The DoD Computational Research and Engineering Acquisition Tools and Environments (CREATE) Program

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DoD HPC Modernization Program

Provide HPC Capabilities for the DoD RDT&E Communities

**DoD Supercomputing Resource Centers**

- **Army Participation**
  - ARL & ERDC DSRCs
  - 1,343 Users/24 Organizations/
    - 108 Projects
  - 56 DREN Sites
  - 15 Challenge Projects/2 DHPIs
  - 5 Institutes

- **Navy Participation**
  - Navy DSRC
  - 942 Users/16 Organizations/
    - 197 Projects
  - 38 DREN Sites
  - 13 Challenge Projects/2 DHPIs
  - 1 Institute

- **Air Force Participation**
  - AFRL & MHPCC DSRCs
  - 1,330 Users/25 Organizations/
    - 199 Projects
  - 24 DREN Sites
  - 11 Challenge Projects/3 DHPIs
  - 3 Institutes

- **Defense Agencies Participation**
  - DARPA, DTRA, JNIE, JFCOM,
    - MDA, PA&E & OTE
  - 537 Users/4 Organizations/
    - 29 Projects
  - 28 DREN Sites
  - 2 Challenge Projects/2 DHPIs

**Software Applications Support**

- Institutes/Portfolios
- Education & Outreach
- CREATE
- SPI

**Networking**

- Defense Research & Engineering Network

**Resource Management Requirements & Allocations**

- DHPIs
- Challenge Projects

**Other**

- ARSC DSRC
- 68 DREN Sites
CREATE Concept

• Use physics-based software to identify design defects throughout the acquisition process thus substantially reducing acquisition time and cost overruns.

Identify problems and fix them before metal is cut.
CREATE Rationale

• “There is a probability of one that 10 structural failures will be discovered in flight test programs where the cost to rework the defect is maximized.” -- Ed Kraft, Chief Technologist, AEDC

• Present designs are based on semi-empirical extrapolations from existing systems—insufficient for new weapons systems

• Building and testing physical prototypes and full systems is expensive and takes a long time

Physics-based computational engineering tools allow performance predictions of virtual prototypes from conceptual design through production and sustainment to augment physical testing
Focus on Four Project Areas

- **Air Vehicles (AV)—Air Force, Army & Navy**
  - Aerodynamics, structural mechanics, propulsion, control, …
- **Ships—Navy**
  - Shock vulnerability, hydrodynamics, concept design
  - RF Antenna electromagnetics and integration with platforms
- **Mesh and Geometry (MG) Generation**
  - Rapid generation of mesh and geometry representations needed by analysis

*CREATE tools will support all stages of acquisition from rapid early stage design to full life-cycle sustainment*
CREATE –
Four Projects → Ten Products

- Air Vehicles—CREATE AV
  - DaVinci - Rapid conceptual design
  - Kestrel - High-fidelity, full vehicle, multi-physics analysis tool for fixed-wing aircraft
  - Helios - High-fidelity, full vehicle, multi-physics analysis tool for rotary-wing aircraft
  - Firebolt - Module for propulsion systems in fixed and rotary-wing air vehicles

- Ships—CREATE Ships
  - RDI - Rapid Design and Synthesis Capability
  - NESM - Ship Shock & Damage-prediction of shock and damage effects
  - NAVYFOAM - Ship Hydrodynamics-predict hydrodynamic performance
  - IHDE - Environment to facilitate access to Naval design tools

- RF Antenna—CREATE RF
  - SENTRI - Electromagnetics antenna design integrated with platforms

- Meshing and Geometry—CREATE MG
  - Capstone - Components for generating geometries and meshes
DoD Acquisition Process

- **Concept Development**
  - **DaVinci** – AV Rapid conceptual design
  - **RDI** – Ship Rapid Design and Synthesis Capability
  - **IHDE** – Ship Environment to facilitate access to Naval design tools
  - **SENTRI** – RF Antenna Design integrated with platforms—Simple, fast models

- **Engineering Development and Production & Deployment**
  - **Kestrel** – AV High-fidelity, full vehicle, multi-physics analysis tool for fixed-wing aircraft
  - **Helios** – AV High-fidelity, full vehicle, multi-physics analysis tool for rotary-wing aircraft
  - **NESM** – Ships Ship Shock & Damage-prediction of shock and damage effects
  - **NAVYFOAM** – Ships Ship Hydrodynamics-predict hydrodynamic performance
  - **SENTRI** – RF Antenna Design— Detailed, accurate RF models integrated with platforms

CREATE Addresses All Phases of Acquisition
The CREATE Approach

- Software is being built by government-led teams
- Each product is released annually following a roadmap
  - Each year there is a release of a usable application
  - Each release builds on the previous release and adds the increased capability called for in the roadmap
  - Each release is beta-tested by targeted user communities before a broader release
  - Each release goes through a rigorous V&V process and follows software engineering practices developed specifically for technical software
- Releases are progressively more scalable for massively parallel computers and responsive to user requirements
- CREATE Program is guided by DoD service acquisition engineering organizations and their senior leadership and US defense industry
- Most of the CREATE software applications made their second release this calendar year
  - Many will have a third release by March 30, 2012
### Incremental Development and Deployment in Annual Releases

<table>
<thead>
<tr>
<th>Years</th>
<th>Stages</th>
<th>Development Milestones</th>
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<tbody>
<tr>
<td>1-5</td>
<td>6-9</td>
<td>Develop Initial Requirements and Plans</td>
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<tr>
<td></td>
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<td>- Physics integration tests,…</td>
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<tr>
<td></td>
<td></td>
<td>- Improve scalability,…</td>
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<tr>
<td>10-12</td>
<td></td>
<td>Fielding Capability,…</td>
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<tr>
<td></td>
<td></td>
<td>ExaFLOP (10^{18} FLOPs) computers</td>
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<tr>
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<td>PetaFlop (10^{15} FLOPs) computers</td>
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- **Rel 1**: Year 1
- **Rel 2**: Year 2
- **Rel 3**: Year 3
- **Rel 4**: Year 4
- **Rel 5**: Year 5
- **Rel 6**: Year 6
- **Rel 7**: Year 7
- **Rel 8**: Year 8
- **Rel 9**: Year 9
- **Rel 10**: Year 10
- **Rel 11**: Year 11

- **Year 12**: ExaFLOP (10^{18} FLOPs) computers
Criteria to Gain Access

Criteria for access:

- **CREATE software is available to industry users if:**
  - It will be used to support a US DoD contract,
  - It is used within the contract scope, and
  - The contract is consistent with the limitations within the CREATE license agreement

- **The software is export controlled; all US export control policies and laws must be followed**

Process for access:

- **A two-factor authentication (CAC or hToken) is required to use the software**

- **To request access to the software, email createaccounts@create.hpc.mil to begin the approval process**
Four Project Areas and Computing Access

- **Air Vehicles (AV)—Robert Meakin**
  - Aerodynamics, structural mechanics, propulsion, control, …

- **Ships—Myles Hurwitz**
  - Shock vulnerability, hydrodynamics, concept design

- **Radio Frequency (RF) Antennas—John D’Angelo**
  - RF Antenna electromagnetics and integration with platforms

- **Mesh and Geometry (MG) Generation—Saikat Dey**
  - Rapid generation of mesh and geometry representations needed by analysis

- **Computers and Portal for Access—David Morton**

- **Discussion and Questions**
See the CREATE Papers

Wednesday

- Track 1  8:00 – 13280 Capstone—Meshing and Geometry
- Track 5  8:00 – 13210 Analysis of Severe Dynamic Loading (US Only)
- Track 3  8:55 – 13457 Portal for easy access
- Track 1 13:30 – 13502 Prediction of Submarine Maneuvers
- Track 1 14:25 -- 13503 Surface Ship Performance
- Track 2 13:30 – 13274 DaVinci, Conceptual Air Craft Design
- Track 2 14:25 -- 13273 Kestrel, Fixed Wing Design and Analysis
- Track 2 15:30 -- 13271 Firebolt, Gas Turbine Module
- Track 2 16:25 -- 13272 Helios, Rotor Craft Design and Analysis
- Track 4 15:30 – 13444 Integrated Hydrodynamic Design Environment
- Track 4 16:25 – 13234 Physics-Based Models for Ship Design

Thursday

- Track 9 10:15 – 13518 RF Antenna Modeling
- Track 10 8:55 – 13623 Conceptual Ship Design