Introduction to Globus: SaaS for Research Data Management

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Research data management today

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 (...)

MIRA
Bridge to instruments

Pre-processed Data

Raw Source Data

Analysis store

High durability, low cost store

Amazon Glacier
Bridge to community/public

Project Repositories, Replication Stores

Public Repositories
Globus SaaS: Research data lifecycle

1. Researcher initiates transfer request; or requested automatically by script, science gateway.
2. Globus transfers files reliably, securely.
3. Researcher selects files to share, selects user or group, and sets access permissions.
4. Globus controls access to shared files on existing storage; no need to move files to cloud storage!
5. Collaborator logs in to Globus and accesses shared files; no local account required; download via Globus.
6. Researcher assembles data set; describes it using metadata (Dublin core and domain-specific).
7. Curator reviews and approves; data set published on campus or other system.
8. Peers, collaborators search and discover datasets; transfer and share using Globus.

• Use a Web browser
• Access any storage
• Use an existing identity
Conceptual architecture: Hybrid SaaS

Subscriber Control Domain

Source Endpoint

Subscriber owned and administered storage system

Globus "client" software

DATA Channel

Destination Endpoint

No data relay or staging via Globus

CONTROL Channel

Single, globally accessible multi-tenant service

Globus Control Domain
Conceptual architecture: Sharing

- **External User Control Domain**
- **DATA Channel**
  - Managed Endpoint
- **CONTROL Channel**
  - Subscriber managed filesystem permissions
- **Globus Control Domain**
  - Shared Endpoint
  - Globus managed "overlay" permissions
- **Subscriber Control Domain**
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
Data Publication and Discovery

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

https://publish.globus.org
Demonstration

Data Publication
How can I use Globus on my system?
...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

• Go to: www.globus.org/login
• Select your institution from the list and click “Continue”
• Authenticate with your institution’s identity system
• Install Globus Connect Personal
• Move some data between an ESnet test endpoint and your laptop
Sharing Data
Exercise: Share files

• Join the “Tutorial Users” groups
  – Go to “Groups”, search for “tutorial”
  – Select group from list, click “Join Group”

• Create a shared endpoint on your laptop

• Grant your neighbor permissions on your shared endpoint

• 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

Globus service

Web

CLI

Rest API

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

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

Use existing institutional ID systems in external web applications
Data App: NCAR RDA
Analysis App: Wellcome Sanger

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.

- Full name
- Organisation
- Email address
- What is this? Globus user identity

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.
Globus PaaS: National Resource Access
Globus PaaS: Identity Management

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.

What can KBase do?
- Combine heterogeneous 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 Siteadmin Jan 6, 2013
- KBase Team at Argonne for November Build
  Posted by Siteadmin Nov 30, 2012
- November Build at Argonne
  Posted by Siteadmin Nov 23, 2012

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

**Python SDK**

**Installation**

The Globus SDK requires Python 2.6+ or 3.2+. A supported version is 3.6.

The simplest way to install the Globus SDK is using the pip package manager:

```
pip install globus-sdk
```

This will install the Globus SDK and its dependencies.

Blended edge versions of the Globus SDK can be installed by:

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

**Requirements**

- You need to be in the tutorial users
- Installed Globus Python SDK

**Jupyter Notebook**

```
from _future_ import print_function # for python 2

In [15]:
    tutorial_endpoint_1 = "gdb59aef-6d04-11e5-ba46-22000b92c6ec" # endpoint "Globus
    tutorial_endpoint_2 = "gdb59af0-6d04-11e5-ba46-22000b92c6ec" # endpoint "Globus
    tutorial_users_group = "50b6a29c-63ac-11e4-8062-22000a68755" # group "Tutorial

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

**Configuration**

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

**docs.globus.org/api**

**github.com/globus**
Thank you to our sponsors…
Globus sustainability model

- **Standard Subscription**
  - Shared endpoints
  - Data publication
  - Management console
  - Usage reporting
  - Priority support
  - Application integration
  - HTTPS support (coming soon)

- **Branded Web Site**

- **Premium Storage Connectors**

- **Alternate Identity Provider** (InCommon is standard)
...and THANK YOU to our subscribers
Globus Connect Server

- Makes your storage accessible via Globus
- Multi-user server, installed and managed by sysadmin
- Default access for all local accounts
- POSIX + connectors
- Native packaging
  
  Linux: DEB, RPM

[link to installation guide]

docs.globus.org/globus-connect-server-installation-guide/
Storage connectors

• **Standard storage connectors (POSIX)**
  - Linux, Windows, MacOS
  - Lustre, GPFS, OrangeFS, etc.

• **Premium storage connectors**

<table>
<thead>
<tr>
<th>Premium Storage Connectors</th>
</tr>
</thead>
<tbody>
<tr>
<td>AWS S3</td>
</tr>
<tr>
<td>Google Drive</td>
</tr>
<tr>
<td>Ceph RadosGW (S3 API)</td>
</tr>
<tr>
<td>Spectra Logic BlackPearl</td>
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<tr>
<td>HPSS</td>
</tr>
<tr>
<td>HDFS (alpha)</td>
</tr>
<tr>
<td>Box (in progress)</td>
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<tr>
<td>HGST ActiveScale (in progress)</td>
</tr>
<tr>
<td>Cleversafe (planned)</td>
</tr>
</tbody>
</table>

[docs.globus.org/premium-storage-connectors](https://docs.globus.org/premium-storage-connectors)
Creating a Globus endpoint on your server

• In this example, server = Amazon EC2 instance
• 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
Install Globus Connect Server

$ 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 “researcher”; you will see the user’s home directory

• Transfer files to/from a test endpoint (e.g. Globus Tutorial) and your endpoint
Configuring Globus Connect Server
Endpoint configuration

• **Globus service “Manage Endpoints” page**

• **DTN (Globus Connect Server) config**
  
  `/etc/globus-connect-server.conf`

  – Standard .ini format: `[Section] Option = Value`

  – To enable changes you must run:
    `globus-connect-server-setup`

  – “Rinse and repeat”
Common configuration options

• Manage Endpoints page
  – Display Name
  – Visibility
  – Encryption

• DTN configuration file – common options:
  – RestrictPaths
  – IdentityMethod (CILogon, Oauth)
  – Sharing
  – SharingRestrictPaths
Exercise: Make your endpoint visible

• **Edit endpoint attributes**
  – Change the name to something useful, e.g. `<your_name> EC2 Endpoint`
  – For the “Visible To” attribute select “Public - Visible to all users”

• **Find your neighbor’s endpoint**
  – You can access it too 😊
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?**
In config file, set Sharing = True

Run `globus-connect-server-setup`

Use the CLI to flag as managed endpoint (will also be configurable via the web app)

* Note: Creation of shared endpoints requires a Globus subscription for the managed endpoint
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)
Endpoint activation using MyProxy

1. Access endpoint
2. Username/password
3. MyProxy Online CA
4. PAM
5. GridFTP Server
6. Transfer
7. Authorization (local, remote)
8. Access files
9. Data transfer
10. GridFTP Server

DON'T LEAVE IT LIKE THIS!
Single Sign-On with InCommon/CILogon

• Your Shibboleth server must release R&S attributes to CILogon—especially the ePPN attribute
• Local resource account names must match your institutional ID (InCommon ID)
• In /etc/globus-connect-server.conf set:
  AuthorizationMethod = CILogon
  CILogonIdentityProvider = <institution_listed_in_CILogon_IdP_list>
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, …
• Convert existing endpoint to managed:
  
  globus endpoint update --managed ENDPOINT_UUID

• **Must be run by subscription manager, using Globus CLI**
• **Important:** Re-run endpoint update **after deleting/re-creating endpoint**

*will be available via the web app in a future release*
Monitoring and managing Globus endpoint activity
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
Endpoint Roles
Usage Reporting
Deployment Scenarios
Best practice network configuration

Data Transfer Node (DTN)

Source Security filters

Destination Security filters

Source Science DMZ

Source Border Router

Source Router

Data Transfer Node (DTN)

Destination Security filters

Destination Science DMZ

Destination Border Router

Destination Router

User Organization

Physical Data Path

Logical Data Path

Physical Control Path

Logical Control Path

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

On-premises Data Transfer Node (DTN)

Data Storage Interface (DSI) for POSIX-compliant filesystems

Non-POSIX DSI
- Google Drive
- Amazon S3 (native)
- Spectra BlackPearl
- Ceph S3 RadosGW
- HPSS

Cloud-hosted DTN

AWS EBS Volume

AWS S3 Bucket

Data Storage Interface (DSI) for POSIX-compliant filesystems

Non-POSIX DSI
- Google Drive
- Amazon S3 (native)
- Spectra BlackPearl
- Ceph S3 RadosGW
- HPSS
Multi-endpoint configuration

Data Transfer Node

POSIX DSI

`~/scratch`

ext* XFS ZFS
Multi-endpoint configuration

Data Transfer Node

POSIX DSI

~/projects

ext* XFS ZFS

~/scratch

GPFS Lustre

~/projects

~/scratch
Multi-endpoint configuration

Data Transfer Node

- POSIX
- DSI
- Spectra BlackPearl DSI

directories:
- ~/projects
- ~/scratch
- ~/archive
- ext*
- XFS
- ZFS
- GPFS Lustre
Multi-endpoint configuration

Data Transfer Node

- POSIX DSI
- Spectra BlackPearl DSI
- Amazon S3 DSI

Directories:
- ~/projects
- ~/archive
- ~/scratch
- ~/vault

Storage Systems:
- ext*, XFS, ZFS
- GPFS Lustre
- Amazon S3 Bucket

File Transfers through Globus Connect for:
- Transfer Files
- Multi-endpoint configuration

Platforms:
- Amazon S3 DSI
Globus Connect Server Deployment

Data Transfer Node

GridFTP Server

gcs-io

MyProxy CA

gcs-id

OAuth Server

gcs-web

ext* XFS ZFS

Microsoft AD

OpenID Connect
Globus Connect Server Deployment

Data Transfer Node

Science DMZ (ACL limited)
Port 2811 accepts inbound connections from Globus

GridFTP Server

ext* XFS ZFS

MyProxy CA

OAuth Server

Windows AD

OpenID Connect
Network paths

• Separate control and data interfaces
• "DataInterface =" option in globus-connect-server-conf
• Common scenario: route data flows over Science DMZ link
Dual-homed DTN – high speed data path
Dual-homed DTN – private network data path

- Data Transfer Node
- Science DMZ
- Firewall
- GridFTP Server
- GridFTP Control Channel
- GridFTP Data Channel
- LAN/Intranet path
- Data Transfer Node

...on performance
Balance: performance - reliability

• Network use parameters: concurrency, parallelism
• Maximum, Preferred values for each
• Transfer considers source and destination endpoint settings
  \[
  \min( \\
  \max(\text{preferred } \text{src}, \text{preferred } \text{dest}), \\
  \max \text{ src}, \\
  \max \text{ dest} \\
  )
  \]
• 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: ESnet Testing

- GridFTP (4 streams)
- GridFTP (1 stream)
- sftp
- scp (w/HPN)
- scp

**Source:** ESnet (2016)

- Berkeley, CA to Argonne, IL (RTT: 53 ms, Capacity: 10Gbps)
- scp is 24x slower than GridFTP on this path
- >1 Gbps (125 MB/s) disk-to-disk requires RAID array
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: ensure use of FIPS capable OpenSSL libraries on DTN
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
  - `-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

• Install Globus Connect Server on all servers

• 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

• Copy the configuration file to all servers
  – /etc/globus-connect-server.conf

• Run globus-connect-server-setup on the server running the –id component

• Run globus-connect-server-setup on all other servers

• Repeat steps 2-5 as necessary to update configurations
Example: Two-node DTN

On “primary” DTN node (34.20.29.57):

/etc/globus-connect-server.conf

[Endpoint] Name = globus_dtn
[MyProxy] Server = 34.20.29.57

On other DTN nodes:

/etc/globus-connect-server.conf

[Endpoint] Name = globus_dtn
[MyProxy] Server = 34.20.29.57
Globus Network Manager

For environments with specialized network constraints…
(a.k.a. "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**
Future directions
Motivations for Globus Connect Server v5

• Facilitate automation of installation and upgrades
• Allow scale out deployment
  – Across DTNs
  – Across multiple file system connectors
• Reduce number of ports required
• Streamline user experience with use of Globus sharing
• Enhance user registration of credentials for cloud storage connectors
• Prepare foundation for next set of enhanced capabilities
Collections: The evolution of endpoints
Collection properties

- Set of blobs (files), hierarchically named (folders)
- Rooted at a unique DNS name
- URL referenceable files, folders
- Accessible and manageable via:
  - HTTPS: client/server file access
  - GridFTP: async bulk transfer
  - REST API: advanced operations
- OAuth2 authentication and authorization via Globus Auth
- Collection-specific access policies
- Data is stored on a storage system, which determines storage policies such as durability and availability
- File change events
New features with v5

- Collection model
- HTTPS access to storage
- Security improvements
  - OAuth2 in GridFTP (no more X.509 user certificates or Myproxy!)
  - OpenID Connect identity provider
  - Credential expiration LoA policies
  - User credential management (e.g., for Google Drive, S3, Kerberos)
- Kerberos protected file systems
- Directory listing with path expressions
Installation & configuration enhancements for v5

- Setup with any identity (GlobusID not required)
- Automatable installation and configuration
- Configuration API, CLI, GUI
- Scale-out deployment without shared file system
- Backup / restore configuration to / from the cloud
- Multiple storage systems simultaneously
- Single port GridFTP (no ephemeral ports)
- Distributed as Docker containers
Streamlined data sharing with v5

- **Remove friction of sharing**
  - Guest collections where possible, e.g., Google Drive
  - Hybrid collections: Mapped access to home & project folders, else guest access

- **Enhanced sharing permissions**
  - Permission expiration
  - Permissions on files (not just folders)
  - Sharing via URL possession

- **Storage connectors: share from anywhere**
New capabilities built on collections and v5

• **Data search**
  – With access control
  – Schema agnostic
  – Custom indexes domain specific

• **Event driven actions for automation**
  – Replication of data (across storage tiers)
  – Metadata extraction and ingest to search
  – Run analysis pipelines
Release plans for v5

• **Series of point releases with added capabilities**
  – v5.0 released in April
    o Google Drive connector support
    o Federated identity for install (no Globus ID required)

• **Separate installation from the current Globus Connect v4**

• **Migration tools for v4 to v5 will be provided**
Globus Connect Server v5.1 (planned)

- **Support multiple connectors in single installation**
  - POSIX and Google Drive connector
- **HTTP/S access**
  - To data on any connected storage system
- **Globus Connect Server Manager service**
  - Some capabilities towards automation of installation
- **Single port for control channel (443)**
  - Ephemeral ports for data required
Support resources

• Customer engagement team
• Globus documentation: docs.globus.org
• Helpdesk and issue escalation: support@globus.org
• Globus professional services team
  – Assist with portal/gateway/app architecture and design
  – Develop custom applications that leverage the Globus platform
  – Advise on customized deployment and integration scenarios
Open Discussion
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