Introduction

DIRAC Tutorial

DIRAC

THE INTERWARE

Plan

- DIRAC Project
- DIRAC interware
- DIRAC as a Service
- Tutorial plan

Massive computations: HEP

- LHC experiments pioneered the massive use of computational grids
  - 10s of PBytes of data per year
  - 100s of thousands CPUs in 100s of centers
  - 10s GB/sec network transfers
  - 100s of users from 100s of institutions

- CERN Director General Rolf Heuer about the Higgs discovery:

  "It was a global effort and it is a global success. The results today are only possible because of the extraordinary performance of the accelerators, including the infrastructure, the experiments, and the *Grid computing*."

- Other domains are catching up quickly with the HEP experiments
  - Life sciences, earth sciences, astrophysics, social sciences, etc

Massive computations

- The computing expertise level in non-HEP scientific domains is relatively lower
  - Grouped around well known applications and scientific portals
  - Moving existing applications to run in distributed environments is still difficult

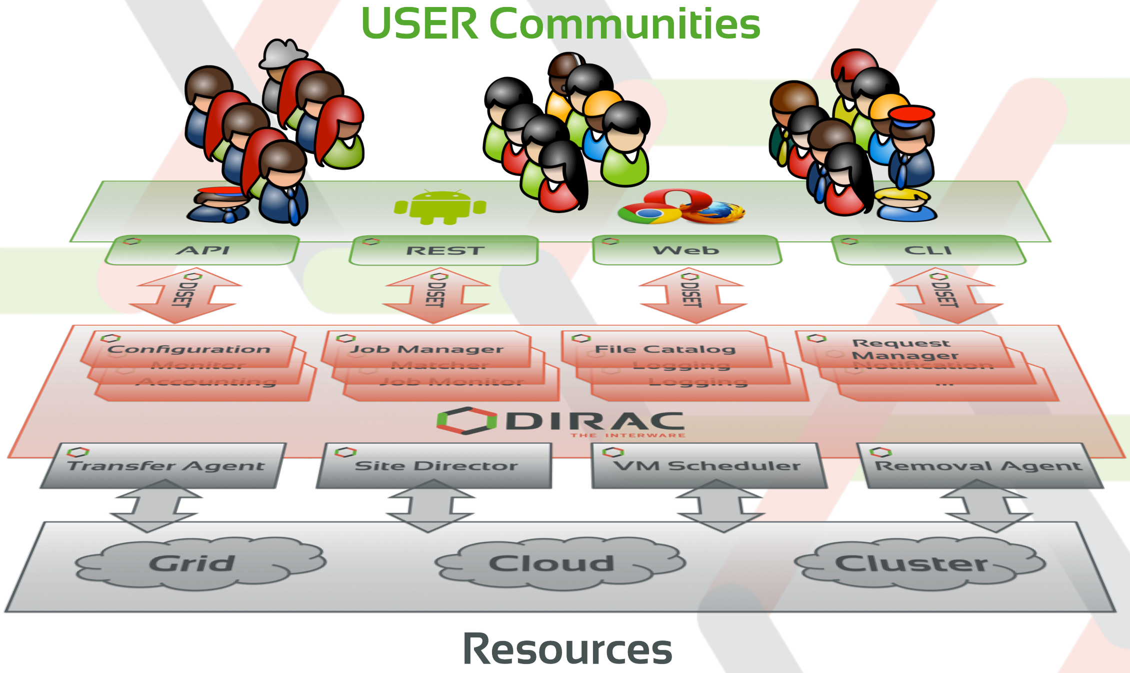
- Convenient tools for small research groups with no local gurus are clearly needed

- All LHC experiments developed their own middleware
  - PanDA, AliEn, glideIn WMS, PhEDEx, DIRAC, …
  - WMS with pilot jobs, intelligent data management, software distribution, …

- Experience of the LHC experiments in using distributed computing infrastructures should now be made available for non-LHC user communities

Interware

- DIRAC provides all the necessary components to build ad-hoc distributed computing infrastructures interconnecting resources of different types, allowing interoperability and simplifying interfaces. This allows to speak about the DIRAC *interware*.



Towards general purpose middleware

- Several new experiments expressed interest in using this software relying on its proven functionality

- In 2009 the core DIRAC development team decided to generalize the software to make it suitable for any user community.
  - Separate LHCb specific functionality into a set of extensions
  - Introduce new services to make it a complete solution
  - Support for multiple small groups by a single DIRAC installation
  - General refurbishing of the code, code management, deployment, documentation, etc

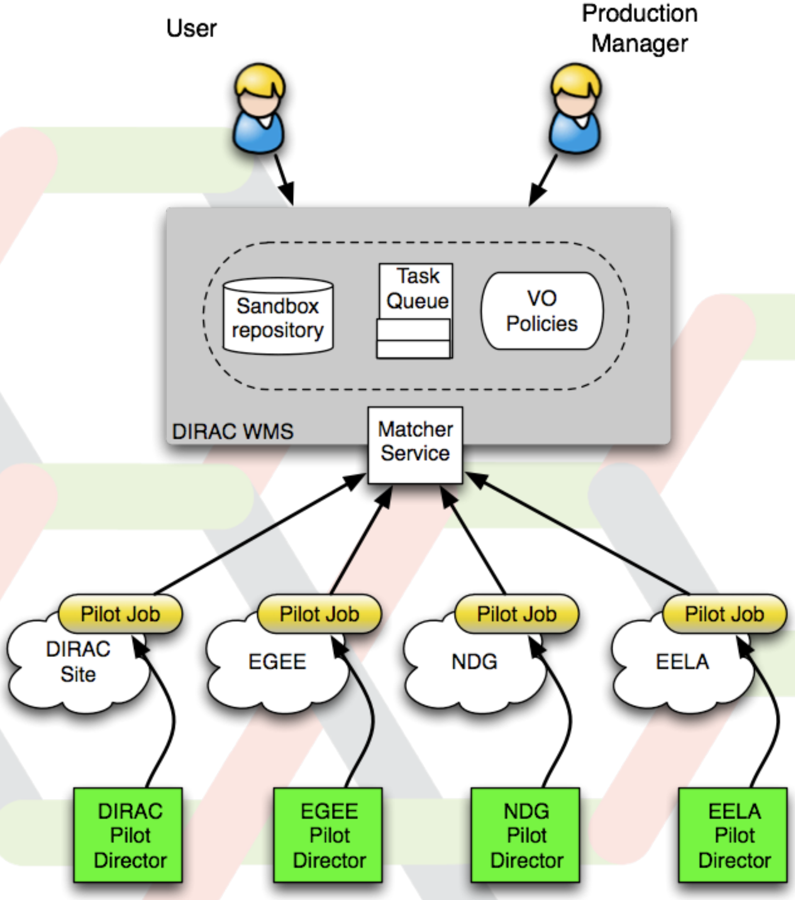
- DIRAC Consortium founded in 2013
  - CNRS, University of Barcelona and CERN
  - Development, maintenance and promotion of the DIRAC software
  - Consortium is the software copyright holder (GPL v3)

- This work made it possible to offer general-purpose DIRAC services to any scientific community

Workload Management

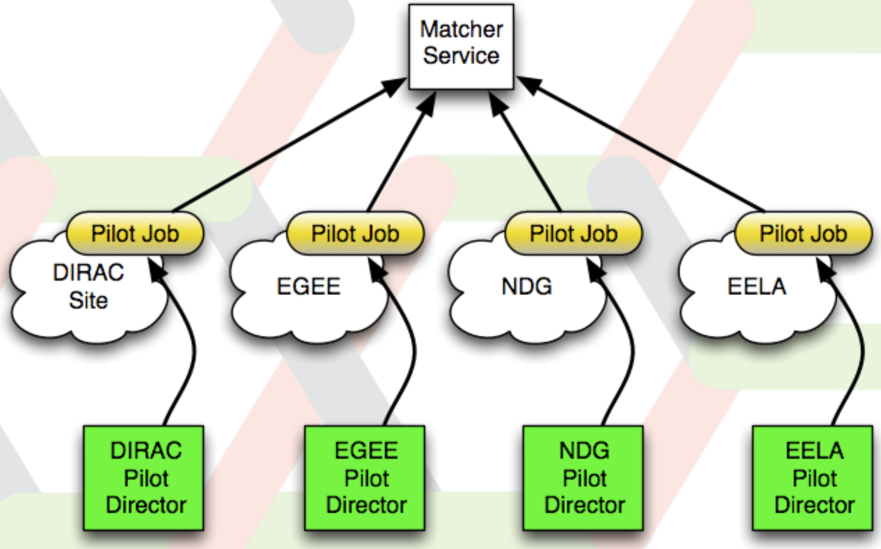
DIRAC WMS

- 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

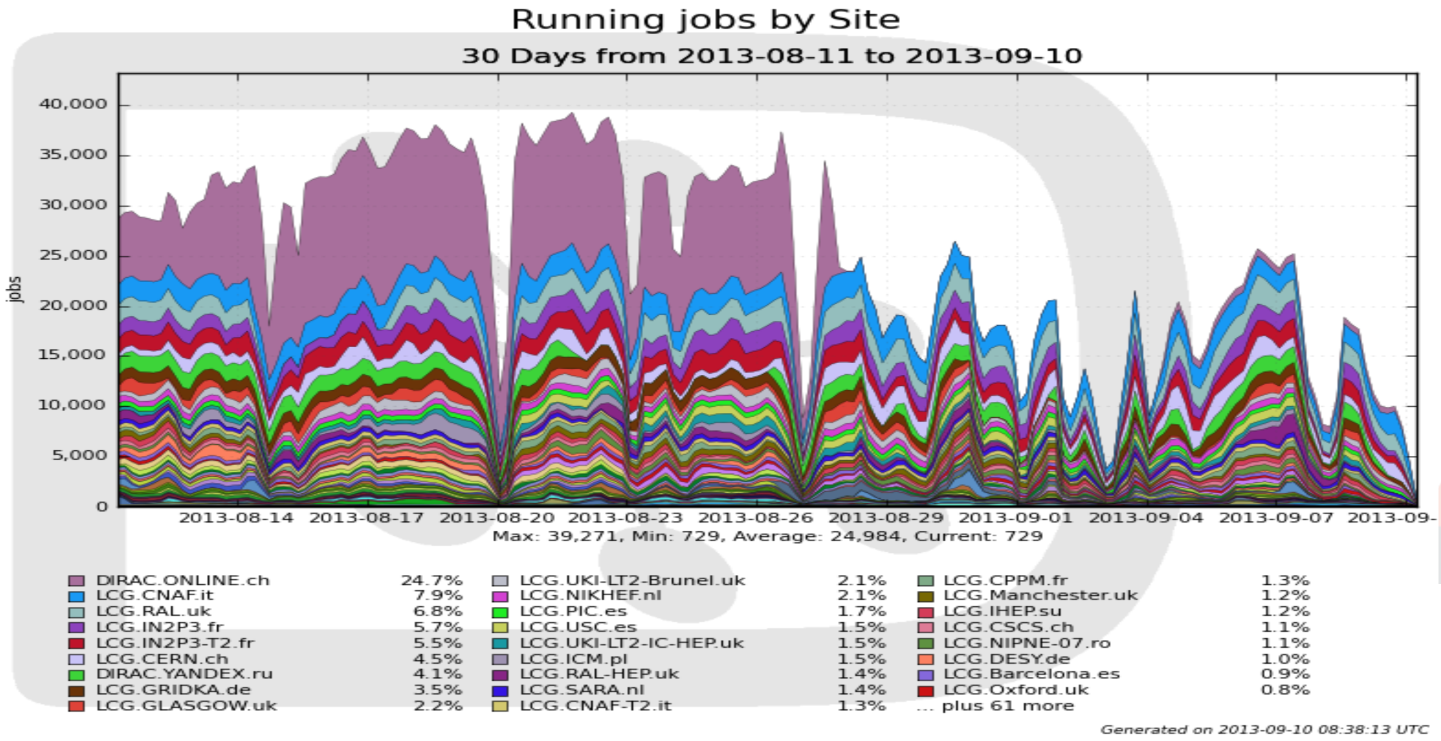
- Including resources in different grids and standalone clusters is simple with Pilot Jobs
  - Needs a specialized Pilot Director per resource type
  - Demonstrated with various grid sites, clouds, etc
  - Users just see new sites appearing in the job monitoring



Resources provisioning

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

LHCb DIRAC performance



- DIRAC performance in production
  - Up to 50K concurrent jobs in ~120 distinct sites
  - 10 mid-range central servers hosting DIRAC services
  - Further optimizations to increase capacity are possible

Data Management

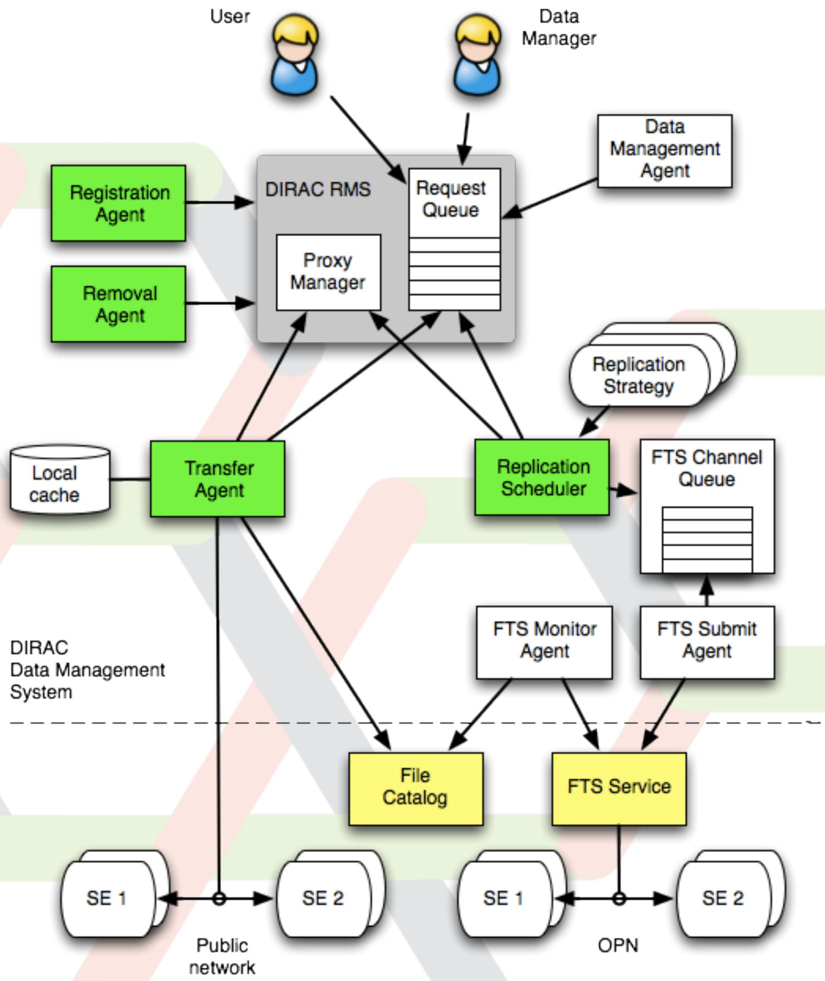
Data Management components

- Storage Elements
  - gLite/EGI Storage Elements
  - DIRAC Storage Elements
  - More Storage Elements can be included
    - (F,SF,HT,BBF)TP servers
    - iRods, S3

- File Catalogs
  - LCG File Catalog (LFC)
  - DIRAC File Catalog
    - Support for the User Metadata
    - Support for data provenance
  - More Catalogs can be included
    - LHCb has developed several specific catalogs in the same framework
  - Different catalogs can be used together

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

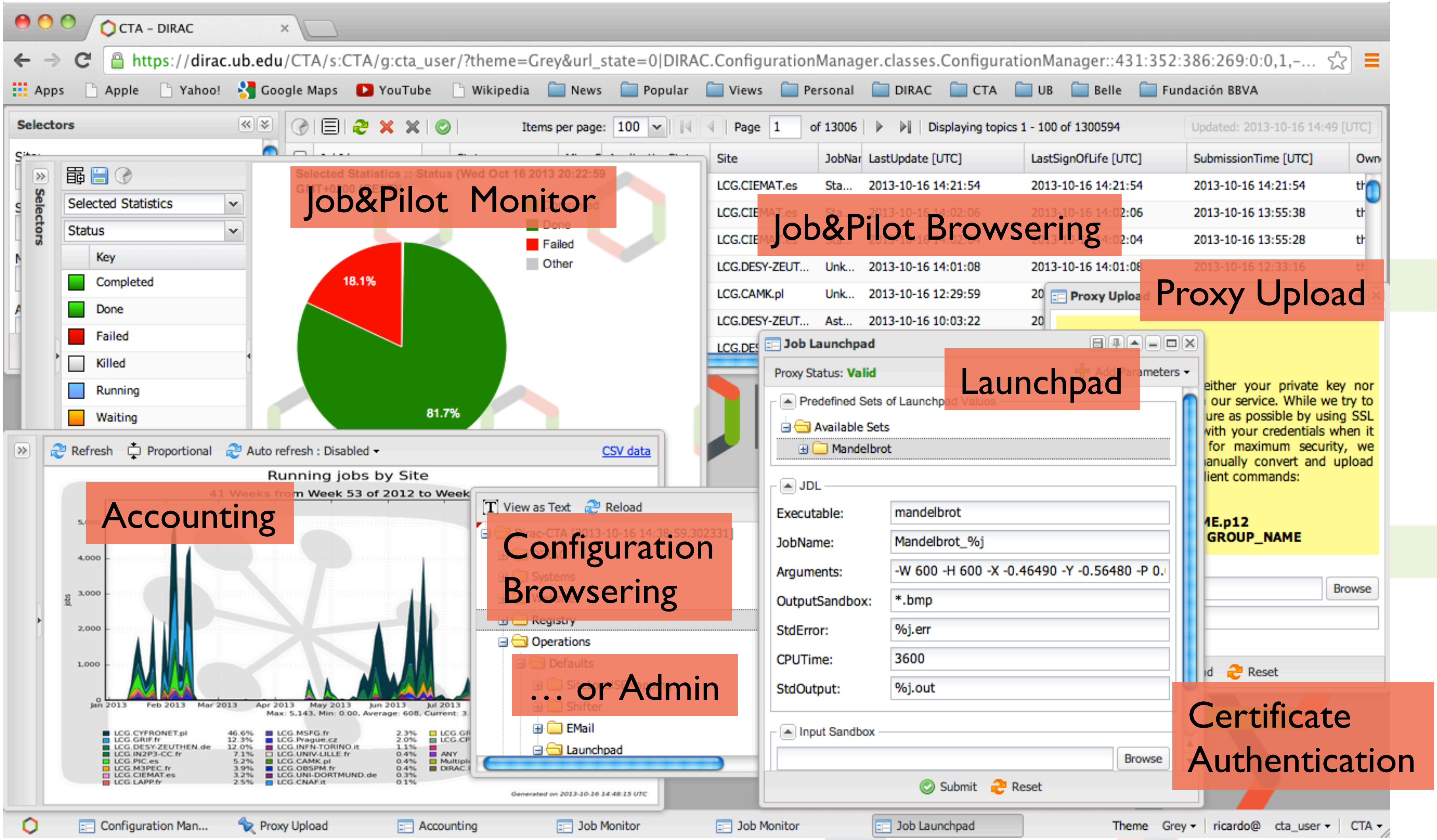


User Interfaces

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



Job&Pilot Monitor

Job&Pilot Browsering

Proxy Upload

Launchpad

Accounting

Configuration Browsering

… or Admin

Certificate Authentication

https://dirac.ub.edu/CTA/s:CTA/g:cta_user/?theme=Grey&url_state=0|DIRAC.ConfigurationManager.classes.ConfigurationManager::431:352:386:269:0:0,1,-...

Items per page: 100 | Page 1 of 13006 | Displaying topics 1 - 100 of 1300594

Site	JobNar	LastUpdate [UTC]	LastSignOfLife [UTC]	SubmissionTime [UTC]
LCG.CIEMAT.es	Sta...	2013-10-16 14:21:54	2013-10-16 14:21:54	2013-10-16 14:21:54
LCG.DESY-ZEUT...	Unk...	2013-10-16 14:01:08	2013-10-16 14:01:08	
LCG.CAMK.pl	Unk...	2013-10-16 12:29:59		
LCG.DESY-ZEUT...	Ast...	2013-10-16 10:03:22		

Job Launchpad

Proxy Status: Valid

JDL

Executable: mandelbrot

JobName: Mandelbrot_%j

Arguments: -W 600 -H 600 -X -0.46490 -Y -0.56480 -P 0.

OutputSandbox: *.bmp

StdError: %j.err

CPUTime: 3600

StdOutput: %j.out

DIRAC Framework

DIRAC middleware

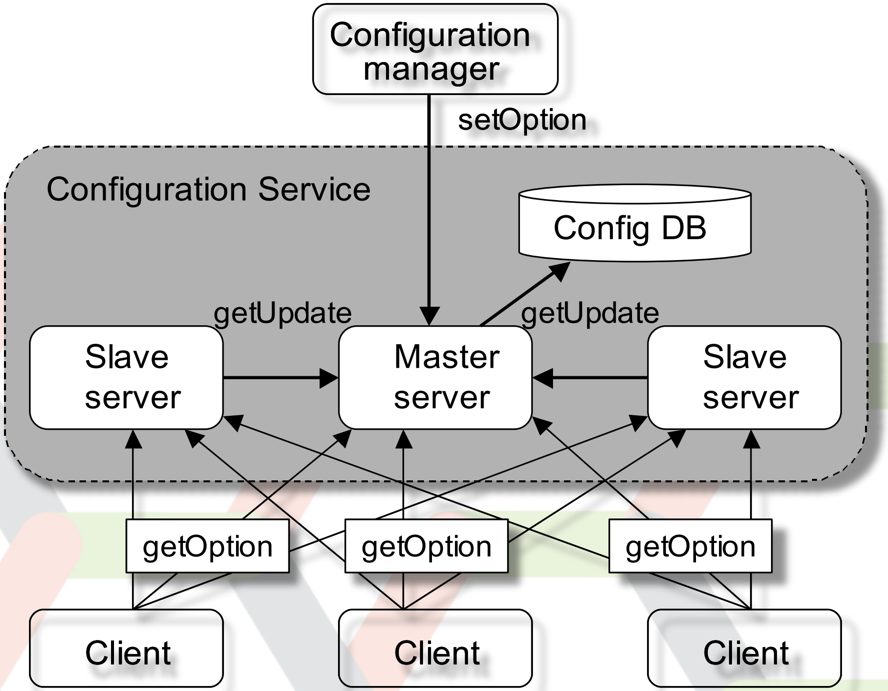
- Services oriented architecture (SOA)
- DIRAC has a well defined architecture
  - Services
    - passive components reacting to client request
    - Keep their state in a database
  - Light distributed agents
    - permanently running components, animating the whole system
  - Clients
    - User interfaces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



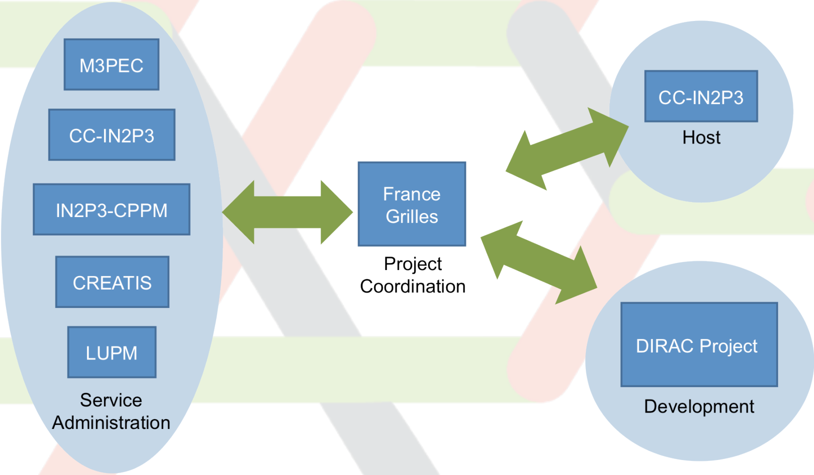
DIRAC as a Service

DIRAC as a service

- DIRAC client is easy to install
  - Part of a usual tutorial
- DIRAC services are easy to install but
  - Needs dedicated hardware for hosting
  - Configuration, maintenance needs expert manpower
  - Monitoring computing resources is a tedious every-day task
- Small user communities can not afford maintaining dedicated DIRAC services
  - Still need easy access to computing resources
- Large grid infrastructures can provide DIRAC services for their users.

France-Grilles

- **DIRAC** services are provided by several National Grid Initiatives: France, Spain, Italy, UK …
- Example: France-Grilles DIRAC service
  - Hosted by the CC/IN2P3
  - Distributed administrator team
    - 5 participating universities
  - 15 VOs, ~100 registered users
  - In production since May 2012
    - 7 millions jobs
- DIRAC 4 EGI service is being setup



Service User Support

- Heavily used for the grid tutorials
  - Using resources of the VO france-formation

- Support for users, applications
  - Forum for experience dissemination
  - Help in porting applications to the grid
  - Help new communities to try out DIRAC for their production systems

□ Fermi-LAT, Glast

□ LSST

□ CTA

□ …

Summary

- DIRAC has most of the features of a "standard" Grid middleware stack
- 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
  - DIRAC client installation
  - 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
- Advanced job operations
  - Jobs with input and output data
  - Bulk job submission
- Emphasis on exercises
- Agenda: https://indico.in2p3.fr/conferenceDisplay.py?confId=9461

DIRAC Tutorial setup

- DIRAC service installation at *dirac.france-grilles.fr*
  - The service used for the tutorial is permanent, will stay in place afterwards
- Resources
  - EGI sites
    - Computing Elements
  - Storage Elements
    - One DIRAC SE (DIRAC-USER)
    - Several SRM EGI SE's
- Tutorial materials are available here
  - https://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/Marseille
  - Vanessa Hamar – Responsible for the DIRAC production infrastructure DIRAC France-Grilles NGI, CC/IN2P3
  - Sorina Camarasu Pop – Member of the DIRAC France-Grilles service administrator team, CREATIS/Lyon