Grid Computing with Globus

Dr. Helmut Heller (heller@lrz.de)
Leibniz Supercomputing Centre (LRZ)
Munich, Germany

IGE Project Director

IDRIS, December 16th, 2010

Overview

- Why Grid computing? What is it anyway?
- A brief history of Globus in context
- Globus toolkit structure
- Globus usage worldwide
- … and Globus in Europe? IGE!
- Outlook: new things to come
- Summary

Why Grid computing?

- Common problems of HPC-center users:
  - A single user computes at more than one HPC center
  - Authentication is cumbersome: username and password have to be entered over and over again (and they differ from site to site!), security problems (password sniffers!)
  - Data have to be transferred manually from one site to another (which can lead to confusion: where are the valid data?)
  - The user has to master different interfaces, e.g., file systems (quota, policies, etc.), queuing systems (NQS, LoadLeveler, etc.), user administration, etc.
- GRID-computing addresses these problems so that the user can concentrate on science and is not distracted by computer idiosyncrasies

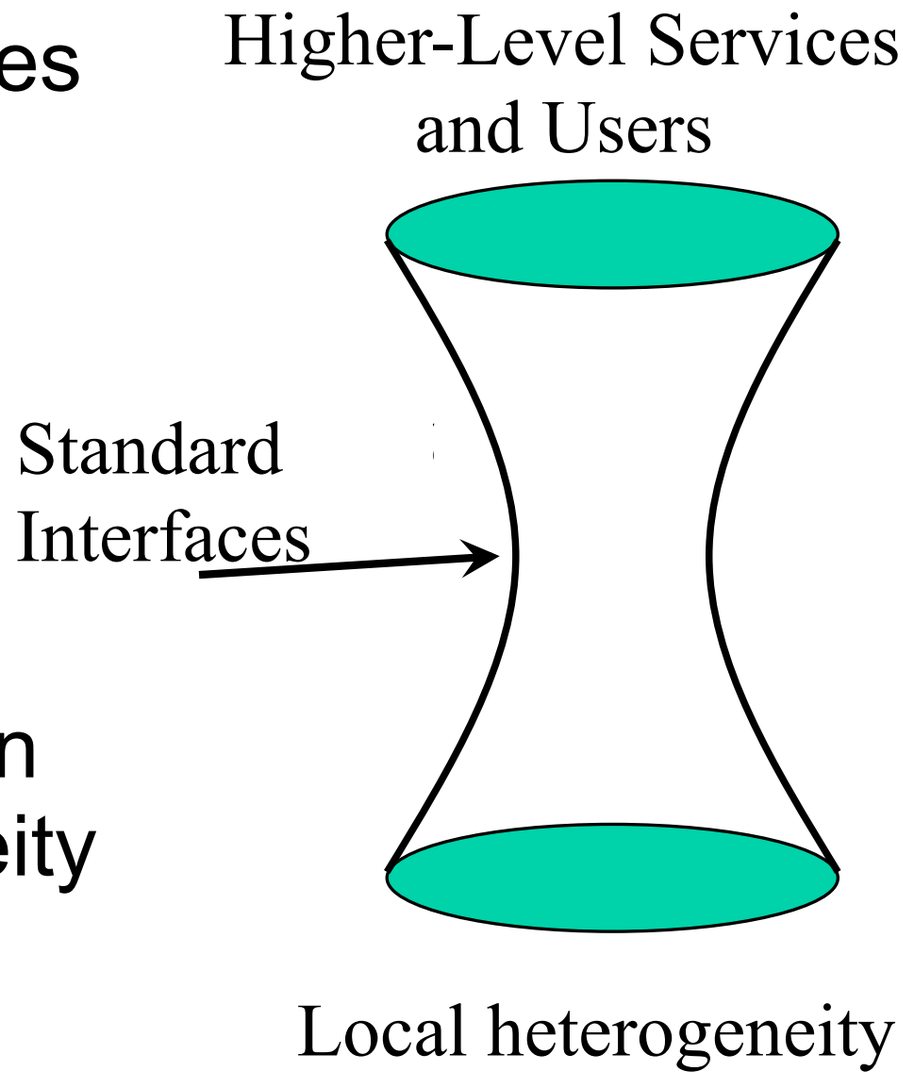
What is Grid computing?

- GRID- computing simplifies the usage of distributed but coupled resources
- This also implies resource sharing and a coordinated usage of shared resources
- GRID-computing provides a **uniform**, simple, and easy-to-learn interface to shared, distributed, coupled resources
  - GRID-computing introduces a **common layer of abstraction**
  - The user no longer has to fight with the idiosyncrasies of each computer system or each computing center
- The user interacts now with the GRID as a whole and not with individual components

Grid Hour Glass Analogy

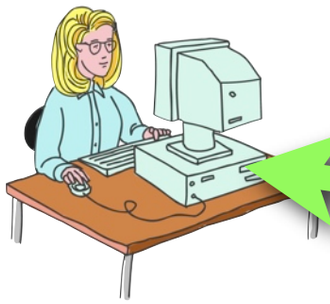
- **Local sites are heterogeneous**
  - Each has its own local policies
  - Queuing systems, monitors, firewalls, etc. are different

- **Grid unifies**
  - Common management abstractions & interfaces
  - Middleware as an abstraction layer to hide local heterogeneity by a standard interface: the **middleware**!



From Jennifer Shopf

My Vision



User at home

Meta-Scheduler

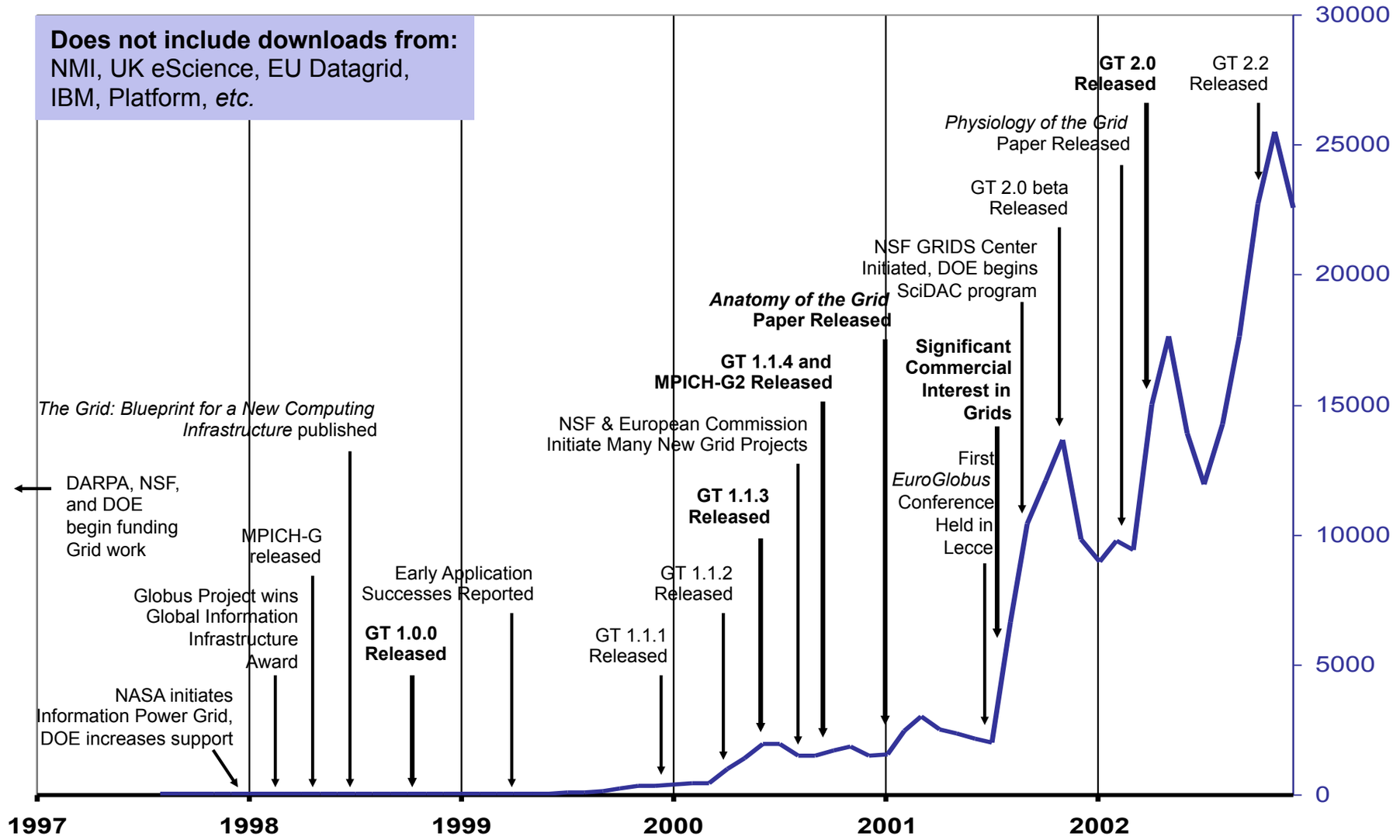
Middleware: Globus, UNICORE, gLite, ...

Resources, world-wide

A Brief History of Globus

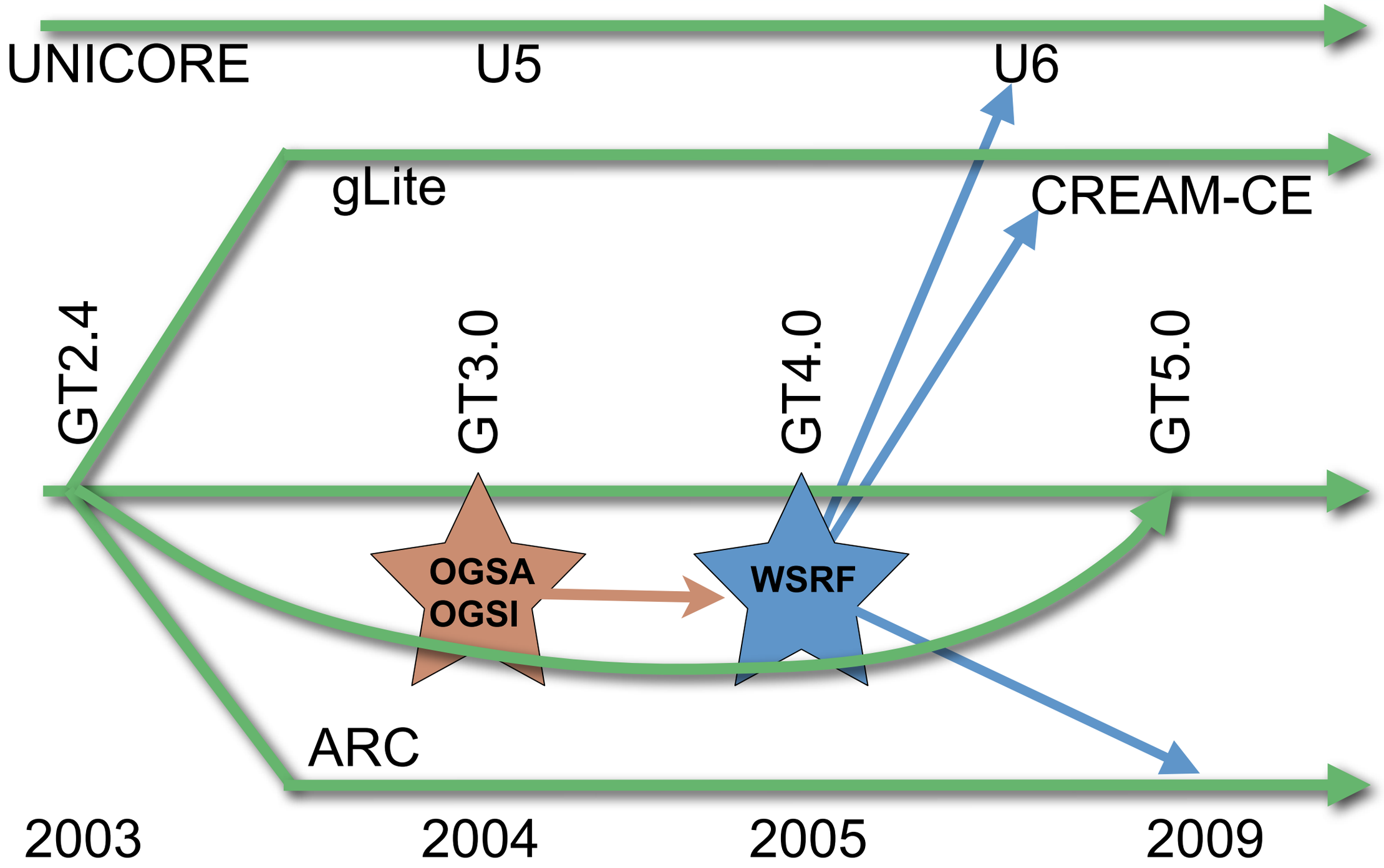
the globus project™
www.globus.org

Globus Toolkit® History

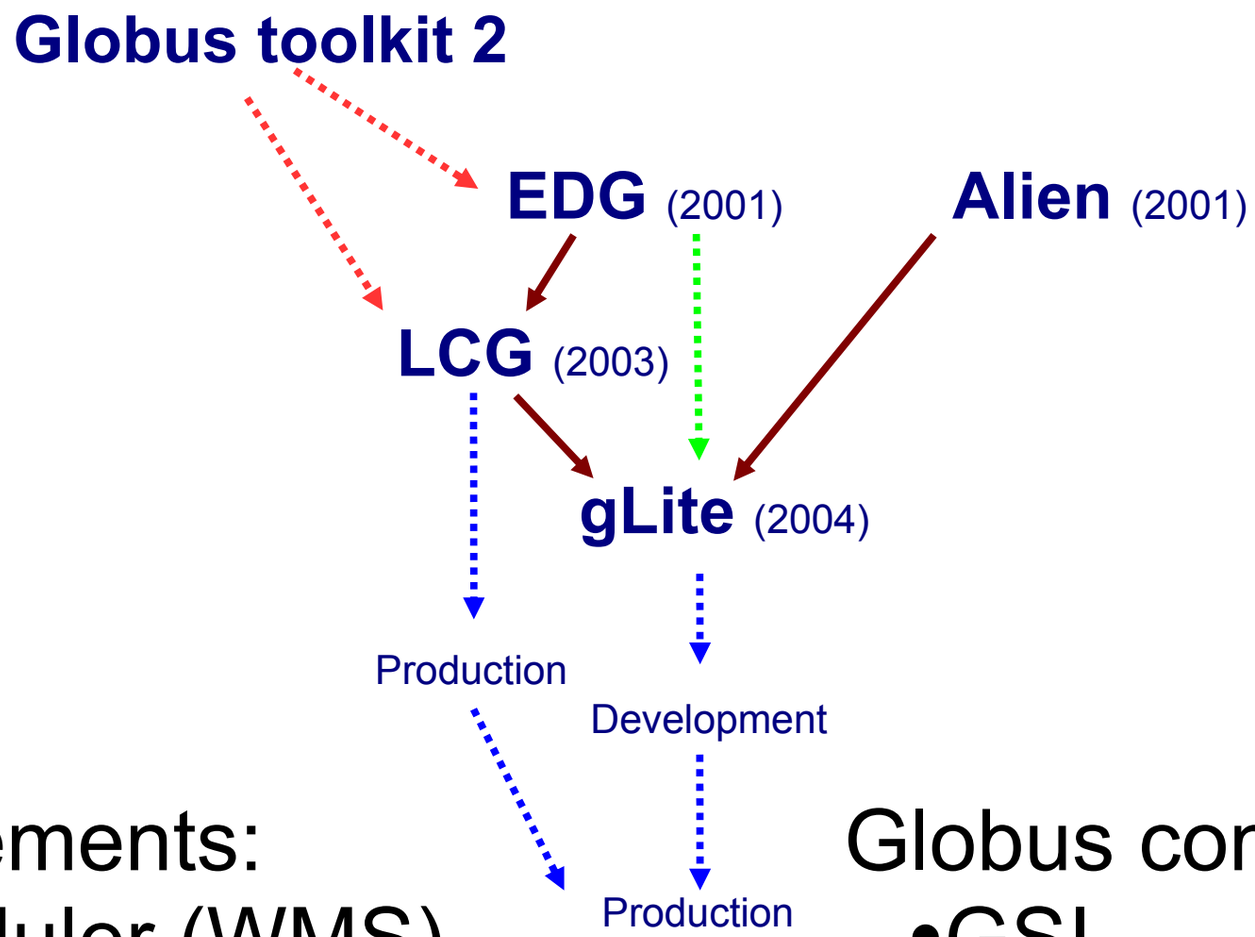


from: www.globus.org

More Recent Globus History in Context



gLite (1)



Main improvements:

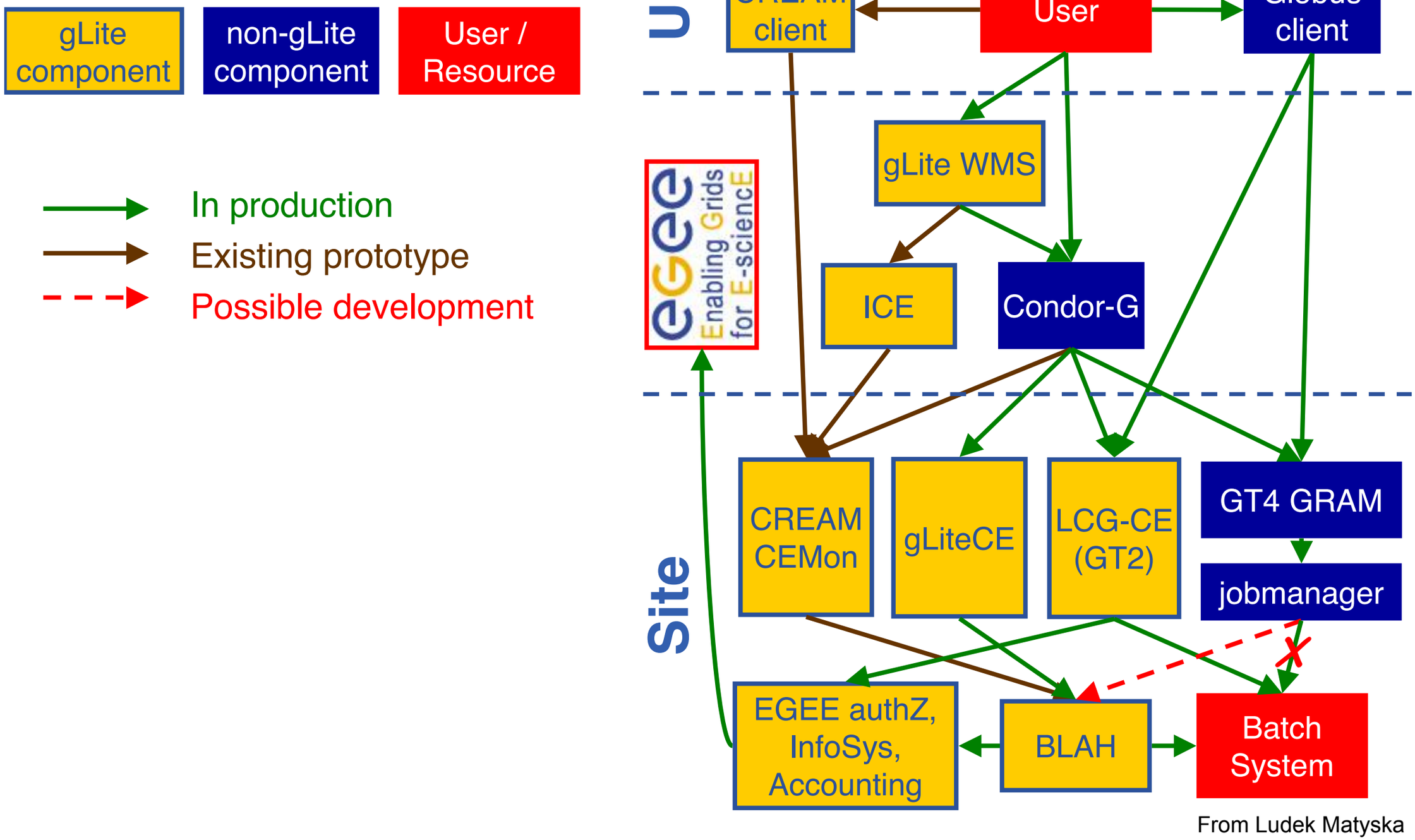
- metascheduler (WMS)
- VO management
- stability: production!
- file catalogs, SRM, dCache...
- UI - CE - SE

Globus components:

- GSI
- myProxy
- GridFTP
- GRAM

From Ariel Garcia

gLite (2)

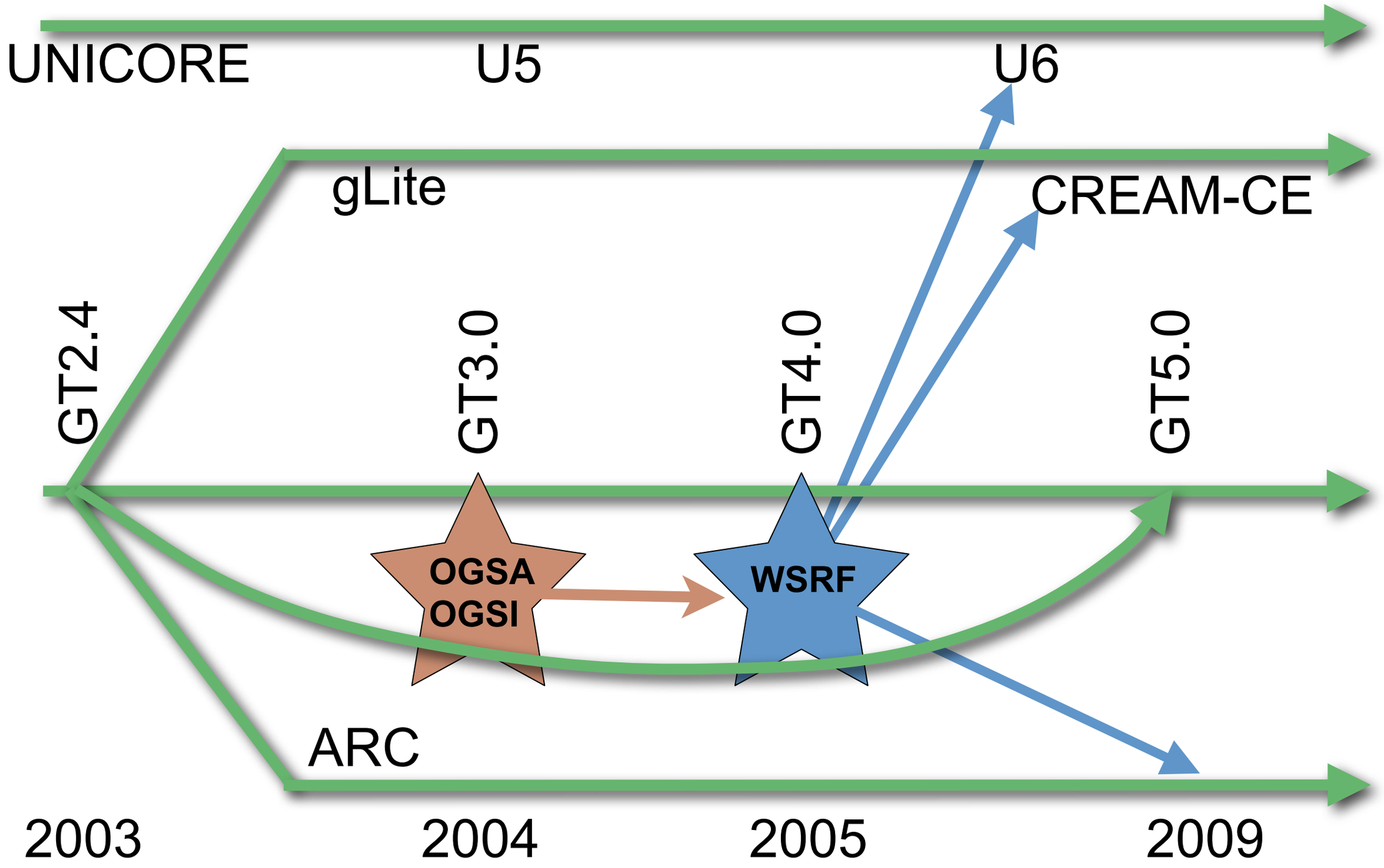


From Ludek Matyska

ARC

- **ARC = A**dvanced **R**esource **C**onnector
- Developed by the Nordic countries
- Used in **NorduGrid** for HEP
- Replaced Globus GRAM with own solution based on GridFTP, as GRAM was not fast enough: HTP!
- EU KnowARC project brings standards to ARC: JSDL, WS, GLUE2, BES, UR, ...
  - HED - hosting environment for Web services (WS)

More Recent Globus History in Context



… and Globus?

- *Many other MWs go WebService (WS), while Globus moves back to PRE-WS – why?*
  - GT4 WS-GRAM was never as stable as GT2-GRAM
  - User survey showed that direct demand from users for WS was very limited, clients use jGlobus, Condor, SAGA, etc. instead
  - Big Grids were still using GT2.4 GRAM
  - GT5-GRAM is more stable than GT2-GRAM and more performant than GT4 WS-GRAM

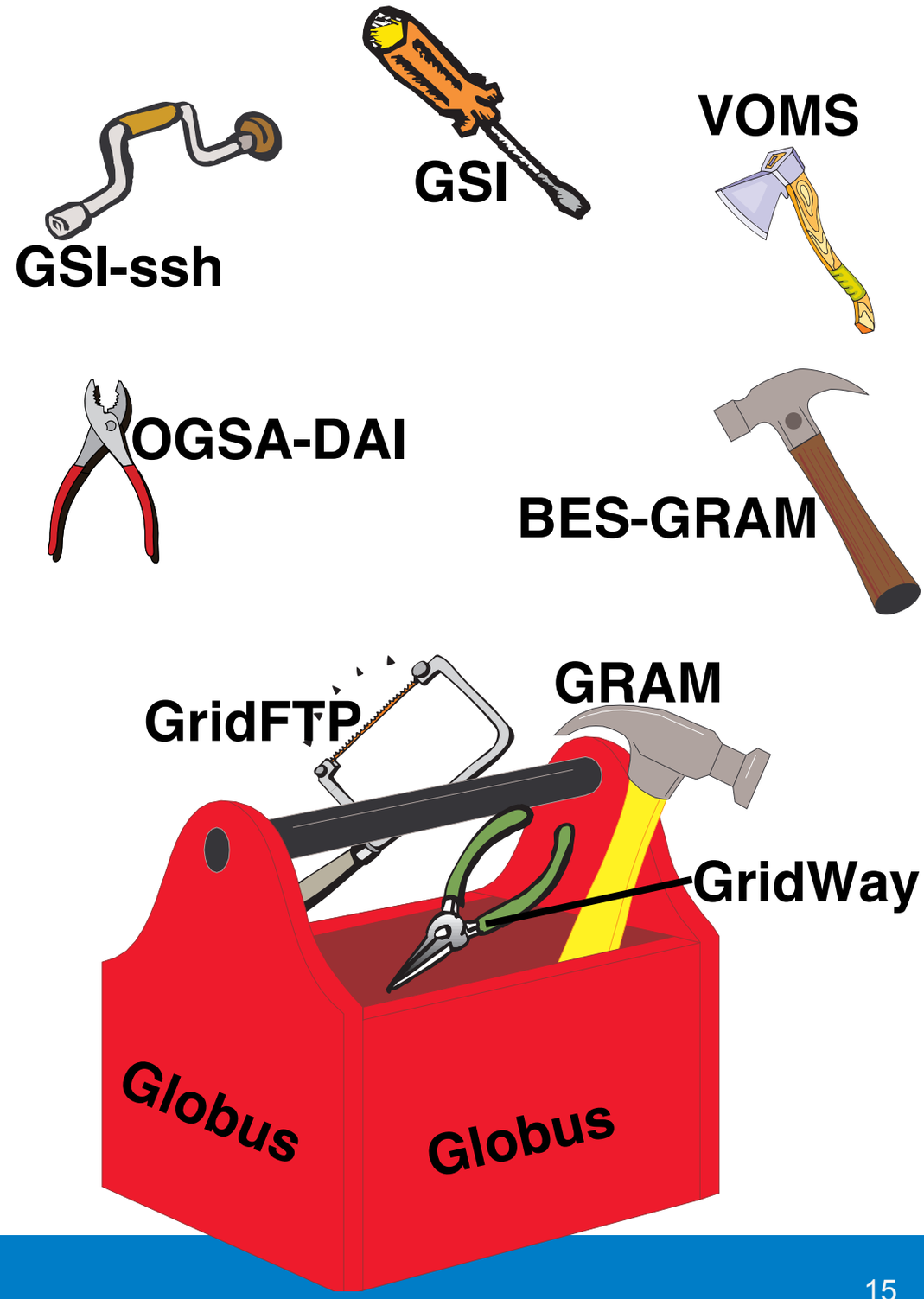
Globus Provides Building Blocks

- Basic components for Grid functionality
  - Not turnkey solutions, but building blocks & tools for application developers & system integrators
- Highest-level services are often application specific; we let apps concentrate on that
- Easier to reuse than to reinvent
  - Compatibility with other Grid systems comes for free
- GT provides basic infrastructure to get you one step closer to your science results

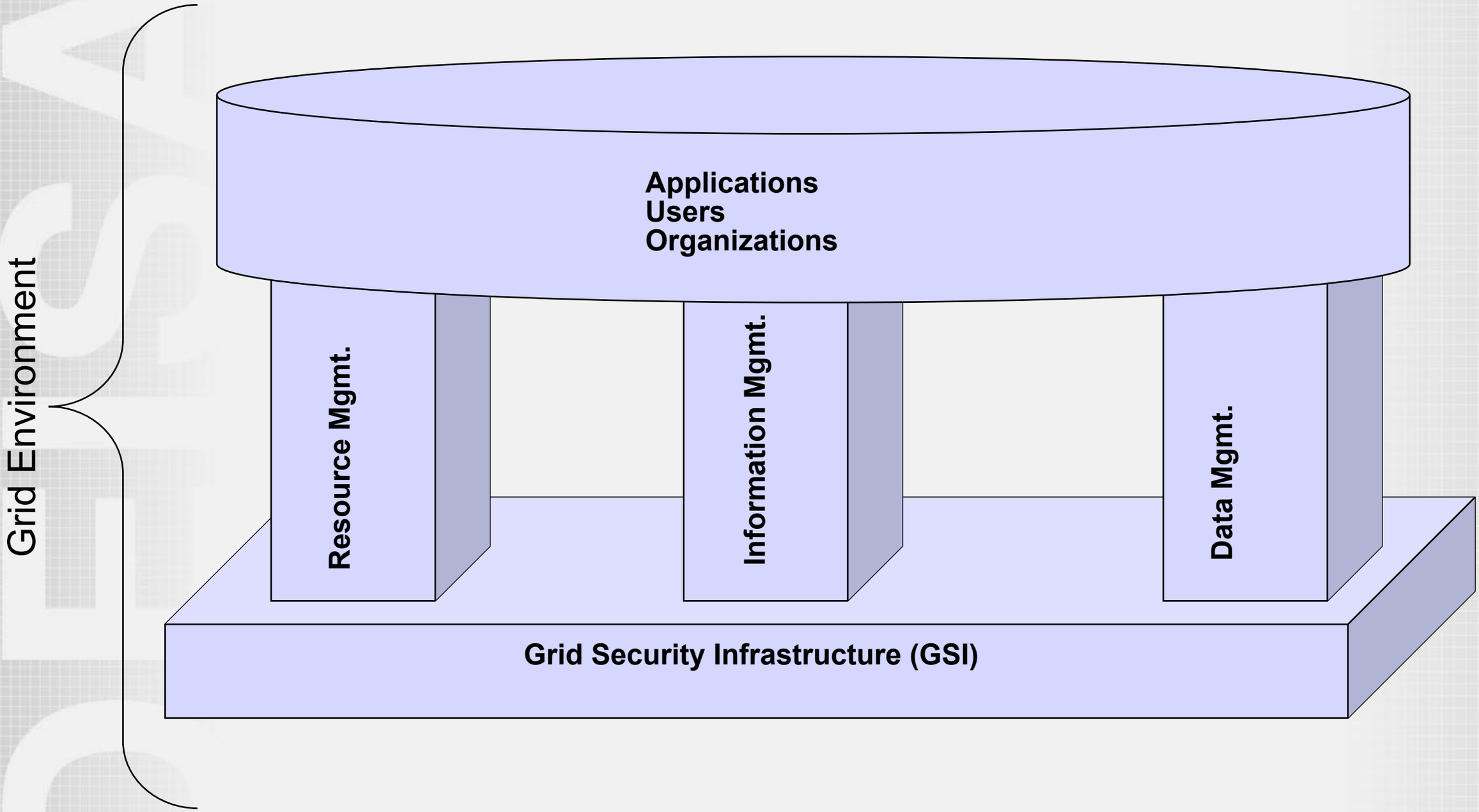
From J. Schopf
Globus Alliance

Toolkit Components

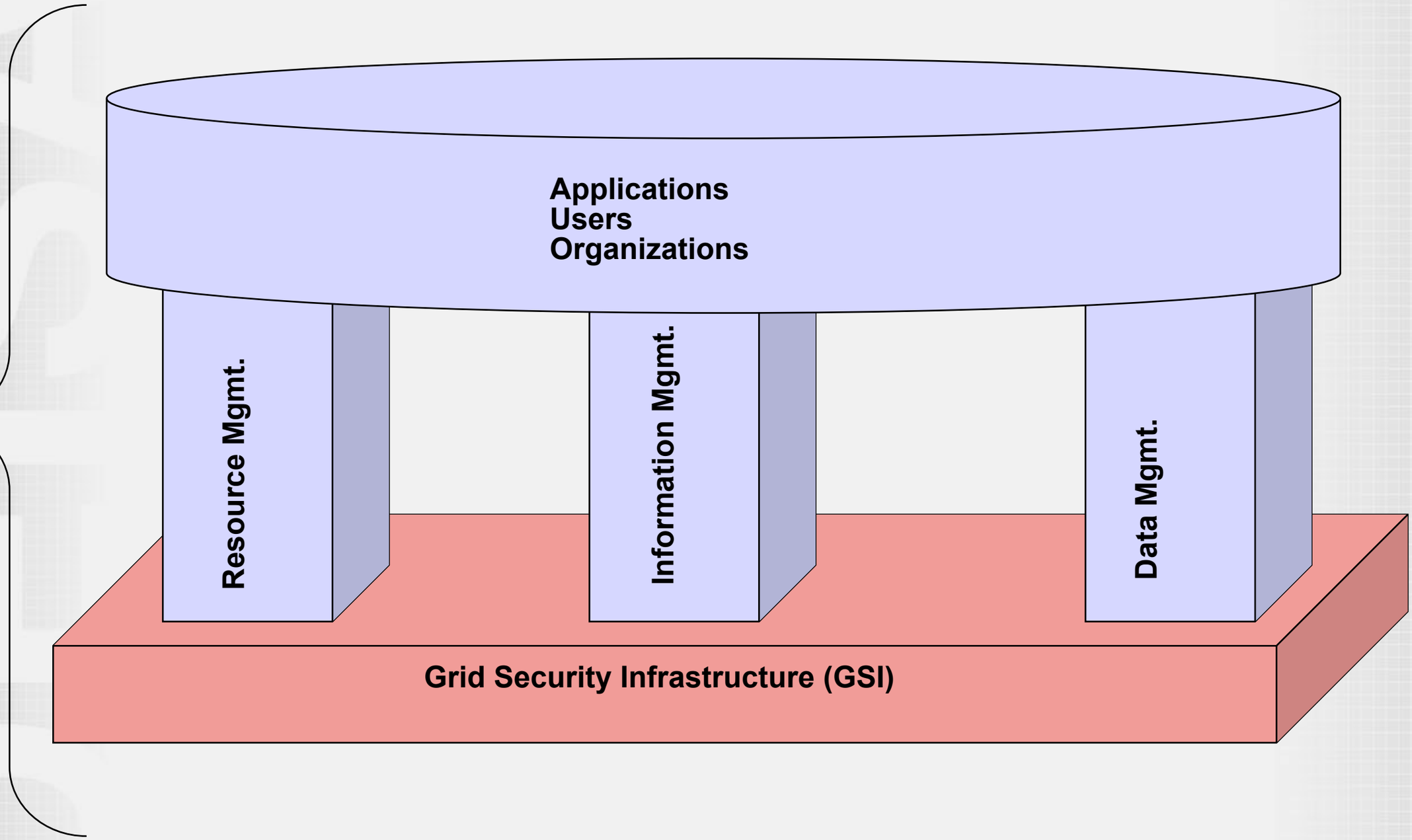
- Globus is a **toolkit** with many owners and contributors
- All is **open source** software, freely usable
- Use the tools (some or all) to build a **Grid**



GT4 Architecture

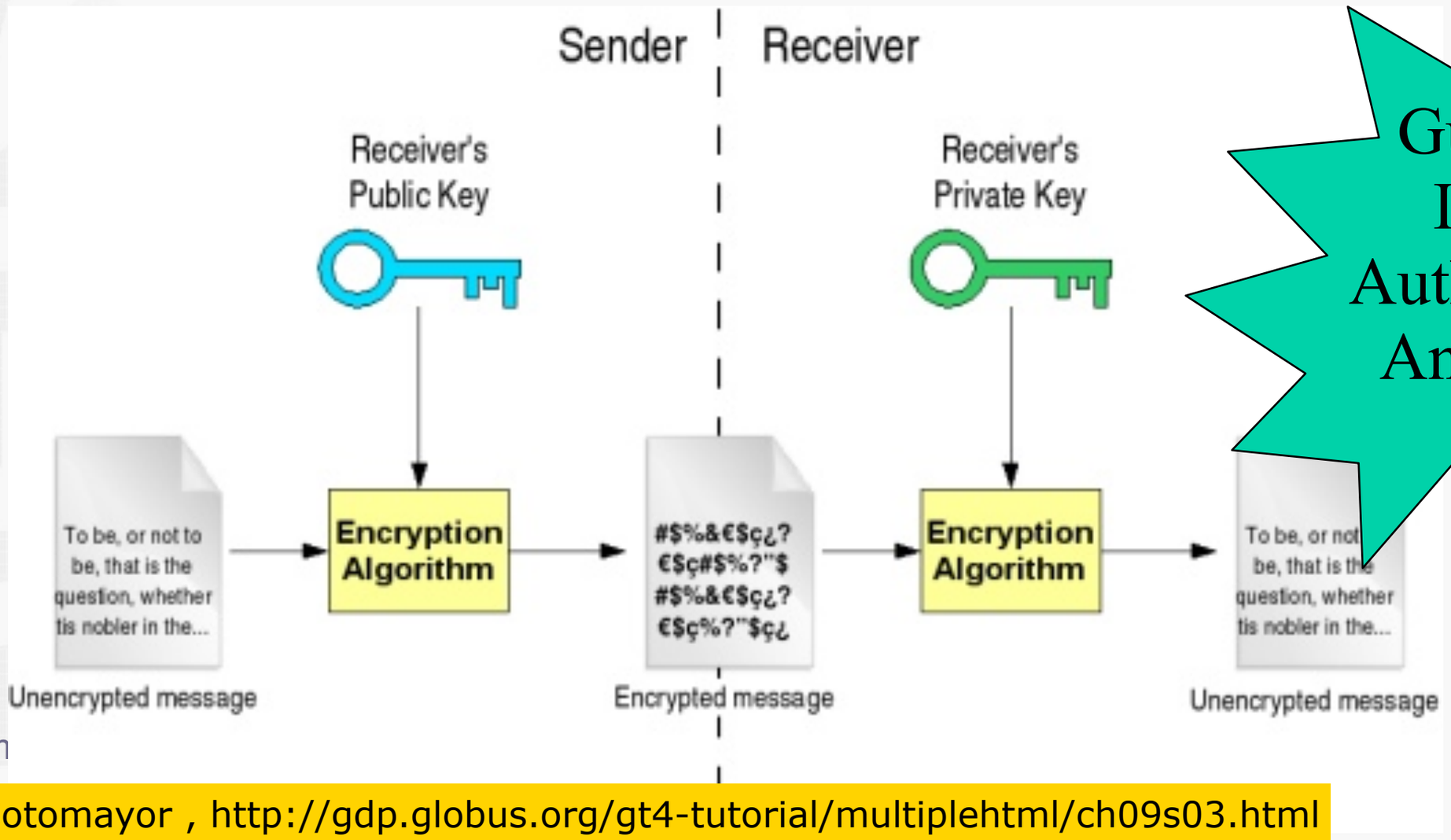


Grid Security Infrastructure (GSI)



Grid Security Infrastructure (GSI)

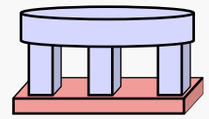
- Private Key - known only by owner
- Public Key- known to everyone
- What one key encrypts, the other decrypts



Guarantees
Integrity
Authentication
And Privacy

From J. Schopf
Globus Alliance

Borja Sotomayor , http://gdp.globus.org/gt4-tutorial/multiplehtml/ch09s03.html

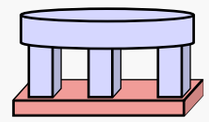


Proxy Certificate

- Proxy allows you to do single sign-on
  - Credential delegation uses proxy
  - Limited lifetime (default: 12 hours)

From J. Schopf
Globus Alliance

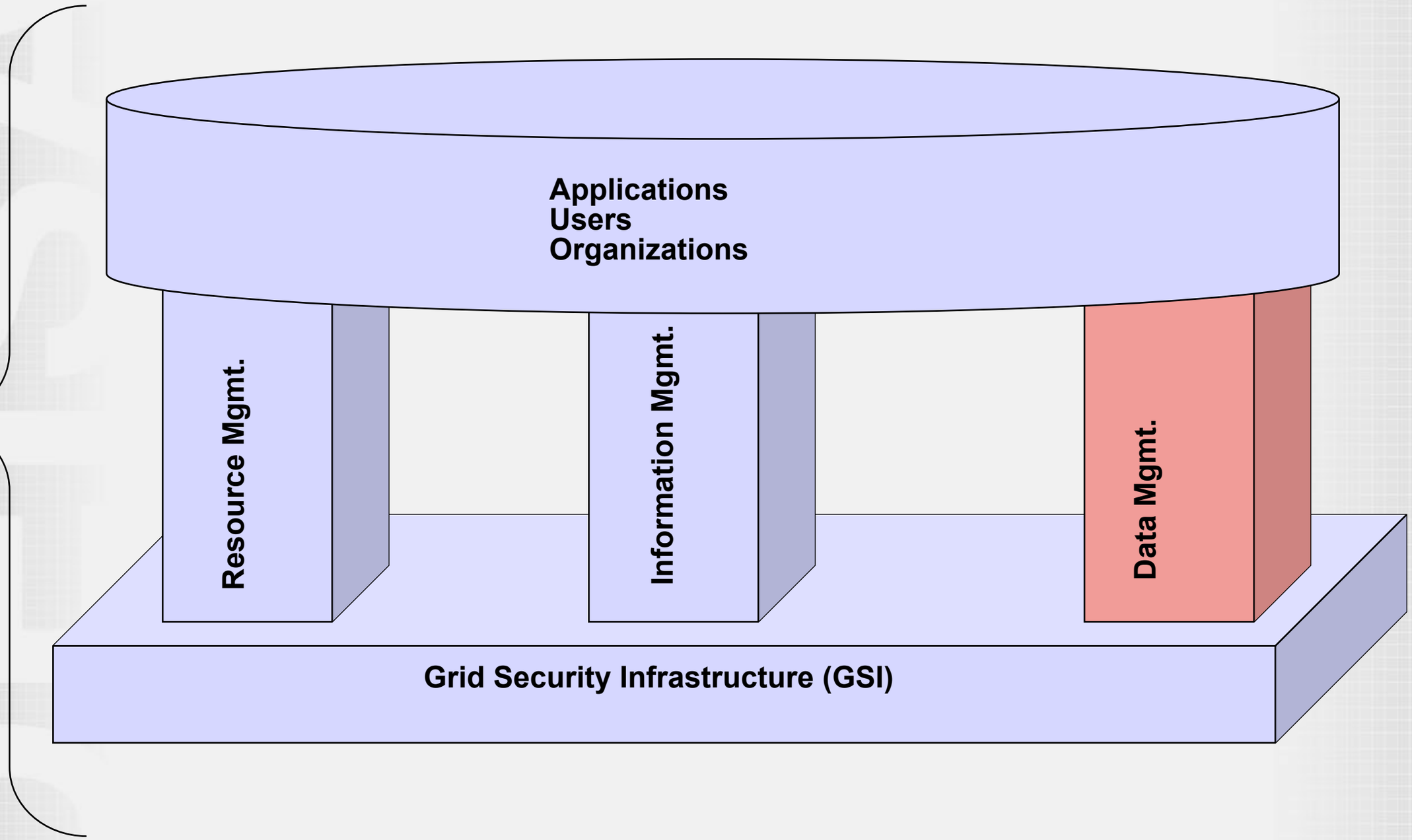
Borja Sotomayor , http://gdp.globus.org/gt4-tutorial/multiplehtml/ch10s05.html

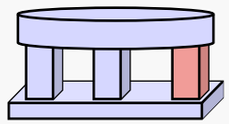


Benefits of Single Sign-on

- Don’t need to remember (or even know) ID/ passwords for each resource
- More secure
  - No ID/password is sent over the wire – not even in encrypted form
  - Proxy certificate expires in a few hours and then is useless to anyone else
  - Don’t need to write down 10 passwords
- *It’s fast and it’s easy!*

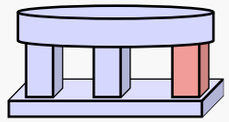
Data Management





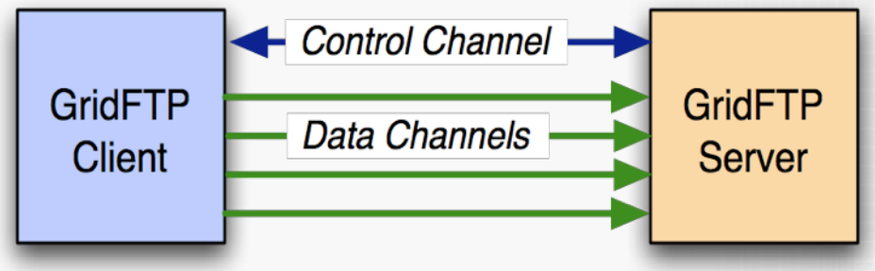
GridFTP: The Protocol

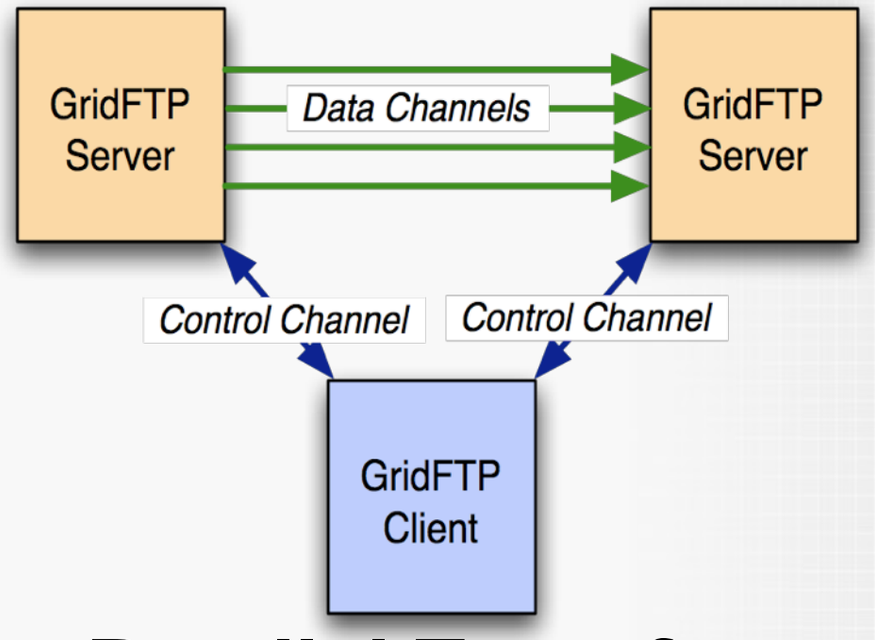
- A high-performance, secure, reliable data transfer protocol optimized for high-bandwidth wide-area networks
  - FTP with well-defined extensions
  - Uses basic Grid security (GSI)
  - Multiple data channels for parallel transfers
  - Partial file transfers
  - Third-party transfers
  - Reusable data channels
  - Command pipelining
- GGF recommendation GFD.20



GridFTP: The Service

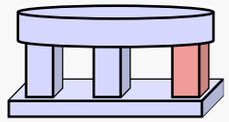
- Multiple TCP streams between sender and receiver possible
- Sender pushes multiple blocks in parallel streams
- Blocks reassembled at receiving side and put into correct order
- Protection against dropped packets for each stream





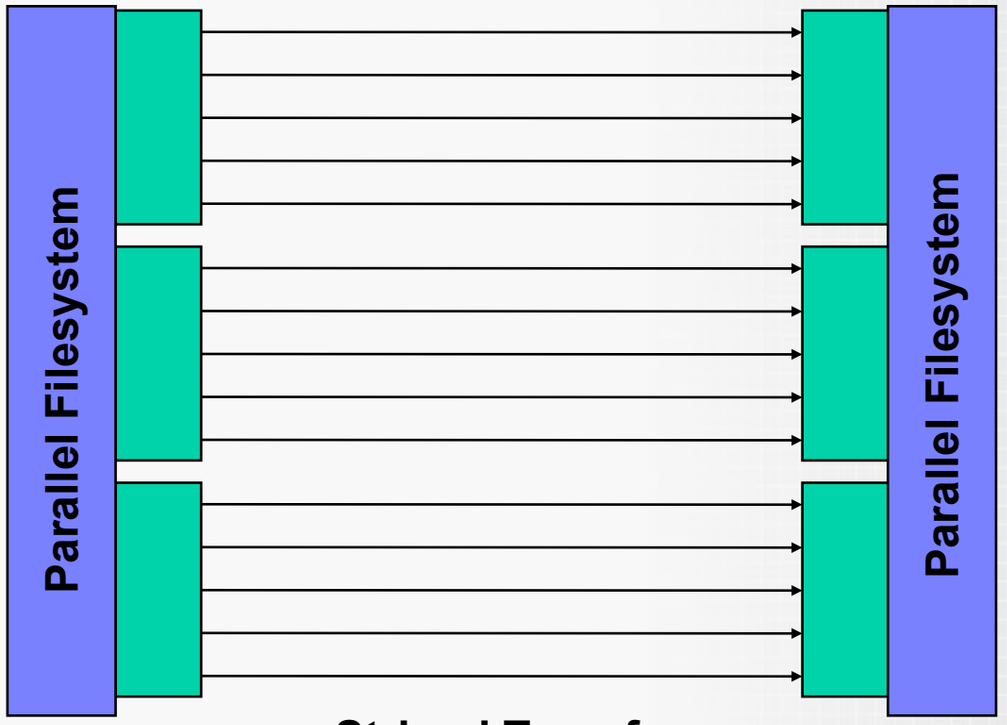
Parallel Transfer
Fully utilizes bandwidth of network interface on single nodes

From J. Schopf
Globus Alliance

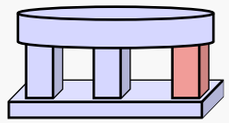


Striped GridFTP Service

- Multiple nodes work together as a single logical GridFTP server
- Multiple nodes of the cluster are used to transfer data into/out of the cluster
  - Each node reads/writes only pieces it is responsible for
  - Head node coordinates transfers
- Multiple levels of parallelism
  - CPU, bus, NIC, disk etc.
  - Maximizes use of Gbit + WANs



Striped Transfer
Fully utilizes bandwidth of Gb+ WAN using multiple nodes



GridFTP Features

- TCP buffer size control
  - Tune buffers to latency of network
  - Regular FTP optimized for low latency networks, not tunable by user
- Dramatic improvements for high latency WAN transfers
  - 90% of network utilization possible
- Tuning has been done by DEISA staff for DEISA systems:
  gscp wrapper with syntax similar to scp

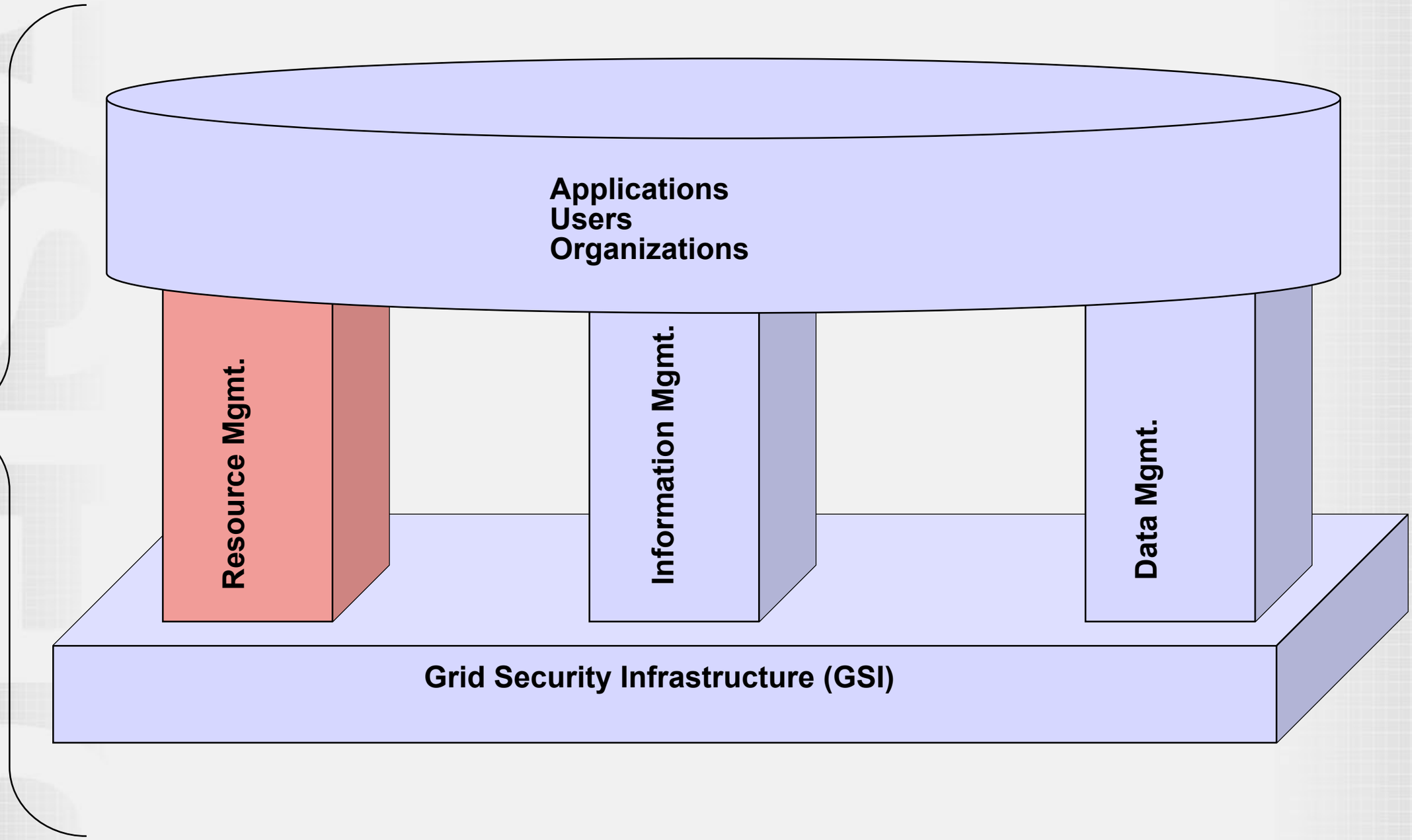
Gsissh: Interactive Access

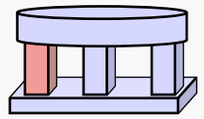
- Interactive access needed for compilation, porting, debugging, optimization, tests, etc.
- Should not be used to submit production jobs, as one looses the Grid advantage of a uniform interface to batch systems
- Gsissh is based on normal ssh but uses the GSI:
  - Log-in via certificates and proxies (not passwords)
  - No need to know or specify UNIX userID on remote system
  - Single sign on (SSO) possible
  - Proxy automatically forwarded to remote site (SSO!)
  - Supports X11 (and other) tunneling just like ssh
- If Globus client tools are not installed, then the stand-alone Java application Gsissh-Term can be used (Java Webstart!)
  http://tinyurl.com/gsissh

Live Demo

DEMO GsiSSH

Resource Management



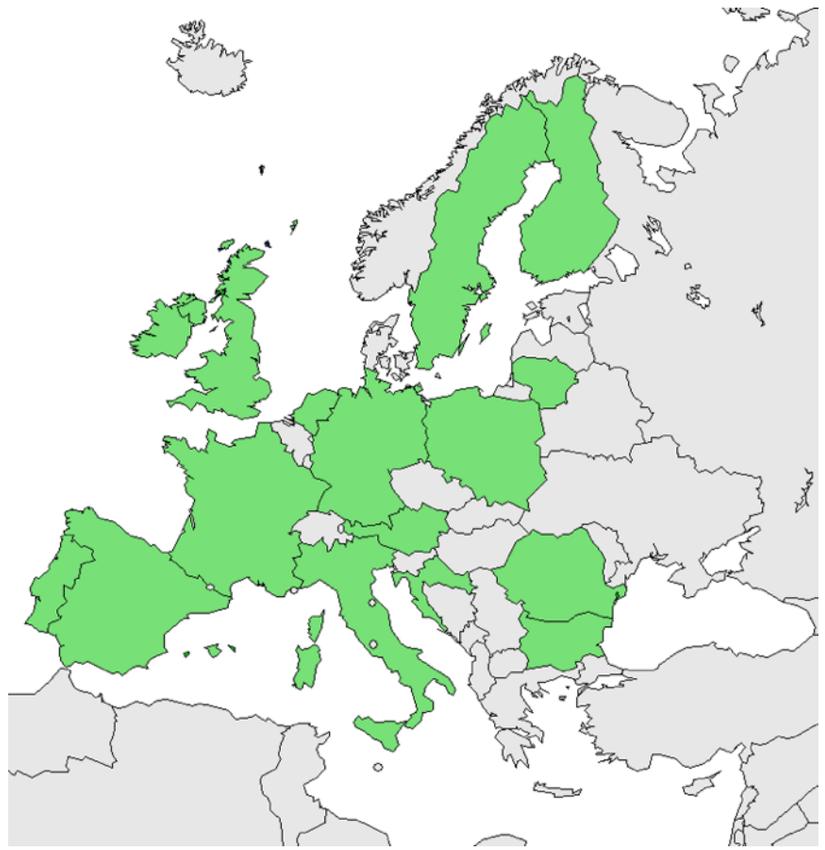


Execution Management (GRAM)

- **G**lobus **R**esource **A**llocation **M**anager
- Common interface to schedulers
  - Unix, Condor, LSF, PBS, SGE, LoadLeveler, …
- More generally: interface for process execution management
  - Lay down execution environment
  - Manages staging of data
  - Monitor & manage lifecycle
  - Kill it, clean up

Globus Usage Worldwide

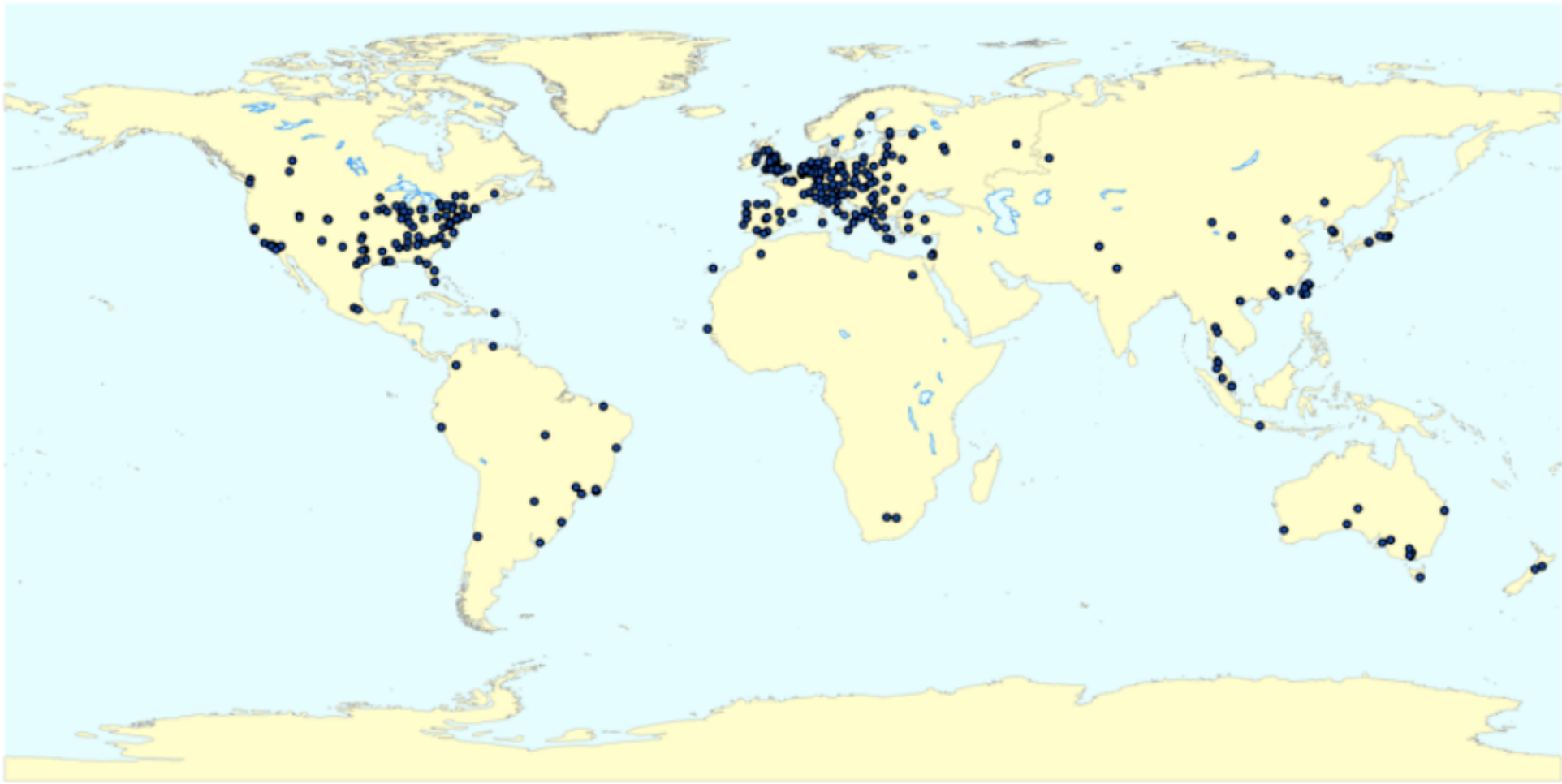
- Globus is one of the most widely used Grid middlewares:
  - DEISA, PRACE
  - TeraGrid
  - EGI
  - ChinaGrid
  - EU-IndiaGrid
  - Earth System Grid (ESG)
  - Open Science Grid (OSG)
  - D-Grid
  - Public Health Grid
  - BIRN (Biomedical Informatics Research Network)
  - CaBIG (Cancer Biology Informatics Grid)
  - LIGO Project



GridFTP Servers Around the World

the globus alliance
www.globus.org

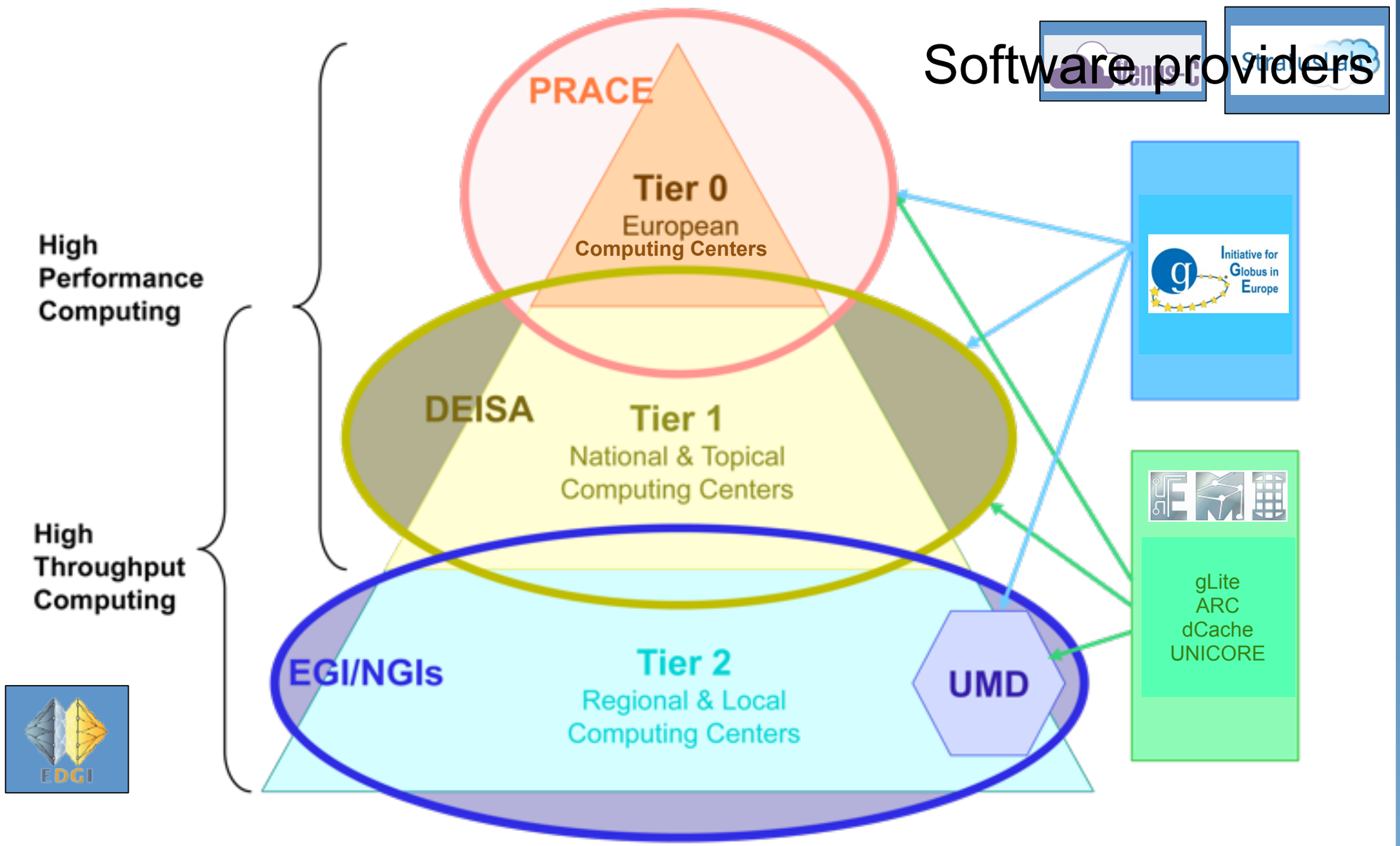
GridFTP Servers Around the World



Created by Tim Pinkawa (Northern Illinois University) using MaxMind's GeoIP technology (http://www.maxmind.com/app/ip-locate).

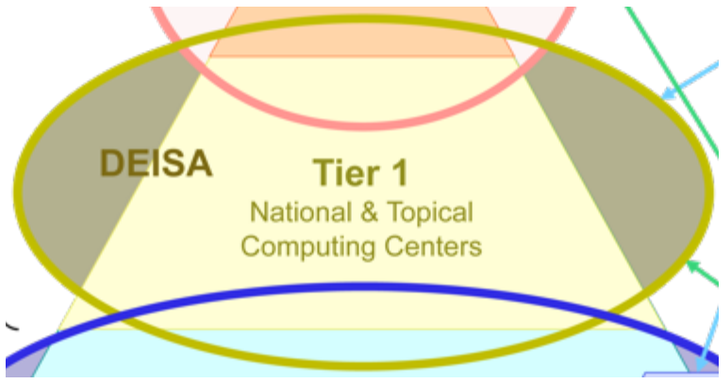
From Steve Tuecke

The European Grid Ecosystem



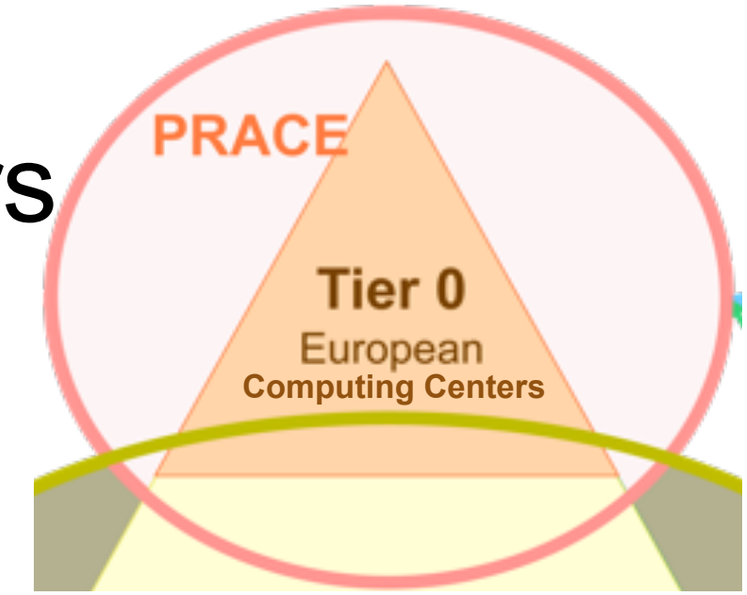
Tier-1: DEISA

- Globus tools used in DEISA
  - **Gsissh** as primary interactive access method to DEISA through Gsissh door nodes
  - **GridFTP** as primary high performance data transfer tool through door nodes to GPFS
  - **WS-GRAM** (GT4) or GRAM-5 available on request
    - GridWay head node operated @LRZ as WS-GRAM/ GRAM door node



Tier-0: PRACE

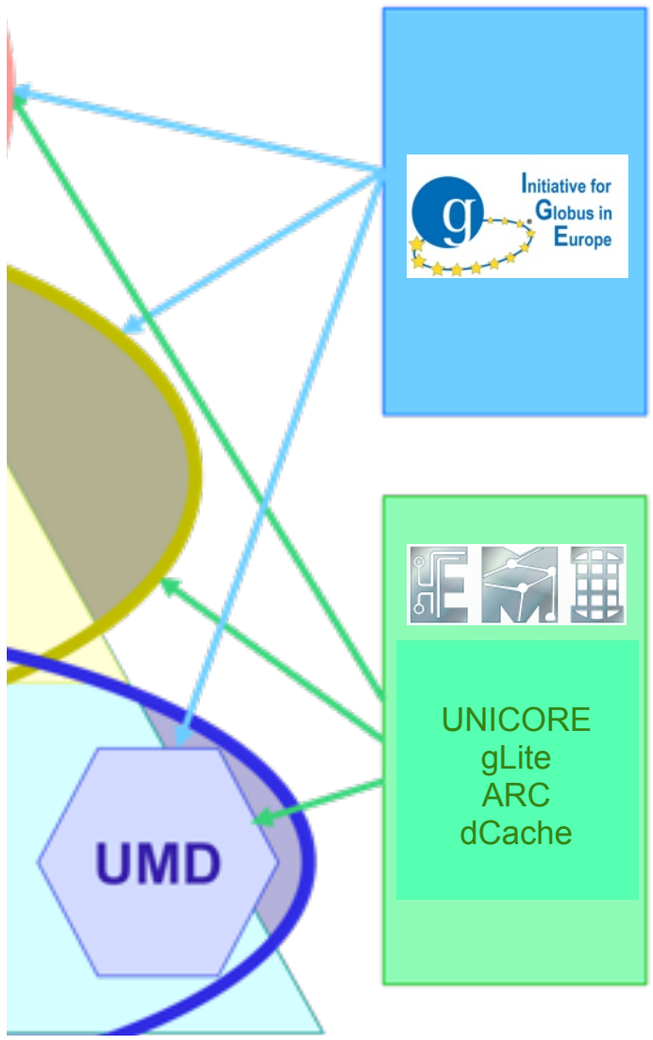
- PRACE: Top level HPC, Petaflop computing
- Six European supercomputers of highest performance



- Globus tools used:
  - **Gsissh** for interactive access
  - **GridFTP** for high speed data transfer

European Integration

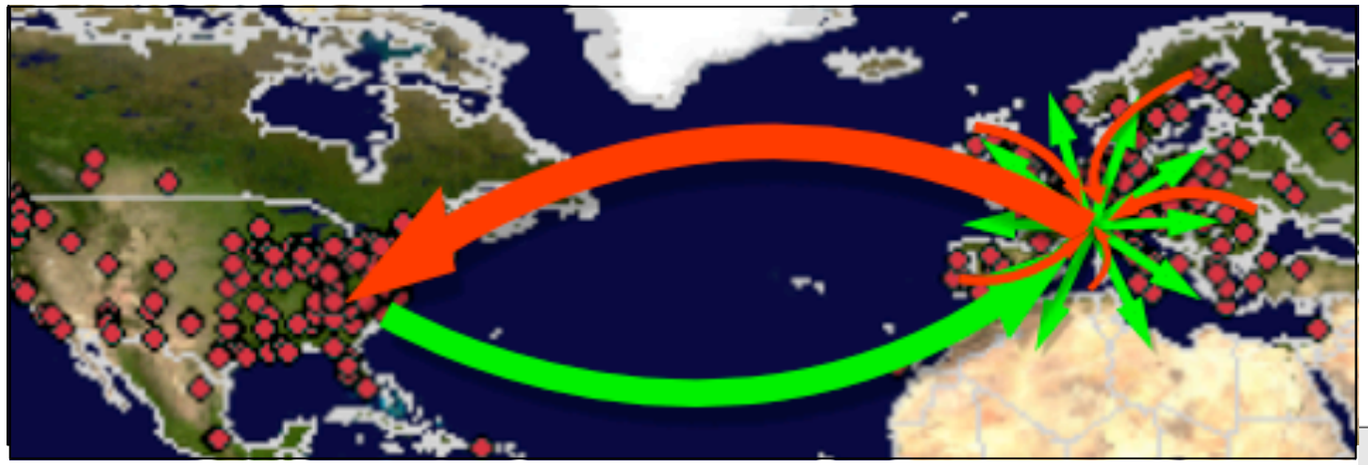
- IGE is a middleware provider and will bring Globus components into UMD
  - Service Level Agreements (SLAs) for EGI
- Service provider for European Grids
- Third level support for Globus in Europe
- Globus can act as bridge between tiers



IGE Vision

Help Scientists in the European Research Area

- Coordination of widespread European Globus development and operation activities



- Central point of contact in Europe for Globus
- Add the European perspective to Globus
- Globus service provider for European e-Infrastructures such as DEISA, EGI, PRACE

IGE Partners

- Leibniz Supercomputing Centre, Coordinator (LRZ)
- Technische Universität Dortmund (TUDO)
- University of Southampton (SOTON)
- The University of Edinburgh (EPCC)
- Poznan Supercomputing and Networking (PSNC)
- GridwiseTech (GWT)
- Technical University Cluj-Napoca (UTCN)
- Complutense University of Madrid (UCM)
- Uppsala University (UU)
- National Inst. for Nuclear and High Energy Physics (NIKHEF)
- The University of Chicago (UC)

Objectives 1

- **Coordination** of European Globus activities
- **Bundle** European input to Globus
- Introduce **adjustments** critical for Europe into Globus **code base**
- Act as **Globus service provider** for European Grids like DEISA, PRACE, and EGI
- Measure Globus **software quality**
- **Standardization**, **training**, **promotion**, and **documentation**
- Organize **Globus Europe conference** and **Globus community forum**

Objectives 2

- Set up **mirror of globus.org** for Europe
- Provide a **European metrics collector** (otherwise privacy concerns)
- Support **interoperability** efforts (BES, SAML, JSDL, LCAS, accounting, etc.)
- Providing a **repository** and **web resource**: http://www.ige-project.eu/
- **Maintain binary packages** for AIX, SuSE, ...
- **Support batch systems** like LL, NQS2, ...

Standardization and OGF

- European Globus related requirements captured via Community Forum and Liaison Office
- Requirements fed into European Globus development groups and OGF etc.
  - Participate in GIN-cg and PGI-wg
  - Other standards-related groups to be monitored (JSDL, BES, GLUE, DMI, …)
  - Open Standards-based solutions to be developed and demonstrated through GIN-cg (community group)
  - Interoperability demo to include increasingly deeper Globus integration (BES, JSDL)
- Support for OGSA-BES, OGSA-DAI in GT5
- Interoperability with other middlewares through implementation of standards

1st Success Story: the Problem

- DEISA supports the VPH VC which wants to use GT5 GRAM to submit jobs with their SAGA-based software (no support for WS-GRAM)
- Many machines in DEISA are IBM-brand with LoadLeveler (LL) batch scheduler
- IBM does not provide a GT5 LL-adaptor, thus SARA's computer could not be used

1st Success Story: the Solution

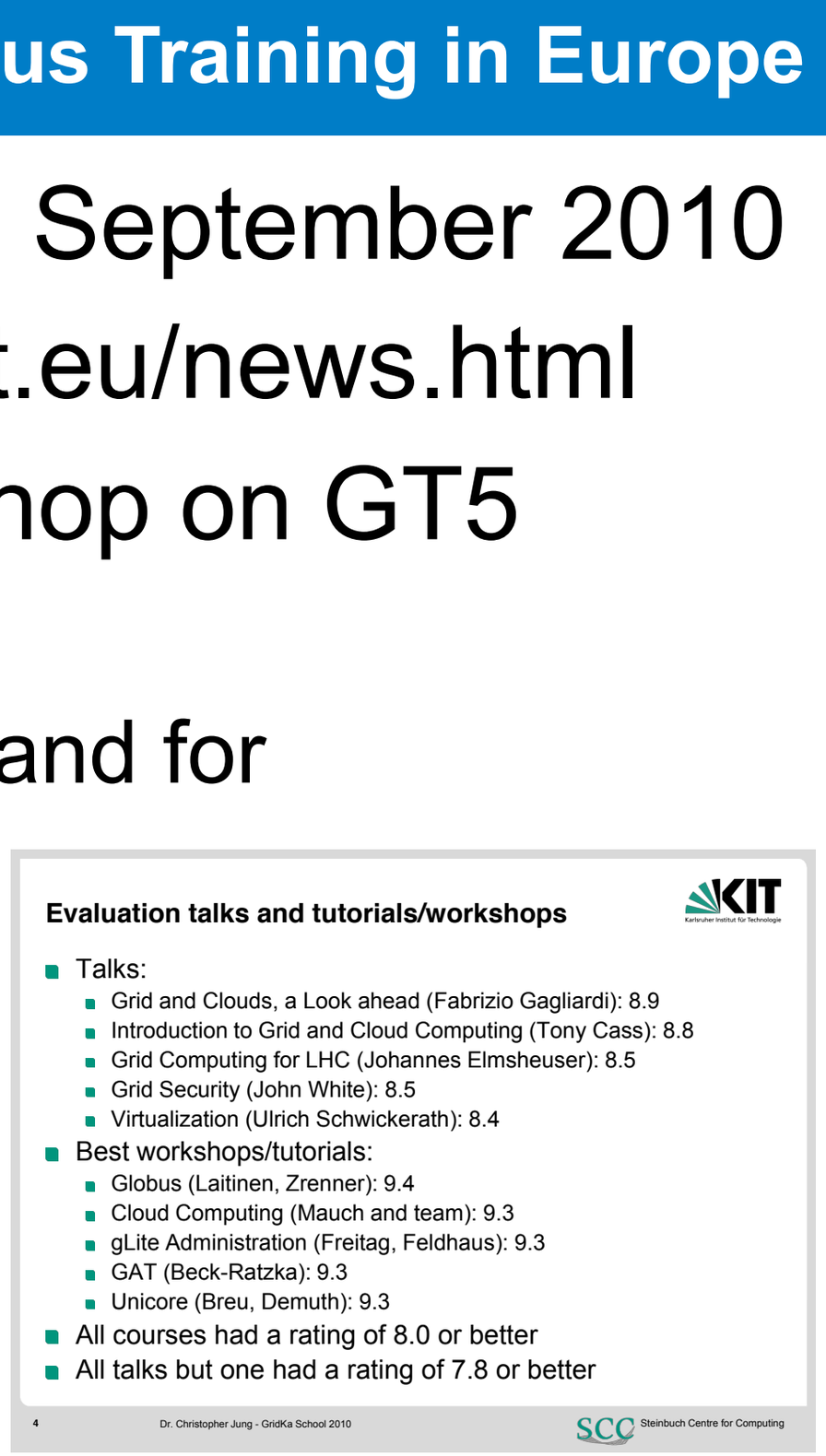
- SARA (Rob van der Wal) contacted **IGE**
- Within WP4 of IGE
  - Eduardo Huedo from Universidad Complutense de Madrid (UCM) offered to have a look
  - but he had no access to an IBM machine
- IGE connected Rob and Eduardo
- Together they ported GT4 LL-adaptor to GT5.0.1
- SARA is now offering GT5 GRAM to VPH
- More work (licensing, packaging, etc.) is needed

2nd Success Story: PGI Use Case for Globus

- Virtual Physiological Human (VPH) research community active in USA and EU
- Using TeraGrid and DEISA resources
- Built on SAGA (and GT5 GRAM)
- DEISA-TeraGrid interoperation submitted as real world use-case to PGI
- Published in 1st use case document of PGI
- **http://tinyurl.com/29ee8uc**

3rd Success Story: Globus Training in Europe

- GridKa Summer School in September 2010
- See http://www.ige-project.eu/news.html
- IGE gave a full day workshop on GT5
  - including hands-on session
  - with tailored parts for users and for administrators
- Voted as **best workshop**
- Lecture slides
  - **http://tinyurl.com/29vjvsy**
  - **http://tinyurl.com/2f6s23y**



Evaluation talks and tutorials/workshops

KIT Karlsruher Institut für Technologie

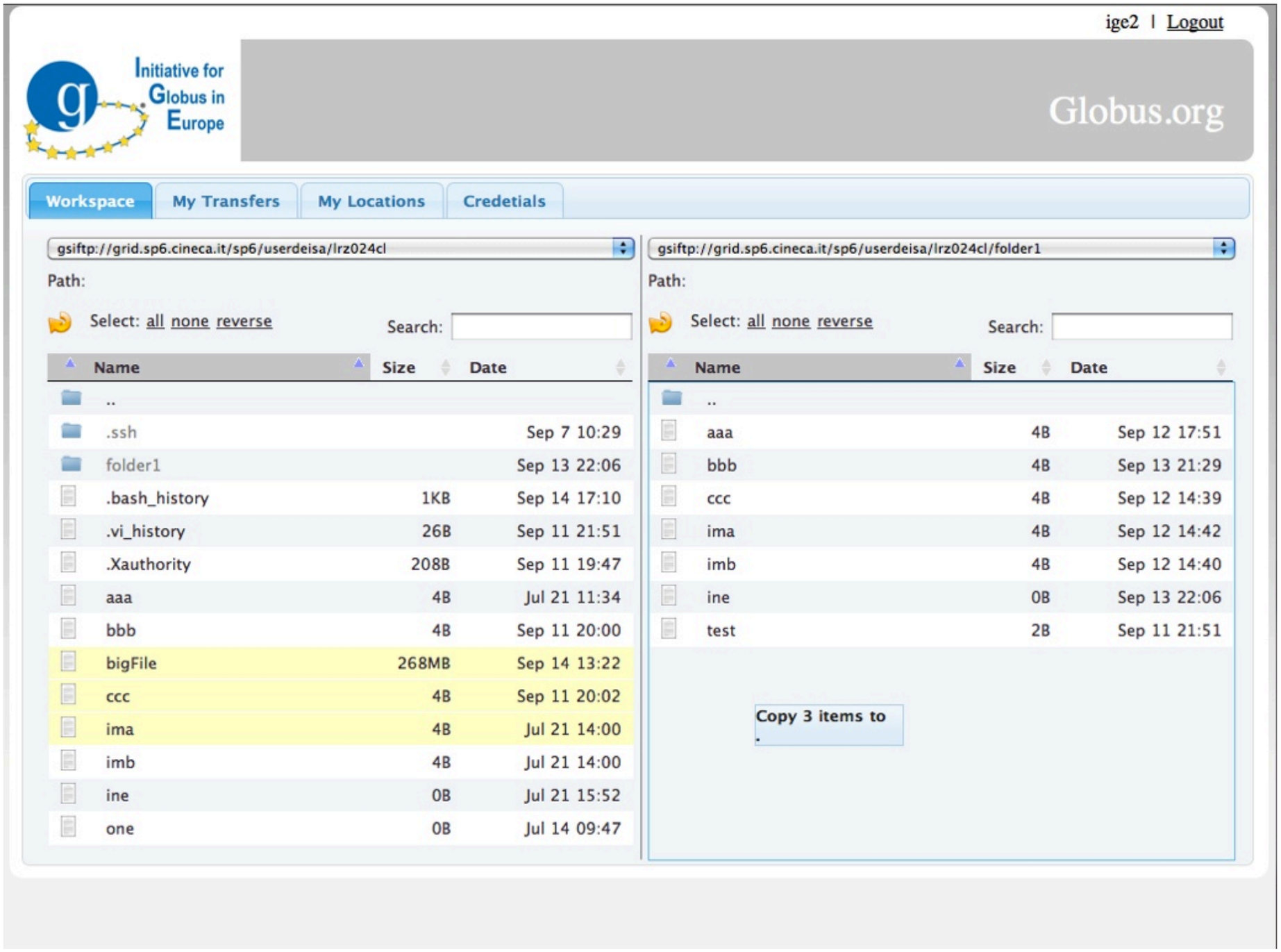
- Talks:
  - Grid and Clouds, a Look ahead (Fabrizio Gagliardi): 8.9
  - Introduction to Grid and Cloud Computing (Tony Cass): 8.8
  - Grid Computing for LHC (Johannes Elmsheuser): 8.5
  - Grid Security (John White): 8.5
  - Virtualization (Ulrich Schwickerath): 8.4
- Best workshops/tutorials:
  - Globus (Laitinen, Zrenner): 9.4
  - Cloud Computing (Mauch and team): 9.3
  - gLite Administration (Freitag, Feldhaus): 9.3
  - GAT (Beck-Ratzka): 9.3
  - Unicore (Breu, Demuth): 9.3
- All courses had a rating of 8.0 or better
- All talks but one had a rating of 7.8 or better

4 Dr. Christopher Jung - GridKa School 2010 SCC Steinbuch Centre for Computing

4th Success Story: GUI for globusonline.org

- Orchestration of file transfer through new service **globusonline.org** (formerly known as globus.org)
- Still in alpha status (not yet production)
  - but open for testing
  - contact **info@ige-project.eu** if you want to test!
- IGE developed a drag&drop GUI

4th Success Story: GUI for globusonline.org



New Things to Come

Globus Toolkit

Build the Grid

Components for building
custom grid solutions

globus.org

IGE: globus.org.eu

Globus Online

Use the Grid

Cloud-hosted
file transfer service

globusonline.org

globusonline.eu

From Steve Tuecke

Why Globusonline?

the globus alliance
www.globus.org

Data movement is hard

For many reasons

- SCP is too slow
- No GridFTP at site
- Firewalls
- Space management
- Net (mis)configuration
- Security config, policies
- Other heterogeneities
- Failures, restarts, mirroring, other tasks

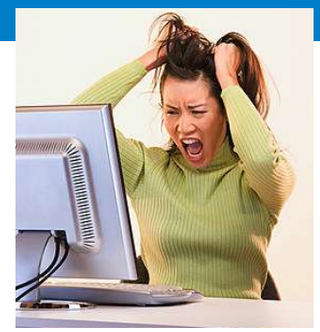
For many people

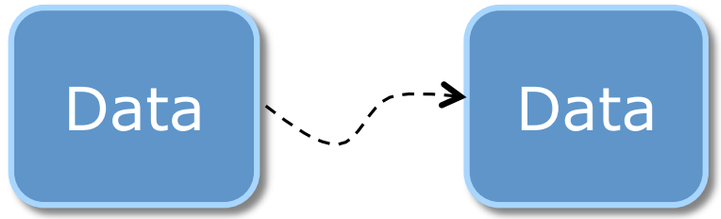
- Ad-hoc: Non-experts who need to move many files
- Scripted: Experts who want to automate large file movement
- System builders: Don’t want to re-engineer solutions to such problems

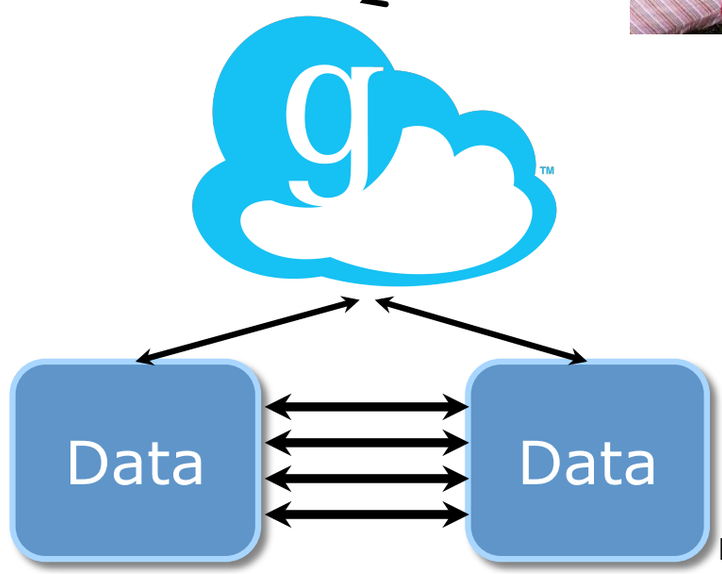
From Steve Tuecke

What Can Globusonline Do For You?

- Easy “fire and forget” file transfers
- Automatic fault recovery
- High performance
- Simplify use of multiple security domains
- No client software installation
- New features automatically available
- Consolidated support and troubleshooting







From Steve Tuecke

How was Globusonline built?

the globus alliance
www.globus.org

Applying Web 2.0/SaaS methods

- Service: Built as scale-out web application
  - Hosted on Amazon Web Services

- Client: Minimize software deployment
  - Web 2.0: AJAX + REST
  - CLI 2.0: ssh cli.globus.org …
  - Support for heterogeneity in end systems: data transfer and security protocols, etc.

From Steve Tuecke

You Can Try Globusonline!

- Just send an email to

info@ige-project.eu

and IGE will sign you up and guide you through the first steps

More New Things to Come

- With new version GT5.2 (alpha release expected in January 2011) GPT (Grid Packaging Tools) will be replaced by **native OS packages** (RPMs, debs, etc.). **Additional OSs supported by IGE**!
- No more “flavors” but **dynamically selectable threads**
- **jGlobus 2.0:**
  - use standard Java SSL library (gives SHA2)
- **BES/JSDL** support by **IGE**

Questions?

Thank you for your attention