5 Feb 81

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SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

REPORT DOCUMENTATION PAGE	READ INSTRUCTIONS BEFORE COMPLETING FORM
1. REPORT NUMBER / 2. GOVT ACCESSION NO.	3. RECIPIENT'S CATALOG NUMBER
4. TITLE (and Subtitle) Improvement of Access to DoD Scientific and Technical Information Part A--Background Information	5. TYPE OF REPORT & PERIOD COVERED Dec. 1979 - Dec. 1980 6. PERFORMING ORG. REPORT NUMBER IDA PAPER P-1537, Part A
7. AUTHOR(s) Murray Kamrass Vincent J. Berinati	8. CONTRACT OR GRANT NUMBER(s) MDA 903 79 C 0320
9. PERFORMING ORGANIZATION NAME AND ADDRESS Institute for Defense Analyses 400 Army-Navy Drive Arlington, VA 22202	10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS Task DTIC-1
11. CONTROLLING OFFICE NAME AND ADDRESS Defense Technical Information Center Cameron Station Alexandria, VA 22314	12. REPORT DATE December 1980 13. NUMBER OF PAGES 103
14. MONITORING AGENCY NAME & ADDRESS(if different from Controlling Office)	15. SECURITY CLASS. (of this report) UNCLASSIFIED 15a. DECLASSIFICATION DOWNGRADING SCHEDULE

16. DISTRIBUTION STATEMENT (of this Report)

Approved for public release; distribution unlimited.

17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

18. SUPPLEMENTARY NOTES

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

Information, bibliography, on-line, security, data bases

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

The regulations governing the implementation of DTIC are reviewed and lack of enforcement is found to be a primary factor in denying to DTIC about fifty percent of the information that should be in the files. A survey of DROLS users indicates that nearly all classified users would be unhappy about a change to a completely unclassified system, although the real benefits of the classified system are small, considering recent and pending improvements to the unclassified system. In addition, an

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IDA PAPER P-1537

IMPROVEMENT OF ACCESS TO DoD SCIENTIFIC AND TECHNICAL INFORMATION

PART A—Background Information

Murray E. Kamrass
Vincent J. Berinati

December 1980

Prepared for
Defense Technical Information Center

INSTITUTE FOR DEFENSE ANALYSES
SCIENCE AND TECHNOLOGY DIVISION

IDA Log No. HQ 80-22919

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SCIENCE AND TECHNOLOGY DIVISION
400 Army-Navy Drive, Arlington, Virginia 22202
Contract MDA 903 79 C 0320
Task DTIC-1

PREFACE

This report has been issued in two volumes. IDA Paper P-1537, Part A (this volume), contains detailed background information on DROLS operations and is intended primarily for those readers who are not so familiar with DROLS. Part B discusses the details of the research performed by IDA in response to the task statement.

ACKNOWLEDGMENTS

The authors acknowledge with gratitude the many helpful comments of Jesse Orlansky and Albert M. Rubenstein, IDA staff members, who provided a technical review of this report. We also acknowledge the gracious cooperation of the Technical Information Services staff at IDA, most notably Mrs. Ruth Smith, Mrs. Evelyn Fass and Mrs. Nancy Venator. With their able assistance we were helped to understand what DROLS and technical information accession and retrieval are really all about. We would also like to acknowledge the contribution of Bernard Rider, an IDA consultant, who authored the response time investigation presented in Appendix D.

CONTENTS

ABBREVIATIONS

ADP	Automatic Data Processing
AFAL	Air Force Avionics Laboratory
AFWL	Air Force Weapons Laboratory
AUTODIN	Automatic Digital Network
CIA	Central Intelligence Agency
DDC	Defense Documentation Center
DLA	Defense Logistics Agency
DoD	Department of Defense
DRIT	DDC Retrieval and Indexing Terminology
DROLS	Defense RDT&E On-Line System
DSA	Defense Supply Agency
DSMS	Defense Systems Management School
DTIC	Defense Technical Information Center
FYDP	Five-Year Defense Program
IAC	Information Analysis Center
IDA	Institute for Defense Analyses
IR&D	Independent Research and Development (File)
MAI	Machine-Aided Indexing
MCIC	Metals and Ceramics Information Center
MIS	Management Information System
MUAC	Master User Address Contract
NAVMAT	Naval Material Command
NLDB	Natural Language Data Base
NRL	Naval Research Laboratory
NSA	National Security Agency
NTDSC	Non-Destructive Testing Data Support Center

ODUSDRE/R&AT	Office of the Deputy Under Secretary of Defense for Research and Engineering (Research and Advanced Technology)
R&D PP	Research and Development Program Planning (File)
RDT&E	Research, Development, Test and Evaluation
RSIC	Redstone Scientific Information Center
RTIS	Remote Terminal Input Subsystem
SBIE	Shared Bibliographic Input Experiment
SDC	System Development Corporation
STI	Scientific and Technical Information
TAB	Technical Abstract Bulletin
TPS	Text Processing System
TR	Technical Report (File)
TSEC	Telecommunications Security
WUIS	Work Unit Information System (File)

I. INTRODUCTION

The Defense Technical Information Center (DTIC), under the overall direction of the Office of the Deputy Under Secretary of Defense (Research and Advanced Technology), OUSDRE, operates a DoD-wide on-line system that provides remote interaction with four major RDT&E data bases. The system was originally designed in the late 1960s to provide secure access to a computerized file containing classified descriptions of ongoing research efforts. This original file of Work Unit Information System data was set up as a management information system (MIS) intended to help keep DoD managers informed about ongoing DoD scientific and technical projects, thereby avoiding duplication of technical effort and helping managers and research personnel to stay knowledgeable about rapidly advancing science and technology and to borrow and use ideas from each other that might be relevant to their projects.

Once the system was in place and operating, it became apparent that it could have a much broader application than the one for which it was expressly designed. Three data bases were added: The Technical Reports (TR), Research and Development Program Planning (PP), and Independent Research and Development (IR&D) files. The operational system became known as the Defense RDT&E On-Line System (DROLS).

Of the four files the TR file is by far the largest, containing about 1.3 million entries. Also, as might be expected, the TR file is the most frequently queried. Although it was designed and constrained to protect a small proportion (about 10 percent) of intrinsically classified records, DROLS is now

very different in scope and intent from its original implementation with the work unit file. Because of what seem, from this time vantage point, to be arbitrary design decisions, DROLS is not compatible with any other DoD system for electronic access to or transfer of S&T information. DTIC cannot, for instance, interface with and utilize the computer resource sharing and terminal access capabilities of the DoD-developed ARPANET. It cannot benefit from the many software and hardware developments in the ADP marketplace. These deficiencies are manifested by high costs for operation, access and enhancement.

DTIC has found some ways of circumventing the original limitations of DROLS. This year, for example, it has developed software that permits unclassified users to access unclassified fields that pertain to classified reports in the file. In addition, it is now possible for low-speed, asynchronous dial-up terminals to access the unclassified DROLS files. Since this study was started, these and other improvements have been made to DROLS that effectively enhance unclassified users' capability to obtain almost as much information from the files as cleared users. We believe that DTIC has gone about as far as it can in enhancing the utility of the unclassified terminals while still conforming to its mandate to protect classified information by releasing it only to those who are properly cleared to receive it. It has been able to accomplish what it has done so far, partly because only a small portion of the information on its files is classified and even of those reports that are classified, there are a number of fields such as title, AD number, authors and descriptors that are not classified.

However, the protection of this small amount of classified information complicates further improvement of the system. It also maintains the high operating costs associated with secure operating systems.

In October 1979, during a ceremony commemorating the redesignation of the Defense Documentation Center to Defense Technical Information Center (DTIC), Dr. Ruth M. Davis, then the Deputy Under Secretary of Defense for Research and Engineering (R&AT), addressed DTIC on the subject of its role. Dr. Davis said that DTIC should expect to "work more closely with R&D managers in the Pentagon and provide them with technical and management information." In addition, she recommended that DTIC "play a more important role in the evolution of OUSDRE data processing activities ... and assisting and improving our management information systems as well." DTIC should "become part of a community providing internal and external interactive data processing support to OSD." It should have "R&D capability to take care of its own growing needs and the requirements of the Defense STI program." DTIC in the future will "contribute to the education and training of R&D managers in the use of DTIC and other data bases and in generating a Federal Government-wide information interchange program. It will also encourage the improvement of the quality of technical reports..." (Ref. 1).

In view of these changes in scope and intent, it seems reasonable to examine the purpose and priorities of DTIC insofar as they concern the handling of classified information on-line. For example, considering the latest developments in information technology, would there be a net advantage to DTIC and the community it serves, as well as the Department of Defense, if DROLS became a completely unclassified system? What alternatives are available to DTIC to supply the needs of the community that uses classified information, if DROLS were limited to unclassified information? What alternative courses of action do users have if they can no longer obtain classified citations from DTIC on-line?

In this study we have tried to examine these questions. We have had to remind ourselves continually that DROLS does not have in its banks much that would be considered by scientists and engineers as "real" data. DROLS provides primarily bibliographic

information and management information such as who is working on what. DROLS then is really more a source of where to find it rather than of the information and data itself. It is not the only such source that DTIC provides, but it is by far the most convenient, time saving and comprehensive source of where to find it information that DTIC offers. Unfortunately, although only a small part of this information is classified, it is necessary that the entire system be set up to protect this small proportion of classified information. Hence, all information that goes out to classified terminals must be encrypted and all such terminals must be located in appropriate enclosures and attended by properly cleared personnel. In addition, strict controls must be maintained on user protocols for addressing the system to ensure that users receive only the information they are supposed to receive as determined by their security status and need-to-know.

DTIC asked IDA to provide an examination and analysis that might help to improve access to DROLS. Of particular interest was the question of whether DROLS should become a totally unclassified system, with classified user's needs handled by some other means. To examine this question IDA was asked to examine the basic objectives and priorities for providing on-line access to and communications of, relevant DTIC-stored Scientific and Technical Information (STI). These would support Defense RDT&E programs and also the National science and technology community.

This report describes the work and results of the IDA effort, which was initiated on December 10, 1979. During the course of this work, DTIC initiated a number of enhancements of DROLS that improved considerably access by the unclassified user. Some of these improvements came unexpectedly, and, since some of the subtasks were made obsolete by the improvements, the original work statement was revised. In this report we have attempted to indicate the work that was accomplished in response to the original task statement as well as to the amended one.

In this part of the report (Part A), we present some of the background relating to DTIC and its mission. Part B (published separately) will present the details of some research that IDA performed to find answers to the basic questions asked in the task statement. Part A of our report contains considerable detail that would be of little interest to the reader who is familiar with DTIC operations. Rather it is intended for those readers who are not so familiar with DTIC operations.

II. DEFENSE TECHNICAL INFORMATION CENTER-- SERVICES, GOALS AND CAPABILITIES

A. INTRODUCTION

1. Purpose

This chapter presents information on DTIC operations and services, the regulatory basis for such services, and some statistics associated with the present level of service of DTIC. Various documents have been used and in some cases quoted freely without further attribution (see Refs. 2-16).

2. Mission

The mission of DTIC is to collect, process, announce, retrieve, and provide formally recorded technical information in all of the scientific disciplines and engineering fields of interest to the DoD, its contractors, and other government agencies and institutions. Objectives have been established by OUSDRE, the Military Departments, and Headquarters, Defense Logistics Agency. General guidance in how to attain these objectives is provided by these same organizations, but they rely on DTIC to develop and implement its mission objectives. DTIC is also charged with developing new products, services and system improvements for DoD technical information transfer.

DTIC was established to provide a single repository and access point for research data from all DoD laboratories and contractors. Within the limits of its mission statement, it also assists in establishing new technical information systems and data bases.

3. Authority and Responsibilities

DTIC is a component of the Defense Logistics Agency and the Deputy Under Secretary of Defense for Research and Engineering (OUSDRE) exercises overall policy direction for the responsibilities assigned to the Director, Defense Logistics Agency. Regulations state that the Director of Technical Information, DRE, serves as the focal point for carrying out this policy direction. However, since there is no such Director at present, this responsibility is assigned to the Director, Research and Information Management, ODUSDRE (R&AT).

4. IDA Task for DTIC

Under Task Order DTIC-1, December 10, 1979, IDA has undertaken to study how to improve access to DoD Scientific and Technical Information through the on-line DTIC data bases. DTIC operates a DoD-wide on-line system to provide remote interaction with four major RDT&E data bases, which are described later in this paper. This system was originally designed in the late 1960s to provide secure access to a file containing classified descriptions of ongoing research efforts. Although other data base applications have been added, the DTIC system is designed for, and constrained by, the need to protect its classified records--which are a small proportion (about 10 percent of all its records). Because of this constraint and other design decisions, the DTIC system is presently incompatible with other DoD systems for electronic access to or transfer of S&T information. DTIC cannot, for example, interface with and utilize the many computer resource sharing capabilities of the DoD-developed ARPANET. It cannot benefit from many of the software and hardware developments of the ADP marketplace. This deficiency is manifested by high costs for operations, access and enhancement of the DTIC system. However, measures taken recently to provide asynchronous dial-up access to the on-line data bases may change this problem in the near future.

DTIC is committed to support and expedite information transfer among DoD agencies, their contractors and the national R&D community and to facilitate access by the DoD contractor community to a broad spectrum of Scientific and Technical Information (STI) relevant to RDT&E programs. For on-line systems this implies broad, flexible, inexpensive and uncomplicated access and compatibility with existing value-added networks (e.g., ARPANET, TYMNET, TELENET), the most common types of terminal devices and other major retrieval systems. DTIC also has the requirement to provide full protection and control for all classified data that is provided or accessible on-line; therefore, a critical element of its design is data security and prevention of unauthorized access to the system. This requires a high degree of control, rigidity, expense and complexity and has led to incompatible and dedicated access methods and terminals.

OUSDRE (R&AT) has designated a new and broader DTIC mission, oriented to expanded, more direct information and data base support to OSD-level managers. The desired degree of flexibility and responsiveness conflicts with DTIC's present secure systems arrangements.

B. DTIC SERVICES AND CAPABILITIES

DDC was directed by OUSDRE to develop and provide on-line terminal remote services to its users. Specifically, this effort was designed (1) to support and aid managers, scientists, and engineers in decisionmaking processes and problem definitions, (2) reduce information delays and associated costs, (3) increase user "creativity" through direct access and interface with the R&D data bases, and (4) eliminate the "middleman" and thereby improve the bibliographic quality.

Beginning in 1968, a prototype DDC Retrieval System was developed in-house to determine the feasibility of direct on-line access to DDC data banks. Initially, only DoD activities and

other government agencies were allowed to participate. The system, as it was developed, had an in-house-programmed real-time communications handler that handled the message transmission to and from the remote terminals and a batch applications software package for actually performing all the search/retrieval system capabilities.

In 1973, a prototype generalized input system was developed in-house to provide a method to input data remotely to DDC. Since many of the organizations who subscribed to the retrieval system also contribute input, it was to the advantage of these organizations to have a remote input capability to achieve better and further utilization of their terminals. This is especially advantageous in the case of those remote sites that have Telecommunications Security (TSEC) equipment and must input classified data. The input system was initially developed as an alternative to the retrieval system.

During the time DDC was developing and enhancing the then-current on-line retrieval and input systems, on-line planning, system requirement analysis, and network expansion began. Attainment of the following objectives broadened the base of the system and moved away from the strict "initial" design parameters to those dealing with practical on-line information retrieval. The objective of this planning was to:

(1) Expand the system network to include several major laboratories,
(2) Redesign and rewrite the system to improve operating efficiency and effectiveness and to accommodate input as well as retrieval processing in one system,
(3) Design, develop and implement an unclassified/classified data transfer network, and
(4) Experiment with remote hardware devices, data management systems and computer-to-computer hook-ups.

In September 1974, DDC implemented its reentrant Defense RDT&E On-Line System (DROLS). This system was written completely in-house by systems and programming personnel and incorporates use of sophisticated reentrant coding and multiple program activities. The system was developed to provide the capability to expand to more than 100 terminals. (The previous system was designed with a real-time communications handler and each terminal was a separate program competing for time in a time-sharing environment. Much of the processing capability of the computer system was tied up with system overhead of moving each terminal's program in and out of core as various applications were processed.)

The new reentrant system is essentially a miniature operating system which is made up of a Communications Monitor, an Applications Controller, the Applications functions and activity buffers for actual data manipulation. The system provides the ability to sort, retrieve, qualify, display, input, and interface with the daily processing system. Also included in the design of the system are specific security controls required to make available, on-line, the four major Defense data banks simultaneously. It was a major problem to control the simultaneous access of data by both classified and unclassified users having various scientific fields of interest and need-to-know. This problem was exacerbated by distribution limitations and the need to control proprietary information while making technical information available to users in a timely manner.

DTIC is one of the few DoD organizations, if not the only one, that has approval to operate in both classified and unclassified modes during the same period of time on the same computer.

Following are the broad ranges of capabilities offered in an on-line environment to remote DTIC users.

1. Search

Users of the Defense RDT&E On-Line System are offered the capability of structuring their own search queries. Subject and non-subject search terms (up to a current maximum of 525 terms) combined by Boolean operators (i.e., AND, NOT) may be used to structure a search strategy. Various file design and programming techniques allow users numerous methods for retrieving data from the "very general" to the "very specific" during search manipulation. Immediate restructuring of search strategies provides the user with the means to refine the search many times, which enables him to get to the data that is wanted before any decision is made as to whether a bibliography is desired or not. If the user does not have the time to view the product of the search query, a method is available to transfer those results for processing in an off-line mode and have a printed bibliography mailed to his organization the next day. Over 400 different bibliography or report formats are available for use.

2. Sort

This capability provides the user with an on-line method to sequence his data output from the terminal by ascending or descending data elements as desired. The user may use any combination of acceptable data element fields to sequence desired output on his terminal screen.

3. Data Display

One of the major capabilities offered by DTIC's on-line system is the direct access into the four major technical information data banks. Scientists and engineers may view, at remote locations, the current status of most of the planned, current, and completed research and development undertaken by the DoD. The system provides users with four specialized display formats for each data base but allows the terminal user to describe his own format if he desires. There are many options such as

continuous display, continuous display and print, skipping accessions forward and back, and other additional methods of viewing desired output.

4. Data Qualification

Data qualification capability allows further refinement of search results. Financial data, dates, and other similar data elements may be searched on a linear basis and each resume scanned individually against user-imposed qualifications criteria. Qualifications statements allow use of Boolean operators (i.e., AND, NOT) and arithmetic comparators (i.e., LT, EQ, NE, GT) for defining qualifications parameters. Qualification results may be displayed using the display capability and all of its options.

5. Order Products

If the user determines that he does not have the time to view the retrieved data at the terminal and wants to have information mailed to him, DTIC has incorporated into the system a means to order either bibliographies or documents through use of this system option.

6. Input

A Remote Terminal Input Subsystem (RTIS) has been incorporated as a function of the Defense RDT&E On-Line System to provide the capability of remote input of data to DTIC. The input subsystem does *not* allow the user to directly change a master file of a data base but affords him the vehicle to interface the remote terminal input with an off-line update process.

7. Additional System Capabilities

There are many other system capabilities that allow for the exhibit of various tutorial information, classified accessions displayed log, information log, data base availability information, and other supporting commands designed to help the user operate the system more effectively.

8. Prevalidation Subsystem

A Prevalidation Subsystem was developed at DTIC to provide in-house personnel with a means to prevalidate, in an on-line mode, requests made to DTIC for limited documents. In order to prevalidate document requests, software was developed to load and query a mass storage Master User Address Contract (MUAC) File and the Technical Report Master Inventory File. A determination can be made via this subsystem as to whether a special form is required of a requester prior to release of a limited document.

9. Dup-Checking Subsystem

This subsystem was developed to provide in-house personnel with a method to help automate the laborious manual method of eliminating duplicates in DTIC's technical report collection. Various system options are available for the accomplishment of this function.

C. SUMMARY

Outlined previously are the types of computer systems and subsystems developed and maintained by DTIC in support of its mission. Data systems applications in DTIC differ from those in DLA Supply Centers especially in that DTIC is not principally concerned with data processing. Routine data processing generally involves manipulation of numerical data in more or less fixed-field format with fairly well-defined and consistent processing procedures. DTIC's efforts are primarily directed to scientific and technical information storage and retrieval. This involves manipulation of masses of variable narrative data, the organization and processing of which must lend itself to ready and precise access by the scientific and technical intellect. With the On-Line System in particular, DTIC cannot control how its users will approach the system, nor can DTIC anticipate what esoteric area of science of technology each one will be researching. The

thought patterns and methodology of the user's scientific discipline will dictate his concept of how the systems should serve him. DTIC must design its systems, therefore, to accommodate to the vagaries of individual users as well as to the changing information requirements of the research and development community in general.

D. SECURITY

Of overriding concern during the development and operation of the Defense RDT&E On-Line System was and is the problem of security and the inadvertent release of limited or proprietary information. Classified and limited information have to be controlled not only by *classification* but also on *need-to-know* and *release* limitations.

DTIC currently has terminals located at intelligence agencies such as NSA, CIA, and DIA; DoD military installations and laboratories such as NAVMAT, NRL, AFWL, and RSIC; Information Analysis Centers such as MCIC and NTDSC; military schools such as the U.S. Naval Academy and the Defense Systems Management School (DSMS); DoD contractors; and other federal agencies.

The operating environment of the system includes all of these terminal user types and controlled access and release of information to each of them by hardware or software controls or a combination of the two. Many levels of security control are applied in all phases of the operation of the on-line system to prevent unauthorized disclosure of data.

A set of comprehensive security control procedures was developed by DTIC for operating the on-line system. Included in the procedures is a security test that provides to remote terminals the opportunity to participate in periodic security integrity testing of the system. Test criteria are organized by data base. NSA and DSA Security Officers have certified the operation of the system.

E. KEY DOCUMENTATION

1. DoD Regulations and Directives

DTIC is authorized to operate by a series of directives issued by the Department of Defense and the Military Services. For example, DoD Directive 5100.36, "Department of Defense Technical Information," December 1962, provides for the coordination and management of the DoD Scientific and Technical Information Program. The policy, as explained in this directive, is that technical information programs will provide for the interchange of technical information within the DoD and between the DoD and the rest of the technical world to the maximum extent permitted by security. Moreover, the technical information program is a basic and integral part of the RDT&E function of the DoD. Also, all DoD components involved in RDT&E are instructed to maintain contacts with all DoD information services so that complete coordination of information is achieved. DTIC is instructed by DoD Instruction No. 5100.38 "Defense Documentation Center for Scientific and Technical Information (DDC)," March 29, 1965, to attain the following objectives:

"A. Active and continuing acquisition of all technical reports (except those in certain specified security categories) . . .

B. Prompt and well-indexed announcements of newly acquired technical reports;

C. Timely response to requests for technical reports and other documentation services;

D. Reconciliation of information acquisition, storage, reproduction and distribution methods with DoD security policies, standards, criteria and procedures;

E. Rapid notification of availability of technical reports to Information Analysis Centers;

F. Increased effectiveness of information flow with other U.S. Government agencies through cooperatively developed standards and improved methods for report dissemination;

G. High standards for the processing and distribution of technical reports;

H. Progressive improvements in documentation processing and services through continuing analysis of advanced techniques and equipment;

I. Coordination of techniques with both domestic and foreign documentation and information analysis centers."

DoD Instruction 5129.43, entitled "Assignment of Functions for the Defense Scientific and Technical Information Program," January 23, 1963, assigns to the Secretaries of the military departments and the heads of other DoD components the responsibility to ensure that DoD Information Centers and DTIC are provided with all pertinent material that results from RDT&E Programs, and it outlines responsibility for participation.

DoD Instruction No. 7720.13, April 16, 1968, provides details on the procedure for submitting Work Unit Information System (WUIS) reports, which are summaries of the ongoing research and technology efforts being accomplished by DoD components within the RDT&E program. It also assigns responsibility for the reporting and for the operation of an automated research and technology WUIS to manipulate such RDT&E data and information. The purpose of the program as given in this instruction is to increase the effectiveness of the R&D Program by making available brief descriptions of ongoing research and technology efforts to all DoD scientists, engineers and managers.

The information in the WUIS is developed at the working level and is stored in a form that will meet the needs of various

users by taking advantage of processing capabilities of modern computer technology. This would assist R&D managers in identifying research and technology work by scientific discipline or technology area, thereby permitting coordination with other DoD programs to eliminate undesirable overlap or effort and to help determine whether R&D policy guidance is reflected adequately in specific areas of endeavor. The system will also help the individual scientist or engineer at the bench level to observe the current status of technical efforts related to his own work, to identify individuals and organizations working in the same areas of interest so they can be contacted for further information and to maintain awareness of current status through periodic review of progress statements in pertinent work units. This instruction further provides that a DoD-wide data bank containing all work unit data will be established and maintained for OUSDRE by the Defense Documentation Center (now DTIC) of the Defense Logistics Agency. Data on work units that must be withheld from DTIC will be forwarded directly to the National Security Agency (NSA). This includes work units that are TOP SECRET, or those that deal with RDT&E in electronic intelligence, communications intelligence and communications security. The instruction requires that data on a work unit shall be submitted to DTIC or NSA within fifteen days after the local action which it reflects has occurred. Moreover, data shall be submitted at any time that significant progress or a noteworthy change has occurred in the approach, resources estimates or any other data element. Each work unit is to be reviewed, updated and resubmitted at least every year so that the data on file will be up-to-date.

DoD Instruction No. 5100.66, January 7, 1975, on "Establishment of Policy for, and Administration of Independent Research and Development Programs (IR&D)," sets up a requirement and procedures for the administration of contractor IR&D programs. To assist in coordinating contract and in-house R&D programs with IR&D, a computer-based IR&D data bank is established at DTIC

which contains information on each IR&D project. Only government personnel are given access to the IR&D data bank since much of the data is company-proprietary. All DoD R&D personnel involved in planning and initiating IR&D projects are encouraged to query the IR&D data bank to be aware of related efforts already underway. The IR&D data bank is a centralized body of information useful in identifying what IR&D is being pursued by whom and for identifying contacts in the performing organization for obtaining additional information. The data bank is not a real-time reporting system; it generally contains data only on those projects on which work has started. The content and format of the IR&D Data Bank are established by the IR&D Technical Evaluation Group, which represents the Office of the Deputy Under Secretary of Defense for Research and Engineering (Research and Advanced Technology) and each of the three Military Departments. The Defense Logistics Agency is charged with establishing, maintaining and operating the IR&D Data Bank.

Directive No. 5010.22, November 22, 1976, "The Management and Conduct of Studies and Analyses," expands on the earlier cited instructions with respect to input of related information to the WUIS data base.

2. Military Services Regulations and Directives

A number of the military services regulations implement the instructions of the above DoD Directives. Among them are Army Regulations AR 70-9 and AR 70-11. AR 70-9, August 22, 1973, updated October 15, 1973, "Army Research and Development Information System Planning and Ongoing Work Reporting," provides specific instructions for preparing and submitting to the Army Materiel Command R&D Planning Summary Data for R&D program planning review at the project and task area levels. It also provides instructions for preparation and submission of Research and Technology Work Unit Summary Data for ongoing R&D work at the unit level. In addition to various Army receivers of this information, the regulation requires that both OUSDRE and DTIC

be furnished copies of Army R&D reports. DTIC is to be furnished a complete copy of DD Form 1634, R&D Program Planning data file, in magnetic tape format. Work Unit Information Summaries are filed on a different form (DD 1498) with the same intention. AR 70-11, July 15, 1968, "Defense Documentation Center for Scientific and Technical Information (DDC)," provides an Army view of DTIC and its functions. This regulation quotes the objectives of DDC given in DoD Instruction No. 5100.38 (see above) and goes on to inform Army components how they must cooperate with and use DTIC. In paragraph 4 it states, "The Objectives of the Department of the Army components will be to cooperate with DDC to the maximum extent possible. The objective of DDC is to provide timely, effective and efficient bibliographic processing, announcements and secondary distribution of technical reports and documents up to the limits of its capacity and within the limits permitted by security and other recognized controlling statements."

The Navy and the Air Force also have issued similar directives with the purpose of providing RDT&E information to DTIC in standardized form (e.g., Refs. 18, 19, and 20).

3. Security Requirements

In addition to the directives that spell out what DTIC is supposed to do, there are the security requirements directives that establish the DoD requirements and policy for protecting classified information. Most explicit among these and applicable to DTIC's role is DoD Directive No. 5200.28, "Security Requirements for Automatic Data Processing (ADP) Systems." This directive orders that the protection of classified material in an ADP system shall be in accordance with that required in DoD Directive 5200.1, "DoD Information Security Program," and DoD Regulation 5200.1R, "Information Security Program Regulation." It states that: "Classified material contained in an ADP system shall be safeguarded by the continuous employment of protective features in the system's hardware and software design and configuration

and by other appropriate administrative, physical, personnel, and communications security controls."

The directive deals further with the problems of multi-level security and need-to-know. Controls are ordered for the operating system that can identify and separate users and classified materials on the basis of need-to-know. The security measures to accomplish this are to be contained within the ADP system's operating system and associated software. Moreover, such controls shall conform to those required for the highest classification and most restricted types of material being handled by the system.

The directive further requires a system operating in a "true" multi-level security mode, where there may be some users with access to the system who have neither a security clearance nor a need to know for the classified material then contained in the system.

The Directive further states (Dec. 18, 1972) that the goal of a true multi-level security mode is desired but considered to be unattainable with the desired confidence due to limitations in the available hardware and software. The Directive authorizes the concurrent processing and storage of more than one security classification category of material, together with unclassified material, provided the following minimum conditions are met:

"1. The Designated Approving Authority (subsection V.C.) has determined that the design and operation of the ADP system will, with reasonable dependability, provide the consistent and correct identification and segregation of (a) the different security classification categories; (b) certain additional restrictive types of classified material, where such concurrent processing is not limited or prohibited

by appropriate directives and (c) unclassified material;

2. Measures have been implemented to monitor the system for malfunctions and occurrences which may adversely affect the dependability of such identification and segregation;

3. Procedures have been instituted which, in the event of a system crash, malfunction or other occurrence adversely affecting the dependability of such identification and segregation, provide that all system output will be initially marked and handled as the highest classification and most restrictive type of material then in the system, pending a determination of actual classification [pursuant to Chapter II, DoD Regulation 5200.1-R, reference (f)] -- these procedures shall remain in effect until the occurrence cause is determined and corrected; and

4. All ADP system users have been advised that this option has been implemented, and they are instructed to return to the ADP System Security Officer (paragraph V.C.3) any system output that is incorrectly labeled as to classification or that was not requested by that user."

Temporary exceptions may be authorized by appropriate authority for specific security measures that might impair operation and mission effectiveness, although progress is to be made toward ultimate full compliance with the Directive at the earliest practicable time. With regard to peripheral devices or remote terminals not under the control of a component responsible for the overall operation and control of the ADP system, the

security measures for the device or terminal shall be prescribed by the authority responsible for the security of the overall ADP System and such measures shall be implemented before the user's device may be connected. Connection to a larger teleprocessing network such as WWMCCS requires the approval and concurrence of both the DoD component operating the ADP system and the DoD component having overall responsibility for the security of the network.

Transmission and communications lines and links that provide secure communications between components of or to an ADP system shall be secured in accordance with DoD Directive C-5200.5 and DoD Regulation 5200.1R.

4. Summary of Documentation

This seemingly never ending trail of regulations and instructions has the overall purpose of providing DTIC with its authority to acquire, store, retrieve, categorize, index and disseminate RDT&E information generated by all defense agencies and their contractors while conforming to national security requirements. It requires the individual services and their contractors to make available to DTIC on a regular basis, and in standard formats, all scientific and technical information that relates to future, current and past RDT&E projects. The clear intention is to avoid needless duplication and to enable scientists and technologists working in military technology and allied fields to build on what has been done rather than repeating or duplicating the work of others, as there is a tendency to do when the flow of information is curtailed. It also is intended to enable managers to monitor and control the flow of technical information in the DoD.

We also note that security requirements contribute nothing toward this end. Security only limits the number of individuals and organizations that can access and receive classified information, thereby (it is hoped) keeping sensitive information from the enemies of the United States.

F. CURRENT PROCESSING CONCEPTS*

DTIC currently uses two major methods for performing its mission of collecting, processing, announcing, retrieving, and providing scientific and technical information (STI) to scientists, engineers, laboratory technicians and management personnel. These are designated by the terms "Off-Line Services" and "On-Line Telecommunication Services." Since this IDA task deals only with the On-Line Services, we shall describe those in detail here, while recognizing the complementarity between the two kinds of services.

The on-line information at DTIC is contained in four major DoD data banks. The contents of each data bank include data up to the level of Secret. Inputs from the military services, and DTIC in-house services are organized by data base and updated and and maintained on a defined cyclic basis. Edit and audit checks are applied during the input and update processes to point out conflicts in the security/limitation control area and in all data elements. Data bank maintenance and the specific functions performed during the update process are controlled by the processing elements unique to that data bank.

1. Technical Report System

Technical Report document input processing by information specialists at DTIC and at selected remote terminal sites includes descriptive cataloging, subject categorization and subject indexing. The objective of this process is to bring scientific and technical information under control and simultaneously produce a computer record from the input data or processing.

R&D managers and researchers use the files to review research results on a specific scientific or technological concept, to identify the research a particular laboratory, installation or researcher has done or to locate a particular report. This

* Section F abstracted from DTIC Statement (Ref. 16).

data base contains both bibliographic data and arrative summaries of the reports. It is the largest data base in DTIC with 1.3 million records and it is updated biweekly.

Input data for the Technical Report (TR) System is in the form of the technical document itself and a summary containing descriptive elements and an abstract. The data elements and abstracts are entered in the system as machine-readable records via UNIVAC Uniscope CRT Terminals that are linked directly to the UNIVAC 1100/82 computer.

Data records are entered as new transactions, deletions or corrections under control of a DTIC-developed software package called the Remote Terminal Input System (RTIS).

2. Research and Development Program Planning Data Bank

This data bank contains planned R&D project and task level summaries. It is intended to provide technical backup for annual reviews and to help R&D managers produce reports on specific research areas. It provides both bibliographic information as well as narrative summaries of work in progress. This data bank receives 3500 new records each year and now contains a total of some 14,000 records. For this data bank, data is received on magnetic tape or is prepared in-house and digitized on UNISCOPE terminals via the Remote Terminal Input System (RTIS). In the latter case, the RTIS-formatted input data is moved from mass storage and input indirectly to the update process.

3. Work Unit Information System

The Work Unit Data Bank describes ongoing DoD Research and Technology efforts at the work unit level. It is intended for the use of R&D managers to identify ongoing R&D and to locate and avoid undesirable duplication of effort. This base also contains bibliographic information and narrative summaries and

is updated fairly frequently. It contains about 23,000 active records, receives 10,000 new records and about 100,000 record changes each year.

4. Independent Research and Development Data Bank

The Independent R&D Data Bank contains contractor's IR&D efforts shared with DoD. It is used to identify industrial research efforts in specific areas of technology and to determine progress. The information available includes bibliographic data as well as narrative summaries. In late 1979 the data base contained records on about 27,000 projects and was receiving new records at an annual rate of 7,000. Since this data base contains proprietary information, it cannot be accessed by any contractor.

G. RETRIEVAL

1. Output Media

Retrieval of technical information at DTIC is provided through various output media.

a. Bibliographic Service - For the past ten or more years, DTIC has been performing a bibliographic service for its users in response to questions asked about research and development activities. Each response requires a mix of man/machine effort and generally is accomplished in the following manner: A question concerning an R&D development effort is dispatched to an information specialist for analysis and review. This information specialist may contact the requester to obtain more specifics. In any event, the information specialist produces a search strategy that is used to obtain an answer to the requester's question. This search

strategy is developed on-line and when deemed satisfactory the search results are transferred with other search results to a series of ADP programs for producing off-line hard copy printouts, i.e., bibliographies. This entire process, exclusive of mail time, averages four to six days.

b. Current Awareness Service - DoD Information Analysis Centers and other DTIC subscribers receive the current awareness service, which provides semi-monthly bibliographies consisting of documents announced in Technical Accession Bulletins (TAB) in specific areas. These bibliographies are produced based on user-established subject interest profiles.

c. Scheduled Bibliographies - DTIC produces comprehensive, prepackaged bibliographies on subjects of high user interest. This type of bibliography is assigned an AD number and is announced and available on request by the user in the same manner as any other document.

d. Rapid Response Bibliographies - This service provides the user with an unreviewed computer search generally within 24 hours. The product consists of accession numbers only and is conveyed by telephone. To benefit from this service the user must have access to a file of the TR documents or TAB.

2. Document Request Processing

The Request Processing Subsystem is designed to accomplish the following: validate the eligibility of the requester to receive the given document; determine the source (reproduction or stock) from which the request will be filled based on inventory counts; make necessary inventory adjustments; generate shipping notices, labels, and receipts for classified documents; and prepare the necessary historical records for statistical accumulation.

3. Technical Report Distribution

Technical Reports are distributed to requesters as full-size paper reproduction or as microforms. The goal is to permit research managers and researchers to obtain DoD-wide technical reports from a single source. This service can also be provided to managers on a particular subject as the reports are received by DTIC. DTIC distributes one million copies of reports each year.

III. SOME DROLS STATISTICS

The characteristics of DROLS have changed over time. The number of terminals has been increasing over the last few years at an average rate of about twelve per year. There are nearly 3000 DTIC registered users, but the number of DROLS user sites is only a small proportion (about 120 or four percent) of the total possible population. We present here some data associated with DROLS users.

A. DROLS USERS, APRIL 1980

The following table, Exhibit III-1, shows the users of DROLS as distributed among the various Services and kinds of users. We have selected kinds of users more or less arbitrarily in four categories that are intended to represent users having different interests: (1) Schools and libraries. These are users whose function is essentially to teach or to provide library services, but not as part of a larger organization. Examples of these are the Service Academies and specialized schools, and the Army Library in the Pentagon. (2) IACs and Laboratories. These are specialized organizations in different areas of technology. The IACs, for example, analyze information in a particular field such as plastics, or infrared technology. The laboratories, such as the Ballistic Research Laboratory or the Naval Research Laboratory, do basic research and development in specialized fields. (3) Command. An operating command is responsible for the development or operation of major systems. Examples are the Naval Sea Systems Command and the Naval Material Command. (4) Developer. A developer is a contractor performing the prime contractor's role in developing a major new military system.

EXHIBIT III-1

DROLS USERS, APRIL 1980

	Army		Navy		Air Force		DoD		Govt.		Contr.		TOT	
	C	U	C	U	C	U	C	U	C	U	C	U	C	U
Schools & Library (S)	2	8	3	1	1	1	2	1	0	1	-	-	8	12
IACs & LABS (L)	11	7	10	3	10	2	5	1	1	1	5	5	42	19
Command (C)	4	6	5	0	1	0	-	-	-	-	-	-	10	6
Developer (D)	-	-	-	-	-	-	-	-	-	-	4	3	4	3
TOTALS	17	21	18	4	12	3	7	2	1	2	9	8	64	40

B. INTENSITY OF USE

Exhibit III-2 shows some overall data on how much use is made of DROLS. It shows that on a monthly basis, about 1/4 million responses are generated to requests. A peak day will sometimes generate as many as 14,000 responses and a peak hour perhaps 2200 responses. These figures are derived from DTIC data for the months of October, November and December 1979. DTIC also claims that 96 percent of all responses are delivered in less than 30 seconds after the request is input to the terminal. This of course is true when the system is up and running, but there may be malfunctions of the computer or peripheral equipment that could cause delays on the order of hours. While such happenings are reasonably infrequent, we believe that they are not represented in the response time data.

EXHIBIT III-2

DROLS RESPONSE DATA

Response per month	250,000
Peak Day Responses	14,000
Peak Hour Responses	2,200

C. CLASSIFIED AND UNCLASSIFIED USE OF DROLS

Exhibits III-3 and III-4 show the distribution of use according to intensity. It will be noted that 28 users each viewed less than 100 displays referencing classified reports in June 1980 while only one user viewed as many as 2300. The next chart, Exhibit III-4, shows the distribution of interrogations, both classified and unclassified, for a six-month period starting in October 1979. Almost half of all users placed only 500 or less interrogations during this period, while a much smaller proportion, only about 2 percent, made as many as 7500 uses. Also, on the average, the classified user used the system almost 50 percent more than the unclassified user.

Exhibit III-5 shows some additional statistics on the current DROLS. The peak day is shown to be variable from month to month; however, the peak hour tends to be in the late morning or early afternoon, which probably reflects the overlap of East Coast and West Coast working hours. It will be noted that December generated fewer overall responses as well as a lower peak day. This is probably due to the leave taken by employees during the holiday seasons.

Exhibit III-6 shows three months of user statistics, indicating the number of users who initiated particular volumes of searches. This table indicates that the users might be divided into four categories according to their intensity of use of the system. The lowest intensity of use, less than, say, 400 searches

was done by a relatively high proportion of users. From 400-1000 searches were done at a medium number of terminals; relatively large numbers of searches (1000-5000) were done at a large number of terminals; and finally, over 5000 searches per month were done by a small number of super-users.

EXHIBIT III-3

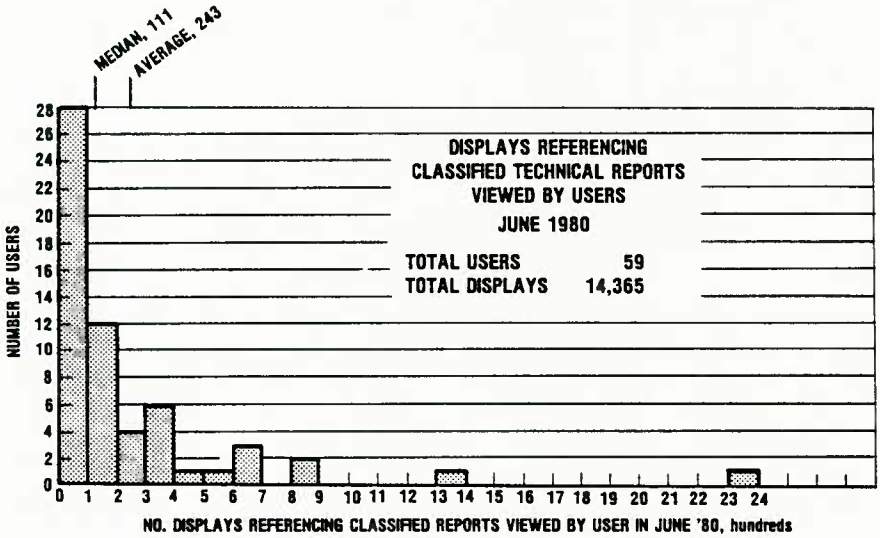

EXHIBIT III-4

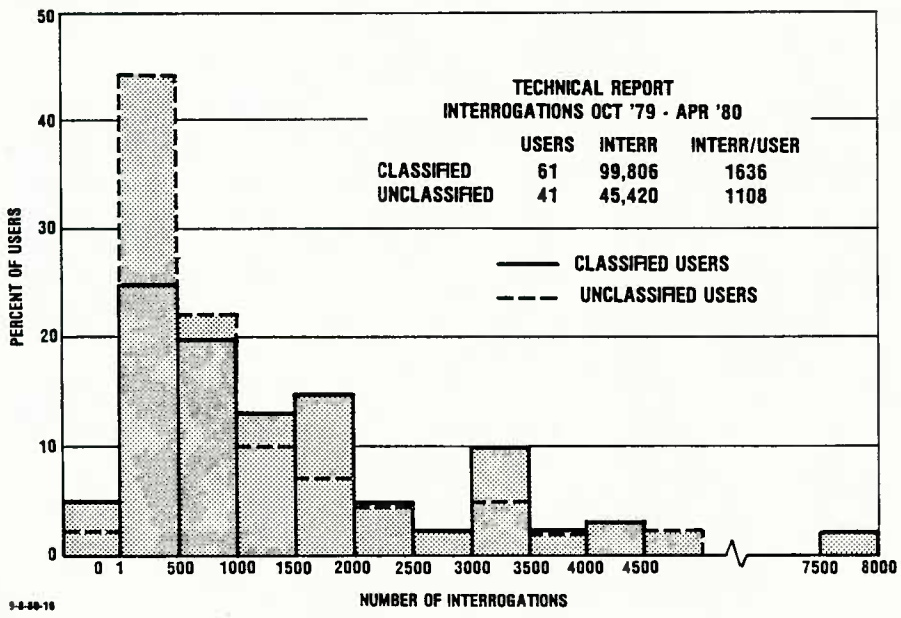

EXHIBIT III-5

SOME RECENT STATISTICS ON THE CURRENT SYSTEM

	OCTOBER	NOVEMBER	DECEMBER
Active Days in Month	22	21	20
No. of Users in Month	128	126	131
Responses in Month	261,711	273,751	201,667
Peak Day of Month	17	20	11
Peak Day Responses	14,333	14,926	13,494
Peak Hour	14:30	11:30	14:30
Peak Hour Responses*	34,143	31,489	27,137
Daily Avg. Peak Hour Responses	1,551	1,449	1,357
Peak Single Hour	2,217	2,172	2,193
Monthly Responses of Peak User	17,454	14,243	11,575
Peak Hour	10:30	10:30	11:30
Peak Hour Responses	2,852	2,086	2,084
Peak Outside User	DCSLA**	DCSLA	DCSLA
Uses in Month	11,161	8,068	6,473
Peak Hour Uses	1,997	1,236	958

*Cumulative Responses over the month for the given peak hour.

**This is the DTIC Terminal in the Los Angeles area that is available to properly cleared users. A similar arrangement exists in the Boston area and also at DTIC Headquarters in Alexandria, VA.

EXHIBIT III-6

NUMBERS OF USERS REQUIRING DIFFERENT
LEVELS OF SERVICE EACH MONTH (EXCLUDES IN-HOUSE TERMINALS)

	NO. OF USERS (TERMINALS)		
NUMBER OF SEARCHES	OCTOBER	NOVEMBER	DECEMBER
0-200	11	11	15
201-400	16	14	16
401-600	9	7	6
601-800	2	8	10
801-1000	8	7	6
1001-1500	11	12	17
1500-2500	21	15	18
2500-5000	13	18	11
5000+	5	2	1
TOTAL REMOTE TERMINALS (Excludes DTIC Terminals)	96	94	100

REFERENCES

1. DTIC Digest No. 81, Defense Technical Information Center, February 10, 1980.

2. Assignment for work to be performed by Institute for Defense Analyses. Task Order DTIC-1, Defense Logistics Agency, Defense Technical Information Center, December 10, 1979.

3. DoD Directive No. 5100.36, *Department of Defense Technical Information*, December 31, 1962.

4. DoD Instruction No. 5100.38, *Defense Documentation Center for Scientific and Technical Information (DDC)*, March 29, 1965.

5. DoD Instruction No. 5129.43, *Assignment of Functions for the Defense Scientific and Technical Information Program*, Harold Brown, DDR&E, January 22, 1963.

6. DoD Instruction No. 7720.13, *Research and Technology Work Unit Information System*, April 16, 1968.

7. DoD Instruction No. 5100.66, *Establishment of Policy for, and Administration of, Independent Research and Development Programs (IR&D)*, January 7, 1975.

8. DoD Directive No. 5010.22, *The Management and Conduct of Studies and Analyses*, November 22, 1976.

9. Army Regulation AR 70-9, *Army Research and Development Information System Planning and On-Going Work Reporting*, August 22, 1973.

10. Army Regulation No. AR 70-11, *Defense Documentation Center For Scientific and Technical Information (DDC)*, July 15, 1968.

11. DoD Regulation No. 5200.1, *Safeguarding Official Information in the Interests of the Defense of the United States*, Department of Defense, July 8, 1959.

12. DoD Regulation No. 5200.1R, *Information Security Program Regulation.* Department of Defense, November 1973.

13. DoD Regulation No. 5220.22M, *Industrial Security Manual for Safeguarding Classified Information.*

14. DoD Directive No. 5200.28, *Security Requirements for Automatic Data Processing (ADP) Systems,* December 18, 1972.

15. No number, No date, No title. Description of DTIC services. Provided by DTIC.

16. No number, No date, No title. Description of DTIC equipment and procedures (apparently from an RFP), provided by DTIC.

17. Various sets of data relating to on-line services, October through December 1979. Supplied by DTIC.

18. Air Force Regulation 80-44, *Defense Documentation Center for Scientific and Technical Information,* Department of the Air Force, August 6, 1969.

19. Air Force Regulation 80-45, *Distribution Statement on Technical Documents,* Department of the Air Force, March 26, 1971.

20. SECNAVINST 3900.24A, *Defense Documentation Center for Scientific and Technical Information,* Department of the Navy, August 4, 1965.

APPENDIX A

CURRENT FUNCTIONS OF THE DEFENSE TECHNICAL INFORMATION CENTER (DTIC)

V. J. Berinati

APPENDIX A

CURRENT FUNCTIONS OF THE DEFENSE TECHNICAL INFORMATION CENTER (DTIC)

I. GENERAL

The following discussion treats only those functions that are pertinent to the scope of the present study, most specifically, the elements of the Defense RDT&E On-Line System (DROLS).

II. TECHNICAL REPORT BIBLIOGRAPHIC SERVICE

DTIC is responsible for the acquisition, announcement, and secondary distribution of technical reports for the Department of Defense (DoD). Technical reports document results obtained from scientific and technical activities. The reports for which DTIC is responsible include all those prepared by a DoD activity, by contractors or grantees to a DoD activity, and by organizations from outside DoD (whether domestic or foreign) when they are pertinent to DoD Research, Development, Test and Evaluation (RDT&E) efforts, but they do not include Top Secret, cryptographic and communications security, communications and electronic intelligence, registered, administrative, or foreign (where dissemination is prohibited by the foreign government) documents.

Authorized recipients of DTIC services are "registered users;" these may be U.S. government agencies, contractors and grantees to the U.S. executive branch, DoD potential contractors, and internationally sponsored research centers; there are about 2800 registered users. The access of registered users to particular information may be limited by their security clearance or distribution limitations imposed by the DoD activity responsible for the technical report (a DoD activity may submit a technical report to DTIC and even request that it not be announced).

Each technical report submitted to DTIC by a DoD activity is accompanied by a Report Documentation Page, DD Form 1473 (see Exhibit A-1). From the information on the DD 1473 (and sometimes from the report itself), DTIC prepares an entry (= announcement; see Exhibit A-2) and issues biweekly a Technical Abstract Bulletin (TAB), a compilation of all of the entries for the period; the entries in the TAB are the primary product of DTIC and constitute most of the basis for the Technical Report (TR) data base in the Defense RDT&E On-Line System (DROLS). No classified or limited distribution (see next paragraph) information is published in the TAB.

In addition to classification restrictions, the technical report and/or its abstract may be limited in their distribution. The government office controlling the report specifies the limitation; distribution by DTIC without the approval of the controlling government office may be limited to U.S. government agencies only, DoD only, DoD and DoD contractors only, or no one. When a report is limited in any way its DTIC accession number has an "L" suffix. If an abstract is limited it is not published* in the entry in the TAB.

Biweekly and annually DTIC issues TAB Indexes which contain indexes by corporate author, subject, title, personal author, contract number, report number, and release authority. Each index permits one to locate the entry for a report where it appears in the biweekly TAB.

In response to requests by qualified organizations, DTIC provides microfiche or paper copies of reports.

Registered users can advise DTIC of the subjects of interest to them (by means of the Field/Group subjects noted in Exhibit A-2 and become subscribers to two DTIC services.

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*Nor are abstracts published in entries for any report which is furnished by the North Atlantic Treaty Organization or which carries the limitation Restricted Data or Formerly Restricted Data.

SECURITY CLASSIFICATION OF THIS PAGE *(When Data Entered)*

REPORT DOCUMENTATION PAGE		READ INSTRUCTIONS BEFORE COMPLETING FORM
1. REPORT NUMBER	2. GOVT ACCESSION NO.	3. RECIPIENT'S CATALOG NUMBER
4. TITLE *(and Subtitle)*		5. TYPE OF REPORT & PERIOD COVERED
		6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR*(s)*		8. CONTRACT OR GRANT NUMBER*(s)*
9. PERFORMING ORGANIZATION NAME AND ADDRESS		10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS
11. CONTROLLING OFFICE NAME AND ADDRESS		12. REPORT DATE
		13. NUMBER OF PAGES
14. MONITORING AGENCY NAME & ADDRESS*(if different from Controlling Office)*		15. SECURITY CLASS. *(of this report)*
		15a. DECLASSIFICATION/DOWNGRADING SCHEDULE
16. DISTRIBUTION STATEMENT *(of this Report)*		
17. DISTRIBUTION STATEMENT *(of the abstract entered in Block 20, if different from Report)*		
18. SUPPLEMENTARY NOTES		
19. KEY WORDS *(Continue on reverse side if necessary and identify by block number)*		
20. ABSTRACT *(Continue on reverse side if necessary and identify by block number)*		

DD FORM 1 JAN 73 1473 EDITION OF 1 NOV 65 IS OBSOLETE

SECURITY CLASSIFICATION OF THIS PAGE *(When Data Entered)*

EXHIBIT A-1. REPORT DOCUMENTATION PAGE, DD FORM 1473

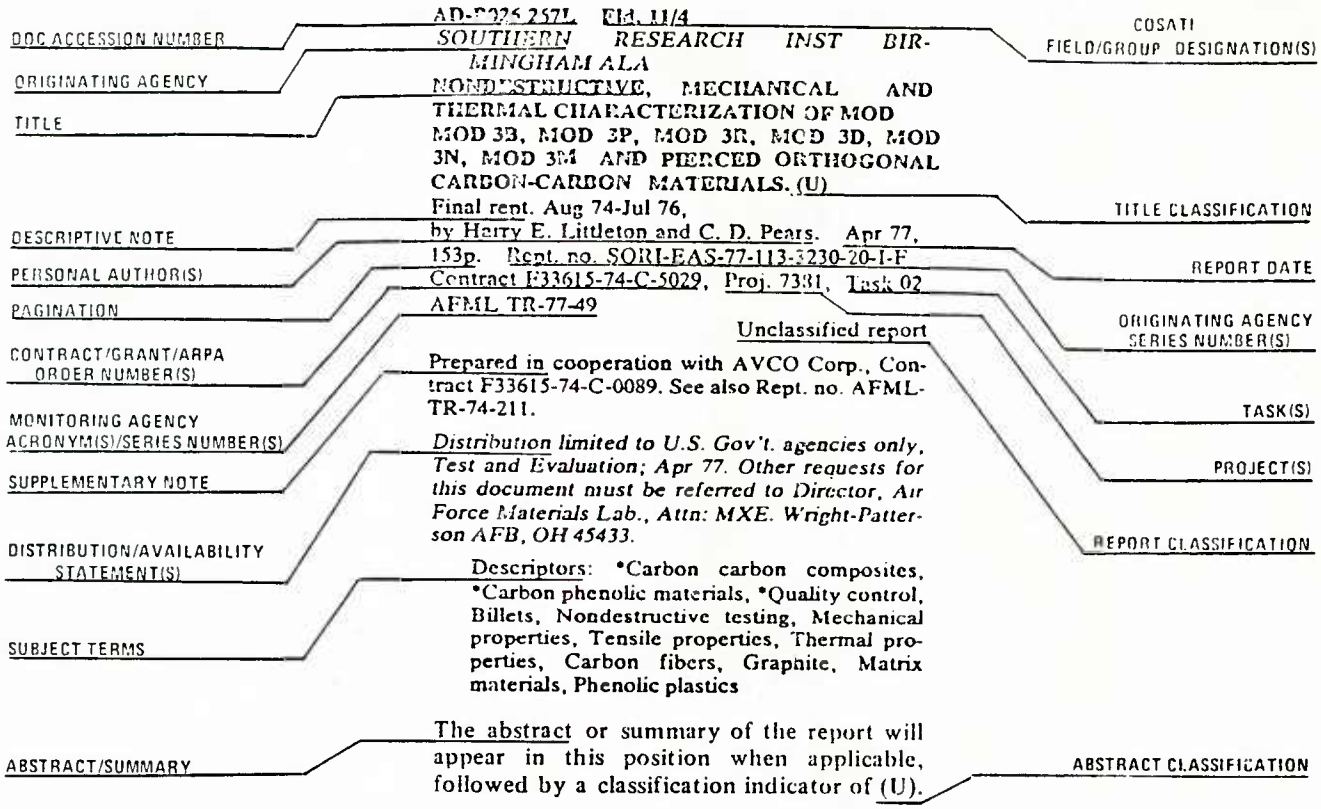

EXHIBIT A-2. SAMPLE TAB ENTRY

In the one service the subscriber receives a custom bibliography based on the current cycle (Current Awareness Bibliographies). In the other service, Automatic Document Distribution, the subscriber receives microfiche copies of the reports. "Demand" bibliographies are also provided as a one-time search.

DTIC provides reproducible masters of unclassified-unlimited reports to the National Technical Information Service (NTIS) which, in turn, makes an announcement of them and sells them to the public; these constitute over half of all the reports listed in the TAB.

III. DROLS

DTIC maintains four computer-stored data bases relating to Technical Reports (TR), Work Units (WU), Program Planning (PP),

and Independent Research and Development (IR). Except for IR, which is limited to DoD users, these data bases are made available to about 100 remote terminals at registered organizations throughout the United States. The IR data base is accessible only to DoD classified users and is not treated in any more detail in this paper. The WU, PP, and TR data bases are similar in that the record, the summary, is a description of a research and development effort underway (WU and IR) or planned (PP); a senior or larger document does not exist. The TR data base differs from these three in that the record, the entry, is a citation for a technical report.

The remote terminal user who knows the AD number of the record can view or print out the entry or summary, but this function is no better than the user could perform using the TAB for technical reports except that classified and limited portions of the record not printed in TAB, which is unclassified, are available on DROLS. The important capability of DROLS is the speed of retrieval in a literature search when the user seeks records of work performed in certain technical fields, in certain time periods, by certain authors, etc.

Users at Remote terminals may be qualified for access to classified (Confidential or Secret) information, for particular Fields/Groups (technical areas), for special access (e.g., critical nuclear weapons information), and for limited distribution. Safeguards are placed in the computer program to observe such restrictions.

A. TECHNICAL REPORT DATA BASE

The format of the entry for a TR is shown in Exhibit A-3; essentially it consists of the bibliographic information prepared for input to the TAB as described in Section II of this Appendix, plus fields devoted to administrative processes: security, availability, and distribution.

Several of the fields are of special interest to this study and warrant description:

EXHIBIT A-3. FIELDS IN AN ENTRY OF A TECHNICAL REPORT

Field Number[1]	Field Title	Inverted[2] File Search Role Code	Direct[3] File Qualify Field Code
1	AD Number, assigned by DTIC to identify technical report		
2	Field/Group, assigned by DTIC to identify subject material		
3	Security Classification of Entry		
4	NTIS Price		
5	Source Name; Corporate or Organization Author		
6	Unclassified Title of Technical Report	55,56	
7	Classified Title of Technical Report	55,56	
8	Security Classification of Title of Technical Report		
9	Descriptive Note (e.g., period covered, final, interim)		
10	Personal Author Names	11	11
11	Date of Technical Report	24	
12	Number of Pages in Technical Report		
14	Source Series (number of technical report assigned by source)	51	
15	Contract Number	16	
16	Project Number	21	
17	Task Number	20	
18	Acronym of Government Monitor	03	
19	Monitor Series	53	
20	Security Classification of Technical Report	58	
21	Supplementary Note (e.g., other volumes)		
22	Limitations (on distribution)		

EXHIBIT A-3 (Cont'd)

Field[1] Number		Inverted[2] File Search Role Code	Direct[3] File Qualify Field Code
23	Descriptors		
24	Security Classification of Descriptors		
25	Identifiers		
26	Security Classification of Identifiers		
27	Abstract		
28	Security Classification of Abstract		
29	Initial Inventory (of report in DTIC)		
30	Index Annotation (variations of title)		
31	Special Code (limitations in addition to Field 22)		
32	Reclassification Code		
33	Limitation Availability Code		
34	Serial Number (e.g., final, supplement)	52	
35	Source Code (from Source Header List, Ref. Table A-3)	02	
36	Document Location (e.g., DTIC, NTIS)		
37	Classification Authority		
38	Declassification Date		
39	Downgrading Date		
40	Geopolitical Code (state and congressional district of source)	30	
41	Type Code (from Source Header List)		41
42	Information Analysis Center Accession Number	04	
43	IAC Document Type		
44	MCIC Subject Terms[4]	48	

EXHIBIT A-3 (Cont'd)

Field[1] Number	Field Title	Inverted[2] File Search Role Code	Direct[3] File Qualify Field Code
44	NDTSC Subject Terms[4]	47	
44	PLASTEC Subject Terms[4]	46	
44	GAC Subject Terms[4]	44	

Notes:
(1) Field Number is also the searching "Sort Field Code" and "Display or Print Field Code;" see Section III-B of this Appendix.
(2) For searching; see Section III-B, this appendix.
(3) For qualifying; see Section III-C, this appendix.
(4) The acronyms represent the names of Information Analysis Centers. Each IAC utilizes different subject terms for searching.

Field 23, Descriptors

Based on information on the DD Form 1473 DTIC selects terms (or descriptors) describing the content of the technical report (e.g., guided missiles). These descriptors are selected in conjunction with a "machine-aided indexing" process from a computer resident thesaurus, the Natural Language Data Base (NLDB). A printed list of NLDB posting terms is the DTIC Retrieval and Indexing Terminology, known as the DRIT (Ref. A-1). From 1978 on, assigned descriptors are unclassified. Prior to 1978 some descriptors are unclassified and some may be classified. If classified descriptors exist, the entire Field 23 carries the classification and it is that of the report. Those descriptors that convey the main subject of the technical report are preceded by an asterisk and are referred to as weighted descriptors. It is the unclassified terms of this field which appear in the entry in the TAB (Ref. Exhibit A-2).

Field 25, Identifiers

These are additional terms for retrieving the content of the technical report. Until 1978, this field was used for unreviewed subject terms and specific names (e.g., Polaris, F-14 aircraft). It was reserved for terms not in DRIT. From 1978 on, any posting terms from DRIT that are considered classified in context appear in this field as well as any very narrow terms that are therefore not in the DRIT, such as a particular guided missile type (e.g., Polaris). If classified identifiers exist, the entire Field 25 carries the classification and it is that of the report.

Field 27, Abstract

DTIC sometimes changes the abstract from that on the DD Form 1473, most often by eliminating administrative information and shortening. If the abstract is poorly written, DTIC prepares a new abstract. If no abstract is provided, DTIC may provide one drawn from the table of contents, introduction or summary.

Four fields can be classified: 7 title, 23 Descriptors (pre-1978), 25 Identifiers, and 27 Abstract. If the descriptor or identifier field is classified, some of the terms within it may be unclassified and are so marked; Titles and Abstracts are classified totally at one level.

Only the abstract can have its distribution limited.

Fields 42, 43, and 44 are used in TR records submitted by Information Analysis Centers (IAC). Such centers, sponsored by the government, provide expertise in their specific technical fields. Five of the 19 DoD-sponsored IACs input bibliographic information on reports in their specialties. Because they maintain their own thesauri in greater detail, the subject terms are peculiar to each IAC. The reports cited by the IACs are generally not available via DTIC unless the citation is to an "AD" document normally accessioned by DTIC.

Originally, the portion of the DROLS TR data base containing their bibliographic records was entered via remote input directly from these IACs and was retrievable only by them. In 1980, these records were made retrievable for the other DROLS users.

Section IV of this appendix describes the retrieval techniques available to a user. The last two columns of Exhibit A-3 list role codes required for retrieval; they are included for reference.

B. WORKING UNIT DATA BASE

DoD members, contractors, or grantees perform scientific and technology efforts; the smallest segment into which such efforts are normally divided is the Work Unit. Summaries of these Work Units make up this data base; they are updated at least once a year.

The format for a summary of a WU is shown in Exhibits A-4 and A-5; the fields that describe the work are: 11, Title; 12, Scientific/Technological Areas; 22, Key words; 23, Technical

Objective; 23, Approach; 25, Progress; 37, Descriptors; and 28, Identifiers. The remainder of the information is administrative (budgeting, dates, security, etc.). Access to the WU data could be important to research personnel because comprehensive hard-copy files of the Summaries do not generally exist. The data base Summary is prepared by DTIC from DD Form 1498 (Exhibit A-4), submitted by the agency responsible for the research. DTIC prepares Field 37, Descriptors and 38, Identifiers.

Seven fields are classifiable, those mentioned above as describing the work other than Field 12, and the Summary itself can be classified even if all of the seven classifiable fields are unclassified.

There are two statements with respect to distribution. Field 8A1 permits distribution of the entire Summary to (1) DoD, (2) government, or (3) anyone. Field 8B permits or denies contractors' access (without specific approval) to Fields 1, Accession Number; 2, Date of Summary; 5, Security of Summary; 6, Security of Work; 7 (All), Regrading; 10 (All), Program Element, Project, Task Area, Work Unit Numbers; 11, Title; 12 (All), Scientific/Technological Areas; 17B, Contract/Grant Number; 19A,B, Responsible DoD Organization Name and Address; 20A,B, Performing Organization Name and Address; 20C,D, Principal Investigator; and 23, Technical Objective. Field 8B is considered to supersede the limitations of Field 8A1, i.e., even if Field 8A1 limited the distribution of the entire Summary to the government, a contractor would have access to the fields designated by Field 8B if Field 8B permitted it. DTIC releases those Summaries which are unclassified and not distribution-limited to the Smithsonian Science Information Exchange for release to any interested party.*

*Recently NTIS has assumed responsibility for reporting ongoing federally sponsored research.

EXHIBIT A-4.
RESEARCH AND TECHNOLOGY WORK UNIT SUMMARY, DD FORM 1498

RESEARCH AND TECHNOLOGY WORK UNIT SUMMARY

1. AGENCY ACCESSION*	2. DATE OF SUMMARY*	REPORT CONTROL SYMBOL

3. DATE PREV SUM'RY	4. KIND OF SUMMARY	5. SUMMARY SCTY*	6. WORK SECURITY*	7. REGRADING*	8a. DISS'N INSTR'N	8b. SPECIFIC DATA - CONTRACTOR ACCESS ☐ YES ☐ NO	9. LEVEL OF SUM A. WORK UNIT

10. NO. CODES.*	PROGRAM ELEMENT	PROJECT NUMBER	TASK AREA NUMBER	WORK UNIT NUMBER
a. PRIMARY				
b. CONTRIBUTING				
c. CONTRIBUTING				

11. TITLE *(Precede with Security Classification Code)**

12. SCIENTIFIC AND TECHNOLOGICAL AREAS*

13. START DATE	14. ESTIMATED COMPLETION DATE	15. FUNDING AGENCY	16. PERFORMANCE METHOD

17. CONTRACT GRANT
a. DATES/EFFECTIVE: EXPIRATION:
b. NUMBER:*
c. TYPE d. AMOUNT:
e. KIND OF AWARD:

18. RESOURCES ESTIMATE		a. PROFESSIONAL MAN YRS	b. FUNDS *(In thousands)*
FISCAL YEAR	PRECEDING		
	CURRENT		

19. RESPONSIBLE DOD ORGANIZATION
NAME:*
ADDRESS:*
RESPONSIBLE INDIVIDUAL
NAME:
TELEPHONE:

20. PERFORMING ORGANIZATION
NAME:*
ADDRESS:*
PRINCIPAL INVESTIGATOR *(Furnish SSAN if U.S. Academic Institution)*
NAME:*
TELEPHONE
SOCIAL SECURITY ACCOUNT NUMBER
ASSOCIATE INVESTIGATORS
NAME:
NAME:

21. GENERAL USE

22. KEYWORDS *(Precede EACH with Security Classification Code)*

23. TECHNICAL OBJECTIVE,* 24. APPROACH, 25. PROGRESS *(Furnish individual paragraphs identified by number. Precede text of each with Security Classification Code.)*

*Available to contractors upon originator's approval.

DD FORM 1498, MAR 68 PREVIOUS EDITION OF THIS FORM IS OBSOLETE.

EXHIBIT A-5. FIELDS IN A SUMMARY OF A WORK UNIT OR PROGRAM PLANNING

Field**		
Work Unit	Program Planning	Field Title
† 1	B	Accession Number
	C	DTIC-Assigned Transaction Code
	1	Contributor-Assigned Accession Number
† 2	2	Date of Summary
3	3A	Date of Previous Summary
4	3	Kind of Summary
	4	Level of Summary
† 5	5	Security of Summary
† 6	7	Security of Work
† 7	6	Regrading
† 7A	6A	Classification Authority
† 7B1	6B1	Date of Declassification
† 7B2	6B2	Declassification Event
† 7C1	6C1	Downgrading Date
† 7C2	6C2	Downgrading Event
† 7D	6D	Multiple Exempt Category Codes
8A1		Distribution Limitations
8A2		Additional Security Restriction
8B		Contractor Access
† 10A1	8A1	Primary Program Element Number
† 10A2	8A2	Primary Project Number
† 10A2A		Army Primary Project (Agency and Program)
† 10A2B	31(I)	Army Primary Project (Project Serial Number)
† 10A3	8A3	Primary Task Area Number

Note: * Classifiable fields.

** The field numbers are the Display/Print Fields (where available) unless followed by (S) or (I) in which case they are Sort or Inverted File Fields, respectively.

† Contractor may be denied access by Field 8B.

EXHIBIT A-5 (Cont'd)

Field		
Work Unit	Program Planning	Field Title
	8A4	Subelement Number
† 10A4		Primary Work Unit Area
† 10A5		Primary Monitor Division Code (Army)
† 10A6		Primary Installation Code (Army)
† 10B1		First Contributor Program Element Number
† 10B2		First Contributor Project Number
† 10B3		First Contributor Task Number
† 10C1		Second Contributor PE
† 10C2		Second Contributor Project Number
† 10C3		Second Contributor Task Number
† 10D1	8B1	Prior Program Element Number
	8B2	Former Project Number
	8B3	Former Task Area Number
	8B4	Former Subelement Number
† 10D2A		Army Prior Project (Agency and Program)
† 10D2B		Army Prior Project (Project Serial Number)
† 10D3		Army Prior Task Number
† 10D4		Army Prior Work Unit
*† 11	*9	Title
† 11A		Title Security
† 12A	16A	Scientific/Technological Area, Code I
† 12B	16B	Scientific/Technological Area, Code II
† 12C	16C	Scientific/Technological Area, Code III
13	11	Start Date
14	12	Estimated Completion Date
15A		Primary Funding Agency
15B		Other Funding Agency
15C		Other Funding Agency
16		Performance Method
17A1		Contract/Grant Effective Date

EXHIBIT A-5 (Cont'd)

Field		
Work Unit	Program Planning	Field Title
17A2		Contract/Grant Effective Date (Range)
† 17B		Contract/Grant Number
17C		Contract/Grant Type
17D1		Contract/Grant Partial Code
17D2		Contract/Grant Amount
17E		Contract/Grant Kind
17F		Contract/Grant Cumulative Dollars
	13A1	Current Fiscal Year
18A(S)		Man-years, CFY
18A1(S)		Man-years, CFY-1
18A2(S)		Man-years, CFY-2
18A3(S)		Man-years, CFY-3
18A4(S)		Man-years, CFY-4
	13A3	CFY Percent Contract
18B(S)	13A4	Funds, CFY
18B1(S)		Funds, CFY-1
18B2(S)		Funds, CFY-2
18B3(S)		Funds, CFY-3
18B4(S)		Funds, CFY-4
	13B1	Budget Fiscal Year
	13BA	Supersede Record Code
	13B3	BFY Percent Contract
	13B4	BFY Funds, Dollars
	13C1	Budget Fiscal Year + 1
	13C3	BFY + 1 Percent Contract
	13C4	BFY + 1 Funds, Dollars
	14	Participation
† 19A	10A1	Responsible DoD Organization Name
† 19B	10B1	Responsible DoD Organization Address

EXHIBIT A-5 (Cont'd)

	Work Unit	Program Planning	Field Description
		10A2	Responsible DoD Organization Name (Level 2)
		10B2	Responsible DoD Organization Address (Level 2)
	19C	10C1	Responsible Individual
	19D	10C3	Responsible Individual Phone Number
	19E		Responsible State or Country Code
	19F	10C2	Responsible Individual Title
	19S	K	DoD Responsible Organization Sort Code
		H	Responsible DoD Organization Type Code
	19T	G	DoD Responsible Individual Source Code
	19U	J	Responsible State and Congressional Code
†	20A		Performing Organization Name
†	20B		Performing Organization Address
†	20C		Principal Investigator
†	20D		Principal Investigator Name
	20F		Associate Investigator (First)
	20G		Associate Investigator (Second)
	20H		Principal Investigator Title
	20L		Performing State or Country Code
	20N		Performing Organization Type Code
	20S		Performing Organization Sort Code
	20T		Performing Organization Source Code
	20U		Performing State and Congressional Code
	21A		Studies and Analysis Category
	21B		R&T/S&A Relation
	21D		Foreign Area Research Study Category
	21E		Military /Civilian Application
*	22		Keywords
		*L	Index Terms
* †	23	*17	Technical Objective
*	24	*17	Approach

EXHIBIT A-5 (Cont'd

	Work Unit	Program Planning	Field Description
		*18	Plans
*	25	*19	Progress
	30		Navy Primary Subelement Number
	31		Army Responsible Organization Installation Digraph
	31A		Army Responsible Organization Installation First Digraph
	31B		Army Responsible Organization Installation Second Digraph
	31C		Army Responsible Organization Installation Third Digraph
	32A		Navy Responsible Individual Organization Symbol
	32B		Navy Principal Investigator's Organization Symbol
*	37		Descriptors (Posting Terms)
*	38		Identifiers
	39	F	Processing Date
	40		Army Performing Organization Identification (Source) Code
	41		Army Performing Organization Location Code
	42		Army Performing Organization Type Code
	43		Cumulative Partial Contract/Grant (Army) Code
	44		Army Foreign Intelligence Considered
	45		Army Coded Mission Objective
	46		Army Narrative Mission Objective
		15	Mission
	47		Army Responsible Organization Location
	48		Army Responsible Organization (Source) Identification Code
		20	General Operational Requirements Code

C. PROGRAM PLANNING DATA BASE

DoD members, contractors or grantees perform research and development efforts; each effort may be categorized (from smallest component up) by its work unit, task area, project, and program element numbers. Planning is normally performed in DoD in the context of the Five-Year Defense Program (FYDP). Summaries of each effort in the FYDP at the project level for Research, and at the project and task area level for Exploratory Development, Advanced Development, Engineering Development and Operational System Development make up this data base; they are updated at least twice a year. The efforts described most often continue for several years and, since any effort in the FYDP must be reported and the FYDP concerns future years, the Summaries may concern the conclusion of past efforts or the initiation of efforts planned for as long as five years in the future.

The format for a Summary of a PP is shown in Exhibit A-6; the fields that describe the work are: 9, Title; L, Index Terms; 16, Scientific/Technological Areas; 17, Technical Objective and Approach; 18, Plans; and 19, Progress. The remainder of the information is administrative (budgeting, dates, security, etc.). While the PP is essentially a budgeting document, access to the PP data base could be important to research or developmental personnel because comprehensive hard-copy files of the Summaries do not generally exist. The data base Summary is prepared by DTIC from DD Form 1634 (Exhibit A-6), submitted by DoD research and development program managers. DTIC prepares Field L, Index Terms.

Five fields are classifiable, those mentioned above as describing the work (other than Field 16), and the Summary itself can be classified even if all of the five classifiable fields are unclassified. Access to each summary is based upon the user's need-to-know as indicated by the user's approved Field/Group.

EXHIBIT A-6.
RESEARCH AND DEVELOPMENT PLANNING SUMMARY, DD FORM 1634

RESEARCH AND DEVELOPMENT PLANNING SUMMARY		1. AGENCY ACCESSION	2. DATE OF SUMMARY	REPORT CONTROL SYMBOL
3. KIND OF SUMMARY	4. LEVEL OF SUMMARY	5. SUMMARY SECURITY	6. REGRADING GROUP	7. WORK SECURITY
8a. PROGRAM ELEMENT/PROJECT/TASK AREA NUMBER		8b. FORMER PROGRAM ELEMENT/PROJECT/TASK AREA NUMBER		
9. TITLE *(Precede with Security Classification Code)*				
10. RESPONSIBLE DOD ORGANIZATION NAME ADDRESS RESP. IND. TELEPHONE NO.		11. START DATE	12. COMPLETION DATE	
		13. RESOURCES ESTIMATE	a. RDT & E FUNDS *(Thousands)*	b. % OF FUNDS ON CONTRACT/ GRANT PROGRAMS
		CURRENT FY		
		BUDGET FY		
		BUDGET +1		
14. PARTICIPATION			15. MISSION OBJECTIVE	
16. SCIENTIFIC/TECHNICAL AREA				
17. THROUGH 19.				

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III. RETRIEVAL FROM THE DROLS TECHNICAL REPORT DATA BASE

A. GENERAL

While a terminal user may know the AD number of a technical report and thus immediately call for the display of any of the fields, the most powerful application of DROLS is in seeking the complete record on a report of which little is known initially, perhaps just an author's name, the year of publication, or the subject. In such complex retrieval the user may resort to the sequential application of several techniques: searching, qualifying, listing, sorting, and displaying. Classified terminals have a cathode ray tube (CRT) for rapid display; unclassified users may have a CRT or teletypewriter terminals. Any information displayed on a CRT can also be printed.

Exhibit A-7 is a guide to the retrieval procedures described below.

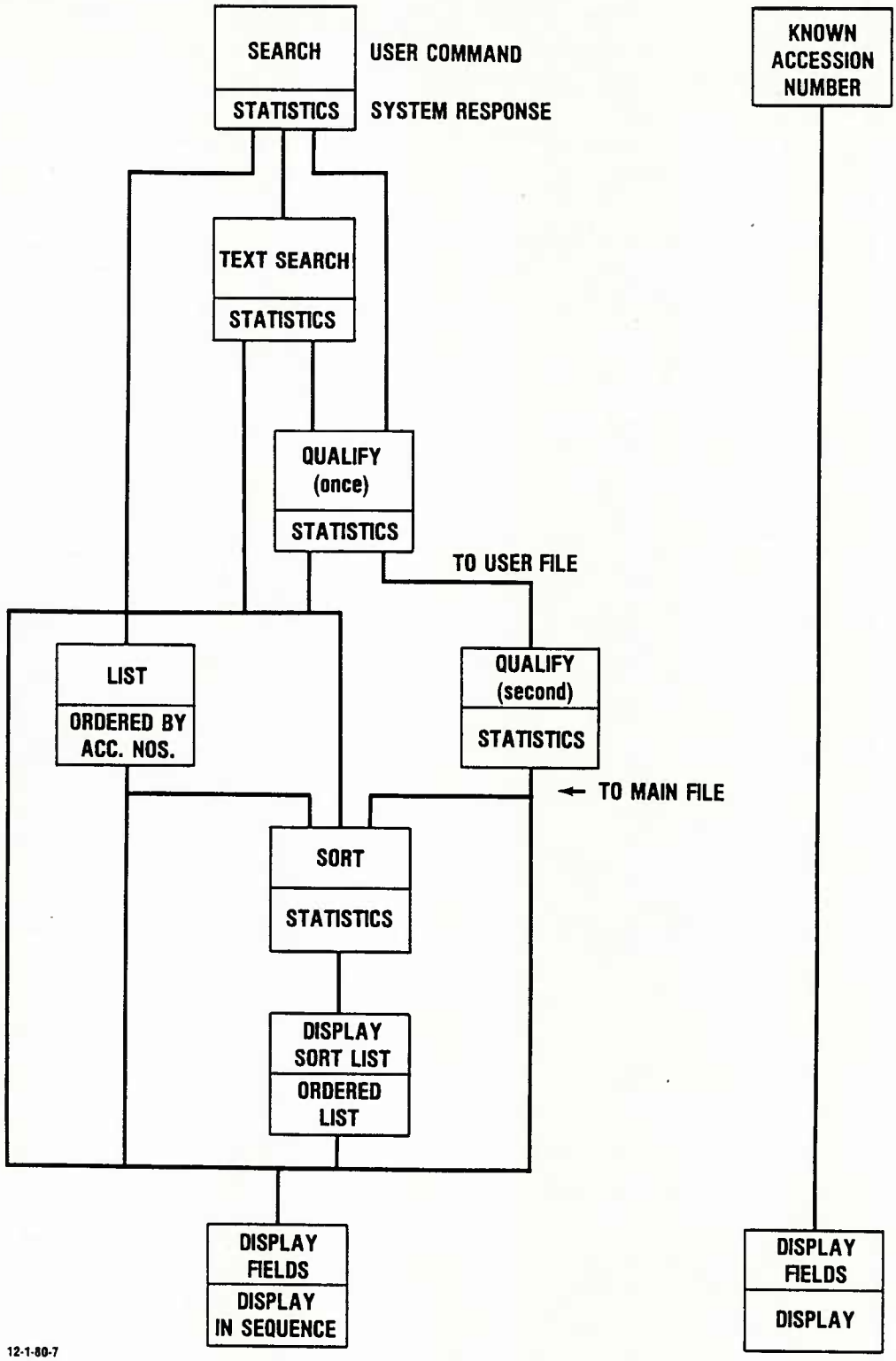

EXHIBIT A-7. DROLS Retrieval from the Technical Report Data Base

B. SEARCHING

DTIC has created Inverted Files for certain fields; an Inverted File is an index to the AD numbers of a technical report using a lead-in term characteristic of the technical report. For example, all technical report AD numbers would be listed under the lead-in "cruise missiles" if each of the technical reports treated cruise missiles and the term appeared among the descriptors or identifiers. When a DROLS remote terminal searches, the search is performed through an Inverted File. Inverted Files exist for Field 23 Descriptors, Field 25 Identifiers, and the 19 fields listed in Exhibit A-8.

Hierarchies have been constructed for two of the fields: 23, Descriptors, and 35, Source Code. Knowing the established hierarchy in the field, a user can indicate that the hierarchical mode is desired (the symbol is $) and the search would be performed on the term indicated and all narrower (junior) terms. Examples of the hierarchies are shown in Exhibits A-9 and A-10. In a subject search using the hierarchical option if one entered "guided missile components," DROLS would report finds for any report carrying a descriptor "guided missile antennas, batteries, computer, etc.," as shown in Exhibit A-9.

EXHIBIT A-8. TECHNICAL REPORT FIELDS
SEARCHABLE BY ROLE CODE

Role Code	Field Number	Field Title
55,56	6	Unclassified Title of Technical Report
55,56	7	Classified Title of Technical Report
11	10	Personal Author Names
24	11	Date of Technical Report
51	14	Source Series (Number of Technical Report)
16	15	Contract Number
21	16	Project Number
20	17	Task Number
03	18	Monitor Acronym
53	19	Monitor Series
58	20	Security Classification of Technical Report
52	34	Serial Number
02	35	Source Code
30	40	Geopolitical Code
04	42	IAC Accession Number
48	44	MCIC Subject Terms
47	44	NTDSC Subject Terms
46	44	PLASTEC Subject Terms
44	44	GAC Subject Terms

Note: In searching by Role Code there is limited searching that can be done. In Fields 6, 7, 14, 19, 34, and 42 only a single statement pertaining to a particular report can be entered by the user. In Fields 10, 11, 15, 16, 17, 18, 35, and 40 more searching can be performed, sometimes by masking. Field 44 provides good search capability due to the fine detail of the terms. By using combinations, searching can be enhanced.

EXHIBIT A-9. EXAMPLE OF POSTING TERM HIERARCHY

GUIDED MISSILES
- (1)AIR-AIR-MISSILES
- (1)AIR-TO-SURFACE MISSILES
- (1)AIR-TO-UNDERWATER MISSILES
- (1)ANTIAIRCRAFT MISSILES
- (1)ANTIRADIATION MISSILES
- (1)ANTISHIP MISSILES
- (1)CRUISE MISSILES
- (1)FLEET BALLISTIC MISSILES
- (1)GUIDED MISSILE COMPONENTS
  - (2)GUIDED MISSILE ANTENNAS
  - (2)GUIDED MISSILE BATTERIES
  - (2)GUIDED MISSILE COMPUTERS
  - (2)GUIDED MISSILE DOMES
  - (2)GUIDED MISSILE FUZES
  - (2)GUIDED MISSILE WARHEADS
  - (2)GUIDED MISSILE WINDOWS
  - (2)NOSE CONES
- (1)RECONNAISSANCE MISSILES
- (1)SURFACE-TO-AIR MISSILES
- (1)SURFACE-TO-SURFACE MISSILES
- (1)UNDERWATER-TO-SURFACE MISSILES

Source: Ref. A-1

EXHIBIT A-10. EXAMPLE OF SOURCE HIERARCHY

ORGANIZATION	SOURCE CODE
Aerospace Corp., El Segundo, CA	009500
·Aerospace Corp., El Segundo, CA Administration Div.	407479
·Aerospace Corp., El Segundo, CA Advanced Programs Div.	410271
·Aerospace Corp., El Segundo, CA Concepts and Plans Group Directorate	409924
·Aerospace Corp., El Segundo, CA Development Operations	409981
··Aerospace Corp., El Segundo, CA Reentry Systems Div.	409055
··Aerospace Corp., El Segundo, CA Technology Operations	403965
·Aerospace Corp., El Segundo, CA Development Planning Div.	408131
·Aerospace Corp., El Segundo, CA El Segundo Technical Operations	400156
··Aerospace Corp., El Segundo, CA Applied Mechanics Div.	403509
··Aerospace Corp., El Segundo, CA Space Systems Div.	400752

Source: Ref. A-2

A second special option is "masking". The term stated by the user is considered to be the beginning of any possible term in the field. For example, if one were searching personal authors (personal authors' names are listed in a manner such as: BROWN RF) but did not know the initials or whether there was a coauthor, the searcher could mask (using the symbol %) and insert BROWN. The search would be performed for all authors of surname Brown.

A search may be performed on the subject or the term role and may be limited by the accession number (Field 1, AD Number, of Exhibit A-3). These techniques are defined below.

1. Subject. The user inserts terms denoting the subjects of interest, which terms may be obtained from the DRIT or from another list provided by DTIC, the Frequency Count (containing all terms ever used as descriptors or identifiers); DROLS will search the Inverted Files in Fields 23, Descriptors and 25, Identifiers. If the subject term has been obtained from the DRIT and if there are narrower terms under it, the user may invoke the hierarchical mode. Masking is available on any term inserted. In addition, if the subject term is from the DRIT it may be entered as a Weighted Descriptor (the preceding symbol is *) and only technical reports will be identified which have that Weighted Descriptor as a main theme.
2. Term Role. The user may search any field of Exhibit A-8 by inserting the role code (preceded by ?). The hierarchical technique is available on 35, Source Code. In searching Field 6, Unclassified Title or 7, Classified Title, the user must know the exact title. In either case, a key of 12 characters is created from the title to search an Inverted File; under Role Code 55 the user creates the key; under Role Code 56 the system creates

the key from the inputted title. Masking is available on any of the fields of Exhibit A-8 except under Role Code 55 and 56.

3. Accession Number. The user may limit the search to a span, or spans, of technical report accession numbers (Field 1 in Exhibit A-3; the field number is not specified, i.e., this is not a term role).
4. Combinations. A subject search is refined by the Boolean operator AND to combine terms, e.g., to find reports on fighter aircraft engines the search terms would read: fighter aircraft and engines. Fighter aircraft is the first level. If, say, 5000 such records were found, the computer then searches those 5000 records for engines and finds, say, 300.
5. Response. The DROLS response to the user is a display of statistics, the number of finds at each level of search. The search levels are the original user search instructions in order 1, 2, 3, etc. In the example in Paragraph B.4 above, the first level would be 5000, the second 300, and the third the span of AD numbers. The Statistics indicates the number of finds at the first level, levels 1 and 2 (thus a smaller number than level 1 above), levels 1, 2, and 3 and levels 1, 2, 3, and 4.

C. TEXT SEARCHING

Following a Search, the user may wish to examine 6, Unclassified Title; 7, Classified Title, and/or 27, Abstract for some term; this is called Text Searching. The system response is similar to that of a Search in that the number of reports passing the new criteria is reported.

D. QUALIFYING

Following a Search or Text Searching, the user may wish to either restrict the inquiry by specifying additional limitations not available in the Search mode; this is called Qualification. In Qualification, DROLS scans the Direct File (not the Inverted File scanned in the Search mode), i.e., it scans the particular entries.

For technical reports qualification, only one of two fields can be queried, from Exhibit A-3:

QUALIFY CODE	FIELD NUMBER	FIELD TITLE
11	11	Date of Technical Report
41	41	Type Code (a code letter or number assigned by DTIC to each type of contributing organization, e.g., academic, industrial, particular government agency)

Operating on the finds from the Search the user may, for example, limit the dates of the technical reports sought to some span of dates (Qualifying Code 11). The System response is similar to that of a Search in that the number of now report-date-limited finds is reported.

If both Qualifications are desired the file may be moved into the User File after the first Qualification, and the second Qualification performed.

E. LISTING

Following either a Search, Text Searching or a Qualification the user may request that the AD numbers be listed for all finds. The system response is a listing of AD numbers in descending sequential order.

F. SORTING

Following a Search, Text Searching, Qualification, or Listing the user may request that information on the entries found be arranged in a specific order and displayed (requires a separate Display command). Up to three of the fields of Exhibit A-3 may be relisted for sorting. For example, if Fields 10, Personal Author Name and 14, Source Series (Number of Technical Report) had been identified for sorting, then there would be displayed an author's name followed by (in order) report numbers by the author, then alphabetically the next author's name and his reports, etc.

G. DISPLAYING

Usually the ultimate goal of the user is to acquire some detailed information from the entries of certain technical reports so as to better decide which reports are of interest. Following Search, Qualification, Listing, or Sorting the user can request a Display of fields he selects from the entries of the technical reports which interest him. Had the user known the AD number of a technical report of interest (without using DROLS to acquire the number) he could also request a similar display for a single technical report. To better understand the content of a technical report the user would probably request for display Fields 7, Title; 23, Descriptors; 25, Identifiers; and/or 27, Abstract.

REFERENCES FOR APPENDIX A

A-1. Defense Documentation Center, DDC 4185.7, AD-A068-500, "DDC Retrieval and Indexing Terminology," May 1979.

A-2. Defense Technical Information Center, DTIC/TR-80/2-Vol. 1, AD-A080-900, "Source Hierarchy List, Volume I, A through H," January, 1980.

APPENDIX B

CURRENT ON-LINE SYSTEM HARDWARE AND SOFTWARE

APPENDIX B
CURRENT ON-LINE SYSTEM HARDWARE AND SOFTWARE

A. GENERAL

The following description of the DTIC on-line facilities has been provided by DTIC. Much of the text that follows is taken verbatim from a DTIC publication (Ref. B-1) with minor editorial changes made for the purposes of this paper. DTIC is continuously changing and upgrading its system and several things were changed during the course of this project. Hence, this description is likely to be obsolete. However, before describing the equipment at DTIC it is important to describe the peripheral environment since it affects many requirements on DTIC.

B. PERIPHERAL ENVIRONMENT

There exists an unclassified technical data base that may be accessed readily by anyone with a suitable terminal, regardless of security clearance. This base is shared with the National Technical Information Service (NTIS). Although DTIC provides unclassified and unlimited services to its users, copies of all unclassified technical reports that have no restrictions on their use, and the related bibliographic data, are submitted by DTIC to NTIS, which is then responsible for their dissemination to the general public. NTIS leases the bibliographic tapes of this information to one or more of the commercial data bases. However, NTIS is prohibited from having information that is classified or controlled in any way. DTIC is responsible for storing and distributing such controlled information only to those users who have established appropriate clearances and need-to-know, in advance, for the information they are requesting. Such

clearances are established by a designated clearing agency and by the contracting agency according to the fields of interest of the requester.

It is conceivable that an individual having acquired the correct password and identification code could gain access to a classified terminal and connect up the the DTIC computer. Hence, it is essential that any terminals which are cleared for classified information must have physical security controls plus personnel security associated with the possible users. This means that the security of the entire system is dependent on the maintenance of remote site security practices which are outside of the purview of DTIC, except that a site is certified as properly classified by the contracting officer and security officers responsible for the contractor's facility. Once DTIC has such certification in hand it can then provide an access code to the terminal in that facility. In addition, since communications lines are not considered secure, all material sent to a classified terminal is encrypted at DTIC. Due to the need for decrypting, it is necessary for the user to have at least one individual cleared for this purpose, since the encrypting code is changed frequently. Now it can be seen how the security of the DTIC system depends on the security of the peripheral environment.

Unclassified user's terminals can also access the DTIC system, but cannot receive any classified data on-line. Even unclassified information, while it does not have to be encoded, may have some restriction on it so that it cannot be sent out freely to any requester. Hence, the DTIC system must ensure that it is sending information out only to appropriate receivers. This problem is handled in the following way. The DTIC system is set up so that a user at an unclassified terminal can access only the unclassified data base. If such a user wants classified information, he must get to a classified terminal or request

it by mail. The right to receive such information by mail is checked by human intervention.

In support of these off-line services, DTIC has several kinds of facilities on its premises at Cameron Station in Alexandria, VA. These facilities include a print shop which prints hard copies of reports on order. Also, there are facilities for producing microfiche copies. In addition, there are cataloguing, indexing and other general library services available.

C. ON-LINE SYSTEM

The Defense RDT&E On-Line System provides the capability for directly querying DTIC's store of TR data and R&D Management data. Circuits between DTIC and classified remote terminals are secured through the use of Telecommunications Security (TSEC) equipment to protect transmission of classified material. Various peripheral printers available to each terminal site provide a limited capability for producing hardcopy output.

The present hardware configuration includes UNIVAC Communications Terminal Module Controllers. Two hundred and fifty-six communications access posts are projected. This could accommodate a mix of up to 600 dedicated and dial-in terminals.

The On-line System software is a complex set of interfaces between data banks, terminal sites, applications programs, etc. Appendix C provides a detailed description of the On-Line System.

D. COMMUNICATIONS SUBSYSTEM

The Communications Subsystem performs the function of providing a flow of data to and from the central processor and the remote terminal devices of the system. A brief description of each major element in the Communications Subsystem follows:

1. The CTMC is a multiplexor subsystem interfaced to the central processor (1100/82) on an External Specified Index (ESI) I/O Channel. The CTMC controls from 1 to 16 Communications Terminal Modules (CTM), each housing four Communications Line Terminals (CLT).

2. The CLT is the actual interface to a remote terminal through MODEMs and a communications line. Transmission lines are placed within the CTMC of each remote terminal device. Because of both an input and output requirement for each remote terminal, two CLTs are required per remote terminal, limiting the maximum number of remote terminals to 32 per CTMC. The CLT formats data and presents service requests to the CTMC which, in turn, scans all the CLTs and selects and locks into the highest priority CLT requesting service.

3. The CLT connected to the CTMC has a unique identification number. This identification is placed on the input data lines for either input or output; if input, the data accompanies the identification.

E. COMMUNICATION CIRCUIT

A remote terminal device is connected to a MODEM, which is connected to a communication line or network that terminates in a second MODEM at the central site. The central site MODEM is connected to the CTMC, which routes the communication data to and from the central processor.

F. UNISCOPE 200 and 100

The UNISCOPE 200 and its predecessor, the U100, visual communications terminals are two-way remote terminal devices which make possible time-shared direct data communications with the central processor. Each UNISCOPE terminal is keyboard operated and has a Cathode Ray Tube (CRT) for message display, the CRT

displays the processor output message and allows input messages to be composed and edited before they are transmitted to the processor.

The operator is required only to compose the message on the display and initiate transmission to the processor. The UNISCOPE terminal automatically decodes characters and functions in all messages to the processor.

The exchanges and control of traffic within the system are controlled entirely by the processor. Exchange of data between the processor and remote terminals is accomplished by a system of interrogation and reply (polling). The processor sends a Poll Message (request for information) to a remote terminal and the terminal, in turn, replies with either a Query or No Traffic Message.

G. SYSTEM GENERATION

At system generation time, each channel is completely defined. For communications devices, this includes specifying the subsystem type and type of line terminal device connected to each remote line (bits per character, speed, fixed or common carrier, etc.). At that time, various devices connected to a single line are given a Line Terminal (LT) identity. This identity is used in assigning communications devices.

H. DATA BANKS

The data fields that comprise the various data banks, varying from fixed one-character codes to variable, free-flow text data fields are contained in the data banks. File sizes of the various data banks vary from several hundred to almost a million unique records.

The data bank consists of two distinct files. The Data File (Direct File) is the Master File and contains all the information pertinent to each reportable work document (work

unit record, technical report, etc.). To facilitate retrieval of these documents, certain entries from each document (search terms) are extracted, collected and sorted into sequence to make the Index File (Inverted File). Associated with each search term on the Index File is the accession number of each document from which it was extracted, thus producing a comprehensive index for rapid search purposes.

No on-line file maintenance exists. Both Direct and Inverted Files within each data bank are updated on tape and loaded to mass storage on a scheduled cyclic basis. During this load, two sets of pointer tables (one for each file) are created to aid in locating the data on mass storage during searches.

I. Retrieval

The on-line retrieval system performs the following major functions: search, display, qualification, format, sort, batch tutorial, and log. Some of these functions cannot be performed against every data bank. Other functions can be performed against specific data banks only to a limited extent.

J. MACHINE-AIDED INDEXING (MAI) AND NATURAL LANGUAGE DATA BASE (NLDB)

The technical reports received at DTIC subsequently become part of the data collection and are indexed for retrieval. The indexing is accomplished through the machine-aided indexing system.

The principal components of the system are two different dictionaries. The first of these, the Recognition Dictionary, consists of single words, each of which is tagged with one of several possible computer routines. As text is read into the computer, one word at a time, each word is looked up in this dictionary, a designated routine is called, and a word string

is built up as a possible index term. Whether or not any given string is accepted as an index term depends upon the second dictionary, the Format Dictionary. All word strings are matched against this small dictionary for acceptability.

The Recognition Dictionary understandably grows as more and more text is indexed. The Format Dictionary, on the other hand, has stabilized at a specific number of permissible string types. Only a few strings longer than four words are permitted. The most common strings found are ZZ, AZ, N, AZZ and ZZZ, where Z represents a noun that requires modification (it is not accepted in isolation), A represents an adjective, and N is a noun semantically strong enough to occur in isolation as a subject index term.

The text may be any scientific prose and is not pre-edited. The text is matched against the Recognition Dictionary of single words and acceptable words are placed in temporary storage, where word strings are accumulated. These word strings are mirrored in symbolic form as N, AN, ZZZ, etc., in the Format Register, and the contents of this register are matched for suitability with the Format Dictionary. Matches with the Format Dictionary are listed as Candidate Index Terms.

The final steps in the MAI process involve the Natural Language Data Base (NLDB). The NLDB is a file of the approved DDC subject terms, the natural language extracts (for which these authorized terms are substituted) and a hierarchy relationship among the subject terms.

The terms generated by the MAI process are matched against the NLDB. Those that match an authorized term are passed through the data base; those that match an equivalent or variant term are converted to the approved term. Both of these cases go forward to eventual posting on the appropriate inverted file. Those

MAI terms which do not match are reviewed by a subject analyst and all worthwhile terms are added to the NLDB either as new authorized vocabulary or as "lead-ins" to authorized terms.

REFERENCES FOR APPENDIX B

B-1. Description of DTIC equipment and procedures (apparently from an RFP), provided by DTIC. No number, date or title.

APPENDIX C

ON-LINE SYSTEM DETAILED DESCRIPTION

APPENDIX C

ON-LINE SYSTEM DETAILED DESCRIPTION*

The On-Line System is logically divided into two major divisions. They are: (1) The Communications Monitor, which interfaces with the UNIVAC 1100 operating system's communications handlier, and (2) The Application Controller, which handles the user oriented tasks. The system is mapped as a "multi-banked" program.

The separation of communications and applications makes the application portion practically independent. Conversely, the communications division is independent of the application. The vital links between the two divisions are the activity data transfer buffers, terminal identifier words and control words which direct each division. A description and discussion of the communications monitor follows.

A. COMMUNICATIONS MONITOR

The Communications Monitor handles all actions concerning communications, i.e., terminal traffic control, message verification and code conversion, retransmission, terminal acknowledgments, terminal component control, cassette read/write, asynchronous dial-up operation, and identifying transmission problems (line and/or terminal).

The Communications Monitor continues to interrogate the terminals until input is received. The Communications Monitor will request action from the Application Controller to perform a function when input is received. When input is received from

*From Ref. 17, Chapter III.

the terminal, the Communications Monitor clears the common buffer area, code converts the message into this area and extracts the hardware identification from the message and places it into the common buffer controls area with a code denoting input present. Once this action is completed, the Communications Monitor continues the polling cycle for more data.

When the request is completed by the Application Controller, the response is placed in the common buffer area with the hardware identifications and code denoting type of response in the buffer control area. The Application Controller can then process another user request, if present in the buffer.

The Communications Monitor verifies the terminal hardware identification and interprets the code denoting type of response. It then converts the message, prepares the line protocol and forwards the response to the terminal.

The Communications Monitor then follows with a poll request to the terminal for acknowledgment of receipt. It is after receipt of the acknowledgment from the terminal that the Communications Monitor clears the input/output buffer areas before processing any request from the next terminal.

B. DETAILED DESCRIPTION OF THE APPLICATION CONTROLLER

The Application Controller is responsible for interfacing the Communications Monitor and the user-oriented tasks, directing the loading/storing of the nonresident user DBanks, data bank access, logging, collection of statistical information, and initialing the appropriate functions requested by user commands.

To understand more fully the operation of the Application Controller, the components that comprise the Controller will be discussed first; secondly, the operation and information

flow; and finally the security checks that are made during the operation of the system.

1. Components of the Application Controller

The Application Controller is composed of 10 major components. They are:

a. System Initialization
b. Traffic Control
c. System Control Tables - System Files
d. Data Tables
e. System Subroutines
f. Application Function
g. Activity Core Buffers
h. Data Save/Work Areas
i. Data Bases

Although there are prime security checks in the system, redundant checks are made throughout the major components to ensure there is not unauthorized access to classified data. A brief discussion of each component follows:

a. System Initialization: Performs all of the preliminary housekeeping chores required to being up to the system. If any vital check fails, control is returned to the Communications Monitor at the error return.

b. Traffic Control: Directs the loading and storing of the user's DBank (program), interprets and sends control words to the Communications Monitor, initiates and terminates terminals, makes all user worker file assignments, validates commands, and file checks.

c. System Control Tables: Are used by the controller to operate the system and for security checking. The tables are used primarily by traffic control.

d. Data Tables: These tables are used by the functions to validate field names, codes, constants, etc. The prime reasons for creating this element were to eliminate duplication and to reduce assembly time because most of the entries are static.

e. System Subroutines/Processes: Are used to eliminate duplication of coding and control certain critical tasks required by the functions.

f. Functions: The system will perform six major functions. They are: (1) Inverted File Search; (2) Direct File Search; (3) Display Direct File Items, Accession Lists, and Miscellaneous Status File; (4) Sort Accession Lists; (5) Order Products; (6) Remote Batch Input.

g. Activity Core Buffers: The system has a core buffer reserved for each activity. The program DBank is read in from mass storage into the appropriate buffer for execution. Classified and unclassified terminals do not share the same core buffers.

h. Data Save/Work Areas: There are mass storage files assigned to the system which are subdivided into logical files. These files are assigned to the terminal as required.

i. Data Bases: The DTIC store of information is comprised primarily of past, present, and planned research and engineering efforts and consists of such data fields as:

- Report Limitation - Work and report security, etc.
- Control Information - Contract number and number codes, etc.

- Identifying Information - Keywords, descriptors, report titles, and scientific and technology codes
- Technical/Management Information - Funding and text data.

Many data fields, varying from fixed one-character codes to variable free-flow text data fields, are contained in the data banks. File sizes of the various data banks vary from several hundred unique records to over half a million.

Each data bank consists of two distinct files. The Data File (Direct File) is the master file and contains all the information pertinent to each reportable work document. To facilitate retrieval of these documents, certain entries from each document (search terms and retrieval points) are extracted, collected, and sorted into sequence to make the Index File (Inverted File). Associated with each search term on the Index File is the accession number of each document from which it was extracted, thus producing a comprehensive index for rapid search purposes.

No on-line file maintenance is permitted at this time. Both Data and Index Files within each data bank are updated on a scheduled cycle basis. During this load, two sets of pointer tables, one for each file, are created to locate the data in mass storage during the search or display.

2. Description of the Operation/Information Flow

a. System Initialization - During the System startup, the Communications Monitor passes control to the Application Controller so that the vital housekeeping chores can be done. The following tasks are attempted:

1. Verification of the System Control Tables - A check is made to see that each system contains the same number of entries. The second check is made to verify that each terminal entry is in the same relative position in each table.

2. Stores a dummy program DBank in the classified and unclassified DBank save files. These DBanks are read into core for terminal initialization.

3. Data base files are assigned. Indicators are set for the files that are assigned.

4. The inverted and direct file pointer tables are loaded to core.

5. A subset of the master user address and contract file is loaded to a mass storage file. The list that governs the loading of the subset of the file is contained within the program. This file is used for Field-of-Interest-Register (FOIR) validation and terminal classification verification.

6. The inverted file work areas are assigned to each activity.

7. The activity log files are assigned.

8. An appropriate log entry will be made.

If there are no critical failures, control is returned to the Communication Monitor via the normal return.

b. Contingency Registration - There is a contingency routine for each activity which allows the system to terminate in an orderly manner once a fatal error is detected by the UNIVAC 1100 Operating System. The only nonfatal error for the application activities is the test and set conflict. Control

is returned to the test and set instruction after a wait of one thousandths of a second. Contingency registration occurs the first time each activity is given control by the Communications Monitor.

c. User Initialization - Each terminal application area must be initialized. This action is taken only at the request of the Communications Monitor. If the controller cannot initiate the application area for the terminal, an appropriate log entry will be made and the Communications Monitor will be notified via a predetermined Code Word (CW). The following actions are required to initialize the applications area for a terminal:

(1) The hardware identifier word sent by the Monitor is validated against the pointer table identifier words. If there is no match, the error is logged, and an appropriate CW is returned to the Monitor.

(2) The activity indicator in the pointer table is checked to see if the activity is correct. The classification is also checked to see if the terminal is unclassified.

(3) The CW is validated and if legal, the appropriate action is taken. At this time, the CW must specify terminal initialization. The check is made in the master control table for the site.

(4) If another user is in core, the (program) DBank is stored, and a dummy (program) DBank is read to core. This is a complete overwrite. The I/O packet is checked to see that the correct number of words is read to core.

(5) The data save/work areas for the terminal are assigned. Each area is cleared to zeros just prior to being assigned to the terminal.

(6) The terminal's user code, terminal identifier word, pointer table index value, activity buffer address, six-digit field-data terminal identifier are stored in the (program) DBank area.

(7) The status is set to active in the terminal MCT. There is still a lock on the user which inhibits the execution of commands until the program identification is made.

(8) The first page, along with a request to enter the site identifier, is sent to the terminal. The site identifier entered by the user is compared against the one stored in the program DBank. If there is no match, the user is given a second chance. If there is no match the second time, the terminal is terminated and an appropriate security error logged. Before the terminal can be activated, the user must telephone DTIC and request activation. A match of site identifiers clears the command inhibit switch and allows the user to begin normal operation. An unclassified user must enter the correct terminal ID the first time or the site is terminated.

d. Normal Operation

(1) The terminal user keys in commands/data and transmits the buffer. The buffer is transferred by the Communications Monitor to the Application Controller via the mutually accessible buffer. The appropriate activity is activated.

(2) Whenever an activity in the controller is activated, the hardware identifier word in the data transfer buffer is validated. If the hardware identifier is illegal, the error is logged and an appropriate CW is placed in the data transfer buffer. The next user's request is processed.

(3) If the hardware identifier is validated, a cross check is made between the activity ID, the terminal classification, and the activity buffer address.

(4) The control word in the data transfer buffer is validated. If invalid, the appropriate CW is placed in the data transfer buffer, the next user is processed.

(5) If the control word indicates a read, a check is made to determine if the terminal DBank is in core. If the referenced DBank is not in core, the DBank in core is rolled out to the save area and the DBank for the referenced terminal is rolled in. The registers are loaded from the register save area in the DBank and the program control is passed to the continuation address.

(6) Read data requests from the Application Controller by application functions are serviced by a single routine, which sends one line of data at a time to the requester. The only exception is during input processing--the entire buffer is transferred. In both cases, each character of data is examined for command delimiters. When a delimiter is detected in the data, an attempt is made to assemble a legitmate command, or in the case of the input

function, a legitimate subcommand. If the controller cannot assemble a legitimate command, one of the following messages is sent to the terminal:

- Format Error in the Command
- Syntax Error in the Command
- Illegal Command/File Relationship

The data in the transfer buffer is overwritten by the print message. The user must now enter a legitimate command for the terminal. If a legitimate command is detected, control is passed to a function entry point to perform the requested task. If no command delimiter is detected by the read routine, the data line is passed on to the requester.

(7) Output requests from the Application Controller are serviced by a single routine which moves the data transfer buffer. The hardware identifiers and the CW are set. The Communications Monitor then transfers the message to the referenced terminal.

e. Terminal Terminations

(1) Normal Termination: The Communications Monitor sends a CW which directs the Applications Controller to terminate a terminal. The work/save areas are returned to a pool and the appropriate status words are set in the master control table. A dummy DBank is written over the DBank in core and the event is logged.

(2) Activity Termination: The Communications Monitor directs the controller to terminate each active terminal assigned to the activity. In this case, each terminal is normally terminated.

(3) The Applications Controller may also terminate a site, activity or the entire program if a critical error occurs. In this event, the Communications Monitor is notified via the CW.

3. Security Control

The prime security checks are made in the traffic control section. Commands are analyzed and a cross check is made between the data base file being referenced and the command requested. However, many redundant secondary checks are made to ensure that if there is a failure in the prime check, one of the secondary checks will prevent an unauthorized access to classified data. The following security precautions are taken:

a. The Communications Monitor and the Applications Controller maintain separate activity assignment lists.

b. Unclassified terminals only are assigned to a specific activity.

c. Classified and unclassified DBank save files are separate cataloged files. I/O packets are generated by a proc at assembly time.

d. The unique terminal identifier word is validated each time data is passed from the Communications Monitor and the Applications Controller which in effect checks the activity assignment and classification.

e. The terminal (program) DBank is checked each time it is rolled into core. (Terminal identifier, pointer word, user code, 6-digit field-data site ID, etc).

f. Commands are validated for: (1) Format, (2) Syntax, and (3) File/Command Relationship. A terminal must be permitted access to the referenced file and command.

g. The delimiter used in the system is a master space or binary zero. The master space is used by the operating system to identify control statements. Any control statement entered as data at the terminal would conclude as an error in the command analyzer.

h. Data Base Access, Direct Files

(1) All access to a direct file data base is made via a fetch direct file item routine.

(2) Classified and unclassified direct files are separately cataloged. The fetch routine cross checks the activity number and the classification indicator. It will not read a classified item into an unclassified activity.

(3) The item is read to core and a field of interest check is made against a subset of the master user address and contract (MUAC) file. The MUAC file also carries the terminal classification. The classification is cross checked. If the validation fails the item in core is overwritten with zeros.

i. Data Base Access, Inverted Files

(1) The retrieval function controls all access to the inverted files.

(2) The retrieval commands are analyzed, and if validated, the appropriate entry point to the search is taken. An additional check is made at the end of the search. If the activity

is unclassified, an additional level of not Confidential, not Restricted, and not Secret is added to eliminate all classified accession numbers.

j. Terminal Data Save/Work Areas

(1) The data save/work areas are assigned when the terminal is activated and their relative starting address is kept in the master control table. These areas are cleared to zeros prior to their assignment to a terminal.

(2) Each access to the file is checked by a routine to verify that a read or write into the file is within the limits assigned to the terminal. The routines that use the files also check to see that the limit is not exceeded.

APPENDIX D

RESPONSE TIME INVESTIGATION

Bernard Rider, Consultant

APPENDIX D

RESPONSE TIME INVESTIGATION

The objective of this investigation was to determine the present system "response time" and to determine the traffic factors relating to it, so that response time could be predicted for projected future traffic increases.

Let us define a "search" as consisting of a series of "transactions." Each transaction consists of an input from a remote terminal and a response from the computer.

Response time is defined as the time between the instant the computer receives the input until the instant that it begins to transmit its response to the terminal. Thus, response time contains two components: (a) the time expended by the terminal input in queue within the computer and (b) the time expended by the computer in processing the input.

It can be shown that the mean response time is

$$\bar{\tau} = \frac{\bar{x}}{1-\rho} \qquad (1)$$

where

$\bar{x}$ = mean time required to process an input

ρ = computer occupancy, erlangs

$$\rho = \lambda \bar{x} \qquad (2)$$

where λ = average arrival rate of terminal inputs at the computer

To investigate response time, the data available in DTIC-84 appeared most appropriate. The last report in this document is called *Defense RDT&E On-Line System, CRT Utilization Report by User Type for the Period 01 Dec 79 thru 31 Dec 79*. Of particular interest were the columns labeled *"Wall Time Active"* and *"System Processing Wall Time"*. It was assumed that the former referred to the terminal "connect" time and the latter referred to the actual time expended by the computer in processing the transactions required for a search. (As will be seen later, System Processing Wall Time is not defined in this way.)

Each page of the report was analyzed with the following result:

TABLE I

PAGE	NO. TERMINALS	PROCESS TIME/ SEARCH (sec)	CONNECT TIME/ PROCESS TIME	NO. SEARCHES
1	33	90.1	17.1	7319
2	32	62.9	26.4	4925
3	22	46.6	21.7	3591
4	15	41.9	18.7	3907
5	6	54.5	38.1	518
6	9	62.1	18.3	1772

Terminals on the first five pages were on government premises, whereas those on page 6 were on contractor premises. Twenty-nine of the thirty-three on page 1 were DTIC in-house terminals.

The column in Table I labeled "process time per search" consists of:

$$\frac{\text{SYSTEM PROCESSING WALL TIME}}{\text{NO. OF SEARCHES}}$$

expressed in seconds.

From Table I, it is evident that page 1 differs from the other pages in having a higher process time per search. It was concluded that terminals on page 1 might be used for batch processing, which time might be included in the total. However, at this stage of the investigation, it was not deemed appropriate to attempt a separation. Accordingly, the mean process time per search is

$$\bar{y} = \frac{90.1 \cdot 7319 + 62.9 \cdot 4925 + 46.6 \cdot 3591 + 41.9 \cdot 3907 + 54.5 \cdot 518 + 62.1 \cdot 1772}{(7319+4925+3591+3907+518+1772)}$$

$$= 65.3 \text{ sec/search} \qquad (3)$$

From the DTIC-84 Report, *Defense RDT&E On-Line System, Total of System Responses Received During Month of Dec,* it was found that there were a total of 201667 responses received during December and that 13.5% of the responses occur during the busy hour on the average. (The busy hour occurs at 14:30).

It is assumed that the term "response" coincides with our definition, "transaction". Thus, the mean number of transactions per search is

$$\bar{n} = \frac{201667}{(7319+4925+3591+3907+518+1772)}$$

$$= \frac{201667}{22032} = 9.2 \qquad (4)$$

Accordingly, the mean process time per transaction is, from (3) and (4)

$$\bar{x} = \frac{\bar{y}}{\bar{n}} = \frac{65.3}{9.2} = 7.1 \text{ sec} \qquad (5)$$

It should now be possible to calculate ρ, the computer occupancy. From the the DTIC-84 report, *Monthly Summary of Terminal Responses (DEC)*, it is evident that there are approximately 2000 responses during a peak hour. Thus,

$$\lambda = \frac{2000}{3600} = 0.556 \text{ transactions per second, and}$$

$$\rho = \lambda \bar{x} = 0.556 \cdot 7.1 = 3.9 \text{ erlangs} \qquad (6)$$

If there are not parallel processors handling this load (there should be at least six), then we must conclude that the data used for $\bar{x}$ is not processing time, as assumed, but is probably the "response time", as we have defined it. Thus, $\bar{\tau} = 7.1$ sec. rather than $\bar{x}$ as originally assumed. This can be confirmed further by noting that, if the response time is exponentially distributed (which is likely), then the CDF for response time can be shown to be

$$P(\tau < t) = 1 - \varepsilon^{-t/\bar{\tau}} \qquad (7)$$

From the DTIC-84 report, *Distribution of System Processes by Time Interval Required for 26 Nov 79*, and equation (7) with $\bar{\tau} = 7.1$ seconds, the following comparison can be made. Entries in the table are $P(\tau < t)$.

TABLE II

DISTRIBUTION OF SYSTEM RESPONSE TIME

Time (Sec.)	5	10	15	20	25	30	> 30
$P(\tau < t)$ DTIC-84	0.413	0.787	0.894	0.936	0.958	0.968	0.032
Eq. (7)	0.506	0.755	0.879	0.940	0.970	0.985	0.015

This indicates a reasonably close agreement between the DTIC report data and equation (7) with regard to the distribution of response time.

Since we have some verification of the hypothesis that the time reported as system processing wall time is response time as defined here, it is appropriate to use the data obtained together with equations (1) and (2) to evaluate the true processing time and then to predict how response time varies with traffic.

We will assume that the response time for the busy hour is equal to the average response time as computed in (5). (In practice it may be greater). With this assumption, from equations (1) and (2)

$$\bar{x} = \frac{\bar{\tau}}{1+\lambda\bar{\tau}} = \frac{7.1}{1+(\frac{2000}{3600})\ (7.1)} = 1.44 \text{ sec} \qquad (8)$$

$$\rho = \lambda\ \bar{x} = \frac{2000}{3600}\ 1.44 = 0.8 \text{ erlangs.} \qquad (9)$$

Discussions with personnel using interactive terminals indicate that a response time delay of more than a few seconds is annoying to the operator. In general, delays are perceived by the operator to be much longer than they are. One operator estimated a delay to be one minute when, in fact, it was about 10 seconds. Thus, an average delay of the order of 7 seconds is considered at the threshold of acceptability. Note that while the average response time is 7.1 seconds, the response time delay distribution of Table II applies. Thus, there will occasionally be much greater delays.

Using the results that have been derived, and with NOV-DEC 79 as a baseline, equation (1) can be used to forecast response times based on a 10% yearly traffic increase.

The results are shown in Table III.

TABLE III

Time	Forecast Mean Response Time
Baseline Period	7.1 sec
1 year later	12.0
2 years later	44.3

The rapid increase in response time results from the fact that the processor is approaching 100% occupancy. Equation (9) indicates that the computer is presently 80% loaded during the busy hour. As traffic increases the computer may become overloaded during the busy hour, which will lead to very large response times. Table III is carried to the point where computer occupancy is still less than 100%.

The present system uses polling to solicit messages from terminals. Polling is appropriate when a group of terminals share a multi-point (party-line) circuit. If individual lines or dial up service is used, there is no advantage in using polling; the mean polling time adds directly to the mean response time reported here. Thus, the response time perceived by a user will exceed the response times of Table III.

The results that have been obtained regarding response time are based on certain assumptions which appear to be corroborated by other data. If the results are valid, they indicate that the DTIC system response time operation is marginal from the viewpoint of the user. It will continue to deteriorate as traffic grows, unless steps are taken to reduce the processing per transaction. This can be achieved by:

(a) Reducing the processing time per transaction with improved software or faster processors;

(b) Reducing the impact of transaction arrivals by using parallel processors;

(c) Eliminating the polling protocol for all except multi-point circuits. Reduce the number of terminals per multi-point circuit.

It is recommended that measurements be made during the busy period of:

(a) Processor utilization

(b) Processing time per transaction

(c) Mean number of transactions in queue, awaiting processing.

These measurements can be used to either verify or correct the results obtained here.

In addition to the response time investigation, work was begun on an investigation of AUTODIN II as a user network for DTIC services. At the time the effort was suspended insufficient data was collected for reporting purposes.