GlobusWorld 2011: When Grid meets cloud ...
Ian Foster
Accelerate scientific discovery and innovation via

1) **On-demand computing**
   - Scale computing with need
   - Access to remote software

2) **Resource federation**
   - Computers
   - Data
   - Software
   - Instrumentation
   - People
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2) Resource federation
   – Computers
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Cloud = hosting
Grid = federation

Infrastructure as a Service (aka Cloud)
Federation as a Service
Globus Toolkit
Build the Grid
Components for building custom grid solutions
globustoolkit.org

Globus Online
Use the Grid
Cloud-hosted file transfer service
globusonline.org
Globus Toolkit architecture overview
Other Globus Toolkit 4 components

- **jGlobus**
  - It’s still there, just not in the figure!
  - GSI, Java clients for GRAM, GridFTP and MyProxy

- **Java Web Services core**
  - Limited adoption of WSRF
  - We recommend authoring Web Services with JAX-RS or JAX-WS
  - Crux project to support stateful Web Services not yet funded

- **WS-GRAM4**
  - We recommend migrating to GRAM5: better performance, reliability, and functionality

- **MDS monitoring and discovery service**
  - Integrated Information System (IIS) is an evolution of this
Recent Globus Toolkit developments

• GridFTP
  – Native packaging (in 5.2 alpha)
  – Globus Connect one-click install, one-paste config (later)
  – Data Channel Security Context support
  – Chrooting GridFTP server
    • Restrict access to a specific path

• GRAM5
  – GRAM2 improved and modernized (no Web Services inside)
  – Greater than 10x scalability than GRAM2 and roughly 10x reduction in resource consumption on the service host
  – Easier to debug (from working with TG)
    • Added RSL attribute to “save_job_description”
• **GRAM5**
  – Native packaging: RPM, Debian
  – Reduce complexity for sites updating GRAM
    • Modify LRM adapter interface to use callouts instead of patching source directly
  – Easier to debug (from working with TG) coming in 5.0.4
    • Added RSL attributes to control log location and level per job
  – Basic Execution Service (BES) interface – from IGE
  – Job Submission Description Language (JSDL) support – from IGE

• **jGlobus 2**
  – Security, GRAM and GridFTP interfaces
  – jGlobus 2 beta available, updates to latest SSL
DemoGrid (Borja Sotomayor)

1. Specify a grid
2. DemoGrid prepares the virtual machine images
3. Deploy your grid using EC2, Vagrant, or KVM
LHC Computing Grid

Averaged Throughput during the last 24 hrs (09/04 - 10/04)
VO-wise Data Transfer From All Sites To All Sites

Throughput (MB/s)

Time (GMT)

Atlas
CMS
LHCb
OTHERS
UNREGD VOs
University of California (UC) Grid
The Nimbus Project

High-quality, extensible, customizable, open source implementation

**Nimbus-Platform**
- Context Broker
- Elastic Scaling Tools
- Multi-Cloud Tools

Enable users to use IaaS clouds

**Nimbus-Infrastructure**
- Workspace Service
- Cumulus

Enable providers to build IaaS clouds

Enable us to experiment with and evaluate cloud computing

www.nimbusproject.org
ESG has delivered a *Petabyte* of climate data to >20,000 users (Feb ‘10)
EU gCube project AquaMaps
NSF XD architecture incorporates GT, GO
Google Summer of Code

- Globus has been a mentoring organization in Google Summer of Code 2008, 2009, and 2010
- 29 students funded by Google to work on Globus technologies over the summer
- Recently accepted to GSoC 2011
NEWT - NERSC Web Toolkit

- NEWT - Web Service that makes NERSC HPC resources available as http URLs
- Build web applications through REST API
- User interacts with a web application that exposes the necessary components of the underlying application
- Upload/download files
- Authentication
- Submit jobs
- Accounting information
- View Batch Queue
- Key Value Store
- http://newt.nersc.gov

Built on top of Globus Toolkit (GT5). Globus provides the underlying security, job and file transfer layers, without directly exposing this to end users.
Thinking about “small and medium labs”

• Big projects like LHC, LIGO, ESG, etc., can run resource-level services reliably—and build and operate effective collective services

• Small labs and collaborations have problems with both

• They need solutions, not toolkits—ideally outsourced solutions

Can we harness the power of the cloud to scale access to the grid?
Deliver research automation functions to small/medium labs via SaaS

• SaaS means:
  1) Application own, delivered, managed by provider
  2) Single code base supports many users at once
  3) Application is properly Web architected

• Has many potential advantages
  – Leverage Web 2.0 to achieve extreme ease of use
  – Substantial economies of scale
  – Expert operations and support
  – Rapid software update

• As well as challenges
  – Paying for it. Security and privacy.
Time-consuming tasks in science

- Run experiments
- Collect data
- Manage data
- Move data
- Acquire computers
- Analyze data
- Run simulations
- Compare experiment with simulation
- Search the literature

- Communicate with colleagues
- Publish papers
- Find, configure, install relevant software
- Find, access, analyze relevant data
- Order supplies
- Write proposals
- Write reports
- ...

www.globusonline.org
Starting with data movement

Discover endpoints, determine available protocols, negotiate firewalls, configure software, manage space, determine required credentials, configure protocols, detect and respond to failures, determine expected performance, determine actual performance, identify diagnose and correct network misconfigurations, integrate with file systems, ...
Globus Online highlights

- Fire-and-forget data movement
- Many files and lots of data
- Third-party transfers
- Performance optimization
- Expert operations and monitoring

**Web interface**

**Command line interface**

```
ls alcf#dtn:~
scp alcf#dtn:~/myfile
nersc#dtn:~/myfile
```

**HTTP REST interface**

```
POST https://transfer.api.globusonline.org/v0.10/transfer <transfer-doc>
```

**GridFTP servers**

**FTP servers**

**High-performance data transfer nodes**

**Globus Connect on local computers**
Globus Online is almost always faster than (even hand-tuned) globus-url-copy
Globus Online architecture
Globus Connect easy install

**Step One: Choose Your Download**
- Globus Connect For Mac OS X
- Coming Soon For Linux
- Coming Soon For Windows

**Step Two: Get Your Globus Connect Setup Key**

- **Endpoint Name:** ag-laptop
- **Description:** (optional) Enter a description for this new endpoint
- **Setup Key:** 432e8ba5-45cf-442b-a374-5a8d1cfa75cb

**Step Three: Finish Globus Connect Setup**
Copy the setup key displayed above. Run Globus Connect and paste the key into the Initial Setup window when prompted. This setup key can only be used once.

Ready to use your endpoint? Click here to start a transfer.
Globus Connect in action

1) Globus Connect client registers with Globus Online

2) User makes request to Globus Online: e.g., "transfer data from MyDesktop to SiteA"

3) Globus Online forwards requests to Globus Connect

4) Globus Connect establishes data channel connection to SiteA and transfers data

User

Globus Online

GridFTP server
"SiteA"

Globus Connect

"MyDesktop"
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11 x 125 files
200 MB each
11 users
12 sites
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35
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www.globusonline.org
Our goal: Accelerate discovery and innovation by providing research IT as a service

“Civilization advances by extending the number of important operations which we can perform without thinking of them”

Alfred North Whitehead, 1911
To leverage software-as-a-service (SaaS) to greatly accelerate the pace of discovery and innovation worldwide, by

• providing millions of researchers with unprecedented access to powerful research tools, and

• enabling a massive shortening of cycle times in time-consuming research processes
In 1972, Janet Rowley discovered that chromosome abnormalities can cause cancer

In 2009, drugs manage Kareem Abdul-Jabbar’s chronic myeloid leukemia
Many other breakthroughs are urgently needed
800,000,000,000 bases/day
30,000,000,000,000 bases/year

Kahn, Science, 331:728, 2011
Research is an iterative, time-consuming process

1. Pose question
2. Design experiment
3. Collect data
4. Test hypotheses
5. Hypothesize explanations
6. Analyze data
7. Identify patterns
8. Publish results

Massive worldwide opportunity
10+ million researchers
Millions of research labs
Technology evolution creates new opportunities

**New opportunities for discovery and innovation**

- Massive deluge of data from many new instruments
- Exponential increase in computing power
- Pervasive collaboration among distributed teams

**GO enables researchers to seize opportunities**

- Creation and management of massive data collections
- Data analysis, mining, and simulation capabilities
- Selective sharing and secure information exchange

**Ability to rapidly identify, analyze, and validate patterns accelerates discovery and innovation**
• Almost all research performed in small laboratories
• Researchers are trained in their field, not in IT
  – They are not experts in collecting, moving, storing, indexing, analyzing, mining, sharing, updating, publishing, and archiving massive amounts of data
• Only limited capital is available for them to spend on data and IT support
• Investment is spent on traditional research tools (e.g., microscopes)—but the world is changing
  – Now need substantial and sophisticated IT to perform research, data manipulation, data mining, collaboration
Researchers lack IT support infrastructure

Traditional lab investment

Area of need
Lab data processing infrastructure
We believe the solution is to leverage SaaS to deliver missing IT

- Remove need for researchers to create and manage their own IT infrastructure
- Deliver capabilities not achievable in individual labs
- SaaS model that is cost effective on a pay-as-you-go basis
• Data and technology proliferation creates huge opportunities for new discoveries and innovations
• But researchers lack the IT skills, tools, and resources ($) to leverage these opportunities
• We propose to solve this problem by providing missing IT to researchers via a cost-effective SaaS platform
• This new approach to research IT can greatly accelerate discovery and innovation worldwide, by
  • providing millions of researchers with unprecedented access to powerful research tools, and
  • enabling a massive shortening of cycle times in time-consuming research processes
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Components for building custom grid solutions
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# Program for the rest of Monday

<table>
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<tr>
<th>Time</th>
<th>Session</th>
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| 3:00p – 4:00p | **Globus Toolkit Updates**<br>
**Led by: Stuart Martin, UChicago**<br>
- CILogon, GridShib, MyProxy – Jim Basney, NCSA<br>- jGlobus – Mike Russell, UChicago<br>- Native packaging – Stuart Martin, UChicago<br>- GRAM – Stuart Martin, UChicago<br>- IIS – JP Navarro, Argonne<br>**Abstract:** This session will update participants on recent developments and current status of core Globus Toolkit components and GT 5.2 native packaging. |
| 4:00p – 5:00p | **Globus Community Updates & User Experiences**<br>
**Led by: Stuart Martin, UChicago**<br>
- VDT – Alain Roy, University of Wisconsin–Madison<br>- OGSA-DAI – Charaka Palansuriya, EPCC<br>- IGE – Alexander Papaspyrou, TU Dortmund<br>- caBIG – Ravi Madduri, Argonne<br>**Abstract:** This session will update participants on the experiences of select Globus communities and users. |
<p>| 5:00p   | Adjourn                                                                 |
| 6:30p – 9:30p (est.) | <strong>GlobusWORLD hosted party</strong> |</p>
<table>
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<tr>
<th>Time</th>
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<tr>
<td>7:30a – 8:30a</td>
<td>Registration &amp; Continental breakfast</td>
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<td>8:30a – 10:00a</td>
<td><strong>Globus File Transfer Updates &amp; User Experiences</strong>  &lt;br&gt; <em>Led by: Steve Tuecke, UChicago</em>  &lt;br&gt; - Globus Online file transfer – Steve Tuecke, UChicago  &lt;br&gt; - ESG – Rachana Ananthakrishnan &amp; Neill Miller, Argonne  &lt;br&gt; - GridFTP – Raj Kettimuthu, Argonne  &lt;br&gt; <em>Abstract:</em> This session will provide attendees with a better understanding of new and soon-to-be-released features, functionality and use of Globus Online file transfer service.</td>
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<td>10:00a – 10:30a</td>
<td>Coffee Break</td>
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<td>10:30a – 12:00p</td>
<td><strong>Globus Community Updates &amp; User Experiences</strong>  &lt;br&gt; <em>Led by: Paul Davé, UChicago</em>  &lt;br&gt; - ARCS – Graham Jenkins, VPAC  &lt;br&gt; - NERSC – Shreyas Cholia, LBL  &lt;br&gt; - iBi – Brigitte Raumann, UChicago  &lt;br&gt; - GARUDA – Prahlada Rao, C-DAC Bangalore  &lt;br&gt; <em>Abstract:</em> This session will update participants on the experiences of select Globus communities and users.</td>
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| 1:30p - 3:00p | **Globus Online – New Features and Future Enhancements**  
Led by: Steve Tuecke, UChicago  
- Globus Online roadmap – Steve Tuecke, UChicago  
- BIRN – Carl Kesselman, USC ISI  
- Virtual Endpoints – Gopi Kandaswamy, USC/ISI  
- Grisu – Markus Boinsteiner, Centre for eResearch, University of Auckland  
Abstract: This session will introduce and demonstrate new Globus Online features. |
| 3:00p - 3:30p | Coffee Break                                                           |
| 3:30p - 4:15p | **Community Technology Updates**  
Led by: Vas Vasiliadis, UChicago  
- Condor – Zachary Miller, University of Wisconsin–Madison  
- Glidein WMS – Parag Mhashilkar, Fermi  
- Data-flow Parallelism – Esma Yildirim, SUNY – Buffalo  
Abstract: This session will update participants on Globus technology extensions, enhancements, and integration. |
| 4:15p - 5:00p | **Session: Recap and Q&A**  
Led by: Ian Foster, Argonne and UChicago  
Abstract: This session will briefly recap the conference and provide time for general questions and answers. |
# Tutorials on Wednesday

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| 8:30a - 10:00a | **Globus Online Introduction**  
*Led by: Lisa Childers, Argonne*  
Abstract: This tutorial will provide an introduction to Globus Online (http://www.globusonline.org), the latest addition to the Globus software suite. The session will begin with context-setting material, including an overview of the motivation for Globus Online and key design concepts. |
| 10:00a - 10:30a | Coffee Break |
| 10:30 - 12:00p | **Enabling Your HPC Cluster with Globus**  
*Led by: Borja Sotomayor, UChicago*  
Abstract: This tutorial will demonstrate how to install and administer Globus Toolkit on a cluster, and how to configure GridFTP (and related security components) so that an HPC resource can be used with Globus Online. |
| 12:00p - 1:30p | Lunch |
| 1:30p - 3:00p | **Globus Online Advanced CLI and Scripting**  
*Led by: Lisa Childers, Argonne*  
Abstract: This tutorial will explore advanced usage of Globus Online via the Command Line Interface (CLI), and how this interface can be used for scripted usage of Globus Online. |
| 3:00p - 3:30p | Coffee Break |
| 3:30p - 5:00p | **Globus Online Transfer REST API**  
*Led by: Bryce Allen, UChicago*  
Abstract: This tutorial will teach attendees how to use the Globus Online Transfer REST API, for programmatic interaction with Globus Online. Examples will demonstrate using the Transfer REST API to integrate Globus Online with Java and Python clients and Web-based portals. |
Other related meetings

- **Cloud Computing and Applications**
  - Wednesday

- **Workshop on High Performance Applications of Cloud and Grid Tools**
  - Thursday

Follow links from [www.globusworld.org](http://www.globusworld.org) for details
Contests at GlobusWORLD

• **Data Challenge**
  – *What you do:* Move the most data during first two days of GlobusWORLD
  – *What you get:* iPad 2

• **Story Challenges**
  – *What you do:* Tell the best Globus Online user story...
    • Most Innovative Use
    • Most Ambitious Vision
  – *What you get:* iPod Touch

• **How to Participate**
  – Visit [www.globusonline.org/gw11contests](http://www.globusonline.org/gw11contests)