Introducing Pelican: Powering the OSDF
Introducing the **OSDF**

The **OSDF** is a federated platform for delivering datasets from repositories to compute* in an effective, scalable manner.

* ‘Compute’ is viewed broadly; everything from a browser to a cluster.
The OSDF: Connecting your repository

The OSDF provides an “adapter plug”, connecting your science repository to the national and international cyberinfrastructure.

The OSDF is operated by [PATH] Using hardware from [NRP] And integrates a wide range of open science,

As part of the OSG Consortium’s Fabric of Services
OSDF Integrates Independent Repositories into a common fabric

- About a dozen repositories integrated already, more on the way.
- Working to grow:
  - clients,
  - integrated resources, and
  - environments.

- AWS Open Data
- NCAR
- LIGO
- OSDF
- DeltaAI
- NCSA
- OSPool

= existing integration
• The next presentation will go into some highlights of what the OSDF has been delivering for science.

• We split out the technology powering the OSDF and christened it the **Pelican Platform**.
  
  • Same components as before, just integrated into a standalone platform.
The Pelican Project

The OSDF is operated by using hardware from and others.

Who develops the software?

The Pelican project (OAC-2331480) is a newly-funded, $7M/4-year project with the following goals:

1. Strengthen and Advance the OSDF.
2. Expand the types of computing where OSDF is impactful.
3. Expand the science user communities.
   • With a particular driver of the climate community.
Meet the team

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Meet the team

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How does the OSDF work?

A brief tour through the Pelican architecture as implemented by the OSDF.
OSDF in Practice

• Currently, the most common use for the OSDF is managing inputs to OSPool (or similar pools).

• Clients include:
  • **HTCSS plugin**, allowing “osdf://” URLs in a HTCondor submit file.
  • **Standalone CLI** with “cp”-like semantics
  • **Python** fsspec implementation, linking Pelican to the Python "data science" ecosystem.

Let’s run through a HTCondor Example
• If HTCondor needs an object – say, a container – for a job, the first step is to start the OSDF client (a “file transfer plugin”).
• The OSDF client contacts the **manager**, requesting to read the object.
OSDF In Practice

• The manager determines a nearby cache to serve the object.
  • Every location in the lower 48 states is within 500 miles from an OSDF cache hosted by the NRP.
• If the object is in cache, it is served to the client immediately.
  • Otherwise...
OSDF In Practice

- The cache contacts the origin hosting the object.
  - The object prefix is used as a routing key to determine the correct origin.
- The origin will read the object from the underlying object store.
  - Typically, a POSIX filesystem – but other backends exist!
Architecture: Recap

• An **origin service** integrates the object store into the OSDF in the same way a CE integrates a batch system into the OSPool. Interfaces to move data and map authorizations.

• The **cache service** stores and forwards objects, providing scalability to the data access.

• The **manager** selects a source/sink of an object for clients and maintains the namespace.
• **Long-term vision**: Pelican Platform, provides a ‘transport bus’, connecting a broad range of dataset providers to consumers.
  - We aim to broaden the supported clients (Python, Browser-based) and provide integrated services with other projects.
  - Become a platform beyond the initial context of a service supporting distributed High Throughput Computing.

Includes OSN pods – anything S3 compat.
Pelican: One Year Down the Line

What are the big project achievements after ~1 year?
Rearchitecting Core Services

• We reimplemented the central services of the federation. There’s now two main central components:
  • The **Director** receives the client’s HTTP requests (GET, PUT) for objects and selects an origin/cache to service the request.
  • The **Registry** maintains the list of approved caches, origins, and known namespace prefixes.
    • Each registry entry is associated with a public key; the public key is used to sign tokens authorizing actions.

• Other federation-level activities exist:
  • Periodically test all caches and origins for functionality.
  • Connection brokering.
  • Monitoring activity (embedded Prometheus).
Standalone Software

• Pre-Pelican, it was not possible to setup your own data federation.
  • The venerable OSDF client, stashcp, had hardcoded hostnames and OSDF-specific logic. Deeply tied into the OSG Topology application and WLCG GeoIP services.

• As Pelican, it’s now a proper software project:
  • Software is managed on GitHub in a single organization. Monthly feature releases, ~weekly bugfix releases.
  • You can setup your own, self-contained data federation!
  • There are dozens of unit tests and end-to-end integration tests run with each commit (~55% test coverage).

• While “unit test coverage” isn’t a user-visible feature, it allows us to start deliver new and evolving functionality with confidence.
Converting OSDF to Pelican

• We are rolling out new services and protocols via a new software stack ... onto the existing infrastructure!
  • E.g., a Pelican-based cache must be 100% compatible with old and new origins and clients.
  • No “flag day” option, cannot force client upgrades.

• Transition of services is >50% done.
  • Slower than anticipated. Familiar story: periodically pause to implement previously-unknown use cases, cleanup old messes in topology and containers.
  • Until we’ve 100% cutover, Pelican carries the burden of supporting both old and new clients.
“Batteries Included” Origin

We aim to simplify the art of running an origin:

• New web UI for viewing, monitoring, and configuring the origin.
• Origin runs built-in health checks
• Can use “connection reversing” so incoming firewall port / hostname / host certificate not needed.
New Backends

Beyond the traditional POSIX storage, we’ve added the following backends:

- **S3**: Works with any S3-compatible endpoint
- **Generic HTTP**: Integrate existing HTTP endpoint into the OSDF.
- **Globus**: Users must authorize sharing a collection to the origin
- **XRootD**: Uses XRootD proxying module.

Note each of these backends can be used remotely – origin does not need to be present at the local site.
Pelican: Looking forward
More Backends!

We want to connect any reasonable scientific data repository to the OSDF. This includes:

• Continuing to mature the Globus backend: more functionality, more example integrations.
  • For WLCG folks: aim is sufficient integration to use with FTS transfers.

• DataVerse: Data repository software (https://dataverse.org/) often used by institutional libraries. Embed OSDF links directly into DataVerse instances.

• Improve origin monitoring and throttling. E.g., NASA datasets are available through HTTP but access must be strictly rate-limited.
Improved Dashboard and Monitoring

Monitoring work is ongoing in two lines:

• Better communicating the data we have:
  • Generating improved graphs of data moved, number of requests, breakdown by project.
  • **Goal:** Clearly show how your institution is impacting/enabling others, just like the HTCondor-CE dashboard.

• Gathering more data:
  • XRootD has deep coverage of successful transfers. Little aggregation of filesystem errors; no monitoring of protocol-level (HTTP) events. Contributing patches upstream to expose this data.
  • What else do you want to see? Chase down a Pelican team member!

Work in-progress by summer CHTC Fellow

Patrick Brophy
Mentor(s):
Haoming Meng
• Each team HTCondor uses Pelican to transfer a file, a summary ClassAd is created (and can be ingested to ElasticSearch; see Jason’s talk tomorrow).
  • Working on a common schema so the AP can make more informed decisions about retries or alternate transfer methods.

• Each month, we scan ElasticSearch to review hold messages generated by Pelican and attempt to make them more “human readable”

• HTCSS can start up a Pelican “local cache” daemon, setting aside EP space to be used for common input files.
  • Goal is to deploy this to the OSPool over the summer

HTCSS and Pelican are a single team!
Collections Management

- Pelican/OSDF are inherently about immutable objects. Upload, download, stat – works at the individual object level.
- Next year, we plan to expose a collections API, representing a group of objects.
  - Analogous to “buckets” in S3 but decoupled from the namespace.
  - Collections would be mutable, and may define a set of objects that are the result of a database query.
  - Provides a way to transport metadata to higher-level cataloguing systems.
  - Access to collections will be separately managed, allowing for simple authorization management.
Conclusions
Pelican Year 1 – quite the whirlwind!

• We reengineered the origin and cache services, added new central services, and greatly improved the OSDF’s integration with HTCSS.
  • OSDF saw corresponding enormous growth, with some days moving >2PB.
• We’ve picked up new science partners (notably, NCAR) and supported some great science (NRAO).
• Working to provide more visibility into the system: what’s my hardware doing? who’s using my objects? who am I impacting?
  • Expect us to take inspiration from OSPool!

Pelican is a happy member of the HTC community and has big plans to move forward data management with HTC.
The **OSDF**: Connecting to your datasets

To acknowledge all of the partners working together...

- Provides the software
- Operates the **OSDF** services
- Operates (most of) the **OSDF** hardware

The OSG Consortium is the “umbrella” we work within.
Questions?

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