

HPCMP SaaS Portal Overview

NDIA Physics-Based Modeling In Design & Development for U.S. Defense

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Overview

- What is the HPC Portal?



- Kestrel
- MATLAB / TASAT
- HPC Portal legacy/COTS application delivery
- HPC Portal development tools
- Future

Motivation for HPCMP Portal

- **Increasingly Difficult to Install ANY Software on DoD Desktop**
 - True Barrier for Many HPC Applications and Associated Workflow Tools
 - Client Software Installation Barriers
 - Firewall and Networking Barriers
 - Networking Bandwidth Barriers
- **Traditional HPC Access Limits Individual User Productivity**
 - Steep Learning Curve for HPC Novice Scientist and Engineers Skill Sets
 - For Experienced HPC Users Traditional Access Limits Collaboration
- **HPC Portal Lower Barriers and Increase Adoption of HPC Tools by Individual Projects (Project Productivity)**
 - No Local Software Installation Required
 - HPC Training and Skill Set Barriers Eliminated
- **Software as a Service (SaaS) Delivery Model Benefits**
 - CREATE: Ease of Product Release, ITAR Restrictions Complications, Bug Fixes
 - USERS: “Self Published” Applications
 - Highly Enhanced Workgroup Collaboration

Portal Objectives

Zero Footprint

Only a web browser is required
Simplified Security Model



HPC Access DoD Wide

Easy and Accessible
Field Device Compatible
Collaboration



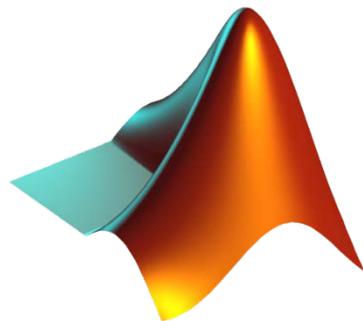
Safe and Secure

Single Sign On



Initial Roll Out: Completed

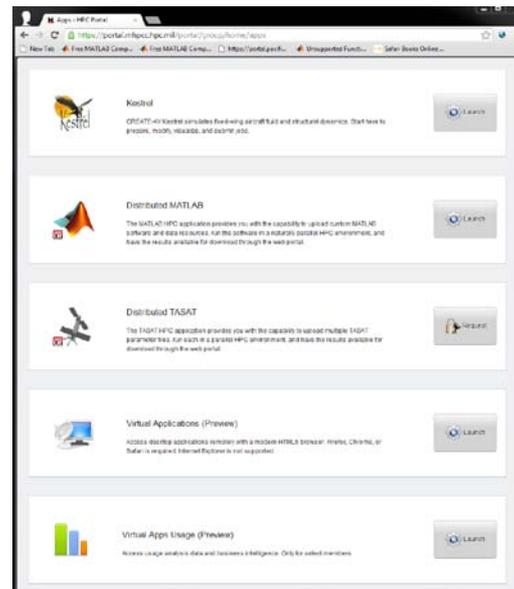
- **Selection of applications based on DoD needs**
 - Value to warfighter
 - Overall sustainability and utility to DoD
 - CREATE-AV Kestrel and MATLAB for initial deployment



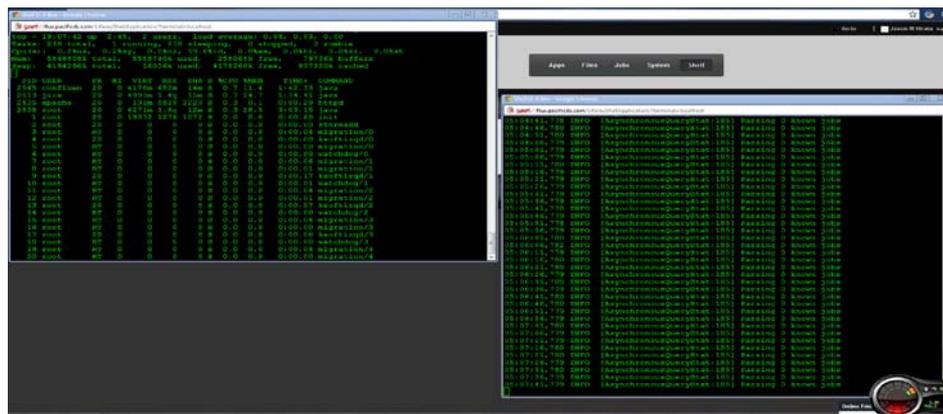
- **2-April-2012, IATT Pioneer Mode for limited users**
- **3-July-2012, Authority to Operate (ATO) received**

Operational Standup 14-November-2012

- Kestrel V2
- Distributed MATLAB
- Distributed TASAT
- Virtual Apps
 - Fieldview, Pointwise, Capstone, MATLAB IDE



- Enhancements
 - Web-Shell
 - Job Management
 - Yubikey



Kestrel Delivery Using HPC-Portal

The screenshot shows the Kestrel web interface with the following parameters:

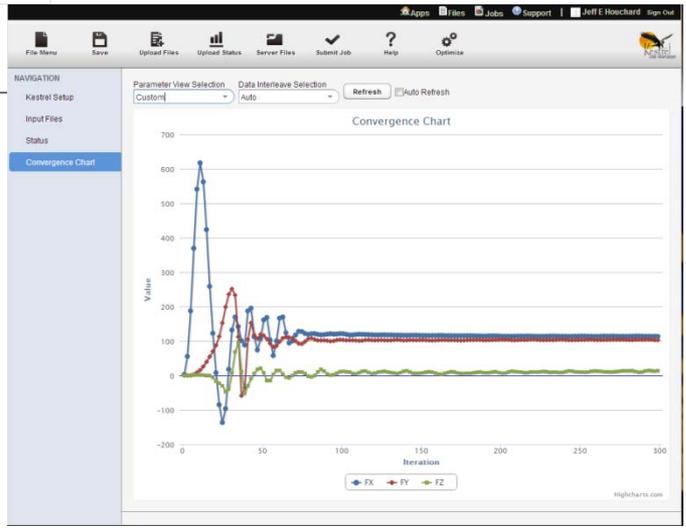
- Global Job Parameters:**
 - Job Name: wwing
 - Description: [empty]
 - TimeStep: 0.001000
 - Startup Iterations: 100
 - Regular Iterations: 200
 - Restart: No
- Output Parameters:**
 - Flow Solution File Format: FIELDVIEW
 - Flow Solution File Type: Volume
 - Structures Solution File Format: TECPLOT (ASCII)
 - Restart Frequency: 0
 - Visualization Frequency: 0
 - Output Reference Frame: Mesh
 - Motion Output Reference Frame: MovesWithBody
 - Visualization Reference Frame: MovesWithBody

The screenshot shows the FieldView software interface. The central window displays a 3D wireframe mesh of a wing structure. The right-hand panel contains various settings for visualization, including 'DISPLAY TYPE' set to 'Constant', 'COLORING' set to 'Geometric', and 'Iso Function' set to $R_{Cyl} = 0 \times 2 + Y^2 + Z^2 - 5$. The 'Scalar Function' and 'Vector Function' sections are also visible.

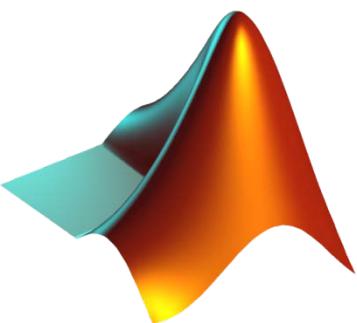
Fieldview Fully Integrated into workflow

Smart Parameter Entry

Convergence Plot (User Selected Parameters)



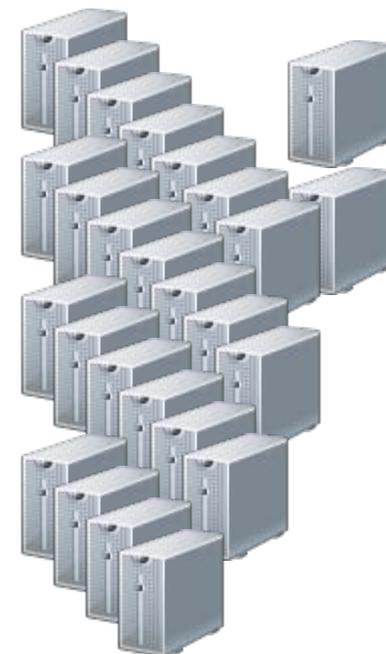
Matlab for Naturally Parallel Jobs



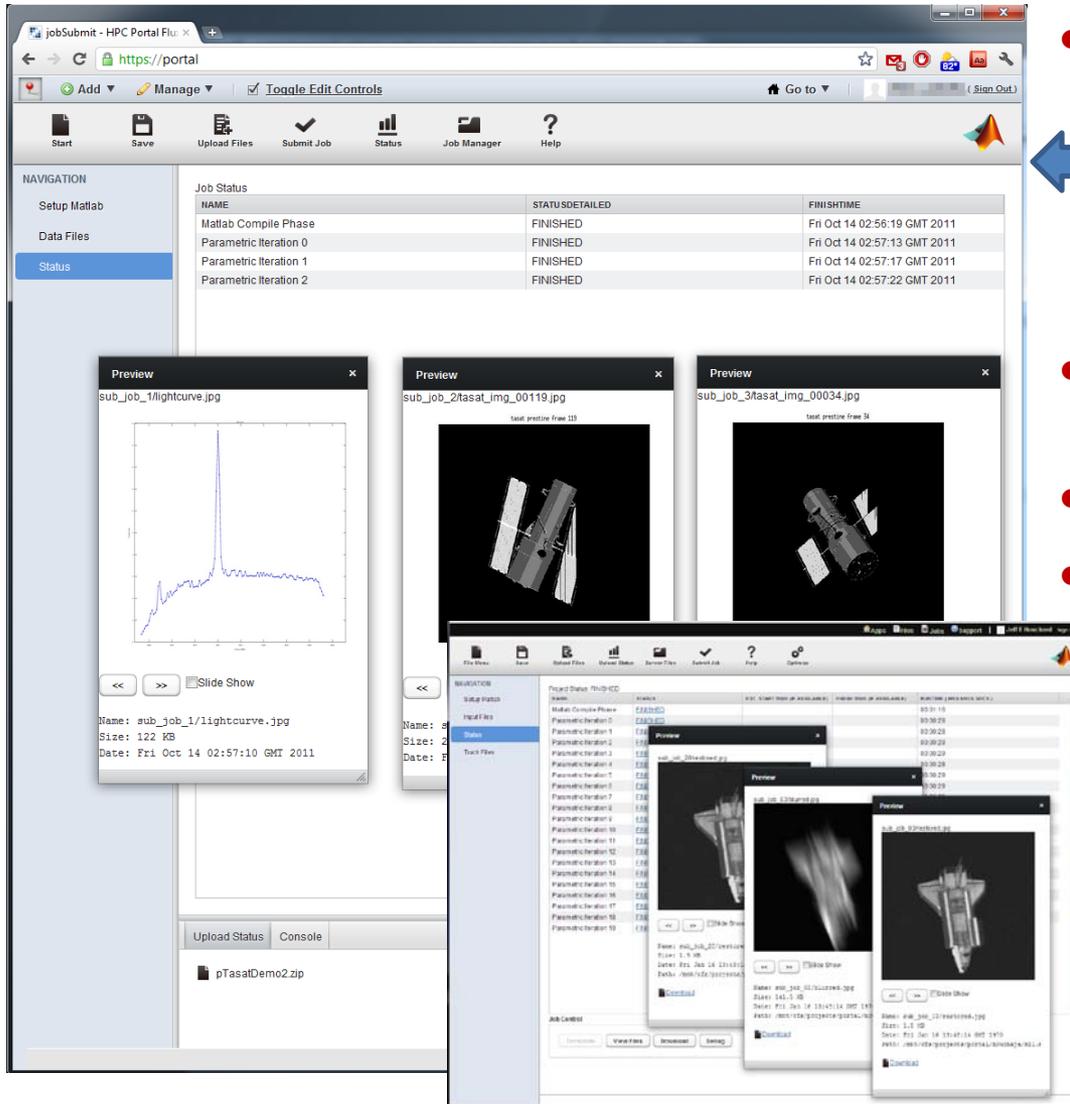
drag and drop
upload
(m files and resources)



automated node
distribution



Matlab Example (Naturally Parallel)



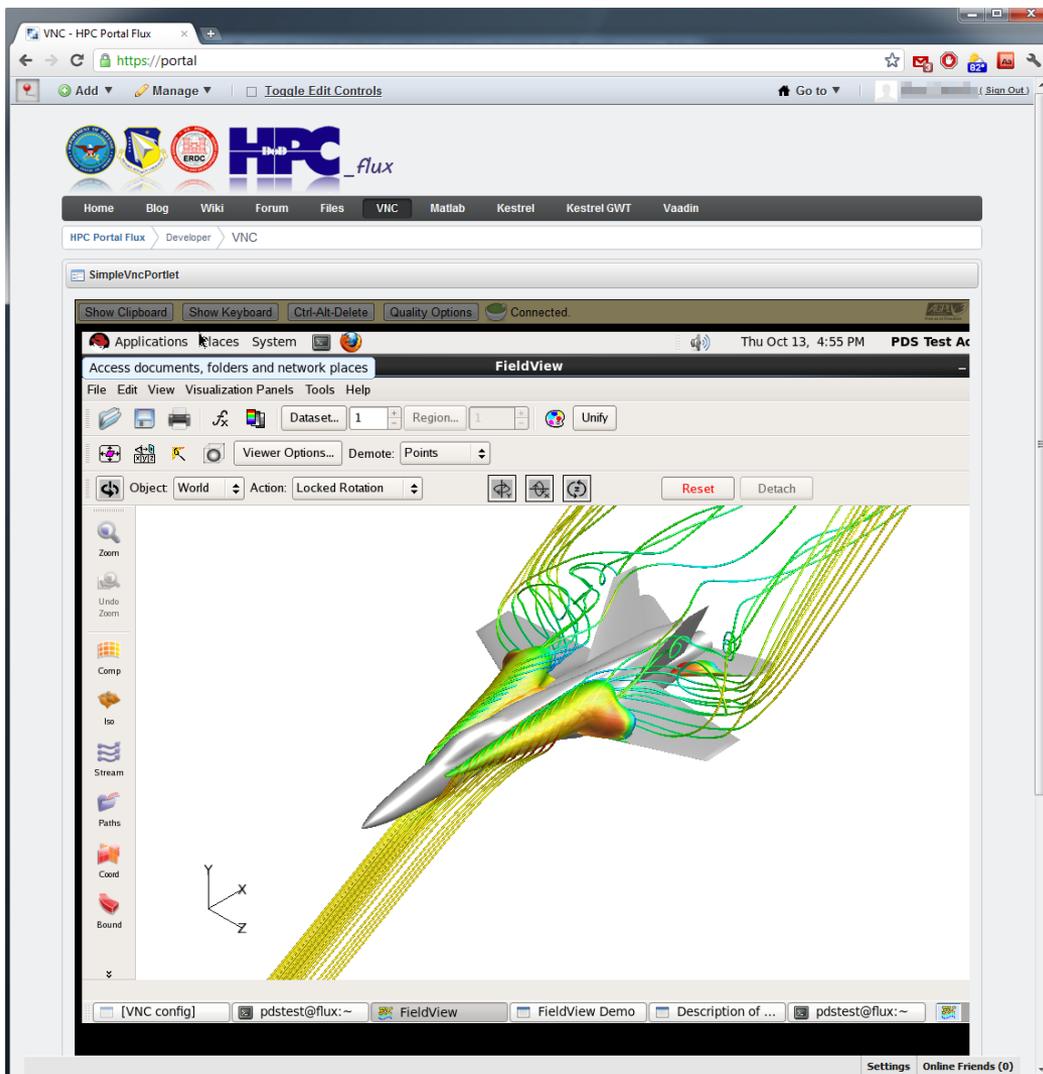
- Example 1: DoD Time-domain Analysis Simulation for Advanced Tracking (TASAT) used to determine accurately simulate reflectance and scattering of satellite materials
- Each iteration generates new light curve with different geometry
- >500 Matlab source files
- Also Includes compiled Fortran modules

Example 2: Blur Deconvolution Study

HPC Portal

VIRTUAL APPS FOR LEGACY / COTS APP DELIVERY

Legacy Application Delivery (Level 0) (Virtual Apps)



- **Quickest standup for legacy apps or COTS**
- **No SW changes**
- **All SW installed at DSRC**
- **Virtualized machine (Windows or Linux) running on a Linux server**
- **App delivered via “zero footprint” browser**
 - HTML5 + JavaScript (AJAX) only
 - No plug-ins or client-side SW required
 - Eliminates user config and maintenance

Example Virtual Applications (vApps)

The image displays a virtual desktop environment with several applications running. On the left is the **vApps Menu**, which lists various applications with their icons and descriptions. In the center is the **Capstone** GUI, showing a 3D model of a mechanical part with various toolbars and panels. On the right is the **MATLAB IDE**, displaying a 3D surface plot titled "Peaks" with axes labeled x, y, and z. The MATLAB window also shows a command window with some text and a workspace window.

Start	Name	Description	Tags
	FieldView Hardware Accelerated	Model and Mesh viewer using Hardware Acceleration.	fieldview, fv, 3d, demo
	FieldView Software Emulated	Model and Mesh viewer using Software Emulation.	fieldview, fv, 3d, demo
	Restricted MATLAB Dev Environment - Projects	Development environment for data analysis, visualization, and computation. Starts in Projects directory. Restricted access for privileged users only.	matlab, analysis, visualization, computation
	Restricted Capstone v2.2	Software system for producing	
	Pointwise	Pointwise	
	GLX Spheres		
	Terminal	Standard basic termina	

HPC Portal SDK

DEVELOPER TOOLS

Portal Developer Tools



HPC Portal Framework

API to simplify
development
of HPC applications



HPC AppUI

Jump start and ease
user interface
development
for interactive HPC web
applications



HPC AppTop & VNC

Legacy application
delivery and enhanced
desktop experience via
the web browser

Portal Developer Tools

- **Portal SDK is being developed for the DoD community using proven concepts**
 - Community share a common repository
 - Community contributes to bug fixes and new features
 - MHPCC moderates changes
- **Portal Framework SDK for HPC resource access**
 - Backend: File and Job Management
 - **HTTP ReSTful service API**
- **Portal AppUI SDK for web interface components**
 - Frontend: Quickly deploy custom HPC web apps
- **Leverage existing technologies**
 - OpenID / Oauth
 - ERDC UIT
 - FY13 demonstration of seamless resource management between MHPCC and ERDC

Status

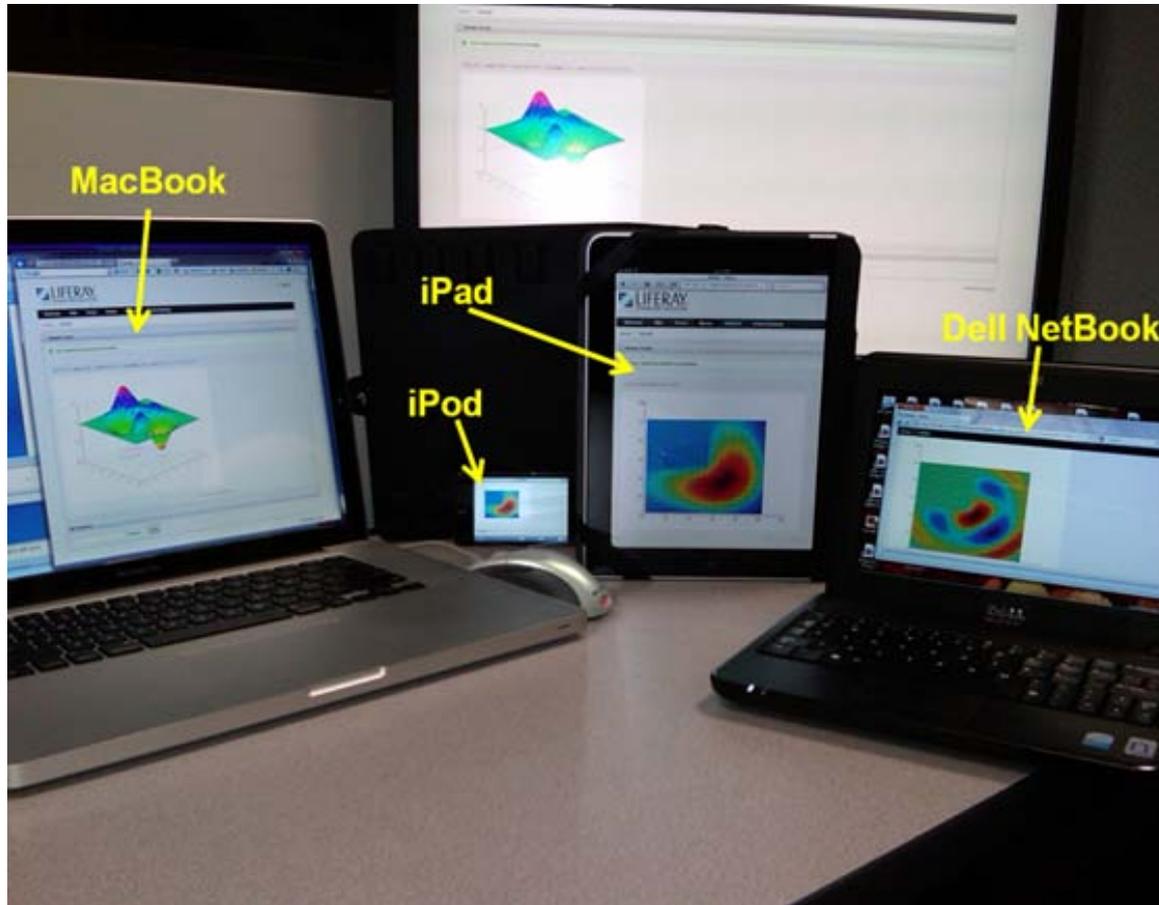
- **Release Cycle “N”, 14-November-2012**

- CREATE-AV Kestrel, Includes ASC Recommended Enhancements (e.g. searchable project mgt) for Pilot
- Distributed MATLAB
- Level 1 TASAT capability for AFRL/RV
- YubiKey support
- Web-based shell access (simplified security model)
- 6-stage agile dev environment for CM, CI, Security, Alpha, Beta, Ops

- **Release Cycle for “N+1” Q2, 2013**

- CREATE-AV DaVinci
- CREATE-AV Kestrel
- CREATE-AV Helios
- JSpOC Mission System (JMS) Development Environment
- One Semi-Automated Forces (OneSAF)
- TASAT (Level 2)

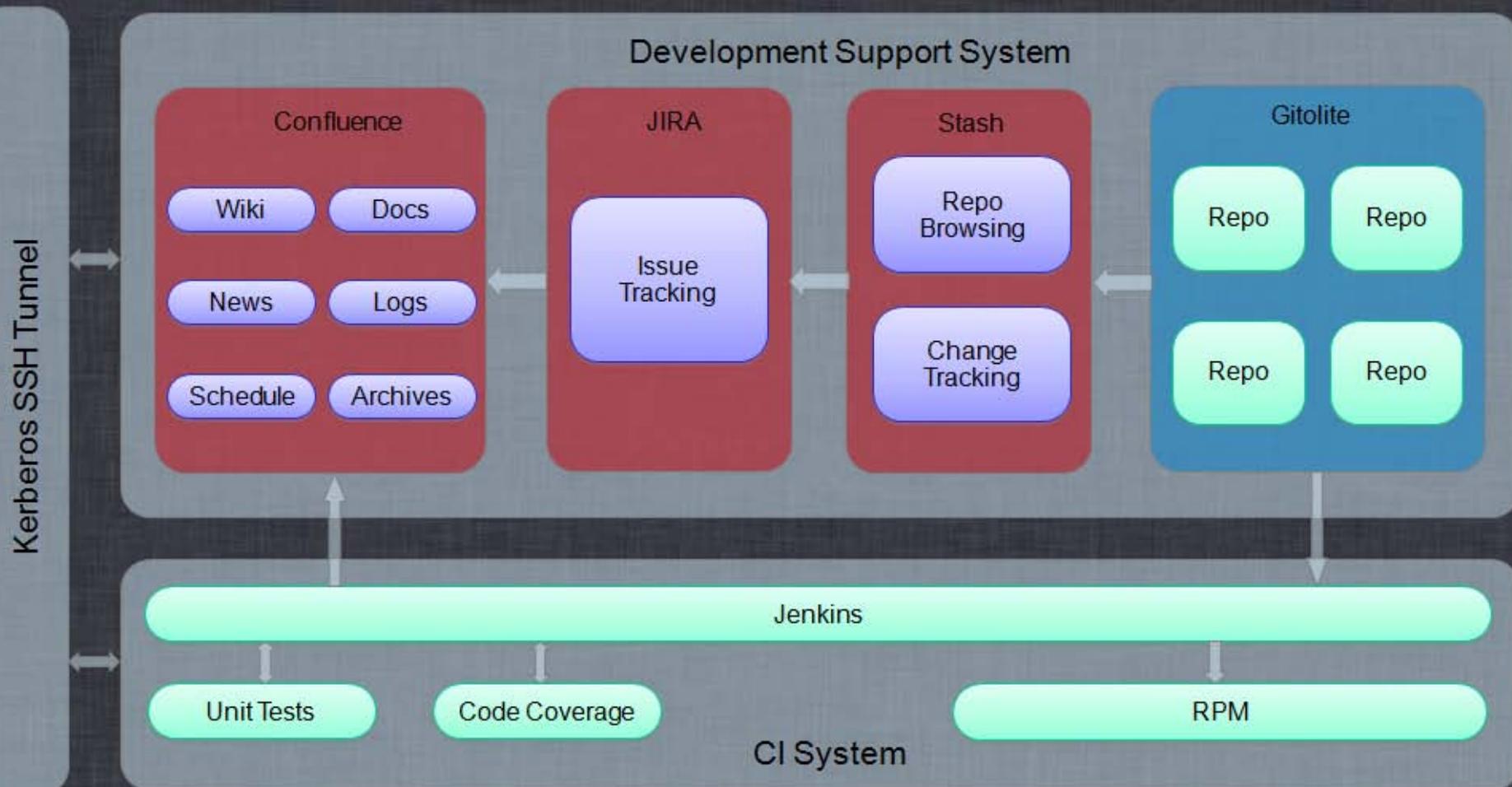
Questions?



- **MATLAB** deliver to traditional and non-traditional devices
- **Drag-and-drop** matlab code
- **Browser** displays HTML results

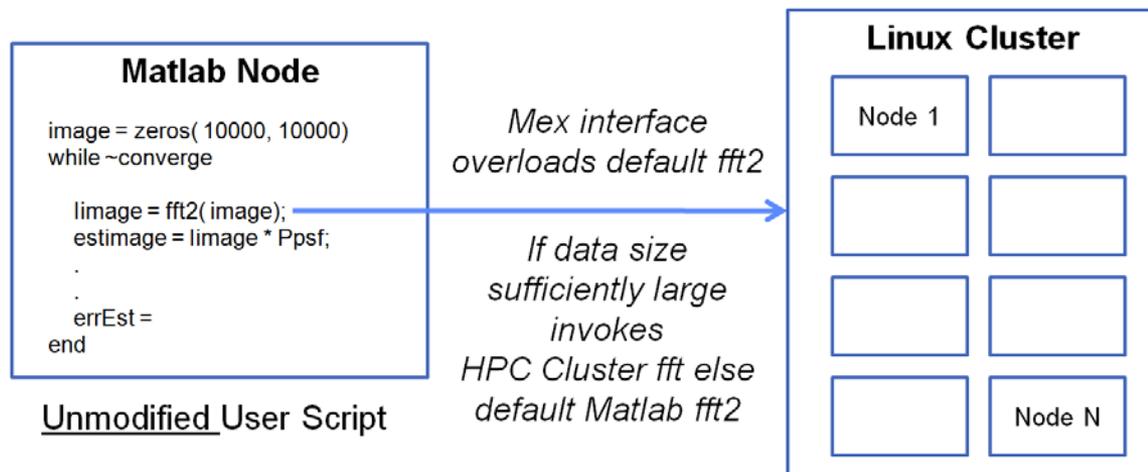
BACKUP

Developer Support Tools



Matlab Example For Deep Parallel Processing

- Matlab on current gen i7 processor
 - `>> tic; fft2(rand(10000)); toc;`
Elapsed time is 7.320237 seconds.
- Typical MFBD image processing will require hundreds of forward and inverse 2-D fft's to estimate a single Object and PSF
- 2D fft (one of many examples) is a naturally parallel
- Useful, for example, for near real-time image processing



- **Example Multi-Frame Blind Deconvolution (MFBD)**
- **fft2 Matlab function is overridden to use compute cluster when warranted by data size and cluster loading**
- **Concept demonstration will be extended to other functions**

Portal Framework API

- Java-Based Object Oriented
- **ReSTful interface for language independence**
- Job-centric
- Models the well-known work flow of a normal HPC user
- Provides software developers with a common API to multiple HPC compute platforms
- Abstracts underlying compute platform implementations through Spring Inversion of Control (IOC)
- Provides Job lifetime management and persistence of Job metadata
- Allows developers to create HPC applications without needing to know HPC "Rules of the Road"



Portal Framework API Example (Java API)

ReST API Available Q2 2013

```
// create the required objects
JobManager job_manager = execContxt.getJobManager(userAuth);
PortalFileManager file_manager = execContxt.getFileManager(userAuth);
HPCCClient client = execContxt.getDefaultHPCCClient(userAuth);

// create the job object through the batch job and add body
BatchJob job = job_manager.createJob(BatchJob.class);
job.append("ps > out.txt");

// create some random test file.
File f = new File("test_file.txt");
file_manager.addFileToJob(f, job);
file_manager.sendFileToFileManager(job, client);
client.executeJob(job);

// busy loop so job is finished before we continue
while(client.updateJobStatus(job) != JobStatus.FINISHED)
Thread.sleep(1000);

// we know an out.txt file ought to have been created.....
Set<String> fileKeys = job.getFileKeys(JobFileType.OUTPUT);
String filename = job.getFilename(JobFileType.OUTPUT, fileKeys.iterator().next());

// get the file..... We know it's on the client because we did not transfer to back to the server
File file = client.getFile(job, fileKeys.iterator().next());
```

Portal AppUI

- **Uses the Portal Framework for backend**
- **Provide default widget sets common to HPC web applications**
 - Example: File manager, Job monitor, File Upload, etc.
- **Full browser window application delivery (e.g. Google Web Apps), IFrame, or Portlet window**
- **Based on Open source API Vaadin**
 - Provides customizable HTML widget sets and backend Java drivers
 - Automatic session management
 - Seamless Portlet/Liferay integration



HPC Portal

FUTURE TECHNOLOGIES

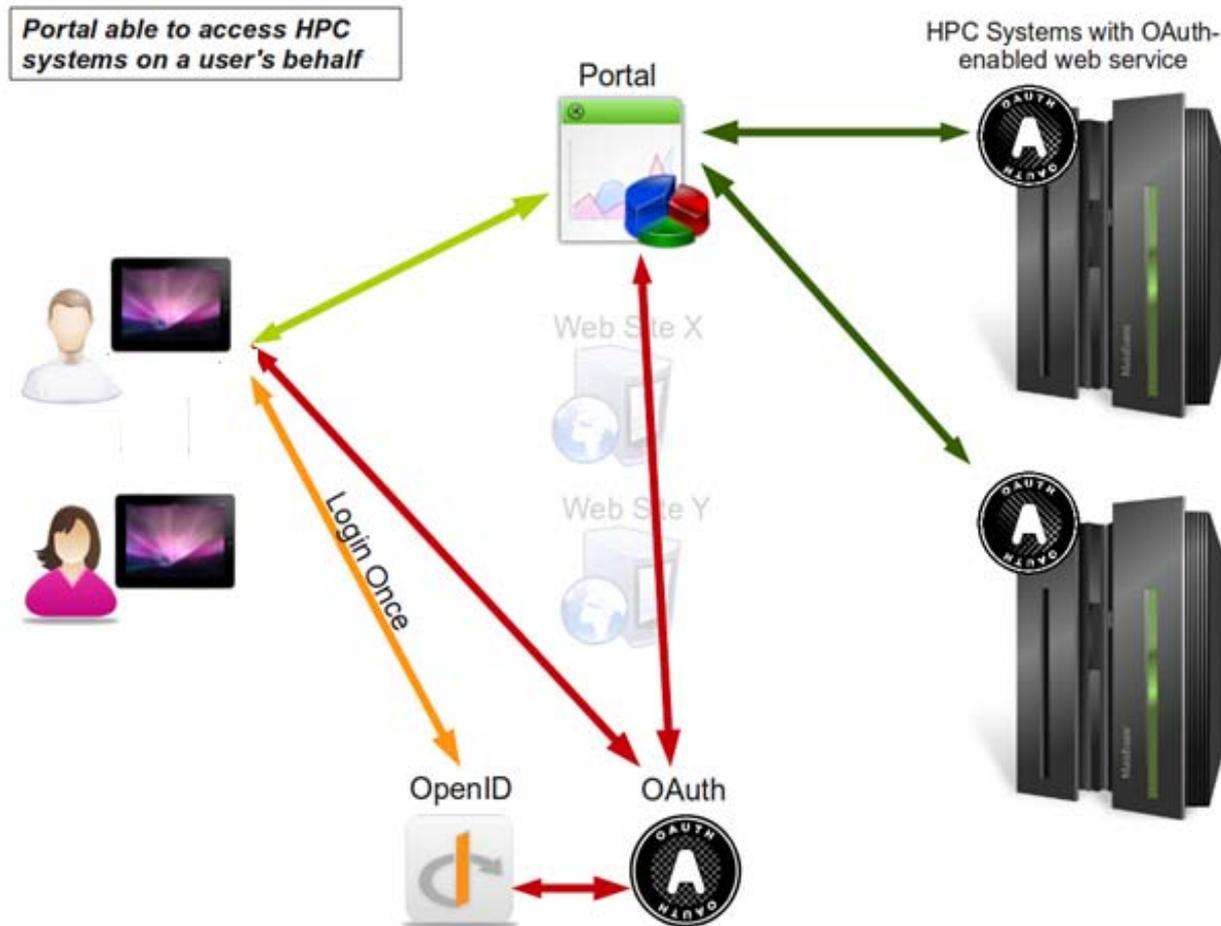
Possible 10 Year Future Vision

- **DoD networks are 20x faster and do not have a “last mile” bottleneck**
- **Most DoD Software is delivered via a browser through DoD-wide portal**
 - Mitigates security concerns; provides full featured commonality across the DoD
 - Browsers become very advanced and very capable
 - Current trend for this is clear HTML 5, web GL, web sockets
 - Browser is thin client OS (Google Model)
 - Supports gesture interface on ipad like devices. Browser becomes “app-store” delivery mechanism.
- **Infrastructure as a service is a DoD standard for super computing**
 - Provides dedicated resources where needed
 - Fast automated buildup and teardown as project resource needs ebb and flow
- **DoD compute jobs are load balanced across the network w/o user intervention**
- **User file systems are cloud based and appear identical and available everywhere to all applications**

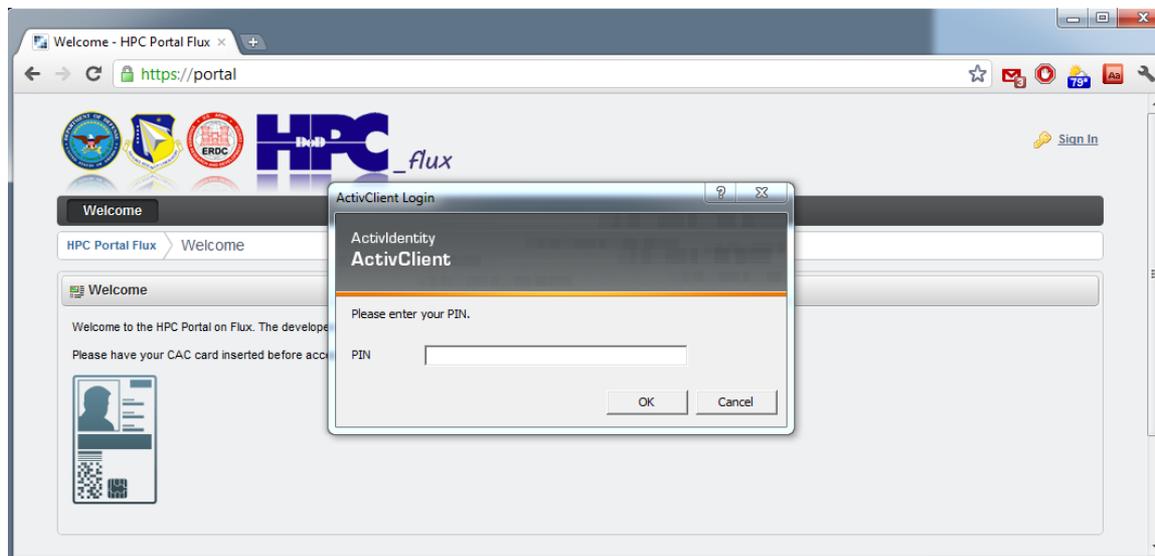
Possible 2 Year Snapshot

- **All CREATE applications available via portal**
- **Common application workflow across CREATE (all applications similar)**
 - Common look and feel of applications like Google docs
 - Knowing one application provides insight into all applications
 - Quicklook utilities provide detailed feedback within the portal w/o downloading the output
- **Commercial software available from portal**
 - Commonly used (possible graphics intense) applications provided w/ either VNC or newer web technologies (e.g. web GL)
- **Load balancing occurs across DSRC's (no user interaction required)**
 - It just works
- **Common file system across DSRC's (what SRB should be someday)**
- **Workflow scenarios (data access and selected applications) easily set up for work groups**
 - Input and output files in easily searchable database
- **Naturally and deep parallel Matlab works without HPC programming**
- **Matlab visual programming available for specialized HPC tasks**
- **Application “publish” capability provide access to approved Matlab applications across the DoD**
 - Provides easy, scalable transition from R&D to production

OpenID / OAuth Provide Secure, Fine Grain Access to HPC on Users' Behalf



Single-Sign-On (SSO)



YubiKey

- In support of “*Enhancements to HPCMP Authentication and Authorization Services*” memo (5 April 2011) OpenID is used for SSO
- DoD high security standards require HW token (CAC or Yubikey) for SSO
 - CAC SSO today, Yubikey SSO soon
- YubiKey selected as a lower cost, higher reliability alternative hToken and secureID

Application Delivery (Cont.)

- **Level 1**

- Hybrid between a clean slate web-based application design and Level 0
- Used for CREATE Kestrel
 - Clean MVC architecture made for easy separation
 - Control logic remains on server
 - Server-side workflow integrated with portal framework
 - Portal appUI used to capture existing KUI user interface
 - Stand-alone version automatically generated for product team development requiring only stand-alone Tomcat

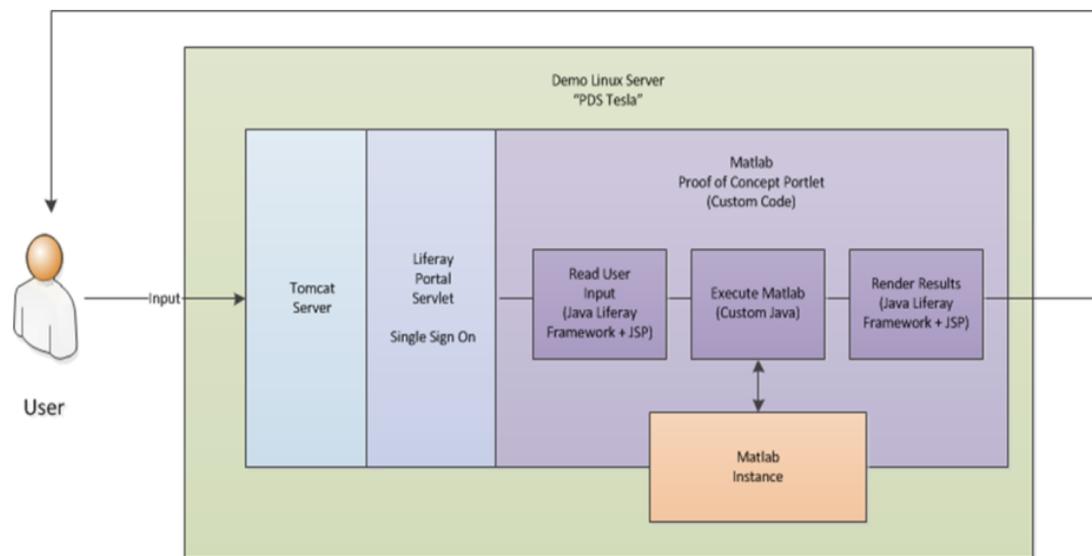
- **Level 2**

- Native HTML5/JavaScript web-based application
- Goal is to provide a bandwidth-aware software development kit (SDK)
 - Capability to view large datasets using level of detail technology
 - e.g. Google Maps supports efficient HTML5 / JavaScript implementations
 - Incorporation of Visual Toolkit (VTK), and ParaViewWeb

Open Source Portal Frameworks Evaluated Using Proof-of-Concept Implementations

Proof-of-concept background

- Drag and drop matlab script into portal window
- Server executes script and returns results including figures and plots to user
- Upload multi-file matlab package for execution
- .mat file download for 3d viewing



- **Matlab Proof-of-concept implemented in frameworks including Liferay, WSO2, Drupal, and Joomla**
- **Liferay selected for superior collaboration & content/identity management**