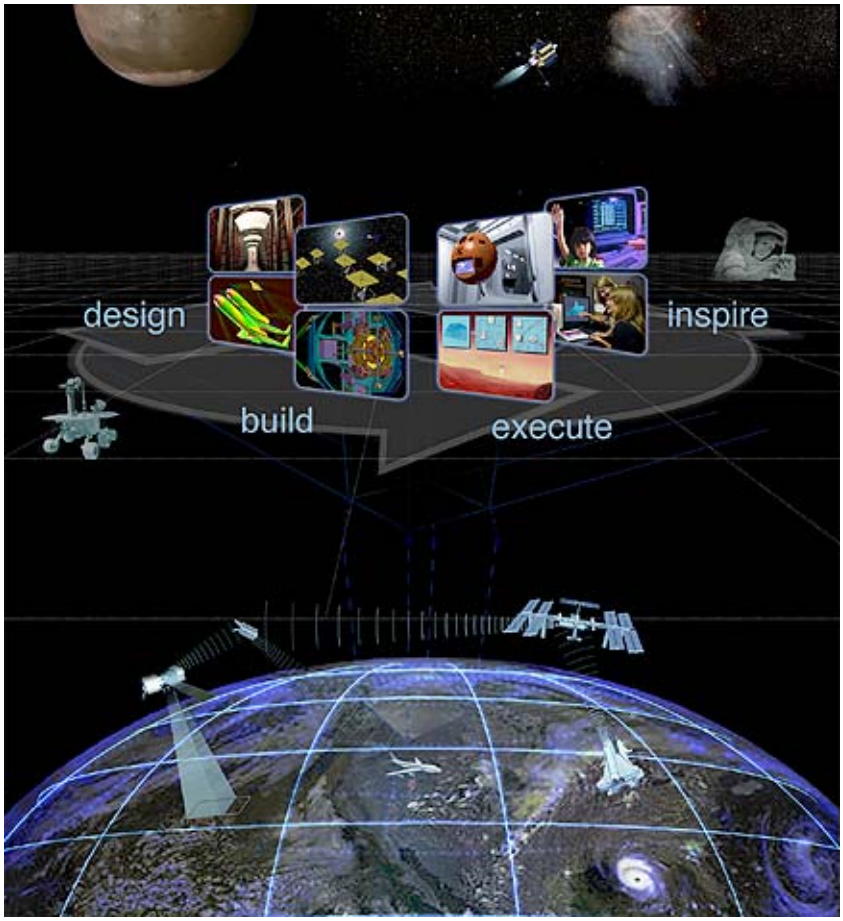
THEME: Mission and Science Measurement Technology



Mission and Science Measurement Technologies will enable new mission and science discoveries. Research in emerging new fields of study, multi-disciplinary approaches, and the development of powerful new engineering tools will one day change the definition of what is possible.

MISSION AND SCIENCE MEASUREMENT TECHNOLOGY

MAJOR EVENTS IN FY 2004

- Demonstrate technologies for millimeter precision formation flying.
- Demonstrate spacecraft communications technologies achieving 1Gbps or greater for near Earth, and 1Mbps or greater for deep space applications.
- Demonstrate lightweight, sub-kilowatt ion engine for small spacecraft.
- Develop prototype workstation that provides capability to identify, track, and trade-off risk.

THEME: Mission and Science Measurement Technology (MSM)

OVERVIEW

The Mission and Science Measurement (MSM) Technology Theme enables revolutionary capabilities through new technology. MSM objectives are to develop science-driven architectures and technology, to create knowledge from scientific data, and to develop capabilities for assessing and managing mission risk. The primary customers for MSM technologies are the NASA Enterprises. The advanced system concepts, fundamental technologies, and engineering tools developed by MSM are unique to NASA needs, and are applicable across many classes of missions in multiple Enterprises. These products may require many years to progress from initial concept definition to mission infusion.

Three programs have been formulated to accomplish MSM objectives. The **Computing, Information, and Communications Technologies (CICT) Program** develops breakthrough information and communication systems to increase our understanding of scientific data and phenomena. The **Engineering for Complex Systems (ECS) Program** develops the capabilities to assess and manage risk in the synthesis of complex systems. The **Enabling Concepts and Technologies (ECT) Program** defines new system concepts and develops new technologies to enable new science measurements.

The MSM Theme uses systems analysis to identify high-payoff technologies, and to guide investment decisions across the three MSM programs. Broadly competed peer-reviewed solicitations are used to capture innovative ideas from the research community, to leverage emerging technologies, and to complement NASA capabilities in critical areas. The Technology Executive Board (TEB), which consists of Enterprise technology representatives, advises the MSM Theme on strategic mission needs, relevance of technology development activities, and opportunities for transitioning technology products.

With the FY04 Budget request, MSM will reduce set-up times for collaborative engineering and science simulations; demonstrate autonomy components for space exploration vehicles; develop risk-based design engineering tools for concept development; demonstrate high data rate spacecraft communications technologies for deep space applications; develop miniature *in-situ* sensors for detecting organic materials on planetary surfaces; and demonstrate precision formation flying in a simulation testbed to enable distributed science collection.

Missions	Goals supported by this theme	Objectives supporting those goals		Reference 2003 Strategic Plan
Inspire the Next Generation of Explorers	6 - Inspire and motivate students to pursue careers in science, technology, engineering, and mathematics.	6.1	Improve student proficiency in science, technology, engineering and mathematics by creating a culture of achievement using educational programs, products and services based on NASA's unique missions, discoveries and innovations.	
	7 - Engage the public in shaping and sharing the experience of exploration and discovery.	7.3	Increase public awareness and understanding of how research and innovations in aerospace technology affect and improve the qualiy of life.	
Space Flight Capabilities	9 - Extend the duration and boundaries of human space flight to create new opportunities for exploration and discovery.	9.2	Develop knowledge and technologies to make life support systems self-sufficient and improve human performance in space.	
	10 - Enable revolutionary capabilities through new technology.	10.1	Improve the capability to assess and manage risk in the synthesis of complex systems.	
		10.2	Create new system concepts and demonstrate new technologies that enable new science measurements.	
		10.3	Create breakthrough information and communication systems to increase our understanding of scientific data and phenomena.	

THEME: Mission and Science Measurement Technology (MSM)

RELEVANCE

By identifying, developing, and transferring breakthrough technologies that have broad potential to enable new capabilities across many types of systems, the MSM Theme directly addresses NASA's Mission. The MSM Theme contributes to NASA's mission to understand and protect our home planet by developing advanced Earth Science instrument, sensor, communications, autonomy, and data analysis technologies. The MSM Theme contributes to NASA's mission to explore the Universe and search for life by developing advanced power, propulsion, communications, and other spacecraft systems technologies; by developing advanced sensors and instruments with increased sensitivity, spectral coverage, and reliability to enable new scientific measurement capabilities; and by developing intelligent, autonomous, and adaptive technologies for remote exploration. The MSM Theme inspires the next generation of explorers by developing exciting concepts for far-term exploration missions and systems, and by directly supporting educational outreach plans in its visionary technology programs. The MSM Theme develops fundamental technologies as only NASA can, because technologies focus on first-of-a-kind and few-of-a-kind NASA space mission applications; quality and performance requirements usually exceed those of all other potential users; and end-use applications may have no known customer outside NASA.

Education and Public Benefits

Public benefits from MSM include new technologies for use in industry, and by the general public through new generations of consumer products. The research will lead to new capabilities lowering the cost of transporting goods and people, as well as increased safety in transportation. Although this research is oriented to helping NASA achieve its objectives, portions of the research are also expected to be used by the Department of Defense, Federal Aviation Administration, Environmental Protection Agency, National Oceanic and Atmospheric Administration, and others.

NASA heavily uses the expertise of academia in this research. This provides educational opportunities to undergraduate and graduate students in our colleges and universities that teach far beyond the methodology of research to encompass exciting new areas of research.

IMPLEMENTATION

MSM program responsibility is in the Office of Aerospace Technology at NASA HQ. The Agency Program Management Council (PMC) has MSMT governing responsibility. Enterprise official is Jeremiah F. Creedon, Associate Administrator for Aerospace Technology at HQ. Theme Director is Dennis Andrucyk at HQ.

Strategy	Schedule by Fiscal Year FY02 FY03 FY04 FY05	Purpose
Resilient Systems & Operations **(ECS)**		Enable mission systems that can analyze unexpected events and adjust plans and adapt systems accordingly with minimal human participation.
System Reasoning & Risk Management **(ECS)**		System-wide life-cycle analysis and reasoning to identify and eliminate risks.
Knowledge Engineering for Safe Systems **(ECS)**		Ensure knowledge is captured, integrated, and utilized continuously to improve safety.
Advanced Engineering Environments **(ECS)**		A state-of-the-art engineering capability to dramatically improve business practices and the quality of services and products.
IT Strategic Research **(CICT)**		Research, develop, and evaluate a broad portfolio of fundamental information and bio/nano technologies for computing.
Computing, Networking, & Information Systems **(CICT)**		Provide seamless access to ground-, air- and space-based distributed computing, information, and knowledge to enable NASA missions.

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Tech. & Adv. Development Operations

THEME: Mission and Science Measurement Technology (MSM)

IMPLEMENTATION (Continued)

Strategy	Schedule by Fiscal Year 02 03 04	Purpose
Space Communications **(CICT)**		Develop space communication technologies required to give NASA scientists pervasive, high data rate access to space assets and the data they acquire.
Intelligent Systems **(CICT)**		Enable smarter, more adaptive systems and tools that work collaboratively with humans in a goal-directed manner to achieve the mission/science goals.
Energetics **(ECT)**		Develop advanced power and propulsion technologies to enable lower-cost missions with increased capability, and to extend mission reach.
Advanced Measurement & Detection **(ECT)**		Develop miniaturized, highly-integrated, and efficient instruments and sensors to provide increased scientific return.
Revolutionary Spacecraft Systems **(ECT)**		Develop revolutionary spacecraft systems and architectures to enable distributed science data collection, explore extreme environments, and lower mission costs.
Large Space Systems **(ECT)**		Develop concepts for large, ultra-lightweight space structures and apertures to expand mission capabilities, and enable new visions of the Earth and the Universe.
Advanced Systems Concepts **(ECT)**		Conceptual studies and systems analysis of revolutionary aerospace system concepts that have the potential to enable new visions for NASA's strategic plans.
Space NRAs **(ECT)**		Broadly announced peer-reviewed solicitations to capture innovative ideas from external organizations, to leverage high-payoff emerging technologies, and to complement NASA capabilities in critical areas.

Tech. & Adv. Development Operations

Tailoring
No exceptions to NPG 7120.5A have been taken.

STATUS

The MSM Theme accomplished the following in the past year:

Computing, Information, and Communications Technology

- Demonstrated pilot-in-the-loop redesign of a CRV vehicle during a flight simulation entry.
- Simulated near real time adaptive neural flight and propulsion controls for transport class aircraft.
- Automated the use of geographically-distributed heterogeneous computing resources to generate over 1100 high-fidelity runs for an aerodynamics database for the Liquid Glide-Back Booster concept.
- Delivered a web-based knowledge management system designed to provide insight into mission status and operations during Mars Exploration Rover surface operations.
- Demonstrated an autonomy architecture for planetary exploration rovers.
- Demonstrated space communication link technology operating at 622 Mbps for direct distribution of data to users
- Developed a reliable and reproducible technique to grow a carbon nanotube based inverter logic circuit.
- Demonstrated DNA-based computations on a 20-variable (exponential) problem representing one of the largest problems solved to-date by molecular computers, which have the inherent potential of vast parallelism, exceptional energy efficiency, and extraordinary information density.

Engineering for Complex Systems

- Identified software errors in the Space Station Biological Research Project.
- Developed a collaborative, web-based analysis tool supporting the CONTOUR mission mishap investigation

Enabling Concepts and Technologies.

- Demonstrated Cryobot Ice Explorer for subsurface sampling of planetary bodies.
- Developed uncooled thermopile IR detectors selected for 2005 Mars Reconnaissance Orbiter atmospheric sounder.

STATUS (Continued)

Enabling Concepts and Technologies

- Demonstrated Cryobot Ice Explorer for subsurface sampling of planetary bodies.
- Developed uncooled thermopile IR detectors selected for 2005 Mars Reconnaissance Orbiter atmospheric sounder.
- Developed prototype MEMS-based microshutter array that was selected for Next Generation Space Telescope Multi-Object Spectrometer.
- Developed 10kW Next Generation Ion Engine that was selected for further development by Code S.
- Developed pulsed plasma thruster that was demonstrated on the Earth Observing-1.
- Demonstrated record 30% efficiency solar array with thin film Fresnel lens concentrators.
- Developed membrane antenna for synthetic aperture radar that was selected for further development by Code Y.
- Demonstrated imaging at 40 microns for proof-of-concept membrane mirror telescope.
- Characterized structural dynamics of a solar sail engineering model in vacuum.
- Developed carbon-nanotube doped polymer film to mitigate spacecraft charging.

PERFORMANCE MEASURES

Annual Performance Goals

6.1.1	**OUTCOME:** Kindergarten through graduate students will be more proficient in science, technology, engineering, and mathematics (STEM).
4MSM15	Provide at least 4 products that deliver or facilitate the delivery of NASA science and engineering content into formal and informal educational institutions. Disseminate educational products to at least 1,000 schools, educators, or students. Provide remote access of educational materials into the classroom via advanced information technologies. Support NASA presence at educational workshops, conferences or symposiums. Support development of academic course material in Aerospace Technology. Progress will be validated in FY04 through external evaluation conducted according to accepted professional standards. (CICT, RMCS & ECT)
7.3.1	**OUTCOME:** Increase public awareness and appreciation of the benefits made possible by NASA research and innovation in aerospace technology.
4MSM16	Maintain publicly-available websites at the Program and Project levels. Publish at least 10 articles or papers on key innovations. Support at least 2 conferences or exhibits highlighting research in Aerospace Technology. (CICT, RMCS & ECT)
9.2.2	**OUTCOME:** Develop knowledge and technologies to make life support systems self-sufficient and improve human performance in space.
4MSM1	Demonstrate ground test of a Mobile Intelligent Vehicle Health Management (IVHM) system for internal spacecraft operations that will provide environmental sensing capabilities and knowledge management services. The Mobile IVHM will perform independent calibration checks for environmental sensors; autonomously replace or substitute for failed environmental sensors; hunt down and isolate gas leaks and temperature problems; and provide a range of crew personal data assistant functions. (RMCS)
10.1.1	**OUTCOME:** Enable new technologies to identify and reduce mission risk.
4MSM2	Develop a Prototype Concept Design Risk Workstation that provides the capability to identify, track, and trade-off risk in the conceptual design phase of missions. The workstation will integrate databases, visualization modules, solicitation routines, system simulations, and analysis programs that support an interactive system design process. (RMCS)
10.2.1	**OUTCOME:** Identify high-payoff mission enabling technologies to guide program investment decisions.
4MSM3	Develop a process for assessing the system-level benefits of new technologies, and complete technology assessments on 3 representative mission classes selected by the Technology Executive Board. A mission class is a set of missions with similar scientific objectives, such as large space-based astronomical observatories. The technology assessment will be concluded when the mission enabling technologies have been identified, and system-level performance goals for these technologies have been established. (ECT)
10.2.2	**OUTCOME:** Reduce trip time for interplanetary missions.
4MSM4	Demonstrate lightweight, sub-kilowatt ion engine for small spacecraft to reduce interplanetary trip time by 30%. (ECT)
10.2.3	**OUTCOME:** Enable new science measurements.
4MSM5	Develop bio-molecular probe to detect specific biomarker signature in-vitro for disease detection and astronaut health monitoring. Demonstrate a molecular probe that detects at least one specific biomarker in cells. (CICT)
4MSM6	Demonstrate > 5% efficiency for 2-micron laser transmitter. State-of-the-art laser transmitters have about 3% efficiency. Higher efficiency will enable smaller, lighter space-based lidar instruments for active sensing of the Earth's atmosphere. (ECT)
4MSM7	Develop 1,000-element array of superconducting transition edge sensors to enable astronomical imaging in the unexplored submillimeter region of the spectrum. (ECT)

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THEME: Mission and Science Measurement Technology (MSM)

PERFORMANCE MEASURES

Annual Performance Goals (Continued)	
4MSM8	Develop miniature chromatography system for separation and detection of organic materials to enable the search for life on other planets. (ECT)
10.2.4	**OUTCOME:** Enable revolutionary spacecraft systems for distributed science collection and lower mission cost.
4MSM9	Demonstrate by simulation millimeter precision formation flying. The simulation will validate sensors and control algorithms needed to enable constellations of spacecraft for distributed science measurements. (ECT)
4MSM10	Develop microspacecraft ground testbed that incorporates micro navigation subsystem, micro thrusters, and multifunctional structure. By integrating miniaturized spacecraft subsystems, the testbed will demonstrate a factor of 2 to 3 reduction in spacecraft mass, which will result in lower mission costs. (ECT)
10.2.5	**OUTCOME:** Increased capabilities to acquire and return scientific data.
4MSM11	Develop critical spacecraft networking technologies. Demonstrate spacecraft communications technologies achieving 1Gbps or greater for near Earth, and 1Mbps or greater for deep space applications. Develop related protocols and software for Internet-like space computing and communications. High bandwidth communications and networking technologies will increase scientific return. (CICT)
4MSM12	Demonstrate in a laboratory environment deployment and rigidization of a jointed inflatable truss to enable modular assembly of large apertures. In-space assembly will enable a factor of 10 increase in aperture size to increase scientific return. (ECT)
10.2.6	**OUTCOME:** Enable intelligent and autonomous systems for science exploration missions.
4MSM13	Complete simulated autonomous science exploration mission - Demonstrate a successful analogue science mission (terrestrial rover or simulated spacecraft) with key autonomy technologies in planning/scheduling, science data priority assignment, system executives, and diagnostic systems, enabling goal-directed systems for science exploration missions. (CICT)
10.3.1	**OUTCOME**: Reduce the time required to design and operate future missions.
4MSM14	Develop collaborative science and engineering technologies for integrated simulation and information management, enabling reductions in set-up and management times for aerospace engineering, science simulations, and mission status awareness of remote exploration missions. Demonstrate standardized protocols and specifications for interoperability of simulation components and heterogeneous data sources; provide visual assembly of workflow components and tools; provide applications-oriented process management; and demonstrate heterogeneous database access technology that can automatically access distributed, heterogeneous data sources. (CICT)

INDEPENDENT REVIEWS

Types of Review	Performer	Last Review	Next Review	Purpose
Quality	NRC	6-Jun-02	1-Jun-05	Peer review of technical quality and program content.
Relevance	ATAC MSM subcommittee	4-Sep-02	1-Mar-03	External community reviews program status and plans.

COST

Budget Authority ($millions)	FY02	FY03	Chng	FY04	Comments
Mission and Science Measurement (MSM) Technology	**276.1**	**274.9**	**+163.5**	**438.4**	
Enabling Concepts & Technologies (ECT)	92.8	92.9	+68.1	161.2	Full cost implications
Computing, Information & Communications Technology (CICT)	155.5	154.0	+79.2	233.2	Full cost implications
Engineering for Complex Systems (ECS)	27.8	28.0	+13.0	44.0	Full cost implications

Indicates budget numbers in Full Cost.

Indicates changes since the FY 2003 Presidents Budget Submit.

Note: For all formats, the FY02 column reflects the FY02 Congressional Operating Plan dated 9/30/02. The FY03 column reflects the FY03 President's Budget Submit (PBS) as Amended. The Change column includes both programmatic and full cost adjustments. The FY04 column is in full cost.

THEME: Mission and Science Measurement Technology

TECHNOLOGY AND ADVANCED CONCEPTS: Computing, Information, and Communications Technology (CICT) Program

PURPOSE

Objective	Reference FY 2004 Strategic Plan	Performance Measures
6.1	Improve student proficiency in science, technology, engineering and mathematics by creating a culture of achievement using educational programs, products and services based on NASA's unique missions, discoveries and innovations.	4MSM15
7.3	Increase public awareness and understanding of how research and innovations in aerospace technology affect and improve the qualiy of life.	4MSM16
10.2	Create new system concepts and demonstrate new technologies that enable new science measurements.	4MSM5, 4MSM11, 4MSM13
10.3	Create breakthrough information and communication systems to increase our understanding of scientific data and phenomena.	4MSM14

The CICT Program will research, develop, demonstrate, and infuse advanced computing, information, and communications technologies to allow NASA to accomplish its commitments to the United States taxpayers with greater mission assurance, for less cost, and with increased science return. CICT research and development, as an integral element of the federal information technology investment, will also act as a catalyst for continued national excellence in computing, communications, and the information technologies.

Specifically CICT Program will **1)** enable smarter, more adaptive systems and tools that work collaboratively with humans in a goal-directed manner to achieve the mission/science goals; **2)** enable seamless access to ground-, air-, and space-based distributed computing, information, and knowledge to enable NASA missions in aerospace, Earth science, and space science; **3)** enable broad, continuous presence and coverage for high rate data delivery from ground-, air-, and space-based assets directly to the users; and **4)** research, develop, and evaluate a broad portfolio of fundamental information and bio/nano-technologies for infusion into NASA missions.

OVERVIEW

Building upon previous investments in a loose array of information science and technology programs, the Aerospace Technology Enterprise initiated the CICT Program in the beginning of fiscal year 2002 and established a tightly coupled and coordinated research and development program. By integrating and applying coordinated management to the Agency's information technology investments, the CICT Program makes strategic investments to enable fundamental computing, information and communication technology advancements that will enable and enhance a broad class of future NASA missions. In addition, CICT will work closely with other NASA programs to enable infusion of these technologies into NASA missions. The CICT Program has been organized into four projects, each with a unique technical focus. The **Intelligent Systems Project** goal is to enable smarter, more adaptive systems and tools that work collaboratively with humans in a goal-directed manner to achieve NASA mission/science goals and will focus on technologies for automated reasoning, human-centered computing, and intelligent data understanding. The **Computing, Networking, and Information Systems Project** goal is to enable seamless access to ground-, air-, and space-based information technology resources in support of NASA mission/science goals. The **Space Communications Project** goal is to develop the space communication technologies required to give NASA scientists pervasive, high-data rate access to space assets and the data they acquire. Finally, the **Information Technology Strategic Research Project** goal is to research, develop, and evaluate emerging information, biologically-inspired, and nanoscale technologies for infusion into NASA missions.

PROGRAM MANAGEMENT

The CICT research program is managed at NASA HQ. The Office of Aerospace Technology Enterprise Program Management Council (EPMC) has CICT governing responsibility. Enterprise official is Jerry Creedon, Associate Administrator for Aerospace Technology at HQ. Theme Director is Dennis Andrucyk, Acting Director for Mission and Science Measurement Technology (MSMT) at HQ. The Program Manager and POC for CICT is Eugene Tu. This program is in full compliance with NPG7120.5B.

THEME: Mission and Science Measurement Technology

TECHNOLOGY AND ADVANCED CONCEPTS: Computing, Information, and Communications Technology (CICT) Program

TECHNICAL COMMITMENT

The baseline for this technical commitment is the FY03 budget.

	Technical Specifications		FY04 President's Budget					Change from Baseline
				FY02	**FY03**	**FY04**	**FY05**	
IS - Intelligent Systems	**Goal-Directed Systems:** Develop and demonstrate 1) automated reasoning technologies that support the need to significantly increase the level of autonomy within NASA's future missions, 2) intelligent data understanding technologies that support NASA mission needs to automatically discover new information from large databases, 3) human-centered computing technologies that optimize the combined performance of human experts and the supporting information system.	TRL	2	2-3	3-4	3-4	--
		$M	63.8	76.5	66.2		--
	Conclusion of a successful analogue science mission (terrestrial rover or simulated spacecraft) demonstrating key autonomy technologies enabling goal-directed systems for science exploration missions. Demonstrate technologies enabling contact instrument placement and vehicle positioning in **one command cycle** (at least 3X improvement over baseline capabilities). (4MSM13)	TRL	2	3	4		--
		$M	4.0	4.0	4.0		--
	Demonstrate capability to **automatically** discover a feature, and its underlying mathematical causal structure.	TRL	2	2	3	3	--
		$M	6.6	10.4	8.5		--
	Successfully demonstrate in a Mission Operations Facility or similar testbed the **use of agent-based integrated tools** for routine operations, as well as anticipated and unanticipated off-nominal operations.	TRL	2	2	3	3	--
		$M	4.5	7.0	6.0		--
	Engage the Computational Sciences community with NASA problems by providing Challenge Problems and conducting periodic solicitations for basic research, resulting in the awarding of **over 50 excellent quality research tasks** (as rated by peer-review panels) over the life of the program.	TRL	2	2	2	2	--
		$M	9.3	10.0	8.5		--
	Develop **at least 11 key technologies** in the areas of Automated Reasoning, Human-Centered Computing, and Intelligent Data Understanding.	TRL	2	2	3	3	--
		$M	38.5	41.6	38.3		--
	University Research and Engineering Technology Institute (URETI).	TRL		2			--
		$M		3.0			--
CNIS - Computing, Networking, & Information Systems	**Seamless access to NASA information technology resource:** Research, develop, test, integrate, demonstrate, and transfer testbed, grid common services, and information environments technologies for seamless and collaborative access to distributed ground-based hardware, software, and information resources.	TRL	4	5	5	6	--
		$M	44.2	33.5	38.9		--
	Exploratory grid environment: Demonstrate at least one Enterprise-relevant application operating on an exploratory grid environment.	TRL	5				--
		$M	2.9				--
	Complete the development of at least 3 sets of technologies in the areas of: **A)** Combinations of advances in Grid technologies (applications, information environments, grid common services, and high-end computing and networking). **B)** Integrated toolsets for creating and managing collaborative science and engineering environments for integrated simulation, information management and data analysis in a Grid environment. **C)** Technologies and services that enable: **(1)** Heterogeneous, geographically-extensible, ground-based Grid; **(2)** Efficient access to and use of Grid resources; **(3)** Integration of high-end computing resources into the Grid; **(4)** Interaction among mobile and communications elements. (4MSM14)	TRL	4	5	5	6	--
		$M	41.3	33.5	38.9		--
	Current TRL status relative to FY03 plan (R/Y/G/B)					Planned TRL status to FY03 plan		

THEME: Mission and Science Measurement Technology

TECHNOLOGY AND ADVANCED CONCEPTS: Computing, Information, and Communications Technology (CICT) Program

TECHNICAL COMMITMENT

Technical Specifications		FY04 President's Budget FY02	FY03	FY04	FY05	Change from Baseline
High rate data delivery: Develop innovative component technologies for on-demand space data delivery enabling high data rates, broad coverage, internet-like data access.	TRL	1-2	1-2	2-3	2-3	--
	$M	7.6	7.5	7.4		--
Ground-based demonstration of spacecraft communications technologies, to achieve at least 1Gbps for near Earth and 1Mbps for deep space applications (representing 10X improvements over current baseline). Develop related protocols and software for Internet-like space computing and communications. (4MSM11)	TRL	2	3	**3**		--
	$M	3.6	3.5	3.4		--
Provide detailed analysis for next generation architectures to enable NASA Enterprises to make timely and cost effective investment decisions in operational systems. Demonstrate emulation environment to verify space architectural designs for implementation. Demonstrate high rate communications for space to space systems and low loss energy efficient technologies for inter-spacecraft and proximity links.	TRL	1-2	1-2	2	2	--
	$M	4.0	4.0	4.0		--
Strategic Research: Demonstrate nano-scale component development and assembly; intelligent, adaptive, immersive, multi-modal control of aerospace vehicles; high confidence automated software development and verification; adaptive and fault-tolerant systems; and new models of computing for emerging and anticipated platforms.	TRL	1	1	2	3	--
	$M	29.1	29.3	26.4		--
Evaluate and promote at least 5 new bio, nano, or information technologies impacting at least 2 NASA Enterprises to a status appropriate for transfer to another NASA program or project, or insertion into a NASA mission. The current research portfolio includes nano-scale component development and assembly; intelligent, adaptive, immersive, multi-modal control of aerospace vehicles; high confidence automated software development and verification; adaptive and fault-tolerant systems; and new models of computing for emerging and anticipated platforms. (4MSM5)	TRL	1	1	2	3	--
	$M	29.1	29.3	26.4		--

SC - Space Communications

ITSR - Info. Tech. Strategy Research

Current TRL status relative to FY03 plan (R/Y/G/B) — Planned TRL status to FY03 plan

Schedule	FY04 President's Budget	Change from Baseline
CICT Consolidation Initiated per OMB Guidance	Feb-01	--
CICT Program Execution Initiated	Oct-01	--
NRC Technical Quality Review	Jun-02	--
Independent Implementation (IIR) Review	Nov-03	--
Non Advocate (NAR) Review of CICT Phase I Follow-On	Jun-04	
CICT Phase I Follow-On Project(s) Execution Initiated	Oct-04	--
NRC Technical Quality Review	Jun-05	--
Non Advocate (NAR) Review of CICT Phase II Follow-On Projects	Jun-06	--
CICT Phase II Follow-On Project(s) Execution Initiated	Oct-06	--
Independent Implementation (IIR) Review	Nov-06	--

ACQUISITION STRATEGY & PERFORMING ORGANIZATIONS

Data current as of 1/19/2003

Changes since FY03 Pres. Budget: None.

Current Acquisitions	Actual *	Selection Method	Actual *	Performer	Actual *
Cooperative Agreements	15.5%	Full & Open Competition	96.3%	Industry	51.5%
Cost Reimbursable	64.0%	Sole Source	3.7%	Government	0.4%
Fixed Price	5.0%		100%	NASA Intramural	27.1%
Grants	5.5%			University	21.0%
Other	10.0%	Sci Peer Review (full & open)	23.7%	Non Profit	0.0%
* as % of FY02 direct procurement	100%	* as % of FY02 direct procurement		* as % of FY02 direct procurement	100%

THEME: Mission and Science Measurement Technology

TECHNOLOGY AND ADVANCED CONCEPTS: Computing, Information, and Communications Technology (CICT) Program

ACQUISITION STRATEGY & PERFORMING ORGANIZATIONS

Data current as of 1/19/2003

Future Acquisitions - Major	Selection	Goals
CICT NASA Research Announcements (NRA) 2003-2004		Award of excellent rated academic, industry and NASA proposals in support of objectives.
CICT upgrades of computational research testbeds 2004-2006		Upgraded computing testbed capabilities to support research objectives.

AGREEMENTS

Internal: Agreement between CICT, ECS, and VST on the demonstrate of neural-based flight control systems for transport aircraft; Agreement with the Mars Exploration Rover (MER) Project on delivery of CICT products in support of the MER mission; Agreement with the Mars Communication Project Office and SOMO on the Transfer of Electronics and High-Power Transmitter Technologies.

External: MOU between NSF and NASA on Research in Distributed Heterogeneous Computing; Space Act Agreement between NASA and Silicon Graphics Inc. (SGI) on research of shared memory high-end computing architectures.

INDEPENDENT REVIEWS

Data current as of 1/19/2003

Types of Review	Performer	Last Review	Next Review	Purpose
Performance	IPAO	None	Nov-03	Non-Advocate Review, followed by annual Independent Implementation Reviews.
Quality	NRC / ASEB	Jun-02	Jun-05	Technical quality and relevance.
Relevance	ATAC MSM SC	4-Sep-02	1-Mar-03	External community reviews status and plans.
Relevance	TEB	29-Oct-02	monthly	Enterprises review the relevance of program activities to their strategic needs, and identify transition opportunities for program products.

COST

Budget Authority ($M)	FY02	FY03	FY04	Comments
FY 2004 President's Budget (Technology)	**155.5**	**154.0**	**233.2**	
Information Technology Strategy Research (ITSR)	38.6	29.8	54.7	
Intelligent Systems (IS)	63.8	79.6	82.2	
Computing, Networking, & Information Systems (CNIS)	44.1	37.0	80.7	
Space Communications (SC)	9.0	7.6	15.6	
Changes since FY 03 Pres. Budget	**-0.4**	**+0.0**	**+78.9**	***Reason for Change:***
Information Technology Strategy Research (ITSR)	-1.7		+24.6	Full cost implications & more people
Intelligent Systems (IS)			+8.4	Full cost implications & less people
Computing, Networking, & Information Systems (CNIS)	-0.1		+37.9	Full cost implications & more people
Space Communications (SC)	+1.4		+8.0	Full cost implications & less people

Indicates budget numbers in Full Cost.

Indicates changes since the FY 2003 Presidents Budget Submit.

Note: For all formats, the FY02 column reflects the FY02 Congressional Operating Plan dated 9/30/02. The FY03 column reflects the FY03 President's Budget Submit (PBS) as Amended. The Change column includes both programmatic and full cost adjustments. The FY04 column is in full cost.

THEM Mission and Science Measurement Technology

TECHNOLOGY AND ADVANCED CONCEPTS: Engineering for Complex Systems (ECS) Program

PURPOSE

Objectives	Reference FY 2004 Strategic Plan	Perf. Measures
6.1	Improve student proficiency in science, technology, engineering and mathematics by creating a culture of achievement using educational programs, products and services based on NASA's unique missions, discoveries and innovations.	4MSM15
7.3	Increase public awareness and understanding of how research and innovations in aerospace technology affect and improve the qualiy of life.	4MSM16
9.2	Develop knowledge and technologies to make life support systems self-sufficient and improve human performance in space.	4MSM1
10.1	Improve the capability to assess and manage risk in the synthesis of complex systems.	4MSM2

The Engineering for Complex Systems Program (ECS) will achieve ultra-high levels of safety and mission success by fundamentally advancing NASA's system life-cycle approach through the infusion of advanced technologies.

OVERVIEW

The program is structured around developing technologies along three major thrusts: **1.** System Reasoning & Risk Management Project, work will encompass Risk-Based Design Methods, Risk, Mishap & Subsystem Models; Hazard & Failure Mode Identification; and Integration of Analysis Tools & Data. **2.** Knowledge Engineering for Safe Systems Project will address Risk Perception & Decision Research, Human & Organizational Risk Factors, Linked Heterogeneous Safety Critical Information, Knowledge Discovery from Data, and Virtual Iron Bird High Fidelity Environments., **3.** Resilient Systems & Operations Project will focus on Autonomous and Adaptive Systems, Resilient Software Technologies, Human Interfaces for State Awareness, and High Fidelity Validation Testbeds.

PROGRAM MANAGEMENT

NASA OAT HQ is responsible for the management and implementation of the ECS program. The Office of Aerospace Technology Program Management Council (PMC) has governing responsibility. Enterprise official is Jeremiah Creedon, Associate Administrator for Aerospace Technology at HQ. Theme Director and Point of Contact is Dennis Andrucyk, Director for Mission and Science Measurement Technology at HQ. The Program Manager is Mr. Yuri Gawdiak at HQ. This program is in full compliance with NPG7120.5B.

TECHNICAL COMMITMENT

The baseline for this technical commitment is the FY02 budget.

Technical Specifications	FY04 President's Budget	FY02	FY03	FY04	FY05	Change from Baseline
Organizational Risk Model: Social & Organizational Systems - risk perception & management within organizations, including culture, decision, and individual agent attributes. TRL advanced from 1-2. Provide a model-building tool for researchers, to capture and analyze data on social/organizational system risks, enabling the description and analysis of risks in organization-level decisions. Successfully model one key risk-drivers (variables) in one specific NASA context; The risk model shall include at least one variable related to culture, two variables related to structure, and two variables related to decision-making; Construct validity check- assessment by two experts that the model represents a reasonable theory of organizational risk. (KESS)	TRL	1	2			--
	$M	2.3	2.4			--
Initial High Dependability Computing Testbeds: High fidelity testbeds supporting key NASA software risks in the areas of dependability performance, risk measurement tools in complex systems. Install, load, and provide initial simulations for at least two NASA software systems. (RSO)	TRL	1	2			--
	$M	3.9	4.4			--
Current TRL status relative to FY03 plan (R/Y/G/B)						Planned TRL status to FY03 plan

Table is continued on next sheet.

TECHNICAL COMMITMENT (Continued)

Technical Specifications		FY04 President's Budget				Change from Baseline
		FY02	**FY03**	**FY04**	**FY05**	
Prototype Concept Design Risk Tool: Address agency-wide risk management gaps in the Concept Development lifecycle phase of program/missions. The current state-of-the-art relies on informal, manual, incomplete, and sporadic processes to generate, assess, mitigate and trade risks in the concept design phases. There exists no standard representations and lifecycle-wide management of risks. The ECS program will develop a concept design risk tool that provides systematic processes to do risk identifications, mitigation strategies, assessments, and key trade-off capabilities not only between risks, but between risks and other mission design criteria. Success Criteria: add two new risk types from either software, organizational, and/or programmatic; demonstrate ability to modify risk profiles as a result of system models; meet customer requirements for real-time design agility performance. (4MSM1) (SRRM, KESS)	TRL	3	4	6		--
	$M	3.0	3.8	3.8		--
Virtual Iron Birds - Enabling knowledge management environment technologies for design and operations engineering models. TRL advancement from 2-4 with two of the following three software demonstrations: 1) Digital Shuttle- ontology and standardized tags for four classes of objects, three dimensional representations for at least two Shuttle components or subsystems; 2) Simstation- two simulation models of Station subsystems that share data and contribute to risk assessment for two classes of risks; 3) WIRe- two types of wire defects modeled, and one wire-related risk modeled. Documents delivered: VIB (as instantiated in Digital Shuttle or SimStation)- Requirements Analysis, Concept of Operations, Architecture/Ontology Description, Benefits and Use Case Analysis; WIRe- Report on risk analysis methods based on library of wire defect models. (KESS, SRRM)	TRL	2	3	3	**4**	--
	$M	4.0	3.9	3.7		--
Mishap Initiator Identification System - Demonstration of integrated tool suite for risk identification, analysis, and lifecycle decision support. Demonstrate the successful delivery of mishap datasets by showing utilization in at least 6 conceptual designs in concert with the risk workstation. Demonstrate IO using at least one ontology, using at least 2 accident models, and accessing mishap information from MCC. Demonstrate investigation organizer tool use in 2 mishap investigations. (SRRM)	TRL		2	3	4	--
	$M		1.4	1.5		--
Organizational Risk Tool Suite - Decision support tool suite for organizational risk assessment. Advance TRL from 2 to 4. Tools can be used by organizational modelers identify and analyze at least two key risk drivers, in at least one NASA domain. Tools based explicitly on the Organizational Risk Model defined in RMCS-3; The following items formally documented: Requirements, Benefits Analysis, Architectural Description. Paper accepted for presentation at a professional conference. Reports and analyses accepted and used for decision-making regarding organizational processes in at least one domain. Preliminary Technology Adoption Report submitted. (KESS)	TRL		--	2	3	--
	$M			2.8		--
Resilient System Technologies - Adaptive technologies that learn and react to complex and dynamic environments. Successful demonstration of 3 out of 4resiliency capabilities including reconfiguration, real-time adaptive recovery from unexpected events, system self-assessment, scenario re-planning and execution, enhanced unambiguous human-machine interactions. Success is defined in the exit criteria for each individual demonstration milestone. (RSO)	TRL	2	3	4	5	--
	$M	5.3	4.9	3.5		--
Current TRL status relative to FY03 plan (R/Y/G/B)						Planned TRL status to FY03 plan

Table is continued on next sheet.

THEME: Mission and Science Measurement Technology

TECHNOLOGY AND ADVANCED CONCEPTS: Engineering for Complex Systems (ECS) Program

TECHNICAL COMMITMENT (Continued)

Technical Specifications		FY04 President's Budget				Change from Baseline
		FY02	FY03	FY04	FY05	
Prototype Model-Based System Analysis Tool Suite- Develop prototype capability to analyze hardware, software, and human system specifications for hazards, risk analysis, and system complexity metrics. Develop and exercise risk assessment and management capability incorporating MIIS, IO, risk workstation, and other tools to develop a complete project risk profile and risk model for one Enterprise. Develop a complete technology development risk profile and risk model for one Enterprise program. Incorporate software risk attributes and models. Incorporate operational HORM model. Demonstrate the capability over the complete formulation phase. (SRRM, KESS, RSO)	TRL	2	2	3	4	--
	$M	5.4	5.4	5.2		--
High Dependability SW Standards - Demonstration of successful measurement of dependability metrics on two NASA mission testbeds. Enable estimation of impact (cost vs. benefit) of software engineering technologies on software and system dependability based on empirically validated models. (RSO)	TRL		--	2	3	--
	$M			5.6		--
Ground Demonstration of Mobile IVHM - Demonstrate the feasibility of adaptive risk management technologies for internal spacecraft operations. Help push the state-of-the-art in spacecraft risk mitigation strategies from redundancy based fault tolerance techniques which have significant cost, weight, volume, & common-cause-failure weaknesses to dynamic, adaptive resiliency approaches. The RMCS program will demonstrate an autonomous, mobile sensing system for spacecraft that will dynamically provide environmental sensing capabilities along with mobile knowledge management services to significantly enhance human operations situational awareness and fault isolation and recovery operations. Success Criteria: Demonstrate mobile navigation & control precision that passes safety requirements for spacecraft operations; Demonstrate environmental monitoring capabilities for the presence for atleast one atmospheric gas, temperature, pressure, humidity, and infra-red scans; Demonstrate intelligent planning & scheduling for fault, isolation, and recovery for a failed environmental sensor. (4MSM2) (RSO)	TRL	2	3	**4**		--
	$M	1.28	1.32	1.4		--
Current TRL status relative to FY03 plan (R/Y/G/B)						Planned TRL status to FY03

TECHNICAL COMMITMENT (Continued)

Schedule	FY04 President's Budget	Change from Baseline
Milestones		
Non-Advocate Review	1 Qtr FY03	--
Program Commitment Auth	1Qtr FY03	--
Organizational Risk Model (ECS3)	4 Qtr FY03	--
Initial High Dependability Computing Testbeds (ECS4)	4 Qtr FY03	--
Prototype Concept Design Risk Tool (ECS5)	4 Qtr FY04	--
Virtual Iron Birds (ECS6)	3 Qtr FY05	--
Mishap Initiator Identification System (ECS7)	1 Qtr FY06	--
Organizational Risk Tool Suite (ECS8)	3 Qtr FY06	--
Resilient System Technologies (ECS9)	4 Qtr FY06	--
Prototype Model-Based System Analysis Tools (ECS10)	4 Qtr FY06	--
High Dependability SW Standards (ECS11)	4 Qtr FY06	--

ACQUISITION STRATEGY & PERFORMING ORGANIZATIONS

The program will employ a mix of broadly competed procurements; full and open competitive procurements will be used to the maximum extent possible. External R&D activities will be solicited and funded under a number of competitive procurement actions utilizing various types of solicitation and contractual vehicles. Commercial systems will be acquired through competitive commercial purchases. Other contract vehicles such as Government-Wide Agency Contracts (GWAC), GSA Federal Supply Schedules, and Consolidated Contract Initiatives will be considered as part of the integrated acquisition strategy. The academic community will be involved in identifying, conceiving and developing new advances to meet Agency goals and objectives. The concept of a full spectrum of academic involvement will help assure that the full potential of these new technology advances can be achieved, and it will also catalyze and stimulate further innovative ideas for critical new technology.

THEME:	Mission and Science Measurement Technology
TECHNOLOGY AND ADVANCED CONCEPTS:	Engineering for Complex Systems (ECS) Program

ACQUISITION STRATEGY & PERFORMING ORGANIZATIONS (Continued)

Current Acquisitions	Actual *	Selection Method	Actual *	Performer	Actual *
Cooperative Agreements	25%	Full & Open Competition	96%	Industry	50%
Cost Reimbursable	62%	Sole Source	2%	Government	2%
Fixed Price	4%	Govt	2%	NASA Intramural	13%
Grants	9%		100%	University	34%
Other	0%	Sci Peer Review	0%	Non Profit	1%
* as % of FY02 direct procurement	100%	* as % of FY02 direct procurement		* as % of FY02 direct procurement	100%

Future Acquisitions - Major	Selection	Goals
NASA Research Announcement FY03-FY06		Solicit broad inputs & innovations into the low TRL portions of the program (complexity research & human & organizational risk).

AGREEMENTS

Internal: The program is not dependent on other NASA activities outside of the control of the Associate Administrator for Aerospace Technology.

External: Memorandum of Understanding: Air Force/Boeing, GE, BAE, SRI International
Cooperative Agreements: U. of FL., CMU, Georgia Tech, & Penn State Software Consortium

Changes since FY 2003 President's Budget: None.

INDEPENDENT REVIEWS

Types of Review	Performer	Last Review	Next Review	Purpose
Quality	NRC / ASEB	11-Jul-02	1-Jul-05	Technical quality and relevance.
Performance	IPAO	n/a	19-Feb-02	Program Readiness Review, Non-Advocate Review, followed by annual Independent Implementation Reviews.
Relevance	ATAC MSM SC	4-Sep-02	1-Mar-03	External community reviews program status and plans.
Relevance	TEB	29-Oct-02	monthly	Enterprises review the relevance of program activities to their strategic needs, and identify transition opportunities for program products.

COST

Budget Authority ($M)	FY02	FY03	FY04	Comments
FY 2004 Budget Submit (Technology)	**27.8**	**28.0**	**44.0**	
System Reasoning & Risk Mgmt.	9.7	9.0	12.6	
Resilient Systems & Operations	12.7	14.0	21.0	
Knowledge Engineering for Safe Systems	5.4	5.0	10.4	
Changes since FY 03 Pres. Budget	**-0.2**	**+0.0**	**+16.1**	***Reason for Change:***
System Reasoning & Risk Mgmt.			+3.8	Full cost implications
Resilient Systems & Operations	-0.2		+6.7	Full cost implications
Knowledge Engineering for Safe Systems			+5.6	Full cost implications

Indicates budget numbers in Full Cost.
Indicates changes since the FY 2003 Presidents Budget Submit.

Note: For all formats, the FY02 column reflects the FY02 Congressional Operating Plan dated 9/30/02. The FY03 column reflects the FY03 President's Budget Submit (PBS) as Amended. The Change column includes both programmatic and full cost adjustments. The FY04 column is in full cost.

Theme: Mission and Science Measurement Technology
Technology and Advanced Concepts: Enabling Concepts and Technologies (ECT) Program

PURPOSE

Objectives	Reference FY 2004 Strategic Plan	Performance Measures
6.1	Improve student proficiency in science, technology, engineering and mathematics by creating a culture of achievement using educational programs, products and services based on NASA's unique missions, discoveries and innovations.	4MSM15
7.3	Increase public awareness and understanding of how research and innovations in aerospace technology affect and improve the qualiy of life.	4MSM16
10.2	Create new system concepts and demonstrate new technologies that enable new science measurements.	4MSM3, 4MSM4, 4MSM6, 4MSM7, 4MSM8, 4MSM9, 4MSM10, 4MSM12

The ECT Program explores revolutionary concepts for aerospace systems, and performs fundamental research and development of high-payoff technologies to enable pursuit of NASA Vision and Mission by all Themes and Enterprises. Program will identify, develop, and transfer breakthrough technologies that have broad potential across many types of systems to provide increased scientific return at lower cost, and to enable missions and capabilities beyond current horizons. Particular foucus on transition and insertion of products to Enterprise mission applications.

OVERVIEW

The ECT Program is the front end of the enabling technology pipeline that supplies the focused technology development programs of the NASA Enterprises. The revolutionary system concepts and technologies developed by ECT are unique to NASA needs, and are applicable across many classes of missions in multiple Enterprises. The ECT program involves three phases: Exploration, Transition, and Insertion. Fundamental technology development is a long-term process that may require from 5 to 15 years to progress from initial conception to mission use. In order to manage short-term progress, each phase is planned for a two-to-three year period, with specific deliverable products at phase end. In the Exploration Phase, promising ideas are developed without specific application. Technology requirements are derived from NASA strategic goals and objectives, advanced concept studies, and systems analysis. The technology requirements guide development of component and subsystem technologies, with emphasis on efficiency, miniaturization, integration, and resiliency. Broadly-competed solicitations and university partnerships are used to capture innovative ideas from the external community, to leverage emerging technologies, and to complement NASA capabilities in critical areas. In the Transition Phase, which is done in collaboration with the Enterprise customers, technology products are integrated into proof-of-concept systems to identify technical issues, to mature designs, and to validate performance in representative applications. In the Insertion Phase, the performance of technologies is measured and evaluated in mission use to capture lessons learned that can benefit the next generation of technology development. The ECT Program departs significantly from past practice in NASA cross-enterprise technology programs that funded the delivery of a technology to a specific Technology Readiness Level (TRL), and it was left to chance as to whether the technology would be picked up by users. Instead, the ECT Program bridges this gap by allocating up to 50 percent of program funding for the transition and insertion of products to Enterprise mission applications. Customer investment (co-funding or partnership effort) is required for entering the Transition Phase, and must constitute all costs in the Insertion Phase that are not related to performance prediction, measurement, and assessment.

Five projects have been formulated to accomplish ECT program objectives:

• The **Advanced Systems Concepts (ASC) Project** performs conceptual studies and systems analysis of revolutionary aerospace systems that have the potential to leap well past current plans, or to enable new visions for NASA's strategic plans. Potentially enabling breakthrough technologies are examined in mission models, and the aggregated benefits of technology investments across multiple mission classes are evaluated.

• The **Energetics Project (Egtc)** develops advanced power and propulsion technologies to enable lower-cost missions with increased capabilities, and to extend mission reach beyond current horizons. Technology development includes solar power generation, energy storage and conversion, power management and distribution, and advanced electrical and chemical spacecraft propulsion.

Continued On Next Page

OVERVIEW (Continued)

• The **Advanced Measurement and Detection (AMD) Project** develops miniaturized sensors, advanced instruments, and nanoscale devices to enable a wide array of in situ and remote sensing capabilities. Technology development includes lidar and radar instrument technology, detector arrays and cryocoolers for focal planes, broadband passive instruments, and in situ biological and chemical sensors.

• The **Revolutionary Spacecraft Systems (RSS) Project** develops advanced spacecraft systems and architectures to enable distributed science data collection, exploration of extreme environments, and lower mission costs. Technology development includes formation control sensors and algorithms for distributed spacecraft, microspacecraft components and subsystems, and space environment models and analytical tools to predict environmental effects.

• The **Large Space Systems (LSS) Project** develops concepts for large, ultra-lightweight space structures and apertures to expand mission capabilities, and to enable new visions of the Earth and the Universe. Technology development includes advanced materials, deployable and inflatable structures, multifunctional and adaptive structures, and ultra-lightweight optical systems.

PROGRAM MANAGEMENT

The ECT Program is managed by NASA Headquarters (HQ). The Aerospace Technology Enterprise Program Management Council (PMC) has governing responsibility. Enterprise official is Jeremiah F. Creedon, Associate Administrator for Aerospace Technology at HQ. Acting Theme Director for Mission and Science Measurement Technology and Point of Contact is Dennis Andrucyk at HQ. Acting ECT Program Manager is Christopher L. Moore at HQ. Projects are established to develop concepts and technologies in specific areas. A Performing Center is designated for each project to lead implementation. This program is in full compliance with NPG7120.5B.

TECHNICAL COMMITMENT

The baseline for this technical commitment is the FY03 budget.

Technical Specifications		FY04 President's Budget				Change from Baseline
		FY02	FY03	FY04	FY05	
Implement a systems analysis process to assess the system-level benefits of technologies in the ECT Program portfolio, and complete pilot technology assessments on 5 representative mission classes selected by the Enterprises. (4MSM3) (ASC)	TRL		1	3		--
	$M		1.6	1.5		--
Develop at least 5 advanced system concepts adopted by Enterprises for their long-range plans. (ASC)	TRL		1	1	2	--
	$M		12.0	12.0		--
Develop advanced power technologies to enable a 40-60% reduction in power system mass. (Egtc)	TRL		2	2	3	--
	$M		9.9	9.5		--
Develop concepts to enable 30% reduction in trip time, or 20% increase in payload for planetary missions. (4MSM4) (Egtc)	TRL		2	2	3	--
	$M		6.7	6.7		--
Demonstrate tunable laser transmitter system with > 5% efficiency for active sensing. (4MSM6) (AMD)	TRL		2	3	4	--
	$M		5.0	5.0		--
Develop detector, readout, and associated component technologies for focal planes and broadband instruments to enable at least 5 new measurement capabilities. (4MSM7) (AMD)	TRL		2	3	4	--
	$M		8.0	7.9		--
Demonstrate at least two high performance, miniaturized (reduction of 10x), integrated biochemical analytical instrument prototypes. (4MSM8) (AMD)	TRL		2	3	3	--
	$M		1.5	2.0		--
Demonstrate millimeter precision formation flying with a hardware-in-the-loop 3D dynamics simulation. (4MSM9) (RSS)	TRL		2	3	3	--
	$M		2.2	2.6		--
Develop microavionics and multifunctional structures to reduce spacecraft mass by a factor of 3. (4MSM10) (RSS)	TRL		2	3	4	--
	$M		1.6	1.3		--
Reduce uncertainty in predicting environmental effects on spacecraft systems to less than 15%. (RSS)	TRL		2	2	3	--
	$M		1.6	1.5		--
Current TRL status relative to FY03 plan (R/Y/G/B)				Planned TRL status to FY03 plan		

Table is continued on next sheet.

Theme: Mission and Science Measurement Technology
Technology and Advanced Concepts: Enabling Concepts and Technologies (ECT) Program

TECHNICAL COMMITMENT (Continued)

Technical Specifications		FY04 President's Budget FY02	FY03	FY04	FY05	Change from Baseline
Demonstrate assembly/deployment of truss segments to enable 50-meter class space structures and apertures. (4MSM12) (LSS)	TRL		2	3	**4**	--
	$M		3.7	4.0		--
Demonstrate diffraction-limited imaging at IR wavelengths with proof-of-concept membrane mirror telescope (area density < 1 kg/m2) and active wavefront control system. (LSS)	TRL		2	3	3	--
	$M		1.0	4.0		--
Develop nanostructured composite material with strength > 2 Gpa. (LSS)	TRL		1	2	2	--
	$M		3.0	9.0		--
Current TRL status relative to FY03 plan (R/Y/G/B)						Planned TRL status to FY03 plan

Major program milestones are independent reviews and competitive solicitations. Technical milestones contributing to the accomplishment of program goals are listed in project plans. The program is completing two sets of 3-year tasks inherited from the Code S Cross Enterprise Technology Development Program (CETDP). CETDP internal tasks were selected in a competition involving the NASA Centers in FY 1999, and will complete in FY 2002. Advanced Cross Enterprise NRA tasks, which are primarily external, were selected in an open competition in FY 2000, and will complete in FY 2003.

Schedule	Date	Change from Baseline
NRC Reviews	first review 6/02; every 3 years	--
Enterprise Relevance Reviews	first review 6/02; every year	--
Technology Assessment Analysis	6/04 pilot studies complete	--
Sign MOAs with Enterprises	3/03	--
Complete CETDP internal tasks	9/02	--
Complete Cross Enterprise NRA tasks	9/03	--
Issue FY04 NRAs	3/03	--
Issue FY05 NRAs	3/04	--
Issue FY06 NRAs	3/05	--
URETI grants start	10/02	--
New project formulation	10/03 to 10/04	--
New project start	10/04	--

ACQUISITION STRATEGY & PERFORMING ORGANIZATIONS

Data current as of 1/10/2003

The program will employ a mix of broadly competed procurements, joint funding of selected activities with partners, and directed funding to NASA Centers to ensure technical excellence, close relevance to NASA goals and objectives, and high infusion rates into NASA missions. The goal for program acquisitions is to openly and broadly compete 75% of all new procurements. A mixture of NASA Research Announcements (NRA), Requests for Proposals (RFP), and Cooperative Agreement Notices (CAN), and grants will be used to award funding for external technology development activities. These opportunities will capture innovative concepts from the external communities to support program objectives. The intent is to have a revolving set of procurements to ensure the timely adoption of the best new concepts from universities and industry into the program. Starting in FY04 and continuing yearly afterward, the program will release a series of solicitations from the ECT projects to fund new multi-year developments and activities. The solicitations will exclude NASA Centers and JPL from participation, to ensure that external organizations and NASA Centers will not compete against each other, and enhance cooperation between the Centers and the awardees. ECT projects will develop gap analyses on the awarded tasks, to guide the direction of internal work and the focus of future solicitations. The Centers will issue the solicitations, evaluate proposals, and administer the resulting contracts or grants.

The ECT Program begins with an existing set of 111 NRA tasks originally selected in the Advanced Cross-Enterprise Technologies NRA issued in 1999 by the Cross-Enterprise Technology Development Program (CETDP) in the Office of Space Science. This NRA encompassed a wide range of technical disciplines including power and propulsion, sensors and instruments, optics, structures and materials, robotics, communications, and advanced computing infrastructures. The research projects have duration of no longer than 3 years, and all will conclude by the end of FY 2003.

Theme: Mission and Science Measurement Technology

Technology and Advanced Concepts: Enabling Concepts and Technologies (ECT) Program

ACQUISITION STRATEGY & PERFORMING ORGANIZATIONS (Continued)

Data current as of 1/10/2003

In FY 2002, three University Research and Engineering Technology Institutes (URETIs) were competitively selected to perform fundamental research in bio-nanotechnology for advanced materials. URETIs are cooperative arrangements between NASA and universities funded at $3M per year for up to five years.

Current Acquisitions	Actual *	Selection Method	Actual *	Performer	Actual *
Cooperative Agreements	%	Full & Open Competition	51%	Industry	19%
Cost Reimbursable	%	Sole Source	49%	Government	5%
Fixed Price	%		100%	NASA Intramural	52%
Grants	24%			University	24%
Other	%	Sci Peer Review	51%	Non Profit	%
* as % of FY02 direct procurement	100%	* as % of FY02 direct procurement		* as % of FY02 direct procurement	100%

Future Acquisitions - Major	Selection	Goals
1. FY04 NRAs	9/03	
2. FY05 NRAs	9/04	
3. FY06 NRAs	9/05	

AGREEMENTS

Internal: The program is not dependent on other NASA activities outside of the control of the Associate Administrator for Aerospace Technology. Memoranda of Agreement (MOAs) will be established with each of the NASA Enterprises to endorse program goals and content, and to collaborate on transitioning technology products from the ECT Program into Enterprise focused technology development and validation programs. The ECT Program and the Enterprises will co-fund technology maturation and integration into proof-of-concept systems in the transition phase.

External: The ECT Program will leverage the technology programs of external organizations where synergy can be achieved. When appropriate, the ECT Program will provide funding, collaborative research, or test facility support to partner organizations. These commitments will be documented with MOAs and Space Act Agreements.

Changes since FY03 Pres. Budget: None.

INDEPENDENT REVIEWS

Types of Review	**Performer**	**Last Review**	**Next Revie**	**Purpose**
Performance	IPAO	Various	FY2003	Program performance against plan.
Quality	NRC/ASEB	6-Jun-02	1-Jun-05	Peer review of technical quality and content.
Relevance	ATAC MSM SC	4-Sep-02	1-Mar-03	External community reviews status and plans.
Relevance	TEB	29-Oct-02	Monthly	Relevance of activities and identify opportunities.

COST

Budget Authority ($M)	**FY02**	**FY03**	**FY04**	Comments
FY 2004 Budget Submit (Technology)	92.8	92.9	161.2	
Energetics (Egtc)	20.3	21.6	34.6	
Advanced Systems Concepts (ASC)	13.0	12.0	43.9	
* Adv Spacecraft & Science Components	19.5	19.3	37.8	
Space NRAs (NRA)	40.0	40.0	44.9	
Changes since FY 03 Pres. Budget	**+0.0**	**+0.0**	**+67.8**	***Reason for Change:***
Energetics (Egtc)			+12.9	Full Cost Implications
Advanced Systems Concepts (ASC)			+31.7	Increase from Rev Space Flight
* Adv Spacecraft (AS) & Science Components			+18.3	Full Cost Implications
Space NRAs (NRA)			+4.9	Full Cost Implications

Indicates budget numbers in Full Cost.

Indicates changes since the FY 2003 Presidents Budget Submit.

Note: For all formats, the FY02 column reflects the FY02 Congressional Operating Plan dated 9/30/02. The FY03 column reflects the FY03 President's Budget Submit (PBS) as Amended. The Change column includes both programmatic and full cost adjustments. The FY04 column is in full cost.

* The budget line for Advanced Spacecraft & Science Components includes the Advanced Measurement & Detection **(AMD)** Project, the Revolutionary Spacecraft Systems **(RSS)** Project, and the Large Space Systems Project **(LSS);** which was restructured.