

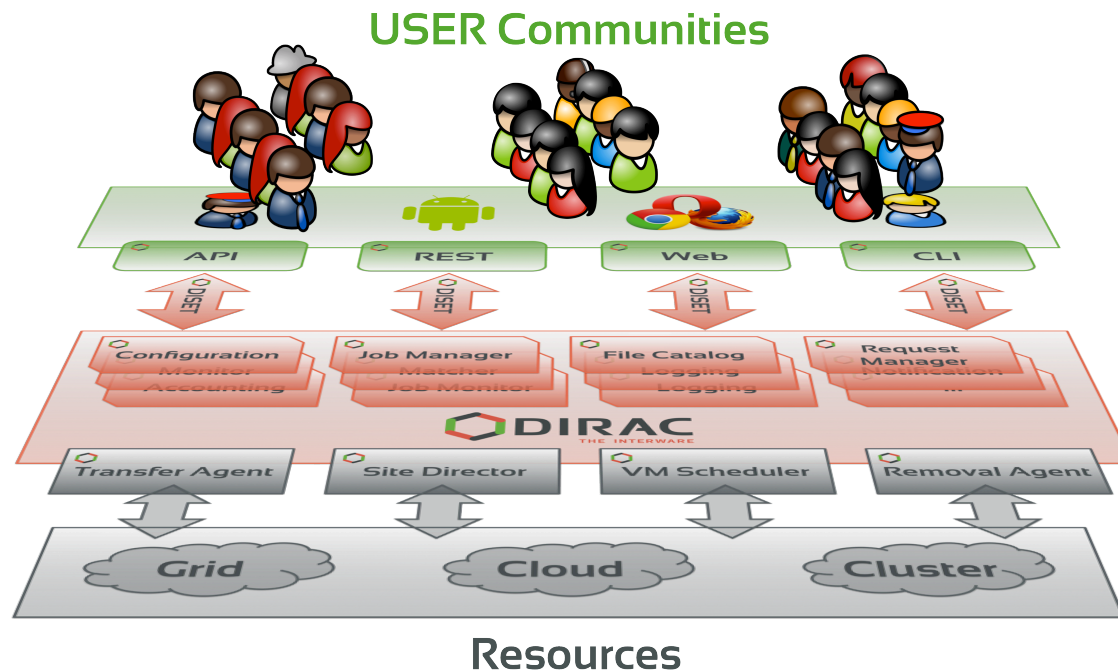
# DIRAC Services for Grid and Cloud Infrastructures

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- ▶ DIRAC in a nutshell
- ▶ DIRAC communities
- ▶ Services for multi-community installations
- ▶ Conclusions

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



- ▶ The project was started in 2003 for the LHCb experiment at CERN
  - ▶ First focusing on the workload management for the LHCb data production system
- ▶ Now DIRAC is the basis for almost all the aspects of the LHCb distributed computing
  - ▶ Workload Management
  - ▶ Data Management
  - ▶ High level production services
  - ▶ Monitoring of resources, activities and services
  - ▶ Accounting
  - ▶ Interfaces
- ▶ Accessing all the resources available to LHCb
  - ▶ HTC/WLCG
  - ▶ Cloud
  - ▶ BOINC
  - ▶ Standalone, e.g.
    - ▶ LHCb Online HLT farm
    - ▶ Yandex (container based) cloud
    - ▶ Non-CE clusters

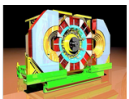
- ▶ The experience collected with a production grid system of a large HEP experiment proved to be very valuable
  - ▶ Several new experiments expressed interest in using this software relying on its proven in practice utility
- ▶ In 2009 the core DIRAC development team decided to generalize the software to make it suitable for any user community.
  - ▶ Split the generic functionality from the LHCb specific features
  - ▶ Consortium to develop, maintain and promote the DIRAC software was created in 2014
    - ▶ Current members: CERN, CNRS, University of Barcelona, IHEP, KEK, University of Montpellier, PNNL
- ▶ The results of this work allow to offer DIRAC as a general purpose distributed computing framework



- ▶ Belle II Collaboration, KEK
  - ▶ First use of clouds (Amazon) for data production
- ▶ ILC/CLIC detector Collaboration, Calice VO
  - ▶ Dedicated installation at CERN, 10 servers, DB-OD MySQL server
  - ▶ MC simulations
  - ▶ DIRAC File Catalog was developed to meet the ILC/CLIC requirements



- ▶ BES III, IHEP, China
  - ▶ Using DIRAC DMS: File Replica and Metadata Catalog, Transfer services
  - ▶ Dataset management developed for the needs of BES III



**BESIII Experiment**

- ▶ CTA
  - ▶ CTA started as France-Grilles DIRAC service customer
  - ▶ Now is using a dedicated installation at PIC, Barcelona
  - ▶ Using complex workflows

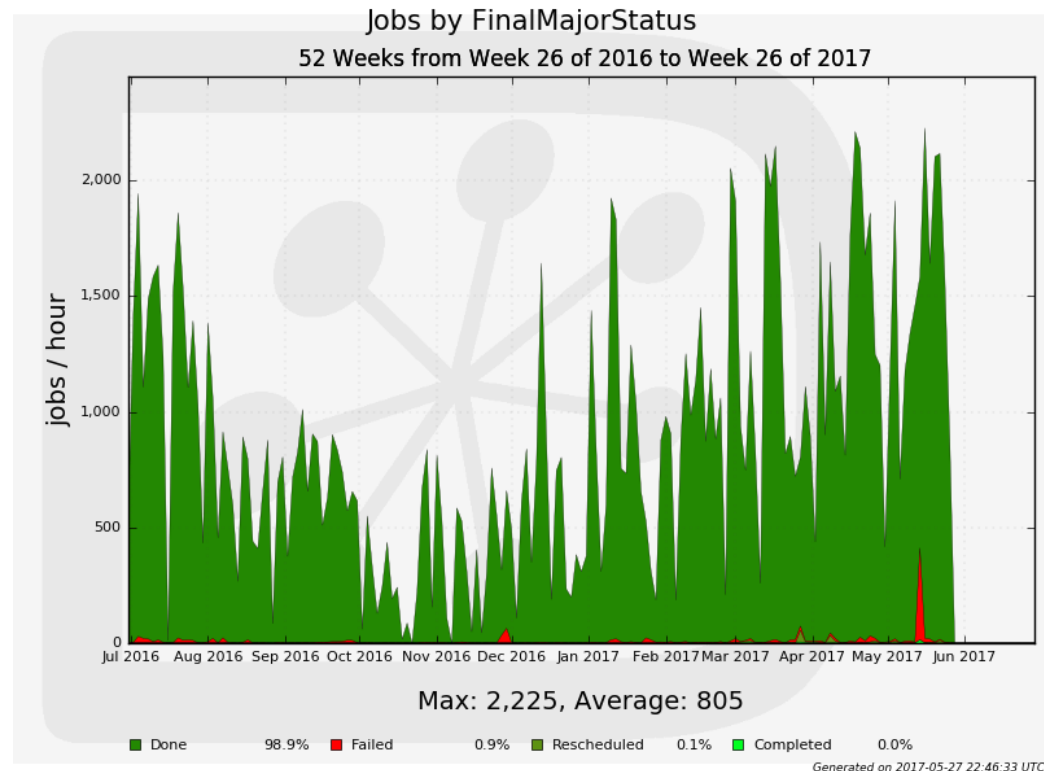


- ▶ Geant4
  - ▶ Dedicated installation at CERN
  - ▶ Validation of MC simulation software releases
- ▶ DIRAC evaluations by other experiments
  - ▶ LSST, Auger, TREND, Daya Bay, Juno, ELI, NICA, ...
  - ▶ Evaluations can be done with general purpose DIRAC services

- ▶ Maintaining DIRAC services for small communities is not affordable
  - ▶ Need for multi-VO installations
  - ▶ DIRAC framework was updated to support this kind of installations
- ▶ Several services provided by grid infrastructure projects
  - ▶ FG-DIRAC, France
  - ▶ GridPP, UK
  - ▶ DIRAC4EGI
- ▶ Some dedicated installations evolved into multi-community services
  - ▶ CERN: ILC, CALICE
  - ▶ IHEP: BES III, Juno, CEPC
- ▶ Recently added services
  - ▶ PNNL: Belle II, Project8, MiniCLEAN, SuperCDMS, nEXO
  - ▶ DIRAC@JINR: NICA, Dubna University

- ▶ In “best effort” production since 2014
- ▶ Partners
  - ▶ Operated by EGI
  - ▶ Hosted by CYFRONET
  - ▶ DIRAC Project providing software, consultancy
- ▶ 10 Virtual Organizations
  - ▶ enmr.eu, vlemmed, eiscat.se
  - ▶ fedcloud.egi.eu
  - ▶ training.egi.eu
- ▶ Usage
  - ▶ Workload Management solution
    - ▶ > 6 million jobs processed in the last year
  - ▶ Data Management solution
    - ▶ E.g. Eiscat 3D
- ▶ Starting from 2018 DIRAC becomes a Core Service of EGI
  - ▶ WMS replacement
  - ▶ Serving both Grid and FedCloud resources

## DIRAC4EGI activity snapshot

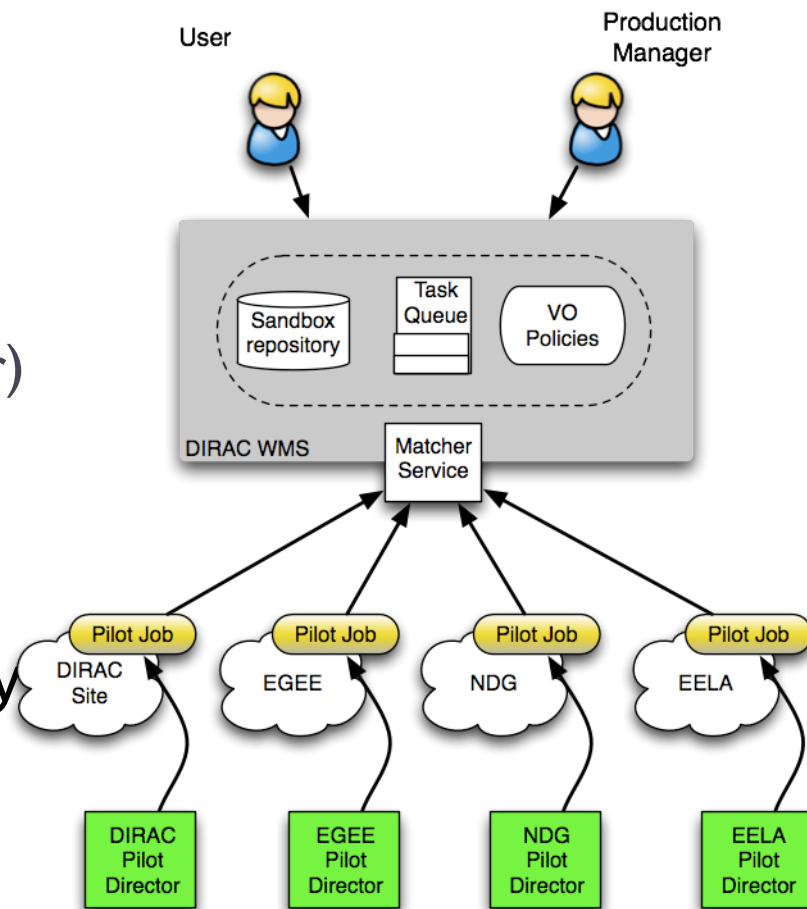




# DIRAC Services

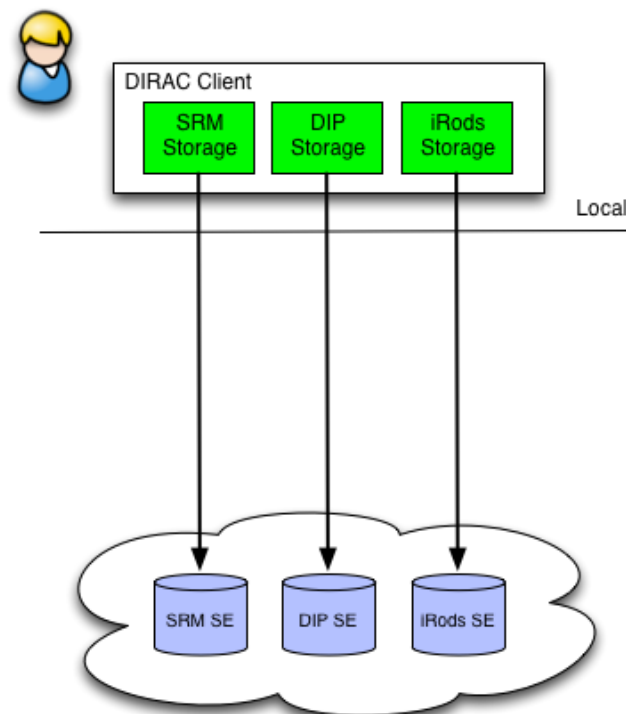
- ▶ Automatic synchronization of resources description with external information services (BDII or ...)
  - ▶ Resource access information
  - ▶ VO access rights
- ▶ **Resource Monitoring Service**
  - ▶ A framework to define and run various probes and update the resource status appropriately
    - ▶ E.g. downtimes announced in the GocDB, testing access to storage and computing resources, VOMS servers, etc
- ▶ **Resource Status Service**
  - ▶ Serve resource status information to interested clients
- ▶ **Work in progress**
  - ▶ Per VO probes and resource status information

- ▶ Pilot based workload management
- ▶ Targeting various computing resources
  - ▶ HTC sites (CREAM,ARC,HTCCondor)
  - ▶ EGI FedCloud sites
  - ▶ HPC
  - ▶ Volunteers, etc
- ▶ Possibility to define community specific ad hoc resources
  - ▶ E.g. local cluster accessible through (GSI)SSH/VPN tunnel



- ▶ Work in progress (still a lot)
  - ▶ More flexible Pilot framework as a separate DIRAC independent set of modules
    - ▶ To run in various ad hoc environments: clouds, containers, BOINC, ...
  - ▶ Accessing HPC resources
    - ▶ Managing multi/single core jobs
    - ▶ Managing HPC special features for efficient job matching
    - ▶ Managing limited outbound connectivity of HPC nodes
    - ▶ ...
  - ▶ VM scheduling for cloud resources
    - ▶ Intelligent scheduler for fair sharing of common resources, optimization of the resource usage cost, etc.

- ▶ Storage element abstraction with a client implementation for each access protocol
  - ▶ DIPS, SRM, XROOTD, RFIO, etc
  - ▶ gfal2 based plugin gives access to all protocols supported by the library
    - ▶ HTTP, DCAP, WebDAV, S3, ...
- ▶ Central File Catalog
  - ▶ DIRAC replica and metadata catalog
    - ▶ Dataset management
    - ▶ Storage usage reports
  - ▶ Possibility to use LFC
    - ▶ Tools for migration from LFC to DFC
  - ▶ Per VO File Catalog service
    - ▶ Possibility to plugin VO-specific modules, e.g. ACLs, metadata or dataset engine

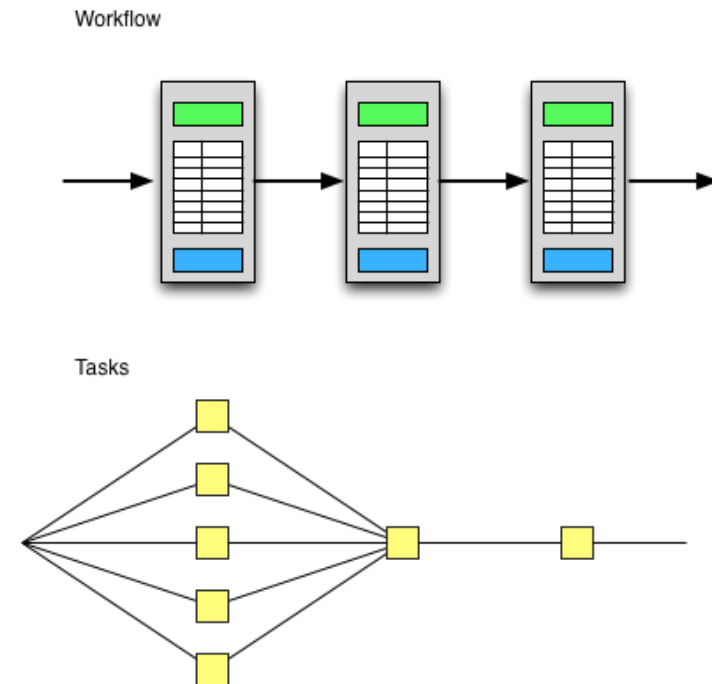
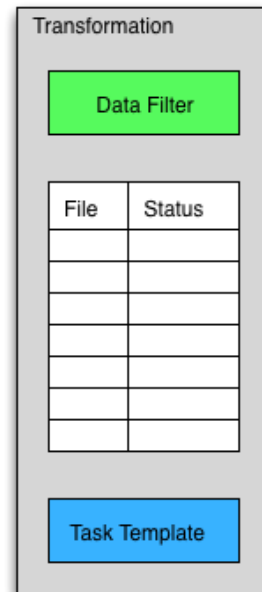


- ▶ Using bulk data operations
  - ▶ Replication, removal, etc
  - ▶ Using DIRAC agents for asynchronous operations with retries and validation
  - ▶ Using external data transfer services, e.g. FTS3
  
- ▶ Work in progress
  - ▶ File Catalog Web interface
    - ▶ E.g. coupling data selection with the job submission application
  - ▶ Enhanced dataset management
  - ▶ Data popularity estimators

- ▶ Data driven workflows as chains of data transformations
  - ▶ Transformation: input data filter + recipe to create tasks
  - ▶ Tasks are created as soon as data with required properties is registered into the system
  - ▶ Tasks: jobs, data operations, etc

- ▶ Automating community production pipelines
  - ▶ Plugins for custom operations, transformation validation

- ▶ Work in progress:
  - ▶ Production System as a set of tools to help defining complex workflows by chaining multiple transformations



- ▶ Command line for all the operations
  - ▶ “gLite-style”
    - ▶ *dirac-wms-job-submit job.jdl*
  - ▶ COMDIRAC style
    - ▶ *dsub echo Hello World !*
- ▶ Web Portal for the most common user and administrator operations
- ▶ Python API
- ▶ REST service interface for third party developments using DIRAC services
  
- ▶ Work in progress
  - ▶ More functionality to be exposed through COMDIRAC and REST interfaces
  - ▶ Focus on usability of the Web Portal as the main user interface
  - ▶ Support for community custom applications built in the DIRAC Web Portal framework



## ▶ Participants

- ▶ A.Tsaregorodtsev, CPPM
  - ▶ Coordination
  - ▶ Resources, data management
- ▶ L.Arrabito, J.Bregeon, LUPM
  - ▶ Complex workflow management
- ▶ F.Hernandez, V.Hamar, CC/IN2P3
  - ▶ Support for DIRAC services (FG-DIRAC)
  - ▶ Support for HPC resources
- ▶ P.Gay
  - ▶ User interfaces
- ▶ S.Pop
  - ▶ Cloud resources, containers

## ▶ Events

- ▶ DIRAC User Workshop, 22-25 May, CC/IN2P3, Lyon