transmitted to the AMT which displays the frame virtually instantaneously. (The delay is less than 1 second when moving about a single fiche and is expected to be typically 4 seconds, with the worst case being about 8 seconds with the 150 fiche magazine.)

At the U.S. Patent Office in Washington, D.C., a system to enable remote access to a data base showing classifications assigned to particular specifications uses MDS terminals connected to a minicomputer, but this is not a bibliographic retrieval system in the sense used throughout this paper.

By using a microimage terminal, the amount of storage needed on the computer can be drastically reduced.[14] By storing dialog and instructional material on fiche the amount of information to be transmitted to the user at any time can be reduced to a minimum, which implies that a simpler I/O package can be used, thus reducing demands on the processor. As the display data are stored on fiche only, index files need be stored on-line. This can, depending on the data base and on the number of different search elements required, lead to the demand for on-line storage being reduced to one-quarter or even one-tenth. This means that a mini can effectively handle a much larger data base in this fashion than it could for a conventional IR system.

As a Central Facility Connected to Specialized Storage Devices

In the preceding section it was shown how a minicomputer was better able to provide a retrieval facility if some of the processing and storage demands on the central computer could be reduced by using microimage storage.

One of the fundamental attributes of a mini was earlier said to be the ability to handle many separate I/O channels, and it is consequently able to handle a large amount of on-line storage. In fact, the inability of a mini to provide a search system for a large data base is due to the large main memory

requirement needed to provide adequate response, rather than to any inherent limitation on the amount of on-line storage that can be handled.

There are a number of reasons why existing on-line retrieval systems, even those using quite large mainframes, are unable to support more than a relatively small number of simultaneous searches, and many of the problems can be overcome to a greater or lesser extent by various means, e.g. front-ending. However, there is one prime factor limiting the overall performance; it is always necessary to transfer a relatively large amount of searchable data from backing store. Various techniques have been put forward and adopted to reduce the amount to be transferred. These range from using novel file structures to data compression techniques and include such ploys as relatively simple partitioning of a data base into subject interest subfields. However, a study of these techniques will show that any reduction in the volume to be transferred is likely to be less than an order of magnitude. The answer to this problem is to devise a system where the amount of searchable data to be transferred is nil; this can be achieved by performing the searching process outside the computer store. Taking the task of searching away from the main computer immediately increases the potential capacity of the system tremendously. Whereas it is unusual for a bibliographic retrieval system to be able to cope with many more than thirty simultaneous users, even with a relatively large and powerful computer, there are many instances in other applications of small machines, even minicomputers, supporting hundreds of terminals or other I/O devices.

During the last few years various articles have described devices, generally described as content addressable, that can separate the searching function from the central computer.[15] A content addressable store can be essentially a conventional disk store (either fixed head or moving head) with local logic for each read/write head. This means that the central computer need only hand over the search statement to the content addressable peripheral which contains the index files, and it will receive back addresses of matching references which can then be retrieved from conventional storage. A considerable amount of main memory that would normally be used either for storing and processing data transferred from disk, or for storing the software to process that data, is therefore released. Consequently, a much smaller main computer can be used or, alternatively, a much more powerful system provided, servicing many more simultaneous users than is normally possible.

It is unlikely that there will be many situations where a mini would be used to support an information retrieval system by itself. However, this is not

to say that it does not have a role to play in the provision of retrospective search facilities. The mini is likely to be used in conjunction with other hardware: with a mainframe machine as a front-end, in a network linking users to a variety of mainframes, to drive microimage display terminals, with content addressable stores, or with some combination of these. It seems probable that in most, if not all, retrospective information retrieval facilities of the future minicomputers will be used in one or more of the ways outlined above.

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