The Computing & Interdisciplinary Systems Office

Annual Review and Planning Meeting
October 9-10, 2002

Dr. John K. Lytle

Outline

• Vision and Objective
• General Description
• Schedule
• Customer Survey Results
• FY02 Accomplishments
• FY03 Milestones
• Future Direction
• Agenda
The Vision

Develop an advanced engineering analysis system that enables high-fidelity, multi-disciplinary, full propulsion system simulations to be performed early in the design process....

...a virtual test cell that integrates propulsion and information technologies...

To enable rapid, high-confidence, cost-effective design of revolutionary systems. (AST Goal 3: Pioneering Revolutionary Technology)

Major Elements of Virtual Testing

- Engineering Applications
  - Coupled aero-thermal-structural analysis
  - Hierarchical methods

- Component Integration
  - MD coupling
  - Zooming

- Computing Testbeds
  - Code Parallelization
  - 3-D Subsystems/System
  - 0-D engine/1-D compressor
  - 0-D core/3-D LP subsystem
  - High-speed networks
  - PC cluster
  - Distributed computing

Seamless integration of people, data, analysis tools, and computing resources

Cost-Effective

High-fidelity, large-scale simulations

Rapid

High-Confidence
NPSS Development Plan to Support Advanced Aerospace Transportation Systems

2002 CISO Review

Software Development Strategy

2002 CISO Review

Developers Kit: Tools for Integrating Legacy Code into the NPSS Engineering Environment

• CICT Information Environments
• CICT Computing, Networking, and Testbeds

3-D Prototype Simulations & Infrastructure

• CICT Grand Challenges
• Aerospace Propulsion and Power Base
• Space Transfer and Launch Technology

Software Products
NPSS V1  V 1.5

2000  2001  2002  2003  2004  2005  2006

NASA/TM—2003-211896 17
Virtual Testing
Opportunities to Impact Major National Programs

Revolutionary Turbine Accelerator (RTA)
Versatile Advanced Affordable Turbine Engine (VAATE)
Ultra-Efficient Engine Technology (UEET)
NASA Intelligent Engine

Virtual Test Capability

Programmatic Support

Fiscal Year

Revolutionary Turbine Accelerator (RTA)
Ground Demonstrators (3) Build 1 Build 2
Versatile Advanced Affordable Turbine Engine (VAATE)
Ground Demonstrator Core Engine
Ultra-Efficient Engine Technology (UEET)
High-Fidelity, Multi-Component Turbomachinery Simulation
NASA Intelligent Engine

Ground Demonstrators

Full 3-D Aero Engine MD Engine TBCC Intell. Engine

Programmatic Support

Funding ($M)

Fiscal Year

00 01 02 03 04 05 06

HPCCP - High Performance Computing and Communications (Revolutionize Civil Aviation)
APP - Aerospace Propulsion and Power (Revolutionize Civil Aviation)
ASTP - Advanced Space Transportation Program (Advanced Space Transportation)
CICT - Computing, Information, and Communications Technology (Pioneering Revolutionary Technology)
Consistent Themes from Customer Survey

- Concern over strong emphasis placed on these (rocket) capabilities at the expense of air breathing simulations

- We would be more interested in using Engineering Application and High Performance Computing tools if they were more readily deployed into our system...

- The development of this environment to support high fidelity components has not been as effective as desired.

- The current approach of trying to coalesce an approach from a variety of different, company proprietary approaches does not appear to be leading to an effective plan that benefits all NPSS members.

- Release policy prohibits widespread acceptance.
Selected FY02 Highlights

- Received two major awards
  - NorTech
  - R&D 100
- Completed prototype of first integrated 3-D aero simulation of the primary flow path of a large turbofan engine.
- Released NPSS V1.5 with visual assembly of complete propulsion system, zooming to 1-dimensional analysis, CORBA security, and rocket engine component modules.
- Demonstrated coupling objects for an object-based multi-disciplinary simulation using ADPAC and ANSYS.
- Demonstrated a 400:1 speed-up using the Lattice Boltzmann method with 500 processors to simulate a transonic compressor cascade.
- Completed a 3-D simulation (VULCAN) using distributed computing resources via CORBA over the Information Power Grid.
- NPSS Release Policy signed by NASA Headquarters.

FY03 Major Milestones

- Automate execution of the 3-dimensional engine simulation through integration with the 0-dimensional simulation
- Complete 0-dimensional models of the advanced combined cycles for the space transportation
  - Rocket-based combined cycle
  - Turbine-based combined cycle
- Complete multi-disciplinary, unsteady simulation of a turbopump for rocket engine applications.
- Complete multi-disciplinary simulation of the integrated forebody, inlet and combustor of a high-speed vehicle and propulsion system.
- Demonstrate coupling high fidelity aerospace application codes using CORBA on the Information Power Grid.
- Develop data translation and system solver objects supporting multi-component simulations
- Implement commercialization space act agreements for NPSS V1.X
Future Directions

- Despite substantial funding reductions in FY 02, NASA will continue to invest in an advanced engineering environment for propulsion.
- Increased emphasis on completing Developers Kit to bring in high-fidelity, multi-disciplinary analysis tools.
- Identify and cultivate commercialization opportunities for NPSS V1.x
- Work through the Propulsion System Technical Committee to address issues associated with reduction in support for Aeronautics applications. Need Executive Committee Help.
- Establish stronger partnerships with related Programs
  - DOE Accelerated Strategic Computing Initiative
  - DOD Versatile Affordable Advanced Turbine Engine Program
  - NASA Ultra-Efficient Engine Technology Program
  - NASA Advanced Space Transportation Program

Propulsion System Technical Committee

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<tr>
<th>Name</th>
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<td>Mr. Ted Exley</td>
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Agenda

- Simulation Environment
- Engineering Applications
- Cost-effective Computing Testbeds