Introduction

DIRAC Project

Plan

- DIRAC Project
- DIRAC grid middleware
- DIRAC as a Service
- Tutorial plan

Grid applications

- HEP experiments collect unprecedented volumes of data to be processed on large amount of geographically distributed computing resources
  - 10s of PBytes of data per year
  - 10s of thousands CPUs in 100s of centers
  - 100s of users from 100s of institutions

However, other application domains are quickly approaching these scales

User problems on the grid

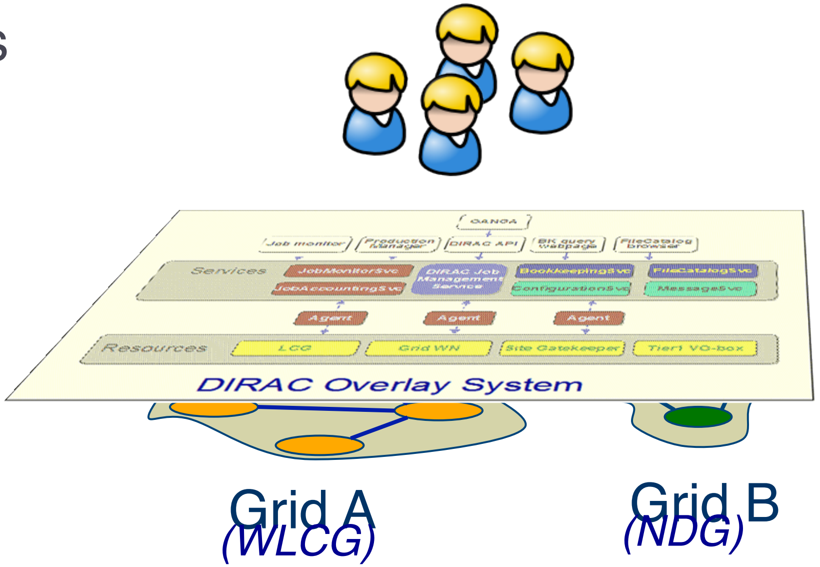
- Complicated interfaces
  - Especially for non-computing experts
- Confusing security infrastructure
  - Not easy to get and properly set up grid certificates
- Frustration with failing resources and middleware
  - Why my jobs worked yesterday and not today ?
- For small communities difficult to organize collective work
  - Lack of expertise in high level computing tasks
    - Massive jobs, massive data movement, etc
- Small communities tend to become larger with time

Large community issues

- Large user communities (Virtual Organizations) have specific problems
  - Dealing with heterogeneous resources
    - Various computing clusters, grids, etc
  - Dealing with the intracommunity workload management
    - User group quotas and priorities
    - Priorities of different activities
  - Dealing with a variety of applications
    - Massive data productions
    - Individual user applications, etc

DIRAC Grid Solution

- LHC experiments developed their own middleware to address the above problems
  - DIRAC is developed originally for the LHCb experiment
- DIRAC is providing a complete grid middleware stack with the goal:
  - Integrate all the heterogeneous computing resources available
  - Minimize human intervention at sites
  - Make the grid convenient for the users:
    - Fault tolerance, quicker turnaround of user jobs
    - Enabling Community policies



Origins

- DIRAC project was started as the LHCb distributed computing project
  - First, as a MC production engine
  - Then extended for all the other LHCb distributed computing tasks
- DIRAC was reorganized to separate generic and LHCb specific functionality in 2008-2010
  - Since 2010 DIRAC became an independent project
    - With LHCb staying the main client of the project
  - Main DIRAC developers are also LHCb experiment members
    - Guarantees of the project sustainability

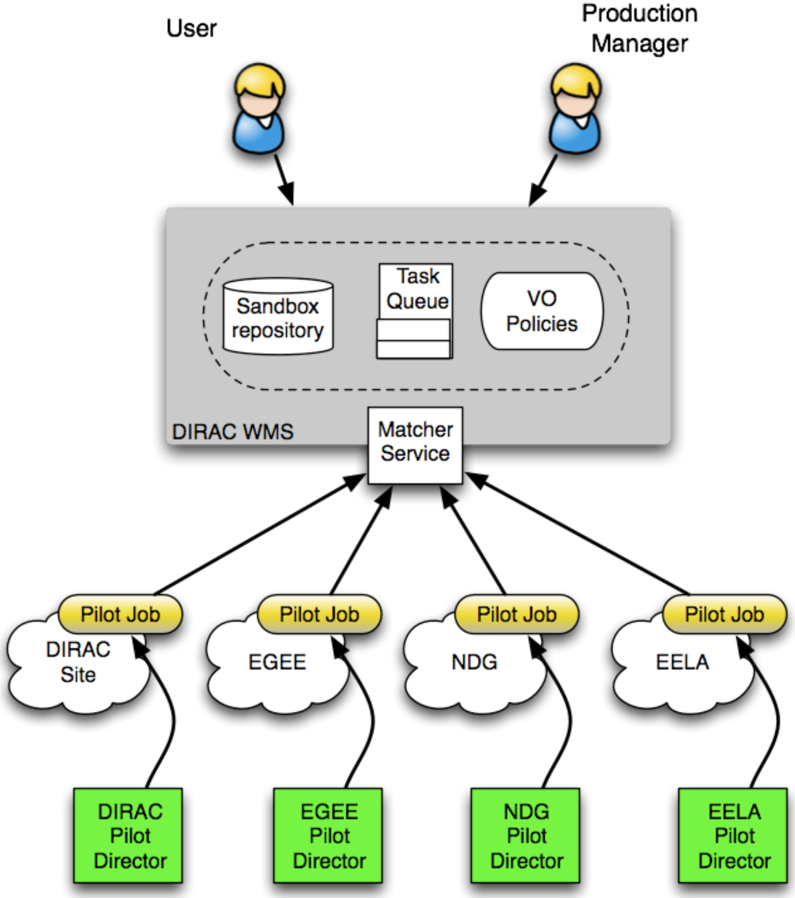
DIRAC Consortium

- Other projects are starting to use or evaluating DIRAC
  - CTA, SuperB, BES, VIP(medical imaging), …
    - Contributing to DIRAC development
    - Increasing the number of experts
  - Need for user support infrastructure
- Turning DIRAC into an Open Source project
  - DIRAC Consortium agreement in preparation
    - IN2P3, Barcelona University, CERN, …
  - http://diracgrid.org
    - News, docs, forum

Workload Management

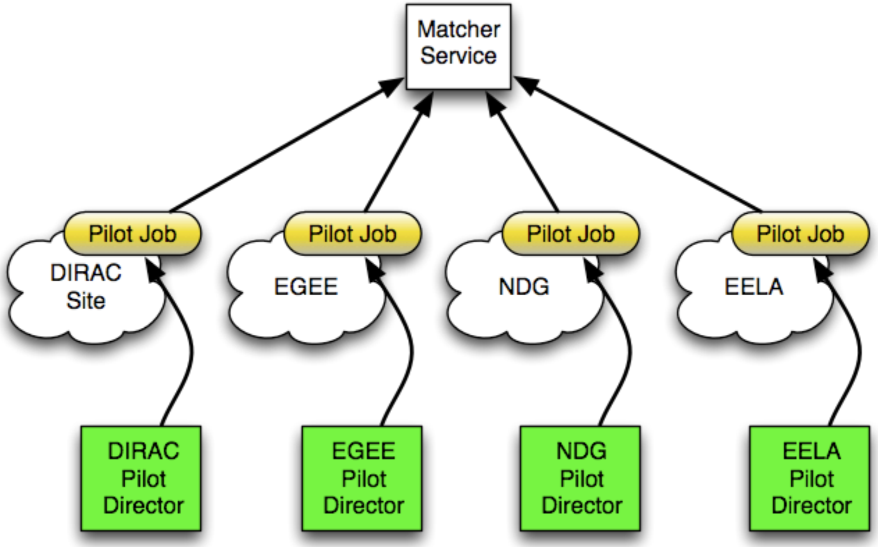
DIRAC WMS

- Jobs are submitted to the DIRAC Central Task Queue with credentials of their owner (VOMS proxy)
- Pilot Jobs are submitted by specific Directors to a Grid WMS with credentials of a user with a special Pilot role
- The Pilot Job fetches the user job and the job owner's proxy
- The User Job is executed with its owner's proxy used to access SE, catalogs, etc



WMS: using heterogeneous resources

- Including resources in different grids and standalone clusters is simple with Pilot Jobs
  - Needs a specialized Pilot Director per resource type
  - Demonstrated with NDG and GISELA grid sites, Amazon cloud, etc
  - Users just see new sites appearing in the job monitoring

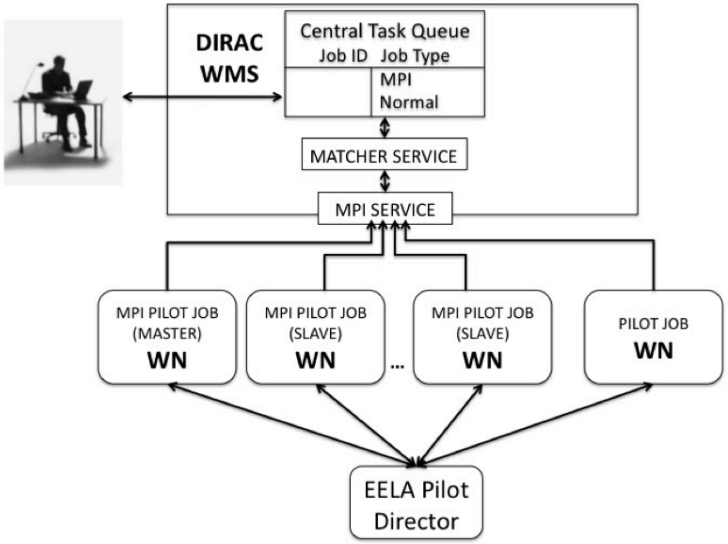


Resources provisioning

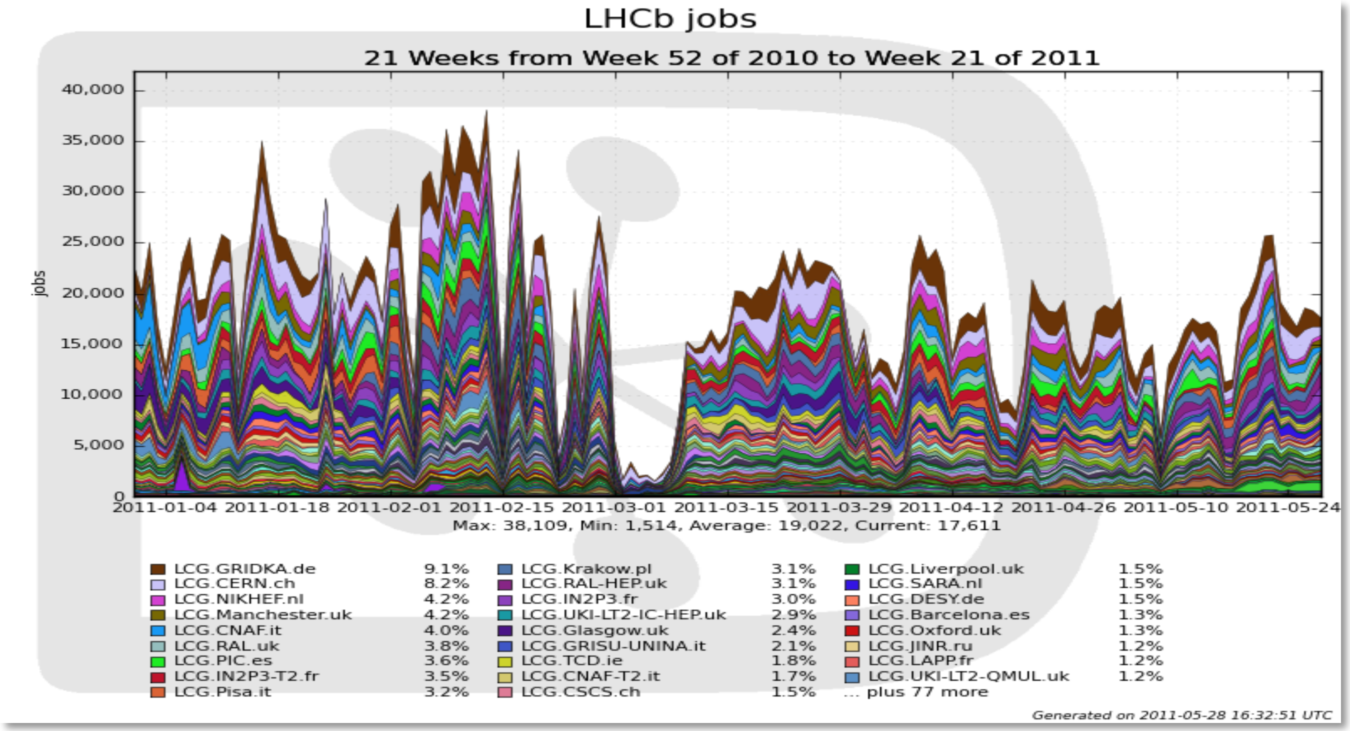
- DIRAC middleware facilitates access to various types of resources
  - gLite based grids
  - Standalone clusters
    - Simple SSH accessible account is sufficient to include the site
  - Clouds (Amazon, OpenNebula, OCCI compliant)
    - Automatic virtual machine scheduling
  - Desktop Grid
    - Based on BOINC technology
    - Support for multiple platforms with virtualization
  - Standalone PCs

Support for MPI Jobs

- MPI Service developed for applications in the EELA Grid
  - Astrophysics, BioMed, Seismology applications
  - No special MPI support on sites
    - MPI software installed by Pilot Jobs
  - MPI ring usage optimization
    - Ring reuse for multiple jobs
      - □ Lower load on the gLite WMS
    - Variable ring sizes for different jobs



LHCb DIRAC performance



- DIRAC performance in production
  - Up to 35K concurrent jobs in ~120 distinct sites
  - 5 mid-range central servers hosting DIRAC services
  - Further optimizations to increase capacity are possible
    - Hardware, database optimizations, service load balancing, etc

Data Management

Data Management components

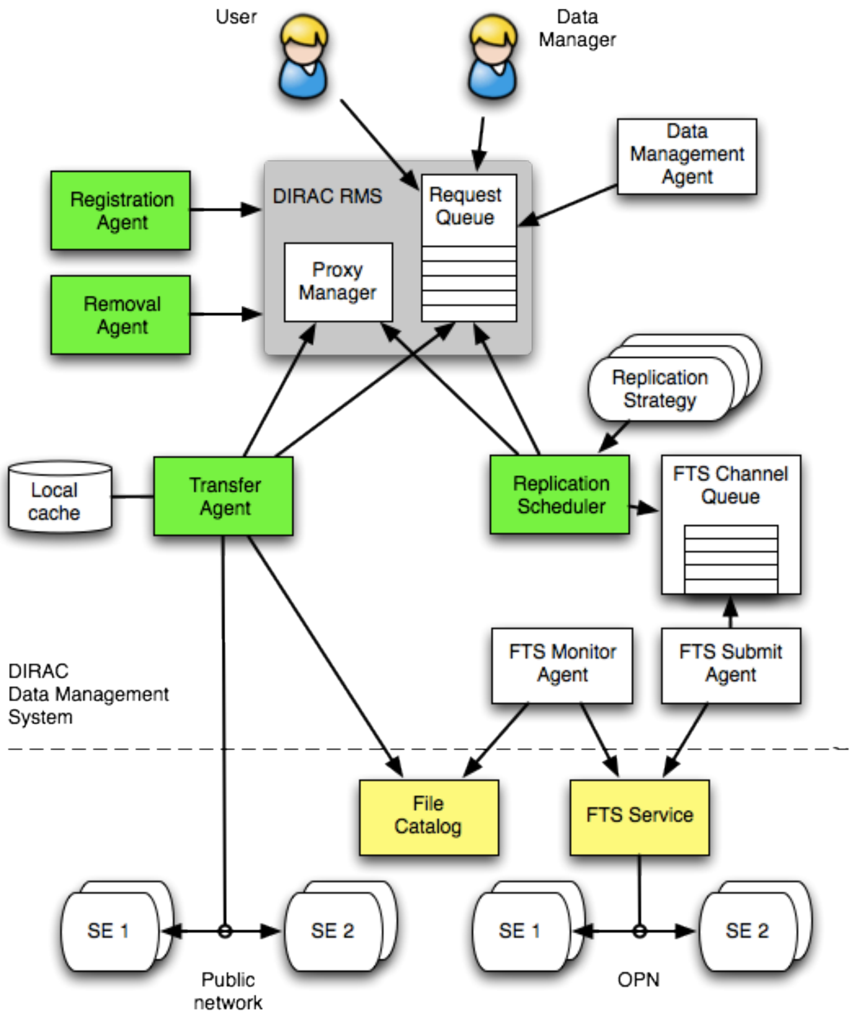
- Storage Elements
  - gLite/EGI Storage Elements
  - DIRAC Storage Elements
  - More Storage Elements can be included
    - (F,SF,HT,BBF)TP servers
- File Catalogs
  - LCG File Catalog (LFC)
  - DIRAC File Catalog
    - Support for the User Metadata (similar to the AMGA gLite service)
    - Support for data provenance
  - More Catalogs can be included
    - LHCb has developed several specific catalogs in the same framework

Data Management components

- For DIRAC users the use of any Storage Element or File Catalog is transparent
  - Community choice which components to use
  - Different SE types can be mixed together
  - Several File Catalogs can be used in parallel
    - Complementary functionality
    - Redundancy
- Users see depending on the DIRAC Configuration
  - Logical Storage Elements
    - e.g. DIRAC-USER, M3PEC-disk
  - Logical File Catalog

Data Management services

- Based on the Request Management System
- Asynchronous data operations
  - transfers, registration, removal
- Two complementary replication mechanisms
  - Transfer Agent
    - user data
    - public network
  - FTS service
    - Production data
    - Private FTS OPN network
    - Smart pluggable replication strategies

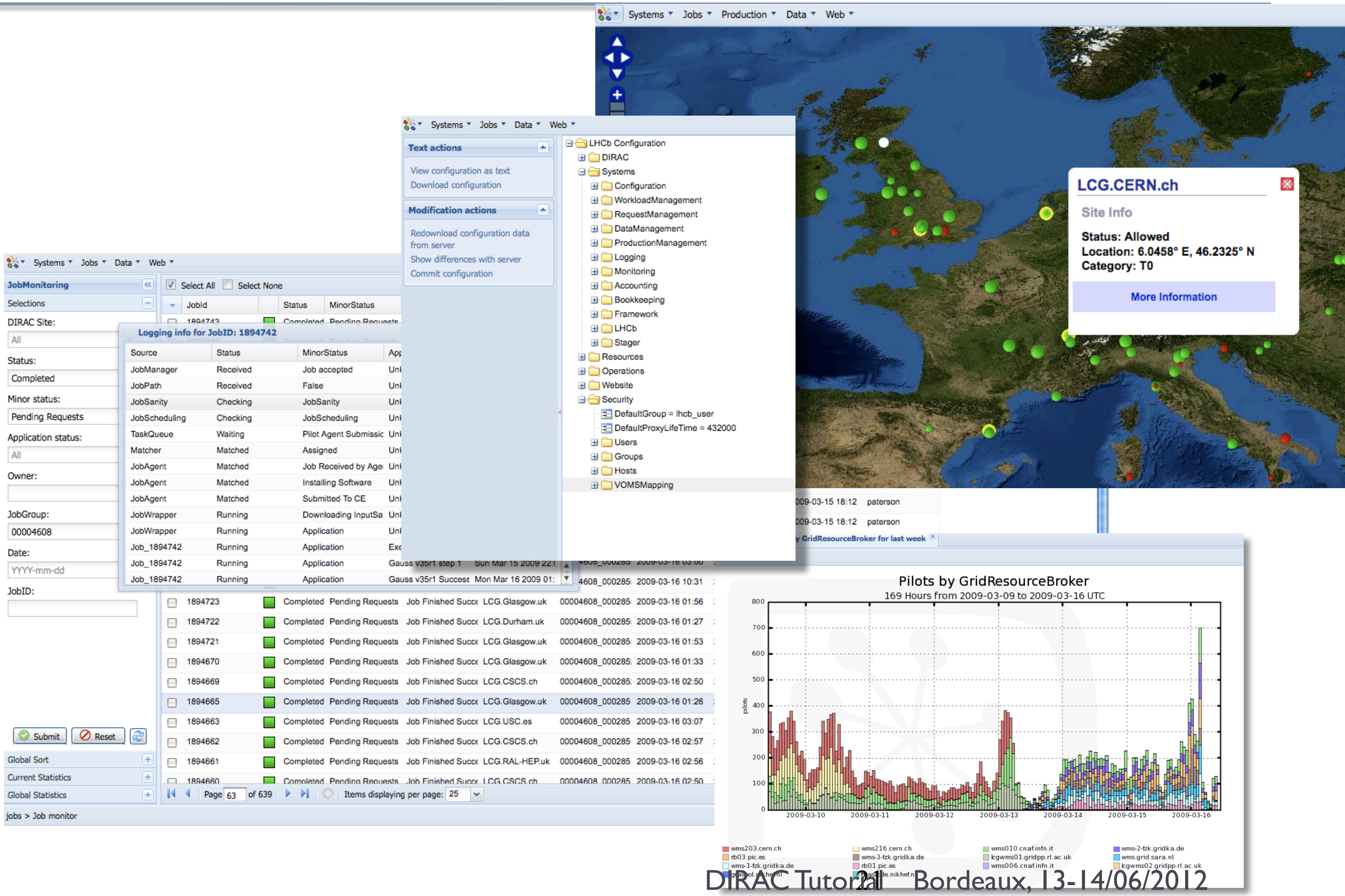


User Interfaces

DIRAC: Secure Web Portal

- Focus on the Web Portal as the main user tool for interactions with the grid
- Intuitive desktop application like interface
  - Ajax, Pylons, ExtJS Javascript library
- Monitoring and control of all activities
  - User job monitoring and manipulation
  - Data manipulation and downloads
  - DIRAC Systems configuration and management
- Secure access
  - Standard grid certificates
  - Fine grained authorization rules

Web Portal: example interfaces



Systems ▾ Jobs ▾ Production ▾ Data ▾ Web ▾

LCG.CERN.ch

Site Info

Status: Allowed
Location: 6.0458° E, 46.2325° N
Category: T0

More Information

Systems ▾ Jobs ▾ Data ▾ Web ▾

Text actions

View configuration as text
Download configuration

Modification actions

Redownload configuration data from server
Show differences with server
Commit configuration

```
⊟ LHCb Configuration
  ⊞ DIRAC
  ⊟ Systems
    ⊞ Configuration
    ⊞ WorkloadManagement
    ⊞ RequestManagement
    ⊞ DataManagement
    ⊞ ProductionManagement
    ⊞ Logging
    ⊞ Monitoring
    ⊞ Accounting
    ⊞ Bookkeeping
    ⊞ Framework
    ⊞ LHCb
    ⊞ Stager
  ⊞ Resources
  ⊞ Operations
  ⊞ Website
  ⊟ Security
    DefaultGroup = lhcb_user
    DefaultProxyLifeTime = 432000
    ⊞ Users
    ⊞ Groups
    ⊞ Hosts
    ⊞ VOMSMapping
```

Systems ▾ Jobs ▾ Data ▾ Web ▾

JobMonitoring

Selections

DIRAC Site: All

Status: Completed

Minor status: Pending Requests

Application status: All

Owner:

JobGroup: 00004608

Date: YYYY-mm-dd

JobID:

Submit Reset

Global Sort
Current Statistics
Global Statistics

jobs > Job monitor

☑ Select All □ Select None

Logging info for JobID: 1894742

Source	Status	MinorStatus	App	
JobManager	Received	Job accepted	Unl	
JobPath	Received	False	Unl	
JobSanity	Checking	JobSanity	Unl	
JobScheduling	Checking	JobScheduling	Unl	
TaskQueue	Waiting	Pilot Agent Submissic	Unl	
Matcher	Matched	Assigned	Unl	
JobAgent	Matched	Job Received by Age	Unl	
JobAgent	Matched	Installing Software	Unl	
JobAgent	Matched	Submitted To CE	Unl	
JobWrapper	Running	Downloading InputSa	Unl	
JobWrapper	Running	Application	Unl	
Job_1894742	Running	Application	Exe	
Job_1894742	Running	Application	Gauss v35r1 step 1	Sun Mar 15 2009 22:(
Job_1894742	Running	Application	Gauss v35r1 Success	Mon Mar 16 2009 01:

	JobId		Status	MinorStatus				
□	1894743	🟩	Completed	Pending Requests				
							4608_000285	2009-03-16 03:00
							4608_000285	2009-03-16 10:31
□	1894723	🟩	Completed	Pending Requests	Job Finished Succe	LCG.Glasgow.uk	00004608_000285	2009-03-16 01:56
□	1894722	🟩	Completed	Pending Requests	Job Finished Succe	LCG.Durham.uk	00004608_000285	2009-03-16 01:27
□	1894721	🟩	Completed	Pending Requests	Job Finished Succe	LCG.Glasgow.uk	00004608_000285	2009-03-16 01:53
□	1894670	🟩	Completed	Pending Requests	Job Finished Succe	LCG.Glasgow.uk	00004608_000285	2009-03-16 01:33
□	1894669	🟩	Completed	Pending Requests	Job Finished Succe	LCG.CSCS.ch	00004608_000285	2009-03-16 02:50
□	1894665	🟩	Completed	Pending Requests	Job Finished Succe	LCG.Glasgow.uk	00004608_000285	2009-03-16 01:26
□	1894663	🟩	Completed	Pending Requests	Job Finished Succe	LCG.USC.es	00004608_000285	2009-03-16 03:07
□	1894662	🟩	Completed	Pending Requests	Job Finished Succe	LCG.CSCS.ch	00004608_000285	2009-03-16 02:57
□	1894661	🟩	Completed	Pending Requests	Job Finished Succe	LCG.RAL-HEP.uk	00004608_000285	2009-03-16 02:56
□	1894660	🟩	Completed	Pending Requests	Job Finished Succe	LCG.CSCS.ch	00004608_000285	2009-03-16 02:50

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y GridResourceBroker for last week

DIRAC Framework

DIRAC middleware

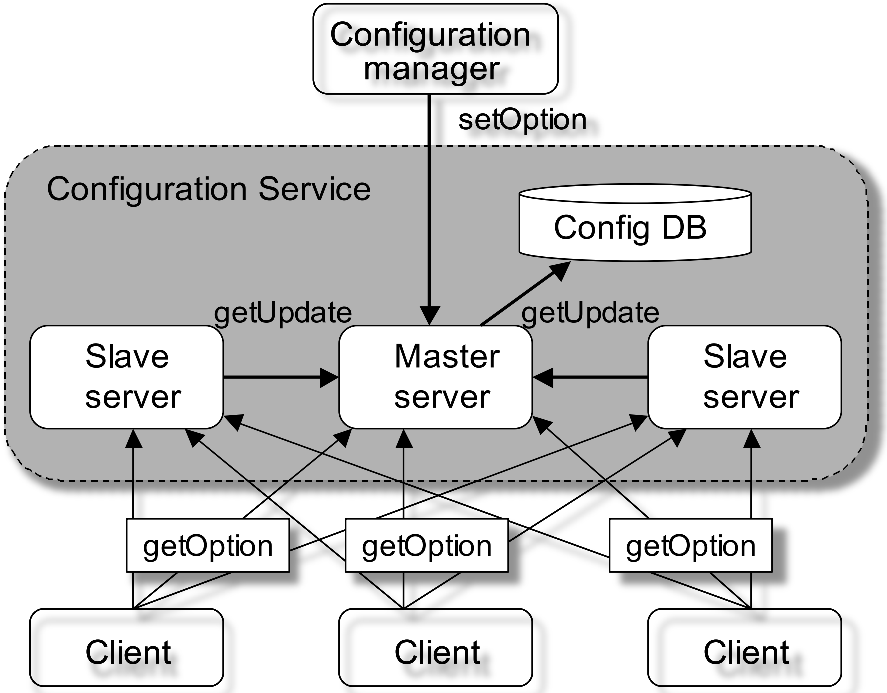
- Services oriented architecture (SOA)
- DIRAC has a well defined architecture
  - Services
    - passive components reacting to client request
    - Keep their state in a database
  - Light distributed agents
    - permanently running components, animating the whole system
  - Clients
    - User interfaces
    - Agent-service, service-service communications
- Technologies
  - Python, MySQL, OpenSSL

DIRAC Framework

- All the communications between the distributed components are secure
  - DISET custom client/service protocol
    - Focus on efficiency
    - Control and data communications
  - X509, GSI security standards
  - Fine grained authorization rules
- Framework allows to easily build these components concentrating on the business logic of the applications
  - Making use of rich base services

DIRAC base services

- Redundant Configuration Service
  - Provides service discovery and setup parameters for all the DIRAC components
- Full featured proxy management system
  - Proxy storage and renewal mechanism
  - Support for multiuser pilot jobs
- System Logging service
  - Collect essential error messages from all the components
- Monitoring service
  - Monitor the service and agents behavior
- Accounting service



DIRAC as a Service

DIRAC as a Service

- DIRAC middleware is providing a complete grid functionality and is rather complex to install and manage
  - especially for small user communities with low grid expertise level.
- Several grid projects are providing now the DIRAC functionality as a ready to use service for their users
  - GISELA Latin America Grid,
  - France-Grilles, IberGrid NGIs
- Other grid infrastructure projects are considering provisioning DIRAC services

France-Grilles DIRAC service

- The DIRAC service provided by the France-Grilles project
  - Hosted by the CC/IN2P3 in Lyon
    - Agreement between the CC and France-Grilles to provide hardware and hosting environment for the DIRAC service
    - 5 servers
      - □ Basic DIRAC services, Web Portal
    - MySQL server
  - Redundant supporting services outside the CC in Lyon
    - CPPM, CREATIS, etc
- Users
  - 10 VOs, 65 registered users
- France-Grilles resources accessible to cofigured VO's
  - And more
  - And more to come

France-Grilles DIRAC service (2)

- Basic DIRAC services, Web portal
  - Advanced services can be also provided
- Distributed administrator team
  - From 5 different institutions in France
    - Marseille, Lyon, Bordeaux, Montpellier, Nice
- User support
  - Forums, tutorials
- Application support
  - Assistance in porting applications to the grid
  - Possibly hosting application specific services
- Support for Grid Infrastructures
  - GISELA, France-Asie
- Access to resources other than France-Grilles
  - Grids, clouds, local clusters
  - VO specific resources

Summary

- DIRAC has most of the features of a "standard" Grid middleware stack

- Occasional users will not see much difference in functionality compared to other middlewares
  - Better efficiency and turnaround for intensive work
- Power users will see extra support:
  - Massive job execution
  - Data operations
- Developers can easily add new functionalities specific for their applications
- Community administrators get tools to apply community policies
  - User and group priorities, quotas
- Site administrators can easily include their resources
  - Easy addition of new resources without bulky installation
  - Easy user management with only one "VO user"

- The DIRAC project is in full development
  - More new exciting features to come – stay tuned !
  - Your contributions are welcome

DIRAC Tutorial plan

- Getting Started
  - Getting ready user credentials
- Job execution mechanics
  - Basic job operations with Web Portal explained
- Job manipulation tools
  - Submission, monitoring, getting results
- Basic data management operations
  - Data upload, download, replication
  - Managing metadata
- Advanced job operations
  - Jobs with input and output data
  - Bulk job submission
- Emphasis on exercises
- Agenda
  - https://indico.in2p3.fr/conferenceDisplay.py?confId=6573

DIRAC Tutorial setup

- DIRAC installation at dirac.france-grilles.fr
  - The service used for the tutorial is permanent, will stay in place afterwards
- Resources
  - >10 EGI sites
  - 4 SE's
    - One DIRAC SE (DIRAC-USER)
    - 3 SRM EGI SE's
- Tutorial materials are available here
  - http://github.com/DIRACGrid/DIRAC/wiki/DIRAC-Tutorials

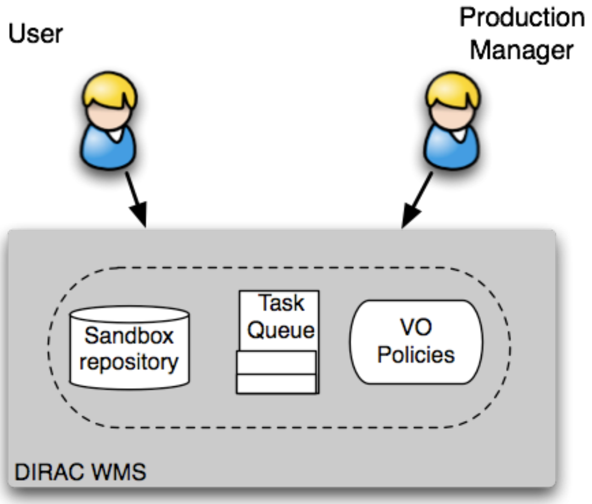
The course tutors team

- The course will be given by the members of the DIRAC Project team (http://diracgrid.org)
- Tutors:
  - Andrei Tsaregorodtsev – DIRAC Project Coordinator, CPPM
  - Vanessa Hamar – DIRAC developer, responsible for the DIRAC production infrastructure of the GISELA (Latin America) Grid and France-Grilles NGI, CC/IN2P3
  - Matvey Sapunov – DIRAC developer, responsible for the DIRAC Web Portal development, CPPM

Backup slides

WMS: applying VO policies

- In DIRAC both User and Production jobs are treated by the same WMS
  - Same Task Queue
- This allows to apply efficiently policies for the whole VO
  - Assigning Job Priorities for different groups and activities
  - Static group priorities are used currently
  - More powerful scheduler can be plugged in
    - demonstrated with MAUI scheduler


User
Production Manager
Sandbox repository
Task Queue
VO Policies
DIRAC WMS