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Risk Management Plan

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HIGH PERFORMANCE COMPUTING AND COMMUNICATIONS PROGRAM

RISK MANAGEMENT PLAN

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HIGH PERFORMANCE COMPUTING AND COMMUNICATIONS PROGRAM

RISK MANAGEMENT PLAN

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Section 1.0 ***Introduction***

1.1 Overview

Risk management is a process by which threats to the successful completion of the High Performance Computing and Communications (HPCC) Program are identified and characterized in order to support effective and timely action by management for mitigation of these threats. Risk management includes the tracking of risks, and the communication of the residual risks among all levels of management. The objective of risk management is the balancing of risks and requirements within available resources.

1.2 Purpose

The purpose of the HPCC Program Risk Management Plan is to:

- (1) Describe the approach by which the risk mitigation requirements of NPG7120.5A will be met;
- (2) Define the process by which the Program intends to manage technical and programmatic risks in order to achieve a resilient HPCC Program;
- (3) Define the participants in managing the Program risks, and the responsibilities of the participants; and
- (4) Define the schedule for the activities comprising the HPCC risk management program.

1.3 Scope

This Plan defines the risk management practices applied to the HPCC Program. The Plan specifies the process by which threats to a resilient Program will be identified, characterized, dispositioned, and tracked throughout the life of the Program.

The Plan also defines requirements on risk management used on the projects within the Program, and the interfaces between the individual project risk management activities and risk data, and the Program risk management activity.

This Plan defines the responsibilities for risk management performed at the Program and project levels.

1.4 Applicability

This Plan applies to the HPCC Program. The content of the HPCC Program is described in the HPCC Program Plan.

Advanced development funded by the HPCC Program is included in the HPCC Program risk management activity covered by this Plan.

This Plan applies to the risks that threaten HPCC projects throughout the Implementation processes. The Implementation process extends to the completion of the HPCC Program as defined in the HPCC Program Plan.

1.5 *Deviations and Waivers*

Deviations to the requirements of this document require the approval of the HPCC Program Manager. Deviations are requested by documenting the proposed practice in the Project Risk Management Plan.

1.6 *Definitions*

Contingency: The pre-planned response to the occurrence of an event which if it happens results in undesirable consequences.

Descope : The pre-planned response to recover from a shortfall of resources needed for timely completion of an activity with acceptable balance of risk and technical performance.

Implementation Risk: Threats to achieving minimum success metrics within programmatic (e.g. cost and schedule) and technical (e.g. launch mass and technology readiness) constraints

Risk: Risks, as used herein, refers to all threats to the successful completion of the HPCC Program and the achievement of Program minimum success metrics. These can take the form of programmatic threats such as budget shortfalls, scope changes/redirection, broken commitments, and the like. These can also take the form of technical threats such as real or potential failures, failure of technology to be ready when needed, and the like. Risks are characterized by the combination of the likelihood (probability) of their occurrence and the severity of the consequences (impact) of the occurrence.

Risk Item: A specific risk together with the characterization of the likelihood and severity of occurrence.

Risk Management: An orderly approach of addressing, disposing, tracking, and communicating threats to the success of an activity.

Risk Mitigation: A set of actions or processes intended to minimize the probability that a given risk will occur.

Risk Position: The aggregate of the risk items for a particular activity together with the decisions made to disposition the identified threats.

Significant Risk List: The repository for all risk items.

1.7 Applicable Documents

The following documents are applicable to the HPCC Risk Management activity:

- NPG7120.5A, NASA Procedures and Guidelines (3 April 1998)
- HPCC Program Plan
- HPCC Project Plans
- Agency ISO Requirements for Risk Management

Section 2.0

HPCC Risk Management Policy

2.1 Policy Statements

Risk management shall be practiced throughout the lifetime of the Program in accordance with the requirements of NPG 7120.5A in order to:

- Identify and characterize threats to the Program and project success;
- Support informed, timely, and cost-effective management decision-making in the disposition of these risks; and
- Document and communicate for management and independent review the aggregate of the risks that threaten the success of the Program and projects, together with the action(s) taken and not taken, and the rationale for choices made.

Safety, both of personnel and mission critical equipment, shall be afforded the highest priority, and shall not be compromised in risk trade-offs.

The priorities that relate to the Program Risk Management activity shall be, in decreasing priority order, as follows:

- (1) Technical Performance
- (2) Cost Performance
- (3) Schedule

Section 3.0

Risk Management Overview

3.1 *General*

Risk management is practiced both at the Program level and by the projects comprising the Program. The objective of both is similar i.e. the ameliorating of unacceptable risk, and the steps of the risk management process (risk identification & assessment, disposition, and tracking & reporting) are similar. However, the priorities of the risk mitigation activity are different, and consequently the approach to the management of the risk mitigation resources is somewhat different in the Program and Project risk management activities. Projects have fixed deliverables and milestone requirements (i.e. schedule), whereas the Program has some flexibility for replanning the rate of accomplishing Program objectives. Projects manage technical margins to be able to counter unforeseen risks, whereas there is no equivalent resource at the Program level. The Program has to fit within a yearly funding constraint, whereas there is an option to rebalance funds or requirements across the Program should a Project exceed its planned cost or not meet anticipated technical performance. So, the priority for the use of risk mitigation resources is somewhat different in the Project risk management activities than in the Program. An overview of the Program's and Projects' uses of risk mitigation resources is summarized in Table 1.

3.2 *Application to Projects*

Projects apply risk management to ensure the successful achievement of the HPCC Program requirements allocated to that project. Projects establish schedule and technical margins within the allocated resources for use in mitigating risk, and develop a descope process for significant (implementation) threats that would make it impossible to succeed within the Project cost, schedule, and technical constraints. Projects may fund back-up technology options to protect the overall goals. Project Managers are responsible for the Project success within these resources.

3.3 *Application to Program*

The Program risk management activity operates continuously throughout the life cycle of the Program. Specifically, risk mitigation activities are focused on prioritizing across the Program uses of the available resources while maintaining acceptable technical performance and risk posture. The Program develops descope processes for significant threats that make impossible the accomplishment of all requirements within available resources. The Program Manager is responsible for the Program success within the available resources.

Table 1
Overview of Risk Mitigation Resource Use

RESOURCE	PROGRAM USE	PROJECT USE
Technical Performance	<p>Relax technical requirements.</p> <p>Reallocate requirements among projects.</p> <p>Consider technical margins of alternate implementation approaches.</p> <p>Advocate effective use of non-HPCC resources for inter-Program synergy and leveraging.</p> <p>Create functional redundancies between projects.</p>	<p>Establish technical margins at the outset, and manage their use throughout the development.</p> <p>Fund back-up options, where necessary to protect the overall Project deliverables.</p> <p>Fund advanced developments.</p> <p>Reduce dependence on unproven technologies.</p> <p>Fund advanced studies where available performance is least certain.</p>
Cost Performance	<p>Rebalance funds across the Program.</p> <p>Request over-guidelines.</p> <p>Develop cost-sharing collaborations.</p>	<p>Rebalance funds across the Project.</p> <p>Develop cost-sharing collaborations.</p>
Schedule	<p>Replan the rate for accomplishment of Program objectives.</p>	<p>Establish schedule margin at the outset, and manage it throughout the development.</p>

Section 4.0

Success Criteria

4.1 General

The HPCC Program risk management activity is deemed to be successful when risk identification and resolution support informed, timely and cost-effective decision-making by management, and when the reporting of risks is encouraged, unrestricted, accurate, and complete.

Section 5.0

Risk Management Planning

5.1 *General*

Risk management planning, as defined by NPG 7120.5A, consists of the following:

- (1) Defining the purpose, scope, applicability, assumptions, and constraints applicable to the risk management activity,
- (2) Defining the Program risk management policy(s),
- (3) Providing an overview of the process, including the relationship to the Program management activity,
- (4) Defining the roles and responsibilities for the activity,
- (5) Defining the methodology, tools, and metrics,
- (6) Developing the schedule for the activity, and the resources required for its application,
- (7) Defining the method for documentation of the risks,
- (8) Describing the Program descoping methodology, and
- (9) Describing the limit of descopes beyond which the Program is no longer viable.

The results of the planning activity are captured in this Risk Management Plan. The planning was done consistent with the Program requirements, the Program performance goals, the Program organization and programmatic interfaces, the Program implementation approach defined in the Program Plan document, and the Program priorities defined in this document.

Section 6.0

Implementation & Organization

6.1 General

The HPCC Program objectives are accomplished through each of its projects, each of which is given a budget, schedule, milestones and metrics, as documented in the Program Plan. Figure 1 illustrates the Program functional elements. The implementing projects are shown across the bottom. The Program Manager is supported in carrying out the Program by a Deputy Program Manager, Resources Executive, and a contract task supporting administrative functions. The execution and planning of the Program is additionally supported by three Integration Management Teams (IMT) in the areas of Applications, System Software and Testbed.

6.2 Risk Management in Program Implementation

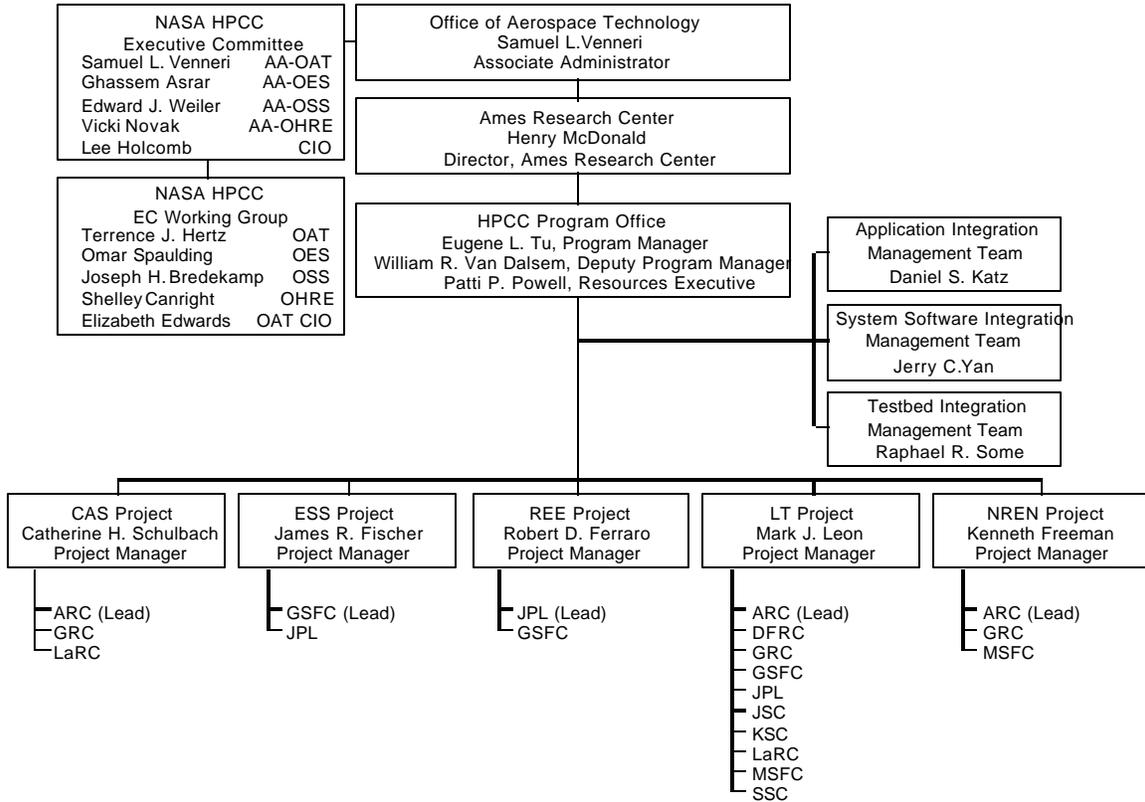
Risk management is practiced at both the Program- and Projects-level within the Program. The Program levies requirements on projects for risk management as a pro-active approach to keeping the Program viable (see Section 12.0). Projects are required to practice risk management integral to the managing of the project. Projects are required to periodically review their risk position, and assess the adequacy of any budget, schedule or technical approach flexibilities to ameliorate the threats. Projects create internal descope processes to address those requirements which would be compromised in order to complete the Project within budget and on schedule. The Program concurs in the requirement priorities inherent in these plans. Projects report risks annually to the Program Office, and at any formal Project reviews. Projects establish schedule margins in order to respond to risks uncovered during development. Projects adhere to proven design practices in order to minimize risk and, where appropriate, seeks opportunities to fund advanced developments, thereby reducing the risks in unproven technologies.

The Program pursues risk management through a series of both pro-active and reactive actions. The Program pursues functional redundancies and other cooperative ventures between projects in order to reduce risks to the Program. The Program is the repository for lessons learned by the projects, thereby minimizing repeats. Through updates of this plan, the Program aggregates total Program risk on an annual basis for assessment and analysis. The Program pursues studies through the Integration Management Teams to identify technology opportunities and gaps. The Program can move funds between projects, and apply to HQ for over-guideline requests in order to ameliorate resource shortfalls. The Program also can re-schedule the attainment of Program objectives, relax the target metrics to the minimum success metrics levied onto projects, and accept a higher level of mission risk than might have been the goal at the outset of a project.

Program risks originate (i.e., are identified) at both the Program and the project levels. Projects identify to the Program risk management activity threats for their ability to meet Program objectives allocated to the project with the available resources (budget and schedule) while

controlling risk to acceptable levels. The Program identifies risks originating from sources external to the Program, and in Program-level elements. Projects and Program elements participate in the options development process (for example, by volunteering status and the range of possible actions in their area, and making assessments of the impacts to their area for mitigation options under consideration by the Program). Program system engineering represents the options to, and pursues follow-up actions from, the decision-making process. Program system engineering maintains the Program risk information to be able to track and report the Program risk posture.

Figure 1
*High Performance Computing and Communications Program
 Organization Chart*



Section 7.0

Program Descope Methodology

7.1 General

The need to exercise a Program descope is indicated when the Program budget and/or schedule does not allow the accomplishment of the Program requirements within acceptable risks. When there is a need to realign the Program technical content with the programmatic, the Program Manager will inform the Lead Center Director, and initiate studies to explore options available to the Program. Through the HPCC Executive Committee, the stakeholders will be involved in any Program restructuring. Options will be explored to characterize the risk, performance, cost, and schedule trade-offs. The following are examples of the options to be considered:

- (1) Characterizing the risks associated with the original budget and schedule i.e. the "do nothing" option,
- (2) Identifying the addition of funds in order to capture the original Program objectives with acceptable risk on the original schedule,
- (3) Identifying the delaying of Program objectives compatible with the available funds and acceptable risk, and
- (4) Identifying the relaxing of Program objectives to get acceptable risk with the original budget and schedule.
- (5) Identifying the deleting of Program scope to continue on the original budget and schedule with acceptable risk.

If appropriate, the Program would consider trades across other Programs for which Ames Research Center has management responsibility. The Program would prepare data that would summarize the pros and cons of the various options considered, and make a recommendation to the Lead Center Director together with rationale for the recommendation given. The Program descope methodology is consistent with the priorities for the risk management activity defined in the Program risk management policy (Section 2.0).

Section 8.0

Risk Mitigation Process

8.1 Process Activities

The Program risk mitigation process is illustrated in Figure 3, and consists of 5 activities: (a) risk identification, (b) analysis and assessment, (c) planning and risk disposition, (d) risk tracking and reporting, and e) control.

Figure 2
Risk Mitigation Process



8.2 Risk Identification

Risks are identified at all levels of the Program on a continuous basis. Project specific risks are identified in the five HPCC Project Plans. Program-level risks, as well as Project-specific risks, are reviewed on at least an annual basis concurrent with the review of the Program’s controlled documents. Program reviews as well as Project-level boards, such as the LT Advisory Board, are essential elements of the risk identification sub-process.

The product of the risk identification activity a list of Program and Project risks that require analysis and assessment (Section 8.3)

8.3 *Analysis and Assessment*

The products of the analysis and assessment activity are the (a) Significant Risk List (SRL) and (b) risk mitigation options.

The baseline SRL is created by deciding the response to the risks and concerns evident at the outset of the activity. This occurs in the development phase, as described in Section 10.0. Additional entries are made to the SRL, subsequent to the roll-out of the baseline SRL, as threats to the established Program become apparent. The responsibilities for risk identification and assessment are defined in Section 11.0.

The SRL shall include the following for each identified risk item:

- (1) Description of the adverse event
- (2) Probability of occurrence
- (3) Impact of the occurrence
- (4) Mitigation options.

8.2.1 *Risk Categories*

Qualitative assessments are used in describing both the risk likelihood and risk consequences of occurrence.

Risk likelihood is expressed in terms of 3 categories: High, Medium, Low, defined as follows:

High: Occurrence is likely (>70%)

Medium: Occurrence is not unlikely (30 to 700%)

Low: Occurrence is unlikely (0 to 30%)

Implementation risk impact is expressed in terms of 3 categories: High, Medium, and Low, defined as follows:

High: The impact is severe enough that minimum success metrics may not be achievable within the existing funding constraint and schedule. The Program would also be unable to respond to any future adverse events without augmentation of funds and/or relaxation of schedule or technical requirements.

Medium: The impact could be mitigated with relaxation of performance objectives to the minimum success criteria within the existing Program funding profile and schedule constraints with perhaps degraded but acceptable resiliency to accommodate future adverse events.

Low: The impact could be mitigated within the existing Program funding profile and schedule constraints without depleting ability to respond to future adverse events, and the performance objectives remain achievable.

Risks, once categorized, are given an overall rating of High (H), Medium (M), and Low (L), for reporting purposes, according to a combination of likelihood and impact:

		<i>Risk Impact:</i>	<u>High</u>	<u>Medium</u>	<u>Low</u>
<i>Probability</i>	High		H	H	M
	Medium		H	M	L
	Low		M	L	L

All risks graded "H" require mitigation action(s). All risks graded "L" do not require any additional action past the categorization. Risks graded "M" will require mitigation at the discretion of the Program Manager. Recognizing the dynamic nature of risks, the rating for all risks will be updated on a periodic basis.

8.4 *Planning and Risk Disposition*

In general, Program-level risks must be monitored continuously, and action is required on a continuous basis to achieve mitigation. The products of the planning and risk disposition activity are the (a) risk decisions, (b) mitigation plans, (c) accepted risks, (d) retired risks, and (e) follow-up actions, if any. The risk disposition activity makes judgments on the need to mitigate risks, in light of the cost, schedule, effectiveness, and risk inherent with the potential mitigation options. The risk disposition concludes by either making risk decision (e.g., accepting the risk or mitigating the risk), or requesting additional data on which to make the decision. The request could be for additional options not previously considered, or for additional detail on one or more of the identified options. Decisions to mitigate risk result in actions like those described in Table 1.

Future actions required to implement decisions made, the date(s) by which these other actions must be completed, and the assignee(s) for the action(s) are captured in the SRL.

8.5 Risk Tracking and Reporting

Risk impact and probability are tracked. In addition, progress towards milestones is used as a risk indicator for the Program. Due to the milestone hierarchical structure (e.g., multiple task milestones enabling project milestones, multiple project milestones enabling program milestones, multiple program milestones enabling PCA milestones) progress towards milestones provides effective warning of risk probability in not meeting schedule commitments.

The products of the risk tracking and reporting activity are risk status reports, a SRL that accurately and completely reflects the current Program risk position, and Program risk assessments. Reports include in addition to risk metrics any pending actions to implement earlier decisions, plus appropriate descope and contingency plans, and dates of their expiration.

The responsibility for tracking the Program risk position is defined in Section 11.0. Program risk status is reported quarterly to the Program Management Council (PMC), and annually at the HPCC Independent Annual Review (IAR).

8.6 Control

Risk-specific indicators may trigger, for example, a review of more aggressive risk impact and risk probability mitigation and/or risk contingency plans. Any foreseeable delay of Program or PCA milestones triggers the review of appropriate Program-level risk mitigation and/or risk contingency plans. Risk indicators triggered at the task- or project-milestone level are addressed with mitigation actions at the Project level.

8.7 Communicate

Risk management processes are reviewed on an annual basis concurrent with the review of the Program's controlled documents.

Section 9.0

Risk Metrics

9.1 Metric Maintenance

Metrics will be maintained on the HPCC risk management activity as follows:

- Risks identified and dispositioned as a function of time
- On-time milestone completions at the PCA, Program and Project levels

Section 10.0

Risk Management Schedule

10.1 Phases

The risk management activity consists of 2 serial phases: development and operations.

The development phase includes installing and tailoring the risk management tool(s) to the HPCC application, creating the baseline Significant Risk List, and developing the descope process for the threats apparent from the external and inter-Project dependencies and programmatic constraints. The development phase starts with release of the Program and Risk Management Plans, and continues until the products of the development phase are baselined, which is estimated to take approximately 6 months.

The operations phase starts at the end of the development phase, and continues thereafter throughout the lifetime of the Program. In the operations phase the Program risk position evolves in response to external forces and internal, continuous risk assessment. The Program risk status is reported quarterly to the PMC and annually at the Program IAR. The Program Risk Management Plan is updated as the risk management practice evolves with experience gained for the effectiveness of the process, and due to the changing priorities for risk management within the Program.

Section 11.0

Risk Management Responsibilities

11.1 General

The responsibility for the HPCC risk management activity shall reside with the HPCC Program Manager.

The responsibility for Program risk identification and assessment, and developing and assessing mitigation options is shared among the Program, Projects and Integration Management Teams staff, each representing their specific area of expertise. The responsibility for coordination among the staff in the identification and characterization of risks, developing mitigation options, and assuring vigorous pursuit of risks across the Program is delegated to the respective managers or leads.

The Program Manager delegates Project-specific risk management to the Managers of the HPCC Projects. Project Managers are responsible for tracking and reporting of risks to the Program objectives allocated to the project. The Program Manager retains an oversight responsibility, since Project failures can adversely impact the Program objectives.

A complete directory of participants in Program risk management is defined in Table 2.

Table 2
Risk Management Responsibilities

FUNCTION	ACTIVITY	RESPONSIBILITY OF
Planning	Defining the methodology, tools, metrics, etc for the risk mgmt activity.	Pgm. Manager; Project Managers
Risk Identification	Identify Program-level risks Identify Project-specific risks Coordinate risk identification across the Program.	Pgm. Manager Project Managers IMT Leads

Risk Assessment & Mitigation Option Development	<p>Characterize risks.</p> <p>Develop functional redundancies between projects to lower Program risk.</p> <p>Define advanced developments to lower Program risk.</p> <p>Develop contingency plans as required.</p> <p>Develop descope plans as required.</p> <p>Develop opportunities to lower risk by diversifying Program objectives across projects.</p> <p>Explore collaborations & partnerships in Projects.</p>	<p>Pgm. and Project Managers</p> <p>Pgm. Managers; IMT Leads</p> <p>Pgm. and Project Managers</p> <p>Pgm. and Project Managers</p> <p>Pgm. and Project Managers</p> <p>Pgm. Managers; IMT Leads</p> <p>Project Managers</p>
Risk Disposition & Decision-Making	<p>Reallocate funds across the Program.</p> <p>Advocate to HQ for over-guidelines.</p> <p>Relax performance requirements to minimum success metrics.</p> <p>Relax performance requirements below minimum success metrics.</p> <p>Reschedule the rate of accomplishing Program objectives.</p> <p>Fund advanced developments within Program guidelines.</p> <p>Fund functional redundancies between projects within Program guidelines.</p> <p>Accept high risks</p>	<p>Pgm Manager</p> <p>Pgm Manager HPCC EC</p> <p>NASA HQ PMC</p> <p>HPCC EC</p> <p>Pgm Mgr</p> <p>Pgm Mgr</p> <p>HPCC EC</p>
Risk Tracking & Reporting	<p>Track risks & report status.</p> <p>Aggregate total Program risk annually.</p> <p>Present Program risk position at reviews.</p> <p>Document Program lessons learned.</p>	<p>Pgm. and Project Managers</p> <p>Pgm. Manager and IMT Leads</p> <p>Pgm. and Project Managers</p> <p>Pgm. Manager</p>

Section 12.0

Project-Specific Risk Management Requirements

12.1 Requirements Sources

HPCC projects shall plan for and implement a risk management activity throughout the life of the Project in accordance with the requirements of this document and the following:

- NPG 7120.5A, NASA Program and Project Management Processes and Requirements
- HPCC Program Plan
- HPCC Risk Management Plan

Deviation(s) from and/or tailoring of these requirements shall be documented in the HPCC Management Plan, which when approved authorizes the proposed requirement variations.

HPCC projects shall integrate the risk management process into the Project Management activity.

HPCC projects shall supply adequate resources to ensure effective implementation of the risk management.

HPCC projects shall participate in the Program risk management activity by identifying and characterizing threats to the project schedule and budget, and to the Program objectives allocated to the project. HPCC projects shall participate in the mitigation of Program threats by defining and assessing options to mitigate such threats, with could arise from any of the HPCC projects and Program-level elements (e.g., Program-funded advanced developments on which a project is dependent for success).

12.2 Risk Management Planning

The product of the planning activity is the Project Risk Management Plan, which describes how each of the risk management requirements will be met. The Plan may be a stand-alone document, or incorporated as a section into the Project Plan document.

Project risk management planning shall be done consistent with the following:

- Project-level requirements
- Project success criteria
- Project organization & programmatic interfaces
- Project priorities
- Project implementation approach (see Section 12.3)
- Project risk policy

Safety, both of personnel and mission critical equipment, shall be afforded the highest priority, and shall not be compromised in risk trade-offs.

The priorities that relate to the Project risk management activity shall be, in decreasing priority order as follows:

- (1) Technical Performance
- (2) Cost Performance
- (3) Schedule

Appendix A

Significant Risk List

A.1 Program-Level Risks

Risk	Risk Impact	Risk Probability	Risk Probability Mitigation Processes
Most critical current applications not addressed	High	Medium	Engage HPCC EC WG in selection processes Periodically review selection criteria and selected projects with HPCC EC and EC WG Review, and if necessary, realign application foci on a periodic basis
Program does not remain current with evolving customer technical requirements	High	Medium	Involve customers in the technical implementation, from concept through delivery Monitor potential changes in customer requirements Design approach to adapt to customer changes
Partners do not meet resource commitments	High	Medium	Formal MOU/MOAs Periodic management review Formal joint plans/teams
Reduction/loss of funding	High	Medium	Advocate benefits to customers/stakeholders Identify opportunities for expanded customer base
Technical projects do not meet performance or schedule commitments	Medium	Medium	Monitor progress towards all milestones in hierarchical milestone structure Regularly-scheduled reviews of technical progress and status Identify and utilize leverage opportunities by redirecting technical approaches among the various activities

Technical project duplicative and/or not coordinated with a different HPCC project	Medium	Low	Facilitate inter-project integration and coordination Re-allocate resources to reduce inappropriate technical duplication
Changes in technical project activities adversely affect a different HPCC project	Medium	Low	Facilitate inter-project integration and coordination
Unavailability of major computational facilities	Medium	Low	Establish partnerships with other programs and organizations Formalize relationships through agreements

A.2 CAS Project Risks

Risk	Risk Impact	Risk Probability	Risk Probability Mitigation Processes
Critical OAT Programs do not express value of CAS, funding may be cut or project may be terminated.	High	Medium	Engage critical programs in identifying priority needs and work closely with them Review selections with HPCCP, HPCC EC and HPCC EC WG Review, and if necessary, realign application foci on periodic basis Advocate benefits to customers Publicize Project accomplishments
CAS work not reflective of changing requirements	High	Medium	Involve customers in technical implementation, from concept through delivery and work closely with them Document requirements Monitor potential changes in customer requirements and document changes Establish and follow engineering/development plans Include customer in discussions involving prioritization of activities or redirection of technical approaches
Partners do not meet commitments	Medium	Medium	Formal joint plans and teams Formal MOUs and MOAs Periodic and regular management reviews Develop contingency plans
Schedule and performance commitments are not met	Medium	Medium	Regular tracking and reporting of progress Set goals that exceed minimum success criteria Develop and implement contingency plans

Testbed requirements exceed capability	Medium	Medium	Establish inter-project communication and coordination processes Establish requirements management process
Changes in another HPCCP project affect CAS ability to meet its commitments	Medium	Low	Establish inter-project communication and coordination processes Develop contingency plans
CAS activities are duplicative of or not coordinated with similar projects	Medium	Low	Facilitate inter-organization communication Track activities of HPC community Realign resources to remove duplication
Access to major computational facilities unavailable.	Medium	Low	Participate in development of NASA strategy for supercomputing. Establish partnerships with other programs and organizations, including those external to NASA Develop MOUs/MOAs to formalize relationships for access to facilities
One CAS activity negatively impacts another project.	Medium	Low	Facilitate intra-project communication. Conduct regular meetings/telecons. Clarify and document roles and responsibilities
Key personnel not available to meet performance expectations.	Medium	Low	Documentation of project requirements and implementation plans Backups for key personnel
CAS does not leverage commercial technology resulting in resources used ineffectively.	Medium	Low	Continual use and evaluation of commercial technology Periodic surveys of commercial technology Participate in HPC community and track activities of peer organization

A.3 ESS Project Risks

Risk	Risk Impact	Risk Probability	Risk Probability Mitigation Processes
Communities of Investigators cannot come to agreement on the policy for the framework.	High	High	Each Investigator Team is required to have an early milestone to achieve agreement on policy for the framework. A software engineering integrator proactively facilitates establishing the basis for agreement among the ESMF participants.
The resulting modeling software lacks fidelity to faithfully model real physical systems.	High	Medium	The CAN proposal evaluation process eliminates proposals that show poor understanding of model validation including model test procedures.
Investigator Teams do not hire the disciplined software engineering expertise required to develop the interoperable and high performance codes required. Investigator Team PIs do not have sufficient motivation or ability to manage their team of multidisciplinary scientists and software technologists to produce a challenging software product on a demanding timeline.	High High	High Medium	The business model of ESS ties each Team payment to achievement of a negotiated milestone. This motivates and assists the PI and the PI institution to manage the Team well. ESS selects twice as many teams as are necessary to meet the Project and Program objectives. The CAN proposal evaluation process eliminates proposals with excessive technical risk. The Testbed vendor staff and ESS Center-based inhouse team computational scientists tasked to provide innovative solutions in support of PI Teams.
Science application codes are selected that cannot be adequately parallelized to achieve performance goals.	Medium	Low	The CAN proposal evaluation process eliminates proposals with excessive management risk. Testbed vendor is motivated by contract arrangements to assist weak Teams.
The NASA production computing infrastructure is not prepared to	High	Medium	ESS partners strategically with NCCS and CoSMO in its initiatives to maximize the opportunity for production computing in

support the increased resource requirements of ESS Investigator Teams after they have been empowered by ESS technology.			<p>NASA to anticipate future requirements.</p> <p>ESS periodically advocates its technology advances directly to Enterprise Science management so that they are aware of emerging capabilities.</p> <p>ESS invests in approaches that can significantly improve the price/performance ratio of high end computing systems.</p>
Resulting ESS software technologies do not propagate into and benefit their intended communities.	High	Medium	ESS designed the Round-3 CAN to emphasize customer use of codes developed including milestones where Investigators identify customer relationships up front and show customer use in the end.
ESS experiences reduction or loss of funding.	High	Medium	ESS involves Headquarters customers/stakeholder Enterprises as ongoing front line participants in Round-3 activities so they know the benefits first hand.
Selected Investigator Teams do not address ESS customer Enterprise requirements.	High	Low	The Earth Science and Space Science Enterprises jointly participate in selecting the Round-3 Investigators. The Enterprises provide the chair of the Peer Review Committee, provide the chair and members of the Selection Committee, and provide the Selection Official for the CAN.

A.4 REE Project Risks

Risk	Risk Impact	Risk Probability	Risk Probability Mitigation Processes
Component technologies do not attain power and performance capabilities projected by industry for 2002	High	Low	Invest in alternative ultra-low-power technologies
SIFT technology does not attain sufficient reliability to permit the extensive use of COTS in space	High	Medium	Allow for replicated/voted components in critical sections of the architecture of the flight prototype Leverage related programs managed by the Air Force and DARPA to incorporate radiation-hardened components into critical sections of the architecture
REE technology transfer unsuccessful	High	Medium	Involve principal REE customer base (instrument scientists) from inception of the project Continuously feed science-driven requirements into the hardware and software development efforts. Ensure interoperability and compatibility with next generation avionics hardware/software systems
Private sector developers of software will not allow prime contractor(s) to license or modify their software	Medium	Medium	Design SIFT layers to minimize need to modify COTS software Maintain active relationships with leading COTS operating system developers
Reduction in funding	High	Medium	Advocate benefits to customers/stakeholders Maintain agile project descope plan

A.5 *LT Project Risks*

Risk	Risk Impact	Risk Probability	Risk Probability Mitigation Processes
Educational Community requirements change	Medium	Low	Track the development of National and State standards to ensure that the technology developed by LT is consistent with any changes in the educational community
Educational projects do not meet expected interactive performance	High	Medium	Assign Task Managers to access their technology platforms annually with educational capabilities and industrial development trends to insure that LT products will exceed or meet interactive performance requirements
Duplication of Process by another federal agency	Low	High	Utilize interagency forums more efficiently through the use of LTP liaisons with various Federal Agencies such as NSF, DOE, DoEd, DARPA, and the DOD
Educational Products overtake NASA development	Low	Medium	Conduct a cancellation review on task. Implement modified design to leverage off of unique elements that will not be overtaken. Formal joint corrective action teams
Reduction/loss of funding	High	High	Advocate benefits to customers/stakeholders Re-plan based on project descope priorities Re-plan based on program descope priorities

A.6 NREN Project Risks

Risk	Risk Impact	Risk Probability	Risk Probability Mitigation Processes
Customer requirements change	High	Medium	<p>Involve customers in the technical implementation, from concept through delivery</p> <p>Design approach to adapt to customer changes</p> <p>Monitor customer requirements for potential changes</p>
Externally developed technologies and capabilities diverge from expectations	High	Medium	<p>Periodically assess external technology developments</p> <p>Consult external experts at technical planning level</p> <p>Periodically assess relevance of project milestones</p> <p>Adjust technical plans at Project level</p> <p>Adjust technical plans at Program level</p>
Technical projects do not achieve performance expectations	Medium	Medium	<p>Schedule regular reviews of technical progress and status</p> <p>Identify and leverage opportunities by redirecting technical approaches among the various activities</p> <p>Document lessons learned and apply them to enhance performance of future projects</p>
Changes in an application for one project adversely affect other NREN task elements	Medium	Low	Facilitate task level integration and coordination
Task activities contain duplicate elements	Medium	Low	Coordinate and integrate activities at the WBS level
Reduction / loss of funding	High	Medium	Advocate benefits to customers/stakeholders
Unavailability of major networking facilities	Medium	Low	Develop and maintain plans for backup strategy

Partners do not meet resource commitments	Medium	Medium	Formal MOU/MOAs Periodic Senior Management reviews Formal joint plans/teams
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