



Introduction to Globus: SaaS for Research Data Management

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Penn State University — June 29, 2017





Research data management today



Index?



How do we...
...move?
...share?
...discover?
...reproduce?



Globus delivers...

Big data transfer, sharing,
publication, and discovery...

...directly from your own
storage systems...

...via software-as-a-service



Globus enables...

Campus Bridging

...within and beyond campus
boundaries



Bridge to campus HPC

Move datasets to campus research computing center



Move results to laptop, department, lab, ...



Bridge to national cyberinfrastructure

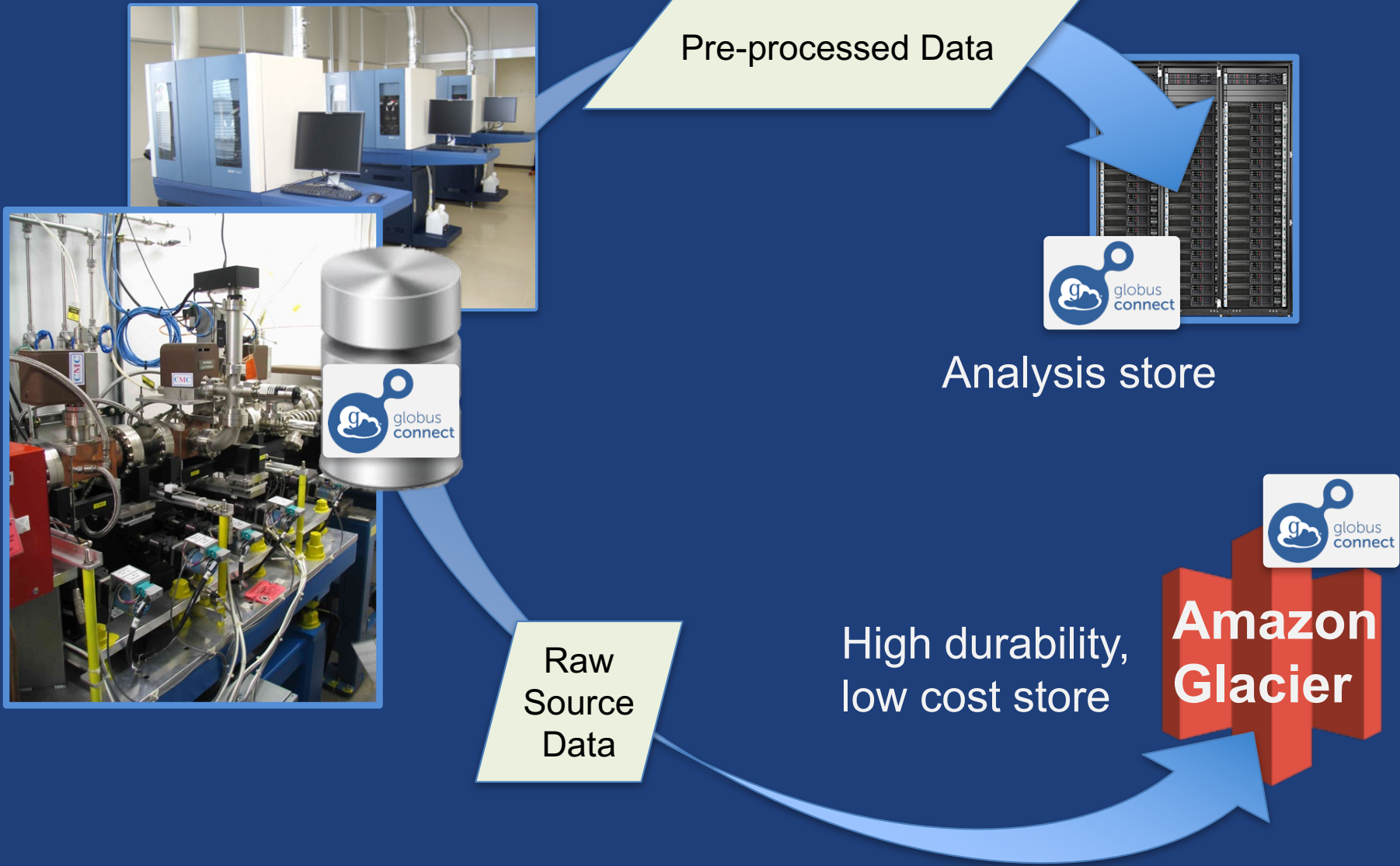
Move datasets to supercomputer,
national facility



Move results to campus (...)

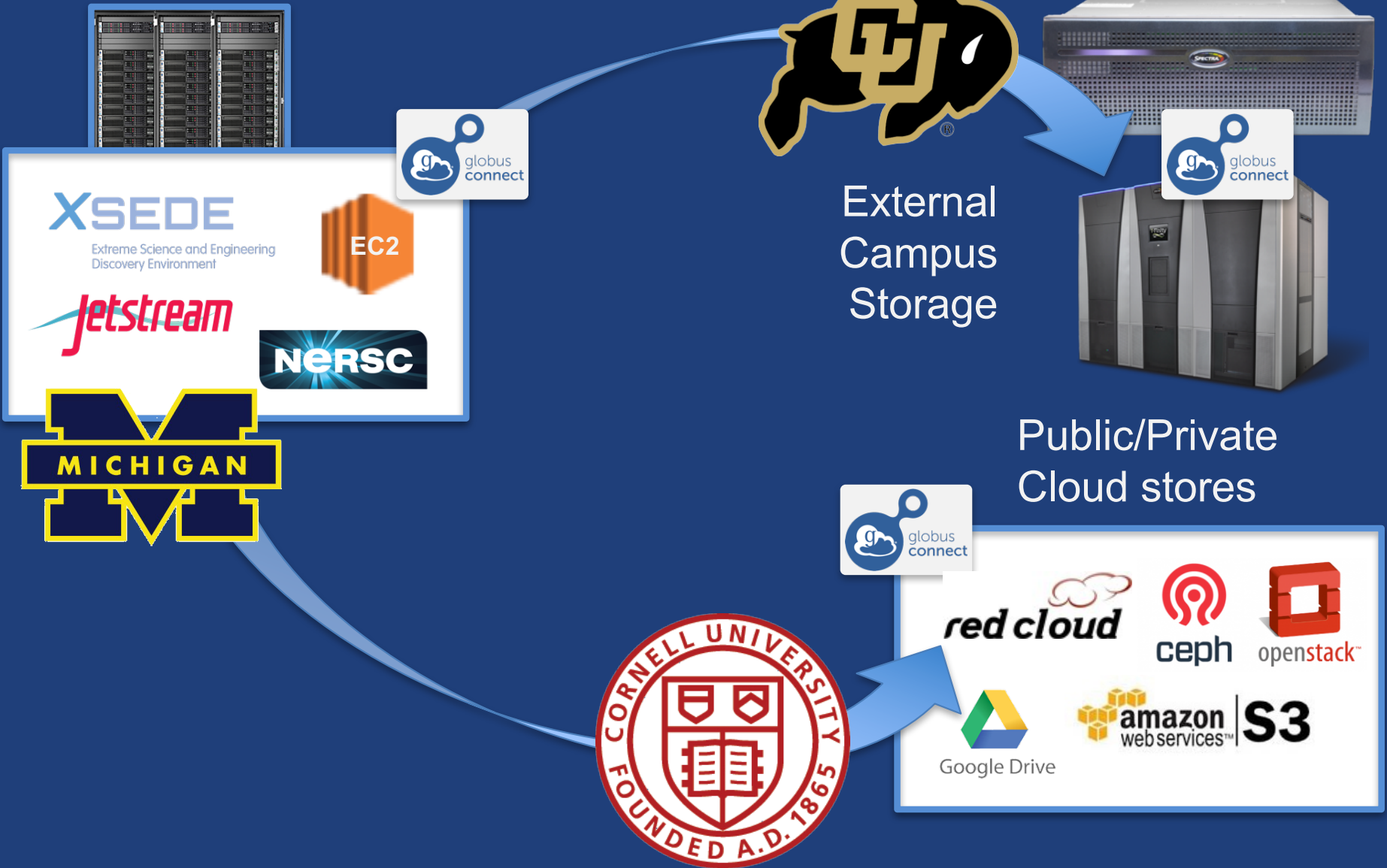


Bridge to instruments





Bridge to collaborators





Bridge to community/public



Project Repositories,
Replication Stores

globus connect

XSEDE
Extreme Science and Engineering
Discovery Environment

Jetstream

EC2

NERSC

Public Repositories

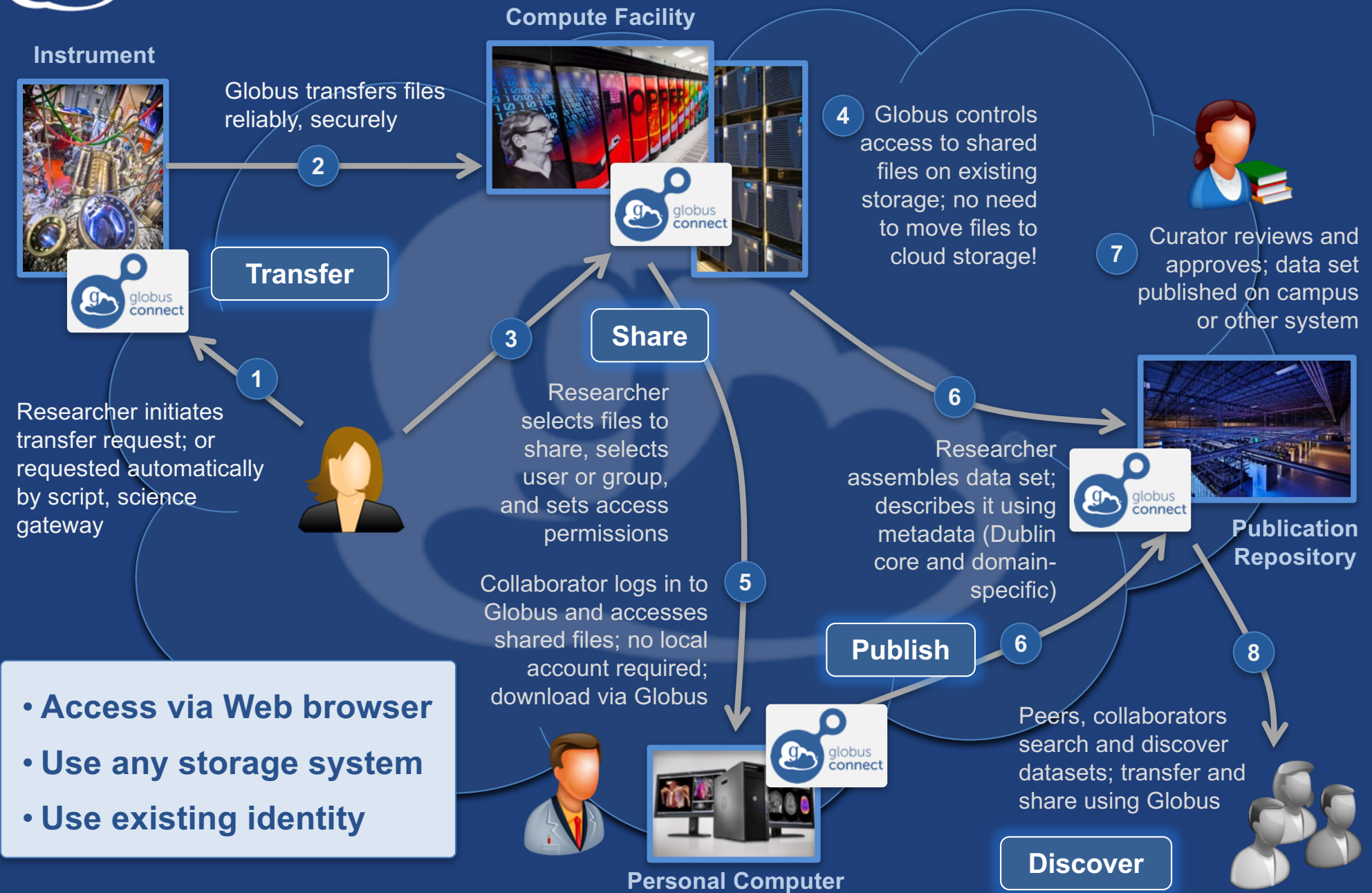
globus connect

globus connect

globus connect



Globus and the research data lifecycle





Why use Globus?

- **Simplicity**
 - Consistent UI across systems
 - Easy access to collaborators
- **Reliability and performance**
 - “Fire-and-forget” file transfer
 - Maximized WAN throughput
- **Operational efficiency**
 - Low overhead SaaS model
 - Highly automatable: CLI, RESTful API
- **Access to a large and growing community**



Demonstration

File Transfer

File Sharing

Federated Identity



Data Publication and Discovery

The screenshot shows the Materials Data Facility (MDF) community home page on the Globus website. The page features a search bar at the top, a navigation bar with "Log In" and "Sign Up" links, and a main content area with the MDF logo and introductory text. Below the main content is a "Browse" section with filters for "Issue Date", "Author", "Title", and "Subject".

globus Log In Sign Up

To submit a dataset or view datasets that have restricted access, please log in.

Search

Materials Data Facility Community home page



The Materials Data Facility (MDF) is a scalable repository where materials scientists can publish, preserve, and share research data. The repository provides a focal point for the materials community, enabling publication and discovery of materials data of all sizes.

MDF is a pilot project funded by NIST, and serves as the first pilot community of the [National Data Service](#).

Contact Ben Blaiszik (blaiszik@uchicago.edu) to begin publishing your data

Browse

Issue Date Author Title Subject

<https://publish.globus.org>

Publish

globus Publish Manage Data Groups Support

Browse & Discover Data Publication Dashboard Communities & Collections

Submit: Describe this Dataset

Please fill in the requested information about this submission below. In most browsers, you can use the tab key to move the cursor to the next input box or button. To save you having to use the mouse each time, click on the save icon to save.

Title*

Authors*

Publication Year* 2000

Publisher*

< Previous Cancel/Save Next >

© 2010-2015 Computation Institute, University of Chicago, Argonne National Laboratory legal

Discover

globus Publish Login Sign Up

Search Results

Collection Results (2 results) advanced search Discover

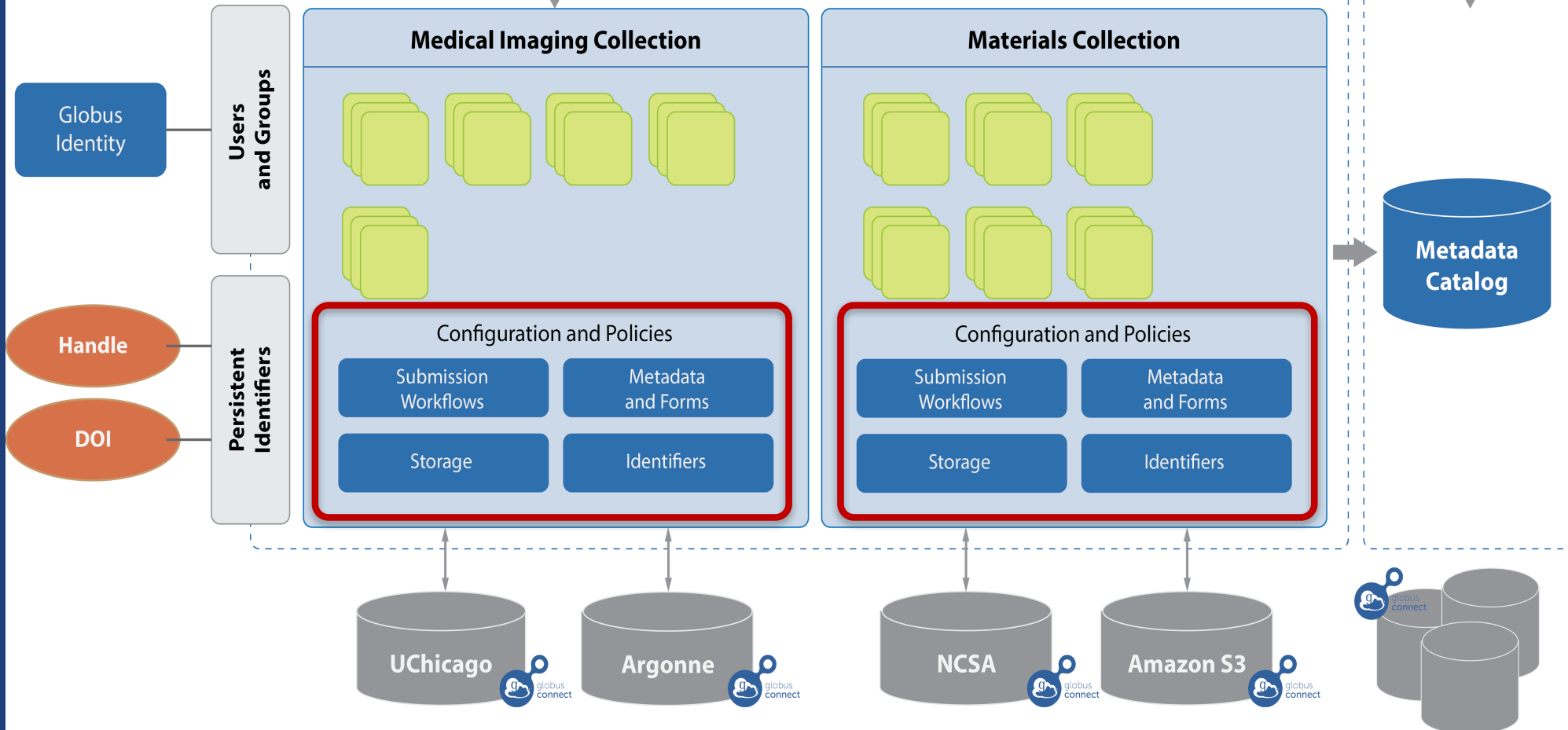
Collection Results (2 results)	Author
Results 1-2 of 2	CAMEL D.G.
21-Jul-2014 Sample CAMEL Data	Markus Rymond
1990 Corning glass ceramic #9006 Thermal Conductivity	Heena, Haru
1990 Thermal Conductivity Amorphous SiO2	Liu, S-H
1990 Thermal Conductivity Amorphous SiO2	Paul, EJ
1990 Corning Pyrex #7740 Thermal Conductivity	Przybyl, Jim
1991 Sapphire Thermal Conductivity	Wendlandt, Lawrence B.

next >



Globus Authentication

Globus Data Publication





Peer reviewed paper data

(Re)format...

- PDF/A
- HDF
- ...

Describe...

- Dublin core metadata
- Domain metadata
- Provenance info
- ...

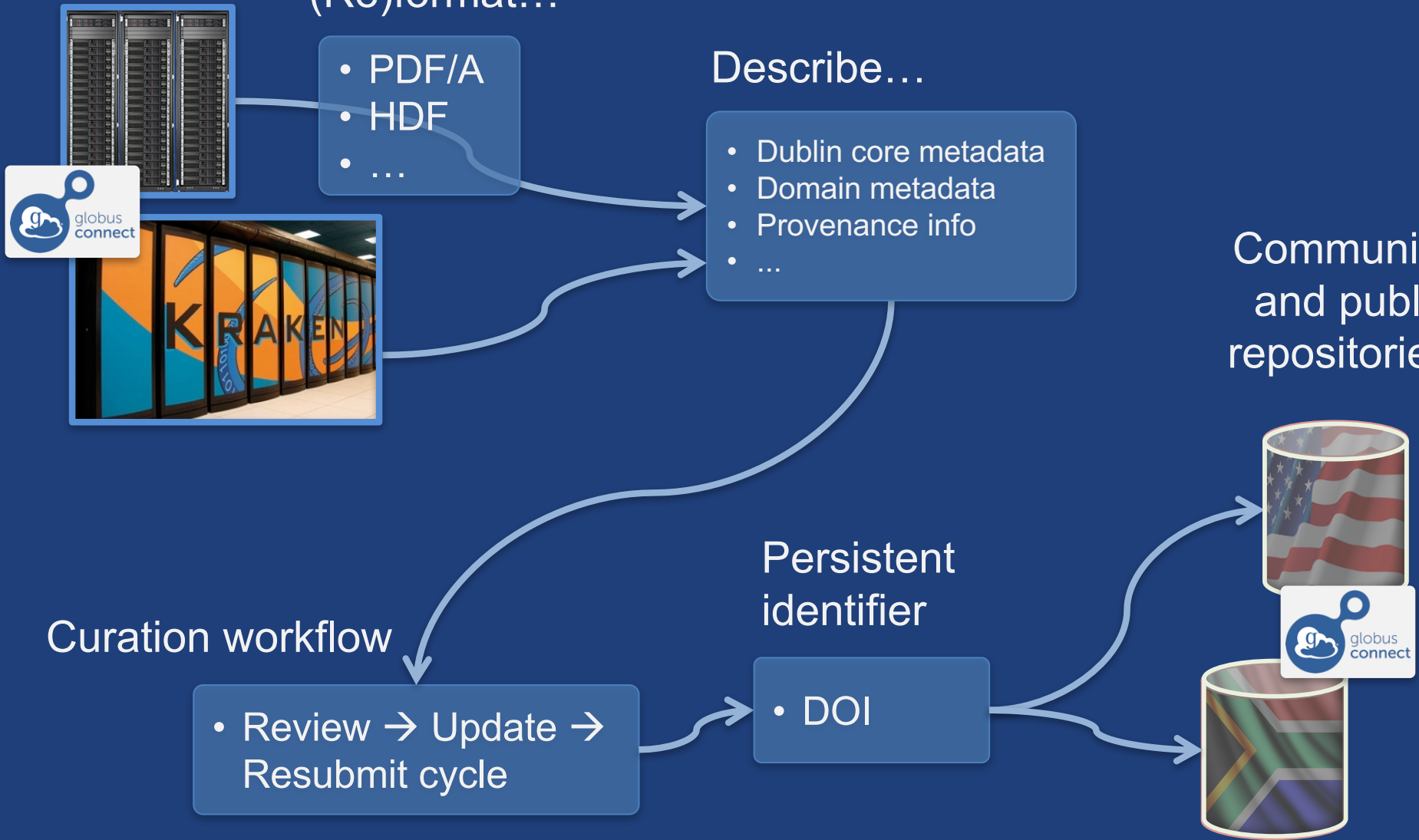
Community and public repositories

Curation workflow

- Review → Update → Resubmit cycle

Persistent identifier

- DOI





Demonstration

Data Publication



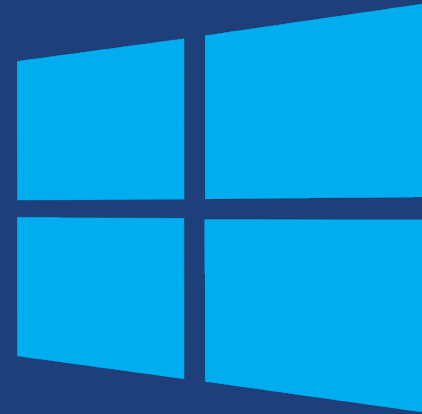
How can I use Globus
on my system?



Globus Connect...
Makes your storage
system a Globus
endpoint



Globus Connect Personal



- **Installers do not require admin access**
- **Zero configuration; auto updating**
- **Handles NATs**



Moving data between your laptop and another system



Exercise: Log in & transfer files

1. **Go to: www.globus.org/login**
2. **Select your institution from the list and click “Continue”**
3. **Authenticate with your institution’s identity system**
4. **Install Globus Connect Personal**
5. **Move file(s) between an ESnet test endpoint and your laptop**



Sharing Data



Share files

- 1. Join the “Tutorial Users” groups**
 - Go to “Groups”, search for “tutorial”
 - Select group from list, click “Join Group”
- 2. Create a shared endpoint on your laptop**
- 3. Grant your neighbor permissions on your shared endpoint**
- 4. Access your neighbor’s shared endpoint**



How can I integrate
Globus into my
research workflows?

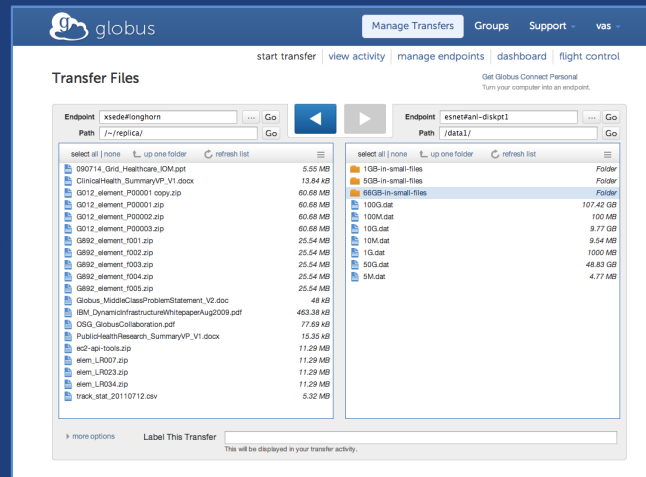


Globus serves as...

A platform for building science gateways, portals and other web applications in support of research and education



Use(r)-appropriate interfaces



Web



Globus service

```
(globus-cli) jupiter:~ vas$ globus
Usage: globus [OPTIONS] COMMAND [ARGS]...

Options:
  -v, --verbose          Control level of output
  -h, --help            Show this message and exit.
  -F, --format [json|text] Output format for stdout. Defaults to text
  --map-http-status TEXT Map HTTP statuses to any of these exit codes:
                        0,1,50-99. e.g. "404=50,403=51"

Commands:
  bookmark          Manage Endpoint Bookmarks
  config            Modify, view, and manage your Globus CLI config.
```

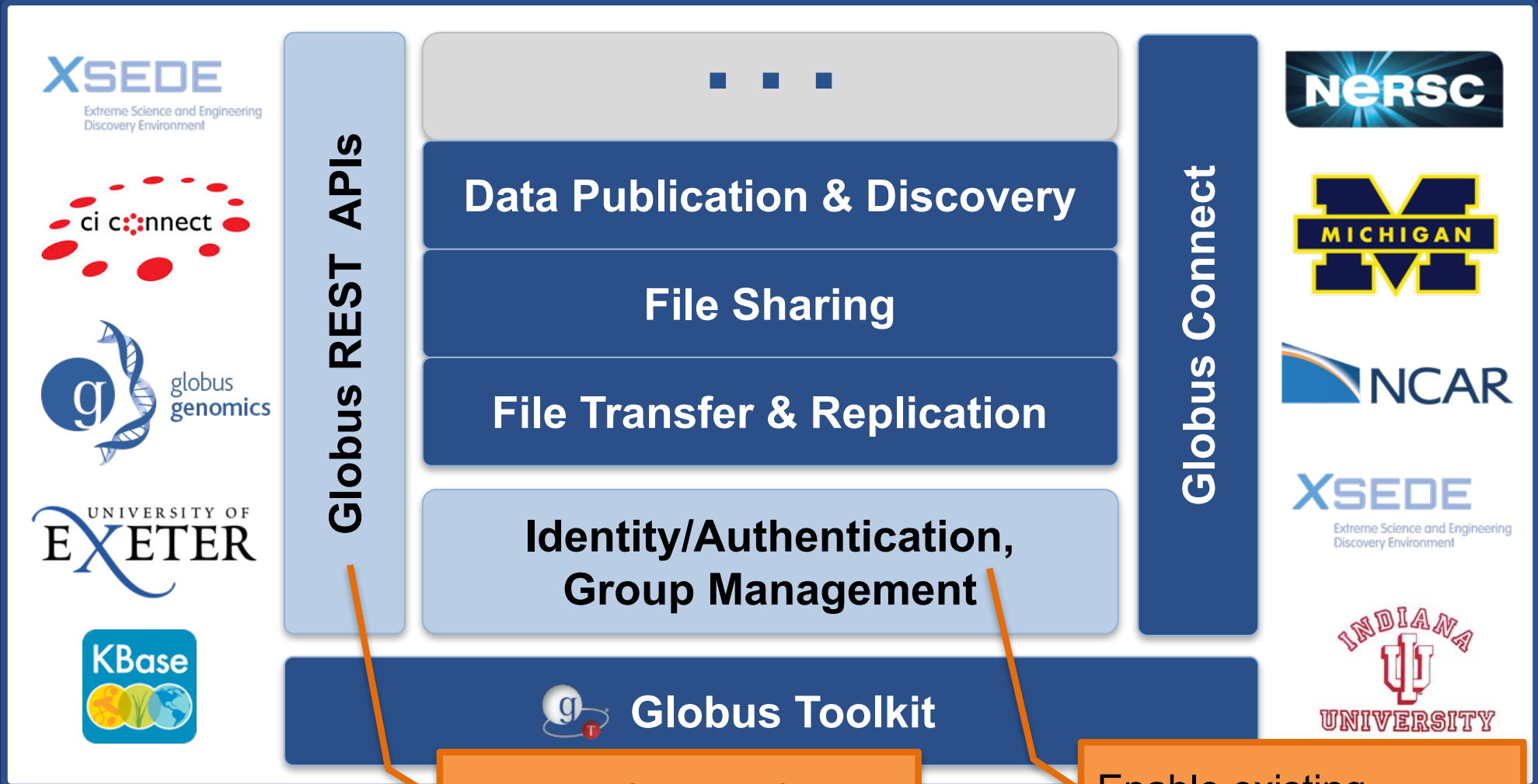
CLI

```
GET /endpoint/go%23ep1
PUT /endpoint/vas#my_endpt
200 OK
X-Transfer-API-Version: 0.10
Content-Type: application/json
...
```

Rest API



Globus as PaaS



Globus REST APIs

Globus Connect

Data Publication & Discovery

File Sharing

File Transfer & Replication

**Identity/Authentication,
Group Management**

 **Globus Toolkit**

Integrate file transfer and sharing capabilities into scientific web apps, portals, gateways, etc.

Enable existing institutional ID systems to be used in external web applications



Data App: NCAR RDA

UCAR NCAR Closures/Emergencies Locations/Directions Find Pe

Hello [trocke@uchicago.edu](#) [dashboard](#) [sign out](#)

NCAR | Research Data Archive
UCAR | Computational & Information Systems Lab *weather • data • climate*

Go to Dataset:

[Home](#) [Find Data](#) [Ancillary Services](#) [About/Contact](#) [Data Citation](#) [Web Services](#) [For Staff](#)

NCEP Climate Forecast System Version 2 (CFSv2) Monthly Products
ds094.2

For assistance, contact [Bob Dattore](#) (303-497-1825).

[Description](#) [Data Access](#)

Mouse over the table headings for detailed descriptions

Data Description	Data File Downloads		Customizable Data Requests	Other Access Methods	NCAR-Only Access	
	Web Server Holdings	Globus Transfer Service (GridFTP)	Subsetting	THREDDS Data Server	Central File System (GLADE) Holdings	Tape Archive (HPSS) Holdings
Union of Available Products	Web File Listing	Request Globus Invitation	Get a Subset	TDS Access	GLADE File Listing	HPSS File Listing
P Diurnal monthly means	Web File Listing		Get a Subset		GLADE File Listing	HPSS File Listing
R						
O Regular monthly means	Web File Listing		Get a Subset		GLADE File Listing	HPSS File Listing
D						



Analysis App: Wellcome Sanger

Sanger Imputation Service **Beta**

Home

About

Instructions ▾

Resources

Status

Sanger Imputation Service

This is a free genotype **imputation** and **phasing** service provided by the [Wellcome Trust Sanger Institute](#). You can upload GWAS data in VCF or 23andMe format and receive imputed and phased genomes back. Click [here](#) to learn more and [follow us on Twitter](#).

Before you start

Be sure to [read through the instructions](#).

You will need to set up a free account with [Globus](#) and have [Globus Connect](#) running at your institute or on your computer to transfer files to and from the service.

Ready to start?

If you are ready to upload your data, please fill in the details below to **register an imputation and/or phasing job**. If you need more information, see the [about](#) page.

What is this [?](#)

→ Next

News

[@sangerimpute](#)

11/05/2016

Thanks to [EAGLE](#), we can now return **phased data**. The HRC panel has been updated to r1.1 to fix a [known issue](#). See [ChangeLog](#) for more details.

15/02/2016

Globus API changed, please see [updated instructions](#).

17/12/2015

New status page and reworked internals. See [ChangeLog](#).

09/11/2015

Pipeline updated to add some features requested by users. See [ChangeLog](#).

[See older news...](#)



Globus PaaS: National Resource Access

XSEDE
Extreme Science and Engineering
Discovery Environment

globus Account ▾

Jetstream Web App would like to:


✓ Access all Jetstream resources

By clicking "Allow", you allow **Jetstream Web** information and services. You can rescind this

Allow

Deny

globus Globus Account Log In



compute | **calcul**
canada | canada

Compute Canada has partnered with Globus to offer this high performance file transfer service.

Calcul Canada s'est associé à Globus pour vous offrir ce service de transfert de fichier à haute performance.

Log in to use Compute Canada Globus Web App

Use your existing organizational login
e.g. university, national lab, facility, project, Google or [Globus ID](#)
(Your Globus username and password used prior to February 13, 2016 is now Globus ID)


WestGrid ▾

Continue

Didn't find your organization? Then use Globus ID to [sign up](#).



Globus PaaS: Identity Management



KBase
PREDICTIVE BIOLOGY
DOE Systems Biology Knowledgebase


[Home](#) [About](#) [News](#) [Developer Zone](#) [KBase Labs](#) [Contact Us](#)

The new **Systems Biology Knowledgebase (KBase)** is a collaborative effort designed to accelerate our understanding of microbes, microbial communities, and plants. It will be a community-driven, extensible and scalable open-source software framework and application system. KBase will offer free and open access to data, models and simulations, enabling scientists and researchers to build new knowledge and share their findings.

[Collaborate with us](#) [Get Started](#) [Develop with us](#)

What can KBase do?

- ✔ Combine heterogenous data types
- ✔ Offer standardized access to bioinformatic and modeling analyses
- ✔ Use evidence-supported annotations of genome structure and genetic function
- ✔ Discover new associations and network structures in community and molecular networks
- ✔ Map genotype to complex organismal traits
- ✔ Design and refine experiments using models of metabolism, regulation and community function
- ✔ Enable sharing of data, hypotheses, and newly-generated knowledge



Latest News

[KBase at International Plant and Animal Genome XXI](#)
Posted by salazar Jan 09, 2013

[KBase Team at Argonne for November Build](#)
Posted by nharris Nov 30, 2012

[November Build at Argonne](#)
Posted by salazar Nov 23, 2012

[view news](#)

Upcoming Events

2013-01-12
[International Plant and Animal Genome XXI \(PAG 2013\)](#)

2013-02-18
[BERAC Presentations](#)

2013-02-24
[DOE/NIFA Plant Feedstocks Genomics for Bioenergy](#)

2013-02-25
[Proposed: Genomic Science Contractors-Grantees Meeting](#)



Globus PaaS developer resources



globus.github.io/globus-sdk-python/

globus-sdk-python 0.2.5 documentation »

Table Of Contents

- Globus SDK for Python (Beta)
- Installation
- Basic Usage
- API Documentation
- License

Python SDK

Installation

The Globus SDK requires Python 2.6

```
pip install globus-sdk
```

This will install the Globus SDK and it Bleeding edge versions of the Globus

```
git checkout https://github.com/globus/globus-sdk-python
cd globus-sdk-python
python setup.py install
```

Basic Usage

Globus Transfer API

API reference for transfer and sharing functions

Sample Application

Requirements

- You need to be in the tutorial
- Installed Globus Python SD

Jupyter Notebook

```
In [15]: from __future__ import print_function # for python 2
tutorial_endpoint_1 = "ddb59aef-6d04-11e5-ba46-22000b92c6ec" # endpoint "Glo
tutorial_endpoint_2 = "ddb59af0-6d04-11e5-ba46-22000b92c6ec" # endpoint "Glo
tutorial_users_group = "50b6a29c-63ac-11e4-8062-22000ab68755" # group "Tutori
```

Configuration

First you will need to configure the client with an OAuth2 access token. For the purpose of this tutorial, you can use the Globus CLI to get a token from the Globus website. Click the "Jupyter Notebook" option and copy the resulting text below, or click on "Globus CLI" and

```
In [16]: transfer_token = None # if None, tries to get token from ~/.globus.cfg file
```

docs.globus.org/api

github.com/globus



HTTPS support (coming soon)

- **Synchronous alternative to GridFTP**
- **Same fine-grained access control model**
- **Greatly simplified sharing/transfer of “small” datasets**
- **Standard browser behaviors**
- **Integration with clients and web apps to further leverage existing research storage systems**



Thank you to our sponsors...



U.S. DEPARTMENT OF
ENERGY



THE UNIVERSITY OF
CHICAGO



NIST

National Institute of
Standards and Technology
U.S. Department of Commerce



Argonne
NATIONAL LABORATORY



powered by
amazon
web services



Globus sustainability model

- **Standard Subscription**

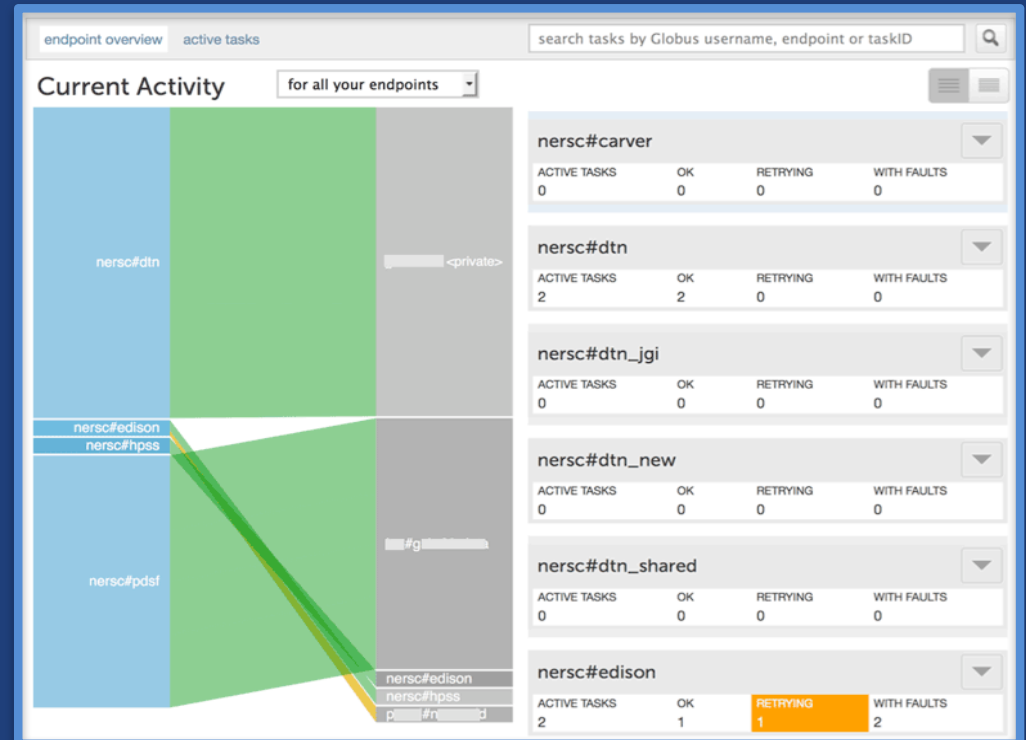
- Shared endpoints
- Data publication
- HTTPS support*
- Management console
- Usage reporting
- Priority support
- Application integration

- **Branded Web Site**

- **Premium Storage Connectors**

- Amazon S3, Ceph, HPSS, Spectra, Google Drive, Box*, HDFS*

- **Alternate Identity Provider (InCommon is standard)**



*Coming soon



Thank you to our users...

5

major services

280PB

transferred

47 Bn

files processed

60,000

registered users

13

national labs
use Globus

10,000

active endpoints

10,000

active users/year

99.5%

uptime

65+

institutional
subscribers

1 PB

largest single
transfer to date

3 months

longest
continuously
managed transfer

300+

federated
campus identities



...and thank YOU, our subscribers!



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UNIVERSITY

Yale



THE UNIVERSITY OF
CHICAGO



syngenta

NIST



VirginiaTech
Invent the Future





Join the Globus community

- Access the service: **globus.org/login**
- Create a personal endpoint:
globus.org/app/endpoints/create-gcp
- Documentation: **docs.globus.org**
- Engage: **globus.org/mailing-lists**
- Subscribe: **globus.org/subscriptions**
- Need help? **support@globus.org**
- Follow us: **[@globusonline](https://twitter.com/globusonline)**



Globus for System Administrators

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Penn State University — June 29, 2017



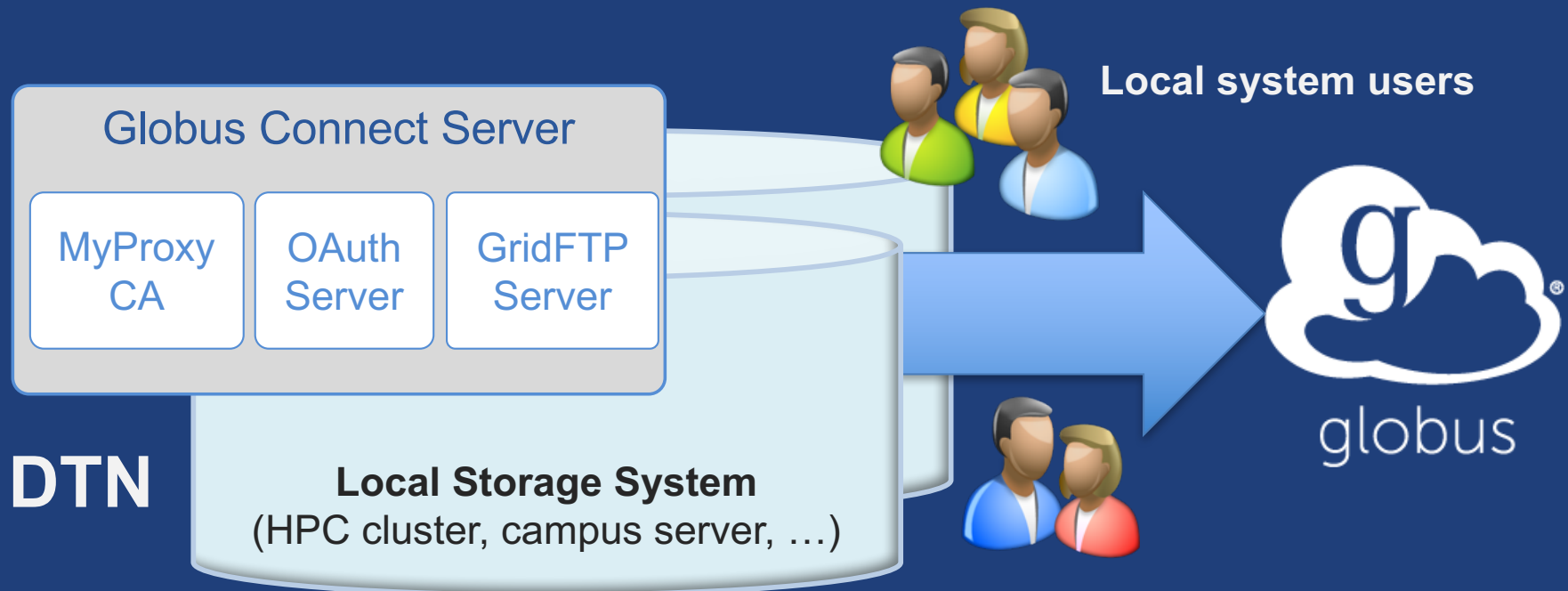


Enabling your storage system:

Globus Connect Server



Globus Connect Server



- **Create endpoint on practically any filesystem**
- **Enable access for all users with local accounts**
- **Native packages: RPMs and DEBs**



Storage connectors

- **Standard storage connectors (POSIX)**
 - Linux, Windows, MacOS
 - Lustre, GPFS, OrangeFS, etc.
- **Premium storage connectors**
 - Amazon S3
 - Google Drive
 - Spectra Logic BlackPearl
 - HPSS
 - Ceph RadosGW (S3 API)
 - iRODS
 - HDFS
- **Planned: Box, Azure, *et al***



Demonstration

- **Creating a Globus endpoint on your storage system**
- **In this example, storage system = Amazon EC2 server**



Step 0: Create a Globus ID

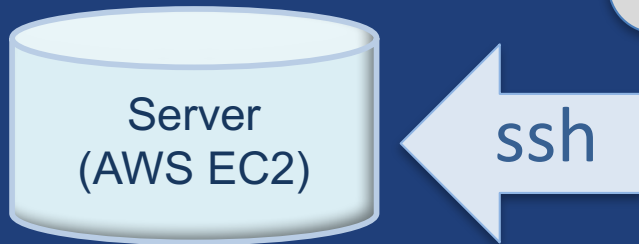
- **Installation and configuration of Globus Connect Server requires a Globus ID**
- **Go to `globusid.org`**
- **Click “create a Globus ID”**



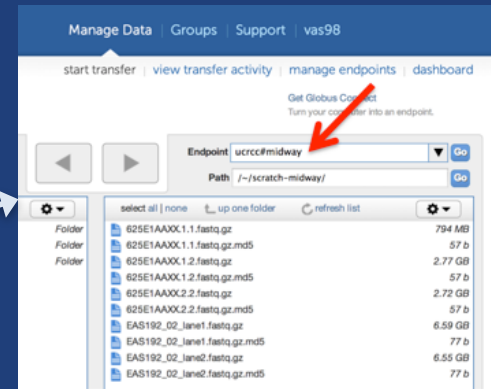
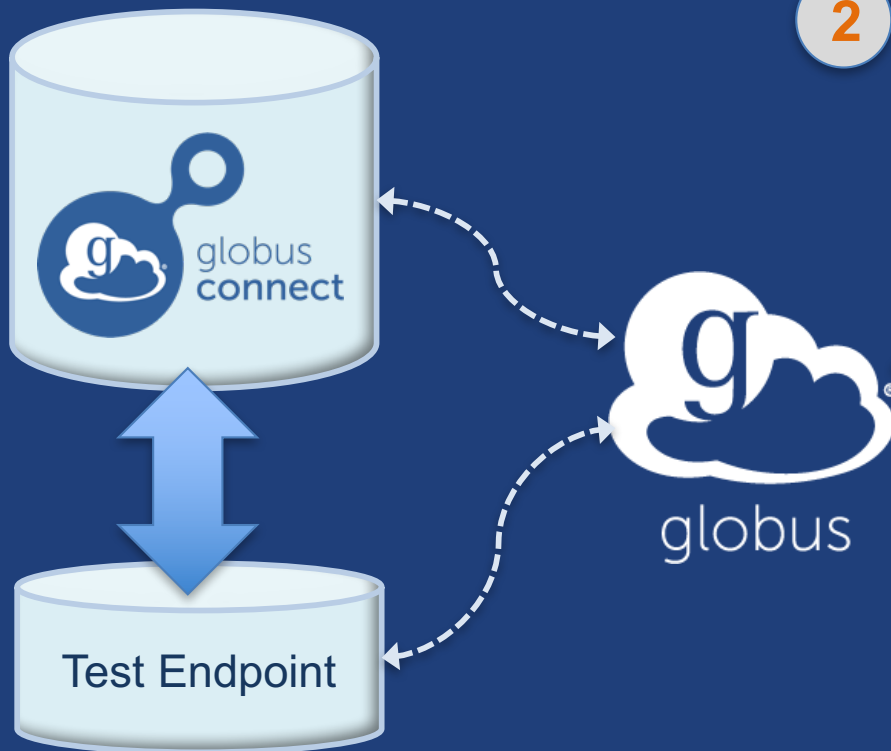
What we are going to do:

1 Install Globus Connect Server

- Access server as user “campusadmin”
- Update repo
- Install package
- Setup Globus Connect Server



2 Log into Globus



3 Access the newly created endpoint (as user 'researcher')

4 Transfer a file



Access your host

- **Create a Globus ID**
 - Optional: associate it with your Globus account
- **Get the DNS for your EC2 server**
- **Log in as user 'campusadmin':**

```
ssh campusadmin@<EC2_instance_IP_address>
```
- **NB: Please sudo su before continuing**
 - User 'campusadmin' has sudo privileges



Step 3: Install Globus Connect Server

Cheatsheet: globusworld.org/tutorial

```
$ sudo su
$ curl -LOs http://toolkit.globus.org/ftppub/globus-
connect-server/globus-connect-server-
repo_latest_all.deb
$ dpkg -i globus-connect-server-repo_latest_all.deb
$ apt-get update
$ apt-get -y install globus-connect-server
$ globus-connect-server-setup
```

↑ Use your Globus ID username/password when prompted

You have a working Globus endpoint!



Access the Globus endpoint

- **Go to Manage Data → Transfer Files**
- **Access the endpoint you just created**
 - Search for your EC2 DNS name in the Endpoint field
 - Log in as user “researcher”; you should see the user’s home directory
- **Transfer files to/from a test endpoint (e.g. Globus Tutorial, ESnet) and your endpoint**



Configuring Globus Connect Server



Endpoint configuration

- **Globus service config**
- **DTN (Globus Connect Server) config**
`/etc/globus-connect-server.conf`
- **To enable changes you must run:**
`globus-connect-server-setup`
- **“Rinse and repeat”**



Configuration file walkthrough

- **Structure based on .ini format**
 - [Section]
 - Option
- **Commonly configured options:**
 - Name
 - Public
 - RestrictedPaths
 - Sharing
 - SharingRestrictedPaths
 - IdentityMethod (CILogon, Oauth)



Exercise: Make your endpoint visible

- **Set `Public = true`**
- **Edit endpoint attributes**
 - Change the name to something useful, e.g. `<your_name> EC2 Endpoint`
- **Find your neighbor's endpoint**
 - You can access it too 😊



Enabling sharing on an endpoint

- In config file, set `Sharing = True`
- Run `globus-connect-server-setup`
- Use the CLI to flag as managed endpoint

* Note: Creation of shared endpoints requires a Globus subscription for the managed endpoint



Path Restriction

- **Default configuration:**
 - All paths allowed, access control handled by the OS
- **Use `RestrictPaths` to customize**
 - Specifies a comma separated list of full paths that clients may access
 - Each path may be prefixed by R (read) and/or W (write), or N (none) to explicitly deny access to a path
 - '~' for authenticated user's home directory, and * may be used for simple wildcard matching.
- **e.g. Full access to home directory, read access to /data:**
 - `RestrictPaths = RW~,R/data`
- **e.g. Full access to home directory, deny hidden files:**
 - `RestrictPaths = RW~,N~/.*`



Exercise: Restrict access

- **Set `RestrictPaths=RW~,N~/archive`**
- **Run `globus-connect-server-setup`**
- **Access your endpoint as 'researcher'**
- **What's changed?**



Limit sharing to specific accounts

- `SharingUsersAllow` =
- `SharingGroupsAllow` =
- `SharingUsersDeny` =
- `SharingGroupsDeny` =



Sharing Path Restriction

- **Restrict paths where users can create shared endpoints**
- **Use `SharingRestrictPaths` to customize**
 - Same syntax as `RestrictPaths`
- **e.g. Full access to home directory, deny hidden files:**
 - `SharingRestrictPaths = RW~,N~/.*`
- **e.g. Full access to public folder under home directory:**
 - `SharingRestrictPaths = RW~/public`
- **e.g. Full access to `/proj`, read access to `/scratch`:**
 - `SharingRestrictPaths = RW/proj,R/scratch`



Accessing Endpoints

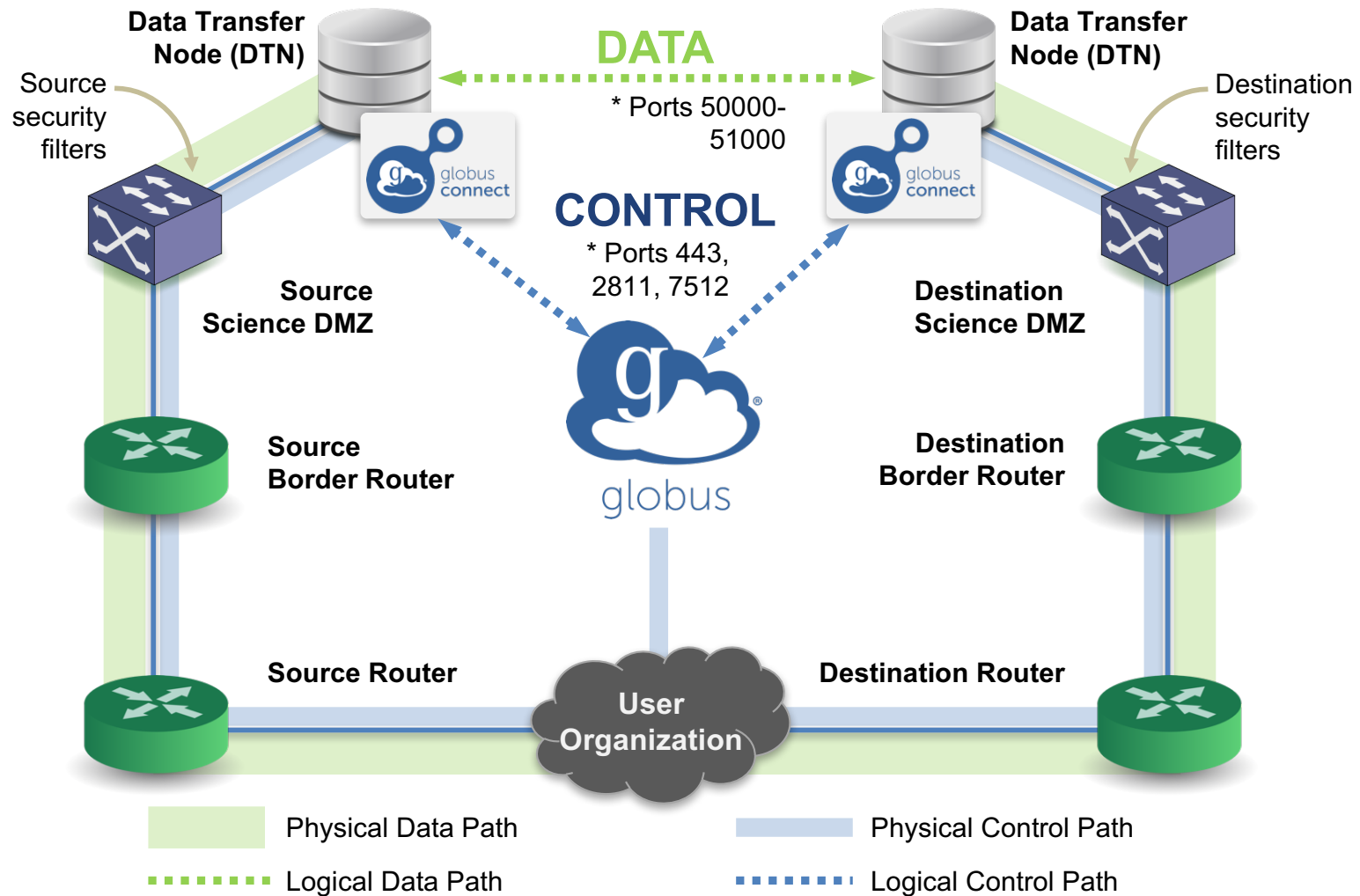


Ports needed for Globus

- **Inbound: 2811 (control channel)**
- **Inbound: 7512 (MyProxy), 443 (OAuth)**
- **Inbound: 50000-51000 (data channel)**
- **If restricting outbound connections, allow connections on:**
 - 80, 2223 (used during install/config)
 - 50000-51000 (GridFTP data channel)



Network Paths



* Please see TCP ports reference: https://docs.globus.org/resource-provider-guide/#open-tcp-ports_section

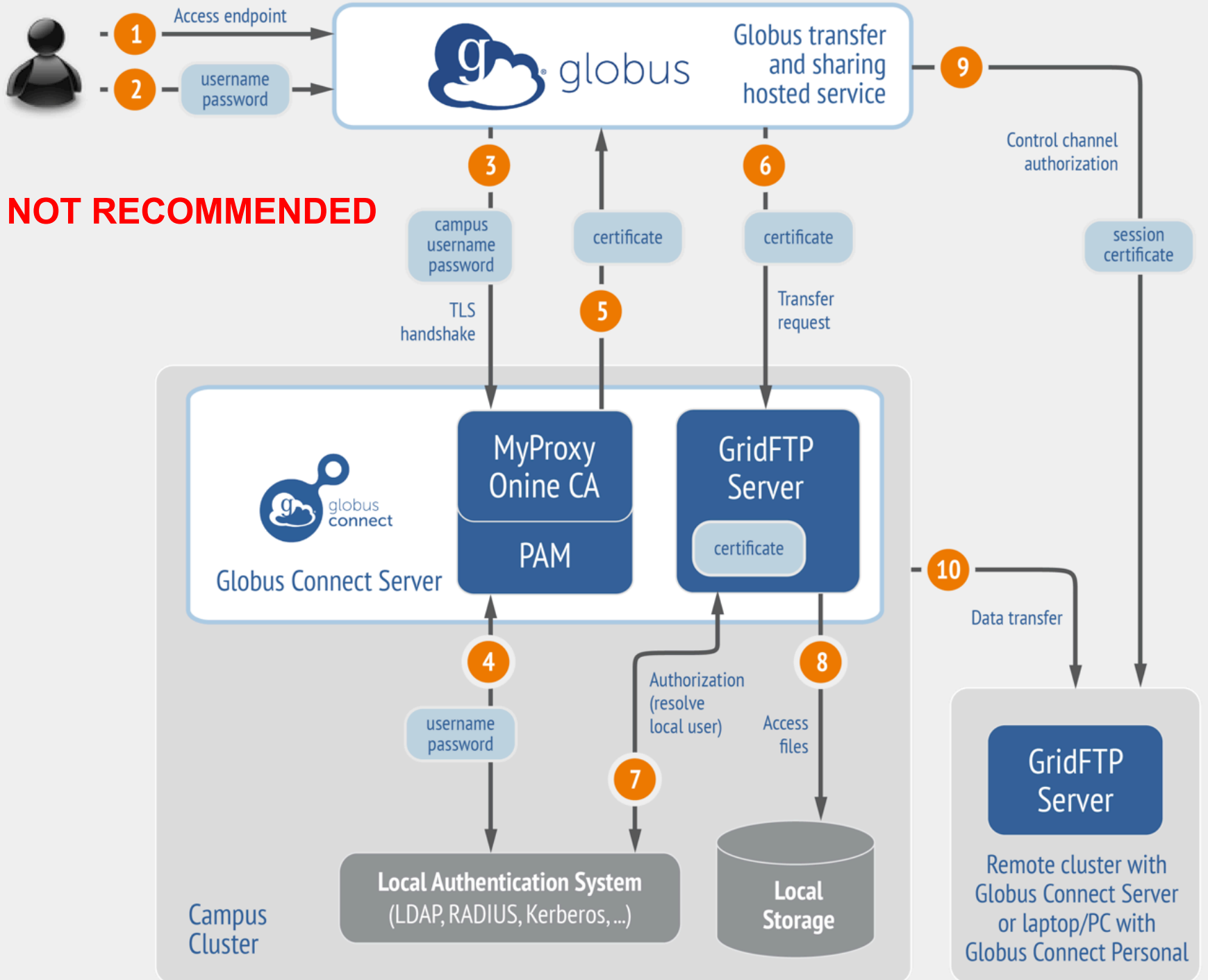


Network paths

- **Separate control and data interfaces**
- **"DataInterface =" option in globus-connect-server-conf**
- **Common scenario: route data flows over Science DMZ link**

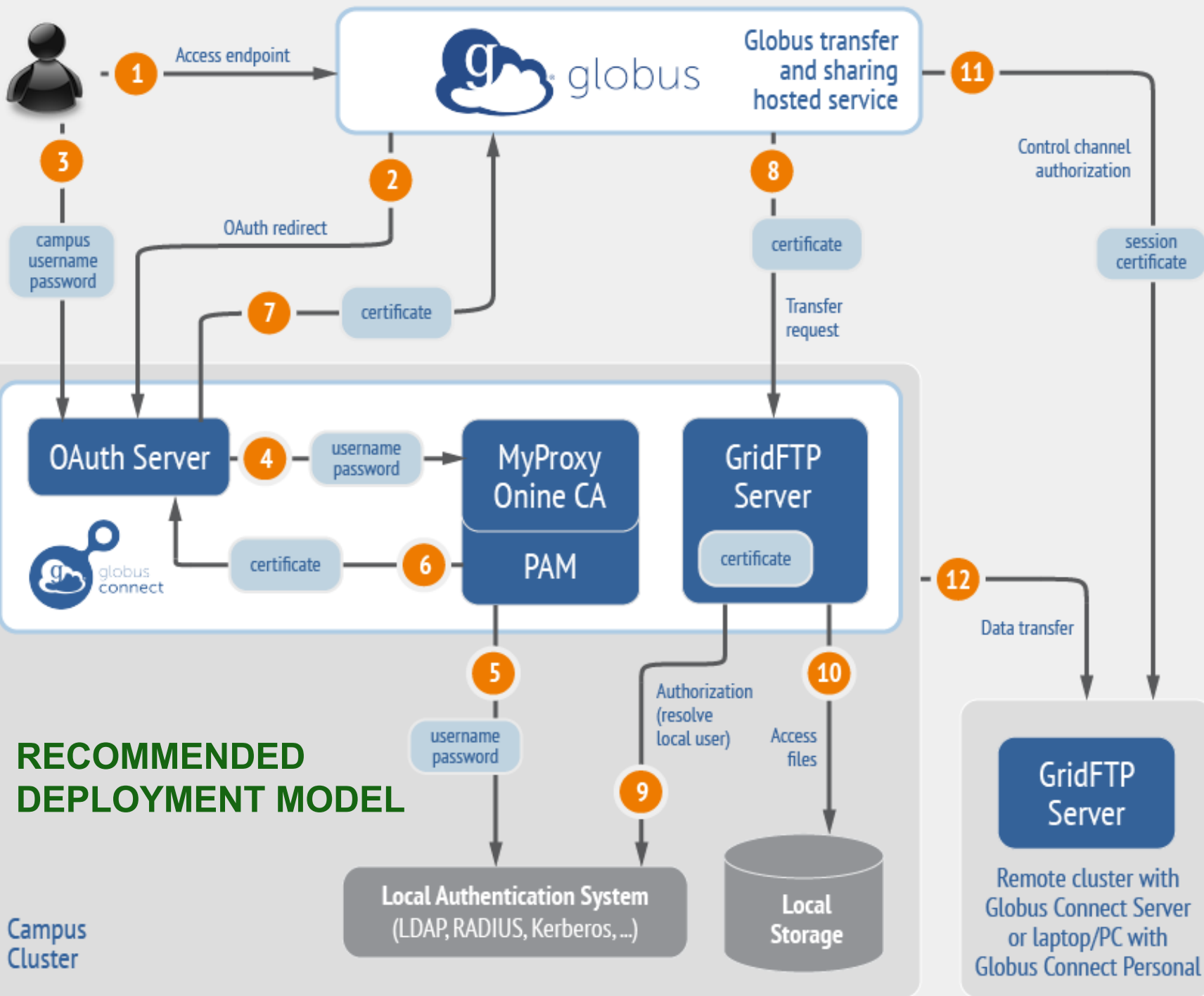


Endpoint activation using MyProxy





Endpoint activation using MyProxy OAuth





Single Sign-On with InCommon/CILogon

- **Your Shibboleth server must release the ePPN attribute to CILogon**
- **Local resource account names must match institutional ID (InCommon ID)**
- **AuthorizationMethod = CILogon**
- **CILogonIdentityProvider = `<institution_listed_in_CILogon_IdP_list>`**



Integrating your IdP

- **InCommon members**
 - Must release R&S attributes to CILogon
 - Mapping uses ePPN; can use GridMap

```
AuthorizationMethod = CILogon  
CILogonIdentityProvider =  
<institution_name_in_CILogon_IdP_list>
```
- **Non-members**
 - IdP must support OpenID Connect
 - Requires Alternate IdP subscription
- **Using an existing MyProxy server**



Optimizing performance



Balance: performance - reliability

- **In-flight tuning based on...**
 - Transfer request profile (#files, sizes)
 - Concurrency, parallelism
- **Request-specific overrides**
- **Endpoint-specific overrides (especially useful for multi-DTN deployments)**
- **Service limits, e.g. concurrent requests**

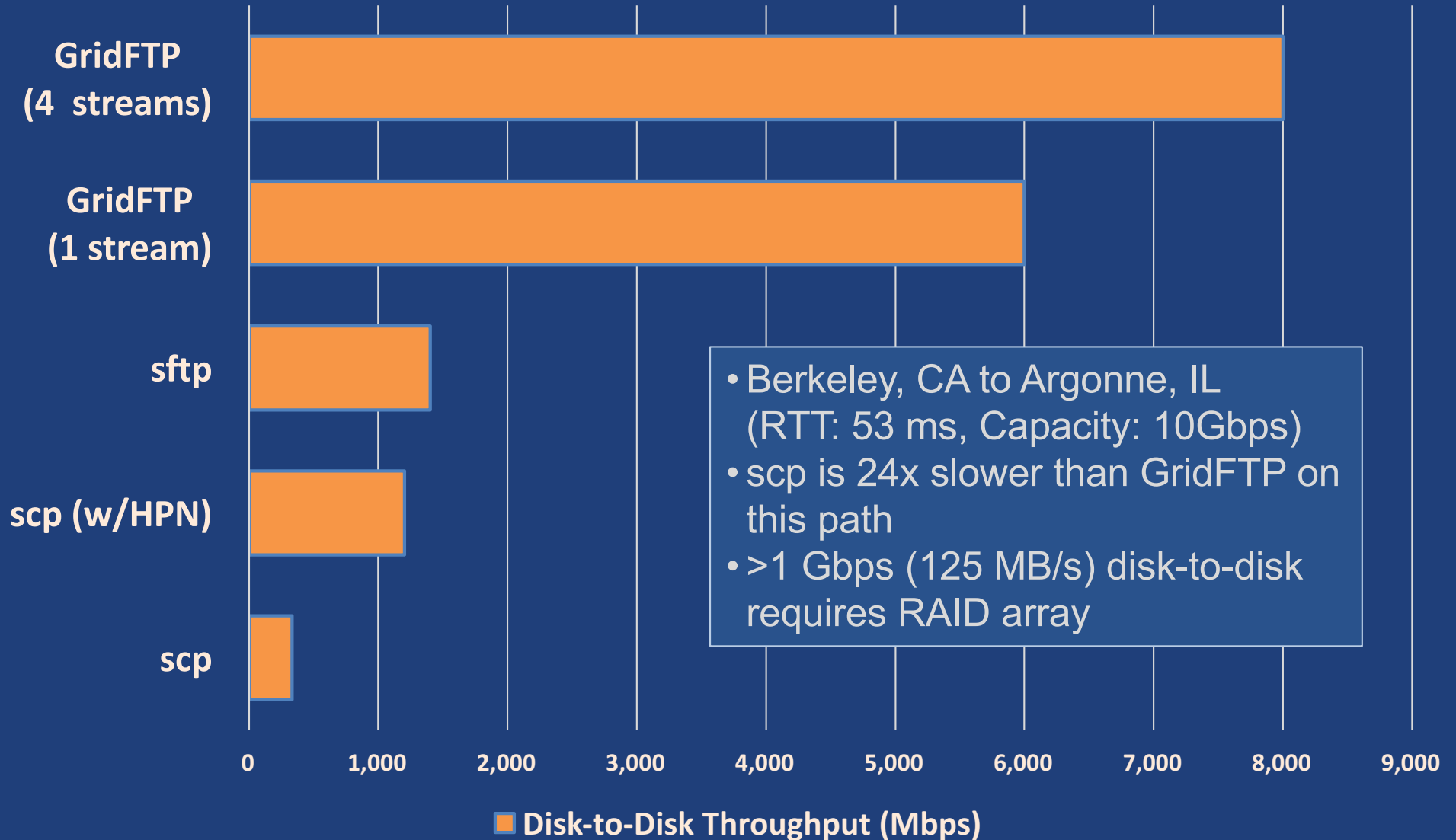


Illustrative performance

- **20x scp throughput (typical)**
 - >100x demonstrated
- **On par/faster than UDP based tools (NASA JPL study and anecdotal)**
- **Capable of saturating “any” WAN link**
 - Demonstrated 85Gbps sustained disk-to-disk
 - Typically require throttling for QoS



Disk-to-Disk Throughput





Network Use Parameters

- concurrency, parallelism used to configure each transfer request
- Maximum, Preferred values for each
- Use source and destination values:
 $\min(\max(\text{preferred src}, \text{preferred dest}), \max \text{src}, \max \text{dest})$



Demonstration: Network Use Profile



Managed endpoints and subscriptions



Subscription configuration

- **Subscription manager**
 - Create/upgrade managed endpoints
 - Requires Globus ID linked to Globus account
- **Management console permissions**
 - Independent of subscription manager
 - Map managed endpoint to Globus ID
- **Globus Plus group**
 - Subscription Manager is admin
 - Can grant admin rights to other members



Creating managed endpoints

- **Required** for sharing, management console, reporting, etc.

- **Convert existing endpoint to managed:**

```
endpoint-modify --managed-endpoint <endpoint_name>
```

- **Must be run by subscription manager, using the Globus CLI**

- **Important: Re-run endpoint-modify after deleting/re-creating endpoint**

- **Note: The above command requires the hosted (legacy) CLI**

https://docs.globus.org/cli/#hosted_command_line_interface_legacy



Demonstration: Command Line Interface (CLI)



Managed endpoint activity accessible via management console

- **Monitor all transfers**
- **Pause/resume specific transfers**
- **Add pause conditions with various options**
- **Resume specific tasks overriding pause conditions**
- **Cancel tasks**
- **View sharing ACLs**



Endpoint Roles

- **Administrator:** define endpoint and roles
- **Access Manager:** manage permissions
- **Activity Manager:** perform control tasks
- **Activity Monitor:** view activity



Demonstration: **Management console**



Other Deployment Options



Encryption

- **Requiring encryption on an endpoint**
 - User cannot override
 - Useful for “sensitive” data
- **Globus uses OpenSSL cipher stack as currently configured on your DTN**
- **FIPS-140-2 compliance**
 - Limit number of ciphers used by OpenSSL
 - <https://access.redhat.com/solutions/137833>



Distributing Globus Connect Server components

- **Globus Connect Server components**
 - globus-connect-server-io, -id, -web
- **Default: -io, -id and -web on single server**
- **Common options**
 - Multiple -io servers for load balancing, failover, and performance
 - No -id server, e.g. third-party IdP such as CILogon
 - -id on separate server, e.g. non-DTN nodes
 - -web on either -id server or separate server for OAuth interface



Setting up multiple `-io` servers

- **Guidelines**

- Use the same `.conf` file on all servers
- First install on the server running the `-id` component, then all others

1. **Install Globus Connect Server on all servers**

2. **Edit `.conf` file on one of the servers and set `[MyProxy] Server` to the hostname of the server you want the `-id` component installed on**

3. **Copy the configuration file to all servers**

- `/etc/globus-connect-server.conf`

4. **Run `globus-connect-server-setup` on the server running the `-id` component**

5. **Run `globus-connect-server-setup` on all other servers**

6. **Repeat steps 2-5 as necessary to update configurations**



Example: Two-node DTN

-id

-io



```
/etc/globus-connect-server.conf
```

```
[Endpoint] Name = globus_dtn
```

```
[MyProxy] Server = ec2-34-20-29-57.compute-1.amazonaws.com
```

-io



```
/etc/globus-connect-server.conf
```

```
[Endpoint] Name = globus_dtn
```

```
[MyProxy] Server = ec2-34-20-29-57.compute-1.amazonaws.com
```



For the very brave...



Globus Network Manager

- **Information from GridFTP to facilitate dynamic network changes**
- **Callbacks during GridFTP execution on local DTN**
- **Supplements information available via Globus transfer API**



Globus Network Manager Callbacks

- **Pre-listen (binding of socket)**
- **Post-listen**
- **Pre-accept/Pre-connect (no Data yet)**
- **Post-accept/Post-connect (data in flight)**
- **Pre-close**
- **Post-close**



Network manager use cases

- **Science DMZ Traffic Engineering**
 - Use SDN to dynamically route data path
 - Control path uses traditional route
- **Automated WAN bandwidth reservation**
 - OSCARS, AL2S
- **Note: All this requires custom code**



Discussion



Enable your storage system

- Everything you wanted to know: **docs.globus.org**
- Need help? **support.globus.org**
- Mailing Lists: **globus.org/mailing-lists**
- Subscribe to help us make Globus self-sustaining:
globus.org/provider-plans
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