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ABSTRACT

The Message Delivery System described, a facility that will link automatic bibliographic services and permit the transmission of messages among the various services, is one of the basic requirements for the development of a comprehensive computerized bibliographic system of nationwide scope. The system will enable users of one system to have access to information and services on other systems that are part of the National Library and Information Service Network. This document lists the general technical requirements for the Message Delivery System and discusses the anticipated evolution of the network. It defines the scope of technical network activities, the system development methodology, and the technical work that must be undertaken to realize an operational network. (Author/MBR)

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Preface

One of the basic requirements for the development of a comprehensive computerized bibliographic system of nationwide scope is the Message Delivery System, a facility that will link automated bibliographic services and permit the transmission of messages among the various services. The Message Delivery System will thus enable users of one system to have access to information and services on other systems that are part of the National Library and Information Service Network. The general requirements document lists the general technical requirements for the Message Delivery System and discusses the anticipated evolution of the network. It defines the scope of technical network activities, the system development methodology, and the technical work that must be undertaken to realize an operational network.

The purpose of the general requirements document is to state the functions of the Message Delivery System and to recommend the next steps in its development. The recommendation was presented to the Network Advisory Committee at their May 1978 meeting, and approval was given to begin work on the preparation of more detailed requirements.

The Network Technical Architecture Group (NTAG) prepared these requirements as part of its work to develop bidirectional computer links between bibliographic utilities (i.e., organizations that maintain large online bibliographic data bases and that provide products and services to their users). Such links will permit the sharing of bibliographic data and services among the various systems.

NTAG is a task force of technical staff from library network organizations that was established by the Network Advisory Committee and given the directive to determine the hardware, software, and communications configuration for the library bibliographic component of the network. Although the requirements were prepared with the library bibliographic component in mind, the requirements could be applied equally well to all components of the network. The Message Delivery System general requirements are not only the first step in a series of activities leading toward an operational network, but are also an important statement to the bibliographic community of the scope of NTAG's work.

CONTENTS

1.0 Brief History

The Network Technical Architecture Group (NTAG) has been dealing with the technical problems of linking computerized bibliographic services. This group consists of technical people, knowledgeable in computer systems, telecommunications, data bases, and library automation generally. Its first two meetings were sponsored by the Research Libraries Group (RLG) who were particularly interested in sharing details of their experience with a communications link to LC. As its first task, the NTAG began to define a phased approach toward implementation of a network which would join several computerized bibliographic services. The first phase called for interconnection by methods similar to those used in the link between RLG and the Library of Congress. Other phases were proposed which would widen participation and improve the modes of communication, providing for bilateral and finally multilateral sharing of information by all organizations involved. Subsequently, the NTAG has specified technical issues which must eventually be resolved before an effective electronic network can be put into place. These include such topics as network topology, reliability, and performance characteristics. At the same time, the NTAG has been building a rational schedule for the completion of technical tasks, clarifying interrelationships between tasks, and suggesting how each task might be accomplished.

2.0 Conceptual Framework

2.1 Network Evolution

As the network becomes a reality, a gradual evolution of new communication patterns will most likely occur. At present, each bibliographic utility distributes service to its users in an independent manner. Some use common carriers while others use specialized distribution networks such as Tymnet or Telenet. Moreover, many of these bibliographic utilities tailor their services to specific types of terminal equipment. This means that if a library wishes to take advantage of services from more than one utility service, separate fiscal and legal arrangements, and sometimes different dedicated local equipment, must be used. Figure 2.1 illustrates this present environment, with many libraries clustered around each utility, and with some libraries obtaining service from more than one utility. In this diagram, arrows indicate the flow of services from the utilities to the libraries, with library L5 receiving services from utilities U2 and U3. Also the utility U2 accepts input data from its participating libraries L3, L4 and L5.

A first step in the evolution of the nationwide network would probably be an interconnection between various bibliographic utilities. This kind of connection would allow one utility to begin defining new products and services which depend on resources located at some other utility. Certain utilities may choose to adopt bilateral arrangements whereby services flow in both directions. Figure 2.2 illustrates such a situation, with U1 and U3 mutually exchanging services but U2 deriving services from U1 and U3 in a unilateral manner. One utility might mediate the services provided by another utility to create a customized 'window' or particular way of using the other utility's services. In general, this should increase the appeal and improve the market for such services to libraries. In the diagram, new libraries L7, L8 and L9 join their respective utilities to benefit from these broadened services. L5 also no longer requires direct access to U3 since it can use the services through U2.

The precise shape of a further evolution of the network is conjectural, since a great many options for development are open. However, Figure 2.3 shows one such possibility. Here, the network is depicted as providing a coherent, fully connected network facility providing for bidirectional flow of services between any two utilities. The diagram further depicts the possibility of a group of libraries coming together around a new facility F1. This facility might have the technical means to offer services of its own or from any of the utilities attached to the network without at the same time requiring dedicated or

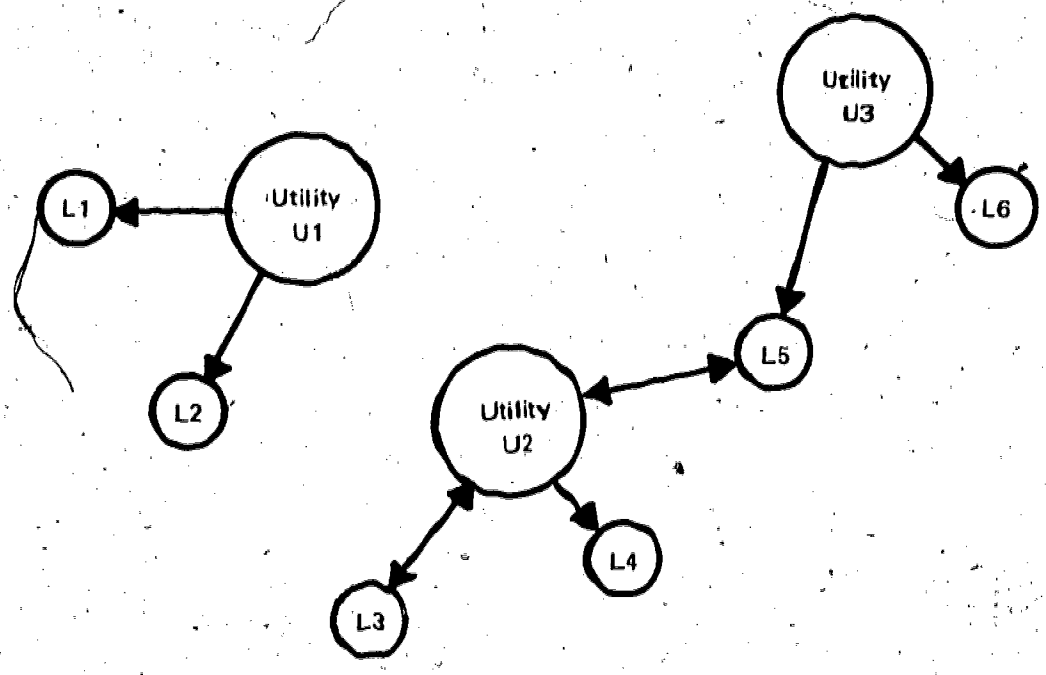

Figure 2.1

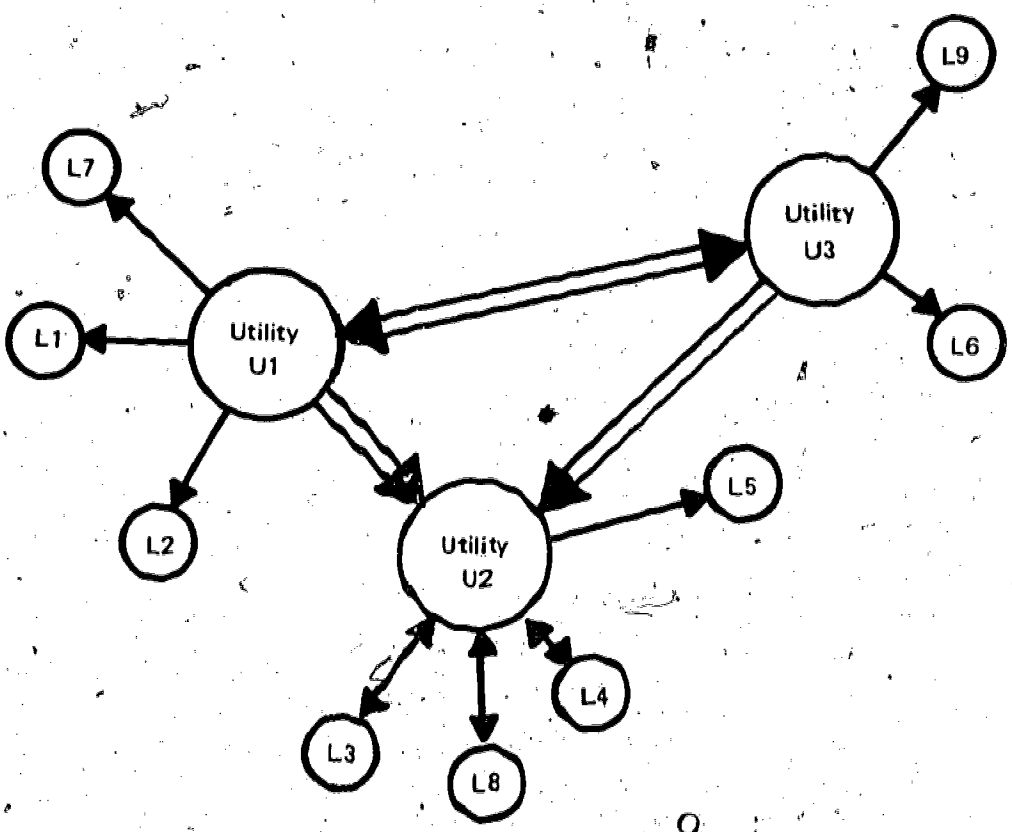

Figure 2.2

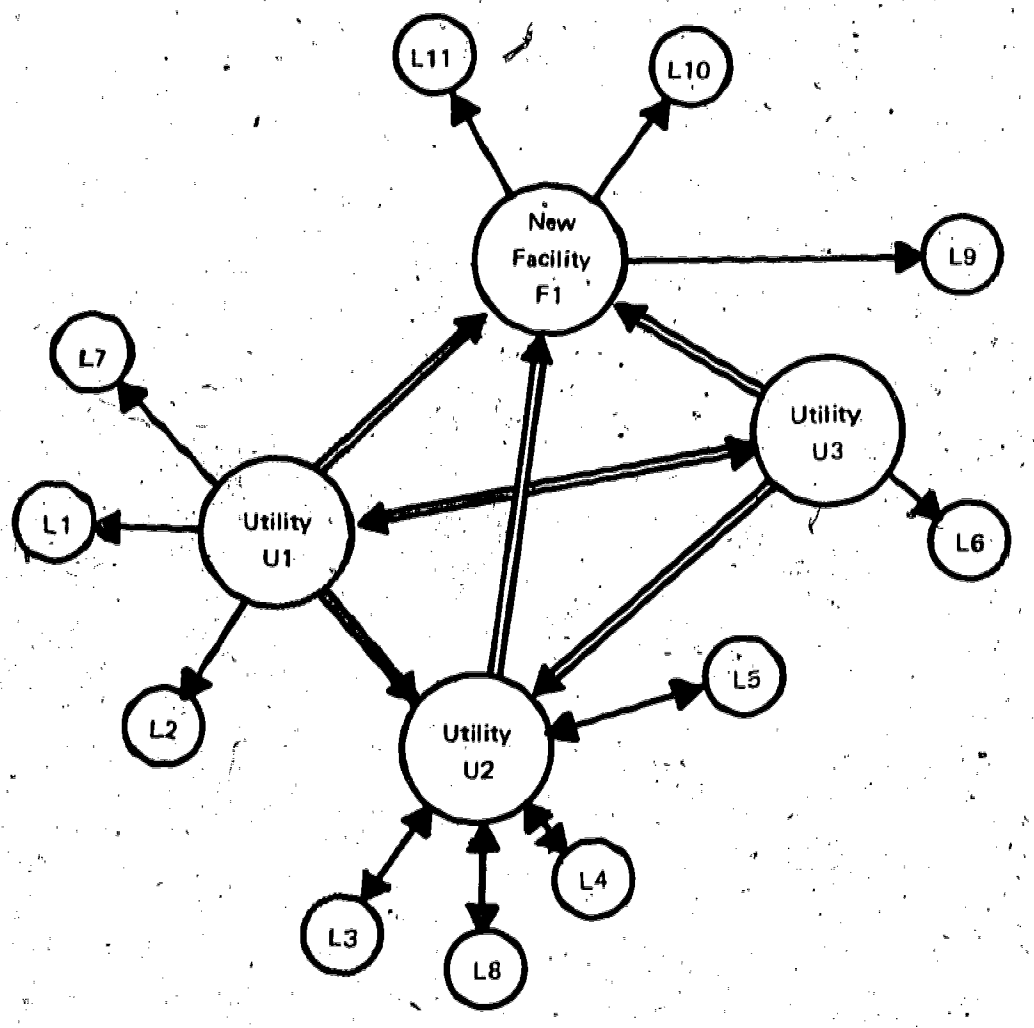
L11
L10
New
Facility
F1
L9
L7
Utility
U3
L1
Utility
U1
L6
L5
L2
Utility
U2
L4
L3
L8

Figure 2.3

unique equipment in the libraries that are in turn attached to it. This interconnection of utilities would allow entirely new techniques for sharing data and might foster new concepts concerning the use of bibliographic data itself.

2.2 Parts of the Network

When a dialogue takes place on the network, it involves two hosts communicating with one another using certain shared transmission facilities. In examining the responsibilities, it is convenient to distinguish between two constituent parts which make up the network. One part consists collectively of the hosts on the network and can be called 'the message processing system.' It is within the message processing system that product definition occurs. Applications on the host computers may, for example, offer particular search strategies or specific library-oriented applications such as cataloging or acquisitions support. The other part of the network is made up of the 'message delivery system.' The message delivery system is responsible for the timely and accurate transmission of messages between hosts connected to the network. The message delivery system is accountable for each message from the time such a message is entrusted to it until it is safely delivered. In performing this function, the message delivery system would be responsible for packaging and routing the message appropriately. From the user's point of view, the message processing system is the locus of all intelligent manipulation and response. Although the message delivery system might in fact perform some rudimentary manipulations on the data being transferred, these transformations are transparent to the user and do not affect the content of any message as far as the hosts are concerned.

Figure 2.4 may help to show the distinction between these two parts of the network. In this diagram, Hosts H1 and H2 are in communication with each other. In fact, the dialogue is taking place between application A1 on host H1 and application A4 on host H2. The two hosts, together with their respective front-end processors, HF1 and HF2 belong to the message processing system. The message delivery system, on the other hand, consists of the network front-end processors NF1 and NF2, the connection between them C, and the interconnections between the respective NF's and HF's designated I1 and I2. Note that I1 is different from I2 in that the interconnection I1 consists of a single link, perhaps indicating some kind of multiplexed channel, while I2 shows several links, perhaps consisting of separate asynchronous terminal connections. The network front-end processors can be customized to provide a variety of interconnection possiblities.

Determining the nature and conditions for using the applications residing on each host is, of course, the

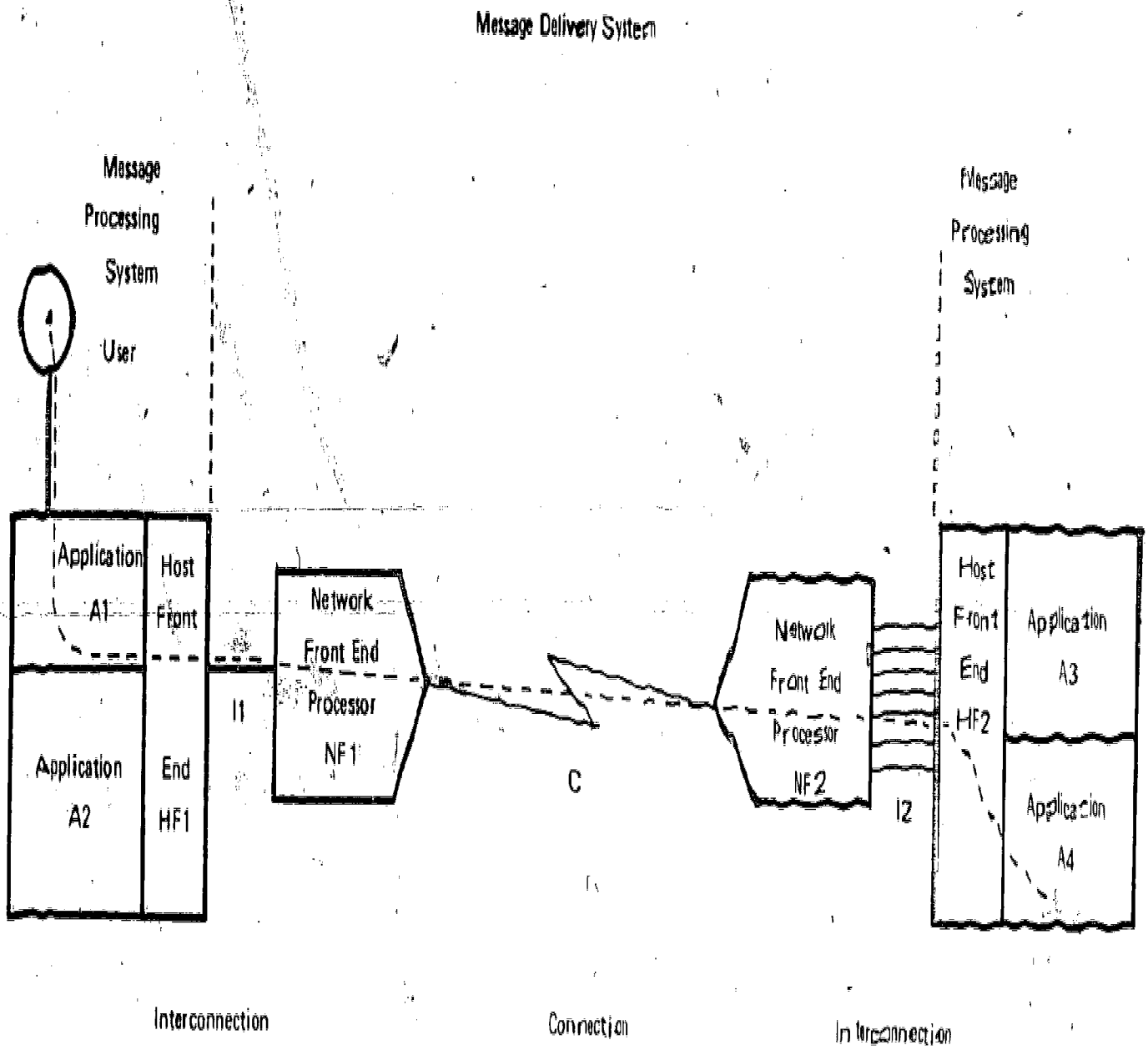
Message Delivery System
Message Processing System
User
Application A1
Host Front End HF1
Application A2
I1
Network Front End Processor NF1
C
Network Front End Processor NF2
I2
Host Front End HF2
Application A3
Application A4
Message Processing System
Interconnection
Connection
Interconnection

Figure 2.4

responsibility of the organization owning that host. Supplying an adequate message delivery capability, and developing standards for using the message delivery system, on the other hand, would be the responsibility of some organization having authority for operating that part of the network.

3.0 Scope of Network Activities

3.1 Types of Functions

The network is expected to facilitate the technical processes regularly occuring in a library, such as acquisitions, cataloging, and serials control. For example, monograph orders might be routed through a clearinghouse, or a union list of serials might be maintained in a nationwide data base. It is also expected to support public service functions such as reference and interlibrary loan. For example, it should be possible for an interlibrary loan librarian to verify the bibliographic accuracy of a citation, ascertain the availability of a particular item, and request the delivery of that item from a distant library. Reference use of the network may involve the retrieval of bibliographic information, browsing through authority files, fact retrieval, and even computer aided instruction. Library users should be able to create their own bibliographies and establish personal subsets of larger catalogs. Strictly speaking, these functions and applications would reside in host computers attached to the network; while the network itself would provide communications highways that facilitate broad use of these applications.

3.2 Types of Material

The types of material controlled by the systems using the network naturally include all the materials usually housed in library collections. These include monographs, serials, journal articles, phonorecords, microforms, slides, films, photographs, and realia. But it also includes some items only rarely held in present day libraries, such as videodiscs, datapacks, and other media for reocrding digital information and data bases. In short, any material susceptible to standardized bibliographic description may be handled by the systems attached to the network. One requirement for the communications capability of the network is that it must facilitate transmission of these descriptions.

3.3 Types of Data

At first the network will be used primarily for bibliographic data. This means that there will be a heavy orientation toward character streams represented in the ASCII character set. Bibliographic data includes: 1) descriptive information concerning particular objects in a collection, such as monographs, serials, journal articles, films, phonorecords, microforms, and realia, 2) classification and indexing information, authority files for subjects, names, and other types of entry and any other records which serve to index and organize

the above descriptive information, and 3) holdings information which indicates the physical location, borrowing privileges, etc., pertaining to particular objects held in a collection. Yet it will be necessary even at the outset to transmit other information pertaining to the billing and accounting for the network's management functions. Further, the network should be built in such a way that it can easily evolve to accommodate the kind of data contained in abstracts, including the special symbols for mathematical, scientific, and chemical expressions. Non-roman alphabets will also have to be accommodated. Other character-oriented data of a non-bibliographic nature includes prompts, errors messages, and plain text dialogues. Almost certainly excluded from possible transmission over the network will be sensitive and secure information of any kind, such as financial data or personnel data. However, patron identifiers and mailing addresses will have to be transmitted for interlibrary loan functions. Ultimately, as it evolves, the network may be used for the transmission of full text. This might imply a requirement for transmission of digitized facsimile. In any case, some method for transmitting transparent binary data will be inevitable, if not for facsimile data then for network maintenance functions such as down-line loads or diagnostics.

3.4 Types of Organizations

The organizations which will be connected to the network in one way or another are indeed diverse. These organizations include: 1) national libraries such as the Library of Congress, the National Agricultural Library, the National Library of Medicine, 2) computerized bibliographic utilities such as BALLOTS, Lockheed Search Service, OCLC, the Systems Development Corporation, and the Washington Library Network, 3) the National Periodical Center, 4) other suppliers of bibliographic service in the commercial sector such as Baker and Taylor, Blackwell, Brodart, and Faxon, 5) regional bibliographic service centers such as AMIGOS, PALINET and SOLINET, 6) statewide authorities and state bibliographic agencies such as CLASS, Illinet, Incolsa, and state library agencies generally, 7) libraries of all kinds, public, private, school, college, university, government, and special.

3.5 Modes of Use

It is anticipated that the network will support a variety of behavioral modes including: 1) on-line interaction for persons at terminals actively engaged in a dialogue with a computer or with another person, 2) on-demand bulk transfers from a file to a device or vice versa, including initiation of transfers destined for remote sites, 3) on-demand bulk transfers

from file to file, for the purpose of moving data from one utility to another, 4) prescheduled transfers, file-to-file or file-to-device, 5) prescheduled absentee interactions, in which routine or repetitive operations are performed from a script, 6) unsolicited periodic dissemination of messages, 7) continuous or open-ended file transfers for updating purposes, and 8) bulk inquiries for later processing. This description points up some of the behavioral modes without ascribing performance specifically to either the message delivery system or the message processing system. In fact, it should be noted that the message delivery system will have a rather limited storage capacity, sufficient chiefly for purposes such as buffering messages. Retention of bulk inquiries, as an example, might be provided by one of the hosts attached to the network and thus would likely be located in the message processing system.

4.0 System Development Methodology

4.1 Summary

The system development process involves a complex interaction of users and technicians. Needs and constraints, benefits and costs, and short-term solutions versus longer-term capability must be considered. However, the objectives are often unclear when there is neither an orderly plan for nor well-defined stages in the development process. Such an unstructured approach results in delays in completing the system, impairment of the quality of the system, and the general dissatisfaction of all parties involved.

A structured approach to the system development process provides a set of orderly interrelated activities with specified products, reviews, and approvals at logical milestones in the process. This general framework more clearly defines to both the user and the development group the methodology of system development.

The activities of the system development process can be grouped into a series of development phases or levels, each with its specific products. Each phase may be viewed as a refinement of the previous phase. At the end of each phase, one-time costs, continuing costs, and the method of assessing costs will be evaluated and refined.

Review and evaluation at the completion of each phase involves a progressively higher investment in the system as well as a stronger commitment to its completion. Firm scheduling for the completion of a given level is possible only at the completion of the immediately preceding level. A formal "sign-off" is made at each level, and changes to "sign-off" documents (e.g., changes to system requirements and system designs) are possible only through a formal procedure for "change control."

4.2 Methodology Description

The goal of the Network Technical Architecture Group (NTAG) is to plan and establish the technical environment to support the development and operation of a nationwide computerized network for library and information service. This goal represents a long term developmental effort to improve the national means for on-line access to and use of both bibliographic information and the resources which that information describes by individuals, by library organizations, by bibliographic utilities, by networks, and by vendors of bibliographic products and services. The accomplishment of this goal requires agreement on the goal, on a strategy for reaching

the goal, and on a methodology for the process of development.

The design, development, and implementation of a message delivery system for the library bibliographic component of the National Library and Information Service Network is a complex task which involves the coordinated efforts of several groups. The methodology proposed in this section is designed to provide the means for conducting this development. The methodology is designed to achieve early agreement on the objectives, requirements, and external characteristics of the message delivery system so that subsequent technical design and development of the system may be guided by these considerations.

The system development methodology is based upon a multiple phased approach to system design, development, and implementation in which the entire development project is divided into separate entities or phases.

Figure 4.1 lists the system development phases along with an estimate of their average cost as a percentage of the cost of the total system development process.

PHASE	AVERAGE PHASE COST	CUMULATIVE PROJECT COST
1. Requirements Definition	20%	20%
2. General Design	10%	30%
3. Detailed Design	15%	45%
4. Development	20%	65%
5. Implementation	35%	100%
6. Operation	-	-

FIGURE 4.1: SYSTEM DEVELOPMENT CYCLE

Each of these phases is described in more detail in Section 5: "General Schedule." Each phase is based upon the work done in the previous phase and lays the framework for the next phase. The individual phases require varying levels of committment from different institutions. Some can be performed by independent experts and consultants and some require a high degree of involvement by personnel of each network participant. Some phases require the support of systems analysts and designers, others require computer programmers and hardware technicians, and others require documentation writers, user support personnel and technical trainers.

Each phase has a well defined end product. This includes a detailed report on the activities performed during that phase, and for certain phases, operational, well tested

programs, a set of installed equipment, leased communications lines, a staff of network technicians, trainers, etc.

One product which is prepared during each phase is a description of the activities of the next phase. This will include a discussion of what activities must be performed, a set of alternative methods of performing the activities, a recommendation of which alternative(s) should be selected, a detailed budget estimate and schedule, and a refined gross budget and schedule for the entire project.

The next phase description must also include any peripheral or parallel activities which should be undertaken at this time. The technical development of a message delivery system is only one step in the evolution of a library and information service network. The development of a management structure in which the technical network can operate, a governance structure to set policy, a nationwide data base design to maintain quality and cost effectiveness, are some activities which must proceed concurrently with the technical network development so that an operational environment can be realized.

The message delivery system development could be considered as a set of sequential phases which lead into one another as shown in Figure 4.2. Each phase accepts input, not only the output from the previous phase, but also requires input from other parallel activities. Similarly each phase not only produces output for the next phase, but also provides input to other activities. A more detailed explanation of the interrelationship of parallel tasks within the development of the National Library and Information Service Network is being prepared as a separate document.

The purpose of the multiphased systems approach is to structure the development cycle into an orderly series of tasks. After each phase one has a better understanding of what tasks must be performed in the next phase, how they should be performed, what it will cost to perform them and how long it will take. By approaching system development in this fashion, interested parties can be kept well informed as to the progress of the project, the interaction of parallel activities can be coordinated, and concurrence on the next phase activities can be achieved by policy makers.

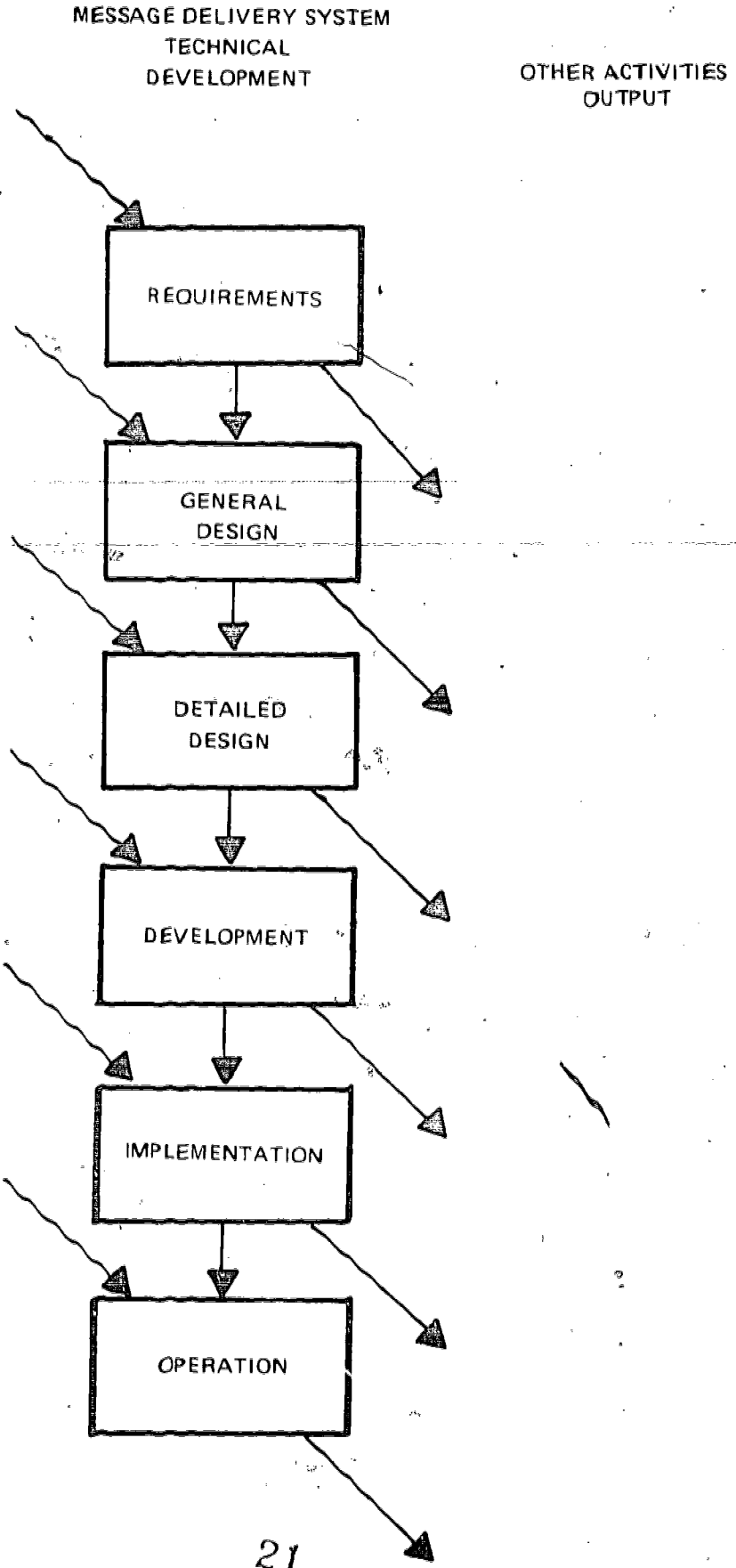
MESSAGE DELIVERY SYSTEM
TECHNICAL
DEVELOPMENT
OTHER ACTIVITIES
INPUT
OTHER ACTIVITIES
OUTPUT
REQUIREMENTS
GENERAL
DESIGN
DETAILED
DESIGN
DEVELOPMENT
IMPLEMENTATION
OPERATION

FIGURE 4.2

5.0 General Schedule

The design, development, and implementation of a message delivery system to support the library bibliographic component of the National Library and Information Service Network will be accomplished in several sequential phases using the system development methodology described in Section 4. The individual phases and their interrelationship are described in the following subsections. A General Schedule for the phases is presented in Figure 5.1.

At the end of each phase, a description of the activities to be undertaken during the next phase will be presented and a more detailed schedule for that next phase will be prepared. The General Schedule will be modified to reflect any changes brought about during the current phase activities or anticipated with the next phase. The General Schedule in Figure 5.1 is more to show the interrelationship of the phases and the relative time frame than the actual timing of the project. The General Schedule will be affected by the intensity of effort made during each phase, such as by performing many man-months of labor in a short time period. In certain phases, such as design, development, and implementation, which will involve the coordination of many diverse institutions, it is anticipated that there will be overlap between the various phases caused by differing institution working at differing speeds.

5.1 General Requirements

The purpose of this phase is to define the objectives, scope, and general requirements of the project. The product of this phase is this document, MESSAGE DELIVERY SYSTEM...: General Requirements. It contains an overview of the problem or need, the objectives of the project, a general description of the system and a schedule of activities which lead toward an operational system.

a. History and Context. In order to place the bibliographic component of the National Library Network in perspective, a history of the evolution of these requirements will be provided. Also included will be a description of relationship between this and other components of the National Library Network.

b. Scope and Constraints. The General Requirements document will contain a description of the economic, operational, and organizational constraints which potentially affect the network. This implies that policy-level (NAC)

GENERAL SCHEDULE

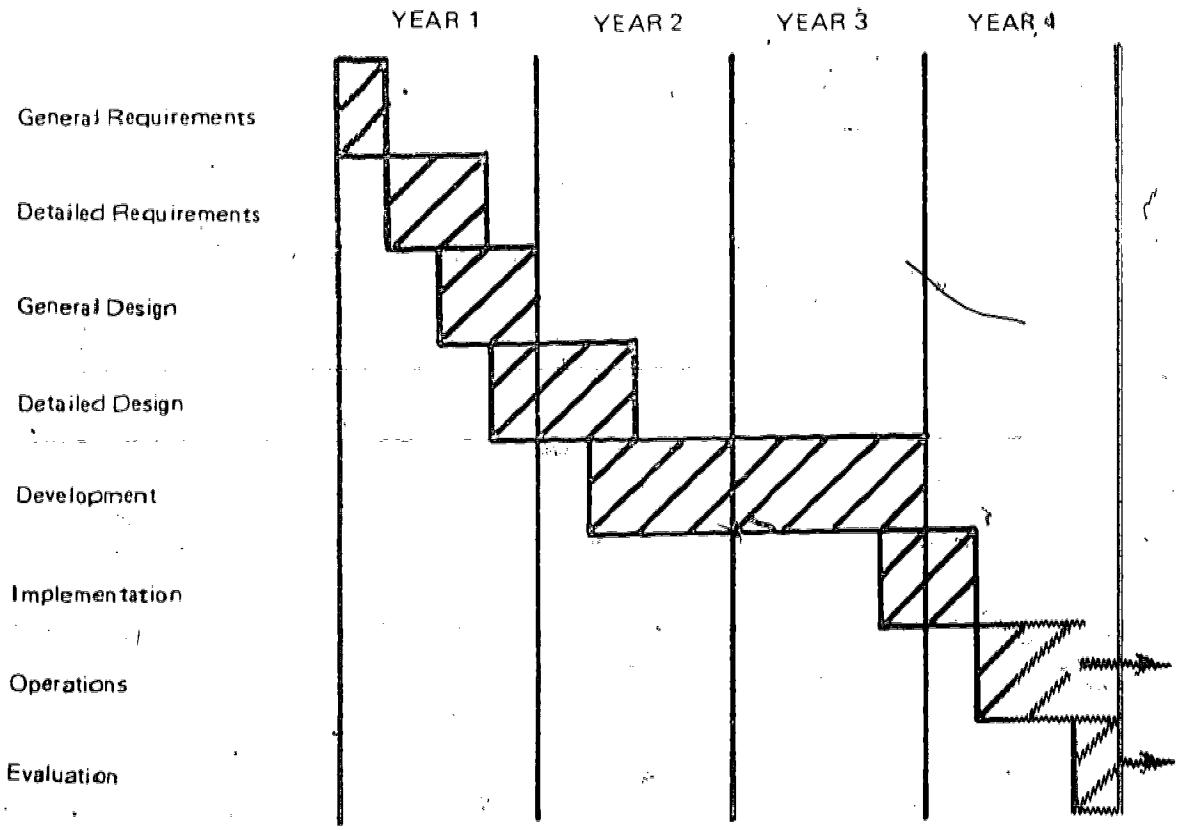

FIGURE 5.1

decisions have identified a favored economic framework, an operational model, and an organizational structure from which these constraints are derived.

c. Descriptive Background - Network Usage. The expected modes of use of the network by end-users will be discussed. Also to be listed are those data types to be dealt with together with the kinds of materials they relate to. Next are defined the general categories of functions which are available in potential network host computers, and identification of those to be available to network users. Finally, the kinds of organizations which are likely to participate in the network are described.

d. Procedural Methodology. Described here are the project management methods to be employed during subsequent phases, with emphasis on how ideas and materials from diverse sources are to be documented and disseminated, and how coordination will take place among the several groups involved in design, development, and implementation.

e. Statement of General Requirements. The most important product of this first phase is a clearly documented set of general requirements to be met by the operation of the bibliographic component. These requirements should be stated in terms which are neutral with respect to possible technical solutions. Emphasis will be placed on the 'what,' and the 'how' will be avoided.

5.2 Detailed Requirements

This phase addresses what the proposed system is supposed to accomplish, independent of particular design approaches or solutions. During this phase the objectives and scope of the system are detailed and constraints on the system are identified. Results of this phase serve as a vehicle for communicating assumptions for review and comment by interested parties. The boundaries set forth in this phase govern the course of future design and development.

a. Functional Requirements. The functional requirements must contain an enumeration of

host nodes which fit the definition contained within the general requirements, together with the expected date of connection to the network. For each host node, a complete description must exist for each function, capability, and resource within the host system that will be available to network users. Included will be statements regarding data base scope and size, search and retrieval capabilities, and pertinent data formats. Using this information it will be possible to list and describe the various types of messages which will be exchanged by the host sites via the network.

b. Performance Requirements. Message traffic statistics must be provided for each logical host-to-host link by message type: in particular, message length and message initiation rate. In addition, requirements for network response and receiving host response must be specified. Finally, an acceptable level of availability and reliability of the network and of the host nodes will be defined.

c. Operational Requirements. Given the operational model described in the General Requirements, it is necessary here to define the specific status information that the network will provide on demand: to any host or to any operations control point (e.g., a network center). Likewise, the kinds of information to be made available on network performance (message traffic, response, reliability, availability, etc.) to network operations personnel must be specified.

When the network begins production operation, the capability must exist for damaged network components to be repaired. Sufficient information must be available to allow faults to be isolated to a particular component, to be diagnosed, and to allow timely and complete communication of the problem and its nature to the organization(s) responsible for performing repair. The capabilities within the network which support those requirements will be specified.

As the network matures in production, it will be necessary to add new host nodes and delete existing ones. As a result, functions and message types will be added and deleted as well. The capabilities and procedures to support these requirements will be described.

d. Administrative Requirements. Here will be described in detail the data flow necessary to support the billing function. Also described will be the management reports and other information tools to be used by the senior staff of the network organization to administer the network.

e. Documentation and Reporting Standards. The product of this subphase will be a specification for the form and content of the documentation which emanates from subsequent phases. This documentation covers hardware configurations, software, operating procedures, planning and scheduling, and periodic progress reports.

f. Design Constraints. A narrative description of the logical and physical constraints imposed on the system design (e.g., support for heterogeneous hardware)

g. Interfaces. Identification of the interfaces between this system and other automated and manual systems.

h. Methodology for Estimation of Operating Costs. As the formulation of the detailed requirements proceeds, elements of potential income and operating cost will be identified. These elements will be used to construct a first-order economic model which is independent of any given set of assumptions regarding cost or revenue. The model will be used in subsequent phases to explore the tradeoffs between management, maintenance and operating costs, as well as alternative pricing strategies, capital investment, and financial equilibrium.

i. Planning, Budgeting and Scheduling, General Design Phase. All major tasks for the next phase will be listed, staffing levels will be applied, and completion dates for each task will be formulated. The completion of certain

tasks will be identified as intermediate milestones for reporting purposes as appropriate. A budget covering all expenditures in the next phase will be created.

This documentation should be designed for both technical and non-technical review.

5.3 General Design

This phase identifies alternative solutions to design problems, selects one of these based on an analysis of the alternatives, specifies the external system characteristics, and describes the environment in which the system functions.

a. Formulation of alternatives. In this subphase, all design alternatives will be investigated which in the designers opinion could satisfy the General and Detailed Requirements. All known technical, economic, and operational characteristics of each alternative will be documented.

b. Systems Analysis and Selection of Alternatives. Each alternative will be evaluated against the General and Detailed Requirements. If necessary, simulations will be performed or models constructed as appropriate to determine the efficacy of each solution from the technical, economic, and operational point of view. A basic approach will be chosen based upon this analysis.

c. Description of Components. Each major hardware, software, and human/procedural component of the chosen alternative will be described in this subphase. Included for each component will be a description of purpose, a general discussion of how the component will function, a description of how control and data is passed between components, and any performance, cost, or operational constraints that are known about the component at this time.

d. Standards which apply to the design. References will be made at this time to any standards which apply to the overall design or to any component of the design.

e. User Environment. A description of the relationship between the communications aspect of the system and the processing portion will be developed.

f. System Operations. A description of each communications function defined for the system along with references to the input and output between the communications system and the processing system will be prepared.

g. Data Dictionary. An item level description of the input to and output from the communications system will be prepared.

h. Planning, Budgeting and Scheduling, Detailed Design Phase. All major tasks for the next phase will be listed, staffing levels will be applied, and completion dates for each task will be formulated. The completion of certain tasks will be identified as intermediate milestones for reporting purposes as appropriate. A budget covering all expenditures in the next phase will be created.

Documentation for this phase should receive review and comment by those involved in both the communications and the processing activities of network development.

5.4 Detailed Design

This phase moves from the external aspects of the system to the internals of the communications system for message exchange. During this phase specification of hardware, specification of software, and specification of the structure and content of system input and output formats occur. In this phase the only material of interest to individuals concerned with the message processing system is the structure and content of input and output formats.

a. Detailed Specification, Hardware. Each major hardware component will be broken down into minor components, if appropriate. Each component will be specified and/or designed in sufficient detail to allow procurement and/or fabrication to proceed.

b. Hardware Selection. The specification for each hardware component will be used to determine

vendors who have (or can build) products which meet the specifications. Vendors will be chosen according to accepted procurement practices, and detailed cost estimates will be drawn up in cooperation with vendors.

c. Detailed Specification, Software. Each major software component will be broken down into smaller constituent components. Each of these minor components will be specified in terms of algorithmic content, and detailed descriptions of how control and data is passed among the components will be created. The level of detail will be sufficient to allow programming to proceed or to allow the procurement of an existing software product if appropriate.

d. Software Standards. In this subphase, any standards which are to apply to software module design and development will be specified. Examples of such standards are the application of structured programming practices, the use of source program comments, data element and module naming practices, and the use of particular programming languages.

e. Testing Plan. A component testing plan which documents the various testing methodologies to be employed in subsequent phases will be formulated. Each software and hardware component will be identified according to the methodology to be employed in testing it. A similar plan for prototype system testing and acceptance testing will also be created.

f. Operating Procedures. Sufficient knowledge should exist at this point to allow the creation of draft operational procedures. The early creation of these procedures will allow review and critique to occur regarding the probable operating efficacy of the network.

g. Planning, Budgeting, and Scheduling, Development Phase. All major tasks in the next phase will be listed, together with staffing levels and completion dates. All projected expenditures for hardware and personnel resources will be documented.

5.5 Development

This phase consists of the acquisition and testing of hardware components and the design, coding, and testing of software modules. The design documentation for this phase should consist of:

a. Hardware Acquisition. All orders for hardware components will be placed with vendors using the specifications drawn up in the Detailed Design Phase.

b. Software Support. Any vendor-supplied software components will be ordered, according to the specifications drawn up in the Detailed Design Phase.

c. Module Design. Each software component will be further decomposed into modules, if necessary, and designed to meet the specifications and standards created in the previous phase.

d. Software Programming. Each software module will be coded according to the module design, to meet the specifications and standards created in the previous phase.

e. Testing. Each module will be tested according to the testing plan created in the previous phase. Each sub-system, and finally the entire system, will likewise be tested according to the testing plan to assure correct functioning and adherence to the specifications.

f. Planning, Budgeting, and Scheduling, Implementation Phase. All major tasks for the next phase will be listed together with staffing levels and completion dates. All projected expenditures for hardware and personnel resources will be documented.

5.6 Implementation

This phase consists of installation of system hardware and software, system testing, pilot operation of the system, and placing the system in production and maintenance mode.

a. Prototype System Testing. The completed system will be installed with pilot host nodes and

operated in prototype mode using the draft operating procedures. The extent and duration of this test must assure the correct functioning of the hardware, software, and procedures under production conditions. Logs and statistics will be rigorously gathered to document the extent to which the system meets performance specifications.

b. Adjustments and Finalization of Procedures. As the prototype testing proceeds, it may be necessary to make adjustments in various system components. As this is done, the system documentation will be upgraded to reflect the changes. As the implementation phase draws to a close, operational procedures will be finalized and published.

5.7 Operations

This phase consists of adoption of operating procedures, system monitoring and evaluation, maintenance, and network enhancements and changes.

a. Assignment of Network Production Personnel. In this subphase, personnel for hardware maintenance, software maintenance, and operations will be identified and assigned.

b. Evaluation and Acceptance. The assigned personnel will review all data gathered in the previous phase and make a determination regarding the correct functioning of the system, using criteria set forth in the testing plan for final acceptance testing.

If the system is accepted, then responsibility for the network operation will be transferred and full production will commence.

6.0 General Requirements

The following requirement statements are to provide an overview of the functions which the Message Delivery System (MDS) will perform and to state in general terms the important technical aspects of the MDS. The requirements should assist the reader in understanding just what the MDS is supposed to do and will provide a basis for the generation of more detailed requirements.

1) The MDS will support computer-to-computer message flow.

The network will be designed so that one bibliographic utility or service center can send and receive messages from any other utility which is part of the network. Rather than supporting direct terminal-to-computer communications, all interactive communication will be through local computer systems. By concentrating on computer-to-computer communications, the network will not have to worry about specialized terminal characteristics and protocols, will support a variety of access arrangements, and will make more efficient use of facilities.

2) The MDS will allow every host computer on the network to communicate with every other host.

Although the MDS will allow any host to communicate with any other host, a host on the network will not <u>have to</u> support communications with <u>every other</u> host. Each host system will internally determine with which other hosts it wishes to communicate; the MDS only allows it the capability of communicating with all other hosts. This is a logical communications capability and not necessarily a physical one.

3) The MDS must support bidirectional communications.

Every host on the network can both send and receive messages. Every host can originate sessions with another host or be the target of a session.

4) The MDS must support multiple simultaneous sessions between hosts.

It is anticipated that most hosts will wish to carry on simultaneous sessions with different hosts or with the same host. The network will allow the hosts to speak with several other hosts at the same time or will

allow logically independent sessions to be established between any two hosts.

5) The MDS will support communications between heterogeneous host systems.

Because current bibliographic utilities use differing systems (both hardware and software), the MDS must allow sessions between these disparate entities. The MDS, therefore, cannot be dependent on one type of host or system and interfaces to the MDS must be hardware independent.

6) The MDS will support both interactive and bulk transfer sessions.

We anticipate that the network will be used to support a variety of activities between host systems -- interactive message flow, in which an online user of one host system can have access to data stored on another host system, and bulk transfer message flow, in which many records ,or files can be sent between host systems. This requirement sets certain parameters for availability, reliability, transmission delay, etc.

7) The MDS will supply network status information for management.

During the operation, as well as the testing, of the network, the management must be able to have accurate and timely information on the status of the network. This includes host system availability, network resource loading (lines, switching nodes), and error rate monitoring. The MDS must have the ability to provide this information automatically.

8) The MDS must be able to detect failures.

In addition to providing status information when requested, the MDS will monitor its components and will notify management of any network failures. This notification will allow timely resolution of difficulties.

9) The MDS will collect statistics on network usage.

The collection and evaluation of statistics concerning the flow of information in an operational network can provide the designer with valuable insight as to its performance at various times and under various loads. Network optimization is closely tied to

statistics evaluation. Statistics can also be used for accounting purposes for equitable sharing of network costs.

10) The MDS will maintain reasonable security to attempt to prevent information within the network from being seen or modified without authorization.

Information network security is an increasingly important concern and nationwide networks must be designed to prevent unauthorized access to the network and its information. However, the level of security is directly related to the costs of developing and operating the network. As such, the MDS will only be expected to provide the level of security which is affordable under given costs. It will be the responsibility of each host on the network to contain its own internal security measures to prevent unauthorized use of its own system.

11) The MDS will transmit information accurately without distortion or errors introduced during distribution.

Information integrity is concerned primarily with accuracy and validity of information flowing between nodes on the network. The MDS must be designed to detect and correct errors, retransmit data, and maintain data continuity.

12) The MDS must meet specified performance parameters with respect to availability and reliability.

Availability is defined as that portion of a time interval during which the MDS is capable of performing its assigned functions. There may be several reasons why an MDS may be unavailable to the user, such as, equipment failure, software failure, or circuit overload. Reliability is defined as the probability that an MDS will perform without failure for a specified time or amount of usage. The concept of reliability is similar to that of availability in that the failure of any component which prevents messages from being sent from an originator to a recipient affects availability of the system, if it is not in use at the time of the failure, and reliability, if it is in use. Detailed functional requirements will state the parameters within which the MDS will perform.

13) The MDS will not be dependent on any single network host for message delivery.

The network must be able to withstand the failure of any of its host computers without affecting the delivery of messages between two other hosts. It is possible, however, that network services may be unavailable if a certain host fails, when that host is the only system on the network offering a particular service.

14) The MDS will be easily maintainable.

To keep high availability, the MDS must be able to quickly diagnose and correct errors. Because the MDS will connect a wide diversity of host systems, and the personnel at each host system will have varying degrees of competence in networking, the network management must assume the responsibility for the integrity of the network. In addition, enhancements to network capabilities must be implemented smoothly with only minor disruption of service.

15) The MDS must be able to accommodate changes in internodal traffic, routing, host computers, and host services.

Because the National Library and Information Service Network is an evolutionary network, under constant growth and flux, the MDS must be able to accomodate changes. It is anticipated that new host systems will be added, old ones deleted, new services implemented at various hosts, all of which will affect traffic patterns and volumes. The network must accomodate these changes gracefully with minimal effect on network operations.

16) The MDS must be managed.

The Network Advisory Committee is currently investigating the legal and organizational aspects of the National Library and Information Service Network. In the course of this investigation, the network management structure will be defined. The technical design of the network must proceed in cooperation with the Network Advisory Committee to ensure that the MDS will be manageable under the organizational constraints.

17) The MDS will adhere to national and international standards.

Within the library and data communication fields, new national and international standards are being developed for link and network protocols, (X.25, ADCCP, etc.) application level protocols (developed by the

NCLIS/NBS Task Force on Computer Network Protocols), bibliographic data formats (MARC), etc. The MDS should adhere to these standards, where possible. In addition, the MDS itself will define certain procedural standards for participation in the network.

18) The MDS will be cost effective.

Today's technology allows the user a wide variety of services for an even wider variety of costs. It should be anticipated that the network will be self supporting in its operation and that developmental costs, while perhaps supported by external funding, must be kept within reason. The Network Advisory Committee in cooperation with the Network Technical Architecture Group will determine the cost effectiveness of the MDS during its development and operation.

7.0 Recommendation for Further Work

This document describes in general terms the requirements for a message delivery system in support of the library bibliographic component of the National Library and Information Service Network. In order to pursue the design, development, implementation, and operation of the message delivery system, further work is necessary in preparing a more detailed requirements statement as described in section 5.2 "Detailed Requirements." In addition, parallel activities must be pursued in the areas of project and network management, governance, and funding so that the technical aspects of the network can proceed in an orderly manner and in coordination with other network activities.

7.1 Detailed Requirements Study

The next phase of activities to be pursued in this project is the detailed requirements phase. The areas of concern for this phase are described in section 5.2 "Detailed Requirements." The major task within this phase is the preparation of a requirements document which can be used to communicate the assumptions about the network for review and comment by involved parties and to allow refinements of the project's scope and purpose. The document will be used to make estimates on manpower and costs for the next phases, and to seek committments from involved institutions--participants and funding sources--to initiate the next steps in the network design and development.

7.1.1 Alternatives

Having identified and isolated the detailed requirements task, NTAG has further identified four distinct avenues of approaching this task, namely:

1) The full NTAG group will perform this task as a committee project,

2) the NTAG Subgroup will perform this task as a subcommittee project,

3) the task will be undertaken by a single NTAG member (Individual Institution), or

4) the task will be assigned to a proven capable contractor (consultant) with demonstrated expertise in the area of telecommunication networking.

NTAG feels that a timely and successful completion of the detailed requirement phase cannot be accomplished by either NTAG as a whole or a subgroup thereof, since each member of NTAG has consuming institutional responsibilities which preclude allotting sufficient time to accomplish the task in a timely manner. And if sufficient time is alloted, the specific institutions will suffer. Further, if the task were to be undertaken by NTAG members, nonnegligible additional resources would be required simply to forestall the suspicion of institutional politics.

If a single NTAG member (Institution) were to undertake the task, it would seem, from the standpoint of available resources, that none could make necessary resources immediately available for this purpose without unfavorably affecting current developments, and it would require several months to gear up for such an undertaking. In addition, an institutional contractor would find it prudent to avoid suspicion of institutional politics--probably with additional expense and limited result.

7.1.2 Recommendation

Having found none of the first three alternatives particularly attractive and considering timely and expeditious implementation of the network, NTAG recommends that an independent contractor with demonstrated expertise in the area of telecommunications networking be engaged to undertake the preparation of detailed requirements for the message delivery system. This work will be monitored by NTAG.

NTAG believes that such an approach will:

1) ensure timely and expeditous accomplishment of the task,

2) provide necessary and sufficient control of the undertaking to assure the needs of the library community are met,

3) free the activity from undue suspicion of political influence, and

4) allow a more economic accomplishment of the task.

In order to accomplish this task, NTAG must:

1) prepare a request for a proposal describing the work to be accomplished,

2) get the concurrence of involved institutions and seek the necessary funding to accomplish this task,

3) prepare a list of prospective contractors and solicit proposals,

4) evaluate proposals and make a selection, and

5) negotiate a contract and establish a contract monitoring process.

7.2 Parallel Activities

The development of the technical message delivery system is only one step in the creation of an operational national network. Parallel work must occur in the areas of management, governance, and funding, to supplement the technical work.

7.2.1 Management

Probably the most important parallel activity during the technical network development is the development of a management structure to coordinate the technical development activities and eventually to operate the message delivery system. Because this activity will involve diverse groups--bibliographic utilities, equipment suppliers, data communications vendors, etc.--there must be a well defined management structure to coordinate activities, set schedules, develop standards and procedures, report on progress, monitor systems tests, and develop operating procedures. After the development cycle has ended, the management structure must coordinate network operation, maintain the system, implement procedures for adding new hosts, monitor the loading, reconfigure the system if necessary, maintain liaison with vendors and other institutions, and plan enhancements and refinements.

NTAG is currently preparing a paper describing the general requirements for a management structure to support the technical development cycle and network operation. This paper will be sent to the Network Advisory Committee for incorporation in their activities in the areas of network legal and governance issues.

7.2.2 Governance

Another area of concern which must be addressed at this time is the governance of the network and its implications for the technical design and operation of the message delivery system. Because initially the network consists of independent utilities linked by a common message delivery system, the role of

all the involved institutions, their responsibilities, authority, and participation must be clearly defined.

This activity is currently being undertaken by a subcommittee of the Network Advisory Committee.

7.2.3 Funding

Closely related to governance is the funding policy to support the development and operation of the network. NTAG thinks that the message delivery system which is implemented must be so cost effective that it will operate on the money it charges its users. Since the library community has very limited funds available for automated systems and networking, the means of funding the development of the message delivery system must be investigated. This investigation must address sources of funding, network participants' involvement, amortization of the cost of development and equipment, and contracting methods.

GLOSSARY

The following glossary defines the terms in this document in the context in which they were used. It does not attempt to contain full and complete definitions but is to assist the reader in understanding the requirements. An attempt was made to use meanings currently accepted as standards and to be consistent with the definitions being prepared in the "Glossary for Library Networking."

Bibliographic Data - data representing individual bibliographic attributes of an item, typically including descriptive and subject cataloging elements, indexing elements, authority elements, and abstracts.

Bibliographic Service Center - an organization that serves as a broker or distributor of computer-based bibliographic services. A service center gains access to national library network resources through the facilities of a bibliographic utility. It does not contribute records directly to or maintain portions of the national library network data base.

Bibliographic Utility - an organization that maintains large online bibliographic data bases, enabling it to offer computer-based support to a subset of the national library network participants.

Common Carrier - a telecommunications company which is regulated by an appropriate government agency and which offers services to the general public via shared circuits.

Host - a system or subsystem in a network which performs actual processing operations against a data base and with which other network nodes communicate.

Host Computer - a network computer which performs the primary processing services such as computation, data base access, and special programs.

Host Front End Processor (HFEP) - a computer at a host site which provides the interface between the host computer and the logical network front end processor. HFEP functions encompass message formatting, character conversion, operating systems control and input/output supervisor control.

Library Bibliographic Component - that portion of the national library network encompassing its bibliographic service system and segments of its communications system,

exclusive of the resource library system.

Message Delivery System - the communications computers and network front end processors which control the transmission of messages between network hosts and the telecommunications facilities used for message transmission. See also: Message Processing System.

Message Processing System - the host computer and host front end processor in a network that perform the network's operations at the application level.

National Library and Information Service Network - a system to facilitate access to the nation's library and information resources. The proposed network is to consist of three coordinated parts: a resource system, a bibliographic service system and a communications system.

Network - two or more organizations engaged in a common pattern of information exchange through telecommunications links, for some common objectives. In this paper, network usually refers to the National Library and Information Service Network.

Network Front End Processor (NFEP) - a front end computer which acts as the interface between the host or host front end processor (HFEP) and the network. Its responsibilities include the reliable routing of messages to and from the associated host front end processor and the transmission of messages from other network nodes.