DEPARTMENT OF THE ARMY DBD/bj/OX 5-0494
DEFENSE SUPPLY SERVICE—WASHINGTON
WASHINGTON, D.C. 20310

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IN REPLY REFER TO:

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Gentlemen:

The Defense Supply Service-Washington contemplates entering into an appropriate type of cost-reimbursement contract for Interface message processors for the Advanced Research Projects Agency (ARPA) computer network. The requirements for this work are set forth in the sample contract attached.

You are invited to submit your written quotation in quintuplet using the attached Standard Form 18, Request for Quotations. Your quotation should include the following information:

a. Total estimated cost and fixed fee, if any, of the work to be performed;

b. Latest date, if any, upon which you are willing to enter into a contract;

c. Detailed cost and price analysis, using DD Form 633 setting forth:

1. Manpower requirements (show by category of work).
2. Supplies and materials.
3. Other direct cost (specify).
4. General and administrative expense (show basis).
5. Indirect costs other than 4. above (specify).
6. Fixed fee, if any, for this contract will be negotiated using the weighted guidelines method set forth in Armed Services Procurement Regulation (ASPR) 3-808.

DD Form 633 shall be attached to the analysis and executed. Breakdowns are required to support the reasonableness of your quotation and are for internal Department of Defense use only. The information required will be held in strictest confidence and will not be revealed to or discussed with competitors. Your established method of costing may be used but should be described.

Note: It is important that your cost breakdown be submitted in such a manner that it can be separated completely from the technical portion of your quotation. This will facilitate evaluation.

d. Statement regarding your insurance program, copy attached, properly executed;

e. Names and resumes of background and qualifications of the person and an alternate who will be assigned by you to be in charge of the entire project and other key professional personnel you propose to assign to the contract.

f. The names and telephone numbers of personnel of your organization who are authorized to negotiate the proposed contract with the Government; and

g. Equal Opportunity Compliance Report, properly executed. If the report has previously been submitted disregard this requirement.

If your quotation contains any information other than cost information which you do not want disclosed to the public or used by the Government for any purpose other than evaluation of your offer, each sheet of such data must be marked with the legend set forth below:

> "This data furnished in response to RFQ No. DAHC15 69 Q 0002 shall not be disclosed outside the Government or be duplicated, used or disclosed in whole or in part for any purpose other than to evaluate the quotation; provided, that if a contract is awarded to this quoter as a result of or in connection with the submission of such data, the Government will have the right to duplicate, use, or disclose this data to the extent provided in the contract. This restriction does not limit the Government's right to use information contained in such data if it is obtained from another source."

h. It is further requested that your quotation set forth the scope of the work required as you understand it. In this statement please indicate the number of manhours you have provided in your quotation for each of the various steps required to complete the contract work. This

will enable the Contracting Officer to confirm that you have a complete understanding of what is required by the Government. Also, indicate in your proposal sufficient information to allow evaluation in accordance with the criteria listed below.

For the purpose of assisting interested prospective contractors to prepare realistic quotations, a preproposal conference will be held at the Pentagon in Room 5A 1070 on 14 August 1968 at 1:30 P.M. Because of space limitations, each quoter is required to limit attendance to two representatives. During the preproposal conference, questions concerning technical matters involved in the performance of work under the contract will be answered. To make the conference as fruitful as possible quoters are asked to submit questions in advance. Nothing done or said at the conference shall be considered as altering, modifying or qualifying any contract resulting from this Request for Quotations. It will not be possible for the Government to make a technical presentation at any other time, therefore, quoters who fail to attend the conference set forth herein cannot be given the information at any other time.

All quotations received will be subject to an evaluation by a duly selected panel of qualified Government personnel for the purpose of selecting the quoter(s) with whom negotiations may be conducted. In addition to price the criteria set forth below is to be used in making the evaluation:

CRITERIA	VALUE
1. Understanding and depth of analysis of technical problems involved.	30 Points
2. Availability of qualified, experienced personnel for assignment to software, hardware, and installation of system.	25 Points
3. Estimated functional performance and choice of hardware, e.g. size, and availibility.	25 Points
4. General quality, responsiveness, and corporate commitment to network concept.	20 Points

Negotiations will be undertaken with those prospective contractors whose quotations as to price and other factors as determined by the Contracting Officer show them to be qualified, responsible and capable of performing the work. Negotiations will be conducted in accordance with the principles stated in ASPR. It is contemplated that the contract which will be entered into will be that most advantageous to the Government, price and other factors considered.

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Written quotations in duplicate will be received at the Contracting Office, shown below, until 4:30 p.m., local time 9 September 1968.

All quotations and any amendments thereto shall be inclosed in a sealed envelope, showing on the outside thereof:

Department of the Army
Defense Supply Service-Washington
Room 1D 245, The Pentagon
Washington, D. C. 20310
ATTN: Mr. Daniel B. Dawkins

All inquiries regarding this procurement should be addressed to Mr. Daniel B. Dawkins, Area Code 202, OXford 5-0494.

Sincerely yours,

Thomas J. Scheblik
Deputy Director for Procurement

5 Incl
1. DD Form 633-4
2. Insurance Statement
3. SF 18
4. Annex "A", General Provisions
5. Annex "B", Statement of Work

STANDARD FORM 18, JULY 1966
GENERAL SERVICES ADMINISTRATION
FED. PROC. REG. (41 CFR) 1-16.201

REQUEST FOR QUOTATIONS
(THIS IS NOT AN ORDER)

PAGE 1 OF 6

1. REQUEST NO.	2. DATE ISSUED	3. REQUISITION/PURCHASE REQUEST NO.	4. CERTIFIED FOR NATIONAL DEFENSE UNDER BDSA REG. 2 AND/OR DMS REG. 1 RATING:
DAHC15 69 Q 0002	1968 July 29	1001/2 (C-69-515)	

5. ISSUED BY

DEFENSE SUPPLY SERVICE-WASHINGTON
Room 1D 245, The Pentagon
Washington, D. C. 20310

FOR INFORMATION CALL *(Name and tel. no.) (No collect calls)* Mr. Daniel B. Dawkins OXford 5-0494

6. DELIVER BY *(Date)*: See sample Contract

7. DELIVERY
- [X] FOB DESTINATION
- [ ] OTHER *(See Schedule)*

8. TO NAME AND ADDRESS *(Street, City, State and ZIP Code)*

9. DESTINATION *(Consignee and address including ZIP code)*: See Sample Contract

10. PLEASE FURNISH QUOTATIONS TO THE ISSUING OFFICE ON OR BEFORE 4:30 p.m. ~~Local time 9/9/68~~ (Date) SUPPLIES ARE OF DOMESTIC ORIGIN UNLESS OTHERWISE INDICATED BY QUOTER. THIS IS A REQUEST FOR INFORMATION, AND QUOTATIONS FURNISHED ARE NOT OFFERS. IF YOU ARE UNABLE TO QUOTE, PLEASE SO INDICATE ON THIS FORM AND RETURN IT. THIS REQUEST DOES NOT COMMIT THE GOVERNMENT TO PAY ANY COSTS INCURRED IN THE PREPARATION OR THE SUBMISSION OF THIS QUOTATION, OR TO PROCURE OR CONTRACT FOR SUPPLIES OR SERVICES.

SCHEDULE

11. ITEM NO.	12. SUPPLIES/SERVICES	13. QUANTITY	14. UNIT	15. UNIT PRICE	16. AMOUNT
	SERVICES NECESSARY TO COMPLETE THE WORK DESCRIBED IN THE SAMPLE CONTRACT, ATTACHED.				
	Total Estimated Cost Fixed Fee Total Estimated Cost Plus Fixed Fee				$ $

NOTE THE CERTIFICATION OF NONSEGREGATED FACILITIES IN THIS SOLICITATION. Bidders, offerors and applicants are cautioned to note the "Certification of Non-Segregated Facilities" in the solicitation. The certification provides that if the amount of the bid or proposal exceeds $10,000, the bidder, offeror or applicant, by signing this bid or offer certifies that he does not and will not maintain or provide for his employees facilities which are segregated on a basis of race, creed, color or national origin, whether such facilities are segregated by directive or on a de facto basis. Failure of a bidder or offeror to agree to the certification will render his bid or offer nonresponsive to the terms of solicitations involving awards of contracts exceeding $10,000 which are not exempt from the provisions of the Equal Opportunity clause. (Mar. 68)

17. PRICES QUOTED INCLUDE APPLICABLE FEDERAL, STATE, AND LOCAL TAXES.

DISCOUNT FOR PROMPT PAYMENT _____ % 10 CALENDAR DAYS; _____ % 20 CALENDAR DAYS; _____ % 30 CALENDAR DAYS; _____ % _____ CALENDAR DAYS.

NOTE: Reverse must also be completed by the quoter.

18. NAME AND ADDRESS OF QUOTER *(Street, city, county, State, including ZIP Code)*	19. SIGNATURE OF PERSON AUTHORIZED TO SIGN QUOTATION	20. DATE OF QUOTATION
	21. SIGNER'S NAME AND TITLE *(Type or print)*	22. TELEPHONE NO. *(Include area code)*

REPRESENTATIONS AND CERTIFICATIONS

The Quoter represents and certifies as part of his quotation that: (Check or complete all applicable boxes or blocks.)

1. SMALL BUSINESS

He ☐ is, ☐ is not, a small business concern. A small business concern for the purpose of Government procurement is a concern, including its affiliates, which is independently owned and operated, is not dominant in the field of operation in which it is quoting on Government contracts, and can further qualify under the criteria concerning number of employees, average annual receipts, or other criteria, as prescribed by the Small Business Administration. (See Code of Federal Regulations, Title 13, Part 121, as amended, which contains detailed industry definitions and related procedures.) If the quoter is a small business concern and is not the manufacturer of the supplies offered, he also represents that all supplies to be furnished hereunder ☐ will, ☐ will not, be manufactured or produced by a small business concern in the United States, its possessions, or Puerto Rico.

2. REGULAR DEALER-MANUFACTURER (Applicable only to supply contracts exceeding $10,000.)

He is a ☐ regular dealer in, ☐ manufacturer of, the supplies offered.

3. CERTIFICATION OF INDEPENDENT PRICE DETERMINATION (Applicable only to quotations in excess of $2,500.)

(a) By submission of this quotation, the quoter certifies, and in the case of a joint quotation, each party thereto certifies as to its own organization, that in connection with this procurement:

(1) the prices in this quotation have been arrived at independently, without consultation, communication, or agreement, for the purpose of restricting competition, as to any matter relating to such prices with any other quoter or with any competitor;

(2) unless otherwise required by law, the prices which have been quoted in this quotation have not been knowingly disclosed by the quoter and will not knowingly be disclosed by the quoter prior to opening in the case of an advertised procurement or prior to award in the case of a negotiated procurement, directly or indirectly to any other quoter or to any competitor; and

(3) no attempt has been made or will be made by the quoter to induce any other person or firm to submit or not to submit a quotation for the purpose of restricting competition.

(b) Each person signing this quotation certifies that:

(1) he is the person in the quoter's organization responsible within that organization for the decision as to the prices being quoted herein and that he has not participated, and will not participate, in any action contrary to (a)(1) through (a)(3) above; or

(2)(i) He is not the person in the quoter's organization responsible within that organization for the decision as to the prices being quoted herein but that he has been authorized in writing to act as agent for the persons responsible for such decision in certifying that such persons have not participated, and will not participate, in any action contrary to (a)(1) through (a)(3) above, and as their agent does hereby so certify; and (ii) he has not participated, and will not participate, in any action contrary to (a)(1) through (a)(3) above.

(c) This certification is not applicable to a foreign quoter submitting a quotation for a contract which requires performance or delivery outside the United States, its possessions, and Puerto Rico.

(d) A quotation will not be considered for award where (a)(1), (a)(3), or (b) above, has been deleted or modified. Where (a)(2) above, has been deleted or modified, the quotation will not be considered for award unless the quoter furnishes with his quotation a signed statement which sets forth in detail the circumstances of the disclosure and the head of the Agency, or his designee, determines that such disclosure was not made for the purpose of restricting competition.

QUOTATIONS MUST SET FORTH FULL, ACCURATE, AND COMPLETE INFORMATION AS REQUIRED BY THIS RFQ (INCLUDING ATTACHMENTS). THE PENALTY FOR MAKING FALSE STATEMENTS IN RFQ'S IS PRESCRIBED IN 18 U.S.C. 1001.

CAUTION - LATE QUOTATIONS. See the special provision in this solicitation entitled "LATE QUOTATIONS".

LETTER AND SAMPLE CONTRACT.

a. DSS-W letter dated 26 July 1968, file RFQ No. DAHC15 68 Q 0002 is by this reference specifically made a part of this Request for Quotations.

b. The period of performance and work required by this Request for Quotation is set forth in the Sample Contract attached.

c. The Contractor will be required to sign a contract substantially in accordance with the Sample Contract attached.

UNNECESSARILY ELABORATE CONTRACTOR'S PROPOSALS.

Unnecessarily elaborate brochures or other presentations beyond that sufficient to present a complete and effective proposal are not desired and may be construed as an indication of the offeror's lack of cost consciousness. Elaborate art work, expensive paper and bindings and expensive visual and other presentation aids are neither necessary nor wanted.

ROYALTY INFORMATION.

When the response to this solicitation contains costs or charges for royalties totaling more than $250, the following information shall be furnished with your quotation on each separate item of royalty or license fee:

(a) name and address of licensor;
(b) date of license agreement;
(c) patent numbers, patent application serial numbers or other basis on which the royalty is payable;
(d) brief description, including any part or model numbers of each contract item or component on which the royalty is payable;
(e) percentage or dollar rate of royalty per unit;
(f) unit price of contract item;
(g) number of units; and
(h) total dollar amount of royalties.

DD Form 783, Royalty Report, is approved for use in furnishing the above information. In addition, if specifically requested by the Contracting Officer prior to execution of the contract, a copy of the current license agreement and identification of applicable claims of specific patents shall be furnished.

LATE QUOTATIONS.

(a) Quotations and modifications received at the office designated in the Request for Quotations after the close of business on the date set for receipt thereof (or after the time set for receipt if a particular time is specified) will not be considered unless:

(i) they are received before award is made; and either

(ii) they are sent by registered mail, or by certified mail for which an official dated post office stamp (postmark) on the original receipt for Certified Mail has been obtained, or by telegraph; and, it is determined by the Government that late receipt was due solely to delay in the mails, or delay by the telegraph company, for which the offeror was not responsible; or

(iii) if submitted by mail or telegram, it is determined by the Government that the late receipt was due solely to mishandling by the Government after receipt at the Government installation; provided, that timely receipt at such installation is established upon examination of an appropriate date or time stamp (if any) of such installation, or of other documentary evidence of receipt at such installation (if readily available) within the control of such installation or of the post office serving it.

(b) Offerors using certified mail are cautioned to obtain a Receipt for Certified Mail showing a legible, dated postmark and to retain such receipt against the chance that it will be required as evidence that a late quotation was timely mailed.

(c) The time of mailing of late quotations submitted by registered or certified mail shall be deemed to be the last minute of the date shown in the postmark on the registered mail receipt or registered mail wrapper or on the Receipt for Certified Mail unless the offeror furnishes evidence from the post office station of mailing which establishes an earlier time. In the case of certified mail, the only acceptable evidence is as follows: (i) where the Receipt for Certified Mail identifies the post office station of mailing evidence furnished by the offeror which establishes that the business day of that station ended at an earlier time, in which case the time of mailing shall be deemed to be the last minute of the business day of that station; or (ii) an entry in ink on the Receipt for Certified Mail showing the time of mailing and the initials of the postal employee receiving the item and making the entry, with appropriate written verification of such entry from the post office station of mailing, in which case the time of mailing shall be the time shown in the entry. If the postmark on the original Receipt for Certified Mail does not show a date, the offer shall not be considered.

EQUAL OPPORTUNITY. (Complete the following.)

The offeror represents that he ( ) has, ( ) has not, participated in a previous contract or subcontract subject to either the Equal Opportunity clause herein or the clause originally contained in Section 301 of Executive Order 10925; that he ( ) has, ( ) has not, filed all required compliance reports; and that representations indicating submission of required compliance reports, signed by proposed subcontractors will be obtained prior to subcontract award. (The above representation need not be submitted in connection with contracts or subcontracts which are exempt from the clause.) Standard Form 100 is attached.

BUY AMERICAN ACT. The following certificate must be executed prior to award. (Signing of the quotation constitutes signing of certificate.)

BUY AMERICAN CERTIFICATE.

The bidder hereby certifies that each end product, except the end products excluded below, is a domestic source end product (as defined in the contract clause entitled "Buy American Act"); and that components of unknown origin have been considered to have been mined, produced, or manufactured outside the United States.

EXCLUDED ITEMS (if none, please insert "None"):_____

_____

Specific information as to articles, materials, and supplies excepted from the Buy American Act is available to prospective contractors upon request.

QUOTER SHALL INCLUDE IN HIS BUSINESS ADDRESS THE COUNTY OF THE STATE IN WHICH THE BUSINESS IS LOCATED.

ORDER OF PRECEDENCE.

In the event of an inconsistency between provisions of this solicitation, the inconsistency shall be resolved by giving precedence in the following order: (a) Annex "B", Statement of Work; (b) the Schedule; (c) terms and conditions of the solicitation; (d) General Provisions; (e) other provisions of the contract, where attached or incorporated by reference.

DISCOUNTS.

Prompt payment discounts will be considered in the evaluation of quotations, provided the minimum period for the offered discount is 20 calendar days. However, offered discounts of less than 20 calendar days will be taken if payment is made within the discount period, even though not considered in the evaluation. Time will be computed from the date a proper invoice is received in the office specified by the Government. For the purpose of earning the discount payment is deemed to be made on date of mailing of the Government check.

LABOR SURPLUS AREA CONCERNS.

This procurement is not a set aside for labor surplus area concerns. However, the quoter's status as such a concern may affect entitlement to award in the case of tie quotations or in the evaluation of quotations in accordance with the Buy American clause of this solicitation. In order to have his entitlement to a preference determined on the ocurrence of those events, the quoter must identify below the areas in which the costs that he will incur on account of manufacturing or production (by himself or his first-tier subcontractors) amount to more than 50 percent of the contract price:

_____

_____

_____

_____

Failure to list the proposed areas of performance as specified above will preclude consideration of such quoter as a labor surplus area concern.
The quoter agrees that if, as a labor surplus area concern, he is awarded a contract for which he would not have qualified in the absence of such a classification, he will perform or cause to be performed the contract in accordance with the circumstances justifying the preference.

ACCEPTANCE TIME.

The quoter shall stipulate a time within which the Government may accept his proposal.

CERTIFICATE OF CURRENT COST OR PRICING DATA.

Prior to award of the contract resulting from this solicitation quoters shall submit a Certificate of Current Cost or Pricing Data as outlined in ASPR 3-807.4.

PAYMENT.

Quoters should indicate the address to which payment should be mailed.

CERTIFICATION OF NONSEGREGATED FACILITIES. (Applicable to contract, subcontracts, and agreements with applicants who are themselves performing federally assisted construction contracts, exceeding $10,000 which are not exempt from the provisions of the Equal Opportunity clause.)

By the submission of this bid, the bidder, offeror, applicant, or subcontractor certifies that he does not maintain or provide for his employees any segregated facilities at any of his establishments, and that he does not permit his employees to perform their services at any location, under his control, where segregated facilities are maintained. He certifies further that he will not maintain or provide for his employees any segregated facilities at any of his establishments, and that he will not permit his employees to perform their services at any location, under his control, where segregated facilities are maintained. The bidder, offeror, applicant, or subcontractor agrees that a breach of this certification is a violation of the Equal Opportunity clause in this contract. As used in this certification, the term "segregated facilities" means any waiting room, work areas, rest rooms and wash rooms, restaurants and other eating areas, time clock, locker rooms and other storage or dressing areas, parking lots, drinking fountains, recreation or entertainment areas, transportation, and housing facilities provided for employees which are segregated by explicit directive or are in fact segregated on the basis of race, creed, color, or national origin, because of habit, local custom or otherwise. He further agrees that (except where he has obtained identical certifications from proposed subcontractors for specific time periods) he will obtain identical certifications from proposed subcontractors prior to the award of subcontracts exceeding $10,000 which are not exempt from the provisions of Equal Opportunity clause; that he will retain such certification in his files; and that he will forward the following notice to such proposed subcontractors (except where the proposed subcontractors have submitted identical certifications for specific time periods):

NOTICE TO PROSPECTIVE SUBCONTRACTORS OF REQUIREMENT FOR CERTIFICATIONS OF NONSEGREGATED FACILITIES. A Certification on Nonsegregated Facilities, as required by the May 9, 1967, order on Elimination of Segregated Facilities, by the Secretary of Labor (32 Fed. Reg. 7439, May 19, 1967), must be submitted prior to the award of a subcontract exceeding $10,000 which is not exempt from the provisions of the Equal Opportunity clause. The certification may be submitted either for each subcontract or for all subcontracts during a period (i.e., quarterly, semiannually, or annually). (Note: The penalty for making false statements in offers is prescribed in 18. U.S.C. 1001.)

ARTICLE I. SCOPE.

Commencing on the effective date of the contract and ending within 1 year the Contractor shall furnish all necessary qualified personnel, material, and equipment, managing and directing the same to complete the work described in Annex "B", Statement of Work, attached hereto and by this reference specifically made a part of the contract.

ARTICLE II. REPORTS.

a. Classified information and all information produced under classified contracts, which the Contractor proposes to release to the public, must be reviewed prior to such release. This applies to all types of disclosures, e.g., oral/visual disclosures by presentations at unclassified meetings or documentary disclosures by publication of papers in technical journals. It includes publicity releases, sales brochures, advertisements, etc.. Requests for permission to release such information shall be submitted, in five copies, by the Contractor directly to the Director, ARPA, ATTN: Security Review Officer.

b. Technical Report Summaries: The purpose of the report summary is to emphasize the importance of meaningful communication and to specify two aspects of the reporting procedures required in the FINAL REPORTS and those intermediate reports which the Contractor believes exhibit results significant enough to be noted.

This summary, prominently identified, should normally not exceed a few pages. The purpose of the project must be specified, together with a description of important equipment purchased or developed, if any, and the conclusions reached by the Contractor. The most important single feature of this summary is that it must be meaningful to readers who are not specialists in the subject matter of the contract.

The requirement for careful preparation cannot be overemphasized as this summary will often provide the basis for decisions on the continuity of a project. The Contractor must recognize that his achievements are quite often surveyed by Department of Defense staff function at a level that precludes a thorough review of detailed reports.

It is not intended that the summary be either didactic or oversimplified. Where appropriate, references should be made to more detailed sections of the report in order to guide those who may be prepared to spend the additional time required to develop a more complete and professional understanding of the accomplishments.

c. Abbreviations, Acronyms and Code Names: It is important that the Contractor avoid abbreviations, acronyms or code names in the summary, or the detailed report, that are not spelled out immediately, e.g., LRL (Lawrence Radiation Laboratory). If the abbreviation,

acronym or code name is to be used several times in succeeding paragraphs and sentences, and in the body of the report itself, it is appropriate to use the abbreviation. However, it is imperative that every technical report, final or intermediate include a complete glossary of abbreviations, acronyms and code names displayed in the text.

d. Quarterly Management Reports: The primary purpose of these brief reports, which should be in letter form and generally not exceed three (3) pages in length, is to inform various levels of management of significant events, accomplishments, and problems associated with the progress of work. The Management Reports should not be used to document technical progress or contain technical description such as graphs, charts, or formulae. These types of data belong in technical reports.

The report should present a narrative summary of work performed including specific reference to the topics listed below. The initial report should include an introduction outlining the background, objectives, and assignment of responsibility for the project.

Any of the following topics may be covered by inserting "none", "not applicable," or "no significant change," when appropriate.

(i) Research Program and Plan. A brief statement of objectives and plan of research will be included in the report.

(ii) Major Accomplishments. This should include a brief description written in lay terms, of any finding or accomplishment considered worthy of being brought to the attention of management. The meeting of routine schedules should not be included, but accomplishment of major milestones should be reported.

(iii) Problems Encountered. This topic should make reference to difficulties associated with personnel, facilities, contracts, availability of literature, funds, strikes, disasters, etc., which significantly affect the progress of the work involved. Problems of a technical nature should also be included, but in brief, non-technical terms.

(iv) Fiscal Status. This should include:

1. Amount currently funded.
2. Estimated expenditures and commitments to date.
3. Estimated funds required to complete the work.
4. Estimated date of completion of the work (when different from that specified in the ARPA Order or contract).

A copy of the fiscal portion of the quarterly management reports shall also be submitted to the Contracting Officer and the Administrative Contracting Officer.

(v) Action Required by the Government. Normally this will include any assistance required of ARPA in resolving "Problems Encountered".

(vi) Future Plans. A brief statement of any significant change which is planned in the course of work under way or on any new item which is considered to be of interest to management.

(vii) Milestone Report: A list of suggested milestones shall be submitted, in ten copies. (Milestones are defined as points of accomplishment which represent significant progress when completed). The list shall include the initiation and completion date for each milestone. A brief description of the milestone should be provided, when necessary, to define specifically the accomplishment to be attained thereunder. The Milestone Report should be included in the Quarterly Management Report.

Milestones should include major phases of hardware development and testing, decision dates on alternate approaches, dates by which control information on facilities or government equipment is required, dates by which a capability must be demonstrated, delivery dates, and other significant phasing and timing points.

Upon approval by ARPA of milestone information, copies of SD Form 350 (copy attached), which contain appropriate instructions, will be made available for use in reporting progress against the milestone schedule.

e. Interim Special Report of Major Events. The Contractor shall report major items of special significance, as they occur. These reports should reach ARPA within five (5) days of the event reported, utilizing TWX facilities when necessary. Such event items shall include, but not be restricted to, strikes and disasters, program delays, technical breakthroughs, major decisions, and requirement for increase in funding. One copy of any such report shall be furnished the Contracting Officer.

f. Program Plan. The Contractor shall submit a program plan containing a detailed research plan, milestone plan, milestone chart, and manpower loading chart for each major task; a chart depicting major subcontracts and equipment/material purchases, the date and approximate amount of each; and a chart depicting major Government furnished equipment (GFE) and facilities required, and the date and duration that such GFE or facilities are required. The estimated cost of GFE or facilities should be included if known. Three copies of the Program Plan shall be submitted directly to the Director, ARPA, Washington, D.C., 20301, within 30 days after the effective date of the contract.

g. Quarterly Technical Reports. This report shall present a concise and factual discussion of technical findings and accomplishments during the period. The report shall be of technical publication quality, including appropriate subject matter references. Three copies of the report shall be submitted by the Contractor directly to the Director, ARPA and are due within 30 days following the close of the report period. The report will present a concise and factual discussion of technical findings and accomplishments during the period. The report should be of technical publication quality, including appropriate subject matter references.

h. Final Technical Report. Upon completion of the project, a final report will be submitted in lieu of the regular technical report, directly to the Director, ARPA.

i. Miscellaneous Reports. In addition to the aforementioned written reports the Contractor shall periodically furnish such written data relative to contract performance as may be requested by the Contracting Officer, and shall be prepared to discuss orally any phase of contract performance or progress as required by the Contracting Officer.

j. A completed Document Control Data - R&D (DD Form 1473) shall be included with each copy of a technical report required under the terms of the contract.

k. The reports required by this Article and the deliverable items set forth elsewhere in the contract are data to be delivered in accordance with the clause entitled "Rights in Technical Data".

l. The heading or cover page of each report shall contain the following information:

ARPA Order No. 1260	Contract Number_____
Program Code No. 8D30	Principal Investigator and Phone Number
Name of Contractor	Project Scientist or Engineer and Phone Number
Effective Date of Contract	
Contract Expiration Date	Short Title of Work
Amount of Contract	

m. Each report prepared will include the following citation on the cover:

Sponsored by
Advanced Research Projects Agency
ARPA Order No. 1260

n. Each publication resulting from ARPA work will contain the following acknowledgement:

This research was supported by the
Advanced Research Projects Agency
of the Department of Defense under
Contract No. _____.

o. Three copies of each report (Management or Technical) shall be submitted to:

Director
Advanced Research Projects Agency
Washington, D. C. 20301

p. One copy of each technical report on all ARPA work shall be sent to:

Institute for Defense Analysis
400 Army-Navy Drive
Arlington, Virginia 22202

q. Twenty copies of each technical report generated on ARPA Projects shall be submitted to:

Defense Documentation Center
Cameron Station
Alexandria, Virginia 22314

ARTICLE III. DELIVERY SCHEDULE.

a. Schedule of Deliverable Items:

Description	No. of Copies	Delivery Date
(i) Quarterly Management Reports	3	15 days after the close of the report period.
(ii) Interim Special Report of Major Events	2	As required by ARTICLE II.
(iii) Program Plan	3	30 days after effective date of contract.
(iv) Quarterly Technical Reports	3	30 days after the close of the report period.
(v) Final Technical Report	3	13 months after effective date of contract.

b. The items set forth above in this ARTICLE III., do not represent the total amount of work to be performed under the contract but are certain deliverable items set forth for administrative purposes. Other items not specifically set forth above, but required by the contract shall be delivered as specified elsewhere in the contract, or if not so specified with the final report.

c. Unless otherwise specified in the contract all deliverable items shall be delivered prepaid to:

Director
Advanced Research Projects Agency
Washington, D. C. 20301

ARTICLE IV. PROJECT OFFICER. The Contracting Officer may designate Contracting Officer's Technical Representatives to:

a. Act as Project Officer under this contract. The Project Officer will receive for the Government, reports and other material called for in this contract and will represent the Contracting Officer in the technical phases of the work. The Project Officer is not authorized to change any of the terms and conditions of this contract. Changes in the scope of work will be made only by the Contracting Officer by properly signed written modifications to the contract. Such representatives as may be appointed will be specifically designated in a letter from the Contracting Officer to the Contractor.

b. Certify Contractor's "need to know" in connection with Contractor's:

(1) requests for information from Government activities,

(2) requests to private contractors for information developed pursuant to Government contracts,

(3) visits to Government installations and other Government Contractors to obtain information to be used in contract performance.

ARTICLE V. ALLOWABLE COSTS. It is understood and agreed that, subject to the provisions of Clause 3, "Allowable Cost, Fixed Fee and Payment", of the General Provisions the following shall be considered as allowable items of cost under the contract when incurred or paid by the Contractor and when necessary and required and used for the performance of the work hereunder; (this Article does not preclude the allowance of other costs allowable under Armed Services Procurement Regulation, Section XV):

a. Salaries and Wages. Expenditures by the Contractor for salaries and wages of his personnel and borrowed personnel directly engaged in the performance of work hereunder and properly allocable to this contract including Federal and State taxes paid by the Contractor and properly allocable to such salaries and wages.

b. Travel and Subsistence. Reasonable subsistence not in excess of actual itemized expenses of $____ per day, or a per diem allowance in lieu thereof of $_____, and transportation for personnel employed in the performance of this contract, while in travel status, provided such travel is necessary for the performance of this contract; and provided that, expenses for transportation hereunder by motor vehicle other than

common carrier or rented automobile shall be reimbursed on a reasonable actual expense basis, or at the Contractor's option, on a mileage basis at a rate of $._____ per mile, plus any toll or ferry charges. The difference in cost between first-class air accommodations and less than first-class air accommodations is unallowable except when less than first-class accommodations are not reasonably available to meet mission requirements. Reasonableness shall be ascertained by a review of all facts pertaining to the specific cost by the Contracting Officer. Should transportation and subsistence expenses be incurred concurrently in connection with the performance of more than one contract, such expenditures shall be allocated on an equitable basis to the contracts involved, such allocation to be based on a review of all pertinent facts concerned with the particular trip.

c. Materials and Supplies. Expenditures by the Contractor for such materials, supplies, apparatus, equipment, and other articles (including rental of apparatus and equipment) properly allocable to performance of the work hereunder.

d. Indirect Costs. A proper method of determining indirect costs will be negotiated.

ARTICLE VI. MAXIMUM CONTRACT COST. Subject to the provisions of Clause 2, "Limitation of Cost", and Clause 3, "Allowable Cost, Fixed Fee and Payment", of the General Provisions:

a. The total of the Allowable Cost under this contract shall not exceed _____ ($_____), which sum is the estimated total cost of the Contractor's performance hereunder, exclusive of fixed fee, and is based upon data on file in the office of the Contracting Officer and is to be considered as the "estimated cost" for the purpose of interpreting Clause 2, "Limitation of Cost" of the General Provisions. This limit may be increased from time to time by the Government solely at its discretion.

b. In addition to the Allowable Cost aforesaid, the Government shall pay the Contractor a fixed fee of _____ ($_____) for the performance of this contract.

c. The total amount of this contract, inclusive of fixed fee, therefore, shall not exceed _____ ($_____).

d. Subject to the withholding requirements of the General Provisions the Contractor at the time of reimbursement of allowable cost will be entitled to payment of fee on the basis of such cost in the same ratio as the total fee is to the total estimated cost exclusive of fee.

ARTICLE VII. STANDARDS OF WORK.

The Contractor agrees that the performance of work and services, pursuant to the requirements of this contract, should conform to high professional standards.

ARTICLE VIII. OTHER PROVISIONS.

Annex "A", General Provisions, "Cost-Plus-Fixed-Fee Contract", is by this reference specifically made a part of the contract.

GENERAL PROVISIONS

Index to Annex "A"

	Clause	ASPR Reference
1.	Definitions	7-103.1
2.	Limitation of Cost	7-402.2(a)
3.	Allowable Cost, Fee and Payment	7-203.4(a)
4.	Standards of Work	7-402.4
5.	Inspection and Correction of Defects	7-402.5
6.	Assignment of Claims	7-103.8
7.	Examination of Records	7-203.7(a)
8.	Subcontracts	7-402.8(a)
9.	Utilization of Small Business Concerns	1-707.3(a)
10.	Termination	8-702(a)
11.	Disputes	7-103.12
12.	Renegotiation	7-103.13(a)
13.	Buy American Act	6-104.5
14.	Convict Labor	12-203
15.	Walsh-Healey Public Contracts Act	12-605
16.	Contract Work Hours Standards Act - Overtime Compensation	12-303
17.	Equal Opportunity	12-802
18.	Officials Not to Benefit	7-103.19
19.	Covenant Against Contingent Fees	7-103.20
20.	Authorization and Consent	9-102.2
21.	Notice and Assistance Regarding Patent Infringement	9-104
22.	Patent Rights An appropriate Patents Rights clause will be selected	9-107
23.	Rights in Technical Data	9-203(b)
24.	Technical Data - Withholding of Payment	9-207.2(b)
25.	Military Security Requirements	7-104.12 as modified by 7-204.12
26.	Insurance - Liability to Third Persons	7-203.22
27.	Utilization of Concerns in Labor Surplus Areas	1-805.3(a)
28.	Payment for Overtime Premiums	12-102.6
29.	Competition in Subcontracting	7-104.40
30.	Audit and Records	7-104.41(c)
31.	Price Reduction for Defective Cost or Pricing Data	7-104.29(a)
32.	Subcontractor Cost and Pricing Data	7-104.42(a)
33.	Filing of Patent Applications	9-106
34.	Excusable Delays	8-708(a)
35.	Negotiated Overhead Rates (if applicable)	3-704.1
36.	Gratuities	7-104.16
37.	Limitation on Withholding of Payments	7-403.12
38.	Small Business Subcontracting Program	1-707.3(b)
39.	Labor Surplus Area Subcontracting Program	1-805.3(b)
40.	Interest	E-620
41.	Changes	7-404.1
42.	Stop Work Order	7-205.7(c)
43.	Reports of Work	7-404.6

NOTE: The above constitutes the General Provisions that will be incorporated in the contract resulting from this solicitation. It is economically impractical to include these provisions with each solicitation, however they will be provided upon your written request.

S T A T E M E N T O F W O R K

ANNEX "B"

Sponsoring Agency:

Advanced Research Projects Agency (ARPA)
Washington, D. C. 20301

SPECIFICATIONS OF

INTERFACE MESSAGE PROCESSORS

FOR THE ARPA COMPUTER NETWORK

TABLE OF CONTENTS

SPECIFICATIONS OF INTERFACE MESSAGE PROCESSORS FOR THE ARPA COMPUTER NETWORK

I. Network Description

A. Introduction

The Advanced Research Projects Agency, with the cooperation of its research contractors, is forming a computer communication network. By the distinctive nature of these contractors, this will be a highly inhomogeneous network. There will be many kinds of computers involved and even in those cases where two contractors possess similar equipment, their operating systems and types of utilization will differ. On the other hand, this will be a network of important potential precisely due to making these advanced research computer systems available to users outside their own design circle. System variety is of utmost importance; any present similarity is to be considered a happenstance of equipment availability and must not be an issue of network design. Each system is oriented to the specialized research of the contractor and after connection to the network, will continue to operate primarily as a stand-alone system for that contractor's use. Each contractor will make some part of his facility frequently available to the network; however, network operation must not depend upon any single contractor's machine. (Hereafter a contractor's computer is called a HOST.)

To effect graceful disconnection of a HOST from the network and to guard against burdening connected HOSTS with network responsibilities, a communication subnet shall be constructed consisting of store-and-forward computers (called IMPS or interface message processors) located at contractor sites. Each IMP shall be connected to several other IMPS by full duplex 50 kbps common carrier communication links creating a strongly interconnected net. Typically, there will be three or four full duplex lines at each site that can serve to benefit routing and network buffering. A list of the projected network nodes and an illustrative interconnection graph is shown in appendices A and B.

In addition to serving the research interests of the ARPA contractors, the network itself is a subject of study and experimentation; for this reason, data gathering facilities are incorporated into the network and must be considered an integral part of the hardware and software design of the communication subnet. The use of these facilities will provide a basis for evolution of the network design.

B. Functional Description of the Network

For the purpose of delineating areas of responsibility and specifying design requirements the network is subdivided into the following components:

1. The USER SUBNET

   a. The HOST systems;

      The contractors hardware and software prior to or independent of the formation or construction of the network.

      The contractors own hardware and software individually designed and implemented for his own convenience in attaching himself to the network.

      The contractors own hardware and software specifically oriented to his utilization of some other HOST system within the network.

2. The COMMUNICATION SUBNET

   a. The CARRIER systems;

      The common carrier facilities available by contract prior to or independent of the formation of the network.

      The circuit switches, leased lines, data sets, and line conditioning equipment utilized by the network.

   b. The IMP systems;

      The store-and-forward message processors dedicated to the service of the network.

      The hardware interfaces attaching the message processors to the data sets of the CARRIER.

      The procedures, hardware and software, for message transmission, validation, failure detection, recovery, and data gathering. In general,

those processes comprising the communication design and performance of the message processors which maintain at all network sites (hereafter called the CARRIER side of the IMP).

The hardware interfaces attaching the message processors to the local HOST (s).

The procedures, hardware and software, for message reformatting either sending or receiving and as specifically required for the local HOST, (hereafter called the HOST side of the IMP).

To visualize the operation of the network, consider the following examples of expected interactions.

Example 1. Documentation activities using the S.R.I. HOST system.

The HOST at Stanford Research Institute will maintain a network library of documentation information. Some of this information is private to S.R.I., some is available to all network users, some is available to particular network users. The S.R.I. system for handling such information on-line is to be made available to the network users. The on-line controls coming from an S.R.I. console specify precisely the program control of the documentation system. Consequently, the outputs generated by any console in the network can be mapped into the set of S.R.I. console outputs by a reformatting program in the user's HOST and thus effect controls of the S.R.I. system. In the other direction, the display output to an S.R.I. console uniquely specifies the visible results of applying the above controls. Consequently, the data stream from the computer to the display system can be mapped into the output data stream required to similarly display such visible results at the user' site. This would also be handled by a reformatting program in the users' HOST.

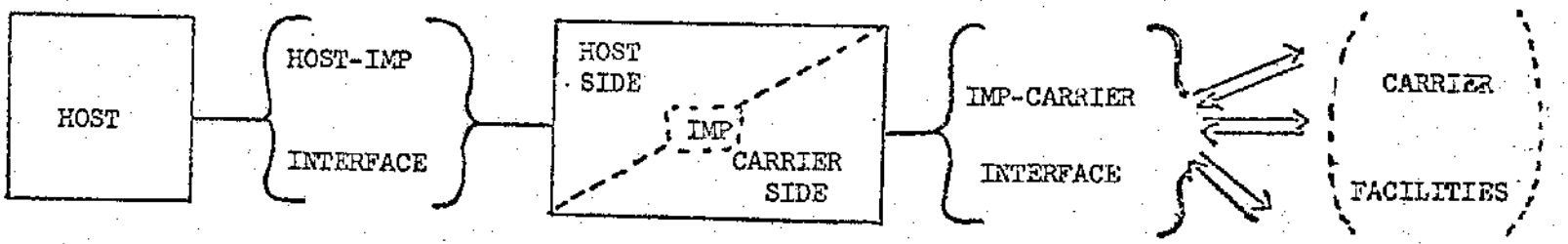
In general, there is room for many different selections of how and where to programmatically connect two HOST sites, the above is only intended as an example. We could just as well elect to transport the S.R.I. document to the user' HOST and reformat this document to a form acceptable by the HOST system and then apply HOST display (or line printer) programs to the resulting document.

Example 2. Network studies using the UCLA HOST system.

The HOST system at UCLA will include analysis programs for studying network performance. The design of the IMPS will include facilities for gathering network data when requested and reporting this data to other sites. A user at an arbitrary contractor site may schedule and run network experiments by supplying program controls to the UCLA HOST system to effect the selection of data gathered and to govern its analysis by the UCLA HOST system. Or, the user may elect to have the raw data sent to him directly for processing by his own programs. To avoid conflicts, such experiments will normally be scheduled and monitored by the UCLA HOST.

Example 3. Extended console operation in the network.

Since many sites have unique facilities, we can expect rich interaction to occur, as it is only necessary to develop INTERCONNECTION SOFTWARE in order to have utilization of the power of another contractor's system. From the point of view of the ARPA contractors as users of the network, the communication subnet is a self-contained facility whose software and hardware is maintained by the network contractor. In designing INTERCONNECTION SOFTWARE we should only need to use the I/O conventions for moving data into and out of the subnet and not otherwise be involved in the details of subnet operation. Specifically, error checking, fault detection, message switching, fault recovery, line switching, carrier failures and carrier quality assessment, as required to guarantee reliable network performance, are the sole responsibility of the network contractor. However, during the period of design and construction of the network, the user contractors can provide aid to the network contractor as suggested in Section IV B below.



Connection of Host to Carrier Facilities through

Interface Message Processor.

C. Functional Description of the IMPS.

The set of IMPS is to serve as the interface between the set of HOSTS and the CARRIER network. Each transmitting HOST looks into the network through its adjacent IMP and sees itself connected to the receiving HOST (which responds to requests from the transmitting HOST after a delay due to IMP and CARRIER congestion as well as its own congestion). Each receiving HOST sees the network through its adjacent IMP and responds to incoming data as from a set of remote terminals making requests. The network sees a set of IMPS providing and accepting message traffic. Each IMP sees the network as a source of messages for its receiving HOST, and as a sink for messages from its transmitting HOST and from messages using it as a relay IMP. The IMP, as part of its basic function must smooth out severe fluctuations in the message traffic by providing temporary message buffering.

Thus, the IMP is to provide store-and-forward switching for messages exchanged between the HOST computers. It is to receive messages from its attached HOST (s) and from other IMPS connected to it by means of communication circuits. These messages, or packets of messages, are to be forwarded, as appropriate, to the other connected IMPS or to its attached HOST (s). In the execution of these functions the IMP is to observe the IMP-IMP communication protocol and the HOST-IMP communication protocol, as established by ARPA. A tentative version of the protocol is provided in Appendix F. These activities of the IMP involve the following functions:

(1) Breaking messages into packets

(2) Management of message buffers

(3) Routing of messages

(4) Generation, analysis, and alteration of formatted messages

(5) Coordination of activities with other IMPS.

(6) Coordination of activities with its HOST

(7) Measurement of network parameters and functions

(8) Detection and disposition of faults

The specific functions to be performed by the IMPS, and the algorithms used to implement the functions, are all subject to change with

time. These changes may occur as the network changes in size, or changes in mode of application, and is subjected to improvements and experimentation. It is necessary, then, that the design of the IMP programs and hardware be such as to permit these changes to be made with relative ease. The program-hardware tradeoffs, the modularity of these elements, the ability to make program changes from remote locations, and the selection of the source language for the programs are all of concern here.

1. Breaking of Messages into Packets

HOSTS will wish to communicate with messages of longer length than can be reasonably transmitted as a single block due to the increasing probability of retransmission. Thus, a Packet is defined as the inter-IMP unit and Message as the inter-HOST unit. A packet will not exceed 1024 bits in length; the IMPS must break all longer messages into multiple packets. Messages will be limited to 8192 bits so as not to require excessive buffer space.

2. Management of Message Buffers

The IMP is to provide buffers for the temporary storage of messages or portions of messages. These buffers will be used:

(1) when speed conversions are to take place

(2) for messages that encounter delays in being forwarded

(3) to provide a copy of forwarded data for which no indication has yet been provided of error-free receipt.

The IMP is to control the flow of the data in and out of its buffers, permitting the flow of incoming data from the net and from its HOST when buffer space is available, quenching this flow when the space is scarce or unavailable. This control (stimulating or quenching) is brought about through the use of IMP-generated abnormal packets.

3. Routing of Messages

For each incoming packet and each IMP-generated packet which is not destined for a particular IMP'S HOST, the IMP chooses the next immediate destination by the execution of a routing algorithm. Such an algorithm will typically take into account the ultimate destination of the packet, the connectivity of the network, the loading and condition of the communication links and other IMPS, and the message priority. When the routing algorithm indicates that a message should wait for a busy

channel, then that message must be placed on a queue in the buffer and the rules appropriate to the priority discipline in effect must be adhered to. The IMP will also be expected to exchange routing and loading information with HOST's and other IMPs of the network, as dictated by the routing process, thus providing periodic updating of the routing tables. (See Appendix G)

4. Generation, Analysis and Alteration of Formatted Messages

The message and packet exchanges between IMPs, and between IMP and HOST, will conform to the formats in the ARPA established protocols. The IMP is to construct all of its outgoing messages and packets in these formats. Header information on a message will be altered in the IMP when appropriate. All IMP analyses of incoming messages and packets are to assume that these messages and packets will (except in case of error) also conform to these formats. Transmitting HOST messages will be disassembled, as required, into packets. Receiving HOST messages will be reassembled, as required, from incoming packets. Thus, in both transmitting and receiving, the HOSTs deal with complete messages.

The IMP will provide the necessary serial to parallel, and parallel to serial conversions for communication with the communication circuits and the attached HOSTs.

5. Coordination of Activities with other IMPS

IMPs will coordinate their actions with other IMPs in the network through the use of IMP or HOST generated messages. These messages will provide for the positive or negative acknowledgement of messages, and the temporary cessation or reinstitution of message transmission. When required, as through a negative acknowledgement, the IMP will repeat messages which have been received in error. Through the use of IMP generated messages, network status information will be sensed and percolated through the network for use in changing the routing tables.

In addition to generating such coordinating messages the IMP will receive and react to coordinating messages.

6. Coordination of Activities with its HOST (s)

Each IMP is required to coordinate its actions with its own HOST. These activities include the acceptance of messages from the transmitting HOST upon request (at the IMPs convenience), and the delivery

of messages to the receiving HOST (at the receiving HOST's convenience). Of course, if the receiving HOST breaks down or accepts messages too slowly, then its IMP must take the necessary steps to prevent further messages from entering the net and being delivered to it. As messages arrive from the transmitting HOST, the transmitting IMP must prepare them into packets with appropriate headers, and parity check bytes. Message protocol must be followed in preparing these packets.

7. Measurement of Network Parameters and Functions

An IMP will, at times, be required to measure selected network parameters. These parameters may include:

(1) occupancy of all communication circuits

(2) utilization of the IMP's buffer storage

(3) utilization of the IMP's CPU time

(4) delays encountered by messages due to IMPs

(5) failure rates of the common carrier net

(6) message arrival rates

(7) message lengths

(8) distribution of network traffic

(9) net configurations

(10) home use versus remote use of computer

(11) queue lengths

(12) transmitting HOST queueing delays

In order to observe delays and the operation of the routing mechanisms, the IMPs will be required to tag selected messages and observe their movement through the network. These data gathered by an IMP may need to be incorporated into an IMP generated message destined for its own or another receiving HOST.

The measurement activities of an IMP will be selectively initiated and terminated by control messages received from its host or another IMP.

8. Detection and Disposition of Faults

The IMP is to protect itself and the network from the effects of faults, whether the source of the fault is external or internal to the IMP. The protection process will involve the detection of faults, and a reaction to faults, where a primary goal of the reaction is to contain the effects of a fault. These activities are to be essentially automatic requiring little or no human intervention.

To detect faults from external sources the IMP must continually examine and analyze the signals presented to it by the communication channels and the HOST-IMP channels. The analyses should determine:

(1) if the signals adhere to the established protocols

(2) if that data contained in a message for use by an IMP is valid

The various forms of error checks specified in the protocols directly relate to this fault detection process.

The detection of externally caused faults must also be concerned with abnormal time behavior of signals. For instance, signals that are too rapid or too slow in response may indicate the presence of a fault. The non-responsive external source should be detected through the use of timing procedures.

Upon detection of a fault the IMP should attempt to isolate its effect in a manner that results in the corruption of a minimum number of messages. Such isolation may involve the negative acknowledgement of a packet or a message.

Recovery procedures should be used to restore service, in an orderly manner, when the fault has been removed. Transmission faults may be overcome by retransmission of the faulty data. Network control messages exchanged between IMPS may report the restoration to service of a faulty IMP or HOST.

The IMP will be so designed that it can be stopped, started, and its operating program loaded or examined by selected network HOSTs.

Such HOSTs, using special secure processes and employing the networks communications facilities, may be used to effect the remote recovery of IMPS suffering from serious faults. Such recovery may effect the automatic restart, with a fresh program, of a halted IMP.

9. IMP Software Separation Protection

Since there is a portion of the IMP software that the HOST's staff may write, it is desirable (not mandatory) that hardware protection be provided to prohibit that portion of the software from harming the basic IMP operation. Standard protection hardware for providing a privileged executive mode should be adequate. The cost for such hardware, if available, should be identified as an option.

The protection desired should prohibit the HOST's staff program from:

(1) controlling any IMP input or output operation except those of the HOST-IMP channel

(2) changing that stored information required by the IMP to serve the remainder of the network

(3) using the processing or storage capabilities of the IMP in such quantities or at times that result in reduced service to the remainder of the network.

D. The HOST-IMP Interfaces

Due to the variety of HOST machines and to the differences in the existing on-line entry points into these systems, it is not possible to describe a universal manner of IMP connection appropriate to all HOST systems. The quoter, therefore, need not propose individual modifications to interface to each host; rather he should propose a single standard interface. All modifications to that interface will be tasked separately after contract award.

It is desired to each IMP interface to more than one HOST using a multiplexing scheme. The hardware and software necessary to accomplish the multiplexing may be too complicated and expensive to warrant its implementation. Each quoter should include his own evaluation of the additional cost of interfacing to multiple HOSTs, but should not include that cost in his basic proposal.

The software within the IMP can be functionally separated into two categories: (1) the HOST side and, (2), the network side. Since the HOST's staff can program the IMP, it is recommended that physical memory protection be provided. The following functions should be included in the software of the HOST side of the IMP:

(1) IMP-HOST single channel control

(2) Buffers and buffer control

(3) Message to packets and packets to message conversion

(4) Packet formatting.

The contractor shall leave sufficient memory space for the HOST to add specialized routines to do:

(1) Character code conversion

(2) Destination discrimination necessary for multiple HOSTS connected to the IMP

(3) Repacking of binary messages.

E. The IMP-CARRIER Interfaces

The only variation from site to site of the CARRIER side of the IMPs is the number of attached data-sets, so the IMP-CARRIER interfaces can be identical at all sites. This will be a multiplex interface capable of direct extension to handling six (6) data-sets, asynchronous and in parallel, but implemented in a modular way with data-set control cards associated with each duplex carrier link. The initial implementation need only contain those modules implied by the communication circuit map of Appendix B or its equivalent at the time of total network implementation. Although six data-sets may be connected to an IMP, the software should be designed to optimize the time delays within the IMP for three communications lines.

In order to achieve the speed and simplicity desired for the CARRIER side of the IMP, channel hardware is required for the following functions:

(1) Character sensing, as required for start, stop, and escape characters

(2) 24 bit cyclic parity construction and comparison

(3) Real time clock of bit time (20 microseconds) resolution

(4) Fault detection and status presentation of fault type.

If hardware is not utilized in the design, the ability of the software to accomplish these functions must be clearly demonstrated.

F. Network Performance Characteristics

The criteria upon which the network will be judged and their priority are given below:

(1) Message delay

(2) Reliability

(3) Network capacity

For the purpose of calculation and evaluation, a simplified model of the network is presented. The model should allow the contractor to evaluate his ideas without either knowing the specific topology of the network (which is not yet fixed) or using the estimated (and unreliable) HOST to HOST traffic statistics presented in Appendix E. The model should be used in calculating the delay times and network capacity.

1. Message Delay

The message delay is the time required for a 100 character message (single packet message) to go from the origin IMP (associated with the sending HOST) to the destination IMP (associated with the receiving HOST). It is desired that the average message delay over the entire network be minimized. In particular, the average message delay should be less than 1/2 second for a fully loaded network (as described in 3 below).

The following factors shall be included in calculation of the message delay:

a. Communications Delay ~ 3.17

b. Full Packet Transmission Delay ~ 20.8 ms.

c. IMP Processing Delay

d. Queuing Delay

e. Average Path Length in Store-and-Forward Operation

2. Reliability

It is vitally improtant that the users have confidence in the overall reliability of the network. Low probability of wrong or lost messages, particularly when undetected, is desired. The mean time between failures due to undetected parity errors is predicted to be less than one message per year; other errors will hopefully not increase that rate significantly. Errors that occur after the message is passed to the HOST should not be considered. Also, when a HOST refuses to accept messages, the loss of those messages, if reported, is not considered as important as other losses.

3. Network Capacity

Third and lowest priority criterion is the network capacity. The capacity is measured as the maximum bit rate that can be input at every node and still have the message delay remain under 1/2 second. It is expected that the capacity will be approximately 20 kb per node for nodes with three communications lines. The bidder should also calculate the single node maximum input rate with all other nodes quiet as a function of the number of communications lines connected to that node.

4. Network Model

The following is a simple model of the network describing its topology and data transmission. Several parameters are given to aid in determining the delays encountered by packets. The parameters are given as averages over the nodes and over a number of sample networks. What is not included is the processing time and queuing delays required to accomplish all the network functions, which should be estimated by the bidder.

a. The number of links which a message must traverse to get from one node to another (represented by the letter m) is 3.

b. The number of links connected to each node (represented by k) is 4.

c. The input rate from the HOST to the IMP is 20 kilobits per second.

d. The traffic flow on each communication channel is 15 kilobits per second.

e. The sizes and distribution of normal packets will be 50% 112 bits long, and 50% 1040 bits long. Each of these packets must be acknowledged and an acknowledgement packet is 112 bits long. The total distribution of packets is therefore 75% 112 bits long and 25% 1040 bits long. The average number of bits per packet is therefore 364 bits.

f. All nodes are separated by 300 miles. The predicted delay due to distance on the communications line is 5.5 microseconds per mile. In addition, there is an estimated 760 microsecond delay in the modem. Thus, total delay due to communications is 3.17 milliseconds per link.

The parameters described above will allow calculation of: the total input rate into each IMP, the rate which packets enter and leave a node and thus the time available to process them; and the total message delay. The bidder should illustrate that the processor chosen will achieve the message delay and communication line capacity modeled or, if it cannot, determine what message delay and capacity it can maintain.

G. HOST-HOST Traffic Characteristics

The HOST to HOST traffic volumes shown in Appendix E are based on the best (albeit poor) estimates available at this time. Note that this traffic is on a site to site basis, and not necessarily descriptive of the traffic on the various communication network circuits. It is necessary to account for the nature of the routing doctrines used by the IMPS in order to develop estimates of circuit traffic.

The trimodal characteristic of the traffic arises from the three generation mechanisms at work. Type I traffic (high rate of origination, short length) is directly related to the individual keyboard actions of a user at a console. Type II traffic (moderate rate of origination, medium length) represents responses directed to a teletypewriter mechanism or to a cathode ray tube display. Type III traffic (low rate of origination, long length) represents large data transfers to and from magnetic tapes, disks, cores, etc.

The traffic generation processes are not necessarily independent, for a message from one host to another may well give rise to a message from the latter host to the former. One message, for instance, may be Type I and the response Type II. Because of the interactive process in which many users may be involved, this form of traffic dependency might be quite prevalent.

As a result of the communication protocol, the communication circuits will be subjected to IMP generated traffic. Message acknowledgements (Appendix F), for example, contricute to this additional traffic. Such IMP generated traffic is not included in the estimates of Appendix E.

H. IMP-Operator Interface

The interface with the operator is to consist of lights (or equivalent displays) and switches only. No restrictions need be imposed regarding operator access to the lights. It shall be possible to restrict (perhaps by use of a lock and key) access to those switches that can be used to affect the operation of the IMP.

Appendix D, "Input and Output Facilities for the IMP Operator," describes the minimum facilities to be provided. Additional facilities should be provided as required for reasons of operation, debugging, and maintenance.

II. Network Contractor Performance

The contract will be for the design of the full 19 node network and the installation of the four node test network. The four IMPS shall be installed on site and functioning within nine months after the start of the contract. The Contractors' responsibility for the IMPS shall continue for three months after delivery; thus the total contractual period for the test network shall be one year. To help evaluate the eventual size of the network and the phasing of installations, each quotation should include unit prices for additional IMPS in quantities of 10, 15 and 20. The unit cost for installation should also be estimated.

The Contractor shall have full system responsibility; separate quotations for hardware or software alone will not be accepted. If the quoter expects to subcontract for either the hardware or software, the details of the arrangement, i.e., manufacturer's name, delivery schedule and price, should be included in the quotation. The quoter shall:

A. Design the COMMUNICATION SUBNET consisting of:

1. Nineteen (19) IMPs (interface message processors)

2. Nineteen (19) data-set multiplexor interfaces capable of handling six (6) full-duplex 50 kbps lines simultaneously and providing the I/O processing required for full occupancy of all lines

3. Nineteen (19) HOST-IMP standard interfaces capable of transferring data at a data rate in excess of one megabit per second (preferably one-half the IMP memory data rate).

4. The communication software, which must provide

a. Store-and-forward facilities with dynamic routing

b. Positive and negative message acknowledgement

c. Fault detection and recovery to guarantee virtually error-free transmission

d. IMP-IMP control and response as required by the system design and network parameter measurement requirements

e. Message decomposition to communication packets and reassembly to message form in the transmitting and receiving IMPS respectively

f. Priority handling of shorter messages.

5. The assembly or compilation software required for the construction of IMP programs by the user contractors, implemented on some system or systems accessible to the user contractors.

B. Construct a prototype IMP including the IMP-CARRIER and HOST-IMP interfaces. Write, checkout and demonstrate the communication programs operationally in this prototype. Attach this prototype to the selected CARRIER and carry out a closed loop connection and demonstrate the operation of the communication system design as proposed by the network contractor and accepted by ARPA.

C. Construct and install four IMPS and associated interfaces at SRI, UCLA, UCSB, U. of Utah, and demonstrate the total network design as proposed by the Contractor and accepted by ARPA.

D. At the time of completion of prototype checkout, the Contractor shall provide system documentation in regard to the IMP hardware, the communication software, the IMP programming language and the appropriate HOST-IMP interface.

III. Elements of System Design

The network Contractor, in proposing a system design, should be sure to include his considerations concerning:

A. Message decomposition and assembly in terms of efficient communication packets

B. Acknowledgement procedures

C. Routing algorithms

D. Traffic control

E. Error assessment and recovery

F. IMP-HOST interface

G. IMP-CARRIER interface

H. Fault recovery

I. IMP-IMP control messages and interrupt facility

J. Estimated timing factors, e.g., queuing and processing delays in packet transmission

K. Network performance measurements

L. Buffer sizes, memory size for the CARRIER side of the IMP, memory size for the HOST side of the IMP

M. Network performance estimates of the totally implemented network

N. Complete description of the processor and peripheral equipment* required

O. Description of all special purpose hardware required.

The network contractor should include his considerations concerning the following optional items:

A. Modifications for multiple HOSTS connected to one IMP

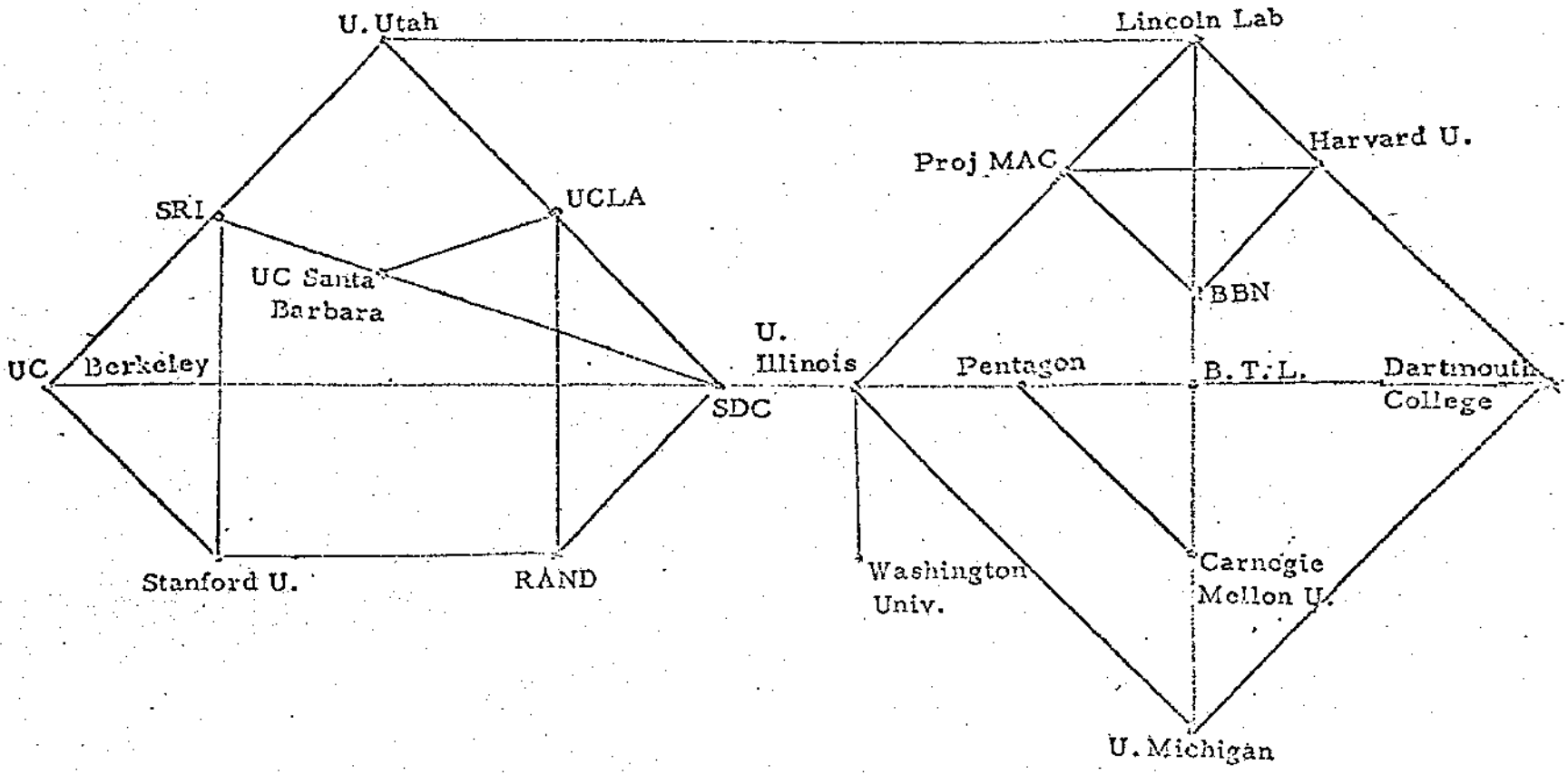
B. Memory protection to maintain store-and-forward operation during checkout of new IMP programs

C. Additional hardware and software necessary for the IMP to be a terminal controller and/or data concentrator for its HOST or for the network (i.e., no HOST, just terminals).

*It is anticipated that mass storage devices such as tapes, disks or drums will not be required for the normal operation of the IMP.

Organization	Abbrev.	Site Location	Network Liaison	Computer
Dartmouth University	DART	Hanover, N. H.		GE 635
Mass. Inst. of Tech.	MAC	Cambridge, Mass.		IBM 7094, PDP-6/10, GE 645
Bolt, Beranek & Newman	BBN	Van Nuys, Calif.		SDS 940, PDP-10
Harvard University	HARV	Cambridge, Mass.		SDS 940, 360/50, PDP-1
Lincoln Lab	LL	Cambridge, Mass.		TX-2, 360/67
Bell Telephone Lab.	BTL	Murray Hill, N. J.		GE 645
Adv. Res. Proj. Agency	ARPA	Wash., D. C.		DEC 338
Carnegie Mellon Univ.	CMU	Pittsburgh, Pa.		1108, 360/67, G-21
Univ. of Michigan	UM	Ann Arbor, Mich.		360/67
University of Illinois	UI	Urbana, Illinois		B-6500/ ILLIAC IV
Washington University	WU	St. Louis, Mo.		Spl Eqpt
University of Utah	UTAH	Salt Lake City, Utah		1108
Univ. of Cal. Berkeley	UCB	Berkeley, Calif.		SDS 940, SCC 6700
Stanford Res. Inst.	SRI	Palo Alto, Calif.		SDS 940 (2)
Stanford University	SU	Stanford, Calif.		PDP-6/10
U of C, Santa Barbara	UCSB	Santa Barbara, Calif.		360/50
U of C, Los Angeles	UCLA	Los Angeles, Calif.		Sigma-7
RAND Corporation	RAND	Santa Monica, Calif.		PDP-6, IBM 1800
System Devel. Corp.	SDC	Santa Monica, Calif.		360/50-65

ARPA NETWORK TOPOLOGY
(Example)



Average Number of Links Between any two Nodes = 2.55
All links are 50 kilobit/second leased lines.

APPENDIX C

IMP Delivery Schedule

Site	Operational Date (in months after contract start)
DART	16
MAC	15
BBN	15
HARV	15
LL	15
BTL	14
ARPA	13
CMU	13
UM	12
UI	12
WU	16
SRI	9*
UCB	11
SU	14
UTAH	9*
UCSB	9*
UCLA	9*
SDC	11
RAND	14

*These four IMPs constitute the test network.

APPENDIX D

Input and Output Facilities for the IMP Operator

Outputs

1. Contents of the program counter
2. Contents of the instruction register
3. Contents of the accumulator register
4. On-off state of electrical power to computer
5. Run-halt state of computer
6. Busy-idle state of each direction of each IMP-HOST channel
7. Transmit-no transmit state of each communication terminal
8. Receive-no receive state of each communication terminal
9. Connected-not connected state of each switched communication terminal
10. In service-out of service state of each communication terminal

Inputs

1. Change contents of the program counter
2. Change contents of the accumulator
3. Turn electrical on-off to computer
4. Cause computer run, single step, halt
5. Cause computer to load from HOST or communication terminal
6. Cause computer to dump to HOST or communication terminal
7. Cause master clear in computer
8. Make-busy specified data terminals
9. Force disconnect of specified data terminal
10. Limit-no limit access to all other operator inputs

ARPA NETWORK

Data Rates Between Nodes in Kilobits/sec.

From	To 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	Node Output Total	Node Input Total	I/O Rate Total
1. Dartmouth		2		1		2	1							1		1				8	4	12
2. M.I.T.	1		1	2	2	1	1	1	1	1	1	1	1	1	2	1	1	1	1	21	15	36
3. B.B.N.		1		1				1				1	2	1						7	12	19
4. Harvard		1	1		1							1		1				1		6	11	17
5. Lincoln Lab		1				1	1		1	1		2		1			1	1		10	18	28
6. B.T.L.	2	1												1						4	8	12
7. Pentagon					1													1	1	3	10	13
8. Carnegie		1	1						2			1		2	1		1	1		10	9	19
9. U of Mich		1			1			2		1	1			1		1			1	9	8	17
10. U Illinois		2		1	5	1	1	1	1			20	1	2	2	10	1	1	1	50	13	63
11. Wash. U.					1	1								1						3	5	8
12. U. Utah		1			5		1	2	1	8				1		5	1	1		26	29	55
13. U.C. Berkeley		1	6	3		1			1					3	1	1	1	1	1	20	6	26
14. S.R.I.	1	1	2	1	1	1	1	1	1	1	1	1	2		2	1	1	1	1	21	19	40
15. Stanford U.		1						1						1						3	8	11
16. Santa Barbara				1						1	1	1					1			5	22	27
17. U.C.L.A.											1			1		1			1	4	10	14
18. RAND Corp.				1	1		2					1				1	1		1	8	10	18
19. S.D.C.		1	1				2							1			1	1		7	8	15
																Total				225	225	

APPENDIX F

DATA COMMUNICATIONS CONVENTIONS

This section describes the data communications conventions which specify at a gross level the protocol which allows the host to communicate with its IMP and the IMP's to communicate with one another. This section, like the others, is designed to provide guidelines to the contractor who may, if he wishes, modify any part of the description in his proposal. Each modification will be evaluated, and will be considered in the final contractor selection.

HOST TO IMP

The Host and the IMP communicate using a form called a Message. There are two kinds of messages, the first being a Message destined for (or coming from) another Host; the second is a message to be interpreted by the IMP as an IMP command (or generated by the IMP for the information of the host). The first type of message will be called the "Normal" message because the primary function of the Message Switching Network is the transmission of this message to the destination host. The other type of message will be called the "abnormal" message and will be used for functions such as the query to (and response from) the Host to insure that the Host (and IMP) are functioning properly, error messages to indicate format or illegal character errors in "Normal" messages, etc.

NORMAL MESSAGE

A normal message when transmitted to the IMP, will consist of not more than 8,192 bits of information and should contain the name of the destination Host and an identification number which can be used for reference by the IMP and the receiving Host. The bit structure of the normal message will be decided by the Host and will probably be different from machine to machine. It is the Host's responsibility, however, to provide the character translation program for his IMP which converts his bit pattern to the standard form used on the network. Since the translation may be greater than one for one, the message may now be greater than the original 8,192 bits. The IMP can then make a decision to send the longer message or return an abnormal message saying a format error has occurred, then drop the message.

The normal message has two kinds of information - character and binary. The principal difference between the handling of these forms of

information is that the character text will be transformed from sending host's format to network standard format and then, after transmission is completed, to the receiving host's format; whereas binary text will be received bit for bit identical to what was sent (though some minor modifications may be made during transmission, as described later).

ABNORMAL MESSAGES

The forms and types of abnormal messages have not been worked out in detail. It will be the Contractor's responsibility to decide what is required to maintain effective communications between the Host and its IMP. The most important constraint is that the number and variety of these messages be minimized so as to minimize the burden the IMP places on the Host (this is a basic network tenet).

Your quotation should contain suggestions of the types of abnormal messages that may be required. This will by no means be binding; it is expected that the final form of abnormal messages will not be decided until after the testing of the initial (four node) network.

IMP to IMP

IMP's communicate with one another using forms called Packets. There are two basic kinds of packets: "Normal" packet is any packet whose final destination is as a normal message for a Host; an "Abnormal" packet is a packet whose final destination is an IMP. All packets are to be equal to or less than 1024 bits starting with the first character of the Header and continuing through the parity code. A packet has three elements within its structure: a Header which must be present in all packets, the Test (Binary and/or Character) which may be missing or null, and the parity check which will be 24 bits long.

To simplify the logic and programming required, all packets will be transmitted on a continuous stream over the communication line between IMP's, i.e., no nesting of packets is permitted.

NORMAL PACKETS

A "Normal" message may be broken into several packets according to its size (multiple packet message, MPM), but a packet will contain only one message. The packets in MPM are not bound together until they reach the destination IMP where they are formed back into a normal message.

They may even flow through different paths of network and reach the destination IMP out of sequential order. A message may also be small enough to fit into a single packet (Single Packet Message, SPM), or very small, e.g. single character (Very Small Message, VSM). All normal messages generate normal packets at sending, and visa versa at receiving.

ABNORMAL PACKETS

Abnormal packets are used for error control, acknowledgements, and the transmission of network status, e.g. new routing tables, communication line down, IMP down, Host down, measurement information, etc. An abnormal packet may be generated by an abnormal message or because of some special internal state of the IMP, e.g. buffers full. All abnormal packets must be acknowledged with the exception of acknowledgement and negative acknowledgement packets.

PACKET FORMAT

The Packet Format is based on an eight bit code (character) format. The packet is sent in 8 bit transparent binary form, independent of whether the text is binary or character. Four special control characters are required to delimit the start and end of a packet and to maintain the communications line. The control characters are:

SYN (Synchronization character). This character is used to fill the communications line between packets; this is required because of the synchronous communications line.

STX (Start of Text). This character indicates the start of a packet and must be preceded by a DLE.

ETX (End of Text). This character indicates the end of a packet and must be preceded by a DLE. The three character cyclic checksum must follow the ETX character.

DLE (Data Link Escape). This character is used to indicate the packet is transmitted in binary form. DLE is the only character that must be handled as a special case within the packet. If a DLE occurs within a packet it should be preceded by an additional DLE on transmission, which should be deleted upon reception of the packet.

The packet should look as follows:

S		S	D	S	Fixed		D	E	C	C	C	S	S
Y	. . . .	Y	L	T	Length	TEXT	L	T	S	S	S	Y	. . . . Y
N		N	E	X	Header		E	X	1	2	3	N	N

HEADER

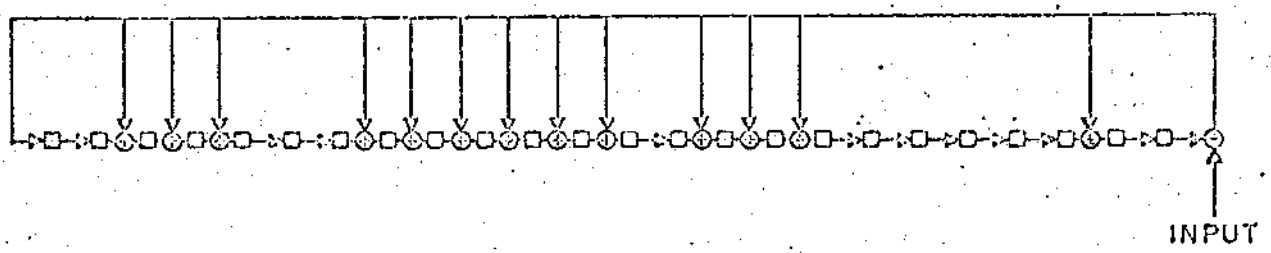
The header is fixed length and contains all the information required by the IMP's to transmit the packet to its final destination. The packet header as envisioned to date is to contain six characters with the following information:

1. Destination Code (8 bits)
2. Origin Code (8 bits)
3. Message I. D. (16 bits)
4. Packet Number (5 bits)
5. Hand Over Number (6 bits)
6. Packet Priority (1 bit)
7. End to End Message Acknowledgement Required (1 bit)
8. Last Packet in Message (1 bit)
9. Text is for IMP rather than Host (1 bit)
10. Text in Packet is in binary (1 bit)

Error Control

A twenty-four bit cyclic parity check has been chosen as the error detection scheme. The cyclic parity check corresponds to polynomial multiplication. A 1000 bit block of binary data may be interpreted as a polynomial a(x) of degree 999 whose coefficients are zeroes and ones. Let g(x) be a polynomial of degree p with binary coefficients. The product a(x)g(x) of the two polynomials with all coefficients reduced modulo two corresponds to a block of 1000 + p bits which may be error checked by polynomial division by g(x). It is possible to arrange matters so that

the first 1000 bits are exactly equal to the information bits and the last p bits are parity check digits. This is possible from the Euclidean division algorithm by selecting the last p bits to correspond to the remainder polynomial when $x^p a(x)$ is reduced modulo g(x). A p stage linear shift register can be constructed to perform division by g(x) and this same device can also be used to detect the presence of errors since that operation requires division by g(x) too. The g(x) recommended is $g(x)=(x^{12}+x^6+x^4+x+1)(x^{12}+x^{10}+x^4+x^3+x+1)$. The shift register which implements this code is illustrated below:



This device is used for both the generation of the checksum and error detection. The device must be cleared upon receipt of the DS LT sequence SEX and started on the first character following the TX character.

The generation of the parity code is done by passing the packet bits stream through the device (including the final DE LT). The parity code is then the EX 24 bits left in the device and is obtained by shifting the bits out, packing them into characters and transmitting them (high order bit is the first one out of the shift register).

The detection of errors requires the passing of the packet through the device until DE LT is sensed. The next three characters (the parity code) EX are input, then the 24 bits in the device are sensed for all zeros which indicates that no error has occurred.

Using this parity check scheme the mean time between undetected errors will be approximately 1/2 to five years throughout the entire net.

NETWORK PACKET FORMAT
(Example)

	Bits
DLE	8
STX	8
PRIORITY (1), FOR IMP (1), HANDOVER # (6)	8
DESTINATION	8
ORIGIN	8
MESSAGE I.D.	16
PACKET # (5), LAST (1), BINARY (1), END ACK. (1)	8
CONTENT TEXT OR BINARY 0-117 CHARACTERS	0-936
DLE	8
ETX	8
CYCLIC PARITY CHECK	24
Total Length	104-1040

APPENDIX G

ROUTING

An IMP, upon receipt of a packet, must decide which of its communications links to send the packet out on. The line is chosen using the Routing Table (RT) which must be generated by the IMP from the Interconnection Table (IT). The IT is a tabular description of the interconnection between nodes in the network, and is identical in each IMP. Each IMP must also have a routing table to tell it directly which communication line is best to use to get a packet to another node. This table is called the RT and is different in each IMP. Described below is one method of obtaining the routing; there are many others. The contractor should describe the one chosen for his system. The method below also chooses a particular network configuration as an example. This network will not be the final configuration. In this scheme an intermediate table must be generated from the IT which describes the number of links to the destination IMP for each communication line. The RT is formed from the Intermediate Table by sorting the lines into first, second, third and fourth choice.

Interconnection Table

The Network, as presently conceived, will have all point to point leased line communications. The IT will therefore be fairly stable, changing only to:

(1) Show the addition of new nodes and/or communication lines, and

(2) Reflect the fact that an IMP or communication line has gone down or has come back up.

An example network and its IT is given below. The nodes are numbered from 1 to 19, with a $\emptyset$ indicating no connection exists; the four communication lines are lettered A, B, C and D.

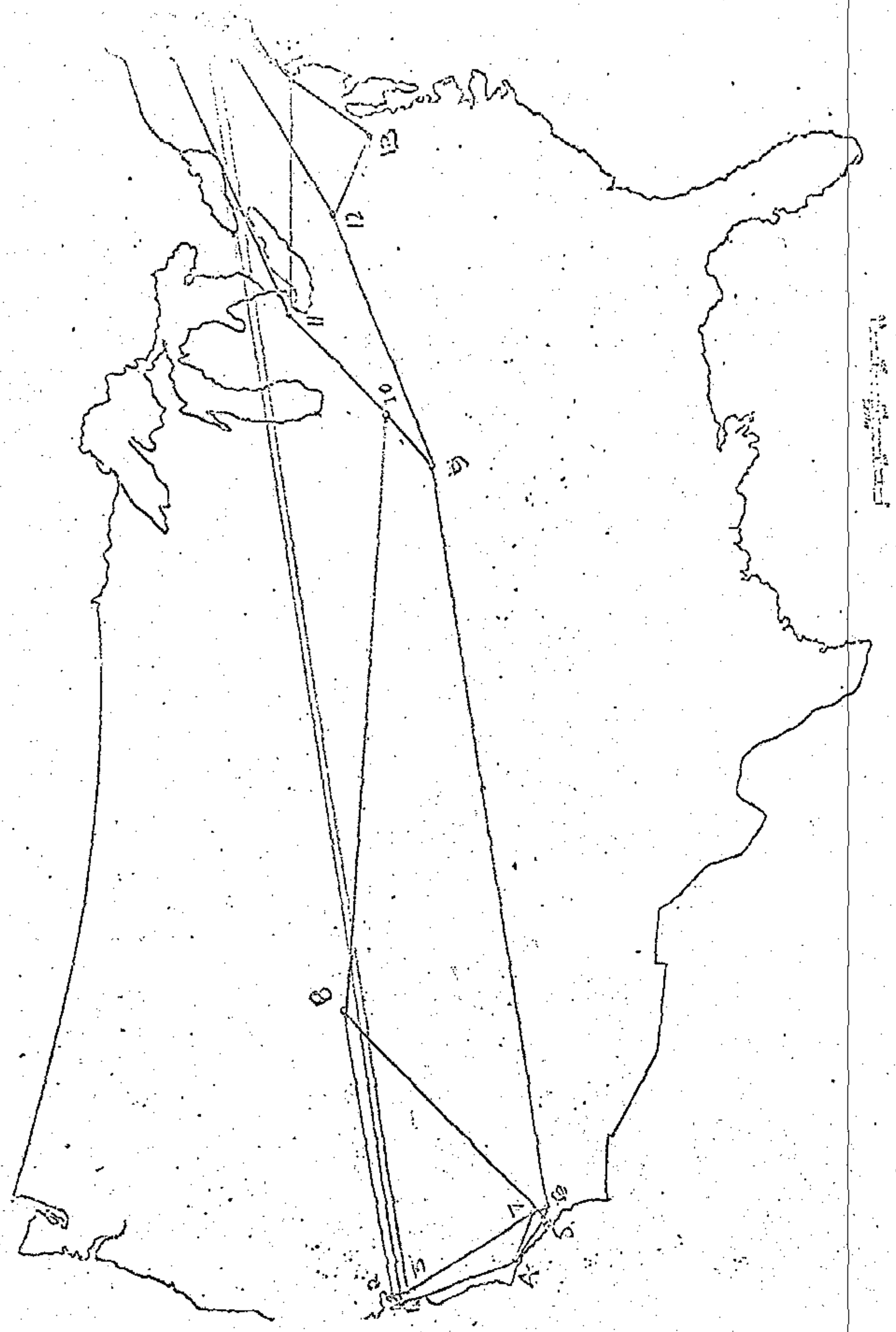
Intermediate Table

The Intermediate Table is generated in each IMP from the IT each time a change in the IT occurs. The technique employed in this scheme involves starting with a cleared table and entering a 1 in the rows corresponding to the nodes connected directly to yours (nearest neighbors) and in the column representing the appropriate communication line. Then find the "nearest neighbors" of all nodes with a 1 in its row and place a 2

in the appropriate column. This procedure should be continued until all entries in the table are covered. In the example, the Intermediate Table for SRI is developed; this table would of course be different for each node.

Routing Table

The Routing Table is a description of the priority of the communications lines in terms of the number of links required to get a packet to its destination. The columns are numbered, with the first entry being the highest priority choice. Entries in the Intermediate Table that are two or more higher than the minimum entry in the same row are underlined in the Routing Table. They are bad choices because the routing doctrine at the next node will probably send the packet directly back to the original node.



	Interconnection Table				Intermediate Table				Routing Table			
	A	B	C	D	A	B	C		1	2	3	
1	19	7	2	0	-	-	-	-	-	-	-	-
2	8	1	3	0	5	4	1	-	C	B	A	-
3	2	4	17	0	4	3	2	-	C	B.	A	-
4	7	5	3	0	5	2	3	-	B	C	A	-
5	8	6	4	0	6	3	3	-	B	C	A	-
6	9	5	7	0	6	2	4	-	B	C	A	-
7	6	4	1	0	6	1	4	-	B	C	A	-
8	10	5	2	0	5	4	2	-	C	B	A	-
9	10	12	6	0	5	3	4	-	B	C	A	-
10	11	9	8	0	4	4	3	-	C	A	B	-
11	18	14	10	0	3	5	4	-	A	C	B	-
12	16	13	9	0	4	4	5	-	B	A	C	-
13	14	12	0	0	4	5	-	-	A	B	-	-
14	15	13	11	0	3	6	5	-	A	C	B	-
15	16	14	10	0	2	6	5	-	A	C	B	-
16	15	12	17	0	3	5	4	-	A	C	B	-
17	3	16	18	0	3	4	3	-	A	C	B	-
18	17	19	11	0	2	5	4	-	A	C	B	-
19	18	15	1	0	1	6	5	-	A	C	B	-