INFORMATION TECHNOLOGY
IMPLEMENTATION PLAN

FY 2001 - FY 2005

National Aeronautics and Space Administration
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1.0 Introduction

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NASA's Information Technology (IT) resources and IT support continue to be a growing and integral part of all NASA missions. Furthermore, the growing IT support requirements are becoming more complex and diverse.

The following are a few examples of the growing complexity and diversity of NASA's IT environment. NASA is conducting basic IT research in the Intelligent Synthesis Environment (ISE) and Intelligent Systems (IS) Initiatives. IT security, infrastructure protection, and privacy of data are requiring more and more management attention and an increasing share of the NASA IT budget. Outsourcing of IT support is becoming a key element of NASA's IT strategy as exemplified by Outsourcing Desktop Initiative for NASA (ODIN) and the outsourcing of NASA Integrated Services Network (NISN) support. Finally, technology refresh is helping to provide improved support at lower cost. Recently the NASA Automated Data Processing (ADP) Consolidation Center (NACC) upgraded its bipolar technology computer systems with Complementary Metal Oxide Semiconductor (CMOS) technology systems. This NACC upgrade substantially reduced the hardware maintenance and software licensing costs, significantly increased system speed and capacity, and reduced customer processing costs by 11 percent.

1.1 Performance Objectives

NASA's IT management continues to focus on reducing the cost of IT support whenever possible while providing improved and innovative IT support capabilities. To help ensure effective IT support NASA has established an Agencywide IT performance objective of improving IT capability and services. Under this objective two targets have been established: enhance IT Security through reduction of system vulnerabilities across all NASA Centers and through emphasis on IT security awareness training for all NASA personnel; and improve IT infrastructure service delivery to provide increased capability and efficiency while maintaining a customer rating of "satisfactory" and holding costs per resource unit to the FY 98 baseline. To measure accomplishment of this performance objective the following metrics are established and baselined at FY 1998 levels for Agencywide IT services, and these metrics are tracked on a quarterly basis.

Customer Satisfaction	
	FY 1999
NASA Integrated Services Network (NISN)	Satisfied
NASA ADP Consolidation Center (NACC)	Very Satisfied
Baseline	Satisfied

Unit Cost	
	FY 1999
NISN $/Kbps/month Actual Average Cost	$0.77
NISN $/Kbps/month Baseline	$0.78
NACC $/MIPS/Quarter Actual Average Cost	$4,990
NACC $/MIPS/Quarter Baseline	$5,185

Exhibit 1-1: IT Performance Metrics

1.2 Best Practices and Success Stories

NASA's innovation in IT support are highlighted by the IT best practices and successes summarized below.

Support for **Network Management**: Network security improvements have been made at NASA Headquarters in which aggressive data security policies have been established, a firewall infrastructures has been deployed and users have been migrated behind the firewall, and strong, industry-leading, cost effective dial-in security mechanisms have been provided. Since these improvements have been implemented, no system compromise has ever been detected. However, approximately 1,300 unauthorized access attempts are detected and stopped on an hourly basis.

The Johnson Space Center (JSC) has outsourced NASA's public web site on Human Space flight in an effort to eliminate the burden and dependencies on NASA servers and their limited bandwidth. This outsourcing has resulted in significant savings to NASA in terms of both Internet traffic on networks and cost per "hit". During most Shuttle missions, Internet traffic saturated the JSC network when it had a 10-megabit per second connection, and even after increasing the data bandwidth by an order of magnitude the network was still being saturated. By off-loading the traffic to the outsource contractor the extremely large public access traffic has been completely eliminated from the JSC network traffic. The estimated current cost per "hit" under the outsource contract is approximately $.00077 per "hit" which is a significant reduction over the cost per "hit" of $.05 under the previous arrangement. Furthermore, using the contractor's dedicated servers and support staff has also eliminated additional costs for JSC servers and server support.

At the Jet Propulsion Laboratory (JPL) a network improvement project has been implemented to reengineer their network services. This project has resulted in consolidating more than 200 sub-networks into a centrally managed state of the art network infrastructure, reducing JPL's aggregate network support costs, and greatly improving JPL's network capability and reliability.

On an Agencywide level, a Public Key Infrastructure (PKI) has been implemented based on various Agencywide pilots which assessed the effectiveness of PKI cryptographic technologies. These pilots included secure electronic mail, electronic forms and secure electronic grants.

Support for **Automated Software Distribution**: NASA Headquarters has automated software distribution by using Microsoft System Management Server (SMS). This automated distribution process is a significant improvement over the former process of visiting each workstation and manually installing or updating software. Using SMS, NASA Headquarters has the capability to install/uninstall software on approximately 1500 desktop seats in a single day.

Support for **Technology Upgrade**: The NASA Automated Data Processing (ADP) Consolidation Center (NACC) reduced the number of older technology mainframes from sixteen in 1994 to four bipolar mainframes in 1997. The goal in 1999 was to modernize NACC's computing resources by replacing the four bipolar mainframe systems with CMOS systems with no budget, performance, or availability impacts to customers. This replacement effort was very successful, and it resulted in the following: Hardware maintenance and software licensing costs were substantially reduced, system speed and capacity was significantly increased, overall customer processing costs were decreased by 11 percent, NASA payroll processing was reduced by one full day, computer floor space requirements were reduced from 1500 square feet to 100 square feet, and power and cooling requirements were substantially reduced.

The Structures Code Modernization Project at Glenn Research Center (GRC) focuses on updating and simplifying the logic in applications written in out of date FORTRAN. Code modernization and validation is providing a cost-effective way of meeting the need for reliable, accurate design and analysis tools for faster product development and implementation. Modernizing usable code extends the usable life of legacy programs and saves the GRC approximately $20,000 per year per 100,000 lines of legacy code over developing new code.

Support for **Command and Control**: The Goddard Space Flight Center (GSFC) Genie Project is automating real-time satellite operations. Genie was the Runner-up for the 1999 NASA Software of the Year Award, and it is the first software tool to enable "Lights-out" operations of a NASA spacecraft, where spacecraft commanding is performed during unstaffed shifts. Genie is also the first software tool to enable complete automation of all routine daily real-time operations of a NASA scientific spacecraft, including all spacecraft and ground system commanding. Genie is used in two satellite ground operations control centers 24 hours per day, 7 days per week. Genie has performed all routine real-time ground support operations for a spacecraft since July 1998, and has enabled a 50 percent reduction in the ground support staff (a saving of approximately $800K per year). Genie may be used to automate real-time pass operations in the GRO, Hubble Space Telescope, TRMM, and ACE missions. If this happens, NASA may save an additional $9 million in staffing costs.

NASA is evaluating a prototype flight system in which 12 aircraft are equipped with a Cockpit Display of Traffic Information (CDTI) system. This CDTI system broadcasts the aircraft's Global Positioning System (GPS) position and identity to all other aircraft and ground stations. The CDTI system has potential for markedly improving air traffic safety, efficiency, flexibility and predictability, and may facilitate modernization of the National Airspace System.

Support for **Data Management**: Support for data management includes the Space Program Integrated Contract Environment (SPICE) which was developed to provide for centralized management (collection, integration, manipulation, and reporting) of contract financial and performance data. The Technical Documentation (Tech Doc) System is a flexible distributed electronic document management system that allows for the management of any type of document. The Langley Management System (LMS) is an internet-based tool for Langley personnel to access current management system documentation and electronic sub-systems.

Support for **Education**: The Orbital Space Settlement Web Site is part of an educational outreach project in which the web site is used to inform the public about orbital space colonies. The web site also provides educational materials for students and teachers to use when preparing entries for the annual NASA Ames Space Settlement Design Contest. In 1999, 259 contest submissions were received from 904 students and 34 teachers.

Support for **Personnel Management**: Support for personnel management includes the Langley Research Center (LaRC) Bank Card System (BCS) which is a web-based application developed to help improve and automate the bank card reconciliation process for the cardholders and the financial management personnel. The system currently manages 635 cardholder accounts at LaRC, and it has been selected to become an agency-wide system.

Another personnel management system is the Goal Performance Evaluation System, which was developed as a web-based strategic planning tool for planning, managing, and evaluating employee contributions to NASA Center and NASA-wide strategic objectives. This system has been adopted by KSC and JSC, and has created 5100 employee performance plans that are linked to NASA objectives and strategies.

1.3 NASA Highlights in IT Strategic Focus Areas

NASA's Information Technology (IT) resources and IT support continue to play an integral role in the delivery of better, faster, cheaper, and safer missions. NASA's four strategic focus areas for IT are: (1) Safety and Security; (2) Cost Effective Common Infrastructure and Services; (3) Transfer of Innovative Technology into the NASA Infrastructure; and (4) Emerging IT Areas. Highlights of FY1999 accomplishments in support of these strategic focus areas are:

Safety and Security. NASA is committed to providing an exemplary IT security posture by aggressively reducing system vulnerabilities, training system and network administrators and ensuring effective security plans for all mission critical systems. IT security, infrastructure protection, and privacy of data are requiring more and more management attention and an increasing share of the NASA IT budget. In FY1999, the Agency continued to aggressively implement a comprehensive security program that addresses policy, training, incident response & reporting, auditing & monitoring, penetration testing, trust, and key security technologies (PKI, VPN, token/smart cards). On an Agencywide level, a Public Key Infrastructure (PKI) has been implemented based on various Agencywide pilots, which assessed the effectiveness of PKI cryptographic technologies. These pilots included secure electronic mail, electronic forms and secure electronic grants. Examples of Center-specific FY1999 accomplishments in support of the Agency's security program include Headquarters and the Jet Propulsion Laboratory (JPL). At Headquarters, network security improvements have been made in which aggressive data security policies have been established, a firewall infrastructures has been deployed and users have been migrated behind the firewall, and strong, industry-leading, cost effective dial-in security mechanisms have been provided. At JPL, a network improvement resulted in consolidating more than 200 sub-networks into a centrally managed state of the art network infrastructure, reducing JPL's aggregate network support costs, and greatly improving JPL's network capability and reliability.

Y2K Program. Also in FY1999, NASA took aggressive actions to ensure that our missions, systems, and supporting infrastructure and facilities are not disrupted by the transition to the new millennium. NASA has completed renovation of all of its mission critical systems and non-mission critical systems and business continuity and contingency plans are complete. With the FY1999 culmination of over three years of analysis, extensive testing, and formal certification processes, NASA transitioned safely and smoothly into the new millennium.

Cost-Effective Common Infrastructure and Services. In FY1999, NASA continued to improve the cost effectiveness and operating efficiency of Agencywide IT services and solutions. As an early adopter of progressive business approaches for delivering common infrastructure and services, NASA continued to realize FY1999 efficiencies through outsourcing and consolidation initiatives, as well as more optimum use of IT for Agencywide services. The Outsourcing Desktop Initiative for NASA (ODIN) and the outsourcing of NASA Integrated Services Network (NISN) support are examples of key initiatives that enabled Agencywide efficiencies and improved business practices in FY1999. In addition, the Johnson Space Center (JSC) outsourced NASA's public web site on Human Space flight in an effort to eliminate the burdens on NASA servers, improve reliability and reduce costs. Outsourcing of public access traffic has resulted in eliminating JSC network traffic interruptions and reduced the cost for public access by ten times.

In addition, NASA continues to employ technology refresh as a way to provide improved support at lower cost. For example, the NASA Automated Data Processing (ADP) Consolidation Center (NACC) upgraded its bipolar technology computer systems with Complementary Metal Oxide Semiconductor (CMOS) technology systems. This upgrade substantially reduced the hardware maintenance and software licensing costs, significantly increased system speed and capacity, and reduced customer processing costs by 11 percent. In addition, NASA payroll processing was reduced by one full day, computer floor space requirements were reduced from 1500 square feet to 100 square feet, and power and cooling requirements were substantially reduced.

Transfer of Innovative Technology Into NASA Infrastructure. In FY1999, NASA continued its role as a critical contributor to national IT research goals in three key program areas: the High Performance Computing and Communications (HPCC), Intelligent Synthesis Environment (ISE) and Intelligent Systems (IS) Initiatives. In FY1999, each of these programs delivered innovative technologies and capabilities to support mission requirements at an affordable cost, at minimum risk, with a goal of maximum science return and engineering productivity. One objective of these initiatives is to fundamentally change the complex engineering and scientific processes by facilitating the rapid and high-fidelity simulation of aerospace vehicle designs during the early conceptual phase of a mission. High-fidelity simulations of conceptual designs can be used for stakeholder and customer validation early in the development cycle. These programs strive to enable informed decisions prior to significant commitment of program resources.

Also in FY1999, IT continued to play a critical role in ensuring the success of the Nation's human space program. The new Mission Control Center at the Johnson Space Center illustrates how innovative commercial IT has facilitated the transition of the program-unique, 1960's-based manned space flight control center to one which meets the needs of the 21st century and beyond. The new control center eliminates the NASA-unique equipment and massive hardware orientation of the original Mission Control, replacing it with a modular, software-oriented design that uses standard, commercially available equipment. The new Mission Control Center offers an unprecedented flexibility in flight control operations. In a similar fashion, the Agency is replacing the current Launch Processing System at the Kennedy Space Center to ensure the economical operation of the Space Shuttle fleet through 2012. This system, developed in the 1970's to track the fleet of orbiters through all steps of processing through launch, has grown costly and difficult to maintain. The replacement Checkout and Launch Control System, using state-of-the-art commercial hardware and software and a modular implementation approach, is anticipated to save approximately 50 percent of the current system costs.

1.4 Other NASA Highlights in IT Support

As the Agency's change agent for the Clinger-Cohen Act of 1996, the NASA Chief Information Officer (CIO) must provide vision and leadership to ensure that:

- The Agency is making the right investments in IT, and
- IT investments are managed in such a way as to ensure the Agency achieves an acceptable return on its investment.

In this planning cycle, the NASA CIO has implemented several key initiatives to improve how the Agency manages IT. NASA has an ongoing and intensive effort to improve the Agency's IT security and to ensure a reliable and secure interoperable environment for employees, contractors, customers, and stakeholders. Principal centers have been established to manage key IT areas and services more effectively and efficiently. The NASA CIO has also initiated a number of activities to evaluate, and where appropriate, to implement alternative business approaches to providing IT services. These activities have included consolidations and outsourcing arrangements for supercomputing, mainframes, desktop, and communications services and assets. The NASA CIO has worked to ensure that the Agency created, tested, verified, and delivered all changes to ground and in-flight hardware and software affected by the Year 2000 problem. The NASA CIO is working with the NASA Chief Financial Officer to support implementation of the Integrated Financial Management Systems Program. This system will serve as the Agency's standard, integrated financial management system and will enable implementation of a full cost management approach for planning, budgeting, and managing Agency investments.

In summary, the recent successes of the Agency are remarkable. Throughout each of these initiatives--from research that is fundamental to future missions to scientific discovery that captures the world's imagination--IT is pervasive. The strategic value of IT lies in its ability to transform routine work processes and deliver capabilities which are critical to achieving NASA's mission. NASA will continue to use IT to make measurable improvements in mission performance, reduce the cost of new and ongoing programs, and improve the delivery of scientific knowledge to the Agency's stakeholders, customers, and the American public. The remainder of this document highlights the initiatives planned to deliver the critical IT capabilities, products, and services that will enable the Agency's continued success.

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2.0 Managing Information Technology

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2.1 NASA's Strategic Framework

The NASA Strategic Plan establishes a framework that organizes the Agency's programs into four Strategic Enterprises through which we implement our mission and communicate with our external customers. The Strategic Enterprises and their missions are:

- **Earth Science--**To understand the total Earth system and the effects of natural and human-induced changes on the global environment;
- **Space Science--**To explore the solar system and the Universe by searching for evidence of life beyond Earth, looking for planets around other stars, and from origins to destiny, charting the evolution of the universe and understanding its galaxies, stars, planets and life;
- **Human Exploration and Development of Space (HEDS)--**To open the space frontier by exploring, using, and enabling the development of space and to expand the human experience into the far reaches of space; and
- **Aero-Space Technology (AST)--**To pioneer the identification, development, verification, transfer, application, and commercialization of high-payoff aeronautics and space transportation technologies.

Four critical cross-cutting processes provide the means for each Enterprise to develop and deliver products and services to internal and external customers. These are Manage Strategically, Provide Aerospace Products and Capabilities, Generate Knowledge, and Communicate Knowledge. NASA centers are responsible for implementing the Agency plans, programs, and activities to support Strategic Enterprise goals consistent with their assigned mission areas.

IT is addressed in the NASA Strategic Plan as part of the crosscut process titled, "Manage Strategically." The objective for IT stated in the current NASA Strategic Plan is:

> ***"To ensure information technology provides an open and secure exchange of information, is consistent with Agency technical architectures and standards, demonstrates a projected return on investment, reduces risk, and directly contributes to mission success."***

The NASA Chief Information Officer (CIO) resides in the Office of the Administrator, the highest organizational entity of the Agency. As part of the Administrator's immediate senior staff, the NASA CIO provides vision, leadership, and advice for the Agency in terms of information technology (IT) strategies to support scientific, engineering, and administrative requirements. The NASA CIO is the principal advisor to the Administrator and other senior officials on matters pertaining to IT plans, policies, standards, investments, and assessments. The IT Investment Council, comprised of senior management representing the strategic enterprises and key Agency functions, is responsible for establishing Agency-level IT policies, plans, and standards. It serves as a forum for addressing key policy and funding decisions for Agency IT resources. The NASA CIO works with CIO Board composed of representatives from the Strategic Enterprises and Centers to ensure an effective and efficient application of IT to support Agency missions.

2.2 Planning and Managing Information Technology Investments

NASA has formalized a process for managing IT investments that is fully integrated with the Agency's strategic management, program management, and financial management framework.

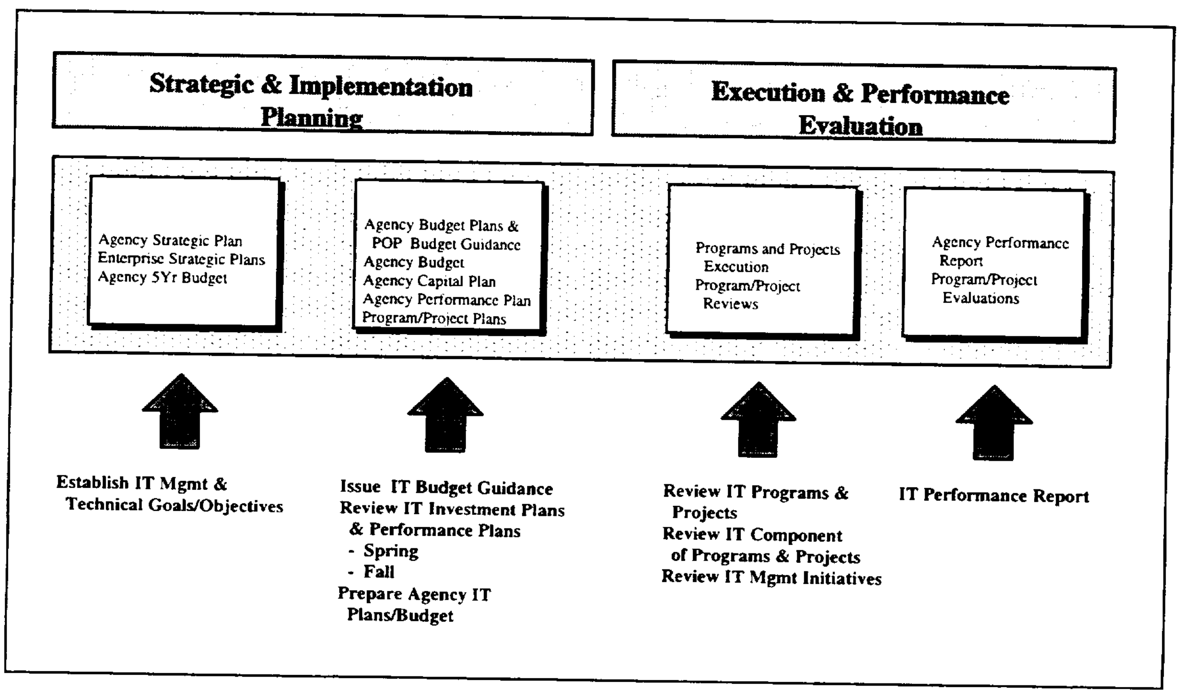

Exhibit 2-1: Process for Managing IT Investments

Exhibit 2-1 illustrates how IT planning, budgeting, execution and evaluation processes relate to Agency processes. NASA's IT management process supports the activities and decisions made to select IT projects and systems, control and monitor these projects throughout their life cycle, and evaluate results. The remainder of the section describes how IT processes are integrated with Agency strategic management processes.

2.2.1 Integrated Strategic Planning

Each year the Senior Management Council assesses and revalidates NASA's mission, goals, objectives, strategies, key assumptions, and performance indicators documented in the NASA Strategic Plan. The NASA CIO, other members of the Administrator's staff, the Associate Administrators, and Center Directors all participate to define the strategic direction for the Agency.

Within the context of the NASA Strategic Plan, the CIO identifies annual IT strategic goals and objectives to support planned missions and promote cross-Enterprise efficiencies, consistent with the Agency and Enterprise Strategic Plans. These annual IT goals and objectives are translated into annual IT focus areas for IT capital investment planning, and IT focus areas form the foundation for the IT budget guidance issued as part of the annual budget planning process. See paragraph 2.2.2 for more detail on current year focus areas.

Investment planning is an ongoing process that incorporates a detailed analysis of current and new requirements with projections of funding needs. Prior to issuance of the Agency's Program Operating Plan (POP) guidance, the NASA CIO conducts reviews and provides recommendations for major new investments in IT. These recommendations are within the management framework for programmatic and capital investments described below.

a. Capital Investment Council

The NASA CIO supports the CIC for investment decisions in the area of IT. The NASA CIO, supported by the NASA IT Investment Council and CIO Board, is responsible for developing or coordinating a complete analysis of the IT strategy, investment plans, and major planned management initiatives to improve the delivery of IT capabilities for the Agency. Upon recommendation of the CIO Council, the CIC reviews proposed major investments in IT infrastructure, multi-Enterprise IT investments, and IT management initiatives and makes recommendations to the Administrator.

Managers seeking approval for major IT investments will provide an analysis containing the relevant elements in the following:

1) A description of NASA requirements based on missions, including linkage to the NASA Strategic Plan, the Enterprise Strategic Plans, and the Center Implementation Plans;

2) A prioritized list of requirements, including time phasing;

3) A description of existing and in-process NASA capabilities, including condition and inputs from appropriate ongoing functional assessment activities;

4) An evaluation of requirements, a description of related Federal, academic, industry, and other capabilities, including partnering potential capabilities, and funding profiles;

5) An investment strategy with proposed roles for the implementing Strategic Enterprises, the Centers of Excellence, and other elements of the organization; and,

6) Cost, schedule, and performance metrics for the entire life cycle.

b. Program Management Council

The majority of NASA's IT investments are made within the context of programmatic investments.

Program Management Councils exist at the Agency, Lead Center, and Center levels to oversee the formulation, approval, implementation and evaluation of Agency programs and projects. The NASA CIO is a member of the Agency-level Program Management Council, and Center CIO Representatives support Program Management Councils at their respective Centers.

At the Agency level, Enterprise Associate Administrators present and advocate major new programs to the NASA Program Management Council which, in turn, presents its recommendations to the Administrator. The Enterprise Associate Administrator includes the needs of Enterprise programs and projects in formulating long-term institutional investment strategies, including IT. Details regarding information to be presented to the Agency-level Program Management Council for proposed new programs/projects are contained in NPG 7120.5A, NASA Program and Project Management Processes and Requirements. IT requirements and the associated investment strategies are addressed as part of the technical, cost, and schedule assessments.

2.2.2 Strategic Planning Focus Areas

Each year, the CIO identifies IT management and technical initiatives/investments that require special management focus. For this planning cycle, the CIO Strategic Focus Areas are:

- **Year 2000:** The Year 2000 problem has the potential to adversely affect almost all computer-based or information technology systems. NASA's Year 2000 (Y2K) Program was initiated in August 1996 to eliminate or minimize the adverse impact to Agency programs, functions, assets, and supporting hardware, software, and firmware resulting from the new millennium. Y2K Program requirements are defined in the NASA Y2K Program Plan (June 1998) and supporting Center Y2K Project Plans.

- **Outsourcing Desktop Management Initiative for NASA (ODIN):** The ODIN contract will deliver comprehensive desktop computer, server, and intra-center communications services to NASA and NASA contractors. Other government agencies will be able to buy from the ODIN contractors through the General Services Administration (GSA).

Under the contract, NASA will define the computer and communications capabilities for each job within the Agency and purchase a particular bundle of hardware, software and communications equipment for each "seat."

- **NASA ADP Consolidation Center (NACC):** The NACC maintains and operates IBM-compatible mainframe systems which support administrative processing requirements for ARC, DFRC, GSFC, HQ, JSC, KSC, LaRC, GRC, MSFC, and SSC, as well the Agency's consolidated payroll and consolidated support for legacy administrative software systems. Also, the NACC maintains and operates IBM-compatible programmatic systems which support manufacture of the Shuttle External Tank (ET) at Michoud Assembly Facility, Space Transportation System (STS) data bases, the JSC Integrated Management Information Computer (IMIC), and the JSC International Space Station. In all cases, the NACC is responsible for centrally operating and maintaining all hardware, system and subsystem software, communications hardware and software, facilities, and front-end processors that make up the NACC. The processes and procedures governing the NACC are structured to ensure maximum reliability, availability, and serviceability to the user community.

- **Digital Television (DTV)**: Each Center, Headquarters, and the Jet Propulsion Laboratory will be required to establish an initial DTV production capability as early as 2000 and completed no later than 2004.

- **High-End Computing:** NASA is examining how to best provide for the high-end computing needs of its engineering and science projects. To do this accurately it is important to know the planned expenditures for high-end computing. For purposes of this planning cycle, high end computing is defined to include:

    Applications that require at least one of the following resources: a sustained computational speed of greater than 1 GigaFLOPS (1×10^9 Floating Point Operations Per Second [FLOPS]); memory size approaching 300 million words; data sets approaching 100 Gigabytes (100×10^9 bytes.)

- **IT Security (ITS):** NASA has a responsibility to provide protective measures to maximize, and where possible ensure, the privacy, integrity and availability of IT resources and information. Expansion of access to NASA information resources through the Internet makes it even more critical that we address this responsibility. There are many different activities underway in NASA to improve ITS. These focus on policy and procedures, training and awareness, security services, and reporting. For the current planning cycle, the NASA CIO has identified the following ITS focus areas:

1. ITS Policy/Management;
2. ITS Training which includes ITS Awareness and Training, ITS System and Network Administrator training and ITS training for managers;
3. Intrusion Detection and Reporting;
4. Audit and Monitoring which includes inter Center penetration testing;
5. Trust Model; and
6. New Technologies (Services).

2.2.3 Integrated Implementation Planning and Budgeting Processes

The NASA CIO budget guidance and investment planning requirement are integrated into NASA's Program Operating Plan (POP) guidance and processes. This year, the CIO provided budget guidance on the six focus areas listed above. Also this year, the NASA CIO conducted IT POP planning workshops with the Center CIO and Chief Financial Officer (CFO) staff members. These workshops focused on integrating the Agency's IT investment plans for major and significant Agency IT systems development and operations support with the Agency's budget planning and review cycle. This focus helped ensured that "Raines Rules" are addressed, and helped ensure that risk and return considerations were properly assessed.

2.2.4 Integrated Implementation and Evaluation Processes

The implementation of IT investment decisions and performance evaluation are conducted within the framework that the Agency executes its mission and assesses its performance. NASA has established program and project management processes, particularly in the areas of tracking progress against established milestones. For example, IT investments that are made within the context of programmatic investments are reviewed within the Agency's established program management processes. Capital investment decisions that support multi-enterprise requirement are reviewed through the Agency's IT Investment Council/Capital Investment Council structure and process. Budget plans, major milestones, and performance indicators to measure outcomes, output, service levels, and customer satisfaction are tracked throughout the investment's life cycle. Status is frequently reviewed at the center level, as part of the annual IT investment review conducted as part of the budget planning process, and as required by the NASA CIO, IT Investment Council, and Capital Investment Council.

NASA has also defined Agency-level performance measure for IT that will be tracked and reported as part of the Agency's annual Government Performance and Results Act (GPRA) Performance Plan. The overall performance of NASA's IT investments will be tracked by measuring resource unit cost and customer satisfaction with IT support received.

2.3 Agency Initiatives to Improve the Management of Information Technology

The overall direction for NASA's management of Agency IT resources is one of consolidation, simplification, and openness. To support the near-term goals and objectives (referred to as CIO focus areas) described in Section 2.2, the Agency has initiated a number of strategic management improvements for IT. Highlights of key initiatives are summarized below.

2.3.1 Achieving an Open, Standard, Scaleable, and Secure Information Technology Environment

NASA has an established Agencywide IT architecture to provide integrated, interoperable, and secure technologies, capabilities, standards, and processes needed to support mission requirements. We have established minimum hardware and software requirements for interoperability, as well as minimum acquisition requirements to help ensure future interoperability between heterogeneous environments of personal computer, Macintosh, and UNIX systems, including file interface standards and products. NASA has also standardized on a networking infrastructure for both the wide and local area applications. The Agency has a successful, Agency-wide X.500 Directory implementation and has standardized on an electronic mail backbone supporting three approved electronic mail products. NASA has also planned and piloted a Public Key Infrastructure (PKI) that will meet the Agency's requirements for encryption, digital signature, and authentication for non-classified systems. A full scale roll out of the NASA PKI in support of the Integrated Financial Management Program, secure electronic messaging, and other applications is underway. Vendors providing outsourced desktop support services to NASA via the Outsourcing Desktop Initiative for NASA (ODIN) program are required to adhere to NASA's IT architecture and standards, and have the opportunity to comment on proposed standards before they are adopted.

NASA continues to make an intensive effort to improve the Agency's IT security. Towards the end of FY 1998, NASA, with participation by expert consultants, conducted a major and comprehensive review of its IT security posture. The review produced thirty-three recommendations, all accepted by the Agency's Deputy Administrator, to strengthen NASA's IT security. In FY 1999, the Agency completed many of those recommendations, including bringing on board a Deputy Chief Information Officer for IT Security, and thereby greatly strengthening the NASA CIO's office resident expertise.

In FY 1999, a new detailed IT security policy procedures and guidelines document was issued. This document represented a major modernization of the previous procedures and guidelines document and significantly improved the Agency's IT Security policy position. NASA also created and distributed to all of its Centers a multimedia CD-ROM that is viewed by all NASA employees as part of their mandatory annual IT Security awareness training. The CD-ROM uses interesting visual and audio approaches to presenting information on IT Security that every NASA employee, regardless of job function, must know. It also includes film clips of the NASA Administrator, a NASA Deputy Center Director, and an astronaut reinforcing the importance of IT Security from the viewpoint of their responsibilities within the Agency. This CD-ROM was created in close cooperation with the Defense Information Systems Agency (DISA), which gave us valuable assistance.

System and network administrators are the first line of defense in protecting NASA's IT assets from intrusions and detecting intrusions when they do occur. Working with other agencies and the private sector, the Agency is creating an IT Security training program for system and network administrators, and, when the program is available, demonstrated proficiency of both civil service and contractor administrators in IT Security will be mandatory. We are currently in the pilot stage, testing several vendors training offerings.

To ensure that IT Security is built into the Agency's missions from the start and not just added on, we are integrating training of IT Security risk assessment and management into the curriculum of the Agency's Academy of Program/Project Leadership. The life cycle approach that we are fostering will increase the security of Agency systems and further sensitize managers to its importance.

In FY 1999, the NASA CIO personally visited nine of our Centers and briefed Center civil service and contractor, senior and line management on the need for IT Security, the nature of the threat, the requirement to adhere to the Agency's policies in the security area, and their personal responsibilities. Center Directors have typically made the briefing mandatory for the target audience and attended themselves, so attendance and participation have been outstanding. The NASA CIO will brief all Centers by the end of the 1999 calendar year.

NASA has recently modified the scope of work of the NASA Automated Systems Incident Reporting Capability (NASIRC) to include real-time coordination of incident response. Mechanisms for coordination include 24x7 coverage at NASIRC and each Center, use of encrypted e-mail for sensitive messages, and call lists for contacts at each Center.

NASA in FY 1999 completed the purchase of system auditing tools for each Center. NASA IT Security Offices are using these tools to audit that required patches have been installed and that other vulnerabilities, such as open ports, have been dealt with. Currently some Centers have implemented this procedure, with the others to follow during this calendar year.

We conducted an Agency-wide workshop on IT security, bringing together from all NASA Installations key personnel involved in the provision of IT security, including our outsource contractors who provide desktop and wide area network services.

NASA began a three-tier Agency program to conduct system audits and penetration tests. This program includes Center self-audits, Center-to-Center peer reviews, and external audits directed by the Chief Information Officer (CIO). Each tier has been exercised this year, and the program has provided valuable guidance to our efforts in ITS. We plan on conducting three CIO-directed external audits per year, as well as a larger number of Center-to-Center peer reviews and Center self-audits that will support the external audits.

In FY 2000, the Agency will review IT security-related directives and modify as needed; further clarify IT security roles, responsibilities, and commitments; further enhance our incident detection and response mechanism; continue our regular program of penetration testing; enhance IT security training for system administrators and project managers; and, deploy our public key infrastructure for signature, authentication, and encryption.

Starting in FY 2000, NASA will also collect a new set of metrics, using auditing and monitoring tools, on the status of critical patches and elimination of other vulnerabilities.

The Ames Research Center has been established as the Center of Excellence in Information Technology. Also, the Ames Research Center , Marshall Space Flight Center, and Glenn Research Center have been established as Principal Centers to support Agency architectural and standards initiatives in the areas of IT security, communications architecture, and workstation hardware and software, respectively. More information on Center of Excellence and Principal Center strategies and plans is provided in Appendix B.

2.3.2 Implementing New Business Approaches to Delivering Services

The Agency has taken the challenge of reducing its expenditures on IT seriously. Across the IT spectrum, senior management has carefully evaluated alternative business approaches for delivering capabilities and services that are not the inherent responsibility of the government. These have included consolidating management functions; consolidating routine operations, services and assets; and transferring responsibility for delivering service and managing assets via outsourcing arrangements. Business strategies for each of the major components of the Agency's architecture are highlighted below.

2.3.2.1 Consolidated Management of Supercomputing Resources

NASA has established the Consolidated Supercomputing Management Office (CoSMO) and charged them with responsibility for acquiring, maintaining, operating, managing, upgrading, and cost-center budgeting for NASA's supercomputing capability regardless of location and function. The scope of supercomputing resources within NASA includes the high-speed processors, mass storage systems, and network interfaces. The supercomputers include production, research and development, and secure compute engines.

The mission of CoSMO is to meet NASA's supercomputing requirements for each Enterprise office while realizing an overall cost savings by effective and efficient management of NASA's supercomputing resources through the end of the decade and into the next century.

2.3.2.2 Outsourcing Agency Desktops and Local Area Networks

In June 1998, NASA selected seven companies to fulfill a multi-billion dollar contract, called the Outsourcing Desktop Initiative for NASA (ODIN). This contract, applies a "faster, better, cheaper" approach to the way the Agency obtains desktop computers and local communications services. ODIN has several goals. Most importantly, it will deliver cost effective services to meet NASA's mission and program needs using commercial practices. It will allow NASA civil servants to focus on the Agency's core mission, make it easier for our systems to operate together and allow the Agency to share risks and rewards with the private sector. The contract also will allow NASA to better account for the funds it spends on local computing products and services. With one set of contracts providing these services across the Agency, it will be clearer how much they are costing NASA. Long-term savings over the life of the contracts could approach 25 percent compared to existing procurement procedures, and that has allowed the Agency to reduce its future Information Technology budgets.

The ODIN contract will deliver comprehensive desktop computer, server, and intra-center communications services to NASA and NASA contractors. Other government agencies will be able to buy from the ODIN contractors through the General Services Administration (GSA). Under the contract, NASA will define the computer and communications capabilities for each job within the Agency and purchase a particular bundle of hardware, software and communications equipment for each "seat." The price for each type of "seat" will be fixed.

The successful offers and the total contract values are: Boeing Information Services, Inc., Vienna, VA; Computer Sciences Corporation, Laurel, MD; Dyncorp TECHSERV, LLC, Reston, VA; FDC Technologies, Bethesda, MD; OAO Corporation, Greenbelt, MD; Intellisource Information Systems, Inc., Lanham, MD; and Wang Government Systems, Inc., McLean, VA. The minimum dollar value of each contract is $1,000. The maximum ranges from $4.35 billion to $13.12 billion, including orders placed by other agencies through GSA.

Under the ODIN delivery-order process, each NASA center or enterprise will place orders exclusively with one vendor. Each delivery order can cover a period of up to three years. The period of performance for each fixed-price, Indefinite Delivery, Indefinite Quantity contract with each ODIN vendor is nine years.

GSA and NASA have formed a partnership to provide a richer set of options to federal agencies for their computing and networking services. This agreement gives other agencies a choice between GSA's Seat Management contracts and ODIN. GSA will act as the focal point for other government agencies desiring to use ODIN. More information on the ODIN initiative can be found at the following Web site: http://outsource.gsfc.nasa.gov.

2.3.2.3 Privatizing Space Communications Operations

The National Space Policy stipulates that NASA will "seek to privatize or commercialize its space communications operations no later than 2005". The approach to meeting this policy requirement is to commercialize and/or privatize the NASA ground network and the space network. If no commercial space network providers materialize, the intent of Space Operations Management Office (SOMO) is to seek other alternatives, such as a government corporation where customers can continue to be served in a business like fashion. The effort began in calendar year 1999. SOMO, located at Johnson Space Center, manages the telecommunication, data processing, mission operation, and mission planning services for the Agency to ensure the goals of NASA's exploration, science, and research and development programs are met in an integrated and business like, cost-effective manner. As NASA's agent for operational communications and associated information handling services, SOMO is committed to seeking and encouraging commercialization of NASA operations services and to participate in collaborative interagency, international, and commercial initiatives.

Procedurally, SOMO will ensure that all existing associated contracts will transition to performance-based contracts. Efforts are ongoing to consolidate and streamline major support contract services in order to optimize space operations, including communications services. The primary effort to accomplish the stated objectives is the Consolidated Space Operations Contract (CSOC). The CSOC was awarded on September 25, 1998, to the Lockheed Martin Company. The consolidation effort began in calendar year 1999. The approach of CSOC is to increase consolidation and integration of operations across the Agency by emphasizing the use of technology, standardization, and interoperability.

2.3.2.4 Preparing for the New Millennium

NASA began efforts to address the Year 2000 (Y2K) challenge in 1996. NASA's spacecraft, satellites, instruments, aircraft, supporting ground control/mission operations systems, as well as our unique research and development infrastructure that includes hundreds of simulators, wind tunnels, test beds, computational facilities, and propulsion and flight test facilities were analyzed, rigorously tested, and formally certified as Y2K compliant. This certification is evidenced by the results of extensive testing and formal Y2K certifications on NASA missions and programs, 158 mission-critical systems, 350 nonmission-critical systems, 19,000 inventory items, and 6,000 commercial products. No significant NASA asset has been untouched. Estimated costs to ensure the Agency safely transitions to the Year 2000 are $68 million.

2.3.2.5 Implementing Full Cost Management

Full cost accounting and resources management is a concept that ties all agency costs to major activities, budgets, and accounts, and then reports and manages programs with a perspective on the entire cost of the programs. NASA is implementing full cost accounting and budgeting to enhance cost effective mission performance by providing complete cost information for improved and more fully informed decision making and management.

The functional elements that will make up the IT-related service pool and sub-pools at each NASA Center are generally operated as charge back systems. For each system, the customer pays the cost of the product or service provided plus an administration fee to cover such elements as order processing, financial support, database support, materials and supplies, administrative support, training, etc. Service pools being established include, but are not limited to, Federal Information Processing Services, Interactive Computer Systems, Communications Support Services, Desktop and Network Systems Services, Voice Communications Services, High Performance and General Scientific/Engineering Computing Services.

2.3.2.6 Integrated Financial Management System

Improving NASA's financial and resources support of the Agency's mission is the overarching goal of the Integrated Financial Management (IFM) Program. To accomplish this goal, the IFM Program has identified the following objectives:

- Standardize financial and resources management business processes and systems as defined by the Joint Financial Management Improvement Program (JFMIP) across NASA;
- Ensure that new business processes and systems are compliant with Federal requirements;
- Provide current, useful, and timely financial information for both internal and external customers.

Central funding for the IFM system contract covers completion of business process reengineering (BPR) at the centers, agency system configuration, system integration, testing, training, data conversion, server deployment and sustaining support. The central program office also funds additional technical and specialized support required to implement the agency-wide system, including BPR at the agency level, change management, data modeling and analysis and independent verification and validation.

The IFM Program Office will fund operational costs for two years. After the two-year funding period is completed, a charge back algorithm based on actual use will be developed by the NASA Automated Data Processing Consolidation Center (NACC) at the Marshall Space Flight Center. At that point the Centers and Institutional Program Offices (IPO's) will be charged for the use of the system.

Centers are providing funding for the development of center system interfaces, installation of client software, training beyond that provided by the contractor, extraction and reconciliation of data from legacy systems for data conversion, support for the center aspects of system configuration and change management planning and execution.

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3.0 Agency Information Technology Investment Plans

3.0 Agency Information Technology Investment Plans

NASA's information technology (IT) investment plans are focused on IT investments that directly support NASA's six mission areas of: Financial Management, Mission Support, Aero-Space Technology, Human Exploration and Development of Space, Earth Science, and Space Science. The investment plans also include support of NASA's Infrastructure and Office Automation plus support for NASA's Architecture and Planning. Exhibit 3-1 summarizes NASA's total IT plans by support area for FY 1999 through FY 2005.

Information Technology Support Areas	Dollars in Thousands						
	FY 1999	FY 2000	FY 2001	FY 2002	FY 2003	FY 2004	FY 2005
Financial Management	$83,830.2	$99,366.3	$78,273.6	$60,765.0	$53,459.5	$52,148.9	$52,437
Mission Support	$355,573.2	$403,647.8	$404,412.8	$324,245.6	$315,330.0	$269,603.5	$261,423
Aero-Space Technology	$191,112.1	$227,510.4	$249,652.2	$247,852.3	$232,776.6	$231,799.8	$209,814
Human Exploration and Development of Space	$625,087.9	$565,411.6	$540,806.7	$539,715.6	$559,052.5	$561,345.0	$566,453
Earth Science	$314,307.2	$324,261.4	$316,992.0	$315,885.1	$317,458.9	$390,050.2	$307,318
Space Science	$168,817.6	$223,675.6	$255,453.6	$249,868.2	$251,333.8	$255,852.4	$274,384
IT Infrastructure	$332,614.7	$351,249.9	$353,025.7	$343,973.7	$341,769.8	$339,518.0	$343,120
IT Architecture and Planning	$41,290.5	$20,485.0	$16,149.2	$14,335.4	$13,248.5	$13,298.4	$13,320
	$2,112,633.3	$2,215,607.9	$2,214,765.9	$2,096,640.9	$2,084,429.6	$2,113,616.2	$2,028,271

Exhibit 3-1: Agency Information Technology Investment Plan

Exhibit 3-2 provides a support area profile of the total Agency IT budget for FY 2001. The six mission areas being supported constitute NASA's major functional and operational activities. The infrastructure and office automation activities being supported are common user systems, communications, and computing infrastructure activities that support multiple NASA programs, projects or initiatives, and, as such, these activities are not directly related to any single NASA program, project or initiative. The IT architecture and planning activities being supported are Agency activities which provide strategic management for NASA's IT operations.

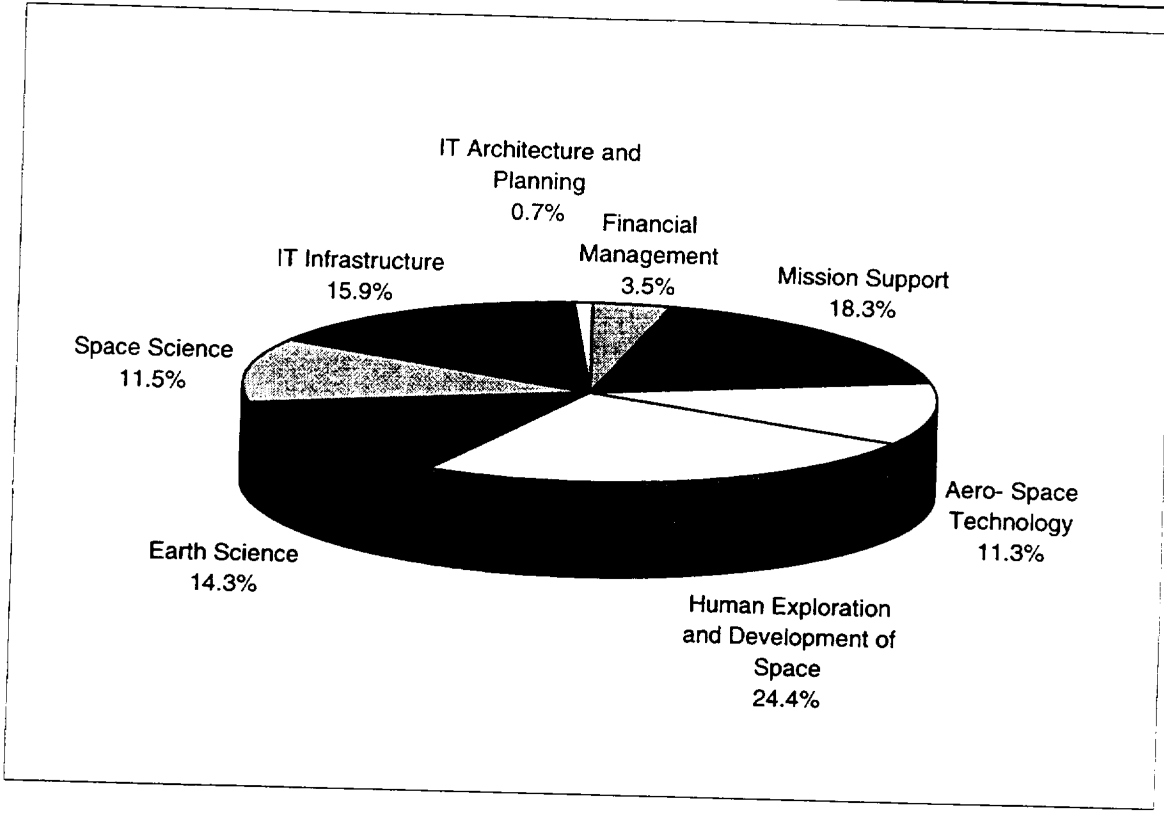

Exhibit 3-2: IT Investment Profile for FY 2001

Exhibit 3-3 summarizes NASA's total IT plans for NASA Headquarters, the Jet Propulsion Laboratory, and the nine NASA Centers for FY 1999, through FY 2005.

Information Technology Costs by NASA Center	Dollars in Thousands						
	FY 1999	FY 2000	FY 2001	FY 2002	FY 2003	FY 2004	FY 2005
ARC	$179,506.7	$212,653.1	$240,993.7	$245,018.3	$236,854.8	$235,894.2	$216,765.6
DFRC	$22,252.2	$20,450.7	$21,454.6	$21,897.1	$21,565.6	$20,958.0	$21,214.2
GSFC	$446,508.9	$423,529.3	$412,842.8	$398,580.8	$394,382.4	$415,770.0	$392,566.7
HQS	$117,174.8	$136,230.0	$113,737.9	$101,644.2	$93,415.2	$92,240.7	$92,871.5
JPL	$205,304.7	$229,717.6	$239,635.8	$234,712.0	$232,540.2	$291,206.5	$242,222.8
JSC	$655,385.7	$740,951.5	$720,598.5	$662,134.5	$694,870.1	$651,396.2	$654,111.0
KSC	$190,267.3	$172,012.1	$173,434.7	$141,082.0	$119,538.1	$115,135.9	$117,490.7
LaRC	$49,389.0	$66,329.3	$87,405.5	$87,374.5	$87,370.5	$87,417.5	$87,491.5
GRC	$51,145.1	$49,574.6	$51,387.5	$51,290.5	$50,484.9	$50,934.4	$49,224.0
MSFC	$180,870.1	$146,116.2	$135,594.8	$135,617.7	$135,679.7	$135,027.6	$136,656.0
SSC	$14,828.8	$18,043.5	$17,680.0	$17,289.3	$17,728.1	$17,635.2	$17,657.3
Total Agency	$2,112,633.3	$2,215,607.9	$2,214,765.9	$2,096,640.9	$2,084,429.6	$2,113,616.2	$2,028,271.2

Exhibit 3-3: IT Investment Plans for each Center, Headquarters, and JPL

Exhibit 3-4 provides an installation level profile of the total Agency IT budget for FY 2001.

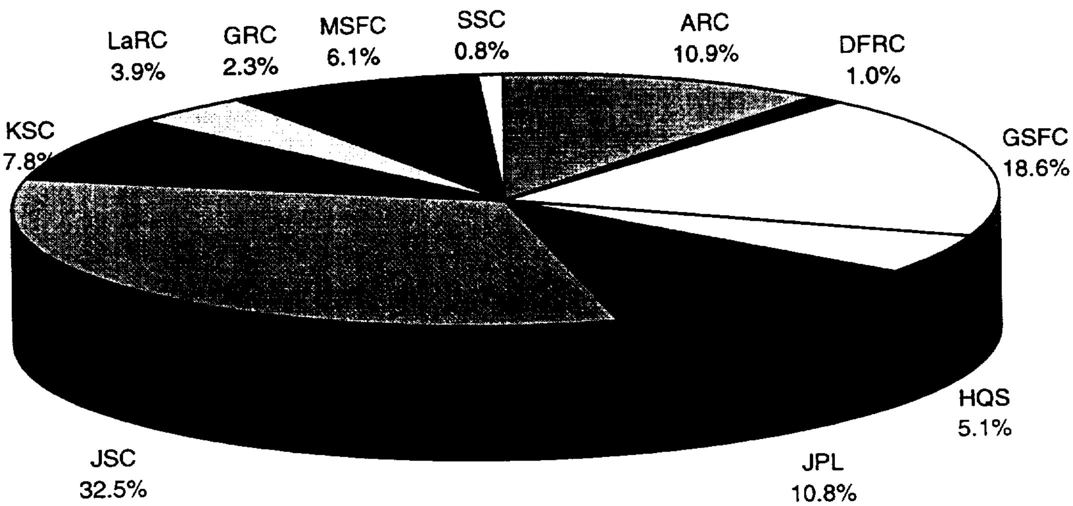

Exhibit 3-4: Profile of NASA FY 2001 IT Investment Plans for each Center, Headquarters, and JPL for FY 2001

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4.0 Strategic Enterprise Plans

4.0 Strategic Enterprise Plans

Each Strategic Enterprise has a unique set of strategic goals, objectives, and strategies that address the requirements of its primary external customers. Details are documented in the strategic plans of each enterprise. This section highlights each enterprise's mission and goals and describes the enterprise's strategy for managing IT. Details on major IT investments are provided in Appendix A, Major IT Investments.

4.1 Aero-Space Technology Enterprise

4.1.1 Mission

The mission of the Aero-Space Enterprise is to pioneer the identification, development, verification, transfer, and commercialization of high-payoff aeronautics and space transportation technologies. Research and development programs conducted by the Enterprise contribute to national security, economic growth, and the competitiveness of American aerospace companies. The Enterprise plays a key role in maintaining a safe and efficient national aviation system and an affordable, reliable space transportation system. The Enterprise directly supports national policy in both aeronautics and space as directed in the President's Goals for a National Partnership in Aeronautics and Research Technology, the National Space Policy, and the National Space Transportation Policy.

4.1.2 Mission Implementation Strategy

The Enterprise manages a portfolio of technology investments to ensure alignment with national policy, Agency goals, customer requirements, and budget availability. The investment strategies are focused on issues associated with future aviation and space systems. Enterprise objectives are outcome-focused and "stretch" beyond our current knowledge base. Designated Lead Centers have been assigned the responsibility to manage the implementation and execution phases of the technology programs. Enterprise programs are often conducted in cooperation with other Federal agencies, primarily the Federal Aviation Administration (FAA) and the Department of Defense. These partnerships take advantage of the national investment in aeronautics and astronautics capabilities and eliminate unnecessary duplication.

The Enterprise supports the maturation of technology to a level such that it can be confidently integrated into current and new systems. In most cases, technologies developed by the Enterprise can be directly transferred to the external customer.

4.1.3 Performance Objectives

Performance Objective	Completion Date
Demonstrate a prototype heterogeneous distributed computing environment (HPCC).	September, 2000
Demonstrate communication testbeds with up to 500-fold improvement over the 1996 baseline (increase from 300 Kbps to 150 Mbps) in end-to-end performance (HPCC).	March, 2000

Bolded item is in the FY 2000 NASA Performance Plan.

4.2 Human Exploration and Development of Space Enterprise

4.2.1 Mission

The Human Exploration and Development of Space (HEDS) Enterprise mission is to open the space frontier by exploring, using, and enabling the development of space to expand human experience into the far reaches of space.

4.2.2 Mission Implementation Strategy

In order to succeed, HEDS must also undertake the following general strategies:

- Engage NASA's customers in setting HEDS goals, objectives and priorities.
- Ensure that safety is inherent in all that we undertake.
- Focus on research and development, and invest in breakthrough technologies.
- Privatize and commercialize operational activities.
- Employ open, competitive processes for selecting research projects.
- Promote synergy with other enterprises and cooperation and engagement with organizations and customer communities outside of NASA.
- HEDS must forge partnerships and customer engagement alliances across a broad spectrum, including:
  - Academia
  - Industry – aerospace; non-aerospace (e.g., healthcare)
  - Other NASA Enterprises – Space Science; Earth Science; Aerospace Technology
  - International Space Agencies and Organizations
  - Other US Government Agencies
  - Other non-profit and non-governmental Agencies.

Information technology (IT) is a vital support capability for meeting the objectives of NASA's HEDS Enterprise, such as:

- Developing new capabilities (e.g., International Space Station)
- Operating existing capabilities (e.g., Shuttle, space communications)
- Procurement of commercial services (e.g., Expendable Launch Vehicle)

IT is embedded and integral to every HEDS program and project. HEDS will:

- Provide robust, multidisciplinary infrastructure of data, information, computing, and communication services for HEDS programs and projects.
- Enhance access to and utilization of data products for the education community and the general public.
- Exploit advances in computer science and information technology to increase the efficiency and effectiveness of all aspects of HEDS endeavors.
- Promote strong collaborations and partnerships involving the NASA Centers and industry.

Advanced information technologies include:
- Mission modeling and simulation
- On-board processing; avionics systems; command and data handling
- Mission control and operations
- Data processing and generation of operations data products
- Data management and distribution
- Data analysis and visualization
- Modeling and simulation of physical processes and comparison with observations
- Distributed and collaborative program/project management and engineering
- Day-to-day information technology (desktops, etc.)

4.2.3 Performance Objectives

The HEDS Enterprise is in transition from an operational role to a developmental role as it proceeds towards privatization of the Space Shuttle and commercialization of other programs. The plan is to use the HEDS expertise in partnership with other entities, such as all NASA Centers, industry, and academia, to develop new technologies for future space initiatives. HEDS objectives are to enhance core capabilities (people, facilities, equipment and systems) to meet Agency objectives and customer needs for faster, better, cheaper development and operations of space systems.

At the enterprise level, IT is seen as a critical enabling technology but not as a core mission area. In pursuing its mission of providing this critical enabler to the HEDS programs in the most cost-effective and -efficient manner possible, the HEDS Enterprise is pursuing a strategy of consolidation and modernization of its IT infrastructure. Further efforts will be pursued to outsource and privatize elements of IT wherever possible. These strategies increase the level of standardization across the Enterprise, and simplify the scale of operations in IT.

An example of HEDS privatization and consolidation of IT supporting its programs is the Space Flight Operations Contract (SFOC). NASA is implementing consolidation of all Shuttle operations efforts under the SFOC (a single prime contract). This contract represents a significant change in NASA philosophy, with accountability for day-to-day operations shifting from NASA to the SFOC contractor. The work is being performed by a new organization, the United Space Alliance (USA), which was established through a joint venture of Rockwell International (now Boeing North American) and the Lockheed Martin Corporation.

The SFOC is achieving the required reductions, providing savings from integration, consolidation, and synergy across the entire scope of Space Shuttle operations. To maximize IT efficiencies, SFOC is exploiting cognizance over specific functions that cut across multiple programmatic organizations. SFOC's program integration roles ensure that overlaps between organizations are minimized. This results in cost reductions by eliminating, consolidating, and streamlining the processes. The SFOC contract is structured such that USA is highly motivated to identify and successfully implement significant operational efficiencies.

Another example of HEDS privatization and consolidation of IT supporting its programs, is the Space Operations Management Office (SOMO), located at Johnson Space Center (JSC), that manages telecommunications, data processing, and mission operation and planning. These services are needed to ensure the goals of NASA's exploration, science, and research and development programs are met in an integrated and cost-effective manner. The SOMO is structured to implement Agency space operations goals while successfully providing services that enable Enterprise mission execution. The primary goal is to ensure that the strategic mission needs of the NASA Enterprises are met while, at the same time, significantly reducing operations costs. The approach has increased consolidation and integration of operations Agency-wide by emphasizing the use of technology, standardization, and interoperability. At the Marshall Space Flight Center (MSFC), under a single project office, the SOMO has successfully managed the consolidation of NASA's telecommunications networks supporting space operations and general programmatic and administrative communications (NASA Integrated Service Network (NISN)).

Procedurally, SOMO ensures that all existing associated contracts transition to performance-based contracts. Operations functions that generate products and services are transitioned to outsourcing, privatization, and commercialized services.

The Consolidated Space Operations Contract (CSOC) is meeting the above goals for SOMO. The CSOC is NASA's agent for operational communications and associated information handling services.

4.3 Earth Science Enterprise

4.3.1 Mission

The Earth Science Enterprise mission is to understand the total Earth system and the effects of natural and human-induced changes on the global environment. The programs of the Enterprise advance the new discipline of Earth System Science, with a near-term emphasis on global climate change. Both space and ground-based capabilities yield new scientific understanding of Earth and practical benefits to the Nation. The research results will contribute to the development of environmental policy and economic investment decisions. The Enterprise mission includes the development of innovative technologies to support Earth Science programs and make them available for solving practical societal problems in agriculture and food production, water resources, and national resource management that provide benefits to the Nation. Knowledge and discoveries will be shared with the public to enhance science, mathematics, technology, education, and increase the scientific and technological literacy of all Americans.

4.3.2 Mission Implementation Strategy

The Earth Science Enterprise conducts global and regional research requiring the vantage point of space. New programs will be developed and deployed through the "faster, better, cheaper" approach. Program managers are encouraged to accept prudent risk, shorten development time of technologies and missions, explore new conceptual approaches, streamline management, and incorporate innovative methods to enhance efficiency and effectiveness. Programs of the Enterprise contribute to the U.S. Global Change Research Program and are conducted in collaboration with ten other U.S. Federal agencies and 13 nations. Cooperative research programs with national and international partners will continue to play a key role in the implementation strategy of the Enterprise.

The same spirit of innovation that embodies the Earth Science flight programs applies to technology development. Long-term, high-risk, and high-payoff technologies are key to implementing the Earth Science mission. The Enterprise priorities feature near-term product milestones on a path of long-term inquiry. Obtaining data from the private sector is an emerging feature of the Enterprise strategy. This will reduce Agency costs and encourage the growth of the commercial remote-sensing industry.

4.3.3 Performance Objectives

Implement open, distributed, and responsive data system architectures.

- EOS DIS will make available data on prediction, land surface, and climate to users within 5 days.
- EOS DIS will double the volume of data archived compared to FY 1998.
- EOS DIS will increase the number of distinct customers by 20% compared to FY 1998.
- EOS DIS will increase products delivered from the DAACS by 10% compared to FY 1998.

4.4 Space Science Enterprise

4.4.1 Mission

The Space Science Enterprise mission is to solve mysteries of the universe, explore the solar system, discover planets around other stars, and search for life beyond Earth. Programs of the Enterprise chart the evolution of the universe from origins to destiny, and improve understanding of galaxies, stars, planets, and life. The Enterprise mission includes developing innovative technologies to support Space Science programs and making them available for other applications that provide benefits to the Nation. Knowledge and discoveries will be shared with the public to enhance science, mathematics, and technology education and increase the scientific and technological literacy of all Americans.

4.4.2 Mission Implementation Strategy

Information technology is a vital support capability for meeting space science research objectives. It is embedded in and integral to virtually every science program and project. Application of advanced information technologies run the gamut of the scientific endeavor, including:

- Mission and instrument modeling and simulation
- On-board processing; avionics systems; command and data handling
- Mission control and operations
- Data processing and generation of science data products
- Data management and distribution
- Data analysis and visualization
- Modeling and simulation of physical processes and comparison with observations
- Distributed and collaborative program/project management and engineering

Science Information Systems Strategic Goals:

- Provide robust, multidisciplinary infrastructure of data, information, computing, and communication services for science programs and projects
- Enhance access to and utilization of science data products by the research community, as well as the education community and general public
- Exploit advances in computer science and information technology to increase the efficiency and effectiveness of all aspects of space science endeavors
- Promote strong collaborations and partnerships involving the science community, NASA Centers, and industry

Science Information Systems Technology Thrusts and Opportunities:

- Science Data Management, Archiving, and Exploration: The Office of Space Science supports a distributed data archiving environment with nodes such as the National Space Science Data Center (NSSDC), the Planetary Data System, Infrared Analysis and Processing Center, etc. These archives operate as a federation with strong coordination to promote integration, interoperability, and commonality of services. The goal is to exploit emerging technologies and present the totality of science data archives as a unified whole, providing users the ability to explore, mine, and discover objects and physical phenomena from the collective set of science data sources across the set of archives.

- Framework for Autonomy: autonomous planning, scheduling, operations, fault detection/correction, intelligent on-board processing, etc.

- Framework for interferometry and/or constellation missions: planning, scheduling, control; data acquisition, registration, processing; and data management, storage, and analysis

- Collaborative Environments
  - Modeling/simulation/visualization
  - Virtual/immersive environments
  - Knowledge management and synthesis " Collaborators"
- Software technology, reliability, and reuse/integration
- High-end, scaleable computing and networking
- Micro-Nano Systems and Bio-informatics

4.4.3 Performance Objectives

- Provide Virtual Observatory capability from investigator workstation for multi-wavelength analysis, discovery, and visualization across the collective set of science data archives
- Virtual Mission- Create accurate, rapid, and cost-effective virtual presence of the mission environment, mission systems, and mission operations in order to enable integrated/collaborative mission design
- Establish an Interplanetary internet with a Mars Network as first interplanetary node

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Appendix A: Major and Significant but Not Major Information Technology Investments

Appendix A: Major and Significant but Not Major Information Technology Investments

This section provides information on NASA's major and significant information technology (IT) investments.

A major IT investment is defined as:
- A high cost IT investment in development programs or a high cost Agencywide IT investment.

A significant but not major IT investment is defined as:
- An IT investment that requires special management attention because of its importance to the Agency mission; or its high development, operating, or maintenance costs; or its high risk or high return; or its significant impact on the administration of Agency programs, finances, property or other resources.

High cost is defined as development, acquisition, and operations or maintenance costs that exceed $5 million in one year or $20 million over the life of the asset or five years, whichever is less.

A significant IT investment is defined as:
All other NASA IT investments are considered significant. The cost of these other investments are included in the total NASA IT budget, but the other investments are not described in this plan.

A.1 INVESTMENT CRITERIA

Major IT investments and significant but not major IT investments are viewed in three categories for purposes of budget decisions as follows:
- New (Development/Modernization/Enhancement),
- Pathfinding, and
- Existing or Steady State (maintenance and operation of a system at its current capability). Investments in each category are evaluated against specific investment criteria.

A.1.1 New (Development/Modernization/Enhancement) IT Investments (Governed by Raines Rules)

New IT investments can be planned, in on-going development, or be major modifications to existing systems. Before initiation, new IT investments must be evaluated against the eight criteria that comprise the "Raines Rules" which include the following:

- **Mission Support**--The investment supports core or priority mission functions that need to be performed by the Federal Government.

- **Alternative Sources**--The investment is undertaken because no alternative private sector or government source can efficiently support the function.

- **Work Process Redesign**--The investment supports work processes that have been simplified or otherwise redesigned to reduce costs, improve effectiveness, and make maximum use of commercial, off-the-shelf technology.

- **Return on Investment**--The investment demonstrates a projected return on the investment that is clearly equal to or better than alternative uses of available public resources. Return may include: improved mission performance in accordance with GPRA measures, reduced cost; increased quality, speed, or flexibility; and increased customer and employee satisfaction. Return is adjusted for such risk factors as the project's technical complexity, NASA's management capacity, the likelihood of cost overruns, and the consequences of under- or non-performance.

- **Architectures**--The investment is consistent with Federal and NASA architectures which integrate NASA work processes and information flows with technology to achieve NASA's strategic goals; reflect NASA's technology vision and year 2000 compliance plan; and specify standards that enable information exchange and resource sharing, while retaining flexibility in the choice of suppliers and in the design of local work processes.

- **Risk Reduction**--The investment reduces risk by avoiding or isolating custom-designed components to minimize the potential adverse consequences on the overall project; using fully tested pilots, simulations, or prototype implementations before going to production; establishing clear measures and accountability for project progress; and securing substantial involvement and buy-in throughout the project from the program officials who will use the system.

- **Phased Development**--The investment is implemented in phased, successive modules as narrow in scope and brief in duration as practicable, each of which solves a specific part of an overall mission problem and delivers a measurable net benefit independent of future modules.

- **Acquisition Strategy**--The investment employs an acquisition strategy that appropriately allocates risk between government and contractor, effectively uses competition, ties contract payments to accomplishments, and takes maximum advantage of commercial technology.

A.1.2 Pathfinding IT Investments (not governed by Raines Rules)

Pathfinding IT investments are a class of projects whose purpose is to advance existing or develop new IT capabilities required by NASA missions. Pathfinding IT investments can not adequately be evaluated against the "Raines Rules" since in research and development of new information technology capabilities, commercial off the shelf software and hardware is most often inadequate, architectures chosen are unique, and most times, incompatible with other Federal program architecture, and last, but not least, the return on investment comes in the future. NASA does, however, appropriately evaluate these investments in terms of mission requirements and takes steps to minimize the risk to the Federal Government by managing these programs by:

- Establishing milestones and minimum success criteria to ensure the validity of the investment,
- Setting-up partnerships and collaborations with other agencies who are doing similar work,
- Involving potential users of the product in the planning phase, and
- Evaluating accomplishments, yearly, by an independent review team against a relevant set of success criteria.

A.1.3 Existing or Steady State (maintenance and operation of a system at its current capability) IT Investments

Existing IT investments are information technology systems or capabilities that are fully operational. Existing IT investments are evaluated against criteria ("Raines Rules") modified to support decisions regarding the need to continue funding for investments already in operation. The decision criteria include the following:

- **Mission Support**--The investment supports core/priority mission functions that still need to be performed by the Federal Government.
- **Alternative Sources**--Continued funding of the investment is required because no alternative private sector or government source can efficiently support the function.
- **Customer Requirements**--The existing system investment continues to satisfy customer requirements in a manner that reduces cost and improves work process efficiencies.
- **Return on Investment**--The existing system investment continues to demonstrate a projected return on the investment that is clearly equal to or better than alternative uses of available public resources. Return may include improved

mission performance in accordance with GPRA measures, reduced cost; increased quality, speed, or flexibility; and increased customer and employee satisfaction.

- **Architectures--**The existing system investment is consistent with Federal and NASA architectures. Architectures should integrate NASA work processes and information flows with technology to achieve NASA's strategic goals; reflect NASA's technology vision and Year 2000 compliance plan; and specify standards that enable information exchange and resource sharing, while retaining flexibility in the choice of suppliers and in the design of local work processes.

A.2 PERFORMANCE MEASUREMENT

For each IT investment the following performance measures are required:

- Budget plans/annual and life cycle costs
- Summary schedule of major milestones
- Performance indicators to measure outcomes, output, service levels, and customer satisfaction

These measures are baselined for each major IT investment and are tracked throughout the investment's life cycle. Since the majority of NASA's IT investments are made within the context of programmatic investments, milestones for mission support IT investments are also reviewed within this context as part of the program/project's overall technical, cost, and schedule assessment.

A.3 DESCRIPTION OF MAJOR AND SIGNIFICANT BUT NOT MAJOR IT INVESTMENTS

This section provides descriptions of NASA's major and significant but not major IT investments in three functional support categories: Mission Areas (consisting of: Financial Management, Mission Support, Aero-Space Technology, Human Exploration and Development of Space, Earth Science, and Space Science), Infrastructure, and Architecture & Planning.

Costs for each major IT investment are considered in terms of:

- Costs associated with development/modernization/enhancement of the system.
- Costs associated with maintenance and operations of the system.

Funding for each major IT investment are considered in terms of the funding source (direct appropriation to NASA or transfer from another account).

Five-year budget plans for each investment are contained in Section A.4.

A.3.1 Mission Area IT Investments

A.3.1.1 Financial Management Mission Area IT Investments

A.3.1.1.1 Integrated Financial Management System (IFMS)

The Integrated Financial Management System (IFMS) was created to improve NASA's financial and resources management support of the Agency's mission. Implementing the IFM processes will replace Center and Enterprise-unique approaches to business with a single set of standard integrated business processes that are compliant with Federal requirements. These requirements are specified in the Joint Financial Management Information Program (JFMIP), a multi-cooperative federal effort to improve government financial management practices. The IFMS will collect complete, reliable, consistent and timely information, provide standardized agency management reporting, provide support for government-wide and agency-level policy decisions, and facilitate the preparation of financial statements and other financial reports in accordance with federal accounting and reporting standards. The IFMS is in alignment with the 1997 NASA IT Architecture (NITA). The system will be fully integrated with the Agency's new strategic management, program management, and budget/financial management planning. Within the NASA strategic plan, the IFMS will be capable of supporting planned missions and promote cross-Enterprise efficiencies consistent with the Agency and Enterprise strategic plans.

NASA awarded a contract to KPMG Peat Marwick LLP in September 1997 to implement a COTS-based agency-wide system. Financial risk is reduced to the government with firm fixed price contract payments tied to milestone deliverable accomplishments. This integrated COTS technology is being used with NASA's Business Process Reengineering (BPR) methodologies to cut costs, improve efficiencies, and improve its understanding of how the Agency utilizes it resources. The BPR methodology ensures a customer focus and systems approach to the redesign of business processes. Emphasis has been placed on integration, standardization, the elimination of unnecessary duplication, reduced cycle times, and the production of useful and timely information.

In preparation for selection of the product, three cost benefit analyses (CBA's) were done (the Phase I implementation business case, the Asset Management business case, and the Human Resources business case) to identity, classify, and measure benefits expected from various product alternatives. The alternatives included integrated COTs products, stand-alone COTs products, outsourcing, cross-servicing, system upgrades and current operations. The COTs-based alternatives provided the best overall solution from a qualitative and quantitative perspective. The projected return on investment is clearly equal or better than the alternatives. The expected payback period is estimated to be 6.4 years with anticipated reductions in legacy costs, direct labor and overhead, and IT sustaining support costs. The business cases clearly show that it would be inefficient and cost prohibitive to retain an outside government agency to implement NASA's IFMS.

The IFMS is currently managed in phased pieces. The original plan was to implement a Phase I piece including core financial, budget formulation, travel management, time and attendance, procurement, and Executive Information System (EIS). Phase II implementation would follow with Asset Management, Human Resources, and Grants Management. After implementation at Pilot Centers, delivery and implementation of the software would be phased in scope and time across the remaining Centers.

Problems in schedule slippage with the prime contractor have instigated a major reexamination of business cases and re-phasing of NASA implementation activities to work smaller, shorter-term successive modules and significant refinement of NASA IT Architecture to guide future IFM deployment. As NASA changes the scope of the IFMS, adherence to Raines Rules will continue as we return to the investment decision stage. Efforts are currently underway to update our business cases, reexamine the balance of risk between government and vendor, work implementation in more manageable pieces, and continue to be capable of supporting planned Agency missions and promote cross-Enterprise efficiencies consistent with Agency strategic plans.

Summary Schedule for Planned Investments
The current negotiated schedule is:

Contract Award: 9/18/97
Receipt of System for Acceptance: 12/1/98
Completion of Initial Testing: 6/2/99
Completion of Validation Testing: 11/29/99
Acceptance of Agency-Baselined System: 12/16/99

System Deployment at NASA Centers

6/1/99
Marshall Space Flight Center
Dryden Flight Research Center

10/01/00
Goddard Space Flight Center
Headquarters

03/01/01
Johnson Space Center
Kennedy Space Center
Stennis Space Center

06/01/01
Ames Research Center
Langley Research Center
Glenn Research Center

This schedule is now obsolete and is undergoing restructuring.

Performance Indicators Used to Measure Outcomes, Output, Service Levels, and Customer Satisfaction. Expected performance indicators are timely and higher quality financial reports, increased availability of larger data sets to more managers, easier access to information, reduced data reconciliation and increased data analysis leading to more timely and informed management decisions, reduced workforce involved in performing operations, and reduced IT sustaining budgets.

Decision Criteria for Continued Funding of Existing Systems: The IFMS is an existing investment in IT. Decision criteria have been reviewed in order to continue funding for this investment. As discussed in the above description, mission support, alternative sources, customer requirements, return on investment, and architecture criteria continue to be reevaluated as we return to our investment decision stage.

A.3.1.1.2 All Other Financial Management Systems

Financial systems are information systems composed of one or more applications that are used to for any of the following:

- Collect, process, maintain, transmit, and report data about financial events.
- Support financial planning or budgeting activities.
- Accumulate and report cost information.
- Support the preparation of financial statements.

These applications support functions such as Funds Control, Accounts Payable, Billings and Collections, General Ledger, Cost Accounting, Property Accounting, and Travel. NASA's financial systems are typically designed to accomplish the record-keeping necessary to maintain a balanced government accounting system through user transaction and report processing. These systems generate reports to the Treasury to ensure funding obligations are met. Reports are also provided to NASA Headquarters on integrated financial, contractual, labor hour and general ledger data to support decision-making, accountability, and reporting to the executive and legislative branches of the US Government. These systems are also used to support local Center management of fiscal and personnel resources. These systems are designed to interoperate with commonly available user computing environments, including UNIX, Macintosh and PC and uses ADABASE and/or SQL compatible database technology.

Agency other financial information systems include:

Center	System Name	% of Application that is Considered **Financial Management Support**
ARC	Ames Cost Obligations, Accruals & Disbursements Accounting System	100
DFRC	Dryen/Marshall's Accounting System	100
GRC	Glenn Accounting System (AS)	100
GSFC	Goddard's Fiscal Accounting System (FAS)	100
HQS	Management Information System (MIS)	25
HQS	HQS. Accounting Support	100
JSC	Johnson's Interactive & Basic Accounting System	100
KSC	Kennedy's Space Transportation Accounting & Resources system (STARS)	100
LaRC	Langley's Resources Management system	100

Center	System Name	% of Application that is Considered **Financial Management Support**
LaRC	Business Data Processing System	25
MSFC	NASA Personnel Payroll System (NPPS)	50
MSFC	NASA Personnel Payroll System (NPPS) Program Support Computer Sys.	50
MSFC	Marshall's Accounting/Resources Tracking System (MARTS)	100
MSFC	Program Support Computer System/IBM	75
SSC	Stennis' Management Accounting & Status System	100
SSC	Program Support Computer System/VAX	50

The current plan is to replace the existing systems with the Agency Integrated Financial Management System (IFMS) and to restructure local Center unique needs to be supplied through this system. Any needs, which are not appropriate for IFMS, will be addressed once the overall architecture is better defined.

A.3.1.2 Mission Support IT Investments

A.3.1.2.1 Standard Agencywide Administrative Systems

These legacy Agencywide administrative systems are those software applications that are used for personnel, payroll, acquisition, and property logistics support for the Agency. These applications include the following:

- NASA Equipment Management System (NEMS)
- NASA Property Disposal Management System (NPDMS)
- NASA Supply Management System (NSMS)
- Acquisition Management System (AMS)
- NASA Payroll/Personnel System (NPPS)
- NASA Training & Development System (NTDS)
- Consolidated Agency Payroll/Personnel (CAPPS)
- AdminSTAR (a COTS system)

This IT includes the maintenance of the "core" software for these systems, but does not include their installation for each center, or their operation, which is the responsibility of each NASA center. Major new enhancements to any of these systems are beyond the scope of this IT task and requires additional approval and funding.

Except for the AdminSTAR system, these systems are maintained on an IBM-compatible mainframe computer at the NACC. Software is written in Software AG (SAG)'s Natural code and uses SAG's ADABAS and other SAG tools. AdminSTAR is a COTS client/server software package.

This IT supports the administrative infrastructure of the Agency, as well as all Enterprises and Programs.

Summary Schedule for Planned Investment.
Major milestones are the routine system releases each year. There are nominally one or two major releases per system each year, and these are usually planned a year in advance. These releases include regulatory and/or policy changes, but no major enhancements.

Other milestones include the replacement on a system-by-system basis by the Integrated Financial Management Program (IFMP) products. The dates shown would be the first full year that support would not be provided to the application. The following summary is based on the latest published IFMP schedule.

- FY-2002 Replacement of AMS
- FY-2002 Replacement of NEMS, NSMS, NPDMS
- FY-2004 Replacement of NPPS, CAPPS, NTDS

Performance Indicators Used to Measure Outcomes, Output, Service Levels and Customer Satisfaction. Performance indicators include the following:

- Discrepancy Reports (DR's) per lines of code released
- DR's per table release
- Help desk response time
- Help desk backlog
- Timeliness of deliverables based on a committed schedule
- Delivery of service or product within budget

Performance metrics are reported quarterly and are based on performance quality metrics established for the four types of services and deliverables under this project. These include:

- Software Releases
- Table Releases
- Help Desk Support
- Special Services and Products which may be requested from time to time by NASA

The four services are evaluated against the three areas as specified by the PrISMS contract. These include:

- Quality of Work Performed
- Timeliness of Performance
- Use of Resources

The quality of software releases is measured by the number of software discrepancy reports (DR's) generated between software releases and are evaluated based on an industry standard of 1 discrepancy per 1000 lines of code released. The number of DR's measures the quality of Table Releases generated against a released table. Technical Support Services and Customer Support Services are evaluated against help desk response time and the timely resolution of customer problems. Help Desk thresholds were established at project initiation and are those used by the NACC. These thresholds are used in performance evaluation for technical services.

Quality of Customer Support Services is evaluated on the timely closure of help desk calls. Closure of a customer support service is defined as:

- providing an answer to the question or concern,
- providing a work around,
- identifying an application discrepancy and creating of a NASA Change Control Request form to document the discrepancy or requirement change.

Timeliness of performance is evaluated on the delivery of the service or product within committed schedule. Deliveries are to be no more than two days late on the average and critical schedules can not be missed.

Use of resources is evaluated based on delivery of service or product within resource cost estimates. Other criteria in evaluating the use of resources is the number and effectiveness of process improvements which result in productivity and quality improvements.

How Planned Investment Meets Decision Criteria for Existing Investments: This investment supports core mission functions that still need to be performed by the Federal Government

A.3.1.2.2 Kennedy Inventory Management System (KIMS)

The KIMS supports the Human Exploration and Development of Space (HEDS) Enterprise. It provides government and contractor users independent inventory integrity as well as providing global information necessary to manage and support logistics operations. The system supports NASA and Air Force missions, contractual functions and obligations, and provides the government with the means to evaluate the effectiveness of KIMS through the use of performance measurements reflecting inventory status, planned versus actual performance, and degree of accomplishment of desired objectives.

KIMS supports an Inventory Management System (IMS) which is mandatory for all users and consists of five sub-functions:

- The IMS function provides file management control with transaction suspense and release features.

- The Cataloging function manages the part number file and the technical data file.
- The Receiving function provides receipt processing, quality assurance and reparable processing.
- The Inquiry function provides pre-formatted inquiries to support the Inventory, Receiving and Cataloging functions.
- The Issue function provides issue processing by stock number or part number and provides for post issue processing.

There are three additional optional subsystems consisting of Provisioning/Replenishment, Transportation, and Procurement. Additionally, woven through the KIMS application software is transaction suspense processing, cradle to grave traceability, reservation processing, non-stock requisitioning processing, reversal of selected transactions and an audit (history) of transactions processed.

In addition to supporting government and contractors at KSC and the ground support activities for launch and landing, Shuttle and payloads, it also provides access to Marshall Space Flight Center, Alabama, and the element contractors at Downey, California; Wasatach, Utah; Canoga Park, California; Dryden Flight Research Facility at Edwards Air Force Base, California; Johnson Space Center, Texas and Michoud Assembly Facility, Louisiana.

The KIMS application is currently being hosted on a Year 2000 compliant hardware and software platform at the Defense Information Systems Agency's Defense Megacenter San Antonio in Texas, where the cost of operation is shared with the USAF and two other customers.

Summary Schedule for Planned Investments
All investments in KIMS are for operations and maintenance. KIMS supports three major contracts: SFOC, PGOC, and JBOSC. Two of the three are obtaining their own inventory management systems. Once those are in place, KIMS will either be reengineered or terminated.

Performance Indicators Customer satisfaction, availability, response times are among the performance indicators for KIMS. All are satisfactory at the present time.

How Planned Investment Meets Decision Criteria for New Investments: The Mission Support function and interfaces of the KIMS remain the same. KIMS is the inventory management system used to support the logistics function at KSC. The functions performed by, or directly supported by KIMS, include file management, transaction suspense and release, cataloging, receiving, QA, repair processing, equipment/material issue, provisioning/replenishment, transportation and procurement. Only the location, hardware and management of the mainframe have changed. The missions supported include Shuttle, Payloads, Space Station and other HEDS and DoD missions.

Alternative Sources were evaluated and the only viable solution, which met the Y2K Directive, was to transfer the mainframe support function to the Defense Information Systems Agency's Defense Megacenter San Antonio. Alternative sources required long lead times to translate the files, followed by down time while the hardware was being switched over, and finally, additional time would be required to download and test the files. It was estimated the alternative source solution would have missed the Y2K deadline by as much as 12 months.

The Customer Requirements have not changed and the KIMS continues to meet those requirements. The only noticeable change is that the current Y2K compatible system is much more efficient. (ex. Some batch jobs now run 4 times faster.)
The Return on Investment is clear. The old system could not meet the Y2K requirements. When tested it failed. And, the alternative sources could not meet the Y2K deadline. In addition, the increased speed and efficiency of the KIMS today has increased customer and employee satisfaction.

The KIMS investment is consistent with Federal and NASA Architecture and is an integral part of the work processes and information flows which work together to achieve NASA's strategic goals; Reflect NASA's technology vision and year 2000 compliance plan; and Specify standards that enable interoperability, security, information exchange and resource sharing, without limiting flexibility in the selection of post Y2K suppliers. The current architecture of KIMS is based upon a Bull DPS 9000 Quad CPU System using Raid Technology.

A.3.1.2.3 Flight Dynamics System

As its title implies, the Flight Dynamics System, managed by the Mission and Data Systems Project, provides flight dynamics support for all NASA orbital missions. The Flight Dynamics Facility (FDF) provides support to flight operations, routine operations, and contingency operations, projects and the tracking networks. FDF support for flight projects is in the discipline of flight dynamics, which involves orbit and attitude determination and control. For both flight projects and tracking networks, the FDF is responsible for analyzing various mission-specific flight dynamics requirements, then designing, developing, testing, operating, and maintaining all systems to meet those requirements.

The FDF supports both launch vehicles and free-flying missions. These include shuttle missions, expendable launch vehicles (ELV's), attached shuttle payloads, and all types of free-flying missions. The FDF currently supports approximately 30 NASA-supported satellites, and launch vehicles (including Space Shuttle, Delta, Titan, Atlas, and Ariane). The FDF is also designated as the backup to JSC Ground Navigation for Space Shuttle orbit determination in the event of an Emergency Mission Control Center (EMCC) contingency. Multiple missions in various phases are supported concurrently within the FDF. In each mission support phase, provisions must be made for critical operations, such as launch and maneuver support, which must be performed in a timely fashion according to a schedule driven by external events. Routine operations, while critical to the overall mission, can usually be scheduled by the FDF with some latitude within the normal workflow. Contingency operations, such as communications loss and safe-hold operations, are performed in the same manner as critical operations.

The FDF architecture consists of a set of workstations and servers, commercial off the shelf (COTS) and locally written software applications, an internal network, and interfaces to external mission support elements. The workstations and servers are primarily Unix-based and perform file, compute, real-time telemetry processing, and database functions. All servers accessed by the mission operations personnel, analysis and software development communities supporting the FDF are located in the Computer Operations Room (COR).

The operational component of the facility has two Sun Sparc 1000E servers as file servers, two HP K200s as compute servers, 2 HP K400s as real-time telemetry and database servers as well as other administrative servers supporting the distributed environment. A FDDI network connects these engines and the 20 end user workstations, 4 x-terminals, and 25 PCs in the mission operations area. A Storage Technology Corporation Silo supports the FDF mass storage requirements. Two system printers (IBM 3835 and IBM 3829) and numerous LAN printers are installed. Connections to NASCOM/NISN and the operational Code 450 network are available as well as consoles equipped with CCTV monitors, communications voice circuits for real-time mission support and coordination, large-screen displays, Greenwich Mean Time (GMT) and Mission Elapsed Time (MET) clocks.

The non-mission operations component of the facility has two HP T500s as file and compute servers, more than 400 PCs, more than 50 Macs, fax servers, and numerous LAN printers which are used primarily for mission planning and software development support. Off-site contractor facilities host additional FDF support personnel providing systems support, mission planning, and software development support in addition to the support provided in Building 28.

The FDF also includes the Flight Dynamics Product Center (FDPC). The FDPC is a multimission service, which makes several standard flight dynamics products and reference databases available to Internet users without restriction. The server used to support the FDPC is accessible from the FDF Homepage on the World Wide Web (WWW). Software systems in use since the transition from mainframes to distributed systems total 4.7 million SLOC in FORTRAN, Ada, C, and C++.

Communications are via the FDF Network, a multi-protocol network providing connectivity between the Flight Dynamics Facility-supporting workstations, PC's and workstations in offices of FDF supporting personnel, and PC's and workstations at the support service contractor off-site location. Access to the GSFC Center Network Environment (CNE) is provided through an Eagle Raptor firewall. FDF Network nodes are monitored using HP Openview.

NASCOM/NISN provides the network interface for the majority of FDF mission operations related communications that are external to the FDF. The FDF receives spacecraft telemetry and metric tracking data from the Ground Network (GN) and Space Network (SN) via NASCOM/NISN. User vectors from Jet Propulsion Laboratory (JPL) and Johnson Space Center (JSC) are also received via NASCOM/NISN. The FDF transmits acquisition scheduling aids to the GN and JPL using NASCOM/NISN. Acquisition scheduling aids also are sent via NASCOM/NISN to the Network Control Center (NCC) for transmission to the SN. Tracking Data Relay System (TDRS) ephemeris data is transmitted from the FDF to JSC using NASCOM/NISN. The Mission Operational/Development Network (MODNET) is a high-speed LAN that provides electronic data communication among the various Code 450 computing facilities. The FDF uses this, or a similar LAN, for the transfer of attitude data from various POCC's and the transfer of spacecraft scheduling and predictive aids such as vector information, view periods, telemetry and other data products to the Command Management System (CMS) and various mission operations and data processing systems.

These services are delivered via the Johnson Space Center Consolidated Space Operations Contract (CSOC)

Summary schedule for planned investments.
Most of the functionality contained within the existing systems described here is proposed to be incorporated into the IMOC over the course of the next several years. The IMOC is intended to both reduce the cost of operations for specified legacy (current) missions and provide an extensible architecture (infrastructure) for servicing additional, future missions in a more efficient manner. (See section A3.1.2.4 for a schedule of IMOC activities which reflects Flight Dynamics infusion into that system.)

Performance Indicators The principle performance indicator is availability to the users, which should be 99.9 percent.

How Planned Investment Meets Decision Criteria for New Investments:
Mission Support - The investment supports every NASA launch and several foreign and domestic launches. The investment further supports every NASA/GSFC flight mission and station keeping for the Space Network (SN) TDRS satellites.

Alternative Sources - Continued funding of this investment is required because no alternative private sector or government source can efficiently support the function.

Customer Requirements - The existing system investment continues to satisfy customer requirements in a manner that reduces cost and improves work process efficiencies. The investment continues to be involved in reengineering activities to provide new and better support at lower costs.

Return on Investment - The existing system investment continues to demonstrate a projected return on the investment that is clearly equal to or better than alternative uses of available public resources.

Architectures - The existing system investment has been modernized by replacing the two (2) mainframe computers with a network of distributed workstations to be consistent with Federal and NASA architectures. These architectures integrate NASA work processes and information flows with new technology to achieve NASA's strategic goals; reflect NASA's technology vision and year 2000 compliance plan; and specify standards that enable information exchange and resource sharing, while retaining flexibility in the choice of suppliers, e.g. COTS, and in the design of local work processes.

A.3.1.2.4 Mission and Data Systems (M&DS)

The M&DS provides services and products associated with the operation of numerous scientific earth-orbiting spacecraft, including, for example, the Hubble Space Telescope, the X-Ray Timing Explorer, the Advanced Composition Explorer, multiple spacecraft in the Small Explorer Program and multiple spacecraft in the International Solar Terrestrial Program. Services include mission planning, command management, real-time command and control, health and safety monitoring, network interface, high rate data capture, level-zero data processing, central data handling and remote facility access, data management and distribution. Products include spacecraft instrument telemetry and science data, provided electronically and on physical media to various investigators and institutions associated with the spacecraft. This work is accomplished in a variety of facilities including Operations Centers, Payloads Operations Control Centers, Data Capture and Packet Processor systems, the Level Zero Processor and the Data Distribution Facility. Work is performed across a wide variety of platforms. These include: IBM and Unisys minicomputers, DEC VAX clusters, Gould super minicomputers, personal computers and workstations manufactured by Sun, Hewlett Packard, Silicon Graphics, DEC and IBM. The M&DS has been very successful in the use of open systems and in the porting of software systems. It has been very active in the production of CD-ROMs containing spacecraft data. These services are delivered via the Johnson Space Center Consolidated Space Operations Contract (CSOC).

Summary schedule for planned investments.
The GSFC Integrated Mission Operations Center (IMOC) is a CSOC-proposed development project, which would consolidate and integrate, missions operations for space science and earth observing missions at GSFC. Most of the functionality contained within the existing systems described here is proposed to be incorporated into the IMOC over the course of the next several years. The IMOC is intended to both reduce the cost of operations for specified legacy (current) missions and provide an extensible architecture (infrastructure) for servicing additional, future missions in a more efficient manner.

The integration of mission services and operations for the on-orbit missions supported by the GSFC IMOC will be accomplished in three stages. The first stage will have the hardware, software, and operational databases installed in the GSFC IMOC with operational spacecraft data sent to the GSFC IMOC in parallel with ongoing operations from the legacy systems, with legacy systems as the prime. This mode of parallel operation continues until the GSFC IMOC clearly demonstrates that it can independently support all aspects of the on-orbit mission. The second stage has the GSFC IMOC as the prime, operating in parallel with the legacy systems as back up. This clearly insulates ongoing legacy operations as the new IMOC systems and automated operations processes are put into place and proven. The final stage is the phasing-out of the legacy operational systems and transition to full on-orbit space mission operations totally under the GSFC IMOC. This approach reduces the risks to on-orbit missions to a minimum and ensures the transition from legacy mission services systems will be successful.

During the first two years of development the GSFC IMOC is developed, tested, installed, and configured at GSFC. By the end of the third year of the CSOC contract, there will be five on-orbit missions that have transitioned into the GSFC IMOC. These are the Advanced Composition Explorer (ACE), the Compton Gamma Ray Observatory (CGRO), the Landsat - 7 mission, the Tropical Rainfall Measuring Mission (TRMM), and the Upper Atmosphere Research Satellite (UARS). For the first three years of the CSOC contract, the existing Hubble Space Telescope (HST), the Earth Observing System (EOS), the Small Explorer (SMEX) based missions, International Solar Terrestrial Physics (ISTPs) missions, the Rossi X-ray Timing Explorer (RXTE), and the Medium Class Explorer (MIDEX) missions will be the only organizations operating outside of the GSFC IMOC. All new non-EOS-based mission service elements beginning after the third year of the CSOC contract are to be integrated into and supported by the GSFC IMOC.

Summary Schedule for Planned Investments
The table below gives the major milestones for the overall GSFC IMOC project.

Functions	FY 99	FY 00	FY 01	FY 02
DEVELOPMENT				
SDR	3/99			
Project Implementation Plan	6/99			
SSFDR	7/99			
SOCB Make Authorization		10/99		
SSDRs		11/99		
Development & Reengineering			3/00	
Installation & Acceptance Test			12/00	
Parallel Operations Testing			2/01	
OPERATIONS				
OPS Training/Certification			05/01	
OPS Readiness (ORR)			06/01	
SUST ENG TRANSITION				12/01

GSFC IMOC Schedule Table

Performance Indicators The services provided by the M&DS are broadly broken into two categories: spacecraft command and control; and spacecraft data capture, processing and distribution. For command and control, measures are centered on successful stewardship of the spacecraft. Metrics include percentages of: passes taken successfully, command loads correctly uplinked and other housekeeping functions correctly performed. We also track effective responses to anomalous spacecraft conditions and targets of opportunity. For data services and products we measure percentages of: data products distributed in a timely fashion, as defined by the NASA Support Plan for each mission, and data transmitted to us successfully captured and distributed. In addition we track the number of customer response forms returned to us that indicate a problem with a distributed data product.

In addition, the M&DS has an active program of conducting periodic customer satisfaction surveys both through interviews and survey forms. Feedback from the surveys is conveyed to those responsible for support.

How Planned Investment Meets Decision Criteria: The decision criteria which must be considered prior to continuing funding for existing systems include the following:

Mission Support - The investment supports the mission critical functions of spacecraft command and control and spacecraft science data processing through level zero and subsequent distribution.

Alternative Sources - The managers responsible for the system continually evaluate alternative sources for performing the function, usually on an individual spacecraft basis. In general the most cost effective solution to meeting requirements is continued funding of the investment. However, some responsibilities are being outsourced, such as command and control of the EUVE spacecraft to the University of California.

Customer Requirements - The existing system investment continues to satisfy customer requirements. However improvements are continually evaluated to lower cost while still meeting requirements. In addition, documented requirements are reviewed with the customer to see if efficiencies can be realized through their modification without significant impact on current mission needs.

Return on Investment - The existing system investment continues to demonstrate a projected return on the investment that is clearly equal to or better than alternative uses of available public resources. This is achieved by continuous evaluation of the systems, their performance, costs and ability to meet requirements (which are also reviewed). Return includes: improved mission performance in accordance with GPRA measures, reduced cost; increased quality, speed, or flexibility; and increased customer and employee satisfaction. Recent focus has also included the NASA strategic goal of increased partnering with educational institutions. In addition to the University of California partnership for EUVE operations, Bowie State is conducting the SAMPEX control center functions and the University of Maryland at College Park is providing the SAMPEX flight dynamics functions. There are also ongoing dialogues with other universities for outsourcing of mission operations for FAST and IMP. The FAST spacecraft command and control functions will be performed at the University of California beginning on October 1, 1999. These constitute another type of return on the investment made to develop the current systems supporting these spacecraft.

Architectures - Older elements of the M&DS are under active review for rehosting to modern distributed workstation architectures. Benefits will include reduced costs for hardware maintenance, software licenses, operations manpower and facilities. This will also aid in Year 2000 compliance and yield greater flexibility for future strategic initiatives such as academic partnerships. One such major initiative that has been completed addresses the WIND, POLAR, SOHO, and GEOTAIL systems. Another initiative addresses the reengineering of a large 9-track tape archive to 8mm tape storage.

A.3.1.2.5 Space Network Systems

The Space Network Systems support mission-critical operations, including both ground and space elements. These dedicated computing facilities provide cross-cutting, common spacecraft-related technology supporting multiple missions across Enterprises to avoid duplication and exploit synergy. The TDRSS White Sands Complex controls NASA's operational Tracking and Data Relay satellites and provides tracking, command uplinks, and telemetry downlinks for all missions using the NASA Space Network. The Network Control Center schedules and coordinates NASA and other agency real-time tracking support and voice/video/data uplinks and downlinks for assigned NASA orbital missions. The STDN Ground Network sites at Merritt Island and Ponce De Leon provide Space Shuttle and ELV launch and landing communications support. The major systems are:

Tracking and Data Relay Satellite System (TDRSS)

The TDRSS, also known as the NASA Space Network, is a space based network of geostationary satellites and a ground terminal complex in New Mexico. TDRSS provides communications and tracking services to Human Flight missions, to other low-Earth orbiting spacecraft, as well as to some suborbital platforms. The system is characterized by its unique ability to provide bi-directional high data rates as well as position information to moving objects in real-time nearly everywhere around the globe.

White Sands Complex (WSC)

The WSC is NASA's receiving station for the spacecraft data downlinked through a TDRS satellite. The WSC comprises two dedicated computing facilities which use a distributed computing architecture with Digital VAX clusters for each of the service equipment chains. The service equipment chains include over 500 racks of signal processing electronics which interface to 6 primary dish antennas. Eight high capacity (80 Gbit), high data-rate (150 Mbit/s) recorders provide rate conversion and line outage buffers. The WSC controls NASA's operational Tracking and Data Relay satellites and provides tracking, command uplinks , and telemetry downlinks for all missions using the NASA Space Network.

Spaceflight Tracking and Data Network (STDN)

The STDN provides tracking and data acquisition services to a large community of low-Earth-orbiting satellites. The STDN consists of a Ground Network and a Space Network that implements telemetry, tracking, and command services. The Ground Network tracking stations, located at Merritt Island and Ponce De Leon Inlet in Florida, provide voice, telemetry, and command communications to Space Shuttle and Expendable Launch Vehicle (ELV) launches. The STDN Ground Network includes two dedicated RF telecommunications facilities which use a distributed computing The service equipment chains include over 275 racks of signal processing electronics which interface to dish antennas. The Bermuda Station provides critical UHF air-to-ground voice support for the Space Shuttle.

Network Control Center (NCC)

The NCC, located at the GSFC, provides operational control for the Space Network Systems. It schedules all mission support activities and provides the interface for all STDN operations and network control activities. The NCC is the element responsible for overall, real-time coordination of network resources to satisfy the support requirements of all network customers. The NCC encompasses several data systems and maintains communication interfaces with the flight projects and control centers, the Sensor Data Processing Facility, the Flight Dynamics Facility, the White Sands Complex, and ground tracking resources. The NCC uses a distributed computing architecture with Hewlett-Packard servers and workstations, Sun workstations, and VAX 8550 clusters.

These services are primarily delivered via the Johnson Space Center Consolidated Space Operations Contract (CSOC). Under that contract, a new CSOC Integrated Operations Architecture (IOA) has been proposed which will centralize some functionality within a new Data Services Management Center (DSMC) to be located at the White Sands Complex. The DSMC is planned to accommodate network management functions that are performed today at the NCC, the WSC TDRS Operations Control Center (TOCC), the Wallops Scheduling Office (WSO), and the Network Operations Control Center (NOCC), as well as TDRS orbit determination and obit prediction functions currently performed within the Flight Dynamics Facility (FDF).

Summary Schedule for Planned Investments

NCC98 Upgrades Operations	12/1998
Guam Remote Ground Terminal Operational	07/1998
MILA/BDA Reengineering Complete	12/1998
TDRS-H Launch	1st Qtr. FY00
TDRS-I Launch	12/2002
TDRS-J Launch	06/2003

Performance Indicators Metrics are included as part of the Consolidated Network and Mission Operations Support contract Tracking, Data Acquisition, and Communications service level agreement. These metrics address: system availability (primary string) NCC = 99.5%, GN = 99.99%, WSC = 99.9% operational proficiency, SN = 99.8% tracking service (critical mission support) and 99.7% customer satisfaction (trend evaluation of customer surveys).

How Planned Investment Meets Decision Criteria

Mission Support - These systems support the core/priority spacecraft operations of NASA.

Alternative Sources - Continued funding of this investment is required because no alternative private sector or government source can efficiently support the function. The Spacecraft Operations Management Office (SOMO) continually evaluates alternative methods of executing space operations and outsourcing of some of these activities will definitely continue to be considered.

Customer Requirements - One of the basic objectives of the Consolidated Space Operations Contract (CSOC) now under development is to reduce cost and improve work process efficiencies.

Return on Investment - The existing system investment continues to demonstrate a projected return on the investment that is clearly equal to or better than alternative uses of available public resources. Through SOMO and CSOC the efficiency and adequacy of current operations will continue to be assessed.

Architectures - Through SOMO, CSOC, and joint investigations with DOD, the most standard and advanced architectures practical will be maintained.

A.3.1.2.6 GSFC Integrated Mission Operations Center (IMOC)

The Goddard Space Flight Center (GSFC) Integrated Mission Operations Center (IMOC) is a Consolidated Space Operations Contract (CSOC) proposed development project to consolidate and integrate mission operations for space science and earth observation missions at GSFC. The IMOC is intended to both reduce the cost of operations for specified legacy (current) missions and provide an extensible architecture (infrastructure) for servicing additional, future missions in a more efficient manner.

The integration of mission services and operations for the on-orbit missions supported by the GSFC IMOC will be accomplished in three stages. The first stage will have the hardware, software, and operational databases installed in the GSFC IMOC with operational spacecraft data sent to the GSFC IMOC in parallel with ongoing operations from the legacy systems, with legacy systems as the prime. This mode of parallel operation continues until the GSFC IMOC clearly demonstrates that it can independently support all aspects of the on-orbit mission. The second stage has the GSFC IMOC as the prime, operating in parallel with the legacy systems as back up. This clearly insulates ongoing legacy operations as the new IMOC systems and automated operations processes are put into place and proven. The final stage is the phasing-out of the legacy operational systems and transition to full on-orbit space mission operations totally under the GSFC IMOC. This approach reduces the risks to on-orbit missions to a minimum and ensures the transition from legacy mission services systems will be successful.

During the first two years of development the GSFC IMOC is developed, tested, installed, and configured at GSFC. By the end of the third year of the CSOC contract, there will be five on-orbit missions that have transitioned into the GSFC IMOC. These are the Advanced Composition Explorer (ACE), the Compton Gamma Ray Observatory (CGRO), the Landsat - 7 mission, the Tropical Rainfall Measuring Mission (TRMM), and the Upper Atmosphere Research Satellite (UARS). For the first three years of the CSOC contract, the existing Hubble Space Telescope (HST), the Earth Observing System (EOS), the Small Explorer (SMEX) based missions, International Solar Terrestrial Physics (ISTPs) missions, the Rossi X-ray Timing Explorer (RXTE), and the Medium Class Explorer (MIDEX) missions will be the only organizations operating outside of the GSFC IMOC. All new non-EOS-based mission service elements beginning after the third year of the CSOC contract are to be integrated into and supported by the GSFC IMOC.

Summary Schedule for Planned Investments

The table below gives the major milestones for the overall GSFC IMOC project.

Functions	FY 99	FY 00	FY 01	FY 02
DEVELOPMENT				
SDR	3/99			
Project Implementation Plan	6/99			
SSFDR	7/99			
SOCB Make Authorization		10/99		
SSDRs		11/99		
Development & Reengineering			3/00	
Installation & Acceptance Test			12/00	
Parallel Operations Testing			2/01	
OPERATIONS				
OPS Training/Certification			05/01	
OPS Readiness (ORR)			06/01	
SUST ENG TRANSITION				12/01

GSFC IMOC Schedule Table

Performance Indicators The implementation of a system that consolidates and integrates mission services into an IMOC architecture must address both a physical system and a mode of staffing and operation for both legacy elements and new missions. Legacy mission service elements fall into two categories. The first category contains those legacy elements that can realize cost savings if they transition into the IMOC fundamental architecture and into automated mode of operation which is also designed for the future mission service elements. The second category contains those elements for which the investment required to convert to the IMOC physical system, staffing, and mode of operation outweighs the return in cost savings. However, if these category two service elements have their mission lifetime extended and/or future implementation costs for transitioning become less expensive, these elements may fall into category one at a later date. New on-orbit missions are easily integrated into the GSFC IMOC as they start right in the planning stages. New on orbit missions have lower implementation costs as they do not have to develop their own systems and infrastructures. The same is true for their operations and maintenance costs as they share these costs with existing on orbit missions for common resources for mission services.

The performance indicator for the successful implementation of the GIMOC is the reduction of the associated headcount. (Note that a significant portion of the GIMOC savings is due to the avoidance of new costs for new missions as they are added.) The quarterly reports can be examined to verify that the proposed reductions are indeed occurring. Also, the Services Catalog will show a reduced cost for the associated services.

How Planned Investment Meets Decision Criteria
Mission Support The GSFC IMOC applications are designed to provide mission services for multiple missions by making maximum use of COTS components combined with legacy custom software for which there is no satisfactory COTS equivalent.

Work Process Redesign Custom legacy software applications are reengineered with Common Object Request Broker Architecture (CORBA) software wrappers so that they interface readily with other applications, both COTS and custom-built. This is the only reengineering done on legacy custom software so the integrity of that custom legacy software is preserved.

Architecture The physical design of the GSFC IMOC is modular, open system, client-server and Local Area Network (LAN) based, and built as much as possible from COTS components. The servers and multiple client strings reside on interconnected LANs with automated network management in the private domain behind a firewall. The servers include database servers, command load servers, telemetry servers, applications servers, configuration servers, and network management servers. Client workstations include both UNIX based workstations and NT based platforms. Users gain access through configured client workstations and platforms to applications residing on the applications servers locally, and remotely via a secure Internet connection through the firewall.

Phased Development: The GSFC IMOC is to be implemented in three phases during the FY99 through FY02 time period.

A.3.1.2.7 Data Services Management Center

This narrative describes changes to the current architecture leading to a centralized DSMC at the White Sands Complex (WSC) consistent with the proposed Consolidated Space Operations Contract Integrated Operations Architecture (CSOC IOA). The Data Services Management Center (DSMC) will accommodate network management functionality that is performed today at the Network Control Center (NCC), WSC Tracking and Data Relay Satellite (TDRS) Operations Control Center (TOCC) 1 and 2, Wallops Scheduling Office (WSO), and the Network Operations Control Center (NOCC). TDRS orbit determination and orbit prediction functions currently performed at the Flight Dynamics Facility (FDF) will be consolidated at the TOCC. In addition, new remote monitor and control capabilities being implemented through other contracts will migrate to the DSMC and be augmented by CSOC to provide a common monitor and control capability. The final consolidation initiative migrates the Deep Space Operations Center (DSOC) to the DSMC completing the centralized network management capability. The DSMC will support all programs.

Implementation of the DSMC encompasses the following major initiatives:
- Ground Network Scheduling Consolidation
- SN/DSN Scheduling Consolidation
- Network Service Accounting Consolidation

- GN/SN Network Monitor Consolidation
- TOCC Consolidation
- BRTS POCC Relocation
- TDRSS Orbit Determination (OD)/Orbit Prediction (OP) Function
- Remote Health and Status Monitoring of Antenna Sites
- DSOC Consolidation at DSMC

Ground Network Scheduling Consolidation

The existing Wallops Orbital Tracking Range Schedule (WOTRS) schedule message output will be adopted as the Ground Network (GN) standard format applicable to Merritt Island/Ponce de Leon (MIL/PDL), Bermuda (BDA) ultra high frequency (UHF) shuttle air-to-ground (A/G) voice system, 11/26-m sub-network and external ground network entities scheduled by other organizations. The schedule cycle will also be standardized to conform to a Monday through Sunday active schedule period.

No new hardware is needed to fulfill the objectives of this initiative however; WOTRS or 26-m software modifications will be needed to achieve schedule format compatibility. After MIL/PDL/BDA scheduling responsibility has transferred to WSO, WOTRS will be relocated to the DSMC allowing WSO closure. Once WOTRS operation at the DSMC is stable, 11/26-m sub-network scheduling responsibility will be absorbed reducing the workload on the NOCC/Network Support Subsystem (NSS).

SN/DSN Scheduling Consolidation

This initiative completes the centralized network scheduling capability at the DSMC with the objective of eliminating the remaining overlapping functions, systems and facilities. Collocation allows for personnel sharing needed to schedule all NASA tracking systems within the CSOC scope. The Service Planning Segment Replacement (SPSR) systems will be physically relocated to the DSMC concurrently with implementation of the rescoped Communications and Control Segment Replacement (CCSR) at WSC.

A Web-based user interface will be implemented allowing global access to schedules and permitting schedule request inputs via a simple, menu-based selection. The Web interface provides a common interface layer giving the appearance of a single scheduling system to the users. Space Network (SN) users who have a User Planning System (UPS) or equivalent, will continue to submit SN schedule requests in accordance with current practices.

Network Service Accounting Consolidation

Concurrently with Service Planning Segment Replacement (SPSR) relocation and Communications and Control Segment Replacement (CCSR) implementation at the DSMC, the CSOC developed Service Accounting System Replacement (SASR) will be implemented at the DSMC. SASR operates autonomously by ingesting network schedules and status data to generate network utilization data reports for Space Operations Management Office (SOMO) and CSOC. There will be the capability to manually enter data but our approach is to implement a highly automated system that generates the monthly utilization report in accordance with DRD 2.4.2.7 without manual intervention.

SASR is not critical for real time operations mission success and as such, does not have to be operable on a continuous basis. It must, however, provide the capability to capture all real time network status messages from appropriately equipped network tracking systems and schedule change messages. When operational, the NCC Service Accounting System (SAS) will be decommissioned and service accounting functionality of WOTRS and NSS will no longer be sustained.

GN/SN Network Monitor Consolidation

GN (includes 11/26-m subnets) and SN network monitor consolidation will be centralized at the Data Services Management Center and will be complete with delivery and implementation of the Communications and Control Segment Replacement (CCSR) system at the DSMC. GN monitoring at the DSMC will precede SN monitor and control which is dependent upon delivery of the CCSR. At completion of CCSR implementation at WSC, the NCC at GSFC can complete phase down and decommissioning. Development activity to provide monitor and control capability at the DSMC include:

- TOCC Communications Segment Controller (CSC) position assumes functions performed by the NCC Performance Analyst position.
- NCC Technical Manager and Mission Operations Support Area (MOSA) functions relocate to DSMC requiring relocation of workstations and standalone PC systems.
- Procure and implement a COTS Network Management software package to automate monitoring functions for remote station operations

TOCC Consolidation

Rationale for this initiative is that savings can be achieved by automating ground systems to facilitate operations of both TOCCs from a single facility thereby eliminating duplication of operations and maintenance personnel. The Consolidated TOCC (CTOCC) location at STGT was selected since room for expansion is available, both S and K-band equipment is housed in the STGT, and the equipment is of newer vintage. Also, existing STGT functionality is greater than WSGT thereby requiring fewer modifications to achieve consolidation. Key modifications needed to achieve this initiative appear below:

- Controller Console/Housings - Accommodates additional workstations (W/S) for operations personnel and increase ergonomics.
- System Application Software - Allows W/S's to be logged onto multiple protocols without W/S reconfiguration.
- Spectrum Analyzer (SA) Control and Monitor System - Enables remote control of SAs over a LAN and between sites.
- Real-Time Command and Telemetry System (RCTS) - Enables remote control of TT&C command and telemetry I/Fs.
- Slave Video System - Increases switch capacity to accommodate additional W/Ss.

- Antenna Monitoring System - Allows viewing of antennas located at both ground terminals from a single TOCC.

BRTS POCC Relocation

The BRTS POCC relocation initiative has been selected for early implementation because of the low cost and lack of dependencies on other capabilities being in place. Overlaps in operations tasks with telemetry monitoring and evaluation functions performed by the BRTS POCC can be absorbed with no increase to the WSC/TOCC operations staff. There are minor costs to transfer equipment but the result is elimination of the BRTS POCC at GSFC and associated staffing.
Modifications needed to accomplish this objective are:

- Install leased workstations in the TOCC
- Connect workstations to the Data Interface System (DIS) Local Area Network (LAN)
- Relocate/install BRTS POCC workstations

TDRSS Orbit Determination (OD)/Orbit Prediction (OP) Function

A commercial-off-the-shelf (COTS) product, Real Time Orbit Determination System (RTODS) will be implemented to replace custom developed software currently used at the FDF. This is a COTS-based technology infusion initiative that can be implemented independent of other initiatives and has been identified for early implementation.

Remote Health and Status Monitoring of Antenna Sites

Remote monitoring of the ground tracking antenna sites is an effort to centralize operations at the DSMC. This objective is accomplished by enhancing the local monitoring capability for health and status at the following sites: MILA/PDL, automated Wallops Orbital Tracking Station (AWOTS), McMurdo Ground Station (MGS), Fairbanks Area Orbital Tracking Station (FAOTS), Svalbard Ground Station (SGS), Alaska Synthetic Aperture Radar (SAR) Facility (ASF), Goldstone 26M, and Signal Processing Center (SPC)-10.

In the Near Term, collection of local health and status information at these sites will be provided as currently generated using existing techniques for transfer to a COTS central monitoring manager at the DSMC. A local server platform and a COTS software management agent will be placed at each site for information collection and communication to the central manager at the DSMC. Where applicable, network management standards (i.e. Simple Network Management Protocol) with standard Management Information Base definitions will be utilized for the information.

DSOC Consolidation at DSMC

A series of CSOC/DSN enhancements and consolidation initiatives will lead to a centralized Data Services Operations Center (DSOC) at JPL. Once operations have stabilized and a window of opportunity is identified, CSOC will initiate the final network management consolidation initiative to migrate and integrate DSOC functions at the

DSMC. When complete all NASA T&DA resources within the CSOC scope will be managed and controlled from the DSMC.

Common processes and operating procedures combined with reduced facilities, systems, and personnel requirements will result in operations efficiency improvements, substantially lower operating costs, and improved utilization of resources directly under CSOC management control.

Summary Schedule for Planned Investments
The DSMC network management consolidation initiative project schedule appears below.

Milestone	FY 99	FY 00	FY 01	FY 02	FY 03
SDR	3/99				
SSFDR	8/99				
SOCB Make Authorization		10/99			
SSDR			11/99		
Development Testing Complete					5/03
OPS Testing Complete					8/03
ORR Complete					9/03

Performance Indicators The benefits of this consolidation lead to application of standard operating procedures and practices, simplified and streamlined processes, sharing of personnel and resources, and elimination of labor intensive hardware and software systems.

The functions to be consolidated are network scheduling, real time monitor and control, and network utilization data collection and reporting. Currently, these functions are all performed at geographically dispersed locations using different systems. By establishing a centralized management facility, the number of facilities and systems will be reduced, personnel that perform similar functions will be shared, and the processes and procedures will be standardized.

The performance indicator for the successful implementation of the DSMC is the reduction of the associated headcount. The quarterly reports can be examined to verify that the proposed reductions are indeed occurring. Also, the Services Catalog will show a reduced cost for the associated services.

How Planned Investment Meets Decision Criteria
Mission Support: The DSMC Major IT Investment supports core mission functions that are included in the Tracking and Data Acquisition system. These assets comprise the

Ground Network Scheduling System, the WSO Wallops Orbital Tracking Range Scheduler, and the NOCC Network Support Subsystem.

Work Process Redesign Via competitive procurement, Lockheed Martin Corporation was chosen as the Consolidated Space Operations Contractor with the goal of sustaining certain NASA assets as reduced costs. Reduction in operating costs is accomplished both by increased operating efficiencies and by consolidation of like activities.

Consolidating and centralizing the scheduling function at the DSMC provides an opportunity to simplify and standardize mission user interfaces, standardize schedule message formats, standardize the scheduling cycle, decommission older systems, streamline the scheduling process, and reduce operations costs.

Phased Development Major project implementation of the DSMC is planned during the FY99 through FY01 time period. Continued modifications will take place through FY04.

A.3.1.3 Aero-Space Technology Mission Area IT Investments

A.3.1.3.1 Western Aeronautical Test Range (WATR)

The WATR plans to provide sustaining engineering, operations, maintenance, and periodic replacement of data processing, display, and archival equipment used during the conduct of flight research activity at DFRC. Also, communications and video systems are maintained in support of those same research missions. This activity is on going and will span the entire budget cycle.

The WATR supports the Office of Aero-Space Technology / OAST(Code R), Human Exploration and Development of Space Enterprise/HEDS (Code M) and Earth Science (Code Y).

Included in this investment area are hardware and software used to acquire, collect, process, and display real-time flight data, communications equipment used to conduct real-time missions, and video equipment used to analyze real-time events that occur during the conduct of flight research activity. Also included is the contractor staff required to operate and maintain the equipment. Existing contracts will be used to provide the contractor staff as well as the purchasing of most of equipment. Blanket Purchase Agreements (BPAs) and other procurement mechanisms are also used when appropriate

Mission Support - The WATR provides connectivity between researchers and flight research aircraft. The system delivers research data to enable researchers to monitor and interact with the research aircraft and crew during flight. The system provides support sending commands to the aircraft, reduction and display of flight system and research instrumentation parameters. The system supports voice/video links between aircraft crew and flight controllers.

Summary Schedule for Planned Investments
As mentioned previously, this is an ongoing effort required to support a multitude of flight research and access to space programs as well as programs such as the space shuttle. As such, investments are staged so that one or more functional area (video, communications, data display, data processing, data archival) is receiving a hardware or software upgrade of some type in any given year. The contract staff for all areas is not expected to fluctuate during the entire budget cycle.

Performance Indicators WATR measures its performance based on customer satisfaction and our ability to meet certain planned metrics. These metrics include time to get data to users, readiness of WATR systems, real-time data to users, onboard data to users and total hours of support to users (cumulative).

How Planned Investment Meets Decision Criteria
Continued funding of these investments is necessary to support core competencies at DFRC and support priority mission functions that need to be performed by the Federal Government. In addition, no other private sector or other government source can efficiently support the function. These investments utilize, to the extent possible, off-the-shelf technology. The existing system continues to satisfy customer requirements in a manner that reduces overall cost and improves the efficiency of conducting flight research. The systems used in the WATR continue to be compatible with other like systems used in the agency.

Alternative Sources - There are Alternative Sources available for some aspects of the functions required to meet the programs at DFRC. These sources reside within the Air Force Flight Test Center (AFFTC) at Edwards, CA and are not duplicated at DFRC. Likewise, some of the requirements of the AFFTC are met by the NASA facilities at DFRC. It should be noted that the AFFTC and the DFRC have very different missions. The AFFTC is primarily concerned with assuring that DoD aircraft meet specifications and that these specifications are reasonable. DFRC conducts flight research. These goals are quite different and require different instrumentation and procedures. Therefore it should not be expected that there would be much overlap in the facilities of the two organizations. DFRC and the Air Force participate in an Alliance Program to jointly maximize the utility of their resources so that redundancy of expense to the Government is avoided. There are no private sector resources available to meet the requirements that have been satisfied to date by the WATR. In fact, the WATR is utilized, on a reimbursable basis, by the private sector to meet some non-government flight research requirements.

Customer Requirement - It is a goal of the WATR to continuously improve the manner and costs associated with providing customer service. Therefore, we are involved in a multi-year effort in data processing and data reduction areas to develop better and faster delivery of post-flight products to the researchers so that quicker turn around is possible for the flight research programs; allowing the accomplishment of research objectives in a shorter time at less cost. One outcome of past activities in the WATR IT program has improved customer service through the elimination of large and mid-range computers; the work of the WATR is now done with micro-computers using a distributed architecture.

Return on Investment - We continually monitor the return on investment of the WATR, as the WATR represents a significant fraction of the cost of every research flight conducted at DFRC. It is our goal to get these costs lower. Wherever we have the opportunity to utilize public or commercial resources we do so. This use leverages our return on investment. For example, we utilize COTS products to the maximum extent possible, and we take advantage of the highly competitive nature of the telecommunications market today to lower our costs of operations.

Architectures - To the maximum extent possible, we will utilize commercially available hardware and software to meet our data processing, delivery, and display requirements while using NASA-wide architectures such as those provided by NASA Integrated Services Network (NISN) to deliver data to off-site customers. As part of the Space Operations Management Office (SOMO) at Johnson Space Center (JSC), DFRC's systems are designed to be compatible with those at other NASA centers that provide similar service and will be compatible with the new SOMO Integrated Operations Architecture.

A.3.1.3.2 High Performance Computing and Communication (HPCC)

HPCC is a computer research program that pursues technologies that are between five and twenty years from maturity. A cross-cutting multi-enterprise initiative, the HPCC Program receives funds from the Aero-Space Technology (AST), Space Science (SS) and Earth Science (ES) enterprises, and NASA's Education program.
The Program is managed by the Ames Research Center, with supporting work at nine field centers and the Jet Propulsion Laboratory, organized into five Projects:

- Computational Aerosciences (CAS)
- Earth and Space Sciences (ESS)
- Remote Exploration and Experimentation (REE)
- Learning Technologies (LT)
- NASA Research and Education Network (NREN)

Through HPCC, NASA collaborates with other Federal agencies in Computing, Information and Communications (CIC), an outgrowth of the 1992 Federal HPCC Program research. Furthermore, NASA participates in the multi-agency Next Generation Internet (NGI) initiative through its NREN Project.

In addition to overall HPCC program management, Ames is the lead Center for CAS, LT, and NREN.

Relationship to Program Mission. The goal of HPCC is to accelerate the development, application and transfer of high-performance computing and computer communications technologies to meet the engineering and science needs of the U.S. aeronautics, earth and space science, spaceborne research, and education communities.

NASA's primary contribution to the Federal program is its leadership in the development of applications software and algorithms for massively parallel computing systems which will increase system performance to the sustained TeraFLOPS (10^{12} floating point operations per second) level for NASA applications. NASA's Grand Challenges include improving the design and simulation of advanced aerospace vehicles, enabling people at remote locations to communicate more effectively and share information, increasing scientists' abilities to model the Earth's climate and forecast global environmental trends, and improving the capabilities of advanced spacecraft to explore the Earth and solar system. An additional component of the HPCC program further broadens the reach of the HPCC program by supporting research and development of technology in education. This thrust supports the development of the National Information Infrastructure and provides quality tools and curriculum to our nation's children through projects such as K-12 and Globe. Underlying and supporting all NASA program components is an element of basic research, development, and application of high performance computer communications networking technology, which contributes, also, to providing new capabilities for the Next Generation Internet (NGI).

Top-level Description of IT Resources. The science and engineering requirements inherent in the NASA Grand Challenge applications require at least three to four orders of magnitude improvement in high-performance computing and networking capabilities over the capabilities that existed at the beginning of the program in FY1992. Without an accelerated development program, this level of improvement may not be available for 15 to 20 years. The NASA HPCC Program will develop and demonstrate high-performance architectures, algorithms, software tools, and operating systems using prototypes and developmental testbed systems. These testbed systems will be scaleable to TeraFLOPS computational and Terabits per second communication performance levels.

Description of Acquisition Strategy. Free and open competitive procurements will be used to the maximum extent possible. Among the procurement vehicles that are expected to be put to use in the NASA HPCC Program are NASA Research Announcements (NRA), NASA Cooperative Agreement Notices (CAN), and Request for Proposals (RFP). These vehicles will result in grants, cooperative agreements and contracts. Cooperative Agreement Notices (CAN) will be used to the maximum extent possible for the incorporation of technology and applications into the Program. The SEWP contract will be used to for major equipment purchases in instances where cooperative agreements are not appropriate. Interagency agreements for joint R&D endeavors and the utilization of early prototype systems will also be used.

Summary Schedule for Planned Investments (Ames-LaRC-GRC Milestones).

FY 1999	Due Date	Actual Metric	Success Criteria
Establish next generation internetwork exchange for NASA to connect Grand Challenge universities' principal investigators to NASA high performance resources	10/1998 Complete	Application performance	Demonstrate 100 times increased capability to access NASA high performance resources by Grand Challenge community
Demonstrate 200-fold improvements over FY1992 baseline in time-to-solution for Grand Challenge applications on TeraFLOPS testbeds	6/1999	Scalability / speedup,	1n or better / 50% of ideal for one application each project (CAS, ESS),
		portability,	all current testbeds for one application each project,
		performance	200x baseline for one application each project
Demonstrate portable scaleable distributed visualization of multi-terabyte 4D data sets on TeraFLOPS scaleable systems	9/1999	Portability, scalability	All current testbeds, 1n or better
FY 2000	Due Date	Actual Metric	Success Criteria
Demonstrate 500 times end-to-end performance improvement of Grand Challenge and/or NASA mission applications based on	3/2000	# application demonstrations,	3+ demos,
		application	500 times more end-to-end performance improvement

FY1996 performance measurements across NREN testbeds over 622 Mbps wide area network		performance	over FY1996 baseline
FY 2001	Due Date	Actual Metric	Success Criteria
Demonstrate 1000-fold improvements over FY1992 baseline in time-to-solution for Grand Challenge applications on TeraFLOPS testbeds	9/2001	Scalability / speedup, portability, performance	1n or better / 50% of ideal for one application each project, all current testbeds for one application each project, 1000x baseline for one application each project
Demonstrate portable scalable debugging and test environment for Grand Challenge applications on a full TeraFLOPS system	9/2001	Portability, scalability	All current testbeds, 1n or better
FY 2002			
Demonstrate high performance network applications across interagency high performance testbed using NREN	9/2002	# application demonstrations, application performance	10+ demos, 100-500 times more end-to-end performance improvement

Performance Indicators used to measure outcomes, output, service levels, and customer satisfaction. Performance indicators include the portability, scalability and performance of parallel application and system software codes, the reduction of application wall-clock turnaround times, end-to-end throughput efficiencies achieved, and independent evaluations of research value.

How Planned Investment Meets Decision Criteria. This HPCC investment is made to perform advanced research in IT areas and is not made as an infrastructure investment with a ROI decision being required.

A.3.1.3.3 IT R&T Base

The Information Technology R&T Base program (IT Program) is an R&T Base program sponsored by the NASA Office of Aero-Space Technology. Its mission is to develop and transfer information technology solutions that support NASA's missions. The goal of the IT Program is to:

> Perform leading edge research in advanced computing systems and user environments, revolutionary software technologies and pathfinding applications that enable the achievement of NASA's missions in Aero-Space Technology.

The IT Program is made up of three distinct program elements: Integrated Design Technology; Software Technology; and Advanced Computing, Networking, and Storage (ACNS). By far, the largest effort is the ACNS, which conducts research to provide cost-effective high-end compute cycles in a balanced infrastructure of high speed processors, hierarchical storage, network communications and visualization platforms. The IT Program also provides tools and procedures to assist in the solution of aerospace problems. These tools and procedures including algorithms, scientific libraries, parallel programming methods, specialized programs to prepare data for computation, and visualization capability to analyze computational results.

Relationship to Program Mission. The IT Program provides a unique, world class supercomputing capability for the nation's top aerospace researchers to perform high speed computations and simulations for a broad range of aerospace research applications. The IT Program also performs an on-going research and advanced technology development activity to ensure the innovative application of newly emerging technologies to computational fluid dynamics and other important computational aeroscience disciplines. The IT Program currently supports about 1,500 users from industry, NASA, DoD, other government laboratories and academia. The IT Program supports the Aero-Space Technology Enterprise primarily; but also supports the Space Science, Human Exploration and Development of Space, and Earth Science Enterprises.
In addition to this IT Program, NASA is currently pursuing other programs in information technology, including the High Performance Computing and Communications Program (HPCCP), the Consolidated Supercomputing Management Office (CoSMO), and projects within other Office of Aero-Space Technology programs. In contrast to these other programs, the IT Program represents NASA's principal investment in longer-term, high-payoff aeronautics IT research.

Top-level Description of IT Resources. The ACNS element responds to the requirements of the Information Technology Program and the Aero-Space Technology Enterprise by investing in simulation-based approaches to aircraft design, manufacture, and operation. The overarching goal of this element is to create an information systems infrastructure that dynamically constructs a supercomputing environment with far greater performance at far lower cost than is available today. The goal is driven by the need to achieve a new plateau in the use of computers for aerospace design.

The computational requirements needed to realize these simulation capabilities are orders of magnitude more than that which is available and affordable today. However, this challenge will drive the ACNS element to pursue radical approaches that promise revolutionary advances, rather than incremental improvements of today's capabilities. The objectives of the ACNS element were carefully selected to provide the basis for the US aerospace community to continue leadership of the world-wide aircraft market. These objectives are:

- Act as a pathfinder in advanced, large-scale, affordable computational capability through systematic incorporation of state-of-the-art improvements in computer hardware and software technologies.

- Partner with key applications projects in aerospace design, production, and operation to evaluate and improve system performance, while at the same time providing research results for the applications community.
- Pioneer radical new approaches to achieving higher-performance systems.

The ACNS system is a distributed computing system in which all processors are peers. All systems execute some variety of the UNIX operating system and are interconnected over a hierarchy of network technologies. TCP/IP is the protocol of choice and is used everywhere except where a higher performance localized alternative is available.

The current operating configuration consists of a Cray C-90 (jointly with CoSMO), two 128-node Silicon Graphics ORIGIN 2000 machines, a 64-node ORIGIN 2000 machine (jointly with GSFC DAO), a Silicon Graphics Power Challenge-class workstation cluster, and a Convex 3820-based mass storage system. Long-haul communications are performed over the Aeronet, a nationwide data communications network with connections to many government, industrial, and academic sites.

Other systems currently installed and jointly supported by the IT Base Program, HPCCP and CoSMO include an IBM SP-2, a second Cray C-90, a Silicon Graphics Power Challenge cluster, and a Cray J-90 cluster. The alignment of many of the goals in computing and networking between these programs will continue to be exploited in the future as joint investments and research projects are undertaken in these two areas.

Description of Acquisition Strategy. The approach for continued advancement of this system is to provide prototype upgrades to system components (processors, data storage, networks, and system software) to maintain leading-edge capabilities for the most challenging research problems in aeronautics and space transportation technology. The system is balanced such that each resource possesses sufficient capacity to manage the desired throughput of the total system.

Free and open competitive procurements will be used to the maximum extent possible. Among the procurement vehicles that are expected to be put to use by the ACNS element are NASA Research Announcements (NRA), NASA Cooperative Agreement Notices (CAN), and Request for Proposals (RFP). These vehicles will result in grants, cooperative agreements and contracts. Cooperative Agreement Notices (CAN) will be used to the maximum extent possible for the incorporation of technology and applications into the Program. The SEWP contract will be used to for major equipment purchases in instances where cooperative agreements are not appropriate. Interagency agreements for joint R&D endeavors and the utilization of early prototype systems will also be used.

Summary Schedule for Planned Investments (ACNS only).

MILESTONES	DESCRIPTION	PERFORMANCE METRIC	FY DATE

Demonstrate prototype heterogeneous distributed computing environment.	Provide tools and software to link multiple geographically distributed computing testbeds into a single computing environment.	OUTPUT: System tools and software provided, testbeds (2 or more classes of machines) at 3 NASA Centers linked, application demonstration completed. OUTCOME: Reduction in end-to-end turnaround time for aerospace simulation problem; peak performance, price performance.	4Q2000
Develop software tools for design of advanced computing systems.	Software tools developed to simulate, benchmark, and optimize the performance of advanced computing architectures from chip-level design to integrated production system.	OUTPUT: Delivery of standards and software modules to accurately predict system performance based on specific computational applications; Provide tools to optimize system performance. OUTCOME: Improved dynamic computing system design, evaluation capability for innovative supercomputing concepts.	4Q2001
Prototype computational infrastructure for aerospace design and operations completed.	System of processors, storage devices, networks, data analysis tools, and system administration technology sized to support pacing problems in aerospace vehicle design and operations.	OUTPUT: Demonstrate processing speed and system throughput required for aerospace design environment; network bandwidth; storage capacity; vendor independence; and data analysis capability. OUTCOME: Reduction in end-to-end turnaround time for aerospace design and operations problems; reduced cost for aerospace design problem; enhanced safety of national airspace system.	4Q2003

Performance Indicators used to measure outcomes, output, service levels, and customer satisfaction. See the table above. Performance indicators also include computer performance measures such as operational hours per month, maximum and average speed of computations, memory and storage capacity, data transfer speed, etc.

How Planned Investment Meets Decision Criteria. This IT R&T Base investment is made to perform advanced research in IT areas and is not made as an infrastructure investment with a ROI decision being required.

A.3.1.3.4 Intelligent Synthesis Environment (ISE)

NASA will advance the ISE, which includes rapid synthesis and simulation on tera-scale systems and distributed collaborative engineering capability. The goal is to demonstrate design and synthesis of vehicles and missions with greatly reduced redesign and rework and improved operational reliability. The first Intelligent Synthesis Environment test bed will apply these benefits to the design of future reusable launch vehicles that promise to greatly reduce the cost of space transportation.

NASA applications, which require tera-scale capability, include understanding seasonal-to-interannual climate change and demonstration of intelligent synthesis environment.

The ISE R&D laboratories and the ISE large-scale applications are critical areas of the ISE Initiative. The ISE Initiative is a Functional Initiative that addresses the Crosscutting Processes Functional Element of NASA's Strategic Plan framework. Specifically, its objectives support several broader objectives of the Provide Aerospace Products and Capabilities (PAPAC) crosscutting process, including cost and delivery time reduction, innovative approaches to missions, integrated technology planning, and improvement of NASA's engineering capability. Customers for ISE-developed capabilities include all NASA enterprises, aerospace and other industries, commercial tool vendors, and other government agencies. In order to achieve the benefits stated above, the ISE Initiative emphasizes the research, development, and transition to the use of revolutionary methods, tools, and processes that apply across NASA's and the nation's engineering and science infrastructure. The ISE Initiative is an agency-wide activity that will develop a future design environment for engineering and science mission synthesis for use by all of the NASA scientists and engineers.

The ISE Initiative is currently in the Formulation Phase as defined in NPG 7120.5a. The specific IT requirements are currently being developed in the detailed ISE plans. These plans are currently in a state of flux due to budget uncertainties. The current high level plans indicate that the IT resources that are planned to be acquired include resources that will support two major areas: 1) research and development activities focused on immersive environments and 2) ISE large-scale applications. A major component of the ISE large-scale application implementation activities is the development of an agency-wide Collaborative Engineering Environment Infrastructure. This infrastructure will provide common collaborative capabilities across the agency and provide a Virtual Private Network (VPN) that will be used by all of the applications. The VPN will provide the applications the communications bandwidth and the security required to perform collaborative, integrated design and analysis activities.

Summary schedule for the planned investments
The initial operational date of the ISE LaRC R&D laboratory and the ISE large-scale applications and associated collaborative engineering environment will be in FY2000 with subsequent upgrades occurring as required. The ISE Virtual Private Network will be deployed across the agency and be operational in FY2001. More detailed schedules for the planned IT investments will be developed using the resource requirements identified during the formulation phase of the initiative.

Performance indicators: The Intelligent Synthesis Environments (ISE) Initiative is intended to research, develop, and implement the tools and processes for a revolution in engineering practice and science integration in the design, development, and execution of NASA's and the nation's missions. When fully deployed, it will function as an advanced, networked collaboration of all of the geographically dispersed entities involved in defining, designing, executing, and operating NASA's missions. The long-term vision is that this collaboration will be in an immersive virtual environment in which humans and analytical models can interact visually in a computationally rich mission life-cycle simulation. A diverse set of life-cycle engineering tools that can be seamlessly integrated to provide unprecedented computational speed and fidelity will be researched, developed and validated focusing on enterprise applications. Involving computer intelligence integrally with engineering and science team decision processes is a fundamental goal.

The performance indicators of the ISE initiative are as follows:

- Reduce design and mission development time to 12 to 18 months
- Reduce design cycle testing by 75 percent
- Reduce costs related to redesign and rework by 75 percent
- Develop capability to predict mission life-cycle cost to within 10 percent
- Develop capability to predict quantified mission life-cycle risks to within a 95 percent confidence interval
- Increase science return per mission dollar by an order of magnitude
- Reduce mission risks by 2 orders of magnitude
- Reduce mission costs by an order of magnitude
- Develop design processes for trading and designing to mission life-cycle cost, risk, and performance
- Demonstrate in practice, reduction of mission development time to 18 months
- Reduce technology insertion time, risk and costs by an order of magnitude
- Reduce by 80 percent the required workforce to support mission operations
- Eliminate operational errors
- Enhance and augment practical experience of new engineering graduates by 50 percent
- Eliminate technical obsolescence of workforce through education and training
- Remove cultural management barriers

How Planned Investment Meets Decision Criteria

The ISE IT investments meet the decision criteria by providing the agency the required architecture that enable interoperability, security, information exchange and resource sharing while retaining the flexibility that allows NASA to take advantage of the rapid improvements in the state-of-the-art IT technologies.

The ISE IT investments also meet the decision criteria of risk reduction as the Program officials who will use the resources have substantial involvement in the planning and implementation of the ISE initiative. In fact, the officials are leading the development of the large-scale applications to ensure the program officials buy-in to the ISE initiative.

A.3.1.4 Human Exploration and Development of Space Mission Area IT Investments

A.3.1.4.1 Shuttle Avionics and Integration Laboratory (SAIL)

The SAIL supports the Human Exploration and Development of Space Enterprise. It provides real-time mission support capability and operational flight task evaluation (e.g., payload operations) and troubleshooting capability. The SAIL has the responsibility for avionics system integration and hardware/software verification in simulated mission environments. The SAIL provides a central facility where the shuttle avionics and related hardware (or simulations of hardware), flight software, carriers/payloads, flight procedures, and associated primary ground support hardware and software can be fully integrated for testing. The SAIL equipment consists of Data General and Encore minicomputers, and Intergraph, SUN, and Motorola workstations.

Summary schedule for the planned investments
There are no planned modification/upgrades to this system.

Performance indicators include a successfully integrated and tested avionics system. The Flight Operations Process Integrity Plans include facility metrics of availability, overall facility critical discrepancies, critical requirements tracking and reliability for critical facilities.

How Planned Investment Meets Decision Criteria
Mission Support Criteria: Satisfied. The SAIL investment supports core/priority mission functions by providing avionics system integration and hardware/software verification support for the Space Shuttle Program. FY96 agency restructuring of the Space Shuttle Program continued to identify the SAIL as an investment required to be performed by the Federal Government.

Alternative Sources Criteria: Satisfied. Considerations for alternative sources has resulted in the implementation of the Space Flight Operations Contract (SFOC) as identified in NASA contract NAS9-20000. The SFOC, as an alternative source, transitions operations accountability, including the SAIL, from the government to the contractor.

Customer Requirements Criteria: Satisfied. Contract requirements induced by incentives within the SFOC ensure that the SAIL investment satisfies customer requirements. Successful completion of requirements is regularly monitored through contract reports and deliverables.

Return on Investment Criteria: Satisfied. In 1992, following the agency's return-to-flight phase, NASA embarked on a series of cost reduction activities that significantly decreased the cost of space flight operations. As a result of the streamlining initiatives, the SFOC was implemented to fly safely, maintain mission success and schedule, and improve mission supportability in a cost-constrained environment. SFOC is designed to create efficiencies of return through the restructuring of NASA management from oversight to insight roles, while absorbing operational roles, including those of the SAIL, traditionally performed by the government.

Architecture Criteria: Satisfied. The SFOC has been specifically structured to exploit cost and performance efficiencies, which include architectural considerations for modernization, obsolescence, interoperability and conformance to NASA policies and goals. The SAIL is continuously under assessment so that its architecture conforms to NASA strategic goals and policies. Compliance to relevant Executive Notices and CIO standards are well documented in IT Plans and contract deliverable documents. The SAIL has been included in the SSP Year 2000 compliance plan.

A.3.1.4.2 Shuttle Mission Training Facility (SMTP)

The SMTF supports Space Shuttle Program goals and objectives for the Human Exploration and Development of Space Enterprise. The emphasis of this facility is flight safety and training. The SMTF exists to provide high-fidelity shuttle and network simulation in support of the man-in-the-loop mission training for flight crews and flight controllers. This facility utilizes high-fidelity flight vehicle crew station replicas, computer complexes and visual simulation devices to accomplish its mission. The Flight Operations Trainers exist to provide various types of part-task, single-system, medium-to-high fidelity training to flight crew and flight controllers. The SMTF is comprised of three full task trainers: Motion Base, Fixed Base, and the Guidance and Navigation System. The SMTF also includes the Flight Operations Trainers. SMTF equipment consists of Encore, SGI, Unisys host computers, Concurrent and DEC computers: and Evans & Sutherland visual systems, including Hughes-JVC visual projectors.

Summary schedule for the planned investments
There are no planned modification/upgrades to this system.

Performance indicators include successful flight operations as measured by a well-trained crew and flight control operations. The Flight Operations Process Integrity Plans include facility metrics of availability, overall facility critical discrepancies, critical requirements tracking and reliability for critical facilities.

How Planned Investment Meets Decision Criteria
Mission Support Criteria: Satisfied. The SMTF investment supports core/priority mission functions by providing primary and mandatory operations, maintenance, and sustaining engineering for flight crew and mission controller training and test requirements supporting the Space Shuttle Program. FY96 agency restructuring of the Space Shuttle Program continued to identify the SMTF as an investment required to be performed by the Federal Government.

Alternative Sources Criteria: Satisfied. Considerations for alternative sources has resulted in the implementation of the Space Flight Operations Contract (SFOC) as identified in NASA contract NAS9-20000. The SFOC, as an alternative source, transitions operations accountability, including the SMTF, from the government to the contractor.

Customer Requirements Criteria: Satisfied. Contract requirements induced by incentives within the SFOC ensure that the SMTF investment satisfies customer requirements. Successful completion of requirements is regularly monitored through contract reports and deliverables.

Return on Investment Criteria: Satisfied. In 1992, following the agency's return-to-flight phase, NASA embarked on a series of cost reduction activities that significantly decreased the cost of space flight operations. As a result of the streamlining initiatives, the SFOC was implemented to fly safely, maintain mission success and schedule, and improve mission supportability in a cost-constrained environment. SFOC is designed to create efficiencies of return through the restructuring of NASA management from oversight to insight roles, while absorbing operational roles, including those of the SMTF, traditionally performed by the government.

Architecture Criteria: Satisfied. The SFOC has been specifically structured to exploit cost and performance efficiencies, which include architectural considerations for modernization, obsolescence, interoperability and conformance to NASA policies and goals. The SMTF is continuously under assessment so that its architecture conforms to NASA strategic goals and policies. Compliance to relevant Executive Notices and CIO standards are well documented in IT Plans and contract deliverable documents. The SMTF has been included in the SSP Year 2000 compliance plan.

A.3.1.4.3 Shuttle Software Production Facility (SPF)

The SPF supports the Space Shuttle Program goals and objectives for the Human Exploration and Development of Space Enterprise. The emphasis of this facility is to process flight software to support various mission objectives. The SPF is a computing, avionics test, and mission support facility with the unique hardware and software necessary to provide mission critical support. The SPF supports the development, implementation, and verification for the Shuttle Orbiter payload and ground systems applications. The SPF also supports prelaunch and mission flight operations for troubleshooting mission anomalies. The SPF currently supports over 2000 users located across the U.S. The SPF utilizes both COTS and custom hardware and software. The COTS hardware consists of two IBM systems with numerous terminal devices and workstations attached. The COTS software consists of 237 products licensed from 36 different vendors. This software is used for SPF operating system and utility functions. The custom-built hardware consists of six Flight Equipment Interface Devices used to test flight software after development. The custom-written software consists primarily of applications software and Orbiter flight software written to accomplish specific Shuttle-related objectives.

Summary schedule for the planned investments
There are no planned modification/upgrades to this system.

Performance indicators include successful Flight software production and test, and successful flight operations. The Flight Operations Process Integrity Plans include facility metrics of availability, overall facility critical discrepancies, critical requirements tracking and reliability for critical facilities.

How Planned Investment Meets Decision Criteria

Mission Support Criteria: Satisfied. The SPF investment supports core/priority mission functions by providing software products, including reconfiguration, associated with multiple aspects of flight support requirements to the Space Shuttle Program. FY96 agency restructuring of the Space Shuttle Program continued to identify the SPF as an investment required to be performed by the Federal Government.

Alternative Sources Criteria: Satisfied. Considerations for alternative sources has resulted in the implementation of the Space Flight Operations Contract (SFOC) as identified in NASA contract NAS9-20000. The SFOC, as an alternative source, transitions operations accountability, including the SPF, from the government to the contractor.

Customer Requirements Criteria: Satisfied. Contract requirements induced by incentives within the SFOC ensure that the SPF investment satisfies customer requirements. Successful completion of requirements is regularly monitored through contract reports and deliverables.

Return on Investment Criteria: Satisfied. In 1992, following the agency's return-to-flight phase, NASA embarked on a series of cost reduction activities that significantly decreased the cost of space flight operations. As a result of the streamlining initiatives, the SFOC was implemented to fly safely, maintain mission success and schedule, and improve mission supportability in a cost-constrained environment. SFOC is designed to create efficiencies of return through the restructuring of NASA management from oversight to insight roles, while absorbing operational roles, including those of the SPF, traditionally performed by the government.

Architecture Criteria: Satisfied. The SFOC has been specifically structured to exploit cost and performance efficiencies, which include architectural considerations for modernization, obsolescence, interoperability and conformance to NASA policies and goals. The SPF is continuously under assessment so that its architecture conforms to NASA strategic goals and policies. Compliance to relevant Executive Notices and CIO standards are well documented in IT Plans and contract deliverable documents. The SPF has been included in the SSP Year 2000 compliance plan.

A.3.1.4.4 Station Vehicle Master Data Base (VMDB)

The VMDB supports the goals and objectives of the International Space Station (ISS) Program for the Human Exploration and Development of Space Enterprise. It provides a tool to manage all design and implementation aspects efficiently. The VMDB, accessible from the Internet, is the authoritative information repository for the ISS vehicle engineering data and will be used throughout the 30 year operational phase. The VMDB supports the Space Station Vehicle (Engineering) manager, in conjunction with engineering processes, to manage and control engineering data through the Design, Development, Test and Evaluation phases of the ISS Program. The VMDB utilizes a single, integrated indentured parts list as a backbone to which categories of vehicle, safety and operational parameter data are appended. The suppliers (builders) of the Space Station provide the data for the VMDB: Development Centers, International Partners, and manufacturers of government furnished equipment, which are linked to the parts list by the prime contractor. The VMDB became operational in 1995 providing a parts list and resources information. Database development continues to expand the number of data categories stored and to improve user functionality, including provision of electronic interfaces to other NASA electronic systems that will be used in vehicle assembly and operations. Enhancements will be completed by June FY 2001.

Summary schedule for the planned investments
The VMDB is a major software application tool used by the ISSP to manage design and implementation. The tool first became operational in 1995 and has been undergoing continuous enhancement and new capability development since then. Although the tool is substantially complete, this activity is expected to continue through FY 01 after which the tool will be maintained in a sustaining mode.

Performance Indicators are tool development and integrated data deliveries on schedule and in budget to support Space Station assembly, operation, and maintenance.

How Planned Investment Meets Decision Criteria
Mission Support Criteria: Satisfied. The VMDB investment supports core/priority Station functions by providing integrated vehicle data for the development, operations, and maintenance of the International Space Station Program: vehicle integration, assembly, O&M and sustaining engineering. Shared data are used for mission planning and training for the Space Shuttle Program.

Alternative Sources Criteria: Satisfied. VDMB tool development/sustaining are in the International Space Station Information Systems Analysis & Integration Team Contract (ISAC) as identified in NASA contract NAS15-10215. Prime, Development Centers, IP and GFE individual data products are integrated into the VMDB to produce a single integrated data source. Integrated data delivered in the VMDB is DRD VE32 in the Prime contract NAS15-10000. Alternative sources would be individual, non-integrated, non-verified data product deliveries.

Customer Requirements Criteria: Satisfied. Contract requirements induced by incentives within the Prime and ISAIT contracts ensure that the VMDB investment satisfies customer requirements. Successful completion of requirements is regularly monitored through contract reports and deliverables.

Return on Investment Criteria: Satisfied. In 1996, the ISAC Contract was awarded as a completion form contract to continue to develop, communicate, and maintain the information architecture of the International Space Station Program Office. This architecture enables the effective definition, collection, and management of critical information during the ISSP development phase and continuing into sustaining engineering. As part of the ISAC, VMDB goals are to provide a synergy among all the ISSPO participants by providing an information service and technology infrastructure that can support the ISSPO requirements by leveraging the existing services and technologies as solutions to requirements, by enhancing the infrastructure to improve productivity and security, and by creating a flexible set of hardware and software standards that support interoperability requirements. Furthermore, VMDB is designed to create efficiencies for return through integrating multiple sources of data into a single source to reduce effort to access data and to improve the quality of results produced through its use.

Architecture Criteria: Satisfied. The VMDB has been specifically structured to exploit cost and performance efficiencies, which include architectural considerations for modernization, obsolescence, interoperability and conformance to NASA policies and goals. The VMDB is continuously under assessment so that its architecture conforms to NASA strategic goals and policies. Compliance to relevant Executive Notices and CIO standards are well documented in IT Plans and contract deliverable documents. The VMDB has been included in the SSP Year 2000 compliance plan. The VMDB is designed to interface directly with Shuttle Data Systems without redundancy and ease of data transfer.

A.3.1.4.5 Mission Control Center (MCC)

The MCC provides flight control and development facilities for the Space Shuttle and the International Space Station Programs. The MCC system design maximizes the use of generic Control Center hardware and software while providing vehicle specific command and telemetry capabilities for the Space Shuttle.

An ongoing sustaining plan includes supporting obsolescence management, use of standard hardware and software products where applicable, and fosters sharing of information within the Agency and among Programs. The MCC uses a distributed architecture, with networked COTS workstations utilizing COTS system software and custom infrastructure software.

The MCC supports the Shuttle and Station Programs. The MCC provides ground data processing for control of Shuttle and Space Station operations and training. The MCC processes telemetry, command, trajectory, payload, voice and network data for flight display/control. The MCC supports the Human Exploration and Development of Space Enterprise.

Summary schedule for the planned investments
The MCC Integrated Mission Operations Center (IMOC) is a system for delivering mission services including mission planning, mission control, flight dynamics, spacecraft analysis, payload analysis, science data processing, and data storage for users. This

IMOC is a consolidation of multiple systems within the existing MCC, IPS, and Shuttle Project Operations Control Center (POCC) Interface Facility-Replacement System (SPIF-RS), and uses COTS hardware and software wherever possible in order to create a common infrastructure for delivering mission services. Custom code is used only when necessary to provide full functionality.

The MCC development costs include tasks involving the Shuttle POCC Interface Facility (SPIF), Front End Processors (FEP's), and MCC IMOC, and incorporates Station tasks and development activities associated with the Integrated Operations Architecture (IOA). The schedule for the SPIF/ Attached Shuttle Payload (ASP) shows Draft PCD to SOMO on 12/98, NASA DP1-SOCB Approval on 10/01/99, and NASA DP3-Final ORR 03/01/00. The FEP consolidation effort schedule shows Draft PCD to SOMO on 12/99, NASA DP1-SOCB Approval on 10/15/00, and NASA DP3-Final ORR on 09/15/03. The MCC IMOC has been scheduled for FY01 through FY03. The plan shows NASA DP1-SOCB Approval on 06/01/01 and NASA DP3-Final ORR as 09/15/02.

Performance indicators include successful support of flight operations and training of the flight control team for each flight as well as timely response to in-flight anomalies. The Flight Operations Process Integrity Plans include metrics of availability, overall facility critical discrepancies, critical requirements tracking and reliability for critical facilities.

How Planned Investment Meets Decision Criteria
Mission Support – Satisfied.
The MCC investment supports core/priority mission functions by providing command and control capabilities for mission operations supporting the Space Shuttle Program. FY96 agency restructuring of the Space Shuttle Program identifies the MCC as an investment required to be performed by the Federal Government.

Alternative Sources - Satisfied.
Considerations for alternative sources has resulted in the implementation of the Consolidated Space Operations Contract (CSOC). The CSOC, as an alternative source, transitions operations accountability, including the MCC, from the government to the contractor. Following the CSOC transition on 01/01/99, the Space Flight Operations Contract (SFOC) retains responsibility for operational readiness of the MCC and interfaces with NASA JSC and the CSOC contractor. Additionally, SFOC retains management, maintenance, operations and sustaining responsibility for the MCC Host computers, the Mission Operations Computer (MOC) software application, and host peripherals. The SFOC is currently reengineering the trajectory application into a portable language with previously identified hardware to eliminate the existing host computers.

Customer Requirements Criteria - Satisfied

Contract requirements induced by incentives within the CSOC ensure that the MCC investment satisfies customer requirements. Successful completion of requirements is regularly monitored through contract reports and deliverables.

Return on Investment Criteria - Satisfied

In 1992, following the agency's return-to-flight phase, NASA embarked on a series of cost reduction activities that significantly decreased the cost of space flight operations. As a result of the streamlining initiatives, the SFOC, and subsequently CSOC, were implemented to fly safely, maintain mission success and schedule, and improve mission supportability in a cost-constrained environment. CSOC is designed to create efficiencies of return through the restructuring of NASA management from oversight to insight roles, while absorbing operational roles, including those of the MCC, traditionally performed by the government.

Architectures Criteria - Satisfied

The CSOC has been specifically structured to exploit cost and performance efficiencies, which include architectural considerations for modernization, obsolescence, interoperability and conformance to NASA policies and goals. The MCC is continuously under assessment so that its architecture conforms to NASA strategic goals and policies. Compliance to relevant Executive Notices and CIO standards are well documented in IT Plans and contract deliverable documents. The MCC has been included in the SSP Year 2000 compliance plan.

A.3.1.4.6 Integrated Planning System (IPS)

The IPS supports the Space Shuttle and International Space Station (ISS) Program goals and objectives for the Human Exploration and Development of Space Enterprise. The IPS is a dedicated facility supporting flight preparation, product development, and real-time operations for the Space Shuttle program. The IPS provides the planning and analysis tools for the Space Shuttle ground support operations. The IPS facilitates the establishment and mathematical testing of flight profiles through simulations and other tools. This information is shared with other facilities and other NASA Centers as data inputs for their specific functions. The IPS uses a distributed network of UNIX workstations and servers, based on Open Systems standards.

Summary Schedule for Planned Investments
Some small development/modernization/enhancement is planned for the Integrated Planning System (IPS) during FY00. The final product delivery for this set of development requirements is scheduled for mid-November 1999.

New IPS requirements, driven by programmatic changes and operations maturation, will be implemented in out years as required.

Performance indicators include successfully implemented flight planning and operations. The Flight Operations Process Integrity Plans include facility metrics of availability, overall facility critical discrepancies, critical requirements tracking and reliability for critical facilities.

How Planned Investment Meets Decision Criteria
Mission Support- Satisfied.
The IPS investment supports core/priority mission functions by providing development, operations, and maintenance of the Space Shuttle Program flight design and trajectory analysis applications. FY96 agency restructuring of the Space Shuttle Program identifies the IPS as an investment required to be performed by the Federal Government.

Alternative Sources – Satisfied.
The ongoing operations and maintenance of the IPS provided by the Consolidated Space Operations Contract (CSOC) is required to meet NASA's unique mission of human space exploration. No other government source or private entity can provide this support.

Customer Requirements Criteria – Satisfied.
Contract requirements induced by incentives within the CSOC ensure that the IPS investment satisfies customer requirements. Successful completion of requirements are regularly monitored through contract reports and deliverables.

Return on Investment Criteria – Satisfied.
In 1992, following the agency's return-to-flight phase, NASA embarked on a series of cost reduction activities that significantly decreased the cost of space flight operations. As a result of the streamlining initiatives, the CSOC was implemented to fly safely, maintain mission success and schedule, and improve mission supportability in a cost-constrained environment. CSOC is designed to create efficiencies of return through the restructuring of NASA management from oversight to insight roles, while absorbing operational roles, including those of the IPS, traditionally performed by the government.

Architecture Criteria –Satisfied.
The CSOC has been specifically structured to exploit cost and performance efficiencies, which include architectural considerations for modernization, obsolescence, interoperability and conformance to NASA policies and goals. The IPS is continuously under assessment so that its architecture conforms with NASA strategic goals and policies. Compliance to relevant Executive Notices and CIO standards are well documented in IT Plans and contract deliverable documents. The IPS has been included in the SSP Year 2000 compliance plan.

A.3.1.4.7 Launch Control System (LCS)

The Launch Control System (LCS) at the Kennedy Space Center is composed of the following five subsystems: The Checkout and Launch Control System (CLCS), the Checkout, Control and Monitoring Subsystem (CCMS), the Central data Subsystem

(CDS), the Shuttle Data Center (SDC), and the Shuttle Processing Data Management System/Integrated Work Control System (SPDMS/IWCS).

Checkout and Launch Control System (CLCS)

The CLCS will replace the current Launch Processing System (LPS), which uses 1970's technology, with state-of-the-art technology.

A layered system architecture will be employed to improve safety, reliability, and quality. The system will deliver a higher level of information than previously possible by including additional data, health, and status to enhance the decision making process. Vehicle configuration from other data bases (e.g., electrical connectivity) along with more complete definitions of valid system states will be combined to determine the actual end-item status. This final status will be more reliable since all pertinent parameters are entered into the calculation.

In addition to improved reliability, a new constraint manager will enhance the sophistication of system control. The constraint manager will provide surveillance over existing processes to enable appropriate actions to be taken for system failures or unplanned excursions. Data samples of all pertinent data throughout the test will be utilized in lieu of selected or spot checks. The constraint manager will ensure that when a test is completed, it meets all the necessary criteria for successful completion. Discrepancies will be reported and handled prior to test completion.

CLCS makes human access to space safer and more affordable in support of Human Exploration and Development of Space (HEDS) Enterprise, Space Shuttle Program goals. The United Space Alliance (USA), Lockheed Martin Space Operations Company (LMSOC), and Dynacs all provide software and hardware design and development support for the CLCS. Primary hardware vendors include Sun Microsystems, Gateway, Silicon Graphics, and Cisco.

CLCS contractor labor was acquired through the use of existing Space Shuttle contracts. Hardware is acquired through the Scientific and Engineering Workstation Procurement contract and open market competition.

Summary Schedule for Planned Investments

FY1999	Atlas Software Delivery
FY2000	Hypergol Maintenance Facility Operational Support
FY2000	Titan Software Delivery
FY2001	Orbiter Processing Facility Operational Support
FY2001	Scout Software Delivery
FY2002	Launch Support
FY2003	Multi-flow Launch Support

Performance Indicators: The basic performance indicator for this investment is successful checkout and launch support for a Space Shuttle flow. A secondary indicator of project success is the reduction of launch control system operational, maintenance, and sustaining engineering costs.

How Planned Investment Meets Decision Criteria
The CLCS satisfies the decision criteria for new IT projects by: (1) supporting the HEDS enterprise objective of making human access to space safer and more affordable; (2) enabling shuttle processing efficiencies; (3) employing an open system architecture; and (4) implementing an iterative delivery process that incorporates customer feedback.

Checkout, Control and Monitoring Subsystem (CCMS) Survivability

The CCMS supports the Space Shuttle Program for the Human Exploration and Development of Space Enterprise. The CCMS is a custom design computer hardware and software system essential for conducting activities for processing and launching the Space Shuttle. The system currently operates with 100 consoles, 305 front end processors, 18 common data buffers, 240 peripherals, and 12 million lines of Launch Processing System source code and 1.6 million lines of executable GOAL code. In June 1996, a modernization project, the Checkout and Launch Control System, was initiated to replace the CCMS and the Central Data Subsystem. The scope of the CCMS Survivability program is limited to sustaining the life of the existing CCMS through FY 2000. Only those engineering tasks necessary year-by-year, to maintain the CCMS through FY 2000 will be conducted.

Summary Schedule for Planned Investments
FY 2000 Digital Recorder Deployment
Enhanced LDBM
Him Deployment
Bulk Disk Delivery
RPS Interface Enhancement
Procure Extended Memory

Performance Indicators: Continued support of Space Shuttle Processing by the existing Control Checkout and Monitoring System (CCMS). The current CCMS must continue to support Shuttle processing till the replacement Checkout Launch Control system is operational.

How Planned Investment Meets Decision Criteria
The CCMS system is required to complete NASA's mission to process and Launch Shuttle. Upgrades to the system are necessary to replace maintenance intensive, high failure rate, or obsolete items. The CCMS must be sustained till the new Checkout Launch Control System arrives.

Central Data Subsystem (CDS)

The CDS supports the Space Shuttle program in the Human Exploration and Development of Space Enterprise. The CDS functions as a simulator to validate CCMS (firing room consoles) programs for each Shuttle mission. The CDS supports data storage and retrieval for vehicle processing data, a master program library, historical data for all Shuttle integrated tests at KSC, pre- and post-test data analyses, and other Shuttle processing data. The CDS consists of two Groupe Bull DPS 90/92T mainframe computers with IBM on-line disk storage, STC cartridge tape intermediate storage, and LMSI optical disk archives. Hardware was commercial off the shelf (COTS) when purchased, except for special I/O channels and two Government-designed interfaces: Video Simulation Interface and Real Time Interface. The operating system for CDS is a site-unique version of GCOS (proprietary to Groupe Bull) that is maintained by on-site Wang Federal personnel licensed by Groupe Bull. NASA Shuttle Program Management directed in October 1994, that the CDS functions be performed with newer technology, but the CDS will continue to support Shuttle processing until the new Shuttle Data Center becomes operational.

Summary Schedule for Planned Investments

June 1 - Disable user ID and passwords to begin virtual shut down
June 30 - Power down machine
July 5 - Start Demolition
August 10 - STK Tape Silo Removal
August 15 - CDS transported to excess at Ransom Road, KSC

Performance Indicators: Decommissioning CDS by June 30, 1999 is the indicator of successful completion of the project.

How Planned Investment Meets Decision Criteria

The Central Data Subsystem is a one of a kind obsolete mainframe and requires a sole source maintenance contract to continue operations. GSA has mandated that KSC show evidence of a plan to move to an open system architecture prior to renewing the existing maintenance contract. Midway through the CDS replacement project (SDC) it was also discovered that CDS was not Y2K compliant and would require an estimated $7 million dollars to keep operational. The SDC schedule was accelerated to meet the government Y2K milestones and mitigate the CDS Y2K expenses.

Shuttle Data Center (SDC)

The SDC will provide storage and recall of all shuttle processing and launch data. The SDC is a standards-based, distributed, client-server system that will replace the current mainframe-based Central Data Subsystem (CDS). The SDC will be able to provide a long- term, non-proprietary solution to the storage, recall, and presentation of Shuttle processing data. SDC will employ commercial off the shelf (COTS) hardware. COTS software will also be used whenever possible.

The SDC, in conjunction with the Checkout and Launch Control System, incorporates several of the "Critical Success Factors" as defined in the Human Exploration and Development of Space strategic plan. Specifically, SDC enables improved management and operations of the integrated government/contractor team; dramatic reductions in the cost of space flight, and maintenance of a skilled and motivated workforce. Additionally, the SDC meets a Space Shuttle Program mandate for the accurate storage and retrieval of all data related to the processing and launch of the Space Shuttle.

Summary Schedule for Planned Investments

FY 1998	Procure SDC Initial Hardware and COTS Software
FY 1999	Procure SDC Augmentation

Performance Indicators:
- Migration of required Shuttle data from CDS to the SDC
- Installation and activation of the SDC augmentation hardware
- Successful firing room load and support using SDC products
- Process an entire flow from OPF through launch and landing

How Planned Investment Meets Decision Criteria

The Shuttle Data Center was driven by the obsolescence of the Central Data Subsystem coupled with the mandate from GSA to show evidence of a plan to move to an open system architecture, eliminating the sole source maintenance contract required to sustain CDS. Midway through the replacement project it was also discovered that CDS was not Y2K compliant and would require an estimated $7 million dollars to keep operational. The SDC schedule was accelerated to meet the government Y2K milestones and mitigate the CDS Y2K expenses.

Shuttle Processing Data Management System/Integrated Work Control System (SPDMS/IWCS)

The SPDMS/ IWCS is a key management tool specific to the support of Shuttle vehicle processing for the Human Exploration and Development of Space Enterprise. The mission specific IWCS applications support work instruction management, scheduling, processing status reporting, and OMRS closed loop accounting The SPDMS is the execution platform for the Shuttle Processing IWCS. SPDMS/IWCS includes the Ground Processing Scheduling System (GPSS) and personal computer workstations. It provides the basic infrastructure of hardware, software, and communication resources necessary to develop and deliver host and client/server solutions to the IWCS user community. The platform consists of dual IBM mainframes running the VM and VSE operating systems with local and wide area networks running Windows 95/NT and UNIX. In addition to supporting mission specific applications, the SPDMS also supports office services functionality via the Windows 95/NT environment, including word processing, spreadsheet presentation, calendars, and electronic mail. During FY 1998, reengineering of the GPSS, including the development of multiflow resource deconfliction and conflict identification will be completed. Application migration and replatform of application components to the Oracle database management system on servers independent of the IBM mainframe is scheduled for FY 1999. Migration of all IWCS applications to a client/server environment independent of the IBM mainframe is scheduled for FY 2000.

Summary Schedule for Planned Investments
SPDMS is scheduled for deactivation in 2002. Only O&M will be funded between now and then.

Performance Indicators: Successful Migration of the Office Services functionality from the mainframe to the client server environment has proved the interoperability needed between USA sites and NASA centers. Application migration to the COTS environment is well underway with the implementations of both the WAVE project which provides client server base engineering work instruction generation, and Maximo which is supporting Ground Systems support activities. These systems as will as the COTS implementations of Peoplesoft Inventory and Manufacturing which are targeted in FY2000, will continue to provide automation tools supporting USA Ground Operations Shuttle Processing requirements.

How Planned Investment Meets Decision Criteria
A major initiative in the replatform of the mainframe based applications is to evaluate the applicability of available industry Off-the-shelf products. Requirements are validated against product capabilities and business processes

A.3.1.4.8 Payload Data Management System (PDMS)

The PDMS supports processing of payloads for the Human Exploration and Development of Space, Earth Science, and Space Science Enterprises. Programs directly supported include: Space Shuttle Payloads and the International Space Station.
The systems are Compaq Alpha (the old Digital) based data base engines, application servers and disk storage running the Rdb relational database. Contractor support consists of PGOC contracts for day to day operations and application development, and Compaq personnel for system maintenance and program management.

The PDMS is the work control system for KSC ISS. PDMS activities range from the procurement of components to supporting facility maintenance, to the development of work authorization documentation, to the tracking of flight hardware elements, to the scheduling of flight processing to the dissemination of information to the experiment customer community and the public via the Internet.
The acquisition strategy is through the PDMS Contract with Digital/Compaq. This contract was established in 1991 through an SEB.

Summary schedule for planned investments.

No major investments are planned for this system. It is anticipated that the follow-on contractor to the current Payload Ground Operations Contract will take over the operations and maintenance when the PGOC terminates December 2001.

Performance Indicators: Continued customer investment, system and sub-system availability metrics, and customer feedback.

How Planned Investment Meets Decision Criteria
Mission Support - The system is required to complete KSC's Payload Processing Mission. The loss of this capability would require either the re-automation of the processes currently supported by PDMS by a different system, or the extension of work schedules to incorporate manual methods. It should be noted that the PDMS Cost Benefit Analysis process identified specific benefits associated with the various applications, and these benefits were "collected: by NASA. Removal of the PDMS would remove these benefits.

Alternative Sources - The PDMS project periodically searches the Government and Private Sector for a source of similar services. The goals is to find technologies and concepts that will allow us to better perform our functions. In addition, the Payload Ground Operations Contractor (PGOC), the primary user of PDMS, is always investigating methods to reduce costs and improve the effectiveness of KSC's Payload Processing activities. To date, no solution has been identified that would indicate that there is an alternative private sector or government source that can efficiently and effectively support this function.

Customer Requirements - The PDMS continues to produce applications and track the associated benefits. PDMS application requests are customer generated and customer funded. Application development work is scheduled for the next several years. This continued request for applications is the best indicator we have into customer satisfaction. If PDMS were not meeting user requirements, PDMS would not be getting the repeat business.

Return on Investment - PDMS Benefits continue to show a significant return on investment. The act of processing payloads has continued to become cheaper and cheaper, in part due to increased application of Information Technology. The PDMS is the focal point for the application of Payloads Information Technology. It hosts the work control systems, the contractor procurement system, all operational documentation, work flow automation systems, equipment tracking systems, quality assurance systems, as well as dozens of process enhancements made possible by the existence of a centralized information storage capability accessible by all Payloads users and Customers.

Architectures - The PDMS Architecture is consistent with current Federal and NASA architectures. The systems meet NASA Obsolescence goals and are continually updated to comply with those goals as well as reduce support costs. The databases are Structured Query Language based and promote information exchange and information sharing. The

N-Tier Application Development environment was designed specifically to provide flexibility in the choice of suppliers and to support the design of local work processes.

A.3.1.4.9 Huntsville Operations Support Center (HOSC)

The HOSC provides the information and communication support necessary to directly manage and control projects and payloads. HOSC comprised systems and overall interfaces are shown in Figure 1.

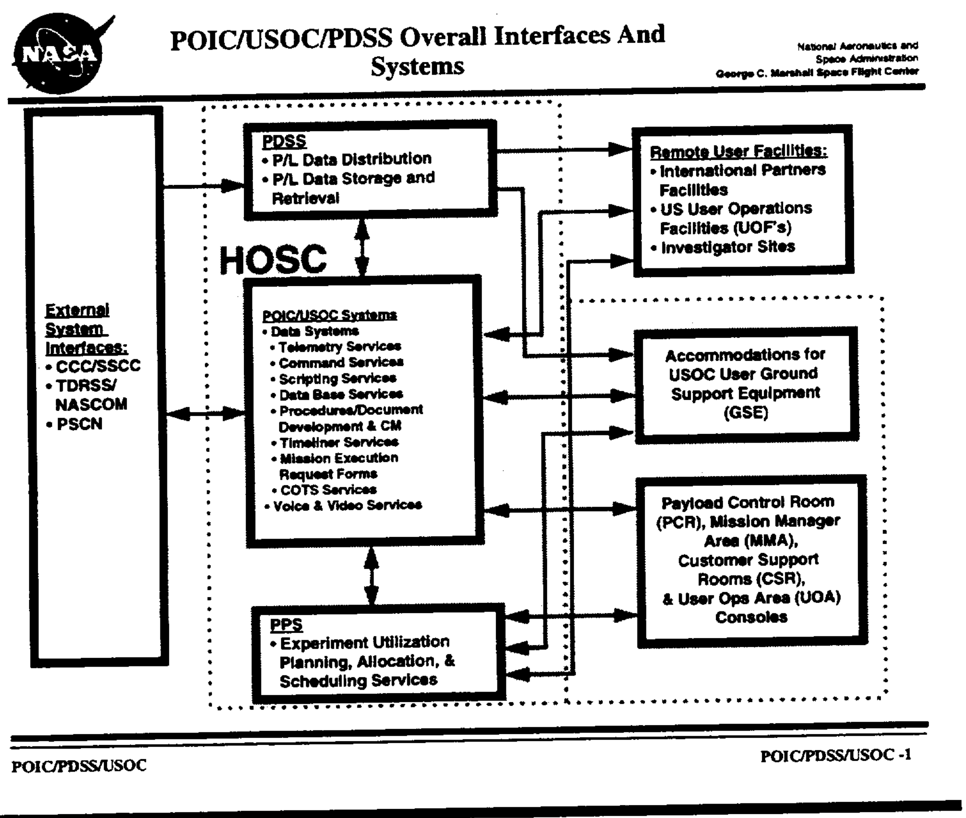

FIGURE 1

Summary Schedule for Planned Investments

FY99	$10,384
FY00	$ 8,826
FY01	$ 5,577
FY02	$ 3,100
FY03	$ 4,874
FY04	$ 5,602
FY04	$ 5,418

MSFC has no plans for major modification of hardware or software. Enhancements to the HOSC consist of: outfitting the Payload Operation Integration Center (POIC) with workstations, servers, and networking equipment; the Payload Data Services System (PDSS) with storage and networking equipment; and the Utilization Development Capability (UDC) and Microgravity Development Lab (MDL) with workstations and networking equipment, as well as the required software licenses, fees, and renewals.

HOSC provides real-time prelaunch, launch, and on-orbit data, video, and voice communications associated with ground support for MSFC projects. It also provides information recall and postflight data processing for those projects. HOSC would support such projects as International Space Station, CHANDRA and other payloads.

All of the workstations, servers, storage, and networking equipment are planned to be purchased through the NASA Science and Engineering Workstation Procurement (SEWP) contracts, which are already in place.

Performance Indicators: Used to Measure Outcomes, Output, Service Levels, and Customer Satisfaction

Metrics provide an indication of how well the information technologies are performing their functions. Maintenance trends, performance data and other relevant factors are monitored. Cost trending is also utilized to ensure information technologies are improving efficiency and are decreasing services costs. Performance indicators include software deliveries versus need dates, delivery of software builds versus scheduled dates, and system verification and validation statistics. Service level indicators include HOSC Operational Problem Reports, in which problems encountered during operational support activities are recorded for evaluation. Customer feedback is also utilized to ensure services are provided that meet the customer needs. Customer feedback is solicited through a variety of forums including technical interchange meetings, mission debriefings, and surveys.

How Planned Investment Meets Decision for New Investments
The investment supports core, or priority mission, functions that need to be performed by the Federal Government.

A.3.1.4.10 Data Reduction Center (DRC)

The MSFC Data Reduction Center (DRC) is considered a general purpose computing facility. The DRC occupies approximately 10,000 square feet in C-Wing of MSFC Building 4663. Of this area, well over half is access and environmentally controlled, with raised floor, and is dedicated to computer system support. The remaining area provides office space for a staff of approximately 25 people.

Power for Building 4663 and the DRC is provided by the Tennessee Valley Authority (TVA) and delivered via two redundant sources. In the event of failure of transmissions sources, the DRC computer systems and chilled air supplies are backed by Uninterruptible Power Supplies (UPS) and generators.

The DRC utilizes 12 Automated Data Processing (ADP) systems, associated peripheral devices, and front-end instrumentation to meet primary mission objectives. Secondary objectives also require approximately 40 workstations.

The 12 ADP Systems Include:

- One Concurrent 6000
- A Digital Equipment Corp. VAX 6000-410
- Three Digital Equipment Corp. VAX 4000-200
- Two Silicon Graphics Inc. Challenge XL systems
- Two Silicon Graphics Inc. O2 Systems
- Two Silicon Graphics Inc. Indigo II Systems
- A SUN Microsystems 670MP

Significant Peripheral Devices Include:

- Thirty Six Dual Channel Digital Telemetry Receive devices
- Eight Dual Channel Telemetry Transmission devices
- Two HP 400 GB Write Many Read Many (WMRM) Optical Storage Systems
- Two HP 600 GB WMRM Optical Storage Systems
- Two 2.5 TB Digital Linear Tape (DLT) archives
- One 13 TB DLT archive
- 132 GB of local Magnetic disk
- A 400 GB shared Random Array of Inexpensive Disks (RAID) file server
- Analog Tape Drives & High Speed Digital Drives (14 & 28 track, 1" tape)
- Nine track, 8mm, 4mm, DAT, and QIC digital tape
- Two single CD-ROM mastering units
- Two 75 CD mastering systems

The DRC systems are networked internally by Ethernet and Fiber Distributed Digital Interface (FDDI). External networks having connectivity to DRC systems include: KMTS, NASCOM, PSCN, PSCNI, NSI, the Internet, and FTS2000. These networks are used primarily for the transmission of electronic data products and the exchange of raw telemetry data.

The MSFC/DRC telemetry processing system is based on general purpose "Open Systems" computing platforms equipped with serial interface devices interfaced via industry standard busses, and integrated with a POSIX compliant automated data reduction software system of modular design. All development is done in standard computer languages, primarily C/C++, facilitating upgrades and open procurement of hardware. File and data structures utilized also are vendor independent. A small suite of standard intermediate file formats are used within the DRC's processing system from which custom output formats satisfying requirements of individual users and user databases are produced.

The Technical Architecture of the DRC's primary processing systems is a heterogeneous set of mini-computers, linked together by both FDDI and Ethernet. The systems all run a variant of UNIX as their operating system and share local disk resources amongst themselves using NFS over FDDI. All the systems also share a common RAID pool and approximately 22 TB of mixed media on-line archive. These systems are utilized to run a critical system of applications which is best described as an automated, multi-node, distributed, event driven, pipelined digital data acquisition, processing, archival, and delivery system. The software system consists of multiple independent processing nodes. Each node is capable of performing all tasks in the integrated system or participating in the distributed execution of the system in a more limited role. Digital data is first acquired in real-time through special purpose interface devices. The data is then normalized for acceptance by the rest of the processing system. Normalized data is then merged with other sources and databased. These steps, acquisition, normalization, merging and databasing constitute the four stages of the front-end pipeline. The back end stages of the pipeline include extraction from the database, product creation, and delivery.

The Data Reduction Center (DRC) is a general purpose computing facility which exists to provide data acquisition, processing, archival, and delivery services for Marshall Space Flight Center (MSFC), the NASA community, and mission related contractors. The DRC utilizes highly automated systems to acquire and process data originating from space flight activities, orbiting experiments, and component ground tests in support of the Space Transportation System (STS), SpaceLab, and Propulsion related project offices. Data sources include real-time telemetry data from an orbiting vehicle or ground support equipment as well as previously recorded data on flight recorder or instrumentation tapes. The DRC also creates and maintains the Certified STS Database for MSFC, operates and maintains the Michoud Assembly Facilities Engineering Support System, and fulfills the requirements of the SpaceLab Data Processing Facility (SLDPF)/Function.

Summary Schedule for Planned Investments
The Data Reduction Center's primary function is STS and SpaceLab Mission support. As a result, all of the DRC's major milestones are driven by the STS manifest and prelaunch test schedule. An average of 8 launches and 4 unsuccessful launch attempts are anticipated each year from 1998 to 2002. SpaceLab related activities are expected to terminate in 1999. The DRC was transitioned from the Program Information Systems Mission Services (PrISMS) contract to the Consolidated Space Operations Contract (CSOC) in May 1999.

Performance Indicators: The DRC uses a number of metrics to evaluate system and facility quality and performance. Utilization of critical system resources is logged and evaluated for capacity planning purposes. Also, DRC users and customers are surveyed regarding the quality and timeliness of data products and services rendered by the DRC.

Problems encountered during mission support activities are recorded and submitted for evaluation via a Problem Report. Problem Reports (PR) and Engineering Change Requests (ECR) result in changes to the DRC software and hardware baselines and are tracked from submission through implementation and acceptance. User/customer detected data problems are identified through the use of a mature problem reporting system in use for more than fifteen years.

How Planned Investments Meets Decision Criteria for Existing Investments
In light of the basic decision criteria provided, continued funding of the Data Reduction Center is warranted based upon the following rationale.

During FY96 meetings of the Shuttle Flight Support Cost Reduction Working Group (FSCRWG), the mission support activities of the Data Reduction Center were scrutinized. The working group's recommendation was that the DRC continue to perform these required functions, most of which are required to create and maintain the official Space Transportation System (STS) database.

The FSCRWG also concluded that the DRC provided a cost effective alternative to performing the center's mission support functions at the contractor's locations. Further, no other government facility has been identified which can meet the DRC mission support requirements without substantial modification or enhancement.

The DRC continues to meet or exceed customer requirements for the timely and accurate delivery of data products or services. Contract ratings, customer surveys, and unsolicited testimonials by customers are evidence of this facility's continued quality and cost effectiveness.

The DRC continues to fulfill its mission requirements in spite of near annual budget reductions and an uncertain future. Through the implementation of the DRC's Five-Year Modernization Plan, the return on investment has improved. Through the implementation of new systems and improved software automation, the DRC has positioned itself to meet the challenges of the future in a cost effective fashion.

One of the primary objectives of the DRC Modernization Plan was to eliminate old or obsolete equipment from our data processing configuration while maximizing the use of NASA and industry standards, and COTS products. This has lead to the current state of the art facility that is the MSFC Data Reduction Center.

A.3.1.4.11 Space Station Training Facility (SSTF)

The SSTF is presently being developed to provide the training environment for the Space Station Crew Members including the International partners. The SSTF consists of several components which will enable high fidelity training lessons for the crew members from a single crew member to a full complement of astronauts performing various experiments and activities aboard the Station.

The architecture of the SSTF is based on an open systems concept and thus makes extensive use of COTS hardware and software. The SSTF is designed to use COTS workstations interoperating through Local Area Networks (LANs) and network components.

The SSTF is being developed as a set of modular components from one-on-one training facilities to a complete replica of the Space Station module. The IT investments were selected through full and open competition resulting in a technology upgrade contract for five years duration. This ensures current equipment within the same architecture will be available for procurement as the facility becomes completely developed and operational. Major components are acquired through the duration of this contract. The progress of the development activity is planned and designed to be completed incrementally and IT resources acquired as needed.

The SSTF supports the International Space Station (ISS) Program. The emphasis of this facility is to support flight safety and mission personnel training. Its primary simulation devices are used to train crew members and ground support personnel in the operation of the ISS. This facility will be used in the preparation of personnel and products, including Astronaut skills and Space Station procedures development and validation.

Summary Schedule for Planned Investments
Completion of this new facility is scheduled for late FY 2004.

Performance indicators include on-time, within budget constraints, and systems development. Ultimately, the performance indicator for this investment is the successful operation of the ISS. Additional performance measurement systems are in place to assure all requirements are satisfied within specified funding.

How Planned Investments Meets Decision Criteria for Existing Investments
Mission Support - The development of the SSTF is required in support of NASA's core mission function of human spaceflight including new requirements for the International Space Station.

Alternative Sources - The ongoing development of the SSTF is required to meet NASA's unique mission of human space exploration. No other government source or private entity can provide this support.

Work Process Redesign - The architecture of the SSTF is a textbook example of implementing the present principles of I/T systems. The current design emphasis includes distributed processing, interoperability, maximum use of COTS software, and minimum custom developed software. This design will assure reduced life cycle costs with reductions in operators and sustaining engineers.

Return On Investment - Due to the unique nature of the SSTF, there are no available public resources that can be utilized. As stated above, the design of the newly developed SSTF minimizes life cycle costs. Performance measurement systems are in place to assure all requirements are satisfied within specified funding.

Architectures - The SSTF is fully consistent with Federal and Agency information architectures with technology to achieve NASA's strategic goals.

Risk Reduction - The SSTF is a security sensitivity Level II facility. Risks are reduced using fully tested pilots, integrated simulations, or proven prototypes. Flight crews (Astronauts) are involved in testing and certification of the facility. The project is utilizing a formal Earned Value Performance Measurement System to assess project progress.

Phased Development - The design and implementation of the SSTF scheduled the development to be incremental. Several major subsystems are scheduled to be completed in phases and integrated over time as they are completed and fully tested.

Acquisition Strategy - NASA has appropriately allocated the risk between the government and the contractor. Major purchases are fully competed and payments are tied to completion of tasks.

A.3.1.5 Earth Science Mission Area IT Investments

A.3.1.5.1 Earth Observing System Data Information System (EOSDIS)

The Earth Observing System Data and Information System (EOSDIS) is a comprehensive data and information system designed to support NASA's Earth Observing System (EOS). The EOSDIS will archive, manage, and distribute Earth science data from NASA missions and will provide spacecraft control and science data processing for the EOS missions. For EOS spacecraft and instruments, the EOSDIS will perform acquisition, capture and processing of telemetry data, processing of telemetry data into higher level science data products, archiving and distribution of standard science products growing at a rate of nearly 2 terabytes per day, and mission operations for instrument and spacecraft control.

EOSDIS supports all EOS missions, and provides data management and distribution for other NASA Earth Science Enterprise activities. EOSDIS development is being coordinated with NOAA and other agency systems to provide an interoperable Global Change Data and Information System (GCDIS) network.

Data products from EOS will be managed along with products from other NASA Earth science missions at Distributed Active Archive Centers (DAACs) to support interactive retrieval and distribution of data products for long term scientific research and understanding of global climate change. The ESDIS project provides project management, systems engineering, and technical direction for the design, development, test, and operation of the overall system; manages development of scientific discipline-unique functions at the DAACs; manages the integration of scientific software provided by EOS science investigators; and manages and directs the application of technology to evolve the EOSDIS capabilities to support growing data bases and user requirements. The Technical Architecture for EOSDIS encompasses several major subsystems, organizations, and computing facilities. These include the EOSDIS Core System (ECS), the EOS Data and Operations System (EDOS), the EOS Backbone Network (EBNet), the NASA Science Internet, the Distributed Active Archive Centers (DAACs), and Scientific Computing Facilities. The ECS is further subdivided into three major subsystems, the Flight Operations Segment (FOS), the Science Data Processing Segment (SDPS), and the Communications and System Management Segment (CSMS). An EOSDIS Test System (ETS) is under development to support end-to-end testing of the EOSDIS subsystems, and an IV&V contractor is providing an independent verification and validation of the EOSDIS.

The EOSDIS Core System (ECS), along with DAAC system extensions to support the EOS missions, will include servers for data ingest, processing servers for science product generation, data type servers for science information management, and distributed information management subsystems. The architecture is scalable to support additional data products, data types, and missions. The design makes maximum use of commercial off-the-shelf (COTS) software and of current and emerging standards. The system design is object-oriented and client-server based. Specific hardware decisions are made as late as possible to take maximum advantage of commercial technology progress. The EOSDIS hardware components selected to support the AM-1 and Landsat 7 missions in 1999 include workstations and workstation servers, shared memory multiprocessors, high performance RAID disks, FDDI and HIPPI networking subsystems, and large scale robotic storage subsystems incorporating the latest in tape storage technologies. EOSDIS software components include the latest 64-bit operating systems, compilers, enterprise management tools, and high performance distributed data base management systems. For future development, ongoing prototyping activities are focused on such areas as automated operations, interactive data access, open distributed architectures, data management and access, high performance networks such as ATM, processing load and production planning, mass storage and robotic archives, high performance and parallel computing, and enterprise management.

Summary Schedule for Planned Investments

Launches

Landsat-7	04/99
TERRA (AM-1)	11/99
METEOR (SAGE III)	10/00
PM-1	12/00
ICESat-1	07/01

EOSDIS Science Data (EOSDIS Core System - ECS)

Version 2.0 (EOS AM-1, Landsat 7)	12/99
Version 3 (PM-1, ICESat)	11/00
Version 4 (CHEM-1, SOLSTICE)	09/02

EDOS

Backup Archive Capability (C2)	06/99
Enhanced Ops. Capability (C3)	03/00
System Upgrade to Full Ops for PM (C4)	06/00

Performance Indicators: The ESDIS project will maintain a comprehensive set of statistics and supporting graphs, reported monthly, on the performance, operation, service levels, and customer satisfaction with the EOSDIS. Current and planned performance indicators include statistics on the number of distinct users accessing DAACs, the number of user accesses, the number of products delivered, and the data volume delivered, presented by DAAC, by access or request mechanism, and by delivery medium (tape, CD-ROM, FTP, WWW, etc.). In addition, statistics are maintained on product request tracking and turnaround, characterization of DAAC users requesting products (e.g., government, educational, commercial, etc.), lists of available DAAC products, and numerous other indicators. Each DAAC supports a user services office wherein appropriate statistics on customer satisfaction will be maintained and reported through the ESDIS project.

How Planned Investment Meets Decision Criteria
The Earth Science Enterprise has a major information technology initiative, the Earth Observing System Data and Information System (EOSDIS). The EOSDIS, currently under development, is a complex distributed information system for spacecraft control and science data processing for the Earth Observing System (EOS) series of spacecraft, and for the archiving, management, and distribution of all earth science data from NASA missions.

Mission Support - For EOS spacecraft and instruments, the EOSDIS will perform acquisition, capture and processing of telemetry data, processing of telemetry data into higher level science data products, archiving and distribution of standard science products, and mission operations for instrument and spacecraft control. Data products from EOS will be managed along with products from other NASA Earth science missions at Distributed Active Archive Centers (DAACs) to support interactive search, access, and distribution of data products for long term scientific research and understanding of global climate change. Total science data product volume is expected to grow at a rate of 1800 gigabytes per day.

Alternative Sources - As part of the continuing evolution of EOSDIS, various options using a variety of public and private sources are being investigated. One option would create a "Federation" of associated data centers which would be competitively selected on a periodic basis. In 1997, a Cooperative Agreement Notice was issued and competitive selections were made for an initial set of "Working Prototype Earth Science Information Partners (WP-ESIPs)" to evaluate concepts for group self-governance in the development of standards, systems, and services for both research and applications. If successful, the WP-ESIP concept could be expanded to include operational EOSDIS functions in the future. More recently, the ESDIS project has developed an "adaptive approach" for production of EOS data products wherein proposals are solicited from principal investigator-led processing systems (PIPS) for EOS missions beginning in the PM-1 timeframe. The goal is to provide the EOS Instrument Teams with more control over the production of the EOS science data products.

Work Process Redesign - The EOSDIS has had constant input from system users from inception to date. Science data users have been involved heavily in all system design reviews, and participate in testing of incremental system deliverables. Teams commissioned by NASA Headquarters, the National Science Foundation, and Congress have conducted formal oversight reviews.

Return on Investment - The EOS spaceflight missions and instruments will map the Earth and support detailed studies of geophysical processes covering a comprehensive set of geophysical parameters. The unprecedented volume of data produced by these missions will rapidly exceed NASA's current data holdings. The investment in EOSDIS will enable science researchers to develop a better understanding of the Earth as a dynamic system, and will provide information to industry, educators, and the public to help plan for potential global change.

Architectures - The EOSDIS architecture has been designed to be "evolving" to incorporate ongoing improvements in Information Technology. The architecture will allow continuing system expansions to accommodate additional Earth Science Enterprise missions, and improvements in technology to benefit from future IT efficiencies.

Risk Reduction - A key strategy for EOSDIS risk reduction is to maximize use of COTS software and hardware throughout the system. In the early stages of design, numerous prototypes are employed to validate key technology decisions and provide an early assessment of performance. Current prototyping for future system deployment covers such areas as networking, data storage, data processing, data access, and distributed data management. New versions of the system are developed, integrated and tested in a separate ECS Development Facility before deployment to the operational DAAC facilities. A project wide performance management system is used to track progress of all subsystems and provide schedule and cost accountability at all levels.

Phased Development - System development has been phased into multiple releases, each with increasing capability and capacity. The design for each release is implemented in subsystems, each of which is further divided into configuration items that are assigned to individual development teams.

Acquisition Strategy - EOSDIS is being built utilizing two major cost plus award fee contracts which effectively allocate risk between the government and the contractor and utilize competitive procedures for acquisitions. Contract payments are tied to completion of work and award fees are based upon the timeliness, content, performance and overall quality of system deliveries. On-going technology assessment and prototyping efforts help assure that the system takes maximum advantage of the latest commercial technologies.

A.3.1.5.2 Earth and Space Science (ESS) Project of the High Performance Computing and Communications (HPCC) Program

The Earth and Space Data Computing Division (ESDCD) houses two computing facilities, the NASA Center for Computational Sciences (NCCS) for production supercomputing (see Section A.3.1.5.3) and the Earth and Space Science (ESS) Project of the High Performance Computing and Communications Program (HPCC) for R&D supercomputing (see Section A3.1.5.2).

The ESS Project serves the Earth Science and Space Science Enterprises and the Life and Microgravity Sciences portion of the Human Exploration and Development of Space Enterprise. The goal of the ESS Project is to demonstrate the potential afforded by balanced TeraFLOPS systems performance to further our understanding and ability to predict the dynamic interaction of physical, chemical, and biological processes affecting the Earth, the solar-terrestrial environment, and the universe. ESS enables scientific investigators to make progress toward solving NASA Grand Challenge problems in Earth and space science by developing, testing and using advanced parallel numerical algorithms that are key to these Grand Challenges, and by providing scalable parallel computer systems on which to conduct this research. These Grand Challenge problems will require computing at the teraFLOPS performance level (one trillion floating point operations per second) or greater. ESS Project milestones chart progress toward this performance level and capability to scale beyond it, requiring demonstration of application code performance at 10, 50 and 100 gigaFLOPS.

ESS has a three year cooperative agreement with SGI/Cray Research under which parallel computer systems are placed at GSFC to meet NASA Grand Challenge Investigator performance milestones. NASA does not take ownership of these resources. The major computer resource currently provided by Cray is a 1024 processor Cray T3E system, of which 512 processors are allocated to this cooperative agreement effort . This system is provided to enable the ESS Grand Challenge Investigators to achieve at least 25 Gigaflop/s sustained on their end-to-end science codes. Cray will de-install the cooperative agreement portion of the T3E in December, 1999. The T3E is running the

DMF hierarchical storage management system on a StorageTek Powderhorn Automated Cartridge data storage subsystem, purchased by the ESS project as a mechanism to manage the large volumes of data necessary for and generated by T3E Grand Challenge applications. The silo has 8 Timberline (800 MB cartridge capacity) drives and 4 Redwood drives with corresponding cartridges of capacities 10 GB, 25 GB and 50 GB. The ESS Project also manages a 32,768 processor MasPar MP-2/MP-1 Cluster. The ESS Project participates in testing, evaluating, and benchmarking other prototype scalable processing systems and high-speed networks such as ATM.

Grand Challenge Investigators were selected in FY96 through a peer reviewed Cooperative Agreement Notice (CAN) process. Ten cooperative agreements, nine with teams at U.S. universities and Government labs and one with Cray Research, a scalable parallel computer vendor, have been awarded to link together the Grand Challenge scientists and the computing testbed on which to achieve these performance goals. Of the nine teams, four are performing Earth science research, four are performing space science research, and one is performing microgravity research. Many of these teams are directly connected to flight missions. The 9 Principal Investigators and 77 Co-Investigators are located at 20 universities and 6 Federal Labs. The nine Grand Challenge Teams share equally 50% of the GSFC resident testbed system.

ESS has allotted 20% of the testbed resource for investigations drawn from the breadth of NASA science, to prepare that community to use scalable parallel systems. These investigations receive no direct funding from ESS but may receive technical support. Investigators are selected by a rapid turn-around process every 6 months. ESS has also allotted 15% of the testbed resource for use by the Aeronautics Enterprise. The Ames Research Center has carried out a solicitation for proposals and the selection process is under way. ESS also left 10% of the testbed resource for Cray to allocate in ways that benefit the company and that serve communities other than those described above. Cray has chosen to give a sizable portion of their allocation to NOAA for use by their National Centers for Environmental Prediction.

The HPCC cooperative agreement with Cray Research, Inc. is a three-year agreement with milestone payments totaling $13.2M. The agreement includes significant cost-sharing by Cray, and includes providing systems (hardware and software) at NASA and access to systems elsewhere, maintenance, support, and training. NASA does not take ownership of any hardware or software under this agreement. This system is classified as a major information system because of its criticality to the future planning for all NASA Earth and space science missions.

Performance Indicators: Performance indicators utilized by the HPCC/ESS Project center around the 117 milestones negotiated into the 10 cooperative agreements signed between NASA, Cray, and the Investigator Institutions. These milestones are located on the web at: http://sdcd.gsfc.nasa.gov/ESS/can.milestones.html. They focus all collaborators to demonstrate 10, 50 and 100 gigaFLOPS performance on their application codes. The vendor must enable the research teams to achieve these performance levels by providing computing systems and applications expertise. Cray was also challenged to port 10 existing NCCS codes to the T3E, and this milestone was achieved in August 1997.

A.3.1.5.3 NASA Center for Computational Sciences (NCCS)

The Earth and Space Data Computing Division (ESDCD) houses two computing facilities, the NASA Center for Computational Sciences (NCCS) for production supercomputing and the Earth and Space Science (ESS) Project of the High Performance Computing and Communications Program (HPCC) for R&D supercomputing (see Section A3.1.5.2).

The mission of the Earth and Space Data Computing Division is to enable NASA-supported scientists to increase their understanding of the Earth and its environment, the solar system and the universe through the computational use of space-borne observations and computer modeling. The Earth and Space Data Computing Division also makes available specialized information systems and computational tools to enable scientists to model, analyze, and visualize the complex multidimensional nonlinear processes governing simulated and real physical, chemical, and biological computational systems. To help assure the research success of NASA and GSFC-related projects and programs, the ESDCD is committed to providing the science community with access to state-of-the-art high-performance computing, leading edge mass storage technologies, advanced information systems, and the computational science expertise of a staff dedicated to supporting that community.

The NCCS and HPCC perform supercomputing activity that accommodates both space and Earth sciences. These facilities extend world-wide through the NASA Science Internet (NSI). Research endeavors for the NASA Headquarters' Offices of Aeronautics and Space Transportation Technology (Code R), Space Science (Code S), Life and Microgravity Sciences and Applications (Code U), and Earth Science (Code Y) include: computational Aerosciences; high energy astrophysics, astronomy and solar physics, planetary and interplanetary physics, astrochemistry, electrodynamics, and extraterrestrial physics; life and microgravity sciences and applications; atmospheric chemistry and dynamics, climatology and meteorology, geodynamics and terrestrial physics, and hydrospheric and hydrological processes. The NCCS and HPCC user community currently encompasses 959 users working on 317 NASA-sponsored research efforts. (The NCCS portion of this user community encompasses 717 users on 198 research efforts; the HPCC portion of this user community encompasses 394 users on 134 research efforts.)

- 15.5% of the HPCC portion of the user community work on computational aeroscience research on 31.3% of the HPCC research efforts.
- 16.6% of the NCCS portion of the user community work on space science research on 16.7% of the NCCS research efforts, and

- 26.9% of the HPCC portion of the user community work on space science research on 26.1% of the HPCC research efforts.
- 3.2% of the NCCS portion of the user community work on microgravity science research on 5.5% of the NCCS research efforts, and
- 3.0% of the HPCC portion of the user community work on microgravity science research on 4.5% of the HPCC research efforts.
- 78.8% of the NCCS portion of the user community work on Earth science research on 76.3% of the NCCS research efforts, and
- 54.6% of the HPCC portion of the user community work on Earth science research on 38.1% of the HPCC research efforts.
- 1.4% of the NCCS portion of the user community work on research outside the disciplines outlined above on 1.5% of the NCCS research efforts.

Approximately 56% of the NCCS and HPCC research efforts are led by scientists in twelve GSFC divisions, and 44% by scientists at thirty-eight major universities, twenty research institutions, and ten other NASA sites.

The major NCCS computer resources include two CRAY J932se computers capable of a total of 12.8 giga-FLOPS running the DMF hierarchical storage management system on a two-silo StorageTek Automated Cartridge data storage Subsystem, one SGI Origin 2000 capable of 16 GFLOPs and a Sun E10000 Solaris system running the UniTree hierarchical storage management system on seven silos and an IBM 3494/Magstar. This provides a total capacity of approximately 220 terabytes (uncompressed) of near-line storage. The NCCS currently manages about 90 terabytes of data for its user community, with over 83 terabytes in automated silos and 7 terabytes in free-standing, operator-mounted archives. One of the automated silos is located offsite and holds a second copy of the UniTree data on high capacity Redwood tapes. The total storage in NCCS facilities is increasing by over 98 gigabytes a day. The NCCS UniTree system transfers an average of over 140 gigabytes of user data per day, primarily in service of scientific processing on the CRAYs and SGI. The main networking paths for this data transfer are through an ATM network. The Sun E10000 utilizes OC-12 and each of the Cray and SGI systems use OC-3. Total disk storage for the two J932se systems is 1.67 terabytes. The SGI Origin has 0.45 terabytes of disk storage. NCCS owns and operates 512 processors and 720 gigabytes of fiber channel disk of the HPCC/ESS Cray T3E . This resource was procured to meet the computational requirements of the NASA Seasonal to Interannual Prediction Project (NSIPP).

Summary schedule for planned investments:
The Earth Science Computing Implementation Plan currently projects the following requirements for NASA in Giga Flops for FY1999 – 2004 respectively: 90, 181, 378, 609, 1123, and 1669. This plan is now at Code Y in NASA Headquarters awaiting approval. This plan dwarfs the current capacity of supercomputing at GSFC and at NASA. It is difficult to determine at this time exactly what requirements at what time will be required. The composition of the proposed competitive contracts can not be determined until there is further approval and sizing of the requirements.

Performance indicators: Performance indicators utilized by the NCCS include: monthly Computer User Committee (CUC) meetings, Lab Chief Representative Committee (LCRC) meetings, and periodic reviews by external Visiting Committees.

How Planned Investment Meets Decision Criteria
The NCCS production facility and the HPCC/ESS R&D testbed (See 3.2.1.6) are co-located allowing maximum cooperation and sharing of knowledge between staff members of the two organizations. This co-location also enables the Earth and space science researchers uniform access to both the production systems and the high-end testbed systems, easing their transition to the next generation hardware and software technologies

Mission Support - The NASA high performance computing investment supports core/priority Earth and space science mission functions that still need to be performed by the Federal Government. The NASA Center for Computational Sciences (NCCS) performs the mission critical role of providing the supercomputing, mass storage, and networking resources to enable the Earth and space science user community to meet priority Enterprise goals and to perform their peer-reviewed NASA sponsored research.

Alternative Sources - Continued funding by the NASA Enterprises of this investment is required because no alternative private sector or government source can efficiently support the function.

The NASA Consolidated Supercomputing Management Office (CoSMO) was created for the purpose of meeting NASA's commitment to achieve the supercomputing requirements for each Enterprise Office, while realizing an overall cost savings through effective and efficient management of NASA's supercomputing resources. In its creation of the CoSMO Management Plan, CoSMO reflects a new way of doing business, consistent with Government reinvention goals. CoSMO continues to investigate alternative sources of providing this critical resource to continue to meet the Agency's requirements for supercomputing providing the lowest cost and delivering the highest performance to the science community.

The industry base for the extremely high end of computing has been shrinking at an alarming rate over the last five years, due in large part to the shrinking government investment in these systems. Functions critical to the U.S. Earth and space scientific community require these types of systems, and a forced reliance on foreign-manufactured products will jeopardize the future mission areas of this community.

Customer Requirements - The existing NCCS system investment in low cost high performance SGI/Cray systems continues to satisfy customer requirements in a manner that reduces cost and improves work process efficiencies. By achieving unprecedented application code performance levels on the HPCC/ESS project machines as well as on the NCCS machines, the Earth and space science community high performance computing requirements are being addressed.

The NCCS GSFC Earth and Space Sciences user requirements are documented in the "NASA Earth and Space Science Computing Requirements 1997 - 2004" document, a report of the Computing Environments and Research requirements Committee, dated January 1995. HQ program managers have validated this document of requirements.

Return on Investment - The existing NCCS system investment continues to demonstrate a projected return on the investment that is clearly equal to or better than alternative uses of available public resources. Return includes: improved mission performance in accordance with GPRA measures, reduced cost; increased quality, speed, or flexibility; and increased customer and employee satisfaction.

CoSMO is currently participating in NASA's transition to full-cost accounting by designing a market-based approach for utilization and costing of supercomputing resources.

Architectures - The existing system investment continues to be modernized (utilizing both technology insertion and technology refreshment) to be consistent with Federal and NASA architectures. Architectures integrate NASA work processes and information flows with the latest advances in technology to achieve NASA's strategic goals; reflect NASA's technology vision and year 2000 compliance plan; and specify standards that enable information exchange and resource sharing, while retaining flexibility in the choice of suppliers and in the design of local work processes.

CoSMO is responsible for proposing the optimal operational supercomputing structure for NASA to the NASA CIO Council for approval. The primary proposed architecture and alternative configurations will be developed by an Optimal Architecture Team consisting of an outside oversight committee and members of the NASA matrixed CoSMO technical team. This team is currently meeting and will propose an optimal architecture to CoSMO to be later presented to the NASA CIO Council for approval to proceed with the implementation.

The co-location of the HPCC/ESS Testbed with the NCCS production facility enables the Earth and space science researchers access to both production systems and testbed systems, enabling seamless transition to the next generation hardware and software technologies.

A.3.1.6 Space Science Mission Area IT Investments

A.3.1.6.1 Intelligent Systems

The Intelligent Systems (IS) Initiative is designed to begin a national strategic research program that will fulfill or exceed the NASA Administrator's vision for next generation information technology capabilities. The Initiative will achieve this vision by developing state of the art and revolutionary IS technologies, by leveraging government and university research, and by feeding maturing technologies to ongoing NASA missions and activities, to industry activities, and to other government agencies.

The IS Initiative emphasizes the research, development, and technology transfer of revolutionary methods, technologies, and processes that apply across NASA's and the nation's engineering and science infrastructure. The Initiative contains four Technology Elements that, in combination, provide a comprehensive strategy that integrates high-risk research, concept and prototype development, and the transfer of mature technologies to all Initiative customers. The four Technology Elements are briefly described as:

- **Automated Reasoning** means taking the programmer out of the loop. Scientists can solve problems in their own terms rather than having to program solutions, and spacecraft can operate autonomously rather than responding to ground commands
- **Human-Centered Computing** means that we design from a systems perspective that looks at how humans and machines interact, taking into account basic human perceptual, cognitive, and social abilities
- **Intelligent Data Understanding** means that all the data we collect is managed as a coherent asset, is integrated to provide the best understanding possible, and is disseminated to interested parties
- **Revolutionary Computing** has to do with breakthrough technologies that can change the way we think of computation

Summary Schedule for Planned Investments and Performance Indicators

FY 2000 (Today)	FY 2005 (In 5 Years)	FY 2015 (In 15 Years)
	Automated Reasoning	
Limited intelligent agents	Adaptive, knowledge-based intelligent agents	Fully cooperative, adaptive intelligent agents
Complex collection of non-reusable automated languages and methods	Increased re-use, rudimentary toolkit for automated reasoning	Maximized re-use with sophisticated automated reasoning toolkit for systems engineers
Loose coupling of autonomy HW and SW	Increasingly fault tolerant HW and SW	SW-driven HW physical reconfigurability
Metric: 80 SW errors/1000 lines of code at integration	Metric: 10 SW errors/1000 lines of code at integration	Metric: 1 SW error/1000 lines of code at integration
Metric: self-replanning for autonomous rovers and ISRU takes 8 hours	Metric: self-replanning for autonomous rovers and ISRU takes 1 hour	Metric: self-replanning for autonomous rovers and ISRU takes 5 minutes
	Human Centered Computing	
Humans must adapt to machines	Tools actively adapt to individual differences	Seamless integration of human/machine functions
Tools based on inadequate cognitive models	Voice/gesture based interfaces	Haptic/immersive interfaces
Passive networks and data	Psychologically/biologically	Tightly coupled hybrid methods

FY 2000 (Today)	FY 2005 (In 5 Years)	FY 2015 (In 15 Years)
repositories	motivated performance support systems	enabling fully integrated human/computer interface
No rationale-capture tools	Expert rationale-capture tools	Tools for Enterprise-wide organizational learning
Metric: Nominal human-machine performance in complex tasks	Metric: 3x enhanced human-machine performance	Metric: 5x enhanced human-machine performance

FY 2000 (Today)	FY 2005 (In 5 Years)	FY 2015 (In 15 Years)
	Intelligent Data Understanding	
Limited utility KDD tools; early statistical analysis and classification methods (correlational)	Flexible, multi-use KDD tools for understanding large data sets; ability to infer causal relations	Hybrid adaptive intelligent KDD tools to mediate discovery and understanding
Onboard anomaly interpretation	Biologically inspired HW and SW; real time learning	Adaptive, autonomous sensor-guided robotic systems
PI-dependent data analysis	Limited brokering of data sets by intelligent agents	Intelligent "librarian" of national data sets
Transmission of data to ground	Transmission of information to ground	Transmission of knowledge to ground
Metric: Years of manual effort to classify and catalog terabyte-sized data sets	Metric: 10x improvement in data cataloguing speed and s/c downlink bandwidth	Metric: 100x improvement in data cataloguing speed and s/c downlink bandwidth
Revolutionary Computing		
Sub-micron scale devices	Nanometer scale devices	Novel substrates for sub-nanometer scale development
Rudimentary biologically motivated SW and HW	Modest fidelity biomimetic SW and HW capabilities	High fidelity biomimetic SW and HW capabilities
Individual neural net and GA applications	Pervasive information appliances	Self-repairing materials and structures
Von Neumann architecture	Autonomous mission information architecture	5x mission operations with same staffing; molecular and quantum computing
Metric: chips with 1K neuron-equivalents	Metric: chips with 100K neuron-equivalents	Metric: chips with >1M neuron-equivalents

How Planned Investment Meets Decision Criteria. This Intelligent Systems Initiative is made to perform advanced research in IT areas and is not made as an infrastructure investment with a ROI decision being required.

A.3.1.6.2 National Space Science Data Center (NSSDC)

The NSSDC supports the wide spectrum of space sciences in managing archived space science data and supporting documentation, and in disseminating those data to a worldwide research user community and to the U.S. education community and general public. NSSDC's computers, mass storage systems, and network links are all used in pursuit of this function. The NSSDC provides a science multi-discipline archive. The SSDC acquires data from spaceflight projects, discipline data systems, and individual principal investigators, and manages these data both in on-line mode and in off-line stores of tape, film, and other media. The NSSDC maintains comprehensive information files about NSSDC held and other data including the widely accessed NASA Master

Directory. The principal computing resource at NSSDC is a DEC Cluster consisting of a VAX 6410 and two DEC Alpha computers running OpenVMS. The facility supports other stand-alone systems including a DEC/Alpha-based media replication system with a variety of peripherals and a variety of workstations including DEC Alpha, SUN Microsystems, and Silicon Graphics. A Cygnet optical disk jukebox and a Digital Linear Tape jukebox provide Mass storage. In addition, the facility has CD-Write Once systems, publication-quality printer stations, and many MS-DOS and Apple Macintosh personal computers. NSSDC uses many commercial-off-the-shelf software products, including Oracle, Sybase, Illustra, and IDL. NSSDC enables wide-area-networking through TCP/IP and DECnet protocols.

Summary schedule for planned investments:
New components of the NSSDC mass storage environment will be added as NSSDC's data holding requirement comes within 70% of its then-current mass storage capacity. Note that NSSDC expects to ingest and provide network access to about 1 TB of data per year for each of the next several years. Likewise CPU's and database technologies will be added as it becomes clear they will be cost-beneficial in support of NSSDC's data management and dissemination responsibility.

Performance Indicators: Primary performance indicators are satisfaction levels voiced by our external customers, relative to our database technologies enabling users to find, identify, and retrieve the "right data," and relative to our mass storage technologies enabling effective accessing of large data volumes. NSSDC has a user survey on the WWW through which it solicits such satisfaction levels. Response times from data order to data downloading is also a metric used.

How Planned Investment Meets Decision Criteria
Mission Support - The NSSDC data archiving and dissemination functions continue to be core/priority to the NASA/OSS mission function, and NSSDC's ADP system is indispensable to its performing this function.

Alternative Sources - Continued funding of NSSDC and its ADP system is required because no alternative private sector or government source can efficiently support the function

Customer Requirements - NSSDC and its ADP system continue to satisfy requirements of both scientific and general public customers in a manner that reduces cost and improves work process efficiencies.

Return on Investment - NSSDC and its ADP environment continue to demonstrate a projected return on the investment that is clearly equal to or better than alternative uses of available public resources. Return primarily consists of enhanced access to and use of expensively obtained NASA/OSS mission data.

Architecture - NSSDC and its ADP environment are being continuously modernized consistent with Federal and NASA architecture recommendations. Mass storage hardware and software technologies are upgraded. Data management standards including CCSDS/SFDU, CDF, and FITS are integrated to facilitate exchange, understanding, and use of data and information.

A.3.1.6.3 Deep Space Network (DSN)

The DSN, with stations strategically placed on three continents, is the largest and most sensitive scientific telecommunications system in the world. It is the Earth-based communications terminal for all of NASA's interplanetary spacecraft. In addition to its spacecraft communications responsibilities the DSN performs radio and radar astronomy observations for the exploration of the solar system and the universe. DSN functions include:

- Telemetry
- Command
- Radio Metric Telecommunications
- Very Long Baseline Interferometry (VLBI)
- Radio Science
- Monitor and Control
- Science Support wherein the DNS is used as an advanced technological instrument for scientific research and development

The DSN currently consists of three deep-space communications facilities placed approximately 120 degrees apart around the world: at Goldstone in California's Mojave Desert; near Madrid, Spain; and near Canberra, Australia. The three-station configuration enables constant observation of a distant planetary spacecraft as the earth rotates. Each complex contains at least four deep-space stations equipped with large parabolic reflector antennas. The operations control center for all three facilities is located at JPL in Pasadena, CA.

Historically, supporting service contract related funding has been at an approximately $30 million level per fiscal year. Current ongoing efforts to reengineer the underlying processes that constitute the functioning DSN are estimated to yield a reduction in required funding to a level of about $25 million per fiscal year.

Summary Schedule for Planned Investments
A high level schedule for the Deep Space Network is shown below. IT related activities are contained in some degree in each area. Data Acquisition Software Development is particularly important to Item #1, with implementation deliveries scheduled in FY 2001, 2003, and 2004. The development effort involving "TurboCode" is particularly IT intensive and is scheduled in early FY 2003.

Schedule to Increase Date Return Capacity	
Introduce Operational DSN Ka-Band Capacity	
Implement Ka-Band on Ground Antennas	DSS25 July 1998 DSS26 September 2001 DSS34 July 2001 DSS54 July 2003 DSS24 March 2004 DSS15 October 2004
Validate Ka-Band Tracking of DS1	Launch October 1998 Finish October 2000
Quantify Ka-Band Performance on the 70m DSN Antennas	October 2000
Develop Ka-Band Hardware for the Flight Elements	Infl. Ant. March 1999 STM Proto. December 1999 STMFEM January 2001 TWTA March 2001 SSPA January 2003
Flight Validate Optical Communications	
Bring Table Mountain 1m R&D Site On Line	September 2000
Conduct Optical Demonstrations	November 2001
Enhance Performance at Current Frequencies	
Implement Turbo Code	October 2003
Implement Antenna Feed Improvements	DSS14 May 2000 DSS43 November 2000 DSS26 September 2001 DSS34 July 2002 DSS63 July 2002 DSS54 July 2003 DSS24 March 2004 DSS15 October 2004

Performance Indicators: The JPL Telecommunications and Mission Operations Directorate has developed several performance indicators that measure service levels and the number of customer missions that are supported over time. Yearly goals have been established, and performance is measured. The trend to date has been increased levels of support to an ever-increasing number of smaller missions with declining resources to provide the needed mission operations support. The Directorate is also committed to developing and implementing improved performance metrics. One metric that deserves particular attention is Telemetry Availability to Customers, committed versus actual. Another is the number of DSN supported hours before a recorded discrepancy.

How Planned Investment Meets Decision Criteria

Mission Support-The investment supports core/priority mission functions that continue to require performance by the Federal Government, supported by appropriate subcontractor involvement.

Operations and maintenance services for the DSN are presently subcontracted to industry. Under the Consolidated Space Operations Contract (CSOC) awarded in early FY 1999 period NASA expects to realize the benefits of a unified strategy in performing mission operations.

Alternative Sources—Continued funding of this investment is required because no alternative private sector or government source can effectively and efficiently perform the function.

The space telecommunications capability provided by the DSN is unique in the world and is not available in the private sector. There is no commercial market for this capability. There is substantial interest from foreign governmental agencies in utilizing DSN services. Many of these agencies have reciprocal agreements for Telecommunications spacecraft in return for providing science data to NASA.

JPL has undertaken an extensive examination of core competencies and has developed an operations plan for FY 2000 in which non-core competencies are being contracted to industry. This effort is in response to passage of the Government Performance and Results Act, The National Laboratory Review, and a series of congressional oversight hearings. The CSOC contract, mentioned above, includes a number of tasks whose responsibility is transitioned from JPL to the CSOC contractor team.

Customer Requirements—The existing system investments continue to satisfy customer requirements in a manner that reduces cost and improves work process efficiencies

Marked increases are expected to continue in the quality, quantity, and efficiency of satisfying both DSN and AMMOS (see below) customer requirements. The cost of providing these services continues to decrease at a substantial rate—well beyond trends anticipated a few years ago.

Return on Investment—The existing system investment continues to demonstrate a projected return on investment that is equal to or better than alternative uses of available public resources. The returns considered include improved mission performance, reduced cost, increased quality, speed, or flexibility, and increased customer satisfaction.

Efficiency gains and cost decreases with respect to meeting customer requirements are discussed above. The return on investment from the DSN and AMMOS principally focuses on the successful reception, processing and delivery of space science and engineering data to the engineering and science teams associated with a particular mission. Quantitatively, science data return is increasing at a rapid rate while the ongoing investment is relatively stable. Meanwhile, operations and maintenance costs continue to decline on a normalized basis.

Architecture—The investment is consistent with Federal and NASA Information Technology Architecture.

A.3.1.6.4 Advanced Multimission Operations System (AMMOS)

The AMMOS is a system of hardware and software components, workforce teams, facilities, and procedures that work together to support JPL's space flight missions. AMMOS provides mission control, data processing and data storage services vital to the success of these missions.

The computer hardware and software components of AMMOS reside on networked, distributed architecture, with gateway links to remote mission teams if required. In addition, authorized external users such as Principle Investigators can access mission-related data via dedicated communication links or via the Internet.

For its flight project customers AMMOS provides the following capabilities:

- Downlink: An integrated, tested, and documented capability to frame-synchronize, extract, decommutate, store, and display spacecraft telemetry data
- Uplink: An integrated, tested, and documented capability for missions to generate and transmit commands to the DSN (see above) for transmission to the spacecraft; includes necessary measures to control system access and insure command integrity
- Data Analysis and Mission Planning: Tool kits furnished to flight project developers for their use in developing their own planning and analysis capabilities—for example, tools for mission and sequence planning

Like its DSN counterpart AMMOS is currently engaged in a number of efforts seeking to:

- Push the state of the art in space mission operations
- Make investments that will upgrade service quality to customers
- Simplify the way in which customers communicate with and service their spacecraft
- Develop improved engineering practices that markedly reduce the lifecycle cost of development and operations
- Reengineer processes to dramatically reduce the cost of operations, maintenance and sustaining engineering

Historically, supporting service contract funding relevant to AMMOS activities has been in the $43 million per fiscal year range. Current ongoing efforts to improve and/or reengineer the relevant AMMOS processes are estimated to yield a reduction in required funding to a level in the $36 to $37 million per fiscal year range. Again, these estimates do <u>not</u> take into account formation of the NASA Space Missions Operation Office or current activities regarding consolidation of NASA mission operations responsibilities under the leadership of JSC.

Summary Schedule for Planned Investments:
A high level schedule for AMMOS is shown below. Development and operational activities for AMMOS are relatively more IT intensive. Activities involving development and implementation of the next generation data systems capability, particularly those involving command, telemetry, and radiometric are scheduled for early FY 2001. Similarly, improved services involving spacecraft health, safety, and performance, including sequence engineering, are scheduled for implementation in the same early FY 2001 timeframe.

Schedule Provide & Operate Multi-Mission Operations Systems	
Develop Mission Operations System (MOS) Services	
Establish TMOD Org. Structure & Relationships to Execute MOS Role	October 1998
Transition Projects to Design or Development Phase to TMOD MOS Service	October 1998
Start Pre-phase A & A SESPD Projects with TMOD-provided MOS	October 1998
Transition to a Services-Based Organization	
Bring Core, End-to-End Services On Line	MDM Service 1998 MDM Nav-OD 1998 CMD-SLE, TLM-SLSE, RMDC, & Time Services 2001
Bring Follow-On Services On Line	ADS 1998 S/C Health/Safety, S/C Performance Payload Seq. Eng. 2001
Develop Service Provision Metrics	Subscription 1998 Efficiency 1999 Quality 1999
Apply Full-Cost Accounting to Service Provision reference NASA Target Date	June 2000

Performance Indicators: Many of the performance metrics applicable to the Deep Space Network are likewise applicable to AMMOS. Because of the consolidated management focus enabled by establishment of TMOD, consolidated metrics and yearly goals have been developed. The effort to develop a common metrics framework is ongoing and is expected to be completed in early FY 2000. Until then it is clear that the focus on metrics will be on improving the service experience from the customer's (flight project's) perspective. Included are an improved process for reaching service level agreements, development of a full cost estimation and charging model, and increased reliability and productivity measures.

How Planned Investment Meets Decision Criteria
Because the DSN and AMMOS are now integrated under the JPL Telecommunications and Missions Operations Directorate, and because mission operations support involves

interactive and interoperable functionality between the two systems, the decision criteria discussed above with respect to the DSN are applicable also to AMMOS.

A.3.2 IT Infrastructure Investments

A.3.2.1 NASA Integrated Services Network (NISN)

The NISN was chartered in 1996 with management responsibility for operations and maintenance of all NASA's wide area telecommunications networking requirements, except for research activities as performed by the NASA Research and Education Network (NREN) project.

The NISN provides voice, video, and data services to meet programmatic, mission, scientific, and institutional requirements. Customer locations include NASA centers, international locations, and affiliated contractors and universities. The NISN services include all Agency coordination of the General Services Administration's FTS2000 and FTS2001 program. NISN services include long distance telephone, facsimile, voice and video teleconferencing, data and video distribution, and Internetworking.

The NISN organization and services are part of the Space Operations and Management Office (SOMO), an element of the Office of Space Flight, Code M. The SOMO Wide Area Network Services Manager (WANSM) and staff is a delegated responsibility to the Marshall Space Flight Center. However the NISN, as a service provider of production wide area networking and telecommunication services, supports all NASA Enterprises and projects that require the transmission of information, whether via voice, video, or data transport. NISN services are much broader than supporting space operations.

NISN services are provided through the employment of three major contractual arrangements:

- Consolidated Space Operations Contract (CSOC):
  The CSOC is managed by Johnson Space Center to provide space operations services. Excepted as noted below, effective May 1, 1999, NISN services are provided under this contract as an outsource arrangement. The existing government-owned equipment has been made available for use by the outsourcer. The government will no longer purchase equipment but will purchase networking and telecommunication services from the outsourcer.

- Program Information System Services (PrISMS) Contract
  Certain NISN services are provided under the PrISMS Contract. These services include: Agency Domain Network Services, Agency X.500 Directory Services, Wide Area Networking Technology Support, and the Russian IT Support Services which provides all telecommunications, networking, and desktop services for NASA Programs and staff working in Russia. These services are provided largely through the use of government owned equipment and leased circuits.

- General Services Administration's FTS2000/2001 Program
  NASA has been a participant in the FTS2000 contract since its inception. With the establishment of FTS2001 contracts, NASA intends to obtain long distance telephone services (domestic and international) and switched video transport services through an FTS2001 vendor. Transition of these services from FTS2000 to FTS2001 will take place in early FY00. The FTS2001 contract is a non-mandatory contract except that the various governmental agencies, including NASA, in cooperation with the GSA, have committed to providing a minimum level of revenue to the successful FTS2001 vendor(s) in order to insure competition that reflected appropriate economies of scale to the government.

Performance Indicators: Through the implementation of the CSOC, NISN (SOMO) has assigned a higher level of integration responsibility and accountability to the contractors. NISN surveillance mode requires only monitoring of customer-identified metrics and contracted milestones. NISN insight into CSOC can range from low intensity, such as reviewing monthly reports, to high intensity, such as the customer performing surveys and reviews.

These indicators included:

Budget (PSLA & CSLA)
Service Availability
- NISN Service Request (NSR) Processing
- Service Utilization
- Problem Management (trouble ticketing)
- Customer Satisfaction

NISN, in conjunction with CSOC, is reviewing the Metrics Management Plan to reflect the appropriate services. The Metric Management Plan addresses:

- **Government/Program Oversight Metrics**
  –IT Investment Performance Metrics
  –Congressional Narrative Metrics
  –Contract Management Metrics
  –SOMO Required Metrics
- **Customer Required Metrics**
  –Customer Satisfaction Metrics
  –Customer Performance Metrics
  –Customer Cost Metrics
- **Day-to-Day Network Management Metrics**

—Problem Resolution Management Metrics
—Service Delivery Metrics
—Utilization Metrics
—Quantity/Capacity Metrics
—Service Cost Metrics

How Planned Investments Meets Decision Criteria for Existing Investments. The NISN provides a core telecommunications infrastructure linking NASA centers and affiliated contractors, researchers, and universities in the transfer and sharing of information vital to the success of each NASA Enterprise and project. With CSOC, NISN has redefined how NASA obtains its needed wide area telecommunication requirements. NISN's role has shifted:

- From one of building private networks to one of integrating the various NASA programmatic requirements.
- From one of operating government owned equipment to one of managing service level agreements with telecommunication service providers.
- From one of purchasing circuits from telecommunication providers to one of purchasing integrated packages of services from those providers.
- From performing hardware integration engineering to one of packaging requirements and acting as a "smart buyer" of services for the Agency.
- From major expenditures for support contractor workforce to major expenditure for commercial services.

Thus the NISN, as a government information technology investment, shall become primarily a NASA office with the appropriately skilled personnel familiar with both the NASA missions and the evolving telecommunications industry to integrate requirements such that NASA is a "smart buyer" in the commercial marketplace of telecommunications services, a catalyst for changes in the marketplace to meet unique requirements, and to achieve economies of scale through Agencywide requirements integration. As such, NISN will be redefined from being an information technology capital investment to a specialized, value added, programmatic support function utilizing a variety of "outsourcing" arrangements.

A.3.2.2 NASA ADP Consolidation Center (NACC)

The National Aeronautics and Space Administration (NASA) Automated Data Processing (ADP) Consolidation Center (NACC) was established in 1994 to centrally integrate, implement, and operate Agencywide computing resources for NASA Centers and Headquarters (HQ) at Marshall Space Flight Center (MSFC). Prior to the establishment of the NACC, each NASA Center planned for, operated, and maintained the International Business Machine (IBM)-compatible mainframe computers required for supporting its administrative and programmatic users.

The NACC was established to do the following:

- Centrally locate, operate, and manage non-Mission Critical IBM-compatible mainframe computers
- Apply similar consolidation strategies to smaller mid-range systems, in a later phase
- Achieve costs savings by eliminating duplication and decreasing the amount of hardware and software, floor space, and operations staffs required for supporting NASA data centers
- Achieve cost effective maintenance agreements for hardware maintenance and software licensing by leveraging economies of scale
- Use cost savings to fund technology upgrades.

The NACC supports administrative processing requirements for ARC, DFRC, GSFC, HQ, JSC, KSC, LaRC, GRC, MSFC, and SSC, as well the Agency's consolidated payroll and consolidated support for legacy administrative software systems. Also, the NACC maintains and operates computer systems which support manufacture of the Shuttle External Tank (ET) at Michoud Assembly Facility, Space Transportation System (STS) data bases, the JSC Integrated Management Information Computer (IMIC), and the JSC International Space Station. In all cases, the NACC is responsible for centrally operating and maintaining all hardware, system and subsystem software, communications hardware and software, facilities, and front-end processors that make up the NACC. The processes and procedures governing the NACC are structured to ensure maximum reliability, availability, and serviceability to the user community.

Functional resource management and service areas for which the NACC is directly responsible for the mainframe systems and will assume responsibilities for added mid-range workloads are as follows:

- Customer Support and Problem Resolution
- Capacity Management
- Configuration and Change Management
- Customer and Data Center Security Management Responsibilities
- Production Scheduling and Production Problem Resolution
- Tape Management/Direct Access Storage Device (DASD) Management
- Resource Management
- Testing, Relocation, and Installation of Mainframe and Mid-Range Hardware and Software
- Performance Monitoring
- Software Licensing
- Long-range Planning
- Network Operations/Engineering
- Data Base Management
- Computer Systems Support
- Disaster Recovery Planning

- Configuration Management and Change Control
- Facilities Planning and Support
- New Implementation of Capabilities and Features to Meet Customer Requirements and
- Technology Changes
- NACC Chargeback and Accounting

NACC workload consolidations have resulted in significant reductions in the number of mainframe processors, amount of floor space, amount of power, and operational support requirements. In the process of consolidating and centrally managing Agencywide systems, the NACC has developed both the internal infrastructure and management organization to efficiently operate and manage the information processing requirements for the Agency.

The detailed NACC systems and telecommunications architectures are listed in the following tables.

NACC ARCHITECTURE

WORKLOAD	PROCESSOR	DISK (Gigabytes)	36-TRK TAPE DR	18-TRK TAPE DR	9-TRK TAPE DR	NETWORK
GRC Admin.	AMD GS722	181	12	16	1	SNA-TCP/IP
ARC Admin.	AMD GS722	155	12	8	1	SNA-TCP/IP
GSFC Admin.	AMD GS722	195	12	16		SNA-TCP/IP
LaRC Admin.	AMD GS722	122	12	8	1	SNA-TCP/IP
JSC IMIC	IBM 9672-RB6	264	8		2	SNA-TCP/IP
MAF/ET	IBM 9672-RB6	412	24			SNA-TCP/IP
MSFC Eng.	IBM 9672-RB6	141	8		1	SNA-TCP/IP
ARTEMIS D/B	IBM 9672-RB6	120	8		2	SNA-TCP/IP
HQ Admin.	IBM 9672-R35	182	12	8	2	SNA-TCP/IP
JSC Admin./VM	IBM 9672-R35	108		5	2	SNA-TCP/IP
JSC Admin./MVS	IBM 9672-R35	102		8		SNA-TCP/IP
KSC Admin.	IBM 9672-R35	146	16			SNA-TCP/IP
MSFC Admin.	IBM 9672-R35	228	12			SNA-TCP/IP
SSC Admin.	IBM 9672-R35	64	8		2	SNA-TCP/IP
NACC APC	IBM 9672-R35	247	12	6	2	SNA-TCP/IP
NACC Comm.	AMD GS722	43	12	6	2	SNA-TCP/IP

Table 1. NACC Detailed Architecture (Processor, Disk, Tape Drives, Network)

NACC Enterprise Server	MIPS Rating	NACC Customer
Amdahl GS722	118 Millions of Instructions Per Second (MIPS)	ARC, GRC, GSFC, LaRC, NACC/COMMON
IBM 9672-RB6	165 MIPS	JSC IMIC, MAF/ET, MSFC Eng ARTEMIS
IBM 9672-R35	165 MIPS	HQ, JSC/VM, JSC/MVS, KSC, MSFC ADMIN, SSC, NACC/APC
IBM 9672-R24	85 MIPs	YEAR 2000 Testbed

Table 2. NACC Detailed Architecture (Processor Capacity in MIPS, Customers)

WORKLOAD	Systems Network Architecture Front End Processor (FEP)	TCP/IP ADAPTERS	PRINTERS	CONTROLLERS	DIAL CNTRLR	CHANNEL EXTENDER
GRC Admin.	1-IBM 3745	2-IBM 3172-III	1-XEROX 4238	2-IBM 3174		1-CNT-NAU
ARC Admin.	1-IBM 3725	2-IBM 3172-III	5-XEROX 4090 1-XEROX 4050	21-IBM 3274	1-IBM 7171	2-CNT SAU
GSFC Admin.	1-AMD 4745	1-IBM 3172-III	1-XEROX 4050 1-IBM 3800 5-XEROX 4890	4-IBM 3174		2-CNT NAU
LaRC Admin	1-IBM 3745	2-IBM 3172-III	2-IBM 424X 2-XEROX 4050	2-IBM 3274		2-CNT-GAU
JSC IMIC	1-IBM 3745 1-IBM 3725	2-IBM 3172-III		2-IBM 3174	1-IBM 7171	1-CNT XAU
MAF/ET	2-IBM 3725	2-3173-III	1-XEROX 4050 1-IBM 4245	2-IBM 3174		
MSFC Eng.	2-IBM 3725	2-IBM 3172-III				1-CNT NAU
ARTEMIS		1-IBM 3172-III	1-IBM 3825	2-IBM 3174		
HQ Admin.	2-AMD 4745	OSA	2-XEROX 4090			
JSC Admin/VM		OSA				1-CNT NAU
JSC Admin./MVS	4-IBM 3745 1-IBM 3725	OSA	1-XEROX 9790 1-IBM 4245	2-IBM 3274		2-CNT XAU
KSC Admin.	1-AMD 4725	OSA	1-XEROX 4090 2-XEROX 4050	2-IBM 3274		1-CNT XAU
MSFC Admin.	2-IBM 3725	OSA	2-XEROX 4254 2-XEROX 4050	1-IBM 3174		1-CNT GAU
SSC Admin.	1-IBM 3725	OSA	1-XEROX 4050 2-IBM 4245	2-IBM 3174 2-IBM 3174		2-CNT SAU
NACC PROD	Channel-to-Channel NACOMM	OSA		I-IBM 3174		
NACC COMMON	2-IBM 3725	1-IBM 3172-III		2-IBM 3274		

Table 3. NACC DETAILED ARCHITECTURE (SNA, FEP, LAN ADAPTERS, PRINTERS, CONTROLLERS, CNTs)
NOTE: OSA = Open Systems Adapter

Relationship of IT to Program Mission

The major goal of the NACC is to achieve further efficiencies and inherent cost savings while continuing support of consolidated Agency IT resources. The optimization of the NACC will be a continual process. At the NACC, efficiencies can continue to be gained by consolidating and standardizing software licenses, people skills, hardware maintenance, and capacity management.

In order to complete these optimization goals, the NACC will:

- coordinate activities with the Centers to assess and implement platform requirements for NASA administrative and programmatic applications, facilitating transitions to new technologies where practical and cost effective
- ensure that centralized, standardized, and disciplined control procedures and processes, as well as customer-focused IT services, are implemented within platform migrations at the NACC
- target removal of obsolete hardware and software as a means of decreasing maintenance cost and offering improved systems and services
- use technology as a primary driver for implementations, business cases, and strategic cost management review.

Summary Budget

Based on the user projected workloads, operational costs have been projected and rates for resource utilization have been computed using the chargeback algorithms. Budget line items have been computed for each Center workload, and all NACC-supported Centers have been notified of projected NACC support costs for their Centers. Continued provision of hardware maintenance, software maintenance, mainframe computer support labor, and associated supply and facility cost are included within planned budgets. The table below documents NACC projected costs. Note that HQ costs include projected Integrated Financial Management Program (IFMP) operational costs.

TOTAL NACC							
SITE	FY99	FY00	FY01	FY02	FY03	FY04	FY05
TOTAL NASA HQ	$2,189,000	$3,256,756	$3,634,217	$3,775,317	$3,917,700	$4,058,908	$4,180,615
TOTAL CODE M	$12,374,000	$11,672,292	$12,091,831	$12,625,738	$13,221,097	$13,820,233	$14,238,607
TOTAL CODE R	$3,747,000	$3,541,848	$3551,749	$3,559,492	$3,616,136	$3,717,679	$3,826,167
TOTAL CODE Y	$1,162,000	$1,074,398	$1,148,514	$1,225,342	$1,291,896	$1,357,505	$1,398,230
TOTAL NACC	$19,472,000	$19,545,294	$20,426,311	$21,185,889	$22,046,829	$22,954,325	$23,643,619

Table 4. NACC Projected Costs

Schedule of Major Milestones

Software Consolidation and Standardization

Efficiencies have already been gained by consolidating software licenses. Core software products have been identified and data center customers are continuing to be converted to these core products to standardize and eliminate functionally redundant software and to provide Year 2000-compliant systems. Software evaluation and selection is a continual process of encouraging NACC customers toward use of a single product to perform similar functions. Negotiations with various software vendors aim toward achieving the greatest technical benefit at the least cost.

System Automation

NACC is striving to move toward a lights-out operation to further reduce cost. Automation software is currently being standardized, and assistance is being provided to those customer sites that do not have automated tools, such as job schedulers. Software versions that support automation are being established as standards. NACC's goal is to automate all workloads as fully as possible for both operational and maintenance interfaces.

Obsolescence Removal

Many of the NACC customers initially had older technology disk storage devices when first migrating to the NACC. NACC has replaced obsolete disk technology with Redundant Array of Inexpensive Disks (RAID) technology. RAID was chosen for its reliability and performance, cost, reduced environmental requirements, growth-in-place capabilities, and minimal conversion impact on the user community. Also, modular, low cost Complementary Metal Oxide Semiconductor (CMOS) processors have been installed to replace large and inefficient bi-polar mainframes that were initially installed at the NACC. Currently the NACC is in the process of replacing obsolete tape management systems with high capacity, automated virtual tape management systems, which will greatly decrease floor space requirements for tape systems and improve user access to tape data.

Standard System Operations

In the future, the NACC will shift from supporting center-specific NASA workloads to supporting standardized software in lights-out environments. Expensive dedicated resources (Logical Partitions, Direct Access Storage Pools, and tape libraries) will give way to shared resource pools and common software. Common monitoring interfaces that function independently of physical location of computing resources will be used.

Client/Server and Mainframe Resource Sharing

Today, users require and vendors are providing platform interoperability between mainframe and client/server environments. Providers can accommodate multiple platforms within the same storage architecture. Consequently, vendors are increasingly called to provide non-disruptive maintenance as greater amounts of data supporting multiple platforms are stored within single storage units. The NACC will maximize the residual value of storage devices by implementing interfaces to open systems.

Web-enabled Applications

Some legacy systems running on the mainframe may be too costly to convert to open client/server systems, while other applications with large data requirements or large transaction volumes may be best suited for the current platform. CMOS servers may be used to continue to run these applications with Web servers employed as the front end access system. Web-enabling of applications carries the added benefit of avoiding client software updates, application redesign, and retraining required for new platforms. The NACC and its customers will determine the applicability of web-enabled front ends for current applications which are too costly to migrate to other platforms.

Performance Indicators: The NACC has well-established practices for ensuring that service levels are met and assessing customer satisfaction. These include NACC measurement of performance in consolidation environments, completion of memorandums of understanding for all customer sites, and establishment of standard service level metrics.

Metrics

The NACC is responsible for producing and providing to its customers metrics which address system performance and availability and for ensuring that capacity and utilization measurements are completed for upgraded environments. The NACC has established metrics for availability, response time, problem management, customer satisfaction, and costs for all workloads. Metrics are posted monthly on the NACC World Wide Web site for NACC customers to review. Additionally, monthly metrics, as well as plans, goals, and accomplishments, are provided for MSFC management review. Also, the NASA CIO is provided cost and customer satisfaction metrics on a quarterly basis.

Customer MOUs

Memorandums of Understanding (MOUs) written for NACC workloads outline duties and responsibilities assigned to the NACC and those remaining at the centers. Within the MOUs are Service Level Agreements (SLAs) that define the requirements, services, and products to be provided by the NACC. Monthly performance metrics and site-specific metrics are created to track service level compliance.

Technical Interchange

Technical Interchange Meetings (TIMs) are used to solicit customer feedback related to performance according to SLAs. In addition, personnel are assigned as points of contact to interact with the centers on a daily basis. Discussion topics include system standalone time activities related to Change Requests (CRs), status of newly requested activities from the user community, database activities, commercial-off-the-shelf software activities, mainframe and applications performance metrics, and communications issues and activities.

Morning Standup Meetings are held to discuss NACC priority trouble tickets opened within the past 24 hours. All NACC customers participate in these meetings, as does NACC staff.

Project Direction

Since 1994, an established board of Center representatives, the NACC Project Team, has existed to participate in NACC planning and validate its strategic direction. The continuing direction of the NACC is reviewed during bi-weekly meetings of the NACC Project Team. This team includes representatives for each NACC customer. Held twice yearly, face-to-face meetings of the NACC Project Team further serve to review NACC technical activities, projects, future planning, and budget. Additionally, the NASA Chief Information Officer (CIO) has directed the NACC to ensure consistency in its program planning with NASA Policy Directive 7120.5A, Program/Project Management and NASA Procedures and Guidelines (NPG) 7120.5A, NASA Program/Project Management. The NASA CIO has named MSFC to be the Lead Center Governing Program Management Council (GPMC) for the NACC and has delegated oversight responsibilities to the MSFC PMC.

How Planned Investments Meets Decision Criteria for Existing Investments

The NACC meets the decision criteria in each of the noted areas as follows:

Mission Support - The NACC provides Agencywide Mainframe support for ongoing Administrative and Programmatic requirements. Centers have projected NACC requirements throughout FY05.

Alternative Sources - In April 1997, the NACC reported to the NASA CIO findings of a multifunctional team review of the feasibility of outsourcing NACC services. The team baselined services and rates of two commercial providers in comparison to NACC services and rates. Findings were that the NACC's rates compare favorably with those of commercial providers and that outsourcing the current workloads would not provide significant cost savings and could possibly impact other Agencywide initiatives that are currently underway. The NACC developed a Strategic Plan (September 1997) which considers the direction and availability of information technology, individual Center application management plans, and timing and impact of other concurrent Agency Information Technology initiatives. Within that plan, further cost management reviews were targeted and scheduled as a planned future activity.

Customer Requirements - The NACC's consolidated support has resulted in a cost avoidance in excess of 49 percent of pre-consolidation projected budgets. New projects, such as the Agency Payroll Consolidation, are able to be added to the NACC centralized resource management with minimal cost increases.

Return on Investment - The NACC continues to project cost avoidance in excess of 49 percent of pre-consolidation projected budgets throughout FY05.

Architecture - The NACC completed the NACC Strategic Plan, September 1997, which addresses technology trends, Year 2000 Planning, and implementation of standard hardware and software systems. The plan addresses mainframe, mid-tier, and client/server technology management within the role of MSFC as Principal Center for Agencywide Operational Computer Support. The NACC has also completed the NACC Program Plan and Program Commitment Agreement in accordance with NPG 7120.

Summary Schedule for Planned Investments
There are no NACC plans to acquire non-existing information technology assets, services, or support services which are equal to or greater than $5 million per year.

A.3.2.3 Desktop LAN & Voice Communications Services (ODIN)

The Outsourcing Desktop Initiative for NASA (ODIN) is a long-term outsourcing arrangement with the commercial sector which transfers to it the responsibility and risk for providing and managing the vast majority of NASA's desktop, server, and intra-center communications assets and services.

Every Center, except the Jet Propulsion Laboratory (JPL), will use ODIN. JPL may use ODIN, however, JPL has embarked on its own outsourcing vehicle. Nonetheless, JPL has agreed to periodically review (at appropriate times) their outsourcing arrangement vis-à-vis ODIN and pursue that arrangement which best meets the needs of NASA and JPL. Other government agencies will be able to buy from the ODIN contractors through the General Services Administration (GSA).

Under the contract, NASA will define the computer and communications capabilities for each job within the Agency and purchase a particular bundle of hardware, software and communications equipment for each "seat." The price for each type of "seat" will be fixed.

The ODIN Objectives are to:

- Shift asset management responsibilities and risk from the Government to the ODIN Contractor.
- Facilitate information technology management
- Increase systems and product interoperability across the Agency.
- Allow civil servant resources to focus on core R&D mission.
- Optimize service delivery using commercial best practices.
- Reduce cost of IT services

The ODIN Services:
Each desktop seat includes the necessary IT support services:

- Hardware and software, installation, maintenance, and technology refreshment
- administration, relocation, and network access
- customer support and training
- server services (e.g., file, print, email, and application servers)

The desktop bundle is referred to as a "seat":

- General Purpose seats - GP1, GP2 and GP3,
- Scientific & Engineering seats - SE1, SE2 and SE3
- Maintenance Only seats - MA1 and MA2
- Network Attached Device seat — NAD

Additional services available include: remote communications services, server services (comp1, web1, file1, and app1), telephone, fax, administrative radio, and local video.

Summary Schedule for Planned Investment.
The ODIN Program has been approved by the NASA Administrator and will terminate only upon his direction. The ODIN contracts expire June 30, 2010 and, unless the Program is terminated, another set of ODIN contracts will be acquired in time to ensure continuity of performance. This will require a re-competition which should begin no later than December 2008.

Schedule performance will be evaluated by assessing the extent to which the Centers deployed ODIN (i.e., executed delivery orders) in accordance with these schedule targets.

- Goddard Space Flight Center — Delivery Order NLT October 16, 1998
Implementation NLT November 2, 1998
- Kennedy Space Center — Delivery Order NLT October 30, 1998
Implementation NLT November 23, 1998
- Johnson Space Center — Delivery Order NLT October 30, 1998
Implementation NLT January 1, 1999

- Stennis Space Center — Delivery Order NLT October 30, 1998; Implementation NLT February 1, 1999
- Marshall Space Flight Center — Delivery Order NLT October 30, 1998; Implementation NLT May 1, 1999
- Headquarters — Delivery Order NLT May 5, 2000; Implementation NLT June 1, 2000
- Glenn Research Center — Delivery Order NLT August 15, 1999; Implementation NLT October 1, 1999
- Dryden Flight Research Center — Delivery Order NLT May 15, 2000; Implementation NLT July 1, 2000
- Langley Research Center — Delivery Order NLT June 23, 2000; Implementation NLT September 1, 2000
- Ames Research Center — Delivery Order NLT June 2, 2000; Implementation NLT July 2, 2000

All Centers will deploy ODIN by October 1, 2000.

Performance Indicators: ODIN success will be measured by the degree to which ODIN achieves (i.e., meets and exceeds (improves upon)), on a continuing basis, the following technical performance, schedule, cost commitments (including actual ODIN participation and realized savings).

Technical Performance Commitments - Technical performance will be evaluated by assessing the response to actions within a set time - Service Delivery, the extent to which a seat/system is operational - Availability, and customer satisfaction - *Customer Satisfaction*. The ODIN technical performance targets are:

Performance Metrics	Service Delivery (%)	Availability (%)	Customer Satisfaction (%)
Desktop User Services	98	98	DOSP agreed to %*
Phone Service	95	99.9	DOSP agreed to %*
Fax Service	95	99.5	DOSP agreed to %*
Local Video Service	95	99.5	DOSP agreed to %*
Administrative Radio Service	95	99.9	DOSP agreed to %*
Public Address Service	95	99.5	DOSP agreed to %*

(NOTE: These "%*" will be negotiated as part of each Delivery Order Solicitation Process (DOSP) and this Program Commitment Agreement modified accordingly.)

How Planned Investment Meets Decision Criteria.
Mission Support - One of the key objectives of ODIN is to allow NASA to concentrate its limited resources more effectively on its core R&D mission, while still securing world-class, commodity-priced IT.

Architectures - ODIN will help transform desktop computing into a commodity within NASA. This will enable NASA to shift personnel and other resources currently supporting these functions to R&D functions supporting core missions. In turn, this should reduce the cost to deliver computing and communication services and facilitate the management of these distributed computing assets through the evolution of more common environments. Embracing commercial practices of using common solutions for common problems wherever practical will lead to improved productivity, cost management, and enhanced interoperability.

Acquisition Strategy -. In June 1998, NASA selected seven companies to fulfill a multi-billion dollar contract, called the Outsourcing Desktop Initiative for NASA (ODIN). This contract, that will apply a "faster, better, cheaper" approach to the way the Agency obtains desktop computers and local communications services. ODIN has several goals, most importantly, it will deliver cost effective services to meet NASA's mission and program needs using commercial practices. It will allow NASA civil servants to focus on the Agency's core mission, make it easier for our systems to operate together and allow the Agency to share risks and rewards with the private sector. The contract also will allow NASA to better account for the funds it spends on local computing products and services. With one set of contracts providing these services across the Agency, it will be clearer how much they are costing NASA. Long-term savings over the life of the contracts could approach 25 percent compared to existing procurement procedures, and that has allowed the Agency to reduce its future Information Technology budgets.

The successful offers and the total contract values are: Boeing Information Services, Inc., Vienna, VA; Computer Sciences Corporation, Laurel, MD; Dyncorp TECHSERV, LLC, Reston, VA; FDC Technologies, Bethesda, MD; OAO Corporation, Greenbelt, MD; RMS Information Systems, Inc., Lanham, MD; and Wang Government Systems, Inc., McLean, VA. The minimum dollar value of each contract is $1,000. The maximum ranges from $4.35 billion to $13.12 billion, including orders placed by other agencies through GSA.

Under the ODIN delivery-order process, each NASA center will place orders exclusively with one vendor. Each delivery order can cover a period of up to three years, but may be renewed on a sole-source basis as a logical follow-on without writing or obtaining approval for a Justification for Other. The period of performance for each fixed-price, Indefinite Delivery, Indefinite Quantity contract with each ODIN vendor is nine years (

June 22, 1998 through June 21, 2007). No delivery order shall be issued with a period of performance extending beyond June 30, 2010.

A.3.2.4 Desktop LAN & Voice Communications Services (non-ODIN)

ARC

This major IT investment, non-ODIN services, is tied to the ARC research efforts in support of our COE for IT mission, providing state-of-the-art central server, networking and voice communications. The Center will consider acquiring this category of services via the ODIN contract at the time of the next delivery order selection process.

Summary Schedule for Planned Investments. Because most acquisition decisions are made at the Branch level or below, the only major milestone is for a planned upgrade of the Center-wide network and communications infrastructure, beginning in FY 2000 and ending in FY 2003. This upgrade will total $6M over the four-year period.

Performance Indicators. Non-ODIN services are measured by customer satisfaction, as determined by customer surveys and service evaluation forms. In addition, network quality of service, speed and flexibility are measured by such tests as percent of capacity, response time, and availability of services.

How Planned Investment Meets Decision Criteria.
Mission Support. The investment supports NASA's core mission functions, Mission Support, Science, Aeronautics and Technology, and Humans in Space.

Alternative Sources. No non-NASA fund sources are available to support these core mission functions.

Customer Requirements. The existing system investment continues to satisfy customer requirements as expressed in customer requests for service improvements. Existing mass-buy contracts are used to minimize cost.

Return On Investment. The existing system investment maximizes return on investment by reducing costs (mass-buy contracts) and improving service. In particular, the upgrade described above sill increase quality, speed and flexibility the Center-wide network and communications infrastructure.

Architecture. The existing system investment continues to be consistent with the NASA (and therefore the Federal) IT Architecture, as described in NASA-STD-2814.

DFRC

DFRC's Non-Odin costs reflect ODIN like services that will not be part of initial ODIN start, development or lab type environments.

GRC

The non-ODIN investments identified in FY00 through FY05 are not considered major IT investments but are comprised of hardware, software, and support services which are procured to support the following activities:

- Testbed hardware and software development
- Specialized research applications
- Systems utilized for specialized scientific purposes (e.g., department servers and computers utilized in laboratories for experiment control)
- Data acquisition system support
- Graphics visualization
- Specialized programmer support to analyze business databases

GSFC

There were many existing contracts at GSFC prior to ODIN, which were still in effect when ODIN was implemented. As contracts for ODIN-like services come to an end, the affected areas may transition to ODIN and we see these trends occurring. The ODIN-like services that are not covered by the ODIN contracts cut across a very wide range of applications, which may or may not be easily transitioned to ODIN for many reasons. A mechanical CAD system, in which special equipment and software must be carefully tailored by the Engineer utilizing the equipment, can not receive the support from ODIN that is needed. But there may be other mechanical CAD systems where ODIN can supply the needed equipment and support. A general transition to ODIN is expected as contracts terminate and as systems are determined to be applicable to ODIN.

Headquarters:

There is a Government Wide Acquisition Contract (GWAC) for Non-ODIN Support. Once the contract extension ends on April 30, 2000, Headquarters non-ODIN support service requirements, e.g., those for mainframe and mid-range computer operations and software applications development, will be met by buying from the government-wide acquisition contract (GWAC) managed by the Department of Transportation (DOT). This contract, call the Information Technology Omnibus Procurement II (ITOP-II), is available for use by all government agencies and provides a broad range of information technology services and support more than sufficient to meet Headquarters' requirements.

Performance Indicators: All functional areas are supported through specific contractor task efforts. Each task has performance measures such as service response times, schedules met, first time acceptance of deliverables, quality of deliverables, problem reporting rates, programming error rates, and customer satisfaction.

Various project management techniques are also used to measure the extent to which software applications and hardware systems satisfy customer requirements. Some examples of these are preliminary design reviews, critical design reviews, test readiness reviews, operational readiness reviews, and post implementation reviews. Also, customer service requests are tracked monthly with regard to timeliness of completion and degree of customer satisfaction.

How Planned Investment Meets Decision Criteria for Existing Investments
Mission Support - Continuous information technology services support is mission critical for Headquarters staff to adequately perform their jobs. Information technology has become a pervasive and integral productivity enhancement tool for all Headquarters employees.

Alternative Sources - An alternative source has been selected for desktop and local area network and communications services and that alternative is the Outsourcing Desktop Initiative for NASA (ODIN). The remaining Headquarters requirements for IT services will be bought from the another government agency through a GWAC.

Customer Requirements - Even with a decreasing information technology budget, customer requirements continue to be satisfied in a highly successful manner. Also, advances in information technology have resulted in significant work process redesign not only in the administration of enterprises and programs, but in interpersonal communications as well, all leading to reduced cost and improved working conditions.

Return on Investment - The information technology support services which are provided are based on the information access and handling needs of Headquarters program/mission managers and support staff. Information technology has to a large degree off-set the significantly down-sized work force and has enabled Headquarters personnel to perform their functions more efficiently and effectively. Overall customer satisfaction remains excellent at 85% or higher.

Architectures - The NASA Headquarters computing and telecommunications infrastructure fully complies with Federal and agency architectures as well as industry standards. Standard COTS-based systems, common NASA administrative systems, and applications systems converted for the year 2000 problem gave NASA Headquarters well integrated work processes. In addition, the state-of-the-art highly integrated computing and telecommunications infrastructure has increased flexibility when it comes to choosing information technology suppliers and providing global communications for every Headquarters employee.

JPL

JPL is not participating in the NASA ODIN program, and all of JPL's desktop support is provided through non-ODIN JPL contracts.

JSC

The Johnson Space Center has identified budget requirements in the "ODIN-Like" portion of the OMB Exhibit 53 for the following types of items:

- Hardware and maintenance for some specific labs
- SEWP purchases for specific types of lab hardware and software
- Software licenses and maintenance for items not provided in the ODIN contract
- Agencywide software contracts
- Small software purchases via Credit Card
- Small hardware purchases via Credit Card
- Hardware and Software purchases for off-site support personnel
- Network administration for specific applications
- Travel and training for products not covered by the ODIN contract
- Application Development
- Steady state operations for our host systems

The Johnson space Center uses "ODIN-Like" funds to cover I/T not available on the ODIN Contract. Examples of these types of service are:

- Having service within a specific lab performed by the same contractor responsible for the technical performance of the task. The contractor is very knowledgeable about the systems and tools being used, and, thus, able to provide strong maintenance support.
- Buying certain type of workstations, such as using the SEWP contract for SUN or Alpha workstations.
- Providing off-site support for contractors. (ODIN is designed for on-site support)

In some cases, we have software licenses, or contracts for specific equipment that are outside of the scope of the ODIN Contract.

The Johnson space Center uses "ODIN-Like" funds to cover I/T that is available on the ODIN Contract. Examples of these types of service are:

- Obtaining I/T via contracts which preceded ODIN and are still in effect.
- Purchasing I/T using Government credit cards when such purchases fall within the boundaries of the credit card process and is in the best interest of NASA/JSC.
- Purchasing I/T using other Government contracts (e.g., SEWP, Agency-wide software contracts) when it is in the best interest of NASA/JSC.

KSC

To the greatest extent possible, KSC uses the ODIN contract for desktop computing capability. The small amount of "ODIN-Like" purchases include:

- Hardware and maintenance for some project specific labs
- SEWP purchases for specific types of lab hardware and software
- Hardware and Software purchases for off-site support personnel
- Network administration for specific applications
- Travel and training for products not covered by the ODIN contract
- Application Development
- Steady state operations for our host systems
- Mission Support hardware and software

LaRC

Non-ODIN type IT at LaRC is managed synergistically with the various missions conducted at the Center. By nature, it is decentralized with investment and support decisions made in conjunction with requirements of the specific programs. Aside from administrative/general purpose computing, the distributed computing environment at the Langley Research Center is characterized as heterogeneous and diverse. Except for a few niches, there is no typical architecture, software load, software configuration, or usage pattern which describes a significant portion of the computers. This absence of commonality stems from the diversity of the research and development tasks carried out at LaRC and the integral relationship between computation and research.

Summary schedule for the planned investments
There is no specific funding stream for IT at LaRC. Each organization determines the extent to which IT expenditures will be made. It is not uncommon for a project manager to increase or decrease IT expenditures deemed appropriate to the overall project, trading those decisions off against other areas of funding. Since the budgets are so tightly integrated into project planning and overall accomplishment of specific project initiatives, LaRC does not operate on a separate IT budget as a means to manage its IT. Each organization is responsible for IT investment planning to meet its organization's requirements.

Performance Indicators: LaRC's non-ODIN IT expenditures are made based on programmatic requirements. The indicators as to the performance of the IT investments are how well the IT purchases are assisting LaRC in meeting its program/project missions and objectives.

How Planned Investment Meets Decision Criteria
The LaRC non-ODIN IT investments meet the decision criteria by providing LaRC the required tools that enable interoperability, security, information exchange and resource sharing while retaining the flexibility that allows NASA to take advantage of the rapid improvements in the state-of-the-art IT technologies.

The LaRC non-ODIN IT investments also meet the decision criteria of risk reduction as the Program/project managers who will use the resources have substantial involvement in the planning and implementation.

SSC

SSC is completing the transition period for the ODIN implementation. However, there are a few non-ODIN requirements still remaining.

A.3.2.5 IT Security

See the Description of the Principal Center for Information Technology Security activity in Appendix B for an explanation of this Agencywide investment.

A.3.3 IT Architecture & Planning Investments

A.3.3.1 Year 2000 Areas

NASA has a comprehensive Year 2000 Project Plan focused on resolving the Year 2000 problem in NASA's Information Technology resources.

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A.4 BUDGET PLANS FOR MAJOR AND SIGNIFICAN BUT NOT MAJOR IT INVESTMENTS

This section provides five-year budget plans for NASA's major and significant but non-major IT investments. The investment types are: Existing, New, or Pathfinding as defined in section A.1 of this plan.

Center	Investment Type	System Name	Fiscal Year				
			FY 2001	FY 2002	FY 2003	FY 2004	FY 2005
			$K				
Major IT Investments for which an Exhibit 300B report is prepared							
HQS	New	Integrated Financial Management System (IFMS)	$66,000.0	$56,900.0	$49,600.0	$48,200.0	$48,400.0
MSFC & JSC	Existing	NASA Integrated Services Network (NISN)	$81,428.6	$71,509.9	$67,161.1	$64,291.8	$64,424.8
MSFC	Existing	NASA ADP Consolidation Center (NACC)	$20,427.0	$21,187.0	$22,046.0	$22,954.0	$23,645.0
GSFC & JSC	New	Earth Observing System Data Information System (EOSDIS)	$252,285.0	$249,208.4	$254,741.6	$281,518.1	$265,918.1
All	New	Desktop LAN & Voice Communications Services (ODIN)	$117,387.9	$118,068.0	$118,884.4	$118,978.7	$119,364.8
Significant, Non-Major IT Investments							
MSFC	Existing	Standard Agencywide Administrative Systems	$4,961.8	$5,006.6	$4,295.1	$2,727.2	$1,614.2
KSC	Existing	Kennedy Inventory Management System (KIMS)	$2,491.0	$2,566.0	$2,643.0	$2,724.0	$2,732.0
GSFC & JSC	Existing	Flight Dynamics System	$22,867.0	$17,529.0	$17,728.1	$10,809.5	$32,616.5
GSFC & JSC	Existing	Mission and Data Systems (M & DS)	$92,323.1	$70,896.9	$70,759.6	$45,115.9	$45,255.1
GSFC & JSC	Existing	Space Network Systems	$83,431.2	$67,588.5	$66,584.8	$57,637.5	$57,849.8
JSC	New	GSFC Integrated Mission Operations Center (IMOC)	$7,341.5	$4,242.4	$3,255.8	$2,922.4	$2,975.0
JSC	New	Data Services Management Center	$6,078.5	$5,434.3	$3,871.5	$2,238.2	$1,826.9
DFRC	Existing	Western Aeronautical Test Range (WATR)	$8,906.4	$8,914.2	$8,599.5	$7,647.2	$7,695.4
ARC	Pathfinding	High Performance Computing and Communication	$59,260.0	$58,060.0	$48,760.0	$48,560.0	$29,360.0
ARC	Pathfinding	IT R&T Base	$52,150.0	$51,550.0	$51,550.0	$52,650.0	$52,650.0
LaRC	Pathfinding	Intelligent Synthesis Environment (ISE)	$40,000.0	$40,000.0	$40,000.0	$40,000.0	$40,000.0
JSC	Existing	Shuttle Avionics and Integration Laboratory (SAIL)	$14,484.0	$14,611.3	$15,168.2	$15,810.3	$16,236.8
JSC	Existing	Shuttle Mission Training Facility (SMTP)	$42,208.0	$51,170.2	$53,135.3	$55,390.9	$56,921.0
JSC	Existing	Shuttle Software Production Facility (SPF)	$19,507.2	$19,485.0	$20,196.1	$21,017.3	$21,562.4
JSC	Existing	Station Vehicle Master Data Base (VMDB)	$2,000.0	$1,000.0	$1,000.0	$1,000.0	$1,000.0
JSC	New	Mission Control Center (MCC)	$52,387.9	$51,793.5	$52,950.4	$50,937.1	$51,251.9
JSC	New	Integrated Planning System (IPS)	$20,983.6	$21,479.8	$21,834.2	$20,626.9	$20,601.0
KSC	Existing	Launch Control Systems (LCS)	$49,751.7	$37,253.2	$18,903.9	$12,214.7	$11,346.2
KSC	Existing	Payload Data Management System (PDMS)	$1,153.0	$1,298.0	$1,349.0	$1,402.0	$1,458.0
MSFC	Existing	Huntsville Operations Support Center (HOSC)	$15,413.0	$16,748.0	$17,916.0	$18,886.0	$19,160.0
MSFC & JSC	Existing	Data Reduction Center (DRC)	$11,729.4	$11,881.1	$12,048.3	$11,491.0	$11,491.0
JSC	New	Space Station Training Facility (SSTF)	$21,048.1	$11,425.9	$8,236.8	$5,695.9	$110.1
GSFC	Pathfinding	Earth and Space Science (ESS) Project of the High Performance Computing and Communications (HPCC) Program	$5,400.0	$4,400.0	$4,400.0	$600.0	$0.0
GSFC	Existing	NASA Center for Computational Sciences (NCCS)	$11,501.5	$15,411.2	$12,315.8	$12,316.8	$12,316.8
ARC	Pathfinding	Intelligent Systems	$40,000.0	$45,000.0	$45,000.0	$45,000.0	$45,000.0
GSFC	Existing	National Space Science Data Center (NSSDC)	$4,986.0	$4,915.0	$4,815.0	$4,815.0	$5,055.8
JPL & JSC	Existing	Deep Space Network	$89,302.9	$79,024.4	$79,450.2	$72,096.3	$94,325.1
JPL & JSC	Existing	Advanced Multimission Operations System (AMMOS)	$49,670.0	$47,922.2	$46,500.7	$47,005.0	$47,018.0
All	New	Desktop LAN & Voice Communications Services (non-ODIN)	$63,268.7	$64,013.5	$65,303.3	$64,743.8	$66,096.4
All	Existing	IT Security	$44,363.3	$43,166.8	$42,342.9	$42,795.1	$43,719.8

Exhibit A-1: Major and Significant but non-Major NASA Information Technology Investments

Appendix B: Principal Center and Center of Excellence Initiatives

Appendix B. Principal Center and Center of Excellence Initiatives

B.1 Ames Research Center as Principal Center for Management of Supercomputing Agencywide

The consolidation of NASA's supercomputing resources has been assigned as a Principal Center responsibility of the Ames Research Center (ARC). The Consolidated Supercomputing Management Office (CoSMO) has been established at ARC and is responsible for the acquisition, maintenance, operations, management, upgrading, and budgeting for NASA's supercomputing capability regardless of location and function. The scope of supercomputing resources within NASA includes the high speed processors, mass storage systems, and network interfaces. The supercomputers include production, research and development, and secure compute engines.

The mission of CoSMO is to meet NASA's supercomputing requirements for each Enterprise office while realizing an overall cost savings by effective and efficient management of NASA's supercomputing resources through the end of the decade and into the next century.

Objective. The NASA goals and objectives for consolidated management of supercomputing are as follows:

- Reduce operational costs.
- Consolidate operations across NASA and design an optimal supercomputing architecture to reduce the number of physical locations for supercomputing.
- Collocate supercomputing platforms within large data centers where applicable.
- Modernize data centers to improve service and reduce life-cycle costs.
- Outsource when cost effective.
- Form partnerships with Centers using matrix management principles.
- Participate in NASA's transition to full cost accounting by designing a market-based approach for utilization and costing of supercomputing resources.

Organizational Structure and Strategy. The Consolidated Supercomputing Management Office (CoSMO) is the performing organization with the Director of CoSMO reporting to the Center Director. The organization strategy for CoSMO is a NASA supercomputing operations team that (1) understands and satisfies validated customer requirements through close personal liaison using distributed participants, (2) achieves service excellence and cost efficiencies through centralized management, integrated supercomputing resources, and leadership with a management team that leverages the distributed expertise, and (3) explores outsource opportunities that lead to efficiencies. The concept of the CoSMO is based on the approach of distributed participation at the field Center level supporting consolidated management through the NASA Principal Center, Ames Research Center.

Staffing and Funding. Staffing of CoSMO includes five employees, four of which are civil servants. Positions included in the Office include a Director, Deputy Director, Assistant Director, Senior Resource Analyst and an Administrative Assistant.

Planned Obligations, $K, by Fiscal Year	2001	2002	2003	2004	2005
Consolidated Supercomputing Management	10000	10000	6000	10000	10000

Funding estimates only include support to OAT Centers; additional resources will be added subsequent to approval of the specific Enterprise.

Of the annual resources identified, $6.0M is identified for Operations and $4.0M for capital refreshment. The specific capital buys in FY 2001 have not been identified yet and will be developed during the next fiscal year. The investments CoSMO makes will meet the decision criteria, especially the criteria for Mission Support and Architectures.

Metrics. CoSMO is in the process of developing metrics for its operations that will evaluate its customer service, consultation services, and cost/performance areas. These should be in place by the beginning of FY 2001.

Status and Next Steps. A management plan that will guide the activities of CoSMO has been developed and approved by the NASA IT Investment Council. The next steps for CoSMO include working with the various Enterprises to identify areas where CoSMO can support them in accomplishing their programs. CoSMO will continue to develop options for the Agency to meet its high-end computing requirements at minimal cost.

B.2 Ames Research Center as Principal Center for Information Technology Security

NASA has a substantial investment in mission data and information technology to accomplish its mission. It is critical that the Agency develop reasonable safeguards for its information technology systems, based on an analysis of the risk involved. To meet this objective, Ames Research Center was designated as the Principal Center for Information Technology Security.

As the Principal Center for IT Security, Ames is acutely aware of the CIO's focus on the increased levels of security required to protect NASA's valuable assets, processes, and important working relationships. The increased focus on IT Security results from:

- Increased use of distributed instead of centralized systems,
- Increased use of dial-in access, increased use of the Internet,
- Expansion of NASA resources available through the Internet,

- Evolving e-mail and encryption standards, and
- The development of new software such as IFMP and other integrated systems.

The strategy for the Principal Center is to identify IT Security focus areas, to consolidate current activities at the Centers, to leverage from each Center's area of IT Security expertise, and to develop plans for Agency-wide IT Security activities. Five strategic IT Security areas have been identified and Expert Centers selected to focus and coordinate Agency activities. The following table describes the Principal and Expert Center roles and illustrates the relationship between the Principal Center and the Expert Centers.

<table>
<tr><th colspan="2">Principal and Expert Center Roles</th></tr>
<tr><td colspan="2">Ames Research Center (ARC) as Principal Center for IT Security
• Recommend IT Security policy, procedures, and standards
• Gather information technology security requirements from the NASA enterprises, functional offices, and centers
• Develop an Agency information technology security strategic plan
• Develop and recommend an IT Security architecture, making sure it is integrated into the overall IT architecture of the Agency
• Promote common methodologies and approaches to IT security
• Recommend IT security metrics and provide a focal point for gathering data on IT security metrics and reporting on IT security status
• Coordinate information technology security incident reporting and response activities
• Recommend budgets to support an Agency information technology security infrastructure</td></tr>
<tr><td>Goddard Space Flight Center (GSFC) as Expert Center for IT Security Notifications, Incident Coordination and Response
Focus: Monitoring and coordination of responses to IT security incidents and evaluation and distribution of ways to protect against IT security threats.</td><td>Incident identification
Intrusion tracking
Response teams
Threat evaluation
Threat resolution
IT Security tools</td></tr>
<tr><td>Glenn Research Center and Stennis Space Center (GRC/SSC) as Expert Centers for IT Security Training and Awareness
Focus: Identifying training requirements, developing training resources, and coordinating training activities across the Agency.</td><td>Curriculum requirements
IT Security workshops
IT Security awareness
On-line courses
IT Security technical training</td></tr>
<tr><td>Marshall Space Flight Center as Expert Center (MSFC) for IT Security Networks and Communications
Focus: Consulting on and evaluating IT security approaches and solutions for network and communication operations.</td><td>Network audit tools
Firewalls
Internet security requirements
Incident tracking tools
Monitoring and testing</td></tr>
</table>

Principal and Expert Center Roles

Principal and Expert Center Roles	
Jet Propulsion Laboratory and Dryden Flight Research Center (**JPL/DFRC**) as Expert Centers for IT Security Systems and Applications Focus: Consulting on and evaluating IT security approaches/solutions for systems, data/application servers, data and application software operations.	Audit tools Application Security Virus detection Secure web applications Secure operating system configurations Secure work flow processes System testing tools
Ames Research Center (**ARC**) as Expert Center for IT Security Development Focus: Evaluating, demonstrating, and recommending cryptographic technology for NASA's IT infrastructure and architecture.	Architectural planning Enabling applications Secure video conferences Crypto-technology demonstrations

Principal and Expert Center IT Security Staffing and Funding

Fiscal	2001	2002	2003	2004	2005
ARC as Principal and Expert Center					
Civil Service staffing, FTE	5	5	5	5	5
Civil Service budget, $K	500	500	500	500	500
Support Service Contractor staffing, FTE	11	11	11	11	11
Support Service Contractor budget, $K	1518	1537	1556	1575	1596
Total budget, $K	**2018**	**2037**	**2056**	**2075**	**2096**

Metrics. ARC will recommend IT Security metrics and provide a focal point for gathering data on IT Security metrics and reporting on IT Security status.
To accomplish this mission ARC has identified ITS Policy/Management; ITS Training; Intrusion Detection and Reporting; Audit and Monitoring; Trust Model; and New Technologies (Services) as focus areas. Accomplishments, activities and planned initiatives in these areas are described for FY1999, FY2000, and FY2001.

ITS Policy/Management		
FY 1999 Accomplishments	FY 2000 Activities	FY 2001 Initiatives
	Recommend metrics and provide focal point for gathering and reporting metrics	

ITS Training		
FY 1999 Accomplishments	FY 2000 Activities	FY 2001 Initiatives
Provided multimedia awareness program to all Centers	Enhance and roll out awareness training program to all Centers	

Test pilot System Administrator certification program	Enhance certification program and roll it out to all Centers	
Intrusion Detection and Reporting		
FY 1999 Accomplishments	FY 2000 Activities	FY 2001 Initiatives
Implemented a new, proactive incident management role for NASIRC	Gauge effectiveness of the new role and make adjustments as required	
	Increase use of penetration testing	
Audit and Monitoring		
FY 1999 Accomplishments	FY 2000 Activities	FY 2001 Initiatives
Purchased audit and monitoring tools and deployed to all Centers	Assess effectiveness of tools and make adjustments as required Roll out second phase	
Trust Model		
FY 1999 Accomplishments	FY 2000 Activities	FY 2001 Initiatives
Developed an Agency baseline rule set for a Trust Model	Implement the common rule set at all Centers	
New Security Technologies (Services)		
FY 1999 Accomplishments	FY 2000 Activities	FY 2001 Initiatives
Established an initial Virtual Private Network (VPN) capability	Expand the VPN capability to more programs and users	
Provide initial PKI to all Centers. Support secure messaging and IFMP schedule	Operate PKI Certification Authority (CA) Expand PKI at all Centers for IFMP and other applications	
		Roll out token/smart card technology
		Develop new capabilities in response to changing threat environment

B.3 Glenn Research Center as Principal Center for Workgroup Hardware and Software

Glenn Research Center (GRC) has been designated as the Principal Center for Workgroup Hardware and Software (a.k.a., Workgroup Principal Center). The Workgroup Principal Center is responsible for developing Agency wide hardware and software standards and architecture for desktop workstations and servers with an emphasis on interoperability and collaboration. GRC is also responsible for testing and integration of Commercial-off-the-Shelf office automation software. All Centers are responsible for following the established hardware and software standards and are responsible for budgeting for the acquisition and implementation of standard workstation, servers and associated software. Standards apply to all IBM compatible, Macintosh compatible, and UNIX workstations and servers.

General Objectives

GRC proposes to support the following NASA CIO priority areas:

- Y2K
- Project Management Standards and Guidelines
- Enhancement of the Basic Interoperability Profile
- IT Security
- Collaboration
- Information Technology Architecture

Due to various factors, the fiscal and human resources available to the Principal Center for Workgroup Hardware/Software (PCWHS) are approximately 50% lower than previous years. This level of resources has forced the PC WHS to re-scope both the number and thoroughness of architecture and standards activities. This narrative describes the focus areas and attempts to delineate the level of thoroughness of evaluations that will be undertaken.

Description of Priority Areas

Y2K

The GRC was responsible for coordinating the Agency's assessment of all desktop and server COTS for Y2K compliance. NASA has validated almost 6000 COTS items in use at NASA. Validation consists of verifying Y2K compliance by either independently testing a product or verifying through other resources such as vendor statements or other Government agency findings. Dispositions as a result of validations are as follows:

- 141 products have been independently tested and certified as compliant; 7 have been tested and certified as non-compliant.

- 1468 products are either not date sensitive or have been certified by the vendor as compliant.
- 852 products have been certified by the vendor to be non-compliant.
- 3159 products have been dispositioned as obsolete.
- 295 products were made compliant by upgrades or replacements.

There are currently 210 Desktop Core COTS on the Agency Desktop COTS database. These line items actually reflect approximately 50-60 unique products (not counting associated platform and version differences).

Objectives:
- Maintain current the validation of 90 Desktop Core COTS products.
- Update WEB-based Desktop Core COTS spreadsheet for the Agency as updated
- validations are received.
- Function as a clearinghouse for information dissemination on Desktop Core COTS products and related Y2K information for the Agency.

Metrics:
- Number of products which changed status after 4/30/99 (report on monthly basis)
- Number of products which changed status from Compliant to Non-Compliant (monthly report)
- Number of products which are non-complaint or failed on 1/1/2000

Project Management Standards and Guidelines

All NASA missions require tools to manage mission projects. Project Management tools are used at every level of a project to organize tasks, status and track project status, allocate responsibilities, and plan and track project costs and resources. Through the standardization of project management software and tools, projects can spend less time analyzing tools and more time managing projects. Tool standardization will also improve data sharing capability and collaboration and increase interoperability with other agency standard tools. A limited budget is available for acquisition of evaluation software. This may enable the most prevalent client-server products to be evaluated.

Objectives:
- Define infrastructure support for the implementation of NASA Policy Guideline 7120.5a, Program/Project Management Processes.
- Increase the ability to share project status information and collaboration among different projects and organizations.
- Increase interoperability and management capabilities among projects and institutional matrix support organizations. Reduce number of incompatible tools in place.

Metrics:
- Degree of compliance with standards.

Enhancement of the Basic Interoperability Profile

NASA has derived significant benefits in interoperability from deploying standards in electronic mail, client Internet software suites, and Office Automation software suites. Minimum desktop systems standards have been established to ensure the required software elements can be supported. NASA must continue to enhance the interoperability profile to enable distributed workgroup functionality in alignment with requirements for increased teaming among workers at NASA centers and with external partners. Further, NASA retains responsibility for standards and architecture to serve as guidance to the outsource vendor community. This activity will receive the largest allocation of human and financial resource and evaluations of products are expected to be of essentially the same quality as in previous years.

Objectives:

- Update of NASA STD-2804/5 twice yearly. Focus areas will include:
    - Product data reviews of Office 2000, Windows 2000, and Calendaring/Scheduling standard
    - Desktop data conferencing standard
    - Document management standards
- Provide guidance to the ODIN benchmarking service for NASA desktop systems to ensure NASA software requirements are properly included
- Ensure requirements of the IFMS are included in the minimum hardware and software standards
- Limited evaluations and establishment of standards frameworks for Linux and mobile computing systems

Metrics:

- Degree of compliance with standards

IT Security

The GRC, in their role as Principal Center for Workgroup HW&SW will support the agency initiatives for IT Security lead by Principal Center for IT Security, Ames Research Center. Due to funding limitations, this activity will be largely focused on IT Security Working Group participation.

Objectives:

In support of the IT Security/Trust Model Working Group GRC will:

- Review architecture documents produced in support of the network or host Trust Models.
- Monitor mailing lists and attend telecons and workshops to represent GRC's PC WHS role.

- Provide guidance in the host trust model development for UNIX configuration standards.
- Provide guidance for PKI implementation at GRC.

Metrics:

- Metrics in these areas will be defined by the Principal Center for IT Security.

Collaboration

Secure collaboration among the NASA centers and our external partners is a key theme in the NASA Strategic Plan. NASA workgroups often span NASA centers, aerospace companies, academia, and other government agencies. A "Collaborative Tools System" can increase communication, coordination, facilitation, and planning for these distributed workgroups. Collaborative tools may also reduce process cycle times by easing the restrictions of time and space. These collaborative tools must also possess the functional capabilities required to utilize the existing NASA security and network infrastructure

Typical collaborative activities or functions that NASA workgroups perform include: ad hoc communication, brainstorming, document creation, document review (comments/dispositions), document sharing for group reading and updating, building a group "memory", scheduling events, attending meetings, and assigning and tracking actions. These functions consume and produce electronic artifacts often consisting of text documents, presentations, spreadsheets, project plans, calendars, images, scientific data, audio, and video. Collaborative workgroup members are typically distributed across NASA centers and external partners. Further, NASA like the world at large, is moving towards a more mobile workforce which expands potential locations of collaborators to almost anywhere. Funding limitations preclude the PCWHS from as aggressively pursuing this area as we believe it deserves to be pursued. However, the work planned will set a solid foundation for moving out much more aggressively in subsequent years. Tentative agreements have been reached with the ISE Program Office for resources to conduct some further collaborative studies. Should these materialize, they will contribute to the foundation for further work.

Objectives:

- Collaborative requirements and tools
- Update agency collaborative tools requirements and document through interviews with programs
- Pending finalization of agreements with programs, select and operate one new pilot collaborative technology
- Draft Collaborative Architecture and Standards
- Collaborative application Directory Services
- Provide requirements and guidance to the Principal Center for Communications to ensure the agency directory can support NASA workgroup applications
- Collaborative Infrastructure Development

- Participate in ISO-WAN pilot activities to establish interoperability dependencies of desktop and server systems and applications
- Provide limited pilot collaborative tools support for the ISE/CEE program

Metrics:

- Will be determined through the interview process while gathering requirements

Information Technology Architecture

The Government Performance and Results Act requires all Federal Agencies to establish and document their Integrated Information Technology Architecture (ITA). An ITA is used for promoting efficiencies, interoperability, information flow, and enabling programs and projects through the effective infusion of required technology. The ITA is also a cornerstone for investment decision making for IT initiatives. The PCIT chair, representing the NASA Chief Information Officer, will lead this effort.

Significant resource will be applied to this critical area. The Zachman framework model will be evaluated. In particular, approaches to integrating both a strategy-driven Agency-level business architecture and an IT technology-driven technical infrastructure architecture will be focused on.

Objectives:

- Develop and share within the IT community a framework Information Technology Architecture model appropriate for NASA
- Identify, select, and populate the tool with representative business and science/engineering application

Metrics:

- TBD

Organizational Structure and Strategy

The Principal Center for Workgroup Hardware and Software is a staff office at GRC and reports to the GRC CIO.

Expert Center support will be primarily provided by the Expert Centers for Basic Interoperability and UNIX in the Computer Services Division also at GRC. At times in the past, several other Expert Centers contributed to meeting overall Workgroup objectives, but with the lack of a resource stream and the restructuring of IT organizations at many Centers due to IT Outsourcing, the Expert Center approach outside of GRC has fallen into inactivity. We do not anticipate any Expert Centers outside of Glenn to be active during FY 2000 or beyond. For the near term, we anticipate the continued utilization of some ad hoc Working Groups as needed.

Objectives for the balance of FY 1999 and 2000 will have considerably less gross aggregated resources applied to them than previous years. Thus, the strategy of the Principal Center for Workgroup Hardware/Software will be to focus very narrowly on selective technologies for workgroups/desktops that have very high potential for payback at Glenn Research Center and within the Agency at large.

We will also seek to perform funded work to various programs where Workgroup solutions hold the potential for significantly impacting the overall NASA IT Infrastructure (for example, providing Collaborative Tools support for the Intelligent Synthesis Environment Initiative).

Staffing and Funding

GRC has created and staffed an office for the Principal Center role that reports to the Center CIO. The Principal Center is funded out of GRC program support. In addition, seed money from the NASA CIO office is utilized for some projects.

	FY 99	FY00	FY01	FY02	FY03	FY04	FY05
Dollars (K)	865	(*) 540	(**) 1000	(**) 1000	(**) 1000	(**) 1000	(**) 1000
C. S. FTEs	6.6	9.0	9.0	9.0	9.0	9.0	9.0

* GRC provides $90K of FY 2000 funding and Headquarters Code AO provides $450K.
** $460K of FY2001 through FY2005 is currently unfunded.

The Expert Center for Basic Interoperability and Unix is staffed by the Computer Services Division and resources are included above.

Status / Next Steps

Major Accomplishments for FY 98/99:

- Bi-annual revisions to NASA STD 2804/5 were accomplished. Products were verified through hands on testing and assessment.
- NASA STD 2817 Computer-Aided Engineering, Design, and Manufacturing Data Interchange Standards was established.
- Y2K Desktop and server COTS inventory, assessment, repair, and validation completed on schedule. Products were verified through hands on testing as required.
- Consultation and guidance in the use of collaborative tools was provided to the ISE initiative.
- An agreement in principal was established to perform an asynchronous tools requirement analysis and pilot for ISE was established.

- Integration of the Livelink document and workflow management system with agency PKI was initiated.
- Guidance to the IFM project for architecture and security was provided.
- Guidance to ODIN project for functional seat benchmarking and standards was provided.
- White Paper describing security risks associated with T120 data conferencing and recommended risk mitigation was developed and presented to the IT Security Working Group. The risk mitigation was substantiated through hands on testing. The resulting architecture will be recommended to the Agency for formal acceptance.
- White Paper describing future proposed standards and capabilities for interoperability and collaboration was developed and presented to the agency for comment. Recommendations were validated through hands on testing.

Next Steps:

The Principal Center for Workgroup Hardware and Software is seeking restoration of funding levels to previous year levels for FY 2001 and beyond.

The PCWHS recognizes that a number of factors have converged to present a reduced budget situation for FY 2000. These factors include the transition to Full Cost methodologies, the intense requirement to improve IT Security, the conclusion of the Y2K crisis, and the pressures associated with outsourcing of several key IT services. However, FY 2001 will significantly reduce all of these factors in criticality, and the pressures to implement Agency-wide collaborative services will be growing dramatically during this same period.

A cost-effective approach to Agency-wide collaborative services will be built largely upon desktop focused client-server applications, and a proactive standards base will be required for the desktop and server environment and applications. A continued shortfall of resources will undoubtedly lead to duplication of efforts and the growth of a non-interoperable environment for collaboration, and lead to overall increased costs. For these reasons, the PCWHS actively and strongly advocates the Agency provide at least the level of resources available in previous years.

B.4 Marshall Space Flight Center as the Principal Center for Communications Architecture

Through its role as Principal Center for Communications Architecture, MSFC will provide unbiased technical analysis of emerging communications systems and capabilities; will develop appropriate communications architectures and standards; and will provide thought leadership in the area of integrating communication components into Agency IT architecture(s) and strategies. Further, the PCCA will serve as strategic "mediator" between Agency communication service providers, other IT service providers, and the vendor community.

Objectives

The highest priority initiatives within the overall PCCA scope include:

- Monitor Year 2000 compliance for all Agency communications COTS within scope of PCCA responsibility
- Provide IT security planning for communications and serve as Expert Center for Network Security
- Evolve communications infrastructure architecture, standards, and products to support IFMP in terms of network bandwidth, network security, integrated network operations, and directory services
- Support the NASA Integrated Services Network (NISN) Project, Consolidated Space Operations Contract (CSOC), and the Outsourcing Desktop Initiative for NASA (ODIN) Project in areas of communications architecture and standards, Local Area Network (LAN) and Wide Area Network (WAN) interface recommendations, and definition of critical Agency communications and network technologies in terms of strategies, architectures, standards, and products
- Complete NASA Integrated IT Architecture and develop appropriate configuration management processes for IT architecture and standards
- Support the Principal Center Integration Team (PCIT) in project and engineering activities in response to Agency CIO initiatives

Additional initiatives include the following: complete Agency firewall rule set and trust guidelines and ensure interoperability with IFMP and other Agency programs; develop virtual private network architecture, standards, and products recommendation; analyze and upgrade the directory service platform to support PKI operation; support Intelligent Synthesis and Collaborative Engineering initiative; provide Agency Domain Name Service and address management; analyze and test Windows 2000 and develop recommendations for Agencywide deployment; update Agency Intranet Strategy in light of ODIN and CSOC outsourcing; develop product standards where appropriate to meet Agencywide requirements; and provide interoperability testing and recommendations.

Organizational Structure and Strategy

The Civil Service component of the PCCA function is supported out of the Systems Engineering and Applications Group in the MSFC Information Services Department (ISD). ISD is contained within the MSFC Center Operations Directorate, the same organization which hosts the MSFC CIO. Organizationally, close coordination is maintained between the PCCA and the Center CIO.

Contract labor is provided by the Program Information Systems Mission Services (PrISMS) contract and funding is provided by the Space Operations Management Office (SOMO) through the NASA Integrated Services Network (NISN) Project.

Initiatives are planned and coordinated through the Principal Center Integration Team (PCIT) and are consistent with the PCIT 18-Month Plan. The PCCA is supported by the

MSFC Expert Center (note: no other Expert Centers are expected to support the PCCA), as well as the NASA Webmasters and the Postmasters Working Group (PWG) which include representation from all Centers. These technical groups provide consultation, peer review, and Center impact assessments of proposed communications strategies, architectures, standards and products. Specific task definition and prioritization are in progress via the PCIT.

Staffing and Funding

Based on planned initiatives and prior levels of effort, support costs are projected at approximately $2,000,000 per fiscal year. As described above, the funding is provided by SOMO through the NISN Project and, therefore, the funding is included in the NISN portion of Exhibit 53. Staffing estimates continue to be 15 FTE's, i.e., 14 contractor employees and 1 Civil Service employee.

Metrics

PCCA tasks are performed by PrISMS, a mission services, cost plus award fee contract. Standard project management performance measurement metrics, such as budget, schedule, and technical excellence, are utilized to monitor and evaluate contractor performance. PCCA performance is a monitored component of the contractor's Performance Evaluation process and, therefore, has a direct effect on the award fee. The contractor has consistently provided superior performance and this high level of support is expected to continue.

Status / Next Steps

The PCCA funding is stable at the present time and all initiatives are expected to be completed within the PCIT 18-Month Plan timeframe guidelines. However, a funding cut would have a direct effect of reducing the number of initiatives completed or extending the timeframe for completion.

B.5 Ames Research Center as Center of Excellence for Information Technology

Ames Research Center and its personnel work to develop technologies that enable the Information Age, expand the frontiers of knowledge for aeronautics and space, improve America's competitive position, and inspire future generations.
Ames' role and approach are a subset of the NASA vision, fully compatible with the Agency objectives and approach. The Ames strategy focuses on this Center's unique facilities, human and other resources, capabilities, location, and program imperatives. The following mission and goal statements address Ames' Agency-wide Center of Excellence responsibilities.

- Design, develop, and deliver integrated information technologies (IT) and applications that enable bold advances in aeronautics and space, accelerating America's emerging IT revolution.
- As NASA's Center of Excellence for IT, Ames provides Agency research leadership and world-class capability encompassing the fields of supercomputing and networking, high-assurance software development, verification and validation, automated reasoning, planning and scheduling, and human factors.
- A crucial role of the Center of Excellence for IT is the formulation and leadership of independent assessment teams (peer review) of all Agency funded IT research and the reporting out of findings and research status to the Agency's senior management annually.
- Expanding and formalizing the existing ad hoc senior IT research advisory and planning process as a standing panel of leading computer scientists and researchers to focus and validate the direction of Agency IT research.
- Acquire, deliver, and maintain a comprehensive database of all Agency IT research capabilities and initiatives and coordinate research activities within the Agency to mitigate/preclude duplication and overlap.

Ames Research Center has embraced its responsibilities as the NASA Center of Excellence for IT. In particular, Ames is successfully recruiting the very best computer scientists available nationwide—researchers who comprise the intellectual engine that will drive NASA's IT research now and in the future. Likewise, Ames has successfully recruited a new senior management team in IT.

The centerpiece of Ames' implementation strategy is to focus on the use of information technology as an enabling and integrating vehicle for the entire Agency.
NASA's proposed bold missions in space exploration and aeronautics require significant advances in many areas of science and technology. Paramount among these needed enabling technologies are those in computer science and other related computational disciplines.

To ensure that NASA fully exploits this most critical enabling technology, Ames has been designated as the Center of Excellence for Information Technology. Both because of Ames' long history of computer science research excellence and because of its location in the heart of Silicon Valley, Ames is the logical place for NASA to focus its information technology research program.

Ames has identified seven discipline-based research areas as critical to support the future needs of NASA's Strategic Enterprises. They include:

- automated reasoning;
- human-centered computing and human/computer interaction (HCI);
- modeling and simulation;
- information management, and knowledge discovery and data (KDD) mining;

- smart sensor systems;
- advanced software technology; and
- high-performance computing (including networking and storage).

Organizational Structure and Strategy. To emphasize information technology's cross-cutting nature and that the "Center of Excellence" appellation applies to Ames as a whole, the Center has established the Office of Assistant Center Director for Information Technology. Its twin purposes are to champion research excellence and to foster innovative IT research and development partnerships with industry, government, and academia. NASA involvement in these partnerships is managed and funded by the participating projects and programs.

Staffing and Funding, by Fiscal Year, for Office of Assistant Center Director for Information Technology	**2001**	**2002**	**2003**	**2004**	**2005**
Planned Staffing, IPAs and visiting scientists and scholars, FTE	TBD				
Planned Obligations, $K	1500	1560	1622	1687	1755

Metrics. Metrics are the responsibility of the participating projects and programs. Some programs will be Ames only, Ames will manage some with participation by others and others will manage some with participation by Ames. All these research programs have their own metrics. Three major programs managed by ARC are listed elsewhere (with their metrics) in this report. These programs are HPCC, IT R&T Base, and Intelligent Systems.

Status. Research is being, and will be, conducted in five specific technology application focus areas.

- Researchers are seeking ways to put an unprecedented level of intelligence into the machines sent out to explore the universe. The machines sent into space will explore the cosmos and bring back information that will change our views of the universe and of ourselves. These machines need to be smart, adaptable, curious, and self-sufficient in harsh and unpredictable environments. Information technology research related to autonomous systems for space exploration will enable a new generation of spacecraft to do more exploration at much lower cost than traditional approaches.

  One such effort supporting this area is Remote Agent, the first artificial intelligence software in history to command a spacecraft millions of miles from Earth. This software was recently was named co-winner of NASA's 1999 Software of the Year award. During three days in May 1999, the Remote Agent software controlled the Deep Space 1 spacecraft, a feat previously accomplished only in science fiction. NASA scientists gave the software package command of

Deep Space 1 during a flight experiment, and the artificial intelligence more than met expectations. The software detected, diagnosed and fixed problems, showing that it can make decisions to keep a mission on track. Remote Agent was developed at ARC and JPL.

- On Earth, many of these same information technologies will provide a catalyst for a new generation of embedded aviation operations systems that promise profound social and economic impact. President Clinton has announced a major initiative to enhance the safety of commercial aviation. A new generation of cognitive prostheses (computational aids designed to leverage human capacities) will be required to assist pilots and air traffic controllers to achieve progressively safer operation of aircraft in increasingly congested air spaces.

  In support of this area, Ames is developing new "smart" software that will enable aviators to control and safely land disabled airplanes. The intelligent flight control system employs experimental "neural network" software. When fully developed, the software will add a significant margin of safety for future military and commercial aircraft that incorporate the system.

  The smart plane software which can help pilots safely land aircraft that have suffered major failures was flight tested on a modified F-15 aircraft. Each sixth of a second, a damaged aircraft's computer can "relearn" to fly the aircraft using special neural network "controller" software. Without the smart software, severe problems such as partially destroyed wings, major fuselage tears or sensor failures can greatly alter how an airplane handles, and the aircraft might respond oddly or pilots' controls may not work properly.

- In the integrated design systems focus area, new IT systems are being developed to accommodate globally distributed and increasingly complex design team interrelationships. They will provide in-depth knowledge for cost-effective, early-design decisions and will expedite aerospace products to market. This will reduce costs for American aerospace manufacturers and expand their market share. New space missions and space transportation vehicles will be made possible as the insertion of focused information technologies significantly reduces both risk and life-cycle costs.

  A key effort in this technology focus area is the latest version of DARWIN, a computerized system developed at Ames providing real-time data to aerospace engineers who can be located in different cities or laboratories. The DARWIN environment speeds up the aerospace engineering design cycle by allowing researchers remote, real-time access to wind tunnels, data, and collaborators. With high-quality video, high-speed networks, and an intelligent web interface, a researcher is no longer required to be physically located at Ames to conduct wind tunnel tests or analyze wind tunnel and/or computational results.

- The use of information technologies in space systems operations will lead to dramatic reductions in launch and operational costs of space flight systems for orbiting and exploration platforms. Additionally, as humans contemplate journeys to Mars and beyond, research requirements clearly exist to develop a wide range of performance support systems (for both astronauts and ground operations personnel), diagnostic systems, condition-based maintenance systems, and other systems that operate autonomously in support of mission requirements.

  For example, ARC scientists are developing an autonomous robot to support future space missions. About the size of a softball, the Personal Satellite Assistant will be equipped with a variety of sensors to monitor environmental conditions in a spacecraft such as the amount of oxygen, carbon dioxide and other gases in the air, the amount of bacteria growth, air temperature and air pressure. The robot will also have a camera for video conferencing, navigation sensors, wireless network connections, and even its own propulsion components enabling it to operate autonomously throughout the spacecraft.

- The challenge in the large-scale information management and simulation technology focus area is to use IT systems to manage increasingly vast data sets and convert them into information that can be accessed rapidly and securely for scientific and educational purposes. In addition to the need to construct high-capacity data storage and dissemination schemes, researchers must develop tools aimed at facilitating human understanding of these immense data sets. This IT research will enable scientists to model the Earth's complex, interactive systems and make predictions about the effects of human-induced changes.

  One of the objectives in the NASA Astrobiology Roadmap supports this technology focus area as it seeks to expand and interpret the genomic database of a select group of key microorganisms in order to reveal the history and dynamics of evolution. Modern computational techniques in genomics and bioinformatics give exciting new insights into biological structure and function at all levels. Using the large array of databases now available, we must extend studies of individual gene families to previously uncharacterized microbial species. These and other studies will help determine when and how key biological functions arose and spread.

Next Steps. Future research in support of ARC's Center of Excellence in IT role is described in more detail in the HPCC, IT R&T Base and Intelligent Systems programs, elsewhere in this plan. This research will continue to emphasize distributed heterogeneous computing (the information power grid), autonomous reasoning, human centered computing, revolutionary computing and intelligent data understanding.

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