Attachment A Technical Specifications

List Of Abbreviations

AC Alternating Current

ANSI American National Standards Institute

ASN Abstract Syntax Notation

ATM Asynchronous Transfer Mode

AUI Attachment Unit Interface

BNC Bayonet Neill Concelman (connector) [electronics]

CAD Computer Aided Design (sometimes seen as CAD/CAM)

CAE Computer-Aided Engineering || Common Application Environment

CASE Computer Aided Software Engineering

CPU Central Processing Unit

CRT Cathode Ray Tube

DAC Dual Attached Concentrator

DAS Dual Attached Station

DAT Digital Audio Tape

DBMS DataBase Management System (rdbms for Relational)

DMA Direct Memory Access

DPI Dots per Inch

DS3 Digital Signal (level) 3

DVT Digital Video Tape

ECAD Electronic Computer Aided Design

EIA Electronic Industries Association

FDDI Fiber Distributed Data Interface

FIPS Federal Information Processing Standards

GByte Gigabyte

GIS Geographic Information System

GUI Graphical User Interface

HiPPI High Performance Parallel Interface

HPGL Hewlett Packard Graphics Language

HSSI High Speed Serial Interface

Hz Hertz (cycles per second)

ICMP Internet Control Message Protocol

IEEE Institute of Electrical and Electronics Engineers

IETF Internet Engineering Task Force

I/O Input/ Output

IP Internet Protocol

IPI Intelligent Peripheral Interface

ISO International Standards Organization

LAN Local Area Network

MAC Medium Access Control

MAU Medium Attachment Unit

Mbit Megabit

MByte Megabyte

Mbps Megabits per Second

MFLOPS Millions of Floating Point Operations Per Second

MIB Management Information Base

MIC Media Interface Connector

MIPS Million Instructions Per Second

msec Milliseconds

NASA National Aeronautics and Space Administration

NASTRAN NAsa STRuctural ANalysis

NFS Network File System

NI Network Interface

NTP Network Time Protocol

NTSC National Television Standards Committee

OODBMS Object-Oriented Database Management System

OC3 Optical Carrier 3 (155 Mbps SONET rate)

OSHA Occupational Safety and Health Administration

OSI Open System Interconnect

Pbyte Petabyte

PC Personal Computer

PHIGS Programmer's Hierarchical Interactive Graphics System

PHY Physical Layer Protocol

PMD Physical Media Device

RAM Random Access Memory

RDBMS Relational Data Base Management System

RFC Request For Comments

RFP Request For Proposal

RMON Remote Monitor/Monitoring

ROM Read-Only Memory

SAC Single Attached Concentrator

SAS Single Attached Station

SMP Symmetric MultiProcessing

SMT Surface Mount Technology

SONET Synchronous Optical NETwork

SPEC Standard Performance Evaluation Corporation

SQL Structured Query Language

TBD To Be Designed/Determined

TByte Terabyte

TCP Transmission Control Protocol

UDP User Datagram Protocol

VC Virtual Circuit

VHS Video Home System (VCR)

VP View Processor

VDT Video Display Terminal

WAIS Wide Area Information Server

WAN Wide Area Network

WORM Write Once, Read Many time

1. Introduction

Section 1 provides a general overview of the structure of these technical specifications.

1.1. Background

The computer facilities at NASA are being systematically enhanced by incorporating the latest in state-of-the-art computer system technologies. These improvements will enable NASA to remain at the leading edge in scientific and engineering processing performance and capabilities and to provide the user community of researchers and engineers with the most advanced and powerful computer tools available. In support of this activity NASA is establishing Indefinite Delivery/Indefinite Quantity contracts of scientific and engineering computer systems and supporting equipment. The computer systems will provide computational and graphics capability to the scientific and engineering disciplines supporting NASA's core missions. The specifications presented in this document represent a comprehensive set of requirements intended to provide a complete environment for computational analysis by NASA engineers and scientists.

1.2. Requirements Structure

The very broad range of NASA's functions in space, earth science, aeronautics, manned flight, mission operations and other activities, results in an equally broad range of computational requirements and consequently a requirement for a broad range of UNIX based computer systems and support equipment. The requirements are structured in a way that clarifies NASA's needs and categorizes the requirements on the basis of application functions. This structure is defined through two categories: Category A consists of a set of functional computer system classes; Category B consists of complementary products and services that enhance and support the computer system functions.

This procurement is for 14 competition areas consisting of 9 Category A computer system classes, and 5 Category B supporting equipment classes. Each of the classes has specific requirements and functional tasks that must be met by the offerings in that class. However, the potential usage of any class is broad and may be based on a variety of applications beyond the specific class definition. These class groupings are to ensure that the Government has a sufficient set of the best available tools for given tasks. The class groupings do not imply either exclusive product offerings by the contractor nor do they restrict the Government from making best value judgments as to which class to use to meet their specific requirements.

1.2.1. Category A Structure

The prelude to the requirements includes the definitions of each computer system class used to identify the general set of applications or environments that distinguish each class. The class definitions intentionally have overlap to ensure that there are no major gaps in requirements. Class definitions are given in Section 2 of this document.

Each of the nine computer system classes is still broad and may represent a variety of applications beyond the specific class definition, yet these groupings produce enough commonality of requirements that applications in a class can share the same hardware platform. Some of the classes are clearly linked to specific functional tasks such as CAD, CAE, or Graphics. Other classes may be more general purpose in nature and are distinguished through a number of factors, including performance requirements.

Each class represents not a single specific computer system, but instead represents a family of systems with a range of capabilities. In order to simplify requirements, each class is represented by two base systems. Within each class, the two systems are differentiated by factors specific to the class with each referred to as a subclass. These subclasses are identified as a and b and are always referred to with the class number. For example, class 3/b is computer system Class 3, subclass b. These base systems are generally distinguished by performance, upgradability and growth potential and define the minimum range of family of systems that should be provided on the contract. It is anticipated that systems will be made available on the contract through the Available Components list which are compatible with the base systems but which also both fill in and expand upon the requirements fulfilled through the base systems.

To ensure a certain level of commonalty exists across all platforms in all computer system classes and to maximize the Open Systems Environment, a set of general requirements referred to as the "Core Specifications" have been developed. The core specifications apply to all classes and must be met by all computer system class proposals, unless an exception is noted within a Class specification. The class specific requirements are combined with the core specifications to produce the nine separate computer system specifications

In general, application software such as CAD packages, databases, visualization software, etc. must be supported on the computer systems, but need not be provided (i.e. are not mandatory deliverables) unless specifically noted in the mandatory deliverables list in Attachment B. These are referred to as non-mandatory software.

A set of mandatory add-on equipment and upgrades is identified in each class to allow for system enhancements. Each class also includes an available components list consisting of desirable items and other software and hardware which provides depth and breadth to the vendor's offerings, such as computer systems in ranges of sizing and functions that complement the basic subclass systems and non-mandatory software.

1.2.2. Category B Structure

The category B classes consist of a set of capabilities that span across all computer system classes. This requirement creates five additional competition areas in this RFP: 1) Server Support Devices, 2) High-end Network Devices, 3) Computer Security Tools, 4) Mass Storage Devices, 5) Advanced Video and Display tools.

Each class has a set of mandatory specifications. In addition, each class includes an available components list consisting of desirable items and other software and hardware that provide depth and breadth to the contract.

1.3. Structure of This Document

This section describes the section layouts of the technical specifications

1.3.1. Category A Computer System Classes

The Core Specifications, which apply to all Category A classes, are presented in Section 3. The specific requirements associated with each class and derived from the applications to be supported are presented in Section 4.

1.3.2. Category B Classes

Requirements for this category are described in separate sections. Category A requirements do not apply to these classes. Server Support Devices requirements are described in Section 5. High-end Networking requirements are described in Section 6. Computer Security Tools requirements are described in Section 7. Mass Storage Device requirements are described in Section 8. Advanced Video and Display tools requirements are described in Section 9.

1.4. Performance Measurement

Performance benchmarks are used to evaluate the appropriateness of the proposed equipment. These performance requirements represent a minimum sizing of the requirement for a class and are based on the estimated performance levels required by applications in the class, and in part based on our best estimate of general technology levels that are expected to be available in the time frame of this solicitation.

A minimum performance is specified in terms of a variety of benchmarks which may include: NASA specific benchmarks, a CPU performance benchmark (SPEC Benchmark Suite), NASA I/O benchmarks (mallards) and others as determined. In summary, the benchmarks are designed/selected to focus on the particular strengths required of individual classes rather than being applied in blanket form across all classes.

For most subclasses a SPECmark and SPECrate value is given. In those cases, the SPECmark value refers to uniprocessor systems and the SPECrate value to multi-processor systems.

1.5. Terminology

Key terms are described in this section and more general definitions are provided in Section 1.6.

1.5.1. Provides / Support

Two key terms in the technical specifications are: provide and support. Use of the term "provide" indicates a product, service, or capability that is either a mandatory or, if modified by the term "desirable", a desirable deliverable item. All mandatory deliverable products, services and capabilities are identified in the Delivery Lists in Attachment B. A mandatory deliverable is either part of the base system, a separate add-on line item, or a separate upgrade line item. If an item is identified in the technical section as needing to be provided and is not listed in Attachment B as a separate add-on or upgrade line item, it is included as part of the Base system.

Note that the term "provide" implies an item is either a part of every delivered base system or is a separately orderable line item. This distinction is made in the Delivery Lists in Attachment B. For example, a FORTRAN compiler must be provided (as indicated in Section 3.3.2.5.a.). But the Delivery Lists indicate that the FORTRAN compiler is a separately orderable line item and it is estimated that only a certain percentage of the base systems will be purchased with a FORTRAN compiler over the life of the contract.

Use of the term "support" indicates a product, service, or capability which the systems must be capable of fully utilizing but which are not part of either the mandatory or desirable deliverable list. When support is used in reference to a software product, a version of the product that can execute on the system must be available in the commercial and/or public domain arena. Supported products, services, or capabilities can be part of the available components list.

1.5.2. Deliverables

The delivery lists use abbreviated terminology for clarity in enumerating delivery items. The complete specifications for these delivery items are fully described in Sections 3 through 10. As an example, the delivery list identifies the operating system as a deliverable and the full set of specifications for that operating system is given in Section 3 as amended by Section 4. This includes items such as file system, system administration, shells, etc.

Deliverables are divided into mandatory and non-mandatory categories:

1.5.2.1. Mandatory Deliverables

Each of the separate class specifications produces a separate set of mandatory deliverables for each class. These delivery requirements are specified in Attachment B of this RFP. The deliverables are divided into a Base Deliverable, and Add-on / Upgrade Deliverables. The Base Deliverables represent the minimum system configuration to be delivered for each equipment category. Add-on deliverables are mandatory line items that may be added to the Base deliverable at the discretion of the end-user. Upgrade deliverables are mandatory line items which upgrade; e.g. additional disk and/or memory, the Base deliverables at the discretion of the end-user.

1.5.2.2. Non-mandatory Deliverables

Non-mandatory deliverables are items that go beyond the mandatory deliverables. Non-mandatory deliverables are identified through the available components list and include desirable features, additional technology and other software and hardware that provide depth and breadth to the offering.

1.5.3. Minimums / Desirables / Advanced Technology / Additional Technology

All technical specifications fit into one of four categories: minimum mandatory; desirable feature; advanced technology, or additional technology.

If a technical specification is not explicitly identified as advanced technology, additional technology or a desirable feature, it identifies a minimum mandatory that must be met. Alternatively, if a technical specification is identified as advanced technology, additional technology or a desirable feature, it is not a minimum mandatory but a technology, item or feature that the Government deems to have value if available.

If a technical section contains the term "desirable", then the section identifies a feature that the Government desires but which the vendor is not required to provide or support.

If a technical section contains the term "advanced technology", then the section identifies advanced capabilities that provide the Government with significant added benefit. These are typically features that are either at the cutting edge of technology or for which standards (industry or de-facto) are still forming.

A technical requirements section may contain the term "additional technology". This designation identifies a basic capability that is intended to provide the Government with added value if the additional technology is

provided in the Available Components list. Typically, "additional technology" indicates broad grouping of technology that, if included in the Contractor's offerings, will provide the opportunity for one-stop solution shopping. For example, network technology is an additional technology in the Mass Storage Devices class as network products are an integral feature of many mass storage systems.

1.6. Assistive Technology

All workstations available and procured through this Contract must be technically capable of supporting commercially available and appropriate technology to ensure that Federal employees with disabilities will have access to and use of that technology unless a department or agency exception to this requirement exists.

1.7. Definitions

To clarify meaning of some terms used in this specification, some definitions are given here.

Add-ons:	Add-ons are mandatory line items which may be added to the Base deliverable at the discretion of the end-user.
Additional Technology	A basic capability that is intended to provide the Government with added value if the additional technology is provided in the Available Components list.
Advanced Technology	Advanced capabilities that provide the Government with significant added benefit.
Available Bus Slots:	The number of unused bus slots available for expansion after satisfying the requirements of the minimum mandatory deliverables and the maximum disk storage requirements for the base computer system.
Available Components	Non-mandatory deliverables including desirable features, additional technology and other software and hardware that provide depth and breadth to the offering.
Binary Compatibility:	Within a class (and across subclasses in the class), source code, object code, libraries, and linked or loaded executables, which are not device dependent, can be freely transported from any computer system in the class to any other system in the class and execute successfully without modification.
Base Systems	The systems which must meet the minimum mandatory specifications and be provided for on the Contract
Category:	A grouping of classes based on similar objectives and/or overall structure
Class:	A grouping of technological requirements based on common functionality
Class Specific Specifications	Set of technical specifications which specific to the given class
Computer Room Environment:	Facilities in which special environmental factors are maintained, such as controlled temperature and humidity, where noise is not limited by office requirements, and in which reliable power systems are available and/or are at levels other than the standard 110 volt, 60 Hz.
Computer System:	A computer workstation or server
Core Specifications	Set of technical specifications which are included in all requirements within

	the specified category, class, or group
Desirable Feature	A feature that the Government desires but which the vendor is not required to provide or support
Mallards:	Unit of measurement in nasa-io benchmark that produces a disk I/O performance index measured in Mallards.
Mandatory Deliverables	Products which must be included in the Contract in order to meet the mandatory requirements of the class
Mandatory Specifications	Set of technical specifications which must be meet by the mandatory offerings
Non-Mandatory Deliverables	Products which go beyond the mandatory deliverables, are identified through the available components list and include desirable features, additional technology and other software and hardware that provide depth and breadth to the offering.
Non-Mandatory Desirable Feature:	A capability that is desired by the Government but not required.
Office Environment:	A human work area providing moderate environmental conditioning but with limited capacity to support or provide unusual power or temperature/humidity requirements and one which may be easily upset by equipment emitting excessive heat and/or noise.
Open Bus Architecture:	A bus with multivendor support. This means that there is an industry published specification to enable third party connectivity.
Open Systems Environment:	The comprehensive set of interfaces, services, and supporting formats, plus user aspects, for interoperability or for portability of applications, data, or people, as specified by information technology standards and profiles. Source: IEEE P1003.0 POSIX Committee.
Provide:	Indicates a product, service, or capability that is either a mandatory or, if modified by the term “desired”, a desirable deliverable item.
SPECmark:	The SPEC benchmark suite measures overall system CPU performance
such as:	The term “such as” is used to list example products which are known to meet the stated capability and for which products which also meet the stated capability may be substituted.
Support	Indicates a product, service, or capability which the systems must be capable of fully utilizing but which are not part of either the mandatory or desirable deliverable list.
Upgrades:	Upgrades are mandatory line items which upgrade; e.g. additional disk and/or memory, the Base deliverables at the discretion of the end-user.
Virtual File System	A virtual file system is an abstraction of a physical file system implementation. It provides a consistent interface to multiple file systems, both local and remote. This consistent interface allows the user to view the directory tree on the running system as a single entity even when the tree is made up of a number of diverse file system types. The interface also allows the logical file system code in the kernel to operate without regard to the type of file system being accessed

2. Contract Definitions

Section 2 provides general paragraph descriptions of the various SEWP classes.

2.A. Category A: Computer System Classes

This Section provides general paragraph descriptions of the SEWP classes in Category A.

2.A.1. Class 1: CAE/CAD Electronic Circuit Design Computer Systems

These computer systems will be used for the development of electronic devices including: Custom analog chips, custom and semi-custom Ultra Large Scale Integration (ULSI) Application, Specific Integrated Circuits (ASICs), Field Programmable Gate Arrays (FPGAs), and High speed digital, analog and mixed signal Printed Circuit Boards (PCBs). Specific functions include: transistor level design, simulation and characterization, Verilog/VHDL Registered Transfer Logic (RTL) design and simulation, gate level simulation, static timing analysis, ASIC place and route, PCB place and route, and PCB signal integrity analysis An extensive network of computer systems utilizing the Cadence tool suite, the Synopsys tool suite, and CAE/CAD software is currently in use at NASA. Licenses are maintained on a license server while the individual applications are run on the users local system. The tool suites are usually located on a server but may also be installed locally. New systems must be compatible with the existing systems and tool suites. Each system must be fully compatible and interoperable with the Cadence and Synopsys tool suites. Class 1/b systems may be used for RTL design and simulation, while class /1a systems may be required for the remaining functions. When used as a server, these systems may require mass storage.

2.A.2. Class 2: CAE/CAD Mechanical Design Computer Systems

These computer systems will be used to support mechanical engineering tasks including structural analysis, mechanical design, and thermal analysis. To accomplish this support, these computer systems must be able to run a wide suite of engineering application software packages including commercial MCAD software, structural analysis programs such as NASTRAN, and analysis pre- and post processing tools. High speed, double precision floating point performance is required together with fast, high resolution, 3D color graphics. Systems in this class are considered turnkey with minimal applications development. The class 2/a systems may also be used as code or data servers for the low-end systems.

2.A.3. Class 3: Mass Storage Server

These Unix-based servers will be used to run high-end hierarchical mass storage systems, storing and retrieving hundreds of gigabytes of data each day, 24 x 7. Fast networking such as HiPPI and Gigabit Ethernet will be used to access the data. Data will be stored initially on high-performing RAIDed disk subsystems and then copied to high-performing tapes within robotic libraries or optical jukeboxes. It is staged back to disk automatically upon retrieval. Users expect stores and retrieves to be accomplished within seconds. These systems are anticipated to be used in conjunction with mass storage devices as defined in Class 13.

2.A.4. Class 4: Database Server

These computer systems will be used to house large data volumes and large databases. Applications are typically based on commercial DBMS packages. Historically these DBMS's have been relational (RDBMS) but this system should also support object oriented databases (OODBMS). Typical use of this class would be to maintain a data base of spacecraft mission parameters, catalogs of telemetry data sets, catalogs of derived science data sets, and ancillary data. In addition, this class would typically provide capability for document scanning and archival and digital libraries. When used with a DBMS, this class would most typically operate in a client/server architecture with this class providing the server function. The client function would be provided by other computer system classes, and existing servers and workstations on the NASA LANs.

The critical features of this class are high level of transactions per second, high volume of network traffic, fast disk access, large amounts of memory (RAM), high volume of memory to disk transfers, and large amounts of secondary storage. It is perceived that the Data Server will most likely reside away from the users work area in a location easily accessible to many LAN users. System should be capable of running Internet information servers, examples would be WAIS and World Wide Web (WWW).

2.A.5. Class 5: High-performance Visualization Computer Systems

These computer systems will be used to provide the highest quality in the visual representation of data to the user. Typical applications from the Earth and Space sciences communities are manned and unmanned spacecraft studies, launch and deployment sequences, and data analysis. Earth and space scientists require the ability to transform volumetric data at high rates to view different perspectives quickly. Additionally, photo realistic representations of data such as the planet Earth with full texture maps are needed to accommodate the overlay of geophysical parameters obtained from spacecraft observations. Three dimensional simulations of the Earth system that generate many gigabytes of data are performed on NASA supercomputers. Visualization and understanding of these simulations on high performance 3D graphics computer systems is mandatory to review the expected data volumes generated from the simulations and correlated with large amounts of data obtained from spacecraft sensors. Applications from the robotics communities include modeling the space station and robotic assembly and the space shuttle and arm assembly, and virtual reality. A critical need to support the real-time modeling of these vehicles is the high speed animation of these vehicles and their antennas (or arms), where the antennas (or arms) move independently of each other. Computer systems must be able to display large numbers of polygons per second to meet the animation needs of the robotics community as well as providing a high degree of graphical representation of the objects displayed.

2.A.6. Class 6: High Performance Compute Servers

The Compute Server class of systems and services will be used to provide systems able to perform very compute-intensive traditional optimized applications such as modeling, and mathematical analysis. Applications include but are not limited to atmospheric and oceanographic modeling, ocean color or crustal dynamics studies, ozone and sea-ice mapping, radio astronomy, high-energy astrophysics applications, flight dynamics computations, and fluid flow dynamic process modeling.

The critical features of this class are high compute capability, fast primary storage and network communications, and large data storage capability. 128-bit arithmetic may be needed to support these requirements. This class of system will most likely reside away from the user's work area and be accessed primarily over the network.

This class will include hardware systems and peripherals, software and software licenses, and hardware and software maintenance services including analyst support.

2.A.7. Class 7: Science and Engineering Research Computer Systems

These computer systems will be used to support scientific and engineering research tasks including data conversion and data plotting. These systems will be used to research a variety of scientific and engineering issues such as engineering equations with thermodynamics and transport properties for simulating, analyzing compressor/combustion/turbine data, climate modeling techniques, and data analysis from Space and Earth satellite systems. These computer systems must be able to run several type of engineering application software packages including commercial MCAD, ESS, DAQ, Easyplot, and IDEAS software, and structural analysis programs such as NASTRAN. They must also support major scientific application software packages such as IDL, IMSL and SAS.

2.A.8. Class 8: Earth Science Computer Systems

The Earth Science class of systems and services will be used to provide systems able to perform compute and I/O intensive optimized applications such as modeling, data processing, and mathematical analysis. Applications include, but are not limited to, simulating the Earth's climate, modeling a variety of processes in the atmosphere, ocean, or land, processing large quantities of spacecraft data and reducing them to usable information, and assimilating spacecraft data into models. Systems in this class will run a large variety of COTS applications in the areas of data/image processing (e.g. IDL/ENVI, Matlab), Geographic Information Systems (e.g. ArcInfo), integrated environments (e.g. Mathematical), etc. The critical features of this class are high compute capability, fast primary storage and network communications, and large data storage capability. Systems in this class may at times also support high-end real-time functions. These computer systems will also be used to provide the highest quality in the visual representation of data to the user. Many Earth science applications will require the ability to transform volumetric data at high rates to view different perspectives quickly. Three dimensional simulations of the Earth system generate many gigabytes of data. Visualization and understanding of these simulations on high performance 3D graphics computer systems is mandatory to review the expected data volumes generated from the simulations and to correlate these with large amounts of data

from spacecraft sensors. This class will include hardware systems and peripherals, software and software licenses, and hardware and software maintenance services.

2.A.9. Class 9: Space Science Computer System

The Space Science class of systems and services will be used to provide systems able to perform very compute-intensive optimized applications such as modeling and mathematical analysis. Applications include but are not limited to simulating space plasmas, magnetofluids, and the galactic and extragalactic source regions of radio and high-energy electromagnetic emissions; modeling of the solar interior and atmosphere; reducing large quantities of spacecraft data to useable information; and combining spacecraft data with modeling codes. The critical features of this class are high compute capability, fast primary storage and network communications, and large data storage capability. Systems in this class may at times also support high-end real-time functions in cooperation with computer systems performing primary data ingestion from spacecraft and other missions. These computer systems will be used to provide the highest quality in the visual representation of data to the user. Many space science applications will require the ability to transform volumetric data at high rates to view different perspectives quickly. Three dimensional simulations of the Sun-Earth system, of the Sun, and of galactic and extragalactic objects generate many gigabytes of data. Visualization and understanding of these simulations on high performance 3D graphics computer systems is mandatory to review the expected data volumes generated from the simulations and to correlate these with large amounts of data from spacecraft sensors. This class will include hardware systems and peripherals, software and software licenses, and hardware and software maintenance services.

2.B. Category B: Complementary Products & Services Categories

This Section provides general paragraph descriptions of the SEWP classes in Category B

2.B.1. Class 10: Server Support Devices

This class consists of Input and Output peripherals and other equipment which support and complement the full implementation of UNIX based computer systems throughout NASA. These items may be purchased by the Government separately from the computer systems but rely on standards and standard interfaces to ensure interoperability with the computer systems. Included in this class are both printers, multifunction machines and plotters for outputting textual and graphical files; X terminals and other low-end client systems to allow user connectivity to a full range of computer systems; scanners to allow inputting of information from hard-copy forms; and PDAs (Personal Digital Assistants) and UNIX portables to allow mobile access to individual's computing needs.

2.B.2. Class 11: High-End Networking

This class consists of a range of network equipment in support of the full implementation of UNIX based computer systems in the NASA network environment. These items may be purchased by the Government separately from the computer systems but rely on standards and standard interfaces to ensure interoperability with those systems. The base technologies for NASA LANs are Ethernet, FDDI and ATM. Hardware, including hubs, switches, routers, NFS routers, concentrators and diagnostic tools, and software including network management are included in this class. Due to the wide range of the current installed NASA network systems and the variety of function and performance requirements, a key requirement in this class is the depth and breadth of the available equipment.

2.B.3. Class 12: Computer Security Tools

This class consists of hardware and software needed to support a full implementation of computer systems and infrastructure in the NASA network environment. These items may be purchased by the Government separately from computer systems but rely on standards and standard interfaces to ensure interoperability with the computer systems and the supporting networks. Items in this class will include password tools, firewalls, auditing tools, intrusion detection systems, encryption capabilities, monitoring tools, remote access and authorization tools.

2.B.4. Class 13: Mass Storage Devices

This class consists of storage devices; e.g. Hard disks and Tape systems which can be used by computer systems in Category A. While it is anticipated that products in this class will be purchased for use with any of the Category A systems, this class is particularly concerned with providing mass storage I/O devices for use with Mass Storage Servers as defined for Class 3: Mass Storage Server.

2.B.5. Class 14: Advanced Video and Display Tools

This class consists of a range of equipment in support of digital television image production and related imaging and display tools. The Government may purchase these items separately from computer systems, but rely on standards and standard interfaces to ensure interoperability with those systems. The hardware in this class includes High Definition (HD) and Standard Definition (SD) Digital TV (DTV) equipment for video acquisition, production, post-production, distribution, and display. It is essential that this class include products which meet the Digital Television Standards for NASA (NASA-STD 2818 dated April 4, 2000). Additionally, the increasing complexity and volume of scientific data benefit from paradigms for interaction and visualization that are much closer to normal human interaction in the physical world. These paradigms require immersion and stereoscopic viewing for three-dimensional data, tracked and/or haptic devices with high degrees of freedom, and audio processing systems for data sonification. These devices act as input/output peripherals to developmental computer systems.

3. Category A: Computer System Core Specifications

Section 3 provides the core technical specifications for all Category A: Computer System Class Equipment.

3.1. Introduction

This section provides a general overview of the core specifications.

3.1.1. Purpose

The purpose of this section is to define the Core Specification requirements for high performance computer systems to support technical scientific or engineering tasks at NASA facilities.

3.1.2. Background

One of the key objectives of this procurement is to support and enhance the established UNIX based Open Systems Environment within NASA. That Open Systems Environment must extend over nine different computer system classes. The potential exists to award contracts for computer systems to nine different vendors and could result in nine (or more) different operating systems. To minimize the potential diversity in the computer system environments, a Core Specification is provided to maximize the uniformity (and Openness) of environments across all classes.

The Core Specifications apply to the base and mandatory products for all classes of computer systems, unless a deviation to the Core Specifications is noted in the Class Specific Sections. Each class will also have its own unique specifications that are identified in Section 4.

3.1.3. Requirements

The vendor computer system base and mandatory offerings shall meet all mandatory specifications provided in this Section (3) unless a deviation to the Core Specifications is noted in the Class Specific Section (4). These systems are intended to meet the NASA requirements over the life of the contract. The use of an indefinite quantity contract will enable acquisition of systems and services, as required, via delivery orders.

3.2. Hardware

This section describes the core hardware specifications.

3.2.1. Chassis and Central Processing Unit (CPU) Requirements

Each system shall provide:

a. all required peripherals, memory and I/O subsystems as specified in the core and class specific requirements.
b. the ability of the system to automatically reboot itself following a system crash or power interruption.
c. a minimum CPU word size of 64 bits.
    1. advanced CPU technology, including higher order bit architecture, (advanced technology).

d. for multiprocessor computer systems, the technology associated with the multiprocessing functions; e.g. symmetric versus non-symmetric, memory utilization, etc. (advanced technology).
e. floating point arithmetic hardware for 32-bit and 64-bit floating point numbers with a format in compliance with the IEEE floating point standard [IEEE 754-1985(R1990)].
f. Advanced memory management capabilities (including address space) (advanced technology)
g. the following error condition handling:
    1. all possible operation codes shall produce documented results.
    2. the CPU shall be capable of detecting floating point arithmetic overflows/underflows in compliance with the IEEE 754 floating point standard. It shall be possible to disable and enable the floating point arithmetic overflow/underflow interrupts.
    3. the CPU shall be capable of detecting memory access violations, illegal instruction execution, and privileged instruction usage by non-privileged users. The CPU or OS shall interrupt program execution on detection of any of these conditions.

h. detection and reporting of memory errors.
i. a power-up self test that as a minimum checks the processor, memory and configurable peripherals and reports any problems.
j. flexibility and expandability, each computer system shall have an Open Bus Architecture.
    1. Advanced forms of Bus Architecture providing improved topology, performance, load-handling, advanced memory interconnectivity, robustness, high performance connectivity and/or other features which improve functionality, flexibility, and expandability (advanced technology).

k. All system unit upgrades shall be field installable.
l. Whenever required expansion capacities exceed the capability of the system unit chassis (memory, disk, processors, tape units, etc.), a compatible expansion chassis shall be provided. Expansion chassis shall have similar physical appearance to system unit chassis and provide power for expansion elements when appropriate.
m. Advanced error reporting and handling techniques for any or all system components (advanced technology)

3.2.2. Data Storage Components

a. Hard disk storage shall be provided with each system. The storage requirements are class specific.
b. Each system shall provide at least 1 SCSI III controller [ANSI X3.253-1998] or Ultra-SCSI controllers or Fibre Channel controller which fully supports connection to internal and external SCSI devices. Add-on SCSI devices which must be provided are noted in the class specific sections.
    1. An option for either Fibre Channel or SCSI connections (desirable)
    2. Advanced versions of SCSI and other standard I/O controller technologies capable of greater configuration flexibility and higher throughput, can replace SCSI/Fibre Channel controllers whenever SCSI/Fibre Channel is required (advanced technology).

c. Each system shall provide optional 8-mm magnetic tape systems.
d. Each system shall provide optional 4-mm DAT magnetic tape systems.
e. Each system shall provide at least a 12x-speed CD ROM drive.
f. All storage devices shall be field installable.
g. All storage devices shall provide hard error detection (resulting in a non-recoverable failure) and all such errors shall be reported to the system logs.
    1. All storage devices shall provide detection of all errors (recoverable and non-recoverable) (desirable)

3.2.3. Communication Interfaces

a. Each computer system shall provide the network interfaces as defined in Section 3.4.
b. Each computer system shall provide at least one free RS-232 serial interface port with the following capabilities:
    1. use one of the following standard or commonly accepted connectors:
        a. 25 pin [EIA RS-232-C];
        b. RJ-11;
        c. DB-9; or
        d. DIN-8.
    2. Communication I/F - 56 Kbs RS-232 interface.

c. Each subclass b system shall provide 1 Centronics compatible DB25 parallel port.

3.2.4. Hardware User Interfaces

Each computer system shall provide a keyboard, mouse and graphic monitor with the following capabilities:

a. keyboard - A detachable and ANSI compatible [ANSI X3.64/R1990] keyboard.

b. mouse - A mouse with three buttons. This device shall permit the user to address individual screen pixels.
    1. alternate pointing devices such as a trackball available as a separately orderable option to the mouse (desirable).

c. a graphics controller
d. a graphics monitor with at least the following capabilities:
    1. vertical scanning frequency of at least 72 Hz noninterlaced.
    2. capable of being powered down without disrupting the system.
    3. all subclass b systems must provide an optional 19 inch or greater or greater monitor.
    4. all subclass a systems must provide an optional 21-inch or greater monitor.
    5. Energy Star compliant (desirable)

3.2.5. Operating Environment

a. Power requirements:
    1. all office environment computer systems shall operate on 108 to 125 volts single-phase at 60 Hz (+/-1%) with a maximum amp rating of less than 15 Amps.
    2. computer systems identified for computer room environments shall be capable of operating on 108 to 125 volts or 216 to 240 volts single-phase at 60 Hz (+/-1%), individually determined by the Government for each computer system at the time of order.

3.3. System Software

This section describes the core system software specifications.

3.3.1. Overview

This section describes required functions and features that normally are performed by the system software. The operating system software shall support the hardware. The system software shall support a set of development tools and utilities to augment the capabilities of the operating system and the required language processors. These software tools shall provide fast, efficient mechanisms to develop application programs, backup and restore files, debug programs, and supply other useful system functions.

3.3.2. Operating System

The operating system shall be

a. UNIX 95 branded with delivery of a copy of the Open Group branding certificate provided with the proposal.
    1. UNIX 98 branding may be substituted for the UNIX 95 requirement (desirable)

b. POSIX [IEEE POSIX 1003.1-1990]; compliant. The Government will accept the vendor's self certification for POSIX compliance

The operating system shall include the capabilities, functions and services as specified in the following sections.

3.3.2.1. Resource Management

The following resource management features shall be provided:

a. The operating system shall be responsible for coordination and management of the system's resources including processor, memory, peripherals and communication subsystems.
b. The operating system shall allow the simultaneous use of these multiple system resources by various users/programs while at the same time protecting each user's resources from other users, avoiding resource deadlocks, and allowing interprocess communications.
c. The operating system shall provide memory and process memory management functions including program segmentation, relocation, and protection.
d. Advanced implementations of system resource, memory, and program management (advanced technology).

3.3.2.2. Kernel Services

The Kernel shall provide the following services and capabilities in addition to the UNIX 95 requirements:

a. Remote Procedure Calls (RPC), [RFC 1057].
b. An interactive crash dump analyzer (desirable).

3.3.2.3. File System

The operating system shall provide a sophisticated local file system and a network file system. The following specific file systems shall be provided:

a. a file system with the following minimum capabilities:
    1. hierarchical structure.
    2. file system control; e.g. inodes (disk file information), and user data information shall be interleaved on the disk.
    3. redundant storage of critical file system structure information on the disk.
    4. asynchronous, non-blocking file I/O.
    5. non-buffered (synchronous) file I/O.
    6. blocked file I/O.

b. Compatible file systems which support the above requirements in part a) with demonstrable advanced capabilities and/or performance (advanced technology)
c. the Network File System (NFS) Version 3 [RFC 1813];
d. other advanced multiplatform networked file systems, such as the Andrew File System and the Distributed File System, or capabilities which improve the basic NFS functions (advanced technology).

3.3.2.4. Software User Interfaces

The operating system shall provide all of the following user interfaces and user interface tools:

a. the System V Bourne Shell, Berkeley C Shell, and the Korn Shell.
b. the X Consortium Athena X Window System Version 11, Release 6 or greater. This shall include the X Window System Protocol, X Version 11; Xlib - C language X Interface; X Toolkit Intrinsics - C Language Interface; and the Portable Compiled Format or Bitmap Distribution Format.
    1. Conversion tools between various formats (desirable)

c. MIT Athena Widget Set
d. Open Software Foundation's Motif or CDE Motif, Motif Window Manager (MWM) or Desktop Window Manager (DTWM), Motif widgets and widget functions, and the Motif X-Toolkit with C programming language bindings.
e. graphical system user interface (often referred to as a "Desktop") such as CDE, VUE, or equivalent (desirable).

3.3.2.5. Programming Environment

Each system shall provide:

a. An ANSI compliant [ANSI X3.9-1978] FORTRAN 77 compiler which shall include:
    1. run time libraries.
    2. a FORTRAN source language compatible symbolic debugger with capability to read core dumps. Shall display source code, program variables (including register contents), debugger commands, and debugger output.
    3. An ANSI compliant [ANSI X3.198:1992/R1997] FORTRAN 90 compiler may be provided in place of the FORTRAN 77 compiler (desirable)
    4. an optional 1 user license
    5. an optional 10 user license
    6. an optional site license (desirable)

b. An ANSI compliant [ANSI/ISO 9899-1990] C compiler which shall include:
    1. run time libraries.

2. a C source language compatible symbolic debugger with capability to read core dumps. Shall display source code, program variables (including register contents), debugger commands, and debugger output.
3. an optional 1 user license
4. an optional 10 user license
5. an optional site license (desirable)

c. An ANSI compliant C++ compiler which shall include:
1. run-time libraries.
2. use the native C and/or C++ libraries to the maximum extent possible. Libraries provided shall accurately mirror the native C library functions.
3. a C++ source language compatible symbolic debugger with capability to read core dumps. Shall display source code, program variables (including register contents), debugger commands, and debugger output. Display of original names of source code variables (desirable).
4. an optional 1 user license
5. an optional 10 user license
6. an optional site license (desirable)
7. ANSI compliance [ANSI 14882:1998] (desirable)

d. Graphics debug interfaces and other tools or capabilities which enhance the coding, testing, and execution of FORTRAN, C, and/or C++ programs (advanced technology).
e. A system linker utility. The link utility shall be able to link object code from the FORTRAN, C and C++ compilers to form an executable file. The user shall not have to perform tasks other than compiling and linking to form an executable file from a combination of C, C++ and FORTRAN source code.
f. System libraries that:
1. provide user access to a timer with millisecond resolution and allow user setting of the system clock to a millisecond resolution.
2. provide the ability for user processes to share memory.
3. support the socket interface for the Internet Protocols IP, ICMP, TCP, and UDP.

g. The ability to create and add custom device drivers.
1. The ability to dynamically configure and load custom device drivers into the kernel without requiring the system to be rebooted (desirable).
2. Access to functional source code and examples (desirable).

h. Text processing programs, including nroff and troff.
i. A source code control system such as the Revision Control System (RCS) or Source Code Control System (SCCS).
j. A Postscript file previewer to allow the review of postscript files on the graphics monitor prior to printing (desirable).

3.3.2.6. System Administration

Each computer system shall provide:

a. the complete backup of all secondary storage (any device containing a file system which is mounted and run by the system) including raw (non-file structured) disk partitions to a tape drive (as specified in 3.2.2.c. and 3.2.2.d.) with the additional capability for incremental backup of file structured disk partitions
b. the ability to manage the system remotely, including the ability to:
1. install the complete operating system and computer system software from a local tape or CD ROM drive or from over the network.
2. restore the system disk from a copy stored on a remote system. (desirable)
3. perform unattended scheduled automatic system backup.

c. delivery and installation of software from tape (as specified in 3.2.2.c. and 3.2.2.d.) or CD ROM (as specified in 3.2.2.e.)

3.3.3. System Software License

Each computer system shall be a multiuser system. The operating system license shall be available in two licensing levels for all systems:

a. a 2-user license defined as allowing 2 users, one possibly remote, to be logged in simultaneously
b. an unlimited license defined as allowing an unlimited number of users to be logged in simultaneously, where 1 or more may be logged in through the console and the rest are connected through either an Ethernet connection (as required in section 3.4.2.a.) and/or FDDI connection (as required in section 3.4.2.b.).

In addition to the operating system license, each computer system shall provide:

c. a central license manager.

3.4. Network Capability

This section describes the core network capability specifications.

3.4.1. General

Each of the systems will be connected to Local Area Networks. All computer systems shall support an Ethernet and a FDDI interface. Network interfaces compatible with campus network technologies shall be supported. Native support of Internet Protocols (IP) is required for compatibility with existing network and computing platforms.

3.4.2. Network Interface

The network interface shall include a controller/interface necessary to provide the physical and media access interface between the computer system and the NASA LANs. The requirement for Ethernet and FDDI interfaces implies the option of purchasing either a FDDI or Ethernet connection, but not necessarily providing both on the same system, unless it is explicitly stated in the class specific requirements that the systems must have the ability to provide both an Ethernet and FDDI connection.

Each system shall:

a. provide an IEEE 802.3, ISO 8802/3 100Base-T Ethernet interface in the base systems.
    1. an embedded interface (i.e. it does not require an external transceiver) in the base systems (desirable)
    2. Options for other physical Ethernet interfaces (desirable).

b. provide an ANSI standard Fiber Distributed Data Interface (FDDI) adapter [ANSI X3T9.5]. The FDDI adapter shall comply with all appropriate ANSI standards for FDDI:
    1. ANSI FDDI X3T9.5 Station Management (SMT) specification (version 7.3 or greater)
    2. ISO 9314-3 FDDI Physical Medium Dependent (PMD) standard.
        a. PMDs which must be supported and one of which must be provided are:
            1. multimode fiber (PMD);
            2. twisted pair (TP-PMD) (unshielded twisted pair support is only required for office environment subclasses).
        b. All other PMD's, e.g. single mode fiber(SM-PMD), low cost fiber (LCF-PMD), unshielded twisted pair where office environment not required, etc. (desirable)
    3. ISO 9314-1 FDDI Physical Protocol (PHY) standard
    4. ISO 9314-2 FDDI Media Access Control (MAC) standard
    5. all computer systems shall provide FDDI as either Single Attachment Station (SAS) cabling, or Dual Attachment Station (DAS) cabling. Both SAS and DAS cabling shall be supported. This requirement may be met with a DAS that can be configured as SAS.
    6. Separate SAS and DAS interfaces (desirable).
    7. A Data Link Layer protocol providing Logical Link Control [ISO 8802/2].
        a. support for other advanced networking capabilities such as Gigabit Ethernet (advanced technology).

3.4.3. TCP/IP Protocols And Software

Internet protocols (IP) and network software necessary to utilize the network interface discussed above and compliant with the following specifications shall be provided:

a. Internet Protocol (IP) [RFC 791], with full routing capability including subnetting
b. The Internet Control Message Protocol (ICMP) [RFC 950].
c. Transmission Control Protocol (TCP) [RFC 793].
d. Application program interface to TCP and IP layer protocols.
e. File Transfer Protocol (FTP) [RFC 959].
f. TELNET Virtual Terminal Protocol [RFC 854].
g. Address Resolution Protocol (ARP) [RFC 826].
h. User Datagram Protocol (UDP) [RFC 768].
i. Simple Mail Transport Protocol (SMTP) [RFC 821].
j. MIME [RFC 2046].
k. Host extensions for IP multicasting [RFC 1112].
l. TCP extensions for high performance [RFC 1323].

The following protocols shall be supported:

m. gated with OSPF V2 or later

3.4.4. Other Network Protocols and Software

All computer systems shall provide the following additional protocols and network software:

a. A sufficient set of the Simple Network Management Protocol (SNMP) [RFC 1157] to act as a network agent and conforms the structure for Management Information Bases (MIB) [RFC 1155] that would allow a network connected SNMP management station to query the status and condition of the system.

The following protocols shall be supported:

b. Point-to-Point (PPP) Protocol [RFC 1661];
   1. Compliance with RFC 1332 , RFC 1662 and RFC 1663 (desirable).

3.5. Documentation

The contractor shall provide complete sets of operator, programmer, software system, utility, installation, and user manuals. The contractor shall also provide other necessary documentation for all hardware and software delivered under this contract in accordance with the contractor's product line documentation standards. If the contractor's software and/or hardware documentation is written other than described below, an alternative set of manuals shall be provided. The manuals shall include, but not be limited to, the documentation described in the following paragraphs.

All provided documentation shall be available either on line or in hardcopy. On-line documentation must be readable via a GUI interface with intelligent search capabilities and must have the ability to be easily printed in readable form on a local Postscript printer.

Documentation be available both on-line and in hardcopy form (desirable).

3.5.1. Hardware Documentation

The hardware documentation shall include:

a. System hardware manuals detailing specifications for system architecture, CPU, memory, and peripheral devices

b. Interface manuals detailing all electrical and mechanical aspects of system interfaces, e.g. I/O channels, peripheral devices, and communication interface devices.

3.5.2. Software Documentation

The software documentation shall include:

a. Reference manuals detailing all elements and operations of all delivered language processors, text editors, I/O handlers, operating system, system generation, system architecture, software tools and utilities, configuration management, and performance measurement software.
b. Reference manuals detailing command language, communication software, input/output system, error handling, and diagnostic software.
c. Computer reference and system programmer manuals detailing every machine instruction and all programming considerations.
d. Problem determination and debugging guides.
e. A guide to writing device drivers.
f. Documentation of known problems and/or suspected system errors.
g. Introductory manuals for new users to the operating system and computer system environment.
h. An on-line introductory tutorial for new users (desirable).

3.5.3. Other Manuals

The contractor may include any other manuals and program descriptions that would be considered helpful to the Government.

3.6 Security

All computer systems must provide the following security related technology:

a. port-blocking software such as tcp-wrappers and portmapper

b. sending all system level logs to a centralized log-host server

All computer systems must support the following security related technology:

c. Secure shell client and server software, protocol 1 and protocol 2 such as F-Secure
   1. public domain versions of secure shell such as OpenSSH (desirable)

d. Intrusion detection software such as TripWire

e. PGP email encryption

f. enhanced methods of identification and authentication (such as biometric and physical card-keys) (advanced technology)

g. fine-grained access control features for operating system services such as C2 security (and more stringent security standards) (advanced technology)

h. security audit tools (advanced technology)

i. enhanced password change software, including the capability to add a user defined dictionary, minimum requirements for password rules, etc (advanced technology)

j. anti-theft and tracking tools such as CompuTrace (desirable)

3.7 Computer Systems Specialists

To assist in product recommendations, installation, and support of computer systems products the following specialists shall be provided:

a. Operations Systems Security Specialist
   1. Provides technical knowledge and analysis of information assurance, to include applications; operating systems; Internet and Intranet; physical security; networks; risk assessment; critical

infrastructure continuity and contingency planning; emergency preparedness; security awareness and training. Provides analysis of existing system's vulnerability to possible intrusions, resource manipulation, resource denial and destruction of resources. Provides technical support and analysis to document organizational information protection framework, and supports policy and procedures preparation and implementation...

2. Bachelor's degree from an accredited college or university with a curriculum or major field of study which provides substantial knowledge useful in operating large, complex IT projects to support integrated systems.
3. Experience Requirements: Seven years of substantial experience in systems operations.

b. Computer Systems Engineer
   1. Tests and analyzes all elements of the computer systems facilities including power, software, mass storage devices, communications devices, computer systems and terminals and for the overall integration of the enterprise network. Responsible for the planning, design, installation, maintenance, management and coordination of the storage systems. Monitors and controls the performance and status of the storage resources. Utilizes software and hardware tools, identifies and diagnoses complex problems and factors affecting storage performance. Maintains technical currency and studies vendor products to determine those which best meet client needs. Provides guidance and direction for less experienced storage support technicians.
   2. Educational Requirements: Bachelor's degree from an accredited college or university in computer science, information systems, engineering or a mathematics-intensive discipline or an applicable technical training certificate from an accredited training institution.
   3. Experience Requirements: Seven years of increasingly complex and progressive experience in computer system/network engineering. Includes two years of specialized experience related to the task.

c. Technician
   1. Provides high level functional and IT analysis, design, development, integration, documentation, and implementation assistance on problems which require a thorough knowledge of the related technical subject matter for effective system deployment. Participates in all phases of systems development. Applies principles and methods of the functional area to difficult problems in technical areas to arrive at automated solutions. Designs and prepares technical reports and related documentation, and makes charts and graphs to record results. Prepares and delivers presentations and briefings as required by the task order.
   2. Educational Requirements: High school graduate or equivalent.
   3. Experience Requirements: Ten years of intensive and progressive experience in functional or IT analysis/programming of subject matter closely related to the work to be automated.

4. Category A: Computer System Class Specific Specifications

For each class, contractors are required to meet both the core requirements defined in the "Computer System Core Specification", (see Section 3) and the additional mandatory requirements defined for that class (provided in each of the subsections that follow).

If there is a conflict in requirements between the Class Specification and the Core Specification, the Class Specification shall always take precedence.

4.1. Class 1: CAE/CAD Electronic Circuit Design Computer Systems

This section describes the CAE/CAD Electronic Circuit Design Computer Systems class specific requirements.

4.1.1. Purpose

The purpose of this section is to define the specific requirements for the Electronic CAD Circuit Design Computer Systems as described in Section 2. The following hardware and software specifications are required of these Class 1 computer systems over and above, or in place of the core specifications defined in Section 3.

4.1.2. Hardware Configurations

This class of computer systems is comprised of a Level 1 computer system (1/a) and a Level 2 computer system (1/b). These systems are differentiated by the application required to be supported. Level 2 systems are typically used for schematic capture while Level 1 systems are used for simulations and Printed Circuit Board (PCB) route and place operations and may function as servers for systems similar to those specified for 1b.

4.1.2.1. Class 1/a and 1/b Computer Systems

All Class 1 computer systems (Class 1/a and 1/b) shall provide the following minimum capabilities, unless noted as desirable:

a. binary compatibility between Class 1/a and 1/b.
b. at least 256 simultaneously displayable colors from a palette of at least 16 million available colors and monitor with a minimum of 1.2 million displayable pixels.
c. a graphics monitor with at least 1600x1200 dpi @ 76 Hz (non-interlaced) 0.25 mm pitch (as a replacement to the core requirement Section 3.2.4.d.1.)

4.1.2.2. Class 1/a High-End Computer System

The Class 1/a high-end computer system shall provide the following minimum capabilities, unless noted as desirable:

a. a minimum memory of at least 2 GBytes
    1. memory expandable to at least 4 GByte.

b. Error Detecting/Correcting (ECC) Memory.
c. hard disk storage with a minimum of 18 GBytes of available user space remaining after installation of all minimum required software as specified in the delivery list (operating system, system swap space, on-line system documentation, linker, drivers, X windows, etc.).
    1. disk storage expandable to at least 60 GByte.

d. 3 available bus slots (2 available slots if Ethernet connection is embedded in the system).
e. ability to simultaneously connect the system to both FDDI and Ethernet to support 1000-Base-T
f. 2 CPUs

The subclass 1/a computer systems must support:

g. the following mass storage systems (including locate, mount, read and write tapes or disks in the jukeboxes). For the supported jukeboxes, the system must support a storage capacity of at least 10 GByte, expandable to at least 60 GBytes:
    1. magneto-optical drives and jukeboxes
    2. worm optical drives and jukeboxes
    3. digital linear tape (DLT) drives, and jukeboxes

4. 8 mm tape drives, and jukeboxes
5. 4 mm tape drives, and jukeboxes
6. CDROM drives and jukeboxes
   a. Recordable CD Drive (desirable)

4.1.2.3. Class 1/b Low-End Computer System

The Class 1/b low-end computer system shall provide the following minimum capabilities, unless noted as desirable:

a. a minimum memory of at least 1 GBytes
   1. memory expandable to at least 2 GBytes.

b. hard disk storage with a minimum of 8 GByte of available user space remaining after installation of all minimum required software as specified in the delivery list (operating system, system swap space, on-line system documentation, linker, drivers, X windows, etc.).
   1. disk storage expandable to at least 36 GByte.

c. operate in an office environment.
d. 2 available bus slots (1 available slot if Ethernet connection is embedded in the system).
e. able to support recordable CD capability (desirable)
f. 21-in or greater graphics monitor (as a replacement to the core requirement Section 3.2.4.d.3.)

4.1.3. Application Software

All Class 1 computer systems (Class 1/a and 1/b) shall support the following software:

a. The following Cadence Design Systems CAE logical and physical design and simulation tools: . Allegro, Concept-HDL, Verilog-XL, Verilog-NC and Analog Artist
b. The following Synopsys Design and Simulation Tools:
   Design Compiler, VSS, Prime Time, VHDL/Verilog Compiler, Tetra Max
c. OPEN GL (desirable)

4.1.4. Performance Benchmarks

This section describes the performance values required for the Class 1 computer systems.

4.1.4.1. Performance for Class 1/a

a. The maximum allowed time for the Synopsis benchmark for the class a computer system is 45 minutes.

b. The minimum SpecRate values for the class a computer system is:
   1. 290 SPEC CINT95rate
   2. 410 SPEC CFP95rate

c. The minimum NASA I/O value for the class a computer system is 100 mallards

4.1.4.2. Performance for Class 1/b

a. The maximum allowed time for the Synopsis benchmark for the class b computer system is 60 minutes.

b. The minimum Spec values for the class b computer system is:
   1. 18 SPEC CINT95
   2. 20 SPEC CFP95

c. The minimum NASA I/O value for the class b computer system is 100 mallards

Table 1 CLASS 1 Performance and Capacity Requirements

PERFORMANCE:

	Synopsis	CINT95	CFP95	mallards	
Subclass(a)	45 min	290 (Rate)	410 (Rate)	100	
Subclass(b)	60 min	18	20	100	

CAPACITY:

	Mem.	Mem. Expand	Disk	Disk Expand	Slots	CPUs
Subclass(a)	2 GB	4 GB	18GB	60GB	3	2
Subclass(b)	1 GB	2 GB	8GB	36GB	2	1

4.2. Class 2: CAE/CAD Mechanical Design Computer Systems

This section describes the CAE/CAD Mechanical Design Computer Systems class specific requirements.

4.2.1. Purpose

The purpose of this section is to define the specific requirements for the mechanical computer aided design (CAD) and computer aided engineering (CAE) Computer Systems as described in Section 2. The following hardware and software specifications are required of these Class 2 computer systems over and above, or in place of the core specifications defined in Section 3.

4.2.2. Hardware Configurations

This section describes the computer system hardware configurations required for the Class 2 systems. Two basic system configurations are required: a 2/a system and a 2/b system. Table 2 defines the performance and disk/memory capacity requirements for this class.

4.2.2.1. Class 2/a and 2/b Computer System

All Class 2 computer systems (Class 2/a and 2/b) shall provide the following minimum capabilities, unless noted as desirable:

a. binary compatibility between Class 2/a and 2/b.
b. operation in an office environment.
c. a second SCSI III, Ultra-SCSI, Fibre Channel compatible interface optionally ordered for one of the available bus slots
d. at least 16 million simultaneously displayable colors and a monitor with a minimum of 1.2 million displayable pixels.
e. a 3-D graphics system supporting double-buffered 24 bit images with a 24 bit Z-buffer
f. support for Windows NT OS as an option to UNIX 95 (desirable)
g. [Core Specification 3.3.2.5.a replaced by]: A FORTRAN 90 compiler, ANSI compliant [ANSI X3. 198-1992]. The FORTRAN compiler shall include:
    1. run time libraries.
    2. FORTRAN source language compatible symbolic debugger with capability to read core dumps. Shall display source code, program variables (including register contents), debugger commands, and debugger output.
    3. an optional 1 user license
    4. an optional 10 user license

4.2.2.2. Class 2/a Computer System

The Class 2/a computer system shall provide the following minimum capabilities, unless noted as desirable:

a. a minimum memory of at least 512 MBytes
    1. memory expandable to at least 2 GB.

b. hard disk storage with a minimum of 8 GByte of available user space remaining after installation of all minimum required software as specified in the delivery list (operating system, system swap space, on-line system documentation, linker, drivers, X windows, etc.).
    1. internal disk storage expandable to at least 18 GByte
    2. disk storage expandable to at least 64 GByte.

c. at least 2 CPUs
d. at least 3 available bus slots
e. Error Detecting/Correcting (ECC) Memory (desirable).

4.2.2.3. Class 2/b Computer System

The Class 2/b computer system shall provide the following minimum capabilities, unless noted as desirable:

a. a minimum memory of at least 256 MBytes

1. memory expandable to at least 1 GB.

b. hard disk storage with a minimum of 8 GByte of available user space remaining after installation of all minimum required software as specified in the delivery list (operating system, system swap space, on-line system documentation, linker, drivers, X windows, etc.).
   1. disk storage expandable to at least 32 GByte.

c. at least 2 available bus slots

4.2.3. Application Software

This section describes the commercial application software packages that are required to run on the Class 2 computer system systems. The following CAD software packages shall be supported:

a. MSC NASTRAN or other commercially available NASTRAN. MSC NASTRAN is a commercially available software product from the MacNeal Schwendler Corporation

b. MSC PATRAN CAE tool. PATRAN s is a commercially available software product from the MacNeal Schwendler Corporation

c. SDRC's I-DEAS Master Series family of CAE/CAD tools. IDEAS Master Series is a commercially available software product from Structural Dynamics Research Corporation.
d. CADSI's DADS CAE tool. DADS is a commercially available software product from CADSI.
e. Parametric Technology's Pro/E package. Pro/E is a commercially available software product from Parametric Technology.

f. OPEN GL

g. MATLAB. MATLAB is a commercially available software product from The MathWorks Inc

4.2.4. Performance

This section describes the performance values required for the Class 2 computer systems.

4.2.4.1. Performance for Class 2/a

a. The maximum allowed CPU time for the NASTRAN benchmark for the class a computer system is 11 minutes.

b. The minimum allowed overall composite score for the SPEC Pro-E benchmark for the class a computer system is 2.3

c. The minimum SpecRate values for the class a computer system is:
   1. 320 SPEC CINT95rate
   2. 480 SPEC CFP95rate

d. The minimum NASA I/O value for the class a computer system is 150 mallards

4.2.4.2. Performance for Class 2/b

a. The maximum allowed CPU time for the NASTRAN benchmark for the class b computer system is 28 minutes.

b. The minimum allowed overall composite score for the SPEC Pro-E benchmark for the class b computer system is 1.7

c. The minimum Spec values for the class b computer system is:
   1. 10 SPEC CINT95
   2. 12 SPEC CFP95

d. The minimum NASA I/O value for the class b computer system is 150 mallards

Table 2: CLASS 2 Performance and Capacity Requirements

PERFORMANCE:

	NASTRAN	Pro-E	CINT95	CFP95	mallards	
Subclass(a)	11 min	2.3	320 (Rate)	480 (Rate)	150	
Subclass(b)	28 min	1.7	10	12	150	

CAPACITY:

	Mem.	Mem. Expand	Disk	Disk Expand	Slots	CPUs
Subclass(a)	512 MB	2 GB	8GB	64GB	3	2
Subclass(b)	256 MB	1GB	8GB	32GB	2	1

4.3. Class 3: Mass Storage Servers

This section describes the Mass Storage Server class specific requirements.

4.3.1. Purpose

The purpose of this section is to define the specific requirements for the mass storage servers as described in Section 2. The following hardware and software specifications are required of these Class 3 computer systems over and above, or in place of the core specifications defined in Section 3.

4.3.2. Hardware Configuration

This class of computer systems is comprised of a 3/a computer system and a 3/b computer system. These systems are differentiated mainly by capacity. Both systems need to support mass storage devices.

4.3.2.1. Class 3/a and 3/b Computer Systems

All Class 3 computer systems (Class 3/a and 3/b) shall provide the following minimum capabilities, unless noted as a desirable:

a. binary compatibility between Class 3/a and 3/b.

b. operation in a computer room environment.

c. option for either Fibre Channel or SCSI Controllers (replaces 3.2.2.b.1.)

All Class 3 computer systems (Class 3/a and 3/b) shall support the following minimum capabilities, unless noted as a desirable:

d. Hierarchical Mass Storage Systems:
   1. UniTree. UniTree is a commercially available software product from UniTree Software Inc (UTSI)
   2. One other hierarchical mass storage system with the ability to at least:
      a. locate, mount, read and write(except CD-ROMs) tapes or disks in the jukeboxes.
      b. support UNIX native file system user calls and commands, e.g. “ls”, “touch”, etc.
      c. support access at hard disk storage speed to the most frequently/recently accessed files.
      d. ‘vault’ media and provide a means of notifying the operator to retrieve a ‘vaulted’ media when an ‘old’ file is requested.
      e. employ a ‘nameserver’ and ‘tapeserver’ or similar means for locating files on media.
      f. utilities for backup and recovery of critical databases
      g. repacking function (repack tapes to remove deleted files)
      h. logging major activities of software components for system monitoring.
      i. write multiple tape copies of a file
      j. scalable up to at least 10 Pbyte, providing the user a way to build up to full use of the mass storage system
      k. write multiple tape copies of a file simultaneously
      l. write multiple simultaneous streams of new data

e. EMC RAID arrays
   1. Other Ultra-SCSI and fibre-attached disk and RAID arrays (desirable)

f. STK 9840, IBM 3590 E1A, STK 3490E, and STK D3(Redwood) tape drives
   1. Other Ultra-SCSI and fibre-attached tape drives (desirable)

g. STK 9310 (Powderhorn) and IBM 3494 robotic libraries
   1. Other robotic libraries (desirable)

h. Optical jukeboxes

i. SAN Technology

j. multiple server capabilities (server functions spread over multiple machines) as described in the IEEE Mass Storage Reference Model; support for higher scalability (e.g. storage capacity up to 100 Pbyte) and other advanced functions / capabilities for the hierarchical storage management system (advanced technology)

4.3.2.2. Class 3/a Computer System

The Class 3/a computer system shall provide the following minimum capabilities, unless noted as a desirable:

a. a minimum memory of at least 8 GBytes
   1. memory expandable to at least 12 GBytes

b. 1 TB of RAID 3 or RAID 5 disk

c. hard disk storage with a minimum of 16 GBytes of available user space remaining after installation of all minimum required software as specified in the delivery list (operating system, system swap space, on-line system documentation, linker, drivers, X windows, etc.).
   1. Disk storage shall be expandable to at least 64 GBytes. This requirement is exclusive of the requirement for a mass storage and RAID disk system.
   2. Disk storage shall have mirroring capability

d. at least 16 available bus slots.

e. 8 CPUs
   1. expandable to at least 12 CPUs

f. In addition to the core network interfaces described in section 3.4.2., class 3/a systems shall provide the following network interfaces:
   1. HiPPI

g. Class 3/a systems shall optionally provide the following network interfaces either in place of or in addition to the HiPPI requirement:
   1. Gigabit Ethernet
   2. ATM OC12

4.3.2.3. Class 3/b Computer Systems

The Class 3/b computer system shall provide the following minimum capabilities, unless noted as a desirable:

a. a minimum memory of at least 4 GBytes
   1. memory expandable to at least 6 GBytes

b. 300 GB of RAID or JBOD disk

c. hard disk storage with a minimum of 8 GBytes of available user space remaining after installation of all minimum required software as specified in the delivery list (operating system, system swap space, on-line system documentation, linker, drivers, X windows, etc.).
   1. Disk storage shall be expandable to at least 32 GBytes. This requirement is exclusive of the requirement for a mass storage and RAID disk system.
   2. Disk storage shall have mirroring capability

d. at least 8 available bus slots.

e. 4 CPUs
   1. expandable to at least 6 CPUs

f. In addition to the core network interfaces described in section 3.4.2., class 3/b systems shall provide the following network interfaces:
   1. ATM OC3

4.3.3. Application Software

All Class 3 computer systems (Class 3/a and 3/b) shall support the following software:

a. database client libraries (allowing database applications to run on the computer systems while accessing remote database servers) on both class 3/a and 3/b computer systems including, but not limited to
   1. Sybase
   2. Oracle
   3. Informix
   4. Ingres
b. database servers (running the actual database instance on the system) on Class 3/a computer system including, but not limited to:
   1. Sybase
   2. Oracle
   3. Informix
   4. Ingres

4.3.4. Performance Benchmarks

This section describes the performance values required for the Class 3 computer systems.

4.3.4.1. Performance for Class 3/a

a. The minimum allowed rates for the NASA Unitree based benchmark for the class a computer system are:
   1. 8.5 MB/s puts
   2. 12 MB/s gets
   3. 8 MB/s migrates
   4. 9 MB/s stages

b. The minimum SpecRate values for the class a computer system is:
   1. 650 SPEC CINT95rate
   2. 775 SPEC CFP95rate

c. The minimum NASA I/O value for the class a computer system is 350 mallards

4.3.4.2. Performance for Class 3/b

a. The minimum allowed rates for the NASA Unitree based benchmark for the class b computer system are:
   1. 7.5 MB/s puts
   2. 10 MB/s gets
   3. 6 MB/s migrates
   4. 7 MB/s stages

b. The minimum SpecRate values for the class b computer system is:
   1. 250 SPEC CINT95rate
   2. 400 SPEC CFP95rate

c. The minimum NASA I/O value for the class b computer system is 250 mallards

Table 3: CLASS 3 Performance and Capacity Requirements

PERFORMANCE:

	Unitree put	Unitree get	Unitree migrate	Unitree stage	CINT95	CFP95	mallards	

Subclass(a)	8.5 MB/s	12 MB/s	8 MB/s	9 MB/s	650 (Rate)	775 (Rate)	350	
Subclass(b)	7.5 MB/s	10 MB/s	6 MB/s	7 MB/s	250 (Rate)	400 (Rate)	250	

CAPACITY:

	Mem.	Mem. Expand	Disk	Disk Expand	Slots	CPUs	CPU expand
Subclass(a)	8 GB	12 GB	16GB	64GB	16	8	12
Subclass(b)	4 GB	6 GB	8GB	32GB	8	4	6

4.4. Class 4: Network Data Server Computer Systems

This section describes the Network Data Server Computer Systems class specific requirements.

4.4.1. Purpose

The purpose of this section is to define the specific requirements for the Network Data Server Computer Systems as described in Section 2. The following hardware and software specifications are required of these Class 4 computer systems over and above, or in place of the core specifications defined in Section 3.

4.4.2. Hardware Configurations

This class of computer systems consists of a class 4/a network data server and a class 4/b network data server (4/b). These machines are differentiated by the system and database performance and the amount of mass storage supported.

4.4.2.1. Class 4/a and 4/b Computer Systems

All Class 4 computer systems (Class 4/a and 4/b) shall provide the following minimum capabilities, unless noted as a desirable:

a. have scalable processing (user can incrementally add processing power).
b. Error Detecting/Correcting (ECC) Memory.
c. at least 256 simultaneously displayable colors from a palette of at least 16 million available colors and monitor with a minimum of 1.0 million displayable pixels.
d. ability to simultaneously connect the system to both FDDI and Ethernet
e. optional interfaces in addition to the core SCSI/Fibre Channel specification:
    1. Option for either Fibre Channel or SCSI
    2. ATM
    3. other high performance interfaces (in addition to supporting a standard SCSI interface) such as the SMD [ANSI X3.91M-1987] or the High Performance Parallel Interface (HiPPI) [ANSI X3.T9/88] (desirable)

f. Network File System (NFS) hardware and/or software performance enhancement (desirable).
g. binary compatibility between 4/a and 4/b systems (desirable)
h. a virtual file system manager (desirable).
i. [Core Specification 3.3.2.5.a replaced by]: A FORTRAN 90 compiler, ANSI compliant [ANSI X3. 198-1992]. The FORTRAN compiler shall include:
    1. run time libraries.
    2. FORTRAN source language compatible symbolic debugger with capability to read core dumps. Shall display source code, program variables (including register contents), debugger commands, and debugger output.
    3. an optional 1 user license
    4. an optional 10 user license

j. Java Interpreter
k. CD Read / Write Drives (desirable)

4.4.2.2. Class 4/a Computer System

The Class 4/a computer systems shall provide the following minimum capabilities:

a. minimum memory of at least 1 GBytes.
    1. memory expandable to at least 2 GBytes.

b. hard disk storage with a minimum of 16 GBytes of available user space remaining after installation of all minimum required software as specified in the delivery list (operating system, system swap space, on-line system documentation, linker, drivers, X windows, etc.).
    1. Disk storage shall be expandable to at least 900 GBytes. This requirement is exclusive of the requirement for a mass storage system.

2. Disk storage be expandable to 2 Tbytes (desirable)

c. at least 2 additional SCSI III, Fibre Channel or higher performance host adapter interfaces.
d. at least 16 available bus slots (15 available slots if Ethernet connection is embedded in the system).
e. at least 2 CPUs
   1. expandable to at least 24 CPUs
   2. expandable to at least 30 CPUs (desirable)

f. at least 2 RAID devices (supporting RAID levels 0, 1, and 5).:
   1. one with at least a 100 GB disk array
   2. one with at least a 1000 GB disk array
   3. Support for RAID levels 2, 3 and 4 (desirable)
   4. Advanced fault tolerance, additional redundancy (e.g., redundant drive controllers, power supplies, SCSI controllers, etc.), disk swap capabilities (e.g., the ability to replace a failed drive without shutting down, the ability to easily swap out drives with higher capacity drives, etc.), and the extent to which implementation is software or hardware based (advanced technology).

g. dual-ported (i.e. connectivity to 2 or more host systems) external peripheral storage devices (desirable).

4.4.2.3. Class 4/b Computer System

The Class 4/b computer systems shall provide the following minimum capabilities, unless noted as a desirable:

a. minimum memory of at least 256 MBytes.
   1. memory expandable to at least 512 MBytes.

b. hard disk storage with a minimum of 8 GBytes of available user space remaining after installation of all minimum required software as specified in the delivery list (operating system, system swap space, on-line system documentation, linker, drivers, X windows, etc.).
   1. Disk storage shall be expandable to at least 120 GBytes. This requirement is exclusive of the requirement for a mass storage system.

c. at least 1 RAID device (supporting RAID levels 0, 1,and 5) with at least 50 GB disk array
   1. support for RAID level 3 (desirable)

d. an optional second SCSI III, Fibre Channel or higher host adapter interface

e. at least 5 available bus slots (4 available slots if Ethernet connection is embedded in the system).

f. at least 1 CPU
   1. expandable to at least 6 CPUs
   2. expandable to at least 8 CPUs (desirable)

g. operation in an office environment (desirable)

4.4.2.4. Mass Storage Systems

In some instances, this Class will be configured to host large digital archives or as large file servers. To meet this requirement, storage management systems that integrate with the computer system and support multiple mass storage systems as noted in 4.4.2.4.a through 4.4.2.4.d must be supported.

a. The subclass 4/b computer systems must support the following storage systems:
   1. digital linear tape (DLT) drives and desktop jukebox
   2. 8 mm tape drives and desktop jukebox
   3. 4 mm tape drives and desktop jukebox

b. The subclass 4/a computer systems must support (including availability of functions described in Section 4.4.2.4.d.) the following mass storage systems:
   1. magneto-optical disk drives and jukeboxes
   2. CD-ROM (read-only) disk drives, and jukeboxes
   3. digital linear tape (DLT) drives, and jukeboxes

4. 8 mm tape drives, and desktop jukeboxes
5. 4 mm tape drives, and desktop jukeboxes
6. DVD drives

c. The subclass 4/a computer systems must support one or more of the following mass storage systems (desirable):
   1. STK 9840 robotic device
   2. IBM 3590/3590E robotic device
   3. multiple media types (e.g. ADIC) jukebox
   4. other state-of-the-art drives, and desktop jukeboxes
   5. other state-of-the-art jukeboxes

d. The jukeboxes must attach to the computer systems with at least a SCSI III interface. The following sizes of jukeboxes must be supported for magneto-optical, CD-ROM and DLT media:
   1. for a large library system with a storage capacity of at least 1 TByte, expandable to at least 100 Tbytes; and
   2. for all supported jukeboxes, a small library system with a storage capacity of at least 10 GByte, expandable to at least 60 GBytes.

e. the file management storage system must be hierarchical, such as UNITREE or EPOCH. The hierarchical storage management software must have the ability to:
   1. locate, mount, read and write(except CD-ROMs) tapes or disks in the jukeboxes.
   2. ability to support UNIX native file system user calls and commands, e.g. “ls”, “touch”, etc.
   3. support access at hard disk storage speed to the most frequently/recently accessed files.
   4. ‘vault’ media and provide a means of notifying the operator to retrieve a ‘vaulted’ media when an ‘old’ file is requested.
   5. employ a ‘nameserver’ or similar means for locating files on media.
   6. utilities for backup and recovery of critical databases
   7. repacking function (repack tapes to remove deleted files)
   8. logging major activities of software components for system monitoring.

f. The hierarchical storage management system should be scalable up to at least 50 TB providing the user a way to build up to full use of the mass storage system.
g. dual (or multiple) tape copies of a file; multiple server capabilities (server functions spread over multiple machines) as described in the IEEE Mass Storage Reference Model; support for higher scalability (e.g. storage capacity up to 1 Pbyte) and other advanced functions / capabilities for the hierarchical storage management system (advanced technology).

4.4.3. Application Software

In many cases this Class would operate a relational data base management system in a client/server architecture. This system may be configured to operate only as a data server supporting clients on other network nodes, or with both client and server on the same computer system. Therefore, the Class 4 computer systems shall support:

a. relational database servers (running the actual database instance on the system) on Class 4/a computer system including, but not limited to:
   1. Sybase
   2. Oracle
   3. Informix
   4. Ingres
   5. object oriented database server such as Versant, ObjectStore, ONTOS

4.4.4. Performance Benchmarks

This section describes the performance values required for the Class 4 computer systems.

4.4.4.1. Performance for Class 4/a

a. The minimum allowed TPC tpmC value for the class a computer system is 6000.

b. The maximum times for the NASA Sybase based database on the class a computer system are:
   1. 170 sec for the small database load time for tables and indices
   2. 25000 ms for the small database query time
   3. 3100 sec for the large database load time for tables and indices
   4. 200000 ms for the large database query time

c. The minimum SpecRate values for the class a computer system is:
   1. 480 SPEC CINT95rate
   2. 320 SPEC CFP95rate

d. The minimum NASA I/O value for the class a computer system is 350 mallards

4.4.4.2. Performance for Class 4/b

a. The minimum allowed TPC tpmC value for the class b computer system is 2000

b. The maximum times for the NASA Sybase based database on the class b computer system are:
   1. 300 sec for the small database load time for tables and indices
   2. 33500 ms for the small database query time
   3. 5500 sec for the large database load time for tables and indices
   4. 240000 ms for the large database query time

c. The minimum Spec values for the class b computer system is:
   1. 15 SPEC CINT95
   2. 24 SPEC CFP95

d. The minimum NASA I/O value for the class b computer system is 150 mallards

Table 4: CLASS 4 Performance and Capacity Requirements

PERFORMANCE:

	tpmC	Small db bcp load	Small db query	Large db bcp load	Large db query	CINT95	CFP95	mallards	
Subclass(a)	6000	170 sec	25000 ms	3100 sec	200000 ms	320 (Rate)	480 (Rate)	350	
Subclass(b)	2000	300 sec	29000 ms	5500 sec	240000 ms	15	24	150	

CAPACITY

	Mem.	Mem. Expand	Disk	Disk Expand	Slots	CPUs	CPU expand
Subclass(a)	1 GB	2 GB	16GB	900GB	16	2	24
Subclass(b)	256 MB	512 MB	8GB	120GB	5	1	6

4.5. Class 5: 3-D Graphics Computer Systems

This section describes the High Performance Visualization Computer Systems class specific requirements.

4.5.1. Purpose

The purpose of this section is to define the specific requirements for the High Performance Visualization Computer Systems as described in Section 2. The following hardware and software specifications are required of these Class 5 computer systems over and above, or in place of the core specifications defined in Section 3.

4.5.2. Hardware Configurations

This section describes the computer system hardware configurations required for the Class 5 systems. Two basic system configurations are required: a 5/a system and a 5/b system. Table 2 defines the performance and disk/memory capacity requirements for this class.

4.5.2.1. Class 5/a and 5/b Computer System

All Class 5 computer systems (Class 5/a and 5/b) shall provide the following minimum capabilities, unless noted as desirable:

a. binary compatibility between Class 5/a and 5/b.

b. a second SCSI III, Ultra-SCSI, Fibre Channel compatible interface optionally ordered for one of the available bus slots

c. at least 16 million simultaneously displayable colors and a monitor with a minimum of 1.2 million displayable pixels.

d. a 3-D graphics system supporting double-buffered 24 bit images with a 24 bit Z-buffer

e. support for Windows NT OS as an option to UNIX 95 (desirable)

4.5.2.2. Class 5/a Computer System

The Class 5/a computer system shall provide the following minimum capabilities, unless noted as desirable:

a. a minimum memory of at least 1 Gbytes
   1. memory expandable to at least 4 GB.

b. hard disk storage with a minimum of 9 Gbyte of available user space remaining after installation of all minimum required software as specified in the delivery list (operating system, system swap space, on-line system documentation, linker, drivers, X windows, etc.).
   1. internal disk storage expandable to at least 18 Gbyte
   2. disk storage expandable to at least 64 Gbyte

c. expandable to at least 4 CPUs.

d. a second 3-D graphics display capability (desirable).

e. at least 3 available bus slots.

f. Error Detecting/Correcting (ECC) Memory (desirable).

g. operation in a computer room environment.

4.5.2.3. Class 5/b Computer System

The Class 5/b computer system shall provide the following minimum capabilities, unless noted as desirable:

a. a minimum memory of at least 512 Mbytes

1. memory expandable to at least 2 GB.

b. hard disk storage with a minimum of 9 Gbyte of available user space remaining after installation of all minimum required software as specified in the delivery list (operating system, system swap space, on-line system documentation, linker, drivers, X windows, etc.).
   1. disk storage expandable to at least 32 Gbyte.

c. at least 2 available bus slots

d. expandable to at least 2 CPUs

e. operation in an office environment.

4.5.3. Graphics Controller and Monitor

This section describes the technical requirements for the computer systems' graphics controller and monitor.

4.5.3.1. Class 5/a and 5/b Computer System Graphics

All Class 5 computer systems (Class 5/a and 5/b) shall provide the following minimum graphics capabilities, unless noted as a desirable or advanced technology:

a. 24 bit z buffering.
b. Gouraud and flat shading.
c. four sample (jittered or regular) anti-aliasing.
d. an overlay plane.
e. diffuse, ambient, emission and specular lighting characteristics with a minimum of 5 simultaneous lights.
f. digitizing graphics tablet.
g. RGB (red, green, blue) 60 or 72 hz video output that will allow the use of video projectors and the adaptation of other video equipment.
h. advanced graphics and image generation capabilities in such areas as: texture mapping, lighting/shading/shadowing, underlays/overlays, hidden surface removal, object primitives, display lists, antialiasing, transparency, surface properties, etc (advanced technology)
i. video capability for virtual reality imaging (e.g., support for booms, head mounted displays, etc.); advanced multimedia capabilities such as inputting, outputting, and editing MPEG, audio, and "raw" video; flexible and programmable video outputs (e.g., resolution, format/timing, number of graphics channels, stereo, composite, etc.) (advanced technology)
j. advanced graphics peripherals such as complex/advanced input devices (e.g., spaceball, 3D-mouse, dial box/button box); output devices (e.g., 16 bit stereo audio support); display technologies (i.e. beyond standard CRT); 3D and stereographic systems such as Fakespace BOOM, non-VGA head-mounted displays, head-tracked and non-head-tracked stereo glasses (advanced technology)
k. 16-bit stereo audio processing card with voice quality speakers (desirable):

4.5.3.2. Class 5/a High-end Computer System Graphics

The high-end system (5/a) shall additionally provide the following minimum capabilities, unless noted as a desirable:

a. alpha-blending (color blending).
b. a minimum of 32 bit color planes with full double buffering.
   1. 48 bit color (RGBA) planes (desirable)

c. minification / magnification filters for texture mapping (linear, constant and smooth) with texture sizes of at least 512 x 512.
d. Field sequential (180hz) video signal output
e. At least a 32 bit z buffer (desirable)
f. at least 8 bit alpha planes (desirable)
g. draw at least 1,000,000 randomly oriented 10 pixel polylines per second in floating point coordinates transformed, scaled, clip tested, and anti-aliased.

h. draw at least 400,000 polygons per second based on 100 pixel polygons, Gouraud shaded with at least one light source, transformed, clipped, and 24 bit Z buffered using floating point coordinates (excluding back faced, culled polygons).

4.5.3.3. Class 5/b Low-end Computer System Graphics

The low-end system (5/b) shall additionally provide the following minimum capabilities, unless noted as a desirable:

a. a minimum of 24 bit color planes with at least 12 bit double buffering.
b. minification / magnification filters for texture mapping (linear, constant and smooth) with texture sizes of at least 256 x 256
c. draw at least 500,000 randomly oriented 10 pixel polylines per second in floating point coordinates transformed, scaled, clip tested, and anti-aliased.
d. draw at least 150,000 polygons per second based on 100 pixel polygons, Gouraud shaded with at least one light source, transformed, clipped, and 24 bit Z buffered using floating point coordinates (excluding back faced, culled polygons).

4.5.4. Application Software

This section describes the commercial application software packages that are required to run on the Class 5 computer system systems. The following Visualization software packages shall be supported:

a. Performer or other commercially available data visualization software product
b. IDL
c. Maya by Alias/Wavefront or Lightwave by Newtek animation software
d. OPEN GL

4.5.5. Performance Benchmarks

This section describes the performance values required for the Class 5 computer systems.

4.5.5.1. Performance for Class 5/a and 5/b

Both the class 5/a and class 5/b systems must meet or exceed the following SPEC GL benchmark values:

a. From clear times:
   1. (Immediate, RGB, full screen, color buffer, depth buffer): 337 M pixels / sec
   2. (CallList, RGB, full screen, color buffer, depth buffer): 336 M pixels / sec
b. From fill rates:
   1. Quads (CallList, RGB, Z, 3D, smooth) 381M pixels/sec
   2. Quads (CallList, RGB, Z, 3D, 64x64 RGB trilinear modulated texture, smooth) 412M pixels/sec
c. From TexImage.rgb:
   1. TexImage (Immediate, RGB, ubyte, 2048x2048) 130M texels/sec
   2. TexImage (Immediate, RGBA, ubyte, 2048x2048) 106 texels/sec
   3. TexImage (Immediate, RGB, ubyte, 2048x2048, mipmapped) 128M texels/sec
   4. TexImage (Immediate, RGBA, ubyte, 2048x2048, mipmapped) 96.5M texels/sec
d. From OPClist.rgb, BgnEnd.rgb, or Triangles.RGB:
   1. Triangle Strip (Immediate, RGB, Z, smooth, 3D): 7.39M triangles/sec
   2. Triangle Strip (Immediate, RGB, Z, 1 infinite light, smooth, 3D): 7.34M
   3. Triangle Strip (Immediate, RGB, Z, 1 infinite light, textured, smooth, 3D): 4.59M triangles/sec

4.5.5.2. Performance for Class 5/a

a. The minimum Spec values for the class a computer system is:
   1. 16 SPEC CINT95
   2. 22 SPEC CFP95

b. The minimum NASA I/O value for the class a computer system is 150 mallards

4.5.5.3. Performance for Class 5/b

a. The minimum Spec values for the class b computer system is:

1. 13 SPEC CINT95
2. 20 SPEC CFP95

b. The minimum NASA I/O value for the class b computer system is 150 mallards

Table 5: CLASS 5 Performance and Capacity Requirements

PERFORMANCE:

	CINT95	CFP95	mallards	
Subclass(a)	16	22	150	
Subclass(b)	13	20	150	

CAPACITY

	Mem.	Mem. Expand	Disk	Disk Expand	Slots	CPUs	CPU expand
Subclass(a)	1 GB	4GB	9 GB	64 GB	3	1	4
Subclass(b)	512 MB	2 GB	9 GB	32GB	2	1	2

4.6. Class 6: Compute Servers

This section describes the Compute Servers class specific requirements.

4.6.1. Purpose

The purpose of this section is to define the specific requirements for the Computer Servers as described in Section 2. The following hardware and software specifications are required of these Class 6 computer systems over and above, or in place of the core specifications defined in Section 3.

4.6.2. Hardware Configurations

This class of servers is comprised of a family of two subclasses: a top-of-the-line Compute Server subclass (6/a) and a high-end Compute Server subclass (6/b). These systems, while differentiated by performance and capacity are both intended for use by highly compute intensive code.

4.6.2.1. Class 6/a and 6/b Computer Servers

All Class 6 computer systems (Class 6/a and 6/b) shall provide the following minimum capabilities, unless noted as a desirable:

a. X/Open Base 95 branded with delivery of a copy of the X/Open branding certificate with proposal. [replaces core specification 3.3.2.a]
   1. UNIX 95 or UNIX 98 branding and may be substituted for the Base 95 requirement (desirable).

b. the capability of performing 64-bit and 128-bit floating point arithmetic [replaces core specification 3.2.1.e]
   1. be capable of reading/writing IEEE 754 floating point standard values.
   2. perform 64-bit and 128-bit floating point arithmetic in hardware (desirable)

c. [Core Specification 3.2.1.b is not required for Class 6]

d. Each system shall provide 3480/3490 tape systems [replace core specification 3.2.2.c and 3.2.2.d]
   1. support for other high performance tape systems (desirable)

e. [Core Specifications 3.2.3.b and 3.2.3.c are not required for Class 6]

f. binary compatibility between Class 6/a and 6/b (desirable).

g. operate in an computer room environment.

h. In addition to Resource Management Core Specifications (Section 3.3.2.1) Class 6/a and 6/b servers must provide:
   1. Any process shall be able to access at least 80% of physical memory within a shared memory node in which a node is defined to be a unit of 1 to N central processing units directly attached to some amount of physical memory.
   2. Batch queuing system
      a. POSIX 1003.2d compliance (desirable)
   3. Techniques for system resource; memory; and batch program management including batch queuing and scheduling, priority and resource control; and executing program management including dynamic priority handling.

i. [Core Specification 3.3.2.5.b.3., 3.3.2.5.b.4., 3.3.2.5.b.5. replaced by]:
   1. a C compiler unlimited system license

j. In addition to File System Core Specifications (Section 3.3.2.3) Class 6/a and 6/b servers must provide:
   1. the capability to create file systems and individual files in excess of 10 GB.

k. [Core Specification 3.3.2.5.a replaced by]:

1. A FORTRAN90 compiler, ANSI compliant [ANSI X3. 198-1992]. The FORTRAN compiler shall include:
    a. run time libraries.
    b. a FORTRAN source language compatible symbolic debugger with capability to read core dumps. Shall display source code, program variables (including register contents), debugger commands, and debugger output.
    c. automatically optimize code to best utilize the hardware architecture; e.g., parallelization and vectorization
    d. ability to clearly list all instances of vectorization, parallelization or other optimizations.
    e. an unlimited system license
    f. Optional FORTRAN 77 compiler, ANSI compliant [ANSI X3.9-1978] (desirable).

l. [Core Specification 3.3.2.5.c.4, 3.3.2.5.c.5., 3.3.2.5.c.5. replaced by]:
    1. a C++ compiler unlimited system license

m. [Core Specification 3.3.2.5.d replaced by]:
    1. Advanced versions of compilers and advanced compiler features which enhance architecture specific performance, software tuning, modularity, functionality, etc.; and tools or capabilities (such as graphics debug interfaces) which enhance the coding, testing, and execution of programs Advanced versions of compilers may be substituted for the mandatory versions (advanced technology)..

n. [Core Specification 3.3.2.5.g, 3.3.2.5.h,, and 3.3.2.5.j deleted]:
o. [Core Specification 3.3.3.a , and 3.3.3.c deleted]:
p. [Core Specification 3.4.2.b.5.and 3.4.2.b.6 replaced by]:
    1. all servers shall provide FDDI Dual Attachment Station (DAS) cabling.

q. . the capability to directly attach to HIPPI and ATM networks.

r. [Core Specification 3.4.4.b is not required for Class 6]:

s. [Core Specification 3.6.e. is not required for Class 6]:

t. Error Detecting/Correcting (ECC) Memory.

4.6.2.2. Class 6/a Compute Server

The Class 6/a compute server shall provide the following minimum capabilities, unless noted as a desirable:

a. minimum memory of at least 32 GBytes
    1. memory expandable to at least 64 GByte.

b. hard disk storage with a minimum of 500 GByte of available user space remaining after installation of all minimum required software as specified in the delivery list (operating system, system swap space, on-line system documentation, linker, drivers, X windows, etc.).
    1. disk storage expandable to at least 1000 GByte.

c. minimum of 64 CPUs
    1. expandable to at least 256 CPUs.

4.6.2.3. Class 6/b Compute Server

The Class 6/b compute server shall provide the following minimum capabilities, unless noted as a desirable:

a. minimum memory of at least 16 GBytes
    1. memory expandable to at least 32 GByte.

b. hard disk storage with a minimum of 200 GByte of available user space remaining after installation of all minimum required software as specified in the delivery list (operating system, system swap space, on-line system documentation, linker, drivers, X windows, etc.).

1. disk storage expandable to at least 500 GByte.

c. minimum of 32 CPUs
   1. expandable to at least 128 CPUs.

4.6.3. Hierarchical Storage Management System

a. In some instances, this Class will be configured to host large digital archives or as large file servers. To meet this requirement, a hierarchical storage management systems (HSM), such as UniTree or Data Migration Facility that integrate with the server and support multiple mass storage systems must be provided. the software must have the ability to:
   1. locate, mount, read and write tapes or disks in the jukeboxes.
   2. ability to support UNIX native file system user calls and commands, e.g. "ls", "touch", etc.
   3. support access at hard disk storage speed to the most frequently/recently accessed files.
   4. 'vault' media and provide a means of notifying the operator to retrieve a 'vaulted' media when an 'old' file is requested.
   5. employ a 'nameserver' or similar means for locating files on media.
   6. utilities for backup and recovery of critical databases
   7. repacking function (repack tapes to remove deleted files)
   8. logging major activities of software components for system monitoring.
   9. dual (or multiple) tape copies of a file; multiple server capabilities (server functions spread over multiple machines) as described in the IEEE Mass Storage Reference Model; and other advanced functions / capabilities (advanced technology).

b. The servers must support the following mass storage systems:
   1. 3480/3490 tape drives, and jukeboxes

c. The servers must support one or more of the following mass storage systems (desirable):
   1. D3 (e.g. STK) drives, and jukeboxes
   2. VHS tape drives, and jukeboxes
   3. NTP (e.g. IBM) drives, and jukeboxes
   4. multiple media types (e.g. ADIC) jukebox
   5. other state-of-the-art drives, and stackers (desktop jukeboxes)
   6. other state-of-the-art jukeboxes

d. large library systems with storage capacity of at least 5 Tbytes, expandable to at least 100 Tbytes must be supported
e. The hierarchical storage management system should be scalable up to at least 500 TB providing the user a way to build up to full use of the mass storage system.
   1. scalability up to the 1 Pbyte range (advanced technology)

4.6.4. Analyst Support

An option for on-site analyst support shall be provided:

a. Applications Systems Analyst/Programmer
   1. .Formulates and defines system scope and objectives. Prepares detailed specifications for programs. Designs, codes, tests, debugs and documents programs. Works at the highest technical level of all phases of applications, systems analysis and programming activities. Provides guidance and training to less experienced analysts/programmers.
   2. Educational Requirements: Bachelor's degree from an accredited college or university with a curriculum or major field of study which provides substantial knowledge useful in managing large, complex AIS projects, is closely related to the work to be automated, and/or in a computer science, information system, a physical science, engineering or a mathematics-intensive discipline.
   3. Experience Requirements: Seven years of increasingly complex and progressive experience in performing systems analysis, development, and implementation of business, mathematical, or

scientific setting using a variety of information technology resources. Has experience with current technologies and, where required for the task, emerging technologies.

4.6.5. Performance Benchmarks

This section describes the performance values required for the Class 6 computer systems.

4.6.5.1. Performance for Class 6/a and 6/b

a. The benchmarks provided include a set of optimized application codes from several NASA sites. These codes represent the type of work which will be performed on systems in this class. A suite of 6 application codes is provided. A description of the requirements for running the codes is given in the table below:

Code	Memory (MB)	Copies
dycore	41.5	69
lrl1	38.9	102
raf3	131.7	2
lrl8	137.7	5
mr2	389.8	14
rs1	452.6	2

Both class 6a and 6b systems shall complete the entire workload as listed above in 2300 wall clock seconds.

b. The minimum NASA I/O value for the class a and b computer systems is 150 mallards

Table 6: CLASS 6 Performance and Capacity Requirements

PERFORMANCE:

	Application wallclock (sec)	mallards	
Subclass(a)	2300	150	
Subclass(b)	2300	150	

CAPACITY:

	Mem.	Mem. Expand	Disk	Disk Expand	CPUs	CPU expand
Subclass(a)	32 GB	64 GB	500GB	1000GB	64	256
Subclass(b)	16 GB	32 GB	200 GB	500GB	32	128

4.7. Class 7: Science and Engineering Research Computer Systems

This section describes the Science and Engineering Research Computer Systems class specific requirements.

4.7.1. Purpose

The purpose of this section is to define the specific requirements for the Science and Engineering Research Computer Systems as described in Section 2. The following hardware and software specifications are required of these Class 7 computer systems over and above, or in place of the core specifications defined in Section 3.

4.7.2. Hardware Configurations

This class of computer systems is comprised of a subclass 7/a and subclass 7/b. These systems are differentiated by capacity, software capabilities and mandated OS. Both computer systems need to support a wide suite of software tools a variety of operating environments.

4.7.2.1. Class 7/a and 7/b Computer System

All Class 7 computer systems (Class 7/a and 7/b) shall provide the following minimum capabilities, unless noted as a desirable:

a. operate in an office environment

b. at least 16 million simultaneously displayable colors and a monitor with a minimum of 1600x1200 resolution

c. DVD drives

d. CD Read/writable drives (desirable)

e. at least 5 available bus slots

f. 1.44 MB Floppy Drive

4.7.2.2. Class 7/a Computer System

The Class 7/a computer system shall provide the following minimum capabilities, unless noted as a desirable:

a. a minimum memory of at least 256 MByte
   1. memory expandable to at least 1 GBytes.

b. hard disk storage with a minimum of 10 GByte of available user space remaining after installation of all minimum required software as specified in the delivery list (operating system, system swap space, on-line system documentation, linker, drivers, X windows, etc.).
   1. disk storage expandable to at least 200 GBytes

c. a 3-D graphics system supporting double-buffered 24 bit images with a 24 bit Z-buffer

d. [Core Specification 3.3.2.5.a replaced by]: A FORTRAN 90 compiler, ANSI compliant [ANSI X3. 198-1992]. The FORTRAN compiler shall include:
   1. run time libraries.
   2. a FORTRAN source language compatible symbolic debugger with capability to read core dumps. Shall display source code, program variables (including register contents), debugger commands, and debugger output.
   3. an optional 1 user license
   4. an optional 10 user license

e. optional Windows based OS

4.7.2.3. Class 7/b Computer System

The Class 7/b computer system shall provide the following minimum capabilities, unless noted as a desirable:

a. Linux-based OS. [replaces core specification 3.3.2.a]
   1. optional Windows based OS

b. a minimum CPU word size of 32 bits [replaces core specification 3.2.1.c.]

c. 3D Sound Card

d. 56 Kbps fax/data modem capability
   1. fax/data modems with ISDN capability (desirable)

e. a minimum memory of at least 128 MBytes
   1. memory expandable to at least 768 MBytes.

f. hard disk storage with a minimum of 10 GByte of available user space remaining after installation of all minimum required software as specified in the delivery list (operating system, system swap space, on-line system documentation, linker, drivers, X windows, etc.).
   1. disk storage expandable to at least 20 GBytes

4.7.3. Application Software

This section describes the commercial application software packages that are required to run on the Class 7 computer system systems.

4.7.3.1. Class 7/a Application Software

The Class 7/a computer system shall support the following software:

a. IDL Interactive Data Language
b. ESRI's ARC/INFO GIS software.
c. ESRI's ARCView software.
d. IMSL Math Library (MATH, STAT and special functions for both C and FORTRAN)
e. SAS
f. Matlab
g. Mathematica
h. AutoCAD
i. MSC NASTRAN
j. database client libraries (allowing database applications to run on the computer systems while accessing remote database servers) including, but not limited to:
   1. Sybase
   2. Oracle
k. Database servers (running the actual database instance on the system) on Class 3/a computer system including, but not limited to:
   1. Sybase
   2. Oracle

4.7.3.2. Class 7/b Application Software

The Class 7/b computer system shall support the following software (each is a separate desirable):

a. IDL Interactive Data Language

b. ESRI's ARC/INFO GIS software.

c. ESRI's ARCView software.

d. IMSL Math Library (MATH, STAT and special functions for both C and FORTRAN)

e. SAS

f. Matlab

g. Mathematica

h. AutoCAD

i. MSC NASTRAN

j. database client libraries (allowing database applications to run on the computer systems while accessing remote database servers) including, but not limited to:
   1. Sybase
   2. Oracle

k. Axum V.5.0

l. Slidewrite

m. Scientific Work

n. Hyperchem Win 95

o. EES- Software for Windows

p. Easyplot Windows NT/95

q. MACSYMA, NUMKIT, PDEASE 2D

4.7.4. Performance Benchmarks

This section describes the performance values required for the Class 7 computer systems.

4.7.4.1. Performance for Class 7/a

a. The maximum allowed time to run the wmr29pc chemical kinetics code on the class a computer system running a Windows OS is 75 sec.

b. The minimum Spec values for the class a computer system running a UNIX OS is:
   1. 15 SPEC CINT95
   2. 20 SPEC CFP95

c. The minimum NASA I/O value for the class a computer system running a UNIX OS is 100 mallards

4.7.4.2. Performance for Class 7/b

a. The maximum allowed time to run the wmr29pc chemical kinetics code on the class b computer system running a Windows OS is 100 sec.

b. The minimum Spec values for the class b computer system running a UNIX OS is:
   1. 10 SPEC CINT95
   2. 12 SPEC CFP95

c. The minimum NASA I/O value for the class b computer system running a UNIX OS is 100 mallards

Table 7: CLASS 7 Performance and Capacity Requirements

PERFORMANCE:

	wmr29pc	CINT95	CFP95	mallards	
Subclass(a)	75 sec	15	20	100	
Subclass(b)	100 sec	10	12	100	

CAPACITY:

	Mem.	Mem. Expand	Disk	Disk Expand	Slots
Subclass(a)	256 MB	1 GB	10 GB	200 GB	5
Subclass(b)	128 MB	768 MB	10 GB	20 GB	5

4.8. Class 8: Earth Science Computer Systems

This section describes the Earth Science Computer Systems class specific requirements.

4.8.1. Purpose

The purpose of this section is to define the specific requirements for the Earth Science Computer Systems as described in Section 2. The following hardware and software specifications are required of these Class 8 computer systems over and above, or in place of the core specifications defined in Section 3.

4.8.2. Hardware Configurations

This class of computer systems is comprised of a subclass 8/a and subclass 8/b. These systems are differentiated mainly by capacity. Both computer systems need to support a wide suite of software tools for UNIX based environments.

4.8.2.1. Class 8/a and 8/b Computer System

All Class 8 computer systems (Class 8/a and 8/b) shall provide the following minimum capabilities, unless noted as a desirable:

a. binary compatibility between Class 8/a and 8/b

b. optional availability of a Linux-based OS (desirable)

c. CD Read/writable drives (desirable)

d. Error Detecting/Correcting (ECC) Memory.

e. DLT tape drives

f. provide an option for Gigabit Ethernet

g. [Core Specification 3.3.2.5.a replaced by]: A FORTRAN 90 compiler, ANSI compliant [ANSI X3. 198-1992]. The FORTRAN compiler shall include:
   1. run time libraries.
   2. a FORTRAN source language compatible symbolic debugger with capability to read core dumps. Shall display source code, program variables (including register contents), debugger commands, and debugger output
   3. an optional 1 user license
   4. an optional 10 user license

All Class 8 computer systems shall support the following minimum capabilities, unless noted as a desirable:

h. DVD drive (desirable)

i. AIT Tape Drive (desirable)

4.8.2.2. Class 8/a Computer System

The Class 8/a computer system shall provide the following minimum capabilities, unless noted as a desirable:

a. a minimum memory of at least 1 GByte
   1. memory expandable to at least 4 GBytes.

b. hard disk storage with a minimum of 18 GByte of available user space remaining after installation of all minimum required software as specified in the delivery list (operating system, system swap space, on-line system documentation, linker, drivers, X windows, etc.).
   1. disk storage expandable to at least 2 Tbytes

c. at least 16 million simultaneously displayable colors and a monitor with a minimum of 1600x1200 resolution
d. a 3-D graphics system supporting double-buffered 24 bit images with a 24 bit Z-buffer
e. optionally rack-mountable and run "headless" (with serial console and no keyboard/monitor required)
f. dual CPU
g. Approach for clustering multiple computers, particularly approach for shared file system across a cluster (advanced technology)

The Class 8/a computer system shall support the following minimum capabilities, unless noted as a desirable:

h. hot-swappable, RAID disk arrays.

i. journaled filesystems

j. 4mm DAT jukeboxes

k. 8mm jukeboxes

l. DLT jukeboxes

4.8.2.3. Class 8/b Computer System

The Class 8/b computer system shall provide the following minimum capabilities, unless noted as a desirable:

a. a minimum memory of at least 512 MBytes
    1. memory expandable to at least 2 GBytes.

b. hard disk storage with a minimum of 18 GByte of available user space remaining after installation of all minimum required software as specified in the delivery list (operating system, system swap space, on-line system documentation, linker, drivers, X windows, etc.).
    1. disk storage expandable to at least 200 GBytes

c. at least 16 million simultaneously displayable colors and a monitor with a minimum of 1280x1024 resolution

d. operate in an office environment

4.8.3. Application Software

All Class 8 computer systems (Class 8/a and 8/b) shall support the following software:

a. ImageWorks package from PCI Geomatics of Ontario, Canada
b. IDL Interactive Data Language
c. ENVI
d. Splus
e. ESRI's ARC/INFO GIS software.
f. ESRI's ARCView software.
g. IMSL Math Library (MATH, STAT and special functions for both C and FORTRAN)
h. SAS
i. Word processors such as: Framemaker
j. Matlab
k. Mathematica
l. database client libraries (allowing database applications to run on the computer systems while accessing remote database servers) on both class 8/a and 8/b computer systems including, but not limited to:
    1. Sybase
    2. Oracle

4.8.4. Performance Benchmarks

This section describes the performance values required for the Class 8 computer systems.

4.8.4.1. Performance for Class 8/a

a. The maximum average runtime for the NASA IDL benchmark performing two simultaneous runs, each running 50 iterations, is 1000 sec.

b. The minimum SPECrate values for the class a computer system is:
   1. 250 SPEC CINT95rate
   2. 360 SPEC CFP95rate

c. The minimum NASA I/O value for the class a computer system is 100 mallards

4.8.4.2. Performance for Class 8/b

a. The maximum average runtime for the NASA IDL benchmark performing two simultaneous runs, each running 50 iterations, is 11000 sec.

b. The minimum Spec values for the class b computer system is:
   1. 16 SPEC CINT95
   2. 22 SPEC CFP95

c. The minimum NASA I/O value for the class b computer system is 100 mallards

Table 8: CLASS 8 Performance and Capacity Requirements

PERFORMANCE:

	IDL runtime	CINT95	CFP95	mallards	
Subclass(a)	1000 sec	250 (Rate)	360 (Rate)	100	
Subclass(b)	11000 sec	16	22	100	

CAPACITY:

	Mem.	Mem. Expand	Disk	Disk Expand	CPUs
Subclass(a)	1 GB	4 GB	18GB	2 TB	2
Subclass(b)	512 MB	2 GB	18GB	200 GB	1

4.9. Class 9: Space Science Systems

This section describes the Space Science Computer Systems class specific requirements.

4.9.1. Purpose

The purpose of this section is to define the specific requirements for the Space Science Computer Systems as described in Section 2. The following hardware and software specifications are required of these Class 9 computer systems over and above, or in place of the core specifications defined in Section 3.

4.9.2. Hardware Configuration

This class of computer systems is comprised of a subclass 9/a and subclass 9/b. These systems are differentiated mainly by capacity. Both computer systems need to support a wide suite of software tools for UNIX based environments.

4.9.2.1. Class 9/a and 9/b Computer System

All Class 9 computer systems (Class 9/a and 9/b) shall provide the following minimum capabilities, unless noted as a desirable:

a. binary compatibility between Class 9/a and 9/b (desirable)

b. Error Detecting/Correcting (ECC) Memory.

c. Efficient multi-tasking, including foreground process priority.

d. [Core Specification 3.3.2.5.a replaced by]: A FORTRAN 90 compiler, ANSI compliant [ANSI X3. 198-1992]. The FORTRAN compiler shall include:
   1. run time libraries.
   2. a FORTRAN source language compatible symbolic debugger with capability to read core dumps. Shall display source code, program variables (including register contents), debugger commands, and debugger output.
   3. an optional 1 user license
   4. an optional 10 user license

e. Hot swappable disks (desirable)

4.9.2.2. Class 9/a Computer System

The Class 9/a computer system shall provide the following minimum capabilities, unless noted as a desirable:

a. a minimum memory of at least 2 GByte
   1. memory expandable to at least 8 GBytes.

b. hard disk storage with a minimum of 20 GByte of available user space remaining after installation of all minimum required software as specified in the delivery list (operating system, system swap space, on-line system documentation, linker, drivers, X windows, etc.).
   1. disk storage expandable to at least 1 Tbytes

c. graphics capability of at least:
   1. 32 bit z-buffer,
   2. texture mapping and alpha blending;
   3. 500,000 100-pixel polygons/sec

d. monitors as required in Core Specification 3.2.4.d must also be:
   1. stereo-ready
   2. minimum of 1900x1200 resolution
   3. at least 16 million simultaneously displayable colors

e. 2 CPUs
   1. minimum of 1 Gflops per CPU

f. Approach for larger, efficient storage; improved graphics performance; parallelizing compiler, including the use of distributed memory and remote CPUs; desktop 100GB backup device (advanced technology)

The Class 9/a computer system shall support the following minimum capabilities, unless noted as a desirable:

g. DVD drives (desirable)

h. 4mm DAT, 8mm, or DLT jukeboxes or other suitable large-volume backup devices

4.9.2.3. Class 9/b Computer System

The Class 9/b computer system shall provide the following minimum capabilities, unless noted as a desirable:

a. a minimum memory of at least 128 MBytes
   1. memory expandable to at least 1 GBytes.

b. hard disk storage with a minimum of 5 GByte of available user space remaining after installation of all minimum required software as specified in the delivery list (operating system, system swap space, on-line system documentation, linker, drivers, X windows, etc.).
   1. disk storage expandable to at least 20 GBytes

c. graphics capability of at least:
   1. 24 bit z-buffer,

d. monitors as required in Core Specification 3.2.4.d must also be:
   1. minimum of 1024x768 resolution
   2. at least 16 million simultaneously displayable colors

e. operate in an office environment

f. minimum of 1 Gflops per CPU

4.9.3. Application Software

All Class 9 computer systems (Class 9/a and 9/b) shall support the following software:

a. Open GL
b. IDL Interactive Data Language
c. IMSL Math Library (MATH, STAT and special functions for both C and FORTRAN)

4.9.4. Performance Benchmarks

This section describes the performance values required for the Class 9 computer systems.

4.9.4.1. Performance for Class 9/a

a. The maximum allowed total "real" time for the NASA Space Science Benchmark is 43 minutes

b. The minimum SPECrate values for the class a computer system is:
   1. 250 SPEC CINT95rate
   2. 360 SPEC CFP95rate

c. The minimum NASA I/O value for the class a computer system is 100 mallards

4.9.4.2. Performance for Class 9/b

a. The maximum allowed total "real" time for the NASA Space Science Benchmark is 53 minutes

b. The minimum Spec values for the class b computer system is:
   1. 15 SPEC CINT95
   2. 20 SPEC CFP95

c. The minimum NASA I/O value for the class b computer system is 100 mallards

Table 9: CLASS 9 Performance and Capacity Requirements

PERFORMANCE:

	Space Science Benchmark	CINT95	CFP95	mallards
Subclass(a)	43 minutes	250 (Rate)	360 (Rate)	100
Subclass(b)	53 minutes	15	20	100

CAPACITY:

	Mem.	Mem. Expand	Disk	Disk Expand	CPUs
Subclass(a)	2 GB	8 GB	20 GB	1 TB	2
Subclass(b)	128 MB	1 GB	5 GB	20 GB	1

4.10. Summary Class Specific Requirements

To clarify relationships between classes, many (but not all) of the requirements are summarized in the following tables.

Table 10: Binary Compatibility within Class

Class	1	2	3	4	5	6	7	8	9
Desirable	-	-	-	X	-	X	-	-	X
Mandatory	X	X	X	-	X	-	-	X	

Table 11: Office Environment Requirements

Class	1	2	3	4	5	6	7	8	9
Subclass (a)	-	R	-	-	-	-	R	-	-
Subclass (b)	R	R	-	D	R	-	R	R	R

D = Desirable R = Required

Table 12: Memory Error Detection/Correction (ECC) Requirements

Class	1	2	3	4	5	6	7	8	9
Subclass (a)	R	D	-	R	D	R	-	R	R
Subclass (b)	-	-	-	R	-	R	-	R	R

D = Desirable R = Required

Table 13: Capacity Requirements Summary

	Mem	Mem. Expand	Disk	Disk Expand	Slots	CPUs	CPU Expand
1(a)	2 GB	4 GB	18GB	60GB	3	2	
1(b)	1 GB	2 GB	8GB	36GB	2	1	
2(a)	512 MB	2 GB	8GB	64GB	3	2	
2(b)	256 MB	1GB	8GB	32GB	2	1	
3(a)	8 GB	12 GB	16GB	64GB	16	8	12
3(b)	4 GB	6 GB	8GB	32GB	8	4	6
4(a)	1 GB	2 GB	16GB	900GB	16	2	24
4(b)	256 MB	512 MB	8GB	120GB	5	1	6
5(a)	1 GB	4GB	9 GB	64 GB	3	1	4
5(b)	512 MB	2 GB	9 GB	32GB	2	1	2
6(a)	32 GB	64 GB	500GB	1000GB		64	256
6(b)	16 GB	32 GB	200 GB	500GB		32	128
7(a)	256 MB	1 GB	10 GB	200 GB	5		
7(b)	128 MB	768 MB	10 GB	20 GB	5		
8(a)	1 GB	4 GB	18GB	2 TB	-	2	
8(b)	512 MB	2 GB	18GB	200 GB	-	1	

9(a)	2 GB	8 GB	20 GB	1 TB	-	2	
9(b)	128 MB	1 GB	5 GB	20 GB	-	1	

5. Category B: Computer System Support Devices

This section specifies equipment needed to support a full implementation of computer systems in the NASA network environment. These items may be purchased by the Government separately from the computer systems but rely on standards and standard interfaces to ensure interoperability with the computer systems.

5.1. X Terminals

X Terminals are graphical devices attached directly to the network and operate as X Servers to X Clients operating on conventional computer systems. Two X Terminal configurations shall be offered. Each shall support the Core X Terminal requirement as well as requirements unique to each X Terminal configuration.

5.1.1. Core X Terminal Requirements

All X Terminals shall provide the following minimum capabilities:

a. keyboard - A detachable ANSI compatible [ANSI X3.64] alphanumeric keyboard.
   mouse - A mouse with at least three buttons. This device shall permit the user to address individual screen pixels.
b. graphic monitor - All graphic monitors shall be color devices with the following capabilities:
   1. RGB (red, green, blue) video output that will allow the use of video projectors and the adaptation of other video equipment.

c. a graphics controller capable of at least 256 colors simultaneously displayable from a palette of at least 16 million available colors.
d. X Window Server software (X-11R6 or greater)
e. a serial interface as described in Section 3.2.3.b.
f. an Ethernet network interface as specified in Section 3.4.2.a. and a sufficient set of Internet Protocols (IP) (as specified in Section 3.4.4) as required to support X Window Server software services and connectivity to X Clients on the network.
g. A parallel interface
h. a Simple Network Management Protocol (SNMP) agent [RFC 1157; RFC 1213] for remote monitoring
i. Energy Star compliant
j. both a ROM based and host based boot
k. X11 security/authority support (desirable)
l. SLIP support (desirable)
m. Support for the following server extensions:
   1. PHIGS Extensions to X (PEX) (desirable)
   2. Distributed/Open Graphics Library, DGL/OpenGL (desirable)

5.1.2. General Purpose X Terminal

The General Purpose X Terminal shall provide the following additional minimum capabilities:

a. a 17” or larger monitor with a vertical scanning frequency of at least 72 Hz noninterlaced.
b. a monitor and graphics controller with at least 1.0 Million displayable pixel resolution.
c. minimum memory of 16 MBytes,
   1. memory shall be expandable to at least 64 MBytes

5.1.3. High Performance X Terminal

The High Performance X Terminal shall provide the following additional minimum capabilities:

a. a 19” or larger monitor with a vertical scanning frequency of at least 75 Hz noninterlaced.
b. a monitor and graphics controller with at least 1.2 Million displayable pixel resolution.
c. minimum memory of 16 MBytes,
   1. memory shall be expandable to at least 128 MBytes.

d. 24-bit graphics with simultaneous display of at least 4096 (out of a palette of 16.7 million colors) for True Color support (this may be offered in place of the core graphics controller in Section 5.1.1.d.). (desirable)

5.2. Printers

Three printers shall be offered. Capabilities shall be as specified in the following sections. Each printer shall meet the Core Printer Specification and the unique requirements in the printer specific section.

5.2.1. Core Printer Requirement

Each of the 3 printers shall provide the following capabilities:

a. Adobe Postscript 3.0 formatted print files.
b. memory shall be non-proprietary
c. Metric A4-size paper with a usable image area of at least 200mm x 271mm and a usable image area of at least 8" x 10" for American Letter-size (8.5" x 11").
d. three interfaces, parallel, USB, and Ethernet 10BaseT (twisted pair also supporting the lpd protocol)
    1. simultaneous availability of the three interfaces; e.g. automatic port sensing/switching

e. non-proprietary utilities.
f. Simple Network Management Protocol (SNMP) agent [RFC 1157; RFC 1213] for remote monitoring.
g. Energy Star compliance.
h. PCL5 and PCL6 emulation

5.2.2. Monochrome Laser Printer

In addition to the Core Printer Specification, the Monochrome Laser Printer shall also provide:

a. print speed shall be at least 21 pages per minute.
b. resolution of at least 600x600 dpi.
c. minimum memory of 32 MBytes,
    1. memory shall be expandable to at least 192 MBytes.

d. a duty cycle of at least 75,000 pages per month.
e. at least 39 Adobe and 157 Type-1 soft fonts.
f. support paper sizes from 3"x5" to 11"x14" (legal)
g. shall support media weight of 60 to 216 grams per meter square; and 16 to 133 lb. Card stock from standard trays.
h. Standard input of 550 sheets minimum paper gauges.

The Monochrome Laser Printer shall also meet the following performance benchmark:

i. a PPST Index Result of at least 25 on the NASA supplied PostScript benchmark (Benchmark 3, PostScript Performance Speed Test—PPST)

5.2.3. High Speed Monochrome Multi-functional Laser Printer

In addition to the Core Printer Specification, the High Speed Monochrome Laser Printer shall also provide:

a. print speed shall be at least 40 pages per minute.
b. resolution of at least 600x600 dpi.
c. minimum memory of 32 MBytes,
    1. .memory shall be expandable to at least 192 MBytes.

d. a duty cycle of at least 200,000 pages per month.
e. at least 39 resident Adobe Type-1 scaleable fonts and 157 Type-1 soft fonts.
f. support paper sizes from 3"x5" to 11"x14" (legal)

g. shall support media weight of 60 to 165 grams per meter square; and 16 to 144 lb. Card stock from standard trays.
h. optional "B" size (11" x 17") paper (desirable)

The High Speed Monochrome Laser Printer must also provide multifunctional capability:

i. Digital devices that allow work group environments to utilize a single device to copy, print, fax, scan, and distribute.

The High Speed Laser Printer shall also meet the following performance benchmark:

j. a PPST Index Result of at least 42 on the NASA supplied PostScript benchmark (Benchmark 3, PostScript Performance Speed Test—PPST)

5.2.4. Color Postscript Printer

In addition to the Core Printer Specification, the Color Postscript Printer shall also provide:

a. color Postscript 2.

b. at least 16.7 million colors with dithering.
c. resolution of at least 1200x1200 dpi.
d. compatibility with the Pantone color-matching system
e. print speed shall be at least 5 pages per minute in color mode.

f. print speed shall be at least 16 pages per minute in monochrome mode.
g. minimum memory of 32 MBytes,
    1. memory shall be expandable to at least 128 MBytes.

h. a duty cycle of 25,000 color pages and 100,000 B/W pages per month.
i. at least 300 Adobe (or equivalent) Type-1 fonts.
j. auto-duplex capabilities
k. optional "B" size (11" x 17") paper (desirable)

The Color Postscript Printer shall also meet the following performance benchmark:

l. a PPST Index Result of at least 36 on the NASA supplied PostScript benchmark (Benchmark 3, PostScript Performance Speed Test—PPST)

5.3. Plotters

Two large-format plotters shall be offered. Capabilities shall be as specified in the following sections. Each plotter shall meet the Core plotter specifications and the plotter unique requirements in the plotter specific sections.

5.3.1. Core Plotter Requirements

Both plotters shall provide the following capabilities:

a. standard RS-232-C and Centronics interfaces
b. energy star compliance (desirable)
c. HP-GL and HP-GL/2 language support

5.3.2. Monochrome Large-Format Plotter

In addition to the Core Plotter Specifications, the Monochrome Large-Format Plotter shall provide:

a. A-size through D-size monochrome media print.
    1. E-size media monochrome print (desirable)

b. 300x300 dpi (or better) monochrome in final and draft modes
   1. 360x360 dpi (or better) monochrome in final and draft modes (desirable)
   2. 600x600 dpi (or better) monochrome enhanced mode output (desirable)

c. minimum buffer of 8 MBytes,
   1. buffer shall be expandable to at least 16 MBytes.

d. final-quality (300 dpi) D size drawings in less than 8 minutes

In addition to the Core Plotter Specifications, the Monochrome Large-Format Plotter shall support:

e. commonly available plain paper roll and sheet media

5.3.3. Color Large-Format Plotter

In addition to the Core Plotter Specifications, the Color Large-Format Plotter shall provide:

a. A-size through E-size color media print.

b. 300x300 dpi (or better) color in final and draft modes
   1. 600x600 dpi (or better) color in the enhanced or highest quality mode of output
   2. 360x360 dpi (or better) color in final and draft modes (desirable)

c. minimum buffer of 4 MBytes,
   1. buffer shall be expandable to at least 64 MBytes.

d. in draft mode the printer should have the ability to run at better than 100 square feet per hour

e. in enhanced quality mode, the printer should have the ability to run at least 40 square feet per hour

f. Minimum of 4 colors and an industry acceptable color management approach to addressing color

g. SCSI III interface

h. production requirements for ink replacement bottles should be 1 liter bottles

i. multiple rolls of media stored in the system and on line (desirable)

j. a power take-up cassette/roller (desirable)

In addition to the Core Plotter Specifications, the Color Large-Format Plotter shall support:

k. both sheet and roll media

l. operation in a NT or Macintosh environment

m. a software based Raster Image Processor

5.4. Scanners

Three scanners shall be offered. Capabilities shall be as specified in the following sections. Each scanner shall meet the Core scanner specifications and the scanner unique requirements in the scanner specific sections.

5.4.1. Core Scanner Requirements

All base scanners shall provide the following capabilities:

a. standard SCSI III interfaces
b. OCR Software available on a variety of Category A type UNIX based computer systems
c. Energy Star compliance

d. ability to print identifiers; e.g. sequence numbers, on scanned documents (desirable)
e. optimization and compression techniques and algorithms; flexibility in scanning resolution and document sizes and thickness; stacker and feeder capabilities; capabilities to store scanned images in a variety of useful image formats (e.g., TIFF); preview, rescanning, user friendly interfaces (advanced technology).

5.4.2. Color Scanner

In addition to the Core Scanner Specifications, the Color Scanner shall provide:

a. color and monochrome
    1. 8-bit (256 grayscale levels),
    2. 36-bit (16.7 million colors)

b. 600 dpi optical resolution
c. document size up to at least 8.5 X 14 inches
d. scanner speed of 3 pages per minute at 600 dpi resolution for 8.5x11 inch color document in portrait mode

5.4.3. High Speed/High Performance Scanner

In addition to the Core Scanner Specifications, the High Speed/High Performance Scanner shall provide:

a. scanner speed of 100 pages per minute at 200 dpi resolution for 8.5x11 inch monochrome document in portrait mode
b. a minimum of 200 dpi
c. duplex (two sided) scanning
d. document size up to at least 8.5x11 inches
    1. ability to handle document sizes up to 11x26 inches (desirable)

e. monochrome
    1. color (desirable)

f. Bar Code Reader (desirable)

5.4.4. Large Format Scanner

In addition to the Core Scanner Specifications, the Large Format Scanner shall provide:

a. handle up to 50” wide originals
b. ability to scan up to .6 in (15mm) thick originals, such as foamboards
c. scan to print, and scan to file
d. tile scanned images that are wider than the output of the attached printer
e. automatic scanner light normalization
f. storage of templates for repeat jobs by job type and department
g. compensation for poor originals
h. user friendly board calibration
i. support Color Management Systems by the International Standard ICC profile
j. ability to control color tone transfer of each of the three channels (RGB) and setting of white & black points.

5.5. UNIX Portables

The UNIX portable(s) must provide the following:

a. UNIX 95 branded with delivery of a copy of the Open Group branding certificate provided with the proposal.
    1. UNIX 98 branding and may be substituted for the UNIX 95 requirement (desirable).

b. POSIX [IEEE POSIX 1003.1-1990]; compliant. The Government will accept the vendor's self certification for POSIX compliance

c. re-chargeable batteries that can sustain continuous operation (e.g., communications, word processing, etc.) for a minimum of one hour wall clock time.
   1. 120v recharger for office use

d. memory shall be at least 128 MBytes.
   1. memory expandable to at least 1024 MBytes.

e. hard disk storage with a minimum of 8 GBytes
   1. Disk storage shall be expandable to at least 16 GByte.

f. an Ethernet 10-BaseT connection.

g. the following external interfaces:
   1. SCSI III
   2. RS-232 serial port
   3. Centronics-compatible parallel port

h. 56 Kbps fax/data modem capability.
   1. fax/data modems with ISDN capability (desirable)

i. padded case which encompasses the whole system.

j. at least a 14" screen, .with 1024X768 pixel resolution.
   1. support for an external monitor

k. at least 256 colors simultaneously displayable from a palette of at least 16 million available colors.

l. keyboard [ANSI X3.64].

m. 3 button mouse, or 3 button trackball or similar device (e.g. trackpad).

n. compliance with all FCC regulations and FAA regulations regarding in-flight use onboard commercial airlines.

o. less then 9 pounds with battery (desirable).

p. no dimension may be greater then 15" (desirable).

q. an overhead display system to support demonstrations (desirable)

5.6. Personal Digital Assistants (PDA)

Personal Digital Assistants (PDA) must provide the following:

a. pen based user interface.
   1. optional PC keyboard

b. at least 8MB storage capacity
c. under one pound.
d. RS-232 serial connectivity.
e. wireless connectivity.
f. ability to develop and install custom NASA programs / applications developed for the provided PDA.
g. a method for receiving and transmitting Email to the Internet.
h. the following additional functionality:
   1. scheduling

2. reminder
3. rolodex/phonebook
4. general note taking
5. Synchronization with desktop PCs

i. hand writing recognition (desirable).

At least two versions of the Personal Digital Assistants (PDA) must be provided:

j. monochrome.
k. multi-color display

5.7 Computer Peripherals

Peripheral computer component providers are expected to provide fully "Plug & Play solutions". All hardware, connector cables, power cords, software, and enablement cards to make the system fully functional are to be provided.

5.7.1 Trackballs

Three button, precise cursor control device will include:

a. Elevated hand support for maximum stress reduction
b. Programmable feature for left or right hand users
c. Windows 95 (or higher) and MAC versions
d. FCC Class B Certified
e. Serial and PS/2 port options
f. Stationary models meeting above requirements (desirable)

5.7.2 Ergonomic Keyboards

Fully functional keyboard with focus to align the wrist of the user in a comfortable position. Split keyboards, and standard configurations applicable.

a. Non skid rubber feet
b. Adjustable tilt legs
c. Integrated trackball and mouse buttons
d. ISO 9001 certified
e. PC and MAC versions
f. Wireless infrared (desirable)

5.7.3 Desktop Video Conferencing

Desktop video conferencing to include:

a. Video for Windows compatible
b. Technology or peripheral to reduce static and echo
c. Open Systems Platform
d. Directory feature maintained by user
e. Shared text and graphic feature
f. GUI based interface with consideration for international users
g. 35mm equivalent digital interface
h. Minimum of 1 Million pixel density in color

5.7.4. Speakers

High quality multi-media stereo speakers to include:

a. Speaker controls to include volume and sound quality

b. Hard wire technology only
c. Mute button
d. Minimum of 2.5W
e. Headphone output option

5.8. Uninterruptable Power Supply

Uninterruptable Power Supply (UPS) unit must provide:

a. Output power capacity of 5000 VA and 3750 Watts
b. Nominal output voltage of 120, 208 and 240 V
c. Nominal input voltage of 208, 240 V
d. Input voltage range for main operations of 156-252 V (208V) and 176-282V (240v)
e. Runtime at 2380 W of 30 minutes
f. Recharge time of 3 hours (to 90% after full discharge)

5.9. Documentation

The contractor shall provide in the Available Components list complete sets of operator, programmer, software system, utility, installation, user manuals and other necessary documentation for all hardware and software delivered under this contract in accordance with the contractor's product line documentation standards. If the contractor's software and/or hardware documentation is written other than described below, an alternative set of manuals shall be provided. The manuals shall include, but not be limited to, the documentation described in the following paragraphs.

5.9.1. Hardware Documentation

Hardware documentation shall include:

a. System hardware manuals describing system architecture, CPU, memory, and peripheral devices.
b. Interface manuals detailing all electrical and mechanical aspects of system and network interface devices.

5.9.2. Software Documentation

Software documentation shall include:

a. Reference manuals detailing all elements and operations of all delivered software, system generation, system architecture, system tools and utilities, and configuration management.
b. Reference manuals detailing error handling, and diagnostic software, problem determination and debugging guides.
c. Documentation of known problems and/or suspected system errors.

5.9.3. Other Manuals

The contractor may include any other manuals and program descriptions that would be considered helpful to the Government. A list shall be provided in the proposal.

5.10. Additional Support Devices Technology

Basic network equipment in support of supporting systems technology (additional technology)

Basic storage equipment in support of supporting systems technology (additional technology)

Devices running client-oriented OSs to allow direct monitoring of supporting technology (additional technology)

Systems security technology (additional technology)

Image and display tools in support of supporting technology considerations and configurations (additional technology)

5.11. Support Devices Specialists

To assist in product recommendations, installation, and support of computer systems products the following specialists shall be provided:

a. Information Assurance Specialist
   1. Analyzes general information assurance-related technical problems and provides basic engineering and technical support in solving these problems. Supports the integration of information assurance solutions and technologies into supporting IT equipment with particular attention to protocols, interfaces, and system design. Analyzes and defines security requirements for supporting IT systems. Designs, develops, engineers, and implements solutions that meet systems security requirements. Responsible for integration and implementation of the security solution. Performs vulnerability/risk analyses of computer systems and applications during all phases of the system development life cycle. Configures test beds and conducts testing, records and analyzes results, and provides recommendations for improvements for the products/systems under test. Analyzes and defines security requirement for computer systems which may include mainframes, workstations, and personal computers. Designs, develops, engineers, and implements solutions that meet security requirements. Responsible for integration and implementation of the computer system security solution. Gathers and organizes technical information about an organization's mission goals and needs, existing security products, and ongoing programs in computer security. Performs risk analyses of computer systems and applications during all phases of the system development life cycle. Applies principles, methods, and knowledge of security to specific areas task order requirements. Test developed systems at each point of entry for ease of unregulated entry; systems resources denial; system information corruption; unlawful use of system resources; vulnerability to electronic disruption.
   2. Educational Requirements: Bachelor's degree from an accredited college or university in electrical, electronic or computer engineering, computer science, or a related field.
   3. Experience Requirements: This position requires a minimum of seven years of substantial experience in system security analysis and implementation; design assurance or testing for information assurance products and systems; integration or testing for information assurance products and systems. Experience in heterogeneous computer networking technology and work in protocol and/or interface standards specification is recommended.

b. Network/Hardware Support Technician
   1. Monitors and responds to complex hardware, software and network problems utilizing a variety of hardware and software testing tools and techniques. Provides primary interface with vendor support service groups or provides internal analysis and support to ensure appropriate notification during outages or period of degraded system performance. Provides LAN server support. Requires extensive knowledge of PC/LAN communications hardware and software in multi-protocol environment, and network management software. May function as task lead providing guidance and training for less experienced technicians.
   2. Educational Requirements: High school graduate or equivalent.
   3. Experience Requirements: Five years of increasingly complex and progressive experience in computer system/network engineering. Includes two years of specialized experience related to the task.

c. Hardware Engineer
   1. Provides functional and empirical analysis related to the design, development, and implementation of hardware for products including, but not limited to, the circuit design of components, development of structure specifications of a personal computer, and the design of a computer display unit. Participates in the development of test strategies, devices, and systems. Possesses and applies a comprehensive knowledge of a particular field of specialization to the completion of significant assignments. Plans and conducts assignments, generally involving the larger and more important projects or more than one project. Evaluates progress and results and recommends major changes in procedures. May lead or direct projects.

2. Educational Requirements: Bachelor's degree from an accredited college or university in computer science, mathematics, or engineering or a mathematics-intensive discipline, or an applicable training certificate from an accredited institution.
3. Experience Requirements: Ten years of intensive and progressive experience in a computer related field including development and design of complex hardware and communications systems.

6. Category B: High-End Network Equipment

This section specifies equipment needed to support a full implementation of computer systems in the NASA network environment. These items may be purchased by the Government separately from the computer systems but rely on standards and standard interfaces to ensure interoperability with the computer systems.

While comprehensive and specific functional and performance specifications do not exist for each supporting network equipment, all equipment must meet the Network Core Specification, unless noted otherwise.

6.1. Network Core Specification

All mandatory network equipment must meet or comply with the Network Core Specification in this section. That means that the requirements of this section are additive to (or a clarification of) the requirements stated for each specification of a Supporting Network Equipment.

a. Advanced networking techniques (both hardware and software) to allow connectivity unassociated with physical location; such as wireless technology and applications which allow roaming client computers to connect to networks and people, (advanced technology)
b. The capabilities of the hubs, routers, switches, and NIC's in terms of high performance interfaces and high bandwidth implementations (advanced technology).

6.1.1. Network Technology

The base technologies for building Local Area Networks in NASA are Ethernet, FDDI and ATM. Throughout the sections on Network Supporting Equipment, the terms "Ethernet", "FDDI" and "ATM" are used to define the requirements. Unless otherwise specified, the specific meaning of these terms is given here and shall apply throughout Section 6.

6.1.1.1. Ethernet

Ethernet interfaces shall comply with both Ethernet Specification 2 and IEEE standards [IEEE 802.3; ISO 8802/3].

6.1.1.2. Fiber Distributed Data Interface (FDDI)

FDDI networks exist throughout NASA. The central element of these networks is the concentrator. NASA's FDDI networks are typically composed of a traditional "ring of trees" as specified in the ANSI standards. The main points addressed by the choice of the dual ring of trees topology are availability, scalability, and maintainability.

a. All FDDI interfaces shall comply with all four ANSI standards for FDDI:
    1. Physical Layer Medium Dependent (PMD) [ANSI X3.166-1990]; ISO/IEC 9314-3:1990] for physical link parameters and cabling.
    2. Physical Layer Protocol (PHY) [ANSI X3.148-1988; ISO 9314- 1:1989] for encoding/decoding, clocking, and symbol set.
    3. Media Access Control (MAC) [ANSI X3.139-1987; ISO 9314- 2:1989] for addressing, frame construction, and token handling.
    4. Station Management (SMT) [ANSI X3T9.5/84-49; ISO/IEC 9314-6:1998] for ring monitoring, ring management, connection management, and SMT frames. Proposed equipment shall implement the Station Management (SMT) standard version 7.3 or higher, as defined in ANSI working and approved documents, for the purposes of communicating with other devices on the FDDI network to report network statistics, neighbor addresses, and status messages. FDDI SMT interfaces shall implement all parameters of the "SM_MA_INITIALIZE_PROTOCOL.request" SMT primitives, and provide manager access to these options.

b. All FDDI equipment shall include the following requirements for multimode PMD FDDI interfaces:
    1. Medium Interface Connector (MIC) shall be the Fixed Shroud Duplex (FSD) connector with appropriate keys or SC terminator.

2. Network interfaces shall be offered either as FDDI Single Attachment Station (SAS) cabling, or Dual Attachment Station (DAS) cabling, selectable by the Government for each interface at time of purchase. The requirement may be met with a DAS that can be configured as SAS.
   a. Network interfaces shall be offered with separate SAS and DAS interfaces (desirable)
3. All Dual Attachment Stations (DAS) interfaces shall provide dual home cleave B attachment to the network.
4. All DAS interfaces shall include an electrical interface for station (optical) bypass (OBR) function.

c. All FDDI equipment shall provide the capability for TPPMD SAS interfaces.
d. All FDDI interfaces shall provide visual indicators which display the following status:
   1. power - displays whether or not the line power is supplied to the interface.
   2. operational - displays whether or not the interface is fully functional, including the readiness of each and all ports.
   3. Station Configuration - displays the connection state of each M port, where applicable and the following conditions:
      a. whether or not the interface is operational but not connected
      b. if the interface is connected. For a DAS interface, display whether both fiber paths are connected or only one is connected
      c. presence of an error condition
   4. Signal Detect - displays whether or not the port is detecting a light signal, including a high error signal.

e. All FDDI interfaces shall have full-duplex capability (desirable).

6.1.1.3. 802.2 Data Link Layer

Both Ethernet and FDDI shall include the Data Link Layer protocol providing Logical Link Control [ISO 8802/2].

6.1.1.4. Asynchronous Transfer Mode (ATM)

All ATM Interfaces shall comply with ATM Forum standards for ATM. The ATM Forum develops interface specifications for transporting ATM cells at both the public and private User-Network-Interface (UNI).

a. ATM Physical Medium Dependent Interface Specification for 155 Mbps Over Twisted Pair Cable [af-phy-0015.000]
b. DS1 Physical Layer Specification [af-phy-0016.000]
c. 622.08 Mbps Physical Layer [af-phy-0046.000]
d. DS3 Physical Layer Interface Specification [af-phy-0054.000]
e. 155 Mbps Over MMF Short Wave Length Lasers [af-phy-0062.000]
f. 155 Mbps over Plastic Optical Fiber (POF) [af-phy-0079.000]
g. Support for LAN Emulation 1.0 standard [af-lane-0084.000] LAN Emulation 2.0 standard [af-lane-0084.000] (desirable).
h. Support for Multiprotocol over Asynchronous Transfer Mode (MPOA) 1.0 standard [af-mpoa-0087.000](desirable)
i. Support for Next Hop Resolution Protocol standard (desirable)
j. Support for Multicast Address Resolution (desirable)-RFC 2022
k. ATM User-to Network (UNI) version 3.1 (Standard ITU-T Q.2931) covering point-to-multipoint signaling; UNI 4.0 (desirable)
l. Network-to-Network Interface (NNI) and Private Network-to-Network Interface (PNNI) version 1.0 [af-pnni-0055.000]
m. ATM switching for automatic VC restoral on VC or VP failure

6.1.2. Network Management

All network equipment in this solicitation shall provide the management functions in this section.

6.1.2.1. Simple Network Management Protocol (SNMP)

Provide an SNMP agent [RFC 1157; RFC 1213] for remote network management and monitoring.

a. vendor specific private extensions shall conform with RFC 1155.
b. vendor specific private extensions shall be made available to the Government in ASN format.
c. remote management and control of all unit, card, and port level SNMP configurable parameters.
d. SNMP Version 2 (desirable)
e. full RMON or RMON II capability (RFC 1271) (desirable)

6.1.2.2. Console Management Access

a. Out-of-band management through a console port shall be available for all networking equipment.
b. Multiple levels of management access (desirable). Preferably, this includes three levels:
   - full read/write,
   - read only of all possible fields except passwords, and
   - limited read only.

6.1.2.3. Configuration Recovery

Non-volatile storage shall be provided on all networking equipment for the purposes of maintaining configuration and fault/diagnostic information. Non-volatile storage shall:

a. enable a network device which has lost power to recover fully on power up by restarting and accessing all configuration data required for proper operation in the network.
b. be accessible from the network and from the out-of-band management console port.

6.1.2.4. Network Management Software

Network management software for multivendor, multiprotocol networks shall be provided with the following characteristics:

a. a consistent user interface and an integrated environment for monitoring, troubleshooting, controlling and measuring performance of network components.
b. be able to discover and display graphically the network components and their relationship.
c. allow a network administrator to make configuration changes, and run diagnostic and performance statistics gathering applications.
d. at least adhere to SNMP and provide MIB and RMON support for various networking technologies (e.g. Ethernet, FDDI, ATM, etc.).
e. include analysis software which presents the performance and monitoring data in easily comprehensible graphics (viewable on a terminal or a printer).

6.1.2.5. Downline loading

Downline loading via the network of software upgrades to all networking equipment (desirable).

6.1.2.6. Network Diagnostic Tools

At least 2 solutions, each from a different vendor, for each of the following network diagnostic tool is required.

a. sniffer tools
b. RMON probe
c. Protocol analyzer
d. Circuit test equipment

6.1.3. Equipment Characteristics

This section describes general equipment characteristics

6.1.3.1. Physical Configuration

All equipment shall be mountable in a standard EIA 19" rack. All mounting hardware shall be included with the equipment.

6.1.3.2. Operating Environment

a. All equipment except large network routers shall be capable of operating o line voltage of 108 to 125 volts single-phase at 60 Hz (+/-1%).

b. Large network routers shall be capable of operating on line voltage of either 108 to 125 volts or 216 to 240 volts single-phase at 60 Hz (+/-1%).

6.1.4. Documentation

The contractor shall provide in the Available Components list complete sets of operator, programmer, software system, utility, installation, user manuals and other necessary documentation for all hardware and software delivered under this contract in accordance with the contractor's product line documentation standards. If the contractor's software and/or hardware documentation is written other than described below, an alternative set of manuals shall be provided. The manuals shall include, but not be limited to, the documentation described in the following paragraphs.

6.1.4.1. Hardware Documentation

The hardware documentation shall include, as appropriate:

a. System hardware manuals describing system architecture (including but not limited to slot usage, maximum number of ports, etc.), CPU, memory, and peripheral devices.
b. Interface manuals detailing all electrical and mechanical aspects of system and network interface devices.

6.1.4.2. Software Documentation

All software documentation shall include, as appropriate:

a. Reference manuals detailing all elements and operations of all delivered software, system generation, system architecture, system tools and utilities, and configuration management.
b. Reference manuals detailing error handling, and diagnostic software, problem determination and debugging guides.
c. Documentation of known problems and/or suspected system errors.

6.1.4.3. Other Manuals

The contractor may include any other manuals and program descriptions that would be considered helpful to the Government.

6.1.5. Auto Configuration

In general, no management intervention or software down line loading should be required to become operational (other than the potential manual installation of an IP address). The network equipment shall auto-configure and self initialize at installation (connection and power up) and during operation. That is, it shall be possible to simply connect the network interfaces and apply power for the network equipment to become operational without detrimental impact to the network. Auto-configuration does not apply to routers or ATM switches.

6.1.6. Bridging

Bridging is required in all hubs and routers and all bridging shall provide the capability for:

a. disabling of any Spanning Tree Algorithm [ISO 8802/1; IEEE 802.1] incorporated within the bridge.
b. Protocol filtering which is based upon user defined filtering masks.
c. interface line speed filtering and 80% of interface line speed forwarding, with minimum data packet sizes applicable to the interface type.

6.1.7. Cabling configuration

All cabling shall connect to the network equipment from a single side (desirable).

6.2. Fiber Distributed Data Interface (FDDI) Concentrator

A Fiber Distributed Data Interface (FDDI) Concentrator shall be offered with the capabilities outlined in the following sections

At least 2 solutions, each from a different vendor are required for FDDI concentrators.

6.2.1. Configuration

a. FDDI Concentrators shall be configurable with at least 8 SAS ports and 1 DAS port:
   1. The SAS ports' PMDs shall be configurable by at least 8 at a time and different for the DAS port PMD.
   2. SC based mini, duplex MICs are an option for the multimode PMDs
   3. 8 DAS ports (desirable)

b. FDDI Concentrators shall include the latest release of the IETF FDDI MIB RFC.

c. FDDI Concentrators shall at a minimum be dual-attached.

6.2.1.1. SNMP Agent

a. The SNMP agent shall provide a control and status interface to the FDDI SMT MIBs defined in the ANSI SMT standards section 6.4.5.1 (v7.3 or later).
   1. The SNMP agent shall provide a control and status interface to the FDDI SMT MIBs defined in the ANSI SMT standards section 6.4.5.2 (v7.3 or later) (desirable).

b. The Concentrators shall provide an SNMP interface that receives and executes commands to report the status of any Slave station, add and remove any connected Slave station.
c. The SNMP interface shall also receive and execute commands to verify and modify any of the FDDI operational configuration parameters.

6.2.1.2. SMT Compatibility

FDDI Concentrators shall maintain backward compatibility and interoperability to SMT Version 7.2 standards, while maintaining interoperation with the latest SMT standards mandatory Objects.

6.3. Ethernet Concentrator Hub

An Ethernet Concentrator Hub shall be offered with the capabilities outlined in the following sections.

At least 2 solutions, each from a different vendor for Ethernet modular hubs and 2 solutions, each from a different vendor for Ethernet stackable hubs are required.

6.3.1. Configuration and Specification

In addition to the Core Network Management requirement, each Ethernet Hub shall provide:

a. the appropriate objects of SNMP MIB II [RFC 1213].

b. high port density options (desirable)

c. at least 24 10BaseT Ethernet ports

6.4. LAN Switches

At least 2 solutions, each from a different vendor, for LAN switches is required. This may be met by a separate vendor for the High End (6.4.1) and the Low End (6.4.2.). Each interface port shall

a. be an independently switched port capable of supporting a LAN segment or single user connection.

b. support the Spanning Tree Algorithm [ISO 8802/1; IEEE 802.1c].

c. all Ethernet uplink ports and uplink port modules shall be capable of supporting trunking (Spanning Tree disabling and aggregate bandwidth utilization over multiple physical uplink ports).

6.4.1. High End LAN Switches

High end LAN switch chassis shall provide the ability to equip any one of the following configurations:

a. 10/100 UTP Autosensing Ethernet interfaces, at least 18 ports.
b. FDDI interfaces, at least 4 ports.
c. 100BaseFX Ethernet interfaces, at least 2 ports.
d. OC3c ATM uplink port.
e. OC12c ATM uplink port (desirable).
f. 1000BaseSX uplink port
g. 1000BaseLX uplink (desirable)
h. Concurrent configuration of at least the Ethernet (6.4.1.a.) and FDDI (6.4.1.b.) and/or 100BaseFX (6.4.1.c) interfaces
    1. Concurrent configuration of all interfaces (desirable)

6.4.2. Low End 10Mbps Ethernet LAN Switches

Low End 10Mbps Ethernet LAN chassis shall provide the ability to equip any one of the following configurations

a. at least 6 10Mbps UTP Ethernet ports.
b. 10/100 UTP Autosensing Ethernet interfaces (desirable).
c. 100BaseT uplink, at least 2 ports
d. 100BaseFX uplink, at least 2 ports
e. OC3c ATM uplink port (desirable).

6.5 Network Interface Cards (NICs)

At least 2 solutions per platform, each from a different vendor, for NICs for FDDI and ATM (ANSI, ITU-T and ATM forum defined UNIs) technologies are required. For all platforms except IBM and SGI, at least 2 solutions per platform, each from a different vendor, for NICs for Ethernet, Switched Ethernet (10Mb/s and 100Mb/s) and Gigabit Ethernet technologies are required. For IBM and SGI platforms, at least 1 solution per platform, for Ethernet, Switched Ethernet (10Mb/s and 100Mb/s) and Gigabit Ethernet technologies is required.

Network interface cards shall be provided which work on the following vendors' UNIX computer systems at the currently supported O/S and hardware architecture level. All software drivers on the NIC's shall be updated within 6 months of a new O/S release:

a. SUN
b. SGI
c. Compaq Alpha Servers
d. HP
e. IBM

Network interface cards shall be provided which work on the following bus architectures :

f. ISA and PCI bus architecture PCs
g. bus architectures for Macintosh models earlier than Power Macintosh G3 (i.e., Macintosh SE, NUBUS, etc.) (desirable)

6.6. Network Router

At least 2 solutions, each from a different vendor for Small, Medium and Large Network Routers is required. Each size router may have different vendors.

Three network routers are required. A small format router with a limited number of interfaces, a medium format router with an average number of interfaces and expansion capability and a large format router with substantial expansion capability and larger variety of interfaces. The next three subsections describe the overall features of the small, medium and large routers, while the fourth subsection describes specific requirements that shall apply to all routers.

6.6.1. Small Network Router

A Small Network Router (single chassis) shall provide the following configuration options; i.e. the chassis shall have the option to be configure in any one of the following ways):

a. 2 Ethernet interfaces.
b. 1 Ethernet interface and 1 serial interface.
c. simultaneous support for 2 Ethernet and 2 serial interfaces (desirable).

6.6.2. Medium Network Router

A Medium Network Router (single chassis) shall provide the following configuration options ; i.e. the chassis shall have the option to be configure in any one of the following ways):

a. 8 or more Ethernet interfaces.
b. 1 or more FDDI interfaces (configured as DAS and/or SAS).
c. 8 or more serial interfaces.
d. simultaneous support for 1 FDDI interface, 2 Ethernet interfaces and 2 serial interfaces.

6.6.3. Large Network Router

A Large Network Router (single chassis) shall provide the following configuration options ; i.e. the chassis shall have the option to be configure in any one of the following ways):

a. 24 or more Ethernet interfaces.
b. 6 or more FDDI interfaces (configured as DAS and/or SAS).
c. 8 or more serial interfaces.
d. simultaneous support for 2 FDDI or GigE or ATM interfaces, and 6 Ethernet interfaces, and 4 serial interfaces
e. 4 or more HSSI interface up to 50Mbps.
f. Gigabit Ethernet
g. ATM interfaces at DS3 or OC3c

6.6.4. All Network Routers

All network Routers shall provide the following specifications

6.6.4.1. Physical Interfaces

Routers shall provide the following serial line interface requirements:

a. speeds from 9.6 Kbps to DS-1.
b. Physical Interface Standard EIA RS-232-C for line speeds up through 19.2 kilobits/second.
c. One of the following must be provided and all three must be supported: Physical Interface Standard V.35, RS422, RS530 for line speeds above 19.2 kilobits/second.

6.6.4.2. General Protocol Requirements

Routers shall provide the following capabilities:

a. simultaneous routing and bridging, selectable by protocol and by port.
b. the Spanning Tree Protocol [ISO 8802/1; IEEE 802.1©].
c. Point-to-Point (PPP) Protocol [RFC 1661]

1. PPP RFC 1332 or subsequent version (desirable).

d. Frame Relay Protocols [ANSI T1.606 with LMI Extensions]

6.6.4.3. Routing Protocols

Routers shall provide the following routing protocols and their sub-elements:

a. TCP/IP Internet Protocol
   1. Routing Information Protocol (RIP) [RFC 2453].
   2. Exterior Gateway Protocol (EGP) [RFC 904].
   3. variable length subnet masking.
   4. manual configuration of the broadcast address (i.e. support for all 1's or all 0's).
   5. Border Gateway Protocol (BGP) [RFC 1771 - 1774]
   6. OSPF version 2 [RFC 2328] .
   7. IP Multicast
      a. PIM [RFC 2362]
      b. DVMRP [RFC 1075]
      c. MOSPF [RFC 1584] (desirable)

b. DECnet Protocol (desirable)
   - DECnet Phase IV routing.
   - DECnet Phase V to Phase IV interoperability

c. XEROX Network Systems (XNS) Protocol and 3Com XNS and Xerox XNS Routing Information Protocol (RIP) including caching of routing tables (desirable).

d. Internetwork Packet Exchange (IPX) Protocol (desirable)
   - Novell IPX Routing Information Protocol (RIP) routing .
   - Routing between Ethernet Version 2 framing to 802.3 framing between interfaces.
   - The caching of routing tables and Service Advertisement Protocol (SAP) tables (i.e. build your RIP and SAP tables and transmit a RIP or SAP table upon expiration of the update time) (desirable).

e. Appletalk Protocol (desirable)
   - Appletalk Phase II routing.
   - Phase II router shall be configurable as a seed or non-seed router.
   - Appletalk Update Routing Protocol (AURP).

6.6.4.4. Network Management

In addition to the Core Network Management requirement (Section 6.1.2.), each Network Router shall include the following:

a. Connectionless Network Protocol MIB [RFC 1238] (desirable)
b. OSPF MIB [RFC 1850] (desirable)
c. Appletalk MIB [RFC 1742] (desirable)
d. MIB extensions for DS1 [RFC 1406; RFC 1239] and DS3 [RFC 2496; RFC 1239] (desirable)

6.6.4.5. Ethernet Connectivity

In addition to the Ethernet requirement (Section 6.1.1.1..), each Network Router shall support connectivity with the following:

a. 10/100BaseT Autosensing
b. 100BaseFX
c. Gigabit Ethernet

6.7. ATM Switches

At least 2 solutions each from a different vendor for High, Medium and Low capacity ATM switches are required. Each size switch may have different vendors.

Three types of ATM switches are required. A low capacity with a limited number network modules and an aggregate switching capacity of 2.5 GBps. A medium capacity with an aggregate switching capacity of 10GBps.

Also, a large capacity with an aggregate switching capacity of 40 GBps. The next three subsections describe the overall features of the low, medium, and high capacity ATM switches.

6.7.1. Low Capacity ATM Switch

A Low Capacity ATM Switch shall have an aggregate switching capacity of 2.5 GBps and support the following interfaces:

a. OC3c

b. 100 or 155 Mbps UNI card

c. OC12 NIs

d. Non-ATM interfaces such as Fast Ethernet, Gigabit Ethernet, and Ethernet (desirable)

6.7.2. Medium Capacity ATM Switch

A Medium Capacity ATM Switch shall have an aggregate switching capacity of 10GBps and support the following interfaces:

a. OC3c

b. 100 or 155 Mbps UNI card

c. OC12 NIs

d. Non-ATM interfaces such as Fast Ethernet, Gigabit Ethernet, and Ethernet (desirable)

e. OC-24

6.7.3. Large Capacity ATM Switch

A Large Capacity ATM Switch shall have an aggregate switching capacity of 40GBps and support the following interfaces:

a. OC3c

b. 100 or 155 Mbps UNI card

c. OC12 NIs

d. Non-ATM interfaces such as Fast Ethernet, Gigabit Ethernet, and Ethernet (desirable)

e. OC-192 (desirable)

f. [network core specification 6.1.3.1. is not required for the Large Capacity ATM Switch]

6.7.4. All ATM Switches

All ATM switches shall meet the requirements listed in this section

6.7.4.1 Configuration Options

Each ATM Switch shall provide the following configuration options:

a. Redundant SCPs
b. 1 Ethernet Interface and 1 Serial Interface per SCP.
c. Redundant Power Supplies fed from separate sources

d. Standard RJ45 providing a single Ethernet connection to all SCPs installed (desirable).

6.7.4.2. Network Management

a. SNMP allows status information down to the interface level (desirable).

b. Integrated Local Management Interface (ILMI) (desirable)

c. Software bundled with the ATM to provide a GUI for VC management.

6.8. ISDN Equipment

ISDN equipment consists of ISDN switches and supporting hardware (6.8.1), ISDN Terminal equipment (6.8.2), Test gear (6.8.3), and Circuit Terminating Equipment (6.8.4)

6.8.1. ISDN Switching Equipment

ISDN Switches shall be capable of providing:

a. multiple users with PRI and/or BRI services,

b. multiple PRI and/or BRI trunks to multiple service providers,

c. routing a minimum of 256 directory numbers.

d. support for as few as four ports for small group applications utilizing high bandwidth or hundreds or thousands of ports for a small- to medium-sized PBX type of application

e. a minimum 64K data, 56K restricted data, and speech.

f. The following services (desirable):
- IMUX capability,
- H.320 MCU functionality,
- V.35 interfaces
- H.323 gateway functionality.

g. SNMP management capability (desirable).

6.8.2. Terminal Equipment

ISDN Terminal equipment shall be suitable for home office and telecommuting applications. Two categories of terminal equipment shall be made available: home-office routers and portable ISDN adapters

a. Home-office Routers
   1. BRI interface
      a. integrated NT-1 (desirable)
   2. A minimum of one Ethernet interface *and/or* a USB interface
      a. four port hub (desirable)
   3. Two analog telephony interfaces (desirable)
   4. Support for NI-1, 5ESS Custom, DMS100 Custom signaling protocols.
   5. Status indicators for U and or S/T interfaces on the NT-1 (desirable)
   6. Channel use indicators for each bearer channel (desirable)
   7. Network Address Translation for Ethernet attached devices.

b. Portable ISDN adapters
   1. A BRI interface
      a. integrated NT-1 (desirable)
   2. PCMCIA type II host interface or USB interface if external

3. Analog telephony interface (desirable)
4. Support for NI-1, 5ESS Custom, DMS100 Custom signaling protocols.
5. Status indicators for U and or S/T interfaces on the NT-1 (desirable)
6. Channel use indicators for each bearer channel (desirable)

6.8.3. Test Gear

ISDN Test Gear shall be capable of evaluating the quality of installed ISDN circuits.

Test Gear should at a minimum be able to perform the following functions:

a. Test gear shall be portable and operate using an internal battery.

b. Test gear should weigh less than 10 lbs (desirable)

c. Support testing of BRI interfaces

d. Support testing of PRI interfaces (desirable)

e. Verify and indicate layer 1 connectivity.

f. Verify and indicate layer 2 capability.

g. Display D-channel signaling in realtime.

h. Record D-channel signaling (desirable).

i. Upload recorded signaling to a PC via serial interface for further analysis using supplied software (desirable).

j. Place calls to an external number (specified by the user) in, at a minimum, each of these modes: uncompressed speech, 64K data, and 56 restricted data.

k. Perform Bit Error Rate Testing of supported ISDN circuits (BRI or PRI) during a call.

6.8.4. Circuit Terminating Equipment

NT-1s for use with ISDN BRI circuits convert the two-wire U interface to a four-wire S/T interface. NT-1s should have the following features and comply with ANSI standards T1.601-1992 on the network side and T1.605.1991 on the terminal side.

a. Wall or desk mountable

b. Support point-to-point or multipoint configuration

c. Built-in surge protection (desirable)

d. RJ45 jacks on all interfaces.

e. Internal power supply (desirable)

f. supports three BRI circuits in a single chassis and power supply.

6.9. Advanced Network Technology

Some advanced networking technologies include Dense Wave Division Multiplexing (DWDM), Data Subscriber Loop (DSL) and wireless connectivity. DWDM provides high speed optical switching for both supporting both LANs and WANs. DSL provides network interfacing through twisted pair telephone wire utilizing ADSL, HDSL2 and RADSL standards. Wireless technology allows network connections through the use of radio frequencies, infra-red and laser light without the use of cables and wires.

6.10. Additional Network Technology

Basic storage equipment in support of network management (additional technology)

Devices running client-oriented OSs to allow direct monitoring of network configurations (additional technology)

Supporting technology such as printers, audio/visual IT equipment, etc. (additional technology)

Network security technology (additional technology)

Image and display tools in support of networking considerations and configurations (additional technology)

6.11 Network Specialists

To assist in product recommendations, installation, and support of computer systems products the following specialists shall be provided:

a. Information Assurance Network Specialist
   1. Analyzes general information assurance-related technical problems and provides basic engineering and technical support in solving these problems. Supports the integration of information assurance solutions and technologies into networks with particular attention to protocols, interfaces, and system design. Analyzes and defines security requirements for local and wide area networks. Designs, develops, engineers, and implements solutions that meet network security requirements. Responsible for integration and implementation of the network security solution. Performs vulnerability/risk analyses of computer systems and applications during all phases of the system development life cycle. Configures test beds and conducts testing, records and analyzes results, and provides recommendations for improvements for the products/systems under test. Analyzes and defines security requirement for computer systems which may include mainframes, workstations, and personal computers. Designs, develops, engineers, and implements solutions that meet security requirements. Responsible for integration and implementation of the computer system security solution. Gathers and organizes technical information about an organization's mission goals and needs, existing security products, and ongoing programs in computer security. Performs risk analyses of computer systems and applications during all phases of the system development life cycle. Applies principles, methods, and knowledge of security to specific areas task order requirements. Test developed systems at each point of entry for ease of unregulated entry; systems resources denial; system information corruption; unlawful use of system resources; vulnerability to electronic disruption.
   2. Educational Requirements: Bachelor's degree from an accredited college or university in electrical, electronic or computer engineering, computer science, or a related field.
   3. Experience Requirements: This position requires a minimum of seven years of substantial experience in system security analysis and implementation; design assurance or testing for information assurance products and systems; integration or testing for information assurance products and systems. Experience in heterogeneous computer networking technology and work in protocol and/or interface standards specification is recommended.

b. Data Communication Manager
   1. Ensures that adequate and appropriate planning is provided for remote hardware and communications facilities to develop and implement methodologies for analysis, installation and support of distributed processing client/server systems. Provides coordination in the analysis, acquisition and installation of hardware, software, and facilities. Manages the training and efforts of a staff engaged in systems and network planning, analysis, and monitoring activities.

2. Educational Requirements: High school graduate with applicable training certificate from an accredited training institution.
3. Experience Requirements: Requires 10 years experience in software/hardware LAN and WAN network design and analysis.

c. Network Engineer
1. Tests and analyzes all elements of the network facilities including power, software, communications devices, lines, modems and terminals and for the overall integration of the enterprise network. Responsible for the planning, design, installation, maintenance, management and coordination of the network. Monitors and controls the performance and status of the network resources. Utilizes software and hardware tools, identifies and diagnoses complex problems and factors affecting network performance. Maintains technical currency and studies vendor products to determine those which best meet client needs. Provides guidance and direction for less experienced network support technicians
2. Educational Requirements: Bachelor's degree from an accredited college or university in computer science, information systems, engineering or a mathematics-intensive discipline or an applicable technical training certificate from an accredited training institution.
3. Experience Requirements: Seven years of increasingly complex and progressive experience in computer system/network engineering. Includes two years of specialized experience related to the task.

d. Network/Hardware Support Technician
1. Monitors and responds to complex hardware, software and network problems utilizing a variety of hardware and software testing tools and techniques. Provides primary interface with vendor support service groups or provides internal analysis and support to ensure appropriate notification during outages or period of degraded system performance. Provides LAN server support. Requires extensive knowledge of PC/LAN communications hardware and software in multi-protocol environment, and network management software. May function as task lead providing guidance and training for less experienced technicians.
2. Educational Requirements: High school graduate or equivalent.
3. Experience Requirements: Five years of increasingly complex and progressive experience in computer system/network engineering. Includes two years of specialized experience related to the task.

7. Category B: Computer Security Tools

This section specifies software and equipment needed to support a full implementation of computer systems and infrastructure in the NASA network environment. These items may be purchased by the Government separately from computer systems but rely on standards and standard interfaces to ensure interoperability with the computer systems and the supporting networks.

7.1. Security Tools Core Specification

All security tools must meet the following specifications:

a. Compliance with NIST Federal Information Processing Standards (FIPS) requirements including FIPS 140-2, where applicable
b. Connectivity to Ethernet (10Mbps, 100Mbps and Gigabit Ethernet), FDDI and ATM network technology shall be supported by all network attached devices specified below.
c. User extensible features in each software package, such as the ability for a user to add intrusion detection signatures, file signatures and similar features to network monitors (advanced technology)
d. Information technology products which have been evaluated and certified/validated in accordance with the provisions of the NIAP Common Criteria Evaluation and Validation Scheme and the Common Criteria Mutual Recognition Arrangement (CCMRA) and conform to the Common Criteria for IT Security Evaluation (ISO Standard 15408) (advanced technology).
e. Site License (desirable)
f. Additional Licensing options (desirable)
g. Additional OS support (desirable)
h. Tools that detect and protect against distributed denial of service attacks (advanced technology)

7.2. Anti-virus Software

Anti-virus software, such as Norton Anti-Virus or McAfee ViruScan, shall be provided which at a minimum:

a. detects and removes computer viruses from computer systems
b. Server based anti-virus scanning tools, enterprise level email virus scanning tools, and other centralized scanning tools (advanced technology).
c. The ability for the customer to centrally distribute and manage virus definition files and software updates (advanced technology)

The following licensing options must be provided for all anti-virus software solutions:

d. single licenses,
e. 10 license packages,
f. 100 license packages,

At least 1 solution must be provided for each of the following UNIX OS's:

g. SUN
h. SGI
i. HP
j. IBM
k. COMPAQ ALPHA,

At least 2 solutions must be provided for each of the following OS's:

l. Windows NT/2000
m. Windows 95/98

At least 1 solutions must be provided for each of the following OS's:

n. Macintosh OS

7.3. Auditing Tools, Host-Based

This section describes the technical specifications for host based auditing tools

7.3.1. File Integrity Assessment

File Integrity Assessment tools, such as Tripwire or Vericity , shall be provided which at a minimum:

a. detect and report changes to system files
b. include a variety of options that shall ensure a robust ability to detect file modification
c. features that provide effective report consolidation for the purpose of prioritizing alarms and reducing the volume of reports (desirable)

The following licensing options must be provided:

d. single licenses,
e. 10 license packages,
f. 100 license packages,

At least 1 solution must be provided for each of the following UNIX OS's:

g. SUN
h. SGI
i. HP
j. IBM
k. COMPAQ ALPHA,

At least 2 solutions must be provided for each of the following OS's:

l. Windows NT/2000
m. Windows 95/98

At least 1 solutions must be provided for each of the following OS's:

n. Macintosh OS

7.3.2. Password Auditing

Password Auditing tools, such as Crack, shall be provided which at a minimum:

a. detect and report weak passwords and passwords not compliant with password policies
b. The ability to check multiple password files to determine if a user uses the same password on more than one system (desirable)
c. The ability for the customer to centrally audit and manage passwords (advanced technology).

The following licensing options must be provided:

d. single licenses,
e. 10 license packages,
f. 100 license packages,

At least 1 solution must be provided for each of the following UNIX OS's:

g. SUN
h. SGI
i. HP
j. IBM
k. COMPAQ ALPHA,

At least 2 solutions must be provided for each of the following OS's:

l. Windows NT/2000
m. Windows 95/98

At least 1 solutions must be provided for each of the following OS's:

n. Macintosh OS

7.3.3. System Logs Auditing

System Logs Auditing tools, such as logcheck or LogCaster, shall be provided which at a minimum:

a. detect and report anomalous events in a system's log files
b. provide reporting in via e-mail, pager, and logs.
c. The ability for a user to flag known suspect sources of connection attempts (desirable).
d. The ability for centralized collection auditing, monitoring and alarming of several systems' logs in an automated manner (advanced technology)

The following licensing options must be provided:

e. single licenses,
f. 10 license packages,
g. 100 license packages,

At least 1 solution must be provided for each of the following UNIX OS's:

h. SUN
i. SGI
j. HP
k. IBM
l. COMPAQ ALPHA,

At least 2 solutions must be provided for each of the following OS's:

m. Windows NT/2000
n. Windows 95/98

At least 1 solutions must be provided for each of the following OS's:

o. Macintosh OS

7.4. Auditing Tools, Host and Network Based

Network Based Auditing tools, such as ISS, COPS or SATAN, shall be provided which at a minimum:

a. scan an entire domain, subnetwork or system to detect security vulnerabilities
b. are capable of scanning a local host or multiple hosts on a given network
c. capable of scanning systems/OSs:
    1. SUN
    2. SGI
    3. HP
    4. IBM
    5. COMPAQ ALPHA
    6. Windows 95/98
    7. Windows NT/2000
    8. Macintosh OS

The following licensing options must be provided:

d. single licenses,
e. 10 license packages,
f. 50 license packages,

At least 2 solutions must be provided for each of the following OS's:

g. Windows NT/2000

At least 1 solution must be provided for each of the following OS's:

h. Macintosh OS

7.5 Firewall Tools (Network and Host-Based)

Firewall tools restrict access between networks, typically between a protected, internal network and the Internet. This can be accomplished using different strategies, most commonly network level and host-based access control.

7.5.1. Network Level Firewalls

Network Level Firewall tools, such as Firewall-1 or Gauntlet, shall be provided which at a minimum:

a. at least 2 self-contained solutions (i.e. including all necessary network, computer, or other IT related hardware or software)
b. selectively control the flow of data to and from a network
c. provide proxy capabilities
d. capable of controlling access to the following types of networks:
    1. Ethernet (10BaseT, 100BaseT, Gigabit)
    2. FDDI
    3. ATM OC-3
    4. ATM OC-12 (desirable)
    5. combination of all of the above (desirable)
e. capable of controlling access to the following systems/OSs:
    1. SUN
    2. SGI
    3. HP
    4. IBM
    5. COMPAQ ALPHA
    6. Windows 95/98
    7. Windows NT/2000
    8. Macintosh OS

The following licensing options must be provided:

f. single licenses,
g. 10 license packages,
h. 50 license packages,

7.5.2. Host-Based Access Control

Host-Based Access Control tools, such as tcp-wrappers or portmapper, shall be provided which at a minimum:

a. provide a program that interacts with external servers on behalf of internal clients
b. capable of controlling access to the following systems/OSs:
    1. SUN
    2. SGI
    3. HP

4. IBM
5. COMPAQ ALPHA
6. Windows 95/98
7. Windows NT/2000
8. Macintosh OS

The following licensing options must be provided:

c. single licenses,
d. 10 license packages,
e. 50 license packages,

At least 2 solutions must be provided for each of the following OS's:

f. Windows NT/2000

At least 1 solution must be provided for each of the following OS's:

g. Macintosh OS
h. Sun Solaris

7.6 Intrusion Detection Tools

Intrusion Detection tools, such as Network Flight Recorder or Tripwire, shall be provided which at a minimum:

a. detect and report unauthorized or hostile activity on a network or host.
b. Features that allow for frequent automatic updates to accommodate the latest threat profiles

The following licensing options must be provided:

c. single licenses,
d. 10 license packages,
e. 100 license packages,

At least 1 solution must be provided for each of the following UNIX OS's:

f. SUN
g. SGI
h. HP
i. IBM
j. COMPAQ ALPHA,

At least 2 solutions must be provided for each of the following OS's:

k. Windows NT/2000
l. Windows 95/98

At least 1 solutions must be provided for each of the following OS's:

m. Macintosh OS

7.7 Public Key Infrastructure (PKI) Tools

Public Key Infrastructure (PKI), such as Entrust or Verisign, shall be provided which at a minimum:

a. a public/private key pair to allow for file and file-system encryption and digital signature

The following licensing options must be provided:

b. single licenses,
c. 10 license packages,
d. 100 license packages,

At least 1 solution must be provided for each of the following UNIX OS's:

e. SUN
f. SGI
g. HP
h. IBM
i. COMPAQ ALPHA,

At least 2 solutions must be provided for each of the following OS's:

j. Windows NT/2000
k. Windows 95/98

At least 1 solutions must be provided for each of the following OS's:

l. Macintosh OS

7.8 Secure Remote Access and Authorization Tools

Secure Remote Access and Authorization tools, such as SSH or Kerberos, shall be provided which at a minimum:

a. use cryptography to allow secure, strongly authenticated communications with remote hosts.
b. Software that also allows the use of one-time passwords (desirable).
c. Other forms of identification and authentication such as biometric identification, "smart-cards", etc. (advanced technology)

The following licensing options must be provided:

d. single licenses,
e. 10 license packages,
f. 100 license packages,

At least 1 solution must be provided for each of the following UNIX OS's:

g. SUN
h. SGI
i. HP
j. IBM
k. COMPAQ ALPHA,

At least 2 solutions must be provided for each of the following OS's:

l. Windows NT/2000
m. Windows 95/98

At least 1 solutions must be provided for each of the following OS's:

n. Macintosh OS

7.9 Virtual Private Networking Tools

Virtual private network (VPN) tools, such as IPSEC or PPTP, shall be provided which at a minimum:

a. provide a private data network that makes use of the public telecommunication infrastructure.
b. maintain privacy through the use of a tunneling protocol and security procedures

The following licensing options must be provided:

c. single licenses,
d. 10 license packages,
e. 100 license packages,

At least 1 solution must be provided for each of the following UNIX OS's:

f. SUN
g. SGI
h. HP
i. IBM
j. COMPAQ Alpha,

At least 2 solutions must be provided for each of the following OS's:

k. Windows NT/2000
l. Windows 95/98

At least 1 solutions must be provided for each of the following OS's:

m. Macintosh OS

7.10 Passive Network Monitoring Tools

Passive Network Monitoring tools, such as Network Flight Recorder or BlackICE, shall be provided which at a minimum:

a. detect and report unauthorized or hostile activity on a network or host without filtering or blocking such activity.
b. provide the capability for real-time alerts for various types of activity, all of which can be tailored and customized
c. shall provide for user-augmentations that can be made to conform to local security policies
d. Central configuration, upgrade and monitoring of several network monitors (advanced technology).
e. capable of monitoring activity to/from the following systems/OSs:
    1. SUN
    2. SGI
    3. HP
    4. IBM
    5. COMPAQ ALPHA
    6. Windows 95/98
    7. Windows NT/2000
    8. Macintosh OS

The following licensing options must be provided:

f. single licenses,
g. 10 license packages,

At least 2 solutions must be provided for each of the following OS's:

h. Windows NT/2000

At least 1 solution must be provided for each of the following OS's:

i. Macintosh OS
j. Sun Solaris

7.11 Anti-Theft Tools

Anti-theft tools, such as Computrace, shall be provided which at a minimum:

a. allow computers to report status and location to central tracking organization
b. allow users to report stolen computers to the tracking organization
c. provide that the tracking organization will work with authorities to recover stolen equipment

The following licensing options must be provided:

d. single licenses,
e. 10 license packages,

At least 1 solution must be provided for each of the following OS's:

f. Windows NT/2000
g. Windows 95/98

7.12 Additional Security Technology

Basic storage equipment in support of security tools (additional technology)

Basic network equipment in support of security tools (additional technology)

Devices running client-oriented OSs to allow interfacing with security tools (additional technology)

Supporting technology such as printers, scanners, etc. in support of security tools (additional technology)

Image and display tools in support of security considerations and configurations (additional technology)

7.13 Information Assurance Specialists

To assist in product recommendations, installation, and support of computer systems products the following specialists shall be provided:

a. Information Assurance Consulting Engineer
    1. Establishes and satisfies system-wide information security requirements based upon the analysis of user, policy, regulatory, and resource demands. Supports customers at the highest levels in the development and implementation of doctrine and policies. Provides leadership and guidance in the development, design and application of solutions implemented by more junior staff members. May have management responsibilities when assigned. Coordinates with senior representatives within the customer organizations to address program goals, milestones, resources and risks. Applies expertise to government and commercial common user systems, as well as to dedicated special purpose systems requiring specialized security features and procedures. Examples could include classified intelligence and command and control-related networks.
    2. Educational Requirements: Master's degree from an accredited college or university in Computer Science, Information Systems, Engineering, Business, or other related scientific or technical disciplines. Requires an expert understanding of security policy advocated by the U.S. Government.
    3. Experience Requirements: This position requires 10 years of substantial experience in development and implementation of information assurance technology programs and policy.

b. Information Assurance Development Engineer
    1. Analyzes and defines security requirement for computer systems which may include mainframes, workstations, and personal computers. Designs, develops, engineers, and implements solutions

that meet security requirements. Responsible for integration and implementation of the computer system security solution. Gathers and organizes technical information about an organization's mission goals and needs, existing security products, and ongoing programs in computer security. Performs risk analyses of computer systems and applications during all phases of the system development life cycle.

2. Educational Requirements: Bachelor's degree from an accredited college or university in Electrical Engineering, Computer Science, or a related field.
3. Experience Requirements: This position requires a minimum of seven years of substantial experience in the design and development of SECURE command/control/ communications and intelligence (C31) and/or SECURE command/control/ communications/computer and intelligence (C41) systems or experience in providing information system security support for such systems. General experience includes information system requirements analysis, system design, implementation, and testing..

c. Information Assurance Systems Specialist
   1. Provides customer support in solving all phases of complex information assurance-related technical problems. Reviews and recommends information assurance solutions to customer problems based on an understanding of products/systems test results. Conducts systems security analysis and implementation, system engineering, electrical design, design assurance, testing, software engineering, program design, configuration management, integration and testing of information assurance products and techniques. Solutions are based on a firm understanding of government/industry policy, practices, procedures, customer requirements, and emerging security technologies and future trends in support of information system and network security. Insures that information assurance solutions are fully compatible with or engineered into the customer's network design.
   2. Educational Requirements: Bachelor's degree from an accredited college or university in electrical, electronic or computer engineering; computer science; or a related field
   3. Experience Requirements: This position requires a minimum of seven years' experience.

d. Information Assurance Network Specialist
   1. Analyzes general information assurance-related technical problems and provides basic engineering and technical support in solving these problems. Supports the integration of information assurance solutions and technologies into networks with particular attention to protocols, interfaces, and system design. Analyzes and defines security requirements for local and wide area networks. Designs, develops, engineers, and implements solutions that meet network security requirements. Responsible for integration and implementation of the network security solution. Performs vulnerability/risk analyses of computer systems and applications during all phases of the system development life cycle. Configures test beds and conducts testing, records and analyzes results, and provides recommendations for improvements for the products/systems under test. Analyzes and defines security requirement for computer systems which may include mainframes, workstations, and personal computers. Designs, develops, engineers, and implements solutions that meet security requirements. Responsible for integration and implementation of the computer system security solution. Gathers and organizes technical information about an organization's mission goals and needs, existing security products, and ongoing programs in computer security. Performs risk analyses of computer systems and applications during all phases of the system development life cycle. Applies principles, methods, and knowledge of security to specific areas task order requirements. Test developed systems at each point of entry for ease of unregulated entry; systems resources denial; system information corruption; unlawful use of system resources; vulnerability to electronic disruption.
   2. Educational Requirements: Bachelor's degree from an accredited college or university in electrical, electronic or computer engineering, computer science, or a related field.
   3. Experience Requirements: This position requires a minimum of seven years of substantial experience in system security analysis and implementation; design assurance or testing for information assurance products and systems; integration or testing for information assurance products and systems. Experience in heterogeneous computer networking technology and work in protocol and/or interface standards specification is recommended..

e. Information Assurance Business Analyst
   1. Provides technical knowledge and analysis of highly specialized business environments that are part of information assurance projects, such as e-commerce and critical infrastructure. Also provides high-level functional systems analysis and implementation advice on complex problems which require extensive knowledge of the subject matter for effective implementation. Applies principles, methods and knowledge of the functional area of expertise to specific task order requirements, advanced business, management and administrative principles and methods to exceptionally difficult technical problems in Government information assurance program.
   2. Educational Requirements: Bachelor's degree from an accredited college or university which provides substantial knowledge useful in managing large, complex IT projects, or is closely related to the work to be automated.
   3. Experience Requirements: Seven years of substantial experience in the individual's field of study and specialization..

f. Information Assurance Applications Analyst
   1. Analyzes complex information assurance requirements based on direct interface with customers, supports the design, development and integration of software-based solutions. Software applications to include cryptographic solutions that provide and/or enhance the security of individual platforms, systems or networks. Supports the development and enhancement of user interfaces to existing information assurance software. Designs test scenarios, exercises and simulations and supports testing of new and enhanced software products. Provides work direction and guidance to other personnel; ensures accuracy of the work of other personnel, operates under deadlines, able to work on multiple tasks..
   2. Educational Requirements: Bachelor's degree from an accredited college or university in Electrical, Electronic or Computer Engineering, Computer Science or a related field.
   3. Experience Requirements: Seven years, experience in software engineering including demonstrated experience in designing, developing/programming information assurance-related software. Experience in designing and developing large software systems is required.

g. Operations Systems Security Specialist
   1. Provides technical knowledge and analysis of information assurance, to include applications; operating systems; Internet and Intranet; physical security; networks; risk assessment; critical infrastructure continuity and contingency planning; emergency preparedness; security awareness and training. Provides analysis of existing system's vulnerability to possible intrusions, resource manipulation, resource denial and destruction of resources. Provides technical support and analysis to document organizational information protection framework, and supports policy and procedures preparation and implementation...
   2. Bachelor's degree from an accredited college or university with a curriculum or major field of study which provides substantial knowledge useful in operating large, complex IT projects to support integrated systems.
   3. Experience Requirements: Seven years of substantial experience in systems operations.

8. Category B: Computer System Storage Devices

This section describes the technical requirements for Storage Devices which complement and support the Computer Systems in Category A.

8.1. Storage Devices Core Specification

Proposed storage devices shall provide:

a. be attachable to a SCSI III controller [ANSI X3.253-1998], Ultra-SCSI or Fibre Channel controllers
   1. An option to select either Fibre Channel or SCSI connections (desirable);
   2. Advanced versions of SCSI and other standard I/O controller technologies capable of greater configuration flexibility and higher throughput including ESCON controllers (advanced technology)

b. where applicable, support both internal and external housing
c. devices which are upgradeable and flexible in hardware configuration; e.g. standard housings/sleds which can accommodate different drive capacities/types, (advanced technology)
d. shall be field installable including all necessary cabling and documentation for installation.
e. shall provide error detection.
f. shall be attachable to a network (desirable)

Proposed storage devices shall support:

g. at least two of the following UNIX computer system platforms: SUN, SGI, IBM, HP, and Compaq (separate solutions may be provided for the two platforms).

h. attachable to any standard UNIX platform (desirable)

i. attachable to other OS's including IBM OS/390 and Cray OS (desirable)

j. Storage Technology that addresses virtual tape, solid state, electronic DASD, and sharing of disk storage between mainframe and UNIX computer systems (advanced technology)

8.2. Storage Devices Configuration

The following devices must be provided:

a. 12x-speed CD ROM drive.
   1. CD ROM drives of greater speed flexibility that may be substituted for the 12x-speed CD-ROM. (desirable)

b. DVD ROM Drives

c. Read/Write CD drive.

d. the following single tape devices:
   1. 8-mm DVT;
   2. 4-mm DAT;
   3. digital linear tape (DLT);
   4. STK 9840
   5. IBM 3590 E1A
   6. STK 9490 (Timberline)
   7. VHS (desirable)
   8. WORM optical (desirable)
   9. magneto-optical (desirable)
   10. STK D3 (Redwood) (desirable)

e. desktop library systems which handle the following media and capacity:
   1. 8-mm: 1 TB uncompressed;

2. CD-ROM: 6GB uncompressed;
3. DLT: 240GB uncompressed;

f. Small robotic devices which handle the following media and capacity (uncompressed values):
   1. magneto-optical: at least 1 TB, expandable to 10 TB
   2. IBM 3590/3590E: at least 200 GB, expandable to 400 GB
   3. DLT: at least 1 TB, expandable to 4.5TB
   4. LTO Ultrium: at least 700 GB, expandable to 7 TB
   5. CD-ROM: at least 30 GB, expandable to .1 TB
   6. STK 9840: at least 3 TB, expandable to 20 TB

g. Large robotic devices which handle the following media and capacity (uncompressed values):
   1. magneto-optical: at least 10 TB, expandable to 100 TB
   2. IBM 3590/3590E: at least 150 TB, expandable to 2 PB
   3. DLT: at least 120 TB, expandable to 1.5 PB
   4. LTO Ultrium: at least 14 TB, expandable to 600 TB
   5. CD-ROM: at least .1 TB, expandable to .5 TB
   6. STK 9840: at least 75 TB, expandable to 1 PB

h. Robotic devices which handle the following media(desirable):
   1. 8 mm tapes (desirable)
   2. VHS (desirable)
   3. 4 mm (desirable)
   4. multiple media types (e.g. ADIC) (desirable)
   5. Super DLT, StorageTek T9940 and other new media (advanced technology)

i. Support for:
   1. proposed jukebox / robotic devices on non-UNIX OS's, particularly IBM OS-390 and Cray OS (advanced technology)
   2. hardware performance enhancements such as controller caching and in-line compression, (advanced technology)

j. at least 2 RAID devices (supporting RAID levels 3 or 5).:
   1. one with at least a 300 GB disk array
   2. one with at least a 1 TB disk array
   3. support for both levels 3 and 5 (desirable)
   4. support for raid levels other than 0 through 5 is advanced technology

k. hard disk drives :
   1. with unformatted disk space of 18 GB
   2. with unformatted disk space of 36 GB
   3. larger disk configurations / packs (desirable)

8.3. Storage Devices Software

The following Storage related software must be provided:

a. Hierarchical Mass Storage Software:

1. UniTree. UniTree is a commercially available software product from UniTree Software Inc (UTSI). The product must provide:
   a. license for up to 75,000 GB of data
   b. 24X7 technical phone support
2. One other hierarchical mass storage software package with the ability to at least:
   a. locate, mount, read and write(except CD-ROMs) tapes or disks in the jukeboxes.
   b. support UNIX native file system user calls and commands, e.g. "ls", "touch", etc.
   c. support access at hard disk storage speed to the most frequently/recently accessed files.
   d. 'vault' media and provide a means of notifying the operator to retrieve a 'vaulted' media when an 'old' file is requested.

e. employ a 'nameserver' and 'tapeserver' or similar means for locating files on media.
f. provide utilities for backup and recovery of critical databases
g. repack function (repack tapes to remove deleted files)
h. log major activities of software components for system monitoring.
i. write multiple tape copies of a file
j. scale up to at least 10 Pbyte, providing the user a way to build up to full use of the mass storage system
k. allow for multiple hierarchies based on various file attributes
l. write multiple simultaneous streams to a tape
m. license for up to 75,000 GB of data
n. 24X7 technical phone support

b. Other software to assist in the storage and retrieval of data (desirable)

c. Other software in support of RAID and DASD technology; e.g. IXFP and SVAA along with tape software such as ACSLS and STKNET (advanced technology)

8.4 Additional Storage Technology

Basic network equipment in support of SAN and other network storage configurations (additional technology)

Devices running client-oriented OSs to allow direct monitoring of storage configurations (additional technology)

Supporting technology such as printers, audio/visual IT equipment, etc. in support of storage configurations (additional technology)

Systems/storage security technology (additional technology)

Image and display tools in support of storage configurations (additional technology)

8.5 Storage Specialists

To assist in product recommendations, installation, and support of computer systems products the following specialists shall be provided:

a. Information Assurance Storage Specialist
   1. Analyzes general information assurance-related technical problems and provides basic engineering and technical support in solving these problems. Supports the integration of information assurance solutions and technologies into storage equipment and any connected networks with particular attention to protocols, interfaces, and system design. Analyzes and defines security requirements for storage area networks. Designs, develops, engineers, and implements solutions that meet network and storage security requirements. Responsible for integration and implementation of the storage security solution. Performs vulnerability/risk analyses of computer systems and applications during all phases of the system development life cycle. Configures test beds and conducts testing, records and analyzes results, and provides recommendations for improvements for the products/systems under test. Analyzes and defines security requirement for computer systems which may include mainframes, workstations, and personal computers. Designs, develops, engineers, and implements solutions that meet security requirements. Responsible for integration and implementation of the computer system security solution. Gathers and organizes technical information about an organization's mission goals and needs, existing security products, and ongoing programs in computer security. Performs risk analyses of computer systems and applications during all phases of the system development life cycle. Applies principles, methods, and knowledge of security to specific areas task order requirements. Test developed systems at each point of entry for ease of unregulated entry; systems resources denial; system information corruption; unlawful use of system resources; vulnerability to electronic disruption.
   2. Educational Requirements: Bachelor's degree from an accredited college or university in electrical, electronic or computer engineering, computer science, or a related field.

3. Experience Requirements: This position requires a minimum of seven years of substantial experience in system security analysis and implementation; design assurance or testing for information assurance products and systems; integration or testing for information assurance products and systems. Experience in heterogeneous computer networking technology and work in protocol and/or interface standards specification is recommended.

b. Storage/Hardware Engineer
   1. Tests and analyzes all elements of the storage facilities including power, software, mass storage devices, communications devices, computer systems and terminals and for the overall integration of the enterprise network. Responsible for the planning, design, installation, maintenance, management and coordination of the storage systems. Monitors and controls the performance and status of the storage resources. Utilizes software and hardware tools, identifies and diagnoses complex problems and factors affecting storage performance. Maintains technical currency and studies vendor products to determine those which best meet client needs. Provides guidance and direction for less experienced storage support technicians.
   2. Educational Requirements: Bachelor's degree from an accredited college or university in computer science, information systems, engineering or a mathematics-intensive discipline or an applicable technical training certificate from an accredited training institution.
   3. Experience Requirements: Seven years of increasingly complex and progressive experience in computer system/network engineering. Includes two years of specialized experience related to the task.

c. Technician
   1. Provides high level functional and IT analysis, design, development, integration, documentation, and implementation assistance on problems which require a thorough knowledge of the related technical subject matter for effective system deployment. Participates in all phases of systems development. Applies principles and methods of the functional area to difficult problems in technical areas to arrive at automated solutions. Designs and prepares technical reports and related documentation, and makes charts and graphs to record results. Prepares and delivers presentations and briefings as required by the task order.
   2. Educational Requirements: High school graduate or equivalent.
   3. Experience Requirements: Ten years of intensive and progressive experience in functional or IT analysis/programming of subject matter closely related to the work to be automated.

9. Category B: Advanced Video and Display Tools

Digital Video Equipment shall adhere to the Digital Television Standards for the National Aeronautics and Space Administration (NASA) (NASA-STD 2818 dated April 4, 2000) for picture formats, video/audio signal sampling, and compression for recording and data transfer. Applicable standards are referenced to the American National Standards Institute (ANSI), the Society of Motion Picture and Television Engineers (SMPTE), and the Audio Engineering Society (AES) published standards. Video and Display Devices may be grouped into several categorizes.

Where HDTV is required the following standards must be met:

- Progressive scanning method
- Active picture pixel size of 1280X720 at 59.94 HZ

Where SDTV is required the following standards must be met:

- Interlace scanning method
- Active picture pixel size of 720X483 at 29.97 HZ

9.1 Video Acquisition Devices

The following video acquisition devices must be provided:

a. Combined HD/SD Field Camera System including:
   1. Field Camera w/ Lens with switchable aspect ratio
   2. Control Cables
   3. Batteries
   4. AC Power Supply
   5. Separate HD and SD Field Camera Systems (desirable)

b. Combined HD/SD Studio Camera System including:
   1. Studio Camera w/ Lens
   2. Control Cables
   3. AC Power Supply
   4. Separate HD and SD Studio Camera Systems (desirable)

c. HD Portable Camera w/Lens

d. Large Professional studio quality pedestals

e. Small Professional studio quality pedestals

f. HD VTR

g. Digital Betacam

h. Audio Acquisition
   1. Production Console 24 Fader Digital Console complete with
      a. 24 - Mic preamps with selectable phantom power
      b. 30- AES/EBU inputs, for inserts, recorders, etc. (64 single channels)
      c. 16- AES/EBU inputs with “SFC” (32 single channels)
      d. 12- Analog Stereo line I/O’s for inserts, etc.
      e. 8- Analog mono Masters outputs
      f. 4- AES/EBU Master outputs
      g. 4- AES/EBU Subgroups outputs
      h. 4- Analog Aux Sends
      i. 8- Digital n-1 outputs
      j. 4- Digital Aux Sends

k. Analog PFL outputs
l. Studio monitor
m. Control room monitor outputs (5+1)
n. 33- AES/EBU outputs, for inserts, recorders, etc. (66 single channels)
o. Channels MADI optical 1/O for Multitrack
p. 8- DSP Cards complete with AES/EBU I/O's
q. Controller Board

2. Microphones
   a. Cardiod Mic
   b. Studio Mic
   c. Handheld Mic
   d. Adaptive Array Mic
   e. Handheld Wireless Transmitter Mic
3. CD Player
4. Mini-Disk Recorder/Player
5. Multi-Track Deck
6. Limiter
7. DAT Machine

9.2 Production and Post Production Devices

The following Videotape Production and Post Production Devices must be provided:

a. Switcher
   1. HD Digital Production Switcher including:
      a. 24 Serial Digital Inputs with 2 M/E
      b. Autophased Inputs and Outputs
      c. 4 PGM Outputs
      d. 12 Aux busses plus Clean Feed
      e. 4:3/16:9 Switchable
      f. Redundant Power Supply-Mainframe
   2. Control Console
   3. Digital Video Processor
   4. Digital Audio Processor
   5. HD Video Processor

b. Telecine

c. HD/SD Converters
   1. HDTV Up converter
   2. HDTV Down-Converter

d. Format Converters
   1. Frame w/ Redundant Power Supply
   2. 422 to NTSC/PAL encoder
   3. NTSC to Serial Digital Converter

e. HD Non-Linear Editor

f. HD Waveform/Videoscope
   1. NTSC Waveform Monitor/Vectorscope
   2. Serial Component Measurement Monitor
   3. HDSI Component Measurement Monitor

g. Graphics Generator
   1. HD Character Generator and Still Store
   2. HDTV Logo Inserter

h. HD DVE System w/ Control Panel including:
   1. Twin Channels for use as Dual Video or Video/Key
   2. SurfaceFX Textures & Dual Light Source each channel
   3. Ultrawarp Nonlinear Effects
   4. Z Axis Combiner
   5. Mosaic, Multipictures, Border, Crop
   6. Two Color suppurate
   7. Time Frame Effects Editor
   8. High Level Motion Path Control
   9. Global Channel with Nested Source & Target Spaces
   10. Control Panel with Internal Floppy Disk Drive

i. Audio Post Production Editing Software

j. Audio Mixing Console

k. Digital Audio Processing Software

l. Audio Limiter

m. Audio Equalizer

n. Teleprompter

o. Sync System
   1. Redundant Power Supply
   2. Clock Auto Change
   3. Master Clock System Driver
   4. Computer Interface
   5. Modem Board
   6. GPS Receiver and Antenna
   7. Time Code Converter
   8. HDTV Sync Generator
   9. Change Over Unit
   10. AES Reference Generator

p. Distribution Amplifiers
   1. Mono Power Distribution Amplifier
   2. AES/EBU Distribution Amplifier Dual
   3. Analog Video Distribution Amplifier
   4. Digital Video Re-clocking Distribution Amplifier
   5. Serial Digital Video Monitoring Distribution Amplifier
   6. Analog Audio Stereo Distribution Amplifier
   7. HD/SDI Distribution Amplifier

q. Intercom
   1. Main Frame
   2. Interface Frame
   3. IFB Modules
   4. Redundant Power Supply 2 Channel IC Combiner

9.3 Transmission and Distribution Devices

The following Transmission and Distribution Devices must be provided:

a. HD Encoder

b. NTSC Encoder

c. HD/SD Video Router including:
   1. 64x64 HD-SDI Routing System
   2. 256x256 AES Router
   3. Control Card
   4. Redundant Power Supply
   5. Serial Interface Module
   6. Routing Server Software

9.4 Audio Video Monitor and Display Devices

The following Audio Video Monitor and Display Devices must be provided:

a. Audio Monitoring
   1. Digital Audio Monitor
   2. Audio Power Amplifier
   3. Digital Audio Storage
   4. Speakers for Surround Sound, including:
      a. Front Pair
      b. Rear Pair
      c. Center
      d. Sub Woofer
   5. Studio Monitor Speakers
   6. Sub-Woofer
   7. AC-3 Decoder/Monitor/Meter

b. HDTV Demodulator

c. ATSC Analyzer

d. HD Monitors
   1. 10” Dual B&W Monitor
   2. 15” Color Monitor
   3. 20” Color Monitor
   4. 30” Color Monitor w/ Remote Control

e. 42” Wide Plasma Display

f. Immersion Desk/Workbench Systems

9.5 Virtual Environment Devices

The following Virtual Environment Devices must be provided:

a. Multiple monoscopic XGA/HDTV projector system (flat or curved) (e.g., “powerwall”)

b. Stereoscopic (active or passive) XGA/HDTV Displays
   1. Workbench display
   2. Head mounted display
   3. Flat multiple projector wall
   4. Multi-walled (plus floor) projector room (e.g., CAVE, RAVE)
   5. Dome-shaped projection display

c. Six degree of freedom tracking mechanism (at least 30Hz update rate)

d. Tracked, handheld wand with one or more buttons

e. Haptic devices
    1. Tactile gloves
    2. Tactile pads
    3. Force feedback wand

f. Three dimensional surround sound system

9.6. Additional Video and Display Technology

Devices running client-oriented OSs to allow running of image and display related tools (additional technology)

Basic storage equipment in support of image and display related tools (additional technology)

Basic network equipment in support of image and display related tools (additional technology)

Supporting technology such as printers, scanners, etc. in support of image and display related tools (additional technology)

Security tools to support of image and display related tools (additional technology)

10. References

ANSI X3.64-1979/R1990	Keyboard encoding standard
ANSI X3.T9/88	Version 7.1 or newer draft of the High Performance Parallel Interface (HiPPI)
ANSI X3.91M-1987 [R1997]	SMD
ANSI X3T9.5	Fiber Data Distribution Interconnect (FDDI) Committee
ANSI X3.139-1987	FDDI Media Access Control (MAC)
ANSI X3.148-1988	FDDI Physical Layer Protocol (PHY)
ANSI X3.253:1995	SCSI-3 Parallel Interface (SPI)
ANSI/ISO 14882:1998	Programming Language C++
ANSI/ISO 9899-1990	C Language Standard
ANSI X3T9.5/84-49; ISO/IEC 9314-6:1998	
Station Management (SMT)	
ANSI X3.166-1990	FDDI Physical Layer Medium Dependent (PMD)
ANSI X3.9-1978/R 1989	FORTRAN 77 Standard
ANSI X3.198:1992 [R1997]	Programming Language Fortran 90
ANSI T1.606	Frame Relay Protocols with LMI Extensions
EIA RS-232-C	Interface between Data Terminal Equipment and Data Communication Equipment Employing Binary Data Interchange.
MIT X	Version 11, Release 6
IEEE 754	Floating Point Format (32 and 64 bit)
IEEE 754-1985(R1990)	IEEE Standard for Binary Floating-Point Arithmetic
IEEE 802.1	LAN/MAN Management (15802-2-1995)
IEEE 802.3	Ethernet Specification
IEEE 1003.1-1990	Portable Operating System Interface Exchange (POSIX) Full Use Interface Definition
ISO 8802/1	LAN/MAN Management
ISO 8802/2	Logical Link Control Type 1 (LLC1)
ISO 8802/3	Ethernet Specification
ISO 9314	Fiber Data Distribution Interconnect (FDDI)
ISO 9314-1	FDDI Physical Layer Protocol (PHY)
ISO 9314-2	FDDI Media Access Control (MAC)
ISO 9314-3	FDDI Physical Layer Medium Dependent (PMD)
RFC 768	User Datagram Protocol (UDP)
RFC 791	Internet Protocol (IP)
RFC 793	Transmission Control Protocol (TCP)
RFC 821	Simple Mail Transport Protocol (SMTP)
RFC 826	Address Resolution Protocol (ARP)
RFC 854	TELNET Virtual Terminal Protocol
RFC 904	Exterior Gateway Protocol (EGP) (Historic)
RFC 950	Internet Control Message Protocol (ICMP)
RFC 959	File Transfer Protocol (FTP) (Updated by RFC2228, RFC2640
RFC 1057	Remote Procedure Call (RPC)
RFC 1058	Routing Information Protocol (RIP)
RFC 1813	Network File System (NFS) Version 3
RFC 1112	IP multicasting (Updated by RFC2236)
RFC 1155	Structure and identification of Management Information for TCP/IP-based internets (MIB)
RFC 1157	Simple Network Management Protocol (SNMP)
RFC 1195	Integrated IS-IS: Use of OSI IS-IS for routing in TCP/IP and dual environments

RFC 1213	Management Information Base for network management of TCP-IP-based Internets: MIB II
RFC 1406	Definitions of Managed Objects for the DS1 and E1 Interface Types.
RFC 1238	Connectionless Network Protocol MIB
RFC 1239	Reassignment of experimental MIB's to standard MIB's
RFC 1742	AppleTalk Management Information Base II.
RFC 1850	OSPF Version 2 Management Information Base
RFC 1323	TCP extensions for high performance \
RFC 1332	Point-to-Point Protocol (PPP) Initial Configuration Options
RFC 2046	Multipurpose Internet Mail Extensions (MIME) Part Two: Media Types
RFC 1661/1662	PPP
RFC 2153	PPP Vendor Extensions
RFC 1771-1774	Border Gateway Protocol (BGP) (Status: DRAFT STANDARD)