



the globus alliance  
www.globus.org

# Globus New and Next

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Argonne National Lab

<http://www.mcs.anl.gov/~jms/Talks/>



# Grid Applications

- Computation intensive
  - Interactive simulation (climate modeling)
  - Large-scale simulation and analysis (galaxy formation, gravity waves, event simulation)
  - Engineering (parameter studies, linked models)
- Data intensive
  - Experimental data analysis (e.g., physics)
  - Image & sensor analysis (astronomy, climate)
- Distributed collaboration
  - Online instrumentation (microscopes, x-ray)
  - Remote visualization (climate studies, biology)
  - Engineering (large-scale structural testing)



# Grids and Changing Science

Collaborative

Project focused, globally distributed teams, spanning organizations within and beyond company boundaries

Distributed & Heterogeneous

Each team member/group brings own data, compute, & other resources into the project

Data & Computation Intensive

Access to computing and data resources must be coordinated across the collaboration

Dynamic Research

Science being addressed is changing as larger data sets can be analyzed and access to additional resources is made possible

**Infrastructure must adapt to this new reality**



## Globus is...

- A collection of solutions to problems that come up frequently when building collaborative distributed applications
- Software for Grid infrastructure
  - Service enable new & existing resources
  - Uniform abstractions & mechanisms
- Tools to build applications that exploit Grid infrastructure
  - Registries, security, data management, ...
- Open source & open standards
  - Each empowers the other
- Enabler of a rich tool & service ecosystem



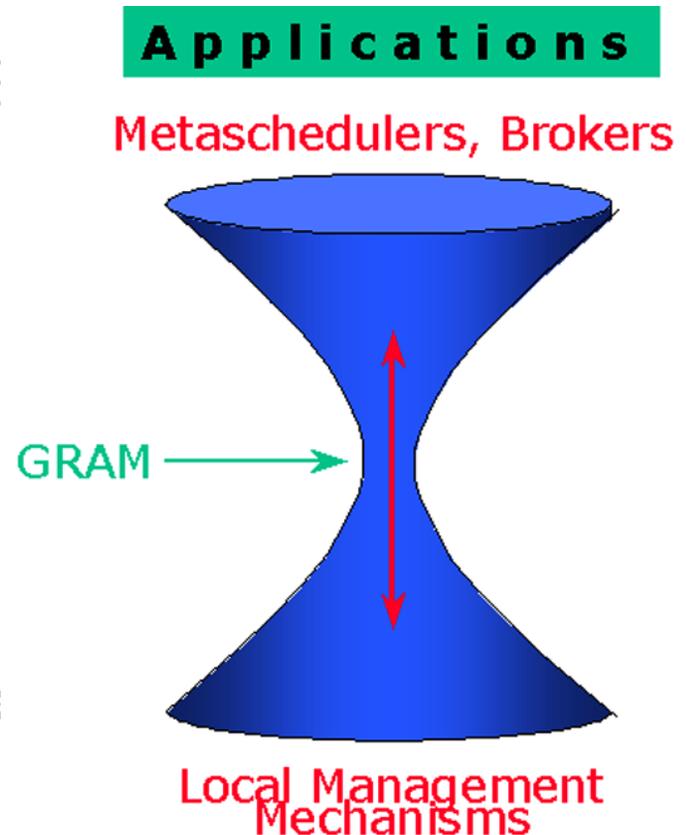
# Top Ten Recent and Upcoming Improvements for Globus

- New This Year
  - 1) Performance improvements for GRAM4
  - 2) Added functionality for GridFTP
  - 3) Ease of use tools (eg. PURSE)
  - 4) New functionality through Incubators
  - 5) Introduce, Gridway
- And in the Upcoming Year
  - 6) Updated standards
  - 7) Managed Object Placement Svc (MOPS)
  - 8) Data Placement Service (DPS)
  - 9) Swift for workflows
  - 10) Virtual Workspaces



# GRAM4: Grid Resource Allocation Manager

- A uniform service interface for remote job submission and control
  - WS interface to LSF, PBS, SGE, Condor, Fork
  - File staging and I/O mgmt
  - Reliability features
  - Supports basic Grid security
- Interface for process execution management
  - Lay down execution environment
  - Stage data
  - Monitor & manage lifecycle
  - Kill it, clean up





## New functionality: GRAM4

- Significant scalability and performance improvements
  - 32,000 active jobs (GRAM2 max ~100)
  - Ability to manage load on control node
  - Reuse delegated credentials
- New functionality 4.1.3 release (Oct 07?)
  - Flexible authorization
  - Modular LRM interface
  - JSDL support
- More information:  
<http://dev.globus.org/wiki/GRAM>



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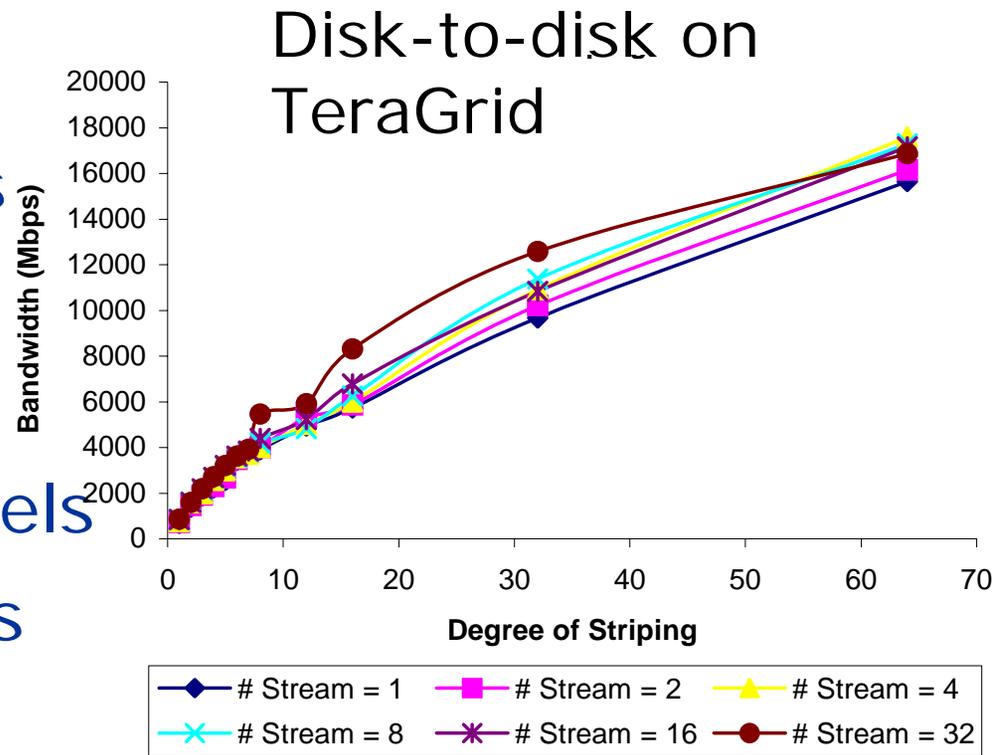
[www.globus.org](http://www.globus.org)

# I nclude graphs



## GridFTP

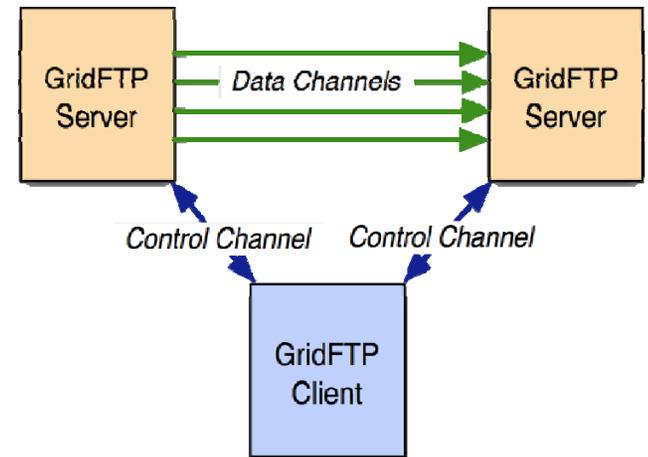
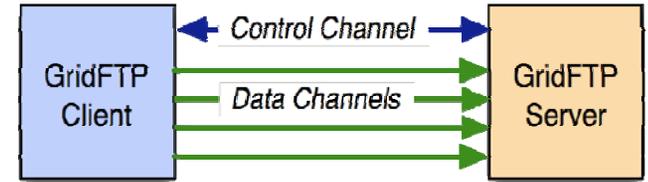
- FTP with extensions
- Uses basic Grid security
- Multiple data channels for parallel transfers
- Partial file transfers
- Third-party transfers
- IPv6 Support
- XIO for different transports
- Striping → multi-Gb/sec wide area transport 9





# New Functionality: GridFTP over SSH

- Problem
  - Not all users require GSI and the need for certificate infrastructure.
- Solution
  - Use SSH for Control Channel
  - Data channel remains as is, so performance is still GridFTP
- Included in 4.1.2 development release



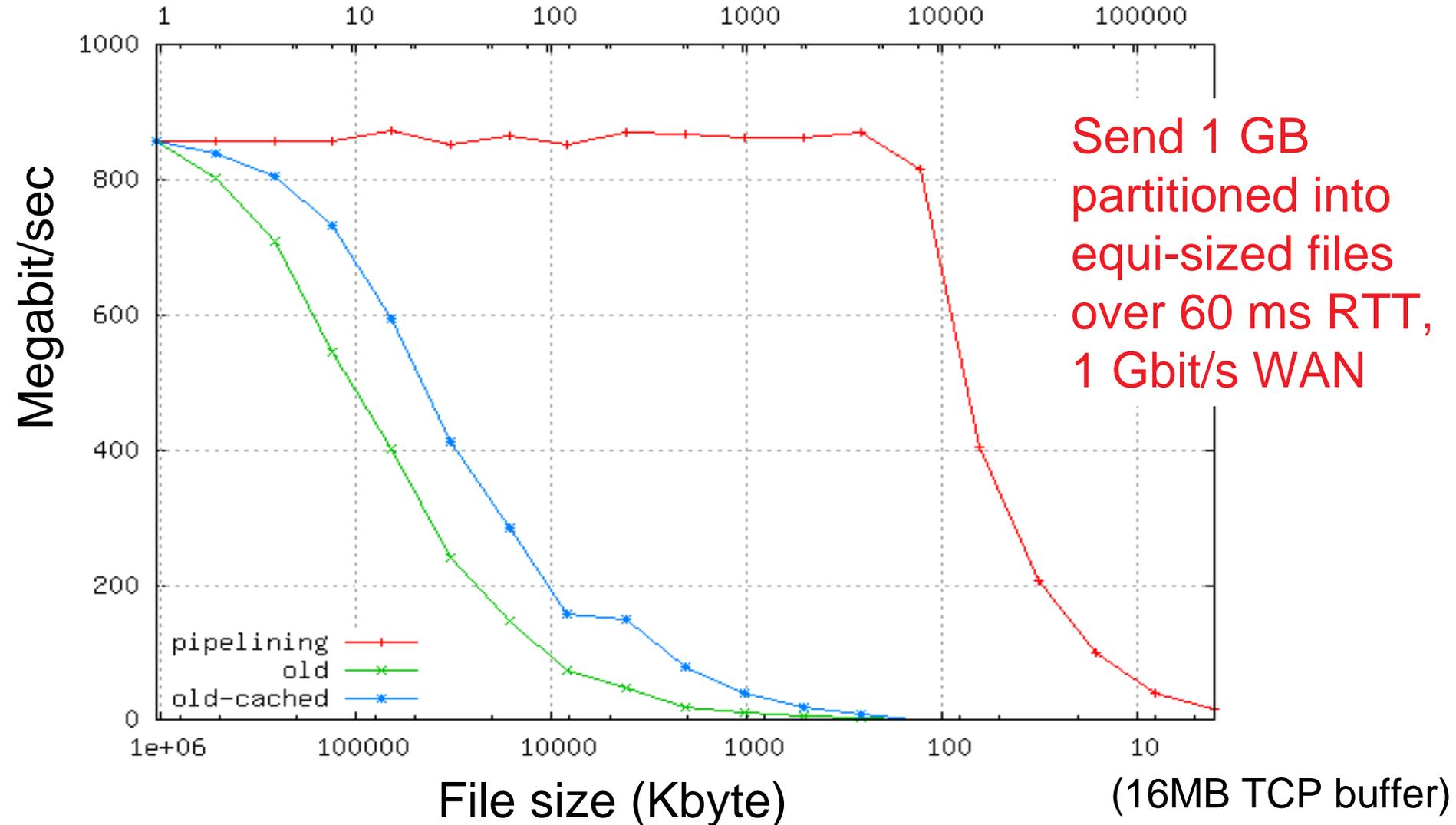


# New Functionality: Lots of Small Files Transfers (LOSF)

- Problem:
  - Performance of 10-100M files often poor since GridFTP tuned for large files
- Solution
  - Pipelining
    - > Avoid large number of outstanding transfer requests by sending second request before the first completes
    - > Latency of request is hidden in data transfer time
  - Cached Data channel connections
    - > Reuse established data channels (Mode E)
    - > No additional TCP or GSI connect overhead
- Included in 4.1.2 development release

# "Lots of Small Files" (LOSF) Optimization

Number of files





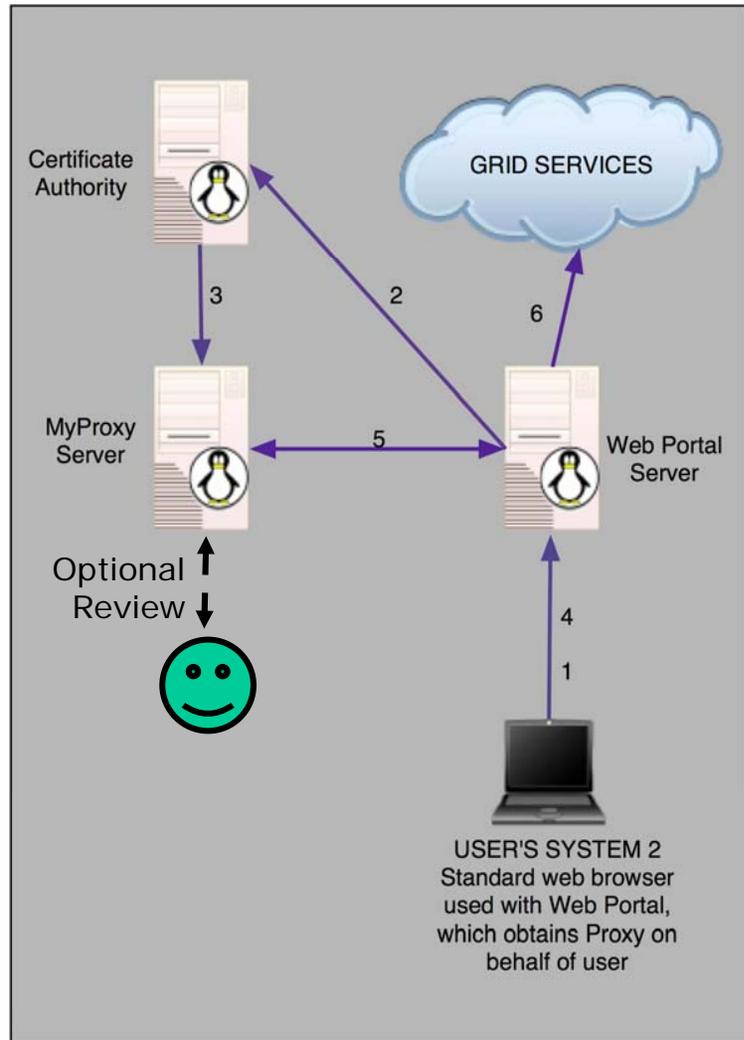
## ESG's Security for Ease of Use

- Security needed so that ESG software can act on users behalf as well
  - Even if data is public, data access needs to be tracked
- Digital certificates can be challenging
  - Often not easy for users to interact with
  - Can be heavy weight for and administrators as well
- ESG uses a system called PURSE: Portal-Based User Registration Service



# Portal-Based User Registration Service (PURSE)

- Portal extensions (CGI scripts) that automate user registration requests
  - Solicits basic data from user
  - Generates cert request from CA
  - Admin interface allows CA admin to accept/reject request
  - Generates a certificate and stores in MyProxy service
  - Gives user ID/password for MyProxy
- Benefits
  - Users never have to deal with certs
  - Portal can get user cert from MyProxy when needed
  - Database populated with user data
- <http://dev.globus.org/wiki/Incubator/PURSe>



## Incubator Process in dev.globus

- Entry point for new Globus projects
- Projects come in and get used to Globus infrastructure
  - Wiki, cvs/svn, licenses, etc
  - When up to speed, they escalate to full Globus projects

[http://dev.globus.org/wiki/Incubator/Incubator\\_Process](http://dev.globus.org/wiki/Incubator/Incubator_Process)



# Globus Software: dev.globus.org

## Globus Projects

MPICH G2

GridWay

Incubation  
Mgmt

Java  
Runtime

Delegation

MyProxy

OGSA-DAI

GT4

C  
Runtime

CAS

GSI-  
OpenSSH

Data  
Rep

Replica  
Location

Python  
Runtime

C Sec

GRAM

GridFTP

MDS4

Reliable  
File  
Transfer

GT4 Docs

## Incubator Projects

Swift

GEMLCA

MonMan

GAARDS

MEDICUS

Cog WF

Virt WkSp

NetLogger

GDTE

GridShib

OGRO

UGP

Dyn Acct

Gavia JSC

DDM

Metrics

Introduce

PURSE

HOC-SA

LRMA

WEEP

Gavia MS

SGGC

ServMark

Common  
Runtime

Security

Execution  
Mgmt

Data Mgmt

Info  
Services

Other



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MPICH G2

GridWay

Incubation Mgmt

Java Runtime

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MyProxy

OGSA-DAI

GT4

Data Rep

Replica Location

C Runtime

CAS

GSI-OpenSSH

GridFTP

MDS4

Python Runtime

C Sec

GRAM

Reliable File Transfer

GT4 Docs

## Incubator Projects

Swift

GEMLCA

MonMan

GAARDS

MEDICUS

Cog WF

Virt WkSp

NetLogger

GDTE

GridShib

OGRO

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Common Runtime

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# Globus Projects

MPICH G2
GridWay
Incubation Mgmt

			OGSA-DAI	GT4
Java Runtime	Delegation	MyProxy	Data Rep	Replica Location
C Runtime	CAS	GSI-OpenSSH	GridFTP	MDS4
Python Runtime	C Sec	GRAM	Reliable File Transfer	GT4 Docs

Incubator Projects			Swift	GEMLCA			MonMan
		GAARDS	MEDICUS	Cog WF	Virt WkSp		NetLogger
GDTE	GridShib	OGRO	UGP	Dyn Acct	Gavia JSC	DDM	Metrics
Introduce	PURSE	HOC-SA	LRMA	WEEP	Gavia MS	SGGC	ServMark

Common Runtime	Security	Execution Mgmt	Data Mgmt	Info Services	Other
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## 24 Active Incubator Projects

- CoG Workflow
- Distributed Data Management (DDM)
- Dynamic Accounts
- Grid Authentication and Authorization with Reliably Distributed Services (GAARDS)
- Gavia-Meta Scheduler
- Gavia- Job Submission Client
- Grid Development Tools for Eclipse (GDTE)
- Grid Execution Mgmt. for Legacy Code Apps. (GEMLCA)
- GridShib
- Higher Order Component Service Architecture (HOC-SA)
- Introduce
- Local Resource Manager Adaptors (LRMA)
- MEDICUS (Medical Imaging and Computing for Unified Information Sharing)
- Metrics
- MonMan
- NetLogger
- Open GRid OCSP (Online Certificate Status Protocol)
- Portal-based User Registration Service (PURSe)
- ServMark
- SJTU GridFTP GUI Client (SGGC)
- Swift
- UCLA Grid Portal Software (UGP)
- Workflow Enactment Engine Project (WEEP)
- Virtual Workspaces

## Active Committers from 28 Institutions

- Aachen Univ. (Germany)
- Argonne National Laboratory
- CANARIE (Canada)
- CertiVeR
- Children's Hospital Los Angeles
- Delft Univ. (The Netherlands)
- Indiana Univ.
- Kungl. Tekniska Högskolan (Sweden)
- Lawrence Berkeley National Lab
- Leibniz Supercomputing Center (Germany)
- NCSA
- National Research Council of Canada
- Ohio State Univ.
- Semantic Bits
- Shanghai Jiao Tong University (China)
- Univ. of British Columbia (Canada)
- UCLA
- Univ. of Chicago
- Univ. of Delaware
- Univ. of Marburg (Germany)
- Univ. of Muenster (Germany)
- Univ. Politecnica de Catalunya (Spain)
- Univ. of Rochester
- USC Information Sciences Institute
- Univ. of Victoria (Canada)
- Univ. of Vienna (Austria)
- Univ. of Westminster (UK)
- Univa Corp.

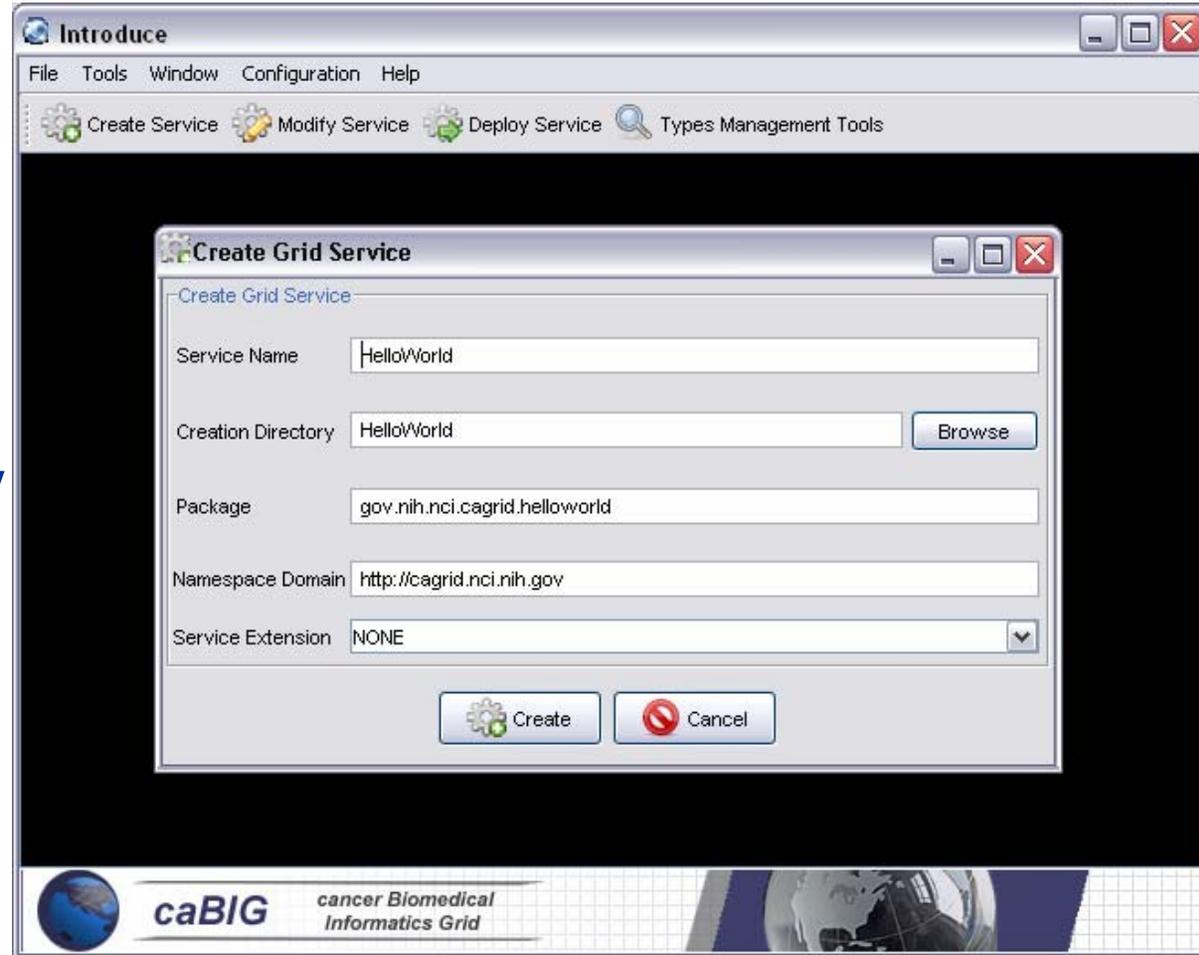


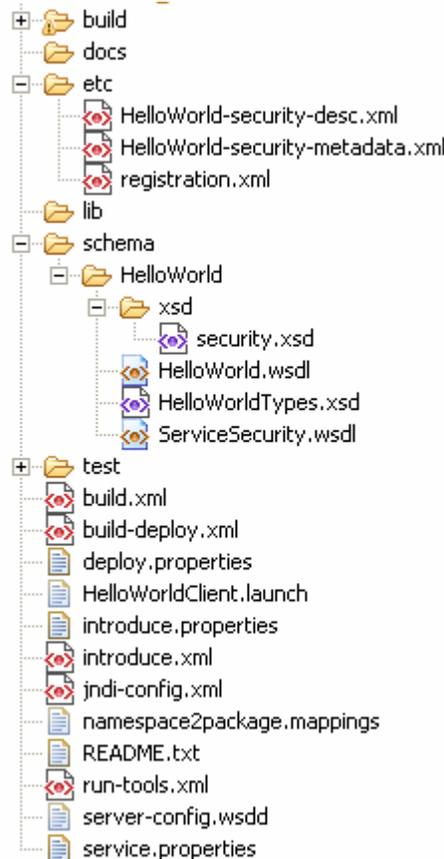
# New Functionality: Introduce Service Authoring Tool

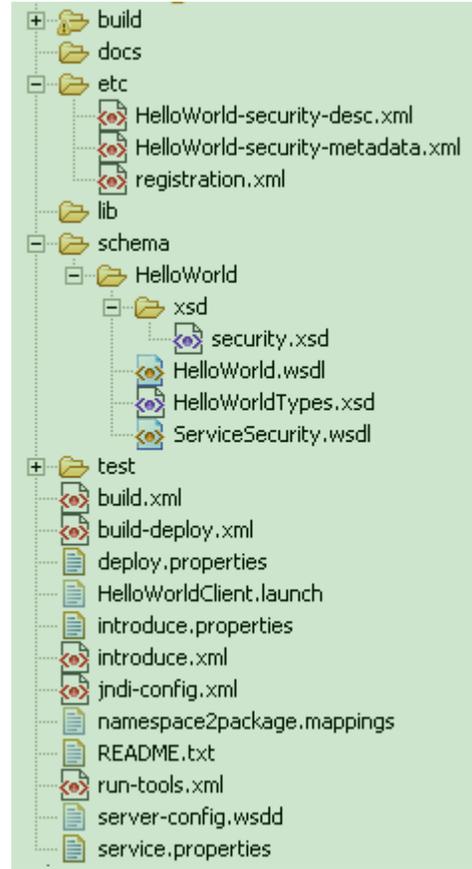
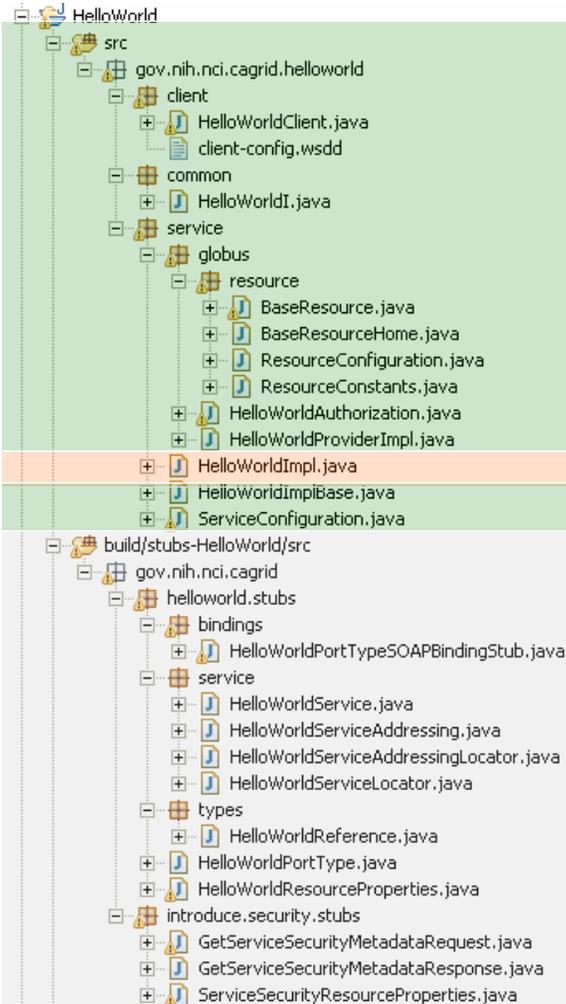


- Define service
- Create skeleton
- Discover types
- Add operations
- Configure security
- Modify service

See also: SOAPLab,  
OPAL, pyGlobus,  
Gannon, etc.







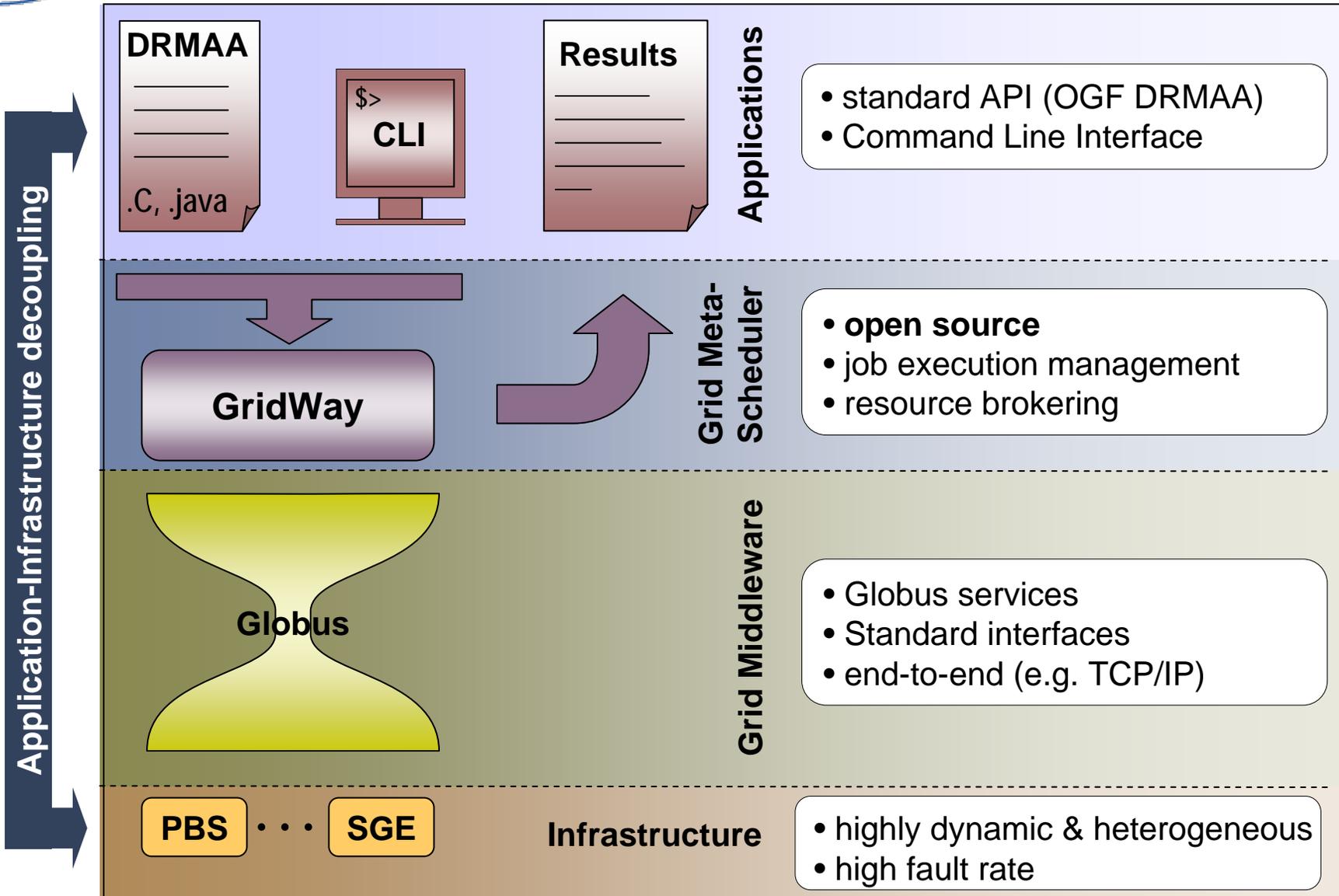
- = introduce generated
- = globus/axis generated
- = developers contribution



# New Functionality: GridWay Meta-Scheduler



- Scheduler virtualization layer on top of Globus services
  - A LRM-like environment for submitting, monitoring, and controlling jobs
  - A way to submit jobs to the Grid, without having to worry about the details of exactly which local resource will run the job
  - A policy-driven job scheduler, implementing a variety of access and Grid-aware load balancing policies
  - Accounting





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- 4) New functionality through Incubators
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- And in the Upcoming Year

- 
- 6) Updated standards
  - 7) Managed Object Placement Svc (MOPS)
  - 8) Data Placement Service (DPS)
  - 9) Swift for workflows
  - 10) Virtual Workspaces



## Updated Standards

- In 4.0 release (April 2005)
  - OASIS WSRF/WSN working draft specifications from June 2004
  - WS-Addressing from March 2004
- For upcoming 4.2 release (Q1 2008)
  - WSRF version 1.2, WSN version 1.3, WS-Addressing 1.0
  - Change in wire message formats
  - Provide optional additional functionality
- Full discussion posted  
[http://dev.globus.org/wiki/Java\\_WS\\_Core](http://dev.globus.org/wiki/Java_WS_Core)



## New Service: Data Placement Service

- Data placement and distribution services implement different data distribution and placement behaviors
  - Decide where to place objects and replicas
  - Policy-driven, based on needs of application and the VO
  - Effectively creates a placement workflow
- Currently designing the first-generation data placement service as part of CEDPS
  - DOE SciDAC Center for Enabling Distributed Petascale Science
- Seeking application input on the type of placement services they need



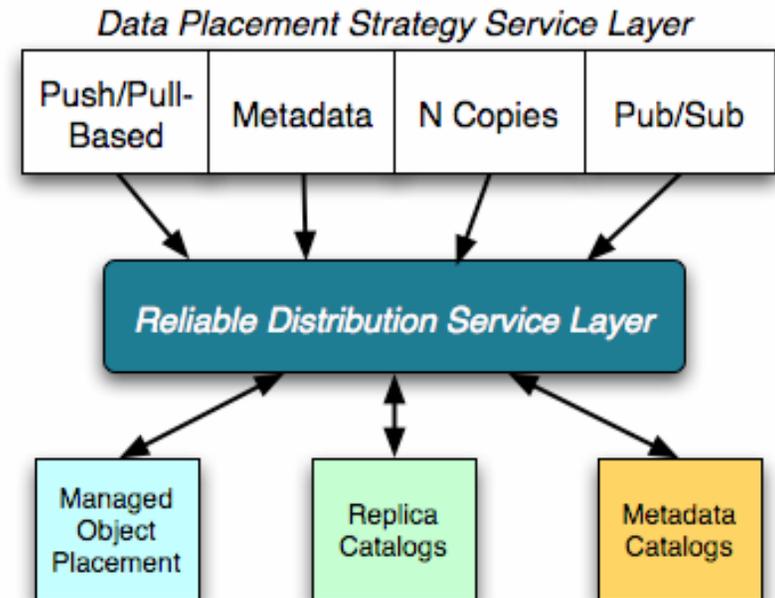
## Data Placement Policies

- Place explicit list of data items
  - Similar to existing Globus Data Replication Service
- Metadata- or subscription-based placement
  - Place data where it is likely to be accessed by scientists and/or used in performing computations
  - Use results of metadata queries for data with certain attributes or subscriptions
- N-Copies: maintain N copies of data items
  - Placement service checks existing replicas, creates/delete replicas to maintain N copies of each
  - Keeps track of lifetime of allocated storage space, migrates data as necessary



## Reliable Distribution Layer

- Responsible for carrying out the distribution or placement “plan” generated by higher-level service
- Provide feedback to higher level placement services on the outcome of the placement workflow
- Call on lower-level services to coordinate
- Release 1.0 available Oct 1, 2006
- <http://www.cedps.net/wiki/index.php/Data>





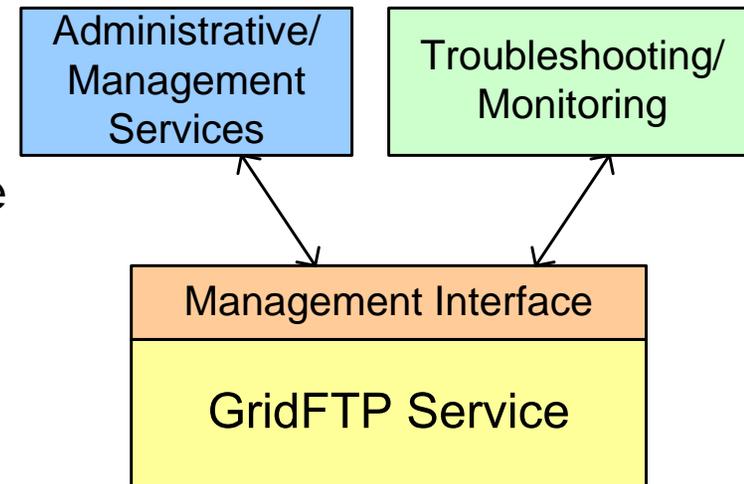
# MOPS: Managed Object Placement Service

- Enhancement to today's GridFTP—that allows for management of:
  - Space, Bandwidth, Connections
  - Other resources needed to endpoints of data transfers
- Building blocks:
  - GridFTP server (Globus): Add resource management
  - NeST storage appliance (U Wisconsin): Provides storage and connection management
  - dCache storage management (Fermi): Improve scalability and fault tolerance



## MOPS Features: Merge GridFTP with NeST

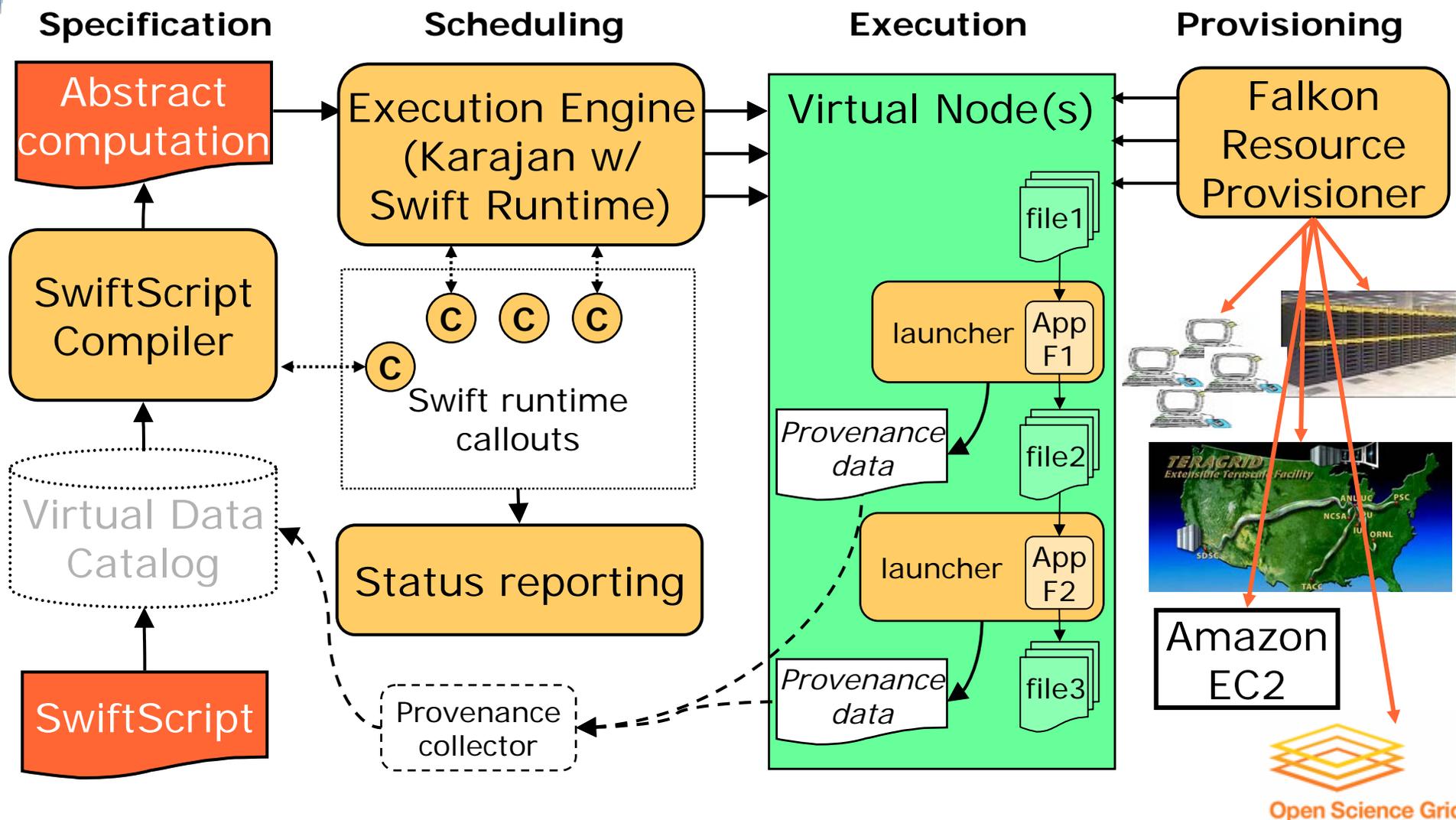
- Better internal resource management
- To overcome issues with GridFTP servers overwhelming resources
- Management interface
  - System admins will prescribe resource limits for GridFTP service (maximum CPU, memory usage, connections, bandwidth)
  - MOPS will report back on current state of its resources to administrative services, troubleshooting
- Release 1.0 available Oct 1, 2006
- <http://www.cedps.net/wiki/index.php/Data>





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# Dynamic Provisioning: Swift Architecture





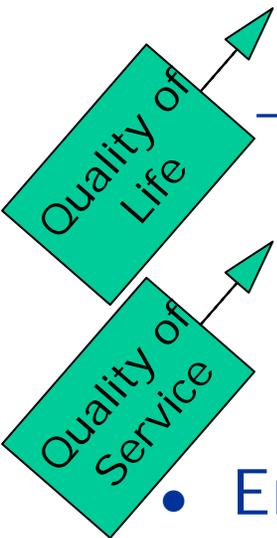
## Swift

- Concise specification of parallel programs
  - SwiftScript, with iteration, etc.
- Clean separation of logical/physical
  - XDTM specification of logical data structures
- Efficient execution on distributed resources
  - Karajan threading, Falkon provisioning, Globus interfaces, pipelining, load balancing
- Rigorous provenance tracking and query
  - Virtual data schema & automated recording
- Improved usability and productivity
  - Demonstrated in numerous applications
- Swift 0.2 release July 2007
  - <http://www.ci.uchicago.edu/swift/>



# Virtual Workspaces

- Two aspects of workspaces:
  - *Environment definition*: We get exactly the (software) environment we need on demand.
  - *Resource allocation*: Provision and guarantee all the resources the workspace needs to function correctly (CPU, memory, disk, bandwidth, availability), allowing for dynamic renegotiation to reflect changing requirements and conditions.
- Environment and resource allocation are two independently manageable aspects





# Globus Workspace Service

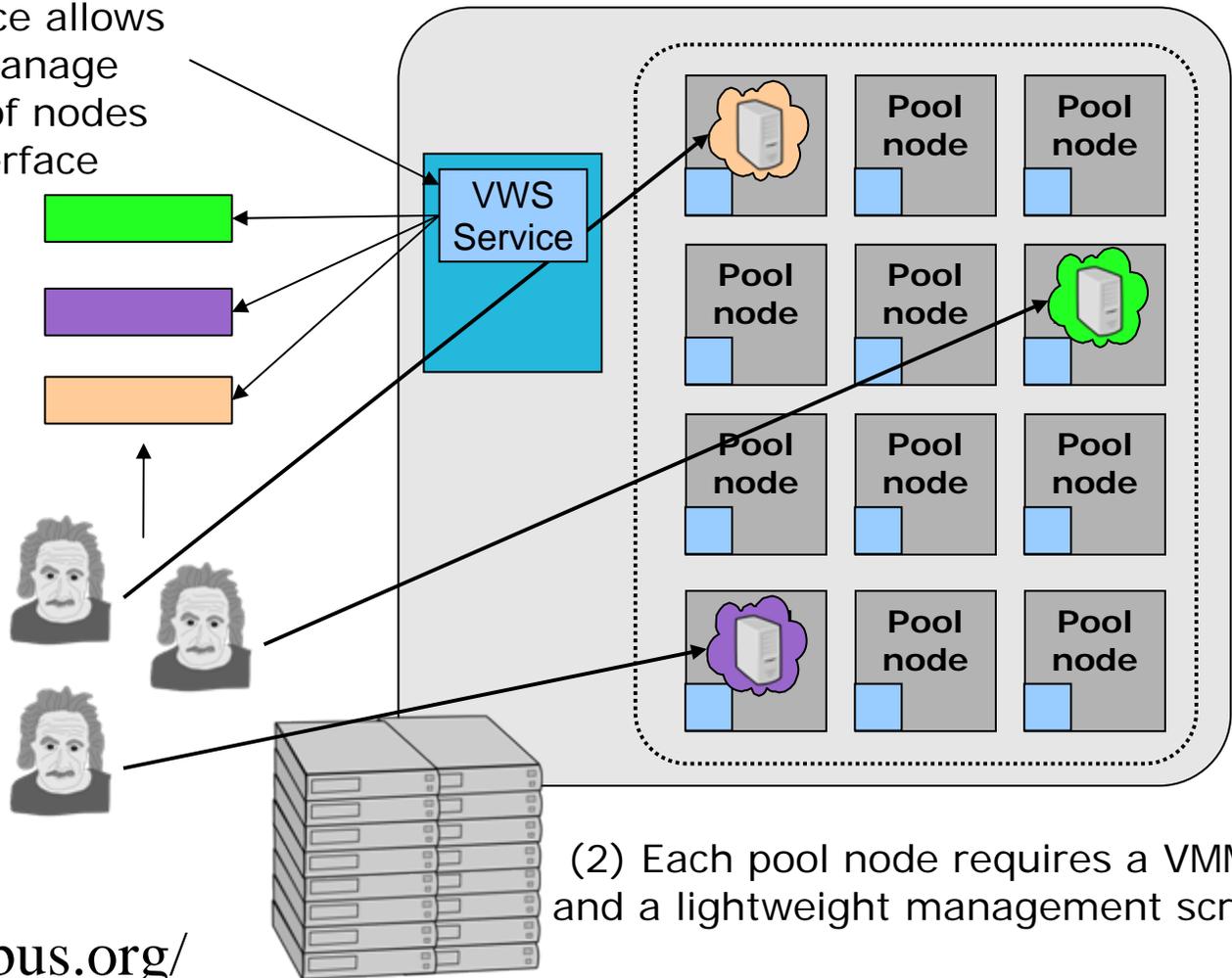
- The Globus Virtual Workspace Service (VWS) allows an authorized client to deploy and manage workspaces on-demand.
  - Globus WSRF front-end (one per site)
    - > Leverages GT core and services, notifications, security, etc.
  - Currently implements workspaces as Xen VMs
    - > Other implementations could also be used
  - Implements multiple deployment modes
    - > Best-effort, leasing, etc.
  - Current release 1.2.3 (April '07)
  - <http://workspace.globus.org>



# Interacting With Workspaces

(1) The workspace service allows users to deploy and manage workspaces on a pool of nodes through a WSRF interface

(3) Information on each workspace is published as WSRF Resource Properties so that users can find out information about their workspace (e.g. what IP the workspace was bound to) or subscribe to notifications on changes



(2) Each pool node requires a VMM and a lightweight management script



# Globus User Community

- Large & diverse
  - 10s of national Grids, 100s of applications, 1000s of users; probably much more
  - Every continent except Antarctica
  - Applications ranging across many fields
  - Dozens (at least) of commercial deployments
- Successful
  - Many production systems doing real work
  - Many applications producing real results
  - Hundreds of papers published because of grid deployments
- Smart, energetic, demanding
  - Constant stream of new use cases & tools



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## For More Information

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  - [jms@mcs.anl.gov](mailto:jms@mcs.anl.gov)
  - <http://www.mcs.anl.gov/~jms>
- Globus Alliance
  - <http://www.globus.org>
- Dev.globus
  - <http://dev.globus.org>
- Upcoming Events
  - <http://dev.globus.org/wiki/Outreach>