The OSG Open Facility: An on-ramp for opportunistic scientific computing

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The Open Science Grid

- **Goal:** *Advance science through open distributed high throughput computing* (DHTC) in the US
  - Operates as a partnership between *resource providers* (sites) and *stakeholders* (scientific communities of users)
  - OSG *project* provides middleware, services, and support
    - *Advancing the state of the art in High Throughput Computing*
  - Over 120 sites (computing and storage elements)
    - Mix of university and national labs; LHC experiment computing sites and campus clusters
  - Uses the *Virtual Organization* (VO) model
    - Most VOs correspond to large HEP experiments and university communities
- Funded by the *US Dept. of Energy* and *National Science Foundation*
  - Second 5 year period of support
In the past 30 days
113 Million Core hours

Over the last 12 months
150 Million jobs consumed
1.2 Billion hours of computing
involving 1.9 Billion data transfers
to move 218 Petabytes

This aggregate was accomplished by
federating 129 clusters
that contributed 1h to 100M hours each

http://display.grid.iu.edu
Growth of the OSG

Past 12 months:
Averaging 100M hours/month
Reaching beyond HEP

Science other than the LHC makes up ~34% of OSG hours
Science other than physics makes up ~20% of OSG hours
Opportunistic computing on the OSG

- Considerable effort to extract **opportunistic resources** across OSG
  - Nearly **200M hours** in 2015
- Most are available through the **OSG VO**
  - Allows **any researcher** from US institutions
  - Accessible through multiple mechanisms (including XSEDE allocation)
  - Most OSG sites support the OSG VO
- Despite LHC Run 2 demand, opportunistic OSG resources continue to grow
  - In part due to **university clusters** not affiliated with HEP experiments offering opportunistic resources
Access to the Open Facility

- OSG operated
- Campus/lab operated

- OSG Connect
- OSG Connect login node [Chicago]
- OSG-XD login node [Indiana]
- Campus login/submit hosts (e.g. MIT)
- OSG VO Flocking (frontend)
- Campus OSGConnect clients (e.g. Duke)
- GlideinWMS factory [UCSD]
- OSG DHTC Fabric: >100 sites
- Stash (data)
- CVMFS (software)

- XSEDE allocations on OSG
- Legacy OSG direct

- OSG operated
- Campus/lab operated

- Researcher
From big science...

- LIGO: 20M hours since 10/2015
- AMS-02: 16M hours since 3/2016
- Mu2e: 35M hours in 2015
- IceCube: 8M hours in 2015
Optical data communication and compression
David Mitchell (NM State)
• Important for digital space/satellite communication
• Simulate whole system (transmitter, decoder, receiver)

Randomness in evolution
Joshua Plotkin (Penn State)
• Understand evolution at molecular scale in DNA
• Uses a combination of mathematical modeling and simulation

Gene interaction graph construction
Alex Feltus (Clemson)
• Discovery of gene sets underlying complex traits in organisms
• Applied to agricultural genomics to find traits that may accelerate crop growth

Study of $\mathbb{Z}_2$ gauge theory coupled to fermionic fields
Snir Gazit (UC Berkeley)
• Quantum Monte Carlo to study confinement transitions

Just a few of the researchers who use 1M+ hours annually on the OSG!
… to individual researchers

115M CPU hours
2/1/2015-2/1/2016

96 projects across 81 institutions

Most prolific individual consumed

34M hours in 2015
• OSG jobs have run on two NSF HPC facilities

• LIGO utilized an allocation at **TACC Stampede** by OSG job submission
  – ~4M hours utilized in 2015
  – Stampede OSG “site” in testing for allocations for CMS and MINOS experiments

• **SDSC Comet** access via its Virtual Cluster (VC) interface
  – Helped commission the VC interface
  – Delivered 3.5M hours in 2016
  – From users’ perspective “just another site” on the OSG
New technologies and growth

• Solving the data movement conundrum: **Stashcache**
  – XRootD-based caching system for O(1TB) data movement
  – See B. Bockelman (#501) on Thursday
• Easing the integration of campus clusters: **HTCondorCE-Bosco**
  – Simplified computing element layer (which can be administered/hosted offsite) needing only SSH access to cluster
  – See D. Weitzel (#503) on Wednesday
• **Virtual computing centers** using OSG technology
  – Single access point accessing campus clusters and OSG open facility
  – See C. Paus (#276) on Thursday
• **Site-in-a-box** using OSG technology
  – Initial deployment at Univ. of California campuses for LHC T3s
  – See J. Dost (#269) on Thursday
Conclusions

• Opportunistic resources and their consumption continue to grow on the OSG
  – On track to delivering over 200M hours opportunistically in 2016

• A wider range of users, including large collaborations, use these resources

• A key to this growth is the expansion of available resources into university HPC clusters and large allocation-based HPC resources

• The OSG is committed to remaining one of the largest open gateways for scientific computing in the US
  – This is from O(1k) collaborations down to individual researchers
  – OSG resource providers remain committed to sharing
Backup: Universities and national labs

This includes Universities that have no LHC involvement

Other

Universities with an LHC T2

DOE Labs: BNL, FNAL, SLAC, NERSC, LLNL

This includes large Campus clusters independent of the LHC.