SUPPLEMENTAL REPORT
Department of Commerce, Annual Budget Proposal, FY 2007

Annual Report on Technology Transfer: Approach and Plans, FY 2005 Activities and Achievements

U.S. Department of Commerce

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In response to the:
Technology Transfer and Commercialization Act of 2000 (P.L. 106-404)

February 2006

Foreword. This is the calendar year 2006 edition of a report series summarizing the technology transfer activities and achievements of the Department of Commerce's federal laboratories. This report responds to the statutory requirement for an annual "agency report on utilization" [15 U.S.C. Section 3710 (f)] under the revised federal-wide reporting process established by the Technology Transfer Commercialization Act of 2000 (P.L. 106-404). All federal agencies that direct one or more federal laboratories or conduct other activities under Section 207 and 209 of Title 35, United States Code are subject to the requirements of this statute.

At the Department of Commerce, technology transfer is a part of the mission and program activities of principally the National Institute of Standards and Technology (Technology Administration), the National Oceanic and Atmospheric Administration, and the Institute for Telecommunication Sciences (National Telecommunications and Information Administration). Accordingly, this report focuses on the activities of these three departmental agencies.

Each of the major sections of this report is organized to summarize the agency's technology transfer approaches and plans and to provide specific information about the activities and accomplishments for FY 2005 and several earlier comparative years. The report begins with a summary of this information for the Department of Commerce as a whole.

This report has been organized and prepared by the Office of Technology Policy (Technology Administration), along with the joint participation of technology transfer personnel at the National Institute of Standards and Technology (Technology Administration), the National Oceanic and Atmospheric Administration, and the Institute for Telecommunication Sciences (National Telecommunications and Information Administration).

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I. DEPARTMENT OF COMMERCE OVERVIEW

Technology Transfer by the Department's Federal Laboratories – Summary of Approaches and FY 2005 Activities/Achievements

The Department of Commerce works in partnership with businesses, universities, communities, and workers to promote innovation and the Nation's overall competitiveness in the global economy. The Department pursues this objective through a host of policy and program activities directed at strengthening the nation's economic infrastructure, facilitating the development of cutting-edge science and technology, providing an information base, and managing national resources.

At the Department, research and development (R&D) in numerous areas of contemporary science and technology is conducted at the federal laboratories of the Technology Administration (the National Institute of Standards and Technology -- NIST), National Oceanic and Atmospheric Administration (various lab facilities across NOAA's bureaus), and the National Telecommunications and Information Administration (Institute for Telecommunication Research – ITS). Technology transfer is a key part of the program activities at each of these agencies' federal lab systems.[1]

■ Agency Missions and Channels for Technology Transfer

Mission	Tech Transfer
Technology Administration – National Institute of Standards and Technology NIST's mission is to develop and promote measurement, standards, and technology to enhance productivity, facilitate trade, and improve the quality of life. NIST laboratories develop and disseminate measurement techniques, reference data, test methods, standards, and other infrastructural technologies and services that support U.S. industry, scientific research, and the activities of many federal agencies. In carrying out its mission, NIST works directly with industry partners (and consortia), universities, associations, and other government agencies.	▪ The general focus of NIST's technology transfer activities is the broad dissemination of research results to industry, rather than just the creation of patents and associated licenses. Accordingly, NIST draws on a diverse group of mechanisms to transfer the knowledge and technologies that result from its laboratory research. ▪ Principal tech transfer mechanisms: CRADAs, Patents and licenses, Technical publications, Standard Reference Materials, Standard Reference Data, Calibration services, Documentary standards Conferences, workshops, and inquiries Guest researchers and facilities users.

[1] In reviewing the technology transfer plans and activity statistics provided by this report, it is important to recognize there are significant differences among the three agencies in the level of resources available to support R&D activities. For NIST, budget authority for R&D (including conduct of R&D and R&D facilities) in FY 2005 totaled an estimated $446 million. For NOAA, the corresponding figure for R&D budget authority in FY 2005 is $574 million. For ITS, the corresponding FY 2005 figure is $6 million.

Mission	Tech Transfer
National Oceanic and Atmospheric Administration NOAA's mission is to understand and predict changes in the Earth's environment and conserve and manage coastal and marine resources to meet the Nation's economic, social, and environmental needs. This mission will become ever more critical in the 21st century as national needs intensify concerning climate change, freshwater supply, ecosystem management, and homeland security.	▪ NOAA's broad approach to tech transfer involves direct transfer, licensing intellectual property, and cooperative research relationships with industry. NOAA works with each of its laboratories based on its ability to provide the necessary resources. ▪ Principal tech transfer mechanisms: Public dissemination CRADAs, Patents and licenses
National Telecommunications and Information Administration -- Institute for Telecommunication Sciences NTIA's Institute for Telecommunication Sciences (ITS) supports agency telecommunications objectives such as promoting advanced telecommunications and information infrastructure development in the United States, enhancing domestic competitiveness, improving foreign trade opportunities for U.S. telecommunications firms, and facilitating more efficient and effective use of the radio spectrum. ITS also serves as a principal federal resource for solving the telecommunications concerns of other federal agencies, state and local governments, private corporations and associations, and international organizations.	▪ ITS participates in tech transfer and commercialization by fostering cooperative research with industry where benefits can directly facilitate U.S. competitiveness and market opportunities. ▪ Principal tech transfer mechanisms: CRADAs, Patents and licenses, Telecommunications analysis services. Technical publications, Development of telecommunications standards.

For a more detailed discussion, see the initial section of each of the agency chapters below.

■ Summary of Technology Transfer Activities and Achievements across the Department, FY 2005 and Recent Years

□ *Selected Activity Measures*

Collaborative Relationships for Research & Development

		FY 2001	FY 2002	FY 2003	FY 2004	FY 2005
● **CRADAs**, total active in the FY (1)						
▪ Traditional CRADAs (2)	Department	190	141	92	67	80
	NIST	174	125	76	51	65
	NOAA	8	8	11	9	8
	ITS	6	6	5	7	7
▪ Non-traditional CRADAs (3)	Department	59	1,744	1,811	1,902	1,826
	NIST	0	1,687	1,577	1,590	1,553
	NOAA	0	0	0	0	0
	ITS	59	57	234	312	273

		FY 2001	FY 2002	FY 2003	FY 2004	FY 2005
● Other types of collaborative R&D relationships (4)						
▪ Facility use agreements	NIST	372	391	511	590	588
▪ Guest scientists and engineers	NIST	1,200	1,300	1,300	1,700	2,115
▪ Collaborative standards contributions	ITS	3	3	2	11	11

CRADA = Cooperative Research and Development Agreement.

(1) "Active" = legally in force at any time during the FY. "Total active" is comprehensive of all agreements executed under CRADA authority (15 USC 3710a).
(2) CRADAs involving collaborative research and development by a federal laboratory and non-federal partners.
(3) CRADAs used for special purposes -- such as, material transfer or technical assistance that may result in protected information.
(4) For details on these types of R&D relationships see the respective agency's chapter later in this report.

Invention Disclosure and Patenting

		FY 2001	FY 2002	FY 2003	FY 2004	FY 2005
● New inventions disclosed in the FY (1)	Department	26	17	21	25	23
	NIST	24	16	16	23	19
	NOAA	1	1	5	2	3
	ITS	1	0	0	0	1
● Patent applications filed in the FY (2)	Department	12	12	5	8	6
	NIST	9	11	5	8	5
	NOAA	3	0	0	0	1
	ITS	0	1	0	0	0
● Patents issued in the FY	Department	21	20	9	11	10
	NIST	20	15	7	10	9
	NOAA	1	5	1	1	1
	ITS	0	0	1	0	0

(1) Inventions arising at the federal lab.
(2) Tally includes U.S. patent applications, foreign patent applications filed on cases for which no U.S. application was filed, divisional applications, and continuation-in-part applications. Excludes provisional, continuation, duplicate foreign, and Paris Cooperation Treaty (PCT) applications.

Licensing -- Profile of Active Licenses

		FY 2001	FY 2002	FY 2003	FY 2004	FY 2005
● **All licenses**, number total active in FY [1]	Department	40	41	101	125	133
▪ **Invention licenses**, total active in FY	Department	40	41	101	125	133
- Patent licenses [2]	Department	40	41	101	30	33
	NIST	36	35	39	22	26
	NOAA	2	3	5	5	4
	ITS	2	3	57	3	3
- Material transfer licenses (inventions)		0	0	0	0	0
- Other invention licenses	Department	0	0	0	95	100
	NIST				0	0
	NOAA				0	0
	ITS				95	100
▪ **Other IP licenses**, total active in FY	Department	0	0	0	0	0
- Copyright licenses (fee bearing)						
- Material transfer licenses (non-inventions)						
- Other						

Multiple inventions in a single license are counted as one license. Licenses that include both patents and copyrights (hybrid licenses) are reported as patent licenses -- and not included in the count of copyright licenses.

(1) "Active" = legally in force at any time during the FY.
(2) Patent license tally includes patent applications which are licensed.

Note: For simplicity, sub-departmental detail is suppressed in this table, where the appropriate disaggregated figures are straightforwardly evident from data listed in other rows.

Licensing Management

		FY 2001	FY 2002	FY 2003	FY 2004	FY 2005
● **Elapsed execution time**,[1] licenses granted in the FY						
▪ **Invention licenses**, average, months						
	NIST	4.8	5.4	3.4	**	1.0
	NOAA	6.0	8.0	5.0	**	**
	ITS	**	5.0	1.0	2.0	2.0
● **Licenses terminated for cause**, number in the FY						
▪ **Invention licenses**						
	NIST	7	3	1	0	1
	NOAA	0	0	0	0	0
	ITS	0	0	0	0	0

** New licenses not executed in the FY

For additional statistics on these metrics see the corresponding table the later agency chapters of this report.

(1) Date of license application to the date of license execution. (Date of license application is the date the lab formally acknowledges the written request for a license from a prospective licensee and agrees to enter into negotiations.)

Characteristics of Licenses Bearing Income

		FY 2001	FY 2002	FY 2003	FY 2004	FY 2005
● **All income bearing licenses**, number	Department	22	39	37	23	25
▪ **Invention licenses**, income bearing	Department	22	39	37	23	25
- Patent licenses [1]	Department	22	39	37	23	25
	NIST	19	33	29	15	17
	NOAA	2	3	5	5	4
	ITS	1	3	3	3	4
▫ Exclusive/partially exclusive/ non-exclusive	Department	13/5/4	19/2/18	20/0/17	11/0/12	12/0/13
	NIST	12/5/2	18/2/13	19/0/10	10/0/5	11/0/6
	NOAA	1/0/1	1/0/2	1/0/4	1/0/4	1/0/3
	ITS	0/0/1	0/0/3	0/0/3	0/0/3	0/0/4
▪ **Other IP licenses**, income bearing		0	0	0	0	0
● **All royalty bearing licenses**,[2] number		22	36	34	23	25
▪ **Invention licenses**, royalty bearing		22	36	34	23	25
- Patent licenses [1]	Department	22	36	34	23	25
	NIST	19	33	29	15	17
	NOAA	2	3	5	5	4
	ITS	1	0	0	3	4
▪ **Other IP licenses**, royalty bearing		0	0	0	0	0

(1) Patent license tally includes patent applications which are licensed.
(2) Note that royalties are one component of total license income.

Note: For simplicity, sub-departmental detail is suppressed in this table, where the appropriate disaggregated figures are straightforwardly evident from data listed in other rows.

Income from Licensing

		FY 2001	FY 2002	FY 2003	FY 2004	FY 2005
● **Total income**, all licenses active in FY [1]		$268,568	$164,622	$127,566	$203,289	$146,660
▪ **Invention licenses**		$268,568	$164,622	$127,566	$203,289	$146,660
- Patent licenses [2]	Department	$268,568	$164,622	$127,566	$203,289	$146,660
	NIST	$261,968	$89,750	$122,850	$144,828	$123,348
	NOAA	$1,600	$9,402	$4,716	$24,961	$16,100
	ITS	$5,000	$65,470	$0	$33,500	$7,212
▪ **Other IP licenses**, total active in the FY		$0	$0	$0	$0	$0
● **Total Earned Royalty Income** [3]		$263,568	$99,152	$127,566	$169,789	$139,448
▪ **Invention licenses**		$263,568	$99,152	$127,566	$169,789	$139,448
- Patent licenses [2]	Department	$263,568	$99,152	$127,566	$169,789	$139,448
	NIST	$261,968	$89,750	$122,850	$144,828	$123,348
	NOAA	$1,600	$9,402	$4,716	$24,961	$16,100
	ITS	$0	$0	$0	$0	$0
▪ **Other IP licenses**, total active in the FY		$0	$0	$0	$0	$0

(1) Total income includes license issue fees, earned royalties, minimum annual royalties, paid-up license fees, and reimbursement for full-cost recovery of goods and services provided by the lab to the licensee including patent costs.
(2) Patent license tally includes patent applications which are licensed.
(3) "Earned royalty" = royalty based upon use of a licensed invention (usually, a percentage of sales or of units sold). Not a license issue fee or a minimum royalty.

Note: For simplicity, sub-departmental detail is suppressed in this table, where the appropriate disaggregated figures are straightforwardly evident from data listed in other rows.

Disposition of License Income

		FY 2001	FY 2002	FY 2003	FY 2004	FY 2005
● **Income distributed** [1]						
▪ **Invention licenses**	Department	$268,568	$164,622	$127,566	$203,289	$146,660
	NIST	$261,968	$89,750	$122,850	$144,828	$123,348
	NOAA	$1,600	$9,402	$4,716	$24,961	$16,100
	ITS	$5,000	$65,470	$0	$33,500	$7,212
- To inventor(s)	Department	$106,440	$67,387	$52,903	$83,654	$60,112
		(40%)	(41%)	(41%)	(41%)	(41%)
	NIST	$102,040	$45,650	$51,773	$54,134	$48,148
		(39%)	(51%)	(42%)	(37%)	(39%)
	NOAA	$1,500	$696	$1,130	$11,070	$8,400
		(94%)	(7%)	(24%)	(44%)	(52%)
	ITS	$2,900	$21,041	$0	$18,450	$3,564
		(58%)	(32%)	(0%)	(55%)	(49%)

		FY 2001	FY 2002	FY 2003	FY 2004	FY 2005
- To other [2]	Department	$162,128	$97,235	$74,662	$119,635	$86,547
		(60%)	(59%)	(59%)	(59%)	(59%)
	NIST	$159,928	$44,100	$71,076	$90,694	$75,199
		(61%)	(49%)	(58%)	(63%)	(61%)
	NOAA	$100	$8,706	$3,586	$13,891	$7,700
		(6%)	(93%)	(76%)	(56%)	(48%)
	ITS	$2,100	$44,429	$0	$15,050	$3,648
		(42%)	(68%)	(0%)	(45%)	(51%)

Invention licenses are the chief policy interest regarding disposition of income; content of table reflects this focus.

(1) Income includes royalties and other payments received during the FY.
(2) To internal purposes, in the case of each agency.

Other Important Mechanisms for Technology and Knowledge Transfer [1]

		FY 2001	FY 2002	FY 2003	FY 2004	FY 2005
Standard Reference Materials (SRMs) available	NIST	1,335	1,353	1,214	1,211	1,246
Standard Reference Materials (SRMs) sold	NIST	31,985	30,996	29,527	30,490	32,163
Standard Reference Data (SRD) titles available	NIST	65	90	106	95	110
Number of items calibrated	NIST	3,192	2,924	3,459	3,373	3,145
Technical publications produced	NIST	2,207	2,236	1,918	2,074	2,070
Journal articles published	NOAA	544	529	626	419	397
Technical reports published	NOAA	274	363	245	300	226
Technical publications produced	ITS	17	17	20	17	19

(1) See the NIST, NOAA, and ITS chapters later in this report for definitions and further information on these measures.

Further detail on the measures cited in the tables above, as well as additional activity statistics can be found in the individual agency chapters later in this report.

□ *Illustrative Outcomes from Technology Transfer Cited by the Agencies*

The following cases were selected and described by the agencies in their 2005 reports as examples of "downstream" outcomes resulting from agency technology transfer efforts:

Agency	Downstream Outcomes Listed
Technology Administration -- National Institute of Standards and Technology	▪ Compact system stabilizes laser frequency. Scientists at JILA, a joint research institute of NIST and the University of Colorado at Boulder, have demonstrated a new compact, inexpensive method for stabilizing lasers that reduces sensitivity to vibration and gravity 100

Agency	Downstream Outcomes Listed
	times better than similar approaches. The method stabilizes the laser to a single frequency so that it can be used as a reliable reference oscillator for technologies such as optical clocks and light-based radar (lidar). ▪ New NIST tool measures silicon wafer thickness. The optics and materials for "printing" nanoscale circuit lines in microprocessors and other integrated circuits chips requires that the silicon wafers used be perfectly flat and of uniform thickness. To assist the industry in achieving this goal, NIST developed a new instrument that accurately measures differences in thickness across a 300 mm wafer with an repeatability of 5 nanometers. ▪ New NIST method improves accuracy of spectrometers. Measurements of the intensity of light at different wavelengths can be made more accurately now, thanks to a new, simple method for correcting common instrument errors. The new method, developed by NIST researchers will benefit fields such as color measurement, lighting development, remote sensing, biotechnology and astronomy. ▪ World's first UV 'ruler' sizes up atomic world. The world's most accurate "ruler" made with extreme ultraviolet light has been built and demonstrated with ultrafast laser pulses by scientists at NIST and the University of Colorado at Boulder. The new device consistently generates pulses of light lasting just femtoseconds (quadrillionths of a second, or millionths of a billionth of a second) in the ultraviolet region of the electromagnetic spectrum. The device is expected to become an important tool for ultraprecise measurements in many fields of science, including chemistry, physics and astronomy. ▪ NIST method improves timing in oscilloscopes. A new method for correcting common timing errors in high-speed oscilloscopes was developed by researchers at NIST. The method improves the accuracy and clarity of measurements performed in the development and troubleshooting of components for wireless and optical communications, military radar and other technologies. ▪ Light scattering method reveals details under skin. A new optical method, jointly demonstrated by NIST and Johns Hopkins University Applied Physics Laboratory can image structures under skin. The method relies on differences in the way surface and subsurface features of various materials scatter light. It was demonstrated with small pieces of pigskin and inorganic materials and might eventually prove useful for imaging living tissues to help diagnose or determine the extent of various types of skin cancers. ▪ Tiny, atom-based detector senses weak magnetic fields. A low-power, magnetic sensor about the size of a grain of rice that can detect magnetic field changes a million times weaker than the Earth's magnetic field has been demonstrated by NIST researchers. The device can be powered with batteries and is about 100 times smaller than current atom-based sensors with similar sensitivities, which typically weigh several kilograms. The NIST miniature magnetometer is sensitive enough to detect a concealed rifle about 12 meters away or

Agency	Downstream Outcomes Listed
	a six-inch-diameter steel pipeline up to 35 meters underground. ▪ Innovative chiral separation breakthrough. NIST scientists have developed a chiral separation technique that will give pharmaceutical companies a new analytical tool that may help to prevent dangerous side effects of drugs in patients. NIST's new chiral separation technique provides a combination of high resolving power and theoretically unlimited concentration enhancement for very low detection limits. Performing remarkably faster and with greater sensitivity than conventional methods, NIST's new technique provides a valuable tool for drug development research. ▪ New temperature and pressure standard. An innovative quasi-spherical cavity resonator has revolutionized temperature standards and may revolutionize pressure standards as well. The quasi-spherical cavity will enable users to have highly accurate standards of temperature and pressure in their own laboratories that they can use to calibrate the transducers they use for process control and for measuring temperature-dependencies of properties of materials. ▪ New design developed for silicon nanowire transistors. Researchers at NIST demonstrated a new design for silicon nanowire transistors that both simplifies processing and allows the devices to be switched on and off more easily. Silicon nanowire devices have received considerable attention recently for possible use in integrated nanoscale electronics as well as for studying fundamental properties of structures and devices with very small dimensions. The NIST work overcomes some key difficulties in making reliable devices or test structures at nanoscale dimensions. The results also suggest that nanowire transistors made with conventional lithographic fabrication methods can improve performance in nanoscale electronics, while allowing industry to retain its existing silicon technology infrastructure. ▪ Chip-scale refrigerators cool bulk objects. Chip-scale refrigerators capable of reaching temperatures as low as 100 milliKelvin have been used to cool bulk objects for the first time by NIST researchers. The solid-state refrigerators have applications such as cooling cryogenic sensors in highly sensitive instruments for semiconductor defect analysis and astronomical research. ▪ Nano-sized chip features measured with atom 'ruler'. Device features on computer chips as small as 40 nanometers (nm) wide—less than one-thousandth the width of a human hair—now can be measured reliably thanks to new test structures developed by NIST with SEMATECH and other collaborators. The test structures are replicated on reference materials that will allow better calibration of tools that monitor the manufacturing of microprocessors and similar integrated circuits. The new reference materials are now being evaluated by SEMATECH member companies. ▪ Detecting anthrax proteins at ultralow concentrations. A new laboratory method for quickly detecting active anthrax proteins within an infected blood sample at extremely low levels has been developed

Agency	Downstream Outcomes Listed
	by researchers at NIST, the U.S. Army Medical Research Institute of Infectious Diseases, and the National Cancer Institute. Current detection methods rely on injecting live animals or cell cultures with samples for analysis and require up to several days before results are available. The new method produces unambiguous results in about an hour. ▪ Chemical link indicated between alcohol and certain cancers. NIST developed a new chemical analysis method that has assisted researchers at the National Institute of Alcohol Abuse and Alcoholism (NIAAA), National Institutes of Health in demonstrating a potentially important chemical link between alcohol consumption and cancer. Using this novel chemical assay, they uncovered a chain of chemical reactions that, under physiological conditions, may lead from alcohol to a known mutagen. ▪ Study of RNA dynamics may help in drug design. NIST and University of Colorado biophysicists have developed a method for studying, in real time, a nanoscale "docking and undocking" interaction between small pieces of ribonucleic acid (RNA). The technique may be broadly useful in studying structural changes in RNA that affect its function with applications in the design of effective new drugs based on small RNA strands. ▪ New NIST SRM. A new NIST reference standard was developed to help genetics labs develop improved methods of searching for a mutant needle in a DNA haystack. To help the research community develop and test more sensitive techniques for detecting low-frequency mutations in heteroplasmic DNA, NIST researchers have developed a new Standard Reference Material, SRM 2394, "Heteroplasmic Mitochondrial DNA Mutation Detection Standard." ▪ New NIST SRM reinforces "fragile-X" screening. A new NIST Standard Reference Material will help clinical genetics labs improve the accuracy of their diagnostic tests for the most common cause of hereditary mental retardation. "Fragile X Syndrome" is a genetic mutation that has been linked to several physical abnormalities and to intellectual problems ranging from minor learning disabilities to severe mental retardation and autism. To assist clinical diagnostic and genetic testing laboratories in accurately counting fragile-X repeat sequences, NIST has developed a new reference material that can be used as a check on test procedures and for quality control. SRM 2399, "Fragile X Human DNA Triplet Repeat Standard" joins more than 50 reference materials produced by NIST for quality control in clinical testing. ▪ HIV database. An international plea for a standardized HIV database resource available to all pharmaceutical research scientists worldwide has been answered by NIST researchers, in collaboration with scientists at the U.S.' National Cancer Institute and Rutgers University. NIST's HIV SRD 102 collects and classifies data from thousands of structures of HIV protease and its inhibitors, organizing drug inhibitors according to their chemical structure with 3-D animations allowing manipulation in all directions. It is easily

Agency	Downstream Outcomes Listed
	accessible, reliable, and standardized. ▪ Bioagent detector guide aids first responders. Ever since envelopes containing anthrax bacteria were mailed to Congressional and media offices in 2001 causing several deaths, many first responder departments have worked to improve their ability to quickly detect toxic biological agents. To help them make informed decisions about which biological agent detection devices best meet their needs, NIST recently developed a guide for the emergency responders that provides ways to compare and contrast commercially available biological detection equipment. ▪ New system 'sees' crimes on audiotape. A real-time magnetic imaging system that enables criminal investigators to "see" signs of tampering in audiotapes -- erasing, overdubbing and other alterations -- while listening to the tapes has been developed by NIST researchers. The new system, which permits faster screening and more accurate audiotape analysis than currently possible, was delivered to the Federal Bureau of Investigation (FBI). ▪ New software judges quality of scanned fingerprints. An improved suite of automated fingerprint analysis tools, including a new software program that judges the quality of a scanned fingerprint, is now available to U.S. law enforcement agencies, manufacturers and biometrics researchers as a result of work at NIST. The software can be used to help ensure that images collected with digital fingerprint scanners will be of high enough quality to produce good matches with fingerprints already on file. ▪ Software advance helps computers act logically. A new software language, developed by NIST and colleagues in France, Germany, Japan and the United Kingdom, promises to enable computers to reason much more precisely and thus better reflect subtleties intended by commands from human operators. The software supports computer systems with this type of rudimentary understanding of context-specific language and is especially suited for the exchange of process planning, validation, production scheduling and control information for guiding manufacturing processes. ▪ Fluid mixture computer simulation innovation. Fluid mixtures are essential in an extremely wide range of practical applications and industrial processes. For example, heat pumps, air conditioners, refrigeration equipment and processes like, chemical (including fuel) production, purification, and separation, and environmental cleanup typically involve multiple coexisting fluids of differing composition (called phases). The amounts of each phase and their compositions change as conditions of temperature and/or pressure are varied - these changes also typically involve energy deposition or release by the fluid system. Accurate knowledge of this complex behavior is required for design, optimization, and control of these industrial devices and processes. Because laboratory determination of these many mixture properties is very expensive and time-consuming, it is highly desirable to have a computational means to determine this information. With NIST's innovation, results are far more accurate

Agency	Downstream Outcomes Listed
	and are realized in less than a single day! This new method is beginning to be recognized by the chemicals industry as a major breakthrough. ▪ Simulation models for refrigeration and air conditioning equipment. The U.S. air conditioning and refrigeration industry is under tremendous pressure from international competition to design and manufacture equipment and systems with increasing performance and decreasing costs. They must do also this in a climate where environmental concerns of customers are becoming increasingly demanding, particularly outside the U.S. Thus the products and systems must perform at an optimum, using working fluids that do not damage the atmosphere and have the highest possible efficiency to limit the impact on global warming. NIST has developed and disseminated a suite of simulation/design tools to the refrigeration and air conditioning industry that enables them to optimize the design of both whole systems as well as individual components that was never possible before. These tools are being used by over 60 companies and organizations in the U.S. that are searching for an optimum refrigerant or refrigerant mixture.
National Oceanic and Atmospheric Administration	▪ Tsunami warning system**.** National and international demand for tsunami forecasts soared after the December 26, 2004 tsunami in the Indian Ocean, which killed approximately 300,000 people and caused over $13B in damage. NOAA's Pacific Marine Environmental Laboratory (PMEL) developed the tsunameter, which is positioned on the seafloor and measures water level data in real time and transmits the data to a surface buoy via satellite, which then relays the data to NOAA's Tsunami Warning Centers. ▪ Science On a Sphere. Science On a Sphere™ uses computers coupled with projectors to display NOAA's global science in an engaging three-dimensional representation of the Earth's features, as if they were viewed from space. NOAA's Forecast Systems Laboratory (FSL) is working cooperatively with industry, governments, and non-profit organizations to install and support Science On a Sphere systems at museums and science centers around the United States. ▪ Solar calculator – a hot Web site. NOAA's Air Resources Laboratory (ARL) Solar Radiation Research Branch has posted a solar calculator that received 66,000 Web hits from a variety of sources. The basic calculations are available in several published forms, but this site provides greater convenience of use. Users include research scientists, students, religious organizations, legal authorities, and the public for event planning. ▪ CMAQ air quality modeling system**.** The Environmental Protection Agency (EPA) has identified the Community Multi-Scale Air Quality (CMAQ) model developed by staff at NOAA's Air Resources Laboratory as the model of choice for regulatory purposes. The CMAQ also serves as the basis for the operational air quality forecasting capability which is presently in final stages of development by NOAA and EPA.

Agency	Downstream Outcomes Listed
	▪ Eta-CMAQ air quality model forecast system. The forecasting version of the CMAQ air quality modeling system was upgraded and transferred to NOAA's National Weather Service (NWS) in March 2005 for use in its operational ozone model forecast activities. The Eta-CMAQ system has also been transferred to state air pollution agencies (such as, New York) for use in issuing health advisory warnings. ▪ CMAQ air quality modeling for environmental public health tracking. The Centers for Disease Control (CDC) is collecting health data for symptoms of specific environmental stressors as part of its Environmental Public Health Tracking Network (EPHTN) program. Simulations from NOAA's CMAQ air quality modeling system are assisting by providing information about the spatial distribution of ozone and particulate matter. ▪ FX-Net transferred to the EPA for state and local air quality forecasting. NOAA and EPA have agreed to provide the FX-Net weather forecasting system to state and local air quality forecasters nationwide. The FX-Net system is being offered to state, regional, and city air quality forecasters to supplement their current methods of real-time weather and air quality data gathering and analysis. Using FX-Net air quality, forecasters can now overlay a wind field on an air quality forecast or a visible satellite image and add real-time air quality observations in preparation for their air quality forecasting tasks. ▪ RSA weather support team supporting the US Space and Missile Program**.** NOAA's Forecast Systems Laboratory (FLC), Range Standardization and Automation (RSA) Team and the Lockheed-Martin Corporation (LMC) have jointly developed a cooperative Statement of Work to install a state-of-the-art weather analysis, forecast, product generation, and display system to support the United States Space and Missile Program at the Eastern Range (Cape Canaveral) and Western Range (Vandenberg AFB). This system, termed the RSA Weather System, is designed to collect all the unique meteorological data available at the ranges, rapidly update and display data, and generate analysis and forecast products of local to global scale. FLC received a NOAA Technology Transfer Award in FY 2005 for its development and implementation of the RSA Weather System. ▪ New software for satellite tropical cyclone analysis software transferred to Japan**.** Software embodying a new method for estimating tropical cyclone wind fields from the Advanced Microwave Sounder Unit (AMSU) on the NOAA polar-orbiting satellites was transferred to the Japan Meteorological Agency/Meteorological Research Institute (JMA/MRI). This software provides a new method to estimate the outer wind circulation in tropical cyclones, which is important for ship routing and in estimating the timing of the arrival of gale force winds during typhoon landfalls. The ability to monitor tropical cyclones from satellites is especially valuable in the eastern hemisphere, where aircraft

Agency	Downstream Outcomes Listed
	reconnaissance data is not routinely available. ▪ Space and tropospheric weather models improve GPS positioning and navigation accuracy**.** The largest remaining source of Global Positioning System (GPS) positioning and navigation error comes from the Earth's atmosphere. Atmospheric scientists at NOAA's Space Environment Center are currently using ground based GPS observations to monitor the total electron content of the ionosphere and to improve predictions of geomagnetic storms. ▪ GPS observations into operational NOAA weather models**.** Data from the network of ground based Global Positioning System (GPS) receivers located mostly over the Continental U.S. are also being used in operational NOAA weather forecast models. The network provides improved atmospheric water vapor measurements for weather forecasting, climate monitoring, and research. ▪ Climate Modeling**.** NOAA's Geophysical Fluid Dynamics Laboratory (GFDL) team has developed timely, state-of-art model simulations of past, present, and future climates. This group has prepared over 7,000 years of climate simulations and enabled open access to the data sets through the Internet. Results from a recent international workshop support the conclusion that the GFDL climate model is among the best in the world. This work lays the basis for addressing a number of critical questions about the nation's current and future environment. ▪ Users of Scientific Graphics Toolkit and ncBrowse increase. These Java-based tools, developed by NOAA, which more easily visualize oceanographic (and other) data for both Web-based and desktop applications had increased users in 2005. Over 9,600 users from 76 countries are now using the SG Toolkit, including users from Australia, France, Germany, Italy, Japan, Poland, Russian Federation, South Africa, Switzerland, and the United Kingdom. ncBrowse now has over 7,400 users from 71 countries, including Australia, Canada, France, Germany, Japan, Norway, Poland, Russian Federation, Sweden, and the United Kingdom. ▪ Web-based access to distributed data sets**.** The NOAA-developed Live Access Server (LAS) is used by other Federal Agencies (NASA, Navy, DOE); internationally in support of major collaborations (Global Ocean Data Assimilation Experiment, GODAE; Hybrid Coordinate Ocean Model, HYCOM; and the International Pacific Research Center, IPRC); and at individual ocean research institutions in Japan, France, Germany, Italy, and other nations. ▪ Sonar processing algorithm**.** The Combined Uncertainty and Bathymetric Editor (CUBE) algorithm for processing multi-beam sonar data, developed by the University of New Hampshire (UNH) and NOAA Joint Hydrographic Center (JHC), was licensed to several major hydrographic software firms in 2004. It was also introduced for widespread use in commercial packages in 2005. This algorithm is rapidly becoming the standard worldwide for processing multi-beam sonar data.

Agency	Downstream Outcomes Listed
	▪ Improving accessibility of integrated, quality controlled weather observations. NOAA's Earth System Research Laboratory, Global Systems Division (GSD), developed the Meteorological Assimilation Data Ingest System (MADIS) to make integrated, quality-controlled observations easily available and useable to the greater meteorological community. MADIS features access to both upper-air and surface datasets, including integrated automated aircraft reports and a unique, national collection of nearly 18,000 mesonet stations from local, state, federal agencies and private vendors.
National Telecommunications and Information Administration -- Institute for Telecommunication Sciences	▪ Video quality metric – ITS has developed a method of measuring video quality objectively by machine which closely predicts the quality that subjective human vision would perceive. This technology is covered by several patents owned by ITS/NTIA and became an international standard in 2004, with approval by the International Telecommunication Union (ITU). ITS received a national award in FY 2004 for its efforts to disseminate the technology nationally and internationally. ▪ Ultrawideband study. ITS began a cooperative research program in 2004 with private industry to investigate the interference potential of various ultrawideband waveforms. In FY 2005, measurement methods and procedures were developed to characterize the interference these UWB signals could cause for digital satellite television systems. Beneficiaries of this work included standards development organization, the FCC, the UWB industry, satellite television industry, and service providers.

See the agency chapters below for further details on these cases.

■ The Department's Performance Metrics for Technology Transfer

This year's annual report again provides a comprehensive set of statistics on the technology transfer activities of each of the department's agencies with federal lab operations. This information covers *cooperative research and development relationships*, *invention disclosure/patenting, licensing*, and *other technology transfer mechanisms employed by the labs*. There is also a new round of agency-selected case illustrations of downstream outcomes (e.g., commercially significant technologies, improved federal lab capabilities) resulting from these federal lab technology transfer activities.

The content and format of this year's performance report is consistent with guidelines issued for the annual performance reporting by the Office of Management and Budget in its July 2005 edition of Circular A-11. (OMB's guidelines draw closely from the performance reporting approach organized by the Interagency Working Group on Technology Transfer, which is coordinated by the Office of Technology Policy at the Department of Commerce's Technology Administration. This approach has been the basis for the Department of Commerce's and other agencies' reporting over the last several years.)

All of the agencies continue to indicate that their overall technology transfer effort involves a good deal more than cooperative R&D, patenting, and licensing. These "other" mechanisms include transfer through technical publications, development of industrial standards, other forms of public dissemination, and opportunities for guest scientists and engineers to participate in federal lab activities. Each of the agencies now includes yearly activity figures for such "other" mechanisms as they are a part of the agency's technology transfer effort.

Plans for technology transfer activities by the Department of Commerce's federal labs generally continue to emphasize the development of better metrics for program performance. In general, a stable framework for this annual reporting has now been established and is comprehensive of the main technology transfer mechanisms used by Department of Commerce federal labs. The Department continues, however, to evaluate the effectiveness of its technology transfer activities and will consider including additional metrics as need arises.

An appendix section at the end of each of the subsequent agency chapters discusses the specific initiatives currently underway.

II. TECHNOLOGY ADMINISTRATION -- NATIONAL INSTITUTE OF STANDARDS AND TECHNOLOGY

Technology Transfer at the Agency's Federal Laboratories – Approach and Plans, FY 2005 Activities Achievements

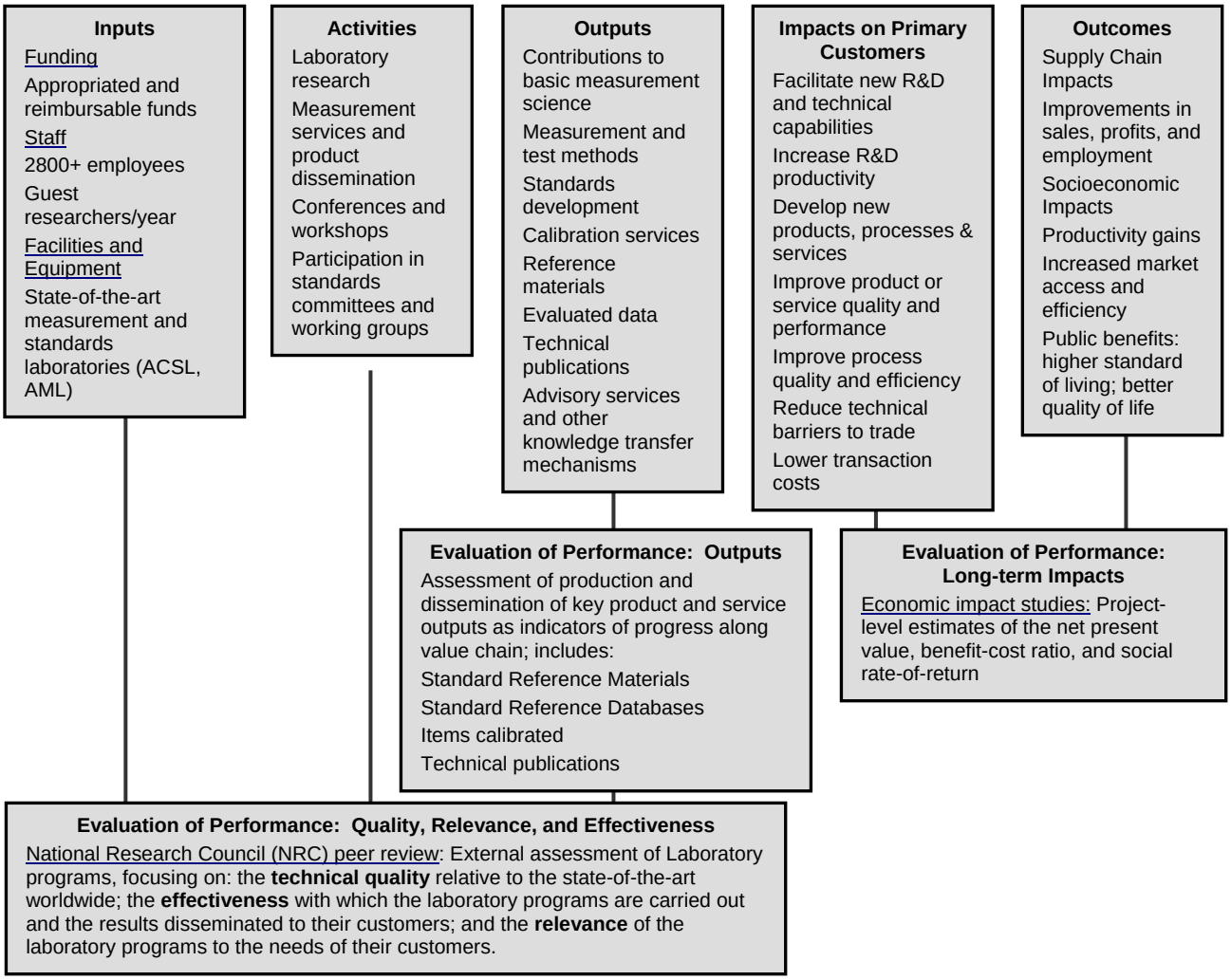
1. Agency Approach and Plans for Technology Transfer

The National Institute of Standards and Technology (NIST) is an unusual federal agency. Its mission is broad – to promote U.S. innovation and industrial competitiveness by advancing measurement science, standards and technology in ways that enhance economic security and improve our quality of life.

An essential part of NIST's work is to anticipate the future measurement and standards needs of U.S. industry. Fast-moving sectors like nanotechnology, biotechnology, homeland security, information technology, and advanced manufacturing need sophisticated technical support systems to flourish and grow. NIST's laboratories develop and disseminate measurement techniques, reference data, test methods, standards, and other infrastructural technologies and services that support U.S. industry, scientific research, and the activities of many federal agencies. In carrying out its mission, NIST works directly with industry partners (and consortia), universities, associations, and other government agencies.

NIST's technology transfer activities are designed to disseminate the Institute's measurements and standards research results broadly to industry and other customers. Leading-edge scientific and technical work requires multiple disciplines, high levels of collaboration among organizations and people with diverse capabilities, and highly specialized facilities and tools. For more than a century, the NIST laboratories have successfully collaborated with industry and universities to provide the measurement techniques and technical tools needed by America's innovators. NIST uses many mechanisms to collaborate with industry and to ensure that the resulting knowledge and infrastructural technologies are broadly disseminated.

The principal technology mechanisms employed for transfer of NIST's intellectual property and assets are, in rough order of significance: informal research and development collaboration with colleagues from industry, academia and other government agencies; peer-reviewed publications; dissemination of Standard Reference Materials, Standard Reference Data, and Documentary Standards; participation in development of industry "road maps", conferences and workshops; hosting U.S. and international Guest Researchers from industry, academia and other government agencies; Facility Use Agreements; CRADAs; and patents/licenses.



The set of outputs that NIST uses to transfer its measurement capabilities and technologies to customers includes standard reference materials, calibration services, and other products and services that are described below.[2]

● Standard Reference Materials

Standard Reference Materials (SRMs) are one definitive source of measurement traceability in the United States. All measurements using SRMs can be traced to a common and recognized set of basic standards that provides the basis for compatibility of measurements among different laboratories. As economic exchange has become more global, customers increasingly use SRMs to achieve measurement quality and conformance to process requirements that address both national and international needs for commerce and trade. NIST produces and disseminates (sells) SRMs to a large and diverse group of customers, including private sector laboratories, universities, and other federal agencies. NIST SRMs support industrial materials production and analysis, environmental analysis, health measurements, and basic measurements in science and metrology.

[2] NIST's authority to perform its technology/knowledge transfer activities does not rest solely in the Bayh-Dole Act, Stevenson-Wydler Act, Federal Technology Transfer Act (FTTA), and related legislation. It also resides in NIST's Organic Act (15 USC 272) and the Standard Reference Data Act (15 USC 290).

The number of SRMs available for sale -- currently over 1,200 --illustrates the breadth of measurements supported by NIST. Over time, NIST expects slight growth in the number of SRMs available, given its current strategy of focusing on those SRMs that cannot be produced by secondary laboratories and which have broad and/or high downstream impact. In establishing its out-year projections, the NIST SRM Program monitors, among other things, trends in emerging technologies, new regulations that will depend on SRMs for enforcement, and the reference material needs of other federal agencies. Several microeconomic studies of NIST SRM programs have shown the technology transfer mechanisms built into these efforts to be effective with resulting high economic benefits delivered to industry.

● Calibration Services

The NIST laboratories provide physical measurement services for their customers, including calibration services, special tests, and measurement assurance programs (MAPs). Calibration services and special tests are characterizations of particular instruments, devices, and sets of standards with respect to international and national standards. MAPs are quality control programs for calibrating entire measurement systems. NIST's calibration services are designed to help the makers and users of precision instruments achieve the highest possible levels of measurement quality and productivity. The services constitute the highest order of calibration services available in the United States. NIST offers more than 500 different types of physical calibrations covering the following measurement areas: dimensional; mechanical, including flow, acoustic, and ultrasonic; thermodynamic; optical radiation; ionizing radiation; electromagnetic; and time and frequency.

Over the past several years, NIST has calibrated approximately 3,000 items annually. Over the next several years, NIST expects to realize a relatively high but slightly declining number of items calibrated. This is in keeping with a long-term trend, over the past several decades, of a decline in the number of items calibrated by NIST. Despite this overall trend, the number of calibrations in individual years may fluctuate slightly due to multi-year calibration cycles. NIST expects to provide fewer but more highly leveraged calibration services over time. NIST's strategy is driven by the need to effectively manage trends in demand from its major industry and government customers for these services. NIST is pursuing three strategies: (1) performing only those calibrations that require a direct connection to the national standards; (2) improving calibration accuracy in those areas where new industry demands are emerging; and (3) accrediting primary and secondary calibration laboratories to meet on-going industry needs. In FY 2005, NIST accredited 6 new calibration laboratories (bringing the total to 84) in fields ranging from dimensional metrology to optical and chemical. NIST also assessed the performance of 43 calibration laboratories. Through this overall approach, NIST efficiently leverages its primary calibration services to support a broader base of secondary calibrations conducted within the private sector. Several microeconomic studies of NIST calibration programs have shown the technology transfer mechanisms built into these efforts to be effective with resulting high economic benefits delivered to industry.

● Standard Reference Data

NIST produces and makes available (i.e., sells or distributes for free) many Standard Reference Data titles (SRDs). SRDs provide numeric data to scientists and engineers for use in technical problem solving, research, and development. These recommended values are based on data

extracted from scientific and technical literature or on measurements done at NIST laboratories, which are then assessed for reliability and evaluated to select the preferred values. NIST's SRD databases cover many areas of science, including analytical chemistry, atomic and molecular physics, biotechnology, and materials sciences.

Historically, NIST has produced two new SRD titles per year. NIST also provides numerous upgrades to existing databases and eliminates some database titles from the NIST catalog each year. In FY 2005, an unusually large number of new titles were released for sale with seven new titles from the NIST Thermodynamics Research Center (TRC). Over time, NIST expects continued modest growth in the total number of SRD titles available. Of those titles currently available, about 50% are available for sale, and 50% are free online systems.

● Technical Publications
NIST uses publications as a key mechanism to transfer the results of its work to the U.S. private sector and to other government agencies that need cutting-edge measurements and standards. Many of these publications appear in prestigious scientific journals and withstand peer review by the scientific community. Others appear in technological forums where measurement standards and technologies developed by NIST staff (at times in collaboration with private sector partners) are disseminated. Of the technical publications produced annually, approximately 80% are approved for external publication (such as in scientific journals), while the remaining 20% are NIST reports and special publications.

Over time, NIST expects a relatively constant level of high quality publications (2,000-2,300 per year) to be produced by its technical staff.

● Informative Collaborative Research, Guest Researchers, and Facilities Users
Each year hundreds of researchers visit NIST to participate in collaborative projects and/or to use NIST's research facilities. NIST makes its facilities available for limited periods of time to domestic and foreign guest researchers to collaborate with NIST staff on research and development projects of mutual interest or to transfer NIST techniques, procedures, and best practices. NIST also sponsors several formal collaboration programs with universities, among them JILA, an interdisciplinary institute for research and graduate education in the physical sciences, located on the main campus of the University of Colorado (CU) in Boulder, and operated jointly by CU and NIST; and the Center for Advanced Research in Biotechnology (CARB). CARB conducts research and provides interdisciplinary training in fundamental problems at the forefront of biotechnology through collaborations with scientists at its parent institutions, the University of Maryland Biotechnology Institute and NIST.

● Conferences, Workshops, and Inquiries
NIST also transfers technology through the hosting of numerous conferences and workshops, as well as through answering inquiries. In FY 2005, NIST handled nearly 8,700 general inquiries. In addition, during FY 2005, NIST held 109 conferences with about 9,500 attendees.

● Participation in Documentary Standards Committees
Still another means by which NIST transfers technology is through staff participation in the activities of documentary standards developing organizations, which develop consensus

standards on a host of technologies. NIST participation enables NIST scientists and engineers to bring NIST technology directly into a standard, which could involve test methods and procedures for protecting health, safety, and/or the environment, or specifications for performance or interoperability, to name a few. During CY 2005, 370 NIST staff participated on 891 committees representing 92 standards developing organizations. NIST staff held 1,182 memberships on these committees including 384 in ASTM International, 88 in the American National Standards Institute (ANSI), 46 in the Institute for Electrical and Electronic Engineering (IEEE), and 90 in the International Organization for Standardization (ISO). These activities are also reported by NIST to the Office of Management and Budget and to Congress as required by the National Technology Transfer and Advancement Act of 1995.

2. Performance in FY 2005: Activities and Achievements

The data below describe the many ways through which NIST transfers knowledge and technology to the private sector.

In response to the reporting requirements of the Technology Transfer Commercialization Act of 2000 and other relevant legislation, data are provided for collaborative relationships for research and development relationships (CRADAs and other kinds of relationships), invention disclosures and patenting, and licensing. In addition, in keeping with the previous discussion, data are also provided for some of the other technology transfer mechanisms utilized by the NIST laboratories, including Standard Reference Materials available, technical publications produced, items calibrated, and guest researcher collaborations. A number of examples of downstream outcomes from NIST technology transfer activities are also provided at the end.

■ Collaborative Relationships for Research & Development

	FY 2001	FY 2002	FY 2003	FY 2004	FY 2005
● **CRADAs**, total active in the FY (1)	174	1,812	1,653	1,641	1,618
- New, executed in the FY	22	1,712	1,589	1,605	1,579
▪ Traditional CRADAs,(2) total active in the FY	174	*125	*76	*51	*65
- New, executed in the FY	22	25	12	15	26
▪ Non-traditional CRADAs,(3) total active in the FY	0	1,687	1,577	1,590	1,553
- New, executed in the FY	0	**1,687	**1,577	**1,590	**1,553
● **Other types of collaborative R&D relationships**					
▪ Facility use agreements, total in effect, end of FY (4)	372	391	511	590	588
-New, executed in the FY	172	62	308	239	280
▪ Guest scientists and engineers during the FY (5)	1,200a	1,300a	1,300a	1,700	2,115

CRADA = Cooperative Research and Development Agreement. a = Figures are approximate.

* Includes CRADAs associated with all NIST programs, including Manufacturing Extension Partnership (MEP), Technology Services (TS), and the Director of Administration/Chief Financial Officer.
**"non-traditional" CRADAs protect the results (under CRADA authority) of calibrated items from disclosure for a period of five years after development. Such "non-traditional" CRADAs are issued (and terminate) on an annual basis.

(1) "Active" = legally in force at any time during the FY. "Total active" is comprehensive of all agreements executed under CRADA authority (15 USC 3710a).
(2) CRADAs involving collaborative research and development by a federal laboratory and non-federal partners.
(3) CRADAs used for special purposes -- such as, material transfer or technical assistance that may result in protected information.
(4) NIST authorizes individuals to use designated facilities. The numbers reported here represent the Facility Use Agreements in effect for the NIST Center for Neutron Research.
(5) "Guest scientists and engineers" includes foreign and domestic guest researchers, and researchers working at NIST under Intergovernmental Personnel Act (IPA) Agreements and CRADAs.

■ Invention Disclosure and Patenting

	FY 2001	FY 2002	FY 2003	FY 2004	FY 2005
● New inventions disclosed in the FY (1)	24	16	16	23	19
● Patent applications filed in the FY (2)	9	11	5	8	5
● Patents issued in the FY	20	15	7	10	9
● Active patents, end of the FY	--	199	198	143	106
● Patents purposely dropped (triaged) during the FY	--	34	17	31	42

-- = Data not requested from agency in reports of earlier years.

(1) Inventions arising at the federal lab.
(2) Tally includes U.S. patent applications, foreign patent applications filed on cases for which no U.S. application was filed, divisional applications, and continuation-in-part applications. Excludes provisional, continuation, duplicate foreign, and PCT applications.

■ Licensing

Profile of Active Licenses

	FY 2001	FY 2002	FY 2003	FY 2004	FY 2005
● **All licenses**, number total active in the FY (1)	36	35	39	22	26
▫ New, executed in the FY	4	2	3	2	5
▪ **Invention licenses**, total active in the FY	36	35	39	22	26
▫ New, executed in the FY	4	2	3	2	5
- Patent licenses, (2) total active in FY	36	35	39	22	26
▫ New, executed in the FY	4	2	3	2	5
- Material transfer licenses (inventions), total active	0	0	0	0	0
▫ New, executed in the FY	0	0	0	0	0
- Other invention licenses, total active in the FY	0	0	0	0	0
▫ New, executed in the FY	0	0	0	0	0
▪ **Other IP licenses**, total active in the FY	0	0	0	0	0
▫ New, executed in the FY	0	0	0	0	0
- Copyright licenses (fee bearing)					
▫ New, executed in the FY					
- Material transfer licenses (non-inventions), total active					
▫ New, executed in the FY					
- Other, total active in the FY					
▫ New, executed in the FY					

Multiple inventions in a single license are counted as one license. Licenses that include both patents and copyrights (hybrid licenses) are reported as patent licenses and not included in the count of copyright licenses.

(1) "Active" = legally in force at any time during the FY.
(2) Patent license tally includes patent applications which are licensed.

Licensing Management

	FY 2001	FY 2002	FY 2003	FY 2004	FY 2005
● **Elapsed execution time**,[1] licenses granted in the FY					
▪ **Invention licenses**					
▫ Average, months	4.8	5.4	3.4	**	1.0
▫ Minimum	2.0	2.5	1.0		1.0
▫ Maximum	5.0	5.0	10.0		1.0
- Patent licenses [2]					
▫ Average, months	4.8	5.4	3.4	**	1.0
▫ Minimum	2.0	2.5	1.0		1.0
▫ Maximum	5.0	5.0	10.0		1.0
● **Licenses terminated for cause**, number in the FY					
▪ **Invention licenses**	7	3	1	0	1
- Patent licenses [2]	7	*3	1	0	1

Data included in this table (intentionally) addresses only invention licenses, with patent licenses distinguished as a subclass.

* In addition to the 3 licenses cited here as terminated "for cause," 4 licenses were terminated by mutual agreement and 4 expired with the end of their original term.
** NIST processed no commercialization licenses in FY 2004.

(1) Date of license application to the date of license execution. (Date of license application is the date the lab formally acknowledges the written request for a license from a prospective licensee and agrees to enter into negotiations.)
(2) Patent license tally includes patent applications which are licensed.

Characteristics of Licenses Bearing Income

	FY 2001	FY 2002	FY 2003	FY 2004	FY 2005
● **All income bearing licenses**, total number	19	33	29	15	17
▫ Exclusive	12	18	19	10	11
▫ Partially exclusive	5	2	0	0	0
▫ Non-exclusive	2	13	10	5	6
▪ **Invention licenses**, income bearing	19	33	29	15	17
▫ Exclusive	12	18	19	10	11
▫ Partially exclusive	5	2	0	0	0
▫ Non-exclusive	2	13	10	5	6
- Patent licenses,[1] income bearing	19	33	29	15	17

	FY 2001	FY 2002	FY 2003	FY 2004	FY 2005
▫ Exclusive	12	18	19	10	11
▫ Partially exclusive	5	2	0	0	0
▫ Non-exclusive	2	13	10	5	6
▪ **Other IP licenses**, income bearing	0	0	0	0	0
▫ Exclusive					
▫ Partially exclusive					
▫ Non-exclusive					
- Copyright licenses (fee bearing)					
▫ Exclusive					
▫ Partially exclusive					
▫ Non-exclusive					
● **All royalty bearing licenses**,(2) total number	19	33	29	15	17
▪ **Invention licenses**, royalty bearing	19	33	29	15	17
- Patent licenses,(1) royalty bearing	19	*33	29	15	17
▪ **Other IP licenses**, royalty bearing	0	0	0	0	0
- Copyright licenses (fee bearing)					

* Of the 35 licenses active in FY 2002 (see earlier table), two were royalty-free research licenses.

In general, license income can result from various sources: license issue fees, earned royalties, minimum annual royalties, paid-up license fees, and reimbursement for full-cost recovery of goods and services provided by the lab to the licensee including patent costs.

(1) Patent license tally includes patent applications which are licensed.
(2) Note that royalties are one component of total license income.

Income from Licenses

	FY 2001	FY 2002	FY 2003	FY 2004	FY 2005
● **Total income**, all licenses active in FY (1)	$261,968	$89,750	$122,850	$144,828	$123,348
▪ **Invention licenses**	$261,968	$89,750	$122,850	$144,828	$123,348
- Patent licenses (2)	$261,968	$89,750	$122,850	$144,828	$123,348
▪ **Other IP licenses**, total active in the FY	0	0	0	0	0
- Copyright licenses					
● **Total Earned Royalty Income** (ERI) (3)	$261,968	$89,750	$122,850	$144,828	$123,348
▫ Median ERI	n/a	$2,300	n/a	n/a	*$2,500
▫ Minimum ERI	$1,000	$700	$960	$640	$640
▫ Maximum ERI	$135,927	$20,000	$35,000	$54,072	$45,000
▫ ERI from top 1% of licenses	n/a	$20,000	$35,000	dw	dw
▫ ERI from top 5% of licenses	n/a	$20,000	$35,000	dw	dw

	FY 2001	FY 2002	FY 2003	FY 2004	FY 2005
▫ ERI from top 20% of licenses	n/a	$50,000	$45,000	dw	dw
▪ **Invention licenses**	$261,968	$89,750	$122,850	$144,828	$123,348
▫ Median ERI	n/a	$2,300	n/a	n/a	*$2,500
▫ Minimum ERI	$1,000	$700	$960	$640	$640
▫ Maximum ERI	$135,927	$20,000	$35,000	$54,072	$45,000
▫ ERI from top 1% of licenses	n/a	$20,000	$35,000	dw	dw
▫ ERI from top 5% of licenses	n/a	$20,000	$35,000	dw	dw
▫ ERI from top 20% of licenses	n/a	$50,000	$45,000	dw	dw
- Patent licenses (2)	$261,968	$89,750	$122,850	$144,828	$123,348
▫ Median ERI	n/a	$2,300	n/a	n/a	*$2,500
▫ Minimum ERI	$1,000	$700	$960	$640	$640
▫ Maximum ERI	$135,927	$20,000	$35,000	$54,072	$45,000
▫ ERI from top 1% of licenses	n/a	$20,000	$35,000	dw	dw
▫ ERI from top 5% of licenses	n/a	$20,000	$35,000	dw	dw
▫ ERI from top 20% of licenses	n/a	$50,000	$45,000	dw	dw
▪ **Other IP licenses**, total active in the FY	0	0	0	0	0
▫ Median ERI					
▫ Minimum ERI					
▫ Maximum ERI					
▫ ERI from top 1% of licenses					
▫ ERI from top 5% of licenses					
▫ ERI from top 20% of licenses					
- Copyright licenses					
▫ Median ERI					
▫ Minimum ERI					
▫ Maximum ERI					
▫ ERI from top 1% of licenses					
▫ ERI from top 5% of licenses					
▫ ERI from top 20% of licenses					

n/a = Data not available from agency at time of this report. dw = Data withheld to protect proprietary information.

*The distribution of NIST's annual license income is bimodal at the extremes. The median figure cited here is rather unrepresentative.

(1) Total income includes license issue fees, earned royalties, minimum annual royalties, paid-up license fees, and reimbursement for full-cost recovery of goods and services provided by the lab to the licensee including patent costs.
(2) Patent license tally includes patent applications which are licensed.
(3) "Earned royalty" = royalty based upon use of a licensed invention (usually, a percentage of sales or of units sold). Not a license issue fee or a minimum royalty.

Disposition of License Income

	FY 2001	FY 2002	FY 2003	FY 2004	FY 2005
● **Income distributed** [1]					
▪ **Invention licenses**, total distributed	$261,968	$89,750	$122,850	$144,828	$123,348
- To inventor(s)	$102,040 (39%)	$45,650 (51%)	$51,773 (42%)	$54,134 (37%)	$48,148 (39%)
- To other [3]	$159,928 (61%)	$44,100 (49%)	$71,076 (58%)	$90,694 (63%)	$75,199 (61%)
- Patent licenses,[2] total distributed	$261,968	$89,750	$122,850	$144,828	$123,348
- To inventor(s)	$102,040 (39%)	$45,650 (51%)	$51,773 (42%)	$54,134 (37%)	$48,148 (39%)
-To other [3]	$159,928 (61%)	$44,100 (49%)	$71,076 (58%)	$90,694 (63%)	*$75,199 (61%)

Invention licenses are the chief policy interest regarding disposition of income; content of table reflects this focus.

(1) Income includes royalties and other payments received during the FY.
(2) Patent license tally includes patent applications which are licensed.
(3) NIST only in FY 2001-2004. In FY 2005, $1,500 to NIH and rest to NIST.

■ Other Performance Measures Deemed Important by the Agency

	FY 2001	FY 2002	FY 2003	FY 2004	FY 2005
Standard Reference Materials (SRMs) available [1]	1,335	1,353	1,214	1,211	1,246
Standard Reference Materials (SRMs) sold [2]	31,985	30,996	29,527	30,490	32,163
Standard Reference Data (SRD) titles available [3]	65	90	106	95	110
Number of items calibrated [4]	3,192	2,924	3,459	3,373	*3,145
Technical publications produced [5]	2,207	2,236	1,918	2,074	2,070

See Section I above for additional information about the measures listed here. See also the Department of Commerce's annual reports under the Government Performance and Results Act (GPRA) for detailed information about each of these measures, analysis of trends, and future-year performance projections http://www.osec.doc.gov/bmi/budget/FY2006APP.htm

* These 3,145 calibrated items were covered by 1,553 "non-traditional" CRADAs that protect the results from disclosure.

(1) Direct and verifiable count of SRMs available to customers at the close of the fiscal year. The number of SRMs available for sale illustrates the breadth of measurements supported by NIST. Over time, NIST expects slight growth in the number of SRMs available.
(2) Direct and verifiable count of NIST SRM units sold during the fiscal year. In recent years, NIST had been expecting a continuing slight decline in the number of SRM units sold, as NIST made greater use of highly leveraged SRM services over time, including accreditation of Nationally Traceable Reference Material producers. However, in FY 2005, the number of SRMs sold increased. Some possible contributing factors include the implementation of new EPA regulations, environmental activities, increased in construction projects, and the availability of previously out-of-stock SRMs.
(3) Direct and verifiable count of SRD products developed and disseminated by NIST. NIST expects continued modest growth in the total number of SRD titles available. Of those titles currently available, about 50% are available for sale, and 50% are free online systems. Over time, a larger percentage of SRDs will be distributed via

the Internet. New growth in online systems is anticipated for FY 2006 with the release of fee-based titles for the Internet.
(4) Direct and verifiable count of items calibrated by the NIST laboratories. Over the next several years, NIST expects to realize a relatively high but slightly declining number of items calibrated. This is in keeping with a long-term trend, over the past several decades, of a decline in the number of items calibrated by NIST. NIST expects to provide fewer but more highly leveraged calibration services over time.
(5) Annual number of technical publications generated by NIST's technical staff. The number is a direct count of the number of technical publications cleared for publication by the NIST Editorial Review Boards at the Gaithersburg and Boulder sites. Over time, NIST expects a relatively constant level of high quality publications (2,000-2,200 per year) produced by its technical staff. Of the publications produced annually, approximately 80% are approved for external publication (such as in scientific journals); the other 20% are NIST reports and special publications.

■ Outcomes from Technology Transfer

NIST develops and disseminates infrastructural technologies and services required by the U.S. private sector and other non-profit and government partners. The outputs of the NIST laboratories provide a foundation for industry in all stages of commerce -- research, development, testing, production, and marketing – and, in turn, enable socioeconomic impacts, such as productivity gains, increased market access and efficiency, and improved quality of life. These impacts are long-term, accruing years after the original infrastructural technologies have been developed by NIST (often in conjunction with industry partners).

The examples below show how NIST's various technology transfer mechanisms – CRADA's, Standard Reference Materials, joint research facilities, software, and documentary standards – have, over the long term, produced outcomes that significantly raise productivity, benefit consumers, and improve the quality of life.

Measurement Science

- **Compact system stabilizes laser frequency**. A new compact, inexpensive method for stabilizing lasers that reduces sensitivity to vibration and gravity 100 times better than similar approaches has been demonstrated by scientists at JILA, a joint institute of NIST and the University of Colorado at Boulder.

The method stabilizes the laser to a single frequency so that it can be used as a reliable reference oscillator for technologies such as optical clocks and light-based radar (lidar). The new stabilizer design performs better than similar systems of comparable size and is much smaller and less expensive than the best-performing systems.

NIST's method improves the reliability of GPS clocks. Widely used by the military, first responders, surveyors, and even consumers, the Global Positioning System is a navigation system consisting of ground-based monitors and a constellation of satellites that rely on atomic clocks to precisely locate positions on the earth. A statistical method developed by NIST, and tested and implemented with the help of several collaborators, has made the job of analyzing the accuracy and reliability of these satellite-borne time signals significantly faster and easier. The

method helps ensure that GPS clocks produce accurate location and distance measurements and remain closely synchronized with official world time.

The NIST method has been incorporated into the GPS clock analysis software system managed by the Naval Research Laboratory used in commercial software and instruments for various timing applications.

- **New NIST tool measures silicon wafer thickness**. The optics and materials for "printing" nanoscale circuit lines in microprocessors and other integrated circuits chips require the silicon wafers used be perfectly flat and of uniform thickness. To assist the industry in achieving this goal, NIST developed a new instrument that accurately measures variability in thickness across a 300 mm wafer with an repeatability of 5 nanometers.

The instrument uses intersecting waves of light to create interference patterns, which in turn are used as a ruler to measure nanoscale dimensions. While most interferometers use red laser light, the NIST instrument uses infrared laser light. These much longer wavelengths pass right through a silicon wafer, with the result that the instrument can illuminate both the top and bottom of wafer, producing a detailed spatial map of differences in thickness in one pass. In contrast, conventional tools require spinning the wafer and measuring at multiple locations. Precision measurements of the wafer's index of refraction—the amount that light is "bent" as it passes through the silicon— is a critical step in correctly interpreting the interference patterns.

- **New NIST method improves accuracy of spectrometers**. Measurements of the intensity of light at different wavelengths can be made more accurately now, thanks to a new, simple method for correcting common instrument errors. The new method, developed by NIST researchers, will benefit fields such as color measurement, lighting development, remote sensing, biotechnology, and astronomy.

The NIST method improves the measurement accuracy of spectrometers, devices that measure optical radiation at different wavelengths. Spectrometers are used widely in industry and research laboratories to analyze the emissions from lamps or other light sources, as well as to analyze optical properties of materials. The new NIST technique corrects errors arising from unwanted scattered radiation within an instrument, to a level less than 0.001 percent of the total signal, a desirable level for most industrial and scientific applications. This allows very accurate measurement of low-power components of radiation and accurate measurements across a large dynamic range of intensities.

- **World's first UV 'ruler' sizes up atomic world**. The world's most accurate "ruler" made with extreme ultraviolet light has been built and demonstrated with ultrafast laser pulses by scientists at NIST and the University of Colorado at Boulder. The new device consistently generates pulses of light lasting just femtoseconds (quadrillionths of a second, or millionths of a billionth of a second) in the ultraviolet region of the electromagnetic spectrum.

The device is expected to become an important tool for ultraprecise measurements in many fields of science, including chemistry, physics, and astronomy. A ruler made with shorter wavelengths of light makes it possible to "see" more precise differences than ever before in the energy levels of light emissions that identify specific atoms, in the timing of chemical reactions, or, if additional applications are developed, in the dimensions of certain nanometer-scale objects. The new device also can be compared to a camera with ultrafast shutter speeds and consistent shot-to-shot frame speed and stability, allowing scientists to take real-time "pictures" of finer structures and dynamics. By combining many such pictures at a high speed, scientists can gain a more detailed understanding of many phenomena.

- **NIST method improves timing in oscilloscopes**. A new method for correcting common timing errors in high-speed oscilloscopes was developed by researchers at NIST. The method improves the accuracy and clarity of measurements performed in the development and troubleshooting of components for wireless and optical communications, military radar, and other technologies.

The software analyzes an oscilloscope's measurements of both a signal of interest and two reference waves that are offset from each other. The reference waves are generated by an external device and are synchronized in time with the signal being measured. Measurements of the reference waves are compared with a calculation of an ideal wave to produce an estimate of total time errors due to distortion and jitter. These errors then can be corrected automatically for each measurement made by the oscilloscope.

The NIST correction method can be applied to older standard equipment, can correct time records of almost any length, and can be applied to electromagnetic signals of almost any frequency. It also provides the user with an estimate of the residual timing error after the correction process has been completed. The Timebase Correction software package has been made available free of charge.

- **Light scattering method reveals details under skin**. A new optical method, jointly demonstrated by NIST and Johns Hopkins University's Applied Physics Laboratory, can image structures under skin. The method relies on differences in the way surface and subsurface features of various materials scatter light. It was demonstrated with small pieces of pigskin and inorganic materials and might eventually prove useful for imaging living tissues to help diagnose or determine the extent of various types of skin cancers.

The method was developed under a CRADA between the two institutions. The project adapted light scattering techniques originally developed by NIST researchers to image surface and subsurface features in inorganic materials such as silicon wafers, mirrors, and paint coatings. Research is continuing on making the new method faster and easier to use.

- **Tiny, atom-based detector senses weak magnetic fields**. A low-power, magnetic sensor about the size of a grain of rice that can detect magnetic field changes a million times weaker

than the Earth's magnetic field has been demonstrated by NIST researchers. The device can be powered with batteries and is about 100 times smaller than current atom-based sensors with similar sensitivities, which typically weigh several kilograms.

The new magnetic sensor is based on the principles of the NIST chip-scale atomic clock, and expected applications for a commercialized version of the new sensor could include hand-held devices for sensing unexploded ordnance, precision navigation, and geophysical mapping to locate minerals or oil, and medical instruments.

Like the NIST chip-scale clock, the new magnetic sensor can be fabricated and assembled on semiconductor wafers using existing techniques for making microelectronics and microelectromechanical systems (MEMS). This improvement offers the potential for low-cost mass production of sensors about the size of a computer chip. When packaged with associated electronics, the researchers believe the mini magnetometer will measure about 1 cubic centimeter or about the size of a sugar cube.

Magnetic fields are produced by the motion of electrons either in the form of an electrical current or in certain metals such as iron, cobalt, and nickel. The NIST miniature magnetometer is sensitive enough to detect a concealed rifle about 12 meters away or a six-inch-diameter steel pipeline up to 35 meters underground.

- **Innovative chiral separation breakthrough**. NIST scientists have developed a chiral separation technique that will give pharmaceutical companies a new analytical tool that may help to prevent dangerous side effects of drugs in patients. Many drugs on the market today, as well as those currently under development, are chiral, i.e., the active drug molecule has an inactive "twin" that is compositionally identical but structurally is a mirror image. As such they are commonly synthesized as mixtures. Because of their physical and chemical similarities, separation and quantitation of two conformations of a chiral drug can be very difficult, yet crucial in protecting patient welfare.

The pharmacological activity and toxicity of the two conformations can be vastly different, sometimes causing serious side effects. Consequently, current FDA guidelines require the development of "quantitative assays for individual conformations in in vivo samples" as well as methods for assessing conformational purity and stability.

NIST's new chiral separation technique provides a combination of high resolving power and theoretically unlimited concentration enhancement for very low detection limits. Performing remarkably faster and with greater sensitivity than conventional methods, NIST's new technique provides a valuable tool for drug development research.

- **New temperature and pressure standard**. The innovation of a quasi-spherical cavity resonator has revolutionized temperature standards and it may revolutionize pressure standards as well. For a temperature standard, NIST researchers simultaneously measured microwave and acoustic resonances of a grapefruit-sized, copper-walled, helium-filled, quasi-spherical cavity

with uncertainties of a few parts per million. The cavity is almost spherical, however it has small, deliberate distortions, hence the name "quasi-spherical." The distortions prevent the microwave frequencies from overlapping each other, making accurate measurements possible. If the frequency uncertainties can be reduced to a few parts per billion, the results also will determine the helium pressure more accurately than existing piston and cylinder standards. One of NIST's goals is to disseminate consistent standards for physical measurements to researchers, industry, and academia. The quasi-spherical cavity will enable users to have highly accurate standards of temperature and pressure in their own laboratories that they can use to calibrate the transducers they use for process control and for measuring temperature-dependencies of properties of materials.

Nanotechnology

- **New design developed for silicon nanowire transistors**. In an advance for nanoscale electronics, researchers at NIST demonstrated a new design for silicon nanowire transistors that both simplifies processing and allows the devices to be switched on and off more easily.

Silicon nanowire devices have received considerable attention recently for possible use in integrated nanoscale electronics as well as for studying fundamental properties of structures and devices with very small dimensions. The NIST work overcomes some key difficulties in making reliable devices or test structures at nanoscale dimensions. The results also suggest that nanowire transistors made with conventional lithographic fabrication methods can improve performance in nanoscale electronics, while allowing industry to retain its existing silicon technology infrastructure.

The NIST design uses a simplified type of contact between the nanowire channel and the positive and negative electrodes of the transistor. The design allows more electrical current to flow in and out of the silicon. The researchers believe the design is the first to demonstrate a "Schottky barrier" type contact for a nanowire transistor built using a "top-down" approach. This barrier, an easily formed metal contact that electrons can tunnel through, requires much less doping with impurities than do conventional ohmic contacts, thereby simplifying processing requirements.

- **Chip-scale refrigerators cool bulk objects**. Chip-scale refrigerators capable of reaching temperatures as low as 100 milliKelvin have been used to cool bulk objects for the first time by NIST researchers. The solid-state refrigerators have applications such as cooling cryogenic sensors in highly sensitive instruments for semiconductor defect analysis and astronomical research.

NIST researchers used the chip-scale refrigerator to cool a cube of germanium about 11,000 times larger than the volume of the chip. This is roughly equivalent to having a refrigerator the size of a person cool an object the size of the Statue of Liberty.

The refrigerators are fabricated using common chip-making lithography methods, making production and integration with other microscale devices straightforward. The devices are much smaller and less expensive than conventional equipment used for cooling down to 100 mK, a target temperature for optimizing the performance of cryogenic sensors.

- **Nano-sized chip features measured with atom 'ruler'**. Device features on computer chips as small as 40 nanometers (nm) wide—less than one-thousandth the width of a human hair—now can be measured reliably thanks to new test structures developed by NIST with SEMATECH and other collaborators. The test structures are replicated on reference materials that will allow better calibration of tools that monitor the manufacturing of microprocessors and similar integrated circuits.

The NIST rulers are precisely etched lines of crystalline silicon ranging in width from 40 nm to 275 nm. The spacing of atoms within the box-shaped silicon crystals is used like hash marks on a ruler to measure the dimensions of these test structures. Industry can use these reference materials to calibrate, for example, tools that can reliably measure microprocessor-device gates, which control the flow of electrical charges in chips. In the absence of reference materials such as these, companies have calibrated measurement tools using in-house standards, which may neither be accurate nor agree with one another. The new reference materials are now being evaluated by SEMATECH member companies.

Biosciences and Health

- **Detecting anthrax proteins at ultralow concentrations**. A new laboratory method for quickly detecting active anthrax proteins within an infected blood sample at extremely low levels has been developed by researchers at NIST, the U.S. Army Medical Research Institute of Infectious Diseases, and the National Cancer Institute. Current detection methods rely on injecting live animals or cell cultures with samples for analysis and require up to several days before results are available. The new method produces unambiguous results in about an hour.

- **Chemical link indicated between alcohol and certain cancers**. NIST developed a new chemical analysis method that has assisted researchers at the National Institute of Alcohol Abuse and Alcoholism (NIAAA), National Institutes of Health in demonstrating a potentially important chemical link between alcohol consumption and cancer. Using this novel chemical assay, they uncovered a chain of chemical reactions that, under physiological conditions, may lead from alcohol to a known mutagen.

It has been known for years that there is a statistical relationship between excessive alcohol consumption and an increased risk of certain cancers, particularly upper gastrointestinal cancer. Alcohol itself is not a carcinogen, but is metabolized in the body to form a suspected carcinogen, acetaldehyde (AA).

NIST and NIAAA researchers filled in the missing link, a class of chemicals called polyamines that are produced in cells and believed to be involved in cell growth. Using a sensitive chemical analysis technique developed at NIST, the team showed that AA reacts with polyamines to produce a compound that in turn reacts with DNA to produce a known mutagen.

The work strongly suggests a pathway between alcohol consumption and cancer, and that certain specific mutations in genes could affect individual susceptibility to cancer for alcoholic beverage consumption.

- **Study of RNA dynamics may help in drug design**. NIST and University of Colorado biophysicists have developed a method for studying, in real time, a nanoscale "docking and undocking" interaction between small pieces of ribonucleic acid (RNA). The technique may be broadly useful in studying structural changes in RNA that affect its function with applications in the design of effective new drugs based on small RNA strands.

The group developed a simple model system for studying the reversible docking of a small piece of RNA at a receptor site in the same molecule. They used a technique called fluorescence resonance energy transfer, in which the two pieces of RNA are labeled with different dyes that have overlapping emission bands. One dye emits light of the same color that the other dye absorbs; the second dye then emits light of a different color. One piece of RNA is excited by a laser and, when the two pieces are close enough together to dock, passes energy to the other one, which then fluoresces. This method was used to measure the distance between the two pieces of RNA as it varied the docked state to the undocked state.

- **New NIST SRM**. A new NIST reference standard was developed to help genetics labs develop improved methods of searching for a mutant needle in a DNA haystack. To help the research community develop and test more sensitive techniques for detecting low-frequency mutations in heteroplasmic DNA, NIST researchers have developed a new Standard Reference Material, SRM 2394, "Heteroplasmic Mitochondrial DNA Mutation Detection Standard." The new material is a set of mixtures, at 10 different certified concentrations, of two DNA fragments that differ from each other at only one position.

Accurate analysis of mitochondrial DNA (mtDNA), either for forensic identification or for studying genetic-based diseases, often hinges on the ability to detect mutations that occur only infrequently, even in the same individual. Unlike the cell's nuclear DNA, a person's mtDNA is often heteroplasmic -- a mix of a dominant DNA sequence with fewer mutated sequences that differ from the dominant version by one or more nucleotides. There are hundreds or thousands of mitochondria in cells, and the exact percentage of the minority mtDNA in the mix can vary dramatically in an individual, from tissue to tissue, and even from cell to cell. In general, it can be very difficult to identify variants that make up less than 20 percent of the sample unless you already know they are there.

• **New NIST SRM reinforces "fragile-X" screening**. A new NIST Standard Reference Material will help clinical genetics labs improve the accuracy of their diagnostic tests for the most common cause of hereditary mental retardation.

"Fragile X Syndrome" is a genetic mutation affecting approximately one in 3,600 males and one in 4,000 to 6,000 females. It has been linked to several physical abnormalities and to intellectual problems ranging from minor learning disabilities to severe mental retardation and autism. The mutation is characterized by an excessive number of repeats of a sequence of three nucleotides (the chemical building blocks of DNA) within a particular gene on the human X chromosome. Proper diagnosis depends on accurate counts of the number of triplet repeats.

To assist clinical diagnostic and genetic testing laboratories in accurately counting fragile-X repeat sequences, NIST has developed a new reference material that can be used as a check on test procedures and for quality control. SRM 2399, "Fragile X Human DNA Triplet Repeat Standard," joins more than 50 reference materials produced by NIST for quality control in clinical testing.

• **HIV database**. An international plea for a standardized HIV database resource available to all pharmaceutical research scientists worldwide has been received and answered by NIST researchers, in collaboration with scientists at NIH's National Cancer Institute and Rutgers University. NIST's HIV SRD 102 collects and classifies data from thousands of structures of HIV protease and its inhibitors, organizing drug inhibitors according to their chemical structure with 3-D animations allowing manipulation in all directions. It is easily accessible, reliable, and standardized.

Each year millions of dollars of both public and private investments target AIDS research, seeking a cure for this deadly disease. Because so many scientists are involved in this endeavor worldwide, the NIST database provides a centrally located resource where all involved in AIDS research can exchange structural information for mutual benefit. The significant impact of NIST's work was quickly recognized by the scientific community, as evidenced by the extraordinary number of web-site hits, highlights in alternate publications, and hyperlinks that have appeared on numerous database websites. Since the public release of the new HIV SRD 102 on July 16, 2004, its multi-million hits make it one of NIST's most accessed databases.

Public Safety and Homeland Security

• **Bioagent detector guide aids first responders**. Ever since envelopes containing anthrax bacteria were mailed to Congressional and media offices in 2001 causing several deaths, many first responder departments have worked to improve their ability to quickly detect toxic biological agents. To help them make informed decisions about which biological agent detection devices best meet their needs, NIST recently developed a guide for the emergency responders that provides ways to compare and contrast commercially available biological detection equipment.

To help first responders decide on appropriate equipment, the guide includes data on 19 selection factors, including sensitivity, specificity, start-up and response times, ease-of-use, alarm capability, power requirements, skill level, cost, durability, and portability.

- **New system 'sees' crimes on audiotape**. A real-time magnetic imaging system that enables criminal investigators to "see" signs of tampering in audiotapes -- erasing, overdubbing and other alterations -- while listening to the tapes has been developed by NIST researchers. The new system, which permits faster screening and more accurate audiotape analysis than currently possible, was delivered to the Federal Bureau of Investigation (FBI).

The FBI's Forensic Audio Analysis Unit receives hundreds of audiotapes annually for analysis from a wide variety of devices, including answering machines, cassette recorders and digital audiotape recorders. At the heart of the NIST technology is a cassette player modified with an array of 64 customized magnetic sensors that detects and maps the microscopic magnetic fields on audiotapes as they are played. The array is connected to a desktop computer programmed to convert the magnetic data into a displayable image. Authentic, original tapes produce images with non-interrupted, predictable patterns, while erase and record functions produce characteristic "smudges" in an image that correlate to "pops" and "thumps" in the audio signal. An examiner can also use the new system to help determine the authenticity of a tape or if that tape is a copy.

- **New software judges quality of scanned fingerprints**. An improved suite of automated fingerprint analysis tools, including a new software program that judges the quality of a scanned fingerprint, is now available to U.S. law enforcement agencies, manufacturers, and biometrics researchers as a result of work at NIST.

The software can be used to help ensure that images collected with digital fingerprint scanners will be of high enough quality to produce good matches with fingerprints already on file. Ideally, a fingerprint image will have clear and distinct ridges and valleys. But problems, including dry skin, the size of the person's fingers, or equipment issues such as dirty or damaged sensor plates, can result in poor images that could produce inaccurate matches.

NIST software will for the first time allow users to compare directly the fingerprint image quality produced by scanners made by different manufacturers. The package also includes improved software for matching fingerprints, pattern classification, minutiae detection, fingerprint encoding and decoding, and segmenting four-finger "slaps" into individual prints.

Information and Knowledge Management

- **Software advance helps computers act logically**. A new software language, developed by NIST and colleagues in France, Germany, Japan and the United Kingdom, promises to enable computers to reason much more precisely and better reflect subtleties intended by commands

from human operators. The process specification language should make computers much more useful in manufacturing.

The software language uses artificial intelligence and mathematical logic to represent computer commands in the context of a manufacturing plan. Researchers have incorporated approximately 300 concepts, such as “duration” and “sequence,” into its software structure. Computers using software with this feature can act on a word’s “meaning,” interpreting a command almost like a person.

For instance, a person who hears the commands “paint it before shipping it” and “turn on the coolant before milling” understands that the word "before" has slightly different meanings in these two different contexts. In the first command, it is understood that painting and drying must be completed prior to the next action, shipping. In the second command, however, the first action, turning on the coolant, continues after the milling starts. The software supports computer systems with this type of rudimentary understanding of context-specific language and is especially suited for the exchange of process planning, validation, production scheduling, and control information for guiding manufacturing processes.

- **Fluid mixture computer simulation innovation**. Fluid mixtures are essential in a wide range of practical applications and industrial processes. For example, heat pumps, air conditioners, refrigeration equipment, and processes like, chemical (including fuel) production, purification, and separation, and environmental cleanup typically involve multiple coexisting fluids of differing composition (called phases). The amounts of each phase and their compositions change as conditions of temperature and/or pressure are varied -- these changes also typically involve energy deposition or release by the fluid system.

Accurate knowledge of this complex behavior is required for design, optimization, and control of these industrial devices and processes. Because laboratory determination of these many mixture properties is very expensive and time-consuming, it is highly desirable to have a computational means to determine this information. With NIST’s innovation, results are far more accurate and are realized in less than a single day. This new method is beginning to be recognized by the chemicals industry as major breakthrough. In addition, it has attracted the attention of biologists for modeling the onset of multiple coexisting phases of large biomolecules such as proteins in solution.

- **Simulation models for refrigeration and air conditioning equipment**. The U.S. air conditioning and refrigeration industry is under tremendous pressure from international competition to design and manufacture equipment and systems with increasing performance and decreasing costs. They must do this in a climate where environmental concerns of customers are becoming increasingly demanding, particularly outside the U.S. Thus the products and systems must perform at their optimum, using working fluids that do not damage the atmosphere and have the highest possible efficiency to limit the impact on global warming.

NIST has developed and disseminated a suite of simulation/design tools to the refrigeration and air conditioning industry that enables them to optimize the design of both whole systems as well as individual components that was never possible before. These tools are being used by over 60 companies and organizations in the U.S. that are searching for the optimum refrigerant or refrigerant mixture.

Appendix:
Progress in Improving the Agency's Performance Metrics for Tech Transfer

The additional activity metrics included by NIST in FY 2002, 2003, and 2004 (notably, for non-traditional CRADAs to cover NIST calibration services; greater detail on licenses and license income; workshops, conferences, and publications; and participation by NIST staff in documentary standards committees) are now well integrated into the annual report process. The present array of metrics covers the wide variety of mechanisms that NIST employs for technology transfer.

NIST continues, however, to evaluate the effectiveness of its technology transfer activities and will consider including additional metrics as the need arises.

III. NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION

Technology Transfer at the Agency's Federal Laboratories – Approach and Plans, FY 2005 Activities/Achievements

1. Agency Approach and Plans for Technology Transfer

NOAA's mission is to understand and predict changes in the Earth's environment and conserve and manage coastal and marine resources to meet the Nation's economic, social, and environmental needs. This mission will become ever more critical in the 21st century as national needs intensify concerning climate change, freshwater supply, ecosystem management, and homeland security.

NOAA is one of the nation's premier scientific agencies. NOAA science and the technology impact the daily lives of the nation's citizens and have a significant effect on the national economy. For example, about one-third of the U.S. economy (approximately $3 trillion) is weather sensitive -- such as agriculture, energy, construction, travel, and transportation. Weather data and forecasts play a critical role -- which are transferred to industry and the public through the media, internet, and NOAA Weather Radio. Governments and the public use weather warnings to save lives and prevent destruction of property. Television weathercasters and many weather related firms use weather data and forecasts in their daily operations. Industry uses NOAA data in home construction and design, crop selection, disease control, and fuel delivery and supply. Additionally, industry has applied weather data for deciding such things as automobile fuel delivery system design, the best time to market umbrellas, and even for when the conditions would be best for the mating of honeybees. Increasingly accurate and longer range weather forecasts depend on an ongoing program of research and development.

Research by NOAA's federal laboratories is aimed at assisting NOAA's operational components. NOAA's research is directed at such topic areas as weather forecasting, solar emission forecasting, estimating fish stocks, predicting water resources, warning of tsunamis, and charting ocean bottom topography. The results of such research are transferred to NOAA's operational components to improve prediction, management, and other mission activities.

NOAA's web page at www.noaa.gov details the voluminous amount of research and technology data made available to the public in the form of information products and services, such as weather and climate forecast data, El Nino prediction and monitoring, tides and currents, satellite imagery and direct readout, fishery statistics and information on protected species, air quality, state of the coasts, beach temperatures, and nautical charts, as well as extensive databases on climate, oceans, ice, atmosphere, geophysics, and the sun.

NOAA's primary technology transfer mechanism has historically been the open dissemination of scientific and technical information to individuals, industry, government, and universities. This transfer means is consistent with the agency's mission and scientific tradition and has been found to be more efficient and economical than transfer through patenting and licensing. Even so,

NOAA continues, where advantageous, to transfer intellectual property through licenses and CRADAs -- including to industry to benefit the competitiveness of U.S. companies.

In FY 2005, NOAA conducted an extensive technology transfer program through applications of meteorological and oceanographic technologies and information, and through open dissemination to individuals, industry, government, and universities. In addition, NOAA provided daily weather forecasts and warnings through the media and NOAA Weather Radio. NOAA technology is transferred through presentations at scientific meetings, publication in peer-reviewed scientific journals, and through NOAA scientific and technical publications. For example, the NOAA laboratories in Boulder, Colorado published 397 articles in scientific journals and 226 papers in NOAA Tech Reports. NOAA Weather Radio has been integrated into the nation's homeland security efforts and will be used to alert citizens to take precautions in response to chemical or nuclear spills and terrorist attacks. The system, called the all-hazards alert system, reaches more than 97 percent of U.S. territory on a 24/7 basis, through broadcasts in the 50 states and in U.S. territories.

NOAA collaborates with other federal research agencies on science and technology development matters of joint interest. For example, NOAA and the Environmental Protection Agency (EPA) teamed to provide new experimental air quality forecast guidance that enables state and local agencies to issue more accurate and geographically specific air quality warnings to the public. The annual cost of poor air quality to the U.S. from air pollution-related illnesses has been estimated at $150 billion.

Furthermore, to ensure that the United States benefits from and fully exploits scientific research and technology developed abroad, NOAA collaborates and shares information with organizations in countries throughout the world. Through these international relationships, technology is transferred into NOAA for the eventual benefit of U.S. industry and public users. For instance, the understanding and forecasting of global phenomena that occur in the atmosphere, oceans, and on the sun requires worldwide collaboration and information sharing. This is accomplished through formal agreements with individual countries and participation in international organizations, such as the World Meteorological Organization (WMO), the Intergovernmental Oceanographic Commission (IOC), and the International Astronomical Union (IAU). NOAA also participates in international scientific programs and shares technology and scientific data, such as in the Global Earth Observation System. This effort involves nearly 50 other countries, the European Commission, and 29 international organizations. NOAA also provides technical assistance and training to individuals from other countries, and participates in a visiting scientist program. In addition, environmental data is shared through NOAA participation in the World Data Center program.

In the future, NOAA will continue to direct its technology transfer and international collaboration activities toward four mission goals: 1. protect, restore, and manage the use of coastal and ocean resources through ecosystem-based management; 2. understand climate variability and change to enhance society's ability to plan and respond; 3. serve society's needs for weather and water information; and 4. support the Nation's commerce with information for safe, efficient, and environmentally-sound transportation.

2. Performance in FY 2005: Activities and Achievements

■ Collaborative Relationships for Research & Development

	FY 2001	FY 2002	FY 2003	FY 2004	FY 2005
● **CRADAs**, total active in the FY [1]	10	10	11	9	8
- New, executed in the FY	3	1	0	0	0
▪ Traditional CRADAs,[2] total active in the FY	10	10	11	9	8
- New, executed in the FY	3	1	0	0	0
▪ Non-traditional CRADAs,[3] total active in the FY	0	0	0	0	0
- New, executed in the FY	0	0	0	0	0
● **Other types of collaborative R&D relationships**	0	0	0	0	0

CRADA = Cooperative Research and Development Agreement.

(1) "Active" = legally in force at any time during the FY. "Total active" is comprehensive of all agreements executed under CRADA authority (15 USC 3710a).
(2) CRADAs involving collaborative research and development by a federal laboratory and non-federal partners.
(3) CRADAs used for special purposes -- such as, material transfer or technical assistance that may result in protected information.

■ Invention Disclosure and Patenting

	FY 2001	FY 2002	FY 2003	FY 2004	FY 2005
● New inventions disclosed in the FY [1]	1	1	5	2	1
● Patent applications filed in the FY [2]	3	0	0	0	1
● Patents issued in the FY	1	5	1	1	1

(1) Inventions arising at the federal lab.
(2) Tally includes U.S. patent applications, foreign patent applications filed on cases for which no U.S. application was filed, divisional applications, and continuation-in-part applications. Excludes provisional, continuation, duplicate foreign, and PCT applications.

■ Licensing

Profile of Active Licenses

	FY 2001	FY 2002	FY 2003	FY 2004	FY 2005
● **All licenses**, number total active in the FY [1]	2	3	5	5	4
▫ New, executed in the FY	1	1	2	0	0
▪ **Invention licenses**, total active in the FY	2	3	5	5	4
▫ New, executed in the FY	1	1	2	0	0
- Patent licenses,[2] total active in FY	2	3	5	5	4
▫ New, executed in the FY	1	1	2	0	0
- Material transfer licenses (inventions), total active	0	0	0	0	0
▫ New, executed in the FY	0	0	0	0	0
- Other invention licenses, total active in the FY	0	0	0	0	0
▫ New, executed in the FY	0	0	0	0	0
▪ **Other IP licenses**, total active in the FY	0	0	0	0	0
▫ New, executed in the FY	0	0	0	0	0
- Copyright licenses (fee bearing)					
▫ New, executed in the FY					
- Material transfer licenses (non-inventions), total active					
▫ New, executed in the FY					
- Other, total active in the FY					
▫ New, executed in the FY					

Multiple inventions in a single license are counted as one license. Licenses that include both patents and copyrights (hybrid licenses) are reported as patent licenses and are not included in the count of copyright licenses.

(1) "Active" = legally in force at any time during the FY.
(2) Patent license tally includes patent applications which are licensed.

Licensing Management

	FY 2001	FY 2002	FY 2003	FY 2004	FY 2005
● **Elapsed execution time**,[1] licenses granted in the FY					
▪ **Invention licenses** ▫ Average , months ▫ Minimum ▫ Maximum	*6.0	*8.0	5.0 6.0 7.0	**	**
- Patent licenses [2] ▫ Average, months ▫ Minimum ▫ Maximum	*6.0	*8.0	5.0 6.0 7.0	**	**

	FY 2001	FY 2002	FY 2003	FY 2004	FY 2005
● **Licenses terminated for cause**, number in the FY					
▪ Invention licenses	0	0	0	0	0
- Patent licenses [2]	0	0	0	0	0

Data included in this table (intentionally) addresses only invention licenses, with patent licenses distinguished as a sub-class.

* Only a single new license was executed in FY 2001 and 2002. Thus, there is no range of execution times to report.
** No new licenses were executed in FY 2004 or FY 2005.

(1) Date of license application to the date of license execution. (Date of license application is the date the lab formally acknowledges the written request for a license from a prospective licensee and agrees to enter into negotiations.)
(2) Patent license tally includes patent applications which are licensed.

Characteristics of Licenses Bearing Income

	FY 2001	FY 2002	FY 2003	FY 2004	FY 2005
● **All income bearing licenses**, total number	2	3	5	5	4
▫ Exclusive	1	1	1	1	1
▫ Partially exclusive	0	0	0	0	0
▫ Non-exclusive	1	2	4	4	3
▪ **Invention licenses**, income bearing	2	3	5	5	4
▫ Exclusive	1	1	1	1	1
▫ Partially exclusive	0	0	0	0	0
▫ Non-exclusive	1	2	4	4	3
- Patent licenses,[1] income bearing	2	3	5	5	4
▫ Exclusive	1	1	1	1	1
▫ Partially exclusive	0	0	0	0	0
▫ Non-exclusive	1	2	4	4	3
▪ **Other IP licenses**, income bearing	0	0	0	0	0
▫ Exclusive					
▫ Partially exclusive					
▫ Non-exclusive					
- Copyright licenses (fee bearing)					
▫ Exclusive					
▫ Partially exclusive					
▫ Non-exclusive					
● **All royalty bearing licenses**,[2] total number	2	3	5	5	4
▪ **Invention licenses**, royalty bearing	2	3	5	5	4

	FY 2001	FY 2002	FY 2003	FY 2004	FY 2005
- Patent licenses,[1] royalty bearing	2	3	5	5	4
▪ **Other IP licenses**, royalty bearing	0	0	0	0	0
- Copyright licenses (fee bearing)					

In general, license income can result from various sources: license issue fees, earned royalties, minimum annual royalties, paid-up license fees, and reimbursement for full-cost recovery of goods and services provided by the lab to the licensee including patent costs.

(1) Patent license tally includes patent applications which are licensed.
(2) Note that royalties are one component of total license income.

Income from Licenses

	FY 2001	FY 2002	FY 2003	FY 2004	FY 2005
● **Total income**, all licenses active in the FY [1]	$1,600	$9,402	$4,716	$24,961	$16,100
▪ **Invention licenses**	$1,600	$9,402	$4,716	$24,961	$16,100
- Patent licenses [2]	$1,600	$9,402	$4,716	$24,961	$16,100
▪ **Other IP licenses**, total active in the FY	0	0	0	0	0
- Copyright licenses					
● **Total Earned Royalty Income** (ERI) [3]	$1,600	$9,402	$4,716	$24,961	$16,100
▫ Median ERI	$800	$1,333	$696	$1,923	$1,000
▫ Minimum ERI	$100	$100	$100	$116	$100
▫ Maximum ERI	$1,500	$7,969	$1,920	$21,000	$9,000
▫ ERI from top 1% of licenses	$1,500	$7,969	$1,920	$21,000	$9,000
▫ ERI from top 5% of licenses	$1,500	$7,969	$1,920	$21,000	$9,000
▫ ERI from top 20% of licenses	$1,500	$7,969	$1,920	$21,000	$9,000
▪ **Invention licenses**	$1,600	$9,402	$4,716	$24,961	$16,100
▫ Median ERI	$800	$1,333	$696	$1,923	$1,000
▫ Minimum ERI	$100	$100	$100	$116	$100
▫ Maximum ERI	$1,500	$7,969	$1,920	$21,000	$9,000
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▫ ERI from top 5% of licenses	$1,500	$7,969	$1,920	$21,000	$9,000
▫ ERI from top 20% of licenses	$1,500	$7,969	$1,920	$21,000	$9,000
- Patent licenses [2]	$1,600	$9,402	$4,716	$24,961	$16,100
▫ Median ERI	$800	$1,333	$696	$1,923	$1,000
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▫ ERI from top 5% of licenses	$1,500	$7,969	$1,920	$21,000	$9,000
▫ ERI from top 20% of licenses	$1,500	$7,969	$1,920	$21,000	$9,000

	FY 2001	FY 2002	FY 2003	FY 2004	FY 2005
▪ **Other IP licenses**, total active in the FY	0	0	0	0	0
▫ Median ERI					
▫ Minimum ERI					
▫ Maximum ERI					
▫ ERI from top 1% of licenses					
▫ ERI from top 5% of licenses					
▫ ERI from top 20% of licenses					
- Copyright licenses					
▫ Median ERI					
▫ Minimum ERI					
▫ Maximum ERI					
▫ ERI from top 1% of licenses					
▫ ERI from top 5% of licenses					
▫ ERI from top 20% of licenses					

(1) Total income includes license issue fees, earned royalties, minimum annual royalties, paid-up license fees, and reimbursement for full-cost recovery of goods and services provided by the lab to the licensee including patent costs.
(2) Patent license tally includes patent applications which are licensed.
(3) "Earned royalty" = royalty based upon use of a licensed invention (usually, a percentage of sales or of units sold). Not a license issue fee or a minimum royalty.

Disposition of License Income

	FY 2001	FY 2002	FY 2003	FY 2004	FY 2005
● **Income distributed** (1)					
▪ **Invention licenses**, total distributed	$1,600	$9,402	$4,716	$24,961	$16,100
- To inventor(s)	$1,500 (94%)	$696 (7%)	$1,130 (24%)	$11,070 (44%)	$8,400 (52%)
- To other	$100 (6%)	$8,706 (93%)	$3,586 (76%)	$13,891 (56%)	$7,700 (48%)
- Patent licenses, (2) total distributed	$1,600	$9,402	$4,716	$24,961	$16,100
- To inventor(s)	$1,500 (94%)	$696 (7%)	$1,130 (24%)	$11,070 (44%)	$8,400 (52%)
-To other	$100 (6%)	$8,706 (93%)	$3,586 (76%)	$13,891 (56%)	$7,700 (48%)

Invention licenses are the chief policy interest regarding disposition of income; content of table reflects this focus.

(1) Income includes royalties and other payments received during the FY.
(2) Patent license tally includes patent applications which are licensed.

■ Other Performance Measures Deemed Important by the Agency

	FY 2001	FY 2002	FY 2003	FY 2004	FY 2005
Journal articles published	544	529	626	419	397
Technical reports published	274	363	245	300	226

Represents publications by NOAA laboratories in Boulder, Colorado.

■ Outcomes from Technology Transfer

For this year's annual report, the cases described below are provided as examples of the downstream outcomes being achieved by NOAA technology transfer efforts:

• **Tsunami warning system.** National and international demand for tsunami forecasts soared after the December 26, 2004 tsunami in the Indian Ocean, which killed approximately 300,000 people and caused over $13B in damage. NOAA's Pacific Marine Environmental Laboratory (PMEL) developed the tsunameter, which is positioned on the seafloor and measures water level data in real time and transmits the data to a surface buoy, which then relays the data to NOAA's Tsunami Warning Centers. PMEL tsunami scientists developed forecast models to interpret the measurements and predict trans-oceanic tsunami propagation and the site-specific inundation of coastal communities. Together, these two new capabilities produce a fast, accurate, reliable forecast of the tsunami impact on coastal communities and reduce costly and dangerous false alarms.

The tsunameter was incorporated into the Deep-ocean Assessment and Reporting of Tsunamis (DART) system. Each DART system consists of a tsunameter that rests on the seafloor and a surface buoy. The tsunameter continuously determines the height of the water column above it through high-precision pressure measurements. Software onboard the tsunameter searches the most recent measurements for a tsunami wave signature. When a tsunami wave is detected, the tsunameter begins to send high frequency time and water column height data to the surface buoy, using acoustic telemetry, through the water column. The buoy relays the data by satellite to tsunami warning centers. Once activated by a tsunami wave, the high frequency data continues to be transmitted for several hours so that forecasters can observe the progress of the tsunami wave energy as it passes the tsunameter.

PMEL has had numerous international inquiries regarding DART capabilities. Representatives from Australia will visit PMEL for training, and an international DART workshop is anticipated in early calendar 2006 to provide DART technical information to the international community.

The Pacific Marine Environmental Laboratory (PMEL) delivered and deployed a tsunami mooring system (DART) and spares to the Chilean government in support of their national tsunami warning program. In addition to the system hardware and software, PMEL provided training and expertise in the initial deployment of the package. This system is compatible with U.S. systems and the information is available to NOAA Tsunami Warning Centers. NOAA's

PMEL received the FY 2005 DOC Gold Metal for Scientific and Engineering Achievement Associated with the Development of a Tsunami Forecasting Capability for NOAA.

- **Science On a Sphere**. Science On a Sphere™ uses computers coupled with projectors to display NOAA's global science in an engaging three-dimensional representation of the Earth's features, as if they were viewed from space. NOAA is working cooperatively with industry, governments, and non-profit organizations to install and support Science On a Sphere systems at museums and science centers around the United States. NOAA's Forecast Systems Laboratory (FSL) was awarded a patent for Science On a Sphere in 2005.

In June 2005, NOAA and Nauticus officials transferred NOAA's Science On a Sphere technology to the National Maritime Center in Norfolk, Virginia. This new technology, in partnership with NOAA's teacher research center at Nauticus, will give the National Maritime Center a teaching tool to enhance the learning experience for local school classes and visitors to this facility. Science On a Sphere is, in essence, a large, computer generated globe which gives the viewer an animated view of a planet's oceans, atmosphere, and land. It is typically installed in a large room in a way that allows viewers to walk around the sphere.

In 2005, NOAA provided a grant opportunity, available to nearly any applicant, to help pay for the hardware pieces required to build a Science On a Sphere system. As a result, four other museums and science centers (in addition to Nauticus) received grant funding to obtain a Science On a Sphere system. NOAA's roles include providing the core software, assisting setup, and assistance in managing the system. Commercial vendors provide the hardware and components for the system.

A key NOAA contribution is to providing rich data sets for the sphere that help teach some aspect of planetary science. Examples are near real time weather data, ocean simulations, and visualization showing climate change. NOAA's ultimate goal is to increase public understanding of the environment and earth system processes.

A representative of Czarnowski Exhibit Service Specialists (an $80 million company) visited NOAA to view the Science On a Sphere system. Discussions took place and the firm is now analyzing how they might be able to use Science On a Sphere in its business.

- **Solar calculator – a hot Web site**. NOAA's Air Resources Laboratory (ARL) Solar Radiation Research Branch has posted a solar calculator that received 66,000 Web hits from a variety of sources (www.srrb.noaa.gov/highlights/sunrise/gen.html. Calculations in the NOAA Sunrise/Sunset and Solar Position Calculators are based on equations from Astronomical Algorithms, by Jean Meeus. The basic calculations are available in several published forms, but this site provides greater convenience of use.

Sunrise and sunset results have been verified to be accurate to within a minute for locations between +/- 72° latitude, and within 10 minutes outside of those latitudes. The website includes a .pdf file covering low accuracy solar position equations, as well as higher accuracy JavaScript

routines used in the new and improved calculators. These calculators are based on the current Gregorian calendar, extrapolated backward through time. The approximations used in these programs are very good for years between 1800 and 2100 and, typically, are sufficiently accurate for the range from -1000 to 3000. Outside this range, results are provided, but the potential for error is higher.

Of the 66,000 Web hits, known users include research scientists, students, religious organizations, legal authorities, and the public for event planning. Often there seems to be an interest in sunrise and sunset for the purpose of planning events. There is some, but minimal commercial use. Some anecdotal uses include: scientists calculating expected incoming solar radiation, architects planning solar lighting and heating in new buildings, movie shots planned for a sunset scene, car accident investigations, the National Transportation Safety Board investigating a plane crash, and sports fishing planning.

- **CMAQ air quality modeling system.** The Environmental Protection Agency (EPA) has identified the Community Multi-Scale Air Quality (CMAQ) model developed by staff at NOAA's Air Resources Laboratory as the model of choice for regulatory purposes. The CMAQ also serves as the basis for the operational air quality forecasting capability which is presently in final stages of development by NOAA and EPA.

There is a Memorandum of Understanding (MOU) between EPA and the Department of Commerce under which NOAA collaborates with EPA on the development and application of air quality models (e.g., CMAQ). EPA uses the CMAQ model to develop national policies for meeting and maintaining the relevant ambient air quality standards. The MOU also facilitates technology transfer to EPA's regulatory office.

Updates to the CMAQ modeling system were introduced in 2005. This revised system was provided to EPA's Office of Air Quality Planning and Standards (OAQPS) for use in several national rulemaking actions and also to the Community Modeling and Analysis System center for public access, including to states and local areas for their air quality management activities (State Implementation Plans). The model revisions included improvements to its aerosol and chemistry algorithms, including the addition of sea salt aerosols, twenty air toxics species, and a new version of the Carbon Bond gas-phase chemical mechanism. Improvements were also made to the physical simulation processes of cloud mixing, vertical diffusion, and mass continuity. An annual simulation of the model covering all of 2001, for the continental U.S. and for the Eastern U.S. at a higher (12km ×12km) grid resolution, was run to test the accuracy and reliability of the revised model. EPA's OAQPS also made use of this latest model version (CMAQv4.5) in its analyses of potential impacts of the Clean Air Interstate Rule (CAIR).

- **Eta-CMAQ air quality model forecast system**. In preparation for the 2005 ozone forecast season, the forecasting version of the CMAQ air quality modeling system was upgraded and transferred to NOAA's National Weather Service (NWS) in March 2005 for use in its operational ozone model forecast activities.

Major changes introduced as part of this upgrade included testing with a revised mesoscale Eta meteorological model, revisions to the cloud mixing scheme, adaptation of surface radiation values from the Eta model for chemistry calculations, and preparation of a suite of 2005 source emissions for the modeling system.

Extensive testing on retrospective and real-time periods was performed in advance of the transfer of this forecast model to NWS. The new Eta-CMAQ model system has performed quite well throughout the 2005 ozone forecast season for the northeastern United States, with reduced biases as compared to its performance during the 2004 season.

The Eta-CMAQ system has also been transferred to state air pollution agencies (e.g., New York) for use in issuing health advisory warnings. In addition, NOAA has been working with other federal agencies (e.g., EPA, USFS, NASA) and academics with interest in the modeling system.

- **CMAQ air quality modeling for environmental public health tracking**. The Centers for Disease Control (CDC) is collecting health data for symptoms of specific environmental stressors as part of its Environmental Public Health Tracking Network (EPHTN) program. The States involved in this program need information about local air quality conditions, but the existing observational networks are too sparse to adequately provide this information. As such, simulations from NOAA's CMAQ air quality modeling system are assisting by providing information about the spatial distribution of ozone and particulate matter ($PM_{2.5}$).

Based on advanced statistical methods, ozone spatial fields and $PM_{2.5}$ surfaces are generated using observed values and interpolations based on model predictions. These CMAQ results for the year 2001 have been provided to the states involved in the CDC's EPHTN for analysis, while these states continue to build their health datasets.

As part of a pilot project wit EPA and CDC, this CMAQ output has been transferred to a number of state agencies (including New York, Wisconsin, Maine) to examine the relationships between air quality and human health. NOAA is also currently exploring ways to enhance collaboration among EPA, NOAA, CDC, and state agencies and make the CMAQ output available to all state agencies on a routine basis as part of the EPHTN.

- **FX-Net transferred to the EPA for state and local air quality forecasting**. NOAA and EPA have agreed to provide the FX-Net weather forecasting system to state and local air quality forecasters nationwide.

The FX-Net system is being offered to state, regional and city air quality forecasters to supplement their current methods of real-time weather and air quality data gathering and analysis. EPA air quality observations and the NOAA/EPA real-time air quality model, CMAQ, have been added to the real-time NOAAPort data distributed and displayed by FX-Net. This time and special matching of air quality and atmospheric data give forecasters real-time capabilities not available to them previously when data were gathered from web sites and

displayed using a variety of web-based data manipulators. Using FX-Net air quality, forecasters can now overlay a wind field on an air quality forecast or a visible satellite image and add real-time air quality observations in preparation for their air quality forecasting tasks.

- **RSA weather support team supporting the US Space and Missile Program.** NOAA's Forecast Systems Laboratory (FLC), Range Standardization and Automation (RSA) Team and the Lockheed-Martin Corporation (LMC) have jointly developed a cooperative Statement of Work to install a state-of-the-art weather analysis, forecast, product generation, and display system to support the United States Space and Missile Program at the Eastern Range (Cape Canaveral) and Western Range (Vandenberg AFB). This system, termed the RSA Weather System, is designed to collect all the unique meteorological data available at the ranges, rapidly update and display data, and generate analysis and forecast products of local to global scale. FLC received a NOAA Technology Transfer Award in FY 2005 for its development and implementation of the RSA Weather System.

Data management, processing, and display by the RSA Weather System are based on the National Weather Service's Advanced Weather Interactive and Processing System (AWIPS), developed within the NOAA laboratory system. This required substantial reconfiguration of AWIPS for new datasets, analysis, and modeling displays. The RSA system also includes a sophisticated local weather analysis and prediction system, consisting of LAPS (the Local Analysis and Prediction System, also developed in NOAA laboratories), and the Mesomodel5, (MM5, developed and supported at the National Center for Atmospheric Research). The LAPS/MM5 system has three nested domains with horizontal grid resolutions of 10, 3.3, and 1.1 km. This modeling system is one of the highest-resolution weather prediction systems in the nation that is routinely running in support of a U.S. government operation.

The agreement with Lockheed-Martin provided for transfer of NOAA technology to the end customers, the Eastern and Western launch ranges. Lockheed-Martin, as prime contractor to the USAF, was responsible for integration of the weather component with the many other system components at these sites. Through the joint efforts with FSL, Lockheed-Martin has gained the expertise to install and support the weather component at these ranges. While some expert support from FSL may continue to be needed, Lockheed-Martin has sufficient knowledge to be the integrator and prime contractor of this technology for other customers – and is in a position to propose the RSA Weather System for other government and commercial applications. Government agencies, such as FAA, NWS, and USAF, increasingly depend on the private sector to provide and support mission-critical systems. On the commercial side, potential customers of this technology include the major airlines, who particularly depend on weather information for safe and efficient routing of flights.

- **New software for satellite tropical cyclone analysis software transferred to Japan.** Software embodying a new method for estimating tropical cyclone wind fields from the Advanced Microwave Sounder Unit (AMSU) on the NOAA polar-orbiting satellites was transferred to the Japan Meteorological Agency/Meteorological Research Institute (JMA/MRI). This software provides a new method to estimate the outer wind circulation in tropical cyclones,

which is important for ship routing and in estimating the timing of the arrival of gale force winds during typhoon landfalls. The ability to monitor tropical cyclones from satellites is especially valuable in the eastern hemisphere, where aircraft reconnaissance data is not routinely available. The software was originally developed by NOAA's National Environmental Satellite, Data and Information Service scientists and was improved during a year long visit to NOAA by a JMA/MRI researcher. Benefits of the transfer include: (1) providing a potential new monitoring capability to JMA for their typhoon warning program, (2) fostering continued collaboration between JMA and NOAA, and (3) providing test data for the algorithm in an ocean basin (the western Pacific) with different tropical cyclone characteristics than the one in which the algorithm was developed (the Atlantic).

• **Space and tropospheric weather models improve GPS positioning and navigation accuracy.** Now that "selective availability," the policy of denying the full accuracy of the Global Positioning System (GPS) to non-military users has ended, the largest source of GPS positioning and navigation error comes from the Earth's atmosphere. Atmospheric scientists at NOAA's Space Environment Center are currently using ground based GPS observations to monitor the total electron content of the ionosphere and to improve predictions of geomagnetic storms. Geomagnetic storms can seriously damage the power grid, impact spacecraft operations, and other systems such as pipelines, high frequency radio propagation, and low frequency radio navigation. They can also impact the health and safety of astronauts and passengers in high altitude aircraft traveling near the poles. Similarly, scientists at the NOAA Environmental System Research Laboratory's Global Systems Division are using ground based GPS observations for weather forecasting, climate monitoring research, and other applications. These observations are assimilated into space and tropospheric weather models that can be inverted to estimate the magnitude of the impact that the ionosphere and troposphere will have on GPS positioning and navigation accuracy. Armed with this knowledge, users of GPS can make significant improvements in their real-time measurement accuracy.

Applications of this new technology include:

- Reducing the amount of time needed to achieve a desired level of positional accuracy for engineering surveys;
- Providing real-time decimeter level positioning accuracy for applications such as autonomous vehicle navigation, determining the amount of water under the keel of heavily loaded ships entering port, and positive train control in freight yards and depots;
- Improving aircraft navigation and safety, intelligent transportation systems, homeland security and national defense.

The tropospheric delay model is currently being evaluated by two commercial companies and several universities. NASA is also considering use of the model.

• **GPS observations into operational NOAA weather models.** Data from the network of ground based Global Positioning System (GPS) receivers located mostly over the Continental U.S. are also being used in operational NOAA weather forecast models. The network provides

improved atmospheric water vapor measurements for weather forecasting, climate monitoring, and research. Other applications for GPS meteorology include Space Weather forecasting, quality controlling global radiosonde moisture measurements, calibrating and validating satellite moisture and temperature measurements, and providing atmospheric correctors for high accuracy GPS positioning and navigation. Data and operational experience from this network are also being used by other nations, most notably Canada, to evaluate and develop a GPS observing system of their own. Under the provisions of the Global Earth Observing System of Systems (GEOSS) agreement signed by the U.S., Canada, and approximately 60 other nations, GPS-Met observations will be freely shared in near real-time to provide all-weather global coverage in support of atmospheric science, geodesy and geophysics, high accuracy positioning and navigation, and land, sea, and air transportation. An overview of this activity is available in the Federal Laboratory Consortium's *NewsLink* of September 2005 issue (page 2) (see www.federallabs.org/ContentObjects/News/NewsLink/NewsLinkSeptember2005.pdf)

- **Climate Modeling.** NOAA's Geophysical Fluid Dynamics Laboratory (GFDL) team has developed timely, state-of-art model simulations of past, present, and future climates. This group has prepared over 7,000 years of climate simulations and enabled open access to the data sets. Results from a recent international workshop support the conclusion that the GFDL climate model is among the best in the world. This work lays the basis for addressing a number of critical questions about the nation's current and future environment: will the droughts in the west continue; will there be a change in the fisheries in the Pacific NW; will temperatures over the U.S. continue to get warmer and by how much; are El Nino impacts getting stronger; what are the environmental benefits and unintended consequences of new energy techniques?

This output is easily available through the Internet. A large amount of data has been shipped to the repository of the Dept. of Energy's Program for Climate Model Diagnosis and Intercomparison (PCMDI); the information is also available locally from a dedicated GFDL Web portal. Extensive data manipulation efforts were needed to enable easy access and use by outside users. GFDL was one of the first centers to store data in the PCMDI archive. Over 500 users have downloaded data from GFDL; 293 users have accessed the PCMDI site. Over 8000 gigabytes of data (enough to completely fill the disks of 100 PCs) has been distributed. A broad cross section of international and national researchers has been served by these actions.

The GFDL Modeling Team received a Department of Commerce Silver Medal for establishing NOAA as a leading source of credible, model-based, scientific information about the past and future climate for national and international climate assessments.

- **Users of Scientific Graphics Toolkit and ncBrowse increase**. These Java-based tools, developed by NOAA, which more easily visualize oceanographic (and other) data for both Web-based and desktop applications had increased users in 2005.

The Scientific Graphics Toolkit (SGT) is designed to aid developers in producing scientific graphics applications. SGT Beans can be used with several Java integrated development environments (NetBeans, JBuilder, etc.) and provides a graphical environment to configure and

develop SGT applications. Over 9,600 users from 76 countries are now using the toolkit, including users from Australia, France, Germany, Italy, Japan, Poland, Russian Federation, South Africa, Switzerland, and the United Kingdom

ncBrowse is a general purpose Java desktop application designed to enable users to interactively browse and visualize data from netCDF files and OPeNDAP resources. netCDF is a file format commonly used by the oceanographic community to store both observations and model results. ncBrowse now has over 7,400 users from 71 countries, including Australia, Canada, France, Germany, Japan, Norway, Poland, Russian Federation, Sweden, and the United Kingdom.

- **Web-based access to distributed data sets.** The NOAA-developed Live Access Server (LAS) is used by other Federal Agencies (NASA, Navy, DOE); internationally in support of major collaborations (Global Ocean Data Assimilation Experiment, GODAE; Hybrid Coordinate Ocean Model, HYCOM; and the International Pacific Research Center, IPRC); and at individual ocean research institutions in Japan, France, Germany, Italy, and other nations. In 2005, the number of estimated users has increased to 50-75 LAS systems. These are supported by a vigorous email users' network. LAS is also a named component of the plan for Data Management and Communications (DMAC) within the U.S. Integrated Ocean Observing System (IOOS), in which NOAA is the designated lead agency.

- **Sonar processing algorithm.** The Combined Uncertainty and Bathymetric Editor (CUBE) algorithm for processing multi-beam sonar data, developed by the University of New Hampshire (UNH) and NOAA Joint Hydrographic Center (JHC), was licensed to several major hydrographic software firms in 2004. It was also introduced for widespread use in commercial packages in 2005. This algorithm is rapidly becoming the standard worldwise for processing multi-beam sonar data. In parallel, the Navigation Surface algorithm for managing multi-beam data processed by CUBE, developed by a NOAA employee, was released for commercial application and has been incorporated into most of the same software packages. No license was involved; this technology is now open-source and being managed world-wide through an open navigation surface working group made up of representatives from government, academia, and industry.

- **Improving accessibility of integrated, quality controlled weather observations.** NOAA's Earth System Research Laboratory, Global Systems Division (GSD), developed the Meteorological Assimilation Data Ingest System (MADIS) to make integrated, quality-controlled observations easily available and useable to the greater meteorological community. MADIS features access to both upper-air and surface datasets, including integrated automated aircraft reports and a unique, national collection of nearly 18,000 mesonet stations from local, state, federal agencies and private vendors.

MADIS datasets have proven to be extremely useful to the meteorological community. The Department of Transportation's Federal Highway Administration views MADIS as the primary data management system to integrate data from more than 2,500 State Road Weather Information

System (RWIS) platforms. GSD now supports hundreds of MADIS users, including the majority of NWS forecast offices, NCDC, NCEP, and many universities and major private companies. Additionally, MADIS supplies surface data providers with Quality Control (QC) and station monitoring information, which has proven very valuable in their maintenance activities.

- **Marketing Study.** NOAA's ORTA contracted for a three month marketing survey, to improve the transfer of NOAA technology to external entities, during which the contractor interviewed NOAA Laboratory personnel and small businessmen and developed a list of potential technologies to transfer to external entities. The contractor also identified companies interested in NOAA's innovations. In addition to commercialization of NOAA research innovations, the contractor considered spin-off applications to other areas of technology. A technology called Windstopper was developed to address wind noise affecting microphones used to make measurement of winds aloft in tornados. The contractor came up with the idea of using the technology as a windstopper for backpacking and tailgate camping stoves. He contacted two potential licensees: MSR (www.msrcorp.com) and Brunton (www.brunton.com) both of whom expressed interest. NOAA obtained a signed nondisclosure agreement from the product development manager at Brunton. Cascade Designs, Inc., also signed a nondisclosure agreement. The contractor also contacted Czarnowski Exhibit Service Specialists, an $80 million company, to invite them to NOAA to see Science on a Sphere™. The firm is now analyzing how they might use Science on a Sphere™.

Appendix:
Progress in Improving the Agency's Performance Metrics for Tech Transfer

In future reports, the agency will list mission-related data that addresses NOAA's primary technology transfer mechanism, which is the open dissemination of its products and services. Presentations at scientific meetings, collaborative research (other than CRADAs), visiting scientists, data exchange agreements, numbers of data requests received by NOAA's environmental data centers, and external agency studies are being investigated as metrics for reporting this aspect of NOAA's technology transfer activities. Annual figures for the number of publications in scientific journals and NOAA technical reports are already included.

IV. NATIONAL TELECOMMUNICATIONS AND INFORMATION ADMINISTRATION -- INSTITUTE FOR TELECOMMUNICATION SCIENCES

Technology Transfer at the Agency's Federal Laboratories – Approach and Plans, FY 2005 Activities/Achievements

I. Agency Approach and Plans for Technology Transfer

The Institute for Telecommunication Sciences (ITS) is the chief research and engineering arm of the National Telecommunications and Information Administration (NTIA).

ITS supports such NTIA telecommunications objectives as promotion of advanced telecommunications and information infrastructure development in the United States, enhancement of domestic competitiveness, improvement of foreign trade opportunities for U.S. telecommunications firms, and facilitation of more efficient and effective use of the radio spectrum. ITS also serves as a principal federal resource for solving the telecommunications concerns of other federal agencies, state and local governments, private corporations and associations, and international organizations.

ITS employs three principal means for achieving technology transfer: cooperative research and development, technical publications, and leadership and technical contributions in developing telecommunications standards.

Cooperative research and development. Cooperative research and development agreements (CRADAs), based upon the Federal Technology Transfer Act (FTTA) of 1986, are a principal means through which ITS aids the private sector. The FTTA both provides a legal basis for and encourages shared use of government facilities and resources with the private sector in advanced telecommunications technologies.

These CRADA partnerships aid in commercialization of new products and service; they also enhance the capabilities of ITS laboratories. In addition, they are the source of insight into industry's needs for improved productivity and competitiveness; such information helps ITS adjust the focus and direction of its programs for greatest effectiveness and value. Private industry partners benefit through such cooperative relationships in that they are able to undertake research in commercially important areas that would not otherwise be feasible.

In FY 2005, ITS fostered cooperative telecommunications research with industry where benefits can directly facilitate U.S. competitiveness and market opportunities. ITS also participated (as it has for a number of years) in CRADAs with private sector organizations to design, develop, test, and evaluate advanced telecommunication concepts. These efforts at technology transfer and commercialization will continue in future years.

These CRADAs, to date, have enabled major contributions to technologies for personal communication services (PCS), local multipoint distribution service (LMDS), ultrawideband (UWB), Broadband over Power Line (BPL). These relationships have also aided U.S. efforts to rapidly introduce new, socially-beneficial, communications technologies. Most recently, CRADAs in the areas of objective audio and video quality and advanced antennas for wireless systems have enabled ITS to contribute to the development of new products and services.

In addition, ITS continues to use the patent process to secure intellectual property rights in laboratory innovations with commercial promise. ITS plans to advance its mission and benefit the competitiveness of U.S. industry by pursuing opportunities to commercially license patents to CRADA partners and other interested parties. As an example, ITS is targeting software for implementing a video quality metric for commercial development. This software incorporates technology covered by two patents. Evaluation software has been requested by 100 parties in FY 2005 for testing purposes and four commercial licensing agreements are currently being negotiated with U.S. corporations.

Technical publications. Historically, technical publication has been the main channel through which ITS has transferred research results to other researchers, to the commercial sector, and to government agencies. Many of these publications – internal reports and monographs, and external, peer reviewed, scientific journal articles – have become standard references in several telecommunications areas.

At present, technical publication remains a principal means for ITS technology transfer. Most of these technical publications are released only after going through an internal peer review process managed by the ITS Editorial Review Board (ERB). Of the publications released through the ERB process in recent years, approximately one half was approved for external publication in the scientific literature; a third was NTIA reports.

Development of telecommunication standards. This third principal avenue for ITS technology transfer directly addresses U.S. competitiveness in telecommunications. For several decades, ITS has provided leadership and technical contributions to organizations, both national and international, that are responsible for developing telecommunication standards. For example, a plurality of the technical recommendations of the International Telecommunication Union (ITU – a treaty organization) are based on research conducted at ITS. Also, key national quality of service standards, developed under the American National Standards Institute (ANSI) T1 committee for video, audio, and digital data incorporate research results obtained at ITS.

In addition, ITS continues to chair numerous committees and working groups in the ITU, ANSI T1, and other telecommunication standards organizations, where it provides technical leadership that is trusted by the commercial sector participants. ITS technical inputs are relied upon as technically advanced, sound, and unbiased by commercial interests.

In FY 2005, ITS continued its technical leadership and contributions to communications standards for public safety, particularly for first responders. The primary area of ITS contribution has been interoperability standards and testing procedures. Also, ITS' objective video quality measurement method has been established as a national standard by ANSI. And, in

testing by the ITU, this ITS method was identified as the best performing metric compared to others around the world.

II. Performance in FY 2005: Activities and Achievements

■ Collaborative Relationships for Research & Development

	FY 2001	FY 2002	FY 2003	FY 2004	FY 2005
● **CRADAs**, total active in the FY (1)	65	63	239	319	280
- New, executed in the FY	--	6	178	185	185
▪ Traditional CRADAs,(2) total active in the FY	6	6	5	7	7
- New, executed in the FY	1	0	0	3	5
▪ Non-traditional CRADAs,(3, 4) total active in FY	59	57	234	312	273
- New, executed in the FY	--	6	178	182	180
● **Other types of collaborative R&D relationships**					
▪ Collaborative standards contributions,(5) total active in FY	3	3	2	11	11
-New, executed in the FY	3	0	1	0	0

CRADA = Cooperative Research and Development Agreement. -- = Data not requested from agency in reports of last years.

(1) "Active" = legally in force at any time during the FY. "Total active" is comprehensive of all agreements executed under CRADA authority (15 USC 3710a).
(2) CRADAs involving collaborative research and development by a federal laboratory and non-federal partners.
(3) CRADAs used for special purposes, such as material transfer or technical assistance that may result in protected information. (For example, CRADAs for Video Quality Software Evaluation.)
(4) ITS' Telecommunications Analysis Services (TA Services) is Internet accessible through Web-based electronic CRADAs. TA Services provides analysis support to private industry and public agencies in the areas of wireless system design and evaluation, and site selection. The service is provided on a cost-reimbursable basis, 24 hours a day/7 days a week throughout the year. TA Services currently reaches numerous government and private sector users across the nation, providing the latest versions of ITS-developed telecommunications models, databases, and tools. Use of the CRADA makes TA Services available to users in a short time and on a cost reimbursable basis. Additionally, CRADA partners provide useful evaluations of the ITS software used. This information aids ITS to improve existing software tools for wireless system design and analysis and to develop new ones – benefiting both ITS' own research capabilities and the resources that outside users can draw upon. The CRADA agreement also allows ITS to gain valuable insights from users' feedback about the rapidly changing needs of industry and government in telecommunications technology.
(5) ITS works with industry, through a number of standards fora, to apply research results to the development of telecommunication performance standards and guidelines. In FY 2004, ITS worked collaboratively with the International Telecommunication Union, the Telecommunications Industry Association, the Alliance for Telecommunications Industry Solutions, and various Federal Public Safety groups to interpret and analyze standards and regulations.

■ Invention Disclosure and Patenting

	FY 2001	FY 2002	FY 2003	FY 2004	FY 2005
● New inventions disclosed in the FY (1)	1	0	0	0	1
● Patent applications filed in the FY (2)	0	1	0	0	0
● Patents issued in the FY	0	0	1	0	0
● Active patents, end of the FY	5	6	6	6	6

(1) Inventions arising at the federal lab.
(2) Tally includes U.S. patent applications, foreign patent applications filed on cases for which no U.S. application was filed, divisional applications, and continuation-in-part applications. Excludes provisional, continuation, duplicate foreign, and PCT applications.

■ Licensing

Profile of Active Licenses

	FY 2001	FY 2002	FY 2003	FY 2004	FY 2005
● **All licenses**, number total active in the FY (1)	2	3	57	98	103
▫ New, executed in the FY	0	2	54	98	100
▪ **Invention licenses**, total active in the FY	2	3	57	98	103
▫ New, executed in the FY	0	2	54	98	100
- Patent licenses,(2) total active in FY	2	3	57	3	3
▫ New, executed in the FY	0	2	54	3	0
- Material transfer licenses (inventions), total active	0	0	0	0	0
▫ New, executed in the FY	0	0	0	0	0
- Other invention licenses, (3) total active in the FY	0	0	0	95	100
▫ New, executed in the FY	0	0	0	95	100
▪ **Other IP licenses**, total active in the FY	0	0	0	0	0
▫ New, executed in the FY	0	0	0	0	0
- Copyright licenses (fee bearing)					
▫ New, executed in the FY					
- Material transfer licenses (non-inventions), total active					
▫ New, executed in the FY					
- Other, total active in the FY					
▫ New, executed in the FY					

Multiple inventions in a single license are counted as one license. Licenses that include both patents and copyrights (hybrid licenses) are reported as patent licenses and not included in the count of copyright licenses.

(1) "Active" = legally in force at any time during the FY.
(2) Patent license tally includes patent applications which are licensed.
(3) International copyright licenses (non fee bearing) for VQM technology

Licensing Management

	FY 2001	FY 2002	FY 2003	FY 2004	FY 2005
● **Elapsed execution time**,[1] licenses granted in the FY					
▪ **Invention licenses**					
▫ Average, months	**	5.0*	1.0	2.0	2.0
▫ Minimum			1.0	1.0	1.0
▫ Maximum			1.0	3.0	3.9
- Patent licenses [2]					
▫ Average, months	**	5.0*	1.0	2.0	2.0
▫ Minimum			1.0	1.0	1.0
▫ Maximum			1.0	3.0	3.0
● **Licenses terminated for cause**, number in the FY					
▪ **Invention licenses**	0	0	0	0	0
- Patent licenses [2]	0	0	0	0	0

Data included in this table (intentionally) addresses only invention licenses, with patent licenses distinguished as a sub-class.

* Only a single new license was executed in FY 2002. Therefore, there are no distributional statistics for elapsed execution time to report.
** No new licenses were executed in FY 2001.

(1) Date of license application to the date of license execution. (Date of license application is the date the lab formally acknowledges the written request for a license from a prospective licensee and agrees to enter into negotiations.)
(2) Patent license tally includes patent applications which are licensed.

Characteristics of Licenses Bearing Income

	FY 2001	FY 2002	FY 2003	FY 2004	FY 2005
● **All income bearing licenses**, total number	1	3	3	3	4
▫ Exclusive	0	0	0	0	0
▫ Partially exclusive	0	0	0	0	0
▫ Non-exclusive	1	3	3	3	4
▪ **Invention licenses**, income bearing	1	3	3	3	4
▫ Exclusive	0	0	0	0	0
▫ Partially exclusive	0	0	0	0	0
▫ Non-exclusive	1	3	3	3	4
- Patent licenses,[1] income bearing	1	3	3	3	4
▫ Exclusive	0	0	0	0	0
▫ Partially exclusive	0	0	0	0	0
▫ Non-exclusive	1	3	3	3	4
▪ **Other IP licenses**, income bearing	0	0	0	0	0

	FY 2001	FY 2002	FY 2003	FY 2004	FY 2005
▫ Exclusive ▫ Partially exclusive ▫ Non-exclusive					
- Copyright licenses (fee bearing)	0	0	0	0	0
▫ Exclusive ▫ Partially exclusive ▫ Non-exclusive					
● **All royalty bearing licenses**,(2) total number	1	0	0	3	4
▪ **Invention licenses**, royalty bearing	1	0	0	3	4
- Patent licenses,(1) royalty bearing	1	0	0	3	4
▪ **Other IP licenses**, royalty bearing	0	0	0	0	0
- Copyright licenses (fee bearing)					

In general, license income can result from various sources: license issue fees, earned royalties, minimum annual royalties, paid-up license fees, and reimbursement for full-cost recovery of goods and services provided by the lab to the licensee including patent costs.

(1) Patent license tally includes patent applications which are licensed.
(2) Note that royalties are one component of total license income.

Income from Licenses

	FY 2001	FY 2002	FY 2003	FY 2004	FY 2005
● **Total income, all licenses active in the FY** (1)	$5,000	$65,470	$0	$33,500	$7,212
▪ **Invention licenses**	$5,000	$65,470	$0	$33,500	$7,212
- Patent licenses (2)	$5,000	$65,470	$0	$33,500	$7,212
▪ **Other IP licenses**, all active licenses in FY	$0	$0	$0	$0	$0
- Copyright licenses					
● **Total Earned Royalty Income** (ERI) (3)	$0	$0	$0	$0	$0
▫ Median ERI					
▫ Minimum ERI					
▫ Maximum ERI					
▫ ERI from top 1% of licenses					
▫ ERI from top 5% of licenses					
▫ ERI from top 20% of licenses					
▪ **Invention licenses**	$0	$0	$0	$0	$0
▫ Median ERI					
▫ Minimum ERI					
▫ Maximum ERI					
▫ ERI from top 1% of licenses					
▫ ERI from top 5% of licenses					

	FY 2001	FY 2002	FY 2003	FY 2004	FY 2005
▫ ERI from top 20% of licenses					
- Patent licenses [2]	$0	$0	$0	$0	$0
▫ Median ERI					
▫ Minimum ERI					
▫ Maximum ERI					
▫ ERI from top 1% of licenses					
▫ ERI from top 5% of licenses					
▫ ERI from top 20% of licenses					
▪ **Other IP licenses**, total active in the FY	$0	$0	$0	$0	$0
▫ Median ERI					
▫ Minimum ERI					
▫ Maximum ERI					
▫ ERI from top 1% of licenses					
▫ ERI from top 5% of licenses					
▫ ERI from top 20% of licenses					
- Copyright licenses					
▫ Median ERI					
▫ Minimum ERI					
▫ Maximum ERI					
▫ ERI from top 1% of licenses					
▫ ERI from top 5% of licenses					
▫ ERI from top 20% of licenses					

(1) Total income includes license issue fees, earned royalties, minimum annual royalties, paid-up license fees, and reimbursement for full-cost recovery of goods and services provided by the lab to the licensee including patent costs.
(2) Patent license tally includes patent applications which are licensed.
(3) "Earned royalty" = royalty based upon use of a licensed invention (usually, a percentage of sales or of units sold). Not a license issue fee or a minimum royalty.

Disposition of License Income

	FY 2001	FY 2002	FY 2003	FY 2004	FY 2005
● **Income distributed** [1]					
▪ **Invention licenses**, total distributed	$5,000	$65,470	$0	$33,500	$7,212
- To inventor(s)	$2,900 (58%)	$21,041 (32%)	$0	$18,450 (55%)	$3,564 (49%)
- To other [3]	$2,100 (42%)	$44,429 (68%)	$0	15,050 (45%)	$3,648 (51%)
- Patent licenses, [2] total distributed	$5,000	$65,470	$0	$33,500	$7,212
- To inventor(s)	$2,900 (58%)	$21,041 (32%)	$0	$18,450 (55%)	$3,564 (49%)

	FY 2001	FY 2002	FY 2003	FY 2004	FY 2005
-To other [3]	$2,100 (42%)	$44,429 (68%)	$0	$15,050 (45%)	$3,648 (51%)

Invention licenses are the chief policy interest regarding disposition of income; the content of this table reflects this focus.

(1) Income includes royalties and other payments received during the FY.
(2) Patent license tally includes patent applications which are licensed.
(3) To ITS/NTIA

■ Other Performance Measures Deemed Important by the Agency

	FY 2001	FY 2002	FY 2003	FY 2004	FY 2005
Technical publications produced	17	17	20	17	19

See "Technical Publications" above in the first section of this report for additional information on this topic.

■ Outcomes from Technology Transfer

For this year's annual report, the cases described below are provided as examples of the downstream outcomes being achieved by ITS technology transfer efforts:

• **Video quality metric.** ITS developed a superior method for measuring video quality objectively by machine that closely predicts the quality perceived by human subjects. This technology is covered by three patents owned by ITS/NTIA. In FY 2003, the ITS method was adopted by the ANSI as a U.S. national standard. In addition, the International Telecommunications Union (ITU) tested a number of proposed video quality metrics from around the world and found the ITS method superior. This ITS method became an international standard in 2004, as approved by the ITU. In FY 2004, ITS received an award from the Federal Laboratory Consortium (FLC) for its efforts to disseminate this technology both nationally and internationally.

ITS has targeted this technology for commercial development, perceiving potential of producing a royalty income for the laboratory within one year. To date, three commercial licenses and one CRADA have been negotiated with U.S. corporations -- with royalty and CRADA funding exceeding $100,000. Four new royalty bearing licenses are currently being negotiated. More than 100 copies of software implementing the method were requested in FY 2005 for purposes of evaluation.

- **Ultra-wideband Study with Motorola.** In 2004, ITS begun a cooperative research program with Motorola/Freescale Inc., to investigate the interference potential of various ultra-wideband (UWB) waveforms. The FCC permitted low power UWB emissions between 3.1 and 10.6 GHz in February 2003. And since then, a number of companies have developed UWB technologies for application in wireless personal area networking (WPAN), to achieve high data rates at short distances (less than 10 meters). In FY 2005, ITS developed measurement methods and procedures for characterizing these newest UWB signals in a way that enables accurate determination of the interference they could cause to digital satellite television systems. This work was of value to many beneficiaries, including standards development organizations, NTIA, FCC, the UWB industry, and the satellite television industry and service providers. It is also being used by many other countries.

Appendix:
Progress in Improving the Agency's Performance Metrics for Tech Transfer

ITS' annual reporting on its technology transfer activities has been revised over last several years to conform to the Department of Commerce's current guidelines.

Starting in 2003, ITS added a new metric under the "Other Performance Measures" heading: the number of publications approved through the Editorial Review Board (ERB) process. Despite a few limitations, this metric provides a useful, working indication of the number of quality publications released to the public. Also, in 2004, ITS added another measure: participation on standards committees.

In 2006, ITS plans to add another metric -- one that more directly provides an indication of ultimate benefit to the public. This new metric will be the total number of hits on the publications listed on the "ITS Online Documents."