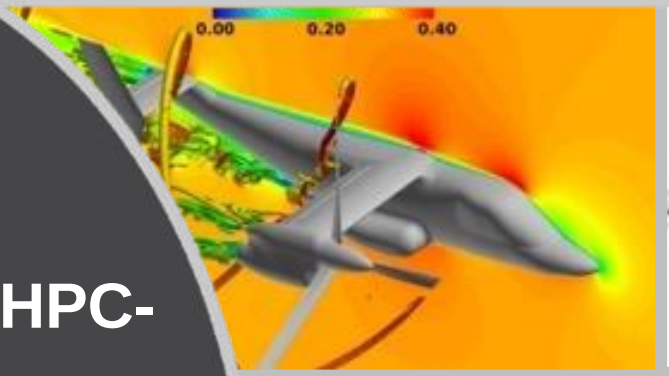
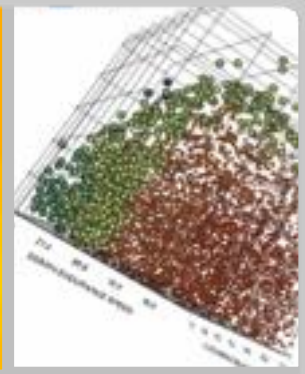
Unique Public-Private Partnerships Provide HPC-Enabled, High-Fidelity Design and Analysis Techniques for Industry Engineering Teams that Speed Development





- **Justin W. Foster, PhD**
  Research Mechanical Engineer
  Army Engineering Research & Development Center
  Information Technology Laboratory

US Army Corps of Engineers

ERDC
ENGINEER RESEARCH & DEVELOPMENT CENTER

Overview

ERDC – ITL Who We Are

- Overall Mission and Business Areas
- Our People
- Our Facilities

Public-Private Partnerships Business Model

- HPC Hardware Resources
- HPC Administration, Engineering, and Software Support
- Contracting Mechanisms

Success Stories

- DARPA CRANE
- AFRL EXPEDITE

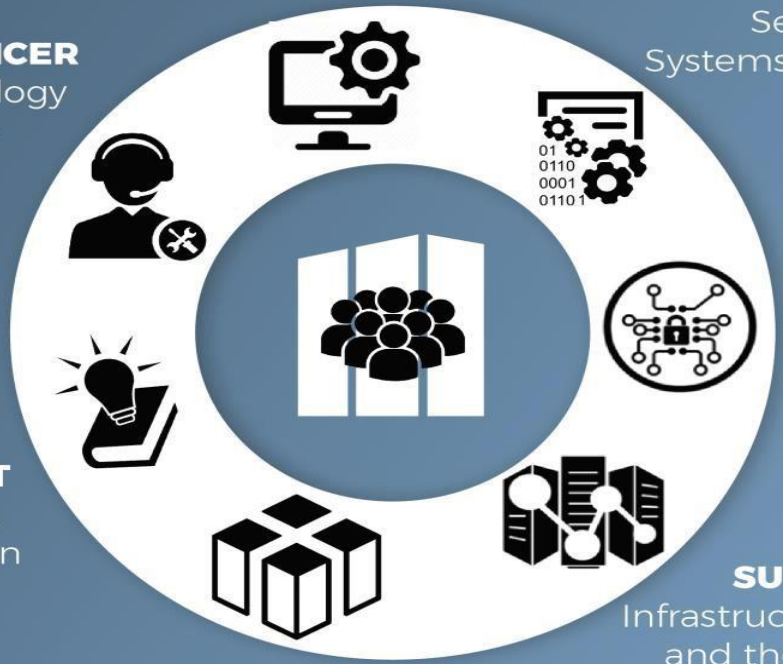
ERDC
ENGINEER RESEARCH & DEVELOPMENT CENTER

ITL INFORMATION TECHNOLOGY LABORATORY

DISCOVER, DEVELOP, AND DELIVER *ADVANCED* COMPUTING SOLUTIONS

OFFICE OF THE CHIEF INFORMATION OFFICER
ERDC Information Technology Oversight and Support

ENTERPRISE SOFTWARE SOLUTIONS
Mobile, Web, and Desktop



COMPUTATIONAL SCIENCE AND ENGINEERING
Sensors, Data Analytics, Systems Engineering, and Software

KNOWLEDGE MANAGEMENT
Research, Editing, Publishing, and Information Administration

CYBERSECURITY
Assessments, Analytics, Monitoring, and Penetration Testing

WORLD-CLASS COMPUTING FACILITIES
Secure Computing Facility and 20,000 Sq. Ft. of Raised Floor Space

SUPERCOMPUTING
Infrastructure, Data Visualization, and the Fastest Unclassified Supercomputer in the DoD

CENTERED AROUND OUR 350+ DEDICATED PROFESSIONALS

Our People

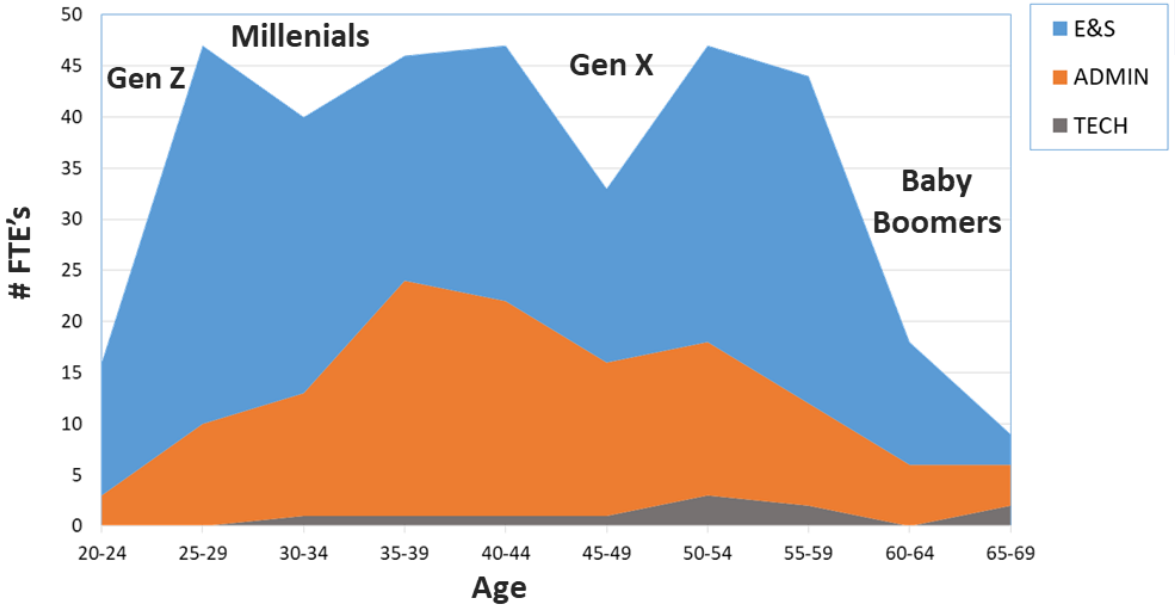
OUR PEOPLE – THE SOURCE OF OUR STRENGTH

355 Strong

63% E&S

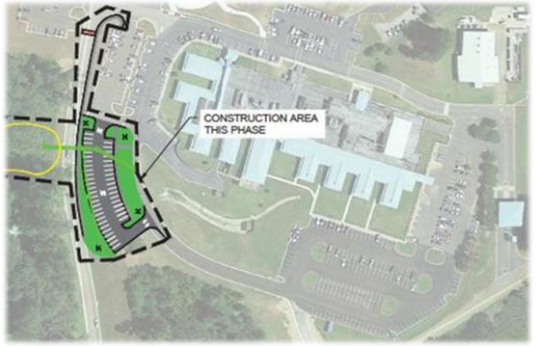
44% Advanced Degrees

23% E&S PhD



ITL Facilities

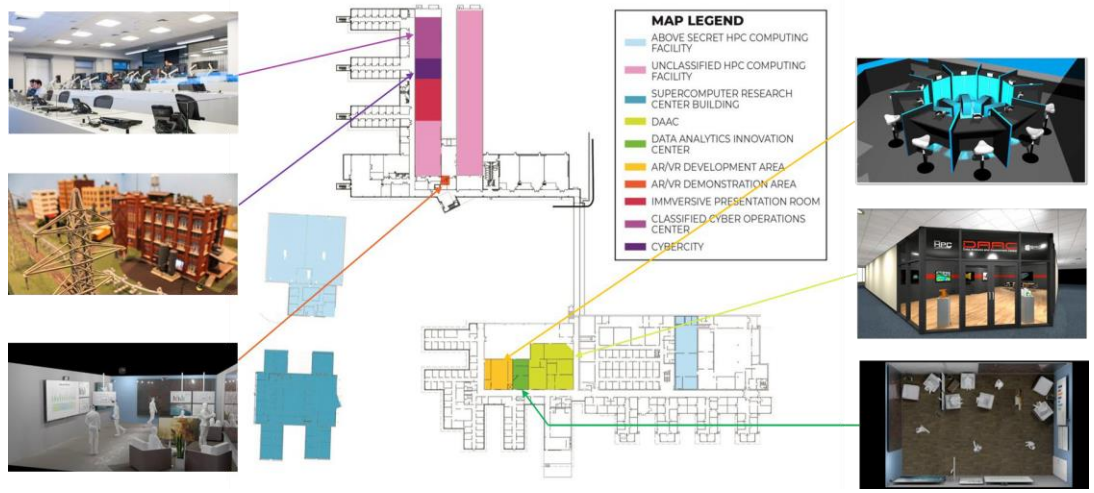
- Centralized, new state-of-the-art facilities
- Collaborative environment
- 29,000 sq ft, raised-floor computing space
- 8,000 sq ft conference center
- Access to 5 networks with top speed of 40Gbps (2 Unclassified, 2 Secret, 1 Top Secret)
- Additional 10,000 sq ft of raised floor space increasing classified and unclassified supercomputing capabilities



Secure Computing Facility

Supercomputing Research Center

Future Infrastructure



ERDC ITL HPC Hardware Overview

ERDC controls & maintains several large-scale HPC machines

- Available as Government Furnished Equipment to DoD
- Offered as a **dedicated** 24/7 resource
- Can be scaled/sized to meet particular needs
- No waiting in shared queues!
- Available to DoD Contractors during program PoP
- Several levels of support available

UNCLASSIFIED Resource

System: SGE ICE-X

- 150k+ cores with 36 cores per node
- 128GB shared memory per node
- 4x FDR InfiniBand with Enhanced LX Hypercube
- PBS Pro queueing system
- Accessible through Defense Research &Engineering Network (DREN)
- OS: CentOS

CLASSIFIED Resources

System: SGE ICE-X

- Similar specs to UNCLASSIFIED resource
- OS: SLES 11
- Customizable to SAP/SAR specs if necessary
- Accessible through Secure Defense Research &Engineering Network (SDREN)
- Also accessible by private network if necessary

ERDC ITL HPC Support Overview

Sys Administration/Computer Science Support

ERDC-ITL Provides all Systems Administration

- Hardware and OS Maintenance & Support
- User Account Creation/Vetting
- Access Controls, IP/Data Protections, Etc.
- License Server access & maintenance

ERDC-ITL Also Provides CS Support as Necessary

- Software Support Includes:
  - Government, Academic, Commercial, Open-Source, and Proprietary owned software packages
  - Compiling, Installation, Testing, Scaling, etc.
- Parallelization and Scaling
- General Scripting for Efficient HPC Usage
- Overall Ease of HPC Experience
- You are not on an island, help is here

Engineering Technical Support

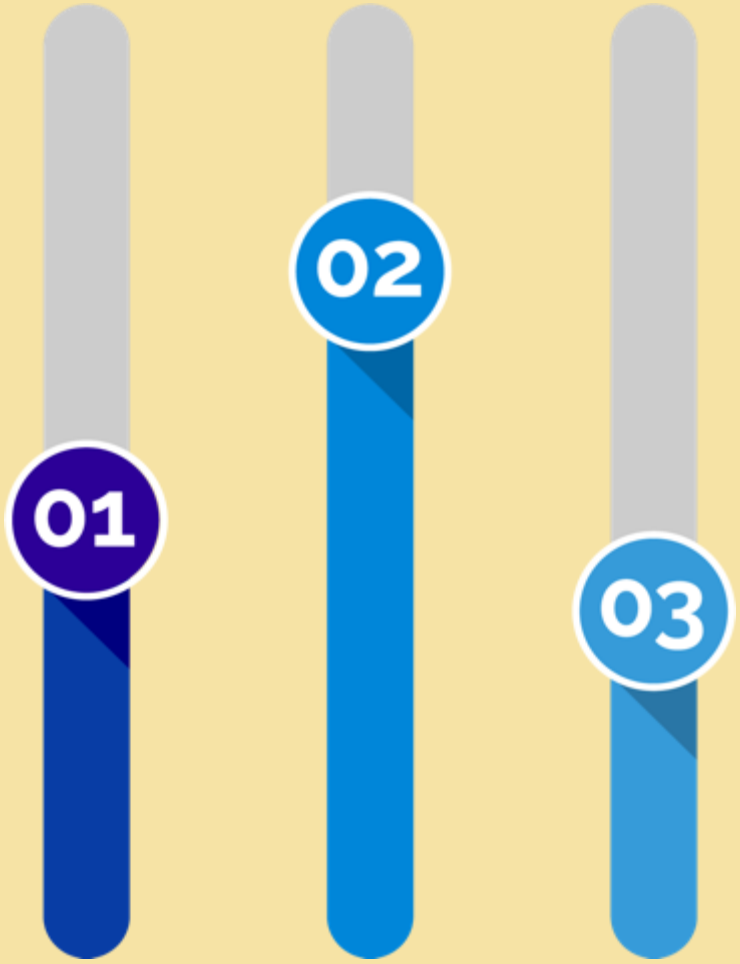
Wealth of Experience in Digital Modeling/Engineering

- CAD Model Building and Meshing
- High Fidelity Modeling Using CFD/FEA
- Multidisciplinary Design Analysis & Optimization (MDAO)
- HPC Workflow Automation for MDAO
- Physics-Informed Machine Learning
- Familiarity with Large Number of Government and Commercial CFD/FEA Software Tools

Strong Background in Data Visualization/Analysis

- Efficient Post-Processing of “Big Data”
- Developing AI/ML Networks for Data Analysis
- Optimization and Dimension Reduction at HPC Scales
- Utility Servers Support Visualization of Large Data
- Support for “off-the-shelf’ Python, R, etc. Data Visualization Packages

Getting ERDC Involved



Contracting Mechanisms Include:

- **Gov-to-Gov MIPR on Behalf of Controlling Program Office**
- **CRADA Between ERDC and Industry Partners**

01 SUPPORT

ERDC can supply labor for systems administration, engineering, software, and user support as needed for a given program

02 HARDWARE

ERDC can supply the needed DoD supercomputing resources at all classification levels – unclassified, secret, and top secret. Rates are quoted on a $/CPU-hr basis

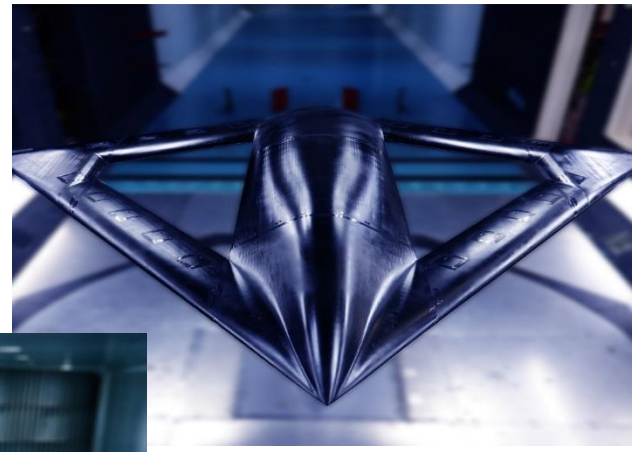
03 SOFTWARE

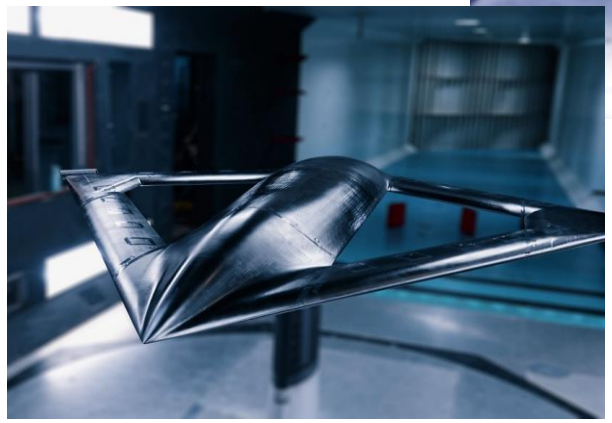
ERDC has the ability to support government-owned, commercial, academic, open-source, and industry proprietary software

ERDC HPC Support for DARPA CRANE

ERDC HPCs Leveraged to Support 4 Industry Contractors Concurrently

- CRANE Performers Include
  - BAE Systems
  - Aurora Flight Sciences
  - Lockheed Martin
  - Georgia Tech Research Corporation
- Created ~30 Industry User Accounts
- Provided over 250M CPU-hrs to Date
- Required Access to US & UK Citizens
- Heavy Utilization of Both Resources & Support





Increased Productivity Output Over Standard Practices

- Allowed for 2-5X output in high fidelity simulations
- Stored 100s of TBs of output data for post-processing
- Increased capacity and fidelity for single simulation studies
- Enabled overall better conceptual designs to eventually move downstream

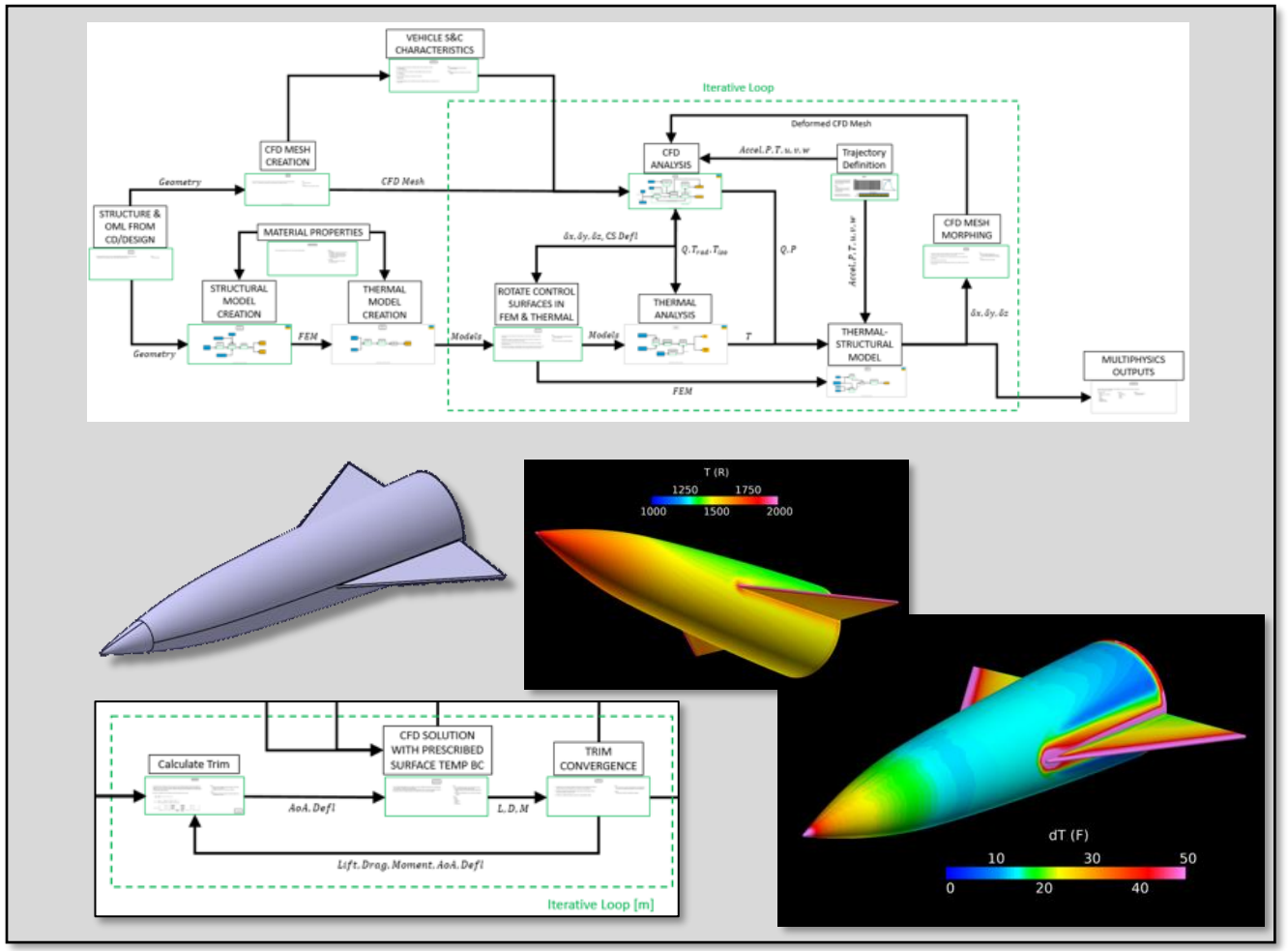
AFRL/ERDC/Lockheed Martin EXPEDITE Partnership

ERDC HPCs Used for Hypersonics Analyses

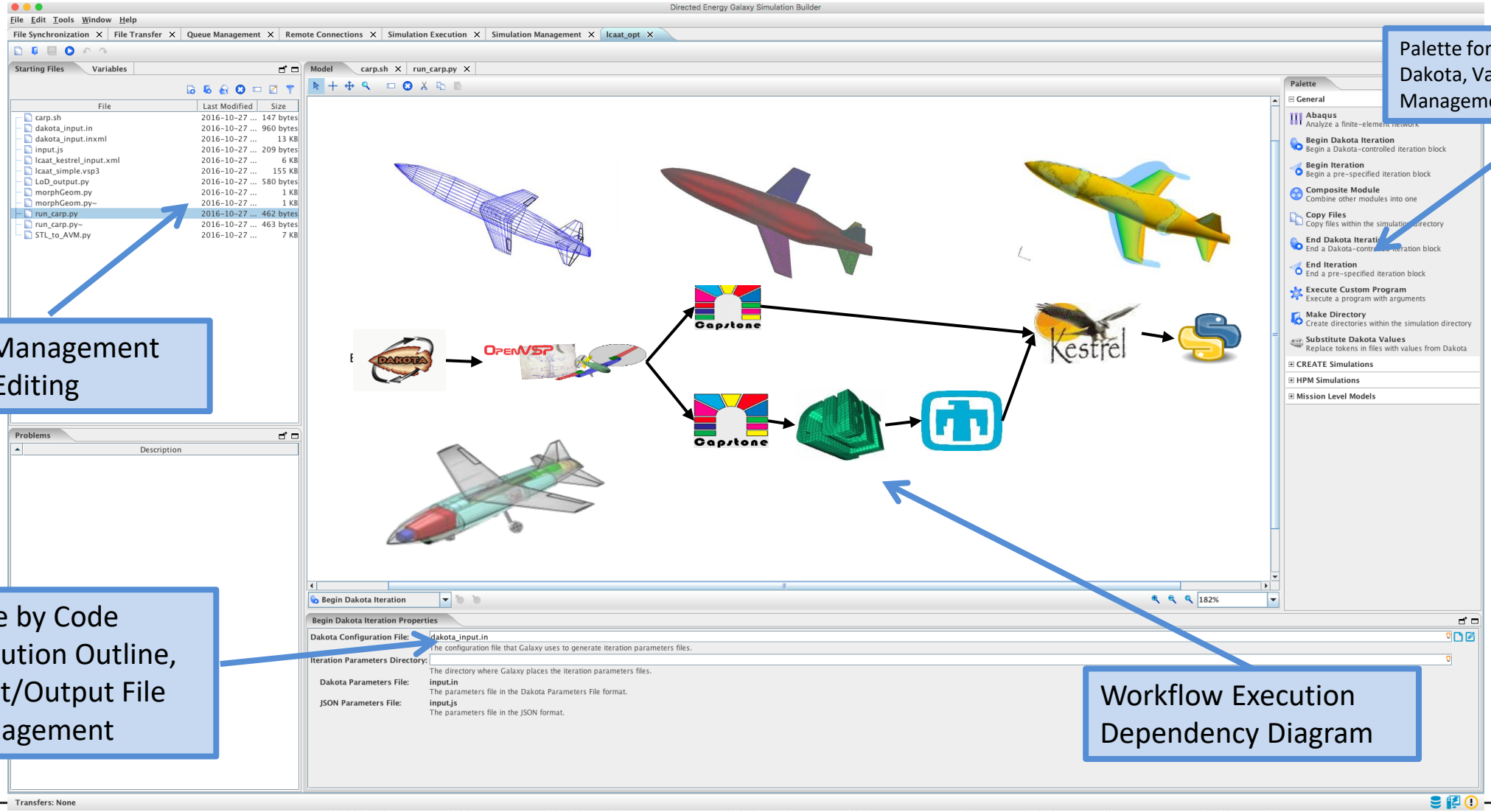
- Created 8 Industry Users
- Used excess of 100M CPU-hrs
- Explored unique multidisciplinary problems requiring both government and industry expertise/data/software

Design Process Development and Exploration

- Developed fully automated process to study Fluid-Structural-Thermal interaction (FSTi) problems relevant to hypersonics
- Increased fidelity and efficiency problems common to FSTi studies
- Transitioned FSTi methodology to other Hypersonics programs of record



ERDC ITL HPC Software Support – Galaxy



File Management and Editing

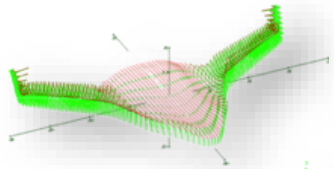
Palette for Pre-Built Modules, Dakota, Variable Substitution Management, etc.

Code by Code Execution Outline, Input/Output File Management

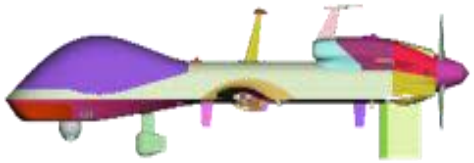
Workflow Execution Dependency Diagram

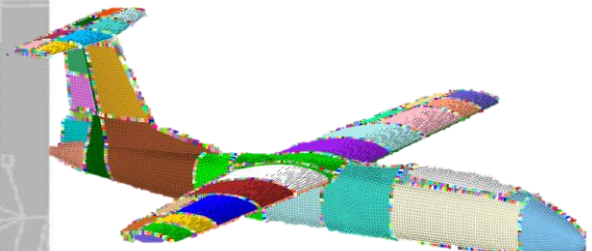
Questions?

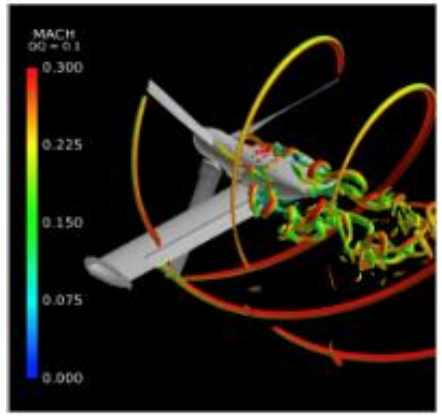
ERDC partnerships with Industry helps reduce program risk, improve vehicle performance, and reduce physical testing through improved computational techniques

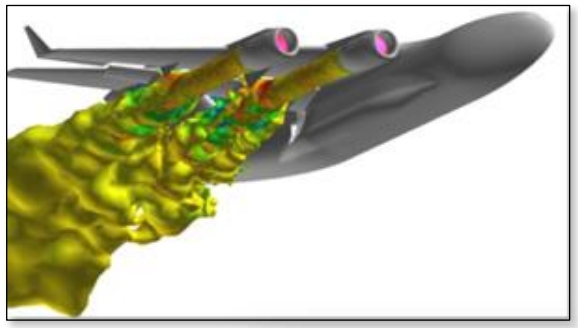


Design

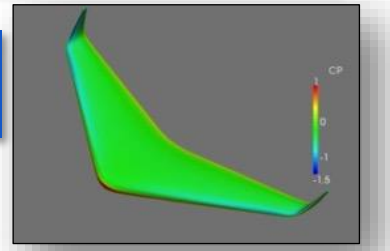




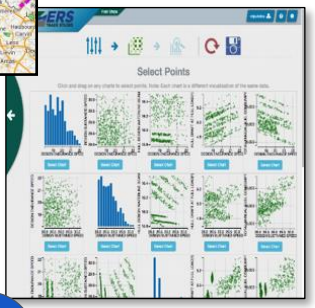




Analyze



Decide Faster!



- Use high-fidelity models to increase trust in system performance
- Create virtual proving grounds and computational testbeds
- Capture small-scale physical effects with multi-discipline models