The Integrated Library System (ILS)
System Overview

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The Integrated Library System (ILS) is a minicomputer-based system in which all automated library functions are processed against a single master bibliographic file. This report describes the functions which the system supports and outlines the system design from a technical viewpoint.

ILS consists of five major subsystems:
  -Bibliographic control (to load and edit MARC-format records),
  -Catalog access (an online public catalog),
  -Circulation (to track item location and status),
  -Serials control (to check in serial issues), and
  -Administrative (to produce management reports and set system parameters.

The ILS software will run on any of three types of minicomputer equipment:

  Data General Eclipse series,
  Digital Equipment Corporation (DEC),
  PDP-11 series (11/23 to 11/70), or IBM series 1.

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Libraries - Information Systems

b. Identifiers/Open-Ended Terms

Library Automation
On-Line Circulation Systems
Machine-Readable Cataloging Systems

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THE INTEGRATED LIBRARY SYSTEM

A RESEARCH AND DEVELOPMENT PROJECT OF THE
LISTER HILL NATIONAL CENTER FOR BIOMEDICAL COMMUNICATIONS, NATIONAL LIBRARY OF MEDICINE

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I. INTRODUCTION

The goal of the National Library of Medicine is the effective transfer of health science information throughout the biomedical community (Cum/8). A major vehicle for achieving this goal is the network of biomedical libraries ranging from local community hospitals to 11 regional medical libraries, and through the latter to the National Library of Medicine. As more libraries move toward automation, it is important that such actions proceed in a way which will build upon and strengthen this already existing network structure.

The Lister Hill National Center for Biomedical Communications (LHNCBC) is the research and development arm of the National Library of Medicine. The Center 's Computer Technology Branch (CTB) initiated the Integrated Library System (ILS) in 1977 to explore and evaluate the application of advanced computer technologies to problems in library automation for both NLM and other members of the biomedical library network. Although there has been a great deal of activity in library automation over the last decade, development of systems to support effectively the requirements of the network has not been achieved.

A. Background

Library automation has long held the potential for improving library services and management beyond the automation of manual procedures. Initial efforts, however, as in every area where the computer was first introduced, were directed towards improving the efficiency of manual procedures. As the community became more mature in both its utilization and expectations of the technology, the major interest moved towards the concept of a total integrated system (DeG76). In spite of early major efforts at Stanford (Sta75) (for an update see reference Vea77) and the University of Chicago (Pay75,Pay77), the goal seemed elusive:

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"... it can be said with considerable justification that the ultimate goal of library automation in the 1960s, the development of a total integrated system for a single library appears to have been abandoned or at least set aside in the 1970s. However, there are indications that the advent of powerful and inexpensive minicomputers and storage capabilities will lead to revival of this concept in the next few years."(DeG76)

In the interim, there has been considerable activity in the automation of single functions, in particular, circulation systems (Sch77, Dra78, Mar78). In the mid 70's, there appeared an integrated library system development by the Washington Library Network (WLN) (Was76,Kun77) to service a statewide network. Except for circulation, all functions in the WLN System are to be implemented on a large-scale computer. The WLN System has been a very ambitious undertaking, intended to support all public and university libraries in the state. This implementation of a totally integrated system offers to resolve many problems identified in the previous systems. Other large-scale integrated systems efforts include NOTIS III at Northwestern University (Hor78), and IBM's DOBIS system (McA79). While referring to the Stanford and Chicago Systems, DeGennaro's observation, "experience seems to indicate that these systems are too costly to operate in a single library environment..."(DeG76), still applies to these efforts.

The potential for minicomputer systems to allow a more cost-effective, totally integrated library system for single libraries, was recognized by the University of Minnesota Biomedical Library in the early 1970s (Bru75). This pioneering effort, however, had one major technical drawback. The system design was implemented in 1972, before much of the advanced minicomputer software support systems and higher-level languages were available. Consequently, the entire system has been implemented in machine language including a generalized file management system for a particular minicomputer (the DEC PDP-11/34). The result is a system that can only be implemented on one vendor's equipment, and which requires systems level data processing personnel for maintenance and/or changes.

Some vendors of minicomputer-based circulation systems (e.g., CLSI, SYCON, and Dataphase) have indicated plans to extend their systems to other functions, but none have designed a totally integrated system from the outset.

Today, the potential of achieving an integrated system is no longer debated. However, the present developments are large mainframe implementations (WLN, NOTIS III, and DOBIS), and systems requiring large minicomputers such as BIBLIOTECH's PDP-11/70 and VAX (Bib81). What is not clear is the lower limit, or the smallest, least cost system that can be effective. In fact, the "least cost" system for any given function/load requirement is time dependent. The dynamically changing technology will continue to make available new alternatives for more efficient implementations over the foreseeable future. With every decrease in cost, a larger proportion of libraries will be able to afford the advantages of automation. A major goal of the ILS project is to make use of available mini- and microcomputer systems and inexpensive storage capabilities to provide a more cost-effective, truly integrated library system for single libraries and local networks, and to identify the smallest, least-cost system that will support such local and shared functions.

B. Design Objectives

Today's library automation efforts and systems are not adequately address-
ing the needs of a distributed library network. Nor do the existing systems
offer the combined functional integration, small system implementation, or user
features needed by small to medium size health sciences libraries. The ILS
design objectives which address these issues are:

    Modular integration of functions/files
    Minicomputer-based systems capability
    Maximize transportability
    Sizing dependent on hardware only
    System network access
    Multi-level user interface
    MEDLARS III compatibility

Following is a detailed description of these objectives.

1. Integration of Functions/Files The core of an integrated library system is
a single integrated or "master" bibliographic file which supports all processes
(circulation, online public catalog, acquisitions, cataloging, and serials con-
trol). The integrated bibliographic file also fosters integration of functions.
Functional integration means that all library processes have access to informa-
tion created and updated by all other functions, without requiring different
searches to see different types of data. For example, the bibliographic data
added at acquisitions may also create the bibliographic portion necessary for
circulation, and act as the partial entry to be completed by cataloging. While
some libraries maintain separate acquisitions "in process" and catalog files,
and require separate access for searching, other libraries (e.g., University of
Chicago) have integrated the bibliographic components of both data bases. Since
separate searches of the common data base are still required in such cases, the
files but not the functions are integrated. If, however, the bibliographic por-
tion of the acquisition "in process" data is entered in "cataloging-compatible"
format as described above, then an integration of functions becomes possible.

Integration of functions does not necessarily imply physical integration in
the sense that all functions (modules) need be implemented on one computer.
Rather, the objective is a design that would allow for distributed processing.
For example, libraries which have heavy circulation and cataloging loads must be
able to implement those functions on separate processors and still maintain
access to a common Master Bibliographic File.

"Modular Integration" is a design and implementation approach in which the
functions of an integrated system may be developed as independent modules. A
modular design offers the greatest flexibility and extensibility over the life
of the system. The system design must insure proper integration of subsequently
developed modules.

2. Minicomputer Based Systems Capability The objective is to achieve efficien-
cies of operation which will allow ILS to be implemented on small systems. This
goal is not meant to preclude large scale system implementations. Small.

efficient systems may be scaled up, while the converse is seldom true.

3. _Maximize Transportability_ Transportability of a minicomputer-based library system has two distinct aspects:

- the ability to transport the software to different minicomputers, and

- ease of maintenance, or transportability of the application away from the site of development.

Satisfying both requirements requires the use of a higher-level computer language and/or system which is also efficient enough to support the particular application requirements. Early minicomputer efforts were programmed in assembly code in order to achieve sufficient performance. Today, the combination of decreased hardware costs, improved hardware performance, and greater availability of higher-level languages offer better opportunities for program transportability.

4. _Sizing Dependent On Hardware Only_ A large spectrum of libraries of different sizes are considering the use of stand-alone library systems. The differences among libraries of various sizes do not, in general, relate to different functional requirements, but to different loads based on size of collection, circulation rate, etc. Since there exists a wide range of processing requirements, there will be systems which vary in size and complexity, and thus vary greatly in cost. As the cost of computer hardware decreases, ever smaller libraries may be able to afford automation. Thus, it would be desirable to have one basic software system that could be sized to different loads and hardware without changes in the software.

5. _System Network Access_ By "system network access" is meant the library automation system's ability to access other library networks by itself. For example, if a cataloger attempts to locate a bibliographic item that cannot be found in the local file, the system should automatically access the appropriate network resource without further intervention by the cataloger. The cataloger should not be required to move to a different terminal or dial up another resource in order to retrieve data to be entered manually in the local file.

The LHNCBC/CTB has demonstrated the ability of a minicomputer to effect system network access by "logging itself on" to different online networks, appearing to each network as a standard computer terminal. Other LHNCBC/CTB efforts have produced an inexpensive (ca. $1,000) "black box" to make such computer/network connections more reliable and secure. Hence, the technology required to effect system network access is available, but must be integrated into the total library automation design.

6. _Multi-Level User Interface_ Significant emphasis has already been given in LHNCBC/CTB to the quality of the interface between user and computer. One aspect of this concern has been the demonstration of "user cordial interfaces" (Gol78) to existing online systems.

Each class of user has its own interface requirements; no one interface can be equally effective for all. The library is an excellent example of the need for different interface requirements to the same data for different classes of

users. There are many differences between library professionals and library users (or patrons). For example, the interface requirements of the catalogue are certainly different from those of the reference librarian. Patron sophistication and understanding also will vary greatly. Current technology provides the opportunity to address these highly-variable needs with multiple and/or user interfaces.

7. MEDLARS III Compatibility The National Library of Medicine is engaged in a significant long-range effort to design its next-generation library automation system. As planned, this system will support NLM technical processing needs and the interlibrary loan and reference needs of the biomedical library network. The remaining ILS functions to be developed will be designed to maintain compatibility with the evolving MEDLARS III system.

C. Systems Design Approach

The ILS design has been approached as an applied R&D effort.

"Proceeding along a path of iterative enhancements, initial efforts were targeted toward the implementation of subsystems to support the online catalog and circulation (item control) functions. Towards this end, a project team of both librarians and systems designers, documented an initial functional specification for an integrated online catalog and circulation subsystem. This documentation (Aut78a,b) provided a structured walk-through of the functional features for the librarian/user. This documentation did not specify the required transaction rates or users to be serviced by a particular hardware configuration.

"Instead of immediately proceeding to a detailed design, studies and experiments were initiated to gain more complete information regarding alternatives and performance. Frequent meetings of the project team afforded a continual review of new information and allowed for step wise refinement of the specifications. The results of these efforts were a set of detailed design notes for each module. Further refinements in the design were realized during integration. As is evident, both the detailed specification and design evolved during the initial implementation. Some of the initial designs for individual modules were "thrown out" after prototype testing. While the process is striving toward highest efficiency, the actual number of users that may be supported by a given hardware configuration will be known only after implementation.

"As the ultimate objective is an operationally viable system, the final documentation will be of a level of detail sufficient to support operations and maintenance. it will also include an up-to-date system design which will synthesize all stepwise refinements. The addition of subsequent modules has been anticipated in the design of the data base and inter-module communication and hence, the addition of future subsystems can proceed without major changes to existing programs." (Gol79, p. 7)

The ILS development has, consequently, been a continuous learning process. As the underlying structure of the system has been implemented and development of additional subsystems is proceeding, the project team has begun to employ a number of structured analysis and design techniques to ensure that the remaining modules are completely integrated into and compatible with current capabilities.

In addition to staff from LHNCBC/CTB and NLM, the project team has included librarians from the Army Library, Pentagon, the Enoch Pratt Free Libraries in Baltimore, the University of Maryland - Baltimore Health Sciences Library, and the University of North Carolina at Chapel Hill Health Sciences Library (the last three working at the LHNCBC under cooperative agreements). Documentation provided by NLM's Library Operations division and the MEDLARS III requirements analysis team also provided important contributions to the design effort. Assistance has also been obtained from a number of contractors who have performed studies in support of the design and have implemented CTB-specified system functions.

II. FUNCTIONAL OVERVIEW

A. Introduction

An overview of the subsystems planned for the Integrated Library System is illustrated in Figure 1. The subsystems shown here perform the major functions in a library:

Bibliographic control
maintains integrated bibliographic file and links to shared cataloging and authority files

Catalog access
provides an online catalog for patrons and staff

Circulation
supports circulation processing and overall collection control

Serials control
maintains serial holdings and supports processing of serial issues

Acquisitions
processes order data and produces preliminary bibliographic records

Administrative
provides summary reports on library activity and features allowing the library manager to control system processing.

Figure 2 illustrates the interaction of these subsystems with related bibliographic activities and organizations outside the local ILS design. Automatic system network access to these outside systems is a major requirement of the ILS design.

The subsystems which have been completed are shown in Figure 3. This version 2.0 (issued by NTIS in July 1981) includes these subsystems and the capabilities described in this document. The full serials control and acquisitions subsystems will be explored in later development efforts.

The diagrams emphasize the significance of the master bibliographic file (MBF) and bibliographic control as the basis for system integration. The MBF is MARC-compatible and contains all bibliographic data, item location, and status information in one online file, which allows all system functions to have access to a common set of up-to-date information.

The following sections present an overview of the general capabilities of each major subsystem.

B. Bibliographic Control Subsystem

This subsystem allows library staff to create and maintain the online bibliographic file, authority file, and search indexes. The bibliographic control functions support four major activities:
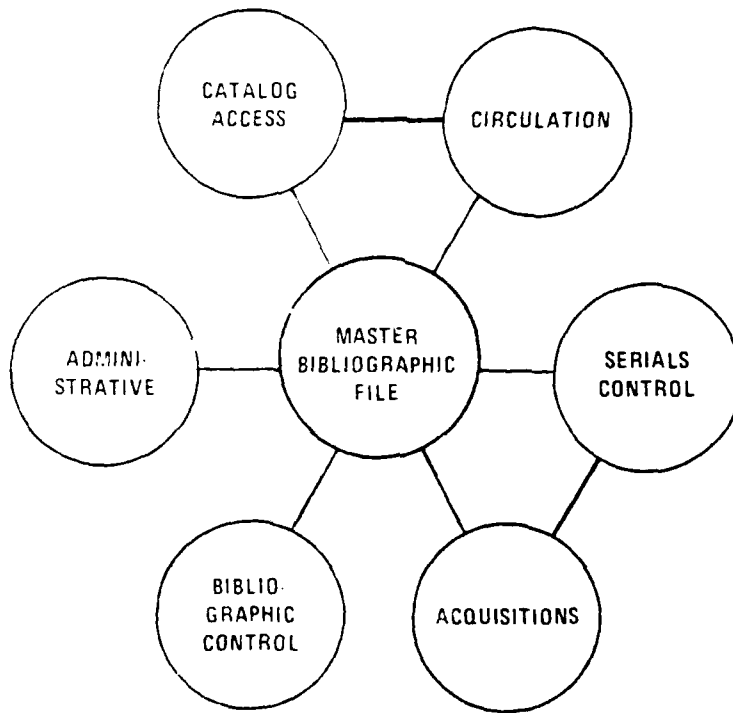
FIGURE 1 FUNCTIONAL SUBSYSTEMS

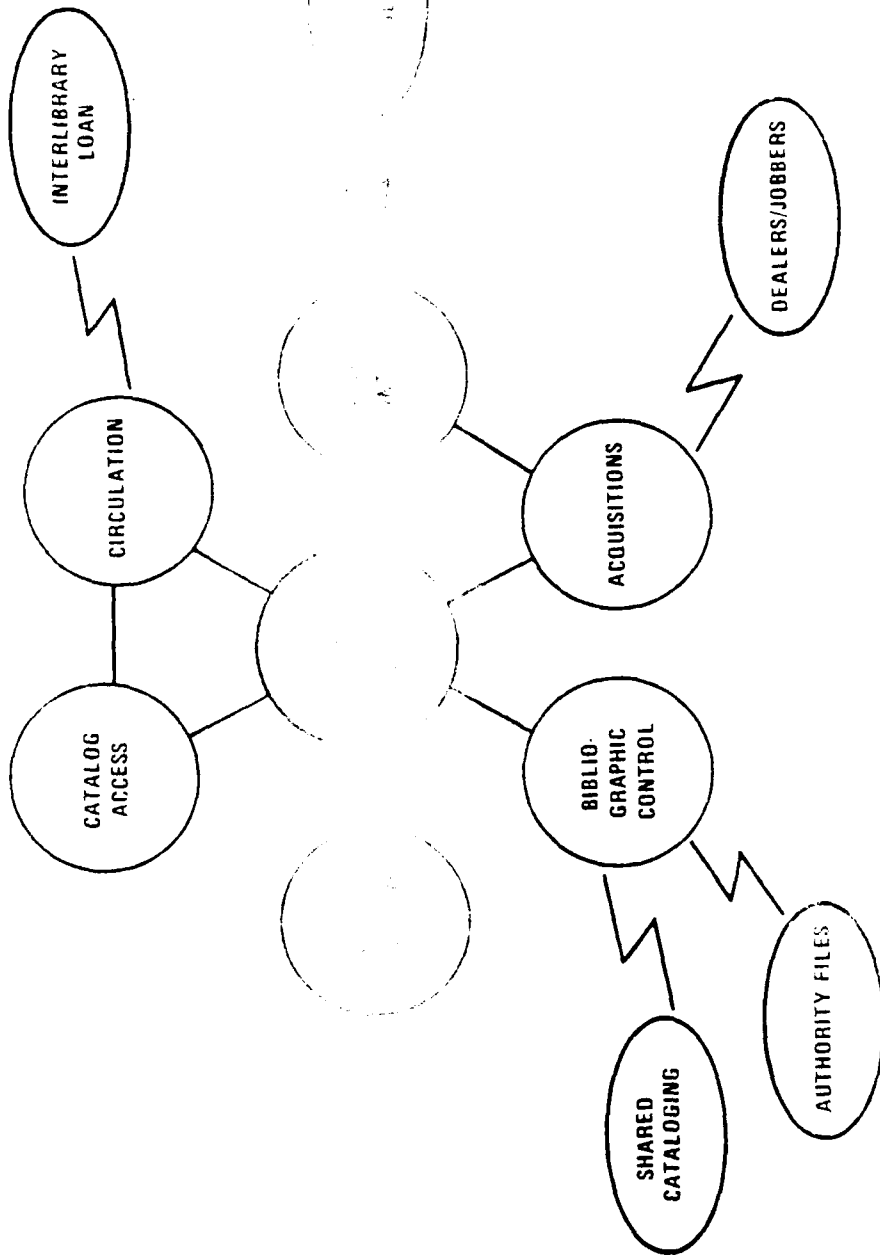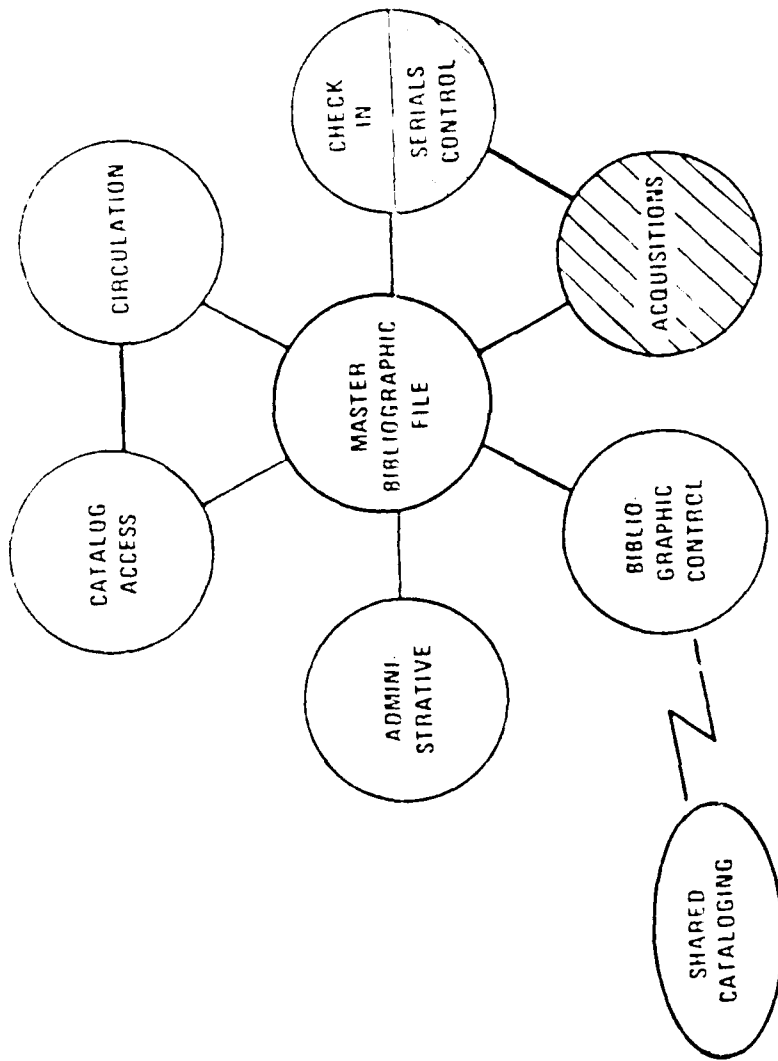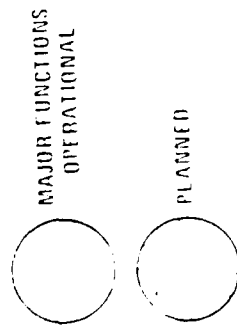FIGURE 2: INTEGRATION OF NETWORK ACCESS

FIGURE 3 ILS VERSION 2.0

MAJOR FUNCTIONS
OPERATIONAL

PLANNED

CIRCULATION

CHECK IN

SERIALS CONTROL

CATALOG ACCESS

MASTER BIBLIOGRAPHIC FILE

ACQUISITIONS

ADMINISTRATIVE

BIBLIOGRAPHIC CONTROL

SHARED CATALOGING

1) bibliographic f... ...inition
2) MARC tape loading,
3) cataloging and ed...
4) authority control.

1. Bibliographic file ...
...compatible format, that ...graphic file is structured ...to the tags
subfields, and indicat... ...acterize the MARC format.

A central step in ... ...ILS is to define the content of the MBF
records. The master f... ...on processes allow the librarian to iden-
tify, online, which M... ...bfields are to be included in the MBF
records when the file ... ...e tags and subfield codes so selected form
the 'local profile', ...rary can choose to store as much or as lit-
tle of the full MARC ... ...eeds. In addition, a library may establish
its own tags to store dat... ...required for its local needs. For example,
to catalog anatomical ... ...ibrarian may define new tags to describe
characteristics of mode... ...nt changes to MARC tag and subfield ...
tions may be entered ... ...new tags and subfields may be added to the
local data base profile w... ...ing the entire MBF.

2. MARC Tape Processing
added to the MBF is M... ...the major source for bibliographic records
information (such as ... ...es containing a library's own holdings
which connects shared ... ...CLC or RLIN). In Figure 3 the li...
common mode of file cr... ...because ILS supports a MARC-compatible
format, the system can ... ...bibliographic source files (such as
Blackwell-North America ...

Once a bibliogra... ...been identified, the library may ...
'selection strategies ... ...records of interest, based ...
tion in the leader par... ...bibliographic records. For instance, ...
library may wish to ... ...records or "previously CIP ... ...
publication) records or ... ...ction strategies are particularly ...
for organizing the init... ...of the library's collection, e.g. ...
all serials first.

The new records ... ...rectly into the MBF or ...
workspace for later rev... ...library's option. Records loaded ...
into the MBF are fully ... ...available for online catalog searching ...
other ILS functions (... ...subsequent editing). Records loaded into a
workspace may be reviewed ..., then moved individually or as a group to
the MBF.

3. Cataloging and edit...
utility is currently the ... ...ent method of creating the master biblio-
graphic file, ILS suppor... ...ve methods for introducing bibliographic
data.

The librarian may ent... ...vidual catalog records using the current ILS
cataloging module which ... ...tags to be entered one-by-one into the MBF.
This function is appro... ... entering brief records for previously

uncataloged items.

To edit records in the MBF, the system displays the record in MARC format (tags, indicators, subfield codes and data). The user indicates which tag and subfield is to be edited and replaces any erroneous parts of the tag data with correct information. Editing can be done without re-entering the full tag or subfield. The librarian may also add fields to or delete tags from any bibliographic record.

4. Authority Control ILS uses a MARC-compatible authority file which can accommodate personal, corporate and conference names, subject headings, uniform titles, and others. The authority file can contain all cross-references and scope notes identified in the MARC authority format, and the library may define local authority fields using a tag definition process like that described for bibliographic records. The authority terms are linked to the bibliographic records in which they are used, so that searching may be authority-controlled.

5. Future Developments in the Bibliographic Control Subsystem

Software is currently being developed to automatically access the authority file during the MARC tape loading and record add/edit processes. All bibliographic tags which are authority-controlled will be matched against the authority file when a record is input from a tape or during online cataloging or editing. New authority terms will be added automatically and may be reviewed and verified or changed. All changes to authority terms will automatically change the associated bibliographic records.

Three major enhancements are planned for the future:

- an improved local cataloging feature,

- online access to source authority files, and

- automatic capture of shared cataloging records.

An improved local cataloging module is being integrated into ILS which makes use of intelligent terminal characteristics such as multiple character sets (for diacritics) and block mode edit. When complete this feature will support extensive edit capabilities for existing bibliographic records, or sophisticated record input for original cataloging or retrospective conversion.

The ILS authority file structure will also support "source" authority files such as those established by the Library of Congress (names and subject headings) and the National Library of Medicine (MEDNAM and MeSH). These files may be loaded by an individual ILS library or shared by a consortium of participating institutions, but would remain separate from the "local" authority file. Catalogers would thus have online access to one or more sources and could extract appropriate authorities for use with their own bibliographic records.

In addition, design is underway for a network interface unit which would allow automatic capture of records from a shared cataloging terminal such as that used with OCLC. The basic capability will allow records entered at the OCLC terminal to be routed to the library's ILS system simultaneously (with

appropriate accounting to the cataloging utility). The generic network access capability which is planned will allow ILS to be used as the front end of any appropriate network, so that local cataloging or searching activities may be forwarded automatically.

C. Catalog Access Subsystem

The most recent addition to ILS is an extensive online catalog searching capability for library patrons. The online public catalog combines the features of traditional divided and dictionary catalogs. Patrons may choose a specific type of search (author, title, subject, and others) or may search for particular terms throughout the catalog. The MARC-compatible authority file provides access to related works through cross-references. Because all other ILS functions are linked through the master bibliographic file, searchers can view the current status of any item (e.g. checked-out, on-order). The design of the search interface emphasizes user-cordial interaction, and allows the user with experience to perform more sophisticated searches.

1. Search types

a. Divided Catalog: The "divided catalog" searches in ILS are those which correspond to the traditional library card catalog divisions: author, title, and subject. In addition, ILS offers searches by corporate author, conference name, call number, ISBN/ISSN, card number, title key and author/title key (the last four are primarily for librarian use). ILS offers the novice patron a choice among author, title, subject, and "others", on the assumption that most patrons will be satisfied by the basic three, while the curious will readily investigate the "others".

Once the patron chooses a search type, ILS searches the appropriate indexes and the authority file, as described below:

1. Author search - For the novice patron, the ILS author search covers personal authors. The patron enters as much of the author name as known, using a fill-in-the-blank form on the screen, then browses a display of authors alphabetically adjacent to the name being sought. The patron may browse forward and backward in the author index. When the desired author name is chosen, ILS displays the associated titles. If there are pseudonyms associated with the name, ILS will display them to assist the patron in finding all works by the chosen author.

2. Title search - The patron enters a full or partial title and browses the alphabetical title index. Enhancements are planned to provide automatic key word searching of titles, with retrieved titles ranked by degree of match.

3. Subject search - The patron enters a subject term and browses the subject key word index. When the appropriate subject key word is chosen, ILS displays all subject headings from the authority file which begin with or contain that word. The system will then display the titles indexed by the chosen subject heading.

4. <u>Corporate and conference name searches</u> - The patron enters the name and browses the appropriate index. The key word ranking described for titles will be available for these searches as well.

5. <u>Call number search</u> - The patron enters a full or partial call number to browse the call number index. This feature provides a shelf list browse of the collection.

6. <u>Unique ID searches (ISBN/ISSN, LC card number, OCLC number)</u>   -   The librarian or patron may use these search keys to retrieve specific bibliographic records. ILS would display only the item(s) which matched the user's input.

7. <u>Title key and author/title key searches</u> - The librarian or patron may search by these keys to quickly retrieve known items. Only matching entries are displayed; there is no browsing of the index unless a partial key is entered. The title key (3,2,2,1) is constructed from the first significant words in the title - 3 letters from the first word, 2 from the second, 2 from the third, and 1 from the fourth. The author/title key (4,4) consists of the first 4 letters of the author's last name plus the first four letters from the first significant title word.

b. <u>Dictionary Catalog</u>: The "dictionary catalog" search allows the patron to search for a term without specifying in advance how it is used, as in an alphabetically-arranged (or dictionary) catalog. The searcher browses the key word index and chooses the desired term; ILS then displays how the term is used in the catalog. For example, when the patron searching for "Freud" chooses that entry from the key word list, ILS displays:

This term appears in

    2 author names
    4 titles
    1 subject

From this point the searcher may pursue any of these searches, to see books by Freud or about Freud.

The search types described above are those already operational in ILS for searching by novice patrons. However, there is great flexibility built into the catalog access and bibliographic control subsystems which allows the library staff to determine the search access to be provided to different types of users.

The installing library may modify or supplement the search capabilities provided in the system through several <u>search group definition processes</u>, which determine what kinds of indexes will be constructed for online searching. Search groups identify which tags and subfields will be indexed and how the indexes are to be treated (e.g., key words, authority-controlled, word adjacency, and others). For instance, the librarian could specify that full subject headings (tag 650) are to be included in the subject index, but only the "a" subfield are to be entered in the key word index. The librarian may define stop word lists in different languages for various types of key word indexes.

In addition, different search groups may be made available to different types of users depending on their needs and experience. For example, the library may wish to provide author search for reference librarians which combines personal, corporate, and conference authors. A "search group" could be defined for "author" using all author main entry tags (100, 110, 111) plus the corresponding added entries tags. This definition would cause bibliographic records containing any of the identified tags to be indexed in a common author index.

Utilizing this very powerful indexing and user type definition process, multiple levels of patron and staff interfaces could be provided based on various search groups.

2. Future developments in the Catalog Access Subsystem Major enhancements planned for the online catalog include the use of touch panels and the addition of a command mode for more advanced searchers which will provide for explicit Boolean searches.

D. Circulation Subsystem

The circulation subsystem provides a collection control capability which maintains accurate, current and easily accessible information about the location and status of all bibliographic items. To facilitate tracking library materials, all items and patrons are identified to the system by machine-readable labels (bar codes). ILS uses "intelligent" bar code labels generated from information in the master bibliographic and patron files. This provides several important attributes: these labels correspond to the internal item identifier for faster retrieval, can be identified independent of copy or volume by assigning a unique number, up to 3 lines of human-readable information can be printed on the label. As items and patrons can be identified by any ILS function by searching bibliographic and patron indexes, the use of machine-readable labels eliminates most keying errors and greatly speeds up processing of circulation and other activities which require handling physical volumes.

ILS supports four major kinds of collection control activities:

- tracking usage of materials,

- displaying status of individual items and patrons,

- reporting circulation activity, and

- maintaining patron records.

1. Tracking usage of materials The basic ILS circulation functions record usage of library materials by patrons.

Check-out   assigns responsibility for identified items to individual patrons. It assigns a due date based on the item type, which can be overridden by the librarian. Check-out is blocked if the patron is over limit or the item is on reserve for someone else.

Check-in   records return of library materials. On-reserve or recall mes-
             sages are displayed if present. Items may be temporarily
             assigned to a book cart at check-in (see description of Cart
             feature below).

Reserve   allows patrons to put a hold on a desired item so they will be
             notified when it becomes available. Patrons may reserve either a
             specific copy or the first available copy of a particular title.

Renew   allows staff to extend an item's due date by patron request.
             This function allows separate counts of original check-outs and
             renewals.

Overdue-notices are sent to patrons after a defined period of time has
             elapsed since the item was due. The library administrator can
             tailor the wait period for overdue notices to encourage returns
             at a minimum mailing cost.

Each of these functions and others are described in detail in the ILS User Manu-
als (Tne80) for circulation.

In addition to these basic functions, ILS has three unique features which
provide true collection control and management capabilities:

- cart (temporary location),

- shelf, and

- set status.

The cart or temporary location function provides a very powerful capability
for tracking item locations during temporary relocations. Shelving carts, book
trucks, and/or technical processing shelves can be identified by bar-code labels
as temporary item locations. Using the cart feature during check-in, the
librarian can record that incoming items are now returned and available on a
specific book cart at a given location. Once all the items on the book cart
have been reshelved, a single transaction will clear all items from the cart
record (no need to re-process each item). Similarly, if technical processing
stations are labeled, the location and status of any item can be tracked con-
tinuously from the moment its record is added to the system.

The shelf function permits the ILS to maintain statistics on use of items
within the library. If the library has a "no-reshelving" policy, those items
used in-house can be collected and "checked in" using the shelf feature, which
will record and count this type of use. In-house use counts are kept separate
from check-out counts so the librarian can derive an accurate picture of usage
patterns.

The set status capability permits the user to explicitly set the status of
a given item to show, for example, that it is lost or that the patron claimed to
have returned the item. This feature also helps to minimize the ambiguous
'not-on-shelf' situation, since any known location problems can be recorded and

displayed with the item status. The system generates lists of any missing item with their call numbers, so that staff may attempt to locate the items by periodically searching for misfiling on the shelf. If the system encounters the missing item through another function such as check-in or out, a message will be sent and the item status changed to "found". After a designated number of unsuccessful searches, the item will be presumed lost and its status set accordingly, which may trigger its consideration for re-acquisition.

2. _Status displays_ The librarian may view the status of any individual item or patron at any time. The _item status display_ shows the item's current availability (on the shelf or in a temporary location, or to whom the item is checked out and when it is due back). Current circulation counts for this item are shown, including number of times it was checked out during the current reporting period, and the number of times used in-house. If there are any messages associated with this title they are shown here (e.g. "Item reported lost 11/10/80)"). The librarian may view the status of all copies for a given title.

The _patron status display_ permits the user to view the patron's record plus a list of items currently checked out and their due dates, the titles of any reserves being held for the patron, and any messages associated with the patron's record. Also included is the total number of items ever borrowed by this patron.

3. _Circulation activity reports_ Reports showing daily and weekly circulation statistics are presently available online. These reports display total activity in a variety of categories (e.g. check-outs/ins, renewals, overdues returned) by item type (monograph, serial). A related report is being developed which will allow the librarian to choose a specific time period to be covered, so that a report could be generated for special uses.

4. _Maintain patron file_ The patron registration function permits the librarian to record identifying information about patrons such as name, address, telephone numbers and patron type. Patrons may be individuals or institutions, departments, or other divisions of the library. The patron registration capability in ILS Release 1.0 was specific to the needs of the Army Library, but a generalized patron registration capability is available with Release 2.0. The first version allows libraries to record patron name, address, borrower category, and a set of other data elements describing the patron including title and office address. The new generalized capability will allow librarians to define at implementation the data elements to be collected, using a process similar to defining the bibliographic profile.

5. _Future developments in the Circulation Subsystem_ Enhancements are planned which will allow the system to support multi-branch circulation and reserve-room processing. A multi-branch environment (which can be a single library organized into branches and/or departments, or a consortium of separate libraries) requires that the system's circulation and searching functions identify and process items at the "branch" level where appropriate while maintaining a core bibliographic record common to all participants. The addition of a reserve room circulation function will allow ILS to track temporary subsets of the general collection whose allowable circulation period is measured in hours.

E. Serials Control Subsystem

The serials check-in function is the only portion of the serials control subsystem that has been implemented so far.

1. Serials check-in Library staff use the serials check-in function to record the receipt of individual serial issues and prepare them for filing and/or circulation. Detailed holdings are maintained in the serial title record showing every volume and issue that has been checked into the system. To check in an issue, the librarian searches for the item by title key or ISSN (or other search key). Once the title has been identified, ILS prompts the librarian for the issue date (year, month, and day if applicable), then displays the expected volume and issue number. If these data are not correct, the librarian may go back to enter the correct volume/issue or provide additional free-text description (i.e. if the issue is an annual supplement.) If the librarian has multiple identical issues to check in (for several subscriptions to one serial), ILS will check them all in at the same time.

When the serial issue is checked in, the system will generate a bar code label if desired, and will produce a routing slip to be attached to the issue if routing has been requested. The add routing feature in the Serials Control subsystem allows the library staff to identify individuals or departments that should receive copies of particular serials as they are received. Routing slips can be generated for all or selected issues.

2. Future developments in the Serials Control Subsystem As indicated above, the serials check-in feature is the first part of a full ILS serials control subsystem. Implementation of other serials control functions including claiming, bindery tracking, and maintenance of summary holdings is one of the major enhancements planned for the remainder of this year.

F. Administrative Subsystem

A major design goal of the ILS project has been to allow the library administrator or manager to set up and operate the system without in-house data processing staff. The administrative subsystem contains a number of functions which provide management control and support initial and ongoing system operations.

1. ILS Reports A number of pre-defined summary reports are presently available online, plus several printed "correspondence" reports. The summary reports cover circulation activity and data base updates for daily and weekly time periods. The circulation reports, described under the Circulation Subsystem, display totals for various categories such as check-outs/ins and in-house use, by item type. Data base activity reports show total bibliographic records added from MARC tape loads and cataloging, plus patron registration summaries. A generalized report writer is planned which will allow the ILS librarian to format special-use reports to supplement those provided with the system.

The printed reports currently available include a master patron list, overdue notices, and recall notices. The administrative subsystem report initiation functions assist the librarian in scheduling and printing such reports on a line printer.

2. <u>System operations</u> The major administrative functions are those which sup-
port system operation:

- defining authorized users,

- establishing system processing parameters, and

- maintaining online user manuals.

In <u>defining authorized users</u> the system administrator provides a password and
indicates what subsystems and specific functions the user will be permitted to
perform. <u>System processing parameters</u> define limits and time periods associated
with various activities. For instance, for the circulation subsystem the system
administrator specifies how many items a patron can check out at one time, how
many days to wait before sending out overdue notices, how many months to collect
current circulation statistics before archiving them, and many other parameters.
The administrator may also set system parameters to adjust the balance of
activities when the system is heavily loaded, by, for example, slowing down file
updates to improve response time for searching and check-in/out.

ILS contains extensive <u>online user manuals</u> which may be viewed from any
point in the system. Access to the online Help text is keyed to each function
so that the user gets assistance for the specific activity being performed,
without having to start at the beginning of the entire subsystem manual. The
Help Maintenance function of the administrative subsystem allows the system
administrator to update and/or reorganize the narrative provided with ILS, and
to produce printed copies for use within the library.

G. Implementation Status

The following table summarizes the current (July 1981) implementation
status of ILS subsystems and functions. ILS Version 2.0 functions are those now
available and released through NTIS in July 1981. Enhancements which are
planned but not yet initiated are indicated in the last column.

ILS IMPLEMENTATION STATUS

SUBSYSTEM FUNCTION	ILS VERSION 2.0	PLANNED
Bibliographic Control Subsystem		
Bibliographic file definition		
Bibliographic tag add/edit	X	
Search group definition	X	
Authority tag add/edit	X	
MARC tape processing		
Selection strategies	X	
Tape loading to workspace	X	
Direct load to MBF	X	
Cataloging and editing		
Record add/edit	X	
Full-screen record add/edit		X
Automatic capture of shared cataloging records		X
Authority control		
Authority file creation from MBF	X	
Online access to authority file during searching	X	
Authority file creation during MARC tape load	X	
Online access to authority file during cataloging		X
Online access to source authority file		X

ILS IMPLEMENTATION STATUS

SUBSYSTEM FUNCTION	ILS VERSION 2.0	PLANNED
Catalog Access Subsystem		
Novice patron search interface		
Divided catalog searches	X	
Dictionary catalog search	X	
Touch-panel input		X
Link to book reserve function		X
Reference librarian search interface		
Command-driven search mode		X
Boolean search options		?
Circulation Subsystem		
Item tracking functions (e.g. checkin/out)	X	
Cart, shelf, set status	X	
Patron and item status displays	X	
Circulation activity reports	X	
Patron registration	X	
Multi-branch/consortium		X
Reserve room processing		X
Pre-printed barcodes		X
Serials Control Subsystem		
Serials check-in	X	
Missed issue claiming		X
Bindery preparation		X
Maintenance of summary holdings		X
Administrative Subsystem		
Online reports		
Circulation activity reports	X	
Data base activity reports	X	
Report writer		X

ILS IMPLEMENTATION STATUS

SUBSYSTEM FUNCTION	ILS VERSION 2.0	PLANNED
printed reports		
Master patron list	X	
Overdue notices	X	
Recall notices	X	
System parameters		
Definition of authorized users	X	
Circulation parameters	X	
Other manual maintenance	X	
Acquisitions subsystem		
Creation of bibliographic record	X	
Creation maintenance of order record		X
Vendor file maintenance		X
Acquisition reports		X

III. TECHNICAL OVERVIEW

The technical design of the ILS is described in four parts:

Design approach
Files and data flow within the ILS
System back-up and recovery techniques
Software/hardware configuration and costs

Refer to Section II for an overview of the library functions supported by this design.

A. Design Approach

One of the most important goals in the design of the ILS was to provide a base for the development of a complete library system. Although the first major module selected for implementation was circulation, a significant analysis effort was performed to insure that all follow-on subsystems could be implemented with little or no impact on the existing functions.

To accomplish this, LHNCBC/CTB determined that two basic design elements must be implemented:

- A Master Bibliographic Record format which could support changes, primarily the addition of fields, as new subsystems are implemented; and

- A program design that logically separates each function from every other. This separation allows new modules to be integrated without significant code changes.

The MARC (MAchine Readable Cataloging) format developed at the Library of Congress is used as the basis for the Master Bibliographic File records. This record structure was designed to accommodate the many optional and variable length fields characteristic of bibliographic records; machine-readable files in this format are widely available and provide a ready source of data base records. However, MARC records are primarily oriented toward the cataloging function. The ILS master bibliographic file uses MARC tags as the basis of the record, but also maintains any other fields required for other library functions. Individual functions retrieve only those portions of the record which they need for processing or display. Section III.B.1 on the master bibliographic file describes this more fully.

The principal program design considerations which contribute to a modular structure for ILS were:

- All authorized functions (commands) may be executed directly from anywhere in the system; that is, the user does not need to return to the beginning of a function or subsystem in order to change to another function. Tree structured programming (nesting) is only allowed in the execution of subfunctions and then only if an exit out of the function is not required.

- Functions which share sub-processes use common programs. For example, check-out and check-in use the same item search programs.

- All functions in the system are made available to the user by a series of tables. These tables are the basis for control in the command processor which validates the user's choice of functions. New functions can be developed independently and added to the system through the tables.

Section B.5 on Data Flow discusses some of the significant aspects of this design.

E. Files and data flow in the ILS

Four important aspects of ILS files are discussed in this section:

- Master bibliographic file structure,

- Transaction files,

- Activity file/exception file structure, and

- Data flow.

1. Master Bibliographic File Structure

In designing the Master Bibliographic File (MBF) record, the design team analyzed the number and type of fields that occur in a MARC record; the characteristics of fields with repeats, subfields, and other such features; and the average length of tags and subfields within each record. This information was provided by OCLC from an internal study conducted on 41,000 records selected from the online data base.

A master bibliographic file was designed which accommodates these bibliographic characteristics in an efficient manner. All data fields for a title are stored under a unique record number. The order in which data fields are stored in the record can be determined by the library, so the most frequently-accessed fields can be stored together at the beginning of the record to minimize the number of disk accesses required for retrieval and display.

Information about individual copies and serial volume/issues is stored as a set of subrecords within the master bibliographic record. An inverted file in the main record indexes the subrecords by copy number and, for serials and monograph series, by volume/issue, and date. This technique provides very fast access for any searchers requesting a specific volume, issue, part, etc. or item by date. Furthermore, the structure required by any particular title is controlled within the record. For instance, one serial record may record bound volumes only while the next record contains volume, issue, part, and supplement.

Figures 4a and 4b provide an overview of the master bibliographic record structure for monographs and serials.

Unique Title ID	
MARC data selected by the site	
Site specific data common to all copies	
Unique Piece ID	Piece specific data
Copy one data	
Copy two data	
:	
Copy n data	
Date Index	
YYMMDD	Unique Piece ID
:	
YYMMDD	Unique Piece ID
Volume, Issue Index	Structure Format
Volume, Issue	Unique Piece ID
:	
Volume, Issue	Unique Piece ID

Figure 4b

Basic Serial Record Format

```
+------------------------------------------------------------+
|  Unique Title I:                                           |
|  ------------                                              |
|                                                            |
|                                                            |
|          MARC data selected by the site                   |
|                                                            |
|                                                            |
|------------------------------------------------------------|
|                                                            |
|                                                            |
|          Site specific data common to all copies           |
|                                                            |
|------------------------------------------------------------|
| Copy one data                                              |
|------------------------------------------------------------|
| Copy two data                                              |
|------------------------------------------------------------|
|                                                            |
|                                                            |
| Copy n data                                                |
+------------------------------------------------------------+
```

Figure 4a

Basic Monograph Record Format

2. Transaction Files

ILS uses transaction files instead of real-time updating to add, edit or delete records in the bibliographic and patron files. The use of transaction processing in the ILS has many benefits. Two of the more significant attributes are:

- Automatic creation of a daily log of system activities which facilitates the system restore capability and retains data on item activities for collection management purposes;

- A means to remotely perform system functions which may be processed after-the-fact or in batch.

Transactions are written to the log on disk using a unique sequence number as the key. A background processor, which does the actual file updates and tallies statistics, keeps track of which transactions have been processed. This information is maintained in a system file so that in the event of a crash or system halt the position in the transaction file can be reset to the correct value during restart.

The transaction file in fact consists of two separate files to increase system efficiency - a high-priority transaction log and a low-priority transaction log. Through background processors working at different intervals the system quickly posts critical functions and batches updates for non-critical changes. The intervals at which these background processors update the files are controllable by the librarian through system parameters, but are usually around 1 second and 5 seconds respectively. The critical or high-priority functions are those that affect patron activity and the status of library resources. The non-critical or low-priority functions are those which do not require instantaneous processing, primarily file edits. This approach is based on the assumption that the volume of updates to the Master Bibliographic File and to the patron file will be low compared to circulation transactions.

There is very little actual code in the background processors for control of the action to be taken. Transaction records include an operation code and a series of arguments and the data to be operated on. Thus, the background processor is basically an interpreter which has a set of instructions that can be invoked by any other process in the system through an entry in the transaction file.

3. Activity file/Exception File Structure

The activity files record items or patrons which have undergone any change of status or which have any action pending. All circulation activities such as checkouts and returns are recorded here. Subsequent circulation functions check the activity file for item information and do not need to access the MBF for those items which have current activity records. Activity records are retained for a parameterized length of time for reporting purposes before being purged.

This mechanism allows ILS to maintain a small efficient circulation processing file even for many large libraries. For research libraries in which a

very small percentage of [illegible] such an approach can significantly reduce [illegible]

ILS also uses an exception [illegible] mechanism to [illegible] encountered while performing [illegible] and other [illegible] based on two important [illegible]:

1. The majority of transactions [illegible] library [illegible] i.e. will not require [illegible] processing.

2. A person is, in general, willing to accept slower response for exception cases than for normal [illegible].

Items and patrons are [illegible] exception file whenever the system recognizes that special handling is required, e.g. when a title is placed on hold for a patron, or a patron [illegible] the maximum number of checked-out items allowed. The Exception [illegible] contains only item/patron ID's and exception codes. All entries for [illegible] be under a single root identifier [illegible] example, to reserve a book that [illegible] carries a single entry in the exception file will intercept any [illegible] copies to the [illegible] individual copies or issues can also [illegible] necessary.

Whenever ILS encounters [illegible] a patron ID during any circulation process, the system checks the [illegible] file to see if the item or patron is recorded there. If the item/patron is not found the processing continues normally; if found, the system [illegible] to look up the problem and prompt the user for resolution. Because it [illegible] entry ID's and exception codes, the Exception File is an extremely [illegible] which provides for very fast lookup time. The result of this approach is that most operations are much faster than they would be if the MBF and/or [illegible] file were accessed for each transaction.

4. Data flow within the ILS

An important design concept dictates that all updates [illegible] bibliographic and patron record adds and edits must be handled via a single entry point. Figure 5 on the following page clearly illustrates how the ILS subsystems produce transactions to update the integrated data files. Given a single source of updates, the area used to store update requests can double as a backup file at the end of the day. This technique, although slower than having each add/edit/delete take place in real time from an originating program, insures complete compatibility between files. It provides the principle mechanism for system restore and reduces the complexity of adding new functions.

The concept of controlled and sequential entry points into the data base provides an easy transition to large distributed systems. Remote processing can be accomplished by creating a data stream for either transaction file in the correct format, and executing a transfer from the external device into the host computer. The background processor will see a very large queue and process the transactions in order of receipt just as if they had been initiated at local terminals. This degree of control provides a natural evolution to off-loading the central system for increased throughput.
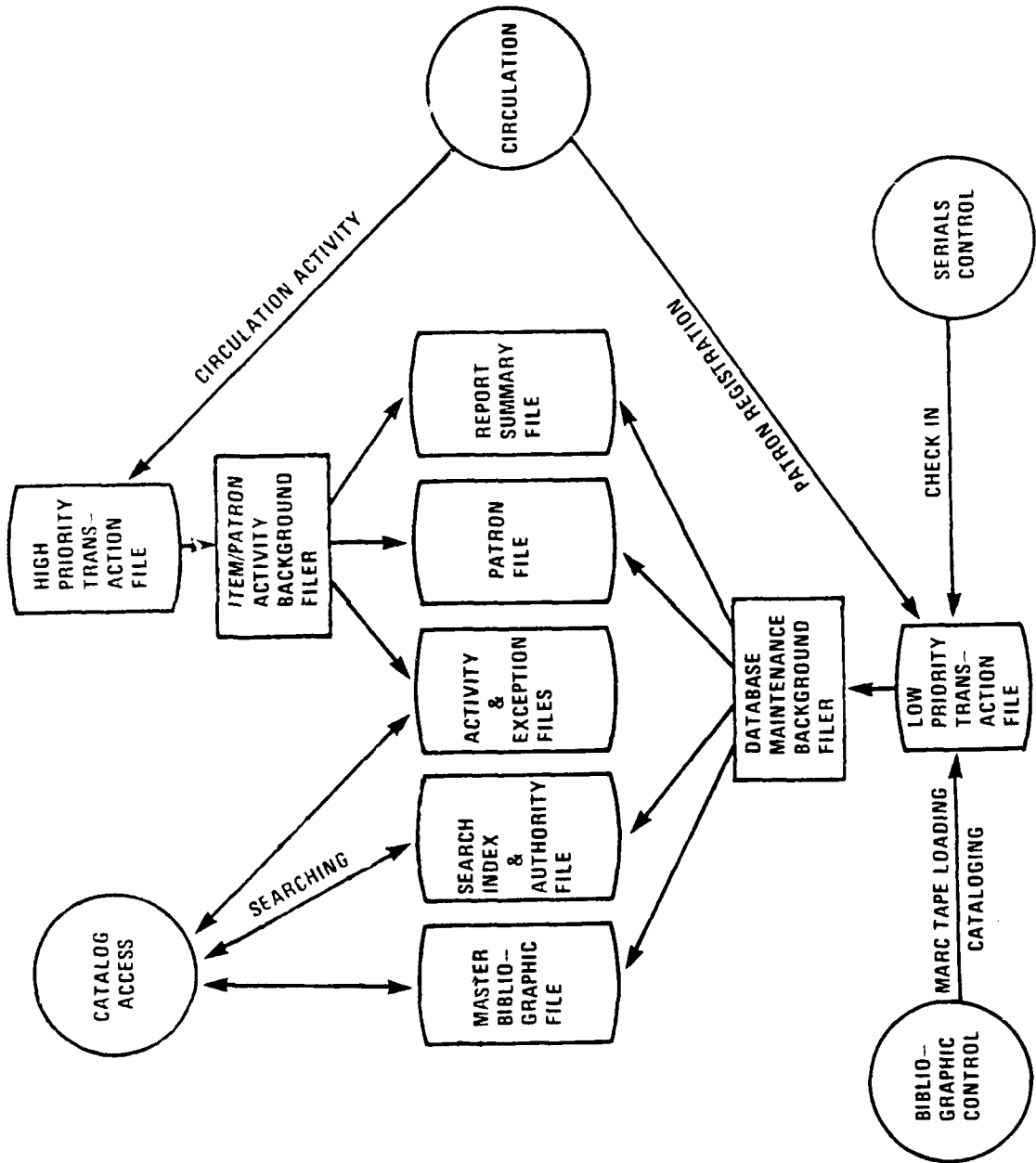
FIG. 5 DATA FLOW IN THE INTEGRATED LIBRARY SYSTEM

C. System Back-up and Recovery Techniques

The ILS is designed to run with proven off-the-shelf hardware and software. All components are standard and operating in thousands of different applications all over the world. There are no special purpose or experimental pieces of equipment or software. However, ILS incorporates a number of security, back-up and recovery techniques to minimize the effects of any failures.

The most important of these is the set of programs and procedures which protect the library from losing or damaging its machine readable data base. A full set of file back-up and recovery techniques is available. The most important of these are:

1. Full transaction logging. As described above, the ILS transaction processing functions provide a high degree of protection against loss of data. The majority of hardware failures may lose at most one or two of the most recent transactions. The worst possible failure-- a complete disk crash--may lose transactions back to the last transaction log dump, if the transaction log is maintained on the same device as the main system files. If the transaction log is running on a physically separate device there should be no loss of data. Any losses in the master files can be recovered by loading the last back-up copy of the data base and reprocessing the transaction log from that point on.

2. Disk to disk and disk to tape utilities. With two or more disk drives, the library can make complete disk backups each night, reducing still further the time required to fully restore the data base after a possible disk failure. In addition, one or more tape copies can be stored in a fire proof safe or off-site site so that even total destruction of the computer room will not destroy the data.

D. Software/hardware configuration and costs

ILS has been implemented using the MIIS/MUMPS language, which is an integrated operating system, data base management facility and programming language. It provides balanced tree data storage, powerful string and text manipulation, true time sharing, and other features which are particularly well suited to libraries. The MIIS dialect (Meditech Interpretive Information System) supplied by Meditech, Inc. of Cambridge, Massachusetts, was originally chosen because at that time it was unique in support of balanced tree data storage and other features since adopted by other implementations of standard MUMPS. Conversion of ILS to standard MUMPS is feasible if the library requires it.

Using the MIIS operating system, ILS will run on any of the following types of minicomputer equipment:

- Data General Eclipse series,
- Digital Equipment Corporation's PDP/11 series
  (including the LSI 11/23 microcomputer), and
- the IBM Series 1.

Two major factors must be considered in choosing computer equipment: the size of processor required and the amount of auxiliary disk space needed to store the

library's data. Processor size largely determines how many users and/or how much of a processing load can be supported with good response time. The library's processing volume and estimated number of simultaneous users must be analyzed to identify the appropriate processor. The amount of disk storage required can be estimated by allowing approximately 3,000 bytes for each full MARC record and its indexes and authority records; thus a collection of 30,000 titles would require approximately 90 megabytes of disk storage. Additional equipment requirements include tape drives, computer terminals, bar code readers, and line printers.

ILS Version 1.0 may be obtained through the National Technical Information Service for a licensing fee of $2,000. The MIIS operating system costs an additional $5,000 to $15,000 depending on the computer equipment chosen, plus an annual maintenance fee of up to $3,000 per year. It is not possible to predict hardware costs with any accuracy since the amount/size/cost of equipment is highly dependent on the size of the library holdings, transaction rates, and the functions being implemented. ILS can be made operational on computer systems listing for as low as $25,000; however, equipment for a medium-size library will probably cost $70,000 or more.

There are many other costs associated with the installation of any automated library system, including those for facility preparation, software changes and maintenance, supplies, and specially trained personnel. Although an effort has been made to design ILS so that library staff can define and control many of the technical aspects of the system, users will require technical assistance from persons familiar with MIIS MUMPS to install and/or modify ILS.

IV. ACKNOWLEDGEMENTS

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