How Resources are Shared and Used through the OSG

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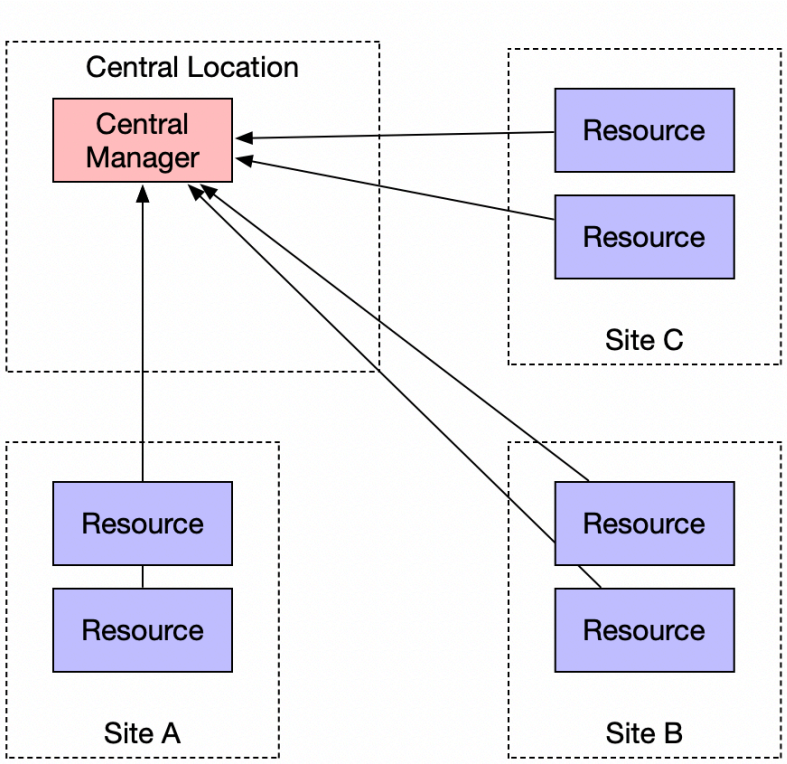
Sites and OSG

- A site on the OSG is a collection of resources – clusters – that are run by a specific administrative domain.
  - **Example**: the Holland Computing Center at Nebraska is an OSG site that makes several clusters available as OSG resources.
  - **Example**: A new CC* award recipient would like to make their new compute cluster available to LIGO and backfilled by other scientific work on the OSG.
- *Goal for today*: explain how OSG facilitates sites to share resources with the communities they are interested in.
  - Ideally, this helps meet your CC* goal of making 20% of your resources available for external communities.
  - A later presentation
  - Some technical details are present but this is meant to be fairly high-level.

Resource Sharing on the OSG

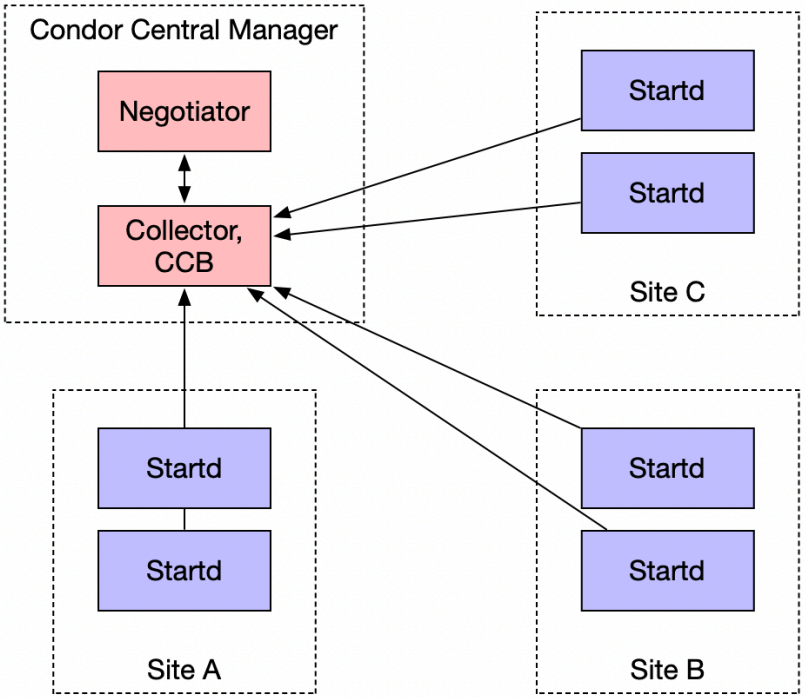
- OSG shares resources via the concept of an “overlay pool”.
  - Disparate worker node resources are allocated (think: starting a VM).
  - Some piece of software (“pilot”) starts on the worker node which subsequently connects to a central pool.
  - Work – batch jobs! - from a the outside is pulled down to the worker node and executed. These are “payload” jobs.
- Technologies we’ll see today:
  - HTCondor manages the jobs and central pool.
  - glideinWMS helps decide where and when to allocate resources.



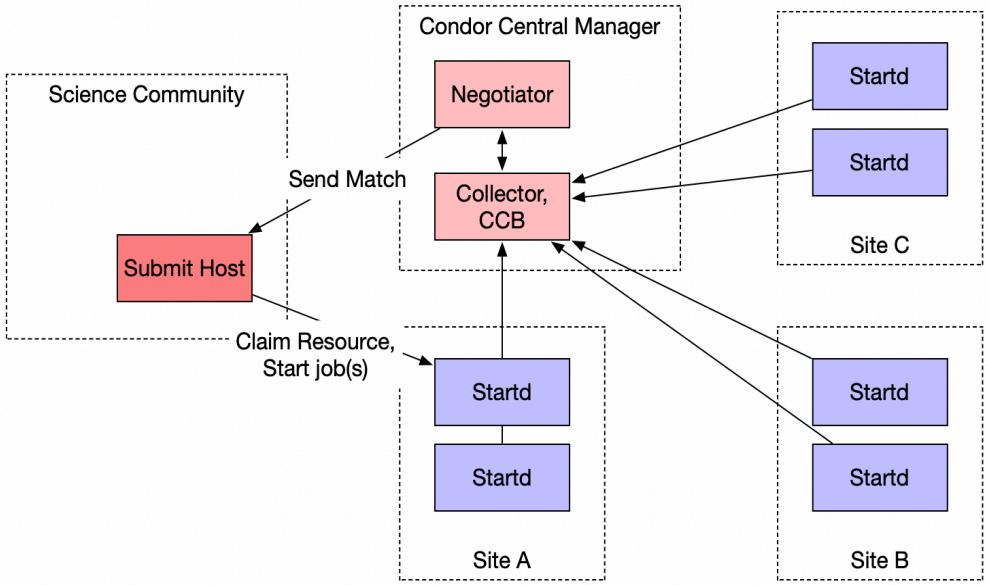
Now with Jargon!

In HTCondor Jargon:

- The software the pilot deploys on the site's worker node is called the **startd**.
- The central manager has three primary components:
  - **Collector**: daemon where all the resource descriptions are uploaded from the worker node.
  - **Condor Connection Broker (CCB)**: Used to manage network connections, allowing **startd** to be behind a NAT.
  - **Negotiator**: Implements policy and allocates the share of resources to different users.



Distributed HTCondor in 2 minutes



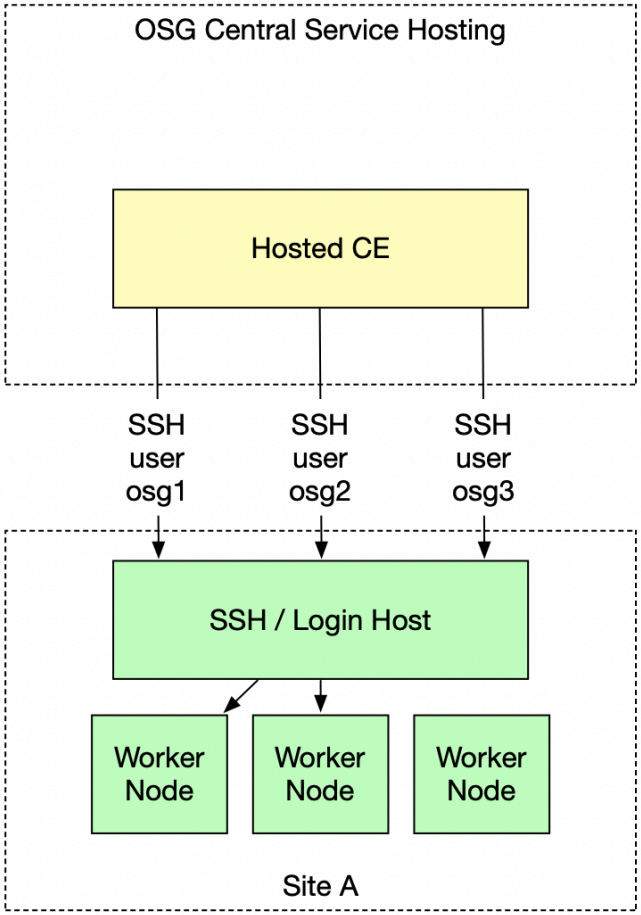
Complexities not shown:

- A science community may have several job submit hosts.
- Different communities (particularly, large ones) may decide to run their own pools.
  - OSG runs a pool for individual PI groups.
  - OSG also runs pools for larger collaborations such as LIGO.
- In this picture, all three sites are only supporting one community.

Allocating Resources

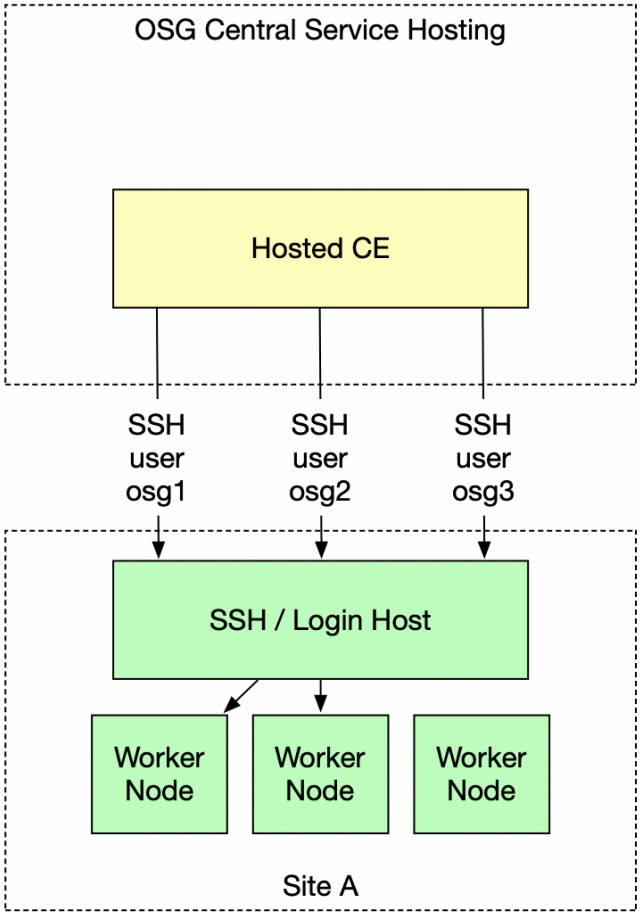
"Resources Allocations" are really batch jobs.

- These batch jobs arrive from an OSG-hosted "Compute Element" to the site login host.
  - One CE per SSH host.
- You can ban or prioritize individual communities without involving OSG as each community is a distinct batch user.
- OSG is here to facilitate resource sharing, not demand specific resource allocations.
  - There is a "special community" (confusingly, also called the "OSG"), run by OSG, which redistributes resources with an emphasis on single PIs.
  - The "OSG Community" also include XSEDE allocations, scientific collaborations -- all under the umbrella of 'open science' and research.
    - We have simple demographics and accounting for this community available to you.



Allocating Resources

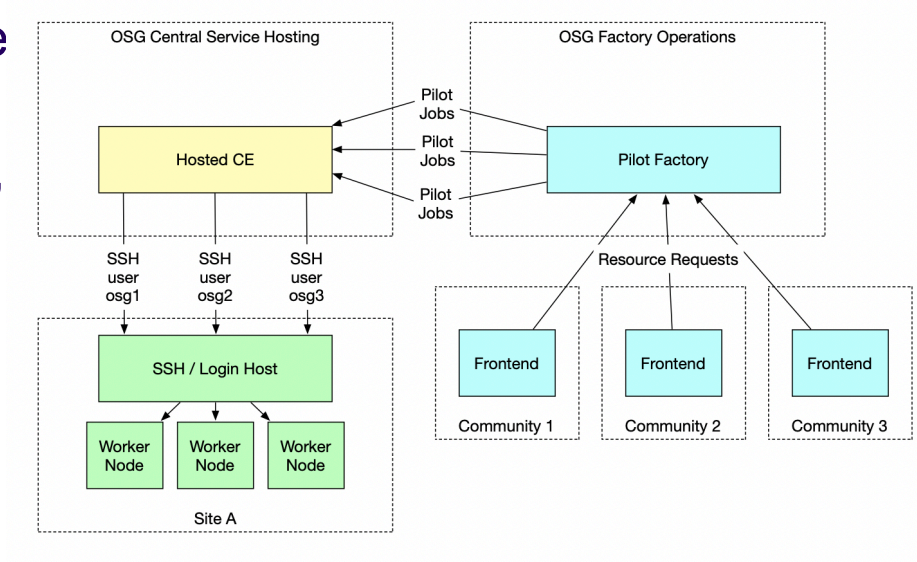
- Each community is mapped to a **different Unix account**.
- For ease of configuration, we request these be of the form osg01, osg02, … osg20.
  - **By pre-creating these accounts, we hope to never ask for new ones in the future**.
  - If this is an undue burden, let us know – we aim to keep startup costs low!
  - The mapping from "osgNN" Unix account to community name is found on our website.
  - We will provide an SSH public key – more later.



Allocating Resources

The OSG "factory" creates pilot jobs for each CE to submit to the local batch system.

- Most, but not all, communities use the OSG-run factory. Some run their own.
- Each community has a "frontend," which determines the resource requests per site based on their current job load and profile.
- The factory translates those resource requests to pilot jobs to various CEs.
  - The hosted OSG-CE will transform these to jobs appropriate for your site's batch system and submit over SSH.



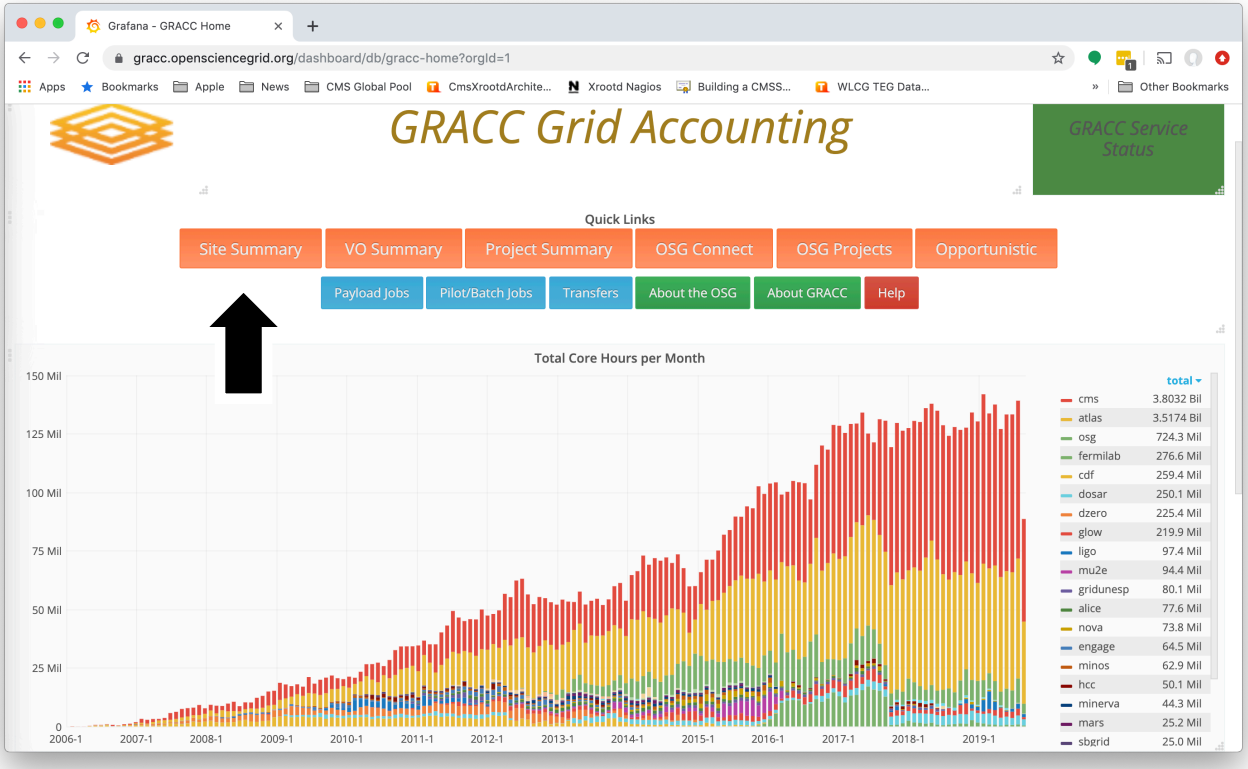
Resource Accounting

- CC* program aims to make available 20% of the resources to external communities.
  - Both “make available” and “20%” are surprisingly hard to define. How you interpret this is between you and ~~god~~ NSF – not OSG’s business!
  - OSG helps provide input to this process by making some simple accounting numbers available.
- Unfortunately, accounting is surprisingly subtle on OSG:
  - **Pilot** accounting tells us what compute resources were made available via the batch system.
  - **Payload** accounting tells us how the communities use the allocated resources.
- Ideally, these are identical: **in practice, they are not**!
  - Example: a pilot may start up but find that all payload jobs are already gone.
  - In most cases, these numbers are within 10% of each other.

Other Accounting Gotchas

- A few other notable “gotchas”
  - Not all communities report the same details to OSG on how they use the resources.
    - **Example**: LHC community does not provide payload details.
  - Some communities utilize the OSG services to reach non-US sites.
    - **Example**: we only get payload information from European sites running IceCube, not pilot.
- Because this is complex, it’s useful to think carefully about what question you want to ask the system.
  - I’ll walk through a few screenshots on what I think is most important.

Grid Resource ACCounting (GRACC) portal



Accessible at https://gracc.opensciencegrid.org or by clicking on "explore our accounting portal" on the homepage.

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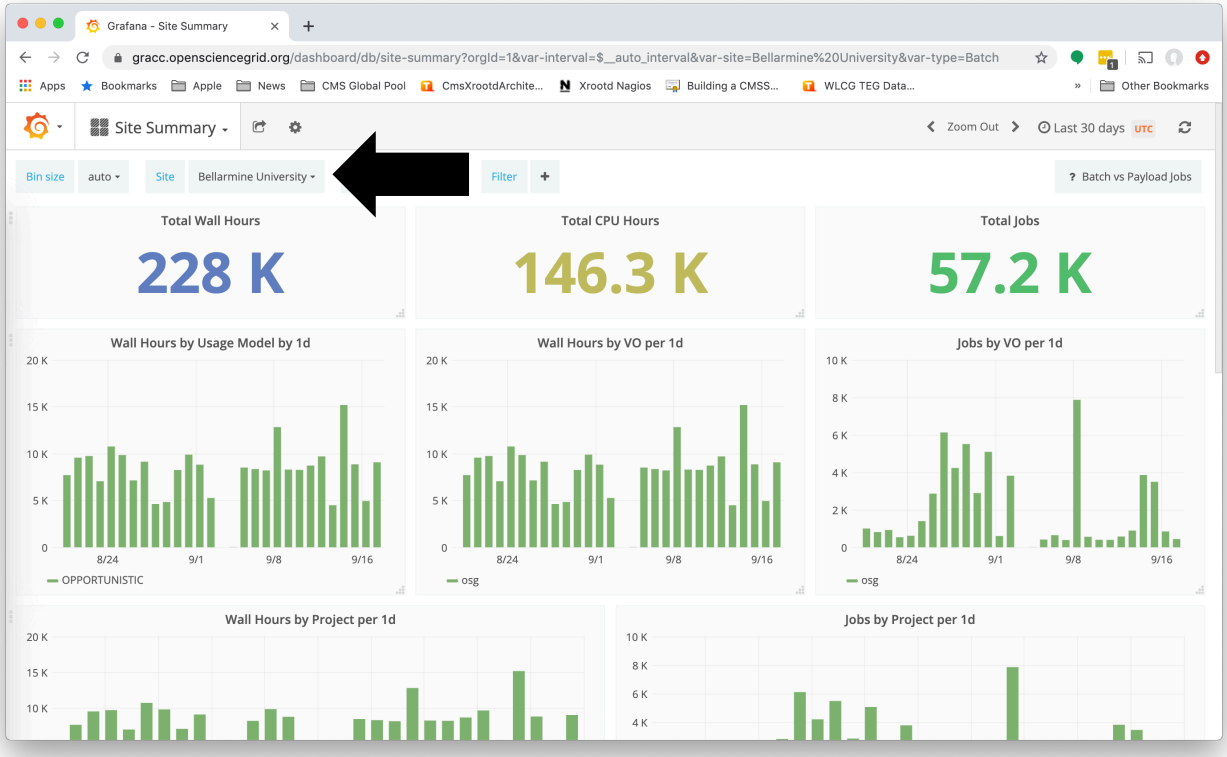
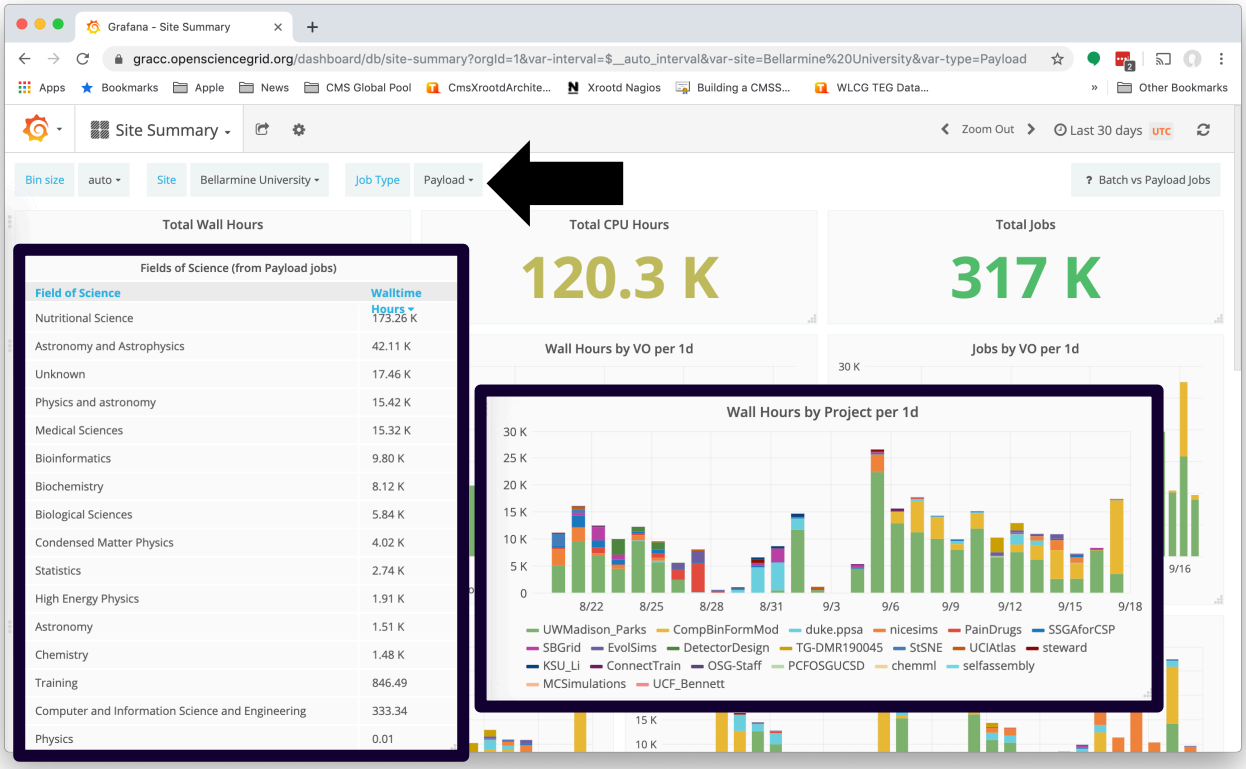


The “Site Summary” page defaults to all sites; use the drop-down to select your site name.

- You get to pick your site name. Names like “Bellarmine University” tend to be more descriptive than “KR-KISTI-GSDC-02”.
- This shows the view by community; in this case, only the special “osg” community was run.

Grid Resource ACCounting (GRACC) portal



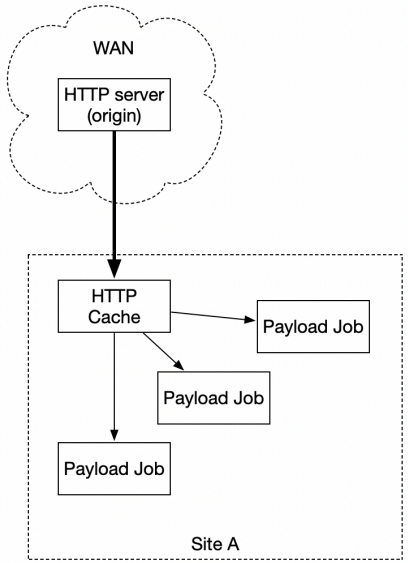
- Switch to the “payload” job type to get information about the resource usage, including
- The projects names inside the community.
- The corresponding fields of science.

Sharing Resources More Effectively

- So far, we've talked about the simplest way to share resources via the OSG. Requires no site-run services and aims to minimize required site effort.
- There are services you can run at your site to either (a) improve the efficiency of jobs or (b) attract a broader range of jobs. Your site does more science – but more effort is involved!
  - **HTTP Cache**: helps avoid frequent retransfer of many (small) resources over HTTP.
  - **CVMFS**: Global, read-only, caching filesystem for distributing containers and software (data is moved via the HTTP cache).
  - **Singularity**: Allows us to launch jobs inside containers.
  - **Data Caches**: Helps jobs avoid moving large data repeatedly.
- I'll include links to documentation; tackle these if desired (and after the basics are working).

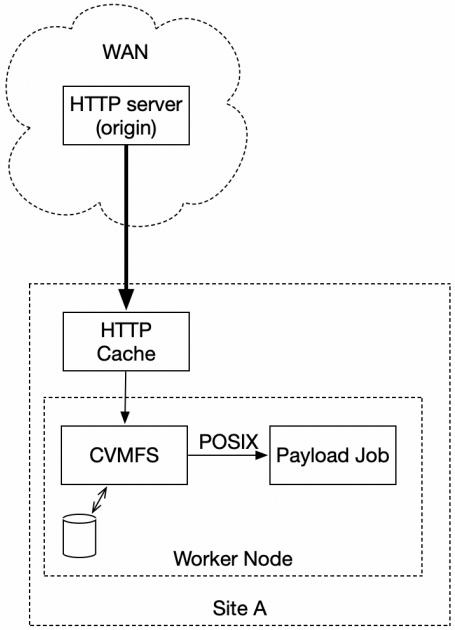
Sharing Resources More Effectively - HTTP Cache

- A broad set of data – software, configurations, job inputs – can be moved to the worker node via HTTP. A significant amount is very frequently reused.
  - By placing a HTTP cache on-site, repeated data use only goes over the LAN instead of the WAN.
  - Any caching HTTP proxy can work for OSG. However:
    - Not all scale well in terms of concurrency.
    - Most are tuned for HTML files, not objects in the >1MB range.
  - We work with the Frontier project to support a special configuration of the venerable Squid software, frontier-squid. Monitoring, logging, and configuration are tuned specifically for OSG usage.
- Sysadmin Documentation. Complexity level: **Easy**.



Sharing Resources More Effectively – Distributed Filesystem (CVMFS)

- CVMFS is a global, integrity-checked, read-only POSIX filesystem. This achieves scale by distributing data through HTTP caches and a CDN.
  - Everything is cached – filesystem metadata and data – all the way to the local worker node. Data is moved to the worker node only on access.
  - In OSG, we use this as a mechanism to distribute science community containers and software. Given the popularity of containers, many jobs require this.
  - **Downside**: This is software that is run on the worker node, which adds complexity.
  - **Downside**: Implemented using FUSE and autofs, two tricky technologies.
  - **Good news on the horizon**: In CentOS 8, this can be done by the batch job completely unprivileged. Nothing to install or monitor on the worker node.
- Sysadmin Documentation. Complexity level: **Moderate**.



Sharing Resources More Effectively – Containers (Singularity)

- Singularity is a container runtime that aims to fit the needs of running containers inside a batch system. No running daemon like Docker – just a process inside the batch job.
  - For full functionality - and on RHEL6 – a `setuid` (extra privileges) binary is needed.
  - For OSG use cases – and on RHEL7 – we recommend using unprivileged.
- The pilot will invoke Singularity prior to starting the payload; this way, the pilot sees the host operating system and the payload sees the container of its choice.
  - The containers are typically distributed via CVMFS.
- OSG provides targeted support for the "community edition" of Singularity; most of the core developers work for a startup company (Sylabs).
- Sysadmin Documentation. Complexity level: **Easy**.

Sharing Resources More Effectively – Data Caches

- The Frontier-Squid software targets the distribution of “small-ish” objects – less then 1GB:
  - Is inefficient to use for files over 1GB.
  - Does not provide a mechanism to securely cache proprietary scientific data. (Note: OSG does not provide mechanisms suitable for HIPAA data.)
- We have a separate software (XCache, a special configuration of the XRootD software) to fill this role.
  - Designed for delivering 1-10GB of data to jobs where there is cache-friendly access and the total working set size of a workflow is <10TB.
  - Provides mechanisms to authenticate and authorize
  - In the end, still transfers data via HTTP / HTTPS.
- Sysadmin Documentation. Complexity Level: Moderate / Hard.

Save This Slide!

- What do we need in order to run at your site?
  - User account(s) setup.
  - Worker nodes need outgoing network connectivity to the central pool and submit hosts. NAT is fine!
    - The outgoing IP addresses will vary from community to community.
  - An automated, external, component will need to submit jobs to the batch system. OSG hosts this service; jobs are submitted over a SSH connection.
    - Some large, complex sites host their own; not a great place to start.
- What additional site services are useful?
  - HTTP cache: helps avoid frequent retransfer of many (small) resources over HTTP.
  - CVMFS: Global, read-only, caching filesystem for distributing containers and software. Runs on worker nodes using FUSE.
  - Singularity: Allows us to launch jobs inside containers.
  - Data Caches: Helps jobs avoid moving large data repeatedly
- Individual science communities (such as LHC) may require additional services; let us know who you want to support and we can provide more details.

Questions?

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