V1 Process for data management, infrastructure and diagnostics

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Manual workflow process for V1

- Infrastructure
- Data Management
- Execution Support
- Analytics

- Archive
- Transfer
- Publication
- Discovery
- Acquisition
- Provenance
Manual workflow process for V1

- Facilities for data analysis and management
  - NERSC, OLCF, ALCF, ORNL/CADES, LLNL/AIMS, condo investment (TBD)

- Services
  - Short-term and longer term archive; data transfer; compute and analysis; publication; provenance; discovery, access and collaboration

- ACME ESGF nodes
  - ORNL/CADES; LLNL/AIMS; NERSC & ALCF (future)
Manual workflow process for V1

- Manual workflow will be managed by individual science teams with workflow team assisting as necessary
- Will provide guidance on best practices
- Independent effort to help with recovery & improve resiliency
- Automated diagnostics (TBD)
Manual workflow process for V1

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Manual workflow process for V1

- Archive
  - ACME HPSS (mass store) utilities to store & retrieve files; use python wrapper around system interface.
  - Native model output
    - archived at source
  - Climatologies
    - created and published incrementally (say every 5 years); and published via federated set of ACME ESGF nodes.
Manual workflow process for V1

- **Transfer**
  - Globus transfer utilities
    - Endpoints available at all key sites
  - Able to transfer 1 PB / week across LCF
  - Incremental transfers possible
  - REST API available for integration with other scripts
  - Globus SDK being tested for ACME
Manual workflow process for V1

- **Publication**
  - Globus publisher tested & deployed
  - Tutorial available online
  - Publisher API
  - Work in progress to publish files residing in HPSS archive (tested at NERSC; in progress at OLCF)
Manual workflow process for V1

- **ESGF**
  - Nodes available at ORNL/CADES; LLNL/AIMS; NERSC & ALCF (future)
  - Climatology and 2D time series files are published & have direct access
  - Work in progress to publish files residing in HPSS archive (tested at NERSC; in progress at OLCF)
Manual workflow process for V1

- NCO (remap; grid generation)
- UV-CDAT (I/O, analysis, regridding, plotting, etc.)
- UVCmetrics (AMWG, LMWG)
- Classic Viewer (.png, .svg)
- Automated diagnostics (to be supported)
Archive Infrastructure: OLCF HPSS ~2013

• 2 x DDN SFA10K (10 GB/s ea)
  – 2 PB disk cache capacity
• 1 x NetApp E5560
  – Files < 16 MB
  – 330 TB of capacity, 150 TB utilized
• 8 Disk movers
  – Responsible for data ingress and migration to tape
  – 10 GbE Networking (~1GB/s each)
• 40 GbE Network switch to Disk movers
• 120 Oracle T10K-{A,B,C} tape drives
  – ~150 MB/s each
• 32 Oracle T10K-D tape drives
  – 252 MB/s each
Archive Infrastructure: OLCF HPSS ~2014

**Disk**
- 2 x DDN SFA10K (10 GB/s ea)
  - 2 PB disk cache capacity
- 3 x DDN SFA12K (40 GB/s)
  - ~12 PB raw capacity for cache
- 1 x NetApp E5560
  - Files < 16 MB
  - 330 TB of capacity, 150 TB utilized
- 20 Disk movers
  - Responsible for data ingress and migration to tape
  - 40 GbE Networking

**Tape**
- 120 Oracle T10K-{A,B,C} tape drives
  - ~150 MB/s each
- 32 Oracle T10K-D tape drives
  - 252 MB/s each

**Network**
- 2 x Arista 7508 40 GbE switches
  - Connectivity to Disk movers
  - Connectivity between Disk and Tape movers
  - 13 x 100 GbE ISL’s
Archive Infrastructure: OLCF HPSS ~2016

**Disk**
- 5 x DDN SFA12K (40 GB/s)
  - ~20 PB raw capacity for cache
- 1 x NetApp E5560
  - Files < 16 MB
  - 330 TB of capacity, 150 TB utilized
- 40 Disk movers
  - 40 GbE Networking

**Tape**
- 112 Oracle T10K-D tape drives
  - 252 MB/s each

**Network**
- 2 x Arista 7508 40 GbE switches
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**Metadata**
- NetApp EF560
  - SAS connected; All Flash
Archive Infrastructure: OLCF HPSS ~2013

• 2 x DDN SFA10K (10 GB/s ea)
  – 2 PB disk cache capacity
• 1 x NetApp E5560
  – Files < 16 MB
  – 330 TB of capacity, 150 TB utilized
• 8 Disk movers
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## Archive Infrastructure: OLCF HPSS ~2016

### Disk
- **5 x DDN SFA12K (40 GB/s)**
  - ~20 PB raw capacity for cache
- **1 x NetApp E5560**
  - Files < 16 MB
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- **40 Disk movers**
  - 40 GbE Networking

### Tape
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### Metadata
- **NetApp EF560**
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*Courtesy: Jason Hill, OLCF*
Performance analysis (2013)

In 2013 asked how long to put in 1PB of data to HPSS
- Getting it to disk took 21 days.
- Migration to tape took another 35 days.
- Single directory, multiple files
  - Processed serially from single node

This seems inefficient, right?

Drive investments in hardware and user experience

Courtesy: Jason Hill, OLCF
In February, a user moved 1.3 PB of data into HPSS in 8 days.
  - Utilized DTN scheduled queue
  - Requested extended wall time (not needed in the end)
  - Used HTAR utility

Migration to tape took ~12 additional days to complete

Significant improvement over 2013 data point

Other success stories out there

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Manual workflow process for V1

Workflow for V1
- Infrastructure
- Data Management
- Execution Support
- Analytics

Right side:
- Archive
- Transfer
- Publication
- Discovery
- Acquisition
## Workflow new features

### Process Flow
- The Pegasus workflow manager is being tested at OLCF and NERSC
- The ACME configure, build, and run process under Pegasus is working at OLCF and NERSC
- The HPSS storage wrapping software is completed and being tested
- Service with REST API for programmatic access
- Web front-end for users to browse and prepare and review models
- Review and create visualizations with CDATWeb
- Refining technical requirements for ACME Workflow Integration Framework

### Data Management
- Set up additional ACME ESGF nodes and work environment:
  - LLNL
- Publish additional data from model runs
- Track a few outstanding issues or limitations, such as:
  - Need additional storage from the ONRL’s CADES storage infrastructure
  - Work with publication team to allow individual ACME scientist to publish data to the ACME archive

### Publication
- Moved authentication from Globus Nexus to Globus Authentication
- Improvements to user interface, e.g.,
  - Remembering last selected facet
  - Rearranged widgets, etc.
- Globus endpoints
  - Users can authenticate to ORNL/OLCF Rhea and Titan Globus endpoints using OSG certificates (instead of only PIN + SecureRSA) what makes scripting data transfer from/to Rhea and Titan possible now.
  - Webinar tutorials

### NCO
- Works uniformly on all ACME, CESM, and observation components
- More accurate and Parallel mode ~25x faster than AMWG
- Remapper and grid/map-generator ncremap:
  - Infers grids from SCRUD (Swath, Curvilinear, Rectangular, Unstructured Data), or creates rectangular grids de novo, and remaps data in parallel
  - Generates weights with ESMF_RegridWeightGen or TempestRemap
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Workflow new features cont.

**UV-CDAT**
- Anaconda build
- Linux, OSX
- Comes with: Matplotlib, VCS, CDMS2, cftime, NumPy, iPython, etc.
- Interactive point selection
- Continue work on cleaner API
- UV-CDAT new user’s documentation

**UVCmetrics**
- AMWG reproduction
- Output customizable for ACME needs
- Generates own "climo" files or uses those generated by NCO
- Diags.py
- Metadiags.py
- Built-in Viewer
- MPI testing (mcenerney paper)
- Vector (.svg) and Raster (.png) graphical output
- ACME model variable name on plots

**DIAGS**
- AMWG reproduction
- Output customizable for ACME needs

**AMWG**
- Test suite
  - Continuous integration and code testing using CMake/CDash (https://cmake.org) and Buildbot (http://buildbot.net)
  - Increased overall code coverage and new tests