

# Introduction to the Open Science Grid

OSG Software Carpentry Workshop

Indiana University-Purdue University Indianapolis

March 5<sup>th</sup>, 2015

Emelie Harstad <eharstad@unl.edu>, Mats Rynge <rynge@isi.edu>,  
Bala Desinghu <balamurugan@uchicago.edu>, David Champion <dgc@uchicago.edu>,  
Suchandra Thapa <sthapa@ci.uchicago.edu>, Rob Quick <rquick@iu.edu>

# The Open Science Grid

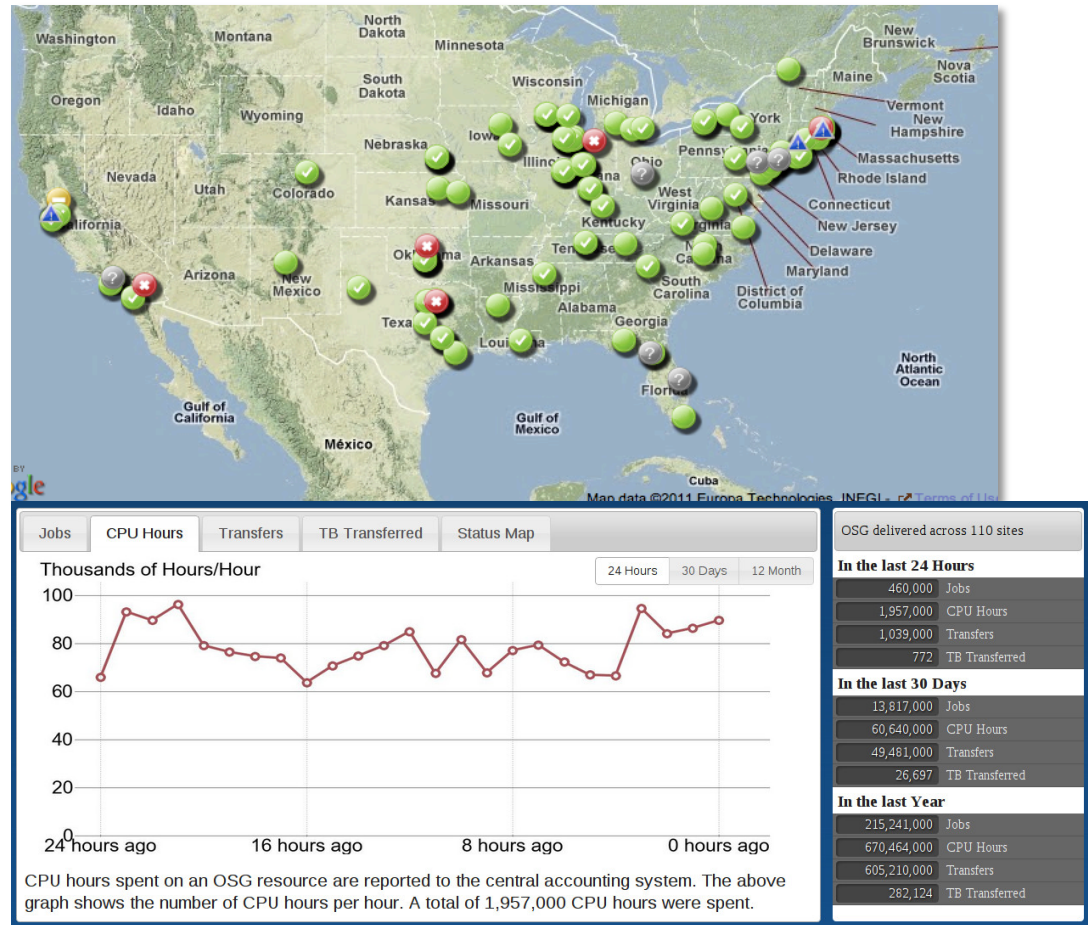
- What is the Open Science Grid
- Organization of OSG
- Who uses OSG
- Computation that is a good fit for OSG
- OSG Connect (Easy on-ramp to OSG)
- Joining a Project
- HTCondor (OSG Job Scheduler)
- Distributed Environment Modules

# The Open Science Grid

A **framework** for large scale distributed resource sharing  
addressing the technology, policy, and social requirements of sharing

OSG is a **consortium** of software, service and resource providers and researchers, from universities, national laboratories and computing centers across the U.S., who together build and operate the OSG project. The project is funded by the NSF and DOE, and provides staff for managing various aspects of the OSG.

Integrates computing and storage resources from over 120 sites in the U.S. and beyond.



# The Open Science Grid

**Mission:** *The Open Science Grid aims to promote discovery and collaboration in data-intensive research by providing a computing facility and services that integrate distributed, reliable and shared resources to support computation at all scales.*

1. Consortium & Project
2. Virtual Organizations
3. Sites

*OSG organizes a set of sites and user communities into a cooperative computing framework for science*

<http://www.opensciencegrid.org/>



# Virtual Organizations

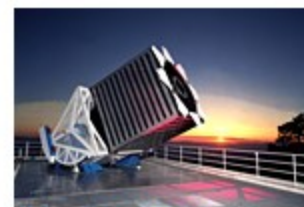
- The OSG environment is VO based.
  - Resource usage accounting
  - VOs can be science communities (e.g. ATLAS, CMS) or
  - Multi-disciplinary Campus based [e.g. U-Nebraska(HCC), U-Wisconsin(GLOW)]
- Each OSG user is a member of a VO (examples: CMS, ATLAS).
- Users can be members of multiple VOs
- Site resources are owned by one or more VOs
- The **OSG VO** provides access to US researchers who are *not already affiliated* with an existing community in OSG.
- OSG VO is “Opportunistic” VO: users take advantage of unused cycles on resources owned by others.

# Who is Using the OSG?

- Astrophysics
- Biochemistry
- Bioinformatics
- Earthquake Engineering
- Genetics
- Gravitational-wave physics
- Mathematics
- Nanotechnology
- Nuclear and particle physics
- Text mining
- And more...



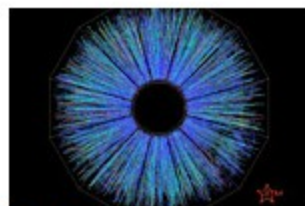
ATLAS Detector  
Copyright CERN  
[Permission Information](#)



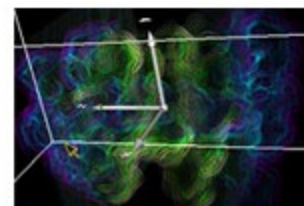
SDSS Telescope  
Image Credit Fermilab  
[Permission Information](#)



CDMS photo  
Image Credit Fermilab  
[Permission Information](#)



STAR Collision  
Image Credit Brookhaven  
National Laboratory/STAR  
Collaboration  
[Permission Information](#)



BioMOCA Application in  
nanoHUB  
Image Credit Shawn Rice,  
Purdue University  
[Permission Information](#)



CMS Detector  
Copyright CERN  
[Permission Information](#)



Auger photo  
Image Credit Pierre Auger  
Observatory  
[Permission Information](#)



MiniBooNE photo  
Image Credit Fermilab  
[Permission Information](#)



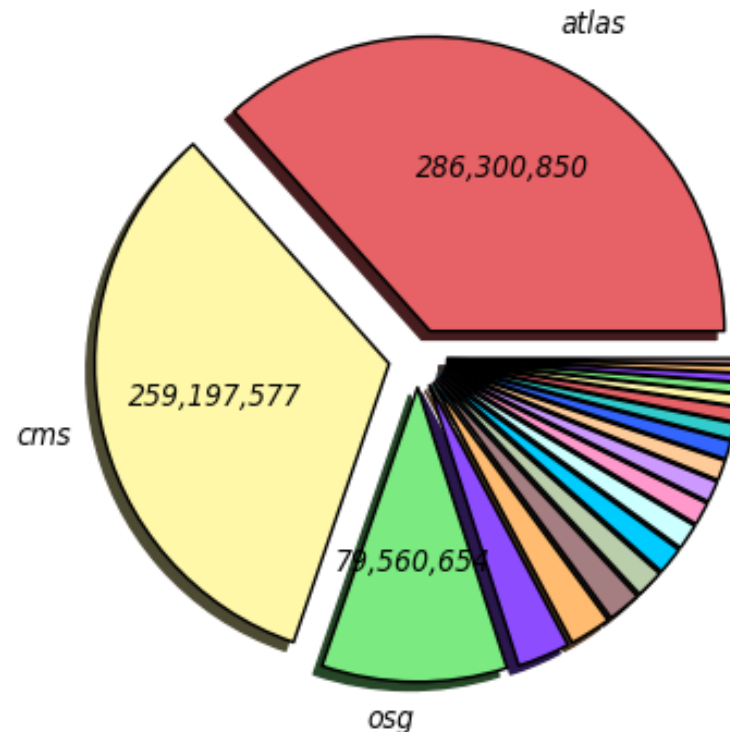
DZero Detector  
Image Credit Fermilab  
[Permission Information](#)



# OSG Usage

Wall Hours by VO (Sum: 782,260,781 Hours)

52 Weeks from Week 44 of 2013 to Week 43 of 2014

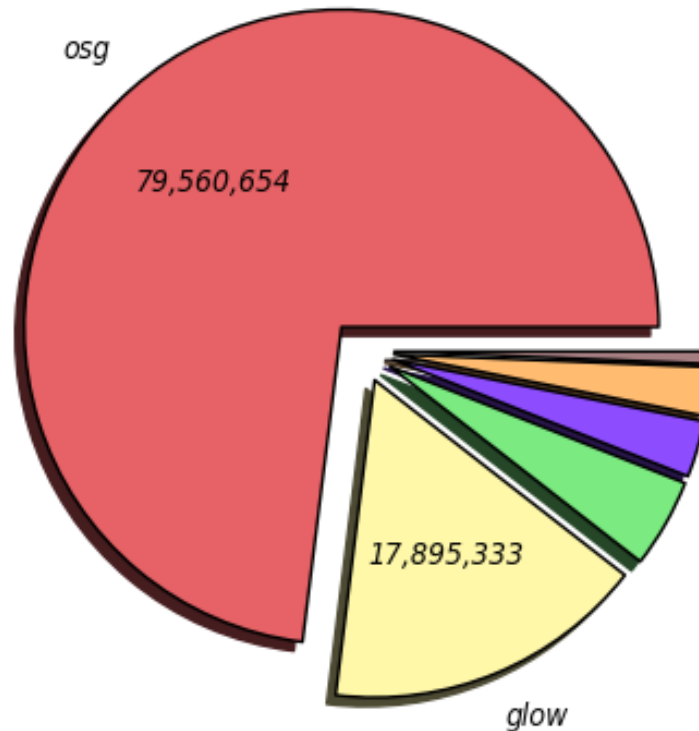


|                     |                       |                    |                    |                    |
|---------------------|-----------------------|--------------------|--------------------|--------------------|
| atlas (286,300,851) | cms (259,197,578)     | osg (79,560,654)   | dosar (22,640,732) | glow (17,895,334)  |
| alice (14,373,223)  | cdf (12,126,817)      | dzero (11,762,440) | mu2e (10,971,064)  | minos (9,859,743)  |
| minerva (9,117,169) | gridunesp (8,627,336) | nova (7,891,909)   | Other (6,848,204)  | mars (6,247,632)   |
| gluex (4,949,466)   | lbne (4,464,922)      | star (3,590,806)   | engage (3,134,371) | sbgrid (2,700,529) |

# OSG Opportunistic Use

*Wall Hours by VO (Sum: 108,929,919 Hours)*

*52 Weeks from Week 44 of 2013 to Week 43 of 2014*



osg (79,560,654)  
hcc (689,565)

glow (17,895,334)

gluex (4,949,466)

engage (3,134,371)

sbgrid (2,700,529)



# OSG Jobs

- **High Throughput Computing**

- Sustained computing over long periods of time. Usually serial codes, or low number of cores threaded/MPI.

- vs. High Performance Computing**

- Great performance over relative short periods of time. Large scale MPI.

- ***Distributed HTC***

- No shared file system
- Users ship input files and (some) software packages with their jobs.

- **Opportunistic Use**

- Applications (esp. with long run times) can be *preempted* (or killed) by resource owner's jobs.
- Applications should be relatively short or support being restarted.

# OSG Jobs

- **High Throughput Computing**

- Sustained computing over long periods of time. Usually serial codes, or low number of cores treaded/MPI.

- vs. High Performance Computing**

- Great performance over relative short periods of time. Large scale MPI.

- ***Distributed* HTC**

- No shared file system
- Users ship input files and (some) software packages with their jobs.

- **Opportunistic Use**

- Applications (esp. with long run times) can be *preempted* (or killed) by resource owner's jobs.
- Applications should be relatively short or support being restarted.

# OSG Jobs

- **High Throughput Computing**

- Sustained computing over long periods of time. Usually serial codes, or low number of cores treaded/MPI.

- vs. High Performance Computing**

- Great performance over relative short periods of time. Large scale MPI.

- ***Distributed* HTC**

- No shared file system
- Users ship input files and (some) software packages with their jobs.

- **Opportunistic Use**

- Applications (esp. with long run times) can be *preempted* (or killed) by resource owner's jobs.
- Applications should be relatively short or support being restarted.

# Properties of DHTC Jobs

- Run-time: 1-12 hours
- Single-threaded / non-proprietary software
- Require <2 GB Ram
- Statically compiled executables (transferred with jobs)
- Input and Output files transferred with jobs, and reasonably sized: <10 GB per job (no shared file system on OSG)

# Properties of DHTC Jobs

- Run-time: 1-12 hours
- Single-threaded / non-proprietary software
- Require <2 GB Ram
- Statically compiled executables (transferred with jobs)
- Input and Output files transferred with jobs, and reasonably sized: <10 GB per job (no shared file system on OSG)

## **These are not hard limits!**

- Checkpointing (built-in to application) – for long jobs that are preempted
- Limited support for larger memory jobs
- “Partitionable” slots – for parallel applications using up to 8 cores
- Distributed Environment Modules – a collection of pre-installed software packages, distributed by OASIS

# OSG Connect

- By joining **OSG Connect**, a user automatically becomes a member of **OSG VO**.
- OSG Connect provides a *virtual cluster* that users can submit jobs to – this makes OSG look like a single resource (single Condor pool) to the user.
- Authenticate through home institution (InCommon/CILogon)  
**NO X509 CERTIFICATES REQUIRED!**
- User support: (online: [Connectbook](#) and [connect-support@OPENSCIENCEGRID.org](mailto:connect-support@OPENSCIENCEGRID.org))



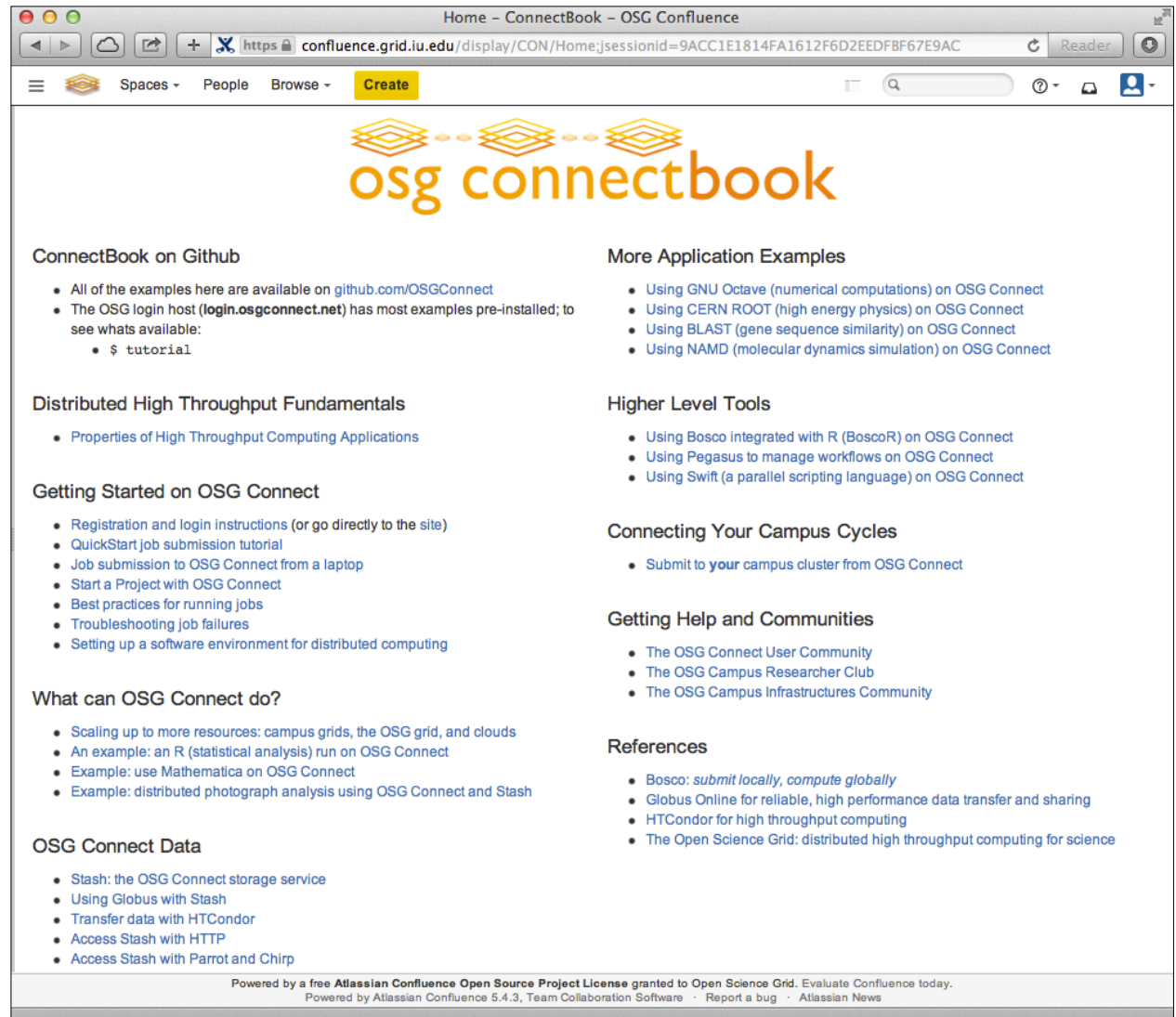
# OSG Connect

Easy entry

No certificates

Comes with  
support !

[<connect-support@opensciencegrid.org>](mailto:<connect-support@opensciencegrid.org>)



The screenshot shows a web browser window displaying the 'ConnectBook - OSG Confluence' page. The browser's address bar shows the URL 'https://confluence.grid.iu.edu/display/CON/Home?sessionId=9ACC1E1814FA1612F6D2EEDF8F67E9AC'. The page features the 'osg connectbook' logo at the top. Below the logo, the content is organized into several sections with bulleted links:

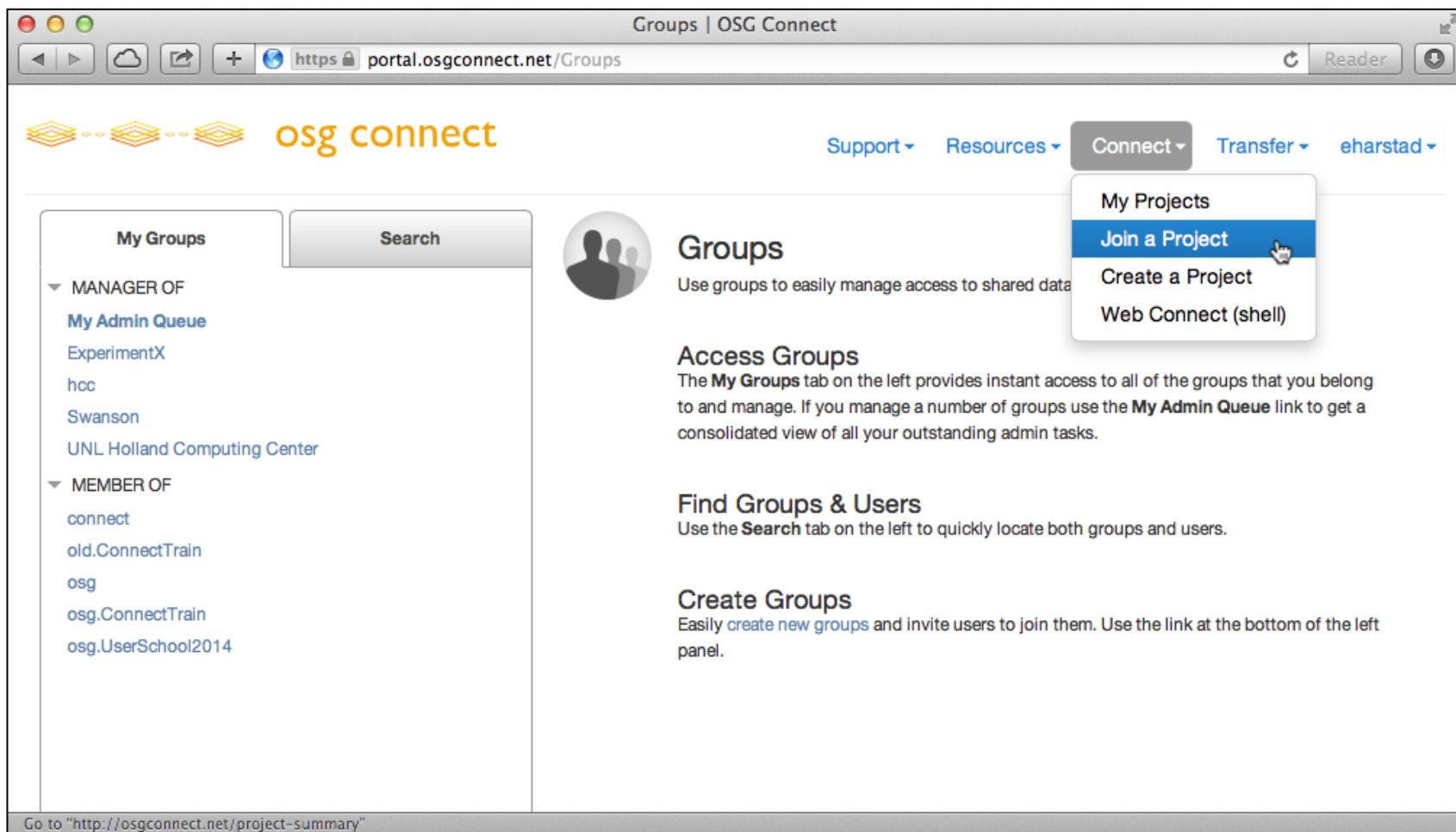
- ConnectBook on Github**
  - All of the examples here are available on [github.com/OSGConnect](https://github.com/OSGConnect)
  - The OSG login host ([login.osgconnect.net](https://login.osgconnect.net)) has most examples pre-installed; to see whats available:
    - \$ tutorial
- Distributed High Throughput Fundamentals**
  - [Properties of High Throughput Computing Applications](#)
- Getting Started on OSG Connect**
  - [Registration and login instructions \(or go directly to the site\)](#)
  - [QuickStart job submission tutorial](#)
  - [Job submission to OSG Connect from a laptop](#)
  - [Start a Project with OSG Connect](#)
  - [Best practices for running jobs](#)
  - [Troubleshooting job failures](#)
  - [Setting up a software environment for distributed computing](#)
- What can OSG Connect do?**
  - [Scaling up to more resources: campus grids, the OSG grid, and clouds](#)
  - [An example: an R \(statistical analysis\) run on OSG Connect](#)
  - [Example: use Mathematica on OSG Connect](#)
  - [Example: distributed photograph analysis using OSG Connect and Stash](#)
- OSG Connect Data**
  - [Stash: the OSG Connect storage service](#)
  - [Using Globus with Stash](#)
  - [Transfer data with HTCondor](#)
  - [Access Stash with HTTP](#)
  - [Access Stash with Parrot and Chirp](#)
- More Application Examples**
  - [Using GNU Octave \(numerical computations\) on OSG Connect](#)
  - [Using CERN ROOT \(high energy physics\) on OSG Connect](#)
  - [Using BLAST \(gene sequence similarity\) on OSG Connect](#)
  - [Using NAMD \(molecular dynamics simulation\) on OSG Connect](#)
- Higher Level Tools**
  - [Using Bosco integrated with R \(BoscoR\) on OSG Connect](#)
  - [Using Pegasus to manage workflows on OSG Connect](#)
  - [Using Swift \(a parallel scripting language\) on OSG Connect](#)
- Connecting Your Campus Cycles**
  - [Submit to your campus cluster from OSG Connect](#)
- Getting Help and Communities**
  - [The OSG Connect User Community](#)
  - [The OSG Campus Researcher Club](#)
  - [The OSG Campus Infrastructures Community](#)
- References**
  - [Bosco: submit locally, compute globally](#)
  - [Globus Online for reliable, high performance data transfer and sharing](#)
  - [HTCondor for high throughput computing](#)
  - [The Open Science Grid: distributed high throughput computing for science](#)

At the bottom of the page, a footer states: 'Powered by a free Atlassian Confluence Open Source Project License granted to Open Science Grid. Evaluate Confluence today. Powered by Atlassian Confluence 5.4.3, Team Collaboration Software · Report a bug · Atlassian News'

# Projects in OSG Connect

- *Projects* in OSG are used for organizing groups and jobs, granting access to resources, usage accounting.
- Every job submitted through OSG Connect must be associated with a project.
- Principal Investigators or their delegates may create projects and manage project membership.
- To apply for a new project: <https://portal.osgconnect.net>  
Select: Connect -> Create a Project
- OSG Connect administrator must approve the new project
- To join a pre-existing project: <https://portal.osgconnect.net>  
Select: Connect -> Join a Project

# Projects in OSG Connect



The screenshot shows the OSG Connect web interface in a browser window. The browser's address bar displays `https://portal.osgconnect.net/Groups`. The page header includes the OSG Connect logo and navigation links: [Support](#), [Resources](#), [Connect](#), [Transfer](#), and [eharstad](#). The [Connect](#) dropdown menu is open, showing options: [My Projects](#), [Join a Project](#) (highlighted with a mouse cursor), [Create a Project](#), and [Web Connect \(shell\)](#).

The main content area is titled "Groups" and features a "My Groups" sidebar on the left. The sidebar lists groups under two categories: "MANAGER OF" (including [My Admin Queue](#), [ExperimentX](#), [hcc](#), [Swanson](#), and [UNL Holland Computing Center](#)) and "MEMBER OF" (including [connect](#), [old.ConnectTrain](#), [osg](#), [osg.ConnectTrain](#), and [osg.UserSchool2014](#)). A "Search" button is located next to the "My Groups" header.

The main content area contains the following sections:

- Groups**: Use groups to easily manage access to shared data.
- Access Groups**: The **My Groups** tab on the left provides instant access to all of the groups that you belong to and manage. If you manage a number of groups use the **My Admin Queue** link to get a consolidated view of all your outstanding admin tasks.
- Find Groups & Users**: Use the **Search** tab on the left to quickly locate both groups and users.
- Create Groups**: Easily [create new groups](#) and invite users to join them. Use the link at the bottom of the left panel.

At the bottom of the page, a status bar indicates: "Go to 'http://osgconnect.net/project-summary'"

# HTCondor - OSG Job Scheduler

- HTCondor is the OSG **Job Scheduler**
- Matches jobs to available resources
- Provides an **overlay**: Collection of compute nodes at different OSG sites appears as a single resource to users
- Simplifies job submission: only one submission necessary to **access nation-wide pool of resources**
- Made possible by **flocking**

Basic procedure:

- 1) Move all job files to the submit node (or create files directly on the node)
- 2) Log in to the submit node (`ssh <username>@login.osgconnect.net`)
- 3) Create a Condor submit script (contains information for the job scheduler)
- 4) Submit the job using the 'condor\_submit' command.

# Distributed Environment Modules

- Popular (and some requested) software packages and libraries are made available via OASIS repository
- Users don't have to transfer software with their jobs
- Modules address ease of use issues
- Many users are already familiar with modules environment
- Example: `module load python/2.7`
- More information: [here](#)