

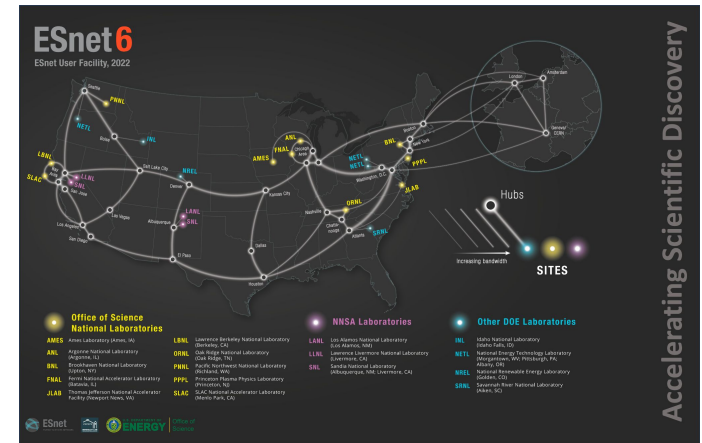
Data Transfers and the Globus Ecosystem



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Data & AI Services
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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`

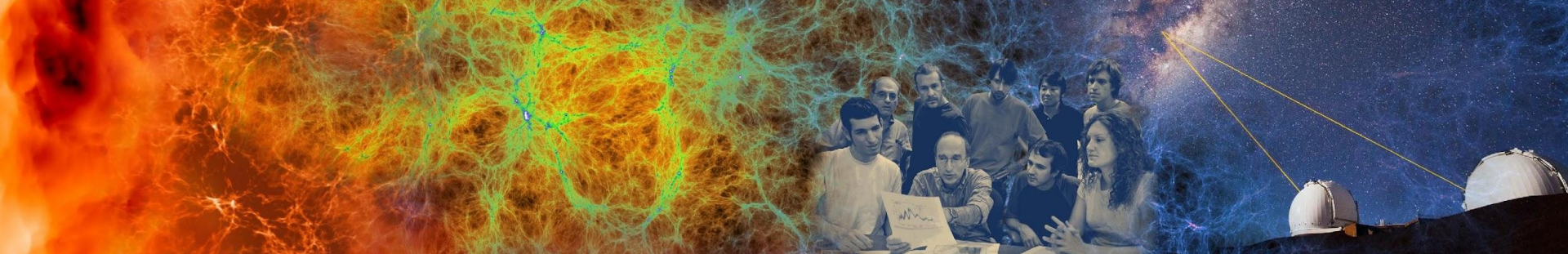
Transferring data on Perlmutter

- 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

```
$ 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
```

```
#!/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

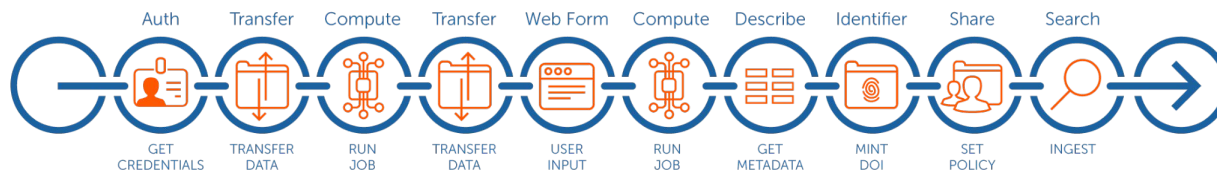
mkdir -p $SCRATCH/work
cd $SCRATCH/work
hsi get achived_inputs.tar
tar -xvf achived_inputs.tar
```

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

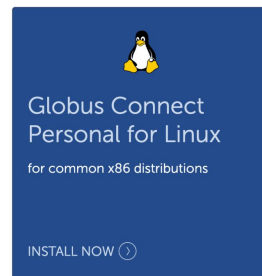


Transfer data to your Personal Computer

- 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

Install Globus Connect Personal

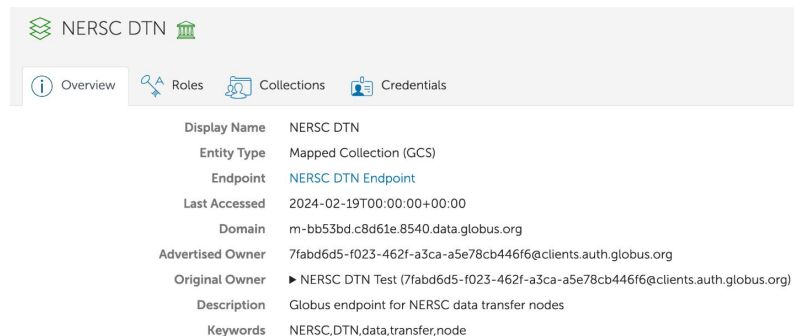
Create a Globus collection on your laptop. Globus Connect Personal is available for all major operating systems.



```
$ 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

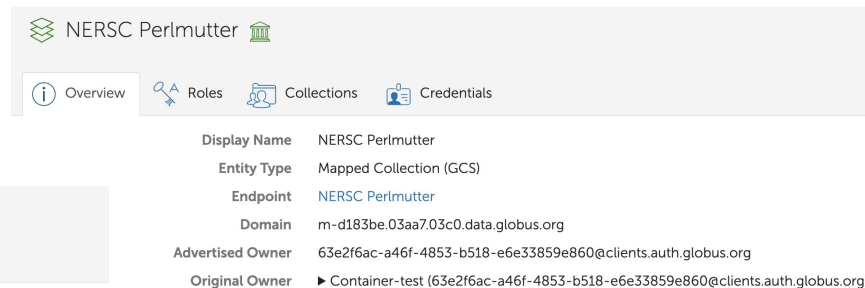
- Multiple Collections
- NERSC DTN
 - Use for CFS or HOME
- NERSC Perlmutter
 - Use for Perlmutter Scratch
- NERSC HPSS
 - Use for HPSS
 - Tar files before transferring!



NERSC DTN

Overview Roles Collections Credentials

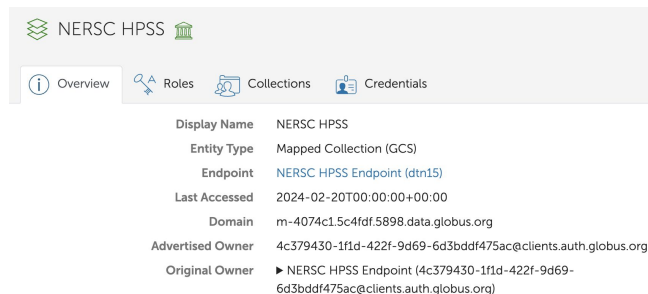
Display Name	NERSC DTN
Entity Type	Mapped Collection (GCS)
Endpoint	NERSC DTN Endpoint
Last Accessed	2024-02-19T00:00:00+00:00
Domain	m-bb53bd.c8d61e.8540.data.globus.org
Advertised Owner	7fabd6d5-f023-462f-a3ca-a5e78cb446f6@clients.auth.globus.org
Original Owner	▶ NERSC DTN Test (7fabd6d5-f023-462f-a3ca-a5e78cb446f6@clients.auth.globus.org)
Description	Globus endpoint for NERSC data transfer nodes
Keywords	NERSC,DTN,data,transfer,node



NERSC Perlmutter

Overview Roles Collections Credentials

Display Name	NERSC Perlmutter
Entity Type	Mapped Collection (GCS)
Endpoint	NERSC Perlmutter
Domain	m-d183be.03aa703c0.data.globus.org
Advertised Owner	63e2f6ac-a46f-4853-b518-e6e33859e860@clients.auth.globus.org
Original Owner	▶ Container-test (63e2f6ac-a46f-4853-b518-e6e33859e860@clients.auth.globus.org)



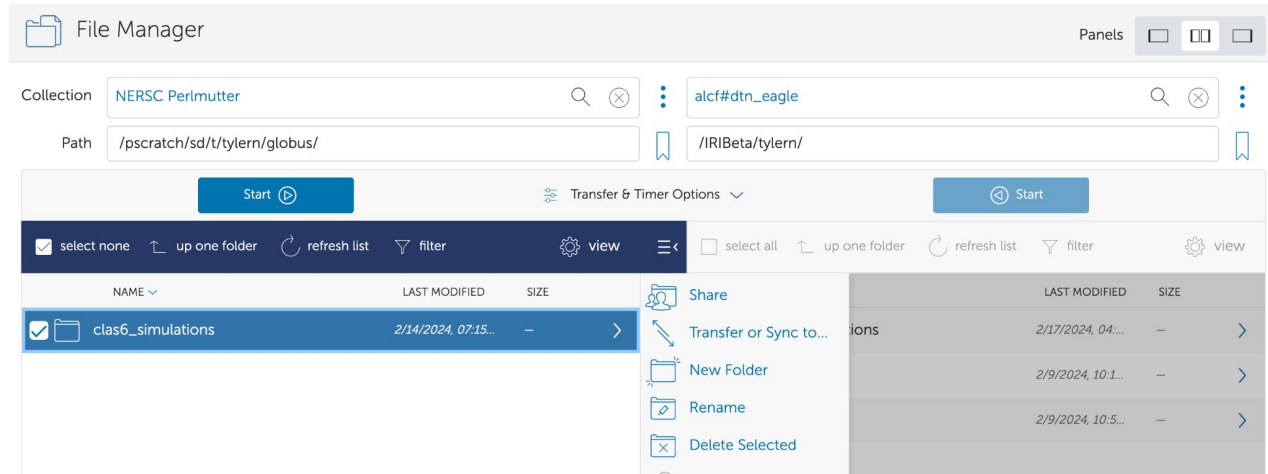
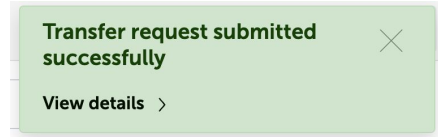
NERSC HPSS

Overview Roles Collections Credentials

Display Name	NERSC HPSS
Entity Type	Mapped Collection (GCS)
Endpoint	NERSC HPSS Endpoint (dtn15)
Last Accessed	2024-02-20T00:00:00+00:00
Domain	m-4074c1.5c4fdf.5898.data.globus.org
Advertised Owner	4c379430-1f1d-422f-9d69-6d3bddf475ac@clients.auth.globus.org
Original Owner	▶ NERSC HPSS Endpoint (4c379430-1f1d-422f-9d69-6d3bddf475ac@clients.auth.globus.org)

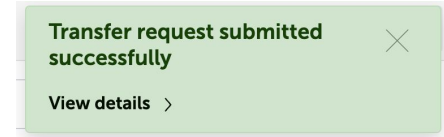
Using the Web GUI to Transfer Data

- 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!



NERSC Perlmutter to alcf#dtn_eagle
sync transfer completed

Overview | Event Log

Task Label	NERSC Perlmutter to alcf#dtn_eagle
Source	► NERSC Perlmutter
Source Local User	tylern
Destination	► alcf#dtn_eagle
Destination Local User	<i>not available</i> you do not have permission to monitor activity on this endpoint
Task ID	f5892b88-c864-11ee-ac7b-f3913dc167ec
Owner	► Nick Tyler (tylern@nerisc.gov)
Condition	SUCCEEDED
Requested	2/10/2024, 02:37 PM
Completed	2/10/2024, 03:10 PM
Duration	33 minutes 25 seconds

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

The screenshot shows a web interface for configuring a data transfer. At the top, there are three buttons: 'Start' (left), 'Transfer & Timer Options' (center), and 'Start' (right). Below the buttons, the 'Label This Transfer' field contains the text 'Back pscratch to CFS'. Under 'Transfer Settings', a note states: 'NOTE: These settings will persist during this session unless changed.' The settings are as follows: 'sync - only transfer new or changed files' is checked, with a dropdown menu set to 'where the modification time is newer'; 'delete files on destination that do not exist on source' is unchecked; 'preserve source file modification times' is unchecked; 'do NOT verify file integrity after transfer' is unchecked; 'encrypt transfer' is unchecked; 'Skip files on source with errors' is checked; 'Fail on quota errors' is checked; and 'Apply filter rules to the transfer' is unchecked. Each setting has an information icon (i) to its right. A note at the bottom of the settings section states: 'Files which were part of an incomplete transfer will not be overwritten by this option.'

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: alcfn#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:$SCRATCH/globus 9d6d994a-6d04-11e5-ba46-22000b92c6ec:/global/cfs/cdir/s/m3792/tylern/backups
Message: The transfer has been accepted and a task has been created and queued for execution
Task ID: eeeeb3ca-cf70-11ee-b0c1-7de3e4236180
(nersc-python)[perlmutter-login01:~]$
```

Using Globus NERSC CLI Tools

- Using cli tools on Perlmutter
- `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

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

```
(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



File Transfer Scripts

Minimal File Transfer Script

The following is an extremely minimal script to demonstrate a file transfer using the [TransferClient](#). It uses the tutorial client ID from the [tutorial](#). For simplicity, the script will prompt for login on each use.

Note

You will need to replace the values for `source_collection_id` and `dest_collection_id` with UUIDs of collections that you have access to.

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)

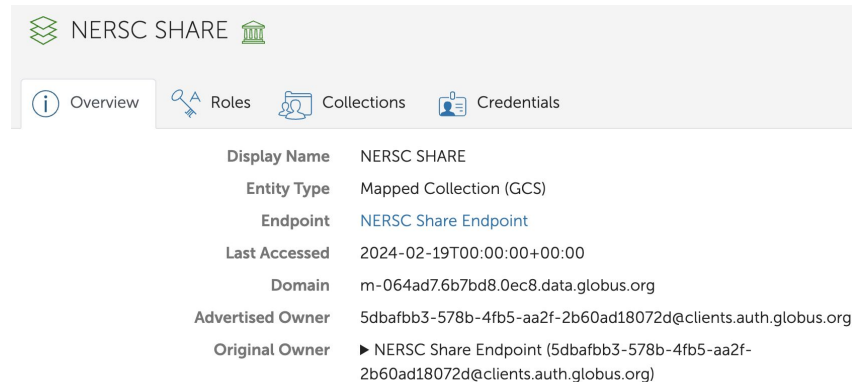
task = transfer_client.get_task(args.taskid)
print(f"Transfer {task['task_id']}: {task['status']}")
```

```
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

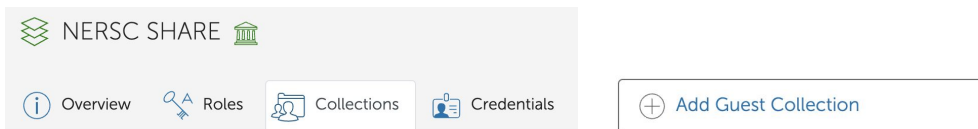
- Allows you to share data with collaborators who don't have NERSC Accounts
- Share data with https links
 - Embed files from CFS onto science gateway or website easily
 - Or as QR codes in presentations!



NERSC SHARE

Overview Roles Collections Credentials

Display Name	NERSC SHARE
Entity Type	Mapped Collection (GCS)
Endpoint	NERSC Share Endpoint
Last Accessed	2024-02-19T00:00:00+00:00
Domain	m-064ad7.6b7bd8.0ec8.data.globus.org
Advertised Owner	5dbafbb3-578b-4fb5-aa2f-2b60ad18072d@clients.auth.globus.org
Original Owner	► NERSC Share Endpoint (5dbafbb3-578b-4fb5-aa2f-2b60ad18072d@clients.auth.globus.org)



NERSC SHARE

Overview Roles Collections Credentials

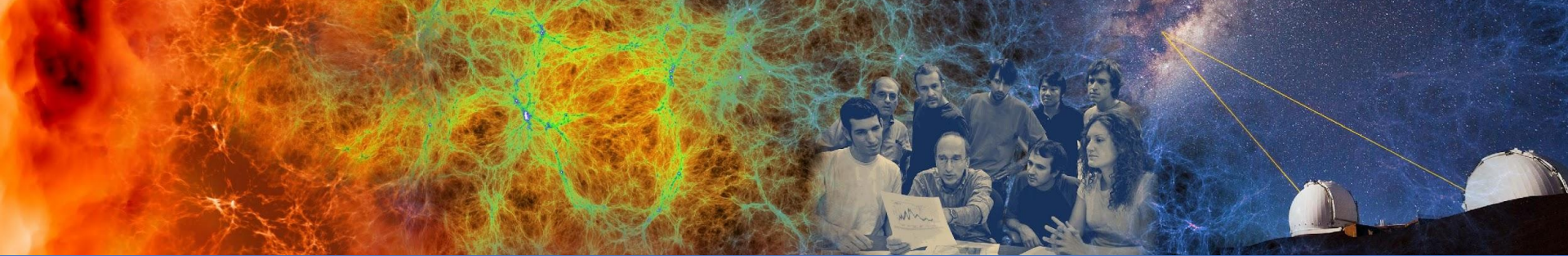
+ Add Guest Collection

Guest Collections



Special Endpoints for Globus

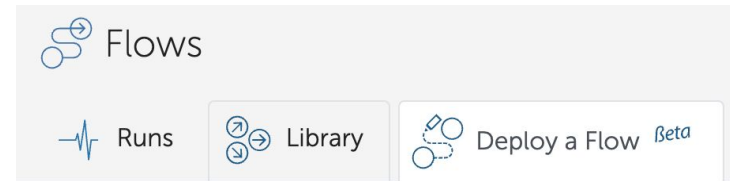
- Collaboration endpoint
 - Give collab accounts have access to Globus
 - Used for automated transfers for large experiments
 - Have your PI/PI Proxy open a ticket to have one made for your collaboration account



Globus: More than Transfers

Globus Flows (Beta)

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



① Create a Flow Definition
A flow definition describes the steps taken at run time and is written as a JSON document. As a starting point, you can view example flows in our [GitHub repository](#) or view our [help page on creating flows](#).

② Create an Input Schema
An input schema provides users (and the Globus web application) a way to validate input to your flow and may be written as a JSON document. In addition to rendering a UI for JSON Schema primitive types, custom Globus format values can be used to make common data types in Globus more user-friendly. To get started, view our [help page on creating input schemas](#).

③ Deploy Your Flow
The final step is to register your flow with Globus by filling out a short form and uploading your flow definition and input schema files.

[Deploy Flow](#)

Globus Compute (Beta)

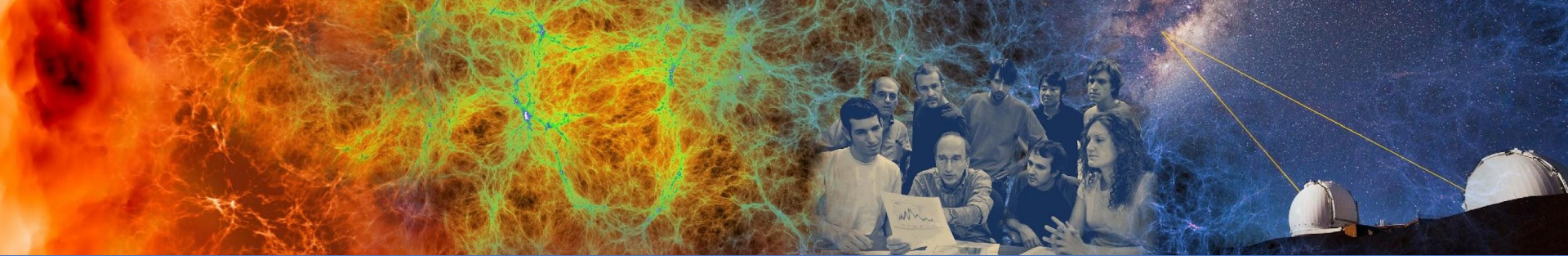


- Globus as a FaaS engine
 - Make functions to run work
 - Globus controls submitting jobs
 - Connects to Slurm
 - Uses Parsl workflow manager to dispatch work
- Also has a Python sdk
- Python multiprocessing futures
 - Define a function to run
 - Submit work as a future
 - Wait for results

```
# 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)
```

```
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



General purpose buckets (1) Info 🔄 📄 Copy ARN Empty

Buckets are containers for data stored in S3. [Learn more](#)

🔍 Find buckets by name

Name	AWS Region	Access
tylern-nersc-globus	US West (N. California) us-west-1	Bucket and objects not public

File Manager

Collection: NERSC S3 Test 🔍 ⓧ

Path: /

Start ▶ 🔄 Transfer & T

select all 📁 up one folder 🔄 refresh list 🔍 filter ⚙️ view

NAME	LAST MODIFIED	SIZE
tylern-nersc-globus	12/31/1969, 03:5...	—

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



XRootD



Questions?

