THE NIST 2010 STRATEGIC PLAN

VERSION 1B
June 2004

NIST continuously updates its programmatic priorities in response to changes in science and technology, markets and business practices, and public needs related to the NIST mission. The original NIST 2010 Strategic Plan was produced in 2001-2002, and highlighted long-term strategic needs in health care quality assurance, information / knowledge management, nanoscale measurements and data, and homeland security. In response to external developments and input from customers, stakeholders, and staff, NIST revised the Plan in 2004 to refine its strategic focus areas and better situate those opportunities in the context of NIST's total work portfolio. Consistent with NIST's original intent, the Plan will remain a working document that NIST uses to solicit input from its customers and stakeholders on the Institute's long-term strategic direction, and to guide operational planning within NIST's Operating Units.

TABLE OF CONTENTS

LETTER FROM THE DIRECTOR: NIST'S PUBLIC VALUE AND LONG-TERM VISION 1

MISSION AND VALUES 1

MISSION 1
NIST VALUES AND OPERATING PRINCIPLES 2

STRATEGIC ENVIRONMENT 3

INNOVATION AND GLOBAL COMPETITION 3
INTERDISCIPLINARY SCIENCE AND TECHNOLOGY 3
DISTRIBUTED ORGANIZATIONS AND RESEARCH NETWORKS 4

OVERVIEW OF THE NIST 2010 STRATEGIC PLAN 5

LONG-TERM GOALS, OBJECTIVES AND STRATEGIES 5

GOAL 1: PROMOTE INNOVATION, TRADE, SECURITY, AND JOBS BY STRENGTHENING THE NATION'S MEASUREMENTS AND STANDARDS INFRASTRUCTURE 5
Objective 1.a: Advance the state of the art of measurement science 6
Objective 1.b: Assure the availability and efficient transfer of measurements and standards capabilities to manufacturing and service industries, universities, and other R&D-intensive organizations 7
Objective 1.c: Build capabilities in Strategic Focus Areas for emerging technology-based industries 8
GOAL 2: ACCELERATE PRIVATE INVESTMENT IN AND DEVELOPMENT OF HIGH-RISK, BROAD-IMPACT TECHNOLOGIES 13
GOAL 3: RAISE THE PRODUCTIVITY AND COMPETITIVENESS OF SMALL MANUFACTURERS 14
GOAL 4: CATALYZE AND REWARD QUALITY AND PERFORMANCE IMPROVEMENT PRACTICES IN U.S. BUSINESSES AND OTHER ORGANIZATIONS 15
GOAL 5: PURSUE ORGANIZATIONAL EXCELLENCE 16
Objective 5.a: Increase NIST's impact by focusing on the customer 16
Objective 5.b: Increase NIST's impact by focusing on our people 17
Objective 5.c: Leverage information science and technology 17

IMPLEMENTATION OF THE NIST 2010 STRATEGIC PLAN 17

Letter from the Director: NIST's Public Value and Long-Term Vision

For more than a century, the National Institute of Standards and Technology has helped to sustain innovation and technology-driven economic growth. The Institute's contributions—measurement research and tools, standards, competitively awarded grants, technical outreach services, and more—promote innovation, trade, security, and jobs.

NIST was spawned by industrial needs and practical necessities stemming from an accelerating industrial revolution and intensifying international competition. At the turn of the 19th century, uncoordinated management of weights and measures disadvantaged U.S. consumers and caused confusion in the marketplace; lack of an authoritative, domestic source of high-accuracy measurement standards penalized nascent U.S. companies by impeding their research, development and technology-commercialization efforts and by forcing them to rely on foreign laboratories to calibrate their precision instruments. Responding to appeals from businesses, scientists, and technical societies, Congress acted on the constitutional assignment "to fix the standard of weights and measures": In 1901, it established the Bureau of Standards to address the burgeoning measurements and standards requirements of an industrializing economy.

Over time the Bureau evolved and expanded to become a premier federal laboratory focusing on the diverse and ever more exacting measurement needs of science, industry, and government. In 1987, a program to galvanize quality improvement efforts in U.S. industry was added. In 1988, Congress assigned two more responsibilities: It launched what is now a nation-wide system of technical-support centers that address the specialized needs of the more than 300,000 small manufacturers in the United States; and it initiated a cost-sharing, competitive grants program to encourage the private sector to pursue promising but high-risk technologies that have the potential to deliver substantial benefits to the U.S. economy. With these new jobs came a new name: the National Institute of Standards and Technology (NIST). Today the Institute is recognized globally for its Nobel-prize winning research accomplishments, its international leadership in measurement and standards, and the critical role it plays in support of innovation-driven economic growth, industrial competitiveness and job creation, and public health, safety, and security.

The new century holds enormous potential for scientific and technological advancements that will enable new manufacturing and service industries, transform existing markets, and generate broad benefits for public health, safety, and the environment. In the context of rapid and revolutionary developments in the physical, biological, and information sciences, NIST-generated infrastructure tools will help industry, universities, and government transform research investments into new technology. Through this value-added chain, NIST improves the quality, capability, and productivity of U.S. research and technology. The economy ultimately expands through technology-based competitive advantage in international markets, through productivity growth, and through more efficient exchange of goods and services in domestic and international markets. And the public benefits not only from economic growth and job creation, but also through measurement and technology-driven improvements in health, safety, and the environment. This is the ultimate path to preeminent performance: Enabled by NIST, industry and other technology-intensive organizations will provide future generations with a level of prosperity and quality of life that will make our current circumstances, generous as they are, modest by comparison.

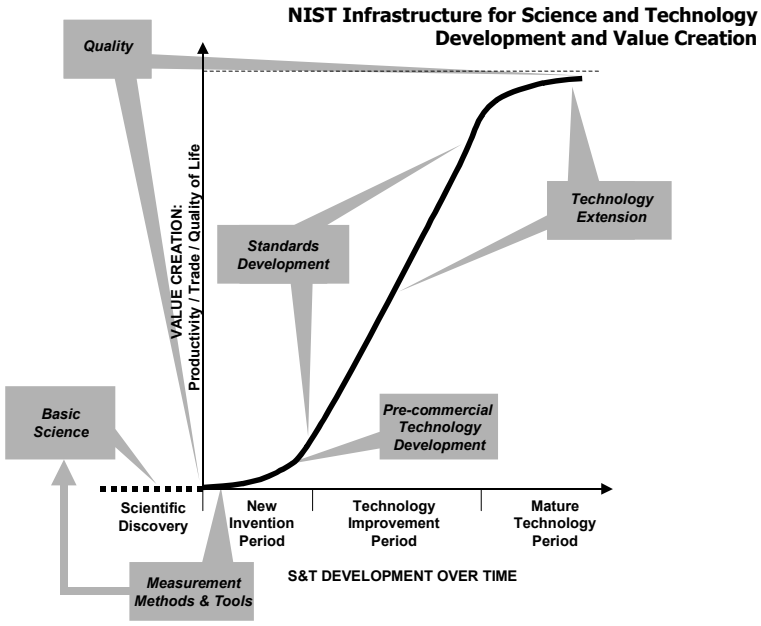
Mission and Values

Mission

> *NIST's mission is to develop and promote measurement, standards, and technology to enhance productivity, facilitate trade, and improve the quality of life.*

The sources of innovation and the economic growth it drives are numerous and complex. While industry transforms technology into the products and services that generate wealth, jobs, and a higher standard of living, government creates an environment for innovation that is essential to this transformation. NIST's unique contribution is to develop and continuously improve portions of the nation's technological infrastructure that are vital to research and innovation as well as production and commercial exchange. When used by industry, universities, and other government agencies, the technical infrastructure provided by NIST enables improvements in productivity, domestic and international trade, and public health, safety, and security.

During its earliest days, NIST (then called the National Bureau of Standards) developed measurement standards that helped to sustain the advance of the emerging electric power industry and many allied industries. Today the NIST laboratories continue to develop and supply critical measurement tools, standards, and services-a Federal responsibility specified in the Constitution and made explicit in the act that created NIST's predecessor agency, the National Bureau of Standards. Examples include measurement and test methods, standard reference materials, evaluated scientific data, calibrations, and other components that the private sector alone will not provide, either because the benefits are too widely distributed or because the time frame and risk level prohibit investments by individual firms. As in the past, NIST's measurement research and services remain central to innovation, productivity, trade, and public safety.



The new authorities granted to NIST in 1987 and 1988 expanded the Institute's responsibilities for supporting the development, wide diffusion, and efficient use of advanced technology and leading business practices throughout the private, public, and non-profit sectors. NIST now operates a program portfolio that provides key elements of the nation's scientific and technical infrastructure—the system of research, tools, and services that support scientific progress and technical innovation in industry, universities, and other technology-intensive organizations.

The research and services provided by NIST support all phases of scientific and technological development, from scientific discovery and new invention through technology development and deployment (see inset graph above). NIST's measurement research, methods, and tools help clear scientific and technical obstacles to such emerging technologies as nanotechnology, biotechnology, and ubiquitous computing. NIST's cost-shared R&D funding stimulates pre-commercial technology development in high risk and generic technologies with the potential for broad-based economic benefits—advanced materials, biotechnology, optics and photonics, polymer synthesis and fabrication, and many others. NIST's impartial expertise and leadership in measurement science and standards development supports the efficient commercialization and exchange of goods and services in today's high technology sectors—semiconductors, communications, biomedical devices, computing, information services—as well as in established but technologically dynamic sectors such as the automotive, chemical, construction, and steel industries, among others. NIST's technology extension services raise the productivity and competitiveness of the nation's small manufacturers. And NIST's promotion of organizational quality supports performance excellence in broad segments of the economy, spanning the entire technology life cycle and supporting our education and health care systems. Through these levels of infrastructure support, NIST improves the environment for innovation, trade, security, and jobs.

NIST Values and Operating Principles

> *NIST has four core values:*
>
> ***People:*** *We respect, value and support each other in all our activities;*
>
> ***Integrity:*** *We are objective, ethical, and honest;*
>
> ***Customer focus:*** *We anticipate the needs of our customers and are committed to meeting or exceeding their expectations; and*
>
> ***Excellence:*** *We expect world-class performance and continuous improvement in all we do.*

These values form the foundation for NIST's organizational performance. They are guiding ideals, setting the standards for how we serve our customers in industry, academe, and government; maintain public trust and confidence; carry out our individual jobs and meet our organizational responsibilities; and treat our fellow employees. The four core values are an integral set: as an organization and as individuals, we aspire to all of them. Collectively, these values are key to NIST's ability to attract and retain high quality personnel. Rigorous, open, technically sound, and competitive processes are NIST hallmarks, and are the basis of the Institute's core operating principles:

- NIST focuses on the nation's most essential technical infrastructure needs.
- NIST sets its priorities through customer consultation, ensuring that programs are aligned with current and anticipated customer needs.
- NIST uses rigorous, open, and competitive processes to steer all programs.
- NIST regularly evaluates its programs to ensure that they yield high returns on taxpayers' investments.

In keeping with its values and operating principles, NIST has established three long-term organizational goals that center on the Institute's customers, its people, and its knowledge and information resources. These goals, described below, will drive NIST's organizational performance—its alignment with and responsiveness to customer needs; the productivity and performance of its people; and the effectiveness and efficiency of its knowledge and information

resources. In so doing, NIST's organizational performance will shape the Institute's overall ability to meet its mission and long-term programmatic goals.

Strategic Environment

Over the next decade three fundamental forces will increase and alter the need for NIST's mission-specific contributions to the U.S. science and technology base: innovation as the basis for U.S. competitive advantage in global markets; the interdisciplinary character of emerging technologies; and the increasingly distributed nature of organizations and research networks.[1]

Innovation and global competition

In the context of broad-based international competition, global supply chains, and extensive international trade, the U.S. economy will prosper only by capitalizing on its longstanding source of competitive advantage: innovation and technology-driven growth. Global economic competition raises the premium on innovation-led business strategies in the United States, rapid productivity growth throughout U.S.-based supply chains, and world-class quality in all aspects of U.S. business and organizational performance. Given these factors, NIST's distinct contributions to a world-class technical infrastructure, a robust standards system, and lower barriers to trade are a strategic imperative for the long-term health of the U.S. economy.

Interdisciplinary science and technology

> "Many of the important developments in the next 10 years will come from within or at the intersection of three broad fields: biological science and engineering, materials science and technology, and computer and information science and technology. Each is characterized by an extremely rapid rate of change of knowledge; has obvious and wide utility; and will benefit from advances in the others, so that the potential for synergy among them is particularly great."
>
> *NRC, Future R&D Environments (2002), p.2*

Many promising scientific and technological trends cut across traditional disciplinary boundaries. New measurement-related challenges arise at every intersection—materials science and biology, for example, or manufacturing engineering and computer science, for another. In the absence of accurate, reliable measurements, technical risks are high and R&D investments uncertain. In addition, developing new knowledge in an interdisciplinary environment depends critically on ready access to and use of data from disparate scientific domains. Progress toward useful technology often is impeded by measurement and information barriers. And as an emerging technology edges toward industrial application or market-ready product, other new measurement needs arise—for controlling processes, ensuring confidence and trust in buyer-seller transactions, and improving marketplace efficiency.

Recent analyses conducted for NIST by the National Research Council point to several key ways in which multidisciplinary research arenas will drive enormous changes in technologies available for manufacturing and production, health and public safety, and for the development of new products and services in diverse sectors.

---

[1] To understand the possible features of the science and technology base in 2010, NIST commissioned the National Research Council to convene diverse experts to identify and evaluate broad trends—scientific and technological trends, business and economic conditions, organization practices, and societal forces—that individually and collectively will shape NIST's strategic environment over the next decade. See: National Research Council, *Future R&D Environments: A Report for the National Institute of Standards and Technology* (Washington, DC: National Academy Press, 2002). The trends outlined in this review of NIST's strategic environment draw heavily on this report and related research.

- *Materials science and technology*: Unknown commercial opportunities will emerge as technological advances allow the fabrication of nano-scale materials, nano particles, and hybrid structures that exhibit unique biological, optical, electrical, magnetic, and physical properties. At the macro level, advances in materials R&D also will drive developments in microelectromechanical systems, fuel cells, and diverse materials for electromechanical applications (such as photonic crystals, materials with improved dielectric properties, organic electronics, and organic/inorganic hybrids).
- *Biological science and engineering*: Research advances that intersect biology and many non-biology fields are paving the way for rapid improvements in testing for, diagnosing, and treating disease; in understanding and controlling the interaction of biological and synthetic materials; in developing new technologies for biological imaging, drug delivery, and other medical instruments and devices; and in generating new methods for collecting and analyzing biological research data.
- *Computer and information science and technology*: Computational and information technologies will affect the pace and nature of scientific and technical advancements in most fields of research and nearly every segment of the economy. For example, advances in molecular and cellular biology will rely on computational and modeling technologies, as will advances in drug design, development, and production. In many areas, complex information systems already have begun to create urgent new infrastructure demands; for example, existing problems in software development, testing, and quality assurance will increasingly limit the implementation of new systems and applications and raise the costs of operating and managing existing systems.[2]

Each of these interdisciplinary areas is ripe with technological and market opportunities and rife with measurements and standards challenges.

Distributed organizations and research networks

Technological change not only will determine which industries prosper but also will transform the very manner in which businesses are organized to compete. New forms of flexible, cooperative enterprises have been developing to explore new technologies, accommodate complex technological systems, and develop new market opportunities. Research organizations will continue to shift toward more distributed or "networked" modes of operation, driven by industry's need for high rates of innovation and rapid response speeds, the continuing decentralization of corporate research, increasing cost pressures, and a sharpening focus on core competencies. Outsourcing and external technology acquisition will become even more pronounced elements of R&D strategies, especially among large companies. University R&D efforts will become ever more closely associated with industrial technology needs and interests, and university-industry technology and personnel flows will increase. The ultimate expression of this trend may be real-time interactive research networks that cut across sectors and often borders as well.

As competition becomes ever more technology-intensive, and as technology becomes more complex and interdisciplinary in nature, firms will rely increasingly on a constellation of external scientific and technological resources provided by other firms, universities, government laboratories and technology programs, and other non-profit research centers and services. Responding to global market pressures, companies will likely increase the emphasis on directing R&D and technology integration toward short-term business goals. In this context there will be

[2] Studies indicate that the national annual costs of inadequate infrastructure for software testing ranges from $22 to $60 billion.

even broader needs for the forms of generic R&D and infrastructural scientific and technological capabilities provided by NIST.

Overview of the NIST 2010 Strategic Plan

The goals and strategies set forth in this plan are designed in response to the strategic environmental trends outlined above. NIST's long-term goals and objectives are summarized in the table below and developed in the subsequent segments of this plan.

Structure of the NIST 2010 Plan: Strategic Direction and Implementing Programs

Long-term goals	Objectives	Lead Program
Promote innovation, trade, security, and jobs by strengthening the Nation's measurements and standards infrastructure	Advance the state of the art of measurement science	NIST Laboratories
	Assure the availability and efficient transfer of measurements and standards capabilities to manufacturing and service industries, universities, and other R&D-intensive organizations	
	Build capabilities in Strategic Focus Areas for emerging technology-based industries	
Accelerate private investment in and development of high-risk, broad-impact technologies	Encourage industry and academia to increase R&D investments in high-risk, broad-impact technologies.	Advanced Technology Program
	Engage all elements of the national R&D enterprise in the ATP	
Raise the productivity and competitiveness of small manufacturers	Collect and disseminate data and information related to high performance business practices, expand MEP advisory services, and improve the effectiveness of MEP Centers	Manufacturing Extension Partnership Program
	Improve efficiency and effectiveness through system integration and development of a broader and more stable revenue base	
Catalyze and reward quality and performance improvement practices in U. S. businesses and other organizations	Develop and disseminate educational materials designed to help businesses and other organizations initiate and sustain performance improvement strategies	Baldrige National Quality Program
	Lead an expanding national system of state and local quality programs	
Pursue organizational excellence	Increase NIST's impact by focusing on the customer	NIST
	Increase NIST's impact by focusing on our people	
	Leverage information science and technology	

Long-term Goals, Objectives and Strategies

Goal 1: Promote innovation, trade, security, and jobs by strengthening the Nation's measurements and standards infrastructure

The nation's ability to innovate, grow, and create high value jobs will rely ever more on a robust scientific and technical infrastructure—including the measurements and standards provided by the NIST Laboratories. The NIST Laboratories perform research to advance the state of the art of measurement science and to develop leading-edge measurement tools, data, and models for advanced science and technology. This forward-looking research yields improvements in NIST's

measurement competencies and generates new knowledge, capabilities, and techniques that NIST transfers to its customers in industry, universities, and other government agencies.

Maintaining pre-eminence as the world's foremost National Measurement Institute requires not only state of the art measurement science but also state of the art mechanisms for transferring new measurement methods and capabilities to users. U.S. industry requires NIST's high quality measurements to underpin technical standards for product development, testing, instrumentation, process monitoring, and product performance enhancement. NIST's measurement capabilities and services provide a common infrastructure that allows customers to verify and gain domestic and international acceptance of their measurement results by tracing them back to the primary national standards. Measurement equivalency among international, national, and local laboratories also is critical for the acceptance of test results for commerce, trade, and health and safety.

Over time, NIST's ability to provide these capabilities will reside in part in the Institute's continued ability to build and mine the interdisciplinary measurements and standards competencies needed to support emerging technologies throughout the manufacturing sector, service industries, university research system, and technology-intensive governmental agencies. Looking forward, NIST sees high rates of growth and broad potential impact for its measurement and standards expertise in the areas of nanometrology, bioscience and health, information and knowledge management, and public safety and security.

Objective 1.a: Advance the state of the art of measurement science

As the National Measurement Institute for the United States, NIST operates at the pinnacle of the measurement system. NIST is uniquely responsible for establishing the ultimate value of the fundamental units of measurement: length, mass, time, electric current, thermodynamic temperature, amount of substance, and luminous intensity. NIST also is responsible for establishing and maintaining an efficient system that links the fundamental units of measurement to the measurement methods used in applied settings. Through these core roles, NIST's measurement science provides a common set of fundamental reference points and a system for using measurement tools that are an essential component of the nation's scientific and technological research base.

Much of NIST's research will continue to focus on laboratory-specific research competencies required to advance specific fields of measurement science, as well as information science, and improve the efficiency of the system that links primary standards defined by NIST to measurement methods and tools used by end users in industry, universities, governmental agencies, and other technology-intensive organizations.

Strategic Drivers and NIST Response in Measurement Science

Area	Strategic Drivers	NIST Response	Impacts
Fundamental units of measurement	Globalization of science and technology; science-based industrial development	Provide U.S. industry and science base with the world's best measurement capabilities; NMI benchmarking; intercomparisons / global measurement harmonization	International leadership in measurement science; accelerated scientific discovery; higher productivity of industrial R&D
Quality and confidence in measurements	Multidisciplinary R&D; growing measurement intensity of manufacturing, service, and information industries; measurement, testing, and standards barriers to multi-sector enabling technologies	Continuously build competencies in fundamental and derived units of measurement; improve organizational and technical flexibility; develop measurement capabilities leading or synchronous with industrial need; develop measurement and test methods for software, IT systems, and other enabling technologies	Greater productivity of R&D; accelerated introduction of new technologies; higher quality research; more efficient scientific and technical collaboration

Objective 1.b: Assure the availability and efficient transfer of measurements and standards capabilities to manufacturing and service industries, universities, and other R&D-intensive organizations

Today's technology-driven marketplace demands rapidly conducted and highly accurate measurements. NIST's measurement services support an increasingly diverse and dynamic group of customers whose needs rapidly change with advances in technology. NIST must deliver high quality, rapid service and continually react to emerging measurements and standards needs. In technology-based industries, NIST also needs to respond to quality and cost pressures that call for more measurements with increasingly high precision and selectivity, as well as technically rigorous standards for product quality and production performance.[3]

In many measurement-intensive research areas, the intense growth in data collection and data mining will outstrip currently available techniques for understanding and ensuring data validity and integrity. , Simulation and modeling are now common and often essential scientific tools, and are rapidly becoming an integral part of the planning, design, development, and discovery infrastructure of U.S. industry. Similarly, efforts to tackle complex national challenges in homeland security, energy sufficiency, and environmental sustainability will rely increasingly on simulation and modeling tools to guide decisions and policies. Reliable use of these tools depends on the availability of trustworthy data across a wide spectrum of scientific and technical domains. Assuring access to these data will demand new informatics methods and common data-sharing standards.

As new technologies become commercialized, the competitive performance and growth of U.S.-based industries will continue to be shaped by the technical underpinnings of standards and tests for production process control, product quality and performance, and other aspects of production and market exchange. In addition, since technology-based industries also produce and sell on a global basis, U.S.-based businesses will need more rapid and extensive harmonization of different measurement and documentary standards systems. Increasingly, access to foreign markets can be

[3] These industries can be extremely measurement-intensive; for instance, measurements account for 25-30 percent of manufacturing costs in the semiconductor industry.

restricted by sophisticated measurements, standards, testing and certification requirements, quality system registration, and other technical prerequisites. With the rapid move toward a global economy, many segments of U.S. industry have identified harmonization with international standards as a high priority for maintaining global competitiveness. NIST's capabilities will be increasingly needed to resolve issues that often create technical barriers to trade.

Strategic Drivers and NIST Response in Measurement and Data Services

Area	Strategic Drivers	NIST Response	Impacts
Physical measurements and services	Measurement intensity of advanced manufacturing and service industries; performance and cost pressures	Improvement in portfolio management and cycle time of measurement services; continuous improvement in matching quality and timeliness of service delivery to customer needs	More efficient and productive R&D; faster time to market; lower market transaction costs; higher product and process quality; reduced product development cycles
Virtual measurements and dynamic data	New demands for physical and chemical property data for new compounds, pharmaceuticals, and materials; dramatic volumes of scientific data and information collection; growing demand for certified models that can recommend values for any real or proposed substance from critically evaluated experimental data and validated and benchmarked predictive methods; growing demand for data management standards and techniques (e.g., quality, traceability, or uncertainty estimates) for gathering, integrating, and maintaining information about data accessed from diverse sources	New methods for generating critically evaluated data: dynamic scientific data generation with embedded uncertainty measures and metadata; virtual scientific measurements using computational experiments and models; and validated approaches for computational modeling and uncertainty estimation New methods for managing data: standards and methods for intelligent scientific data management and data mining; standards and methods for deriving meaning from incomplete or imperfect information; and performance metrics, tests, and standards for measurement systems using knowledge-based techniques	

Objective 1.c: Build capabilities in Strategic Focus Areas for emerging technology-based industries

Next-generation measurement and standards needs in many emerging technology-based industries create special challenges and opportunities for NIST: the technologies and applications are changing rapidly; the nature of the technical demands requires collaboration and coordination within NIST and between NIST and its external partners; and the potential economic and societal impacts of adoption and commercialization are exceedingly high. NIST will focus on three technology areas that exhibit these features as well as measurements and standards-related barriers to development and commercialization: nanometrology, biosciences and health, and information / knowledge management. In addition, new demands and governmental priorities for public safety and security will continue to exert a strong influence on NIST's program portfolio. NIST currently has a broad range of competencies to draw on in each area, but these emerging measurements and standards needs require a higher level of strategic focus, internal and external collaboration, and organizational commitment.

Nanometrology

> *Research focus: Leading-edge nanometrology research and a sophisticated understanding of other nanotechnologies to ensure that NIST provides industry, government, and university research efforts with nanoscale measurement and data capabilities that are unmatched in the world.*

Nanotechnology will allow the manipulation and control of processes and the creation of devices and structures on the nanometer scale, a capability that is widely expected to generate disruptive technology shifts in many markets.[4] While currently there is no global nanotechnology industry, nanotechnology commerce has begun, primarily in materials science. Some observers predict that virtually every global market will be shaped by nanotechnology, and that some markets—such as materials (including aerospace, automotive and construction), information technology, and energy—will see large disruptive effects within a few years. Given the broad potential impact of nanotechnology, both public and private sector R&D has been substantial and continues growing, not only in the United States but also in other advanced industrial countries. NIST's unique capacities in nanoscale measurement and data characterization provide critical infrastructure for nanotechnology R&D. Looking toward 2010, NIST must provide a rigorous foundation in measurement science for near-term nanotechnology applications, particularly nanomagnetics and nanoelectronics (where commercialization paths already are being constrained by inadequate measurement capabilities), and for more long-term and potentially disruptive applications, particularly nanobiotechnology and quantum devices (where advances require a sustained research effort by NIST). In addition, NIST's nanoscale metrology capabilities—including improved methods for providing traceability to the fundamental units of measurement—and its ability to characterize nanomaterials will provide the measurement methods and data needed to accelerate advances in a broad range of nanotechnologies.

[4] As defined by the National Nanotechnology Initiative, nanotechnology is "research and technology development at the atomic, molecular or macromolecular levels, in the length scale of approximately 1 - 100 nanometer range, to provide a fundamental understanding of phenomena and materials at the nanoscale and to create and use structures, devices and systems that have novel properties and functions because of their small and/or intermediate size".

Strategic Drivers and NIST Response in Nanometrology

Area	Strategic Drivers	NIST Response	Impacts
Nanometrology and materials characterization	Revolutionary developments are expected from the use of materials with nanoscale features, including multifunctional nanocoatings, nanosensors, and materials that provide for biological decontamination of air and water systems as well as surfaces; further advances require measuring and manipulating individual structures on the nanoscale; rate of progress is limited by inadequacies of the spatial, temporal, and mechanical (e.g. mass and force) resolution of research tools and ability to quantify and validate these tools; nanometrology tools and techniques are highlighted as a grand challenge in the National Nanotechnology Initiative	Measurements, standards and data that enable nanoscale quantities to be traceable to the fundamental units of measurement Extend fundamental units of measurement to new domains, such as picometer dimensional measurements or nanonewton force measurements Measurements, standards, and data that establish the accuracy and reliability of nanoscale measurement and analytical tools; Improve materials characterization and data through metrology capable of probing structure and composition, and having properties with nanometer-scale resolution	Greater productivity of nanotechnology R&D; accelerated development of nanotechnology products using new materials, phenomena, and applications. Potential downstream impacts extend to energy consumption, environmental remediation, health care, and national security, with broad applications in practically every sector of the U.S. economy
Nanometrology for magnetics and electronics	Market pressures for dense and fast storage devices, and smaller and faster memory technologies Nearing of technical limits to complementary metal oxide semiconductor (CMOS) technologies; market pressure for replacement technologies	Measurement methods, standards, and data for nanomagnetic memory and storage devices New metrology for nanolithography, molecular electronics, and other emerging nanoscale technologies	Accelerated commercial development of nanomagnetic technologies and next-generation microelectronic devices (downstream impacts in many sectors)
Nanometrology for biotechnology and quantum devices	Long-term R&D for “beyond the roadmap” quantum computing Nanobio R&D for applications ranging from biosensors and drug-release systems to tissue repair and regeneration	Measurement science to advance quantum computing and characterize quantum electronic devices Reproducible measurement techniques and uncertainty specification for nanobiotechnology research	New quantum-based technologies for cryptography, communication, and computation will broadly affect commerce, homeland security, and national defense; accelerated development of nanoscale biomaterials, also with broad multi-sector impacts

Biosciences and Health

> *Research focus: critical measurements and standards needed to advance life sciences research, generate new health care technologies, and improve the quality and cost-effectiveness of health care delivery systems and processes.*

The biosciences and the health care sector are the focus of an extraordinary national research effort encompassing government, industry, and university research. The areas of the life sciences most closely associated with emerging health care applications—systems biology and genomics, genetic modification, biomedical engineering, disease therapy, and drug discovery—all depend upon diverse scientific and technological competencies that interweave the biological sciences with physics, chemistry, engineering, and information technology. With the Institute's world-class multidisciplinary competencies in the physical sciences, engineering, and information technology, NIST is uniquely positioned to provide the new measurements and standards methods, tools, and data needed by industry, academe, and other government agencies to advance biosciences research, generate new health care technologies, and improve the quality and cost-effectiveness of health care delivery systems and processes. Without NIST's contributions, the lack of a common infrastructure for bioscience measurements, standards, and data will constrain innovation and stifle the commercialization of new bioscience-based applications in health care, agriculture and food, environmental protection, homeland security, and many other areas.

Strategic Drivers and NIST Response in Biosciences and Health

Area	Strategic Drivers	NIST Response	Impacts
Biosciences	Broad-based demand for measurements and standards framework for biosciences research and development; rapidly changing, multidisciplinary research environment; multi-industry and multi-sector impact paths with high spillover benefits	New measurement capabilities, standards, and data in key bioscience arenas such as systems biology and genomics, regenerative medicine, proteomics, and bioelectronics	Greater productivity of bioscience R&D; accelerated introduction of new technologies; improvements in public health and safety
Diagnostics	High growth rates; high R&D intensity; promising multidisciplinary research pipeline; revolutionary research and diagnostic tools Large and growing cost drivers—medical errors, incl. diagnostic testing	Measurements and standards for emerging array-based diagnostic technologies; measurement methods and data for research tools that enable analysis of proteins	Accelerated introduction and improved quality of new diagnostic technologies; higher quality, lower cost health care
Health informatics	Inadequate infrastructure for health care services compromises patient safety, lowers the quality of care, and drives up costs throughout the health care system; two major drivers of cost, quality, and safety trends are medical errors and inefficient administrative systems High costs and reduced functionality due to inadequate data integration; inadequate interoperability; inefficient administrative systems	Measurement methods, tests, and standards that affect the quality and cost of health care services, including diagnostic testing, patient care, administration and facilities management, and information systems. Includes data, modeling, and standards for interoperability; standards for access control and security systems; standards for data / database quality, imaging, and wireless communication	Lower costs and higher productivity throughout the health care supply chain; higher quality care; greater privacy, security, and portability of health care data; improved data access and more efficient decision-making systems for medical professionals

Information / Knowledge Management

Research focus: New measurement, test, and standards tools that enable more effective intelligent systems and control processes and improve interoperability and data exchange.

Over the past decade business investment in new information technologies has forever altered how information is acquired, exchanged, and synthesized into new knowledge used in discovery and innovation. By 2010 NIST and its partners in industry, government, and academia will have broad access to low-cost computational and information resources orders of magnitude beyond that available today. Computers and information sources will be so interlinked as to blur the boundaries of each, often sharing resources and content in a transparent and real-time basis over high-bandwidth and wireless communication networks. Many of these systems will employ technologies that not only self-organize and manage themselves but continuously reach beyond their immediate domain to gather information and knowledge from other geographically distributed and heterogeneous knowledge systems.

NIST has identified two key strategic opportunities in the broad area of information / knowledge management: infrastructure for intelligent interconnected systems; and interoperability for sharing and collaboration. Technological advances in these areas will have a broad impact on nearly all industry sectors, on major governmental functions, including but not limited to research and development activities. In each area, inadequate measurements and standards infrastructure threatens the rapid development and extensive use of information and knowledge management technologies and imposes large costs on industry and other users. Key strategic drivers and potential NIST response in each of these areas are described in the table below.

Strategic Drivers and NIST Response in Information / Knowledge Management

Area	Strategic Drivers	NIST Response	Impacts
Intelligent interconnected systems	Long-term trend toward ubiquitous interconnected systems with "intelligence" (e.g. self-correcting; self-integrating; and other autonomous behavior; inference and response capabilities, etc.). Underlying drivers include low cost / higher capacity microprocessors and systems, high-bandwidth and wireless communications networks, and new interface technologies (human / computer voice and natural language processing, intelligent sensors, and software agent systems)	Standards, tools, and technologies that will enable self-integrating systems of all types Performance metrics, tests, and standards for intelligent systems, sensors, and interfaces Standards and security for autonomous and self-organizing software agent systems Standards to support high-capacity and adaptable network and communication technologies	More efficient and productive R&D; higher product quality; lower production and maintenance costs; and productivity growth Sector-specific benefits in manufacturing, health care, homeland security, and many other areas
Interoperability	Increasing demand for intra- and inter-organizational collaboration within and across supply chains; rapid growth in size and heterogeneity of data and information; inadequate standards and testing infrastructure for interoperability creates barriers to integration of diverse databases and knowledge sources.	Performance metrics, tests, and standards for collaborative systems Human/computer interface standards, test data, and reference implementations Tools, semantics, reference implementations, and standards for data integration	More efficient scientific and technical collaboration; lower cycle times; higher product quality; productivity growth Sector-specific benefits in manufacturing, health care, homeland security, and many other areas

Measurements and standards for public safety and security

Research focus: Technical and performance measurements and standards to provide critical infrastructure for public safety and security.

Government currently is the primary driver for homeland security, but over the longer term a broader combination of public and private sector needs and response strategies will shape technology and market developments. NIST will build on its successful tactical responses to urgent homeland security needs and work with both government and the private sector to provide the measurement infrastructure, measures of system performance, and standards for interoperability and reliability that will enable long-term improvements in homeland security. NIST's strategic approach to homeland security will be flexible and responsive to changing national needs. NIST will continue to take advantage of its extensive interactions with other government agencies and industry to identify and respond to current and developing measurements and standards needs for homeland security.

To this end, NIST will focus its measurements and standards activities on chemical, biological, radiological, nuclear and explosives detection and security (CBRNE); and cyber security and critical infrastructure protection; and biometric technologies for enhanced border security.

Strategic Drivers and NIST Response in Public Safety and Security

Area	Strategic Drivers	NIST Response	Impacts
CBRNE	Expanded national needs for detection, identification, collection, and monitoring technologies; requirements for highly accurate, sensitive, and robust measurement techniques	Measurement methods, test systems, and technical expertise for evaluating fielded and developmental hardware systems designed to detect multiple CBRNE threats and their interactions	More effective deterrence against terrorist attacks; improved safety for first responders; greater public protection
Cyber security, critical infrastructure protection, and border security	Growing incidence of cyber attacks (computer viruses, password cracking, denial of service, service hijacking, root access, etc.); potential impact of IT vulnerabilities on critical infrastructure (manufacturing plants, utilities, financial services, public buildings, etc.); economic and social risks from inadequate border security and vulnerabilities of physical infrastructure to natural, technological, and terrorist threats.	Cyber security tools, guidelines and evaluation certificates; Internet and wireless system security tools, standards and guidelines; tools, guidance, and the technical basis for security standards and practices relevant to physical infrastructure protection and emergency communication systems; technical basis and standards for biometric identification technologies; develop, validate, and demonstrate technologies, measurements and evaluation methods, and best practices	Lower vulnerability and greater integrity of critical systems dependent on IT; more effective deterrence against terrorist attacks; improved safety for first responders; improved border control; threat reduction and improved public safety

Goal 2: Accelerate private investment in and development of high-risk, broad-impact technologies

Goal 2: Anticipated impacts

- Generation and diffusion of technical knowledge, as evident in patents, licensing agreements, and publications
- New, broad-impact technologies created
- High level of R&D spillovers within and across sectors

While private sector funds nearly 70 percent of the nation's R&D, market pressures often deter firms from investing in particular types of technology. Private industry never has accounted for a large percentage of the nation's basic R&D,

because firms must be able to appropriate returns within a timeframe and at a level satisfactory to investors. For the same reasons, industry tends to avoid investing in certain types of enabling technologies: infrastructural technologies, which require distinct competencies and are broadly applied; multi-use technologies, which benefit multiple segments of an industry or group of industries; and high-potential breakthrough technologies, which typically involve risk levels and timeframes that far exceed the horizons of individual firms.

These enabling technologies are the focus of the **Advanced Technology Program**: ATP works with industry and universities to identify and promote investment in technologies with significant potential for broad-based economic benefits but inadequate levels of private investment. The Program uses joint ventures and teaming arrangements to combine private investment and the best available scientific and technological talent in industry, universities, and government. ATP will pursue two fundamental strategies over the planning period:

1. *Encourage industry and academia to increase R&D investments in high-risk, broad-impact technologies*. ATP will use partnership strategies for identifying and stimulating investment in emerging, infrastructural, and/or multi-use technologies. ATP will continue to fund industry- and academia-driven, cost-shared research in technologies identified through a broad and rigorous assessment of 1) the economic potential of advancements in particular technologies; 2) the technical strength of project proposals and the degree of commitment; and 3) the opportunity for ATP funds to complement and leverage private investment in those technologies.
2. *Engage all elements of the national R&D enterprise in the ATP*. ATP will expand its partnership activities with both the public and private sectors, and strengthen linkages among various sources of innovation—such as small entrepreneurial firms, universities and other sources of basic research, and new research consortia (particularly those involving small businesses and universities).

Goal 3: Raise the productivity and competitiveness of small manufacturers

Goal 3: Anticipated impacts

- Productivity gains of MEP clients exceed control group
- Improved competitiveness indicators for MEP clients—growth in sales, cost savings, and capital investment attributed to MEP

U.S. manufacturing firms are among the most productive in the world, but small manufacturers consistently lag behind their larger counterparts in value added per employee. Large firms typically have greater financial, technical, and human resources available for production modernization and continuous performance improvement. However, the nation's 360,000 small manufacturing establishments employ about 12 million people—nearly two-thirds of all manufacturing jobs—and produce intermediate parts and equipment that contribute more than half of the value of finished products. Due to the pervasive role of small firms in the manufacturing supply chain, the future productivity of the nation's supply base will rest largely on the ability of small firms to improve quality, raise efficiency, and lower costs.

The comparatively low productivity growth of small U.S. firms can be attributed to numerous factors, including technical, cost, and information barriers. Through the **Manufacturing Extension Partnership** (MEP), NIST helps to overcome these barriers by providing information, decision support, and implementation assistance in adopting new and more advanced manufacturing technologies, techniques, and business practices. The national MEP network helps small companies transform themselves into high-performance enterprises—productive, innovative, customer-driven, and competitive businesses—by efficiently providing high value technical and advisory services, including access to industry best practices. MEP's ultimate goal is to

measurably improve the productivity of all its clients. Two fundamental strategies will enable MEP to enhance its effectiveness and impact over the planning period:

1. *Collect and disseminate data and information related to high performance business practices, expand MEP advisory services, and improve the effectiveness of MEP Centers.* Given a stable federal funding base and the current distribution of Centers, MEP will continue to develop and deploy shared programs and resources that will increase the breadth, depth, and effectiveness of services delivered by the MEP manufacturing and business experts. MEP also will deploy best practices in performance-based management to improve the performance and effectiveness of MEP Centers.

   MEP also can broaden its scope of services by leveraging NIST's laboratory capabilities and competencies. Potential avenues for expanding the scope of services include but are not limited to: utilizing NIST expertise in networking technologies; evaluating new IT-based process technologies; learning about and managing new production process technologies and related standards issues; advising on technical issues relating to clean production materials and similar factors driven by environmental regulatory considerations; and adopting efficient building environment systems and advanced materials.

2. *Improve efficiency and effectiveness through system integration and development of a broader and more stable revenue base*. MEP will increase overall system efficiency by gradually integrating the Centers and field offices into an administratively efficient and programmatically synergistic national network that will be more widely recognized and utilized by the nation's small businesses. In addition, MEP will seek to improve program effectiveness by broadening and stabilizing the funding base of the MEP Centers, and in cooperation with the Minority Business Development Agency will expand MEP services to better assist small minority-owned enterprises.

Goal 4: Catalyze and reward quality and performance improvement practices in U.S. businesses and other organizations

Goal 4: Anticipated impacts

Improved quality and performance of organizations in business, health care, education, and non-profit sectors

Quality and performance improvement have become requirements—not options—for competitive businesses and high performance organizations of all types. Through the **Baldrige National Quality Program** (BNQP), NIST provides a systematic and well-tested set of values, performance criteria, and assessment methods that all organizations can adopt to improve their productivity and overall effectiveness. BNQP catalyzes organizations to define what they must do to improve their performance and attain (or retain) market leadership, and provides a mechanism for broadly disseminating that information.

The Malcolm Baldrige National Quality Award is granted annually to businesses—manufacturing and service, small and large—and to education and health care organizations that apply and are judged to be role models in seven areas: leadership, strategic planning, customer and market focus, information and analysis, human resource focus, process management, and organizational results.

In addition to the annual Award competition, the Baldrige Program represents an entire value system, a definition of performance excellence, a vehicle for cooperation, and a catalyst for change. The Baldrige Program reflects the nation's commitment to excellence, elevates quality as a national priority, and provides a mechanism for identifying and disseminating best practices.

To expand the scope of the Program and widen its potential impact, the BNQP will pursue the following major strategies:

1. *Develop and disseminate educational materials designed to help businesses and other organizations initiate and sustain performance improvement strategies*. These materials will include case studies, self-assessment primers, and data on best practices for performance improvement.
2. *Lead an expanding national system of state and local quality programs*. The BNQP will seek to broaden and deepen state and local quality efforts already based on Baldrige principles, in order to provide these regional programs with a nationwide system that can better serve small businesses.
3. *Conduct research to further quality/performance management as a business discipline*. The BNQP promotes quality awareness as well as the learning and dissemination of successful performance management practices, principles, and strategies. Since its inception in 1987, the BNQP has generated a wealth of knowledge from the experiences of its applicants. Because much of the information in Baldrige applications is proprietary, this valuable knowledge base has not yet been researched for key business insights. Given the great potential utility of this information, NIST will conduct research to identify best practices and articulate the underlying principles of leading management practices and performance evaluation techniques. The BNQP will seek new channels for disseminating this information; for instance, it will encourage colleges and universities to adopt BNQP research within course curricula.
4. *Explore possibilities for creating a new Baldrige Award category for not-for-profit organizations*. The Baldrige Program could greatly expand its impact by extending its coverage to include not-for-profit organizations.

Goal 5: Pursue Organizational Excellence

To complement its long-standing focus on technical excellence, NIST will continue to set high performance standards and expectations for all aspects of the organization. NIST will strive for state-of-the-art organizational performance through continuous improvement strategies that are driven by assessments of best practices in similar types of research organizations. Key components of NIST's pursuit of organizational excellence will include NIST's focus on its customers; its ability to plan for, acquire, and manage its people; and its use of information technology to produce and efficiently deliver high-value products and services.

Objective 5.a: Increase NIST's impact by focusing on the customer

Customer-focused organizations are able to anticipate and quickly respond to market movements, are more efficient because there is a shared understanding of mission and direction, and deliver results and impacts that customers value and recognize. Delivering high-value products and services requires constant attention to best practices in cognate organizations, continuous evaluation of opportunities for improvement, and thorough integration with customers from planning to delivery of service improvements.

NIST will continuously improve the Institute's understanding of and responsiveness to customer needs; expand customer interactions and thoroughly integrate customer input and market knowledge into NIST's planning processes and evaluation mechanisms; and build customer focus into work systems and processes.

Objective 5.b: Increase NIST's impact by focusing on our people

Changes in the technological and demographic landscape are shaping a workforce that will be increasingly diverse, entrepreneurial, highly mobile, and team-oriented. NIST's workforce will have a broader span of expertise; multi-disciplinary training will be used extensively, and high potential staff will be offered management and leadership training as a fundamental part of their professional preparation. In this context, NIST will continuously improve internal communications, strive for clarity and transparency in all organizational decisions, encourage innovation through cross-organizational interactions, and provide every available resource needed to sustain a highly motivated, high-performance workforce. To achieve its 2010 mission, NIST also will reinforce high levels of knowledge sharing and teamwork by using best practices in performance management and organizational development.

Objective 5.c: Leverage information science and technology

The adequacy of NIST's information technology and knowledge management processes will shape the ability of its employees to effectively and efficiently accomplish their work. The laboratory research programs substantially shape the Institute's information technology strategies because they use the bulk of NIST's high-performance computing resources. In addition, the efficiency and quality of other NIST activities—including not only internal administrative functions but also technology transfer services and other customer interfaces—will depend increasingly upon seamless, secure, powerful, and highly accessible information technology resources.

In light of these needs, NIST will implement strategies that are designed to: 1) produce a reliable, transparent, and cost-effective information technology infrastructure; 2) provide computationally-intensive modeling capabilities, high-speed database search and retrieval mechanisms, and integrated access to experimental data that can be used to validate computational models; and 3) support full electronic submission of data to NIST by customers (where needed) and permit efficient customer access to relevant NIST data.

Implementation of the NIST 2010 Strategic Plan

The goals and objectives outlined in this strategic plan will shape the Institute's budget requests for new initiatives and will guide the near-term planning efforts within each of NIST's operating units. Through these two channels—successful pursuit of new initiatives, and gradual redirection of base resources—NIST anticipates marshalling the resources required to implement the strategic objectives outlined in this Plan.

The Plan will remain a working document that NIST uses to solicit input from its stakeholders, customers, and staff on the Institute's long-term strategic direction. NIST anticipates continued adjustments to this Plan over time, in response to changing customer and stakeholder needs, scientific and technological developments, shifts in available resources and competencies, and changes in external factors that could affect how NIST can best carry out its long-standing mission.

The table below summarizes NIST's methods for evaluating progress over time.

Strategic Direction		*Evaluation and Management*	
Long-term goals	**Objectives**	**Evaluation Methods**	**Program**
Promote innovation, trade, security, and jobs by strengthening the Nation's measurements and standards infrastructure	Advance the state of the art of measurement science	NRC peer review of technical quality and merit Citation rates Technical publications in peer reviewed journals	Labs
	Assure the availability and efficient transfer of measurements and standards capabilities to manufacturing and service industries, universities, and other research organizations	Web access to / downloads of NIST-maintained databases Items calibrated Reference materials sold Microeconomic impact studies: Net benefit to cost ratio; net present value; social rate of return	
	Build capabilities in Strategic Focus Areas for emerging technology-based industries	External assessment by Visiting Committee on Advanced Technology (VCAT)	
Accelerate private investment in and development of high-risk, broad-impact technologies	Encourage industry and academia to increase R&D investments in high-risk, broad-impact technologies.	Generation and diffusion of technical knowledge, as evident in patents, licensing agreements, and publications New, broad-impact technologies created High level of R&D spillovers to other product and market areas	ATP
	Engage all elements of the national R&D enterprise in the ATP		
Raise the productivity and competitiveness of small manufacturers	Collect and disseminate data and information related to high performance business practices, expand MEP advisory services, and improve the effectiveness of MEP Centers	Productivity gains of MEP clients exceed control group Improved competitiveness indicators for MEP clients—growth in sales, cost savings, and capital investment attributed to MEP	MEP
	Improve efficiency and effectiveness through system integration and development of a broader and more stable revenue base		

(table continued)

Strategic Direction		***Evaluation and Management***	
Long-term goals	**Objectives**	**Evaluation Methods**	**Program**
Catalyze and reward quality and performance improvement practices in U. S. businesses and other organizations	Develop and disseminate educational materials designed to help businesses and other organizations initiate and sustain performance improvement strategies	Improved quality and performance of organizations in business, health care, education, and non-profit sectors	BNQP
	Lead an expanding national system of state and local quality programs		
Pursue organizational excellence	Increase NIST's impact by focusing on the customer	Improvements in customer satisfaction	NIST-wide
	Increase NIST's impact by focusing on our people	Continuous organizational improvement relative to benchmarked best practices in cognate organizations	
	Leverage information science and technology	High employee productivity and satisfaction	
		Improved safety and diversity	