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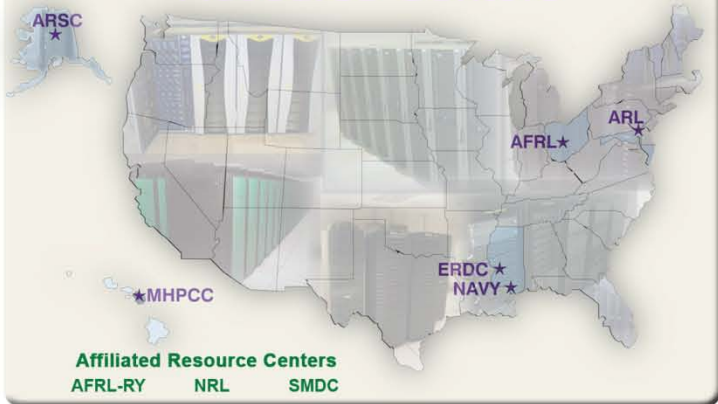
CREATE

DoD HPC MODERNIZATION PROGRAM

Dr. Douglass Post

Associate Director For CREATE

DoD HPC Modernization Program

Provide HPC Capabilities for the DoD RDT&E Communities

DoD Supercomputing Resource Centers

ARSC ★
AFRL ★
ARL ★
AFRL ★
ERDC ★
NAVY ★
★ MHPCC

Affiliated Resource Centers
AFRL-RY   NRL   SMDC

Networking
Defense Research & Engineering Network

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, JNIC, JFCOM,
MDA, PA&E & OTE
537 Users/4 Organizations/
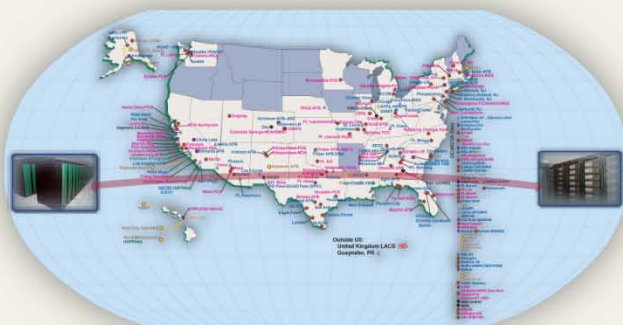   29 Projects
28 DREN Sites
2 Challenge Projects/2 DHPIs

Other
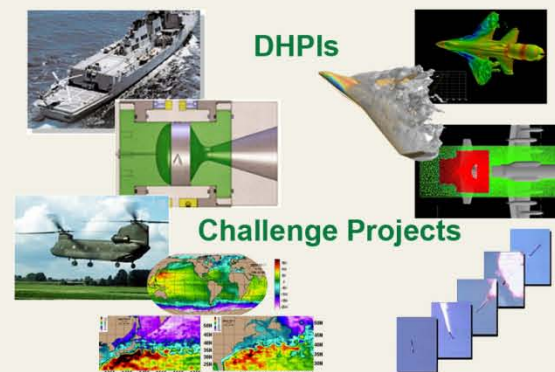ARSC DSRC
68 DREN Sites

Software Applications Support

Institutes/Portfolios

Education & Outreach

CREATE

PET^3

SPI

Resource Management
Requirements & Allocations

DHPIs

Challenge Projects

CREATE Concept

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

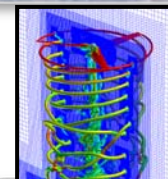**Identify problems and fix them before metal is cut.**

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
- **Radio Frequency (RF) Antennas—Air Force, Army & Navy**
  - RF Antenna electromagnetics and integration with platforms
- **Mesh and Geometry (MG) Generation**
  - Rapid generation of mesh and geometry representations needed by analysis

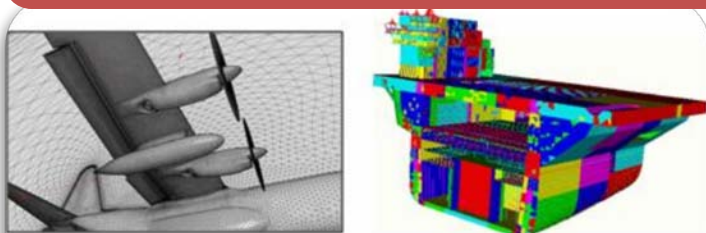*CREATE tools will support all stages of acquisition from rapid early stage design to full life-cycle sustainment*

F-35

Design concept

Seakeeping and resistance

Shock vulnerability

Aircraft and aircraft carrier meshes

Military platforms with antennas

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	→	Engineering Development	→	Production & Deployment

- **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

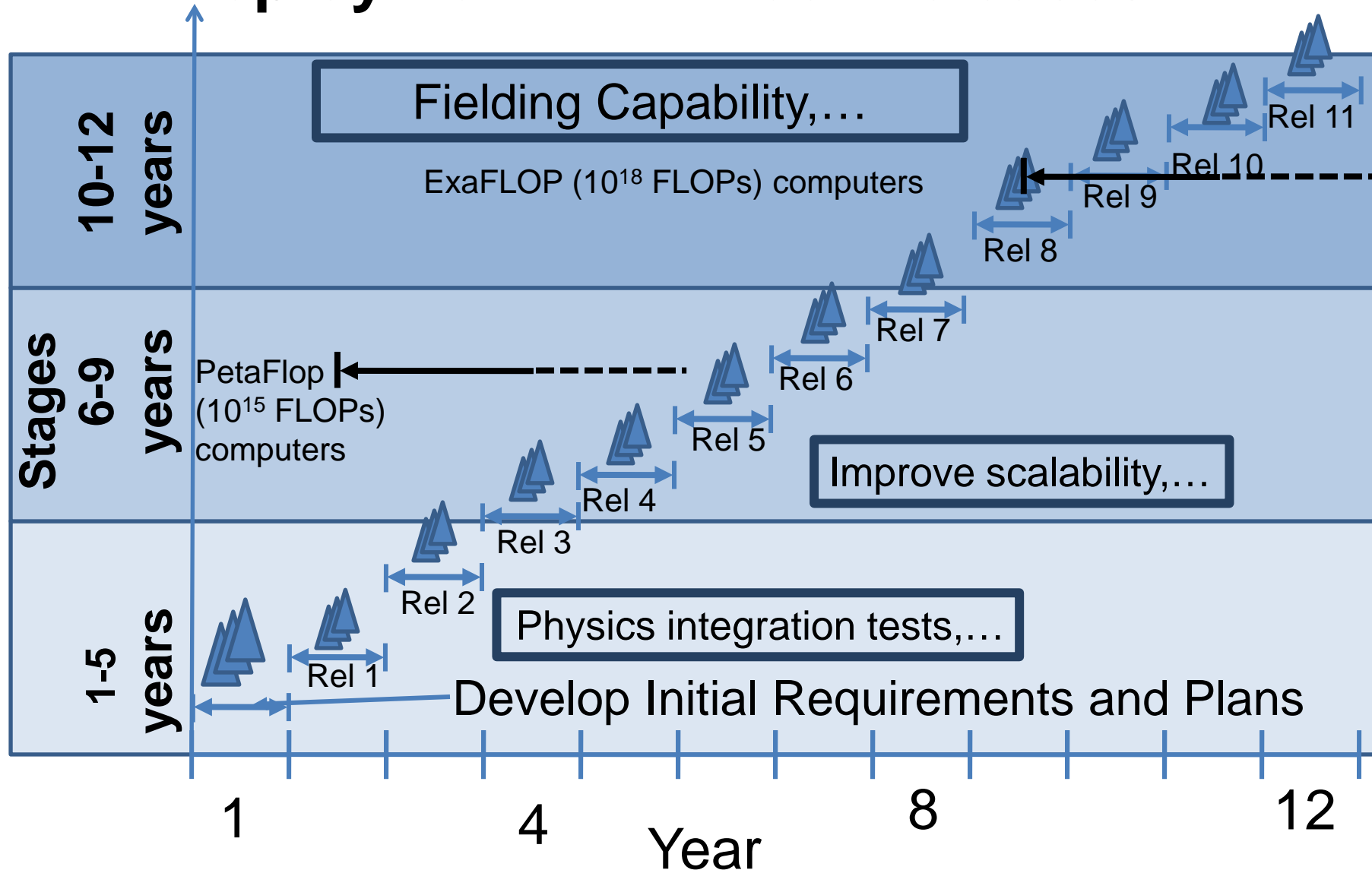- **Engineering Development and Production & Deployment**
  - **Kestrel – AV** High-fidelity, full vehicle, multi-physics analysis tool for fixed-wing aircraft
  - **Helios – AV** High-fidelity, full vehicle, multi-physics analysis tool for rotary-wing aircraft
  - **NESM – Ships** Ship Shock & Damage-prediction 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

Stages

10-12 years

Fielding Capability,…

ExaFLOP (10^{18} FLOPs) computers

Rel 11

Rel 10

Rel 9

Rel 8

6-9 years

PetaFlop (10^{15} FLOPs) computers

Rel 7

Rel 6

Improve scalability,…

Rel 5

Rel 4

Rel 3

1-5 years

Rel 2

Physics integration tests,…

Rel 1

Develop Initial Requirements and Plans

1   4   8   12

Year

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**