Annual Report on Technology Transfer: Approach and Plans, Fiscal Year 2013 Activities and Achievements

U.S. Department of Commerce

Report prepared by:

National Institute of Standards and Technology
National Oceanic and Atmospheric Administration
National Telecommunications and Information Administration
Institute for Telecommunication Sciences

Pursuant to the
Technology Transfer and Commercialization Act of 2000 (Pub. L. 106-404)

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FOREWORD

This report summarizes technology transfer activities and achievements of the Department of Commerce's (DOC's) federal laboratories for fiscal year (FY) 2013. At the DOC, technology transfer is a significant part of the mission and programmatic activities of the National Institute of Standards and Technology (NIST), the National Oceanic and Atmospheric Administration (NOAA), and the National Telecommunications and Information Administration's (NTIA's) Institute for Telecommunication Sciences (ITS). Accordingly, this report focuses on the activities of these agencies.

This report has been prepared in response to the statutory requirement for an annual "agency report on utilization" (15 U.S.C. Section 3710(f)) process established under Section 10 of the Technology Transfer Commercialization Act of 2000 (Pub. L. 106-404). All federal agencies that operate or direct one or more federal laboratories or conduct other activities under Sections 207 and 209 of Title 35, United States Code, are subject to the requirements of this statute. Pursuant to the Presidential Memorandum – Accelerating Technology Transfer and Commercialization of Federal Research in Support of High-Growth Businesses (October, 2011), this report contains significantly expanded metrics on technology transfer from previous editions.

DOC's overall and laboratory-specific approaches and its plans for technology transfer are summarized within this report. The report focuses on current year activities and accomplishments, and provides statistical information from FY 2009 through FY 2013.

NIST, NOAA and ITS technology transfer offices have contributed to the organization and preparation of the material reported. An electronic version of this report and versions from previous fiscal years are available online at: http://www.nist.gov/tpo/publications/index.cfm.

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CHAPTER 1 Department of Commerce Overview

Technology transfer plays an important role in DOC's mission to promote job creation, economic growth, sustainable development, and improved standards of living for all Americans. DOC works in partnership with businesses, universities, State, tribal and local governments, and communities to promote innovation and improve the nation's overall competitiveness in the global economy. DOC pursues these objectives through policies and programs directed at strengthening the nation's economic infrastructure, facilitating the development of cutting-edge science and technology, providing critical scientific information and data, and managing national resources.

DOC conducts research and development (R&D) in areas of science and technology at the laboratory facilities of NIST, NOAA, and NTIA's ITS. Technology transfer, which is a key part of the programmatic activities in these laboratories, connects technological advances of DOC's science and engineering programs to the American economy.

In addition to the technology transfer efforts of DOC laboratories, DOC is responsible for coordinating technology transfer activities across federal agencies. DOC coordinates the Interagency Workgroup for Technology Transfer (IAWGTT) through NIST facilitating interagency discussion on policy, new approaches to technology transfer, and lessons learned from agency technology transfer programs. NIST also serves as the host agency for the Federal Laboratory Consortium for Technology Transfer (FLC), which is a nationwide network of federal laboratories that provides a forum to develop strategies and opportunities for linking laboratory mission technologies and expertise with the marketplace. [1]

DOC's role in coordinating technology transfer activities across federal agencies was further expanded by the Presidential Memorandum – *Accelerating Technology Transfer and Commercialization of Federal Research in Support of High-Growth Businesses* (PM) of October 21, 2011.[2] The purpose of this PM is to foster innovation by increasing the rate of technology transfer and the economic and societal impact from federal R&D investments. The PM directs agencies with federal laboratories to take actions to establish goals and measure performance, streamline administrative processes, and facilitate local and regional partnerships in order to accelerate technology transfer and support private sector commercialization. The aim is to increase the successful outcomes of agency technology transfer and commercialization activities significantly over the next 5 years, while simultaneously achieving excellence in each agency's focused research activities.

Section 2 of the PM calls for establishing performance goals, metrics, and evaluation methods, as well as implementing and tracking progress relative to those goals, specifically directing that "[t]he Secretary of Commerce, in consultation with other agencies, including the National Center

[1] Agencies participating in the IAWGTT, established pursuant to Executive Order 12591 of April 10, 1987, include the Department of Agriculture, Department of Commerce, Department of Defense, Department of Energy, Department of Health and Human Services, Department of Homeland Security, Department of Interior, Department of Transportation, Department of Veterans Affairs, Environmental Protection Agency, and National Aeronautics and Space Administration.

[2] http://www.whitehouse.gov/the-press-office/2011/10/28/presidential-memorandum-accelerating-technology-transfer-and-commerciali

for Science and Engineering Statistics, shall improve and expand, where appropriate, its collection of metrics in the Department of Commerce's annual technology transfer summary report, submitted pursuant to 15 U.S.C. § 3710(g)(2)." [3]

More information about DOC technology transfer is available on the following websites:

NIST: http://www.nist.gov/tpo/index.cfm
NOAA: http://www.noaa.gov/
ITS: http://www.its.bldrdoc.gov/programs/tech_transfer/

Summary of Technology Transfer Activities FY 2009 – FY 2013

This annual report provides comprehensive statistics on the technology transfer activities of DOC laboratories. Information is provided regarding invention disclosures, intellectual property (patents/licenses), collaborative relationships for research and development agreements (CRADAs), and other technology transfer mechanisms. Examples of successful downstream results (e.g., commercially significant technologies) from these technology transfer activities are also highlighted.

Section 10 of the Technology Transfer Commercialization Act of 2000 (Pub. L. 106-404, codified at 15 U.S.C. Section 3710(f)) requires each federal agency which operates or directs one or more federal laboratories, or conducts activities under 35 U.S.C. Sections 207 and 209, to report to Congress the results of its technology transfer activities. This information is also required by Office of Management and Budget Circular A-11. The tables below present the required data.[4]

[3] For a list of available reports see http://www.nist.gov/tpo/publications/doc-annual-reports-techtransfer.cfm
[4] Technology transfer data is typically adjusted over time to account for new information resulting from changes in reporting procedures, patent decisions, programmatic changes, etc. Throughout this report, data prior to FY 2013 has been adjusted, where necessary, to reflect the most accurate estimates for each year reported.

Table 1 – Invention Disclosure and Patenting

	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013
Invention Disclosures					
NIST	36	30	25	52	33
NOAA	4	1	1	0	8
ITS	0	0	0	0	0
Department Total	40	31	26	52	41
Patent Applications Filed					
NIST	19	19	17	20	22
NOAA	1	1	0	1	3
ITS	0	0	0	0	0
Department Total	20	20	17	21	25
Patents Issued					
NIST	7	10	14	11	19
NOAA	0	2	2	2	1
ITS	0	0	0	0	0
Department Total	7	12	16	13	20
Jointly-Owned Patents					
NIST	--	--	--	--	17

In addition to the number of patents issued that are reported by each agency, the National Science Foundation (NSF) provides additional insight into the technology areas addressed by DOC patents.[5] For example, in FY 2012, 46% of DOC's patents were in the technical area of Measurement Techniques and Instruments. This includes techniques and use of instrumentation which measures, tests, inspects or analyzes a wide variety of materials or processes.[6]

Figure 1 – Percent of USPTO patents assigned to DOC, by technology area: FY 2012

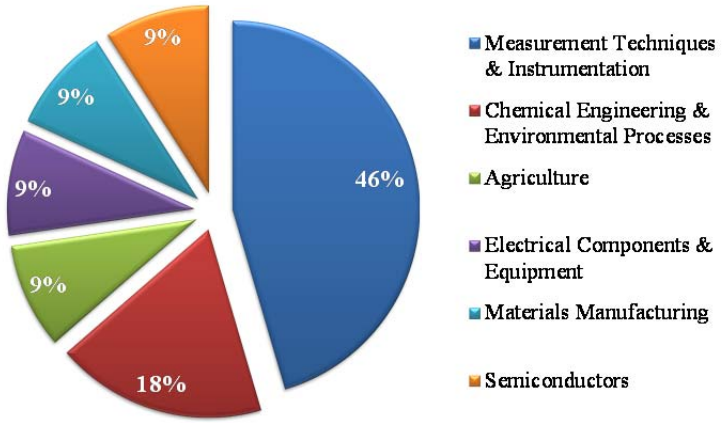


Table 2 – Licensing – Profiles of Active Licenses

	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013
Active Patent Licenses [(a)]					
NIST	33	40	34	38	35
NOAA	7	6	6	5	4
ITS	0	0	0	0	0
Department Total	40	46	40	41	39

(a) "Active" means an agreement in effect at any time during the fiscal year.

[5] NSF routinely researches a wide range of data for its publication "Science and Engineering Indicators" (http://www.nsf.gov/statistics/.) NSF data presented here has been provided at the request of NIST and is in compliance with NSF's goal of supporting agencies in their tasks of enhancing the measurement of technology transfer activities.

[6] Sources: National Science Foundation, National Center for Science and Engineering Statistics, and The Patent Board,™ special tabulations (2013).

Table 3 – Characteristics of Income-Bearing Licenses

	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013
Total Income-Bearing Licenses					
Department Total	28	29	26	25	27
Patent Licenses					
NIST	23	25	23	22	23
NOAA	5	4	3	3	4
ITS	0	0	0	0	0
License Types[(a)]					
Exclusive					
NIST	11	12	12	12	15
NOAA	0	0	0	0	0
ITS	0	0	0	0	0
Department Total	11	12	12	12	15
Partially Exclusive					
Department Total	0	0	0	0	0
Non-Exclusive					
NIST	6	7	7	6	5
NOAA	5	4	3	3	4
ITS	0	0	0	0	0
Department Total	11	11	10	9	9

(a) Other licensing types not show here include Assignments and Custody Transfers.

Table 4 – Income from Licensing

	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013
Total Licensing Income					
NIST	$197,445	$202,216	$ 169,347	$146,796	$102,532
NOAA	$138,444	$ 35,044	$ 107,220	$100,867	$ 48,798
ITS	$0	$0	$0	$0	$0
Department Total	$335,889	$237,260	$ 276,567	$ 247,663	$ 151,330

Table 5 – Collaborative Relationships for Research and Development

	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013
CRADAs					
Department Total	2,397	2,253	2,245	2,410	2,428
Traditional CRADAs[(a)]					
NIST	65	66	103	140	179
NOAA	5	6	7	10	15
ITS	31	29	23	60	82
Joint CRADA Agreements (NIST and ITS)[(b)]		1	35	57	79
Department Total[(c)]	101	100	98	153	197
Non-Traditional CRADAs[(d)]					
NIST	2,284	2,141	2,138	2,255	2,231
NOAA	0	0	0	0	0
ITS	12	12	9	2	0
Department Total	2,296	2,153	2,147	2,257	2,231

(a) Traditional CRADAs involve collaborative research and development projects by a federal laboratory and non-federal partners.
(b) NIST and ITS have been jointly involved in several Public Safety 700 MHz Broadband Demonstration Agreements.
(c) Department totals for Traditional CRADAs are adjusted to avoid double counting CRADAs where NIST and ITS are jointly involved.
(d) Non-traditional CRADAs are used for special purposes, such as laboratory accreditation, materials transfer or technical assistance that may result in protected information.

Scientific and Technical Publications

As discussed in the Department's response to the PM[7], technology transfer mechanisms include more than just accounting for CRADAs, patenting, and licensing. For example, technology transfer is also accomplished through DOC's scientific and technical publications. In FY 2013, NIST, NOAA, and ITS researchers published 3,198 scientific and technical papers in peer-reviewed journals.

Table 6 – Scientific and Technical Publications

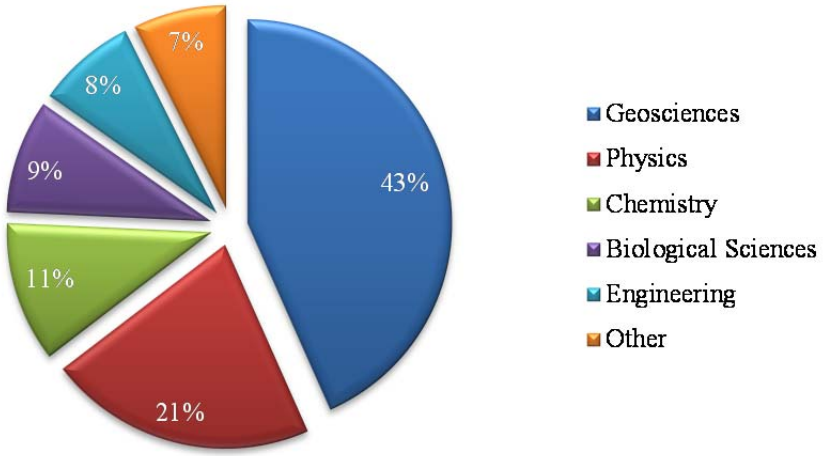
	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013
Technical Publications					
NIST	1,463	1,243	1,210	1,335	1,393
NOAA	789	709	1,034	1,769	1,781
ITS	12	12	15	13	24
Department Total	2,264	1,964	2,259	3,117	3,198

In addition to the number of publications reported by each agency, the National Science Foundation (NSF) provides insight into the technology areas addressed by each federal agency.[8]

[7] See http://www.nist.gov/tpo/publications/upload/DOC-Tech-Transfer-Plan.pdf
[8] The National Science Foundation routinely researches a wide range of data for its publication "Science and Engineering Indicators" (http://www.nsf.gov/statistics/.) The data presented here has been provided at the request of

Using data from Thomson Reuters' Science Citation Information (SCI)[9] and Social Sciences Citation Index (SSCI)[10] databases, NSF identifies the general technology areas addressed by each agency's publications. The latest data available from NSF is for calendar year 2012. As shown in Figure 2, the largest technology area DOC publications include is Geosciences (43%), followed by Physics (21%) and Chemistry (11%).

Figure 2 – Percent of Articles by Technology Area Authored by DOC Staff in 2012[11]



Data is also available on the number of times U.S. patents cite U.S. science and engineering articles authored by DOC staff. These cited articles are from the set of journals covered by SCI and SSCI, classified by the year of publication, and assigned to a federal agency on the basis of the institutional addresses listed in the article. U.S. patents issued in 2012 cite 558 publications authored by DOC researchers. As shown in Figure 3, the largest technology area these cited DOC publications include is physics (31%), followed by chemistry (29%) and biological sciences (11%).

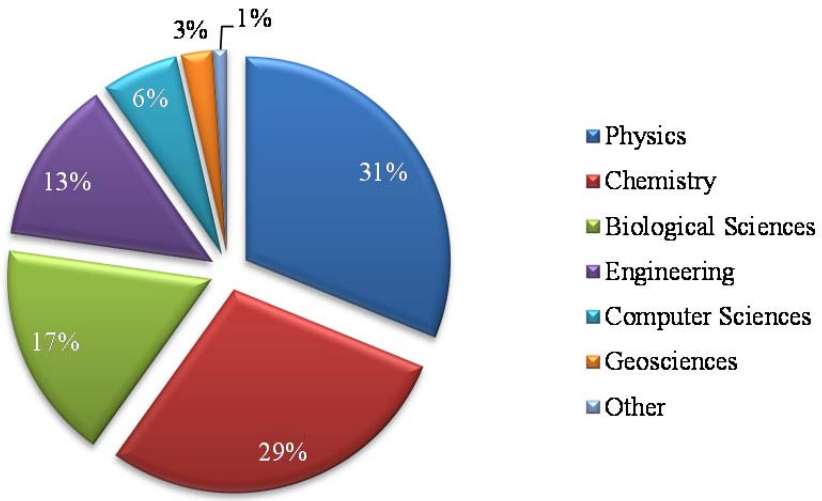
NIST and is in compliance with NSF's goal of supporting agencies in their tasks of enhancing the measurement of technology transfer activities.

[9] See http://www.sci-thomsonreuters.org/

[10] See http://www.ssci-thomsonreuters.org/

[11] Publications are classified by the year they are entered into the database, rather than the year of publication, and are credited on a whole-count basis (i.e., each publication receives one count).

Figure 3 – Percent of Articles by Technology Area Authored by DOC Staff and Cited in U.S. Patents in 2012[12]



The following chapters provide details on other agency-specific technology transfer activities, such as technical support development for industrial standards and reference materials, public dissemination activities (meetings and workshops), collaborations with guest researchers, etc.

[12] Cited articles are classified by the year of publication, and are classified on a whole count basis (i.e. each cited article receives one count). Citation counts are based on an 11-year window with a 5-year lag (e.g., citations for 2012 are references in USPTO patents issued in FY2012 to articles published in 1997–2007. The sum of the federal agencies may exceed the total when cited articles have authors from multiple federal agencies.

CHAPTER 2 National Institute of Standards and Technology

NIST has a broad mission: to promote U.S. innovation and industrial competitiveness by advancing measurement science, standards, and technology in ways that enhance economic security and improves our quality of life.

An important part of accomplishing NIST's mission is to anticipate future measurement and standards needs of U.S. industry. Rapidly evolving sectors like nanotechnology, biotechnology, homeland security, information technology, and advanced manufacturing need sophisticated technical support systems in order to flourish and grow. NIST laboratories develop measurement techniques, test methods, standards, reference materials, reference data, and other technologies and services that support U.S. industry, scientific research, and the activities of many other federal agencies. In carrying out its mission, NIST works directly with industry partners (individual companies and consortia), universities, standards organizations, other domestic and foreign associations, and other government agencies.

Approach and Plans for Technology Transfer

Technology transfer activities at NIST are designed to disseminate fundamental research results, measurements, and standards research results to industry and other interested parties. In order to provide leading-edge scientific and technical work, NIST is required to have expertise in multiple disciplines, maintain high levels of collaboration with organizations and people with diverse capabilities, and have highly specialized facilities and tools. For more than a century, laboratories at NIST (and its direct predecessor agency: the National Bureau of Standards) have successfully collaborated with others to provide the measurement techniques and technical tools needed by America's innovators.[13]

In order to implement the PM, the NIST Director established a NIST Technology Transfer Policy Committee (the "Committee"), and directed the Committee to develop a more comprehensive definition of technology transfer and identify improvements to processes and metrics that would accurately capture the full impact of our scientific enterprise. The Committee, comprised of senior NIST management, reviewed current definitions of technology transfer at NIST, other agencies and the Federal Laboratory Consortium, and recommended the following broader definition for NIST:

> ***"Technology transfer is the overall process by which NIST knowledge, facilities, or capabilities in measurement science, standards and technology promote U.S. innovation and industrial competitiveness in order to enhance economic security and improve quality of life."***

The broader definition of technology transfer for NIST intends to reflect the many means by which NIST reaches its external partners and transfers technology. The Committee recognized that the definition includes, *inter alia*: 1) knowledge transfer, the act of transferring knowledge from one individual to another by means of mentoring, training, documentation, or other

[13] Additional details on NIST's technology transfer program are available at: http://www.nist.gov/tpo/index.cfm.

collaboration; and 2) commercialization, the adoption of a technology into the private sector through a business or other organization.

The Committee reviewed NIST policies governing technology transfer and discussed other means by which NIST can transfer technology to benefit the Nation. The Committee discussed the need to encourage and facilitate formal mechanisms of technology transfer when these best suit the mission of NIST and the mission of its Operating Units (OUs). The Committee also advocated collecting measures of informal collaborations, when appropriate, as these are no less significant to NIST's mission.

The Committee's recommendations supported two broad goals: 1) improving the transfer of NIST technology and work products; and 2) improving NIST technology transfer through collaborations. The Committee recommended specific metrics for evaluating progress towards these goals.

The following summarizes different technology transfer mechanisms NIST uses to promote innovation and ensure that the resulting technologies are broadly disseminated.

NIST Work Products and Collaborative Activities

Participation in Documentary Standards Committees

Documentary standards are shared sets of rules that specify, as examples, a test method, a product's properties or a practice. Documentary standards codify, among other things, measurement methods, standard practices, and product specifications. Econometric studies have concluded that standards contribute significantly to economic growth, and at least one study concludes the following: development of standards is integral to innovation; documentary standards contribute to economic growth at least as much as do patents; and the macroeconomic benefits of the development of standards extend beyond the benefits to the companies that use the standards.[14]

One mechanism used to transfer NIST measurement-science research and other technologies to market use is through participation in the development of consensus documentary standards. NIST has nearly 400 staff involved with more than 100 standards organizations. Such participation helps NIST respond programmatically to the needs of private sector and enables its scientists and engineers to bring NIST technology and know-how directly into standards-setting bodies. NIST reports its activities in standards development to the Office of Management and Budget and to Congress, as required by the National Technology Transfer and Advancement Act of 1995 (Pub. L. 104-113).[15]

The NIST Standards Coordination Office (SCO) maintains the Standards Committee Participation Database for employees to self-report their involvement, including leadership positions, within standards organizations. SCO has been proactively expanding the database to

[14] Peter Swann, G.M., Report for the UK Department of Business, Innovation, and Skills (BIS), 2010 http://www.bis.gov.uk/assets/biscore/innovation/docs/e/10-1135-economics-of-standardization-update.pdf

[15] See: http://gsi.nist.gov/global/index.cfm/L1-1

collect information on staff tenure on a standards committee, standard(s) developed with NIST staff participation, and other information relevant to NIST's contributions in new and existing documentary standards.

Standard Reference Data

The Standard Reference Data (SRD) program provides critically evaluated numeric data to scientists and engineers for use in technical problem-solving, research, and development. Many types of reference data are critically important in engineering structures, optimizing chemical processes, and other industrial applications. Standard Reference Data are extracted from the scientific and technical literature, or developed from measurements conducted at NIST laboratories, and are critically evaluated for accuracy and reliability. NIST SRD databases cover many areas of science, including analytical chemistry, atomic and molecular physics, biotechnology, and materials sciences.[16]

Data evaluations conducted at NIST laboratories are supplied to NIST customers through the Standard Reference Data Program. NIST plans to study SRD-related data to determine whether information regarding usage of databases is sufficiently centralized, and whether NIST can obtain comprehensive metrics for judging impact.

Table 7 – Standard Reference Data

	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013
Standard Reference Data					
Available	120	120	120	111	120

Standard Reference Materials

Standard Reference Materials (SRMs) are a definitive source of measurement traceability in the United States. Measurements made using SRMs can be traced to a common and recognized set of basic standards that provide the basis for measurement compatibility among different laboratories. The certified property values for Standard Reference Materials often depend on the development of unique measurement capabilities within NIST.[17]

NIST will continue to report on the number of SRMs sold and new SRMs developed while studying whether other meaningful impact information can be developed using existing customer data.

Table 8 – Standard Reference Materials

	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013
Standard Reference Materials					
Available	1,283	1,283	1,177	1,298	1,299
Units Sold	29,769	31,667	32,864	33,441	32,267

[16] See: http://www.nist.gov/srd/index.cfm
[17] See: http://www.nist.gov/srm/index.cfm

Patents and Licensing

NIST actively seeks to identify commercially valuable inventions that result from its research. The Patent Review Committee at NIST evaluates each reported invention's potential to promote U.S. innovation and industrial competitiveness. NIST will generally seek patent protection when a patent: (1) would enhance the potential for an invention's commercialization; (2) would have a positive impact on a new field of science or technology and/or the visibility and vitality of NIST; (3) would further the goals of a CRADA or other agreement; (4) would further U.S. manufacturing; or (5) would likely lead to a commercialization license.

NIST will continue to report on patents, licenses, age and size of companies licensing NIST technologies, number of jointly-owned inventions, and other relevant information.

Information on patenting and summary information on licensing is presented in Chapter 1. Additional details on licensing are included below.

Table 9 – Profile of Active NIST Licenses

	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013
Total Number of Active Licenses[(a)]	33	40	34	36	35
New Licenses Executed	11	7	5	6	5
Total Invention Licenses Active	33	40	34	36	35
New Invention Licenses Executed	11	7	5	6	5
Total Patent Licenses Active[(b)]	33	40	34	36	35
New Patent Licenses Executed	11	7	5	6	5
Total Material Transfer Licenses Active (Inventions)	0	0	0	0	0
New Material Transfer Licenses (Inventions)	0	0	0	0	0
Total Material Transfer Licenses Active (Non-Inventions)	0	0	0	0	0
New Material Transfer Licenses Executed (Non-Inventions)	0	0	0	0	0
Total "Other Invention Licenses" Active	0	0	0	0	0
New "Other Invention Licenses" Executed	0	0	0	0	0
Total "Other IP Licenses" Active	0	0	0	0	0
New "Other IP Licenses" Executed	0	0	0	0	0
Copyright Licenses (Fee-Bearing) Active	0	0	0	0	0
New Copyright Licenses Executed	0	0	0	0	0
NIST Licenses Issued to Small Companies	--	--	--	2	7

(a) "Active" means an agreement in force at any time during the fiscal year.
(b) Patent licenses include licenses to pending patent applications.

Table 10 – Licensing Management

	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013
License Negotiation Time[(a)]					
Invention Licenses (Patent Licenses)[(b)]					
Average (months)	4.8	3.0	1.9	2.9	6.0
Minimum (months)	3.0	2.0	1.0	2.4	2.3
Maximum (months)	7.0	4.0	4.5	5.5	13.5
Licenses Terminated for Cause					
Invention Licenses (Patent Licenses)	0	0	0	0	0

(a) Date of license application to date of license execution. (Date of license application is the date the laboratory formally acknowledges the written request for a license from a prospective licensee and agrees to enter into negotiations.)
(b) Patent licenses include licenses to pending patent applications.

Income from licensing comes from a variety of sources: license issue fees; earned royalties; minimum annual royalties; paid-up license fees; reimbursement for full-cost recovery of goods; and services provided by the laboratory to the licensee (including patent costs).

Table 11 – Characteristics of Licenses Bearing Income

	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013
Total Income Bearing Licenses	22	24	22	21	25
Exclusive Licenses	15	17	15	15	17
Partially Exclusive Licenses	0	0	0	0	0
Non-Exclusive Licenses	7	7	7	6	8
Total Income Bearing Invention Licenses (Patent Licenses)[(a)]	22	24	22	21	25
Exclusive	15	17	15	15	17
Partially Exclusive	0	0	0	0	0
Non-Exclusive	7	7	7	6	8
Total Other Income Bearing IP Licenses	0	0	0	0	0
Total Royalty Bearing Licenses	22	24	22	21	25
Total Royalty Bearing Invention Licenses	22	24	22	21	25
Royalty Bearing Patent Licenses	22	24	22	21	25
Other Royalty Bearing IP Licenses	0	0	0	0	0

(a) Patent licenses include licenses to pending patent applications.

Table 12 – Income from Licenses

	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013
Total Income, All Active Licenses[(a)]	$197,445	$202,216	$169,347	$146,796	$102,532
Invention Licenses (Patent Licenses)[(b)]	$197,445	$202,216	$169,347	$146,796	$102,532
Other IP Licenses, Total Active	$0	$0	$0	$0	$0
Total Earned Royalty Income (ERI)[(c)]	$197,445	$202,216	$169,347	$146,796	$102,532
Median ERI	$15,625	$3,438	$1,844	$9,971	$10,000
Minimum ERI	$320	$1,245	$1,500	$1,500	$640
Maximum ERI	$100,000	$100,000	$100,000	$64,185	$58,642
ERI from Top 1% of Licenses[(d)]	--	--	--	--	--
ERI from Top 5% of Licenses[(d)]	--	--	--	--	--
ERI from Top 20% of Licenses[(d)]	--	--	--	--	--
Invention Licenses (Patent Licenses)	$197,445	$202,216	$169,347	$146,796	$102,532
Median ERI	$15,625	$3,438	$1,844	$9,971	$10,000
Minimum ERI	$320	$1,245	$1,500	$1,500	$640
Maximum ERI	$100,000	$100,000	$100,000	$64,185	$58,642
ERI from Top 1% of Licenses[(d)]	--	--	--	--	--
ERI from Top 5% of Licenses[(d)]	--	--	--	--	--
ERI from Top 20% of Licenses[(d)]	--	--	--	--	--
Other IP Licenses, Total Active	$0	$0	$0	$0	$0

(a) Total income includes license issue fees, earned royalties, minimum annual royalties, paid-up license fees, reimbursement for full-cost recovery of goods and services provided by the laboratory to the licensee including patent costs and Standard Reference Data. “Active” means an agreement in force at any time during the fiscal year.
(b) Patent licenses include licenses to pending patent applications.
(c) “Earned Royalty Income” is a royalty based on use of a licensed invention (usually, a percentage of sales or of units sold). Not a license issue fee or a minimum royalty.
(d) Data withheld to protect proprietary information.

Table 13 – Disposition of Invention License Income

	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013
Income Distributed[(a)]	$197,445	$202,216	$169,347	$146,796	$102,532
Invention Licenses (Patent Licenses)[(b)]					
Licensing Income to Inventor(s)	$66,757	$72,157	$56,698	$61,300	$38,732
	34%	36%	33%	42%	38%
Licensing Income to NIST	$130,688	$130,058	$112,649	$85,497	$63,799
	66%	64%	67%	58%	62%

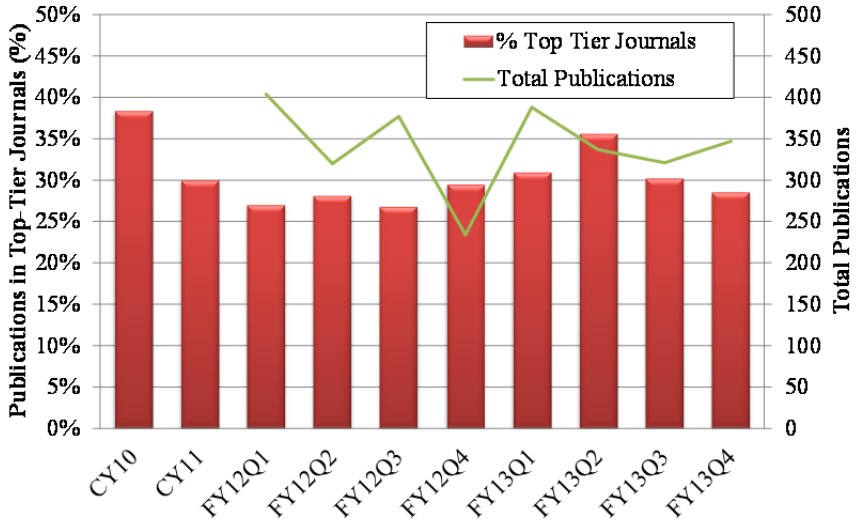
(a) Income includes royalties and other payments received during the fiscal year.
(b) Patent licenses include licenses to pending patent applications.

Software and Other Downloadable Products
NIST provides a wide variety of application software programs, testing tools, and databases that are accessible via the Internet and available to U.S. industry, academia and other interested users. These applications are an important means of disseminating NIST research results and technical information.

NIST will explore methods for assessing significant technology transfer contribution made through downloads of NIST software and data. NIST will create a site-wide group for exchanging effective practices and study appropriate metrics for assessing the impact of NIST published software.

Scientific and Technical Publications
Technical publications are one of the major mechanisms NIST uses to disseminate the results of its research to industry, academia, and other agencies. In FY 2013, NIST staff authored 1,393 publications in peer-reviewed journals,[18] including 436 papers (31.3%) published in 102 "top tier" journals. "Top tier" is defined as any journal with a Thomson Reuters' Journal Impact Factor (IF) that falls within the top 10 percentile in its *Web of Science* Subject Category.[19]

Figure 4 – NIST Publications in Top-Tier Journals vs. Total NIST Publications



The top tier journals with the most NIST authored publications include *Physical Review Letters* with 78 NIST publications and *Optics Express* with 20 NIST publications. *Physical Review Letters* has a 2012 IF of 7.943 and is ranked 5 out of 83 in the *Web of Science* category Physics, Multidisciplinary, and *Optics Express* has an IF of 3.546 and is ranked 5 out of 80 in the category Optics.

[18] See: http://nvl.nist.gov/
[19] See: http://wokinfo.com/essays/journal-selection-process/

While the percentage of papers published every year in top tier journals has fluctuated since 2007, about one third of the NIST authored papers indexed in *Web of Science* are published in top tier journals each year.

In addition, NIST researchers collaborate and co-author with researchers from around the world. NIST researchers co-authored papers with 3,402 unique non-NIST authors from 943 unique institutions in 54 countries in 2012.[20] Table 14 summarizes the NIST publication collaboration data collected for the years 2009-2013 (the most recent data available).

Table 14 – NIST Publications (Calendar Year)

	2009	2010	2011	2012	2013
Number of NIST papers	1,293	1,200	1,351	1,339	--
Number of Unique Non-NIST Co-Authors	3,297	3,560	4,086	3,402	--
Number of Unique Institutions	877	992	1,034	943	--
Number of Countries	57	62	64	54	--

NIST also publicizes its planned, ongoing and recently completed work in the trade and technical press, which is typically followed by the organizations most likely to have an interest in NIST's research and services. In addition to news releases, websites and contacts with the media, NIST publishes ***Tech Beat***, a biweekly plain language newsletter of recent research results.[21]

Cooperative Research and Development Agreements (CRADAs)

Collaborative research and development projects between federal laboratories, academia and outside partners are an effective means of technology transfer. Beyond the improved know-how and new technologies that result, these joint efforts often help collaborators to leverage each other's resources and technical capabilities. They also provide mechanisms for collaborators to gain technical competencies and acquire new skills. CRADAs are a major collaborative mechanism for establishing joint relationships with industry, academia, and state and local governments. A CRADA is an agreement between a federal laboratory and one or more partners to collaborate on defined R&D projects. Created as a result of the Stevenson-Wydler Technology Innovation Act of 1980, as amended by the Federal Technology Transfer Act of 1986 (Pub. L. 99-502), a CRADA allows federal laboratories to participate in R&D partnerships with non-Federal partners to advance promising new technologies toward commercialization.[22]

NIST will expand how it considers collaborations beyond the number of CRADAs into a comprehensive metric that encompasses the broad range of NIST formal and informal collaborations. NIST will implement this by (i) developing a definition of a credited "collaboration," (ii) developing processes and procedures to capture credited collaborations, and (iii) conducting a feasibility study on whether impact data can be generated.

[20] Unique co-authors and institutions were identified by performing a search for all NIST authored papers in the *Web of Science (WoS)* database. This includes publications in the peer-reviewed literature but excludes most conference proceedings papers and all NIST series publications. The data is provided on a calendar year basis in order to be consistent with internal data collection practices.

[21] See: http://www.nist.gov/public_affairs/tech-beat/index.cfm

[22] See: http://www.nist.gov/tpo/collaborations/crada.cfm

Table 15 – NIST Collaborative Relationships for Research and Development

	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013
NIST CRADAs					
Total Active CRADAs	2,349	2,207	2,241	2,916	2,410
New CRADAs Executed	1,492	2,142	2,173	2,810	2,252
Total Active Traditional CRADAs	65	66	103	140	179
New Traditional CRADAs Executed	19	16	51	53	48
Total Active Non-Traditional CRADAs	2,284	2,141	2,138	2255	2,231
New Non-Traditional CRADAs Executed	1,473	2,126	2,122	2236	2,204
Other Type of Collaborative R&D Relationships					
Guest Scientists and Engineers[(a)]	2,828	2,897	2,899	2,782	2,963
Traditional CRADAs Involving Small Businesses	--	--	--	20	31

(a) "Guest scientists and engineers" includes foreign and domestic guest researchers and researchers working at NIST under Intergovernmental Personnel Act (IPA) agreements, CRADAs, and Facility Use Agreements.

User Facilities – Research Participants

NIST operates two unique and valuable laboratory facilities – the NIST Center for Neutron Research (NCNR) and the Center for Nanoscale Science and Technology (CNST) – for supporting U.S. industry, academic institutions, NIST laboratories, and other government laboratories. These facilities are a vibrant means by which NIST customers can tap directly into NIST measurement expertise to solve their problems. The NCNR is a national center for research using thermal and cold neutrons. Many of its instruments rely on intense beams of cold neutrons emanating from an advanced liquid hydrogen moderator. The CNST supports the development of nanotechnology from discovery to production. The CNST operates a national shared-use nanofabrication and measurement facility (the NanoFab), complemented by a multidisciplinary research staff creating next-generation tools for advancing nanotechnology.[23]

"Research Participants" at NIST's User Facilities are non-NIST researchers who directly participate in NCNR experiments or CNST projects. Participants include those who use the facility on-site or remotely for an experiment or project and their collaborators.

Table 16 – NIST Research Participants

	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013
NIST Research Participants					
CNST	524	970	1,402	1,669	1,683
NCNR	2,290	2,290	2,265	1,976	2,148

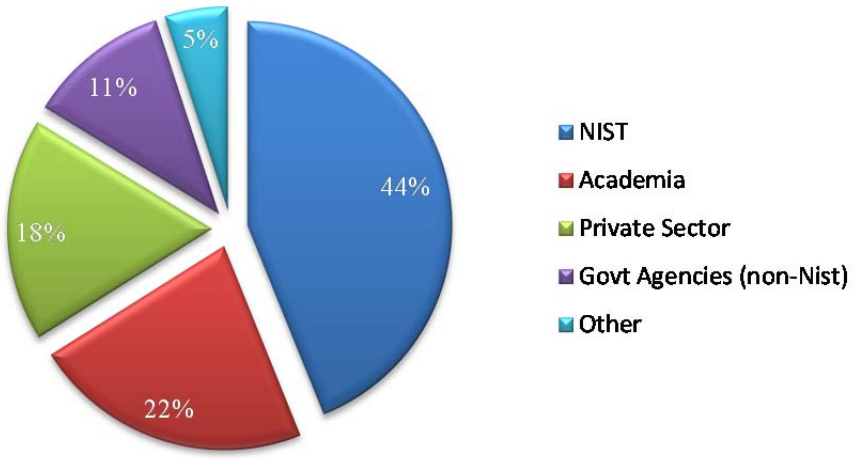
[23] See: http://www.nist.gov/user-facilities.cfm

Postdoctoral Researchers

Technology transfer not only involves inventions, innovations, data, patents and licenses, but also the people who perform the actual research and development. Postdoctoral researchers, or "postdocs," working at NIST are therefore another important means by which NIST technology is transferred.[24] For the purpose of this report, NIST uses the National Science Foundation's description of a postdoctoral researcher[25] as one who has a temporary position taken within five years after the completion of a doctoral degree for the purpose of gaining scientific, technical, and professional skills. For FY 2013, there were 471 postdocs on the NIST campus.

Postdocs are considered a measure of technology transfer because once their tenure at NIST ends they can take what they have learned at NIST and apply it to other projects outside of NIST. NIST has begun efforts to track postdocs after their initial tenure at NIST. A survey of 290 researchers, who were postdocs with the NIST NRC program between FY 2009 and FY 2013, shows that 43% stayed at NIST,[26] 22% moved to academia, 18% moved to industry, 11% moved to other government agencies, and 6% have either become independent researchers or are unemployed (6%). As more data becomes available, NIST will employ advanced research tools, such as those utilized in the Star Metrics Program,[27] to track and evaluate the post tenure work of postdocs from NIST.

Figure 5 – Tracking Researchers after Initial Postdoc Tenure at NIST (FY 2009 – FY2013)



[24] See: See: http://www.nist.gov/iaao/postdoc.cfm
[25] See: http://www.nsf.gov/statistics/seind12/
[26] Researchers who left their postdoc positions and stayed at NIST were either hired in career conditional / term appointments (25%) or hired in non-career conditional or as term employees, i.e. contractors or guest researchers (19%).
[27] See: https://www.starmetrics.nih.gov/

Guest Researchers
In addition to postdocs, each year thousands of researchers visit NIST to participate in collaborative projects.[28] NIST hosts many term appointment researchers and non-NIST employees working as guest researchers, collaborators, and student fellows. Like postdoctoral researchers, many guest researchers seek career opportunities in academia, the private sector, or federal agencies after their tenure at NIST. While some guest researchers' work at NIST may result in inventions, all guest researchers leave NIST with technical and research skills that place them on the cutting edge of their disciplines. Each researcher takes these skills, knowledge and a desire to employ them in innovative ways to new careers and employers. Further, these researchers ("NIST alumni") know how to collaborate with federal laboratories and what federal resources are available to assist companies in creating and developing new and improved technologies. This reflects NIST's views on technology transfer as involving "people" transferring new knowledge and innovative "things."

NIST will significantly expand mining information related to careers of NIST alumni from existing sources, and study linkages between the mined data and other metrics.

Start-ups and Young Entrepreneurial Companies
NIST recognizes the need to provide both funding and technological support for start-ups and young entrepreneurial companies. There are several means by which NIST and its Joint Institutes nurture young companies, including start-ups in high-growth technology areas.

In addition to financial support provided by the SBIR program and technical support through CRADAs, NIST recently implemented several new licensing options to aid innovators and lower developmental risk for potential partners who wish to obtain and use NIST technology. For example, the Science/Technology Advancement Research (STAR) license provides a no-cost, non-exclusive field-of-use research license to explore and advance NIST technologies for commercialization.

NIST has recently begun evaluating a sample of 25 young companies (existing for five years or less) that have either spun off technologies from NIST or that have receive considerable support in their core area of technical development. NIST expects to eventually track the development of such companies and to assess how working with NIST enables technology transfer and promotes the economic success of start-ups and young entrepreneurial companies.

Calibration and Accreditation Services
The NIST laboratories provide unique physical measurement services for their customers, including calibration services, special tests, and measurement assurance programs. NIST calibration services are designed to help manufacturers and users of precision instruments achieve the highest possible levels of measurement quality and productivity. NIST calibrations often serve as the basis for companies that provide commercial calibration services and calibration equipment.[29]

[28] See: http://www.nist.gov/tpo/collaborations/guestresearchers.cfm
[29] See: http://www.nist.gov/calibrations/index.cfm

The NIST National Voluntary Laboratory Accreditation Program (NVLAP) is a voluntary and fee-supported program to accredit private sector laboratories that are found competent to perform specific tests or calibrations, or types of tests or calibrations. Through NVLAP, NIST efficiently leverages its primary calibration services to support a broader base of secondary calibrations conducted within the private sector.[30]

Table 17 – Calibration Services

	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013
Calibrations					
Number of Calibration Tests Performed	18,609	17,697	18,195	17,206	14,974

Education Outreach Programs and Partnerships

NIST has been recognized[31] as a vital contributor to the efforts in improving science, technology, engineering and mathematics (STEM) education in the United States. As part of its mission, and to help create a long-term and well-qualified workforce for standards and measurement research, NIST has several education outreach programs and partnerships that enrich basic research programs such as:

- the Summer Undergraduate Research Fellowship (SURF) program;[32]
- the Summer High School Internship (SHIP) program;[33]
- the Pathways Program;[34]
- the NIST Summer Institute for Middle School Science Teachers;[35] and
- the Professional Research Experience Program (PREP).[36]

In FY 2013, there were 66 students enrolled in the STEM program and 100 enrolled in the Pathways Program.

NIST provides student and post-doctoral fellows with information on the use of science by industry, and co-sponsors a career fair with other federal agencies and Rockville Economic Development Inc., Rockville, Maryland.

In addition, NIST jointly operates several research organizations that have been established to promote cross-disciplinary collaborations.[37] These include:

- JILA,[38] Boulder, Colorado, a world-class physics research institute jointly operated by NIST and the University of Colorado at Boulder;

[30] See: http://www.nist.gov/nvlap/
[31] The Federal Laboratory Consortium (FLC) gave its 2013 award for excellence in the support of STEM education to Dr. Mary Satterfield, a scientific advisor in the Material Measurement Laboratory at NIST.
[32] See: http://www.nist.gov/surfgaithersburg/index.cfm
[33] See: http://www.nist.gov/hrmd/staffing/ship.cfm
[34] See: http://www.nist.gov/hrmd/staffing/students.cfm
[35] See: http://www.nist.gov/iaao/teachlearn/index.cfm
[36] See: http://www.boulder.nist.gov/bdprepo.htm
[37] See: http://www.nist.gov/locations.cfm

- Institute for Bioscience and Biotechnology Research, Rockville, Maryland an interdisciplinary partnership in cutting-edge biotechnology between NIST and the University of Maryland;
- Joint Quantum Institute, College Park, Maryland, a new institute for advancing quantum physics research that is jointly operated with the University of Maryland; and
- Hollings Marine Laboratory, Charleston, South Carolina, a national center for coastal ocean science, in which NIST is one of five federal, state, and university partners.

Over the last five years, approximately 6,000 students have participated in NIST Seminars. In FY 2013, approximately 1,200 students participated in over 60 NIST measurement and documentary standards seminars. These seminars were taught by scientists from other national metrology institutes, officials from U.S. federal agencies, weights and measures officials from state governments, laboratory staff from U.S. industry calibration laboratories, and middle-school science teachers. In addition to laboratory and classroom courses, NIST offers special webinars to participants.

Small Business Innovation Research (SBIR)

NIST's Small Business Innovation Research (SBIR) program funds science and technology based small businesses in the U.S. The program offers qualified small businesses the opportunity to propose innovative ideas that meet specific NIST research and development needs, and have the potential for commercialization.[39]

NIST has taken the following steps to improve and streamline its SBIR program. NIST has implemented changes to administrative practices, proposal solicitation and review process to reduce the administrative burden on small businesses and time needed to process and issue awards.

1. Streamlining practices to reduce the administrative burden on small businesses and time needed to process and issue awards.
2. Reducing the number of topics and subtopics to balance the work required to obtain proposals while increasing the selection rate for worthwhile proposals. NIST Programmatic Investment Priority Areas in the NIST Three Year Programmatic Plan serve as topics to align SBIR priorities to NISTs mission. The goal is to bring the Phase 1 SBIR award rate up to the national average of 17%.
3. Implementing a two-step review process to evaluate technical feasibility and to maximize investments, catalyze commercialization, and achieve a strategic focus. The first step is a technical evaluation conducted by the NIST laboratories. The second step is prioritization of proposals considered meritorious in the laboratory review through the use of criteria based on the overall NIST strategy and SBIR program goals.
4. Reducing by 10% the time from close of solicitation to award issuance.

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[38] When first established by NIST and the University of Colorado-Boulder, JILA stood for "Joint Institute for Laboratory Astrophysics." At present, according to common usage, JILA simply denotes the joint NIST-UC research institute.

[39] See: http://www.nist.gov/tpo/sbir/index.cfm

Conferences, Seminars, and Workshops
Some of the most important mechanisms for technology dissemination are communication, education, and interaction among researchers, developers and users of technology. NIST hosts numerous conferences, workshops, and other meetings each year to facilitate the transfer of technology.

For example, in FY 2013, the NIST Conference Program arranged for 86 conferences that attracted 8,579 researchers to NIST's facility in Gaithersburg, Maryland and Boulder, Colorado. NIST's Office of Weights and Measures, which promotes uniformity in U.S. weights and measures laws, regulations, and standards, trained over 1,200 weights and measures administrators, laboratory metrologists, and field enforcement officials during the FY 2012 and FY 2013 as part of 52 classroom-based seminars and 45 webinars.

In addition, NIST hosts events sponsored by other organizations that provide metrology training. For example, in FY 2013, NIST hosted Sistema Interamericano de Metrologia (SIM), a consortium of national metrology institutes (NMIs) which attracted 53 students from 29 member nations.

Table 18 – Conferences, Seminars, and Workshops

	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013
NIST Conference Center					
Conferences and Workshops [(a)]	--	--	--	--	86
Attendance [(b)]	--	--	--	--	8,579
Metrology Training					
Office of Weights and Measuress (Metrology Training)					
Seminars	--	--	--	167	446
Webinars	--	--	--	448	110
Workshops	--	--	--	--	55
Students	--	--	--	615	633

(a) A total of 79 conferences were held in Gaithersburg, Maryland and seven conferences were held Boulder, Colorado.
(b) A total of 7,815 attended conferences in Gaithersburg, Maryland and 764 attended conferences in Boulder, Colorado.

NIST will continue to retain current information on metrology training as a metric and is expanding its efforts to include additional information on OU-specific training activities that are conducted for facility users. Further, NIST staff answers e-mail, telephone, and mail inquiries from the public, including inquiries from researchers requesting information and details about NIST technical developments and research results.

Streamlining Technology Transfer
In response to the PM, NIST has undertaken several efforts to streamline and simplify the technology transfer process. NIST has performed a revision of its standard CRADA resulting in several internal updates to expedite review and reducing the overall size of the document by

approximately one third. NIST has also implemented several new licensing programs to encourage small businesses to participate. These programs lay out terms in advance to ease concerns by small businesses about overall costs. NIST is conducting detailed analysis of the flow of documents to understand where significant delays occur within the system. In many cases, these delays are with the partner and NIST does not have direct control. However, by continued efforts to identify and understand issues experienced by partners, NIST will continue to identify new ways to simplify and streamline technology transfer practices.

Table 19 – Streamlining

	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013
Streamlining Efforts					
Average Number of Days to Prepare a Patent Application[(a)]	406	360	407	342	424
CRADA Approval Time[(b)]	179	85	122	145	91

(a) The time between the date an invention disclosure was received and the date the non-provisional patent application was filed.
(b) The time between the receipt of the award memo and the time the memo was approved.

Assessing the Economic Impact of Technology Transfer

As a federal research organization, NIST provides a wide range of public goods and services that private sector sources do not provide. While public sector investments in areas of measurement science, standards and innovative technology solutions are critical for the Nation's sustained economic security and growth, there is a continuing need to demonstrate the value of NIST's investments.

NIST regularly assesses the downstream impact of its research projects and technologies. NIST utilizes a diverse, yet complementary, set of performance indicators and measures to evaluate its programmatic performance over time. NIST's performance evaluation system accommodates the Institute's diverse products, and addresses the intrinsic difficulty of measuring the results of federal investments in scientific and technological products and services. NIST evaluates its performance and plans its work with assistance from peer reviews and other forms of external assessments including customer surveys and independent economic impact studies. From 2000 to 2012, 14 economic impact studies were conducted on NIST research programs. These studies show an overall return on investment ratio of approximately 36:1.[40]

In response to the PM, NIST will commission a series of studies to assess economic impact utilizing the wider range of technology transfer metrics identified earlier in this report. These studies will address the impacts of critical outputs, such as standard reference materials, standards committee participation, CRADA participation, etc.

[40] See: http://www.nist.gov/director/planning/impact_assessment.cfm

NIST is also evaluating other research efforts and has commissioned a review of contemporary literature dealing with efforts to assess federal technology transfer activities.[41] This review focuses on peer-reviewed studies published between 2000 and 2012 that assess the impact of technologies developed in and transferred from federal laboratories. [42]

Of more than 200 studies dealing with the topic of technology transfer and published in this time period, the majority focused on technologies developed at and transferred from academic institutions. About a third focused on federal technology transfer. For each of these studies, Dr Bozeman provided an in depth assessment based on who actually did the transfer, how they did it, what they transferred, and to whom the technology was transferred. This approach, which employs Dr. Bozeman's "Contingent Effectiveness Model", groups the studies according to a set of "effectiveness criterion." These groups are then analyzed according to a set of common traits including advantages and disadvantages of the approaches used. The benefit of using this model is that it not only helps to identify the various approaches use to assess technology transfer but more importantly, it helps to identify the most efficient approaches to use when designing future impact assessment studies.

In addition to the insight gained from using the Contingent Effectiveness Model, the review also provides insight from individual studies as well. For example, with regard to collaborative relationships (i.e. CRADAs) involving both federal laboratories and private companies, studies have shown that the highest marginal benefit (as estimated by the company officials responding) occurs when the company's technical role involves pre-commercial research (but not development) and the federal laboratory's role involves basic research. On the other hand, the least beneficial combination tends to occur when both federal laboratory and private company are engaged in the same role, e.g. both are engaged in basic research, applied research, or product development.

Dr. Bozeman's review also provides some general guidelines on preparing impact studies. Studies involving impact analysis should always begin with well-prepared hypothesis about the domain of influence that a developed technology should have. Assessing impacts should focus upon testing this hypothesis against real world observations. Researchers should be well versed in impact theory and have a clear understanding of the expected scale and scope of the impact in order to avoid statistical estimates that are clearly not feasible.

Through all of these efforts, NIST will continue to improve its ability to measure and analyze the economic impact of its funding decisions and will work to remove barriers that prevent the efficient and timely transfer of technologies to industry.

[41] *Technology Transfer Research and Evaluation: Implications for Federal Laboratory Practice* by Dr. Barry Bozeman.

[42] Dr. Bozeman is the Arizona Centennial Professor of Public Management and Technology Policy and Director of the Center of Organizational Research and Design at the School of Public Affairs, Arizona State University. This paper has recently been submitted for external publication.

Downstream Outcomes from NIST Technology Transfer Activities

Public Safety Broadband Demonstration Network

Before Congress passed the First Responder Network Authority (FirstNet) legislation, issues with cross-organization and cross-jurisdiction communications in the land radio environment hindered the effectiveness of public safety communication among first responders. Specifically, the use of proprietary systems and the non-contiguous spectrum assignments prevented the standardization of nationwide public safety communications.

To address these issues, NIST's Office of Law Enforcement Standards and ITS have jointly created the Public Safety Communications Research (PSCR) Program. With funding from the Department of Homeland Security, this program has initiated the Public Safety Broad Band (PSBB) Demonstration Network that provides a viable platform by which members of the telecommunications industry can work together to design, develop and implement a variety of public safety 700 MHz broadband technologies for the benefit of emergency service agencies nationwide.

Currently the PSBB Demonstration Network is set up as a consortium of seventy-nine members (fourteen of which are small businesses) each with its own consortium CRADA with NIST that provides access to a wide range of resources including infrastructure, supporting tests, equipment, software and hardware.

The Demonstration Network provides multiple phases of testing and evaluation. The first phase, which has been successfully completed, focused on basic functionality tests to determine if the Long Term Evolution (LTE) equipment provided by user equipment manufacturers has been configured properly to achieve at least a minimal level of functionality. The second phase has also been completed successfully. The goal of this phase was to evaluate the performance of the LTE radio network and also evaluate LTE network interoperability between the various CRADA partners and equipment manufactures. The consortium is currently planning their next phase of testing that will include load testing and Quality of Service testing.

Through the creation of a variety of device requirements and minimum operational guidelines, this project provides the means by which manufactures can enhance the designs of new products that will ultimately enable highly effective and interoperable public safety communications. Furthermore, the activities of the consortia which has attracted the largest concentration of 700 MHz public safety LTE equipment manufactures has promoted PSCR's leadership role in developing solutions for network deployment of LTE broadband. The ongoing work has shown the need to develop standardized implementations of LTE, verify implementations of the LTE standard and utilize the commercial industry to meet public safety requirements.

ERCC Controls for Quality of Gene Expression Measurements

NIST has released a Standard Reference Material designed for use with RNA sequencing (RNA-seq), DNA microarrays, quantitative reverse transcription PCR (qRT-PCR), or any other gene expression measurement technology. This reference material, based on the work of the External RNA Control Consortium (ERCC), will pave the path for gene expression studies to enter routine clinical use, enabling doctors to more effectively diagnose patients or design a tailored course of treatment.

The Standard Reference Material (known as NIST SRM 2374, DNA Sequence Library for External RNA Controls) provides a tool that gives users confidence in technical performance of gene expression measurements. With this foundation, scientists now have an effective and simple way to evaluate the performance of a gene expression test and the means to collaborate across laboratories.

The reference material consists of a library of 96 DNA templates (for a total of 86,319 bases) used to make RNA controls that allow users to gauge the technical performance of their gene expression tests. The controls can be added, or spiked in, to RNA samples at the start of any gene expression test to improve measurement confidence. These ERCC controls have already been incorporated into products and protocols by all major vendors of gene expression measurement technologies, including Illumina, Agilent, and Nanostring.

SRM 2374 was certified by NIST for DNA sequence. In addition to the primary Standard Reference Material certified and maintained by NIST, mixes of RNA controls created using the SRM DNA templates are also commercially available. Though initially developed for use with gene expression microarrays, these materials have become an indispensable tool for characterizing new and emerging next-generation sequencing instruments and capabilities.

NIST's Vitamin D Program

The prevalence of vitamin D deficiency or insufficiency in the general population remains a global concern. Measurements of vitamin D in serum or plasma have been particularly challenging and inconsistent. NIST, in collaboration with the Centers for Disease Control (CDC) and the National Institutes of Health (NIH), has developed and released a vitamin D Standard Reference Material used to qualify Vitamin D measurement systems.

Vitamin D deficiency is associated with rickets in children and osteomalacia (bone softening) in adults. A number of studies have linked vitamin D deficiency or insufficiency with increased cancer risk, cardiovascular disease, and autoimmune disorders. Accordingly, testing for vitamin D deficiency has increased dramatically over the past decade to hundreds of thousands of clinical tests each year. However, many studies demonstrate multiple inconsistencies in the measurement of vitamin D, between various techniques, across different labs, and even year-to-year, which impede reliable diagnosis of vitamin D deficiency. Further, these discrepancies limit the ability to interpret or compare data from multiple research studies or to assess the nutritional status for diverse populations.

In response to the need for better vitamin D deficiency diagnosis, NIST developed and deployed SRM 972 (Standard Reference Material 972: Vitamin D in Human Serum) to provide a gold standard for qualifying measurements of vitamin D in patients. It was developed in collaboration with the NIH Office of Dietary Supplements and the CDC. The initial reference material was so widely adopted by the clinical testing community that the first batch of 1450 units sold out in just two years. A renewal material, SRM 972a (Vitamin D Metabolites in Human Serum) was issued in early 2013 and includes value assignments for several commonly tested metabolites of vitamin D, which will further enhance testing accuracy.

NIST Center for Automotive Lightweighting (NCAL)
The NIST Center for Automotive Lightweighting (NCAL) has been established to develop the measurement methodology, standards and analysis needed by enable the U.S. auto industry and base metal suppliers to fully deploy advanced lightweight materials for auto body components. The lighter vehicles made from these advanced materials will have significantly increased fuel efficiency and reduced emissions. Dramatic weight reductions are often achieved through the incorporation of lightweight aluminum alloys, high-strength steels, and polymer composites. However, the data and material models needed to reliably manufacture components from these new lightweight substitutes are inadequate. As a consequence, the U.S. auto industry loses hundreds of millions of dollars every year in lengthy trial-and-error development cycles when designing their metal-forming dies for specific parts.

NIST has responded by developing new measurement capabilities that allow the direct measurement of the stress-strain response of advanced materials under complex (multi-axial) deformations. These measurements allow direct observations of new lightweight materials under the kinds of stress required for high performance applications. Additionally, NIST is working with industrial partners to develop predictive models of the evolving material microstructure during deformation. Currently, industry partners served by NCAL include GM, Ford, Chrysler, US Steel, and Alcoa. In addition, the knowledge and data generated by NCAL are used by industry groups such as the Automotive/Steel Partnership, USCAR, and the American Iron and Steel Institute.

NCAL research has produced new measurement capabilities that have been vetted and disseminated via standards organizations (ASTM E-2492, ISO pending) and direct interactions with companies via regular industry workshops hosted at NIST. NIST scientists provide technical expertise for the Auto/Steel Partnership collaboration 061, an industry consortium focused on understanding the behavior of new lightweight materials. Steel manufacturers have already begun to modify material processing based on emerging NIST measurements and modeling so that the materials they produce are more readily deployed in cars. Automotive manufacturing companies have reported that NIST models and data have helped them significantly reduce die tryout cycles, which will ultimately reduce new model development costs.

Green Button
A new user guide for web developers recently released by NIST will enable electric utilities and vendors to provide customers with tools and applications for convenient access to their energy usage data. These tools and applications were developed as part of the new “Green Button” initiative. Green Button aims to provide electricity and gas consumers with their own energy usage information in an understandable and computer-friendly standardized electronic format via a "Green Button" on a utility's web site. Consumers armed with this information can then use an array of new Web applications to make more informed energy decisions and to verify that their energy-efficiency investments are performing as promised. The User Guide, which is available via the website, provides an overview for those utilities not yet using Green Button, contains information on the composition of Green Button data, how to make Green Button data accessible/comprehensible to users, sample source code showing what data to begin with, as well as examples of finished data sets.

Standard Reference Materials for Cement and Concrete

NIST SRM 2492 is the first SRM for Rheological Properties of Paste Mixtures and was designed to help the concrete industry develop new tests to measure the flow or rheological properties of concrete. There is a need to predict flow properties of cement during mix development and a need to measure flow properties at the construction site to ensure the proper placement and quality of the finished product. The instrument typically used to measure rheological properties of fluids is called a rotational rheometer, in which the tested fluid is sheared between two surfaces, one of which is rotating. Commercial laboratory rheometers are mainly designed for homogeneous liquids containing little or no solid particles, such as polymers, mayonnaise or creams, and are calibrated using a standard oil of known viscosity. However, calibration of non-standard rheometers used to measure flow properties of cement and concrete is nearly impossible using standard oils. To address the issue, SRM 2492 was developed as a paste that can be used to calibrate a conventional rheometer (SRM 2492). Future SRMs currently under development in this series will simulate mortar by adding fine beads to the paste (SRM 2492 with fine beads), and concrete by adding coarse aggregates (mortar with coarser beads).

Standard for Automated Guided Vehicles Advances Technology to Improve Safety and Speed

NIST contributions provided the basis for a significant revision of the ANSI/ITSDF1 B56.5-2012 Safety Standard for Driverless, Automatic Guided Industrial Vehicles and Automated Functions of Manned Industrial Vehicles. Revision of the standards were developed under the direction of the Industrial Truck Standards Development Foundation (ITSDF), and the revisions introduce for the first time the use of non-contact sensing, obstacle detection, and advances in vehicle control. The standard overcomes barriers to adopting new technologies that will allow both increased vehicle speeds and reduction of risk of collisions and injury. Specific NIST contributions to this new standard over a multi-year period included development and evaluation of new test methods to assess safety performance, development of standard test artifacts, evaluation and demonstration of prototype safety systems, and development of the standards document itself. The safety requirements defined by this new standard will be incorporated into new automated industrial vehicle product lines sold in the U.S., and manufacturing industry users of these vehicles will benefit from the increased safety and reduced numbers of accidents and injuries, as well as increased efficiency of operations.

New NIST Test for Firefighter Breathing Equipment

As of Sept. 1, 2013, standard firefighter breathing equipment cannot be certified to National Fire Protection Association (NFPA) standards unless the facepiece lenses pass a new rigorous test developed by NIST. The new test is designed to reduce the degradation and possible failure of the facepiece lens in self-contained breathing apparatus (SCBA) under high-heat firefighting conditions. Under high heat conditions, lenses have been found to bubble, deform, and form holes/crazes, exposing a firefighter to toxic gases and resulting in burns to the respiratory tract as well as asphyxiation. The January 2013 version of NFPA's 1981 standard contains a new "Elevated Temperature Heat and Flame Resistance Test" that exposes the SCBA to 500 °F (260 °C) for 5 minutes in an oven, followed by 10 seconds of direct flame contact. In addition, the new version contains a new "Lens Radiant Heat Test" that subjects the SCBA facepieces to a radiant heat flux of 15 kilowatts per square meter (kW/m^2) for five minutes. As part of this test,

the facepiece is required to maintain an air supply (positive pressure) inside the mask for a total of 24 minutes. The incident radiant heat flux of 15 kW/m^2 was determined by NIST researchers in controlled experiments to be representative of the flux experienced by firefighters approaching the onset of "flashover", a state of total surface involvement in a fire of combustible material within an enclosure. The new test and test conditions are important advances in improving the performance of what has been the most vulnerable component of a firefighter's protective gear in high-heat conditions.

Awards

- Dave Wineland of the Physical Measurement Laboratory has been elected to the National Academy of Inventors' (NAI) 2013 class of Fellows. Election to NAI Fellow status is a high professional distinction accorded to inventors who have demonstrated a highly prolific spirit of innovation in creating or facilitating outstanding inventions that have made a tangible impact on quality of life, economic development, and the welfare of society.

- PML physicists Bryan Barnes and Richard Silver, ITL statistician Nien Fan Zhang, and NIST associate Hui Zhou have earned a prestigious 2013 R&D 100 Award from R&D Magazine for their invention of quantitative hybrid metrology (QHM). QHM integrates statistical techniques and measurements made with two or more instruments to rigorously determine the sizes of nanoscale transistor features on semiconductor chips. The team estimates that a three-fold decrease in measurement uncertainty achievable with this innovation could save manufacturers as much as $7 for each chip—that translates to savings of billions of dollars annually for semiconductor manufacturers. The public-domain invention does not replace chip makers' standard measurement tools, such as scanning electron microscopes and optical devices known as scatterometers. Rather, the new method enhances these tools and ties them together in novel combinations.

CHAPTER 3 National Oceanic and Atmospheric Administration

NOAA's mission is to understand and predict changes in climate, weather, oceans, and coasts; to share that knowledge and information with others; and to conserve and manage coastal and marine ecosystems and resources. This mission will become ever more critical in the 21st century as national issues related to climate change; limited freshwater supply, ecosystem management, and homeland security intensify.

NOAA's technology and innovation enterprise consists of more than 50 laboratories, programs[43], and offices headquartered in Silver Spring, MD, and staffed across the United States, supporting NOAA's four service-based Line Offices: the National Marine Fisheries Service, the National Ocean Service, the National Weather Service, and the National Environmental Satellite, Data, and Information Service, as well as thematic programs including Climate, Aquaculture, Arctic, Ocean Exploration and Research, Weather and Air Quality, and Ocean Acidification. While the service-based Line Offices each have an R&D component, the entire enterprise is also supported by a dedicated R&D Line Office: the Office of Oceanic and Atmospheric Research.

Approach and Plans for Technology Transfer

NOAA's Technology Partnerships Office (TPO), housed under NOAA's Office of Oceanic and Atmospheric Research (OAR), serves as the central point for providing service to all NOAA Labs and external organizations for technology transfer.

During FY 12, in response to President Obama's request to accelerate technology transfer out of federal labs, NOAA developed a 5-Year Plan to improve its technology transfer activities. The following section provides an overview of plan objectives, progress to plan, and updates for 2013.

Optimize TPO (formerly ORTA) Management and Staffing Structure

TPO is the link between internal laboratories and external technology transfer customers. In order to provide the required level of service, TPO reviewed staffing levels and made recommendations in 2011 for appropriate staffing.

Progress to Plan:
TPO reached recommendations staffing levels in 2012 and is now operating with a Program Manager for Technology Transfer and a part-time program assistant.

Next Steps:
TPO is developing a list of contact points for technology transfer within each laboratory, program and office engaged in technology development. This group will act as liaisons with the lab/program, but will also work as extension agents to provide training and enhanced communications from TPO to the scientists in the field. Ideally, these staff will participate in local and regional technology transfer groups as well.

[43] See: http://techpartnerships.noaa.gov/PartneringwithNOAA/NOAALabsScienceCenters.aspx

TPO has a longer term goal to better develop the human capital within the agency by providing detail assignments and entrepreneurial education and training. TPO staff will work closely with other agencies to implement a set of commercialization best practices for NOAA. The goal for these activities will be to maintain and develop a consistent process and framework with other agencies, streamline administrative processes where possible, and take advantage of the lessons-learned from more mature programs. The National Science Foundation *Innovation Corps* is a possible example we would like to implement. In the shorter term, we will seek to use NOAA's Rotational Assignment Program (NRAP), the Knauss Fellowship Program, and other vehicles to engage new staff on a temporary basis.

Lastly, TPO staff will continue training in all aspects of the technology transfer processes to answer staff questions regarding patents, licensing, CRADAs, and other forms of technology transfer. TPO will work closely with designated staff in NOAA's Office of General Counsel and with experts in our sister bureau at NIST to provide consistent and seamless support and minimize the administrative burden on NOAA scientists and staff.

Central Management of Patents

To encourage the broader use of patents in NOAA, TPO will review the feasibility of setting aside a portion of its program funding to support patent application and ongoing patent maintenance fees. Centralized payment capabilities, as well as centralized management of NOAA patents by TPO would reduce the administrative and cost burden on NOAA labs, thereby encouraging staff to disclose their inventions to TPO and more readily seek patent protection for new technologies. Once mature, a centralized management process would allow TPO to develop a more robust and fair process for evaluating which new technologies have the highest licensing potential and have the greatest need for patent protection (see Action 4 below).

Progress to Plan:

TPO has established a central account with the US Patent and Trademark Office for the payment of maintenance and filing fees. We have used this account to offset all maintenance fees and USPTO filing fees in 2012-13. However, this account is currently not included as a budget line item, so there is no guarantee funds will be available to maintain this account in the future.

Next Steps:

TPO will consult with senior management from each Line Office and NOAA's Chief Financial Officer to determine if TPO should include funding of this account in its annual budget, and to determine if funding of all technology transfer fees (including attorney's fees) centrally through TPO would be realistic and beneficial.

Programmatic Advice and Guidance

TPO will work through NOAA's Research Council (RC) to provide advice and general guidance to TPO for technology transfer activities. The RC will provide guidance and advice on issues of strategic importance for NOAA R&D. The RC will also help focus NOAA technology transfer activities to align closely with strategic R&D priorities. Finally, the RC will provide a direct line of communication with NOAA leadership through NOAA's Chief Scientist.

TPO will also create a NOAA-wide coordination group to increase the awareness and facilitate a range of technology transfer activities.

In addition, TPO will closely coordinate with NOAA Line Office Transition Managers to ensure TPO policies and procedures are consistent with their activities as guided by NOAA Administrative Order NAO 216-105.

Progress to Plan:
TPO has successfully implemented this action and is working through the Research Council for guidance. TPO has created a working group at headquarters to facilitate outreach and education, and is participating in the activities of Line Office Transition Manager Committee for NOAA.

Next Steps:
TPO will continue to work through its established network. In the future, TPO hopes to expand the network to include lab liaisons (see Action 1) to further expand the network of technology transfer professionals in NOAA.

Establish Technology Transfer Review Board
Determining technologies for which NOAA should seek patent protection is a key component of the technology transfer process. Currently, there is no process in place for this activity. A NOAA review board would provide inventors the opportunity to present detailed information concerning their technology. The review board would determine which technologies to move forward with based on NOAA mission and which has the highest commercial potential. TPO will work with the RC to determine the best path forward for establishing this proposed board.

Progress to Plan:
TPO has not moved to establish a technology transfer review board to date. Instead, the decision to pursue a patent or other protection is determined through collaboration between the inventor, the lab director, TPO, and NOAA's General Counsel.

Next Steps:
In order to implement this action in the future, TPO will first need to establish a baseline of NOAA's technology and intellectual property portfolio; second, create standard processes for technology transfer where they do not currently exist; third, determine if central funding and management of NOAA IP is realistic and beneficial; and, finally, increase the profile of TPO within the organization to ensure new inventions are disclosed.

TPO is working steadily to educate lab and headquarter staff on the importance of technology transfer in their work and the role of NOAA's TPO. As a part of that process, we are discovering and establishing a baseline of all NOAA technologies and innovations to be tracked. At the same time, TPO is communicating existing processes and developing new standards, as needed. As the program matures, we will explore establishing a technology review board.

Enhance Internal Education on Patents and Technology Transfer Issues
TPO will provide NOAA laboratory and program personnel with training, website resources, forms and templates, as well as extensive background information on program benefits.

Progress to Plan:
TPO continues to train NOAA staff at labs and Headquarters through a combination of on-site training, video-teleconference, telephone calls and website materials. We have budgeted for additional training sessions in 2014, which are pending approval.

Next Steps:
We will continue regular training as possible, based on budget allocations. We will also explore the possibility of incorporating a brief overview of technology transfer into the initial orientation sessions for new scientists. TPO is also working through NOAA's Research Council to determine how we can best incorporate technology transfer performance measures into lab or staff performance plans and evaluations. The goal will be to develop a mechanism that provides positive incentives for the scientists to report new inventions and seek to get them to the public in a way that maximizes the impact of the science and the public investment.

Increase Outreach to Industry
TPO will begin activities designed to better inform the public of the processes and benefits of partnering with NOAA for research and development activities. The activities may include:

- **Website Redesign**: We will redesign TPO website to feature pending opportunities, benefits, success stories, and answers to FAQs for staff, private companies, or other entities looking to partner with NOAA.
- **Trade Show Marketing**: TPO staff will attend selected events and trade shows to meet with target audiences and distribute ORTA marketing materials.
- **Targeted Meetings**: TPO staff will meet with select trade associations and NGOs to increase awareness of technology transfer opportunities and brainstorm methods of increasing technology transfer activities with NOAA.
- **Joint Meetings with DoC Partners:** TPO staff will collaborate with its sister bureaus in DOC and in other agencies to initiate joint outreach and promotional activities.

Progress to Plan:
TPO successfully rolled out a complete web redesign in FY 2013. The design has been very well received and is highly placed on NOAA's homepage and in search engine results.

TPO has also undertaken a plan to work closely with state and local development offices on a regional level. We have begun initial conversations with groups in Maryland, California, Mississippi, and Colorado.

TPO has worked closely with NIST on training for employees and will continue to collaborate closely with their TPO for both best practices and training.

Next Steps:
TPO will continue to build on its regional strategy by setting up targeted trainings and visits with outreach groups in specific regions. For 2014, we will be working specifically on the Southeast U.S., as there is a high concentration of active NOAA facilities and a number of good potential state and local partners. We will also seek to have our lab liaison network included in the Federal Laboratories Consortium regional meetings and activities.

Develop Database of NOAA Technologies and Opportunities

An important component of TPO's plan to improve management of NOAA's technology transfer activities will be a database to easily track and monitor basic information on CRADAs, MOUs, invention disclosures, and patents (including status and regular maintenance fees). Tracking this basic information will allow staff to develop regular reports without adding administrative burden to the labs and will provide easy tracking of metrics.

In addition, TPO envisions a portion of the Laboratory Technology Transfer Representative's time would be spent compiling a list of technologies available in their respective Laboratory. These technologies and capabilities would be tracked in the data base and provided to the public through the TPO website.

TPO is currently exploring a number of internal NOAA and existing technology transfer database capabilities for hosting NOAA technology transfer data. The focus of TPO's effort will be to use existing capabilities to meet these needs and not recreate or duplicate efforts.

Progress to Plan:
TPO has developed an internal database to house technology transfer and SBIR information. While the database is limited in its functionality, TPO is now able to quickly query the information and report out on the status of NOAA's intellectual property portfolio.

For the first time, the data call for this annual report was pre-populated with data from the database. This step simplified the data call to the labs by changing the focus to mostly data validation and reporting of missing information.

Next Steps:
Despite progress in this area, TPO has a number of steps to improve this action. First, the database capabilities will need to be enhanced to improve data query and report generation. TPO will continue with these enhancements in-house and at minimal expense while a planned NOAA-wide R&D database is completed. Eventually, we foresee including a technology transfer component into the full NOAA R&D database.

In the meantime, reporting and maintenance of the data continues to be a significant challenge we will continue to address. We believe establishing liaisons at the individual laboratories will have a broader impact than we have been able to achieve to date.

Improve Performance Measurement and Tracking

NOAA has identified eight performance measures as an initial basis to track the effectiveness of its technology transfer. TPO will review this set annually and update measures to ensure NOAA's ability to effectively monitor its performance. NOAA's TPO will request reporting of these performance measures quarterly to determine progress toward quarterly and annual goals. We believe individual performance results will vary even under ideal programmatic circumstances. However, taken as a whole, we believe this set of performance metrics will offer an accurate snapshot of NOAA's ongoing technology transfer activities and will provide valuable insight for TPO to structure its education and training activities in the future.

Progress to Plan:

For this report, we have added a number of metrics we hope to track both anecdotally and with specific data. We have included trademark filings as a specific data metric in this report and will continue to track new trademark filings as part of our intellectual property portfolio.

We have also added anecdotal reporting for visiting scientists and facilities use agreements. NOAA works regularly with visiting scientists, both domestic and international. However, reporting is not always easy or obvious, as many of these "visiting" scientists are actually from our Cooperative Institutes (CI) and are treated as regular staff at the labs. For now, we have reported the number of CI staff receiving more than 50% of their funding from NOAA and we have reported international visitors in the text below.

Facilities use agreements are not a large part of NOAA's technology transfer portfolio, but will likely grow in the future. We are working to catalogue the full scope of facilities use agreements for possible future reporting.

We are also gathering information on materials transfer agreements. As with facilities use, materials transfer is a smaller part of the portfolio, but one that could be tracked moving forward.

This year we have also dropped a metric, which was website hits from one NOAA laboratory. We do not believe this metric was representative of the broader NOAA and was not particularly valuable from a technology transfer perspective. We have other possible web metrics we may include in the future.

Next Steps:

TPO will continue to gather data on NOAA's portfolio in an effort to get more complete and accurate reporting of valuable metrics. Materials transfer, facilities usage, and visiting scientists will all be a focus for future inclusion in this report.

In addition, we will carefully explore measures that speak to the impact of NOAA science and technology transfer. Specifically, we will look at citations on NOAA publications, not just the publications counts. We will also consider adding metrics for

easily reported, but meaningful, web statistics (data downloads, number of partners using data sets or decision support tools) that demonstrate impact.

TPO will also follow closely the efforts of interagency groups to establish meaningful measures across the federal government. Over the next five years, we will adopt new measures to continue to improve our reporting at the least cost in terms of effort to our lab staff.

NOAA Work Products and Collaborative Activities

Cooperative Research and Development Agreements and MOUs

NOAA's labs executed seven new CRADAs and two new MOUs to bring the total reported NOAA portfolio of cooperative engagements to 29.[44] There are four additional cooperative agreements under negotiation.

Table 20 – Collaborative Relationships for Research & Development

	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013
NOAA CRADAs and MOUs	--	--	--	--	29
New, Executed	--	--	--	--	9
Traditional CRADAs,[(a)] Total Active[(b)]	5	6	7	10	15
New, Executed	2	2	2	4	7
Non-Traditional CRADAs, Total Active	0	0	0	0	0
New, Executed	0	0	0	0	0
Other Types of Collaborative R&D Relationships[(c)]					
MOUs	--	--	--	--	14
New, Executed	--	--	--	--	2

(a) Traditional CRADAs involve collaborative research and development projects by a federal laboratory and non-federal partners. Non-traditional CRADAs are used for special purposes, such as laboratory accreditation, materials transfer or technical assistance that may result in protected information.
(b) "Active" means an agreement in force at any time during the fiscal year. "Total active" is comprehensive of all agreements executed under CRADA authority (15 USC 3710a).
(c) First year reporting of Memorandum of Understanding (MoU) figures.

Inventions, Patents, and Licensing

In 2013, NOAA researchers disclosed eight new inventions, received one patent, filed two provisional patent applications, and one full patent application. NOAA inventors are also listed in two other provisional patent filings made in conjunction with academic partners (University of Colorado, University of New Hampshire). In addition, NOAA voluntarily let one unlicensed patent expire, bringing its total patent portfolio (intramural and extramural) to 25.

[44] Prior to 2013, NOAA's Technology Partnerships Office (TPO) has only tracked CRADA data. This year, TPO has requested MoU information to provide a more comprehensive view of the collaboration portfolio. These data are preliminary, so they are not included in the metrics section below. Once data are validated over the course of two or more reporting periods, we may revise our metrics to include MoU data.

NOAA continues to maintain four active licenses on its technologies and is actively pursuing licensing agreements on its newly patented technologies.

Table 21 – Invention Disclosure and Patenting

	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013
New Inventions Disclosed	4	1	1	0	8
Patent Applications Filed	1	1	0	1	3
Patents Issued	0	2	2	2	1

Table 22 – Profile of Active Licenses

	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013
All Licenses, Number Total Active[(a)(b)]	7	6	6	5	4
New, Executed	1	0	0	0	0
Invention Licenses, Total Active	7	6	6	5	4
New, Executed	0	0	0	0	0
Patent Licenses,[(c)] Total Active	7	6	6	5	4
New, Executed	0	0	0	0	0
Material transfer licenses total active[(d)] (Inventions)	0	0	0	0	0
New, Executed	0	0	0	0	0
Other Invention Licenses, Total Active	0	0	0	0	0
New, Executed	0	0	0	0	0
Other IP Licenses, Total Active	0	0	0	0	0
New, executed	0	0	0	0	0
Copyright Licenses (Fee Bearing)	0	0	0	0	0
New, Executed	0	0	0	0	0
Material Transfer Licenses, Total Active (Non-Inventions)	0	0	0	0	0
New, Executed	0	0	0	0	0
Other, Total Active	0	0	0	0	0
New, Executed	0	0	0	0	0

(a) 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.
(b) "Active" means an agreement in force at any time during the fiscal year.
(c) Patent license tally includes patent applications which are licensed. One-Time License only with one-time flat fee royalty
(d) NOAA is not currently tracking MTAs and related agreements

Table 23 – Licensing Management

	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013
Elapsed Execution Time,[(a)] Licenses Granted					
Invention Licenses					
Average, Months	7	7	7	7	7
Minimum	--	--	--	--	--
Maximum	--	--	--	--	--
Patent Licenses [(b)]					
Average, Months	7	7	7	7	7
Minimum	--	--	--	--	--
Maximum	--	--	--	--	--
Licenses terminated for cause					
Invention Licenses	0	0	0	0	0
Patent Licenses [(c)]	0	0	0	0	0

(a) Data included in this table (intentionally) addresses only invention licenses, with patent licenses distinguished as a sub-class. No new licenses were executed in FY 2008, FY 2012, or FY2013.

(b) 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.)

(c) Patent license tally includes patent applications which are licensed.

Table 24 – Characteristics of Licenses Bearing Income

	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013
All Income Bearing Licenses, Total Number[(a)]	5	4	3	3	4
Exclusive	0	0	0	0	0
Partially exclusive	0	0	0	0	0
Non-exclusive	5	4	3	3	4
Invention Licenses, Income Bearing	5	4	3	3	4
Exclusive	0	0	0	0	0
Partially exclusive	0	0	0	0	0
Non-exclusive	5	4	3	3	4
Patent licenses,[(b)] Income Bearing	5	4	3	3	4
Exclusive	0	0	0	0	0
Partially exclusive	0	0	0	0	0
Non-exclusive	5	4	3	3	4
Other IP Licenses, Income Bearing	0	0	0	0	0
Exclusive	0	0	0	0	0
Partially exclusive	0	0	0	0	0
Non-exclusive	0	0	0	0	0
Copyright Licenses (Fee Bearing)	0	0	0	0	0
Exclusive	0	0	0	0	0
Partially exclusive	0	0	0	0	0
Non-exclusive	0	0	0	0	0
All Royalty Bearing Licenses,[(c)] Total Number	5	4	3	3	4
Invention Licenses, Royalty Bearing	5	4	3	3	4
Patent Licenses, Royalty Bearing	5	4	3	3	4
Other IP Licenses, Royalty Bearing	0	0	0	0	0
Copyright Licenses (Fee Bearing)	5	4	3	3	0

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

Table 25 – Income from Licenses

	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013
Total Income, All Licenses Active [a]	$138,444	$35,044	$107,220	$100,867	$48,798
Invention Licenses	$138,444	$35,044	$107,220	$100,867	$48,798
Patent Licenses [b]	$138,444	$35,044	$107,220	$100,867	$48,798
Other IP Licenses, Total Active	0	0	0	0	0
Copyright Licenses					
Total Earned Royalty Income (ERI) [c]	$138,444	$35,044	$107,220	$100,867	$48,798
Median ERI	$19,000	$5,000	$34,000	$9,902	$11,000
Minimum ERI	$1,000	$1,000	$1,000	$1,000	$1,000
Maximum ERI	$75,000	$17,044	$69,000	$89,965	$36,798
ERI from Top 1% of Licenses	$75,000	$17,044	$69,000	$89,965	$36,798
ERI from Top 5% of licenses	$75,000	$17,044	$69,000	$89,965	$36,798
ERI from Top 20% of Licenses	$75,000	$17,044	$69,000	$89,965	$36,798
Invention Licenses	$138,444	$35,044	$107,220	$100,867	$48,798
Median ERI	$19,000	$5,000	$34,000	$9,902	$11,000
Minimum ERI	$1,000	$1,000	$1,000	$1,000	$1,000
Maximum ERI	$75,000	$17,044	$69,000	$89,965	$36,798
ERI from Top 1% of Licenses	$75,000	$17,044	$69,000	$89,965	$36,798
ERI from Top 5% of Licenses	$75,000	$17,044	$69,000	$89,965	$36,798
ERI from Top 20% of Licenses	$75,000	$17,044	$69,000	$89,965	$36,798
Patent Licenses [2]	$138,444	$35,044	$107,220	$100,867	$48,798
Median ERI	$19,000	$5,000	$34,000	$9,902	$11,000
Minimum ERI	$1,000	$1,000	$1,000	$1,000	$1,000
Maximum ERI	$75,000	$17,044	$69,000	$89,965	$36,798
ERI from Top 1% of Licenses	$75,000	$17,044	$69,000	$89,965	$36,798
ERI from Top 5% of Licenses	$75,000	$17,044	$69,000	$89,965	$36,798
ERI from Top 20% of Licenses	$75,000	$17,044	$69,000	$89,965	$36,798
Other IP Licenses, Total Active	0	0	0	0	0

(a) Total income includes license issue fees, earned royalties, minimum annual royalties, paid-up license fees, and reimbursement for full-cost recovery of goods & services provided by the lab to the licensee including patent costs.

(b) Patent license tally includes patent applications which are licensed.

(c) "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.

Table 26 – Disposition of License Income

	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013
Income Distributed [(a)]					
Invention Licenses, Total Distributed	$138,444	$35,044	$107,220	$100,867	$48,798
To Inventor(s)	$45,153	$14,514	$34,266	$35,331	$16,740
	-33%	-41%	-32%	-35%	-34%
To Other	$93,291	$20,530	$72,954	$65,536	$32,058
	-67%	-59%	-68%	-65%	-66%
Patent Licenses, [(b)] Total Distributed	$138,444	$35,044	$107,220	$100,867	$48,798
To Inventor(s)	$45,153	$14,514	$34,266	$35,331	$16,740
	-33%	-41%	-32%	-35%	-34%
To Other	$93,291	$20,530	$72,954	$65,536	$32,058
	-67%	-59%	-68%	-65%	-66%

(a) Invention licenses are the chief policy interest regarding disposition of income; content of table reflects this focus. Income includes royalties and other payments received during the FY.
(b) Patent license tally includes patent applications which are licensed.

Trademark and Copyright

NOAA has not tracked trademarked and copyrighted materials in the past, but has requested this information moving forward. A search of the USPTO database has revealed a total of 82 live trademarks for NOAA products, services, and logos. This year, the National Weather Service has reported two additional trademarks were filed for their Turn Around, Don't Drown educational campaign.

Table 27 – Trademark and Copyright

	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013
New Trademarks Disclosed[(a)]	--	--	--	--	2
New Copyrights Disclosed[(a)]	--	--	--	--	0

(a) Trademark and Copyright is a new metric NOAA is introducing for 2013. Copyright filings will only be international, if any.

Although much of the science in NOAA laboratories is transitioned internally for operational purposes, NOAA science and data products are also routinely provided to the public free of charge in service to NOAA's mission of protecting lives and property.

Data Products and Services

NOAA scientists provide details of their research and technology to the public in the form of information products and services. These include weather and climate forecast data, El Niño prediction and monitoring, tides and currents, satellite imagery, fishery statistics, information on protected species, air quality, coastal conditions, beach temperatures, nautical charts, and databases on climate, oceans, ice, atmosphere, geophysics and the sun. These data are provided, often in real-time, through the network of NOAA data centers and websites.

Decision Support Tools
NOAA labs also develop dedicated decision support software tools that enable the use of our data to meet specific public management and decision-support needs. In some cases these sites are developed in conjunction with academia and private sector partners.

Cooperative Institutes
NOAA is proud to support our Cooperative Institute (CI) partners, and within the NOAA we spent $168M across all of our existing 16 CIs in FY 2013. This funding supported work at 41 universities in 27 states and the District of Columbia. In addition, NOAA executed $12M in funding from the Disaster Relief Appropriations Act, 2013 through the CIs for a total investment of $180M.

Visiting Scientists and Facilities Use
In addition to NOAA's Cooperative Institutes, a number of NOAA labs transfer technology by hosting visiting scientists, both domestic and international, as well as by allowing public use of portions of NOAA facilities.

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, NOAA receives technology that may eventually benefit U.S. industries and public users. For example, the understanding and forecasting of global phenomena that occur in the atmosphere, oceans, and on the sun require 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 participates in international scientific programs, such as in the Global Earth Observation System, and shares technology and scientific data. This effort involves nearly 50 countries, the European Commission, and 29 international organizations. NOAA also provides technical assistance and training to individuals from other countries, and participates in an international visiting scientist program. Further, NOAA shares environmental data through its participation in the World Data Center program.

- **MICAPS Delegation Aug 19-21, 2013**
  A China Meteorological Administration (CMA) delegation led by Mr. XIAOXIANG ZHU, Deputy Director-General of the National Meteorological Center (NMC) in Beijing, visited from August 19 through 21 the NWS Office of Science and Technology (OST) in Silver Spring and the National Centers for Environmental Prediction (NCEP) at College Park. The visit was conducted under the auspices of NOAA-CMA bilateral agreement for Cooperation in Atmospheric Science and Technology. The purpose of the visit was to exchange information on development of the two service's core weather analysis and display systems – NWS AWIPS-2 and CMA's Meteorological Information Comprehensive Analysis and Processing System (MICAPS-3). MICAPS-3 uses an Open Architecture based on a LINUX Operating System to combine a range of core operations including weather analysis and forecasts. The CMA NMC provided OST's MDL with a comprehensive overview of the MICAPS-3 including current state of implementation in China and future improvements.

Although developed by CMA for use in its weather forecast offices, MICAPS-3 is used by other China ministries and academia. MICAPS-3 has several innovative features including Severe Weather Auto Nowcasting (SWAN) and a Fine Forecast User Support Environment (FUSE). CMA still relies on its forecasters editing forecast grids whereas the NWS is transitioning forecasters more to Impact Decision Support Services. CMA has extended an open invitation to MDL to visit CMA in Beijing to discuss digital forecast processes and as well as view MICAPS demonstrations.

- **Ongoing interactions between NWS and Taiwan Central Weather Bureau**

NWS Office of Science and Technology/Meteorological Development Laboratory are hosting rotating visiting scientists (usually 6 months) from the Taiwan Central Weather Bureau to work on AWIPS II development. This activity is conducted under the auspices of the American Institute in Taiwan - Taipei Economic and Cultural Representative Office (AIT-TECRO). NOAA's Agreement with AIT-TECRO is managed by OAR's ESRL/GSD; the AWIPS II activity is under Arrangement 5 of this Agreement. A 31 August 2011 NOAA/OAR/ESRL/GSD "Memo to Record" describes export control of the AWIPS II Software. OST/MDL's Stephan Smith and/or Lingyan Xin can provide more information as required.

- **Visiting Scientist from Japan Meteorological Agency**

Jun Ryuzaki, visiting scientist from Japan Meteorological Agency, served a six-month fellowship with the NWS/Office of Climate, Water, and Weather Service/Aviation Weather Services Branch, September 2012 - March 2013

- **Southwest Fisheries Science Center – Ocean Technology Development Tank**

A testing ground for the sensors, submersibles, and other devices emerging from the workshops of NOAA scientists and engineers, the Tech Tank will hold as much water as twenty-five back yard swimming pools, and it will be the only tank of its size in the world that can be controlled for both temperature and salinity. From tropical temperatures to polar, and from freshwater to salt, scientists will be able to test their equipment under the broad range of conditions they find in the field.

Another thing that sets this tank apart: it will have life support systems for a variety of marine animals. Many sensors developed by NOAA scientists are designed to remotely detect marine species and measure their distribution and abundance. Having live organisms in the tank will allow scientists to calibrate their instruments against the real thing.

The research boost will benefit non-NOAA scientists as well. With the largest tank of its kind in the world, this testing facility is a national asset that will be shared with partners and colleagues from other agencies and nations, from universities, and from the military.

"This tank will allow us to test the engineering of our instruments under near-real conditions, where you have the variability of the oceans and the presence of live organisms," said Cisco Werner, Director of NOAA's Southwest Fisheries Science Center. "Having a facility where you can do that is what makes this Science Center unique."

Technical Publications[45]

In 2013, NOAA's TPO began tracking its publications centrally through a Web of Science analysis. In previous years, the data were obtained through a data call to the agency. Although each methodology has some drawbacks, the tracking through Web of Science will allow us to conduct a more detailed impact analysis by including citations beginning in 2014.

Table 28 – Technical Publications

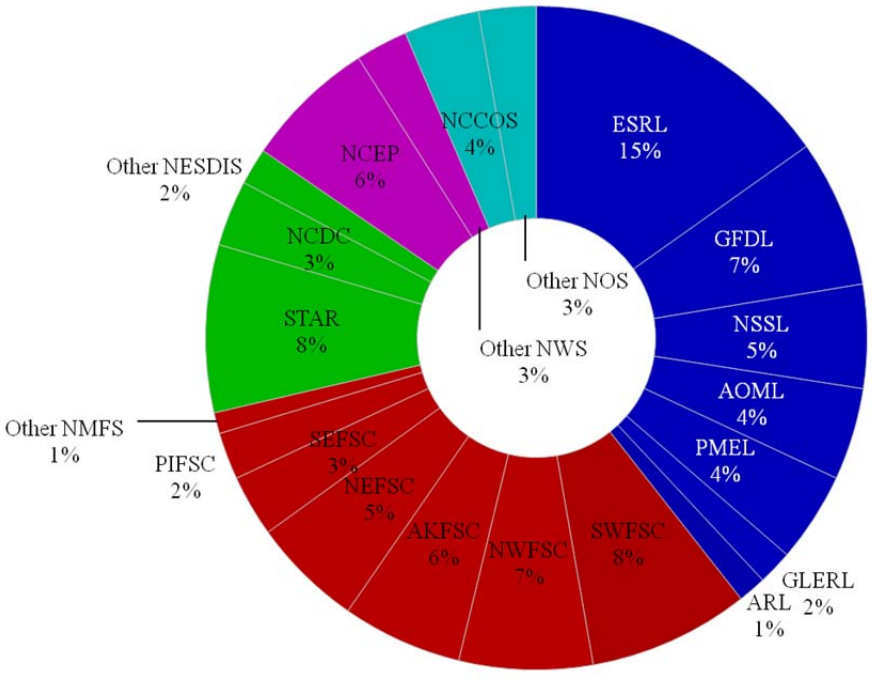
	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013
Journal Articles Published	789	709	1,034	1,769	1,781[(a)]
Technical Reports Published	186	161	151	250	82[(b)]

(a) Web of Science search result through NOAA Central Library.
(b) NOAA Central Library search result on 2013 publication date, "technical" series type.

In FY 2013, peer-reviewed publications by NOAA scientists totaled 1,781. The following charts show the breakdown of publications by NOAA R&D unit, as well as co-authorship by institution and Country. In future versions of this report, we hope to provide a more detailed analysis of citations for our publications to give a better sense of the impact these publications had in their field.

[45] NOAA publications data for 2013 were derived on November 15, 2013, using queries through the Web of Science database. As a result of variations in titles and nomenclature, these data do not provide a comprehensive measure of all NOAA publications. This reporting includes only those publications by NOAA scientists that were captured by the search queries. Extramural publications funded by NOAA either directly or indirectly are also not included.

Figure 6 – Intramural Publications per R&D Unit



AKFSC - Alaska Fisheries Science Center
AOML - Atlantic Oceanographic Meteorological Laboratory
ARL - Air Resources Laboratory
ESRL - Earth Systems Research Laboratory
GFDL - Geophysical Fluid Dynamics Laboratory
GLERL - Great Lakes Ecosystems Research Laboratory
NCCOS - National Center for Coastal Ocean Sciences
NCDC - National Climate Data Center
NCEP - National Centers for Environmental Prediction
NEFSC - Northeast Fisheries Science Center
NESDIS - National Environmental, Satellite, Data and Information Service
NMFS - National Marine Fisheries Service
NOS - National Ocean Service
NSSL - National Severe Storms Laboratory
NWFSC - Northwest Fisheries Science Center
NWS - National Weather Services
PIFSC - Pacific Islands Fisheries Science Center
PMEL - Pacific Marine Environmental Laboratory
SEFSC - Southeast Fisheries Science Center
STAR - Center for Satellite Applications and Research
SWFSC - Southwest Fisheries Science Center

Figure 7 – Co-Authored Publications per Institution (top 15)

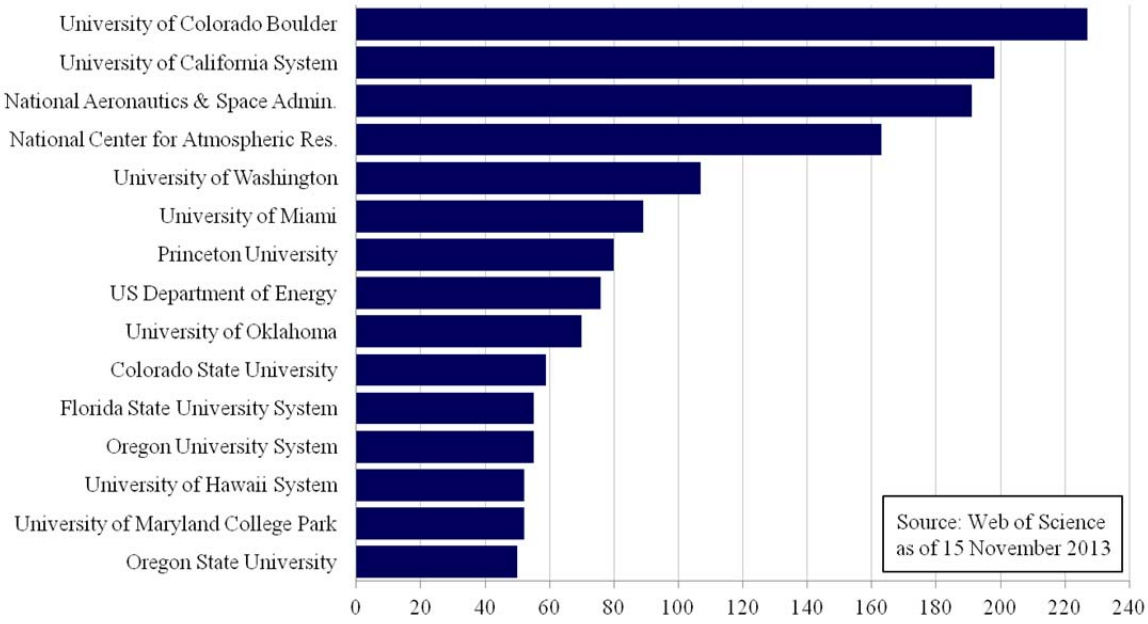
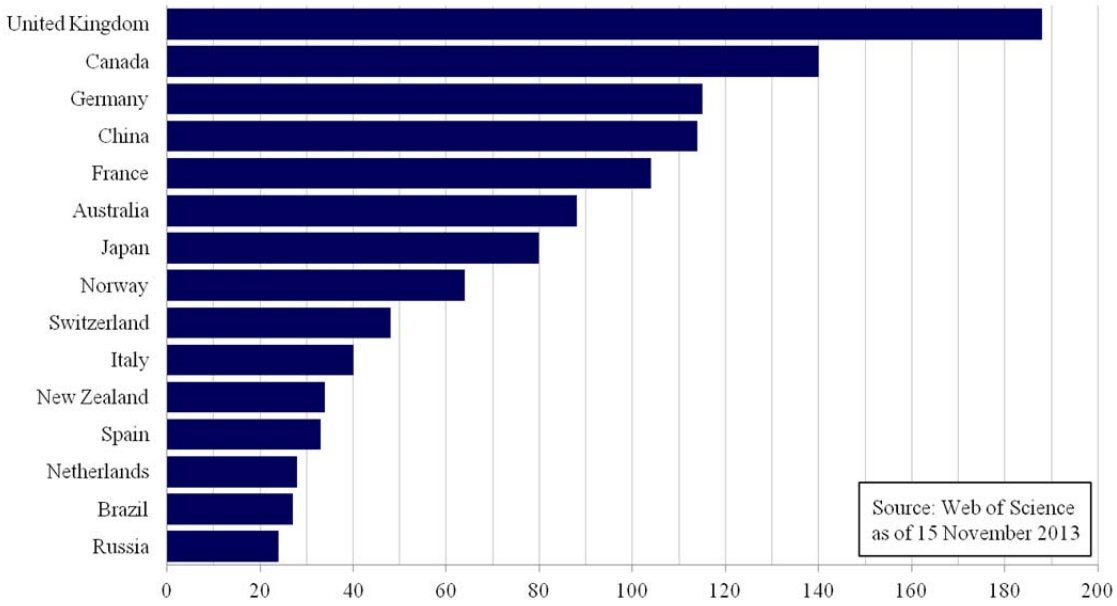


Figure 8 – Co-Authored Publications per Country (Top 15)



Downstream Outcomes from NOAA Technology Transfer

Research across NOAA's laboratories is primarily aimed at improving the ability of the operational components to accomplish their respective missions. Recent examples demonstrating the direction of NOAA's research are severe storm (hurricane, tornado, derecho winds) and drought forecasting, physical forecasts for renewable energy siting, predicting fresh water resources, tsunami warnings, air quality measurement, solar emission forecasting, monitoring and estimating of fish stocks and species health, coastal habitat monitoring and pollution, invasive species monitoring, coral reef health, ocean acidification, coastal/ocean disaster response and restoration, charting ocean bottom topography, and a wide variety of climate research and the impacts of a changing climate on human health, coastal zone management, and oceans. Research results are transferred to NOAA's operational components to improve prediction, management, and other mission activities.

The U.S. Weather Enterprise: a $5 Billion Industry Enabled through Tech Transfer
About one-third of the U.S. economy (approximately $3 trillion) is weather sensitive. Industries related to agriculture, energy, construction, health, travel, and transportation are almost entirely weather dependent. Weather data and forecasts play a critical role in these major economic sectors. NOAA's operations in the areas of weather and climate form the backbone of a thriving Weather and Climate Enterprise, including the federal government, the private sector, and the academic sector. Together all three sectors serve the nation's need for weather and climate services. The private sector in the Weather and Climate Enterprise is a thriving business including the media, private consultants, and equipment manufacturers supporting the weather industry. Current estimates are that this is a $5 billion industry. The private sector relies on NOAA observations and forecasts as the foundation of their business. Transfer of these data to our partners in the private sector is vital to the success of this industry.

Ocean Service Signs CRADA with Biosortia Pharmaceuticals
The National Ocean Service, National Centers for Coastal Ocean Service, Center for Human Health Risk at Hollings Marine Laboratory (CHHR/HML) and Biosortia Pharmaceuticals dba Alagaeventure Systems (AVS) entered into a CRADA in 2013 to conduct R&D for the analysis and purification of novel bioactive compounds. If successful, this research will result in the commercial development of new and unique chemical compounds from the sea which have benefits to human health, either through disease prevention or new treatments for disease.

Ocean Exploration Telepresence Brings Science and Exploration to the Masses
NOAA's Office of Ocean Exploration and Research continued to build a cadre of "citizen scientists" on shore who participate virtually in ocean expeditions at sea. The Ocean Explorer website[46] shattered all previous traffic records in August, receiving around 1.9 million visits. About 870,000 of those were to the live video feeds from deep-sea canyons[47] off the U.S. northeast coast, which were accompanied by real-time commentary from scientists both aboard the *Okeanos Explorer* and ashore. The previous monthly record was about 964,000 visits set in July 2013. Every month since February has broken records set in previous years, and the site is on pace this year to exceed 11 million visits – which would surpass 2012 visits by over 4 million.

[46] See http://go.usa.gov/DQu5
[47] See http://go.usa.gov/DQuV

National Weather Service Corpus Christi Provides Data for Coastal Flood Assessment
The National Weather Service office in Corpus Christi, Texas, shares a variety of data from various models on a daily basis with Texas A&M Corpus Christi's Conrad Blucher Institute (CBI). These data sources are primarily used in the prediction of tidal levels for the Middle Texas Coast. The forecasters at Weather Forecast Office (WFO) Corpus Christi and persons with marine and beach interests greatly benefit from these tidal level forecasts. From the WFO Corpus Christi perspective, these forecasts provide a valuable tool in assessing the potential for coastal flooding.

National Weather Service Little Rock Provides Geospatial Data for State Operations during Tornados
On April 10, 2013, an EF2 Tornado touched down at Clinton, AR. The track was 17.3miles long and 800 yards wide. That same day, four additional Tornadoes also touched down. Shortly after this event, the National Weather Service provided subjective, storm-centroid tracks, to the Arkansas Geographic Information Office, which was then distributed to a number of other state agencies, including the Arkansas governor's office, Arkansas Department of Emergency Management, and local government agencies. These data assisted with the decision support services provided by WFO Little Rock , AR, for "Rescue and Recovery" efforts immediately following the tornado touchdown. The Storm Damage Survey lasted a couple days and follow-up information were given each day by the WCM to other Law Enforcement personnel and AR Emergency Management working the detail.

National Weather Service/National Hurricane Center Collaborates with Commercial Venture to Introduce new Communication System for Critical Weather Information:
In 2010, NOAA's National Hurricane Center (NHC) entered into a CRADA with America's Emergency Network, Inc. (AEN), whereby regular briefings with NHC specialists during land-falling hurricanes would be broadcast from a fixed, ceiling-mounted camera and linked through an Internet system at NHC via its website to the AEN website, permitting anyone with a personal computer to view the broadcasts.

From 2010 to 2012, the system was used experimentally during four tropical cyclone threats to the U.S. - 2010's Hurricane Earl, 2011's Hurricane Irene and 2012's Hurricane Isaac and Hurricane Sandy. After each event, NHC worked closely with AEN to recommend improvements to the site and process.

In 2012, AEN was sold to Weather Decision Technologies (WDT) and NOAA extended the CRADA until December 2013. NOAA used the technology in 2013 for Tropical Storm Karen, which had prompted a hurricane watch along the Gulf Coast. . The NHC would like to implement this technology and is exploring appropriate legal mechanisms to allow delivery of hurricane warning messages to hurricane-threat zones where there are no direct communication links between them and NHC.

Geophysical Fluid Dynamics Laboratory Delivers State-of-the-Science Climate Model Results (GFDL)

The Coupled Model Intercomparison Project[48] is an international effort to improve climate models by comparing multiple model simulations to observations and to each other. These comparisons can help our understanding of past and future climate changes, and also lead to climate model improvements.

Together, these models have produced over 180 terabytes of data that are publically available on GFDL's Data Portal[49] and through the Earth System Grid Federation.[50] To date, over 150 terabytes of data have been downloaded to over 25 institutions in North America, 11 in Europe, nine in Asia, four in Australia, and two in Russia.

Great Lakes Environmental Research Laboratory Transitions Satellite Ice Classification Algorithm for Operational Use

A satellite synthetic aperture radar (SAR) algorithm to classify and map Great Lakes ice types, co-developed by NOAA (GLERL) and NASA (JPL), has been transitioned to operational production at NOAA's National Environmental Satellite, Data, and Information Service (NESDIS). The method uses a library that translates digital data from satellite radar instruments such as the Canadian Space Agency's RADARSAT-1/2, the European Space Agency's European Remote Sensing Satellite 2 (ERS-2), and Envisat to identify and map different types of ice over the Great Lakes. This is done by pairing the satellite SAR observed ice type to a unique library of radar polarimetric backscatter signatures from ice types measured on the lakes using advanced C-band radar aboard a U.S. Coast Guard icebreaking ship. The method has now been transitioned to NESDIS for routine use in generating ice type maps across the Great Lakes. These maps will provide important information for environmental management, ice forecasting and modeling, off-shore wind farm development, operational ice breaking activities in support of winter navigation, and science research. This work was awarded NOAA's Bronze Medal Award for research and development of an algorithm for automatic lake ice classification utilizing satellite radar data.

NOAA Great Lakes Lab Provided Leadership in a Special Issue of the Journal of Great Lakes Research on Remote Sensing of the Great Lakes and Other Inland Waters

NOAA scientist Dr. George Leschkevich was co-guest editor along with Michigan Tech Research Institute Dr. Robert Shuchman on a 219 page special collaborative journal issue which included 20 peer-reviewed articles covering satellite, airborne, ship-borne, and in-situ remote sensing describing product development, data collection and analysis of the Great Lakes and other inland waters. Collaborators with NOAA's Great Lakes Environmental Research Lab (GLERL) included (in no particular order):

- Michigan Sea Grant
- NASA Jet Propulsion Laboratory (JPL)
- NOAA National Centers for Coastal Ocean Science (NCCOS)
- U.S. Fish and Wildlife Service

[48] See http://www-pcmdi.llnl.gov/projects/cmip/
[49] See http://data1.gfdl.noaa.gov/
[50] See http://esgdata.gfdl.noaa.gov/esgf-web-fe/

- U.S. Army Corp of Engineers
- Michigan Technological University Research Institute (MTRI)
- University of Minnesota Large Lakes Observatory and Department of Physics
- Indiana University
- Purdue University
- University of Massachusetts
- University of Michigan
- Upstate Freshwater Institute (New York)
- Wisconsin Department of Natural Resources
- Canada Centre for Inland Waters (CCIW)
- Nansen International Environmental and Remote Sensing Centre (Norway)
- Max Planck Institute for Meteorology (Germany)
- Veolia Environnement Recherche et Innovation (France)

Buoy System Power Controller Design Provided to Vendors
The technology to build the System Power Controller (SPC) module designed by scientists at NOAA's Great Lakes lab and used in the Realtime Coastal Observation Network (ReCON) buoys and platforms was provided to vendors for the benefit of the public. The SPC module is an essential intelligent device that controls the power of the various components and sensor instrumentation on buoys and other in-situ data collection platforms. Its purpose is to maximize the utility of data collection in platforms that are power limited because they are operated from solar panels. The electrical design, board layout, software, and quality control testing procedures that were designed by NOAA were made available to any vendor who wanted to manufacture it. Two companies are currently producing the modules, which are being used by NOAA and are also publicly available for the benefit of others.

Ocean Service Data Help Drive Blue Marble Geographic Calculator
In 2013, Blue Marble Geographics, working together with the National Ocean Service integrated regional tidal model grids from NOAA's VDatum Program[51] into their *Geographic Calculator* tool.[52]

Earth System Research Laboratory and University of Colorado Researchers File Provisional Patent
NOAA scientists at the Earth Systems Research Laboratory (ESRL) in Boulder, Colorado, working together with Cooperative Institute staff at the University of Colorado (CIRES) have filed a provisional patent in 2013 for a method to offset range in Frequency Modulation-Continuous Wave (FM-CW) Radar. FM-CW radar was first developed in 1969 and has been used extensively to study the atmosphere.

Pacific Marine Environmental Laboratory - NOAA Diving Program
NOAA's Diving Program, or NDP, is headquartered at NOAA's Diving Center in Seattle, Washington. NOAA's Diving Program trains and certifies scientists, engineers and technicians to perform the variety of tasks carried out underwater to support NOAA's mission. With more

[51] See: http://vdatum.noaa.gov
[52] See: http://www.bluemarblegeo.com/products/geographic-calculator.php

than 400 divers, NOAA has the largest complement of divers of any civilian federal agency. In addition, NOAA's reputation as a leader in diving and safety training has led to frequent requests from other governmental agencies to participate in NOAA diver training courses.

NOAA Scientist Awarded Patent for Novel Improvements to an Integrating Nephelometer
John Barnes (Earth System Research Laboratory) was awarded a U.S. Patent for his invention of an *Imaging Polar Nephelometer*, a tool that measures light scattered by aerosols (or particles) in a gas or liquid. In an advancement of the art over the previous design, Dr. Barnes' nephelometer is able to measure particles scattered at individual angles, which allows both an estimate of the number of particles present, as well as their average size, shape, and composition. This new polar nephelometer also features a simple design that provides higher sensitivity and resolution.

NOAA Technology Partnerships Office Announces Three Winners for the 2013 Tech Transfer Awards
NOAA has selected three projects to receive the Agency's Technology Transfer Award in 2013. These projects exemplified the highest standard for developing a new technology in cooperation with private sector partners in the service of NOAA's mission. The winners will receive plaques and will be recognized in a ceremony on December 3, 2013.

- **Ansari and Del Greco, National Environmental Satellite, Data, & Information Service**
  For developing the Weather and Climate Toolkit which makes complex weather and climate data available to a wide range of users in the public and private sectors.

- **Ziemer at al., National Weather Service**
  For developing with the private sector, the first real-time flood forecast inundation mapping system, and transferring its operation to the partners.

- **Jorgensen, Oceanic and Atmospheric Research**
  For leading the development of an on-demand, near real-time, web-based tool for tracking severe weather and hail swaths across the continental US.

CHAPTER 4 National Telecommunications and Information Administration: Institute for Telecommunication Sciences

ITS is the research and engineering arm of NTIA. ITS supports NTIA telecommunications objectives of 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 telecommunications concerns of other federal agencies, state and local governments, private corporations and associations, and international organizations.

ITS is a partner in the Public Safety Communications Research (PSCR) program with the NIST Law Enforcement Standards Office. Over the last 15 years this joint program has focused on improving first responder communications and interoperability through the development of communication standards, research, testing, and evaluation (RDT&E) on behalf of sponsors at the Department of Homeland Security (DHS) and the Department of Justice (DOJ).

Approach and Plans for Technology Transfer

ITS efforts in technology transfer and commercialization foster cooperative telecommunications research in areas where U.S. companies can directly benefit from improved competitiveness and market opportunities. These efforts will continue in future years. ITS uses three principal means for achieving technology transfer:

- Cooperative research and development
- Technical publications
- Leadership and technical contributions in the development of telecommunications standards.

ITS Work Products and Collaborative Activities

Cooperative Research and Development

ITS is authorized under the Federal Technology Transfer Act of 1986 (FTTA) to enter into cooperative research agreements with private industry, universities, and other interested parties. ITS CRADAs protect proprietary information, grant patent rights, and provide for user licenses to private entities. They also provide the legal basis for shared use of government facilities and resources with the private sector.

In FY 2013, ITS participated—as it has for a number of years—in CRADAs with private-sector organizations to design, develop, test, and evaluate advanced telecommunication concepts. CRADAs provide ITS with insights into industry's needs for productivity growth and competitiveness. This enables ITS to adjust the focus and direction of its programs for effectiveness and value. The private industry partner benefits by gaining access to the results of research in commercially important areas that it would not otherwise be able to undertake. To date, major contributions to personal communication services (PCS), local multipoint distribution service (LMDS), ultra wideband (UWB), Broadband over Power Line (BPL), objective audio and video quality, advanced antennas for wireless systems, and remote sensing

and global position (GPS) technologies have been achieved through CRADAs. These have aided U.S. efforts to rapidly introduce new socially constructive communications technologies. More recently, CRADAs in the areas of high resolution laser radar (LADAR), autonomous networks for unmanned aerial vehicles (UAVs), and broadband air-interface and core network capabilities for Long Term Evolution (LTE) mobile communications have allowed ITS to contribute to the development of new products and services.

The vast majority of CRADAs ITS has entered into in the past three years are the Public Safety 700 MHz Broadband Demonstration Agreements. These agreements allow vendors, including equipment manufacturers and wireless carriers, who intend to supply 700 MHz LTE equipment and service to public safety organizations to operate various elements of an LTE network in the Public Safety Communications Research test bed and over-the-air (OTA) network (both hosted and managed by ITS) in order to test interoperability of public safety communications equipment under simulated field conditions, with the participation of public safety practitioners. At the close of FY 2013, 68 CRADAs were in place under this program. The CRADAs protect the intellectual property of vendors and manufacturers, and encourages participation in testing that simulates real multi-vendor environments in the field. This is the first government or independent facility in the U.S. capable of testing or demonstrating public-safety-specific LTE implementation requirements.

Table 29 – Collaborative Relationships for Research & Development

	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013
CRADAs					
Number of Active CRADAs	43	41	32	62	82
Number of Newly Executed CRADAs	18	15	17	30	29
Active CRADAs with Small Businesses Involvement	--	--	--	--	17
Number of small businesses involved in active CRADAs	--	--	--	--	17
Traditional CRADAs					
Active Traditional CRADAs	31	29	23	60	82
Newly Executed Traditional CRADAs	10	9	10	28	29
Non-Traditional CRADAs[(a)]					
Active Non-Traditional CRADAs	12	12	9	2	0
Newly Executed Non-Traditional CRADAs	8	6	7	2	0

(a) ITS Telecommunications Analysis Services (TA Services), discontinued in FY 2012, provided Web-based analysis support on a cost-reimbursable basis for wireless system design/evaluation and site selection to private industry and public agencies through on-demand electronic CRADAs. The programing language used for TA Services is too old to update. Other service applications may be developed in the future depending on funding.

Technical Publications
Publication has historically been the means through which ITS has transferred research results to other researchers, the commercial sector, and government agencies. Many of these publications—both internal reports and monographs and peer-reviewed articles in external scientific journals—have become standard references in several telecommunications areas. 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). Approximately two-thirds of the publications released through the ERB process in FY 2013 were approved for external publication in scientific journals or conference proceedings and one third were published as NTIA reports. At one time, only official NTIA publications were counted, but recently it became apparent that journal articles and conference papers have equal, and sometimes greater, reach in transferring new tools and discoveries, and now all publications are being counted.

Technical Publications downloaded
ITS makes all of its publications available to the public through its Web site, and provides online users with advanced search capabilities that will locate relevant publications by keyword. Changes in the Internet environment, in particular an explosion in the number of "bot hits," have rendered the "hit" and "pageview" metrics unreliable, inflated, and meaningless. Therefore, in the first quarter of FY 2013, ITS implemented the more accurate metric of actual PDF downloads of publications.

Consumer Digital Video Library users downloading clips
In FY 2010, ITS began development of the Consumer Digital Video Library, a web site hosted and maintained by ITS that provides researchers access to high quality, uncompressed video clips royalty-free for use in video processing and video quality product development and testing. The technical committee for this collaborative project includes industry and academic representatives as well as ITS and Public Safety Communications Research staff. ITS launched the site with 1000 clips and clips continue to be added by ITS and other collaborators. At the end of FY 2013 there were about 3100. Users must register for each download or upload session. The number of registrants who perform downloads each year was selected as the most significant measure of the impact of this resource, and collection began in FY 2011.

Table 30 – Other Performance Measures Deemed Important by the Agency

	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013
Technical Publications Released	12	12	15	13	24
Technical Publications Downloaded	--	--	--	--	7,174
Consumer Digital Video Library Users Downloading	--	--	242	187	418

Development of Telecommunication Standards[53]

ITS works with industry to apply research results to the development of telecommunication performance standards and guidelines. For several decades, ITS has provided leadership and technical contributions to organizations, both national and international, responsible for developing telecommunication standards. ITS's technical inputs are relied upon as technically advanced and sound, and as unbiased by commercial interests.

In FY 2013, ITS worked collaboratively with the International Telecommunication Union (ITU), the Telecommunications Industry Association (TIA), the Alliance for Telecommunications Industry Solutions (ATIS), and various federal public safety groups to interpret and analyze standards and regulations. This method of ITS technology transfer directly addresses improvement of U.S. competitiveness in telecommunications. For example, a plurality of the technical recommendations of the 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.

ITS continues to chair numerous committees and working groups in the ITU, ANSI T1 (now ATIS), and other telecommunication standards organizations, providing technical leadership that is trusted by the commercial-sector participants. ITS staff hold numerous key leadership positions in the ITU-R, including the U.S. Chair of SG3, International Chair of SG3 Working Party 3K, and U.S. Chair or Co-chair of four other Working Parties. In FY 2013, ITS developed a new reference implementation of ITU-R Rec P.533 for use in multi-threaded applications on multiple computing platforms. This code was presented as a technical contribution towards the revision of P.533 that was approved in September 2013. It has been adopted as the official ITU code for use by all broadcasters in HF propagation prediction.

ITS video quality measurement software tools use an objective video quality measurement method, which has been made a national standard by ANSI, to estimate the quality of video impairments, providing users an inexpensive alternative to viewer panels for testing new transmission technologies.

In FY 2013, ITS continued its technical leadership and contributions to communications standards for public safety, particularly for first responders. ITS's primary area of contribution in this area has been interoperability standards, testing procedures, and multi-vendor testing venues. In FY 2013, ITS staff assigned to the Public Safety Communications Research program advocated for and obtained inclusion of two key LTE features that are critical priorities for public safety and FirstNet in the 3GPP Release 12 agenda.

[53] In 2004, ITS added a collaborative standards contributions measure for participation on standards committees. As standards bodies increasingly move towards digital collaboration methods using wikis, email threads, and discussion boards, it has become impossible to define what constitutes a single "contribution." This metric was dropped for FY 2013.

Licensing
Since FY 2008, ITS no longer licenses Video Quality Metric (VQM) technology. Instead, ITS has made this software available via open-source download. Therefore, no licensing metrics are reported. Since FY 2008, approximately 1,500 users have downloaded the VQM software.

Downstream Outcomes from ITS Technology Transfer Activities

Table Mountain Research
The Table Mountain Field Site and Radio Quiet Zone supports fundamental research in the nature, interaction, and evaluation of telecommunication devices, systems, and services. Each year, private companies, universities and other organizations conduct research at Table Mountain under CRADAs. The following are brief descriptions of some of these recent CRADAs:

- For the past seven years, the University of Colorado's Research and Engineering Center for Unmanned Vehicles has conducted measurements on the performance of ad hoc wireless networks with both ground-based and airborne terminals at Table Mountain.
- In FY 2013, several companies performed antenna, Light Detection and Ranging (LIDAR), Global Positioning Satellite (GPS), and other testing at the Table Mountain turntable facility under a CRADA.
- Lockheed Martin Coherent Technologies is in its fourteenth year of field-testing and characterizing components, subsystems and systems for eye-safe coherent laser radar. This has benefited NTIA and the Department of Defense.

Video Quality Research
Both CDVL and the VQM tools are used by industry and academia for research into new techniques for transmitting video. The clips may be used to test codecs, to evaluate new display technologies, or for validation testing of new standards. For example, in FY 2013, ITU-T Study Group 12 used CDVL clips for research into the development of parametric models and tools for multimedia quality assessment and the MPEG committee opened a conversation with ITS about using the CDVL video clips for validation testing of new video coding standards.

Public Safety Broadband Demonstration Network
The PSCR Public Safety Broadband (PSBB) Demonstration Network facilitates accelerated development of testing for emerging LTE broadband equipment specific to public safety. The PSBB Demonstration Network was established in the ITS labs in FY 2010 by the Public Safety Communications Research program. This network provides a central and independent test bed/laboratory to help public safety understand 3GPP Band 14 LTE. Through CRADAs that protect their intellectual property, manufacturers and carriers test the deployment of 700 MHz systems under development in this multi-vendor environment and execute public-safety specific test cases to provide proof of concepts and improve the quality of future systems. This cooperative program provides ITS with guidance to develop technical contributions toward LTE standards to support public safety and First Responder Network Authority (FirstNet) requirements. This work advances the development of new public safety communications equipment that will eventually operate on the nationwide First Responder Network.

SUMMARY

Technology transfer is an essential mission of the DOC, using our Nation's innovation and investment in science and technology to strengthen our economy and competitiveness in world markets. This report details the results of technology partnering activities originating from DOC's federal laboratories. Federal research is a complex process that provides the opportunity for new ideas and innovations to achieved practical application for the benefit of U.S. citizens. The success stories in this report provide examples of how society benefits from technology transfer activities across DOC's federal laboratories. As knowledge advances and the needs of the economy change, DOC will continue to play a role in keeping America in the forefront of innovation and supporting our economy by aiding in the transfer and commercialization of knowledge.