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ABSTRACT

Activities of the Institute for Computer Sciences and Technology (ICST) within the U.S. Department of Commerce during fiscal year 1986 are described in this annual report, which summarizes research and publications by ICST in the following areas: (1) standards and guidelines for computer security, including encryption and message authentication device test systems; (2) software standards, testing of these standards, and standards for information interchange between software programs; (3) software acceptance testing, selection, evaluation, and maintenance; (4) standardization of data elements for geographical locations; (5) standards and technical assistance for information interchange among automated office systems; (6) methods for measuring performance of parallel processing systems, their architectures, and their support environments; (7) implementation of Open Systems Interconnection (OSI) networking standards in off-the-shelf products; (8) development of OSINET, an experimental computer network for OSI standards; (9) evaluation and improvement of the operation of the International Organization for Standardization (IOS) transport protocol for use over satellite channels; (10) standards for data communication and computer interfaces; (11) test methods for computer storage media; and (12) automated speech recognition. The appendix includes lists of ICST conferences, workshops, and publications. (MES)

FY 1986 ANNUAL REPORT

Institute for Computer Sciences and Technology

U.S. DEPARTMENT OF COMMERCE
National Bureau of Standards

Institute for Computer Sciences and Technology

FY 1986

ANNUAL REPORT

U.S. DEPARTMENT OF COMMERCE
Malcolm Baldrige, Secretary

National Bureau of Standards
Ernest Ambler, Director

Institute for Computer Sciences and Technology
James H. Burrows, Director

DIRECTOR'S FOREWORD

Computer technology continues to be a technology of rapid change. Almost every day, we read about new products and new applications of computers. As with all new, changing technologies, we also hear about new problems related to computer use.

The Institute for Computer Sciences and Technology's programs for standards development, technical assistance, and research focus on helping government and industry manage that change for improved productivity, and on helping U.S. industry keep its technical lead in international trade.

Voluntary computer standards are one of the most effective means for managing change. Not long ago, a computer industry executive said that "without standards, the computer industry would be in chaos." The industry recognizes that standards help to bring order to the computer marketplace and to broaden the market for computer products. Without standards, users would also be in "chaos." The complexities of computer systems, and their many interfaces between users, programs, data, operating systems, hardware, and communications systems make it difficult to link different components and systems, to exchange information between different automated activities, and to take full advantage of automation.

As a large computer user, the Federal government's requirements for standards are similar to other large users. More than $15 billion is spent annually on computer related activities by Federal departments and agencies. While this is an enormous expense in itself, the implications of faulty computer operations, waste, and inefficiency are far reaching. Almost all Federal outlays and recordkeeping are done by computers. Standards help to make these complex systems manageable.

Standards are the potential unifying force for integrating isolated and incompatible automated activities. Many organizations have made large investments in small computers for individual applications. Microcomputers and large mainframe computers serve other organizational needs. Yet tying these systems together for true distributed processing is still a technical challenge.

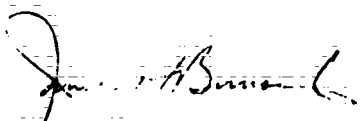
User requirements to integrate existing automated systems are driving changes in the standards process. Standards development can no longer be segmented by technical issues addressed, by special user community needs, and by organizations doing the standards development. To be effective, standards must meet international requirements and must address large application systems, not individual components or technologies. To achieve the integration of large, complex systems,

technology is needed for testing products for conformance to standards. The activities of the MAP/TOP (Manufacturing Automation Protocol/Technical and Office Protocol) users and the Corporation for Open Systems are examples of the new push for a comprehensive and consistent system of internationally accepted standards with a broad systems perspective.

This report highlights some of ICST's activities in FY1986, including work with the groups that are helping to drive the development of standards. I believe that we have had a productive year, and that our work has contributed to more effective use of computers by government and industry.

We have become much more effective in getting standards developed, tested, and implemented because of the solid relationships that we have established with users and with industry, and the talent and resources that these organizations have contributed to achieve common goals. By continuing to work together, we can manage the process of change to benefit the Federal government and the nation.

I welcome your comments on our programs.



James H. Burrows
Director
Institute for Computer
Sciences and Technology

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FY1986 ACTIVITIES

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In FY1986, ICST's direct Congressional appropriation was $9.657 million, supplemented by $900 thousand in funding for research. These funds supported research, technical advice, and standards development to advance the goals of the Department of Commerce and the U.S. government: to maintain a U.S. competitive position in international trade; to improve U.S. productivity; and to improve the management of government and the delivery of services. Under its Organic Act, NBS provides technical support to industry, academia, government, and the general public. The Brooks Act, under which ICST carries out specific computer-related activities, emphasizes Commerce's responsibility in the area of computer applications in the Federal government.

To meet Federal needs for coherent and compatible standards, ICST works with more that 70 different committees in national and international organizations. The range of issues is broad and includes: standards for interfaces between all of the components of systems hardware, software, communications, and users; guidance in the development and use of application software, microcomputers and office systems; standard formats, codes, and media for data interchange, data input, and data output; assessments of performance and characteristics of advanced technology; and computer security and risk management. Although all of these program areas are important to improved information processing, ICST's program priorities dictated more emphasis in some areas than others.

During the past year, ICST continued to emphasize laboratory-based activities that support the development of standards for complex systems; the development of test and measurement methods; and technology transfer and technical assistance programs. Many research projects were conducted in cooperation with industry guest scientists and research associates who collaborated with ICST staff in developing non-proprietary technology. About $1 million in equipment and software has been donated to ICST by industry.

Standards play a significant role in the effective and widespread use of computer technology by making it possible to integrate hardware, software, and communications systems and to exchange information across the boundaries of different systems. "Off-the-shelf" products that implement standards help reduce the risks of investing in complex systems like computers. Off-the-shelf products are likely to be supported for a long time, and they help to expand the marketplace for new products. When markets are expanded, the costs of production can be reduced, initially a benefit to the producer and ultimately to the user.

Standards are needed not only for computer products themselves but also for guiding how those products are used. Standard practices help organizations more fully utilize the skills of their staff members and reduce their training costs. When an organization adopts a policy of using standard programming languages, for example, programmers do not have to relearn programming rules as they move from one job to another. Organizations are prudent to use standard practices that have been accepted by a wide community and that have withstood the scrutiny of experts.

But standards by themselves are not enough. They must be implemented in products that work together. To achieve this, both buyers and sellers need ways to test products to assure compatibility. Without the tests, standards are simply paper specifications, and no one can be sure that products are compatible. Many standards projects describe a function or a process and not a specific product; for example, the Open Systems Interconnection (OSI) standards. In these cases, test methods are absolutely essential to getting the standards implemented in products. Both buyers and sellers look to ICST as the neutral expert to develop the testing methodology.

The continuing and expanding use of computers throughout government and the private sector was reflected in increased requests for information, technical assistance and guidance. ICST received $4 million in funding from other Federal agencies for direct technical assistance for specific projects. Agencies such as the Department of Defense, the Department of Energy, and NASA received assistance in solving technical problems dealing with computer security, software engineering, data management technology, and networking. These projects provide ICST staff with direct, in-depth experience in the application of new technology and in evaluating the effectiveness of standards and guidelines.

In FY1986 about 30 proposed, completed, and revised Federal Information Processing Standards (FIPS), and information, research, and guidance reports were issued. Federal Information Processing Standards are published standards and guidelines to aid Federal agencies in acquiring, using, and managing computers and networks. About 100 FIPS and several hundred other reports covering many aspects of computer utilization and standards implementation are currently available to government and industry. In addition to transferring information via publications and reports, ICST also participated in cooperative programs, such as teleconferences, workshops, and laboratory experiments to share technology and information with government and industry. Large national conferences, seminars and workshops were held to identify problems and potential solutions in

applying new technology. ICST staff members participated in hundreds of meetings briefing Federal agencies, user groups, and other professional groups, and contributing to national and international standards development groups.

Electronic bulletin boards were used to transfer information to thousands of computer users with dial up capabilities. ICST sponsored Federal user groups for data management and software maintenance, and a Federal council for computer storage media standards and guidelines. Information on the electronic bulletin boards and the user groups is in the Appendix.

During the past year, ICST transferred an extensive collection of reports and studies dealing with early developments in computer science to the Smithsonian Institution and The Charles Babbage Institute. These transfers will make a valuable historic collection of documents more readily available to future historians and archivists.

Highlights of a variety of ICST technical activities are included in the following sections.

COMPUTER SECURITY

Computers are no longer esoteric devices, but are now a vital part of the infrastructure that supports the flow of information and goods throughout the economy. It is impossible to return to manual methods of work once automated processing methods are adopted. Small desk top and personal computers are becoming necessary equipment in almost every office. Many people, not just computer professionals, know how to access and use computer systems. Networks and distributed processing are making it possible to send information across the nation and around the world. In this environment, computer systems are vulnerable to a variety of external and internal threats unless steps are taken to protect them.

ICST develops standards and guidelines for computer security as part of its overall mandate to provide technical support in the effective use of computers. The goals of the computer security program are:

- Information integrity: computer data is the same as the source data, or has been correctly computed from source data and has not been accidentally or maliciously modified or destroyed.

- Information confidentiality: computer data is protected from unauthorized disclosure or use.

- System availability: computer services including system data bases can be obtained when needed.

To achieve these goals, every organization is encouraged to adopt a security policy, to carefully select its employees, to stimulate awareness of computer security among managers and users, to provide proper training, and to perform analyses of risks and vulnerabilities of systems. Based on the risks and vulnerabilities, other controls can be instituted. These include: back up and recovery procedures to assure availability of computer systems; fire and water protection; protection of electrical power supply and magnetic media; physical and technical access controls; personal identification and authentication techniques; audit trails to detect security variances; and use of encryption when appropriate. Many standards and guidelines have been issued to address these requirements. During FY1986, the following new guidance documents were added to the already available standards and guidelines.

Guide on Selecting ADP Backup Processing Alternatives (NBS Spec. Pub. 500-134) discusses the selection of ADP backup processing support in advance of events that cause the loss of data processing capability. Emphasis is placed on management support at all levels of the organization for planning, funding, and testing of an alternate processing strategy. The alternative processing methods and criteria for selecting the most suitable method are presented, and a checklist for evaluating the suitability of alternatives is provided.

Technology Assessment: Methods for Measuring the Level of Computer Security (NBS Spec. Pub. 500-133) summarizes and assesses a variety of methods for measuring the level of computer security in computer applications, systems, and installations. Because of the complexity of modern computer systems, it is difficult to perform positive measures of security. This technology assessment analyzes and compares the major approaches and methodologies in use today and provides technical assistance to organizations conducting security evaluations. This report is a companion to FIPS PUB 102, Guideline for Computer Security Certification and Accreditation.

Security for Dial-Up Lines (NBS Spec. Pub. 500-137) discusses ways to protect computers from unauthorized access via common dial-up telephone and communications ports. Intruders have been able to exploit weaknesses in software access controls to enter the system itself. If many computer systems are so poorly protected that

hobbyists can penetrate them readily, then more serious adversaries can do the same. The true nature of this external intrusion threat, the typical vulnerabilities which make it possible, and the methods which can be used to reduce this problem need to be better understood by many system managers. This guide explains software and procedural approaches to protecting dial-up systems as well as a wide variety of hardware devices and the way that they function.

Work Priority Scheme for EDP Audit and Computer Security Review, (NBSIR 86-3386), describes a methodology for prioritizing the work performed by EDP auditors and computer security reviewers. Developed at an invitational workshop that was cosponsored by ICST and the EDP Systems Review and Security Work Group of the President's Council on Integrity and Efficiency (PCIE) and attended by government and private sector experts, the work plan enables users to evaluate computer systems for both EDP audit and security review functions and to develop a measurement of the risk of the systems. Based on this measure of risk, the auditor can then determine where to spend review time. This methodology will be included in an audit guide for ADP system development that will be jointly published by PCIE and ICST.

Encryption and Message Authentication

ICST continued to assist the Department of Treasury in protecting electronic financial transactions through the use of data encryption, key management, and data authentication techniques. The standards being implemented by Treasury are the voluntary industry banking standards that were developed with ICST assistance. Encryption is used to protect the privacy of data that is transmitted between computers or stored in computer systems. Encryption allows the sender to transform data into an unintelligible form called cipher, and decryption reverses the process for the receiver.

While protecting the secrecy of data, encryption alone gives no guarantee that the message is authentic, i.e., that it came from a particular sender and that it has not been modified by unauthorized parties. The integrity of data can be protected through data authentication, which uses a cryptographic algorithm and a secret key to calculate a cryptographic checksum called the Message Authentication Code (MAC). The MAC is sent with the plain text data. The receiver, who has the correct key, can calculate the MAC on the data and compare it to the received MAC. If the two agree, the data is considered authentic. Otherwise, an unauthorized modification is assumed. Any party trying to modify the data without knowing the key would not know how to calculate the appropriate MAC corresponding to the altered data.

The standard for message authentication adopted by the Federal government (FIPS PUB 113) and by the banking industry (ANSI X9.9-1982) use the algorithm specified in FIPS PUB 46, Data Encryption Standard, and a secret key to calculate a MAC which is sent to the receiver along with the unencrypted message. The receiver calculates the MAC using the same secret key, compares it to the received MAC, and determines whether the data is authentic. The message authentication process defined in the standards is independent of the transmission media and computer systems used; it can be implemented in both automated and manual systems; and it is suitable for use by both large and small organizations.

In 1984, the Department of Treasury issued a policy directive requiring the use of message authentication for electronic fund transfers between organizations in Treasury. Devices to carry out the authentication process are being certified by Treasury with the assistance of ICST and the National Security Agency.

A test system for validating such devices was developed by ICST and used successfully in 1986 for two commercial systems. Additional devices from different manufacturers will be validated during 1987, and will then become commercially available for government and industry applications in protecting sensitive information.

ICST staff members assisted Accredited Standards Committee X9E9, Wholesale Telecommunications Security, in the development of other standards to protect electronic fund transfers including encryption of wholesale financial messages, key management in a multiple center environment, and secure sign on. Assistance was also provided to national and international efforts to develop standards for integrated circuit cards which contain on-card computers for use in banking, computer access, and credit card applications. This standards effort addresses the physical (form-factor, location of chip) and electrical (interface voltages, protocols) characteristics of the card. Work was started on a technology assessment of smart cards and a database of information about products and designs that implement the emerging standards.

Communications security was the focus of laboratory work to investigate the features needed for secure networks. This work, which is expected to be continued over the next few years, will support the development, demonstration, and evaluation of security features in networks that implement Open Systems Interconnection (OSI) standards. The application of integrated circuit cards is being investigated as a method for controlling access to networks and databases. These "smart cards" contain computation and data storage capabilities.

SOFTWARE STANDARDS

Representing more than 60 percent of Federal computer expenditures, software development is an area where considerable savings can be realized. Use of computer programming language standards is one way to control high software development costs. These standards make it easier and less costly to transport software from one language processor to another, in both single vendor and multi-vendor systems. Also standards help to preserve the value of programmers' skills, reducing training costs. Because of the high costs of software development and maintenance, many organizations are using software tools, application generators, and commercial software packages rather than develop custom software systems.

ICST supports the development of software standards by participating in national and international standards activities and by providing technical assistance to Federal agencies on software-related issues.

Federal Information Processing Standards (FIPS) are available for the following programming languages:

- Ada, FIPS 119 (adopts ANSI/MIL-STD-1815A-1983)
- COBOL, FIPS 21-2 (adopts ANSI X3.23-1985)
  This standard was revised in 1986 to adopt revised voluntary industry specifications.
- Minimal BASIC, FIPS 68 (adopts ANSI X3.60-1978)
- FORTRAN, FIPS 69 (adopts ANSI X3.9-1978)
- Pascal, FIPS 109 (adopts ANSI/IEEE 770X3.97-1983)

New software standards approved in FY1986 include:

- Graphical Kernel System (GKS) (FIPS PUB 120). This standard adopts ANSI X3.124-1985 which specifies a library (or toolbox package) of subroutines for an application programmer to incorporate within a program in order to produce and manipulate two-dimensional pictures. The standard is expected to promote portability of graphics application programs between different computers, and to aid programmers in understanding and using graphics methods. GKS is also an international standard (ISO 7942). ICST started evaluating test routines that were developed in Europe to validate implementations of the GKS standard. Fifteen U.S. companies are cooperating with ICST in conducting the evaluation.

- FIPS PUB 125, MUMPS. This standard adopts a voluntary industry standard (ANSI/MDC X11.1.1984). MUMPS is a programming language that is suitable for applications involving the creation and manipulation of string-oriented or text-oriented, hierarchically organized collections of data, and those applications requiring interactive data management. MUMPS has been used traditionally, but not exclusively, in medical, health-service and related administrative systems.

Two programming languages standards for developing database management systems and applications were recommended for adoption as FIPS. Database Language NDL will adopt ANSI X3.133-1986 and Database Language SQL will adopt ANSI X3.135-1986. These standards will make it possible to transfer database definitions and database application programs between different computer systems and provide two different approaches to structuring databases. SQL is appropriate for applications that require flexibility in data structures and access paths to the database. NDL is appropriate for highly structured applications requiring rapid access along predefined paths through the database. Agencies will be able to select the database language suitable for their needs.

Also recommended for approval as a FIPS was Computer Graphics Metafile adopting ANSI X3.122-1986. This standard is a graphics data interface standard that defines a file format for non-interactive picture descriptions. These picture descriptions can be stored at a central facility and used by devices of different makes and models, transferred between different devices, and stored for future use. This standard will make it easier and less costly to develop and use computer graphics software systems, and to convert graphics software to new systems.

Software Standards Testing

Because these software standards are extremely complex, tests are needed to assure that products work properly. A new cooperative program with industry was started to jointly design, develop, and evaluate software test methods. A workshop held in June 1986 included representatives from IBM, Sperry, DEC, Applied Data Research, Ford Aerospace, General Dynamics, Computer Sciences Corp. and Vitro. Also participating were Federal agency personnel, and a representative of the National Computing Centre in the United Kingdom. Conformance tests for standards for database languages, data dictionaries, file formats, computer graphics and other applications software, and

portable operating systems were discussed. Participants agreed that cooperative efforts would be effective in developing the needed tests and that follow-up workshops and work in voluntary standards committees would be useful. Cooperative projects in conformance testing for portable operating systems and computer graphics software were started.

To consolidate government efforts in software testing, the General Services Administration's Office of Information Resources Management and ICST agreed in principle to transfer the GSA Software Test Center to ICST. Both GSA and ICST had been involved in the development of tests for software in support of their responsibilities under the Brooks Act. This transfer marks the return to NBS of an activity originally transferred to the Department of Defense in 1973 and will accelerate the development of test methods by ICST in areas such as computer graphics, database management, distributed processing, and portable operating systems.

Information Interchange

ICST has been active for the past several years in developing standards needed to integrate different computer programs and user applications, and to establish standard formats and definitions for data processed by computer. These standards are essential for information interchange and productive use of computers.

The following FIPS to support these objectives were issued in 1986:

- FIPS PUB 123, Specification for a Data Descriptive File for Information Interchange. This standard adopts ANSI/ISO 8211-1986 which specifies media-independent and system-independent file and record formats for the interchange of information between computer systems. The standard is for use with physical media as well as with communications media in applications where a high volume of data is to be interchanged. It provides a mechanism for transporting data structures from one computer system to another without loss of content or meaning.

- FIPS PUB 124, Guideline on Functional Specifications for Database Management Systems. This publication assists organizations in developing specifications for database management systems based on functional characteristics of the systems.

ICST continued to provide support to the voluntary industry groups developing an Information Resources Dictionary System (IRDS) standard which is expected to be adopted as a national and international standard. The structure and processes carried out by an IRDS, a key computer software tool for the management of data and information resources, were discussed at a Federal workshop on Information Resource Dictionary Systems (IRDS) held in June 1986. The seventh in a series, this workshop focused on the capabilities, features, and benefits of the IRDS, and the status of efforts to establish a voluntary industry standard for IRDS.

The IRDS is a software system that records, stores, and processes information about an organization's significant data and data processing resources. The IRDS is expected to play a major role in the development and integration of large systems, such as the Department of Defense's Computer Aided Logistics Support (CALS) program.

The proceedings of the fourth Data Base Directions workshop were published as NBS Spec. Pub. 500-139, Data Base Directions: Information Resource Management - Making It Work. The workshop was sponsored by ICST, in cooperation with the Association for Computing Machinery, the IEEE Computer Society, and the Federal Data Management Users Group.

Patterned after the three previous Data Base Directions workshops, this workshop evaluated current practice to identify problem areas, reviewed important technologies and tools and when to apply them to information resource management, and explored the motivation and inhibitors to decentralized and distributed environments. The approximately seventy workshop participants from government, industry and academia were organized into four working panels, which met to discuss IRM in the 1990's, IRM and the System Life Cycle, Technologies for IRM, and IRM in a Decentralized and Distributed Environment.

ICST has been investigating the benefits and pitfalls associated with the use of new program development techniques. With many people developing their own computer applications, it is important that programming methods are efficient and that programs are easy to maintain. Much has been said about the benefits of the so-called fourth generation programming languages (4LGs), but little has been known about whether the claimed benefits are real or not. A workshop was held for users in November 1985 to share information about experiences in evaluating and using 4GLs.

Following up on the workshop discussions of need for assistance in the use of fourth generation languages, ICST issued:

- A Functional Model for Fourth Generation Languages (NBS Spec. Pub. 500-138). The functional model discussed in this report defines fourth generation languages (4GL) in terms of the functions performed and services provided. Some commonly provided functions and services are: user functions such as query language, screen formatter, report formatter, and procedural language components; data management functions such as data dictionary and database management system components; and system functions such as file handling, job control and communications. A 4GL is a system of integrated tools that help users develop interactive applications with minimum knowledge of programming. Successful uses of 4GLs include generating and modifying functioning models of systems, and prototyping new systems.

- Guide to the Selection and Use of Fourth Generation Languages (NBS Spec. Pub. 500-143). The study recommends a ten step process for selecting fourth generation languages with emphasis on analysis of the hardware, software, organizational and user environments and of the product features to achieve the best match. The factors that affect the selection and use of 4GLs, and various features of 4GLs are discussed. Recommendations on the use of 4GLs are made based on types of application and successful implementations.

OTHER SOFTWARE RELATED ACTIVITIES

ICST continued its support to the development of a standard user interface to UNIX operating systems. AT&T and ICST began a cooperative effort directed toward the development of methods for testing the conformance of portable operating systems to a proposed voluntary industry standard. The Standard for Portable Operating System Environments (POSIX[1]) that was developed by the Institute of Electrical and Electronics Engineers with participation by industry, including AT&T, and by ICST was approved as a trial use standard (IEEE 1003.1). ICST proposed a Federal Information Processing Standard (FIPS) for UNIX[2] Operating System Derived Environments, which will adopt the full use version of IEEE 1003.1 when it is completed. Use of the standard is expected to promote the portability of computer programs among different manufacturers' computer systems and improve staff productivity.

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[1]POSIX trademark of the IEEE.

[2]UNIX is a trademark of AT&T.

AT&T provided its System V Verification Suite (SVVS) to ICST for use in developing the test methods to evaluate conformance of operating systems to POSIX. Both organizations started working together to analyze the results of the trial use of POSIX and to assist the IEEE in adopting the final standard for full use. The test methods for POSIX are being developed under the IEEE Computer Society standards development process which is open to all vendors and other interested parties. Under a Research Associate agreement with Digital Equipment Corp., a DEC computer scientist started working with ICST staff to develop information to assist users in evaluating and selecting POSIX-type operating systems.

Off-the-shelf software packages are being widely used to avoid software development costs and to supply high quality software. But software packages introduce problems of compatibility with existing software if they are to be integrated into existing systems. A workshop was held in April 1986 for researchers and software experts to share their experiences in testing software packages to assure that they meet user requirements. Topics discussed were: similarities and differences of software acceptance testing of off-the-shelf versus custom software; test case selection techniques; automated support for software acceptance testing; software acceptance criteria; management issues of software acceptance testing; research areas for software acceptance testing; standardization of software acceptance testing; state of practice of software acceptance testing. These workshop discussions will be used to assist in the development of guidance on acceptance testing.

Issued in 1986 was An Overview of Computer Software Acceptance Testing (NBS Spec. Pub. 500-136), which explains the process of formal testing that should be conducted to determine whether a software system satisfies organizational requirements for that system. Requirements include attributes such as hardware/software optimization, user interfaces, and program documentation in addition to the proper functioning of the software. The guide describes how to develop acceptance test plans and criteria, and how to analyze acceptance test results.

Two other publications dealing with acceptance testing provide detailed descriptions of the testing process:

- NBSIR 86-3407, An Experiment in Software Acceptance Testing, describes the use of a methodology to determine whether a software system is acceptable. The experiment was conducted to assess the applicability of current software engineering guidance and traditional acceptance test procedures and to identify areas where more research is needed to improve acceptance testing.

- NBSIR 86-3408, Study of a Prototype Software Engineering Environment, describes the features of a support system which provides tools for software development. Factors to be considered when evaluating a software engineering environment are discussed.

Other guides published by ICST during the past year to aid in the selection and evaluation of commercial software were:

- Integrated Software for Microcomputer Systems (NBS Spec. Pub. 500-135) explains software products that combine several applications within a single program and enable information to be shared between the applications. Five ways to achieve the integration are: the multifunction application package; a program suite that works together; a software integrator; an operating system that controls and coordinates applications programs; and a background utility program. The advantages and disadvantages of each approach to integration, and the key issues to be considered in selecting integrated software, are discussed.

- An application of generalized performance analysis methodology for the benchmarking of database systems is presented Benchmark Analysis of Database Architectures: A Case Study (NBS Spec. Pub. 500-132). The report covers performance measurement of three different database system architectures: a microcomputer database system, a minicomputer database system, and a database machine. Experiments conducted demonstrated the viability of methodology and provided performance measures which can be used to evaluate today's database systems.

Since software maintenance costs represent a significant portion of overall software costs, ICST continued its efforts to provide assistance to executives, managers, and users in controlling software maintenance costs. Supplementing earlier guides on software maintenance and software maintenance management were:

- A Management Overview of Software Reuse (NBS Spec. Pub. 500-142) provides general guidance on the problems and benefits of software reuse. Software reuse can substantially reduce software costs and risks, while improving software quality and productivity. However, organizations may experience substantial up-front investments in order to lay the basis for future gains. This report discusses both the technical issues and non-technical issues, including lack of standards, resistance to change, data and proprietary rights, and project management problems that need to be addressed to make software reuse cost-effective.

- Annotated Bibliography on Software Maintenance (NBS Spec. Pub. 500-141) contains summaries of 285 articles and papers from computer science journals, books, proceedings, periodicals, and other publications. Covering a fifteen-year period from 1972 to 1986, the bibliography overviews both the management and technical issues of software maintenance, and identifies the techniques, procedures, methodologies, and tools that have been effectively employed to improve the quality of software systems. These references provide comprehensive information on how many organizations handle software maintenance and associated problems.

ICST staff members participated in several cooperative efforts to develop standards and guidelines for the acquisition and development of complex software systems. Technical assistance to National Aeronautics and Space Administration focused on the development of procedures to implement software quality assurance techniques for NASA's software dependent systems. Because systems that are dependent on software carry out critical functions, NASA has been adopting software quality assurance methods as part of a comprehensive effort to achieve excellence in software engineering and management.

The Department of Defense has also been giving considerable attention to software acquisition management. ICST assisted in the development of DOD standards (DOD-STD-2167 and 2168) which provide a formal process for managing software development and for measuring whether quality objectives have been met. Both were developed using the experiences learned throughout DOD and aim toward achieving modern software development practices for mission-critical computer resources.

Assistance was provided to the IEEE in the development of voluntary technical standards for software engineering methods. IEEE Standard 1012-1986 for Software Verification and Validation plans is compatible with and incorporates information from several ICST documents on software validation, verification and testing. Other IEEE standards to which staff members contributed were IEEE P982, Measures to Produce Reliable Software, and IEEE P1042, Software Configuration Management Standard.

Data Elements

ICST has issued fifteen FIPS that provide standard data elements and representations for geographic places, dates, time, industrial classifications, Federal organizations, and other data. These standards help to eliminate duplication and incompatibilities in the

collection, processing and dissemination of data and to promote useful information interchange. Issued in 1986 were:

- FIPS PUB 104-1, American National Standard Codes for the Representation of Names of Countries, Dependencies, and Areas of Special Sovereignty for Information Interchange. These codes are used by Federal government organizations in reporting contract placement to the General Services Administration's Federal Procurement Data Center; in activities concerned with international trade that do not involve Department of State or national defense programs; and in data interchange with international organizations. Another code set, FIPS PUB 10-3, provides country codes for Department of State and defense applications. FIPS PUB 104-1 implements American National Standard, ANSI Z39.27-1984, which adopts international standard ISO 3166.

- FIPS PUB 70-1, Representation of Geographic Point Locations for Information Interchange; this standard is a revision of FIPS PUB 70 and adopts a revised voluntary industry standard (ANSI X3.61-1986). Geographic point location refers to the use of a coordinate system to define the position of a point that may be on, above, or below the earth's surface. This standard establishes uniform formats for geographic point location data and provides a means for representing the data in digital form for information interchange between data systems.

- A new computer tape was developed for FIPS PUB 55-1, Codes for Names of Populated Places, Primary County Divisions, and Other Locational Entities of the United States. The new tape features a complete update of post office names and ZIP codes. Metropolitan Statistical Area Codes were updated also. The identification of postal facilities and update of ZIP codes is based on the 1986 U.S. Zip Code Directory and its related computer update tapes for approximately thirty-eight thousand five-digit ZIP codes. The tape is available from the National Technical Information Service. FIPS PUB 55-1 is used by many Federal agencies in analysis of data by geographic location and in other data administration functions.

OFFICE SYSTEMS ENGINEERING

Standards and technical assistance for information interchange among automated office systems were the focus of activities in this program area which was started in 1985. Support was provided to voluntary

standards committees developing Office Document Architecture/Office Document Interchange Format (ODA/ODIF) and the Standard Generalized Markup Language (SGML) Standards. Researchers started developing a reference parser and a validation suite for the SGML standard. The parser will identify the elements of an electronic document according to the rules of SGML and verify that the document conforms to its declared document type and to the specification of the SGML standard. The validation suite will be a collection of both conforming and non-conforming documents that will be submitted to a candidate SGML parser. Non-conforming documents submitted to the parser should produce error messages from the parser; conforming documents should not.

The SGML reference parser will serve as a guide for implementors to develop their own implementations of the SGML standard and will expedite the development of SGML products. The SGML validation suite will ensure that these products meet the specification of the SGML standard. A reference implementation and validation suite were also started for the ODA standard.

The SGML standard provides for the specification and tagging of the logical elements of a document and the specification of the relationships of the elements to each other. This standard will enable the text and format of a document produced on a personal computer or word processor to be preserved and enable parts of the text or the entire document to be interchanged, stored, and retrieved as required. The ODA standard provides a logical structure for the content of an office document, and will enable documents to be revised, processed, and interchanged without changing the structure.

A guide to aid computer users in establishing electronic bulletin board systems was completed. Electronic Bulletin Boards (NBSIR 86-3356) discusses hardware, software, and communications requirements. Bulletin boards are computer services that enable callers with microcomputers or terminals with communications capabilities to post and read messages, and to transfer files to and from the service. Usually implemented on microcomputers connected to a public telephone, network electronic bulletin boards are used for dissemination of information and message exchange.

Available technology for personal computer communication and peripheral sharing was described in Personal Computer Networks (NBS Spec. Pub. 500-140). This report is oriented toward users to aid in the evaluation and selection of computer networks and services. Information is presented on networks which are designed specifically to meet the needs of personal computer or workstation users, as well as networks composed of personal computers connected to existing communications systems, such as a telephone system, or a network designed for large computers.

A personal computer network model is described in terms of the user's needs and expectations for network functions. These include tasks such as file service, print service, mail, messaging and conferencing, log in, remote task execution, and distributed services. Current off-the-shelf technology does not provide all of the features of the personal computer network model today, and organizations must provide the missing hardware and/or software components. However, the model provides a basis for identifying requirements for networks and helps the user find solutions to networking problems using today's technology.

HIGH PERFORMANCE COMPUTING

ICST has been investigating methods for measuring the performance of parallel processing systems, their architectures and their support environments. Multiprocessor systems are being used to increase performance and reduce cost of processing data. However, current methods for measuring performance are inadequate and cannot express the complex relationships between the hardware and the software.

This project has been partially funded by the Defense Advanced Research Projects Agency (DARPA). Two reports were completed for DARPA. The first, Performance Measurement Techniques for Multi-Processor Computers (NBSIR 85-3296), describes the various aspects of a multi-processor system that can be measured such as processor speed, memory caches and local memory, switching methods, buses, queues, processes, variables, and instructions.

The second report, Simple Multi-Processor Performance Measurement Techniques and Examples of Their Use (NBSIR 86-3416) describes techniques that automate the collection and analysis of information about processing events using a minimum amount of code imbedded in the users' system software. At selected test points in the programs, the code triggers processors to write events to a board called the Event Data Card, which has been installed in the normal input/output space of the system. Only a few microseconds are required for the computer being measured to execute each statement.

While this approach causes minimal perturbation to the execution of programs, there is still an effect on system operation due to the measurement process. To address this problem, research was started to develop special hardware that will collect data from many points in the system under test. Signals from these points will be divided into groups, and each group fed into a preprocessor which will perform extensive reduction and interpretation of data. The preprocessors will run independently, but when any one activates a trigger mechanism, they will cooperate to place a record of the system state

into a large memory from which further analysis can be performed. Continued development of this measurement system is planned to collect measurement data without perturbation of the system under test.

Problems related to measurement and evaluation of parallel computers were discussed by experts from industry, government, and academia at a workshop held in June 1985. Reports of the discussions held at the workshop are included in NBSIR 86-3395, National Bureau of Standards Workshop on Performance Evaluation of Parallel Computers. One of the points of discussion was the need for a library of benchmark programs that are available for evaluating processor performance. A collection of such programs donated to ICST has been made available to users through the ARPANET. The benchmark collection provides challenging computational problems that can be used to evaluate the efficiency of a system's design and its software.

NETWORK STANDARDS

ICST has been working with more than 150 organizations to get standards for Open Systems Interconnection (OSI) implemented in off-the-shelf products that users can buy. OSI describes an architecture for computer networks and a family of standards to make it possible for different manufacturers' equipment and systems to be interconnected for distributed processing.

Despite the widespread use of computers in factories and offices, it is often difficult to integrate and transfer information between systems. Computers are often incompatible with one another, and data cannot be exchanged between different equipment, systems, and applications.

OSI standards provide a set of rules (protocols) by which information processing devices communicate with one another in a network. While the engineering required to develop these complex rules is significant, the task can be done once in a standard way, used by many organizations, and not repeated or reinvented every time that a network is designed.

International standards for OSI have been and are continuing to be developed by the International Organization for Standardization (ISO) and the Consultative Committee on International Telephone and Telegraph (CCITT) with the support of computer manufacturers, communication carriers, large users, and governments of countries such as the U.S., France, Canada, U.K., Japan, and West Germany. Many computer manufacturers are supporting this effort to avoid expensive network architecture development for different users. Instead, resources can be put into new products that will expand the computer

market. Other organizations supporting OSI include the American National Standards Institute (ANSI), European Computer Manufacturers Association (ECMA), Institute of Electrical and Electronics Engineers (IEEE), and ICST.

In February 1983, ICST organized a workshop for implementors of OSI. The workshop met five times in 1986 bringing together users and potential suppliers of OSI protocols enabling them to jointly develop the detailed implementation specifications upon which compatible commercial products will be based. The workshop is an open international forum, and representatives of more than 200 computer manufacturers, semiconductor manufacturers, word processing vendors, process control vendors, communication carriers, and industry and government users from the U.S., Canada, and Europe participate.

To cut the enormous development effort down to manageable size, the workshop participants identify activities and events where implementation specifications can be applied and progress made in product development. Standards are selected for implementation, and decisions are made on what and how to implement. Special interest groups focus on specific application areas such as file transfer and messaging. The workshop has inaugurated several special events and has had a role in the adoption of ISO standards by large user organizations. The Manufacturing Automation Protocol (MAP) and the Technical and Office Protocol (TOP) being used by General Motors (GM) and Boeing Computer Systems (BCS) respectively are subsets of OSI standards derived from the workshop. Several hundred user companies are also implementing these MAP and TOP specifications.

In the past the activities of the workshop led to two demonstrations of OSI products: the 1984 National Computer Conference demonstration of a limited group of network standards and the more extensive demonstration of standards at AUTOFACT '85, a major trade show.

OSINET

The 1986 activity stemming from the workshop was the development of OSINET, an experimental computer network for OSI standards. Twenty-seven organizations joined this effort: Amdahl; AT&T; Boeing Computer Services; Charles River Data Systems; Defense Communications Agency; Digital Equipment Corp.; General Motors; Hewlett Packard; Honeywell; ICST; IBM; ICL; Industrial Networking Inc.; NCR; Comten; OMNICOM; Protocom Devices; Retix; Sperry; System Development Corporation; Tandem Computers Inc.; The Analytic Sciences Corp.; U.S. Department of Agriculture; U.S. Department of the Navy; Wang Laboratories, the University of Wisconsin-Madison, and Wollongong Group. A 25-member OSINET Steering Committee manages the network and plans its activities.

OSINET was developed for use in building and verifying conformance and performance test tools for OSI protocols; for cooperative testing of products and services that implement OSI standards; for the development of test services; and for research supporting the development of OSI standards.

The technical features of OSINET are: OSINET is geographically distributed. Long-haul services are provided by private and/or public sub-networks offering services that conform to CCITT recommendation X.25. Local environments include standard local area networks (LAN) and other subnetworks.

With the assistance of IBM, ICST developed a Network Information Center (NIC) which can be accessed by OSINET participants. IBM donated a Series 1 computer, an operating system, and full set of protocols for the NIC, and provided technical assistance in setting up the NIC. Initial services provided by the NIC include descriptions of NIC files, file naming conventions, information about OSINET members and their systems, and addresses for the members systems. Ed Strum of IBM provided the technical assistance in setting up the NIC under a cooperative work agreement with ICST.

Agreements governing the operation of OSINET were published as NBSIR 86-3478, Implementation Agreements Among Participants of OSINET. The report describes the organization of OSINET and its steering committee, the protocols and services to be implemented by participants, and the X.25 services to be used. It also provides information about the site configurations, locations, protocols and points of contact for each of the participating organizations.

Also published were the agreements reached by the implementors' workshop. NBSIR 86-3385, Implementation Agreements for Open Systems Interconnection Protocols, documents the work done to develop the technical basis for the compatible OSI products.

ICST established cooperative relationships with industry groups supporting OSI standards including MAP/TOP users and the Corporation for Open Systems (COS), a new private sector venture to advance the use of OSI standards.

Government OSI Users

To assist the Federal government in its use of OSI standards, Secretary of Commerce Malcolm Baldrige announced a new interagency committee, the Government OSI Users Committee, in September 1986. Representatives of 15 Federal agencies and departments met at NBS in September 1986 and adopted a program of work that includes:

- developing a specification based on OSI standards to enable Federal agencies to plan for and acquire OSI systems. This specification was expected to be completed in early 1987.

- cooperating with industry to accelerate the development of OSI products that meet Federal government requirements, and

- identifying future Federal government requirements for standards and focusing government resources to meet those requirements through the voluntary standards process.

NETWORK PROTOCOLS RESEARCH

ICST and COMSAT continued their joint research to evaluate and improve the operation of the ISO transport protocol for use over satellite channels. As a result of previous experiments, improvements to the acknowledgement procedures and expedited data transmission mechanism of the transport protocol were submitted to U.S. standards bodies by ICST and COMSAT. The improvements were adopted as U.S. positions for International Organization for Standardization (ISO) and CCITT working documents.

The second phase of the live satellite experiments started testing full-duplex data transfer, multi-connection operation, and several new schemes for expedited data transmission. As a secondary experiment a newly developed small earth terminal will be tested by COMSAT. Later phases of this cooperative effort may examine the performance of the internetwork protocol and higher layer protocols over satellite channels, and evaluation of integrated services digital network standards now under consideration by standards bodies.

Further work on the performance of the transport protocol over X.25 networks was conducted in cooperation with the postal, telegraph and telephone agency of Spain. An analytical model of performance was developed and presented at a 1986 technical conference of the IEEE.

Research continued to evaluate the real time performance characteristics of OSI protocols, resulting in improvements to the Manufacturing Automation Protocol (MAP) architecture. Cooperating in this research were guest scientist, Cornelis Franx of N.V. Philips and Intel Corp., which donated hardware and software.

ICST supported the development of Estelle - A Formal Description Technique Based on an Extended State Transition Model which was published by ISO as a draft standard. Researchers developed a

prototype compiler for Estelle and a users guide for the compiler, which translates formal descriptions written in Estelle into the C language. Use of Estelle and the compiler enable the partial automation of the standards development process for network protocols.

Work continued in research in the integration of network technologies. Aided by guest workers from industry, ICST developed a test method to insure that modem and headend equipment from different manufacturers can communicate using the IEEE standard 802.4, Broadband Token-Passing Bus physical layer protocol. By transmitting and receiving various test frames, modems from various manufacturers were tested against headend equipment from other manufacturers. The equipment was donated by industry. The test methods make it possible for vendors to know whether the complex protocols are being implemented correctly.

COMPUTER SYSTEM INTERFACES

ICST has had a long-term effort to develop standards for data communications and computer interfaces. More than 25 existing FIPS are concerned with these functions.

In 1986, a revision to joint FIPS PUB 100/Federal Standard 1041 was proposed to adopt changes in technical specifications for the interface between data terminal equipment and data circuit-terminating equipment for operating with packet-switched data networks. These technical specifications were developed and approved by the International Telegraph and Telephone Consultative Committee (CCITT) and the International Organization for Standardization (ISO). This revised standard will help to assure the compatibility and interoperability of Federal computer and telecommunications equipment and services that use packet switched technology. The proposed revision will adopt a voluntary industry standard, ANSI X3.100-1986, which in turn adopts CCITT Recommendation X.25 (1984), ISO 7776 and ISO 8208.

Also issued was FIPS PUB 122, Conformance Tests for FIPS PUB 100/FED-STD 1041 Version of CCITT 1980 Recommendation X.25, Interface Between Circuit-Terminating Equipment (CDE) for Operation with Packet-Switched Data Communications Networks. The conformance tests are for use by test evaluators, test suite designers or implementors, and by organizations that are acquiring telecommunications facilities or services based on the CCITT Recommendation X.25. FIPS PUB 100/FED STD 1041 is the government's standard for interfacing data terminals and computers to public data networks operating in packet mode. The tests provide uniform verification testing and unambiguous evaluation procedures to be applied by vendors and suppliers whose equipment must interwork.

The Secretary of Commerce approved the adoption of the joint American National Standard X3.110/Canadian Standard CSA T500, Videotex/Teletext Presentation Level Protocol Syntax (North American PLPS), as Federal Information Processing Standard 121. The standard describes the formats, rules, and procedures for encoding of alphanumeric text and pictorial information for videotex and teletext applications. Developed with ICST assistance through the voluntary industry standardization process, this standard will improve the interchange of text and pictorial information between Federal agencies and other private sector and government organizations.

ICST staff assisted in the development of a NAPLPS Conformance Testing Package in cooperation with Accredited Standards Committee X3L2 and the Canadian Standards Association. The test package will be used by videotex/teletext equipment manufacturers and vendors to assure that their products conform with the standard.

ICST has been providing technical assistance to a new generation of input/output (I/O) interface standards. These new interface standards are expected to produce large dollar savings for both users and suppliers of computer equipment. About one quarter to one half or more of the total hardware costs of computer systems are spent on mass storage peripherals for personal computers, minicomputers, and large systems. About $25 billion is expected to be spent on rigid magnetic disks in 1989.

User requirements for tape drive products, cartridge streaming devices, and flexible magnetic disks are mounting with the increased use of computers throughout government and industry. The mass storage industry is becoming a commodity-oriented industry.

I/O interface standards are the key to this trend. A few years ago computer system vendors frequently used proprietary interfaces for storage peripherals; today a large proportion of computer systems use one of the existing I/O interface standards. In the future most will do so. This is largely because system vendors, even vendors with storage peripheral manufacturing capability, can lower prices and offer their customers better systems by using standard interfaces and commodity peripherals. Users are beginning to push for the standards that they need in order to buy commodity storage devices in quantity and to attach them to many different computer systems.

Two new interface standards for connecting computers to mass storage devices such as magnetic disk and tape devices were proposed as FIPS. The standards were proposed as alternatives to FIPS PUB 60, I/O Channel Interface, associated power control and operational specifications, and FIPS PUB 111, Storage Module Devices.

The proposed standards are:

- Intelligent Peripheral Interface (IPI); adopts ANSI X3.129-1986; X3.147-1986; X3.132-1986; and X3.130-1986. IPI is a 16-bit parallel master-slave interface which allows transfer rates up to 10M bytes/s. It consists of a bus standard and separate device command set standards.

- Small Computer System Interface; adopts ANSI X3.131-1986. SCSI is a general purpose interface suitable for connecting up to eight computers and "intelligent" peripherals (peripherals with internal controllers) to form a computer system.

These new standards, which address different interface technologies or market classes, were developed with ICST assistance by Accredited Standards Committee X3T9, I/O Interfaces. Other new interface standards will be added to the family as they are developed by the voluntary standards community.

COMPUTER STORAGE MEDIA

ICST has been actively involved in the development of test methods for computer storage media since the late 1960's. In addition to participating in the development of voluntary industry standards for storage media, ICST provides calibration services, develops measurement methods and standards reference materials, and carries out research in the properties and characteristics of the media.

Reference measurement systems and reference materials are needed to support the standards that are developed for tapes, disks, and cartridges. ICST has developed and maintained such reference services for 6 different types of magnetic media. Standard reference materials are used to evaluate the performance of media and systems and to maintain quality control over their production. NBS and the Physikalisch-Technische Bundersanstalt (PTB) in West Germany are the only organizations worldwide providing these services. To focus the efforts of both organizations more effectively, ICST agreed to concentrate on developing new standard reference materials for magnetic tape products while PTB concentrates on reference materials for flexible disk cartridges. ICST also plans to develop standard reference materials for optical digital data disks.

The sixth Standard Reference Material (SRM) to be completed by ICST was issued in 1986 as SRM 3217. The new reference material supports

the following voluntary industry standards for high density magnetic tape cartridges.

- American National Standard X3.127-198X, Unrecorded Magnetic Tape Cartridge for Information Interchange, 0.250 in (6.30 mm), 6400-10 000 ftpi (252-394 ftpmm).
- American National Standard X3.116-198X, Recorded Magnetic Tape Cartridge for Information Interchange, 4-Track, Serial, 0.250 in (6.30 mm), 6400 bpi (252 bpmm), Inverted Modified Frequency Modulation Encoded.
- American National Standard X3.136-198X, Serial Recorded Magnetic Tape Cartridge for Information Interchange, Four and Nine Track, 0.250 in (6.30 mm), 8000 bpi (315 bpmm) Streaming Mode Group Code Recording.
- International Organization for Standardization Standard, ISO 8063/1&2.
- International Organization for Standardization Standard, ISO 8462/1&2.
- European Computer Manufacturers Association Standard ECMA 79.
- European Computer Manufacturers Association Standard ECMA 98.

ICST researchers developed the testing and calibration procedures and the software support systems to produce this SRM.

A research program was started to investigate optical digital data disks (OD^3), their defect mechanisms, underlying causes, prevention, and effect on media operations and lifetimes. The goal of this multi-year research program is to develop experience in the care and handling of media and to develop standardized test methods for assuring data interchange and for predicting media lifetimes. Guidance will be issued to assist Federal agencies in selecting and evaluating these new systems.

The projected market potential for OD^3 media and their associated systems is estimated to be in the range of $700 million to $13 billion by 1990. OD^3 media offer vast data storage capacities on small surface areas and permit rapid on-line access to these data. OD^3 are removable media that have potential for interchange among systems and for long term preservation of data.

AUTOMATED SPEECH RECOGNITION

The ICST research in automated speech recognition includes development of performance measurement methodologies; creating, distributing and archiving speech databases; and investigation of continuous speech recognition methods.

Automatic speech recognition systems are used for inspection and inventory applications -- in which people must have their hands and eyes free to do their jobs -- and a variety of command and control applications -- in which voice input is used to control execution of a computer program or the operation of a machine. However, measuring and specifying the performance of this technology presents significant challenges.

Under partial funding by the Defense Advanced Projects Agency (DARPA), ICST is developing performance evaluation methods based on databases consisting of digitized speech and collected under well-controlled conditions. Within the past year, ICST has worked actively with the Air Force Aerospace Medical Research Laboratory and the Central Research Laboratories of Texas Instruments to define, collect and distribute a robust speech database. Since these databases are very large, the use of optical disk storage technology and data management techniques will be investigated.

Speech databases have been collected and made available in the public domain through ICST, typically on a "loan and copy" basis. Organizations, including Bell Laboratories, Stanford, Brown, and Indiana Universities are using these databases in their research projects.

Ongoing research in continuous speech recognition at ICST has been focused on the development of improved algorithms and software for phonetically-based recognition of speech. This work supports research in automated recognition of continuous speech being conducted at Carnegie Mellon University.

TECHNICAL ASSISTANCE

In addition to the technical assistance projects already discussed in connection with specific standards efforts, the following activities took place:

ICST completed its review of the technical aspects of automation within the Patent and Trademark Office. The review was conducted at

the request of the Deputy Secretary of Commerce as a step toward reaching the Secretary of Commerce's goal of a fully automated Patent and Trademark Office. ICST recommended improved planning for and implementation of hardware, software and communications systems. Other cooperative activities with the Department of Commerce included technical assistance on export control issues and technical exchanges on trade-related issues.

Technical assistance was provided to the Office of Management and Budget in the development of OMB's Five-Year Plan for Meeting the Automated Data Processing and Telecommunications needs of the Federal government. ICST developed a technology forecast and other portions of the plan.

The American National Standards Institute (ANSI) Board of Standards Review approved the Standard Format for the Exchange of Fingerprint Information, which was issued as ANSI/NBS-ICST 1-1986. Developed by ICST with assistance from users and vendors of fingerprint identification equipment, the standard specifies data formats which enable fingerprint information to be exchanged between different manufacturers' systems. ICST conducted the review of the standard under accreditation by ANSI as a canvass sponsor of information exchange standards. The standard addresses the problem of incompatibility between different systems that extract information from fingerprint images. This information relates to discrete features which are measured, described, and presented in different ways by different systems. The standard provides a way to convert data from one system to the form used by another. A new cooperative development effort was started for a benchmark standard for testing the performance of automated fingerprint information systems.

The Defense Logistics Agency began sponsoring a project in office document interchange and distributed transaction processing that complements other joint programs that ICST has with various DoD agencies. The first part of the project focuses on study and analysis of DLA's special requirements for data processing and related communication capabilities and identification of those standards that will support the requirements. Candidate standards include those for office document architecture (ODA), document interchange format (DIF), data descriptive file (DDF), and electronic data interchange (EDI). These standards build on existing and proposed network protocol standards and are consistent with the Open Systems Interconnection (OSI) reference model.

Issues to be addressed later in the study include interoperability between DLA and DLA customer sites, performance, and reliability of equipment and software. A requirements document will be developed for use in acquiring systems for distributed transaction processing. In

later phases of the project, a prototype facility will be developed to demonstrate hardware and software systems that support the concepts of distributed processing. Future plans include use of fiber optic technology for network interconnections.

Another DoD sponsored project that involves the integration of different systems is in support of the DoD Computer Aided Logistics Support (CALS) Program. ICST efforts aimed at identifying, enhancing, and accelerating the implementation of standards needed by DoD for electronic data transfer. Projects were funded in both ICST and the National Engineering Laboratory (NEL) and included work on IGES, for the transfer of engineering drawings; Computer Graphics Metafile (CGM) for the transfer of picture data; and Standard Generalized Markup Language (SGML) for the transfer of text.

ICST assisted the Defense Communications Agency in building gateways between Department of Defense protocols and Open Systems Interconnection (OSI) protocols. Researchers developed automated techniques to test implementations of protocols for conformance to OSI standards. This underlying research to develop testing methodologies for OSI standards was done in cooperation with industry and user organizations. When completed, the tests will be applied by manufacturers to help develop their products and by users to assure that the products conform to standards. DoD will use the tests to facilitate their conversion to OSI networks.

Assistance was provided to the National Telecommunications and Information Systems Security Committee established under National Security Decision Directive 145 to develop policies for safeguarding computer and telecommunications systems that process sensitive data.

Other major technical assistance projects included advisory services to the Air Force in the development of their United Local Area Network Architecture (ULANA), to the Navy in basic research in speech recognition, and to the FBI in automation of their fingerprint identification system.

ICST is assisting ISO's Technical Committee 97 by serving as the registration authority for computer graphics standards. Vendors of products register characteristics that vary across standards conforming implementations. This allows implementations using the same characteristics to reference them in the same way.

APPENDIX

SELECTED STAFF ACCOMPLISHMENTS

Department of Commerce awards for major contributions to Department programs were presented to:

Mabel V. Vickers	-	Gold Medal
Helen M. Wood	-	Silver Medal
David K. Jefferson	-	Bronze Medal
Gerard F. Mulvenna	-	Bronze Medal
Dennis D. Steinauer	-	Bronze Medal
Joan E. Wyrwa	-	Bronze Medal

ICST Director James H. Burrows was appointed to the Engineering Research and Development Committee of the Institute of Electrical and Electronics Engineers (IEEE). The committee reviews and comments on Federal government engineering programs. Burrows was also appointed the chair of an interagency group that is conducting a Computer Network Study for the Office of Science and Technology Policy. Requested by Congress, the study will address the networking needs of academic and Federal research computer programs over the next fifteen years. The study is being coordinated through the Federal Coordinating Council on Science, Engineering and Technology.

Helen M. Wood was appointed Vice President for Standards of the IEEE Computer Society, the largest society in the Institute for Electrical and Electronics Engineers with nearly 90,000 members world-wide. Wood was also elected to a two-year term on the Computer Society Governing Board, and was appointed Editor of the Standard Department for the IEEE Computer magazine.

Robert Rountree was appointed Vice President for Standards of the MAP (Manufacturing Automation Protocol) Users Group.

Allen L. Hankinson, Systems and Software Technology Division Chief, was appointed a member of a government/industry committee to review and develop revisions to the Department of Defense's Software Development Standard (DOD-STD-2167). Developed by DoD after eight years of work and an investment of about $20 million, the software development standard applies to the complex software of mission critical activities. One goal of the revision effort is to determine the potential applicability of the standard to other DoD functions. In addition, other government agencies, such as NASA, are interested in applying rigorous requirements for software development to their complex computer-dependent operations.

Leonard Gallagher was the convenor and the chair of a new technical committee of Accredited Standards Committee X3. The new committee, X3T2,

is addressing standards requirements for Presentation Transfer Syntax and Notation. Gallagher also participates in standards activities of X3H2, Database, and was the chair of a study group on data interchange which identified standards needs for data interchange between programming languages, office systems, open systems interconnection, graphics, database, and other software systems.

Software Validation, Verification, Testing, and Documentation, published by Petrocelli Books, Inc. was edited from six reports prepared by ICST. Issued as NBS Special Publications, these reports cover the overall software development process and explain the role of validation, verification, testing, and documentation in achieving quality software. ICST authors included staff members Roger Martin, Wilma Osborne, and Dolores Wallace.

Zella Ruthberg was a member of the U.S. EDP Audit Delegation that visited the People's Republic of China (PRC) and Hong Kong. The visit was initiated by the Chinese Computer Society, arranged by the Citizen's Ambassador Program of People to People International, and hosted by the Chinese Association for Science and Technology (CAST).

David Pallett's article, "Performance Assessment of Automatic Speech Recognizers," originally published in the NBS Journal of Research (Volume 90, Number 5, September-October 1985), was included as a chapter in Electronic Speech Recognition - Techniques, Technology, and Applications. Published in the United Kingdom by Collins Professional and Technical Books, and in the U.S. by McGraw-Hill, the book was edited by Dr. Geoff Bristow as a companion volume to an earlier work.

Care and Handling of Computer Magnetic Storage Media (NBS Spec. Pub. 500-101) by Sidney B. Geller was used as the basis for Magnetic Media Archival Recommendations issued by the International Council on Archives. The Recommendations were prepared and issued at the request of the council's Automation Committee to prevent media and data loss due to faulty handling. The introduction to the Recommendations commends Geller's "comprehensive research and consolidation of information" on computer media. Issued in 1983, Care and Handling of Computer Magnetic Storage Media recommends good practices for physical care and handling, protection from adverse environmental conditions, proper storage and transportation of media, and recovery of damaged media and data. The Government Printing Office has sold several thousand copies of the publication. It is also used as the basis for the General Services Administration's guidance to Federal agencies.

Fernando L. Podio was elected an Associate Member by the National Bureau of Standards' Chapter of the Scientific Research Society Sigma-Xi and was appointed as the Chair of the CD-Data Disc Drive/Media Evaluation Group of the Special Interest Group on CD-ROM Applications and Technology (SIGCAT).

PARTICIPATION IN VOLUNTARY STANDARDS COMMITTEES

ICST staff members participate in more than 70 voluntary standards committees, including the following:

- American National Standards Institute
  - Information Systems Standards Board (Chair)
  - T1 Telecommunications
  - X3 Information Processing Systems
    - International Advisory Committee
      - U.S. TAG for ISO/TC97/SC21
      - U.S. TAG for ISO/TC97/SC7
    - Standards Planning and Requirements Committee
      - Programming Languages Study Group
      - Database System Study Group
- CBEMA Standards Policy Management Committee for ANSI/X3
- ANSI/X3 technical committees for:
  - Data communications
  - Open systems interconnection
  - Computer graphics
  - BASIC
  - COBOL
  - Data representation
  - Information resource and dictionary system
  - Digital magnetic tape
  - Magnetic instrumentation tape
  - Magnetic disks
  - Flexible cartridge disks
  - Codes and character sets
  - Optical digital data disk
  - I/O Interface
  - Data encryption
  - Office systems
  - Optical character recognition
  - Database
  - Labels and file structure
  - Project documentation
  - Vocabulary
- ANSI/X9 technical committee for financial key management
- ANSI/X12 technical committee for electronic business data interchange
- International Organization for Standardization technical committees for:
  - Office systems
  - Open systems interconnection

PARTICIPATION IN VOLUNTARY STANDARDS COMMITTEES
(Contd.)

- Data communication
- Flexible magnetic media
- Character sets and coding
- Interconnection of equipment
- Micrographics
- Programming languages

Institute for Electrical and Electronics Engineers
- Standards Board
- Local area network standards
- Operating systems
- Computer Society Standards Activities Board
- Software Engineering Standards
  - Software reliability
  - Software maintenance
  - Configuration management
  - Software quality metrics
  - Software validation, verification and testing

ASTM Security Systems and Equipment

ANSI/PH 1 Photographic Films, Plates and Papers technical committees

ANSI/PH 5 Micrographic Reproduction

American Society for Testing Materials technical committees

European Computer Manufacturers Association technical committees

Federal Interagency Coordinating Committee on Digital Cartography

Federal Telecommunications Standards Committee

Federal COBOL Task Group

U.S. Board on Geographic Names

Consultative Committee on International Telegraph and telephone technical committee
- Data Communications Networks

ICST staff members hold positions as officers, international representatives, and technical advisors in 18 committees.

ICST RESEARCH ASSOCIATES AND GUEST WORKERS

FY1986

Research Associates 2

Digital Equipment Corp.
Manager Software Products

Guest Workers 29

Organizations represented included:

Agence de Informatique, France
Atlantic Research Corp.
Department of Treasury
Electrotechnology and Telecommunications Institute, Korea
Fairchild Data Corp.
General Motors
IBM
Industrial Technology Institute
Korea Standards Research Institute
National Security Agency
Philips Co., Netherlands
Tektronix Corp.
Tsinghua University, China
University of Bordeaux, France
University of Loughborough
Post-Telecommunications Science Research Institute of Heilongjiang, China
Vance Systems

Faculty Appointments

University of Delaware
University of Maryland
University of Massachusetts
Worcester Polytechnic Institute

PUBLICATIONS

COMPUTER SCIENCE AND TECHNOLOGY SERIES
FY1984 - FY1986

NBS Spec. Pub.	Title
500-105	Guide to Software Conversion Management Mark Skall, Editor SN 003-003-02515-1 $6.50
500-106	Guide on Software Maintenance By Roger J. Martin and Wilma Osborne SN 003-003-02535-6 $2.50
500-107	A Bibliography of the Literature on Optical Storage Technology By James R. Park SN 003-003-02539-9 $4.50
500-108	Guide on Data Models in the Selection and Use of Database Management Systems By Leonard J. Gallagher and Jesse Draper SN 003-003-02543-7 $3.00
500-109	Overview of Computer Security Certification and Accreditation By Zella Ruthberg and William Neugent SN 003-003-02567-4 $1.50
500-110	Microcomputers: Introduction to Features and Uses By M. Hecht, H. Hecht, and L. Press SN 003-003-02560-7 $4.25
500-111	Standardization Issues for Optical Digital Data Disk (OD^3) Technology By Jean B. Freedman, Editor PB 84217785 $22.95
500-112	Selection of Microcomputer Systems By John Barkley, Dennis Gilbert, and Al Hankinson SN 003-003-02553-4 $1.50
500-113	Assessment of Techniques for Evaluating Computer Systems for Federal Agency Procurements By H. Letmanyi SN 003-003-02561-5 $2.00

SN numbers - stocked by GPO
PB numbers - stocked by NTIS

NBS Spec. Pub.	Title
500-114	Introduction to Software Packages Sheila Frankel, Editor SN 003-003-02569-1 $2.25
500-115	Report on Approaches to Database Translation By Leonard Gallagher and Sandra Salazar SN 003-003-02583-6 $3.25
500-116	Toward an Improved FIPS Cost-Benefit Methodology, Phase II: Descriptive Models -- General Purpose Application Software Development and Maintenance By Mary Lou Chipman, Marco Fiorello, Monty Snead, Peg Kay, and Patricia Powell SN 003-003-02591-7 $2.25
500-117	Selection and Use of General Purpose Programming Languages By John Cugini Volume 1 - SN 003-003-02612-3 $3.00 Volume 2 - SN 003-003-02163-1 $5.50
500-118	A Guide to Performance Evaluation of Database Systems By Daniel R. Benigni PB 155794 $11.95
500-119	Future Information Technology - 1984: Telecommunications By Peg Kay and Patricia Powell, Editors SN 003-003-02626-3 $9.50
500-120	Security of Personal Computer Systems: A Management Guide By Dennis D. Steinauer SN 003-003-02627-1 $3.00
500-121	Guidance on Planning and Implementing Computer Systems Reliability By Lynne S. Rosenthal SN 003-003-02628-0 $2.25
500-122	Guide on Logical Database Design Elizabeth N. Fong, Margaret W. Henderson, David K. Jefferson, Joan M. Sullivan, Editors SN 003-003-02631-1 $4.50
500-123	Guide on Workload Forecasting By Helen Letmanyi SN 003-003-02634-4 $3.00

SN numbers - stocked by GPO
PB numbers - stocked by NTIS

NBS Spec. Pub.	Title
500-124	A Topological Approach to the Matching of Single Fingerprints: Development of Algorithms for Use on Rolled Impressions By Malcolm K. Sparrow and Penelope J. Sparrow SN 003-003-02656-5 $3.00
500-125	Issues in the Management of Microcomputer Systems By John Barkley and Lynne S. Rosenthal SN 003-003-02678-6 $2.25
500-126	A Topological Approach to the Matching of Single Fingerprints: Development of Algorithms for Use on Latent Fingermarks By Malcolm K. Sparrow and Penelope J. Sparrow SN 003-003-02680-8 $2.25
500-127	Workshop on Analytical and Simulation Modeling of IEEE 802.4 Token bus Local Area Networks Editor, Robert Rosenthal SN 003-0903-02660-3 $9.50
500-128	Starting and Operating a Microcomputer Support Center By Ted Landberg and Stanley Winkler SN 003-003-02683-2 $1.75
500-129	Software Maintenance Management By James A. McCall, Mary A. Herndon and Wilma M. Osborne SN 003-003-02681-6 $2.75
500-130	Executive Guide to Software Maintenance By Wilma M. Osborne SN 003-003-02685-9 $1.00
500-131	Guide for Selecting Microcomputer Data Management Software By Charles Sheppard SN 003-003-02682-4 $2.50
500-132	Benchmark Analysis of Database Architectures: A Case Study Daniel R. Benigni, Editor SN 003-003-02684-1
500-133	Technology Assessment: Methods for Measuring the Level of Computer Security By William Neugent, John Gilligan, Lance Hoffman, and Zella G. Ruthberg SN 003-003-02686-7 $8.00

SN numbers - stocked by GPO
PB numbers - stocked by NTIS

NBS Spec. Pub.	Title	
500-134	Guide on Selecting ADP Backup Processing Alternatives By Irene Isaac SN 003-003-02701-4	$1.75
500-135	Integrated Software for Microcomputer Systems By Lynne S. Rosenthal SN 003-003-02711-1	$1.75
500-136	An Overview of Acceptance Testing of Computer Software By Dolores Wallace SN 003-003-02172-0	$1.00
500-137	Security for Dial-Up Lines By Eugene F. Troy SN 003-003-02723-5	$3.75
500-138	A Functional Model for Fourth Generation Languages By Gary Fisher SN 003-003-02731-6	$2.25
500-139	Data Base Directions Information Resource Management -- Making It Work Elizabeth Fong and Alan Goldfine, Editors SN 003-003-02738-3	$9.00
500-140	Personal Computer Networks By John Barkley SN 003-003-02746-4	$3.25
500-141	Annotated Bibliography on Software Maintenance By Wilma M. Osborne and Ron Raigrodski SN 003-003-02756-1	$6.50
500-142	A Management Overview of Software Reuse By William Wong SN 003-003-02757-0	$1.50
500-143	Guide to the Selection and Use of Fourth Generation Languages By Martha M. Gray SN 003-003-02758-8	$3.25
500-144	Guidance on Software Package Selection Edited by Sheila Frankel SN 003-003-02773-1	$6.00

SN numbers - stocked by GPO
PB numbers - stocked by NTIS

OTHER NBS PUBLICATIONS

FY 1984 - FY 1986

Pub. Number	
NBSIR 84-2966	An IEEE 802.4 Token Bus Network Simulation By Jean-Luc Archambault October 1984 PB 85-137735 $11.50
NBSIR 84-2984	Minutes of the Seventh NBS Workshop for Implementors of OSI By Kenneth Dymond November 1984
NBSIR 84-2985	Minutes of the Sixth Workshop for Implementors of OSI By Robert Toense November 1984
NBSIR 85-3104	Performance Measurement of OSI Class 4 Transport Implementation By Kevin Mills, C.M. Chernick, and J.W. Gura October 1984 PB 85-177657 $11.95
NBSIR 85-3113	Annotated Bibliography of Recent Papers on Software Engineering Environments By Raymond Houghton and Dolores R. Wallace February 1985 PB 85-191385 $11.95
NBSIR 85-3138	Metrics and Techniques to Measure Microcomputer Productivity By Wilma M. Osborne and Lynne Rosenthal March 1985
NBSIR 85-3141	COMSAT/NBS Experiment Plan for Transport Protocol By Richard Colella, Marnie Wheatley, and Kevin Mills April 1985
NBSIR 85-3164	A Technical Overview of the Information Resource Dictionary System Alan H. Goldfine and Patricia A. Koenig March 1985 PB 85-224491 $16.95
NBSIR 85-3165	Using the Information Resource Dictionary System Command Language By Alan H. Goldfine April 1985 PB 85-227783 $11.95

SN numbers - stocked by GPO
PB numbers - stocked by NTIS

Pub. Number	Title
NBSIR 85-3173	Reference Model for DBMS Standardization By David K. Jefferson and Elizabeth N. Fong May 1985 PB 85-225217 $11.95
NBSIR 85-3236	An NBS Host to Front End Protocol By C. M. Chernick August 1985 PB 85-113966 $11.95
NBSIR 85-3250	Characteristics and Functions of Software Engineering Environments By Raymond Houghton, Jr. and Dolores Wallace September 1985 PB 129749 $9.95
NBSIR 85-3296	Performance Measurement Techniques for Multiprocessor Computers By John W. Roberts February 1986 PB 86-186855 $11.95
NBSIR 86-3324	Data Administration Workshop Proceedings By Frankie Spielman February 1986 PB 86-191152 $22.95
NBSIR 86-3356	Electronic Bulletin Boards By Ted Landberg April 1986 PB 86-197209 $9.95
NBSIR 86-3361	GRIDNET: A Highly Survivable Digital Communications Network By A. Mink, G. Nacht, A. L. Koenig, and A. Holt Order from NTIS
NBSIR 86-3385	Implementation Agreements for Open Systems Interconnection Protocols Jerry Mulvenna, Editor April/May 1986 Available from NTIS
NBSIR 86-3386	Work Priority Scheme for EDP Audit and Computer Security Review By Zella Ruthberg and Bonnie Fisher August 1986 PB 86-247897 $11.95
NBSIR 86-3395	National Bureau of Standards Workshop on Performance Evaluation of Parallel By Sandra B. Salazar and Carl H. Smith July 1986 PB 86-244175 $11.95
NBSIR 86-3407	An Experiment in Software Acceptance Testing By Dolores R. Wallace July 1986 PB 247590 $11.95

SN numbers - stocked by GPO
PB numbers - stocked by NTIS

Pub. Number	Title
NBSIR 86-3408	Study of a Prototype Software Engineering Environment By Dolores R. Wallace and D. Richard Kuhn June 1986 PB 245263 $9.95
NBSIR 86-3416	Simple Multiprocessor Performance Measurement Techniques and Examples of Their Use By Alan Mink, John W. Roberts, Jesse M. Draper, and Robert J. Carpenter July 1986 Available from NTIS

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PB numbers - stocked by NTIS

PAPERS AND OTHER PUBLICATIONS

OCTOBER 1985 - SEPTEMBER 1986

Dymond, Kenneth. Benchmarking. Encyclopedia of Computer Science and Technology, Publisher - Mercel Dekker, Inc. Editor - Allen Kent, Univ. of Pittsburgh. To be published.

Troy, Eugene. Addressing the Telephone Intrusion Threat. Proceedings of the 4th Intenational IFIP/SEC Conference on Computer Security, North-Holland Publishers. December 1986.

Osborne, Wilma, and Martin, Roger. Building and Sustaining Maintainable Software. Journal of Systems and Software, Elsevier Science Publishing Co., Inc. To be published. February 1987.

Osborne, Wilma. Sustaining Maintainable Software. COMPSAC '86 Proceedings. October 1986.

Branstad, Dennis. Considerations for Security in the OSI Architecture. Proceedings of IBM Europe Conference on OSI. 1986.

Blanc, Robert. NBS Program in Open Systems Interconnection (OSI). Proceedings of IBM Europe Conference on OSI. 1986.

Steinauer, Dennis. Securing Your PC - Which Security Devices You Should Select. Government Data Systems. September/October 1986.

Smid, Miles; Barker, Elaine; and Balenson, David. The National Bureau of Standards Message Authentication Code (MAC) Validation System. Proceedings of the 9th National Computer Security Conference. September 1986.

Fong, Elizabeth; Goldfine, Alan. Data Base Directions: Information Resource Management - Making It Work. ACM SIGMOD Record. September 1986. IEEE Computer Society Database Engineering Bulletin. June 1986.

Skall, Mark. NBS' Role in Computer Graphics Standards. IEEE Computer Graphics and Applications. August 1986.

Wolf, David; Nugent, Edward; Douglas, Robert; Rosenthal, Robert. Interframe Timing and Preamble Length Measurement of an IEEE 802.4 Token Bus Local Bus Area Network Implementation. To be published.

Fong, Elizabeth; Jefferson, David. Progress Report on the Development of a Reference Model for Distributed DBMS. Proceedings 25th Annual Technical Symposium of the Washington, D.C., Chapter of the ACM. June 1986.

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Wood, Helen. Emerging Software Standards: Opportunity and Challenge. Proceedings of IEEE Computer Standards Conference 1986, IEEE Computer Society Press. May 1986.

Wallace, Dolores; Daughtrey, Taz; Fufii, Roger. Case History: Development of a Software Standard. Proceedings for the IEEE Computer Standards Conference 1986. May 1986.

Fong, Elizabeth; Jefferson, David. Reference Models for Standardization. Proceedings of Computer Standards Conference -1986, San Francisco, CA. May 1986.

Moore, R.T.; McCabe, R.M. Standards Format for the Exchange of Fingerprint Information. Carnahan Conference on Security Technology. May 1986.

Saltman, Roy. Data Element Standards: Communication Standards for End Users. Proceedings of the IEEE Computer Standards Conference - 1986. May 1986.

Wallace, Dolores. Federal Software Engineering Standards Program. Proceedings of Pharmaceutical Manufacturers' Association Computer System Validation Conference. April 1986.

Rosenthal, Lynn. A Guide to Integrated Software Government Data Systems. April/May 1986.

Lyon, Gordon. Programming the Parallel Processor. Proceedings of the Second Symposium on the Role of Language Problem Solving, North-Holland (Amsterdam). To be published.

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Hieronymus, James; Majurski, William. Compensating for Vowel Coarticulation in Continous Speech Recognition. Proceedings of Workshop on Speech Recognition. February 1986. Proceedings of ICASSP '86. April 1986.

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Smid, Miles. Using DES in IBM PC Compatible Workstations. Proceedings of 1986 IEEE Workstation Technology and Systems Conference. March 1986.

Blanc, Robert. Closing the Gap Between OSI Standards and Compatible OSI Products. Computer Magazine. March 1986.

Lyon, Gordon. A Tagless Marking That Is Linear Over Subtrees. Information Processing Letters. To be published.

Linn, Richard; Favreau, Jean-Philippe. Automatic Generation of Test Scenarios from Protocol-Specificatons Written in Estelle. To be published.

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Kuhn, Richard; Weiser, Mark. Formal Semantics and Program Modification. To be published

Linn, Richard. Testing to Assure Interworking of Implementations of ISO/OSI Protocols. To be published.

Wallace, Dolores. The Validation, Verification, and Testing of Computer Software. Proceedings of Conference on Software Maintenance - 1985. November 1985.

Goldfine, Alan. The Information Resource Dictionary System. The Fourth International Conference on Entity-Relationship Approach. October 1985.

Goldfine, Alan; Konig, Patricia. A Technical Overview of the Information Resource Dictionary System. Computers and Standards, Vol. 4, No. 3, 1985.

CONFERENCES AND WORKSHOPS

October 1985 - September 1986

DATE-1985	EVENT
September 30-October 3	Eighth National Computer Security Conference; cosponsored by DOD Computer Security Center
October 4	Federal Risk Management Workshop; cosponsored by DOD Computer Security Center and HQ US Air Force/SITT
October 16-18	Software Testing Conference; cosponsored by National Security Industrial Association, Department of Defense, IEEE Computer Society, Association for Computing Machinery, and Electronics Industry Association
October 21	Federal Council on Computer Storage Standards and Technology
October 22-24	Workshop on Fingerprint Information Standards; cosponsored by International Association of Identification
October 31	Seminar on Open Systems Interconnection Standards; cosponsored by Computer and Business Equipment Manufacturers Association
November 4-8	Meeting of ISO Database Working Group
November 11-13	Conference on Software Maintenance; cosponsored by IEEE Computer Society, Data Processing Management Association, Association for Women in Computing and Software Maintenance Association
November 13-15	Application Development Productivity Workshops
December 9-12	Workshop for Implementors of OSI
1986	
February 2-6	Meeting of Task Group X3S3.4, Data Communication Standards
February 10-13	Workshop for Implementors of OSI
February 11	Meeting of X12-X9 Task Force; cosponsored by Citibank
March 13	Artificial Intelligence Conference; cosponsored by U.S. Intelligence Community

DATE-1986	EVENT
March 19	Federal Council on Computer Storage Standards and Technology; cosponsored by Special Interest Group on Compact Disc Read-Only-Memory Applications (U.S. Geological Survey)
March 21	Vitro Colloquium Series; cosponsored by Vitro Labs and Software Productivity Consortium
April 1-2	Software Acceptance Test Workshop
April 4	Selection Criteria for Computer Security Evaluation Methods and Tools
April 21	Cooperative Projects with DoD on Open System Interconnection
April 29	Federal Software Maintenance Users Group
April 29-May 1	Workshop for Implementors of OSI
June 6	Software Standards Test Methods Workshop
June 11-12	Optical Memory Technology Review; cosponsored by Naval Air Development Center
June 12-13	Annual Technical Symposium; cosponsored by Association for Computing Machinery
June 26	Workshop on FIPS for Information Resource Dictionary System
July 15-16	Workshop on Performance Benchmarks for Automatic Fingerprint Identification Systems; cosponsored by International Association for Identification and Search
July 21-24	Workshop for Implementors of OSI
August 5-7	Meeting of Committee X3B5, Digital Magnetic Tape
August 18-21	Meeting of Committee X3H4, Information Resource Dictionary System
August 26	Federal Software Maintenance Users Group
September 15	Risk Analysis: Methodology & Application; cosponsored by National Computer Security Center
September 15-18	Ninth National Computer Security Conference; cosponsored by National Computer Security Center
September 19	Federal Council on Computer Storage Standards and Technology

DATE-1986	EVENT
September 22-26	Plenary Meeting of ISO TC97 SC13; cosponsored by Accredited Standards Committee X3T9
September 22-26	Meeting of American National Standards Committee X3L2, Information Processing Codes and Character Sets; cosponsored by Computer and Business Equipment Manufacturers Association (CBEMA)
September 29 October 2	Workshop for Implementors of OSI

PLANNED CONFERENCES AND WORKSHOPS

October 1986 - September 1987

October 1	Prime Computer Security Conference; sponsored by Prime Computer Users Group
October 24-31	Meeting of ISO TC171, Micrographic Standards; cosponsored by Association for Information and Image Management and International Micrographic Congress
November 11-21	Meeting of American National Standards Accredited Committee X3V1, Office and Publishing Systems
December 8-12	Workshop for Implementors of OSI
December 16	Federal Software Maintenance Users Group

1987

March 17-18	Workshop of Factory Communications; cosponsored by IEEE Industrial Electronics Society
April 27-29	Office Automation and Personal Computing; cosponsored by IEEE TC on Office Automation and IEEE TC on Personal Computers
September 21-24	Conference on Software Maintenance - 1987; cosponsored by IEEE Computer Society, Data Processing Management Association, Association for Computing Machinery, Association for Women in Computing and Software Maintenance Association

TALKS

During he past year, ICST staff members presented papers and gave talks to a large number of external organizations, including the following:

American Automobile Association
American Society for Testing and Materials
Association for Federal Information Resources Management
Association of Federal Computer Users
Association for Computing Machinery SIGCOM '86

Bureau of Census

Chase Manhattan Bank
Chinese Association for Science and Technology
Computer and Business Equipment Manufacturers Association
Computer Networking Symposium
Computer Security Institute

Data Processing Management Association
Defense Computer Graphics Conference
Department of Air Force
Department of Energy
Department of Interior
Department of State
Department of Treasury
Digital Image Applications Group
DoD Computer Security Center

EDP Auditors Association
EDP Auditors Foundation
Electric Power Research Institute
Electrotechnical Laboratory, MITI (Japan)

Federal Computer Conference
Federal Council on Computer Storage Standards and Technology
Federal Data Management Users Group
Federal Office Automation Conference
Federal Office Systems Expo
Federal Reserve Bank of Dallas
Federal Reserve Bank of Minneapolis
Federal Risk Analysis Users Group
Federal Software Maintenance Group

General Services Administration
Government Computer Expo Conference
Graphics Communication Association
GUIDE 64
GUIDE/SHARE Interchange Group

Howard Community College

TALKS
(Contd.)

IEEE Communications Society Workshop on Computer-Aided Modeling, Analysis, and Design of Communication Links and Networks
IEEE Computer Society
IEEE Computer Standards Conference
IEEE International Conference on Acoustics, Speech, and Signal Processing
IEEE Workshop on Software Testing
Information Systems Security Association
Interagency Committee on Information Resources Management
Internal Revenue Service
International Federation of Information Processing
International Information Integrity Institute

Johns Hopkins Applied Physics Laboratory

MAP Users Group
MIS Training Institute

National Association for State Information Systems
National Computer Security Conferences
National Security Industrial Association
New York University

OSI Implementors Workshops
Open Systems Interconnection Forum

People to People International - Peoples' Republic of China
Pharmaceutical Manufacturers Association
PRIME Users Group

Quality Assurance Users Group

Second Conference on Hypercube Microprocessors
Social Security Administration
Society of American Archivists
Software Maintenance (CSM-85) Conference
State of Florida

USDA Graduate School
U.S. Postal Data Services Center

WWMCCS ADP/WS Security Technical Conference

X/OPEN

ELECTRONIC BULLETIN BOARDS

ICST operates these electronic bulletin boards for information exchange.

Information about microcomputers and their applications, computer security, and General Services Administration publications and activities related to information resources management.	(301) 948-5717 and 948-5718
Information about data management activities and applications	(301) 948-2048 and 948-2059

Users can reach the bulletin boards by dialing the numbers listed above. Terminals should have the following capabilities:

ASCII, 300 or 1200 baud, 8 or 7 bits, even or no parity, 1 stop bit.

If a connection is not established at the end of two rings or if the line is busy, hang up and try again.

After "CONNECT" strike the carriage return twice and the system will be accessed. The system will now guide you through the bulletin board by asking key questions and providing helpful menus.

USER GROUPS

SPONSORED BY ICST

Federal Data Management Users Group (FEDMUG): meets three or four times a year to share information on data administration and management.

CONTACT: Dan Benigni
A-265 Technology Building
National Bureau of Standards
Gaithersburg, Md. 20899
Telephone: (301) 975-3266

Federal Software Maintenance Group (FEDMAIN): meets several times a year to exchange information on software techniques, methodologies, and tools.

CONTACT: Wilma Osborne
B-266 Technology Building
National Bureau of Standards
Gaithersburg, Md. 20899
Telephone: (301) 975-3339

Federal Council on Computer Storage Standards and Technology (FCCSST): meets several times a year to discuss requirements for standards and guidelines for information exchange.

CONTACT: Jean Freedman
B-52 Technology Building
National Bureau of Standards
Gaithersburg, Md. 20899
Telephone: (301) 975-2922

NBS Workshops for Implementors of Open Systems Interconnection: meets five times a year to discuss detailed implementation specifications for Open Systems Interconnection Standards.

CONTACT: Gerry Mulvenna
B-217 Technology Building
National Bureau of Standards
Gaithersburg, Md. 20899
Telephone: (301) 975-3631

FEDERAL INFORMATION PROCESSING STANDARDS

Approved, Revised, and Withdrawn

FY1986

FIPS NO.	TITLE	DATE
FIPS 21-2	COBOL (ANSI X3.23-1985) (Revision)	86 Mar 18
FIPS 43	WITHDRAWN	
FIPS 44	WITHDRAWN	
FIPS 47	WITHDRAWN	
FIPS 68-1	Minimal BASIC (ANSI X3.60-1978) (Revision)	85 Dec 24
FIPS 69-1	FORTRAN (ANSI X3.9-1978) (Revision)	85 Dec 24
FIPS 104-1	ANS Codes for the Representation of Names of Countries, Dependencies, and Areas of Special Sovereignty for Information Interchange (Revision)	86 May 12
FIPS 119	Ada (ANSI/MIL-STD-1815A-1983)	85 Nov 08
FIPS 120	Graphical Kernel System (GKS) (ANSI X3.124-1985)	86 Apr 18
FIPS 121	Videotex/Teletext Presentation Level Protocol Syntax (North American PLPS) (ANSI X3.110-1983/CS T500-1983)	86 May 06
FIPS 122	Conformance Tests for FIPS PUB 100/FED-STD 1041 Version of CCITT 1980 Recommendation X.25, Interface Between Data Terminal Equipment (DTE) and Data Circuit-Terminating Equipment (DCE) for Operation with Packet-Switched Data Communications Networks	86 May 28
FIPS 123	Specification for a Data Descriptive File for Information Interchange (DDF)	86 Sep 19
FIPS 124	Guideline on Functional Specifications for Database Management Systems	86 Sep 30

FIPS NO.	& CATEGORY	TITLE	DATE	CHANGE NOTICES
0	(1) P	General Description of FIPS Register	68 Nov 01	
1-2	(2&3)S	Code for Information Interchange, Its Representations, Subsets, and Extensions (ANSI X3.4-1977, X3.32-1973, X3.41-1974)	84 Nov 14	
2-1	(2) S	Perforated Tape Code for Information Interchange (ANSI X3.6-1965/R1983)	84 Nov 14	
3-1	(2) S	Recorded Magnetic Tape for Information Interchange (800 CPI, NRZI) (ANSI X3.22-1973)	73 June 30	
4	(4) S	Calendar Date	68 Nov 01	
5-1	(4) S	States and Outlying Areas of the U.S.	70 June 15	8
6-3	(4) S	Counties and County Equivalents of the States of the U.S. & District of Columbia	79 Dec 15	8
7	-	"WITHDRAWN"		1
8-5	(4) S	Metropolitan Statistical Areas (MSAs) (Including CMSAs, PMSAs, and NECMAs)	84 Oct 31	4
9	(4) S	Congressional Districts of the U.S.	69 Nov 14	2
10-3	(4) S	Countries, Dependencies, Areas of Special Sovereignty, and Their Principal Admin. Divs.	84 Feb 09	5
11-2	(3) G	Guideline: American National Dictionary for Inform. Processing Systems (ANSI X3/TR-1-82)	83 May 09	
12-2	-	"WITHDRAWN"		1
13	(2) S	Rectangular Holes in Twelve-Row Punched Cards (ANSI X3.21-1967/R1980)	71 Oct 01	
14-1	(2) S	Hollerith Punched Card Code (ANSI X3.26-1980)	80 Dec 24	
15	-	"WITHDRAWN"		1
16-1	(2) S	Bit Sequencing of Code for Information Interchange in Serial-By-Bit Data Transmission (ANSI X3.15-1976/R1983)	77 Sept 01	
17-1	(2) S	Character Structure and Char. Parity Sense for Serial-By-Bit Data Communication in the Code for Inform. Interchg. (ANSI X3.16-1976/R1983)	77 Sept 01	
18-1	(2) S	Character Structure and Char. Parity Sense for Parallel-By-Bit Data Communication in the Code for Inform. Interchg. (ANSI X3.25-1976/R1983)	77 Sept 01	
19-1	(4) G	Catalog of Widely Used Code Sets	85 Jan 07	1
20	(3) G	Guidelines for Describing Information Interchange Formats	72 Mar 01	
21-2	(3) S	COBOL (ANSI X3.23-1985)	86 Mar 18	
22-1	(2) S	Synchronous Signaling Rates Between Data Terminal and Data Communi. Equip. (ANSI X3.1-1976)	77 Sept 01	
23	-	"WITHDRAWN"		1
24	(3) S	Flowchart Symbols and Their Usage in Information Processing (ANSI X3.5-1970)	73 June 30	
25	(2) S	Recorded Magnetic Tape for Information Interchg (1600 CPI, Phase Encoded) (ANSI X3.39-1973)	73 June 30	
26	(2) S	One-Inch Perforated Paper Tape for Information Interchange (ANSI X3.18-1967/R1974&1982)	73 June 30	
27	(2) S	Take-Up Reels for One-Inch Perforated Tape for Information Interchg. (ANSI X3.20-1967/R1982)	73 June 30	

FIPS NO. & CATEGORY	TITLE	DATE	CHANGE NOTICES
28 (4) P	Standardization of Data Elements and Representations	73 Dec 05	1
29-1 (1&3)P	Interpretation Procedures for Federal Information Processing Standard Programming Languages	81 Dec 31	
30 (3) S	Software Summary for Describing Computer Programs and Automated Data Systems	74 June 30	
31 (5) G	Guidelines for Automatic Data Processing Physical Security and Risk Management	74 June --	
32-1 (2) S	Character Sets for Optical Char. Recognition (OCR) (ANSI X3.2-1970/R1976, X3.17-1981, X3.49-1975/R1982)	82 June 25	
33-1 (2) S	Character Set for Handprtg. (ANSI X3.45-1982)	84 Nov 05	
34 (1) P	Guide for the Use of International System of Units (SI) in Federal Information Processing Standards Publications	75 Jan 01	
35 -	"WITHDRAWN"		1
36 -	"WITHDRAWN"		1
37 (2) S	Synchronous High Speed Data Signaling Rates Between Data Terminal Equipment and Data Communications Equipment (ANSI X3.36-1975)	75 June 15	
38 (3) G	Guidelines for Documentation of Computer Programs and Automated Data Systems	76 Feb 15	
39 (5) G	Glossary for Computer Systems Security	76 Feb 15	
40 (2) G	Guideline for Optical Character Recognition Forms	76 May 01	
41 (5) G	Computer Security Guidelines for Implementing the Privacy Act of 1974	75 May 30	
42-1 (5) G	Guidelines for Benchmarking ADP Systems in the Competitive Procurement Environment	77 May 15	
43 (3) G	"WITHDRAWN"		1
44 (3) S	"WITHDRAWN"		1
45 (4) G	Guide for the Development, Implementation & Maintenance of Standards for the Representation of Computer Processed Data Elements	76 Sept 30	
46 (5) S	Data Encryption Standard	77 Jan 15	1
47 (3) G	"WITHDRAWN"		1
48 (5) G	Guidelines on Evaluation of Techniques for Automated Personal Identification	77 Apr 01	
49 (5) G	Guideline on Computer Performance Management: An Introduction	77 May 01	
50 (2) S	Recorded Magnetic Tape for Information Interchange, 6250 cpi (246 cpmm), Group Coded Recording (ANSI X3.54-1976)	78 Feb 01	
51 (2) S	Magnetic Tape Cassettes for Information Interchange (3.810 mm [0.150 in] Tape at 32 bpmm [800 bpi], PE) (ANSI X3.48-1977)	78 Feb 01	

FIPS NO. & CATEGORY	TITLE	DATE	CHANGE NOTICES
52 (2) S	Recorded Magnetic Tape Cartridge for Inform. Interchg, 4-Track, 6.30 mm (1/4 in), 63 bpmm (1600 bpi), Phase Encoded (ANSI X3.56-1977)	78 July 15	
53 (3) S	Transmittal Form for Describing Computer Magnetic Tape File Properties	78 Apr 01	
54 (2) S	Computer Output Microform (COM) Formats and Reduction Ratios, 16 mm and 105 mm	78 July 15	
55DC (4) G	Guideline: Codes for Named Populated Places Primary County Divisions, and Other Locational Entities of the United States	83 Nov 01	3
55-1 (4) G	Same as 55DC except without codes.	83 Dec 30	3
56 (5) G	Guideline for Managing Multivendor Plug-Compatible ADP Systems	78 Sept 15	
57 (5) G	Guidelines for the Measurement of Interactive Computer Service Response Time and Turn-around Time	78 Aug 01	
58 (4) S	Representations of Local Time of the Day for Information Interchange (ANSI X3.43-1977)	79 Feb 01	
59 (4) S	Representations of Universal Time, Local Time Differentials, and United States Time Zone References for Information Interchange (ANSI X3.51-1975)	79 Feb 01	
60-2 (2) S	I/O Channel Interface	83 July 29	1
61-1 (2) S	Channel Level Power Control Interface	82 July 13	
62 (2) S	Operational Specifications for Magnetic Tape Subsystems	79 Feb 16	1+F.R.notice
63-1 (2) S	Operational Specifications for Variable Block Rotating Mass Storage Subsystems	83 Apr 14	
63 SUPPLEMENT	Additional Operational Specs for VBRMSS	83 Apr 14	
64 (3) G	Guidelines for Documentation of Computer Programs and Automated Data Systems for the Initiation Phase	79 Aug 01	
65 (5) G	Guideline for Automatic Data Processing Risk Analysis	79 Aug 01	
66 (4) S	Standard Industrial Classification (SIC) Codes	79 Aug 15	
67 (2) G	Guideline for Selection of Data Entry Equipment	79 Sept 30	
68-1 (3) S	Minimal BASIC (ANSI X3.60-1978)	85 Dec 24	2
69-1 (3) S	FORTRAN (ANSI X3.9-1978)	85 Dec 24	
70 (4) S	Representation of Geographic Point Locations for Information Interchange	80 Oct 24	
71 (2) S	Advanced Data Communication Control Procedures (ADCCP) (ANSI X3.66-1979)	80 May 14	1
72 (5) G	Guidelines for the Measurement of Remote Batch Computer Service	80 May 01	
73 (5) G	Guidelines for Security of Computer Applications	80 June 30	
74 (5) G	Guidelines for Implementing and Using the NBS Data Encryption Standard	81 Apr 01	

FIPS NO. & CATEGORY	TITLE	DATE	CHANGE NOTICES
75 (5) G	Guideline on Constructing Benchmarks for ADP System Acquisitions	80 Sept 18	
76 (3) G	Guideline for Planning and Using a Data Dictionary System	80 Aug 20	
77 (3) G	Guideline for Planning and Management of Database Applications	80 Sept 01	
78 (2) G	Guideline for Implementing Advanced Data Communication Control Procedures (ADCCP)	80 Sept 26	
79 (3) S	Magnetic Tape Labels and File Structure for Information Interchange (ANSI X3.27-1978)	80 Oct 17	
80	"WITHDRAWN"		1
81 (5) S	DES Modes of Operation	80 Dec 02	1
82 (2) G	Guideline for Inspection and Quality Control for Alphanumeric Computer-Output Microforms (AIIM(NMA)MS1-1980)	80 Sept 26	
83 (5) G	Guideline on User Authentication Techniques for Computer Network Access Control	80 Sept 29	
84 (2) S	Microfilm Readers (ANSI/AIIM(NMA)MS20-1979)	80 Oct 31	
85 (2) S	Optical Character Recognition (OCR) Inks (ANSI X3.86-1980)	80 Nov 07	
86 (2) S	Additional Controls for Use with Amer.Natl.Std. Code for Inform. Interchg. (ANSI X3.64-1979)	81 Jan 29	2
87 (5) G	Guidelines for ADP Contingency Planning	81 Mar 27	
88 (3) G	Guideline on Integrity Assurance and Control in Database Administration	81 Aug 14	
89 (2) S	Optical Character Recognition (OCR) Character Positioning (ANSI X3.93M-1981)	81 Sept 04	
90 (2) G	Guideline for Optical Character Recognition (OCR) Print Quality (ANSI X3.99-1983)	83 Sept 29	
91 (2) S	Magnetic Tape Cassettes for Information Interchange, Dual Track Complementary Return-To-Bias (CRB) Four-States Recording on 3.81-mm (0.150-in) Tape (ANSI X3.59-1981)	82 Mar 12	
92 (4) G	Guideline for Standard Occupational Classification (SOC) Codes	83 Feb 24	
93 (2) S	Parallel Recorded Magnetic Tape Cartridge for Information Interchange, 4-Track, 6.30 mm (1/4 in), 63 bpmm (1600 bpi), Phase Encoded (ANSI X3.72-1981)	82 June 29	
94 (2) G	Guideline on Electrical Power for ADP Installations	83 Sept 21	
95 (4) S	Codes for the Identification of Federal and Federally-Assisted Organizations	82 Dec 23	20
96 ( ) G	Guideline for Developing and Implementing a Charging System for Data Processing Services	82 Dec 06	
97 (2) S	Operational Specifications for Fixed Block Rotating Mass Storage Subsystems	83 Feb 04	
98 (3) S	Message Format for Computer-Based Message Sys.	83 Mar 01	1

FIPS NO. & CATEGORY	TITLE	DATE	CHANGE NOTICES
99 (3) G	Guideline: A Framework for the Evaluation and Comparison of Software Development Tools	83 Mar 31	
100 (2) S	Interface Between Data Terminal Equipment (DTE) and Data Circuit-Terminating Equipment (DCE) for Operation with Packet-Switched Data Communications Networks (FEDSTD1041)	83 July 06	
101 (3) G	Guideline for Lifecycle Validation, Verification, and Testing of Computer Software	83 June 06	
102 (5) G	Guidelines for Computer Security Certification and Accreditation	83 Sept 27	
103 (4) S	[illegible] for the Identification of Hydrologic [illegible] in the United States and the Caribbean [illegible] Areas (USGS/CIRCULAR#878-A)	83 Nov 15	
104-1 (4) S	[illegible] for the Representation of Names of [illegible]es, Dependencies, and Areas of Special [illegible]eignty for Information Interchange	86 May 12	
105 (5) G	[illegible]eline for Software Documentation Management	84 June 06	
106 (5) G	Guideline on Software Maintenance	84 June 15	
107 (2&3) S	Local Area Networks: Baseband Carrier Sense Multiple Access with Collision Detection Access Method and Physical Layer Specs. & Link Layer Protocol (ANSI/IEEE 802.2&802.3)	84 Oct 31	
108 (2) S	Alphanumeric Computer Output Microform Quality Test Slide (AIIM MS28-1983)	84 Nov 05	
109 (3) S	Pascal (ANSI/IEEE770X3.97-1983)	85 Jan 16	
110 (3) G	Guideline for Choosing a Data Managemt Approach	84 Dec 11	
111 (2) S	Storage Module Interfaces (w/extensions for enhanced storage module interfaces) (ANSI X3.91M-1982)	85 Apr 18	
112 (5) S	Password Usage	85 May 30	
113 (5) S	Computer Data Authentication	85 May 30	
114 (2) S	200mm (8in) Flexible Disk Cartridge Track Format Using Two-Frequency Recording at 6631 bprad on One Side - 1.9tpmm (48tpi) for Information Interchange (ISO 5654/2)	85 Sept 30	
115 (2) S	200mm (8in) Flexible Disk Cartridge Track Format Using Modified Frequency Modulation Recording at 13262 bprad on Two Sides - 1.9tpmm (48tpi) for Information Interchange (ISO 7065/2)	85 Sept 30	
116 (2) S	130mm (5.25in) Flexible Disk Cartridge Track Format Using Two-Frequency Recording at 3979 bprad on One Side - 1.9tpmm (48tpi) for Information Interchange (ISO 6596/2)	85 Sept 30	
117 (2) S	130mm (5.25in) Flexible Disk Cartridge Track Format Using Modified Frequency Modulation Recording at 7958 bprad on Two Sides - 1.9 tpmm (48tpi) for Information Interchange (ISO 7487/3)	85 Sept 30	

FIPS NO. & CATEGORY	TITLE	DATE	CHANGE NOTICES
118 (3) S	Flexible Disk Cartridge Labelling and File Structure for Information Interchange (ISO 7665)	85 Sept 30	
119 (3) S	Ada (ANSI/MIL-STD-1815A-1983)	85 Nov 08	
120 (3) S	Graphical Kernel System (GKS) (ANSI X3.124-1985)	86 Apr 18	
121 (2) S	Videotex/Teletext Presentation Level Protocol Syntax (North American PLPS) (ANSI X3.110-1983/CS T500-1983)	86 May 06	
122 (6) T	Conformance Tests for FIPS PUB 100/FED-STD 1041 Version of CCITT 1980 Recommendation X.25, Interface Between Data Terminal Equipment (DTE) and Data Circuit-Terminating Equipment (DCE) for Operation With Packet-Switched Data Communications Networ s	86 May 28	
123 (3) S	Specification for a Data Descriptive File for Information Interchg (DDF) (ANSI/ISO 8211-1985)	86 Sep 19	
124 (3) G	Guideline on Functional Specifications for Database Management Systems	86 Sep 30	

CATEGORY KEY:
(1) GENERAL PUBLICATIONS
(2) HARDWARE STANDARDS/GUIDELINES
(3) SOFTWARE STANDARDS/GUIDELINES
(4) DATA STANDARDS/GUIDELINES
(5) ADP OPERATIONS STANDARDS/GUIDELINES
(6) CONFORMANCE TESTS

S - Standard
G - Guideline
P - Program Information Document
T - Conformance Tests