PCA	Prog	Proj	Task	Milestone	Due Date	Metrics
PCA1				**Develop component technologies for performance**	**9/30/01**	
	H1.1			Establish high-performance testbed for application performance	9/30/00	Integrated hardware and software to provide a computing and communications testbed for HPCC applications capable of 250 GFLOPS (benchmarks) and 3 locations with Gigabit WAN capability.
		C1.1.A		Install high-performance system to allow investigators to establish baseline performance and demonstrate integrated HPCC technologies	9/30/00	250 GFLOPS (benchmarks) on CAS testbed including high-performance system at Ames and med-performance systems at Ames, Glenn and Langley. Provide high-performance systems for inclusion on Gigabit WAN connecting three locations.
	H1.3			Develop and apply technologies to measure and enhance performance on high-performance testbeds	9/30/01	Software tools to reduce parallelization time from months to one week while maintaining 50% application performance compared with manual parallelization. Tools to benchmark testbed performance in computing capability, database manipulation, and scheduling to evaluate alternate scheduling strategies and choose optimal approaches to reduce variability and improve predictability of turnaround time. 3 relevant application codes parallelized; 3 data analysis codes parallelized; documented evaluation of parallelization tools.

		C1.3.A	Develop, apply, and evaluate the effectiveness of automated parallelization tools and techniques to enhance performance	9/30/01	Apply parallelization tools to benchmark set of large (>10,000 lines of code) and previously untested applications. Show automated parallelization time of 1 week or less on benchmark codes. For benchmark codes for which parallel versions exist, show average performance of >50% of versions parallelized by hand. Document results.
		C1.3.B	Evaluate and document the effectiveness of alternate performance enhancement strategies	9/30/01	Document experiences on applying performance enhancing tools and techniques.
		C1.3.C	Deliver benchmarking tools for measuring testbed performance in areas relevant to application performance	9/30/01	Provide the following benchmarks to characterize new applications: (1) benchmarks to measure computing capability using new programming paradigms, (2) database benchmark consisting of solutions from mixed set of multi-fidelity physical solvers with potentially different storage formats, including structured and unstructured data, to evaluate software tools for data manipulation (e.g., neural nets, data mining, knowledge capture, feature extraction, accuracy assessments, data compression, post processing, etc.), and (3) execution benchmark consisting of sets of multi-discipline, multi-fidelity physical model solvers to test scheduling strategies on distributed systems.

		C1.3.D	Enhance performance of relevant applications using parallelization and performance enhancing tools and techniques	9/30/01	Enhance performance of at least 3 application codes and at least 3 data analysis codes using appropriate manual and automated parallelization and performance enhancing tools and techniques. Document results.
PCA2			**Develop component technologies for reliability and resources management**	**12/31/02**	
	H2.2		Develop embedded tools and services for autonomous resource estimation/request of local and distributed ground based systems	12/31/02	Tools for broadcasting local system status for utilization on distributed systems. 3 applications with tools for automated submission and management of multiple jobs; 3 applications with tools for utilization of new or modified resources on a distributed computing system within 1 day. Tools for job execution management on distributed systems; integration of new computing or storage node into distributed computing system within one day.
		C2.2.A	Deliver tools for monitoring and tracking use of distributed systems	12/30/01	At least 1 toolkit to provide information on resource status and at least 1 toolkit to provide information on job status.
		C2.2.B	Deliver tools for automated job submission and job execution management capability on distributed systems	9/30/02	At least 3 applications demo capabilities for automated job submission and job management on distributed computing system.
		C2.2.C	Demonstrate ability to easily integrate and use new distributed computing resources	12/31/02	Demonstrate integration of new computing or storage node into distributed computing system within 1 day. At least 3 applications demo ability to use new or modified resources of a distributed computing system within 1 day.

	H2.3			Develop tools for reliability of ground based computing systems	6/30/03	Application tools to detect, classify and adapt to faults on distributed computing nodes and networks; 99% availability on distributed computing systems (10 distinct resources including one each of computing node, mass storage system and wide area network).
		C2.3.A		Show how tools improve the reliability of computing systems by enabling applications to adapt to failures	6/30/03	Provide at least 1 toolkit to detect, classify, and allow applications to adapt to faults on distributed computing nodes and networks. Show how toolkit enables 99% of events requested in 24 hours to be completed on distributed system of at least 10 resources, including at least 1 computing node, 1 mass storage system, and 1 WAN.
PCA3				**Develop component technologies for interoperability and portability**	**9/30/03**	
	H3.1			Tools and techniques for interoperable and portable applications in aerospace, Earth science and space science communities	3/31/02	Distributed debugging capability on 6 distinct platforms; adapt codes for interoperability within 1 week.
		C3.1.A		Provide portable distributed debugging capability	9/30/01	Extend existing parallel and distributed debugging capability to a grid environment and demonstrate debugging of an application that spans at least 6 distinct platforms
		C3.1.B		Develop tools and techniques to facilitate interoperability of codes within a framework running on a distributed computing systems	3/31/02	Demonstrate that benchmark code(s) can be adapted to inter-operate within relevant application-oriented framework(s) within 1 week

	H3.3			Interoperable and portable systems, services and environments	9/30/03	Interoperability of 3 tools pre-processing CAD geometry data for application input; interoperability of 10 tools spanning 3 aerospace disciplines and including high-fidelity analysis; integration of new tool into interoperability framework within one day.
		C3.3.A		Provide environments/frameworks for multi-disciplinary investigations	9/30/03	Demonstrate integrated set of at least 3 tools/codes to facilitate and automate flow-solver input preparation. Demonstrate framework(s) of at least 10 interoperable tools/codes (including some tools/codes for high-fidelity analysis) from 3 aerospace disciplines.
		C3.3.B		Provide services to enhance portability and interoperability	9/30/03	Contributes to achievement of portability or interoperability metrics.
		C3.3.C		Demonstrate ease of interoperability	9/30/03	Demonstrate that benchmark tool(s)/code(s) can be adapted to inter-operate within relevant application-oriented framework(s) within 1 day.

PCA4				**Develop component technologies for usability**	**9/30/04**	
	H4.3			Develop tools to improve usability of aerospace simulation capabilities	3/31/04	Visual-based assembly capability applied to 3 aerospace applications to speed the problem set-up, reduce learning time, and reduce set-up errors.
		C4.3.A		Provide problem specification via visual based syntax	3/31/04	At least 3 applications demonstrate the use of visual based assembly techniques for problem set-up.
		C4.3.B		Develop additional strategies to improve applications usability	3/31/04	Automate existing capability or provide new capabilities that enhance usability and/or performance, especially across distributed computing systems. Evaluate new capabilities.
PCA5				**Demonstrate integrated HPCC technologies**	**9/30/02**	
	H5.3			Demonstrate improvement in time-to-solution for aerospace applications	12/31/01	Improvement in aerospace applications: Complete combustor and compressor simulation in 3 hours each; high-fidelity space transportation vehicle analysis in 1 week and optimization enabled; S&C database generation for aerospace vehicles within 1 week; demonstration of improvements in 4 NASA-sponsored design events.
		C.5.3.A		Demonstrate impact of improved space transportation vehicle analysis	12/31/01	Demonstrate high-fidelity analysis of space transportation vehicle in 1 week, and provide capabilities for performing optimization. Document application to at least 2 NASA designs/design events.
		C.5.3.B		Demonstrate impact of improved aero/aerospace vehicle simulation capability	9/30/01	Demonstrate ability to generate a stability and controls database for an aerospace vehicle using high-fidelity flow solvers in 1 week. Document application to at least 1 NASA design/design event.

		C.5.3.C	Demonstrate impact of improved engine simulation capability	9/30/01	Complete high-fidelity combustor simulation for modern, high-bypass, turbofan engine in 3 hours (1000X improvement over 1992 baseline). Complete high-fidelity compressor simulation for modern turbofan engine in 3 hours (1000X improvement over 1992 capability). Complete 3-D steady-state, aerodynamic simulation of an aircraft engine (from inlet to exit) overnight. Document application to at least 3 NASA designs/design events.

PCA6				**Demonstrate significant engineering, scientific, and educational impacts from integrated HPCC technologies**	**9/30/05**	
	H6.3			Establish impact on aerospace design and operations through the demonstration of integrated systems of applications, tools, services and resources which enable the high-performance execution of interoperable aerospace applications across distributed heterogeneous testbeds	9/30/05	Utilize distributed heterogeneous computing system (10 components) for: 3D steady-state multidisciplinary propulsion system analysis in 1 day; high-fidelity full-vehicle simulation of aircraft in 1 day; high-fidelity space transportation vehicle analysis in 1 day and optimization in 1 week. Document improvements in 6 NASA-sponsored design events and impact to 3 elements of the national airspace system.
		C.6.3.A		Document impact of improved simulation of elements of national airspace system	6/30/05	Document improved capabilities for simulation of national airspace components/systems using 10-component distributed heterogeneous computing system. Document application to at least 3 elements of national airspace system.
		C6.3.B		Demonstrate impact of improved propulsion system simulation capability	6/30/05	3-D high-fidelity, steady-state, multi-disciplinary propulsion system analysis in 1 day using 10-component distributed heterogeneous computing system. Document application to at least 3 NASA designs/design events.
		C.6.3.C		Demonstrate impact of improved aircraft simulation capability	7/30/05	High-fidelity full-vehicle simulation in 1 day using 10-component distributed heterogeneous computing system. Document application to at least 2 NASA designs/design events.

		C.6.3.D	Demonstrate impact of improved space transportation vehicle simulation capability	8/30/05	High-fidelity analysis in 1 day and optimization in 1 week using 10-component distributed heterogeneous computing system. Document application to at least 3 NASA designs/design events.
PCA7			**Establish sustainable and wide-spread customer use of HPCC Program technologies**	**9/30/06**	
	H7.4		Establish sustained use of CAS tools and techniques towards meeting Aerospace Technology Enterprise pillars and goals	9/30/05	Surveys demonstrating infusion of production-ready applications and system software tools into NASA Aero-Space Technology programs, aerospace engineering industry and high-performance computing communities.
		C7.4.A	Demonstrate improvement in level of infusion of CAS technology into Aerospace Technology Enterprise	Annual	Demonstrate 5% per year improvement (over previous year, or over baseline for first year) in level of infusion of CAS technology into relevant NASA and national aerospace and computing communities.
		C7.4.B	Train future professionals in computational aerospace sciences	Annual	10+ students trained/supported per year

PCA	Prog	Proj	Task	Milestone	Due Date
PCA1				Develop component technologies for performance	9/30/01
	H1.1			Establish high-performance testbed for application performance	9/30/00
		C1.1.A		Install high-performance system to allow investigators to establish baseline performance and demonstrate integrated HPCC technologies	9/30/00
			C1.1.1	512-processor Origin 2000 available to CAS community	5/1/00
			C1.1.2	512-processor Origin 2000 integrated into distributed testbed	7/1/00
			C1.1.3	Demonstration of 250 GFLOPS benchmark on testbed	9/30/00
	H1.3			Develop and apply technologies to measure and enhance performance on high-performance testbeds	9/30/01
		C1.3.A		Develop, apply, and evaluate the effectiveness of automated parallelization tools and techniques to enhance performance	9/30/01
			C1.3.1	Apply parallelization tools to benchmarks and document performance	6/30/00
			C1.3.2	Apply parallelization tools to relevant application codes and document performance	12/31/00
			C1.3.3	Document that parallelization tools can parallelize application in one week while maintaining 50% performance compared to manual parallelization	6/30/01
		C1.3.B		Evaluate and document the effectiveness of alternate performance enhancement strategies	9/30/01
			C1.3.4	Develop high performance extensions for openMP and evaluate using CAS codes	9/30/01
			C1.3.11	Complete NRA activities to investigate and evaluate performance improvements from innovative algorithms	9/30/01
			C1.3.12	Investigate highly-parallel, distributed algorithms for aerospace propulsion applications	9/30/01
		C1.3.C		Deliver benchmarking tools for measuring testbed performance in areas relevant to application performance	9/30/01
			C1.3.5	Develop HPF, OpenMP, and Java implementations of NAS Parallel Benchmarks (NPB)	9/30/01
			C1.3.6	Develop database benchmark to evaluate database manipulation capabilities	9/30/01
			C1.3.7	Develop execution benchmark for testing alternate scheduling strategies	9/30/01

		C1.3.D		Enhance performance of relevant applications using parallelization and performance enhancing tools and techniques	9/30/01
			C1.3.8	Develop initial parallel versions of PEGSUS, CART3D, CIR, and INS3D; document performance; and compare to serial versions	9/30/01
			C1.3.9	Develop parallel version of unsteady turbomachinery code MSTURBO, document performance, and compare to serial version	9/30/01
			C1.3.10	Develop initial parallel versions of data reduction codes, document performance, and compare to serial version	9/30/01
			C1.3.13	Develop algorithmic enhancements for selected parallel applications to improve execution time 25%	9/30/01
			C1.3.14	Demonstrate distribution of analysis and optimization on many concurrently operating processors by replication of existing codes (coarse-grain parallelism) for subset of RLV problem	9/30/01

PCA2				**Develop component technologies for reliability and resources management**	**12/31/02**
	H2.2			Develop embedded tools and services for autonomous resource estimation/request of local and distributed ground based systems	12/31/02
		C2.2.A		Deliver tools for monitoring and tracking use of distributed systems	12/30/01
			C2.2.2	Provide information on queuing, tracking, and monitoring jobs in distributed systems that can be accessed by user applications	9/30/01
			C2.2.3	Provide information on status of components of distributed system resources that can be accessed by user applications	9/30/01
		C2.2.B		Deliver tools for automated job submission and job execution management capability on distributed systems	9/30/02
			C2.2.4	Develop Jini-based resource management and scheduling system for MDO applications	9/30/01
			C2.2.5	Develop tool to allow automated submission of sets of jobs to perform parameter studies	3/31/02
			C2.2.6	Demo automated job submission tool on 3 applications	7/30/02
		C2.2.C		Demonstrate ability to easily integrate and use new distributed computing resources	12/31/02
			C2.2.1	Demonstrate ability to incorporate and utilize a new computing or storage node into distributed computing system	3/31/01
			C2.2.7	Demo ability of 3 applications to incorporate and utilize new or modified resources	10/30/02
	H2.3			Develop tools for reliability of ground based computing systems	6/30/03
		C2.3.A		Show how tools improve the reliability of computing systems by enabling applications to adapt to failures	6/30/03
			C2.3.1	Develop application tools to detect, classify and adapt to faults on distributed computing nodes and networks	2/29/03
			C2.3.2	Demonstrate 99% availability on distributed computing systems	4/30/03
PCA3				**Develop component technologies for interoperability and portability**	**9/30/03**
	H3.1			Tools and techniques for interoperable and portable applications in aerospace, Earth science and space science communities	3/31/02
		C3.1.A		Provide portable distributed debugging capability	9/30/01

			C3.1.2	Demonstrate that p2d2 can be used to debug program distributed across multiple distinct platforms	9/30/01
		C3.1.B		Develop tools and techniques to facilitate interoperability of codes within a framework running on a distributed computing systems	3/31/02
			C3.1.1	Evaluate methods of providing user interface to distributed systems that facilitates interoperability of applications	6/30/01
			C3.1.3	Develop and demonstrate tool to semi-automatically derive application interfaces for CORBA environment	9/30/01
			C3.1.4	Develop tools for wrapping and executing legacy codes using CORBA	12/31/01
			C3.1.5	Evaluate approaches to deploying security services in distributed systems	3/31/02

	H3.3			Interoperable and portable systems, services and environments	9/30/03
		C3.3.A		Provide environments/frameworks for multi-disciplinary investigations	9/30/03
			C3.3.1	Demonstrate NPSS capability to deploy zoomed parameter study between engine and 1D high pressure compressor using CORBA	9/30/01
			C3.3.2	Demonstrate NPSS capability to deploy zoomed parameter study between engine and 1D high pressure compressor using CORBA, with CAPRI CAD interface	9/30/02
			C3.3.3	Enhance PEGSUS to be capable of producing flow solver ready overset grid systems and running coupled w/flow solver to produce grids for moving unsteady problems	9/30/03
		C3.3.B		Provide services to enhance portability and interoperability	9/30/03
			C3.3.5	Develop high performance language extensions and evaluate using CAS applications	9/30/03
			C3.3.6	Extend resource management and scheduling system to include modules for security, monitoring and steering	9/30/03
		C3.3.C		Demonstrate ease of interoperability	9/30/03
			C3.3.4	Demonstrate capability to integrate new tool into NPSS	9/30/03
PCA4				**Develop component technologies for usability**	**9/30/04**
	H4.3			Develop tools to improve usability of aerospace simulation capabilities	3/31/04
		C4.3.A		Provide problem specification via visual based syntax	3/31/04
			C4.3.1	Demonstrate NPSS V 1.0 with Visual Based Syntax assembly of complete engine (zoomed analysis)	9/30/02
			C4.3.3	Demonstrate adaptive coupling for object-based multidisciplinary application	3/31/04
		C4.3.B		Develop additional strategies to improve applications usability	3/31/04
			C4.3.2	Demonstrate CORBA interface for executing applications in distributed environment with security	12/31/03
			C4.3.4	Develop tool for automated gridding with pre-processing capabilities including grid-resolution error assessment and grid refinement.	3/31/04
			C4.3.5	Assess potential of advanced computing/optimization methods (investigated under NRA's) to provide order-of-magnitude improvements in speed and/or capability	3/31/04
PCA5				**Demonstrate integrated HPCC technologies**	**9/30/02**

	H5.3			Demonstrate improvement in time-to-solution for aerospace applications	12/31/01
		C.5.3.A		Demonstrate impact of improved space transportation vehicle analysis	12/31/01
			C5.3.1	Demonstrate ability to couple tools for multi-disciplinary high-fidelity analysis of RSTS in descent	9/30/01
			C5.3.2	Perform external and internal high-fidelity flow computations for RSTS in ascent	9/30/01
			C5.3.7	Apply MDO to subset of RLV conceptual design problem	11/30/01
		C.5.3.B		Demonstrate impact of improved aero/aerospace vehicle simulation capability	9/30/01
			C5.3.3	Demonstrate techniques to efficiently generate enhanced stability and controls database for an aerospace vehicle by executing moderate to large numbers of related computations using high-fidelity solvers.	9/30/01

		C.5.3.C		Demonstrate impact of improved engine simulation capability	9/30/01
			C5.3.4	Perform complete high-fidelity combustor simulation	9/30/01
			C5.3.5	Perform complete high-fidelity compressor simulation	9/30/01
			C5.3.6	Perform 3-D steady-state, aerodynamic simulation of aircraft engine	9/30/01
PCA6				**Demonstrate significant engineering, scientific, and educational impacts from integrated HPCC technologies**	**9/30/05**
	H6.3			Establish impact on aerospace design and operations through the demonstration of integrated systems of applications, tools, services and resources which enable the high-performance execution of interoperable aerospace applications across distributed heterogeneous testbeds	9/30/05
		C6.3.A		Document impact of improved simulation of elements of national airspace system	6/30/05
			C6.3.1	Identify and integrate into CAS plans new CAS tasks to support National Air Space needs	12/31/00
		C.6.3.B		Demonstrate impact of improved propulsion system simulation capability	6/30/05
			C6.3.2	Perform high-fidelity aerodynamic analysis of RLV propulsion system	9/30/02
			C6.3.3	Perform high-fidelity multi-disciplinary analysis of RLV propulsion system	9/30/03
			C6.3.9	Perform high-fidelity steady-state multidisciplinary analysis of aircraft propulsion system	3/30/05
		C.6.3.C		Demonstrate impact of improved aircraft simulation capability	7/30/05
			C6.3.4	Perform time accurate computation of powered-lift vehicle in landing and/or takeoff maneuver	6/30/04
			C6.3.5	Evaluate Computational Infrared Radiation (CIR) method for validating complex time-accurate aerodynamic flowfield predictions and reducing analysis time	6/30/04
		C.6.3.D		Demonstrate impact of improved space transportation vehicle simulation capability	8/30/05
			C6.3.6	Perform combined internal/external steady simulation of RSTS in ascent with RBCC in air-breathing mode (including unsteady turbopump)	6/30/04
			C6.3.7	Create optimized multidisciplinary designs of RSTS concept in descent	6/30/04

			C6.3.8	Apply MDO to RLV preliminary design	6/30/04
			C6.3.10	Demonstrate RLV design cycle improvements using integrated resource management and scheduling environment	6/30/05
			C6.3.11	Apply MDO in multicenter application	6/30/05
PCA7				**Establish sustainable and wide-spread customer use of HPCC Program technologies**	**9/30/06**
	H7.4			Establish sustained use of CAS tools and techniques towards meeting Aerospace Technology Enterprise pillars and goals	9/30/05
		C7.4.A		Demonstrate improvement in level of infusion of CAS technology into Aerospace Technology Enterprise	Annual
			C7.4.1	Survey NASA aerospace and high performance computing communities and partners to determine infusion of CAS technology	12/31/00
			C7.4.2	Demonstrate 5% improvement over previous year in level of infusion of CAS technology into Aerospace Technology Enterprise	Annual
		C7.4.B		Train future professionals in computational aerospace sciences	Annual
			C7.4.3	Support graduate and post-doctoral high-performance computing research	Annual