HPCMP Portal:

Productive Supercomputing for Access-Constrained DoD Environments

Date: 2 February 2015

http://www.mhpcc.hpc.mil/portal

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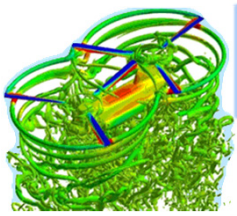
HPCMP Scale Enables Impact

Performed by HPCMP CREATE Army AMRDEC/AED, and Boeing

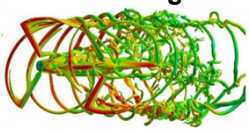
CH-47F Performance Improvement

Increasing helicopter hover thrust performance normally equates to a loss of forward flight performance. Army AMRDEC/AED and Boeing used HPCMP CREATE AV Helios software and three million CPU-hours on DSRC supercomputing hardware to confirm Boeing's predictions of improved and isolated rotor performance. For the first time, they verified computationally that rotor/rotor and rotor/fuselage interactional dynamics do not adversely affect the installed performance of the new rotors.



Hover

Forward Flight



HPCMP resources enabled:

- **Virtual testing of the integrated CH-47F with new rotor via high-fidelity analysis early in the design process, including aft pylon height and blade indexing.**
- **Enabled flight test planning.**

HPCMP CREATE resources and expertise enabled early design stage predictions of helicopter performance that project improved hover thrust for 400+ Chinooks with no degradation of forward flight performance.

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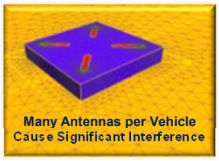
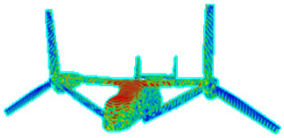
Performed by HPCMP CREATE and by AFRL

Weapon System Acquisition Kept on Track

The government review board of a recent acquisition program found that in one critical criterion the contractor had neither the computational tools nor the skill set to perform the necessary design study. To avoid delay in the delivery of this system, government personnel stepped in and analyzed the device using HPCMP CREATE RF SENTRi and Capstone software for multiple design configurations. SENTRi was also used to determine the range of input parameters that met the government's functional requirements. As a result, a design was chosen and the system was fielded on schedule.





HPCMP resources enabled:

- **Project Chief Engineer: SENTRi "provided user command confidence in the acquisition of the device."**
- **SENTRi saved appreciable time and expense that would have gone into parametric physical model construction and testing.**
- **The government analyst was nominated for Outstanding Programmatic Achievement.**

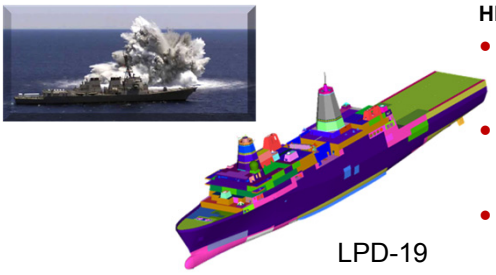
HPCMP CREATE resources and expertise enabled the antenna to be fielded on schedule and meet its functional requirements.

MB Page-4

Performed by HPCMP CREATE™SHIPS and the Naval Surface Warfare Center, Carderock Division

Surface Ship Survivability Assessment

Navy vessels must meet design requirements for surviving threat engagements. Previously, the development process required Full-Scale Ship Shock Trials, which involve exploding munitions near the vessel – expensive, complex, and risky testing. HPCMP CREATE NESM software and over 3,000,000 CPU-hours were used in 2012 to develop and validate the ability to derive the shock responses of vital ship systems without requiring the ship's exposure to explosive bursts. The insights from the LPD-19's physics-based analyses will be applied to all 11 LPD-17 class ships.



LPD-19

HPCMP resources enabled:

- **Risk reduction of physical tests which impact on ship delivery and T&E schedules.**
- **Future identification of shock-related problems in the design phase – before the ship is built.**
- **Rapid calculations of multiple ship configurations for ship shock analyses.**

NAVSEA Technical Warrant Holder: HPCMP CREATE NESM "is an appropriate and acceptable M&S tool which meets the M&S requirements to support current and future surface ship shock applications." *(This is the only such designation made to date for surface ships.)* "…concurs that NESM is an appropriate tool for the performance of DDAM calculations."

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Performed by HPCMP Portal

KC-46 Tanker Hydrodynamic Ram Analysis

The KC-46 is a $51B program, including the key performance parameter that the aircraft shall be capable of operating in hostile threat environments. Analysis of the KC-46 for dynamic structural response utilized the Secure Remote Desktop (SRD) and over two million hours of supercomputing. High Performance Computing (HPC) modeled the thermal/structural interactions of metallic wings subjected to penetrating and exploding threats.

HPCMP resources utilized:

- **Two million CPU core hours used on 20M cells**
- **1,400 hours of SRD desktop usage in CY2013**
- **LSDyna, LSPrepost, CTH, EPIC, Ensight, Paraview**

The KC-46 will offer superior, modern multi-role capabilities for the warfighter, including advanced refueling systems and military avionics, and the ability to transport cargo, passengers, and patients.

HPCMP Secure Remote Desktop enabled evaluation of an order of magnitude with more threat scenarios employing HPC assets.

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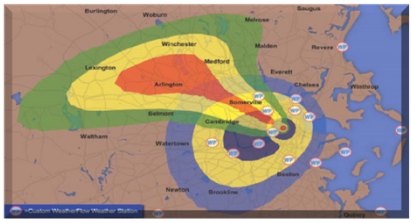
Performed by HPCMP Portal Team and the Defense Threat Reduction Agency

HPC Portal Enables DTRA Nuclear Effects Exercise

For the first time, the HPC SIPRNet Portal enabled a geographically-distributed team to perform Nuclear Weapons Effects (NWE) analysis. The Defense Threat Reduction Agency (DTRA) – Nuclear Effects Office utilized the HPC Portal implemented on the Secret Internet Protocol Router Network (SIPRNet) to support a high priority exercise with USSTRATCOM and the UK, within 30 days of authorization. The HPC SIPRNet Portal allowed dispersed teams to conduct secure, high fidelity supercomputer modeling, including post-processing and visualization using a Web browser and demonstrating a real world crisis response capability.



HPCMP resources enabled via HPC Portal:

- **Parallel, high-fidelity NWE Modeling and Simulation Tools from desktops without user-installed software**
- **End-to-end HPC workflow including post-processing and visualization without large file transfers**

HPCMP Portal facilitated the Weapons Effects Strategic Collaboration Fire Exercise by implementing a Web-enabled Portal. Beyond avoidance of travel time and costs, the secure portal demonstrated the capability, for the first time, for remote HPC support of a potential crisis.

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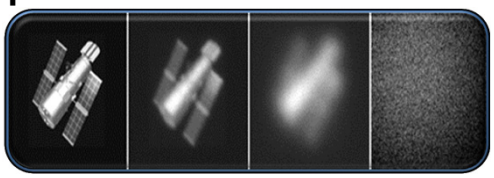
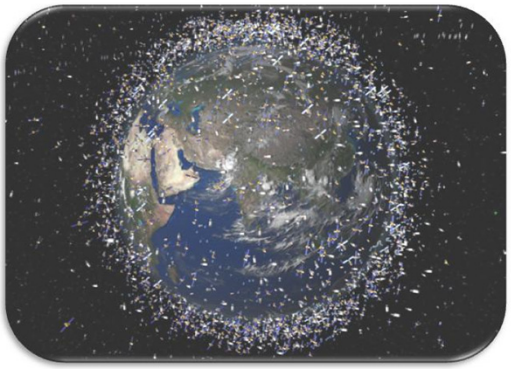
Scientific Progress Made Possible by the Centers' Technical Support

Space Situational Awareness

- Satellite collision simulation
- HPC-processed images
- Satellite surveillance, trajectory and reentry assessment





Maui High Performance Computing Center (MHPCC) provided 440,000 processor hours and nine people to assist in program management, technical support, algorithm development and optimization, and software application engineering, design, testing, and implementation.

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HPCMP Capability

DoD HPC Modernization Program

Joint Community

Army HPCMP Participation
- ARL & ERDC DSRCs
- SMDC ARC
- 106 Projects/21 Organizations
- 41 DREN Sites
- 12 Challenge Projects/2 DHPIs
- 3 Institutes

Navy HPCMP Participation
- NAVY DSRC
- NRL & SSC-SC ARCs
- 228 Projects/21 Organizations
- 35 DREN Sites
- 12 Challenge Projects/4 DHPIs

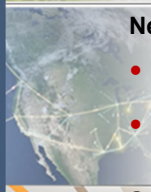
Air Force HPCMP Participation
- AFRL & MHPCC DSRCs
- AFRL-RI ARC
- 187 Projects/25 Organizations
- 23 DREN Sites
- 14 Challenge Projects/5 DHPI
- 1 Institute

Agencies
- DARPA, DTRA, MDA, & Other Defense
- 29 Projects/5 Organizations
- 20 DREN Sites
- 3 Challenge Projects

Other
- 25 DREN Sites

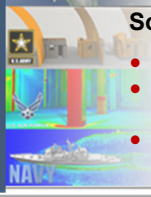
HPC Centers

- DoD Supercomputing Resource Centers (DSRCs)
- Affiliated Resource Centers (ARCs)
- Dedicated HPC Project Investments (DHPIs)



Networking

- Defense Research & Engineering Network (DREN/SDREN)
- Information Assurance Services (Security)



Software Applications Support

- Software Institutes
- User Productivity, Enhancement, Technology Transfer and Training (PETTT)
- Computational Research and Engineering Acquisition Tools and Environments (CREATE)

DoD Supercomputing Resource Centers (DSRCs)
Current Capability

Location	System	Available Processors *(Cores)*	Memory *(GB)*
AFRL	SGI Altix X	73,728	158,144
ARL	Cray XT5 (Classified)	15,600	40,128
	SGI Altix ICE 8200	10,752	34,152
	SGI Altix ICE 8200 (Classified)	6,656	21,264
	IBM iDataPlex	20,160	42,624
	IBM iDataPlex (Classified)	17,472	72,064
ERDC	SGI Altix ICE 8200	15,360	48,480
	Cray XE6	150,912	309,360
	Cray XE6 (ORS)	14,976	30,552
MHPCC	IBM iDataPlex	12,096	25,600
NAVY	IBM iDataPlex (Classified)	4,032	9,088
	IBM iDataPlex	19,776	41,728
	IBM iDataPlex	19,776	41,728
	Total	**381,296**	**874,912**

FY13 HPC Systems shown in ORANGE
FY11 HPC Systems shown in BLUE (TI-11/12 HPC systems operational in FY12)
FY09 HPC Systems shown in GREEN
FY08 HPC Systems shown in RED

As of: July 2013

Software Configuration Management
Sharing Licenses Across the Enterprise

ARL DSRC

AFRL DSRC

NAVY DSRC

MHPCC DSRC

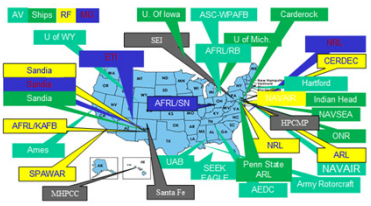
ERDC DSRC

Package	Baseline as of January 2013
Abaqus	244 & add-ons; 36 & add-ons (classified)
Accelrys	Site licenses: MS_COMPASS, MS_DISCOVER, MS_DMOL3-SOLID-STATE Flexible tokens: 8; MS_VISUALIZER 8
ANSYS	Negotiated WAN model: 23 CFD Solvers, 2048 CFD HPC, 5 Gambit (locked to geographic pools); 1 CFD Solver, 192 CFD HPC (classified)
CFD++	3 site licenses: 1 ARL, 1 AFRL, 1 ERDC
Cobalt	Site licensed at all sites
EnSight Suite	11 Standard, 10 Gold, 5 Enlitengold, 2 DR 8 Standard, 4 Gold, 2 DR (classified)
GASP	10 (unlimited cores per job)
Gaussian Suite	3 site licenses: 1 ARL, 1 AFRL, 1 ERDC
LS-DYNA & 3D	500
MATLAB	21 (3 Classified), 64 Dist Comp Toolbox, 10 Parallel Comp Toolbox
Star-CD, Star-CCM+	10 Power Session licenses (unlimited cores per job)
TotalView	50 architecture-free
DDT	8,260 maximum processes
FieldView	10 Utility Servers, 5 Standard and 5 batch AFRL
Pointwise	5 Utility Servers, 4 AFRL. 4 ARL
Tecplot	10 Utility Servers, 9 AFRL, 8 ARL
Utility Server Software	
INTEL	5 Cluster Toolkit seats

Building A Community

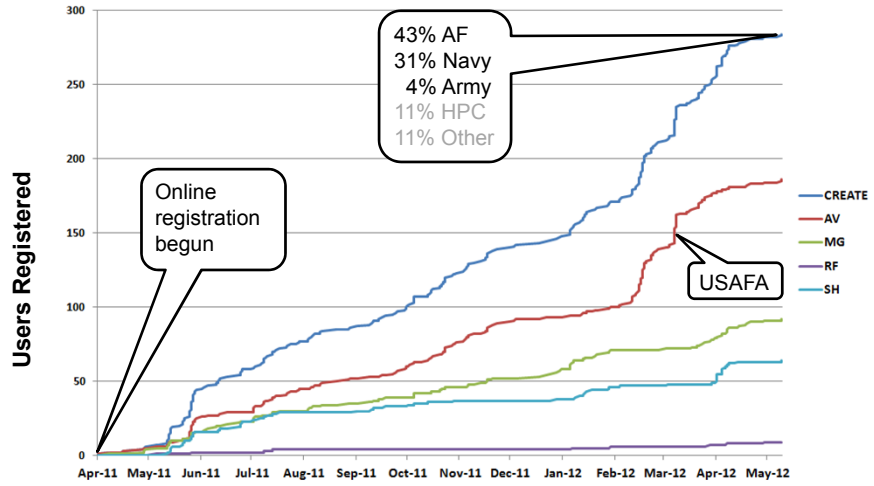
User Community

- **HPCMP CREATE™ is a multi-service, multi-institutional program**
- **User Types**
  - Developers
  - Quality Assurance and User Support
  - Prospective acquisition engineering users
  - Supported users from DoD, academia and industry (e.g., Boeing, Bell Helicopter, Raytheon).
- **Continued growth**
  - Over 50 DoD programs
  - Over 500 CREATE distribution agreements



CREATE User Community Trend

- **421 CREATE Registrants (01 Aug 2013)**



- **CREATE has set up an AV Support organization to be owned and supported by the Services (Army, Navy, and Air Force Aviation communities)**

Notes:
- Developers omitted from above
- 196 requesters not registered online and omitted
- Service usage based on sponsor email

HPCMP Access Issues

Supercomputing Access

Services' engineering user issues *

For contractors who do not have DREN access and cannot open the necessary firewall ports for direct Kerberos access, connectivity to the HPC is an issue. We use the front-end machine uas.afrl.hpc.mil for access as a work-around. It works, but there is definitely room for improvement on this issue. Army SMDCH

Please advocate within the DoD IA community for the acceptance of KERBEROS as the standard and acceptable way for HPCMP users to access HPCMP assets. A DoD level certification for its installation rights on DoD computational platforms and approved communication protocols will go along way in making HPCMP assets readily available soonest at our installation and likely throughout the DoD. AFWAC

We anticipate increasing usage of data mining and visual analytics through interactive means, particularly web portals. AFHEW

Information and access to visualization packages on the HPC machines. **Visualization tools on the HPC machines is becoming especially important, given the data volume**, velocity, and variety. Navy NRLDC

Some or most of our users also work from their home computers that are either windows or mac, **so we need to access HPC resources using Yubi Keys, as they do not have CAC card readers**. Army ERDCV

Interactive functionality via secure remote desktop (SRD) or web browser for pre and post processing is currently severely impaired due to latency and/or transfer speeds at my building, Bldg 11A, Wright-Patt. ASCWP

Work on increasing bandwidth to port graphics - so post-processing can be used at HPCMP servers to visualize / analyze large data sets. AFMNG

* Responses to questions 31 and 32 only, HPCMP 2013 Requirements Survey

Performed by HPCMP CREATE, MHPCC HPC Portal, and US Air Force Academy

USAFA Aero Course

Lt. Col. Andrew Lofthouse, Ph.D.

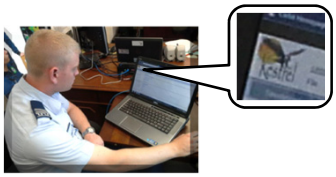
Professor and Director, Modeling & Simulation Research Center, USAFA

- Can focus on CFD: All the tedious elements of the workflow go away
  - Upload mesh, download solution, remote X-session, kerberos kit install, desktop software install, configuration of solver
  - 144 core cluster out of warranty, no need for another cluster
- 60 cadets each year
  - Portal has all the tools the students need, from mesh generation, to computation, to visualization
  - 2-D airfoils and 3-D wings looked at in the course. Latencies are sufficient for simple geometries, but release lag Kestrel desktop releases – so not sufficient for research.

Cadets go on TDY for the semester for the flying team, and they missed 1.5 weeks at the end of the semester. They couldn't access the USAFA cluster for analysis remotely -- but now they can complete the coursework with the HPC Portal.

Software as a Service
Zero install access to HPC

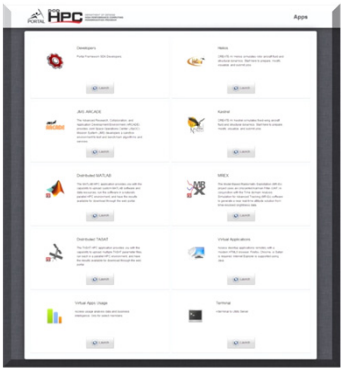
HPC Portal
Supercomputing via a Browser



Easy
- Similar to a webmail interface
- No user-installed software or patches
- Integrated tutorials, community forums, and help

Secure
- No desktop install is a security best-practice
- Quick DoD CAC-authentication
  - Yubikey for University and Industry
- Secured at one server vs many desktops

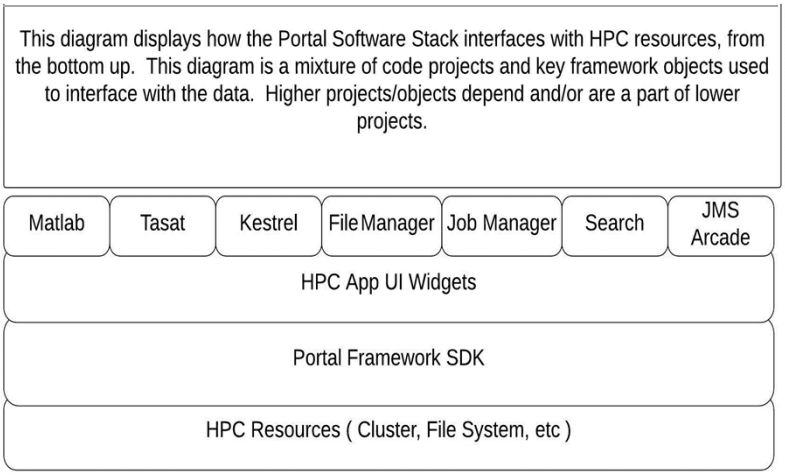
Powerful
- Access to >> 10,000 CPU Cores
- Shell for power users
- Applications at one link
- Software near increasingly large datasets



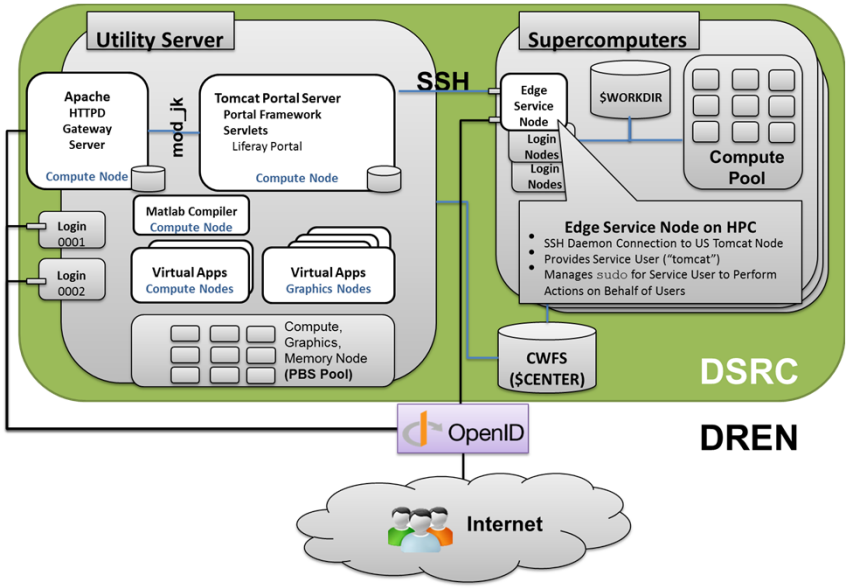
HPCMP Portal Architecture

- Portal Stack hosted on Utility Servers
  - Apache/MySQL/Liferay Content Management System
  - Java Servlets Support Common Framework
    - Vaadin: Open Source Java for RIA
      - » Server Side WebApp Framework w/AJAX
  - Leverages Centerwide File System (CWFS)
    - Mounted on Utility Servers and Cluster Login Nodes
    - Portal Home directories
  - Job Submit/Monitor for US and Clusters
  - Remote display for legacy apps
    - Virtual Apps on US

HPCMP Portal Overview



Portal Architecture

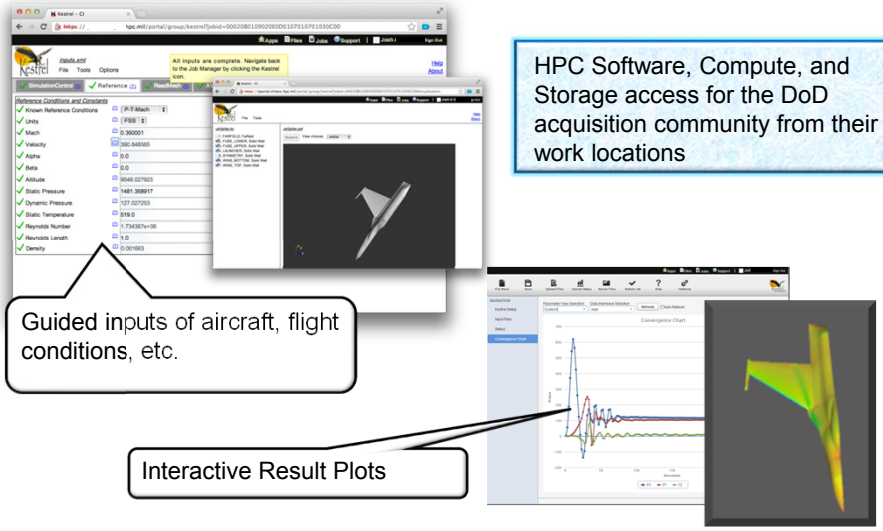


Edge Service Node

- Each HPC Requires "Edge Service Node" for Portal
- Essentially Re-purposed Login Node
  - Dedicated Only to Portal Service User (Tomcat)
  - Mounts CWFS for Job Submission Work Flow
- SSH Daemon Connection to US Tomcat Node
- Provides Service User ("tomcat")
- Manages `sudo` for Service User to Perform Actions on Behalf of Users
- https://jira.portal.hpc.mil/confluence/display/DOC/Configuring+the+HPC+Edge+Service+Node
- Access Guideline
  - https://jira.portal.hpc.mil/confluence/display/DOC/Portal+Installation

HPCMP CREATE Kestrel

HPC Portal: Simplified Access



HPC Software, Compute, and Storage access for the DoD acquisition community from their work locations

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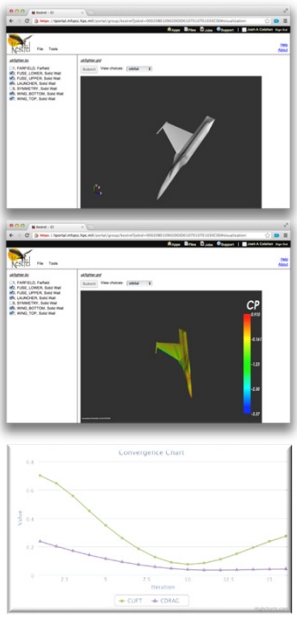
Kestrel Workflow

- Mesh Upload
- Initial and Boundary Conditions
- Visualization
- Job Submission
- Monitor Convergence
- Solution Inspection
- Resource Downloads



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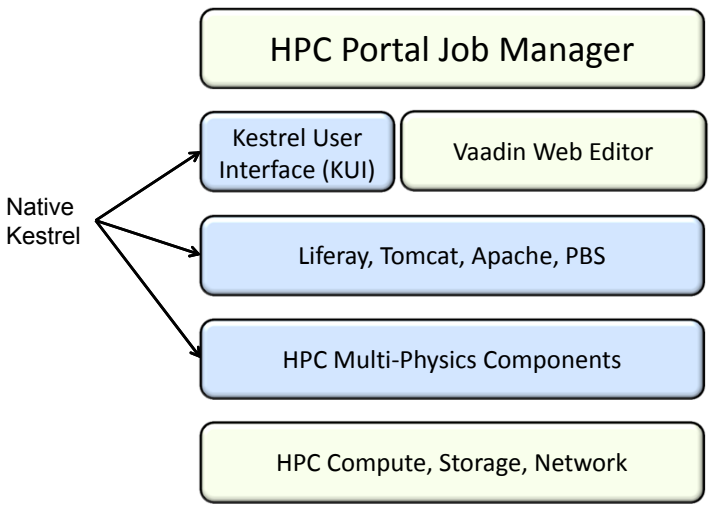
HPC Portal: Migrating Legacy Kestrel Stack



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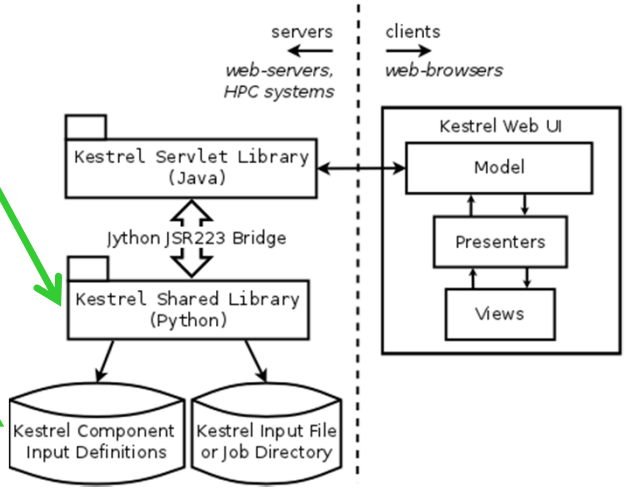
Fast Code Migration via Code Re-Use

Kestrel Web Editor reuses model and controller code

5000+ lines of existing, tested Kestrel code

Existing Kestrel, configuration and input repositories



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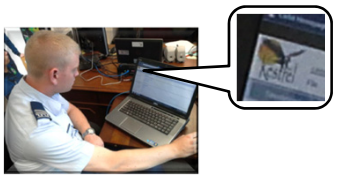
HPC Portal
Supercomputing via a Browser



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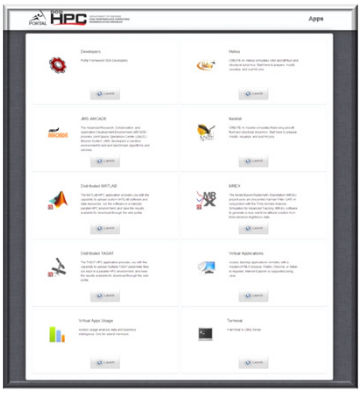


Appendix

HPCMP CREATE Software Lifecycle

Develop

- Distributed team
- Develop and debug at scale
- Common integration servers

Deploy

- Zero desktop install is a security common practice
- Quick DoD CAC-authentication
  - Yubikey for University and Industry collaboration
- Secured at one server vs many desktops

Community

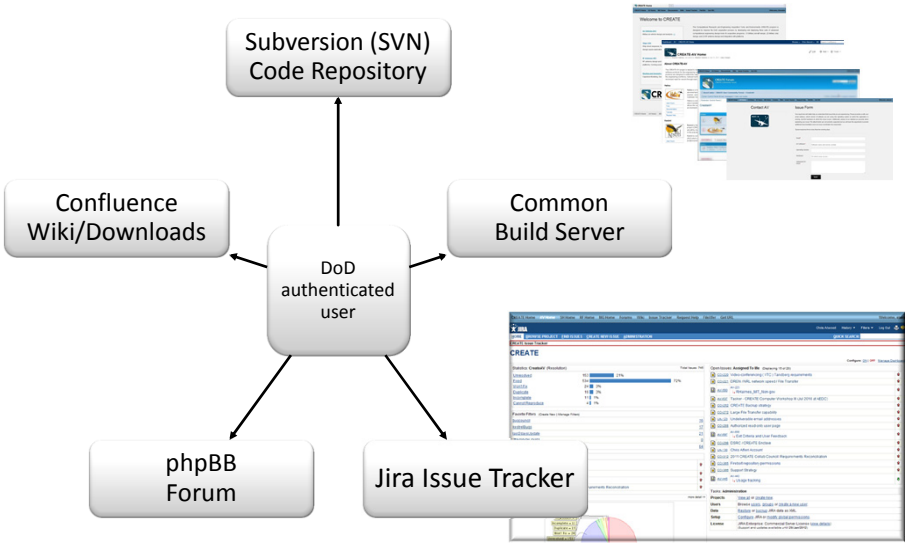
- Support for O(1000) personnel
- Tutorials, Docs, Issue tracking

Scale

- DoD supercomputing systems, networking, and storage
- Explore burst to private or public clouds

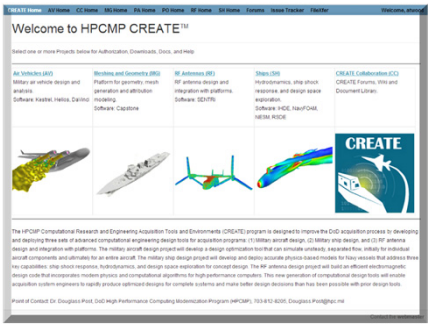
Collaborative Developer and User Support

Authenticated Access to Issues, Wiki, and Community



User Authorization and Access

- DoD RDT&E personnel with DoD CAC or HPCMP YubiKey holders may access CREATE Community.
- Access to sections of the web services and/or servers is determined by user role as assigned by the CREATE Project Manager.
- Web services support single sign-on (SSO). Access to code repositories and common build servers are restricted to developers, require specific authorization, and are not SSO.
- Annual renewal of the CREATE Distribution Agreement is required to ensure uninterrupted access.

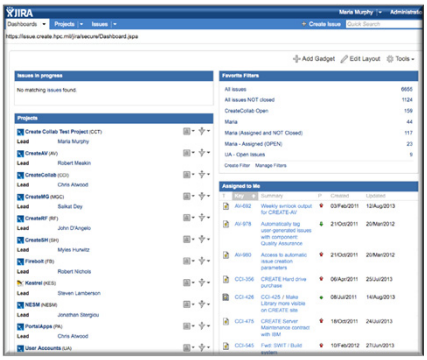


Confluence Wiki

- Structured space for users to access tutorials, download software releases and submit formal help requests.
- Serves as a document repository for projects and library for publicly-released materials, such as papers and videos.
- Delegated access control and versioning allows authors to manage distribution of content and maintain a history of modifications.

Issue Tracking

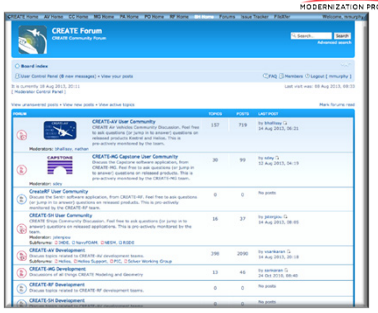
- Keeps record of defects, tasks, requirements and feature requests.
- Useful in evaluating health of product from concept through development to customer feedback.
- Each CREATE project and/or product has its own issue space which can administer its own permission, security and notification levels.
- Supports tracking by version, component and release.



- Email 'bridge' configured to create and assign issues from email and Confluence Wiki Help pages.
- Contains over 6500 issues across 12 projects.

Discussion Forum

- Self-help site for the user community.
- Hosts user and developer forums for each CREATE Project and product.
- Generates a searchable archive of the CREATE Community knowledge base which continues to grow with each code release.
- Moderated by technical experts; responses are useful to entire community and minimize the need for developers to respond individually to recurring questions.



- Discussions may result in an action item which may generate an issue for JIRA or documentation updates in Confluence wiki.
- Currently contains ~3200 posts across 650 threads.

Tier 1 Support

Types of Available Support

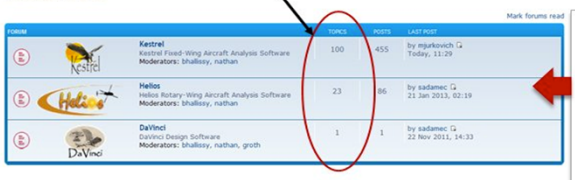
- **Self Help**
  - User's Manual
  - Product Tutorials
  - FAQs
  - Forum (Past Topics)

- **QA Support**
  - Forum
  - Request Help Form
  - Email (Given during training)
  - Phone

CREATE-AV Homepage

Need Help?

If you are unable to solve your problem with the documentation, FAQs, or user forums linked above, or the request help form above, then telephone support is also available at (301) 684-8641.

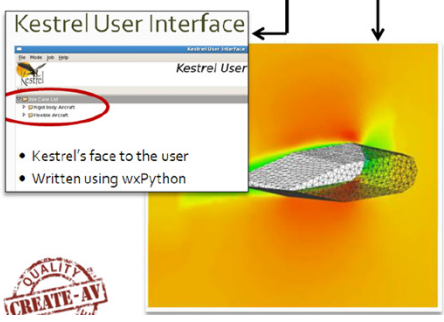


- **Forum Activity**
  (as of 2/21/2013)
  - 542 Posts
  - 124 Topics
  - On track to DOUBLE # of posts in one year
  - Monitored by QA, typical response: 2 business days

Training Modalities: Online and Classroom

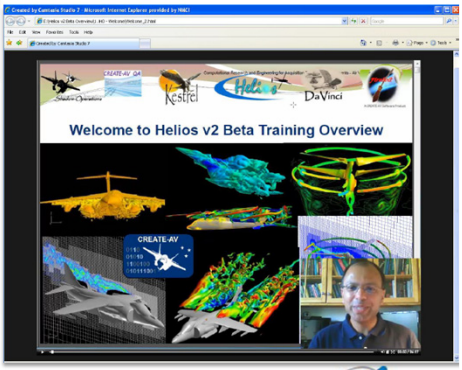
Classroom-Based – On-Location

- Fall 2011, two sessions, (AFRL and AEDC), 33 trainees total, Kestrel v2
- Kestrel only, to play diminishing role as user base grows, due to cost
- Dual Screens: Kestrel Demo (Linux) + PPT (Windows)

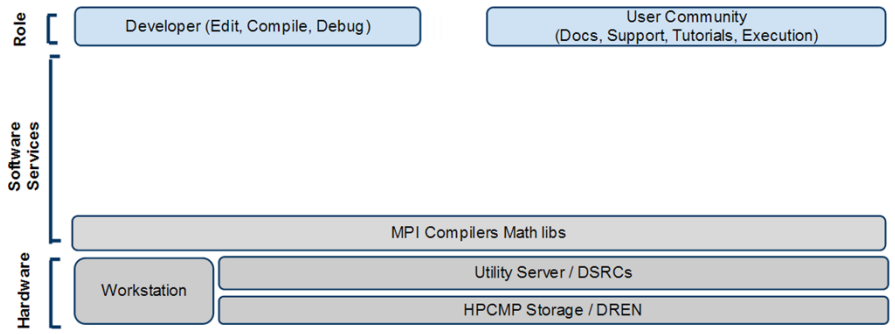


Video-Based – Remote Distribution

- Helios only, Expected for Kestrel v3
- Cross-Platform: Videos Play in Browser



Step 3: Evaluate Current Application Lifecycle



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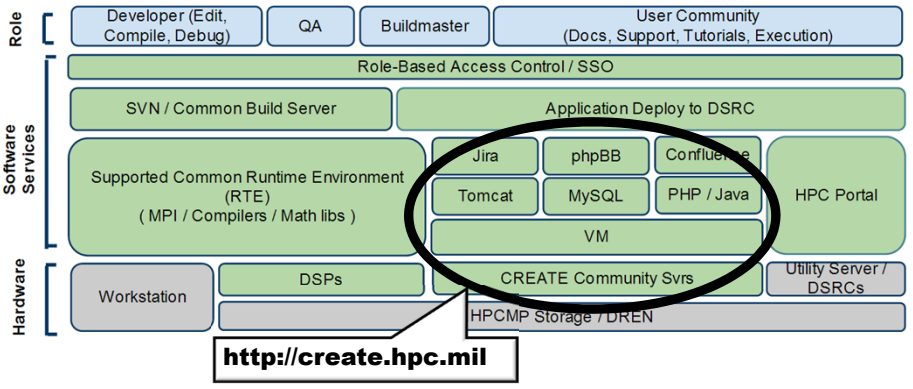
Step 4: Architect Supportable App Lifecycle



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Tier 2

CreateAV / AV-977
Carpenter seg fault when reading large UGRID meshes: Kestrel 2.1.2
Dates Created: 20/Oct/2011 07:42

CreateAV / AV-1037
100M Cell Job Freezes on Diamond
Dates Created: 01/Dec/2011 07:58

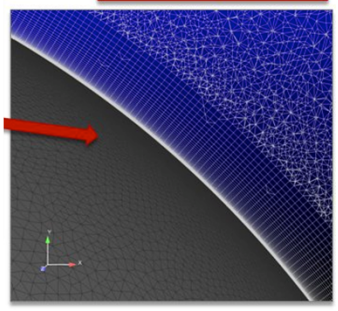
CreateAV / AV-1071
ASC User unable to view FieldView flow solution for 94M cell grid
Dates Created: 11/Jan/2012 12:44

Did not hamper project progress, first occurrence. Back-burner.

Fixed related "large-grid" issue for user on Diamond through interaction with CCAC and modified run scripts

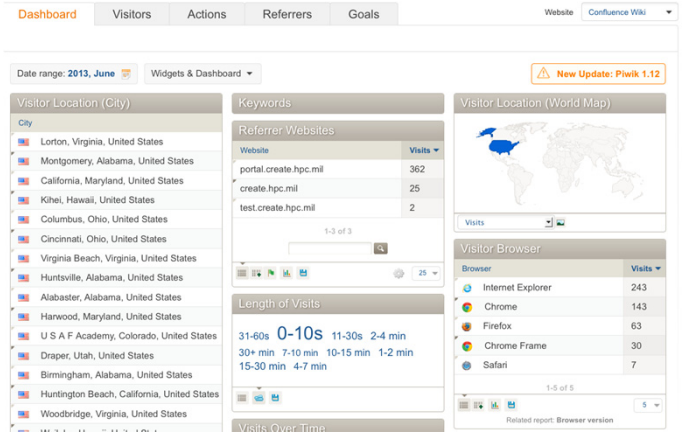
Recurring issue, now on Mana. Same user as prior AV-977. Work-around found, but issue priority elevated.

- JIRA records over the course of 4 months used to compile issue data
- Geometry in question is NOT DISTRIBUTABLE, so neither QA nor Development team can access.
- QA creates simple sphere geometry and mesh family with 60M, 73M and 92M cells to help reproduce and diagnose issue. (aka "Humongosphere")
- QA tries fix that worked on Diamond - unsuccessful on Mana.
- Forward case files, test grids to Development team for further examination. Resolved by Kestrel v2.2.1

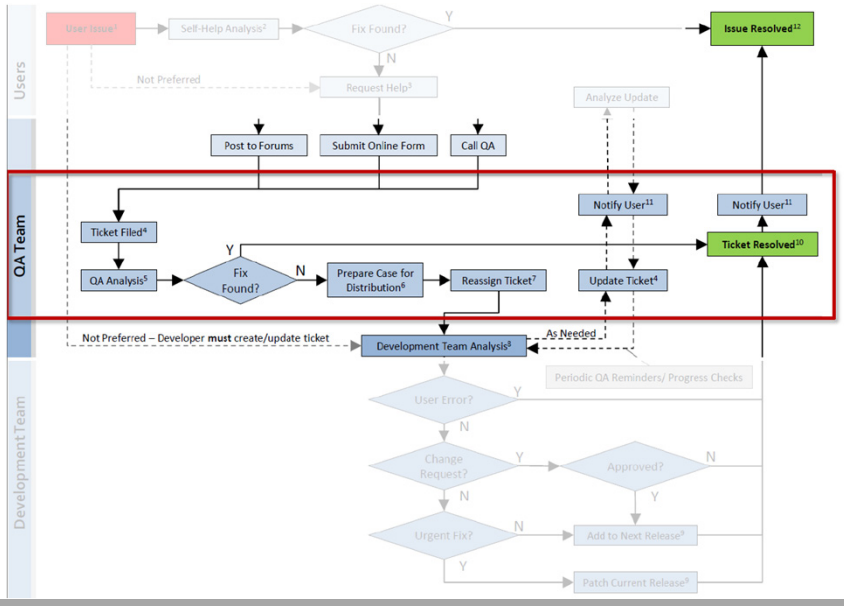


Software Adoption and User Analytics

- User engagement correlated to forum activity, support requests, and software use
- Passively collect information using Piwik analytics



User Support via Team Issue Tracker



Portal/CREATE Community Efforts

Developer and User Support