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PUBLICATIONS

# TECHNICAL ACCOMPLISHMENTS 1997

working with  
industry and  
government  
to make  
information  
technology  
more usable,  
interoperable,  
and secure

# INFORMATION TECHNOLOGY LABORATORY

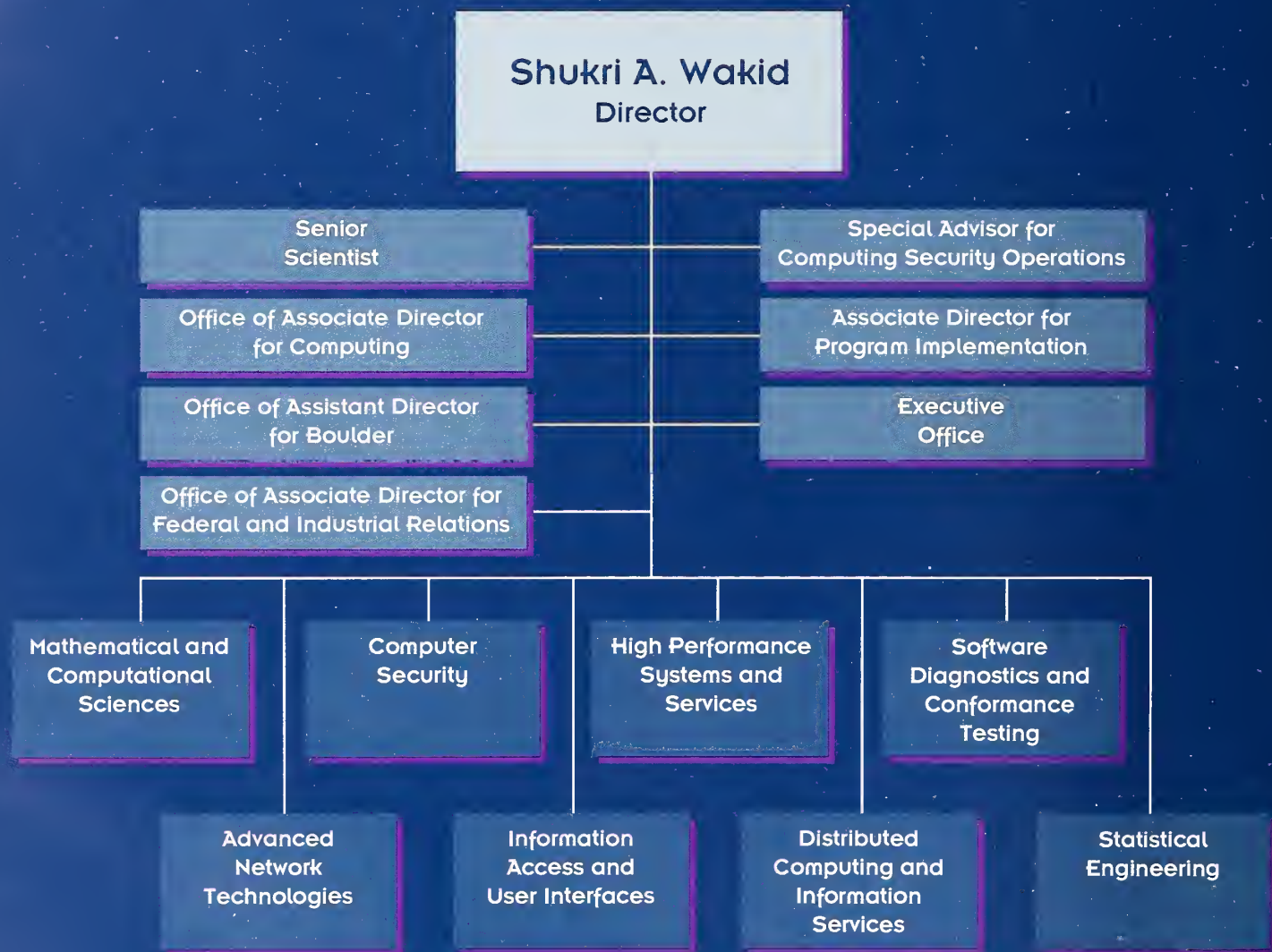
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National Institute of  
Standards and Technology

# Information Technology Laboratory





# TECHNICAL ACCOMPLISHMENTS 1997

## INFORMATION TECHNOLOGY LABORATORY



**January 1998**

**SP 500-239**

**U.S. DEPARTMENT OF COMMERCE**

**William M. Daley, Secretary**

**Technology Administration**

**Gary R. Bachula, Acting Under Secretary for  
Technology**

**National Institute of Standards and Technology**

**Raymond G. Kammer, Director**

**Information Technology Laboratory**

**Shukri A. Wakid, Director**

## **Reports on Information Technology**

The Information Technology Laboratory (ITL) at the National Institute of Standards and Technology (NIST) stimulates U.S. economic growth and industrial competitiveness through technical leadership and collaborative research in critical infrastructure technology, including tests, test methods, reference data, and forward-looking standards, to advance the development and productive use of information technology. To overcome barriers to usability, scalability, interoperability, and security in information systems and networks, ITL programs focus on a broad range of networking, security, and advanced information technologies, as well as the mathematical, statistical and computational sciences. This Special Publication 500 series reports on ITL's research in tests and test methods for information technology, and its collaborative activities with industry, government, and academic organizations.

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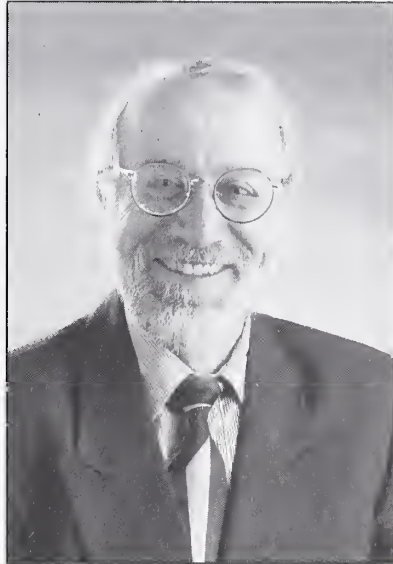
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## DIRECTOR'S FOREWORD

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I am pleased to report to all of our stakeholders on the work of the Information Technology Laboratory (ITL) in 1997. This report covers the first full year of operation of the ITL, which was established by NIST in 1996. ITL works with industry to develop key elements of the technical infrastructure for information technology. These elements are needed by industry and users to have confidence in the quality, interoperability, and security of their information technology products. Additionally, ITL provides information technology services to NIST staff.

ITL is one of NIST's seven laboratories covering technical activities in areas of electronics and electrical engineering, manufacturing engineering, chemical science and technology, physics, material science and engineering, building and fire research, as well as information technology. NIST laboratories develop measurements, standards, reference materials, and data that help U.S. companies achieve higher quality products, more reliable and more flexible processes, fewer rejected parts, speedier product development, and improved interoperability of equipment.

This report describes some of the areas in which ITL is working with industry to develop a needed technical infrastructure for IT. Our goals are to:

- overcome the barriers to the interoperability of emerging network technologies
- develop ways to measure the performance of high performance computing and communications systems and enable their use in both small and large applications
- improve access to and exchange of complex, multimedia information
- develop safeguards for the integrity, confidentiality, reliability and availability of information resources
- improve the quality of software
- advance the application of mathematical and computational sciences, and of statistical methods, to information technology
- provide high quality mathematical, computational and information technology services to NIST scientists and collaborators

Information technology has an important role in our society, creating new industries and new ways of doing business. Almost every sector of our economy depends upon the effective use and communication of vast quantities of data. As we move into the twenty-first century, we want to assure that information technology remains a powerful tool for advancing electronic commerce, manufacturing, transportation, health care, education, and government. A sound infrastructure for IT is essential.

This IT infrastructure is not complete because we have not yet mastered the use of measurements for information technology. Measurement science, or metrology, has been an important factor in the advancement of commerce and the development of useful, standard products in almost all technical areas. We know how to measure physical and chemical properties and to apply those measurements to improve products. But IT is a relatively new and rapidly changing technology, and many tests, test methods, and other technical references for measurement are missing.

In 1997, NIST staff members studied this problem, and issued a report, "Metrology for Information Technology," which establishes a scope and a conceptual basis for IT metrology. As the study explains, there is a measurement chain of related events that starts with the concept of a property to be measured and concludes with the actual measurement. Once the attribute or quantity to be measured has been defined, the units for expressing the measurement, scales, and a system of standards for calibrating, testing, and measuring must be developed.

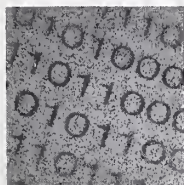
We have had some success in measuring the performance of IT hardware and telecommunications, in some cases using traditional physical and chemical measurement science. But we are challenged to test and measure the quality of software. The many combinations and possibilities of software lead to unforeseen outcomes and uncertain results. Measurement science has the potential to help us improve software development and testing, measure and control complex network reactions, estimate the accuracy of simulations, and validate the trustworthiness of information exchanged in networks. International electronic commerce is just one area that will depend upon a measurement infrastructure to enable participants to have confidence that their transactions are protected and conducted as intended.

With industry partners, ITL has started to address some of these critical challenges. We know that we cannot do the job by working alone. We expect to strengthen and intensify our efforts with our partners and to develop many new partners. We have started discussions with organizations such as the Institute of Electrical and Electronics Engineers, Educom, the National Science Foundation, the Department of Defense, industry organizations and consortia, international organizations, and universities.

We invite all who are interested in collaborating with us under Cooperative Research and Development Agreements (CRADAs) to contact us. We welcome your thoughts and comments on the work currently being done and on future needs for measurements for information technology.



Shukri A. Wakid, Director  
Information Technology Laboratory  
E-mail: [itlab@nist.gov](mailto:itlab@nist.gov)



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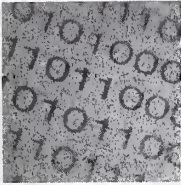
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# OVERVIEW OF THE INFORMATION TECHNOLOGY LABORATORY

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<b>Director:</b>	<b>Shukri A. Wakid</b>
<b>Deputy Director (Acting):</b>	<b>Kathleen M. Roberts</b>
<b>Special Advisor for Computing Security Operations:</b>	<b>Robert Raybold</b>
<b>Senior Scientist:</b>	<b>Andre Deprit</b>
<b>Associate Director for Computing:</b>	<b>Fred Johnson</b>
<b>Assistant Director for Boulder:</b>	<b>Paul Domich</b>
<b>Associate Director for Program Implementation:</b>	<b>R.J. (Jerry) Linn</b>
<b>Associate Director for Federal and Industrial Relations:</b>	<b>David Kahaner</b>
<b>Executive Office:</b>	<b>Judith Lyons</b>

Today, information technology (IT) influences almost all areas of human endeavor, creating new products, services, and industries. The rapidly changing nature of IT challenges us to define and quantify the new technology. Unlike other technologies, IT lacks a well-established measurement base that has proved to be essential to the development of high-quality products and services by U.S. industry for the world marketplace.

## Tests and Test Methods for IT

The Information Technology Laboratory focuses on research and development of tests, quality assurance techniques, tools, models, and reference data that define a measurement science for IT. We collaborate with many people and organizations - industry, research, government and standards organizations - to solve generic measurement problems, and to make the results broadly available. Tests and measurements build a common language for technology advancement, and provide objective criteria that enable developers and users to evaluate product quality and performance and to develop IT standards.

ITL's activities cover a broad range of technologies in mathematical and computational sciences, advanced networks, computer security, information access and user interfaces, high performance systems and services, distributed computing and information services, software diagnostics and conformance testing, and statistical engineering. Our products include tests and test methods, reference data sets and evaluation software, advanced software tools, automated software testing techniques, conformance tests and test methods, statistical model-based testing, and specialized databases. We also provide high-quality services to the NIST staff, including hardware and software support, Internet and intranet services, high performance computing services, and mathematical, computational, and statistical consulting services.

## **Interaction with Industry**

Working in partnership with industry, ITL helps to promote the U.S. economy and expand the Nation's technology base. Industry customers include IT providers and users, research communities, industry standards organizations, software and Web browser developers, security technology developers and vendors, and specialized constituencies such as the mathematical software and high-speed network and wireless technology industries. These product developers and IT providers share common problems with interoperability, scalability, usability, and security of IT products. Our commitment to federal agencies remains strong; we develop standards and guidance for our federal customers and provide technical assistance, in fulfilling our responsibility under the Computer Security Act of 1987.

To pursue common goals, we work with industry organizations and federal agencies by means of the Cooperative Research and Development Agreement (CRADA). In 1997, we collaborated with 37 government, industry, and academic institutions through CRADAs. ITL contributed to the activities of industry groups such as the ATM Forum, the Digital Audio Visual Council (DAVIC), and the Internet Engineering Task Force (IETF) to support interoperability and forward-looking standards. We continued to support the North American Integrated Services Digital Network (ISDN) Users' Forum (NIUF). Many other informal interactions with government and industry partners involved the sharing of equipment or expertise. These cooperative arrangements benefit all participants through a better understanding of the advantages and barriers to the development and use of information technology.

## **G7 Information Society Pilot Projects and Related Activities**

ITL serves as the U.S. contact for the G7 Information Society Global Inventory Pilot Project (GIP) and the Electronic Commerce component of the Global Marketplace for Small and Medium Enterprises (SMEs) Pilot Project. These pilot projects resulted from the Naples Economic Summit in July 1994, when the G7 leaders decided to "encourage and promote innovation and the spread of new technologies including, in particular, the development of an open, competitive, and integrated worldwide information infrastructure." Eleven information society pilot project themes were identified which demonstrate the potential of the information society and stimulate its deployment. The key objectives are to support international consensus on common principles governing the need of access to networks and applications and their interoperability and to help create markets for new products and services. ITL serves on the Steering committee for the GIP and SME Projects. Further, ITL is responsible for developing and maintaining Web access to the National Inventory of projects related to the eleven G7 theme areas and developing and maintaining the registration process and Web site for the Electronic Commerce testbed projects. The G7 material is found on the NII Virtual Library Home Page at <http://nii.nist.gov>.

ITL also participated as the NIST representative in the following electronic commerce-related activities:

- the working group drafting the Administration's paper "A Framework for Global Electronic Commerce,"
- the steering committee for the Global Standards Conference held in Brussels, October 1-3, 1997, and
- JTGII (U.S. TAG to JTC1 SWG on GII).

## **The ITL Organization**

ITL's work is accomplished in eight technical divisions: Mathematical and Computational Sciences Division, Advanced Network Technologies Division, Computer Security Division, Information Access and User Interfaces Division, High Performance Systems and Services Division, Distributed Computing and Information Services Division, Software Diagnostics and Conformance Testing Division, and the Statistical Engineering Division. Our professional staff consists of computer scientists, mathematicians, computer specialists, electrical and electronics engineers, and statisticians. Staffing resources in FY 1997 included 384 full-time-equivalent employees of which about 75 percent were professional and technical staff and 25 percent were administrative support personnel. In addition, 92 research associates, guest scientists, and faculty appointments enhanced our research program.

Funding for ITL programs in FY 1997 consisted of \$44.5 million from the NIST Congressional appropriation (STRS), including \$12.3 million for the Consolidated Scientific Computing System (Super Computer) and \$0.6 million for Technical Competence; \$2.2 million from the Advanced Technology Program; and \$11.9 million in reimbursable funds, mostly from other federal agencies for direct technical assistance. See the Interactions and Accomplishments section of this report for a complete list of our collaborative interactions.

## **Sharing Information with our Customers**

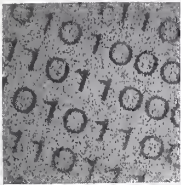
Through a broad range of publications and online resources, we share information and technology with industry, government, academia, and the public. We publish Federal Information Processing Standards (FIPS) and guidelines; special publications series focusing on information technology, computer security, and federal electronic data interchange (EDI) implementation conventions; technical interagency reports on research and tests; a quarterly "ITL" newsletter; and a ITL bulletin series published about eight times a year on topics of interest to the information systems community. See the Interactions and Accomplishments section for a list of publications currently available for sale through the Government Printing Office (GPO) or the National Technical Information Service (NTIS). ITL also sponsors, co-sponsors, and hosts a variety of conferences and workshops throughout the year, and our staff members address many industry and government organizations.

We welcome your interest in the Information Technology Laboratory and invite you to visit our Web site at:

<http://www.itl.nist.gov>







# MATHEMATICAL AND COMPUTATIONAL SCIENCES DIVISION

---

**Chief (Acting):** Shukri A. Wakid

**Group Managers:** James L. Blue, Mathematical Modeling

Ronald Boisvert, Mathematical Software

Shukri A. Wakid (Acting), Optimization and Computational Geometry

Anastase Nakassis, Compression Algorithms

The Mathematical and Computational Sciences Division provides technical leadership within NIST in modern analytical and computational methods for solving mathematical problems of interest to American industry. A program of advanced research focuses on selected areas of applied and computational mathematics and collaboration with technical experts in other NIST divisions, industry, and academia. The scope includes the development and analysis of theoretical descriptions of phenomena (mathematical modeling); the design and analysis of requisite computational methods and experiments; the transformation of these methods into efficient numerical algorithms for high performance computers; the implementation of these methods in high-quality mathematical software; and the distribution of this software to potential clients, both within NIST and to the external community.

The work of the division can be grouped into three broad areas: testing and evaluation methodology, mathematical modeling, and tools for high performance computing.

## Highlights of the Year's Work

B. Alpert (ITL) and colleagues M. Francis (Electronics and Electrical Engineering Laboratory [EEEL]) and R. Wittmann (EEEL) won a Department of Commerce Bronze Medal for their work in developing an algorithm for the processing of antenna measurements corrupted by probe position errors. The method exploits position information available during the measurement procedure to compute far fields as accurately as when no position errors are present, and at a computational cost which is acceptable even for electrically very large antennas. The algorithm has been implemented and the software has been distributed to antenna calibration laboratories in government and industry.

Roldan Pozo used funding from his 1996 Presidential Early Career Award for Scientists and Engineers to develop JazzNet, a dedicated cluster of PCs for use in scientific computing applications. The goal was to build an inexpensive "personal supercomputer" using off-the-shelf components, capable of achieving more than 1 Gflop (one billion floating-point operations per second) for under \$30,000. Initial performance studies indicate that this milestone has been surpassed. We expect such systems to become increasingly common at NIST and other scientific computing sites in the future. JazzNet was featured in a variety of external publications including Government Computer News, the Montgomery Business Gazette, and New Technology Week, sparking wide interest, and many queries from industries such as Gillette Corp., Dean Witter-Reynolds, and Sunshine Medical Electronics. (See <http://math.nist.gov/jazznet/>.)

Overall the staff of the division continued its high level of productivity and professional activity. We produced 56 refereed publications, gave 72 talks of which 37 were invited, served on the editorial boards of five journals, served as Editor-in-Chief of one journal, participated on five review panels, refereed for numerous journals and funding agencies, and obtained one patent.

## Testing and Evaluation Methodology

We made significant new efforts on the development of testing and evaluation methodology and infrastructural services for computational science, including the design and analysis of testing methodology, evaluation criteria, reference data, and reference algorithms. Customers for this work are industrial developers of software products for scientific computing, as well as the computational science research communities in industry, government, and academia.

The Matrix Market provides online access to a large collection of test data for use in comparative studies of algorithms and software for numerical linear algebra. Done in collaboration with Boeing, the Matrix Market features some 500 large sparse matrices from a variety of applications as well as matrix generation tools and services. In its second year of operation, the service has been accessed by more than 7,500 distinct Internet hosts and has distributed more than 4 Gbytes of matrix data.

(See <http://math.nist.gov/MatrixMarket/>.) In a related effort, we are working with the BLAS Technical Forum on the development of community standards for basic linear algebra software components to promote portability and high performance of applications. The Forum brings together researchers in government laboratories and academia with vendors such as Cray, HP/Convex, NEC, Intel, Tera, and NAG. As leader of the Sparse BLAS Subcommittee, we developed a working proposal for the Sparse BLAS, as well as reference implementations in C and Fortran. (See <http://math.nist.gov/spblas/>.)

This year we inaugurated work on the NIST Digital Library of Mathematical Functions (DLMF), a joint project of ITL, the NIST Physics Laboratory, and the NIST Standard Reference Data Program. The DLMF is envisioned as a modern replacement for the NBS Handbook of Mathematical Functions, which was first issued in 1964. The Handbook contains technical information, such as formulas, graphs, and tables, on a variety of mathematical functions of widespread use in the sciences and engineering. The new DLMF would revise and expand this core data and would make use of advanced communications and computational resources to disseminate the information in ways not possible using static print media. In July 1997, we held an invitational workshop for well-known experts in special functions and their application to begin planning for the project. Substantial external funding is now being sought to permit the participation of outside technical experts in the many subfields of mathematical functions. (See <http://math.nist.gov/DigitalMathLib/>.)

There is a large demand for micromagnetic modeling results, both for industrial design processes and for the materials science and physics of magnetism. Currently there are weaknesses in the physical and computational models and a public modeling code is unavailable. In collaboration with NIST's Materials Science and Engineering Laboratory, we are developing standard test problems for micromagnetic modeling. We presented the first standard problem results this year. We collected solutions from several researchers (submitted anonymously) and found that the results showed little agreement. (See <http://cobalt.nist.gov/mumag/prob1/prob1report.html/>.) We are also developing a public code for micromagnetics, whose initial release will be in FY 98.

Work has also been initiated in the development of metrics for use in the evaluation of image transformations such as compression. Initial studies are attempting to model images as parameterized surfaces plus error components. Such modeling seeks to combine earlier results on metrics with recent findings of division staff and others on the contrast sensitivity function associated with human vision. Initial results show that a vast category of models can be obtained through linear filtering and that improved metrics can be obtained by using the L2 norm of the residual vector.

Finally, we are cooperating with the Statistical Engineering Division on the development of reference data for the evaluation of statistical software. The Statistical Reference Datasets service, which was formally unveiled this year, contains a collection of test problems for nonlinear least squares developed by division staff.

## **Mathematical Modeling**

Mathematical modeling is an interdisciplinary effort requiring close collaboration between scientists inside and outside the division. Our researchers cooperate with the outside scientists to develop specific mathematical models that capture the essence of the phenomena under study. They analyze the model, propose and develop numerical algorithms, and produce a computer program. The resulting program is run to provide simulations that are compared with experimental results to validate the entire process and to provide the basis for further refinements and enhancements. This process provides more cost-effective, quicker, and better information than experimentation alone. Indeed, such modeling and simulation activities are augmenting and, in many cases, replacing the need to do experiments or used to guide the experimental process into more fertile areas. The information allows the outside scientists to gain understanding or to predict behavior of a complex system, and thus forms the basis for techniques to improve the performance of the system under study.

The customers for our work include our collaborating ITL and NIST scientists and engineers, and through these collaborators, industrial scientists and engineers; other customers are the larger community of researchers in computational science and engineering. Our aim is to work on a spectrum of tasks, including engineering and advanced development, to conduct both short- and long-term research, and to accelerate the adoption of advanced modeling and simulation techniques.



We are active in an inter-laboratory NIST competence project, "Measurement Science for Optical Reflectance and Scattering." This project seeks to identify and measure the physical and optical characteristics of surfaces with desirable appearance characteristics. The results of this work could lead to a computer-based foundation for the virtual design of a surface and a tool for predicting its appearance. This past year, we formed a consultative and collaborative relationship with researchers in the very rapidly expanding computer graphics industry. We organized a two-day meeting attended by researchers in industry and academia for the purposes of discussing and critiquing the proposed ITL research program; scientists from Silicon Graphics Inc. and IBM strongly supported the research proposal, as did participants from Cornell University and the Massachusetts Institute of Technology. Our research will help to move the field of computer graphics rendering from a craft to an engineering discipline so that rendered surfaces have more of the visual properties of real surfaces.

Composite materials with complicated microstructures, such as ceramics, are important in many industrial applications. The microstructure is determined by the processing of the material, but it is the macroscopic properties that are relevant in applications. Previous analysis and computer simulations of the macroscopic properties have been based on idealized simplifications of the microstructure. In collaboration with the Materials Science and Engineering Laboratory (MSEL), we constructed a finite-element computer model that has as input a digitized image of a real microstructure. This program, while still two-dimensional, models elasticity and fracture much more realistically than previous programs, and will help material scientists determine the properties of actual composite materials.

High-speed machining processes are becoming increasingly important in modern manufacturing, but such processes can lead to discontinuous chip formation that is strongly correlated with increased tool wear, degradation of the workpiece surface finish, and less accuracy in the machined part. In an ongoing collaboration with the Automated Production Technology Division in the Manufacturing Engineering Laboratory, a new approach to modeling some high-speed machining processes is being developed that has the potential to predict the onset of discontinuities. One of the main objectives of this effort is to provide improved mathematical models for computer simulations of manufacturing processes which involve high-speed cutting of materials. This information can then be used to control and improve the machining processes.

The use of Monte Carlo simulations to explore phenomena continues to be an important topic of research. It was known that the number of different dimer coverings of a cubic lattice grows exponentially with the size of a lattice. We calculated the exponent, which is a physical constant whose determination has resisted theoretical and computational efforts for over 40 years. We did this by conducting a very large scale Monte Carlo calculation. The method extends to the monomer-dimer case and should enable the first ever computation of the partition function for monomer-dimer systems. This result is of interest in chemistry and materials science because it explains how energy states are distributed. The core computation has been parallelized.



The nondestructive testing of welds is a common problem in many manufacturing industries. Special "test blocks" are used to calibrate transducers used in the nondestructive testing of materials and welds. The problem, however, is that these blocks have not been easy to calibrate. At the request of the American Society for Testing and Materials (ASTM) and in collaboration with MSEL, we developed two- and three-dimensional models for elastic wave propagation that were used to study elastic wave behavior in various test block geometries. The computer model was used as part of a sensitivity study to determine the effect of source and test block geometry. International and U.S. standards committees devoted to the use of ultrasonics in welding are using these results to help the committees improve the methods used to calibrate transducers for nondestructive testing. The International Institute of Welding expressed interest in this work.

## **Tools for High Performance Computing**

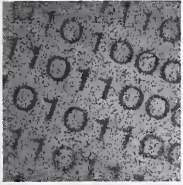
Division consulting and collaboration activities often lead to the development of general purpose tools that can be reused in other NIST and external applications.

A primary tool for the dissemination of information about mathematical software tools is the NIST Guide to Available Mathematical Software. GAMS indexes more than 10,000 software components from 110 libraries and packages. These are components which were either developed at NIST, selected for use at NIST, or archived at netlib, an external repository of the numerical analysis community. GAMS serves the needs of local users for information about software available on local systems; however, the information is of wide interest and has been made available to the public. GAMS is accessed by 10,000 external users each month, and the Web server which hosts GAMS, the Matrix Market, and other division project pages is now averaging more than 400,000 "hits" per month, having exceeded seven million hits since it started operation in 1994.

Our work in support of distributed memory parallel computing led to the development of PHAML, a parallel hierarchical adaptive multilevel software package for elliptic boundary-value problems. Work on PHAML has resulted in fundamental advances in multigrid methods and automated load balancing for adaptive computations. A public release of PHAML is expected this year. Work on PHAML led to the need for portable interactive graphics accessible in Fortran. To solve this problem, f90gl, a Fortran binding, along with a reference implementation, for the OpenGL graphics interface was developed and submitted to the OpenGL Architecture Review Board (ARB). The ARB is composed of representatives of a variety of manufacturers with OpenGL products, including Digital, Evans & Sutherland, Hewlett-Packard, IBM, Intergraph, Intel, Microsoft, and Silicon Graphics. Favorable initial reviews were obtained from the ARB and the J3 Fortran standards committee, and f90gl is now under consideration as the official Fortran binding for OpenGL. (See <http://math.nist.gov/f90gl/>.)

Our work in image analysis and metrics also led to a variety of new methods and tools. For example, we studied progressive transmission techniques, with applications to downsampling/upsampling schemes, and are in the process of developing prototype software. We developed software to generate optimal biorthogonal wavelets, as well as prototype software to apply wavelet transforms to color pictures. We also generalized the lifting schemes used for ordinary biorthogonal wavelets to multiwavelets. Lifting is the process of starting with a wavelet pair and generating a new one that satisfies some property such as vanishing moments.





# ADVANCED NETWORK TECHNOLOGIES DIVISION

---

**Chief:** Kevin Mills

**Chief (Acting):** Craig Hunt

**Group Managers:** David Su, High Speed Network Technologies

Nader Moayeri, Wireless Communications Technologies

Jean-Philippe Favreau, Multimedia & Digital Video Technologies

Craig Hunt, Internetworking Technologies

Information technology trends indicate an ongoing move toward a future of universal, continuous access to information. Three barriers to realizing this future are interoperability problems, scaling problems, and security problems. The Advanced Network Technologies Division concentrates primarily on overcoming the first two barriers and on eliminating their detrimental effect on the development of a global network infrastructure. Our contributions to overcoming these barriers are focused on developing test methods, such as testbeds and reference implementations for interoperability testing, and simulation analysis of protocol interactions and scaling limits. Each group's projects and accomplishments are described below.

## High Speed Network Technologies

The High Speed Network Technologies Group continues its leadership role in the development of Asynchronous Transfer Mode (ATM) network protocols by active participation in the ATM Forum. The ATM Forum is an industry standards consortium that develops standards for high speed digital network technology. We develop abstract test suites (ATS) for conformance and interoperability testing of the ATM network protocols through participation in the Testing Working Group of the Forum. Our efforts concentrate on testing of call control signaling, routing, and traffic management. During 1997, the group developed conformance tests for the user-network interface (UNI) version 3.1 signaling layer for user side equipment, and interoperability tests for the Private Network-to-Network Interface (PNNI). Currently, the group is developing conformance tests for PNNI and for the Available Bit Rate (ABR) service.

At the international level, we participated in the ITU-T Study Group 13 in the development of the Protocol Implementation Conformance Statement (PICS) Proforma for ATM Adaption Layer (AAL) Type 2 and related service parts. This work contributed to defining the real requirements of the AAL Type 2 protocol and helped the members reach agreement on the ITU-T Recommendations. An important application of AAL2 is the transport of voice over ATM networks.

There is an increasing need for residential broadband access network standards to provide high-speed Internet access from homes that can support the new multimedia applications. The industry standards group IEEE 802.14 is developing protocols for high speed bi-directional data communication over the Hybrid Fiber/Coaxial (HFC) networks currently being used or deployed by the cable TV industry.

For the past three years, the IEEE 802.14 group has been working on a draft specification that will include protocols for the Physical Media (PHY) and Medium Access Control (MAC) protocol layers. As an unbiased third party, ITL participated in the evaluation of several MAC proposals submitted to the 802.14 group. We produced several reports to the group based on the results of computer simulations conducted in our laboratory. The subjects of these reports included performance comparison of MAC proposals, analysis of MAC frame formats, comparison of contention resolution algorithms, and evaluation of bandwidth allocation methods. These reports helped the standards group achieve several important agreements in arriving at a final MAC protocol. In addition, our work on the HFC MAC protocol was extended to include performance evaluation of Transmission & Control Protocol/Internet Protocol (TCP/IP) and ATM ABR service in an asymmetrical network environment such as HFC. The results were presented at technical conferences and in journal publications.

A Video-on-Demand (VoD) Interoperability Testing Laboratory was established jointly by the High Speed Network Technologies Group and the Multimedia and Digital Video Group. In this laboratory, a VoD system was developed based on the DAVIC (Digital Audio-Visual Council) specifications. The system implemented DAVIC's control and data flow. The data flow delivers MPEG2 (Moving Picture Experts Group [MPEG]) data directly over ATM network while the control flow carries control data such as video selection and VCR-type controls via the DAVIC standard protocol stack, or alternatively, through an Internet Web browser.

Test tools are being developed for conformance testing of protocols involved in the laboratory testbed. In 1997 we developed a conformance test suite for the Digital Storage Media Command and Control (DSMCC) protocol which is to be included as part of the International Organization for Standardization (ISO) MPEG2 standards. This facility offers vendors the opportunity to test product interoperability with other vendors' products as well as with NIST's VoD implementation.

In addition to the interoperability tests of VoD applications, we conducted experiments on the transport of digital video information over ATM networks. In a collaborative effort with Bellcore and Bell Atlantic, we used a Bellcore prototype Video Dial Tone system to test transfer of video over multiple wide area networks. ATM networks between New Jersey and Maryland were used in these tests, which specifically addressed the impact of ATM quality of service (QoS) parameters on the performance of the digital video application.

## **Wireless Technologies**

Wireless technology is emerging as an important new area of network research. To meet the interoperability and scaling challenges of the effective use of wireless technology, we are strengthening the Wireless Technologies Group to give it a stronger research focus.



## Multimedia and Digital Video

The Multimedia and Digital Video Group works with industry to promote the development of cost-effective, interoperable, distributed multimedia applications and to enable the development of digital video technologies for broadcast, interactive television, video-on-demand, and video conferencing. The group focuses on three areas: measurement techniques for characterization of distributed multimedia technologies and digital video devices and services; techniques for integrating multimedia services with network technologies; and industry-driven standards for multimedia technologies and digital video devices and services. The video-on-demand work is done in collaboration with the High Speed Network Technologies Group.

In collaboration with MITRE and Carnegie Mellon University (CMU), the group works on the Defense Advanced Research Projects Agency (DARPA) Intelligent Collaboration and Visualization Program (IC&V) program. The goal is to identify and apply an evaluation and benchmarking approach to the collaboration infrastructure and applications that will be developed with DARPA funding.

As the Internet has gained popularity over the past decade, the need for collaborative multimedia conferencing and application sharing systems has risen significantly. Application sharing allows participants to view and interact with the same application (e.g., spreadsheet) during their conference. These systems are beginning to play large roles in research, education (e.g., distance learning), and business.

In collaboration with Old Dominion University, ITL is designing and implementing an adaptable and extensible architecture for platform-independent multimedia conferencing and collaborative application sharing. The JCE (Java Collaborative Environment) uses Java-based collaboration mechanisms that provide solutions to overcome the platform-dependency problems for collaborative computing in heterogeneous systems. The Java programming language produces bytecodes that can be run on any platform which has a Java Virtual Machine. This enables application developers to write the application once and have it run anywhere.

## Internetworking Technologies

Division personnel actively participate in the design, standardization, development, and testing of next-generation internetworking technology. These activities focus on current design and standardization efforts within the Internet Engineering Task Force (IETF) to add significant new functionality to the Internet Protocol Suite (IPS). Our efforts concentrate in areas that hold promise for the most significant improvements to the capabilities of the IPS infrastructure: network security technology, the next-generation internetwork protocol (IPv6), and protocols and architectures to support integrated services.

In the area of network security technology, staff members took a leadership role in the IETF and vendor community in the design and standardization of internetwork layer security protocols, known as IPsec. IPsec protocols are designed to provide authentication, integrity, and confidentiality services to both the current IP protocol (IPv4) and IPv6. We concentrate our current efforts on IPv4 because of the high level of interest in fielding Internet security technology as quickly as possible.

At the request of IETF directors, ITL staff collaborated with key industry partners to develop several specifications for emerging IPsec protocols. Our staff co-authored IPsec protocol specifications with Cisco Systems, Inc., Bay Networks, IBM T. J. Watson Research Center, the National Security Agency, and Sable Systems.

In addition to providing leadership in IETF standards development, we designed and developed *Cerberus*, a leading-edge prototype and reference implementation of the latest IPsec specifications. *Cerberus* serves as a publicly available reference implementation and a platform for ongoing research on advanced issues in IPsec technology.

To answer an industry call for more frequent and accessible interoperability testing for emerging commercial implementations of IPsec technology, we developed the NIST IPsec WWW-based Interoperability Tester (*IPsec-WIT*). *IPsec-WIT* is built around the *Cerberus* prototype and ubiquitous WWW technology and allows implementers to remotely execute series of interoperability tests against the NIST reference implementation. *IPsec-WIT* also serves as an experiment in test system architectures and technologies. The novel use of WWW technology allows *IPsec-WIT* to provide interoperability testing services anytime and anywhere without requiring any distribution of test system software or relocation of the systems under test. Work is currently underway to expand *Cerberus* and *IPsec-WIT* to support emerging key management protocols and to address IPv6 in addition to IPv4.

In the area of integrated services, we focused our initial efforts on test and instrumentation tools to foster early experimentation with emerging IETF signaling, routing, and transport protocols for real-time traffic. Our tools address the gap between the capabilities of new network services and the requirements and capabilities of new and existing applications. Two of the most difficult aspects of engineering performance sensitive applications are being able to realistically test and measure the behavior of such applications in a controlled laboratory environment, and understanding how to map application requirements to new, real-time network services.

To address the first issue, we developed the NIST Network Emulation Tool (*NIST Net*) that enables experimentation with arbitrary IP network performance dynamics in a simple laboratory setting. The tool allows developers to use inexpensive PC components to experiment with bandwidth, delay, congestion, and corruption dynamics commonly experienced in large, wide area networks (e.g., the public Internet) and new subnetwork technologies (e.g., xDSL, cable modems).

To address the second issue, staff members developed the Integrated Services Protocol Instrument (*ISPI*). The *ISPI* tool enables one to measure the performance of real-time data streams transmitted over IP networks and to experiment with resource reservations without modifying existing applications. *ISPI* is capable of measuring in real-time the performance seen by applications distributed at various points in the network and to dynamically adjust the real-time attributes of the underlying network service.



# COMPUTER SECURITY DIVISION

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**Chief:** Stuart Katzke

**Group Managers:** Miles Smid, Security Technology

Tim Grance, Systems and Network Security

As information technology (IT) and electronic commerce become integral to all aspects of the government and private sectors, the security and protection of that technology becomes critical. Both industry and government require swift, seamless, and secure computer systems and networks to compete in the global marketplace. Our Computer Security Division emphasizes the development of vital tests and test methods, reference data, proof-of-concept implementations, and technical analyses needed by government and industry. These products, tools, and techniques enable security technology developers, vendors, and integrators to deliver high-quality, reliable products into the marketplace.

The NIST Computer Security program has six primary focus areas:

- **Cryptographic Technology and Applications** - to help establish common cryptographic security technology (algorithms, functionality, and interfaces) to support information technology (IT) systems and networks. This also includes development of conformance tests for cryptographic-based security technology and management of the NIST Cryptographic Module Validation Program.
- **Public Key Infrastructure** - to enable establishment of a nationwide (ultimately, global) infrastructure for managing public key certificates needed to facilitate data integrity, authentication, access control, non-repudiation, and data confidentiality services in global applications.
- **Internetworking Security** - to ensure that incident prevention, detection, reaction, and information sharing capabilities are embedded in the technical and operational fabric of IT systems and networks.
- **Criteria and Assurance** - to ensure the availability of affordable, reliable, and trustworthy security technology, systems, and products for use in IT systems and networks.
- **Security Management and Support** - to provide direct support and other guidance to ensure effective use and management of security technology. Activities include the National Information Systems Security Conference and a number of special projects.
- **Cryptographic Key Recovery** - to develop tests and validate standards for systems that provide for the recovery of cryptographic keys used for confidentiality in the event that such keys are not available from the originator.

The following are highlights of activities and accomplishments of the Computer Security Division in FY 97.



## Advanced Encryption Standard

In anticipation of future needs for the next generation of high-quality cryptography, the division initiated the development of an Advanced Encryption Standard (AES) that will provide a strong cryptoalgorithm for use by the public and private sectors in protecting sensitive unclassified information for the next 20 to 30 years. A *Federal Register* notice of January 2, 1997, announced NIST's intent to develop an AES and proposed minimum acceptability requirements and evaluation factors. Draft submission requirements for candidate algorithms were also announced. An AES Requirements Workshop attracted about 80 participants from industry, government, and academia, including representatives from Canada, the UK, Belgium, and Japan.

In September 1997, NIST issued a public call for submission of candidate algorithms. After the call period closes on June 15, 1998, NIST will make all submissions available for public review and analysis. Through a series of open workshops and public review periods, NIST will select the best algorithm for the AES based on its ability to provide the required level of security first, then on cost and flexibility considerations. For more information, visit NIST's Computer Security Resource Clearinghouse Web site at <http://csrc.nist.gov/encryption>.

## Cryptographic Module Validation Program

The Cryptographic Module Validation (CMV) Program has resulted in the validation of four cryptographic modules as complying with Federal Information Processing Standard (FIPS) 140-1, *Security Requirements for Cryptographic Modules*. This included the validation of Netscape Security Module 1, by Netscape Communications Corporation, for use by federal agencies. In addition to Netscape's software module, Entrust Technologies has received two validations for software modules used in their Entrust family of products. These modules received an overall rating of Level 1, which may be sufficient for many user's security needs. Four hardware cryptomodules have also received validations, including Fortezza PC Cards from National Semiconductor, Mykotronx, and SPYRUS, in addition to a module used in some of Motorola's radios. The radio module received a security rating of Level 1, while all three Fortezza cards have been validated at Level 2.

FIPS 140-1 specifies four separate levels of security provided by Cryptographic Modules with each level providing increased security and assurance. The Netscape Module was validated for secure email, certificate management, and password management and received an overall rating at Level 2. These validations expand choices for federal agencies in securing sensitive information over the Internet.

The CMV program is a joint effort between NIST and the Communications Security Establishment (CSE) of the Government of Canada. ITL and CSE serve as validation authorities for the program. Currently, there are three National Voluntary Laboratory Accreditation Program (NVLAP) accredited laboratories that test cryptographic modules. Currently, the laboratories are testing approximately two dozen varying types of cryptomodules, which will be posted to the Cryptographic Modules Validation List as they are validated by NIST and CSE.

For more information on FIPS 140-1, validated modules, and the accredited laboratories, visit the Web site at <http://csrc.nist.gov/cryptval>.



## **Public Key Infrastructure (PKI)**

Without a common infrastructure to support the issuance, management, distribution, and verification of public key certificates, the full benefits of cryptographic services will not be achievable. NIST is leading efforts to develop such a public key infrastructure (PKI). In July 1997, we coordinated a Public Forum on Certificate Authorities and Digital Signatures: Enhancing Global Electronic Commerce sponsored by the Department of Commerce. The forum provided an opportunity for the public to comment on various issues of the public key infrastructure related to certificate authority and digital signatures.

Many of the U.S. Government's PKI activities are coordinated through the Federal PKI Steering Committee. NIST chairs the Technical Working Group of the steering committee and hosts meetings of the committee itself. The working group has produced several technical documents on PKI issues, including an overall PKI Concept of Operations and PKI architectural and policy analyses. Industry participation in the PKI development process showed a marked increase in 1997.

In a related activity, ITL developed the Minimum Interoperability Specification for Public Key Infrastructure (PKI) Components (MISPC) with the cooperation of ten industry partners under Cooperative Research and Development Agreements. The MISPC provides a basis for interoperation between PKI components from different vendors. The specification supports interoperability for a large-scale PKI that issues, revokes, and manages public key certificates that bind public keys used for digital signatures to their owners. Interoperable PKIs are essential as more and more business transactions are carried out electronically. The work is published as NIST Special Publication 800-15.

Key features introduced by the MISPC have been incorporated into industry standards, such as the Internet Engineering Task Force (IETF) PKIX (Public Key Infrastructure Using X.509) documents. The convergence of PKI specifications increases vendor and consumer confidence and encourages the development and procurement of PKI components.

## **Key Recovery Standard**

NIST serves as secretariat for the Technical Advisory Committee for the development of a Federal Key Management Infrastructure. This advisory committee, which met six times in 1997, was established to obtain private-sector assistance in the development of needed cryptographic key management services for the government. As participants in an Interagency Key Recovery Demonstration Project, we established the Pilot Root Certification Authority (CA) and developed Pilot Tests. We also conducted a Broad Agency Announcement for Key Recovery System Components.

## **National Information Assurance Partnership (NIAP)**

To promote the independent evaluation of security products, NIST and the National Security Agency (NSA) formed the National Information Assurance Partnership (NIAP). This new federal initiative focuses on ensuring the security of information technology systems and networks through cost-effective testing, evaluation, and certification programs. The partnership encourages the availability of objective measures and test methods for evaluating the quality of information technology security products.

The NIAP will develop tools, test methods, and tests for specification-based information technology security products. This means that the security functionality and assurance requirements of a product or system must be formally described or specified. These specifications then form the basis for the development and conduct of tests for the product or for a class of product (e.g., for a firewall, an access control device, or even a network router).

In addition, NIAP will promote the development of commercial testing laboratories to provide testing and evaluation services that will meet the demands of both producers and users. NIST's National Voluntary Laboratory Accreditation Program (NVLAP) will be the basis for much of the NIAP test laboratory accreditation efforts. The program should help producers increase the value and competitiveness of their products (in the U.S. and abroad) through the availability of formal, independent testing and certification. NIAP efforts will help users in both public and private sectors by providing a sound and reliable basis for the evaluation, comparison, and selection of security products.

Initial industry reaction to the new partnership has been very positive. NIST and NSA are committed to the National Performance Review goal of transferring methodologies and techniques to private-sector laboratories. Accordingly, the agencies registered the NIAP as a National Performance Review Reinvention Laboratory through the Department of Defense in September 1997. Visit the NIAP home page at <http://niap.nist.gov/>.

## **Common Criteria (CC)**

The internationally developed Common Criteria (CC) are the focus of much of NIAP's work. The CC provides a comprehensive, rigorous method for specifying security functionality and assurance requirements for products (or classes of products), usually in the form of protection profiles (PPs). The CC provides an internationally recognized basis for specifying and testing a wide range of security technology, from components to products and systems. For more information on the CC, visit our Web site at <http://csrc.nist.gov/nistpubs/cc/>.

## **Role Based Access Control (RBAC)**

U.S. industry is increasingly using ITL's RBAC research in new product development. Corporations using the RBAC mechanism include the Secure Computing Corporation and Sybase, Inc. Citing the fact that in the software industry there is a premium on bringing new functionality to market quickly, Sybase was able to reduce significantly the development time of the next version of the SQL Server, Adaptive Server Enterprise 11.5 that will include a robust RBAC mechanism based on ITL research.

Under a CRADA, SETA Corporation and NIST are working together to modify the RBAC administrative tool, for use in an SQL/RDBMS environment. Open Group, a consortium that includes nearly every major software and computer vendor, is developing a new security system, Adage, that will be used in a variety of Internet applications. Adage is being designed to include a number of security features that have been derived from the RBAC security model. As a result of NIST's success in transferring its RBAC technology, the ITL RBAC research and development team won the 1998 Federal Laboratory Consortium Award for Excellence in Technology Transfer.

ITL developed the first formal, general model for RBAC, which provides access to IT resources based on a user's role in an organization. A joint project of the Computer Security Division and the Software Diagnostics and Conformance Testing Division, researchers are developing a technical specification, including a formal description, of RBAC on the Web. Also being developed is a proof-of-concept model implementing RBAC. Three patents on this research are in process.

## **FedCIRC**

The number and complexity of Internet-related incidents increased in the past year. With start-up funding from the Government Information Technology Services (GITS) Innovation Fund Committee, ITL coordinated the establishment of the Federal Computer Incident Response Capability (FedCIRC). FedCIRC provides a capability to assist federal civilian agencies in their incident handling efforts by providing proactive and reactive computer security-related services, cost-reimbursable technical assistance, and technical support. To date FedCIRC has six subscribers: the Department of Justice, the Department of State, the U.S. Customs Service, the Department of Agriculture National Finance Center, the General Services Administration Federal Supply Systems, and the Department of the Treasury Bureau of Alcohol, Tobacco, and Firearms.

## **Security Management and Support**

**Computer Security Resource Clearinghouse** - To facilitate access to NIST publications and guidance, as well as a wide variety of other sources of computer security information, we maintain the Computer Security Resource Clearinghouse (CSRC). The CSRC is a World Wide Web (WWW) site containing references to or electronic copies of many NIST computer security documents as well as links to many other valuable resources available on the Web. The address of the CSRC is <http://csrc.nist.gov>.

**National Information Systems Security Conference** - NIST co-sponsors, with the National Security Agency, the annual National Information Systems Security Conference (formerly the National Computer Security Conference). The conference, one of the largest of its kind, provides a forum for the government, commercial, and academic communities to come together to discuss the latest developments in information security technology.

**Agency and Public Input** - In addition, NIST serves as secretariat for advisory committees and other groups designed to further discussion, cooperation, and coordination among the key communities in the information security field. Two notable groups are the Computer Systems Security and Privacy Advisory Board (CSSPAB), which met four times in 1997, and the Federal Computer Security Program Managers Forum, which met six times in 1997.

**Agency Assistance and Collaboration** - The NIST Computer Security Division is frequently called upon by other agencies to assist with or collaborate in IT security-related analyses, program development, or technology implementation. In FY 1997, we undertook a number of such projects. NIST participated in an interagency Collaborations in Internet Security (CIS) project to enable multiple-agency use of advances in IT security technology and products. NIST was also involved in supporting standards and guidance development for the Health Insurance Portability and Accountability Act (HIPAA) of 1997. As in previous years, NIST also produced several ITL Bulletins that addressed IT security topics of current interest.





# INFORMATION ACCESS AND USER INTERFACES DIVISION

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**Chief (Acting):** Martin Herman

**Group Managers:** David Pallett, Spoken Natural Language Processing  
Donna Harman, Natural Language Processing and  
Information Retrieval

Charles Wilson, Visual Image Processing

Sharon Laskowski, Visualization and Virtual Reality

The Information Access and User Interfaces Division accelerates the development of technologies that allow intuitive, efficient access, manipulation, and exchange of complex information by developing and coordinating measurement methods, evaluation methodologies, test suites and corpora, prototypes, workshops, and standards.

## Spoken Natural Language Processing

The Spoken Natural Language Processing Group advances the state of the art of spoken language processing technologies, which serve as an alternative modality for the human-computer interface. They are also used to provide transcripts from speech input that can be searched to provide relevant excerpts of audio. We develop test procedures, coordinate community-wide benchmark tests, provide reference materials (speech corpora) used by the research and development community, and build prototype testbed systems.

The group has worked with the Defense Advanced Research Projects Agency (DARPA) spoken language community since 1984, and has played a key role in the development of speech corpora (databases of speech, transcriptions, and related materials) for the research community to use in both system development and benchmark tests. Over 200 CD-ROMs containing these corpora have been produced by ITL and are used throughout the worldwide speech research community.

Benchmark tests, which we have implemented within this community since 1987, are used to track the development of several speech technologies including English and multi-lingual speech recognition and understanding, spotting technologies, language identification, and most recently, spoken document retrieval. These tests, which provide diagnostic information that helps to identify strengths and weaknesses in the technology, have facilitated increased accuracy and robustness of the technology over time.

The scope of speech recognition technologies under development and test within our community now includes recognition of conversational telephone-channel speech in several foreign languages, including Spanish, Mandarin, Japanese, Arabic, and German. In FY 1997, we implemented large vocabulary continuous speech recognition benchmark tests for DARPA's Human Language Systems Program and other Department of Defense agencies with participation of U.S. and international government-sponsored organizations.

ITL's work helped to move the research community into real application domains by designing new benchmark tests and test materials using "found" speech from television and radio news broadcasts involving background noise and music, foreign dialects, spontaneous and conversational speech, varying recording/channel effects, and unconstrained vocabularies. Continuous speech recognition benchmark tests now include audio recordings from radio and television news broadcasts in Spanish and Mandarin as well as English. Error rates for the task decreased substantially over the last three years.

In conjunction with the Natural Language Processing and Information Retrieval Group, our group organized the first benchmark test of spoken document retrieval (SDR) technology which involves the retrieval of excerpts from collections of audio recordings. Since SDR is implemented by applying information retrieval techniques to the output of speech recognition systems, the benchmark test provided the opportunity for speech research organizations to work with information retrieval organizations. Fourteen organizations participated in the SDR test and 3 of the 13 submitted systems were joint efforts between speech recognition and information retrieval organizations. Several sites had SDR results which were nearly comparable to their retrieval on human-generated control transcripts and demonstrated that successful retrieval can be performed with current speech recognition technology.

We developed a portable UNIX-based software package (SCLITE) for scoring the performance of speech recognition systems, and we use this software to score, tabulate, and analyze results for the speech recognition benchmark tests we administer. Publicly available, SCLITE is used internally by many research organizations to evaluate their speech recognition systems. It produces a variety of performance reports and includes implementations of several paired-comparison statistical tests. These tests, developed in part with the assistance of the Statistical Engineering Division, quantify the significance of performance differences across systems.

We initiated the development of an interactive spoken document retrieval evaluation testbed. When complete, the modular system will permit us to explore measurement and evaluation techniques for speech recognition and understanding, spoken document retrieval, adaptive language modeling, information acquisition, and human-computer interaction.

## **Natural Language Processing and Information Retrieval**

This group promotes the use of more effective and efficient techniques for manipulating unstructured textual information, especially the browsing, searching, and presentation of that information. The work is accomplished via three complementary mechanisms: the creation of testing materials and metrics for text retrieval, the sponsorship of the annual Text REtrieval Conference (TREC), and the ongoing investigation of specific issues in text access using in-house prototypes.

In past years we developed testing material for evaluating text retrieval in English (over 5 gigabytes of test documents and 300 test questions), created the first test collections ever built for retrieval in Spanish and Chinese, and produced new metrics and testing material for evaluating retrieval using input produced by degraded optical character recognition (OCR). All these testing materials and metrics were first used as part of the evaluation of participating systems in TREC, and then distributed for use by researchers in industry and academia.

During 1997 we expanded this effort into new areas. In cooperation with the Swiss Federal Institute of Technology (ETH), we produced the first test collection for evaluation of cross-language retrieval, i.e., the retrieval of documents in different languages than the input query language. This testing material is comprised mainly of newswire data in three languages: English, French, and German. The 25 test questions built are also in these languages, to enable testing in both a monolingual and a cross-lingual mode.

Additionally, in cooperation with the Spoken Natural Language Processing Group, we created testing material for the evaluation of speech retrieval against 50 hours of broadcast news. New metrics and evaluation methodologies were developed for using this material in TREC-6. As a third project for TREC-6, the group provided extensive guidance to the Australian National University during their creation of a very large (20-gigabyte) corpus for use in testing the efficiency of search engines.

A final project for TREC-6 involved the design and implementation of a new testing methodology for evaluating interactive text retrieval. With major help from the Statistical Engineering Division, we created an experimental design involving the use of a control system to help separate the various factors in the performance of interactive systems. NIST's ZPRISE retrieval system was slightly modified for use as the control system, and nine TREC-6 groups participated in this experimental evaluation test.

The TREC-6 conference, the latest in the ongoing series of conferences designed to improve text retrieval algorithms, took place in November 1997. This conference, co-sponsored by NIST and DARPA, attracts international participation from information retrieval researchers in industry, academia, and government. The conference, which has grown from 25 systems in 1992 to 51 systems in 1997, serves as a major technology-transfer mechanism in the field. Participating groups worked with large (NIST-built) test collections, used the same evaluation procedures, and met for a three-day workshop to compare techniques and results. In 1997 there were ten areas of testing: retrieval in English in both new query and standing query modes, retrieval in Chinese, cross-language retrieval, speech retrieval, filtering, interactive retrieval, high-precision retrieval, retrieval using natural language processing techniques, and retrieval using a 20-gigabyte corpus.

Other areas of research during 1997 included successful experiments building a simple German stemmer and decompounder for use in the TREC-6 cross-language task, the initial design work for a digital library for access to archival publications in information retrieval, and the user testing of a pilot search system (EAMATE) in conjunction with the Social Security Administration (SSA). The group's prototype search engine (PRISE) was used in an experiment to develop better search algorithms based on the type of documents being searched. This experiment led to a revision in the current algorithm. A client/server version of this search engine, called ZPRISE, continued to be distributed as public domain software, and was sent to 30 additional institutions in 1997.



The group worked on two projects particularly oriented towards improved hypermedia access, including the Web. The HyperIndexer project, with SSA, continued its investigation into the building of automatic links, including a small user test of the effectiveness of these links. Along with changes to the prototype based on this testing, new work has started on the automatic creation of embedded links. The second project involves the design and building of test metrics for usability evaluation of Web sites remotely. This project, called WebMetrics, is being conducted jointly with the Visualization and Virtual Reality Group, and has already resulted in experimental testing of three very different Web sites.

## **Visual Image Processing**

ITL supports the technology of image recognition in government and industry by developing new image recognition methods, developing techniques for the evaluation of existing methods, and providing technology transfer to the commercial imaging and document conversion industry.

In cooperation with the Federal Bureau of Investigation, we developed methods for the evaluation of fingerprint applications and mugshot standards. The goal of the mugshot standards project is to develop a standard method for acquiring electronic mugshots which is usable at all levels of law enforcement. Also in 1997, we initiated a project to explore combining a fingerprint biometric with existing digital signature standards. This project will allow electronic law enforcement records to be authenticated with a digital signature accessible only after a matched fingerprint has been used to verify the identity of the sender.

In 1997 researchers in the optical information processing project began to develop evaluation methods for system components of pattern recognition and holographic memory systems. The goal of this project is to develop the metrology needed to industrialize optical information processing using a real commercial application as a test bed. Initially, we explored the feasibility of optical methods of image storage, 3D holography, and combining optical correlation and neural networks for fingerprint matching.

These efforts showed that properly characterized 3D analog holographic memory has capabilities for image storage which is sufficient to support various correlation methods of pattern recognition. In the initial phase of the project, we also showed that a combination of local optical correlation and neural network matching can be used to provide the first advance on minutia matching in 20 years. If properly combined, these methods should allow a new class of optical pattern matching system to be developed. This will require development on new measurement methods to characterize components of the system, such as the input and output devices, and the development of new phase coherent optical computer-aided design (CAD) methods. A researcher from Carnegie Mellon University worked with the group on these new measurement methods.



The expertise developed in this project allowed us to specify a high-impact commercial application which could use this technology. This is real-time fingerprint matching for user verification for financial use, credit, law enforcement, and Internet security. The Financial Services Technology Consortium is interested in the first application and several small companies are pursuing the network access market. In both applications, fingerprint matching, retinal scan matching, and face recognition have all been suggested. The projected costs, the input device, and user inconvenience make fingerprint and face matching more attractive candidates than retinal scanning. At the present state of the technology, fingerprint matching provides much higher levels of security. In samples of a few thousand, look-alike faces can usually be found. In 30 million fingerprint samples, no matches have been found between different individuals.

In 1997, the group began an initial investigation of new pattern recognition methods based on the statistical learning theories of V. N. Vapnik. This project may provide a more accurate method of pattern recognition and should allow the performance effects associated with the distributions functions of the testing and training sets to be more accurately evaluated.

Work continues on cost-effective document conversion technology in cooperation with the National Security Agency (NSA). Commercial off-the-shelf (COTS) technology for many areas of document conversion is widely used for tasks such as universal library conversion but this technology does not address the need for large-scale, timely conversion of low-quality documents and the impact of this type of conversion on information retrieval. Studies at NIST which evaluate COTS solutions to this problem show that for high-quality images, COTS packages all perform well; on medium-quality images, some COTS packages perform well enough to be useful; and on low-quality documents, no COTS package performs well enough to be useful.

In 1997, our group collaborated with the Natural Language Processing and Information Retrieval Group and NSA to organize a committee to run the METTREC Conference (Metadata Text Retrieval Conference). Conferences of this type have been used in the case of OCR and TREC to define and focus both commercial and academic research efforts on specific problem areas. These conferences provide high leverage for potential government users and aid in technology evaluation by encouraging exchange of research ideas and by demonstrating the strengths and identifying areas requiring future work in the selected technologies.

Initially, METTREC will use 67,000 pages of the Federal Register (the entire year 1994) which have full typesetting instructions and paper documents. This allows comparison of images generated by typesetting with real images on scanned paper and enables assessment of OCR techniques in generating images. Initially, this comparison took place in a subset of the data in the 1996 TREC Conference. The results demonstrated that word error rates from OCR in the 5 percent range had little effect on retrieval. Future tests in METTREC should demonstrate the effects of 40 to 50 percent error rates that COTS packages produce on low-quality documents.

## Visualization and Virtual Reality

Information visualization is receiving much attention within the human-computer interaction and graphics research communities because it holds promise as a technology that will enable the display and exploration of large, complex information spaces. The Visualization and Virtual Reality Group advances the state of the art in information visualization and virtual environment technology through the development of evaluation methodologies, benchmarks, and metrics that address the usability and scalability of three-dimensional visualization approaches and through the creation of proof-of-concept prototypes, benchmark data sets, and formats for simplifying the integration of visualization tools with applications. Secondly, the group seeks to develop evaluation methodologies for leading-edge human computer interaction technologies that support information access.

In FY 1997, ITL developed several three-dimensional interfaces to the NIST PRISE information retrieval system to support easier access to document collections. These systems now form the basis of experiments to support the evaluation of the effectiveness of such interfaces. The group continues to pursue opportunities within the information retrieval and digital library communities to supply appropriate evaluation methodologies and guidelines that will leverage the technology to support innovative uses of visual displays of information for information retrieval.

A second project, begun three years ago, centers around investigating the appropriateness of virtual environments and the Virtual Reality Modeling Language (VRML) for manufacturing applications. The project is affiliated with users and developers through a collaboration with NIST's Manufacturing Engineering Laboratory and the Systems Integration for Manufacturing Applications program. The goal is to assist the manufacturing community in exploring how visualization can improve the manufacturing process. This led to the software modeling of factory floor assembly lines, machine tools, and parts with all associated multimedia information as a virtual environment in VRML.

The VIM (Visual Interface for Manufacturing) prototype was constructed in FY 1996 and supported an investigation of the feasibility and usability of Web-based virtual environments for modeling manufacturing processes. This was followed by a successful effort in translating various 3D designs and physical models into VRML2 and integrating into one VRML model. We also acquired data from the Consumer Product Safety Commission consisting of detailed infant and child measurements. This database was placed into electronic form and converted to VRML models of children via a human body motion simulation package. The VRML models and data developed by ITL have been integrated into several commercial packages.

We continued collaborating with researchers who have formed a group to develop large datasets to support the visualization and data mining community. The goal is to create large, public datasets in which researchers can experiment with and evaluate the effectiveness of visualization techniques to support information exploration. This is similar to efforts in the machine learning community, but with an emphasis on very large, timely datasets. In FY 1997, we successfully participated in a comparison of visualization and mining techniques for the first dataset.

We also continued our work with the DARPA Intelligent Collaboration and Visualization Program. As part of an evaluation effort designed to provide evaluation tools for DARPA-funded researchers, this year we developed a framework for evaluation of collaborative systems and associated scenario templates and test scenarios. This framework will be valuable as there currently exists a large body of knowledge about collaborative systems and computer-supported cooperative work, but no easy way to structure and apply this knowledge across the many dimensions of group work and technologies.







# HIGH PERFORMANCE SYSTEMS AND SERVICES DIVISION

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**Chief:** Dean Collins

**Group Managers:** Gordon Lyon, Scalable Parallel Systems and Applications

Jack Newmeyer, High Performance Systems Usage

John Antonishek, Network and Telecommunications Systems

Developers and users of high performance computing technologies need tests, test methods, and innovative measurement standards to produce high-quality products and to evaluate the products. The division assesses the functionality, interoperability, and operational characteristics of high performance systems to assist industry and users. It also provides high performance computing and telecommunications services to NIST researchers.

## S-Check

S-Check is NIST's novel tool for assaying and improving performance of parallel and networked programs. This year researchers expanded the capability of S-Check by developing extensions of the tool. S-Check augmentations now allow users to acquire the tool with either syntax-checking of C code or with a capacity to handle multi-languages without syntax-checking (variant S-Check ML). R&D Magazine selected S-Check® as a R&D 100 Award Winner for 1997. The tool is available at:  
<http://cmr.ncsl.nist.gov/scheck/scheck.html>.

S-Check is especially suited for improving code running on parallel systems, where component interactions are common but difficult to evaluate with conventional profiler tools. Displayed in color graphical formats, results from S-Check provide programmers with quantitative predictions on the effect of code improvements in their programs without actually requiring the changes to be made, saving a lot of time. With the added extensions, the tool is stable and mature for extended marketing to a wide variety of users.

## Distributed Systems Technologies

ITL is working with industry to apply MultiKron boards for assessing the performance of systems of various sizes. The MultiKron series of Very Large Scale Integration (VLSI) instrumentation chips and interface boards are measurement tools that promote the development of high performance computing and flexible, scalable systems. The Microsoft Corporation expressed an interest in applying the board to normal applications on multi-processor machines, to video servers where Peripheral Component Interconnect (PCI) utilization and synchronization are important, and to client server and cluster performance applications where a synchronized timebase is important. ITL provided four MultiKron boards to Microsoft and is working with the company to enhance the functionality of the technology, particularly in the area of clustering.

Work continues on our public server asynchronous transfer mode (ATM) cluster "Buffet," a demonstration testbed for distributed clustered computing for the NIST technical community. We added and tested representative programs on the cluster, and installed 16 Pentium Pro machines on the cluster to provide substantial compute power to message passing interface (MPI) users on the ATM network. Many MPI programmers use a Single-Program Multiple-Data (SPMD) model that assumes a homogeneous set of processors; the Pentiums provide this base set.

## **Time Synchronization for Distributed Computing**

Synchronized clocks are important in the distributed computing market, where they support commerce, security, monitoring, and billing. The NIST Physics Laboratory (PL) provides a synchronization service on the Internet with 10 ms precision; the service receives about two million synchronization requests per day. NIST would like to increase the precision of the service by overcoming the problems of variability of delays, to one microsecond.

ITL is developing a hardware supplement employing our MultiKron<sup>®</sup> clocking chip and low-cost commercial global positioning system (GPS) receivers. We are testing the hardware implementation for this application. Although such hardware support is sufficient to achieve higher precision time synchronization, the cost and availability of such specialized hardware limit its use. PL and ITL will investigate distributed software time synchronization algorithms targeted to achieve one microsecond precision and use this NIST hardware support instrumentation to evaluate the precision achieved and identify the impediments encountered. These low-cost techniques and guidelines can then be transferred to industry.

## **Interoperable Message Passing Interface**

ITL and industry are working together to define an interoperable message passing interface (IMPI) standard. In September 1997, ITL hosted the third Interoperable Message Passing Interface (IMPI) Workshop. All major U.S. computer vendors participate in this effort; representatives of these vendors as well as representatives from the embedded computing community attended the workshop. The group agreed that implementation of IMPI by the vendors would go on in parallel with the standard definition in order to get the most information on the choices made. The release of the first standard, IMPI-1, is expected by December 1998.

## **WebSubmit**

ITL researchers continued to enhance WebSubmit, an advanced Intranet application tool that provides a Web page interface to supercomputing applications. It differs from other Web applications because it allows interaction with a user's data files and directories on the target supercomputer as if the user were logged on. The advantage of a Web-based interface is that it is hardware- and software-independent; it depends only on whatever Web browser the user has available.

The current implementation of WebSubmit provides an interface to an IBM SP2 running the IBM LoadLeveler job scheduler. It supports general LoadLeveler use, utility operations on the SP2, and an application-specific interface to Gaussian94, a computational chemistry package. All of the Web pages are dynamically generated with common gateway interface (CGI) scripts written in Tcl. The Tcl code is modular, making the addition of new interfaces very easy, and simple to customize for a particular SP2 site. Future enhancements will include the addition of a NIST-developed cryptography toolkit for security, a generalized module constructor, as well as extension to other computer environments. Software developers and Web-page designers have requested information about this tool.

## **Parallel Library for NIST Staff**

Work continued on the development of a portable parallel library for NIST users. We wrote a simple version of a "reproducible parallel Random Number Generator" called `rrandom_array()`. It produces the same array or the number of processors the array is distributed across.

For heterogeneous cluster computing based upon MPI, we added "unions" to the AutoMap/AutoLink utility set, enhancing the ability of NIST users to send data structures over network connections. Similarly, the NIST tool PADE can now manage DPARLIB code (the NIST parallel library) on multiple platforms.

Due in part to library development by ITL staff, the SP2 is now being used as a true parallel machine. The SP2's 16-node queue is in greatest demand by users, indicating that NIST users are adopting parallel coding techniques.

## **CD-Electronic Book**

The CD-Electronic Book project demonstrated for the NIST staff the use of Microsoft Word and Powerpoint to simulate the features of an electronic book with touch-screen display. The software simulated electronic pagination, annotation, and electronic dictionary functions. Work is underway to use Visual Basic for the two-page version of the book.

## **Flat Panel Display**

ITL played a significant role in the development of several recent standards within Video Electronics Standards Association (VESA), an industry standards association which develops display-related voluntary industry standards. Flat panel displays are an essential enabling technology for portable computers, desktop monitors, and instruments. Panel architecture makes proper timing much more critical than for cathode ray tube (CRT) displays; failure to meet the timing requirements can cause permanent damage to the panel. The standard timings and "plug and play" compatibility of CRTs have not been available for flat panel displays, an omission that VESA is moving to correct.



At VESA's request, researchers analyzed flat panel display interface timing characteristics, based on product information submitted by manufacturers to ITL which conducted an impartial analysis. The necessary timing characteristics were derived, analyzed, and reported to VESA as general information without brand names or product identification. This information will be used as the technical foundation for a new standard for interfacing flat panels and other digital input displays to computers.

Co-sponsored by ITL and VESA, the Display Forum '97 Workshop in October 1997 attracted 85 representatives, mostly from industry. Future trends of the display industry were discussed and recommendations were made on ways in which ITL can continue to support industry in this work.

## **Advanced Information Processing, Recognition and Storage Systems**

Work continued on developing simulation models for ATM network architectures that include Network-Attached Storage Devices. We also established an optical tape testing laboratory, led an industry effort to define dynamic optical tape testing methods, and initiated the development of a digital media error test system with remote testing capabilities.

We initiated work under a Cooperative Research and Development Agreement (CRADA) with Calimetrix, Inc., for the investigation of test methods, standards, and High Performance Distributed Computing applications for CD-ROM and Digital Versatile Disc (DVD)-based optical data storage subsystems. We led an industry effort to specify prototype metadata for the portability of sequential storage media (including optical tape) between File Storage Management Systems (FSMSs). A staff member, Fernando Poggio, was appointed by the Association of Information and Image Management (AIIM) as the chair of the FSMS Subcommittee to lead the effort of developing an industry standard based on the metadata specification. This effort received wide industrial support among FSMS vendors and mass storage and high performance computing users.

ITL worked with the AIIM Optical Tape Study Group to develop a preliminary set of media specifications and identified a methodology for dynamic testing of optical tape. These proposals were submitted to AIIM for the development of industry optical tape standards: Write-Once Read Many Times (WORM) Optical Tape Cartridges in a "3480" form factor; and "Media Error Monitoring and Reporting Information (MEMRI) to Verify the Integrity of Stored Data on Tape Media."

## **The NIST Scientific Computing Environment**

The continued upgrading of the IBM SP2 expanded the capabilities previously provided for NIST researchers for scalable parallel processing. Upgrades to the system included the addition of IBM new switch technology to the existing 31 nodes; 6 additional nodes to create a 37-node system; an IBM Parallel System Support Package and Performance Toolbox Software upgrade for the SP2 control workstation; and a 256 MB memory upgrade for the SP2 control workstation. In addition, we acquired an SGI Origin 2000 system with 8 CPUs, 8 GB memory, 96 GB disk storage, and operator and system administrator consoles. The security of the SP2 system was also enhanced.



## Networking and Telecommunications

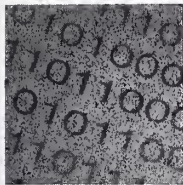
We continued to upgrade the PEPnet/Eznet network infrastructure at NIST. The MAC watch (NIST developed) and Arp watch software are now running in an automated environment. This software has proved to be a real time saver in the PEPnet operation. The software has been ported to the NIST Boulder Eznet environment where it is running successfully. Further enhancements are planned.

A switched CAT5 network was installed in NIST's Radiation Physics Building to support PEPnet users in the Physics Laboratory. We also provided switched FastEthernet to ITL's Scalable Parallel Systems and Applications Group for their cluster computing experiments. The upgrade of Eznet to CAT5 cabling continued. All NIST Administration Building networks were migrated to the FDDI-based Cabletron switches.

Our network monitoring programs were modified to page our staff if a subnet becomes unreachable or show a packet loss of greater than 15 percent. This is determined by testing a single host on the subnet that was supplied by the subnet administrator as "always available."

To provide state-of-the-art telecommunications services to the NIST staff, we are identifying the requirements of future telephone services at NIST, determining needed features for a telephone switch upgrade. We also started a trial of test users for Bell Atlantic's Asymmetric Digital Subscriber Line (ADSL) service.





# **DISTRIBUTED COMPUTING AND INFORMATION SERVICES DIVISION**

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**Chief:** Oscar Farah

**Group Managers:** Robert Crosson, Distributed Processing and Operating Systems  
Support

James Graham III, Information Processing Support

Robert Lee, Administrative Computing Support

Ronald Wilson, PC Support

The Distributed Computing and Information Services Division provides the information technology resources, supporting infrastructure, applied research, and assistance to NIST staff, collaborators, and clients in the conduct of NIST's scientific, engineering, and administrative applications and in the dissemination of information, including:

- an easy-to-use, robust, secure, distributed heterogeneous environment with support for desktop systems and workstations, network capabilities, information services, and access to external and mobile users;
- common computing environments, information access tools, software development tools, and specialized applications software;
- site-wide hardware maintenance for standardized desktop systems and workstations and site-wide software licensing;
- maintenance and repositories for standardized platforms and applications; and
- large-scale testbeds, advanced prototypes, and reliable systems as part of the continuous improvement in scope and quality of service.

## **Distributed Processing and Operating Systems Support**

In FY 1997, the Distributed Processing and Operating Systems Support Group continued to provide the NIST staff with high-quality computing support services. One major project was to simplify and streamline the administration of the NIST-wide software checkout service. This service provides NIST scientists and researchers the option to access and use expensive, licensed data processing software packages. Updated versions of these software packages were obtained and installed on the server to ensure that the users had the latest versions. The administration of the software was improved and automated where possible.

The NIST electronic mail servers operated by the group in Gaithersburg and Boulder continue to provide highly reliable service to over 2,500 users, with over 3,000 electronic mail messages processed per day. These servers have been reprogrammed to provide the electronic mail alias translation service for NIST staff, so that e-mail addressed to *firstname.lastname@nist.gov* is delivered no matter where the staff member actually receives mail. A third e-mail service, administering over 200 mailing lists used by NIST staff, was also updated. Three of these lists are large and are updated automatically overnight -- that for Gaithersburg staff, that for Boulder staff, and that for all NIST staff.

During the year the group assumed responsibility for another NIST-wide service, the administration of the Usenet News server. Usenet is an informal collection of news servers supporting over 25,000 special-interest groups. The news servers allow individuals to read and post messages to those groups, and to periodically transfer messages to other servers supporting the same news groups. The group manages the news server that communicates with servers external to NIST, distributes postings to all NIST users, and supports the NIST-specific special-interest groups.

The upgrade of hardware continued, to support the increasing demand for service by the NIST staff and to improve system reliability. A new server, a Sun Microsystems Ultra Enterprise 4000, was acquired. Once configured, this server will replace five currently used computers and provide better and faster service.

## Information Processing Support

In FY 1997, the responsibilities of the Information Processing Support Group continued to grow. Currently, the group hosts a total of 28 World Wide Web (WWW) servers that provide Web services to 7 of the 11 NIST Measurement and Standards Laboratories and Programs. These are the Information Technology Laboratory (ITL), Technology Services (TS), the Chemical Science and Technology Laboratory (CSTL), the Manufacturing Engineering Laboratory (MEL), the Physics Laboratory (PL), the Advanced Technology Program (ATP), and the National Quality Program. The group also constructed an operating prototype of an electronic commerce system for limited use by Technology Services to sell standard reference materials and databases through the Internet.

System performance and security are continually monitored by the staff and by special software installed on the servers. The software is programmed to page the staff responsible in case of a malfunction or in case it appears that an intruder is trying to obtain access to any part of the system. This approach of centralized monitoring by staff who are experienced in this area results in a more secure system and improved operation over the previous approach of having each Operating Unit (OU) run its own system.

The group also provided consulting and programming services to NIST OUs. Help with the creation of Web pages, with access to databases from the Web, and with the programming of special OU-specific WWW applications was provided to NIST staff. Assistance was also provided to OUs interested in developing intranets for use by their staff. Additionally, applications that generally support NIST staff, improve communication between NIST offices, and provide monitoring of Web access and traffic were developed. Improved services included development of a Web forum capability, development of electronic forms, and generation of statistics of Internet users that access NIST WWW servers. The group also participated in the development of policies for NIST Web pages. CGI scripts to warn Internet users when they exit NIST were developed with the cooperation of the NIST Information Coordinators.



Additional information on all group services may be found at  
<http://webservices.nist.gov/>

## **Administrative Computing Support**

In FY 1997, the Administrative Computing Support Group completed an inventory of the administrative systems at NIST. The inventory consisted of one hundred and thirteen systems with over one million lines of code, written in COBOL, dBase, FOCUS, and REXX. The majority of these systems support the three primary business units at NIST: the Chief Financial Office, the Office of Human Resource Management, and the Acquisition and Assistance Division. This inventory served as the basis for determining which systems may have Year 2000 problems, prioritizing which systems need to be addressed first, and reporting progress to NIST senior management, DoC, and the Office of Management and Budget (OMB).

The group also completed a series of pilot conversion projects. These pilot projects allowed the staff involved to learn about the Year 2000 problems and to implement solutions. These projects also served as templates for future conversion projects. During a four-month period, 16 systems were converted and made Year 2000-compliant.

The group supported the Department of Commerce Administrative Management Systems (CAMS) project. The CAMS effort may be viewed as the Core Financial System (CFS) (General Ledger, Accounts Payable, etc.) and supplementary modules to be developed by NIST and other DoC agencies. The testing of the CFS required a considerable amount of staff resources. Insufficient documentation, changes in configuration management, and suspect program design required extensive code review while testing and debugging.

NIST agreed to take the lead to develop two supplemental modules, a Personal Property module and a Time and Attendance (T&A)/Estimated Labor module. For the Personal Property module, after reviewing commercial, off-the-shelf (COTS) packages, Oracle Assets was selected in April 1997 as the base package, and the implementation began at NIST in May 1997. A model of the proposed T&A/Estimated Labor module was completed and was demonstrated to yield estimates accurate to 99 percent from the T&A records.

In addition to these two initiatives, the group continued to support the business operations of the 100+ administrative computing systems at NIST. This included revising DOS-based systems to be Windows 95-compatible, responding to auditors' requests, developing Web pages for the administrative officers and secretaries, assisting in automating the telephone billing system, and supporting the ATP Survey project.

## **PC Support**

The event that had a major impact on NIST staff was the approval by the NIST O-Board of ITL's recommendation to change the current collection of software office automation packages to a modern, integrated suite of software. The cutoff date for the switch to the new package was set as October 1, 1997. In preparation for the changeover, a number of training sessions in the use of the new software were offered by group members to NIST staff. In addition, seminars that highlighted the differences between the previous group of NIST office automation software and the new integrated suite were held in Gaithersburg and Boulder.

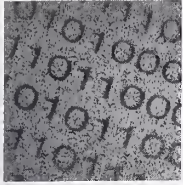
To augment the Help Desk support staff, a contract for telephone support for the new software products was let to Battelle Memorial Institute at the Pacific Northwest Laboratories (PNL) in Richland, Washington. Battelle currently runs this Department of Energy laboratory. Initial statistics on this service indicate that, although the staff that used it considered it very helpful, very few calls were made. If the call rate remains low, current NIST staff would be able to handle this service and the contract with Battelle will not be renewed.

In the past year, steps were taken to improve communications between group members and PC support staff employed by other OUs at NIST with the goal of improving service level across NIST. The PC Assistance Group was revived and meetings to improve staff "networking" and to discuss installation, operation, and maintenance of the new software suite were and continue to be held frequently. A new NIST-wide group, the PC Liaison Group, was also formed to facilitate staff networking and discuss hardware problems.

Another development in 1997 was the replacement of the DOS- based virus detector/remover with a Windows-based virus detector/remover whose virus list is updated automatically through the Web and which can detect virus in e-mail. A site license for the new detector was purchased for NIST and group members developed a self-installing package that can be accessed through the NIST intranet.

Another new service added to group responsibilities was to provide installation and maintenance support for NIST's Travel Manager System. Travel Manager grew from a small pilot project to a system that is currently servicing more than 300 users. Many of the NIST laboratories plan to make the use of Travel Manager mandatory on January 1, 1998.

Staff continue to work on methods to improve software distribution to NIST users. Prototypes are being developed to make installation of new software through the Web much easier.



# SOFTWARE DIAGNOSTICS AND CONFORMANCE TESTING DIVISION

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**Chief:** Mark W. Skall  
**Group Managers:** D. Richard Kuhn, Software Quality  
Lynne S. Rosenthal, Conformance Testing  
Bruce K. Rosen, Software Standards

Activities in the Software Diagnostics and Conformance Testing Division focus on the development of software evaluation technology, conformance tests, and standards that can be used to assist U.S. industry in the development of high-quality software. In this role, the division develops software testing tools and methods, participates with industry in the development of forward-looking information technology standards, and leads efforts for the development of conformance tests even at the early development stage of standards.

## Software Analysis Tools

Division researchers participate in the development of tools for static and dynamic analysis of software, focused on measuring conformance to specifications and diagnosis of the causes for deviations from specifications. Included is work on static analysis tools for program slicing and generation of paths for basis testing, and the extension of object-oriented languages to allow for the detection of pre- and post-condition violations.

Building on previous work in role based access control (RBAC), we developed a prototype of the first RBAC extension to World Wide Web servers. The software developed in this project can be incorporated into existing Web servers to provide access control based on users' roles in the organization, simplifying security for both administrators and users. Our formal model for RBAC, developed jointly with the Computer Security Division, was adopted by two major software vendors for incorporation into their own products.

A unique graphical search engine, Reference Information for Software Quality (RISQ), was developed in cooperation with the Software Engineering Institute at Carnegie-Mellon University. The RISQ search tool uses a graphical taxonomy-based query system to simplify and speed up user searches for information on software quality. Although developed for searching software quality information, the RISQ facility is ideally suited to other types of taxonomy-based data.

For the Nuclear Regulatory Commission, ITL developed the Unravel Program Slicer which computes "slices" of C programs, where a slice is a subset of the program that contains all lines of code that can directly or indirectly affect the value of a particular variable at a particular point. The tool assists in the effort to debug or test a program since it allows the programmer to focus on those parts of the program that are relevant to the logic in question. Other front ends for the Unravel Program Slicer are being considered for development for other programming languages such as C++ or Java.



To allow software developers to measure the effectiveness of development techniques and compare their results with others, a unique database of software errors, faults, and failures is being developed. In addition, to assist industry in the evaluation of the methods and tools they use to improve software quality, we are developing a library of standard reference materials consisting of software with known errors. This library can be used by software developers to determine the effectiveness of the test tools and techniques they use in developing their systems. As part of this effort, we plan to develop statistical methods of evaluating testing procedures and software development tools and techniques.

We initiated a project to develop methods and tools for automatic generation of tests from software specifications. Successful automated testing methods promise significantly more economical means for testing software than are currently available. This will reduce time to market for software products and benefit consumers by making quality software less costly to produce.

## **Software Conformance Testing**

Division researchers develop test methods and tests to determine whether implementations of public specifications conform to that specification. The division is also working closely with outside organizations to help them establish certification test services based on division tests, for the issuing of certificates of conformance.

Working with industry, we are developing conformance tests and test tools for the Virtual Reality Modeling Language (VRML), Java, Computer Graphics Metafile (CGM), and Programmer's Imaging Kernel System (PIKS). For VRML, we developed a reference parser and initial VRML Test Suite (VTS). We are continuing to augment the VTS, by extending the parser and using it to automatically generate VRML test files. To develop the VTS, ITL researchers work in cooperation with the VRML community to validate completed tests and to develop new tests.

In the area of Java, we initiated a project to develop conformance tests, tools, and methods for the areas of Java technology that need test metrics. An ITL-sponsored workshop on Java conformity assessment provided a forum for interested parties to discuss testing philosophies and methodologies for the varying Java technologies and to formulate a direction forward. Working with industry, we will build Java tests and tools that will ensure the consistency and accurate use of the Java specification, applications, and applets.

In cooperation with the Air Transport Association (ATA), ITL is building Computer Graphics Metafile (CGM) conformance test suites and is helping ATA establish its certification service. Also cooperating in this effort is the Aerospace Industries Association (AIA).

Additionally, we are working with several private sector companies and federal agencies to assist them in the establishment of conformance testing programs. In support of this technology transfer, we are developing a certification system framework which describes the processes and procedures for establishing, administering, and operating a conformance testing service. Our goal is to transition current operational testing and certification programs from ITL to private industry, as well as help to establish new testing programs in the private sector. In support of this effort, we developed a Web-based Directory of Conformance Testing Programs, Products, and Services for information technology standards. This directory provides a source for linking providers of conformance testing materials and services with users of these materials and services.



As a research project, ITL is currently investigating new and more efficient approaches to the development of conformance tests. Current conformance tests are developed through the extremely time-consuming process of developing falsification tests. Such testing, while extremely useful, can never cover all requirements and thus never actually provides total proof of correctness. We are investigating new methods for software testing based on stochastic processes and statistical measures in order to improve the quality of software and to provide quantitative measures for determining the probability that software correctly adheres to its specifications. In addition, we are investigating the effectiveness of using automated test generation methods to develop conformance tests for specifications of standards. This research could lead to faster ways of developing conformance tests, which would then result in an increased capability for product developers to determine if their products work according to specifications.

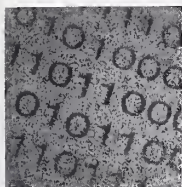
## **Forward-Looking Standards**

ITL researchers seek to make significant technical contributions to standards which are on the cutting edge of software technology. In this effort, we pursue work in areas that have a research component for either the technology itself or for the concept of conformance testing, and for which vendors preferably do not yet have implementations or other vested interests in the work. In performing this work, ITL researchers are working both within the traditional standards community, such as Information Technology Technical Committees that operate under the auspices of the American National Standards Institute, and within other standards related organizations such as the World Wide Web Consortium.

Users of standards are often faced with the daunting task of trying to locate and access standards that are appropriate to their work. To simplify this task, we are working with other standards-related organizations in the development and application of a taxonomy and framework for standards that can be used to both coordinate the development of forward-looking standards and to assist potential users of standards in finding and applying those standards that are applicable to their particular requirements. As part of this effort, an online standards locating and retrieval capability, offering the user multiple interfaces, was implemented to provide access to standards from both government and commercial sources. This retrieval capability is being expanded to provide World Wide Web availability for retrieval of correct values for specific instances of data codes in those standards containing large numbers of uniquely identified data codes.

In cooperation with the Environmental Protection Agency, ITL continued its work on a project that focuses on development of several specific infrastructure components needed for the intelligent integration of database information with intelligent information services techniques. Particular attention is being paid to the application of classification taxonomies and ontologies, as related to development of an Environmental Data Registry, in order to provide for testable, high-quality access interfaces for multiple types of software that serve as information search engines. As part of this task, we are investigating the application of specified infrastructure components in the research area of network Object Registration.

Also in the area of Object-Oriented technology and testing, ITL is working with other organizations in developing and testing object-oriented technology components that can be specifically applied to the concept of "distance learning." In this area, ITL researchers are working on the complete network system from interoperability standards to repository object exchange protocols, including metadata fields for educational objects, and finally to the concept of conformance testing of educational objects.



# STATISTICAL ENGINEERING DIVISION

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**Chief (Acting):** Keith Eberhardt

**Group Managers:** M. Carroll Croarkin, Measurement Process Evaluation  
Keith Eberhardt, Statistical Modeling and Analysis

The Statistical Engineering Division seeks to catalyze experimentation, enhance research, and improve communication of results by working collaboratively with, and developing effective statistical methods for, NIST scientists and our partners in industry. To accomplish this mission, the division develops strong collaborative research relationships with NIST staff in all fields, maintains expertise in the development of statistical methods relevant to measurement science and technology, and ensures that NIST staff have access to information on the latest statistical modeling and analysis techniques needed for their research.

## Statistical Consulting

The division collaborates with NIST staff on research projects where optimal experiment design, statistical modeling, and data analysis can play a significant role in improving measurement processes and gaining scientific insight. Staff members also provide general statistical consulting services to NIST scientists working in all aspects of NIST's mission. Specific contributions include:

- leadership in the establishment of a high standard of statistical practice within NIST via interactions with technical staff, publications, workshops, and seminars;
- design and analysis of experiments, and evaluation of measurement uncertainties for the NIST Standard Reference Materials and Calibration Programs;
- design and analysis of experiments, and evaluation of protocols and processes associated with NIST scientific endeavors; support of NIST industrial clients engaged in the design and analysis of experiments;
- development of statistical and probabilistic models for physical science and engineering applications;
- development of statistical methodology to enhance collaborative research with other NIST laboratories; and
- advancement of statistical methodology via development of algorithms and software; and transfer of statistically based measurement methodology to industry through direct interactions with industrial clients, publications, workshops, and seminars.

The following examples of statistical applications are typical of the work of our division.

## Statistical Planning for a Neutron Lifetime Experiment

ITL statisticians contributed their expertise in planning an experiment at the NIST Cold Neutron Research Facility (CNRF), where researchers are developing a dramatic new technology to trap polarized ultracold neutrons in a three-dimensional magnetic trap filled with superfluid helium. With this technology, the mean lifetime of the neutron will be determined. The present experimental value of the neutron lifetime is 887.4 s. The associated estimated standard deviation is 1.7 s. The planned experiment should reduce the experimental error by a factor ranging from 10 to 100. Along with other experimental data, this measurement allows one to test the consistency of the standard model of electroweak interactions. Further, the mean lifetime of the neutron is an important parameter in astrophysical theories.

At the CNRF, many runs of a two-stage experiment are planned. In the first stage of each run cycle, the trap is filled with neutrons to a desired level. In the second stage, scintillation events due to neutron decay or background processes are observed. The statistical properties of the lifetime estimate depend on the time allocation between the fill and decay stages, as well as the particular nonlinear algorithm used for estimation of the mean lifetime from the time sequence of events. In collaboration with NIST's Physics Laboratory staff, our staff developed a stochastic model for the data. Based on this model, a strategy for maximizing the precision of the lifetime estimate was formulated.

## Optical Fibers

In another collaboration, ITL statisticians achieved a more precise measurement of polarization mode dispersion (PMD), which arises in single-mode communication fibers when there is imperfect circular symmetry in the fiber core. An optical pulse input to a fiber is split into two orthogonally polarized pulses. Distortion arises as a result of a differential group-delay time between these two orthogonally polarized pulses at the output. This differential group-delay can have a limiting effect on the speed of digital communication systems and therefore is a good indicator of the performance of a lightwave system. PMD is routinely measured both at the manufacturing stage and in installed systems.

Among the methods of PMD measurement, the fixed analyzer technique is perhaps the simplest to use. division scientists collaborated with NIST's Electronics and Electrical Engineering Laboratory to improve PMD measurements using the fixed analyzer technique. A new value for the polarization mode coupling factor of 0.805 (a 2 percent discrepancy with the old value of 0.824) was found. Systematic biases due to sampling density and extrema thresholding were quantified (6 to 12 percent for typical measurement conditions), and a simple correction algorithm was developed which removes the effects of these biases to within 1.7 percent.



## Ballistic Imaging Interoperability Test Methods

To facilitate interoperability between existing ballistic imaging systems, the Office of the National Drug Control Policy, the Federal Bureau of Investigation, and the Bureau of Alcohol, Tobacco, and Firearms executed a memorandum of understanding recognizing that the two ballistic image systems currently in use should be interoperable. Under this memorandum, NIST, as a neutral third party, was charged to develop a standard for interoperability and to develop and oversee interoperability conformance tests. The purpose of ballistic imaging systems is to permit forensic evidence (cartridge cases and bullets) recovered at a crime scene to be imaged and compared to an existing database of thousands of images to identify possible links between crimes previously unsuspected as being related. However, due to differences in software, image acquisition, and networking capabilities, the images captured on either one of the two systems cannot be used on the other, thus denying crime laboratories full access to all image databases.

NIST has developed a specification for interoperability between the two image systems that requires the capability of creating cartridge-case images on either system in such a manner that the image can be correlated to the database on the dissimilar system. With respect to image acquisition and matching, the concept of interoperability is not a yes/no characteristic but rather is a matter of degree of interoperability. That is, it is recognized that acquiring images on a non-native system may produce subtle differences in image “quality” that could result in changes match probability, relative to images acquired on the native system.

To address the problem of experimental evaluation of interoperability for image-matching, division staff developed measures of disarray for comparing ranked ballistic images from a native database to the array of images obtained by matching the corresponding non-native test image. Initially, ordinary rank correlation coefficients were suggested for measuring and testing interoperability, but these were thought to be inadequate since only the top few rank positions are believed to have any practical significance. So, we developed the statistical theory for two new rank coefficients of disarray that assign greater importance to the higher ranks. Furthermore, by contrast to common rank correlation procedures, these procedures are designed to measure the agreement of a novice “judge” with a known standard ranking, rather than the mutual agreement between equally weighted rank vectors. A limited interoperability test program is presently underway, and an analysis based on our interoperability measures will be used to evaluate and refine system modifications in advance of more extensive testing.

## Intrusion Detection in Computer Networks

Network vulnerability is widely recognized as a key problem for the technological future. Hack attacks or performance anomalies have, in a number of high-profile cases, crippled key industries and services. This makes it urgently necessary to develop tools that identify aberrant behavior as early as possible, and flag those problems and apparent causes for the system administrator.

The Defense Advanced Research Projects Agency (DARPA) awarded a three-year grant for joint work in our division and Carnegie Mellon University on intrusion detection in computer networks, and, more generally, anomaly detection in complex datasets. The work entails the combination of methods from time series analysis, cluster analysis, multivariate analysis, and pattern recognition. The ultimate aim is to develop a system monitor that combines high sensitivity, low false-alarm rates, and the capability to respond in real-time to apparent threats to system integrity.

The project takes advantage of an existing cross-ITL group of researchers who are studying the junction of statistics, data mining, and visualization. The group established competence in this inter-disciplinary area by participating in a network intrusion detection contest. The contest was designed to explore the relationship between data mining and visualization. The ITL group produced one of the most successful entries in the contest.

### **Sharpness of Scanning Electron Microscopes**

Fully automated or semi-automated scanning electron microscopes (SEM) are commonly used in semiconductor production and other forms of manufacturing. Sharpness is an important characteristic of SEMs, and at the present time, no self-tests are incorporated into these instruments to test this characteristic even though the goal of industry is to have the instruments perform without human intervention for long periods of time. Nien-fan Zhang of our division and Michael Postek of NIST's Precision Engineering Division collaborated on identifying suitable test objects for this purpose and developed a statistical measure of sharpness, based on a multivariate kurtosis statistic with an appropriate analytic algorithm. This year, a small company that develops software for precision instruments implemented the algorithm in software and demonstrated its effectiveness at the 1997 SPIE Conference; and IVS, Inc., requested assistance in implementing the technique.

### **Random Number Generation for Evaluation of Cryptosecurity**

Ensuring the integrity of information technology is now a national issue whose importance has been highlighted by many recent security compromises. A crucial component of system security is the encryption of data and text. The standard format for encrypted transmissions depends upon large, nominally random, and balanced binary bit streams, which are used as keystreams in stream ciphers or in block cipher algorithms. Their randomness and balance are critical. Failure of either quality provides an exploitable compromise in system security.

Statisticians in our division, together with ITL's Computer Security Division, are collecting, inventing, analyzing, and organizing algorithms designed to test the integrity of the random binary generators that are the key components of security systems. The study seeks to clarify the interdependencies among the tests and to identify tests to cover deficiencies among those already in use. The final product will be a highly portable, user-friendly package that will enable a wide spectrum of government, commercial, and private users to validate the cryptosecurity of their systems.

## **Engineering Statistics Handbook**

We continue our collaboration with the SEMATECH Statistical Methods Group on the production of a Web-based statistics handbook to help physical scientists and engineers incorporate statistics into their work more efficiently. The material in the handbook will include case studies from the semiconductor industry and NIST laboratories. The handbook will also be integrated with statistical software, allowing users to reproduce examples from the handbook interactively and to perform similar analyses on other data.

Over the last year, prototype handbook designs, navigation, and technical materials have been favorably critiqued by several audiences, including engineers, statisticians and managers from SEMATECH member companies, academia, and other industries. Current work includes formal usability testing as well as development of new technical material. The usability testing is being done in collaboration with ITL's Visualization and Virtual Reality Group and will examine both the organizational structure and content of the handbook. The project is supported in part by the NIST Systems Integration for Manufacturing Applications program which is part of a government-wide effort in High Performance Computing and Communications (HPCC).



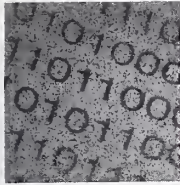


Information  
Technology  
Laboratory



# INTERACTIONS AND ACCOMPLISHMENTS





# SELECTED STAFF ACCOMPLISHMENTS

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## Department of Commerce Medal Awards and NIST Awards

**Bradley K. Albert** shared a 1997 Bronze Medal Group Award with two colleagues in NIST's Electronics and Electrical Engineering Laboratory for their work in developing an algorithm for the processing of antenna measurements corrupted by probe position errors that extends the usefulness of existing antenna measurement techniques to higher frequencies and mobile antennas.

**John K. Antonishek** received a 1996 Bronze Medal for the installation, implementation, and management of the NIST North network and telephone systems. He also received the 1996 NIST Safety Award for Superior Accomplishment for his safety leadership in the installation of the computer communication network at the NIST North campus.

**Patricia D. Barnett** received a 1996 Bronze Medal for extraordinary service in supporting the hardware and software for the NIST-wide e-mail and calendaring functions.

**William Burr, Donna Dodson, Noel Nazario, and W. Timothy Polk** received a 1997 Bronze Medal Group Award for exceptional technical and managerial work in the development of Public Key Infrastructure technology.

**Judith E. Devaney, Robert R. Lipman, and William F. Mitchell** received a 1996 Bronze Medal Group Award for creation of the NIST Parallel Applications Development Environment (PADE).

**William F. Guthrie** received a 1997 Bronze Medal for statistical contributions to the measurement services critical to the electronics and optoelectronics industries.

**Walter S. Liggett, Jr.** shared the 1996 Edward Bennett Rosa Award with four other NIST scientists for the development and international acceptance of a method for the more accurate determination of Rockwell C Hardness, a measured material property of great importance in manufacturing and commerce.

**James R. Lyle** received a 1996 Bronze Medal for advancing the state of the art and practice in static analysis methods for computer software.

**David S. Pallett** received a 1997 Silver Medal and a 1996 Bronze Medal for leadership in the development of speech corpora and its valuable use by spoken language recognition researchers.

**Marianne Swanson and John P. Wack** received a 1996 Bronze Medal Group Award for the successful establishment and management of the Forum of Incident Response and Security Teams (FIRST).

## External Recognition

For a 1997 R&D 100 Award, R&D Magazine selected S-Check(r), an advanced software performance improvement tool developed by ITL. Started from an idea of **Gordon Lyon** and developed and managed by **Robert Snelick**, the S-Check project has included team members **John Antonishek**, **Michel Courson**, **Nathalie Drouin**, **Michael Indovina**, **Joseph Ja'Ja'**, **Raghu Kacker**, and **Dominique Rodriguez**.

The Federal Laboratory Consortium (FLC) selected the team of **David Ferraiolo**, **Richard Kuhn**, **John Barkley**, **Anthony Cincotta**, all of ITL; **Serban Gavrilla**, VDG; and **Janet Cugini**, Citicorp, to receive a 1998 Award for Excellence in Technology Transfer for their work in Role Based Access Control. The award recognizes Federal Laboratory employees who have done an outstanding job of transferring technology developed in the laboratory to partners in government agencies as well as the private sector.

**Michael Garris** received an FLC 1996 Award for Excellence in Technology Transfer for his software distribution of a form-based handprint system for evaluating optical character recognition (OCR). Garris and his associates transferred this state-of-the-art technology in the public domain to numerous industry and government users via a CD-ROM using ISO-9660 format.

Secretary of Commerce Daley presented a 1997 Hammer Award, issued by the National Performance Review, to NIST, NOAA, and the Bureau of the Census who participate in the Federal Geographic Data Committee (FGDC); ITL's **Bruce Rosen** is the NIST representative. The award recognized the work done by these organizations to cooperatively produce and share current and accurate geospatial data which contributes locally, nationally, and globally to economic growth, environmental quality and stability, and social progress.

The General Accounting Office (GAO) presented 1997 Special Commendation Awards to **Shu-jen Chang**, **Donna Dodson**, **Jim Foti**, **Mike Indovina**, **Sharon Keller**, and **Miles Smid**. The awards recognize "contributions in the development of a very robust and secure electronic signature system that can be used by a variety of applications and agencies to provide transaction level data integrity."

**Daniel R. Benigni** served as Vice President for Professional Activities and Chairman of the United States Activities Board (IEEE-USA) for 1997.

**Paul Boggs** was appointed to the Advisory Board for the newly formed High Performance Computing Users (HPCU) Group.

The IEEE Computer Society presented **Anthony Cincotta** with an Outstanding Contribution service award for his "outstanding contribution as technical editor for IEEE/CS Project P2003, POSIX Test Methods."

**Leslie Collica** received the ATM Forum Spotlight Award for her technical contributions and her work as Editor and Vice-Chair of the Testing Working Group at the December 1996 ATM Forum.



**David Cypher** received at the December 1996 ATM Forum the Editorship of the Protocol Implementation Conformance Statement (PICS) of the Private Network to Network Interface (PNNI) standard.

**Christopher Dabrowski** received an Outstanding Achievement Award from the Information Infrastructure Standards Panel (IISP) for his key role in developing the IISP "Framework for Identifying Requirements for Standards for the National Information Infrastructure (NII)," which provides a guide to identifying needed standards.

**Lisa Gill** was elected in 1997 to a three-year term as Treasurer/Secretary of the Quality & Productivity Research Conference Steering Committee of the American Statistical Association.

**Lynne B. Hare** received the William G. Hunter Award from the ASQ Statistics Division at the 1997 Fall Technical Conference for his contributions to the field of applied statistics as a consultant, educator, communicator and integrator of statistical thinking into other disciplines. He also chaired the Ellis R. Ott Scholarship Award Committee of ASQ's Statistics Division and Chair, Section on Quality and Productivity, American Statistical Association.

**Karen Hsing**, who leads the DAVIC-based (Digital Audio Visual Council) Video-on-Demand (VoD) Interoperability testing project, received an award for outstanding contributions to the completion of DAVIC specification 1.1 and 1.2 in the 16th DAVIC meeting in London, UK, March 7, 1997.

**Victor McCrary** was invited by the prestigious Sigma Xi Distinguished Lectureships Program to serve on the 60th College of Distinguished Lecturers for a two-year term from July 1997 to June 1999.

**Fernando L. Podio** received a 1997 Association for Information and Image Management International (AIIM) Master of Information Technology Award for outstanding accomplishments in the field of information and image management.

**Roldan Pozo** received a 1996 Presidential Early Career Award for Scientists and Engineers, the highest honor bestowed by the U.S. government for outstanding scientists and engineers beginning their independent research careers. The award recognizes exceptional potential for leadership at the frontiers of scientific knowledge during the twenty-first century.

**Karin Remington** was elected to a four-year term on the Board of Directors of SIG-  
NUM, the Association for Computing's (ACM) Special Interest Group on Numerical Mathematics (SIGNUM).

**Jean Scholtz** is ACM SIGCHI vice chair of finance 1997-99.

**Marianne Swanson** received the 1996 Leadership and Achievement Award from the Industry Advisory Council of the Federation of Government Information Processing Councils for her work with the Government Information Technology Services (GITS) Board in promoting support mechanisms for governmentwide security initiatives.

**Jim Tighe** received a 1997 NIST Boulder Labs Young Scientist Award for his creativity, initiative, and outstanding contributions to the scientific mission of NIST.

Marvin Zelkowitz was selected as a 1997 Institute for Electrical and Electronics Engineers (IEEE) Fellow for contributions toward the development of a practical programming environment for effective software development.

ITL staff members serving in editorial positions include:

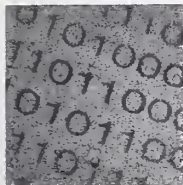
**Paul Boggs** - HPCU Editorial Board of *The Journal of HPC Users*, the *SIAM News*, and *Applied Mathematics Letters*.

**Ronald Boisvert** - ACM Publications Board; Editor-in-Chief for the *ACM Transactions on Mathematical Software*.

**Daniel Lozier** - Associate Editor of *Mathematics of Computation*.

**Geoffrey B. McFadden** - Editorial Board of the *SIAM Journal of Applied Mathematics* and the *Journal of Computational Physics*.

**Mark Vangel** - Chair of the Statistics Working Group of MIL Handbook 17 on Polymer Matrix Composites; program chair-elect for the Section on Risk Analysis of the American Statistical Association.



# PARTICIPATION IN VOLUNTARY STANDARDS ACTIVITIES

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## TECHNICAL ACTIVITIES

### Technical Activity

(within National Committee for Information Technology Standards, NCITS)

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H2	(JTC1/SC21/WG3) Database	E. Fong
H3	(JTC1/SC24) Computer Graphics & Image Processing	L. Rosenthal M. Brady
	• Virtual Reality Modeling Language (VRML) Reference Implementation and Conformance Tests	M. Skall
H3	(IEC/JTC1/SC24/WG6) Multimedia Presentation and Interchange	L. Rosenthal M. Brady
H3.8	(JTC1/SC24/WG7) Image Processing & Interchange	M. Skall S. Sherrick
H7	Object Information Management	E. Fong
J22	(JTC1/SC22/JSG) Java	G. Fisher L. Carnahan
L1	(ISO TC 211) Geographic Information Systems	C. Dabrowski
L3.1	(JTC1/SC29/WG11) MPEG Development Activity	A. Nakassis
L3.2	(JTC1/SC29/WG1) Still Image Coding	M. Rubinfeld
L8	(JTC1/SC14) Data Representation	J. Newton B. Rosen
L8.6	(JTC1/SC14/WG4) Classification of Data Elements	J. Newton
T4	(JTC1/SC27) IT Security Techniques	E. Troy E. Flahavin

### Technical Activity (other)

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ACM	Role Based Access Control	J. Barkley
AIIM	Committee C21 Storage Devices and Applications	F. Podio
ANSI/NISO	Z39.50 Implementors Group	P. Over
	• ZPRISE Prototype	
ASTM E-11	Quality and Statistics	C. Croarkin
ATM Forum	Private Network to Network Interface Group	D. Cypher

ATM Forum	Testing Working Group	L. Collica
ATM Forum	Traffic Management, Residential Broadband, Service Applications	D. Su
CCIB	Common Criteria/Implementation Board	G. Troy S. Katzke
DAVIC	Digital Audio Video Council	K. Hsing
ECMA	Java Scripting Language Study Group	G. Fisher
	Educom IMS Consortium	J. Barkley
IEEE	P802.14 Cable Modems	D. Su
IETF-INT	Internet Area (IPv6, IP/ATM)	R. Glenn D. Montgomery H. Fang
IETF-MGMT	Management Area (SNMP, MIBs)	W. Chang
IETF-RTG	Routing Area	D. Montgomery
IETF-SEC	Security Protocols Area	R. Glenn S. Chang
IETF-TSV	Transport Area (RSVP, RTP)	D. Montgomery S. Chang
IETF	Privacy & Security Research Group	T. Polk
IMA	Interactive Multimedia Association • metadata standard for digital objects	T. Rhodes
IMTC	Video Conferencing Standards (H.324/H.323/H.320/T.120)	J.P. Favreau
OMG	Applications Development Working Group	T. Rhodes
OMG	Business Object Management	E. Fong
OMG	Object Request Broker Task Force	J. Barkley
OMG	Object Services Task Force	J. Barkley T. Rhodes
OMG	Portable Common Tool Environment (PCTE) Special Interest Group	T. Rhodes
OMG	User SIG - Metrics WG	J. Barkley
NIST	ANSI Data Format for the Interchange of Fingerprint, Facial & SMT Information	M. McCabe
NIST	Interoperable Message Passing Interface	Dean Collins Judy Devaney
NIST	Public Key Infrastructure	D. Dodson W. Burr
NIST	Advanced Encryption Standard	M. Smid



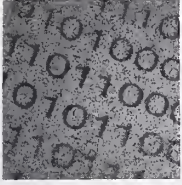
T1S1	Services, Architectures and Signalling	D. Cypher
U.S. TAG for ISO TC 69 Applications of Statistical Methods		C. Croarkin
VESA	Flat Panel Display Interface Committee	J. Roberts
VRML	VRML Consortium	L. Rosenthal
X9F	Data and Financial Information Security	M. Smid
X9F.1	Public Key Cryptography for Financial Systems	M. Smid
X9F.3	Wholesale Bank Security	E. Barker
X9F.4	Authentication and Access Control	J. Dray
OPEN GROUP Security Group		S. Chang

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## MANAGEMENT ACTIVITIES

AIIM Standards Board	F. Podio
ANSI ASC Statistics Subcommittee	C. Croarkin
ANSI Executive Standards Council	M. Hogan
ANSI Information Infrastructure Standards Panel (IISP)	M. Hogan C. Dabrowski
ANSI IISP Steering Committee	S. Wakid M. Hogan
ANSI Information Systems Standards Board (ISSB)	M. Hogan
ANSI Information Technology Consultative Committee (ITCC)	M. Hogan
ATM Forum	D. Su
CommerceNet Consortium	B. Rosen
EDUCOM Instructional Management Systems (IMS) Advisory	S. Wakid
G7 Pilot Project: Global Market SMEs	J. Moline
G7 Pilot Project: Global Inventory of IT Projects	J. Moline
IEEE Computer Society Technical Advisory Board	S. Wakid
IEEE Computer Society Publications Board	S. Wakid
IEEE Standards Board	D. Benigni
ISO/IEC/ITU Global Standards Conference Planning Committee	J. Moline
ISO/IEC JTC1 SWG-GII (Special Working Group on the Global Information Infrastructure ) US TAG	J. Moline
ISOC Internet Society	D. Montgomery C. Hunt
JTC1 TAG (U.S. TAG to ISO/IEC JTC1 on Information Technology) and JTC1	M. Hogan B. Rosen

Multimedia Communications Forum Board	S. Wakid
National Software Council	S. Wakid
Network Management Forum	F. Nielsen
NIUF (North American ISDN Users Forum)	L. Collica
North American Interoperability Policy Council (IPC)	M. Hogan
Object Management Group (OMG)	J. Barkley
Video Electronics Standards Association (VESA)	J. Roberts
XIWT Cross Industry Working Team	S. Wakid J. Linn
NCITS National Committee for Information Technology Standards	M. Hogan B. Rosen
NCITS/OMC Operational Management Committee	M. Hogan B. Rosen
NCITS/PPC Policy and Procedures Committee	M. Hogan
X9 (ISO TC 68) Financial Services	M. Smid D. Dodson
X12 (ISO TC 154, UNEDIFACT) Electronic Data Interchange	J.P. Favreau



# INDUSTRY INTERACTIONS

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ITL participates in many consortia and industry interest groups including the following:

## **Air Transport Association (ATA) and Aerospace Industries Association (AIA)**

The ATA and AIA are international nonprofit organizations for the airline industry and aerospace suppliers. The ATA and AIA consist of the major airline companies, aerospace industries, and software and systems suppliers of the commercial aerospace industry. The ATA, AIA, and ITL are working together to develop a graphics profile and conformance tests methods for the interchange of graphics data within the commercial aerospace industry. The commercial aircraft industry is moving away from paper-based delivery of maintenance data to digital delivery. Conformance testing is critical in ensuring that graphics tools and implementations conform to the ATA profile and ease the transition to digital delivery of data. Lynne Rosenthal is the ITL contact.

## **Association for Information and Image Management International (AIIM)**

ITL participates in AIIM International, the world's leading association for information industry users and providers. Members include key U.S. players of the information, document, and image management industry. AIIM is an accredited American National Standards Institute (ANSI) standards development organization involved in creating, disseminating, and promoting industry standards worldwide. Fernando Podio worked with the AIIM Optical Tape Study Group which developed a preliminary set of media specifications, identified a methodology for dynamic testing of optical tape, and submitted two proposals for the development of optical tape ANSI standards. Podio also chairs the Optical Tape Subcommittee of AIMM.

## **Asynchronous Transfer Mode (ATM) Forum**

The ATM Forum is an international nonprofit organization which accelerates the use of ATM products and services through a rapid convergence of interoperability specifications. About 170 U.S. telecommunications corporations comprise the ATM Forum membership. Through the forum, ITL works with test equipment vendors such as Hewlett-Packard, GN Nettest, and Tekelec, and ATM switch vendors to develop interoperability test specifications and conformance test suites. David Su is the ITL principal.

## **BLAS Technical Forum**

This working group is developing standards for core mathematical software components which promote both performance and portability of scientific software. Optimized implementations of the earliest versions the standards, known as the Basic Linear Algebra Subprograms (BLAS), are now supported by most hardware and software manufacturers of scientific computing products. The BLAS Technical Forum is composed of representatives of computer hardware and software manufacturers as well as government and academic research laboratories who wish to extend the BLAS to new domains. Roldan Pozo and Karin Remington represent ITL. Pozo chairs the sparse matrix subcommittee.

### **Center for National Software Studies (CNSS)**

The CNSS is being established by the National Software Council, an organization of concerned software professionals who recognize the need for national focus and informed leadership on software issues, to study software as a national resource, and help inform the nation and its leadership on the impact of software to the economy. ITL representatives are helping the CNSS identify issues that affect the software capability of the nation, and the will help to reduce their costs and risks. CNSS's initiatives are national competitiveness, trustworthiness of software systems, and competency of the software workforce. Shukri Wakid and Dolores Wallace are the ITL representatives.

### **Cross Industry Working Team (XIWT)**

The Cross Industry Working Team (XIWT) is a multi-industry coalition committed to defining the architecture and key technical requirements for a powerful, sustainable national information infrastructure (NII). Members include firms from the computer, networking, telecommunications, publishing and banking sectors, and others with business interests in the NII. NIST is represented on the executive committee by R.J. (Jerry) Linn; other ITL representatives participate in working groups related to their research and development activities.

### **Digital Audio Visual Council (DAVIC)**

The Digital Audio Visual Council (DAVIC) is an international consortium for the emerging digital audio-visual applications and services. The purpose of DAVIC is to identify, select, augment, and develop internationally agreed specifications of open interfaces and protocols that maximize interoperability across countries and applications/services. ITL works with DAVIC members on the interoperability testing of digital video products conforming to DAVIC specifications. These efforts concentrate on the development of conformance test suites and establishment an interoperability testbed where developers could test their products. The ITL principal is David Su.

### **Educom**

ITL's work with the Educom committee on educational multimedia software resulted in the adoption of NIST's Role Based Access Control model for the Educom Instruction Management System (IMS) application program interface. Educom is a consortium of university and industry providers of educational material. Shukri Wakid, John Barkley, and Tom Rhodes serve as advisors to the Educom IMS consortium.

### **Forum of Incident Response and Security Teams (FIRST)**

This international, government/industry/academia coalition was formed to share information on information security vulnerabilities and attacks. ITL participates as a member of the FIRST steering committee. Marianne Swanson represents ITL in this interaction.



### **Information Infrastructure Standards Panel (IISP)**

The IISP was formed by the American National Standards Institute (ANSI) in 1994 to accelerate the development of standards critical to the deployment of information infrastructure products and services. The IISP is an open forum with participation by a broad spectrum of companies, government agencies, standards and specifications developing organizations, industry associations, consortia, etc.

By the end of 1997, the IISP had identified 164 standards needed to implement the Global Information Infrastructure. ITL has actively contributed to the fulfillment of the IISP's mission since its inception. This has included the development of a conceptual framework that helps diverse groups identify requirements for standards for the Global Information Infrastructure. An IISP Outstanding Achievement Award was presented to Christopher Dabrowski in January 1997 for his development of the IISP "Framework for Identifying Requirements for Standards for the NII", among other achievements. Christopher Dabrowski is the ITL contact.

### **Information Infrastructure Standards Panel (IISP) Steering Committee**

Based upon the successes and experiences of the IISP to date, the IISP Steering Committee reviewed and revised the IISP's mission and method of operations for 1998. Michael Hogan of ITL led the Steering Committee's group which revised the IISP's Charter and Organization & Operation documents. The revisions were approved by IISP in November 1997. Shukri Wakid is the ITL principal representative to the IISP Steering Committee.

### **Information Technology Industry Council (ITI)**

ITL collaborates with the Information Technology Industry Council (ITI), an industry association that includes the leading U.S. providers of information technology products and services. One of ITI's activities is to develop positions on issues in standards, testing, certification and quality assurance. Areas include ergonomics, health, safety and hardware, software and systems functional and performance characteristics. ITI also serves as the secretariat for the American National Standards Institute (ANSI) Accredited National Committee for Information Technology Standards (NCITS) and as U.S. Technical Advisory Group (TAG) administrator for ISO/IEC Joint Technical Committee 1 on Information Technology. The ITL liaison to ITI is Michael D. Hogan.

### **Institute of Electrical and Electronics Engineers (IEEE)**

The Institute of Electrical and Electronics Engineers, Inc. is the world's largest technical professional society, promoting the development and application of electrotechnology and allied sciences for the benefit of humanity and the advancement of the profession. ITL maintains close ties with the IEEE to help IEEE identify forward-looking standards efforts and to provide industry input to ITL's program planning for standards and test activities. IEEE's close ties to industry and to academia help ITL to understand industry needs and requirements; to know about academic research in areas of interest to NIST; and to communicate about ITL projects. Daniel R. Benigni is Vice President for Regional Activities for 1998 and is the ITL liaison to the IEEE Standards Association Board of Directors.

**International Information Integrity Institute (I4)**

This internationally based membership organization of information technology security managers consists of the senior security managers from large, international organizations. NIST is a U.S. Government representative in I4. I4 is managed by SRI Consulting, which conducts meetings (three per year), produces regular technical reports, and undertakes special research projects. In October 1996, NIST hosted Forum 29, one of the yearly conferences sponsored by I4. The conference focused on electronic commerce security and brought together over 200 specialists from the U.S. and overseas. Stuart Katzke is the ITL contact.

**International Multimedia Teleconferencing Consortium (IMTC)**

The IMTC is a non-profit corporation founded to promote the creation and adoption of international standards for multipoint document and video teleconferencing. The IMTC and its members promote a "Standards First" initiative to guarantee interworking for all aspects of multimedia teleconferencing. The concentration of this group is on promoting and facilitating the broad use of multimedia teleconferencing based on open standards, including the standards adopted by the ITU. Jean-Philippe Favreau is the principal ITL contact for these activities.

**Internet Engineering Task Force (IETF)**

ITL contributes to the technical development of the Internet through its participation in the Internet Engineering Task Force (IETF). The IETF develops standards for new technology based upon the TCP/IP protocol suite and addresses various operations and support issues for the public Internet. ITL is actively participating in IETF activities in the areas of IP security, key management, public key infrastructure, IPv6, IP integrated services, resource reservation, IP switching, and advanced routing. ITL has technical representatives in numerous working groups related to these topics. Doug Montgomery is the ITL contact for general issues related to the IETF and for reference to further points of contact on specific issues.

**MultiMedia Communications Forum (MMCF)**

The MMCF is an international industry consortium dedicated to the goal of accelerating market acceptance of multimedia communications equipment from multiple vendors, with this equipment interoperating across different types of networks. Since its formation in June 1993, the MMCF serves users, service providers, and hardware and software vendors of networked multimedia applications. The MMCF is committed to a broad systems approach through the creation of specifications, the education of the industry, and through alliances with other industry groups working toward complementary objectives. ITL is a principal member of the MMCF. The ITL contact is Leslie Collica.

**North American Integrated Services Digital Network (ISDN) Users' Forum (NIUF)**

ITL collaborated with industry to form the NIUF in 1988. A Cooperative Research and Development Agreement (CRADA) with industry was established in 1991 to govern the management of the forum. The NIUF was formed to create a strong user voice in the implementation of ISDN applications. The forum provides users of ISDN technology with the opportunity to work with implementors to assure that users' needs are met in the ISDN design process. Through the NIUF, users and manufacturers concur on ISDN applications and the resolution of issues, enhancing the strength of the U.S. telecommunications industry in the world marketplace. Through support of the forum, ITL advances new uses of computer and telecommunications technology in government and industry. ITL provides the Chair and Secretariat positions in the NIUF.

**Object Management Group (OMG)**

The OMG is a nonprofit international consortium, based in Framingham, Massachusetts, of over 500 organizations whose mission is to research, develop, and promote the use of object oriented technology for distributed systems development. The membership consists of all the major producers of information technology hardware and software (e.g., IBM, DEC, Sun, Microsoft), large user organizations e.g., Boeing, Bellcore, Merrill Lynch, Citibank, GTE, MCI, British Telecom), government agencies (e.g., NASA, NSA, DISA, NIH), and universities (e.g., MIT, Stanford, University of Illinois, University of Michigan). Over the past year, NIST representatives from ITL and the Manufacturing Engineering Laboratory attended OMG meetings to develop standards for business models and electronic commerce. John Barkley is ITL's technical point of contact in the OMG.

**Society for Information Display (SID)**

This worldwide professional society and forum is committed exclusively to the advancement of information display technologies. Membership in SID entitles ITL to participate in SID-sponsored symposia, seminars, and access to SID publications. John Roberts is the principal contact.

**Software Engineering Institute (SEI)**

Established by Congress in 1984, the SEI is a research and development center with a broad charter to address the transition of software engineering technology. ITL established a memorandum of understanding (MOU) with SEI to work collaboratively on software engineering issues of mutual interest. Under this agreement, ITL and SEI worked together to complete development of the hypertext facility for Reference Information for Software Quality. SEI is also supporting ITL in its Software Error, Fault and Failure Data Repository project in acquiring and in developing software collection and analysis tools. Dolores Wallace is the ITL principal.

### **Software Productivity Consortium (SPC)**

An industry-based consortium founded in 1985, the SPC focuses on advancing the fundamental processes and methods of software and systems engineering technologies for developing high-quality software intensive systems. The SPC provides a forum for ITL to collaborate with industry, government, and academia on development, application, and exchange of advanced software processes and methods for developing high-quality software systems. The forum allows ITL to contribute its technical views, program results, and capabilities to various industry sectors and provides a mechanism for technology exchange and further collaboration with industry. Thomas Rhodes represents ITL in this consortium.

### **Video Electronics Standards Association (VESA) Flat Panel Display Interface Committee**

Following an ITL workshop, VESA formed a committee to develop a standard or series of standards for the interface between a flat panel display and its controller. This interface standard addresses both active and passive flat panel displays in integrated devices, and will cover both the electrical and the mechanical specifications. As a full member of VESA, ITL participates in the technical development of standards and develops laboratory implementations of proposed interface architectures by developing laboratory metrics. John Roberts serves as committee vice chair. Other VESA committees with ITL participation include the Monitor Committee (desktop analog CRT displays, the Plug and Display Committee (desktop displays with digital interface), and the PC Theatre Committee (combining advanced television/HDTV with computer displays).





## SELECTED COLLABORATIONS

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ITL works with industry, government, and academia to pursue research and development projects of mutual interest, including the following:

### **Antenna Calibration Algorithm and Software**

ITL's Mathematical and Computational Sciences Division and NIST's Electronics and Electrical Engineering Laboratory (EEEL) Electromagnetic Fields Division collaborated on developing an algorithm and corresponding software for the processing of antenna measurements corrupted by probe position errors. The method exploits position information available during the measurement procedure to compute far fields as accurately as when no position errors are present, at a computational cost which is acceptable even for electrically very large antennas.

The interpretation of near-field antenna measurements, which requires transformation to the far field, is typically accomplished with the fast Fourier transform (FFT). When the measurement positions deviate from an ideal rectangular grid, however, the FFT is not applicable without modification. The new algorithm employs a combination of a recently developed, unequally spaced FFT, interpolation, and the conjugate gradient method to accurately transform to the far field at a cost proportional to  $N \log N$ , where  $N$  is the number of measurements (typically between 10,000 and 1,000,000).

The method can be used for measurements at higher frequencies and those taken on mobile platforms, where tight tolerances are difficult to maintain. The software is available to antenna measurement laboratories in government and industry and will support the future deployment of communications satellites operating near the terahertz band. Bradley Alpert is the ITL contact.

### **ATM Network Tests of a Prototype Video Dial Tone System**

Video Dial Tone (VDT) systems promise to make a wide range of video services available in the home and workplace including, for example, video-on-demand, electronic marketplace access, Internet access, and multiplayer games. Bellcore developed a prototype VDT system in collaboration with European partners, utilizing ATM (asynchronous transfer mode) technology. ATM is a cell-based routing and multiplexing technology designed to be a general-purpose, connection-oriented transfer mode for a wide range of telecommunication services. ATM routing is characterized by uniformly sized 53-byte packets and offers quality of service (QoS) guarantees not easily available from packet-switched systems.

ITL's High Speed Network Technologies Group collaborated with Bellcore in testing the prototype VDT system, specifically addressing the impact of ATM network QoS parameters on the performance of the VDT video-on-demand service. Test results showed that ATM QoS is a critical issue of common concern to the VDT system developer and the ATM network service provider and should be addressed by both in coordination. Test results can be used by VDT system developers to pursue robust and stable VDT system designs and by ATM network service providers to plan for VDT system QoS needs. Mike Frey is the ITL contact.

### **Efficient New Search Engine**

Locating relevant information on the World Wide Web is often difficult because of the large amount of information available. The Reference Information for Software Quality (RISQ) system, a Web-based tool for referencing information on software quality, offers a new search engine which allows the user to do efficient searches for information within a specific domain. The initial application of the engine is in the domain of high integrity software systems. RISQ was developed by ITL and Software Engineering Institute technical staff.

The search engine allows searches by taxonomy-based keywords, other keywords, and artifact type. Artifacts can range from simple abstracts, documents, and software to video, audio, and online interactive demonstrations of software tools. The RISQ facility makes available a wide variety of artifacts related to software quality in a highly organized manner. The current RISQ facility is located on the Web at <http://hissa.nist.gov/risq/>, making the material available to a large and geographically diverse set of potential users. Dolores Wallace coordinated the project.

### **Interoperability of Broadband Communication Technologies**

In June 1997, ITL's Advanced Network Technologies Division hosted the meeting of the Multimedia Communications Forum (MMCF) Broadband Access Applications (BAA) Working Group. The BAA is a new working group established to identify multimedia application requirements for accessing various broadband communication technologies, including asymmetrical digital subscriber line (ADSL), digital wireless, and asynchronous transfer mode (ATM). The group is focusing on a common application approach to quality of service (QoS) and interoperability across a range of broadband technology offerings. NIST will be the focal point for interoperability tests for the group; Leslie Collica is the ITL contact.

### **Interoperable Message Passing Interface Standard**

In September 1997, ITL hosted the third Interoperable Message Passing Interface (IMPI) Workshop to continue work defining the IMPI standard. All major U.S. computer vendors participate in this effort. Representatives of these vendors as well as representatives from the embedded computing community were present to continue this work. The group agreed that implementation of IMPI by the vendors would go on in parallel with the standard definition in order to get the most information on the choices made. The release of the first standard, IMPI-1, is expected by December 1998. As a representative of the U.S. government, NIST does not vote at these meetings but takes the role of facilitator. Judith Devaney is the ITL contact.

### **Leveraging Cyberspace**

Along with the White House National Economic Council and Xerox PARC, NIST co-sponsored the Conference on Leveraging Cyberspace held in Palo Alto, California, on October 8-9, 1996. People with shared interests use the Internet to solve problems, accomplish tasks, and create resources that would be well beyond the reach of any one person or organization. The conference explored the ability to leverage the efforts of large numbers of networked users as well as the economic, social, and political consequences. Technical experts discussed technologies that support wide-area collaboration, case studies of successful and unsuccessful efforts to leverage cyberspace, implications for business strategies, and proposals for promising collaborations. Judi Moline is the ITL contact.

### **NIST Car Welder VRML 2.0 Model**

Qiming Wang, Information Access and User Interfaces Division, implemented one of the first working Virtual Reality Modeling Language (VRML) 2.0 models demonstrating the functionality of animation in VRML 2.0. This Car Welder model is being used to explore the potential of applying VRML 2.0 to simulation interfaces in the manufacturing domain. VRML is a file format to describe interactive 3-D objects and worlds delivered across the Internet. VRML 1.0 provides a means of creating and viewing static 3D world. VRML 2.0 provides more extensions and enhancements to VRML 1.0, such as interaction, animation, scripting, and prototyping. SGI Cosmo Player is a VRML 2.0 browser which is a Netscape plugin for the SGI and PC Windows 95 platforms.

The Car Welder is listed in the SGI "VRML 2.0 Worlds - Cosmonaut Academy" WWW page at <http://vrml.sgi.com/worlds/vrml2.html>. The geometry of this model was translated from Deneb Robotics Software using the translator developed at NIST by Qiming Wang. To try out this model, go to:

<http://www.nist.gov/itl/div878/ovrt/projects/vrml/vrmlfiles.html>. A VRML 2.0 browser is required. Sharon Laskowski is the ITL contact.

### **Optical Fingerprint Recognition in Financial and Internet Security Applications**

ITL researchers combined optical correlation methods and digital neural networks to provide more accurate real-time fingerprint matching for financial, credit, and Internet security applications. The Information Storage and Interconnect System Project, sponsored by the Federal Bureau of Investigation (FBI), explored how optical methods of image storage and 3-D holography can support various correlation methods recognizing unique patterns such as fingerprints. Such methods would be more accurate and user-friendly than current optical correlation or retinal scanning.

Fingerprints are differentiated by a process known as minutia matching, in which the coordinates of the ridge ending of the fingertips are used for differentiation. However, this method tends to result in a number of false positives. In optical pattern recognition, the fingerprint image is loaded onto a liquid crystal spatial light modulator and is Fourier transformed into a 3-D hologram by a system lens developed by ITL scientist Eung-Gi Paek. Then, the correlation of the input is analyzed via the output plane. The optical system can more accurately enter the input pattern into the neural network system, which in turn can "recognize" and differentiate a pattern when it is introduced to the system again. When used in addition to minutia matching, the technology adds another dimension to the identification specifications, allowing a more detailed search of the neural network.



Possible commercial applications include the use of fingerprint images for credit card verification, automatic teller machine access, and Internet access in place of or along with passwords. ITL researchers are seeking industry collaborators to move into the project's next phase of refining the neural network and testing the prototype system in industry. ITL is working with the Financial Services Technology Consortium, an organization of banks, financial service providers, technology companies, national laboratories, universities, and government agencies to advance the commercialization of the technology. Charles Wilson and Victor McCrary represent ITL in this effort.

### **Standard for Exchange of Forensic Information**

ITL's successful collaborations with industry and with the law enforcement community resulted in the development of a specification, which supplements a previous standard, for the exchange of forensic information. Consensus on the specification was achieved through a canvass that ITL conducted under its accreditation by the American National Standards Institute (ANSI) as a sponsor of standards for information interchange. ITL also sponsored workshops where participants reached agreements on technical details. The ANSI Board of Standards Review approved the Data Format for the Interchange of Fingerprint, Facial and SMT Information (ANSI/NIST-ITL 1a-1997) as an American National Standard. This work is also a component of the framework that ITL has been discussing with the Office of Law Enforcement Standards to support digital representation and exchange of cartridge and bullet imagery data gathered at a crime scene. Mike McCabe is the ITL contact.

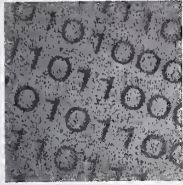
### **Standard for Interactive Cable TV**

IBM, Lucent, Scientific Atlanta, and Zenith Electronics worked with ITL to develop standard specifications for cable TV over Hybrid Fiber Coaxial networks. Working jointly with these companies and other members of the IEEE 802.14 standards group, ITL conducted an unbiased performance evaluation of the media access control (MAC) protocols that had been submitted to the standards group. Researchers implemented the candidate MAC protocols using a commercial network simulation package. The results from this work were reported to the IEEE 802.14 group and the software simulation modules were released to the public. These modules are currently being used by companies such as 3Com, Bellcore, Com21, Digital Equipment, General Instruments, LANcity, Lucent, and Scientific Atlanta as they develop their own standards-conformant MAC protocols. David Su is the ITL contact.

### **Web Site Helps Designers of Children's Products**

In a 1997 workshop "Systems Anthropometry" co-sponsored by NIST and the Consumer Product Safety Commission (CPSC), speakers and over 100 attendees discussed the use and applications of human dimensional measurements, the field of anthropometry. With the support of the CPSC, ITL established a Web site called "AnthroKids" which makes available the only anthropometric survey data of children conducted in the U.S. This data is valuable to designers of any type of product with which children come into contact, i.e., cars, playgrounds, cribs, etc. The NIST Web site, <http://www.itl.nist.gov/div894/ovrt/projects/anthrokids>, provides the data in several data formats. In addition, ITL is working with several companies that make human modeling software to incorporate the data as part of their products. Sandy Ressler represents ITL in this work.





# COOPERATIVE RESEARCH AND DEVELOPMENT AGREEMENTS

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Through Cooperative Research and Development Agreements (CRADAs), we establish partnerships with industry, academia, and government to pursue mutual areas of research. Our technical staff worked with the following 37 organizations in 1997:

Research Partner	Project
University of Tennessee, Knoxville	Mechanisms for Adaptable and Efficient Information Retrieval Clients and Servers
SETA Corporation	Role Based Access Control (RBAC) Software Development
Calimetrics, Inc.	Investigation of Test Methods, Standards, and High Performance Distributed Computing Applications for CD and DVD-Based Optical Data Storage Subsystems
SoHaR Incorporated	Standard Reference Material for Software Error, Fault, Failure Data -- Collection & Repository

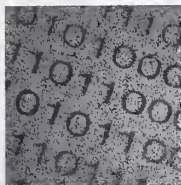
The North American ISDN Users' Forum (NIUF) is an industry/government forum established in 1988 to create a strong user voice in the implementation of ISDN applications. In 1997, CRADA partners were:

ADTRAN  
AHK & Associates  
Alliance Data Systems  
Ameritech Services  
AT&T Bell Laboratories  
Bell Atlantic Network Services, Inc.  
Bell Communications Research  
BellSouth  
Defense Communication Agency  
EICON Technology Corporation  
Ericsson Inc.  
GTE Southwest Incorporated  
Hayes Microcomputer Products, Inc.  
Intecom, Inc.  
International Business Machines Corporation  
Lucent Technologies  
Metropolitan Fiber Systems  
Network General Corporation

*NIUF CRADA partners (continued)*

North Carolina State University  
Northern Telecom, Inc.  
NYNEX  
RLR Resources  
Siemens Telecom Networks  
Southwestern Bell Telephone Company  
Synergy Group, The  
TASC (The Analytic Sciences Corporation)  
Telamon, Inc.  
Telrepco Services, Inc.  
The Boeing Company  
Transaction Network Services, Inc.  
U.S. Air Force (Technology Integration Center)  
U.S. West  
West Virginia University

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# GUEST RESEARCHERS

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## **Guest Scientists and Research Associates**

71

Organizations represented include:

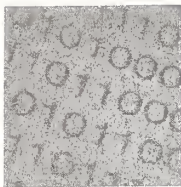
Arizona State University  
Armament Development Authority  
Chungnam National University  
Department of Defense, National Security Agency  
Ecole Normal Supérieure  
Ecole Nationale Supérieure Des Telecommunications  
Ecole Supérieure D'Informatique et Applications De Lorraine  
Electronics and Telecommunications Research Institute, Korea  
Environmental Protection Agency  
Flinders University  
George Mason University, Operations Research and Engineering  
George Washington University  
GMD Fokus  
Hyundai Electronics America  
Institute for Computer Aided Design, Russian Academy of Sciences  
Institute for Defense Analysis  
Institut National Des Telecommunications, France  
IUT de DIJON  
Korea Telecom Research Laboratories  
Los Alamos National Laboratory  
Ministry of Information and Communications, Taiwan  
National Science Foundation  
National Institute of Applied Sciences  
Naval Research Laboratory  
Purdue University  
Swiss Federal Institute of Technology (ETH)  
Universidad Complutense de Madrid  
University of Huddlesfield  
University of Maryland  
University of Nancy, France  
University of South Florida  
University of Twente, The Netherlands

## **Faculty Appointments**

21

**Colleges and universities represented include:**

Arizona State University  
Clemson University  
Colorado State University  
Columbia University  
George Mason University  
George Washington University  
Loyola College  
Old Dominion University  
University of Delaware  
University of Maryland  
University of North Carolina



# INTERNATIONAL ACTIVITIES

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## **Assistance to Singapore Government**

ITL continued its long-standing collaboration with government and private organizations in Singapore by providing technical advice and assistance in computer security to standards working groups, government departments, the Productivity and Standards Board which provides testing and metrology services to the Singapore government, and the banking industry. Stuart Katzke is the ITL contact.

## **ATM Network Technology in Korea**

Through a Memorandum of Understanding, ITL, the Korean Telcom Research Group (KTRG), and the Electronics and Telecommunications Research Institute (ETRI) are jointly developing abstract conformance test and interoperability test suites for the ATM network protocols and Video-on-Demand (VoD) service. KTRG and ETRI assigned guest scientists to work at NIST with ITL researchers in developing test suites and VoD reference implementations.

## **Collaboration with Japan's Electrotechnical Laboratory**

Staff from the Mathematical and Computational Sciences Division are collaborating with researchers of Japan's Electrotechnical Laboratory (ETL) on network infrastructure for high performance computing. As part of this work, ETL is providing a Japanese mirror of the NIST Matrix Market, a visual database of large sparse matrices from industrial applications, while NIST is incorporating interactive matrix generation software from ETL into the Matrix Market.

## **Collaboration with the Russian Academy of Sciences**

As part of a cooperative agreement between NIST and the Russian Academy of Sciences (RAS), Daniel Lozier, Mathematical and Computational Sciences Division, has been participating in a scientific exchange with Dr. Yuri Rappoport of the RAS Institute for Computer Aided Design. They are working on algorithms for the MacDonald, or modified Bessel, functions. These arise as the kernel of the Kantorovich-Lebedev integral transform, for which little software exists in Western computer libraries. Lozier visited the Russian Academy for two weeks in the fall of 1996, while Rappoport visited NIST for three months during the summer of 1997. The National Research Council (NRC) is considering a proposal to send an NRC postdoctoral researcher to Moscow to work with Rappoport on the project.



### **Common Criteria (CC)**

To improve the metrics and methods required to specify, build, and evaluate advanced information technology (IT) security products and systems, ITL is collaborating with Canada, France, United Kingdom, Germany, and the Netherlands to develop a common criteria specification that is flexible, extensible, responsive to market forces, and accepted by the major western economic powers. The CC is a comprehensive framework and technical criteria for defining and evaluating the security of IT products and systems. Specific activities include a North America-Europe effort to develop a harmonized CC and the conduct of trial evaluations to validate the CC. Another project, funded by the Defense Advanced Research Projects Agency, compares evaluations of the Trusted Mach Operating System against the European Information Technology Security Evaluation Criteria. The evaluations are being conducted by United Kingdom and German commercially licensed evaluation laboratories.

### **Cryptographic Module Validation**

ITL and the Communications Security Establishment of the Government of Canada collaborated on the development of the Cryptographic Module Validation Program, which has been operational since July 1995. To date four software cryptographic modules and four hardware cryptomodules have been validated. Products validated by this program as conforming to FIPS 140-1, *Security Requirements for Cryptographic Modules*, are accepted for use in both the U.S. and Canada for the protection of sensitive, unclassified information.

### **G-7 Global Information Society Inventory Pilot Project**

Under the coordination of the European Community and Japan, the Global Inventory Project (GIP), one of eleven pilot projects designed to stimulate global applications of information technologies, aims to produce a multimedia inventory of national and international projects, studies, and calls relevant to the promotion and further development of knowledge and understanding of the information society. As the U.S. point of reference, ITL established an entry point for a sampling of current and proposed U.S. information infrastructure projects under ten application areas defined by the G7 nations. Electronic project submission and access to the resources are available via the U.S. National Information Infrastructure Virtual Library Home Page at <http://nii.nist.gov>.

### **G-7 Pilot Project on Global Electronic Commerce**

Along with Japan and the European Community (EC), the National Institute of Standards and Technology was designated the lead agency in the G7 Information Society Pilot Project "Global Marketplace for Small and Medium Enterprises (SMEs)." The SME project seeks to identify the information needs of SMEs, promote SME use of the information infrastructure, and encourage the development and demonstration of electronic commerce. ITL maintains the Web site for the G7 Electronic Commerce Testbed Pilot Projects found at [http://nii.nist.gov/g7/10\\_global\\_mp/testbeds/registered.html](http://nii.nist.gov/g7/10_global_mp/testbeds/registered.html). Judith Moline is the U.S. contact for the G7 GIP and SME projects.

### **International Federation for Information Processing (IFIP)**

ITL is active in the IFIP Working Group on Numerical Software (WG 2.5), which is part of the IFIP Technical Committee on Programming Languages (TC 2). Ronald Boisvert, Mathematical and Computational Sciences Division, who was elected to membership in WG 2.5 last year, edited the proceedings of the IFIP WG 2.5 Conference on the Quality of Numerical Software held in July 1996 in Oxford, England. The proceedings, published this year by Chapman & Hall, contains papers by R. Boisvert, K. Remington and R. Pozo on the NIST Matrix Market, and by D. Lozier on the NIST Software Testing Service for Special Functions.

### **International Public Sector Information Technology (IPSIT) Group**

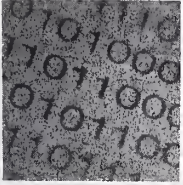
IPSIT is an informal association of representatives of public sector organizations that identify, discuss, share experiences, and raise awareness on issues in information management and technology in an informal and candid way with a view to encouraging action and resolution. IPSIT discusses topics of mutual interest from the perspective of national solutions. Areas of interest include common information and communications architectures, interconnectivity, information exchange, use of standards, and publicly available specifications. Participation includes representatives from Australia, Canada, Germany, Italy, Japan, Korea, Portugal, South Africa, Sweden, Switzerland, the UK, and the U.S. ITL participates as a representative of the U.S. Government.

### **Organization for Economic Cooperation and Development (OECD)**

Based in Brussels, Belgium, the OECD is associated with the European Community (EC). ITL participated in the U.S. delegation to the OECD Cryptography Experts Group resulting in OECD's Cryptography Principles. Edward Roback represented ITL in this effort.

### **System for Inter-American Metrology (SIM)**

In cooperation with the NIST Office of International Relations, the Statistical Engineering Division worked to acquaint SIM partners with statistical methods for calibration of artifacts and certification of reference materials (RM). Mark Levenson and Lisa Gill spent several days at Queretaro, Mexico, consulting with CENAM staff on problems associated with the certification of RMs; namely, selection of materials, design of experiments to optimize information gained from analysis, and uncertainty analysis. James Filliben and Lynne Hare participated in the Advanced School for Metrology: Evaluation of Uncertainty in Measurement which was held in Brazil. Carroll Croarkin spent three days in Panama City presenting a Workshop on Advanced Mass Measurements to metrologists from the national laboratories in the CAMET region with the goal of achieving comparability of mass calibrations within SIM via standardization of weighing procedures and statistical analyses.



# PATENTS

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Patents issued to ITL researchers are:

- Cryptographic Key Notarization Methods and Apparatus  
Miles Smid and Dennis Branstad  
Issued May 31, 1983
- Object/Anti-Object Neural Network Segmentation  
Charles Wilson, Michael Garris, and R. Wilkinson  
Issued September 14, 1993
- Method and Apparatus for Analyzing Character Strings  
Jon Geist  
Issued July 12, 1994
- Automated Recognition of Characters Using Optical Filtering With Positive and Negative Functions Encoding Pattern and Relevance Information  
Charles Wilson  
Issued November 1, 1994
- Automated Recognition of Characters Using Optical Filtering With Maximum Uncertainty Minimum Variance (MUMV) Functions  
Charles Wilson and James Blue  
Issued December 6, 1994
- Apparatus For Identifying Unknown Words By Comparison to Known Words  
Jon Geist  
Issued February 21, 1995
- Procedure for Digital Image Restoration  
Alfred S. Carasso  
Issued May 9, 1995
- Aerosol Mass Spectrometer  
Kensei Ehara  
Issued June 27, 1995
- Procedure for Digital Image Restoration  
(continuation in part)  
Alfred S. Carasso  
Issued May 6, 1997



# PUBLICATIONS

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**October 1996 - December 1997**

NIST Publications are available from the Government Printing Office (GPO) at (202) 512-1800 or the National Technical Information Service (NTIS) at (703) 605-6000. SN numbers are stocked by GPO; PB numbers are stocked by NTIS. Our NIST Publications List 88, *Information Technology Publications and Products*, is available online at <http://www.nist.gov/itl/lab/list88.htm>.

NIST SPECIAL  
PUBLICATION

TITLE

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## STANDARD REFERENCE MATERIAL SERIES

- 260-131 *The Certification of 100 mm Diameter Silicon Resistivity SRMs 2541 through 2547 using Dual-Configuration Four-Point Measurements*  
By J. R. Ehrstein and M. Carroll Croarkin  
August 1997 SN003-003-03495-9 \$8.00

## NIST INFORMATION TECHNOLOGY SERIES

- 500-236 *Overview of the Fourth Text REtrieval Conference (TREC-4)*  
Donna K. Harman, Editor  
October 1996 SN003-003-03430-4 \$59.00
- 500-237 *Symposium Transcription - Usability Engineering: Industry-Government Collaboration for System Effectiveness and Efficiency*  
Laura L. Downey and Sharon J. Laskowski, Editors  
July 1997 SN003-003-03484-3 \$21.00
- 500-238 *Overview of the Fifth Text REtrieval Conference (TREC-5)*  
Ellen M. Voorhees and Donna K. Harman, Editors  
November 1997 SN003-003-03505-0

## NIST COMPUTER SECURITY SERIES

- 800-15 *Minimum Interoperability Specification for PKI Components (MISPC), Version 1*  
By William E. Burr, Donna F. Dodson, Noel A. Nazario, and William T. Polk  
November 1997



## NIST FEDERAL IMPLEMENTATION CONVENTIONS FOR ELECTRONIC DATA INTERCHANGE SERIES

- |        |   |                   |        |
|--------|---|-------------------|--------|
| 881-10 | <i>Federal Implementation Guideline for Electronic Data Interchange, ASC X12 003040 Transaction Set 810, Invoice -- [Commercial Invoice] Implementation Convention</i><br>Jean-Philippe Favreau, Editor<br>March 1997 | SN003-003-03450-9 | \$4.75 |
| 881-11 | <i>Federal Implementation Guideline for Electronic Data Interchange, ASC X12 003040 Transaction Set 820, Payment Order/Remittance Advice Implementation Convention</i><br>Jean-Philippe Favreau, Editor<br>March 1997 | SN003-003-03451-7 | \$4.00 |
| 881-12 | <i>Federal Implementation Guideline for Electronic Data Interchange, ASC X12 003040 Transaction Set 855, Purchase Order Acknowledgment Implementation Convention</i><br>Jean-Philippe Favreau, Editor<br>March 1997   | SN003-003-03452-5 | \$3.00 |
| 881-13 | <i>Federal Implementation Guideline for Electronic Data Interchange, ASC X12 003040 Transaction Set 997, Functional Acknowledgment Implementation Convention</i><br>Jean-Philippe Favreau, Editor<br>March 1997       | SN003-003-03453-3 | \$1.75 |
| 881-14 | <i>Federal Implementation Guideline for Electronic Data Interchange, ASC X12 003050 Transaction Set 864, Text Message Implementation Convention</i><br>Jean-Philippe Favreau, Editor<br>March 1997                    | SN003-003-03454-1 | \$2.25 |
| 881-15 | <i>Federal Implementation Guideline for Electronic Data Interchange, ASC X12 003050 Transaction Set 824, Application Advice Implementation Convention</i><br>Jean-Philippe Favreau, Editor<br>March 1997              | SN003-003-03455-0 | \$2.25 |
| 881-16 | <i>Federal Implementation Guideline for Electronic Data Interchange, ASC X12 003050 Transaction Set 832, Price/Sales Catalog Implementation Convention</i><br>Jean-Philippe Favreau, Editor<br>March 1997             | SN003-003-03456-8 | \$6.00 |
| 881-17 | <i>Federal Implementation Guideline for Electronic Data Interchange, ASC X12 003050 Transaction Set 997, Functional Acknowledgment Implementation Convention</i><br>Jean-Philippe Favreau, Editor<br>March 1997       | SN003-003-03457-6 | \$1.75 |
| 881-18 | <i>Federal Implementation Guideline for Electronic Data Interchange, ASC X12 003040 Transaction Set 840, Request for Quotation Implementation Convention</i><br>Jean-Philippe Favreau, Editor<br>March 1997           | SN003-003-03458-4 | \$9.00 |

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881-19	<i>Federal Implementation Guideline for Electronic Data Interchange, ASC X12 003040 Transaction Set 864, Text Message Implementation Convention</i> Jean-Philippe Favreau, Editor April 1997	SN003-003-03459-2	\$1.75
881-20	<i>Federal Implementation Guideline for Electronic Data Interchange, ASC X12 003060 Transaction Set 194, Grant or Assistance Application Implementation Convention</i> Jean-Philippe Favreau, Editor March 1997	SN003-003-03463-1	\$7.00
881-21	<i>Federal Implementation Guideline for Electronic Data Interchange, ASC X12 003060 Transaction Set 841, Specifications/Technical Information (Request for Technical Information) Implementation Convention</i> Jean-Philippe Favreau, Editor March 1997	SN003-003-03464-9	\$2.75
881-22	<i>Federal Implementation Guideline for Electronic Data Interchange, ASC X12 003060 Transaction Set 841, Specifications/Technical Information (Provide Technical Information) Implementation Convention</i> Jean-Philippe Favreau, Editor March 1997	SN003-003-03465-7	\$3.00
881-23	<i>Federal Implementation Guideline for Electronic Data Interchange, ASC X12 003050 Transaction Set 870, Order Status Report Implementation Convention</i> Jean-Philippe Favreau, Editor March 1997	SN003-003-03480-1	\$2.50
881-24	<i>Federal Implementation Guideline for Electronic Data Interchange, ASC X12 003050 Transaction Set 869, Order Status Inquiry Implementation Convention</i> Jean-Philippe Favreau, Editor March 1997	SN003-003-03466-5	\$2.00
881-25	<i>Federal Implementation Guideline for Electronic Data Interchange, ASC X12 003050 Transaction Set 805, Contract Pricing Proposal Implementation Convention</i> Jean-Philippe Favreau, Editor March 1997	SN003-003-03467-3	\$5.00
881-26	<i>Federal Implementation Guideline for Electronic Data Interchange, ASC X12 003050 Transaction Set 251, Pricing Support Implementation Convention</i> Jean-Philippe Favreau, Editor August 1997	SN003-003-03474-6	
881-27	<i>Federal Implementation Guideline for Electronic Data Interchange, ASC X12 003040 Transaction Set 822, Customer Account Analysis Implementation Convention</i> Jean-Philippe Favreau, Editor August 1997	SN003-003-03489-4	

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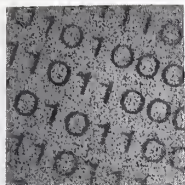
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# CONFERENCES, WORKSHOPS, LECTURES, AND TRAINING COURSES

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In 1997, our organization sponsored, cosponsored, and conducted many conferences, workshops, lectures, and training seminars, including the following:

## **Annual conferences and ongoing workshops**

- 20<sup>th</sup> National Information Systems Security Conference
- COMPASS '97, 12<sup>th</sup> Annual Conference on Computer Assurance
- FedCIRC Annual Conference
- Fifth Text REtrieval Conference (TREC-5)
- North American ISDN Users' Forum (NIUF)
- Tenth Annual Federal Information Systems Security Educators Association (FISSEA) Conference
- Usability Engineering 2: Measurement and Methods (UE2)
- Workshop on Improving Product and Process Quality Using Experiment Design

## **Specialized conferences and workshops**

- Advanced Mass Measurements Workshop
- Conference on Leveraging Cyberspace
- Display Forum '97 Workshop
- International Symposium on the Year 2000: Mastering the Millennium Rollover
- Interoperable Message Passing Interface (IMPI) Workshop
- Invitational Workshop on Digital Library of Mathematical Functions
- Public Forum on Certificate Authorities and Digital Signatures: Enhancing Global Electronic Commerce
- Prototype Conferencing Products Interoperability Events
- Software Standards and Conformance Testing: An Update
- Statistical Methods for Certification of Reference Materials
- Systems Anthropometry Workshop
- Uncertainty Calculations in Chemical Measurements
- Workshop on Developing the Advanced Encryption Standard
- Workshop on Protection Profile for Network Firewall Devices
- Workshop on Role Based Access Control

## **Seminars and Lectures**

- Federal Computer Incident Response Capability (FedCIRC) Seminar for Federal Agencies
- FedCIRC Seminar Series
- High Integrity Systems Lecture Series
- High Performance Systems and Services Division Lecture Series
- Joint Seminar of the Computer Security and Statistical Engineering Divisions:  
Patterns in Words
- Joint Seminar of the Statistical Engineering Division and the Software Diagnostic and Conformance Testing Division: Improved Engineering of the Software Manufacturing Process

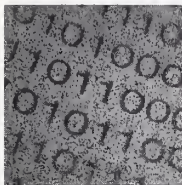
**Seminars and Lectures (continued)**

Incident Handling Workshop  
Lecture on Manufacturing Infrastructure for Optoelectronics  
Lecture on Virtual Humans for Animation, Ergonomics, and Simulation  
Lecture Series on Matrix Algorithms  
Mathematical and Computational Sciences Division (MCSD) Colloquia  
Session on Scientific Software, IMACS 97  
Seminar Series on the Future of Information Technology  
Statistical Engineering Division Seminars  
Strategic and Technical Directions from the Visionary Leaders of the World Wide  
Web Consortium (W3C)  
Supporting Interactive Information Retrieval through Relevance Feedback: A Study  
of End-Users

**Training courses and tutorials**

Analysis of Variance  
Basics of Synchronize Training  
Computer Security, Management Update  
Design of Experiments  
Distributed Computing & Information Services, Management Update  
Eudora Training  
Exploratory Data Analysis, Statistics for Scientists and Engineers  
Intermediate Synchronize Training  
Introduction to AVS5, AVS/EXPRESS, and IBM Data Explorer  
Introduction to PV-WAVE  
Introduction to Virtual Instrumentation Using LabVIEW  
LabVIEW Users' Group  
MS Word for Windows Equation Editor  
Overview of Microsoft Word  
Practical Intrusion Detection Workshop  
Regression Models  
Spectral Methods for Data Analysis  
Statistical Automation for Parallel Code and Improvement  
Time Series Analysis





# ELECTRONIC PRODUCTS AND RESOURCES

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For information on ITL electronic products, services, and resources, access the WWW at:

<http://www.itl.nist.gov>

**Advanced Network Technologies** - includes Cerberus, a leading edge prototype and reference implementation of emerging network layer Internet security; the Integrated Services Protocol Instrument (ISPI), an interactive, integrated tool for measuring the performance of quality of service (QoS) sensitive data streams while conducting experiments with emerging Internet resource reservation protocols and real-time network services; IPsec WIT, an interoperability test system built around the Cerberus IPsec prototype and commonly available WWW technology; and NIST Net, a general-purpose tool for emulating performance dynamics in IP networks.

<http://www.antd.nist.gov>

**ATM/HFC Simulator** - a means for researchers and network planners to analyze the behavior of Asynchronous Transfer Mode (ATM) and Hybrid Fiber Coax (HFC) networks without the expense of building a real network:

[http://www.hsnt.nist.gov/misc/hsnt/prj\\_atm-sim.html](http://www.hsnt.nist.gov/misc/hsnt/prj_atm-sim.html)

**Computer Security Resource Clearinghouse** - information on computer security awareness and training, publications, conferences, software tools, security alerts, and prevention measures, as well as the Cryptographic Module Validation Program:

<http://csrc.nist.gov>

**Directory of Conformance Testing Programs, Products, and Services** - sources for measuring software for conformance to IT standards:

<http://www.nist.gov/ctdirectory.html>

**Guide to Available Mathematical Software (GAMS)** - a cross-index and virtual repository of mathematical and statistical software components of use in computational science and engineering:

<http://gams.nist.gov/>

**High Integrity Systems and Software Assurance** - methods and tools for assuring dependability in software:

<http://hissa.ncsl.nist.gov>

**Matrix Market** - a visual repository of test data for use in comparative studies of algorithms for numerical linear algebra, featuring nearly 500 sparse matrices for a variety of applications, as well as matrix generation tools and services:

<http://math.nist.gov/MatrixMarket/>

**MultiKron** - a series of very large scale integration (VLSI) instrumentation chips and interface boards which measure the performance of parallel processors and workstations on high-speed networks:

<http://cmr.ncsl.nist.gov/multikron/multikron.html>

**North American Integrated Services Digital Network (ISDN) Users' Forum (NIUF)** - approved documentation, working group charters, ISDN applications, meeting highlights, and future meeting announcements:

<http://www.niuf.nist.gov/misc/niuf.html>

**Open Virtual Reality Testbed** - software and information for virtual reality and the Virtual Reality Modeling Language (VRML):

<http://ovrt.nist.gov>

**Role Based Access Control** - an implementation of the NIST RBAC model for the WWW running on Unix Web servers:

<http://hissa.ncsl.nist.gov/RBACdist/>

A tool for viewing and establishing access control lists for Windows NT:

<http://hissa.ncsl.nist.gov/RBACdistNT/>

**S-Check** - NIST's novel tool for assaying and improving performances of parallel and networked programs:

<http://cmr.ncsl.nist.gov/scheck/scheck.html>

**Statistical Reference Datasets (StRD)** - a Web-based service that provides reference datasets with certified computational results for several statistical areas:

<http://www.itl.nist.gov/div898/strd/>

## STANDARD REFERENCE DATABASES

### NIST Special Databases

To order NIST Special Databases or NIST Special Software, write or call NIST Standard Reference Data Program, Building 820, Room 113, Gaithersburg, MD 20899, telephone (301) 975-2208; fax (301) 926-0416; email SRDATA@enh.nist.gov

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|---|-------|
| ■ Special Database 2  |       |
| NIST Structured Forms Reference Set of Binary Images (SFRS) | \$150 |
| ■ Special Database 4  |       |
| NIST 8-Bit Gray Scale Images of Fingerprint Image Groups    | \$150 |

■ Special Database 6	
NIST Structured Forms Reference Set of Binary Images II	\$150
■ Special Database 8	
NIST Machine-Print Database of Gray Scale and Binary Images	\$270
■ Special Database 9	
NIST Mated Fingerprint Card Pairs (vols. 1-5)	\$270 each
■ Special Database 10	
Supplemental Fingerprint Card Data for NIST Special Database 9	\$270
■ Special Database 11	
NIST Census Miniform Training Database 1: Binary Images from Microfilm	\$150
■ Special Database 12	
NIST Census Miniform Training Database 2: Binary Images from Paper and Microfilm	\$150
■ Special Database 13	
NIST Census Miniform Test Database: Binary Images from Paper and Microfilm	\$150
■ Special Database 14	
NIST Mated Fingerprint Card Pairs 2	\$270
■ Special Database 18	
NIST Mugshot Identification Database	\$270
■ Special Database 19	
NIST Handprinted Forms and Characters Database	\$150
■ Special Database 20	
NIST Scientific and Technical Document Database	\$330
■ Special Software 1	
NIST Scoring Package Release 1.0	\$150









For more information, contact:

Information Technology Laboratory  
National Institute of Standards and Technology  
Building 225, Room B261  
Gaithersburg, MD 20899-0001

Telephone: 301 975-2900

Facsimile: 301 840-1357

Email: [itlab@nist.gov](mailto:itlab@nist.gov)

Elizabeth B. Lennon, Writer/Editor

Susan Permut, Design Consultant

Kathie Koenig Simon, Photographer

Don Price, Production

Warren F. Overman, Printing Coordinator

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