# The Computing & Interdisciplinary Systems Office

## Annual Review and Planning Meeting
October 9-10, 2002

## Information Environments

**Gregory J. Follen**
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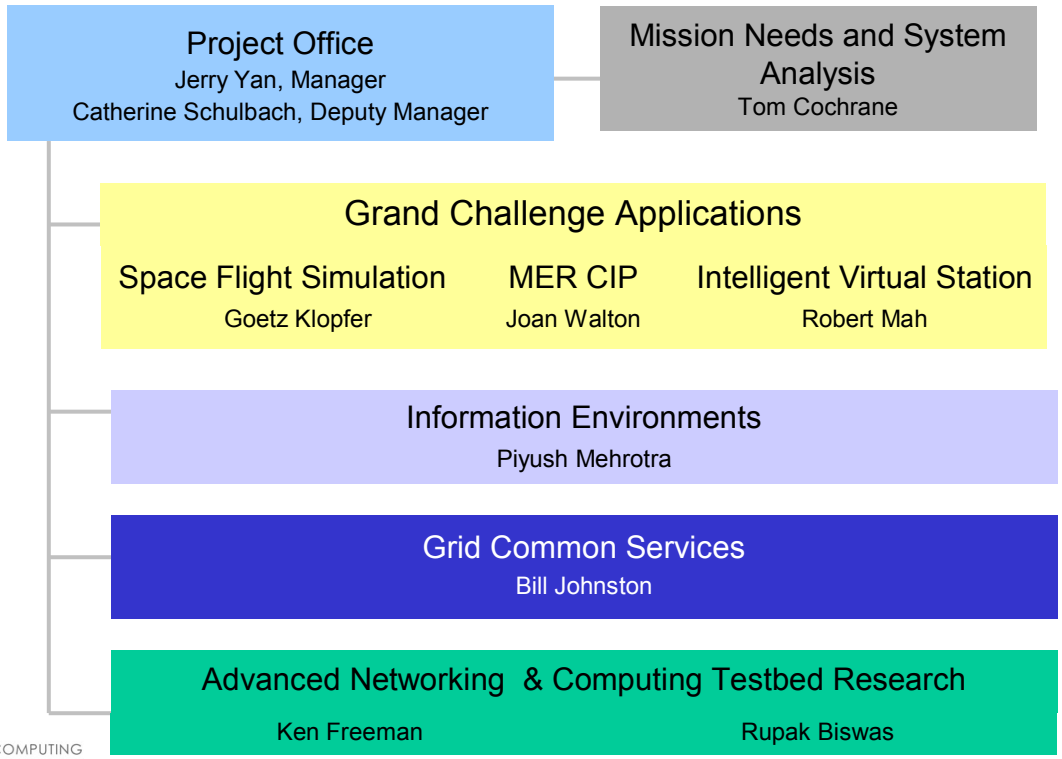
Agenda:

- CNIS organization
- NPSS V1.5 milestone
- FY'02 milestones accomplished
- Status of Information Environments
- FY'03 plans

# CNIS - Organization

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# Information Environments

The **objective** of GRC CNIS/IE work is to build a plug-n-play infrastructure that provides the Grand Challenge Applications with a suite of tools for coupling codes together, numerical zooming between fidelity of codes and gaining deployment of these simulations onto the Information Power Grid. The GRC CNIS/IE work will streamline and improve this process by providing tighter integration of various tools through the use of object oriented design of component models and data objects and through the use of CORBA (Common Object Request Broker Architecture).

**Approach:**

Interface Layer
Assembly of the simulation, this could be simple to sophisticated. It defines the order of execution, linking of components, and validity check of components.

Execution Layer
Startup, control, shutdown of simulations, events, provide batch to command switching with strong ties to the generic needs of the Grand Challenge Applications.

Simulation Services Layer
Initially, this layer will be populated with objects/agents to provide security of data, coupling infrastructure, zooming infrastructure, visualization, temporal data storage, portals for collaboration. The Simulation Services layer ends up closest to Grid Common Services.

Programming Services
Best practices in developing a stable, accurate, repeatable simulation. Definitions of expected simulation behavior. Automated Tools for wrapping code, data parameter extraction and movement.

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# Information Environments –FY02 Milestones

**Demonstrate the Visual assembly of a complete aerospace propulsion system with 1 Dimensional zoomed analysis. 2nd QY 2002**

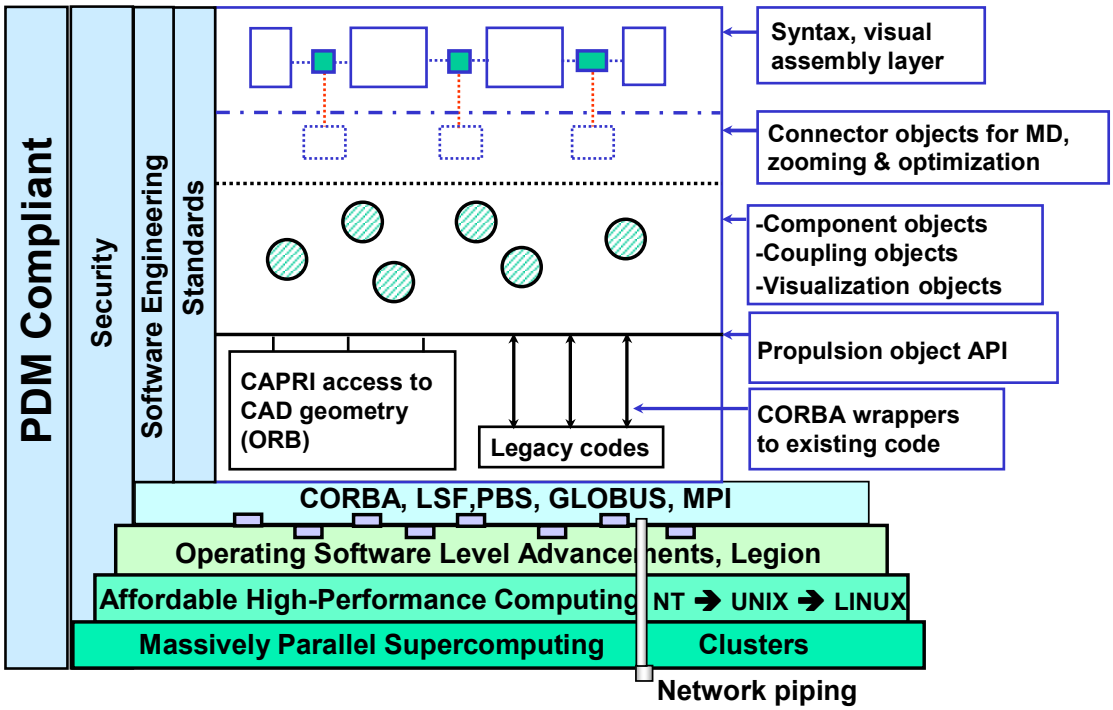
**Develop a mechanism for component based models to read/write standard formats such as XML/HDF/CCA/CGNS. 4th QY 2002.**

**CORBA wrap the Information Power Grid Services , meta-computing directory services (MDS), resource management (GRAM) and access to secondary storage (GASS supporting a zoomed propulsion parameter study. 4th QY 2002.**

**Demonstrate coupling objects for an object-based multidisciplinary simulation using ADPAC, ANSYS. 4th QY 2002**



# Information Environments - Object-Oriented Architecture

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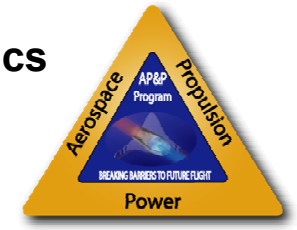
# NPSS 1.5.0W Release Highlights


- **Space Transportation Components & Capabilities**
- **New/Enhanced Engineering Components**
- **Improved Socket Design**
- **Enhanced CIAPP Development Kit**
- **CIAPP CORBA Server Mode**
- **Initial Visual Based Syntax Capability**
- **Plug-n-Play Thermo**
- **Enhanced Customer Deck**
- **Enhanced Solver: Discrete State Variables, Constraints**
- **Enhanced C++ Converter, Autodoc, Message Handler**
- **Unit Conversions**
- **NT Port**
- **Linear Model Generation**



# NPSS 1.5.0W Release Statistics




Active CRs = open, assigned, scheduled, ready_test, and ready_merge states
Finished CRs = built and closed since V1.0.0 released (March '00).

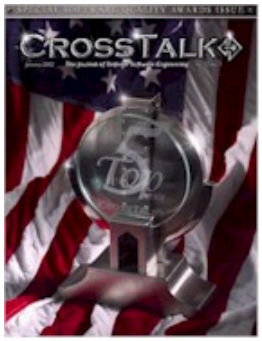
| DEFECTS | | ENHANCEMENTS | |
|---|---|---|---|
| Active | 291 | Active | 84 |
| Finished | 310 | Finished | 117 |
| Deferred | 34 | Deferred | 19 |
| Rejected | 3 | Rejected | 0 |
| Total DEFECTs | 638 | Total ENHANCEMENTs | 220 |

REQUIREMENTS
Active CRs (REQs) 11 (cover 20 reqs)
Finished since 3/00 25 (cover 43 reqs)

Total REQs 36 (cover 60 reqs)*
* 1 REQ covered 12 VBS reqs.
NOTE: Total aero & space SRS reqs = 193

| | |
|---|---|
| Total Active CRs | 386 |
| Total finished since 3/00 | 452 |
| Total Currently Deferred | 53 |
| Total Currently in Rejected State | 3 |
| TOTAL Version 1.5.0W CRs | 894 |

## Award Winning Software




- **Finalist to *CrossTalk: The Journal of Defense Software Engineering* TOP Software Projects for 2001 (top 16 out of 87 entries)**

- **2002 NorTech Innovation Award Winner**

- **2002 R&D 100 Award Winner**

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## NPSS V1.5+ current usage

•Georgia Institute of Technology: specifically the Aerospace Systems Design Laboratory of the School of Aerospace Engineering, is using the NPSS software strictly for NASA contract work for the Ultra Efficient Engine Technology Program.

•Rolls-Royce plc: (in Bristol, England), under contract to Pratt & Whitney for the Joint Strike Fighter LiftFan (R), will probably present LiftFan (R)aerodynamic performance to Pratt & Whitney in the form of NPSS input. Rolls-Royce Corp. (in Indianapolis) will assist Rolls-Royce plc in this event.

•GEAE:Besides GP7000, we are currently using it for selected PD/new engine studies and are using it to support the CF34-10, our latest commercial engine certification program. The support work and test data analysis for the recent CF34-10 first engine to test (FETT) was done using NPSS. We have trained over 50 people on NPSS and will have trained more than 80 people by the end of the year. We are in the process of migrating some current models and all of our future engine performance simulation work to NPSS.

•Boeing: We have used NPSS to model two systems that contain fuel cells. NPSS is lacking in many of the components needed for this type of simulation, but elements are fairly easy to construct using the interpreted code which is a plus for these kind of studies. Both GE and P&W have delivered sample models preliminary to models later this year for the sonic cruiser program.

•DRFC: Long term plan is to eventually use NPSS to analyze ram/scramjets, RBCC, and TBCC propulsion systems that we might flight test here in Dryden. I also might need to use it to analyze rockets, as we spool up a small rocket flight test capability here. We are looking at solid-fuel rockets, but we will probably look at liquid-fuels as well as hybrids.

•PWFL: We are currently involved in the process of validating NPSS for use in modeling liquid rocket engines (NASA SLI via P&W / AEROJET COBRA engine) and for use in modeling Hypersonic engines (ISTAR) here at Pratt & Whitney Space Propulsion.

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# NPSS V1.5 current usage

•FTT has been using NPSS for almost a year now, primarily in support of advanced DoD programs in the Air Force and Navy. FTT has also been evaluating NPSS as regards application to industrial gas turbines, electric power plants, and chemical process facilities. Our future intentions for use (provided a continuing agreement for NPSS usage is obtained from NASA)include expansion of these activities to additional programs in military and civilian aviation, power systems, and process industries, and eventual integration of NPSS into the design process at FTT.

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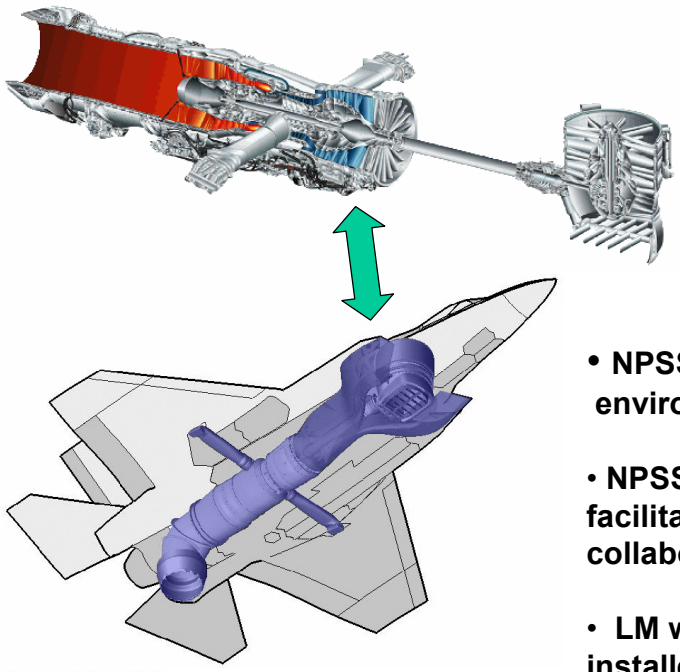
## Lockheed Martin Utilizing NPSS to integrate propulsion simulations of PW and GE engines into the F-35 Joint Strike Fighter



**Pratt & Whitney F135**
**General Electric F136**

- **NPSS will allow a common modeling environment between all JSF partners.**
- **NPSS Component based architecture facilitates the JSF STOVL variant collaborative propulsion system.**
- **LM will be transitioning to total NPSS installed engine performance models in 2003.**

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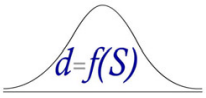
## NPSS/Linear Model Generator

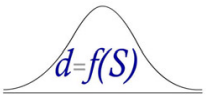



- What
  - Linear Models relate changes in selected State Derivatives and output variables to changes in the corresponding States and selected input variables.
  - Linear Model represented by 4 sensitivity matrices, referred to as the ABCD matrices, that contain these sensitivities.

- Why
  - Provides characteristic response data to control design tools
  - Provides individual Linear Models that collectively represent a piece-wise linear model of an engine.



## NPSS/Linear Model Generator




- How
  - Validate against P&W SOAPP generated linear model of the same engine.
  - Number match not exact due to small differences between SOAPP and NPSS non-linear models.
  - Matlab analysis shows responses of the SOAPP and NPSS linear models are essentially identical.

- Status
  - Initial version completed and release.

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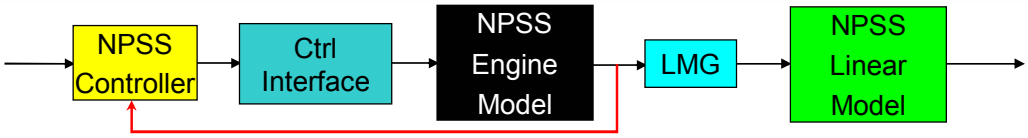
Tasks for 2002

- Setup NPSS in SimLab. Completed
- Deliver 90K NPSS Engine model to Controls Group. Completed
- Develop and Validate linear/non-linear XTE46 NPSS Models. Near Completion
- Establish Initial Communication between NPSS and MatLab. Completed
- Incorporate Simple Controller with NPSS. Completed

## NEAR-TERM TASK GOALS

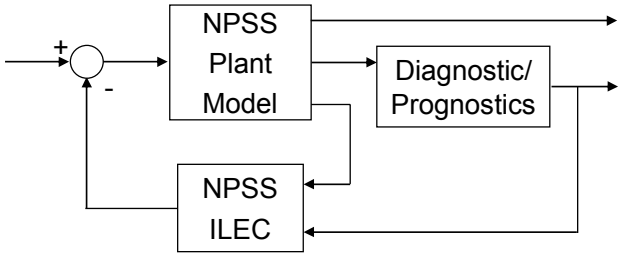
- Develop NPSS controller interface Completed
- Give NPSS the ability to model 1-D transients.
- Develop a Linear Model Generator (LMG) Completed




NPSS Plant Model

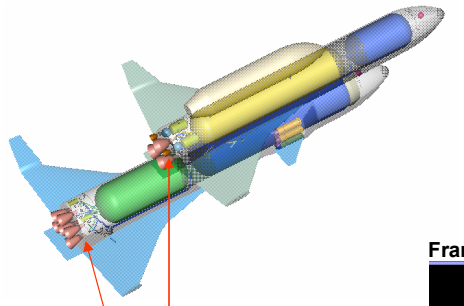
ECS WBS 2.2.5 Subsystem Model Integration Methods
L5: Propulsion Subsystem Performance Modeling

## LONG-TERM TASK GOALS



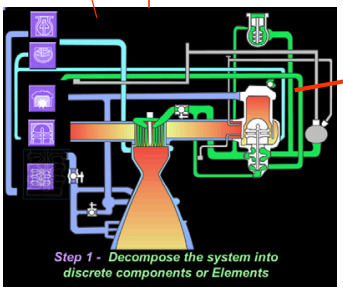

- Add health monitoring parameters and diagnostic/prognostic capability.
- Add life models to NPSS model.
- Use NPSS with updated capability to develop and validate Intelligent Life Extending Control (ILEC).

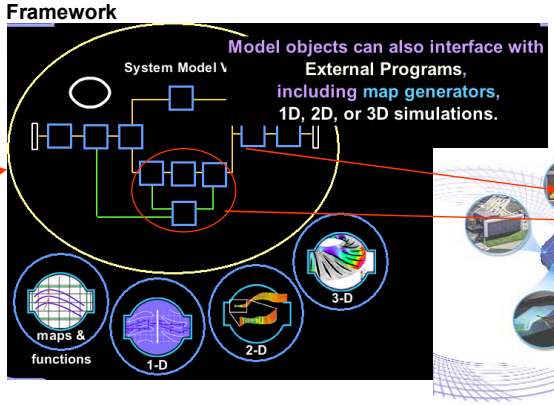
# NASA/GRC – CNIS Framework for Grid Enabling of Multi-Discipline & Multi-Fidelity Aerospace Simulations



Demonstrates the use of the CNIS Framework for Grid Enabling of High Fidelity modeling for space propulsion simulations.

Framework




Grid Computing

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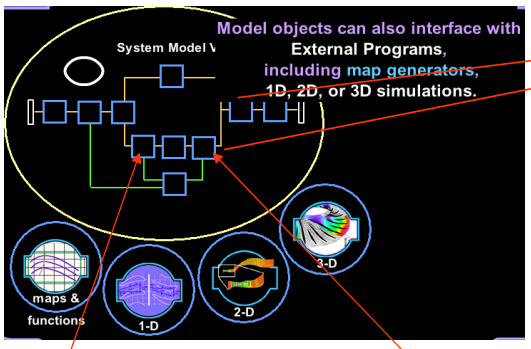
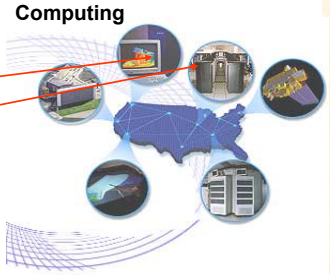
# NASA/GRC – CNIS Framework for Grid Enabling of Multi-Discipline & Multi-Fidelity Aerospace Simulations

**Demonstrates the use of the CNIS Framework for coupling ANSYS and HAH3D analyses of a MSFC Pump design.**

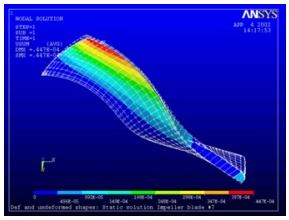
Framework

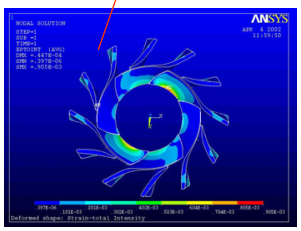


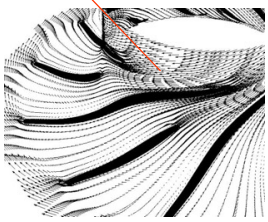

Grid Computing

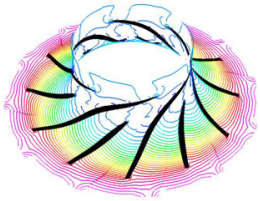


Pump Impeller Deflections Resulting from Rotational and Pressure Effects





Velocity Vectors/Pressure Contours Impeller Fluid Solution

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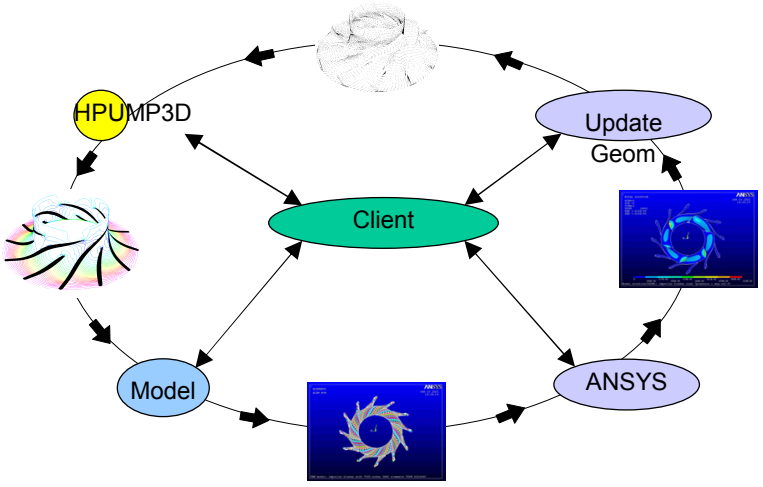
# Coupling between HPUMP3d and ANSYS under CORBA Development Kit

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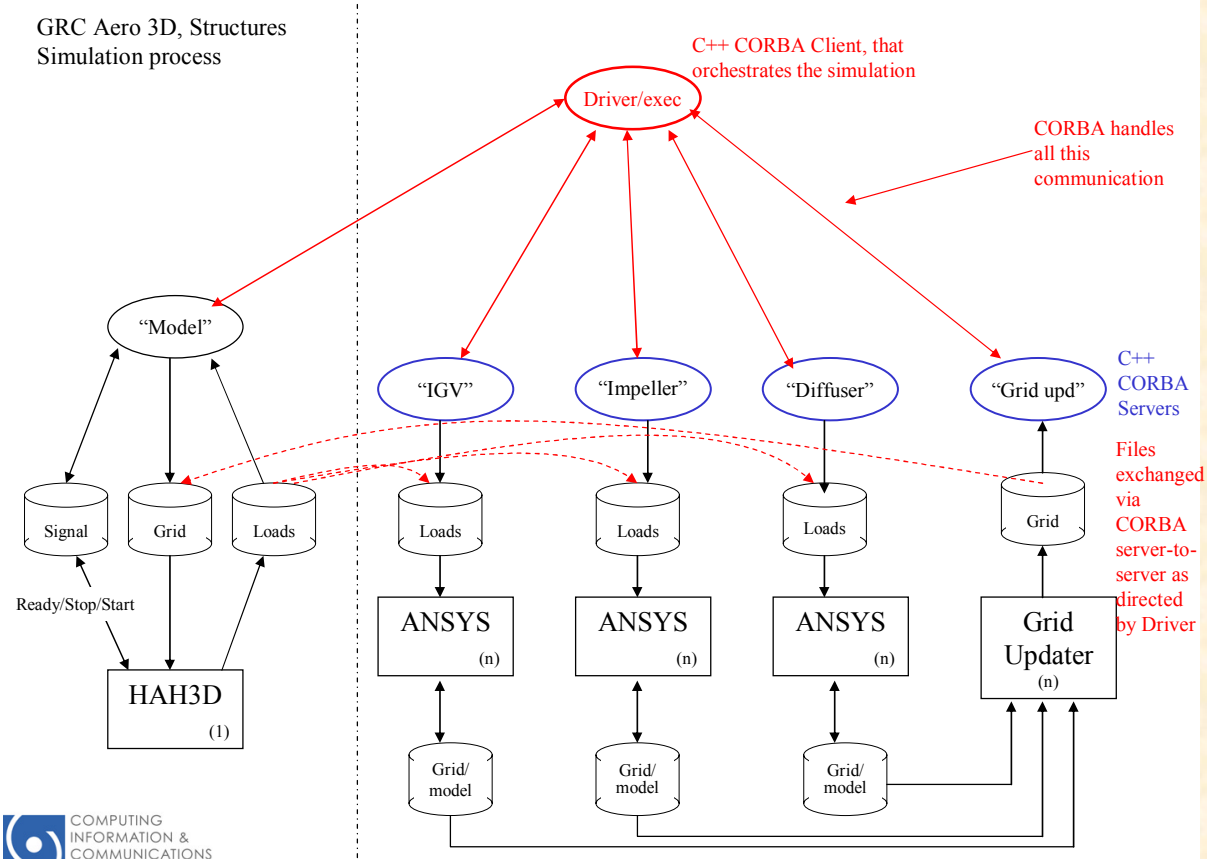
GRC Aero 3D, Structures Simulation process

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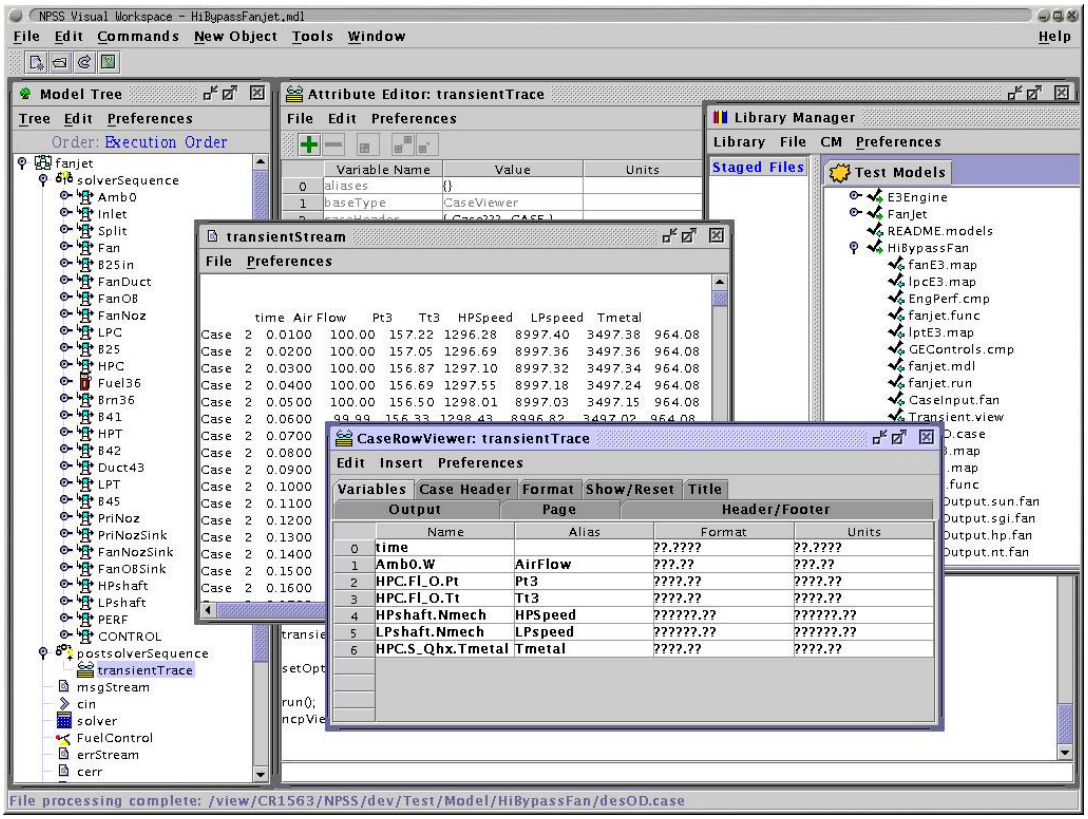
(n) – means multiple times called

# Information Environments - Visual Assembly

- First release with NPSS version 1.50
- Object editor framework, with CaseRow, CaseColumn and VarDump Viewer editors
- Preferences Editor
- Library Manager
- Printing
- Alternate NPSS Interface (non-CORBA)
- GUI for solver setup



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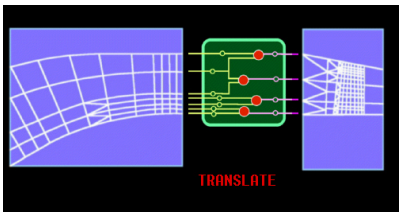
# I.E. - Development Kit FY02 Accomplishments




**Overall**

**- Linux port - New Sun compiler port - MICO port for all platforms except NT (requires patched MICO 2.3.7) - Unified IDL: now server mode can be external component (no ports), and includes file transfer support. - 3rd party file & variable transfers. HDF capability added to VOB.**

**CCDK developments in VOB**

*** - Higher fidelity support in a separate deliverable (HiFi.tar.gz)* - PUMPA is now a separate deliverable (CCDKrockets.tar.gz)* - C++ standalone client support includes Prof. Sang's caching scheme, support for all array types. - New CORBA security technique incorporated, but not tested with a secure ORB. (update of Tammy Blaser's code)**

**CCDK developments not in VOB**

**- BRSTK component - ptyWrapper tool (from last year, but now portable and in standard build form) - Simple indirect wrapper support, 'file signaling' wrapper support.**

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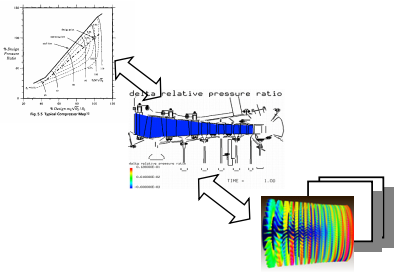
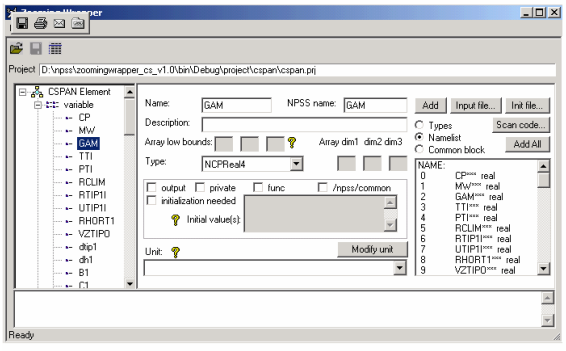
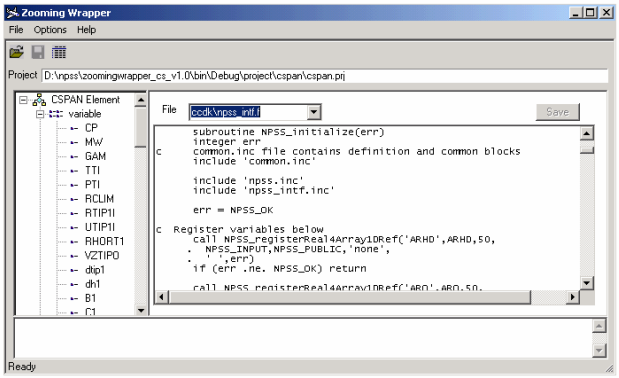
# I.E. - Development Kit FY02 Accomplishments

## Zooming & CORBA Wrapping




- **A GUI based tool to aid in the wrapping of DLM's and CORBA elements is being developed.**

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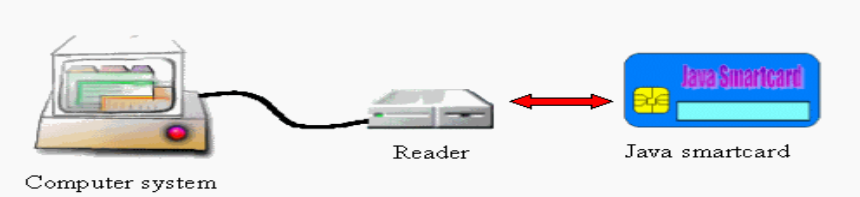
# I.E. - Development Kit FY02 Accomplishments
# CORBA Security, Smart Card Prototyping

CNIS Smart Card High Level Architecture Based On JavaCard Technology






# I.E. - Development Kit FY02 Accomplishments
# CORBA Security, Smart Card Prototyping

CNIS Prototyping using JavaCard And Biometric Devices


Development JavaCard
EEPROM 18K


Main Development JavaCard
Common Criteria EAL 5+
FIPS 140-1
EEPROM 57K

Biometrics fingerprint smart card
reader for C & C++ developments
EEPROM 8K (Learning Tool)

Development JavaCard
EEPROM 28K

Development JavaCard
with pre installed Java PKI
digital certificate applet
EEPROM 21K

Biometrics fingerprint smart card (JavaCard) reader
with preinstalled Java Bio applet (On Order)

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# I.E. - Development Kit FY02 Accomplishments CORBA Security, Smart Card Prototyping

- **Development Approach: Use JavaCards technology to develop web based cryptographic prototypes to support:**
  - Generation of key pairs on a card, Store X.509 certificates on a card
    - X.509 most widely used standard (International Telecommunication Union (ITU) recommendation) for defining a digital certificate
  - Use private key for digital signing of an electronic document and encryption/decryption of messages
  - Use certificates to authenticate CNIS card holder users for access to CNIS distributed Web Services and Applications
    - Simple Object Access Protocol (SOAP) and Extensible Markup Language (XML) based Web Services and Globus Web Services
  - Common Object Request Broker Applications (CORBA) Applications
  - Experiment with porting JavaCard applets to various operating system environments (Win2K, Linux, Solaris) by leveraging off of open standards
- **Future Plans:**
  - Integrate JavaCard prototype efforts with biometric fingerprint devices
  - Integrate prototype with Organization for the Advancement of Structured Information Standards (OASIS)
    - Integrate enterprise technologies Security Assertion Markup Language (SAML)
  - Integrate Entrust compatible on card X.509 Rivest, Shamir and Adleman asymmetric algorithm (RSA) Personalization
  - Integrate CNIS web services and CORBA applications to include delegation security models
  - Demonstrate multiple applet JavaCard configuration supporting multiple card holder (user) authorized tasks



# I.E. - Development Kit FY02 Accomplishments CORBA Security, Smart Card Prototyping

- **Significance:**
  **In order to support NASA's heterogeneous computing base a generic smart card prototype architecture design is being developed …**
  - The prototype will consist of a profile driven set of generic authentication JavaCard applets
    - User's ONE JavaCard can be used at various different computer platforms to do different authorized tasks
  - JavaCard development is a technical leveraging point to implement wireless security.
  - Entrust Personalization supports NASA Certificate Authority (CA) signing
    - Allows integration crossover from CNIS JavaCard research to NASA JavaCard deployment.
  - BIG ENCHALOTA: Future development will include multiple-factor authentication by combining techniques
    - Biometric (something users are)
    - Digital certificates and/or SecurID (something users have)
    - PIN (something users know)

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# I.E. - Development Kit FY02 Accomplishments
# CORBA Security, Smart Card Prototyping





Why JavaCards? Prior to smart cards or JavaCards, Public Key Infrastructure (PKI) storage and processing of cryptographic keys was a very challenging task to keep the private keys safe. JavaCard technology also supports platform independence; prior authentication devices are unique designs. JavaCards also provide application growth with its support for secure multiple applet development.



# I.E. - Development Kit FY02 Accomplishments
# CORBA Security, Smart Card Prototyping


- **Digital certificate generation and storage on JavaCard**
  - **Commercial CA and self signed on card X.509 RSA Personalization (initial phases)**
  - **Entrust compatible on card X.509 RSA Personalization signed by NASA Ames CA (future phase)**

- **Secure communications channel between JavaCard and CardTerminal Manager using X.509 RSA Authentication, Data Encryption Standard (DES) Integrity, DES Confidentiality**
  - **CardTerminal Manager (Card Issuer Management)**
  - **PIN and X.509 card holder authentication (initial phase)**
  - **Fingerprint card holder authentication (future phase)**
  - **Uses digital certificate on JavaCard**
  - CNIS User PKI Authentication Applet

- **Delegation management between JavaCard and CardTerminal Application (Client or Server) using token driven X.509 RSA certificates and DES encryption/decryption**
  - **Ensures that the files being transmitted to the JavaCard and the applications being installed upon a JavaCard by an entity other than the card issuer (i.e. CardTerminal Application Client or Server) has been previously "Authorized" by the card issuer (i.e. CardTerminal Manager).**
  - **Uses CNIS User PKI Authentication Applet**
  - **Delegation Applet**

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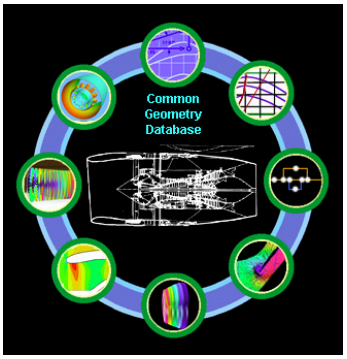
# I.E. - Development Kit FY02 Accomplishments
# CORBA Security, Smart Card Prototyping

- **SSL or CORBASec session between "Authorized" CardTerminal CORBA Client and "Authorized" CardTerminal CORBA Server using on card secure applets (future phase)**
  - **Uses CNIS User Authentication Applet**
  - **Uses Delegation Applet**
  - SSL CORBA Applet
  - CORBASec Applet
- **SSL session between "Authorized" CardTerminal Web Service Client and "Authorized" CardTerminal CORBA Server using on card secure applets (future phase)**
  - **Uses CNIS User Authentication Applet**
  - **Uses Delegation Applet**
  - SSL Web Service/CORBA Applet
- **Secure SAML session between "Authorized" CardTerminal CORBA Client and "Authorized" CardTerminal CORBA Server using on card secure applets (future phase)**
  - **Uses SSL CORBA Applet Development**
  - Secure SAML CORBA Applet
- **Secure SAML session between "Authorized" CardTerminal Web Service Client and "Authorized" CardTerminal CORBA Server using on card secure applets (future phase)**
  - **Uses SSL Web Service/CORBA Applet Development**
  - Secure SAML Web Service/CORBA Applet



# I.E. - Development Kit FY02 Accomplishments

## CAD Services V 1.0, A CORBA Interface for Geometry Information Sharing

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# I.E. - Development Kit FY02 Accomplishments

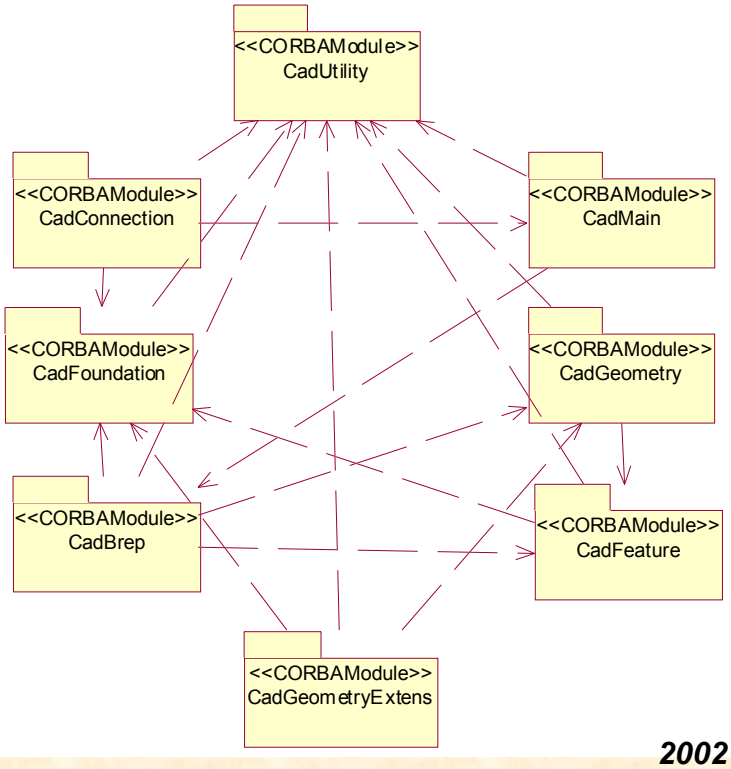
## CAD Services V 1.0, A CORBA Interface for Geometry Information Sharing

### Features

- Geometry and topology queries for both manifold and non-manifold geometries
  - Tessellated representation and point queries
- Parametric regeneration of solid models
- Tagging geometric entities with application-specific information
- Geometry creation



## CAD Services V 1.0 Modules




COMPUTING INFORMATION & COMMUNICATIONS TECHNOLOGY
*2002 CISO Review*

# I.E. - Development Kit FY02 Accomplishments

## Current Status

June 28, 2002 CAD Services Standard made "Available"
By Object Management Group – highest level of standard

- **CAD Services commercial software available soon**
  - **ITI TranscenData (available now- built on CADscript)**
  - **Unigraphics (available next year)**
  - **Catia (?)**
- **Open Source Implementation**
  - **OpenCASCADE (http://www.opencascade.org/3dwb/cadservices)**
    - **(beta available now – email: m-kazakov@opencascade.com )**
    - **Full commercial version early next year**
- **Future Efforts:**
  - **Solid Modeling RFP to be released Oct. 2002**



# Information Environments – Milestones FY03-FY05

| | | | | |
|---|---|---|---|---|
| | Develop data translation and system solver objects supporting multi-component simulations. | Couple ANSYS, HPUMP3d using translation methods. | Sep-03 | GRC |
| | Develop a Visual Assembly capability to allow the assembly, coupling of high fidelity codes for distributed systems. | AssembleANSYS, HPUMP3D into a simulation using Visual tool. | Sep-03 | GRC |
| | Develop the object middleware to setup a simulation, start/stop servers, component codes, and simulation application | Start and stop a code such as CIAPP coupled with ANSYS, HPUMP3D | Sep-03 | GRC |
| | Develop a grid aware application API definition for GCA | Deploy the Vulcan or Hah3D code on the Grid using the API | Sep-04 | GRC |
| | Develop a web-enabled visual assembly capability for coupling codes over a distributed system. | Assemble Vulcan and Overflow into a simulation using Visual tool. | Jun-04 | GRC |
| | Develop multiple cross-dimensional data translation methods to support multi-fidelity component models automated reasoning features, celestial networks. | Couple at least two aeropropulsion CFD codes (ie ANSYS, HAH3D, VULCAN) using translation methods. | Sep-04 | GRC |
| | Extend Visual Assembly capabilities to include sensory interface | Assemble 3Dimensional CFD (ie Vulcan and Overflow) into a simulation using Visual tool. | Sep-05 | GRC |
| | Develop the infrastructure allowing a mixed Dimensional, Aero/Thermal/Structural CFD Propulsion System Simulation incorporating wireless sensor input deployed over a Celestial/Terrestrial Information Power Grid (IPG). | Deploy a simulation using mixed fidelity CFD (ie CIAPP, ANSYS, and Vulcan) over the IPG. | Sep-05 | GRC |

# Summary & Takeaways

- **Information Environment (IE) focus is on Coupling, Zooming, Wrapping and, in general, the building of the CORBA Development Kit for Grand Challenge Applications over the Information Power Grid.**
- **FY'02 has been a transition year that has begun to move away from the 0-Dimensional focus toward the object middleware to deploy higher fidelity simulations securely over the Information Power Grid.**