Data Transfers and the Globus Ecosystem

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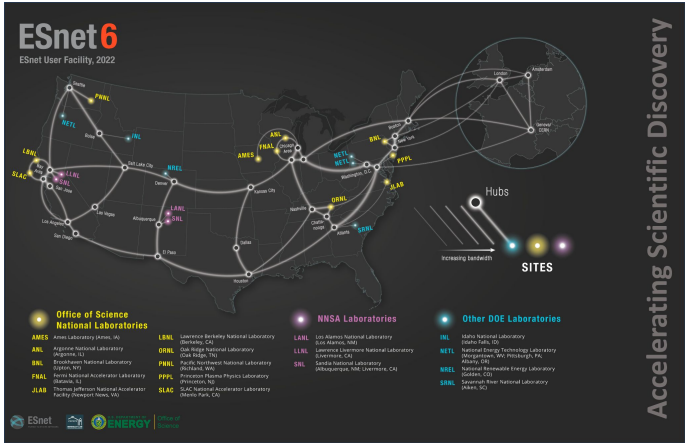
Data Transfers Overview

- Transferring data to and from NERSC
  - Data Transfer Nodes (DTNs)
  - Can also use Perlmutter Login nodes
    - xfer queue
- Globus is a great tool for transferring data
  - Internal Transfers (Scratch, CFS, HPSS)
  - University/Institution Cluster
  - Local Computer
  - Share data with others
  - Globus is more than just data transfer
- Some future ideas for transferring data



Transferring data to and from NERSC

- Data Transfer Nodes (DTNs)
- Special nodes for designed for transferring data
  - Two 100-gigabit ethernet links for transfers to internet
  - Two 10-gigabit ethernet links to NERSC internal resources (HPSS)
  - Two FDR IB connections to the global file system
- Different maintenance schedule from Perlmutter
  - Get your data even when Perlmutter is off
    - Like today's maintenance
  - CFS / HOME / HPSS
- Currently does not have access to Perlmutter Scratch

Accessing DTNs at NERSC

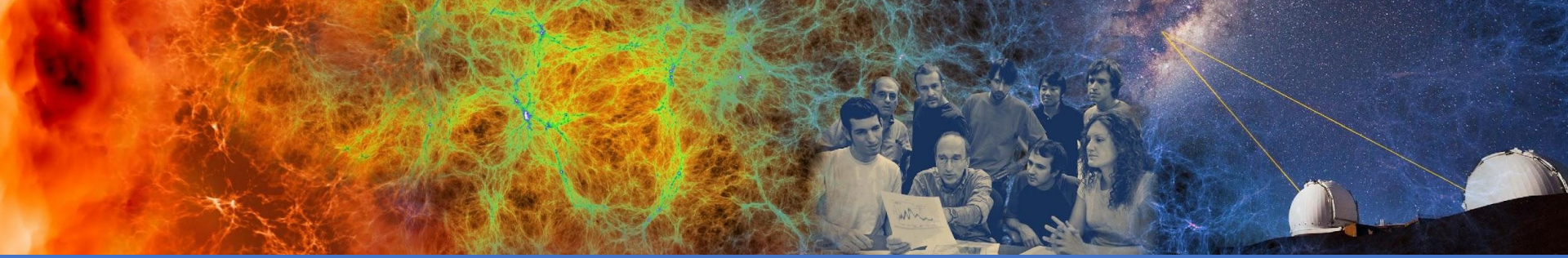
- Login to DTNs
  - ssh/NoMachine
  - `ssh -i ~/.ssh/nersc user@dtn.nersc.gov`
- Transfer a file
  - scp/rsync
  - `scp /local/file user@dtn.nersc.gov:/path/at/nersc`
- Download files from the web
  - wget/curl
  - `wget https://gist.githubusercontent.com/Example.ipynb`
- Transfer to/from HPSS
  - hsi/htar
  - `htar -cvf backups.tar /path/to/backups`
  - `hsi get backups.tar`

Transferring data on Perlmutter

- Using Perlmutter for data transfers
  - scp / rsync / wget / curl / etc.
  - Only use for SCRATCH!
- Transfer queue on Perlmutter
  - Simple workflow to transfer data
  - Slurm job dependency on xfer qos

```
#!/bin/bash
#SBATCH -A m0000
#SBATCH -q xfer
#SBATCH -t 2:00:00
#SBATCH -J tranfser_files
#SBATCH -o %x_%j.out
#SBATCH -e %x_%j.err

mkdir -p $SCRATCH/work
cd $SCRATCH/work
hsi get achived_inputs.tar
tar -xvf achived_inputs.tar
```

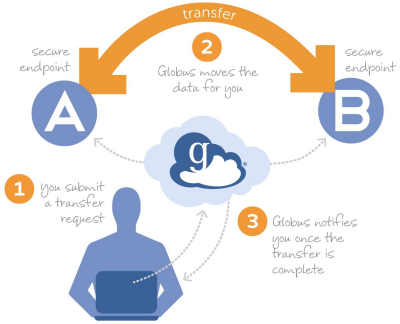
```
$ sbatch transfer_files.sh
Submitted batch job 12345
$ sbatch --dependency=afterok:12345 compute_job.sh
Submitted batch job 12346
$ sbatch --dependency=afterany:12346 archive_files.sh
```

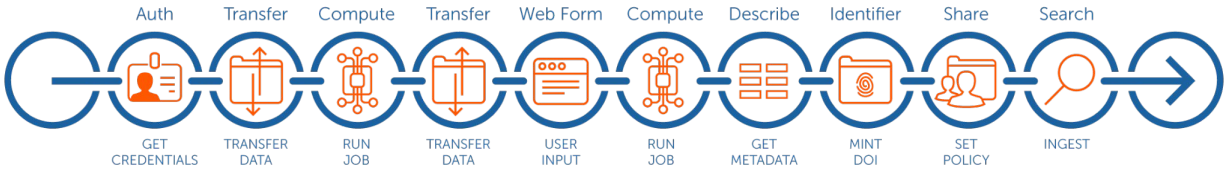


Using Globus For Transferring Files

What is Globus?

- Transfer and share data between different locations
  - Allows you to link identities so both sides know who you are
    - National labs
    - Universities
  - Access and transfer files between locations
- Start a transfer and leave the web app
  - Your transfer will continue to run
  - Check back later to see your data has gone through
- Globus is expanding its ecosystem





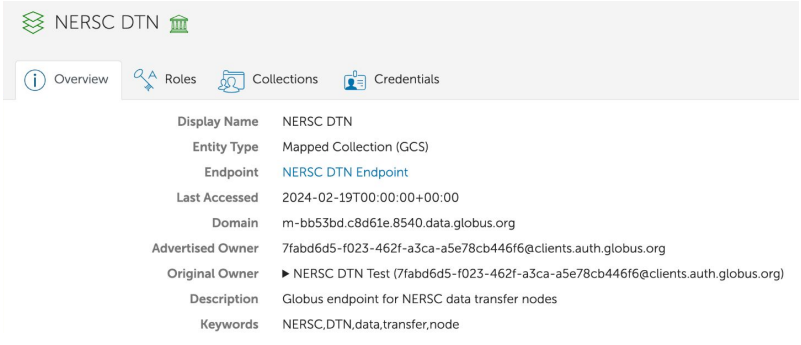
Transfer data to your Personal Computer

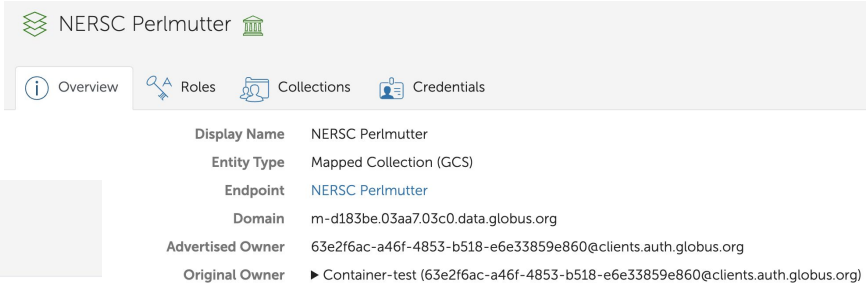
- Globus Connect Personal
  - Create a Globus Collection on your local compute
  - Can transfer data from any Collection to your computer
- Setup in user space on linux
  - If your institution doesn't have Globus you may be able to setup a personal endpoint to transfer data

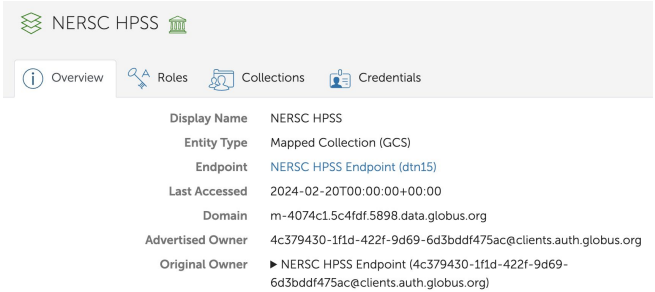

```
$ wget https://downloads.globus.org/globus-connect-personal/linux/stable/globusconnectpersonal-latest.tgz
$ tar xzf globusconnectpersonal-latest.tgz
$ cd globusconnectpersonal-*
$ ./globusconnectpersonal -start
```

Transferring data at NERSC

- Multiple Collections
- NERSC DTN
  - Use for CFS or HOME
- NERSC Perlmutter
  - Use for Perlmutter Scratch
- NERSC HPSS
  - Use for HPSS
  - Tar files before transferring!

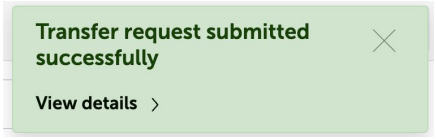


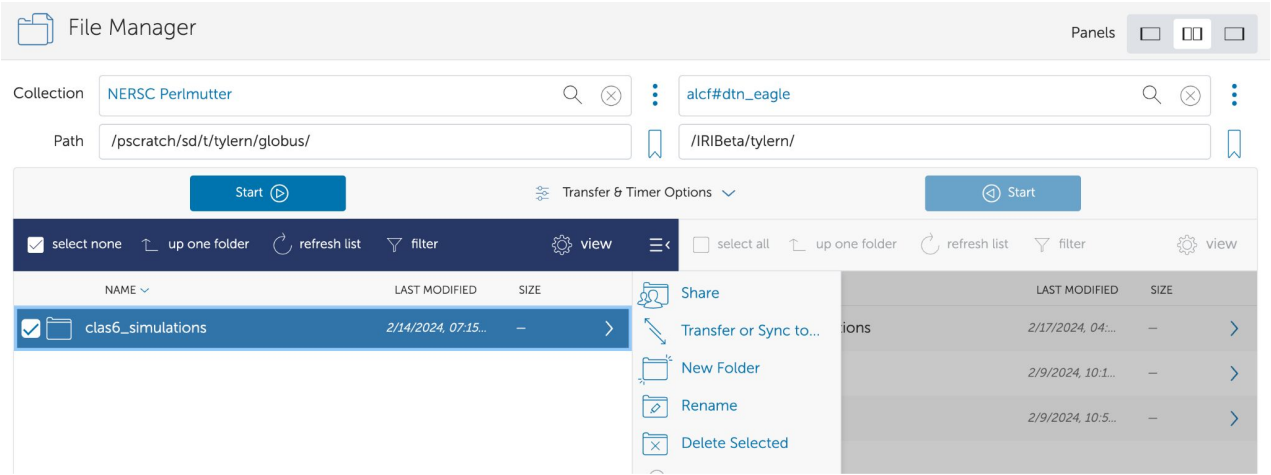




Using the Web GUI to Transfer Data

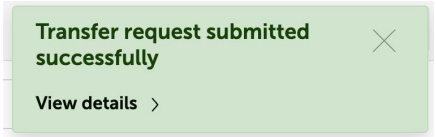
- Choose the two collections
  - Can be two NERSC collections
  - Other institution to/from NERSC
- Choose the files or folders
- Start the transfer
- Wait for the transfer to complete

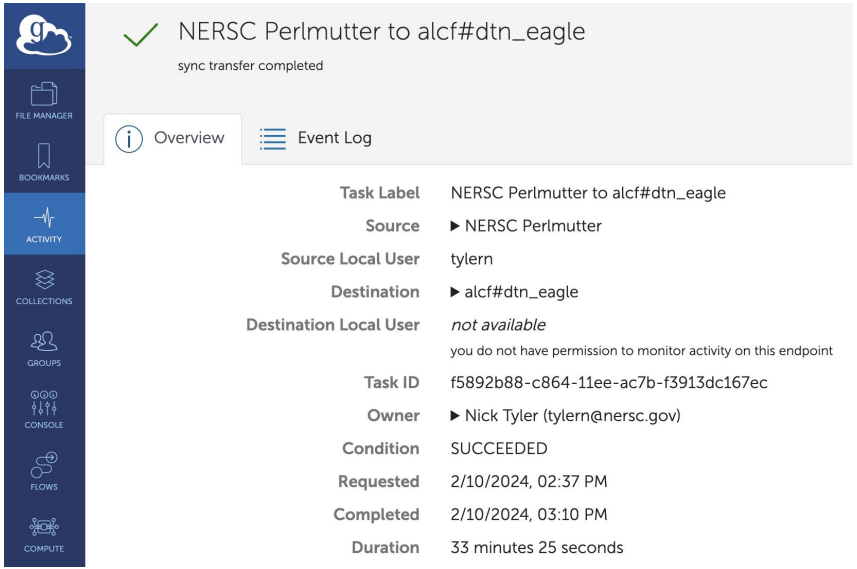




Using the Web GUI to Transfer Data

- Checking on your transfers
  - View transfer details in activities
  - Extremely fast!

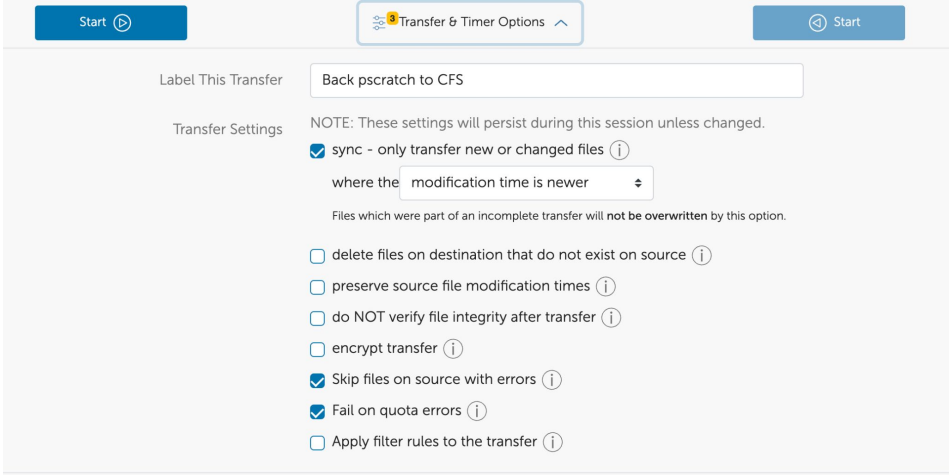




47	Files
1	Directories
47	Files Transferred
5.88 TB	Bytes Transferred
2.93 GB/s	Effective Speed
0	Skipped files on sync
0	Skipped files on error

Using the Web GUI to Transfer Data

- Transfer Options
  - Sync
    - Change sync options
    - Won't overwrite files
    - Helpful for restarting a failed transfer
  - Skip files on source with errors
    - Skips to next file if there's errors
    - Transfers can get stuck for permissions issues
  - Fail on quota errors
    - Stops the transfer disk full or quota exceeded



Using Globus CLI Tools

- Using cli tools on Perlmutter
- `globus`
  - Maintained by Globus
  - Installed as module by NERSC
  - Has all features of the web interface
  - Gives you easy command line ways to control transfers
- Install locally
  - `pip install globus-cli`

```
$ module load globus-tools
```

```
(nersc-python)[perlmutter-login01:~]$ globus task show f5892b88-c864-11ee-ac7b-f3913dc167ec
Label:                          None
Task ID:                        f5892b88-c864-11ee-ac7b-f3913dc167ec
Is Paused:                      False
Type:                           TRANSFER
Directories:                    1
Files:                          47
Status:                         SUCCEEDED
Request Time:                   2024-02-10T22:37:25+00:00
Faults:                         0
Total Subtasks:                 49
Subtasks Succeeded:             49
Subtasks Pending:               0
Subtasks Retrying:              0
Subtasks Failed:                0
Subtasks Canceled:              0
Subtasks Expired:               0
Subtasks with Skipped Errors:   0
Completion Time:                2024-02-10T23:10:50+00:00
Source Endpoint:                NERSC Perlmutter
Source Endpoint ID:             6bdc7956-fc0f-4ad2-989c-7aa5ee643a79
Destination Endpoint:           alcf#dtn_eagle
Destination Endpoint ID:        05d2c76a-e867-4f67-aa57-76edeb0beda0
Bytes Transferred:              5883452682752
Bytes Per Second:               2934663725
```

```
(nersc-python)[perlmutter-login01:~]$ globus transfer -r --fail-on-quota-errors -s exists 6bdc7956-fc0f-4ad2-989c-7aa5ee643a79:$SCRATCH/globus 9d6d994a-6d04-11e5-ba46-22000b92c6ec:/global/cfs/cdirs/m3792/tylern/backups
Message: The transfer has been accepted and a task has been created and queued for execution
Task ID: eeeeb3ca-cf70-11ee-b0c1-7de3e4236180
(nersc-python)[perlmutter-login01:~]$
```

Using Globus NERSC CLI Tools

- Using cli tools on Perlmutter

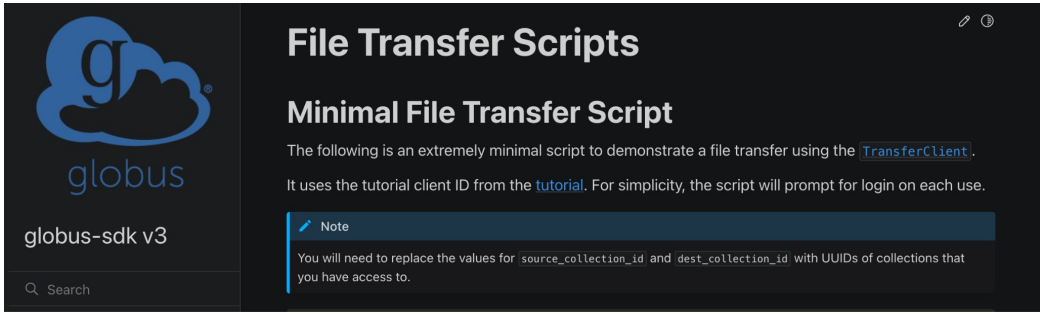
```
$ module load globus-tools
```

- `transfer_files.py`
  - NERSC Maintained
  - Shortcuts for NERSC endpoints
  - Sorts HPSS files for more efficient retrieval
  - Give an arbitrary list of files to transfer to an output directory

```
(nersc-python)[perlmutter-login01:~]$ transfer_files.py --help
transfer_files.py: error: the following arguments are required: -s, -t, -d, -i
Globus transfer helper

Required arguments:
  -s SOURCE        source endpoint UUID (NERSC short cuts: NERSC DTN = dtn,
                   NERSC HPSS = hpss, NERSC Perlmutter = perlmutter)
  -t TARGET        target endpoint UUID (NERSC short cuts: NERSC DTN = dtn,
                   NERSC HPSS = hpss, NERSC Perlmutter = perlmutter)
  -d OUT_DIR       target endpoint output directory
  -i INFILES       file containing list of full path of input files

Optional arguments:
  -p, --preserve   Preserve time stamps
  -r, --recursive  Make transfer recursive
  --renew
(nersc-python)[perlmutter-login01:~]$
```

Globus Python sdk

- Using Globus sdk in Python
  - Great for integrating into a workflow
  - Start a transfer and wait until it's completed for the next step
  - Globus has basic tutorials online
- Our CLI tool is built on top of the python sdk
- We use the sdk to manage our Globus Collections
- Also a Javascript sdk
  - Useful for making web apps



Globus Python sdk

- Using Globus sdk in python
- `TransferData`
  - Same options as online portal
  - Creates the base transfer
- `task_data`
  - Object from `TransferData`
  - Add items giving the full input and output
  - Can also be recursive over directory
- Submit the transfer

```
task_data = globus_sdk.TransferData(
    source_endpoint=PERLMUTTER,
    destination_endpoint=DTN,
    fail_on_quota_errors=True,
    skip_source_errors=True,
    preserve_timestamp=True,
    notify_on_succeeded=False,
    notify_on_failed=True,
    notify_on_inactive=True,
    sync_level=2
)
task_data.add_item(
    "/pscratch/sd/t/tylern/work/e1d_npip_maid2000.tar",
    "/global/cfs/cdirs/m3792/tylern/work/e1d_npip_maid2000.tar",
    recursive=False
)
```

```
transfer_client = globus_sdk.TransferClient(authorizer=authorizer)
task_doc = transfer_client.submit_transfer(task_data)
task_id = task_doc["task_id"]
print(f"submitted transfer, task_id={task_id}")
```

Globus Python sdk

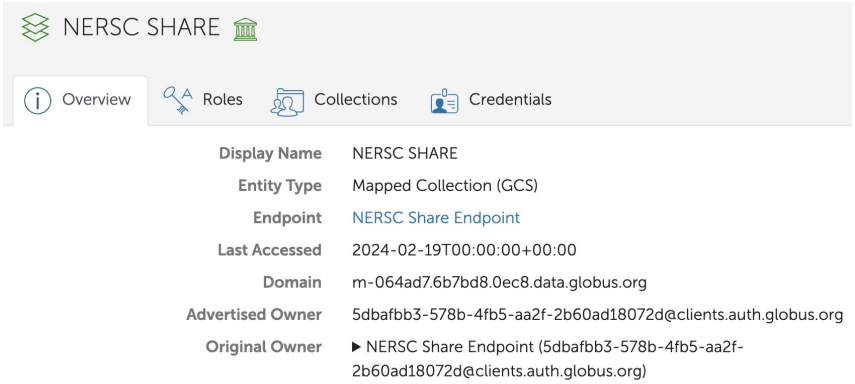
- Using Globus sdk in python
- Check the transfer
  - Check the state is still active
  - Wait for it to finish
- Also check on previous transfers
  - Get the list of previous tasks
  - Get information about the status
  - Is the task completed?

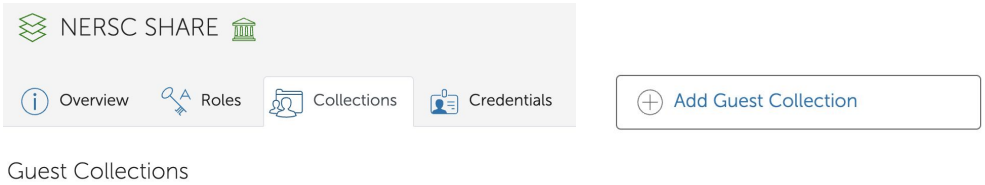
```
transfer_client = globus_sdk.TransferClient(authorizer=authorizer)
task = transfer_client.get_task(args.taskid)
while not transfer_client.task_wait(args.taskid):
    print(f"Waiting on {task['task_id']}")
    time.sleep(10)

task = transfer_client.get_task(args.taskid)
print(f"Transfer {task['task_id']}: {task['status']}")
```

```
transfer_client = globus_sdk.TransferClient(authorizer=authorizer)
task_list = transfer_client.task_list().data['DATA']
for task in task_list:
    print(task['task_id'], task['status'])
```

Special Endpoints for Globus

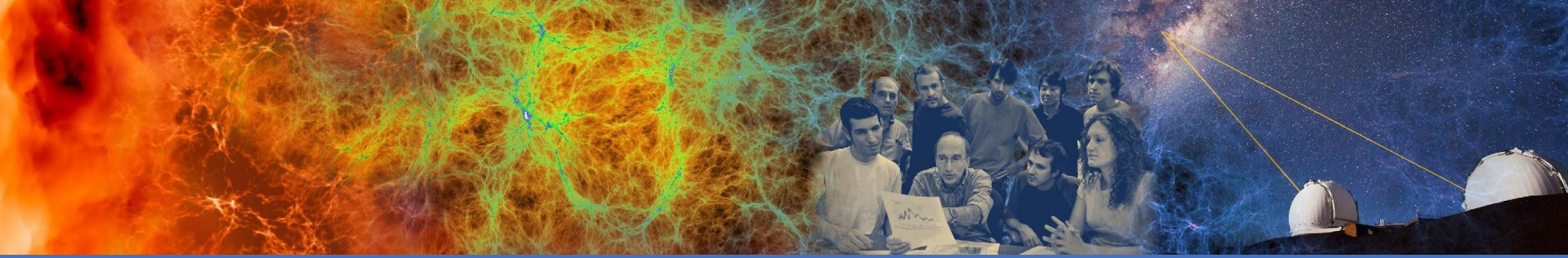
- Share Endpoint
  - Allows you to share data with collaborators who don't have NERSC Accounts
  - Share data with https links
    - Embed files from CFS onto science gateway or website easily
    - Or as QR codes in presentations!





Special Endpoints for Globus

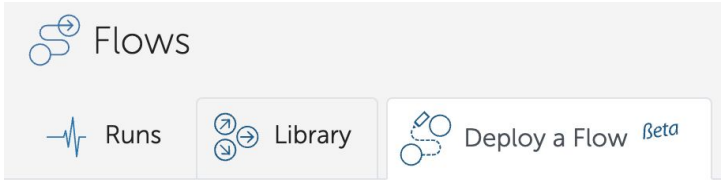
- Collaboration endpoint
  - Give collab accounts have access to Globus
  - Used for automated transfers for large experiments
  - Have your PI/PI Proxy open a ticket to have one made for your collaboration account

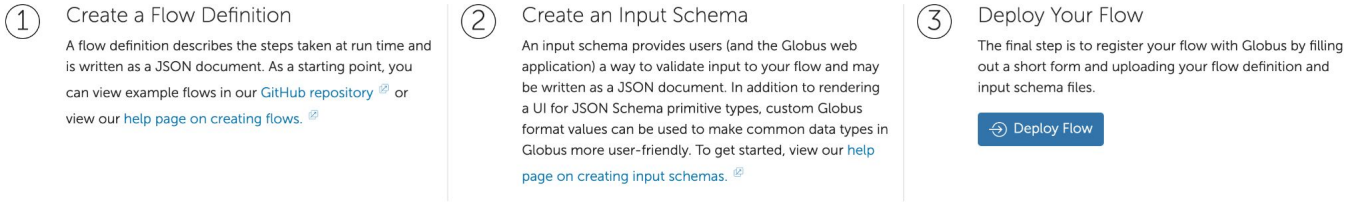


Globus: More than Transfers

Globus Flows (Beta)

- Use Globus as a workflow engine
  - Make a Directed Acyclic Graph based on Actions
  - Actions
    - Transfer
    - Computer
    - User input
- Also has a Python sdk
- Build your own action endpoints



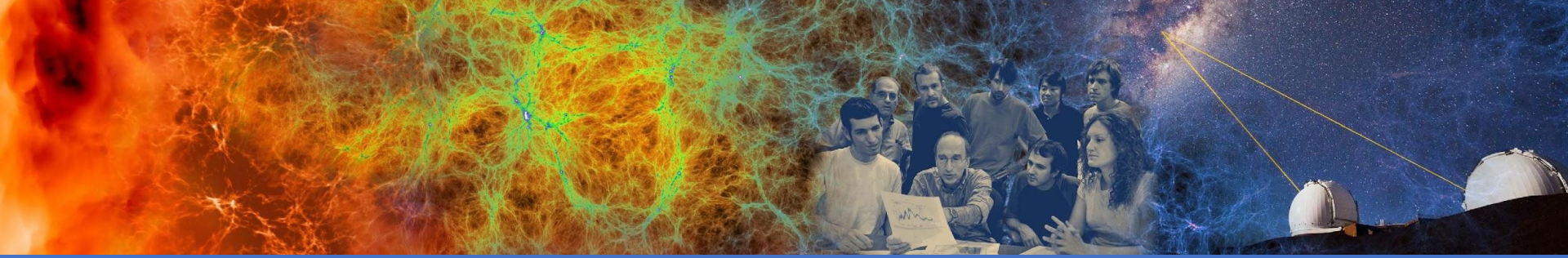


Globus Compute (Beta)

- Globus as a FaaS engine
  - Make functions to run work
  - Globus controls submitting jobs
    - Connects to Slurm
    - Uses Parsl workflow manager to dispatch work
- Also has a Python sdk
- Python multiprocessing futures
  - Define a function to run
  - Submit work as a future
  - Wait for results


```python
# function that estimates pi by placing points in a box
def pi(num_points) -> Any:
    from random import random
    inside = 0
    for i in range(num_points):
        x, y = random(), random()  # Drop a point randomly within the box.
        if x**2 + y**2 < 1:        # Count points within the circle.
            inside += 1

    return (inside*4 / num_points)
```

```python
gce = Executor(endpoint_id=endpoint_id)
estimates = []
for i in range(256):
    estimates.append(gce.submit(pi, 100))

total = [future.result() for future in estimates]
print("Average: {:.5f}".format(sum(total)/len(estimates)))
```



Future Plans for Data Transfers

Other ways we want to support collaborations

- xrootd
  - Data transfer service common among HEP community
  - Supports streaming of data
  - HTTPS and Object Interfaces
- If you're interested let us know
  - We can work with your collaboration on setup and authentication
  - Working on acceptable access policies

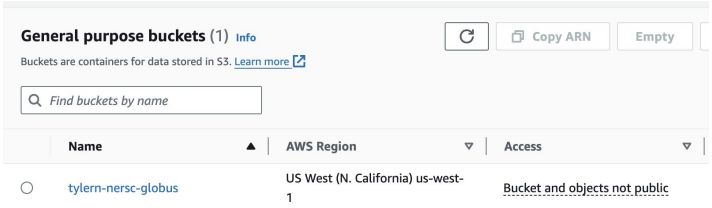
Future work

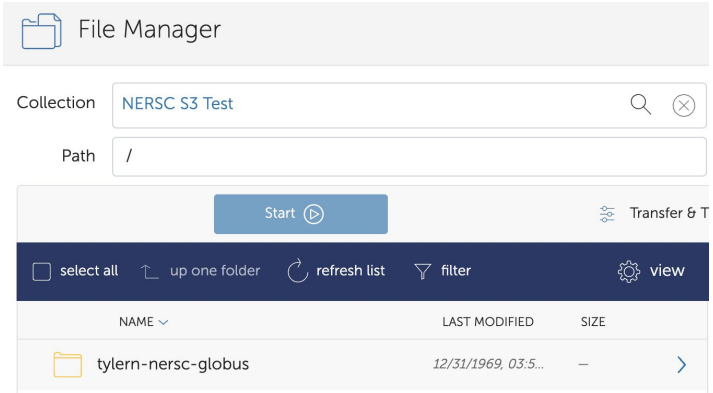
- Burst Buffer like interface
  - Instead of using the xfer qos with Slurm dependencies
  - Slurm will stage data into SCRATCH
  - From CFS/HPSS
  - Could also stage data out
    - Auto-archive to CFS/HPSS
- Only in the idea phase
  - Working with CSG/ISG on implementation

```
#!/bin/bash
#DW jobdw type=scratch capacity=1GB access_mode=striped,private pfs=/scratch
#DW stage_in type=file source=/tmp/a destination=/ss/file1
#DW stage_out type=file destination=/tmp/b source=/ss/file1
srun application.sh
```

Cloud storage using Globus

- Re-Add an AWS S3 interface
  - With new GCSv5 changes this is easier to use
- Also enable other types as need arises
  - Google Drive
  - Google Cloud Storage
  - Azure Blob Storage





Conclusion

- Use Data Transfer Nodes (DTNs)
- Globus is a great tool for transferring data
  - Internal Transfers (Scratch, CFS, HPSS)
  - Becoming an ecosystem of transfer and workflow engine
- Future plans for data transfers
  - Plan to support more and different tools
  - Let us know what tools your community is using and you want us to look at

globus

XRootD

Questions?