FY 2004 AGENCY RESEARCH PLANS BY PROGRAM COMPONENT AREA (PCA)

The long-term research agenda of the NITRD Program is embodied in agency activities designed to achieve critical agency mission goals. It is through steady year-by-year progress toward those goals that far-reaching advances emerge, as the early sections of this FY 2004 Blue Book attest. The following summary of agency FY 2004 research plans by PCA suggest current high-priority areas of investigation, such as R&D in high-end computing architectures, the Grid, middleware, cognitive systems, quantum technologies, modeling and simulation, visualization, networking (optical, wireless, mobile, adaptive, scalable, networked sensors, modeling and management, scalability), software in many dimensions (specification, engineering, testing, software for embedded systems, software-enabled control, cost issues), large scale digital libraries, the Web, speech and language translation, assistive technologies, collaboration technologies, assurance, dependability, robustness, security, standards, IT infrastructure for research, social and economic issues.

High End Computing Infrastructure and Applications (HEC I&A)

NSF: Terascale cyberinfrastructure; grid resource management; application of high-performance computing for science and engineering research

NIH: Creating models and visualizations for both basic and applied science sciences

NASA: Develop terrestrial information grid with numerous geographic locations containing resources including computing, networking, data, and instruments (both fixed and mobile) to solve problems of interest to the NASA aerospace, earth science, and space science enterprises

DOE Office of Science: Partnerships for terascale science

DOE/NNSA: Innovations in high-end systems architecture and software, and in visualization techniques to enable modeling and simulation for U.S. stockpile stewardship

NIST: Creating models and visualization for basic sciences (e.g., physics) and applications (e.g., building structure and material strength)

NOAA: Development and dissemination of modeling frameworks and tools for parallelizing geophysical fluid dynamics equations for the research and development of advanced weather and climate models and the resources to support these applications

EPA: Paradigms, techniques, and tools for modeling complex environmental phenomena – such as interactions of air, water, and soil – and for analyzing simulations' sensitivities and uncertainties

High End Computing Research and Development (HEC R&D)

NSF: Systems software, middleware, software environments, libraries, visualization, data management, and algorithms for heterogeneous distributed high-end systems; quantum and biological concepts

DARPA: High Productivity Computing Systems; polymorphous architectures; networked embedded sytems; biocomputational systems; cognitive computing systems

NASA: Simulated autonomous science exploration; collaborative science and engineering technologies; biomolecular probe for disease detection and astronaut health monitoring; Intelligent Vehicle Health Management system; advanced methods to assist in complex, distributed mishap investigation; prototype Concept Design and Risk Tool that identifies, tracks, and trades risks

NIH: Bioinformatics; computational biology; tools for determining 3-D molecular structures; visualization and analysis of images from instrumentation data

DOE Office of Science: Scalable mathematical algorithms and software infrastructure (operating systems, component technologies, optimal mathematical solvers) for terascale modeling and simulation applications

DOE/NNSA: Science and engineering innovations in high-speed computation and visualization to enable supercomputer modeling and simulation for U.S. nuclear stockpile stewardship

NSA: Collaborations with high-end systems manufacturers; operating system and programming language improvements; fundamental technologies for special-purpose devices (optical interconnects, power controls, cooling, switches, and design tools); computer memory interconnects performance; fundamental physics of quantum information systems

NOAA: Earth System Modeling Framework; improved climate and weather models via enhanced Modular Ocean Model, Flexible Modeling System, and Scalable Modeling System; high-performance scalable systems

NIST: Research in quantum computing, secure quantum communication, optimization and computational geometry, photonics, nanotechnologies, optoelectronics, and new chip designs and fabrication methods

ODDR&E: University-based research in novel information processing, including quantum communications and memory

Human-Computer Interaction and Information Management (HCI & IM)

NSF: Innovative IT applications for learning; stochastic models of human interaction with computing systems; interactive multimodal devices and assistive technologies; technologies for collaborative work; development of new online collections of scientific and educational resources; research in architectures, tools, and technologies for digital libraries; preservation of digital records; knowledge discovery, analysis, and visualization in multiscale, heterogeneous data sets; multilingual access to audio archives

DARPA: Rapid, two-way, natural language speech translation interfaces and platforms; rich, accurate, automatic speech-to-text transcription; multilingual detection, extraction, and summarization of information; augmented cognition

NIH: Modeling and simulation tools for exploring biomedical data; aggregatation and management of large-scale data resources for the medical community

NASA: Use neuro-engineering to develop and integrate technologies for task management, enhanced cognitive performance of teams; model knowledge use in context of work; develop "smart" software and autonomous devices; novel algorithms and software tools for extraction and visualization of very-large-scale, multisource data sets

DOE Office of Science: Integrated set of software tools for scientific collaboratory environments; research in software and infrastructure to manage very-large-scale data, instrumentation, and research results; integration of massive, heterogeneous data sets

NIST: Evaluation methods to measure relevance of content extraction; metrics, standards, and testing to advance technologies for access to and use of multimedia information; measuring performance of robotic and intelligent systems; pervasive computing and "smart spaces"; study of modes for effective human-robot communication

NOAA: Collaborative tools and information management techniques for distributed research and collaboration

ODDR&E: University-based research in computer-assisted tutorial systems; reasoning across data with diverse measures of uncertainty; representations of uncertainty for decision making

AHRQ: Information management to enable studies of health care and delivery system effectiveness; supports research in tools to enhance patient safety by reducing medical errors; funds studies of IT methods enabling providers to share information with patients; established and maintains both the National Guidelines Clearinghouse and the National Quality Measures Clearinghouse™ with detailed online information about health care metrics

EPA: Prototype tools to support evaluation of results from diverse environmental models

Large Scale Networking (LSN)

NSF: Support expansion of Extensible Terascale Facility providing high-end computing and networking infrastructure for colleges and universities; continue National Middleware Initiative to develop common enabling middleware and domain-specific cybertools for grid computing; fund development of discipline-based networks for collaboration; research in cybersecurity technologies

NIH: Distributed biology resources, knowledge management and discovery, training and education, telemedicine, re-engineering the clinical research enterprise

DARPA: Adaptive networking; network modeling and simulation

NASA: Distributed operation of advanced aerospace simulation; distributed access for computational modeling and simulation of the Earth's environment; networking for seamless access to ground, air, and space-based distributed computing, information, and knowledge

DOE Office of Science: Collaboration applications development, distributed applications environments, high-performance network facilities for science

NSA: Wide-area optical networking including optical transparency, dense wavelength division multiplexing (DWDM), physical-layer transmission impairments, and high data-rate signal encoding

NIST: Sensor interfacing and networking for interoperability and integration, cybersecurity, security and effectiveness of wireless and ad hoc networks

NOAA: Networking to support real-time access to environmental data and information; innovative data access including Web-based tools and agents; support for visualization and collaboration; network tools for crisis management

ODDR&E: Adaptive protocols for mobile wireless networks; scalable optical networking; and mobile wireless, scalable, peer-to-peer networking

AHRQ: Supports practice-based research networks of primary care physicians across the U.S. and an online medical journal of patient safety incidents including root cause analyses

Software Design and Productivity (SDP)

NSF: Empirical software engineering research; continuous change management of component-based software; profiles and patterns of software evolution; strategic software design to move from a risk-driven to a value-driven development model

DARPA: Model-based integration of embedded software; software-enabled control

NIH: Software investigations in support of biomedical computing applications

NSF/NASA: Cooperative program in Highly Dependable Computing and Communication Systems Research for projects to design, implement, test, evolve, and certify dependable, cost-effective software-based systems, using a new NASA testbed facility to evaluate research findings on real-world hardware and software artifacts

NASA: Automated software engineering methods, including technologies and tools for embedded and robotic devices; specification using Bayesian techniques; experimental evaluation of software

DOE/NNSA: Create common software development/execution environment for all Advanced Simulation and Computing (ASC, formerly ASCI) high-end platforms that supports end-to-end ASC application needs for robustness and scalability as well as I/O, storage, and visualization needs

NIST: Develop a common reporting format for sharing usability data with consumer organizations; determination of software quality using automated and knowledge-based methods; with industry partners, plan shared manufacturing business-to-business interoperability testbed; improve software engineering processes and the profession's development through international cooperation in defining its body of knowledge

NOAA: Develop a component-based modular research model of the geophysical environment

ODDR&E: University-based research in software model checking for embedded systems; real-time fault-tolerant network protocols

High Confidence Software and Systems (HCSS)

NSF: Innovative research in trustworthy computing, including scientific principles for construction of high-confidence systems, component technologies, composition and decomposition methods, modeling and analysis techniques, design tradeoffs between security and performance; safety, security, and privacy for Internet-enabled systems; real-time distributed, embedded, and hybrid systems; fault-tolerance approaches for critical infrastructure protection

DARPA: Self-regenerative systems (natural robustness through biological metaphors, self-rejuvenating software, scalable redundancy, diagnosis and healing, and probabilistic measurement and validation)

NIH: Assurance methods and technologies for life-critical medical devices and telemedicine applications; reliability, privacy, and security of medical data and IT infrastructures for research

NASA: Software design for safety, including development of High Dependability Software Consortium with leading universities and industry for improving methods and techniques to achieve very high reliability in mission-critical software; artificial intelligence and

formal methods techniques for specification, automated fault detection, and validation

NSA: Research in secure network management, secure switched network technologies, and advanced research in cryptography (key management, algorithms); advanced research in high-confidence software and system technologies (formal specification, synthesis, and verification tools and techniques, domain-specific languages, reliability engineering, and functional programming); and continuing advanced research in securing end-user systems (security middleware such as the security-enhanced operating system LINUX kernel, Object Request Brokers)

NIST: Security technologies for critical infrastructure protection; standards, methods, and metrics in authorization and authentication, including biometric techniques; tools for NIST's advanced encryption standard; with NSA, support the National Information Assurance Partnership to promote cost-effective international standards for software evaluation, testing, and certification; conformance testing for adherence to standards

ODDR&E: University-based research on Decision Making under Information Uncertainty

Social, Economic, and Workforce Implications of IT and IT Workforce Development (SEW)

NSF: Support for fundamental research on the complex processes of adaptation and interchange between society and new information technologies, including studies of large-scale technologies for collaboration and information integration in research, education, and work; human values in IT design; impacts of IT on socio-technical systems such as markets, professions, and communities; human aspects of cybersecurity and system vulnerabilities; technologies and tools for independence throughout life; and computational approaches in the economic, social, and organizational sciences. Development and evaluation of IT applications in education and training; research on barriers to IT careers for women and minorities; multidisciplinary research opportunities for students

NIH: Support opportunities for IT training, especially in bioinformatics; individual and program grants for advanced IT R&D training for health professionals

NASA: Foster public-private collaborations to develop advanced technologies, such as interactive, virtual-presence, and immersive environments and interfaces to remote instruments, that integrate agency science and engineering capabilities to strengthen K-12 science and mathematics education in alignment with national education standards

DOE Office of Science: Computational Science Graduate Fellowship Program, a nationwide competitive program to train the next generation of leaders in computational science for DOE and the Nation