DIRAC Services for EGI Users

A.Tsaregorodtsev,

Aix Marseille Univ, CNRS/IN2P3, CPPM

EGI Webinar, 23 October 2020

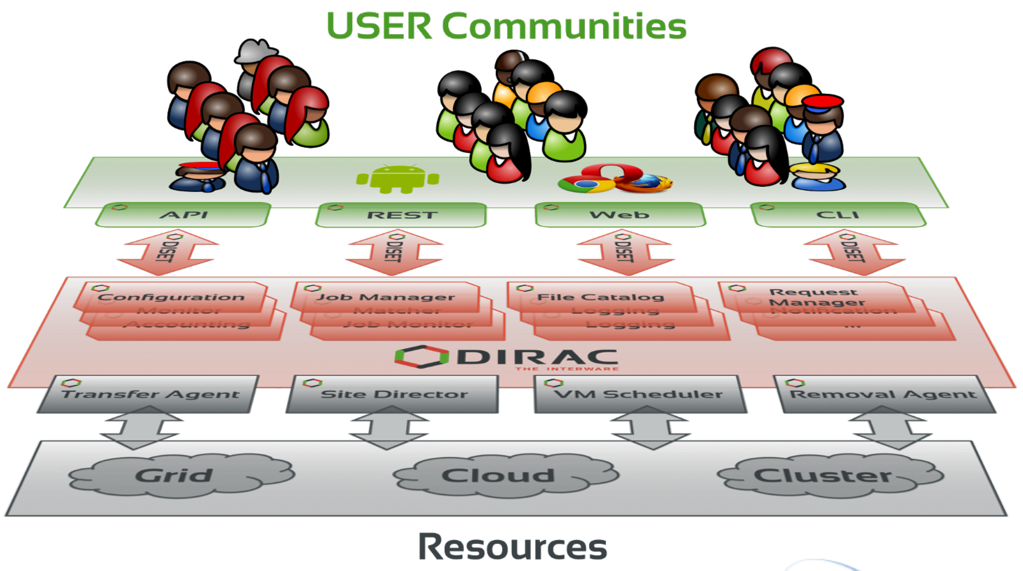
Outline

- DIRAC Interware project
- EGI Services
  - Managing jobs
  - Managing data
  - Managing computing resources
  - Managing workflows
- Development Framework
- Conclusions

DIRAC THE INTERWARE

Interware

- A software framework for distributed computing
- A **complete** solution to one (or more) user community
- Builds a layer between users and resources
- A *framework* shared by multiple experiments, both inside HEP, astronomy, and life sciences



An open source project

- Started as an LHCb project, became experiment-agnostic in 2009
  - First users (after LHCb) end of 2009
- Developed by communities, for communities
  - Open source (GPL3+), GitHub hosted, python 2.7
  - No dedicated funding for the development of the "Vanilla" project
  - Publicly documented, active assistance forum, yearly users workshops, open developers meetings
  - 4 FTE as core developers, a dozen contributing developers
- The DIRAC consortium as representing body
  - CNRS, CERN, IHEP, KEK
  - PNNL, University of Montpellier, Imperial College

DIRAC
THE INTERWARE

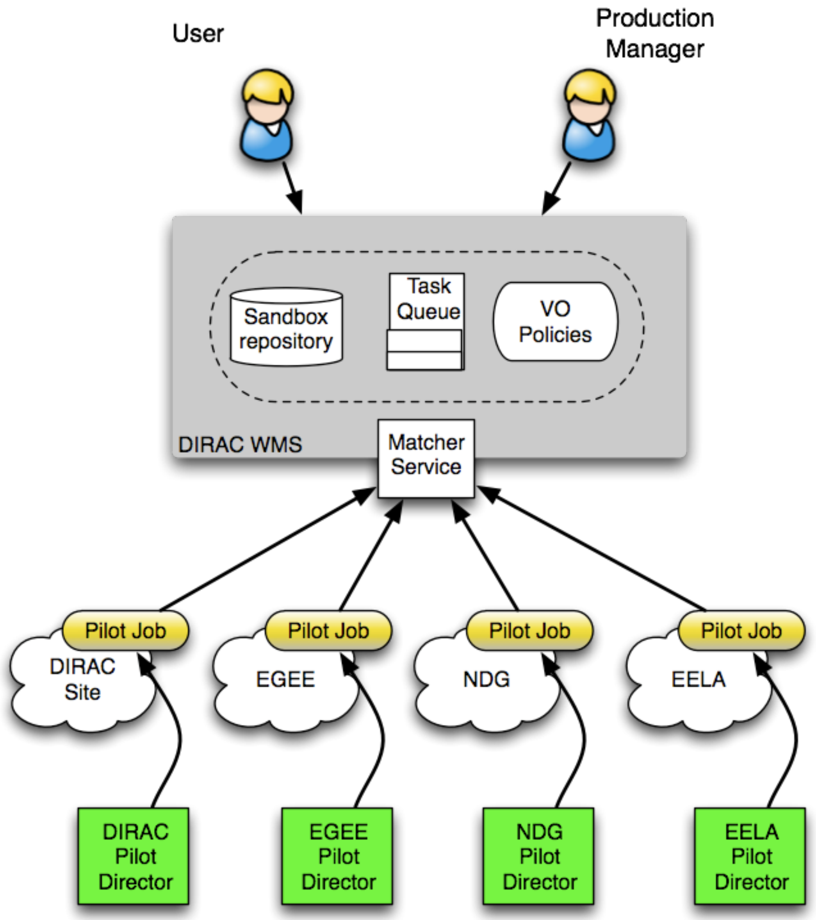
Managing user jobs

WMS: Pilots are federators

- Pilot jobs are submitted to computing resources by specialized Pilot Directors

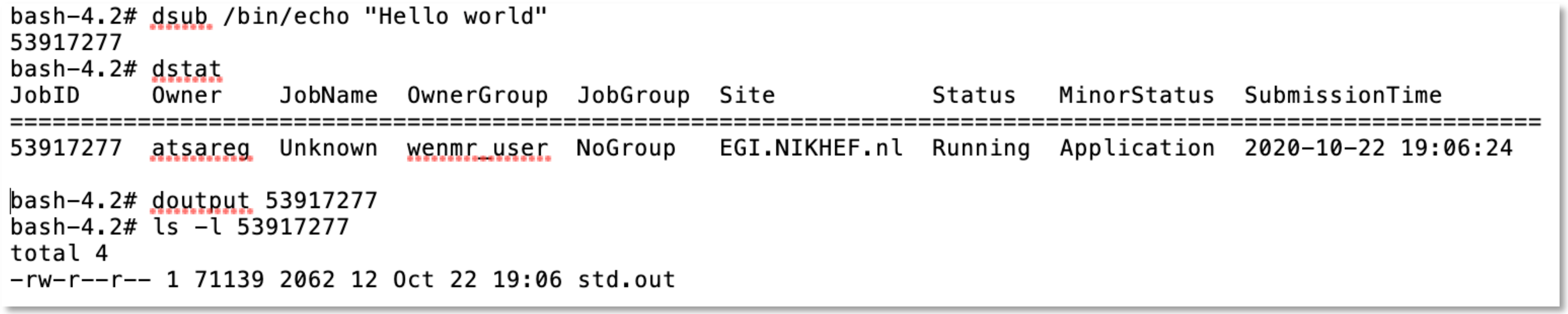
- Pilots retrieve user jobs from the central Task Queue and steer their execution on the worker nodes including final data uploading

- Pilot based WMS advantages:
  - increases efficiency of the user job execution
  - allows to apply efficiently community policies at the Task Queue level
  - allows to integrate heterogeneous computing resources



User jobs

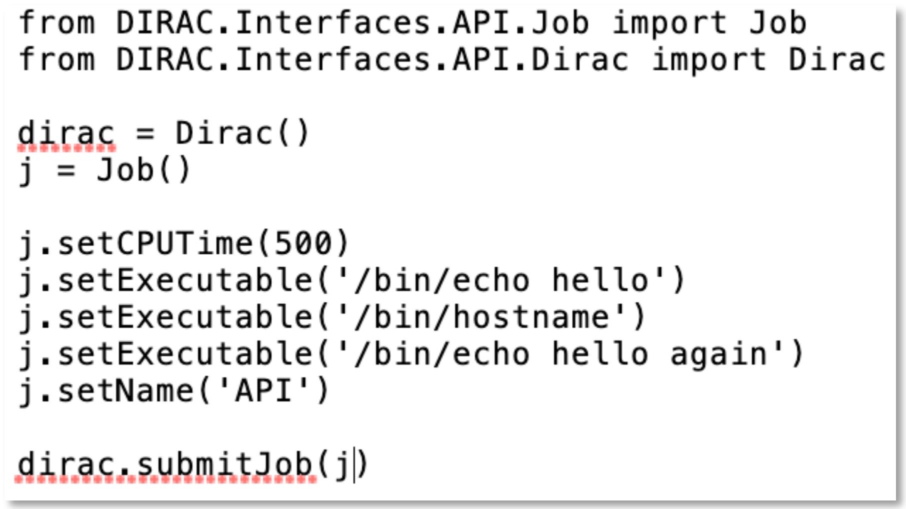
- Users are managing jobs using various tools
  - Command line (batch system like interface):



```
bash-4.2# dsub /bin/echo "Hello world"
53917277
bash-4.2# dstat
JobID     Owner    JobName  OwnerGroup  JobGroup  Site          Status   MinorStatus  SubmissionTime
==============================================================================================================
53917277  atsareg  Unknown  wenmr_user  NoGroup   EGI.NIKHEF.nl Running  Application  2020-10-22 19:06:24

bash-4.2# doutput 53917277
bash-4.2# ls -l 53917277
total 4
-rw-r--r-- 1 71139 2062 12 Oct 22 19:06 std.out
```

  - Python API



```
from DIRAC.Interfaces.API.Job import Job
from DIRAC.Interfaces.API.Dirac import Dirac

dirac = Dirac()
j = Job()

j.setCPUTime(500)
j.setExecutable('/bin/echo hello')
j.setExecutable('/bin/hostname')
j.setExecutable('/bin/echo hello again')
j.setName('API')

dirac.submitJob(j)
```

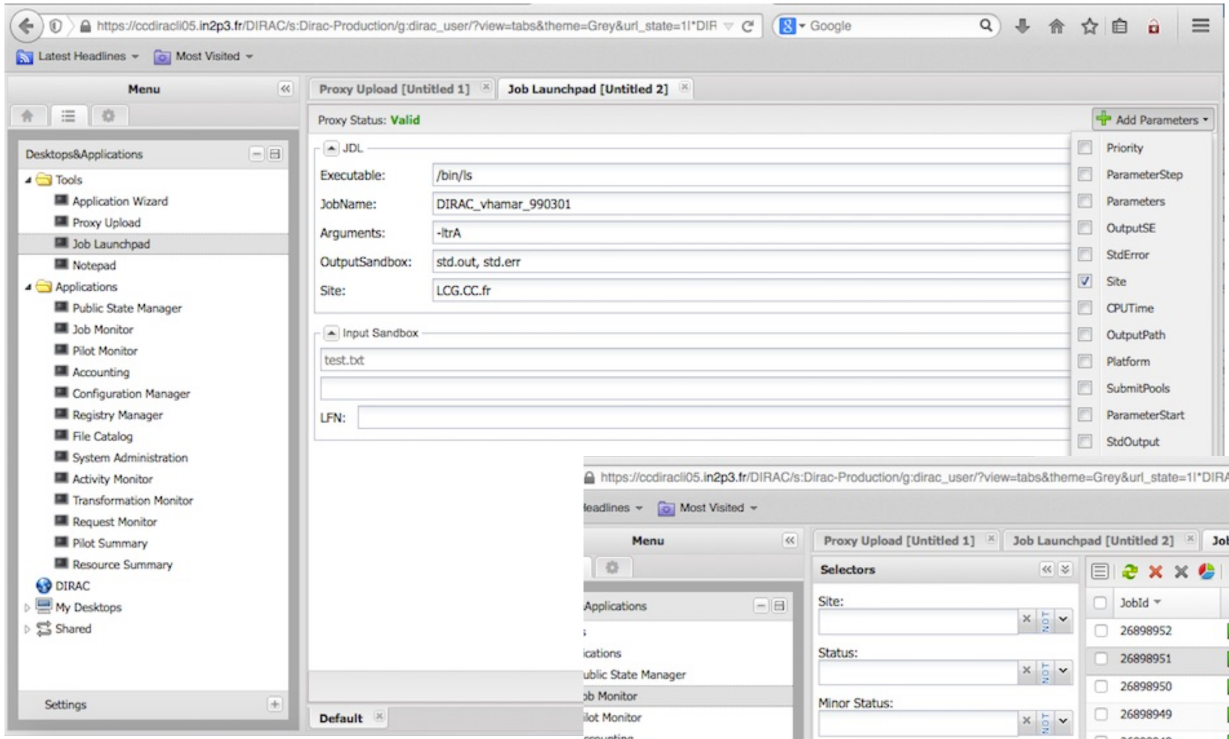
DIRAC client

- Several methods to install DIRAC client on user workstations/laptops (Linux flavors)
  - **dirac-install** installer tool
    - Rather tedious (see tutorials)
    - Suitable for various flavors of Linux
  - **Docker** container (Linux, MacOS)
    - docker run -it -v $HOME:$HOME -e HOME=$HOME diracgrid/client:egi
  - **CVMFS** client installation (Linux)
    - source /cvmfs/dirac.egi.eu/dirac/bashrc_egi
  - **Conda** environment (Linux, MacOS)
    - conda create -c conda-forge --name dirac ipython dirac-grid
      conda activate dirac

DIRAC
THE INTERWARE

Web Interface

Job Launchpad



Proxy Status: Valid

JDL

Executable:	/bin/ls
JobName:	DIRAC_vhamar_990301
Arguments:	-ltrA
OutputSandbox:	std.out, std.err
Site:	LCG.CC.fr

Input Sandbox

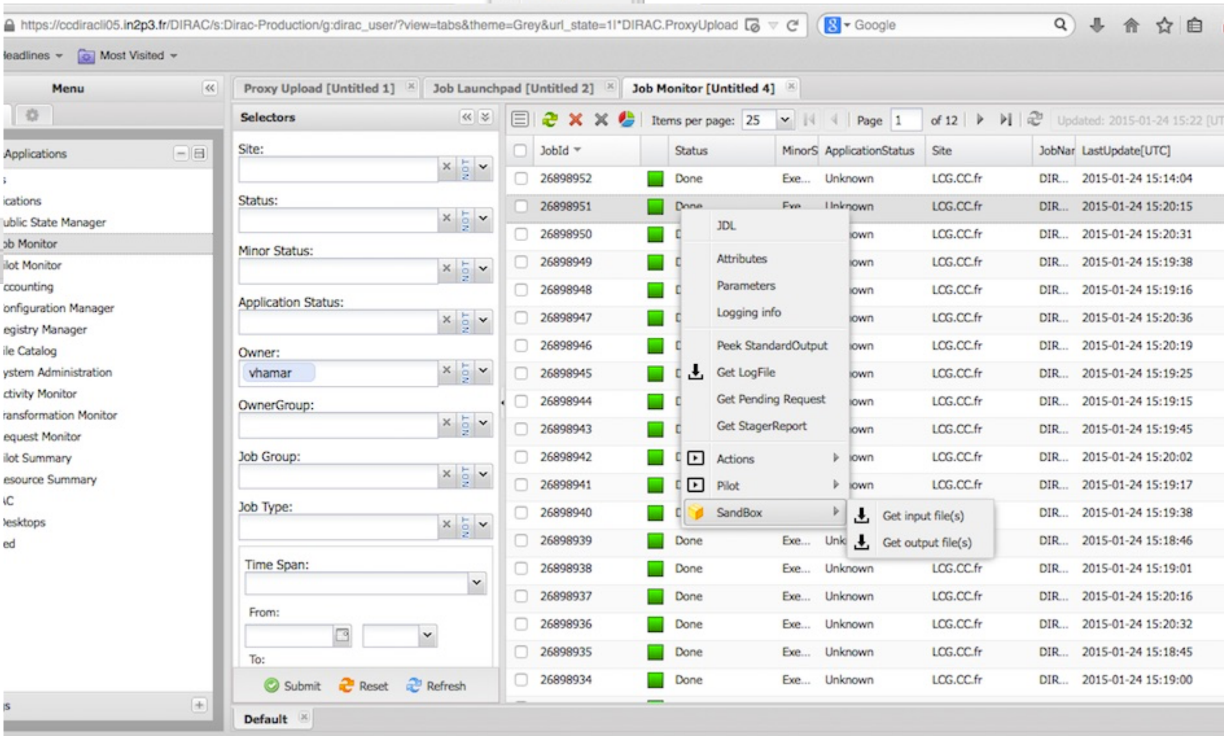
test.txt

LFN:

Add Parameters:

- [ ] Priority
- [ ] ParameterStep
- [ ] Parameters
- [ ] OutputSE
- [ ] StdError
- [x] Site
- [ ] CPUTime
- [ ] OutputPath
- [ ] Platform
- [ ] SubmitPools
- [ ] ParameterStart
- [ ] StdOutput

Job Monitoring



Selectors

Site:

Status:

Minor Status:

Application Status:

Owner: vhamar

OwnerGroup:

Job Group:

Job Type:

Time Span:

From:

To:

Items per page: 25 | Page 1 of 12 | Updated: 2015-01-24 15:22 [UT

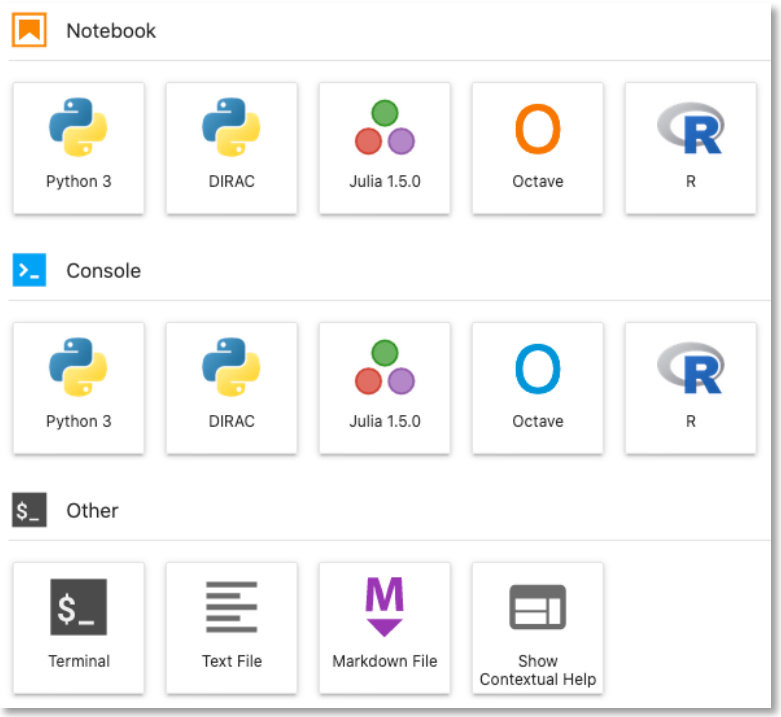
JobId		Status	MinorS	ApplicationStatus	Site	JobNar	LastUpdate[UTC]
26898952	🟩	Done	Exe...	Unknown	LCG.CC.fr	DIR...	2015-01-24 15:14:04
26898951	🟩	Done	Exe...	Unknown	LCG.CC.fr	DIR...	2015-01-24 15:20:15
26898950	🟩	D		own	LCG.CC.fr	DIR...	2015-01-24 15:20:31
26898949	🟩	D		own	LCG.CC.fr	DIR...	2015-01-24 15:19:38
26898948	🟩	D		own	LCG.CC.fr	DIR...	2015-01-24 15:19:16
26898947	🟩	D		own	LCG.CC.fr	DIR...	2015-01-24 15:20:36
26898946	🟩	D		own	LCG.CC.fr	DIR...	2015-01-24 15:20:19
26898945	🟩	D		own	LCG.CC.fr	DIR...	2015-01-24 15:19:25
26898944	🟩	D		own	LCG.CC.fr	DIR...	2015-01-24 15:19:15
26898943	🟩	D		own	LCG.CC.fr	DIR...	2015-01-24 15:19:45
26898942	🟩	D		own	LCG.CC.fr	DIR...	2015-01-24 15:20:02
26898941	🟩	D		own	LCG.CC.fr	DIR...	2015-01-24 15:19:17
26898940	🟩	D				DIR...	2015-01-24 15:19:38
26898939	🟩	Done	Exe...	Unk		DIR...	2015-01-24 15:18:46
26898938	🟩	Done	Exe...	Unknown	LCG.CC.fr	DIR...	2015-01-24 15:19:01
26898937	🟩	Done	Exe...	Unknown	LCG.CC.fr	DIR...	2015-01-24 15:20:16
26898936	🟩	Done	Exe...	Unknown	LCG.CC.fr	DIR...	2015-01-24 15:20:32
26898935	🟩	Done	Exe...	Unknown	LCG.CC.fr	DIR...	2015-01-24 15:18:45
26898934	🟩	Done	Exe...	Unknown	LCG.CC.fr	DIR...	2015-01-24 15:19:00

Other job interfaces

- REST API
  - A language neutral interface for job manipulation

- The next generation DIRAC service interface will be based on HTTPS
  - Will allow for a language neutral RPC interface

- Jupyter Notebook interface
    - Soon availalbe
  - DIRAC API enabled iPython shell
  - Terminal with DIRAC command line interface
  - Managing user credentials is being sorted out
    - Functional for users having grid certificates and registered in the Check-In SSO service



Bulk jobs with multiple parameters

- Example JDL

```
Executable = "testParametricJob.sh";
JobName = ”Parametric_%{Name}";
Arguments = "%{Energy}";
Parameters = 3;
Parameter.Energy = {0.1, 0.2, 0.3};
Parameter.Name = {“Good”, “Better”, “Best”};
StdOutput = "StdOut_%j";
StdError = "StdErr_%j";
InputSandbox = {"testJob.sh"};
OutputSandbox = {"StdOut_%j","StdErr_%j"};
```

- Bulk job submission is possible with all the interfaces
  - Most suitable for APIs

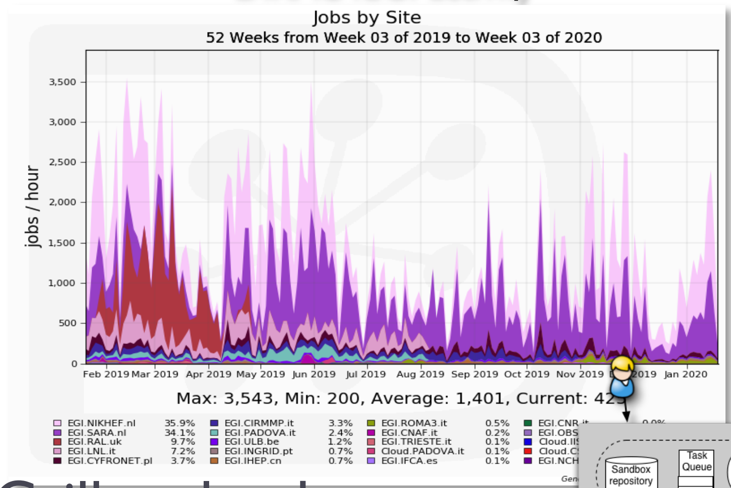
Managing user computing resources

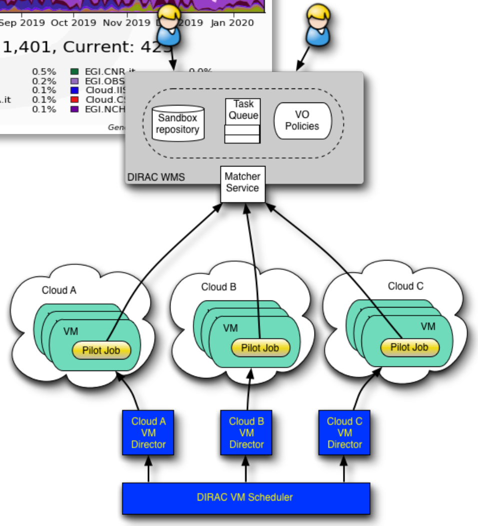
DIRAC THE INTERWARE

Computing Grids and Clouds

- DIRAC was initially developed with the focus on accessing conventional Grid computing resources
  - WLCG grid resources for the LHCb Collaboration
- Grid infrastructures
  - E.g. EGI, WLCG, OSG
  - CREAM, HTCondorCE, ARC
- Cloud infrastructures
  - EGI Federated Cloud, France-Grilles cloud
- Others
  - Vacuum, Volunteer grids

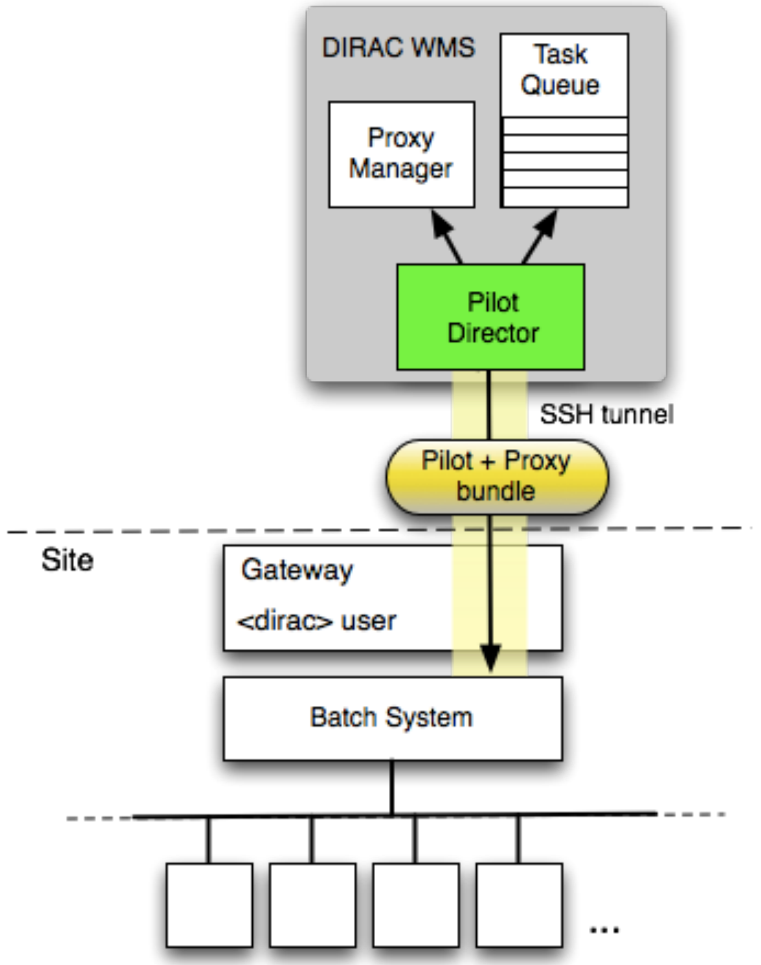
DIRAC4EGI activity





Standalone computing clusters

- Users can connect their own computing resources
  - Not making part of any grid infrastructure
- The user site can be:
  - a single computer or several computers without any batch system
  - a computing cluster with a batch system
    - LSF, BQS, SGE, PBS/Torque, Condor
      - Commodity computer farms
    - SLURM
      - HPC centers



Managing user data

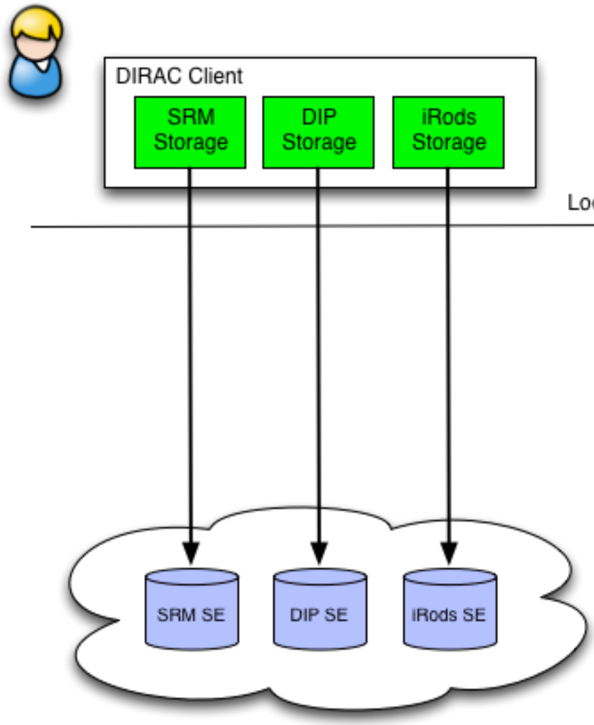
DIRAC THE INTERWARE

DMS basics

- **LFN**: unique identifier within DIRAC of a file
  - **Logical File Name**
  - (described as paths)
- **LFNs** are registered in **catalog**(s).
  - and there are implementations like the DFC
    - and you can connect as many catalogs as you want
      - (including the LFC or Rucio catalog)
- **LFNs** *may* have **PFNs**, stored in **SEs**.
  - **Physical File Name** on **Storage Elements**
- **PFNs** can be accessed with several protocols.
  - e.g. root, gsiftp, srm, http, file, dips
  - (and can also be brought online - i.e. staged)

Storage plugins

- Storage element abstraction with a client implementation for each access protocol
  - DIPS – DIRAC data transfer protocol
  - FTP, HTTP, WebDAV
  - SRM, XROOTD, RFIO, DCAP, etc
    - HEP centers specific protocols
    - Using gfal2 library developed at CERN
  - S3, Swift, CDMI: cloud specific data access protocols
- Each SE is seen by users as a logical entity
  - With some specific operational properties
    - Archive, limited access, etc
  - SE's can be configured with multiple protocols
- New data access technologies require creating new specific plug-ins



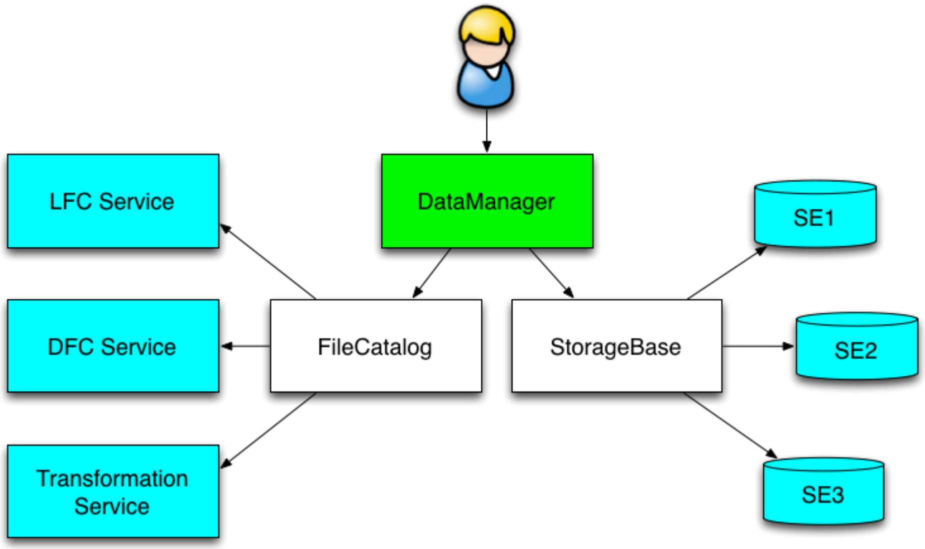
DIRAC
THE INTERWARE

File Catalog Service

- File Catalog is a service to keep track of all the physical file replicas in all the SE's
  - Stores also file properties:
    - Size, creation/modification time stamps, ownership, checksums
    - User ACLs
- DIRAC relies on a *central* File Catalog
  - Defines a single logical name space for all the managed data
  - Organizes files hierarchically like in common file systems

Combined data API

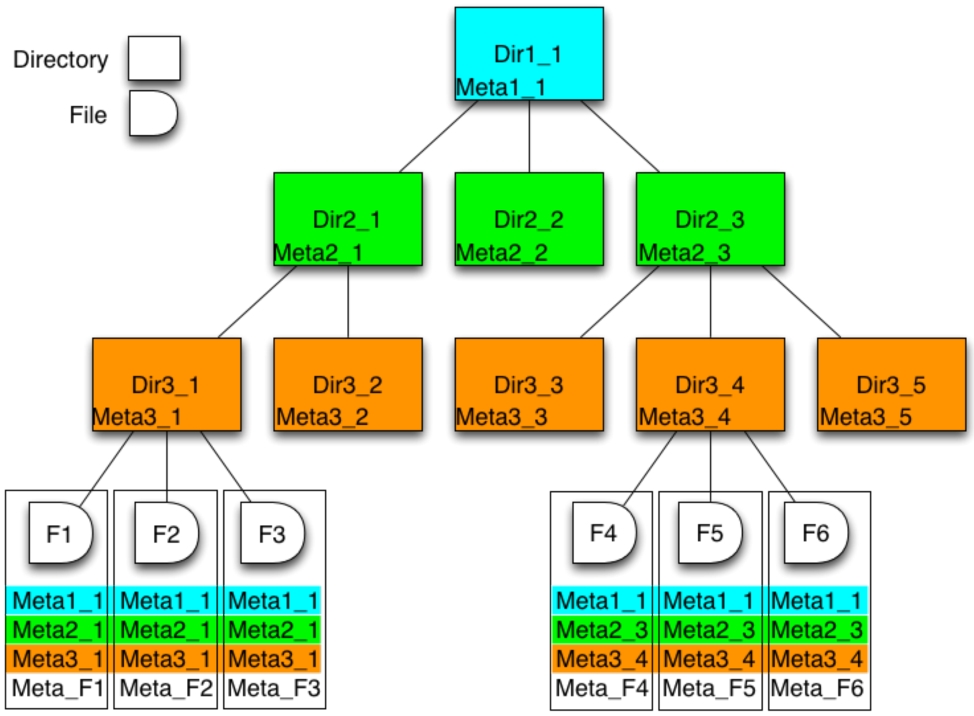
- Together with the data access components DFC allows to present data to users as a single global file system
- DataManager API is a single client interface for logical data operations



DIRAC THE INTERWARE

File Catalog: Metadata

- DFC is Replica and Metadata Catalog
  - User defined metadata
  - The same hierarchy for metadata as for the logical name space
    - Metadata associated with files and directories
    - Allow for efficient searches
  - Efficient Storage Usage reports
    - Suitable for user quotas



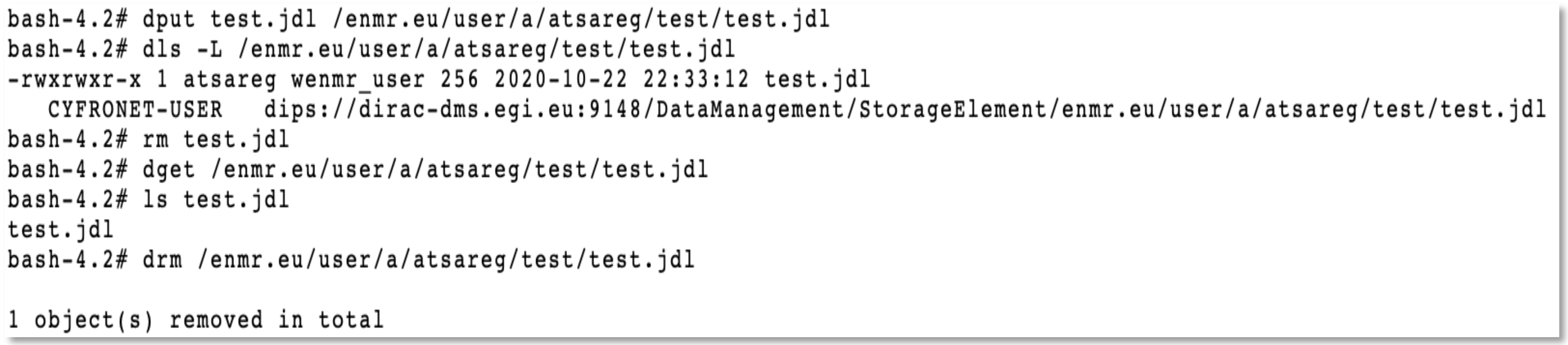
- Example query:
  - `find /lhcb/mcdata LastAccess < 01-01-2012 GaussVersion=v1,v2 SE=IN2P3,CERN Name=*.raw`

Integrating user storages

- Deploying a DIRAC Storage Element service in front of a user File Server
  - Needs minimal DIRAC installation on the server
    - Plus adding a record to the Configuration Service
  - Files should be registered in the DIRAC File Catalog
    - **dirac-dms-register-directory** tool
      - keeping file hierarchical namespace
      - registering file checksums
  - The SE will be accessible with the user credentials and ACL defined in the File Catalog
  - Example: Eiscat-disk Storage Element
    - With 117M files registered in a dedicated File Catalog

DM user interfaces

- Command line tools
  - Multiple dirac-dms-… commands
  - File Catalog console (dirac-dms-filecatalog-CLI)
  - *https://dirac.readthedocs.io/en/latest/UserGuide/commands.html*
- COMDIRAC
  - Representing the logical DIRAC file namespace as a parallel shell
    - **dls, dcd, dpwd, dfind, ddu,** etc commands
  - Commands for file upload/download/replication
    - **dput, dget, drepl**

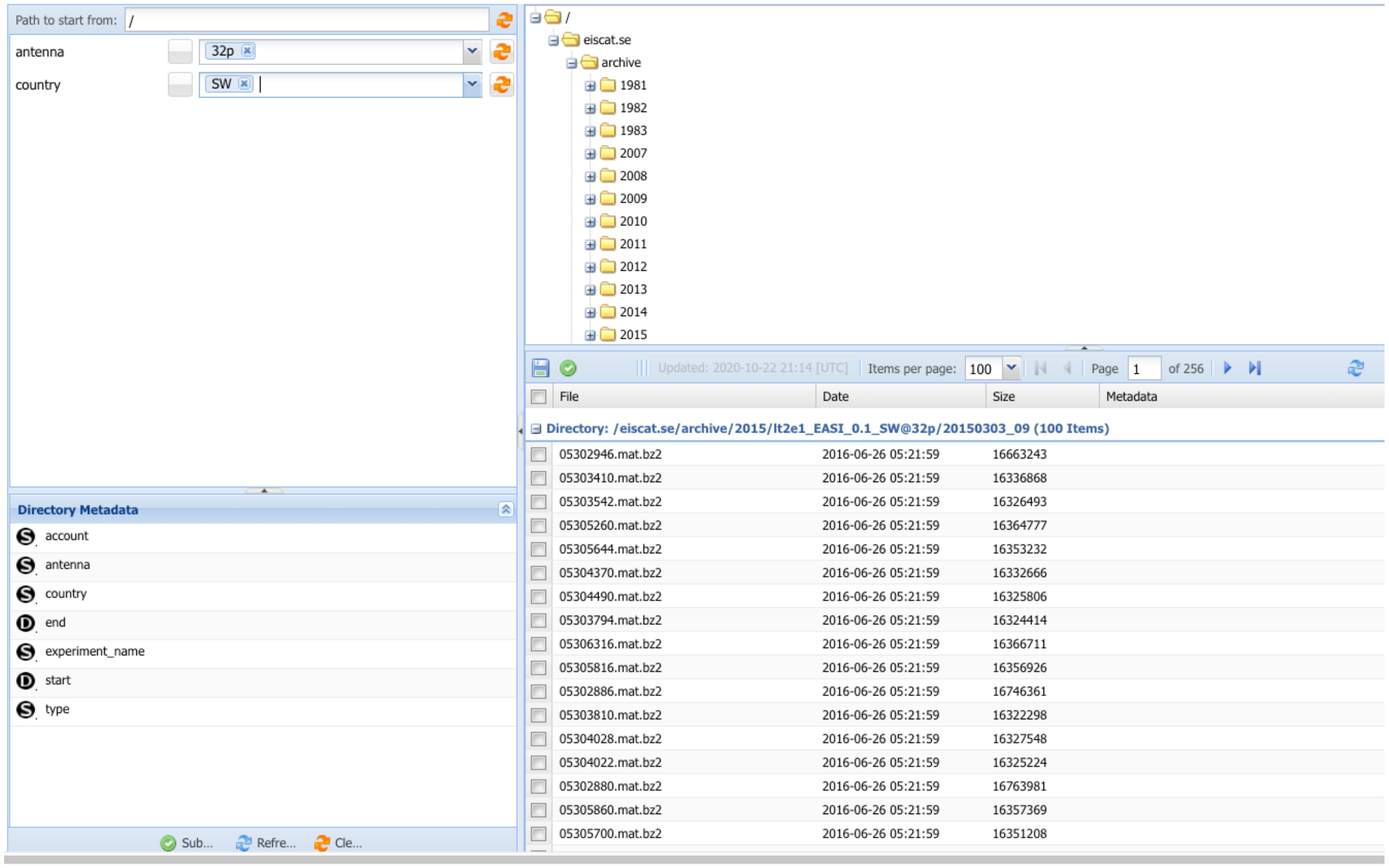


```
bash-4.2# dput test.jdl /enmr.eu/user/a/atsareg/test/test.jdl
bash-4.2# dls -L /enmr.eu/user/a/atsareg/test/test.jdl
-rwxrwxr-x 1 atsareg wenmr_user 256 2020-10-22 22:33:12 test.jdl
   CYFRONET-USER   dips://dirac-dms.egi.eu:9148/DataManagement/StorageElement/enmr.eu/user/a/atsareg/test/test.jdl
bash-4.2# rm test.jdl
bash-4.2# dget /enmr.eu/user/a/atsareg/test/test.jdl
bash-4.2# ls test.jdl
test.jdl
bash-4.2# drm /enmr.eu/user/a/atsareg/test/test.jdl

1 object(s) removed in total
```

DIRAC THE INTERWARE

File Catalog Web interface



Path to start from: /

antenna	32p
country	SW

Directory Metadata

- S account
- S antenna
- S country
- D end
- S experiment_name
- D start
- S type

Sub... Refre... Cle...

/
- eiscat.se
  - archive
    - 1981
    - 1982
    - 1983
    - 2007
    - 2008
    - 2009
    - 2010
    - 2011
    - 2012
    - 2013
    - 2014
    - 2015

Updated: 2020-10-22 21:14 [UTC] Items per page: 100 Page 1 of 256

Directory: /eiscat.se/archive/2015/lt2e1_EASI_0.1_SW@32p/20150303_09 (100 Items)

File	Date	Size	Metadata
05302946.mat.bz2	2016-06-26 05:21:59	16663243	
05303410.mat.bz2	2016-06-26 05:21:59	16336868	
05303542.mat.bz2	2016-06-26 05:21:59	16326493	
05305260.mat.bz2	2016-06-26 05:21:59	16364777	
05305644.mat.bz2	2016-06-26 05:21:59	16353232	
05304370.mat.bz2	2016-06-26 05:21:59	16332666	
05304490.mat.bz2	2016-06-26 05:21:59	16325806	
05303794.mat.bz2	2016-06-26 05:21:59	16324414	
05306316.mat.bz2	2016-06-26 05:21:59	16366711	
05305816.mat.bz2	2016-06-26 05:21:59	16356926	
05302886.mat.bz2	2016-06-26 05:21:59	16746361	
05303810.mat.bz2	2016-06-26 05:21:59	16322298	
05304028.mat.bz2	2016-06-26 05:21:59	16327548	
05304022.mat.bz2	2016-06-26 05:21:59	16325224	
05302880.mat.bz2	2016-06-26 05:21:59	16763981	
05305860.mat.bz2	2016-06-26 05:21:59	16357369	
05305700.mat.bz2	2016-06-26 05:21:59	16351208	

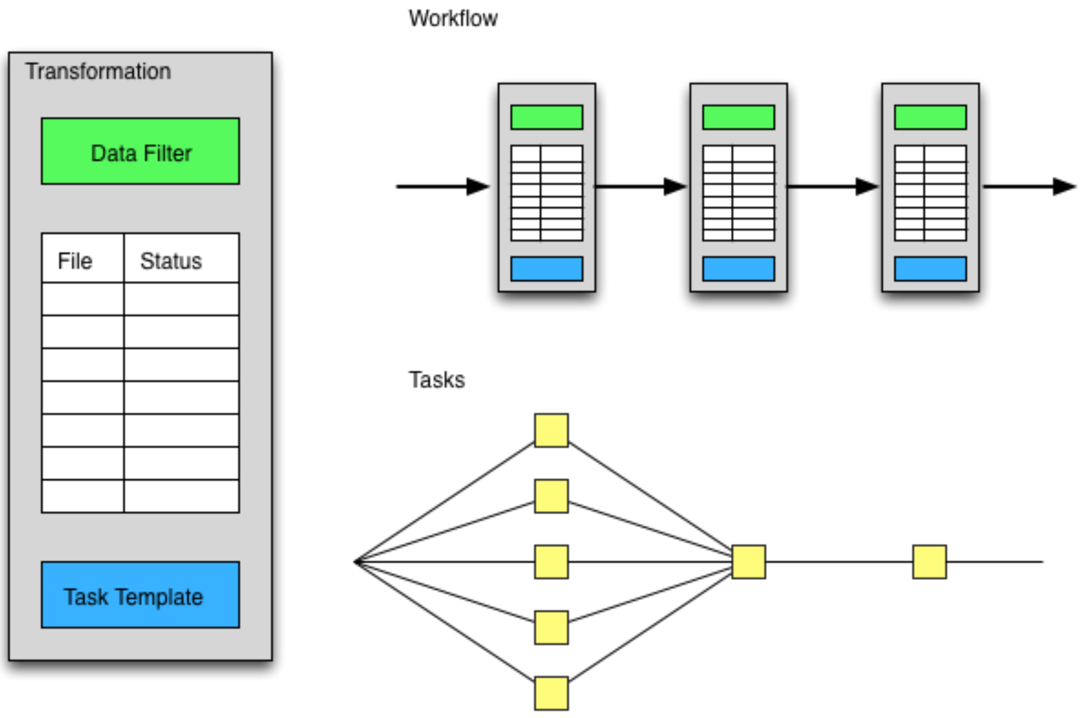
Managing workflows

Massive operations

- DIRAC can deal with large numbers of jobs
  - > 100K simultaneously running jobs
  - > 10M jobs in the WMS
- DIRAC can deal with large volumes of scientific data
  - 10's of Petabytes
  - 10^7-10^8 of files and directories
- There is a need for massive (bulk) operations
  - Examples:
    - Submit and monitor 50K jobs
    - Replicate 10^5 files from SE A to SE B
    - Remove 10^5 files and all their replicas in all the storages
- Massive operations supported
  - Asynchronous execution
  - Automatic failure recovery
  - Data integrity checking
  - Automated data driven workflows

Transformation System for data driven workflows

- 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 submission
    - Data replication, removal
    - *etc*
- Transformations can be used for automatic data driven bulk data operations
  - Scheduling RMS tasks
  - Often as part of a more general workflow



DIRAC Framework

DIRAC Framework

- DIRAC systems consist of well defined components with clear recipes for developing

  Services

  passive components reacting to client request

  Keep their state in a database

  Agents

  Light permanently running distributed components, animating the whole system

  Clients

  Used in user interfaces as well as in agent-service, service-service communications

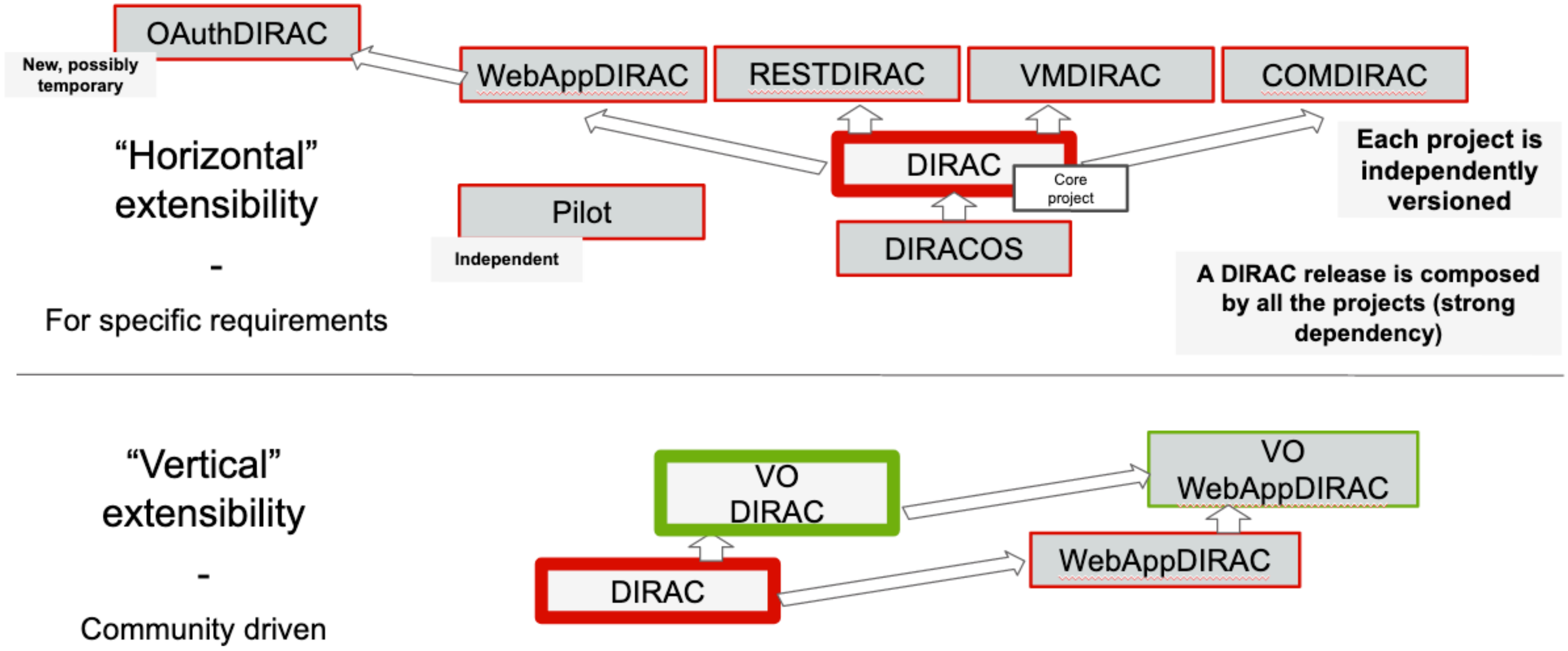
DIRAC THE INTERWARE

DIRAC Framework

- The Framework allows to easily build these components concentrating on the business logic of the applications
  - Development environment: Python, MySQL
  - Using framework services (configuration, service discovery, access control, etc)
  - Specific functionality can be provided in many cases as plugin modules, e.g.
    - Data access policies
    - Job scheduling policies

Extending DIRAC

- Adding new general or community specific functionalities
  - Or overriding existing algorithms
- Tools for extensions packaging and deployment
  - Example extensions in the EGI DIRAC installation
    - EiscatDIRAC: File Catalog with custom file ACLs
    - EscapeDIRAC: Corsica application portal



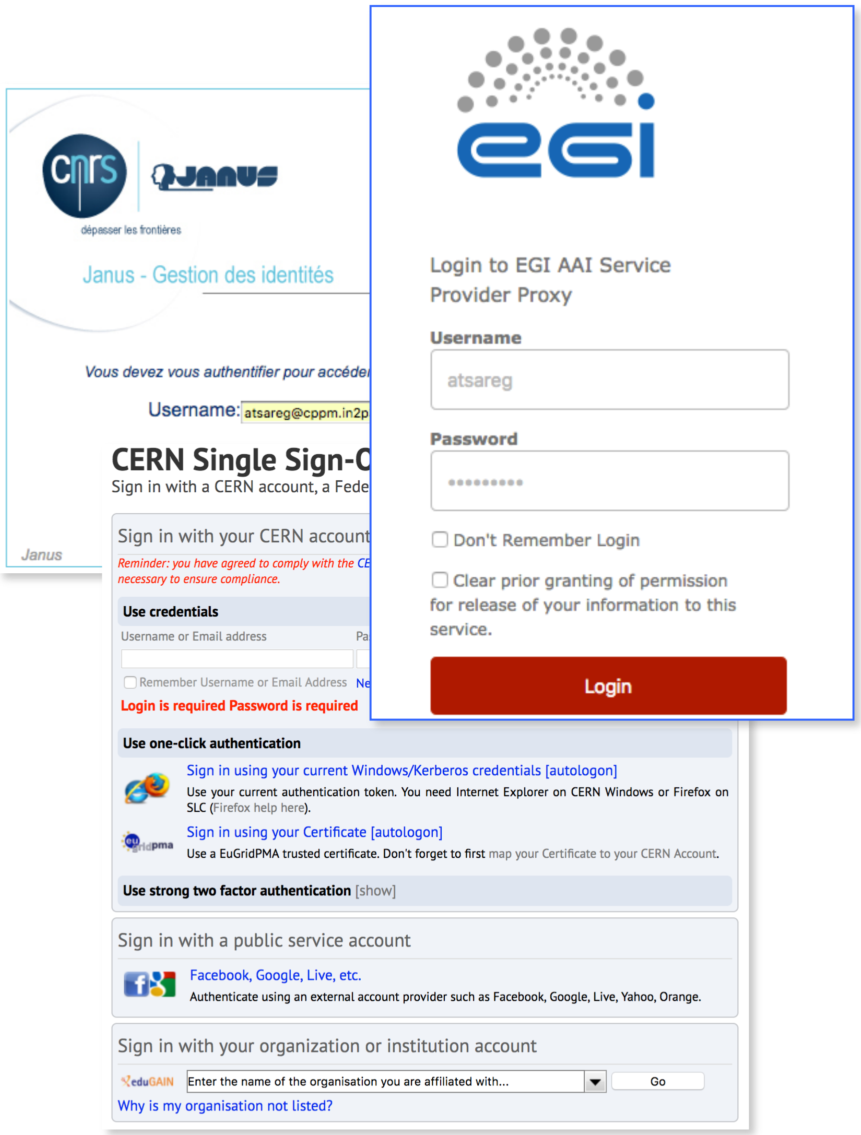
DIRAC is evolving

- Several ongoing developments
  - dips:// $\longrightarrow$ https://
    - **dips**: proprietary DIRAC protocol for RPC calls
    - **http(s)**: frameworks already exists in python 2&3 for server-side (*tornado* framework) and client side (*requests* Python module)
  - Python 3
    - Migration started, first production release next year
      - DIRAC client in Python 3 available before
  - DIRAC $\longleftrightarrow$ Rucio bridge
    - Development in the context of Belle II and SKA collaborations

DIRAC THE INTERWARE

SSO solutions

- There are multiple examples of SSO solutions
- The EGI Check-in service enables access to EGI services and resources using federated authentication mechanisms
  - A hub between federated Identity Providers (IdPs) and Service Providers (SPs) that are part of EGI



cnrs dépasser les frontières JANUS

Janus - Gestion des identités

Vous devez vous authentifier pour accéder

Username: atsareg@cppm.in2p

Janus

CERN Single Sign-O

Sign in with a CERN account, a Fede

Sign in with your CERN account

Reminder: you have agreed to comply with the CE necessary to ensure compliance.

Use credentials

Username or Email address | Pa

Remember Username or Email Address | Ne

Login is required Password is required

Use one-click authentication

Sign in using your current Windows/Kerberos credentials [autologon]

Use your current authentication token. You need Internet Explorer on CERN Windows or Firefox on SLC (Firefox help here).

Sign in using your Certificate [autologon]

Use a EuGridPMA trusted certificate. Don't forget to first map your Certificate to your CERN Account.

Use strong two factor authentication [show]

Sign in with a public service account

Facebook, Google, Live, etc.

Authenticate using an external account provider such as Facebook, Google, Live, Yahoo, Orange.

Sign in with your organization or institution account

eduGAIN Enter the name of the organisation you are affiliated with... Go

Why is my organisation not listed?

egi

Login to EGI AAI Service Provider Proxy

Username: atsareg

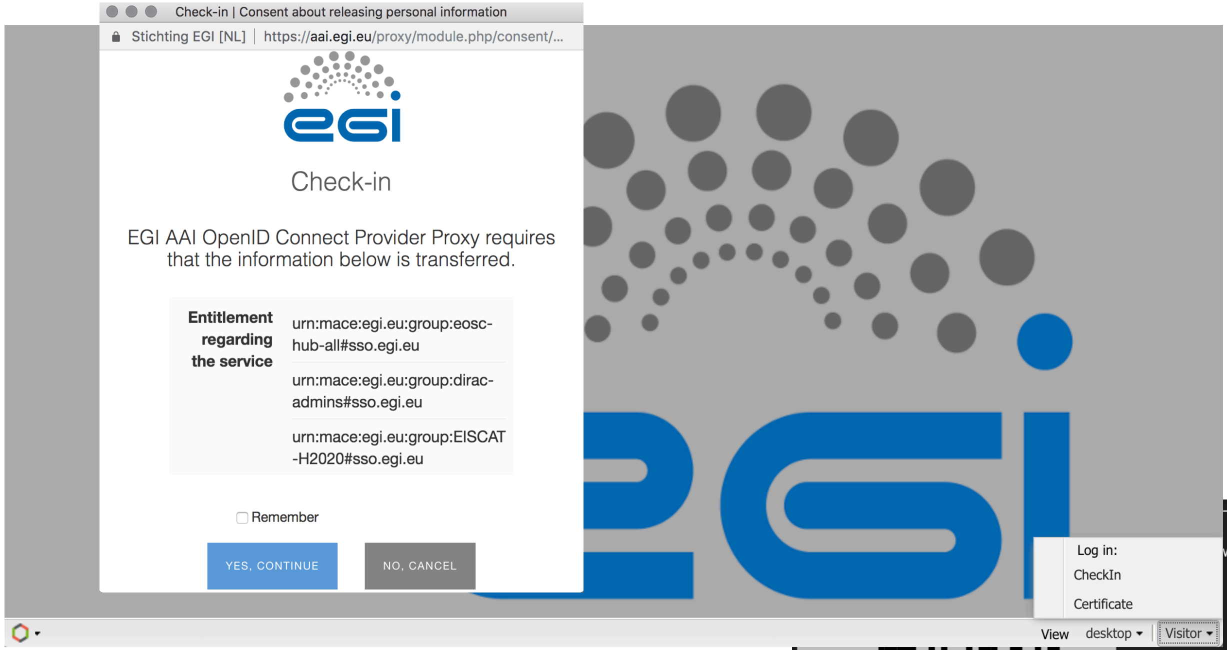
Password: •••••••••

Don't Remember Login

Clear prior granting of permission for release of your information to this service.

Login

Oauth/OIDC Authentication



Check-in | Consent about releasing personal information

Stichting EGI [NL] | https://aai.egi.eu/proxy/module.php/consent/...

Check-in

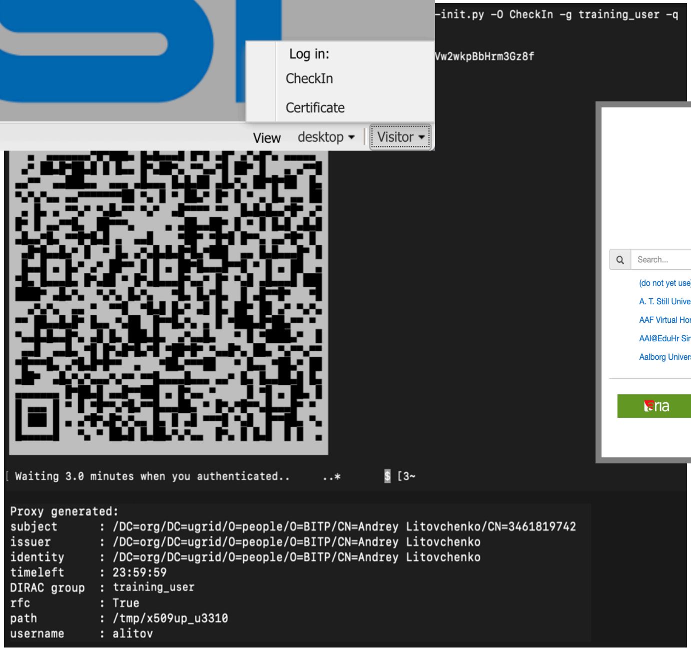
EGI AAI OpenID Connect Provider Proxy requires that the information below is transferred.

Entitlement regarding the service	urn:mace:egi.eu:group:eosc-hub-all#sso.egi.eu
	urn:mace:egi.eu:group:dirac-admins#sso.egi.eu
	urn:mace:egi.eu:group:EISCAT-H2020#sso.egi.eu

☐ Remember

Web Portal

functional prototype

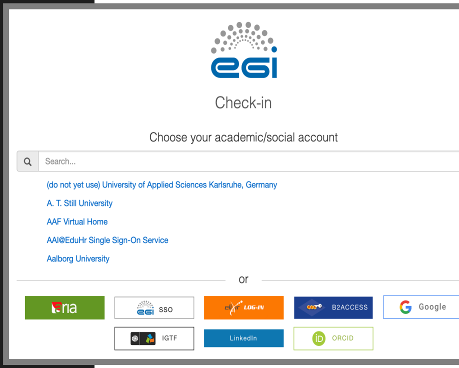


```
-init.py -O CheckIn -g training_user -q

Vw2wkpBbHrm3Gz8f

Waiting 3.0 minutes when you authenticated..     ..*

Proxy generated:
subject      : /DC=org/DC=ugrid/O=people/O=BITP/CN=Andrey Litovchenko/CN=3461819742
issuer       : /DC=org/DC=ugrid/O=people/O=BITP/CN=Andrey Litovchenko
identity     : /DC=org/DC=ugrid/O=people/O=BITP/CN=Andrey Litovchenko
timeleft     : 23:59:59
DIRAC group  : training_user
rfc          : True
path         : /tmp/x509up_u3310
username     : alitov
```



Check-in

Choose your academic/social account

(do not yet use) University of Applied Sciences Karlsruhe, Germany
A. T. Still University
AAF Virtual Home
AAI@EduHr Single Sign-On Service
Aalborg University

Command Line

functional prototype

Conclusions

- Large scientific communities have to employ various geographically distributed computing and storage resources
- DIRAC provides a framework for building distributed computing systems aggregating multiple types of resources
- DIRAC provides an integrated solution with a reach set of ready to use services for managing computing resources, application workloads and data
- DIRAC modular architecture allows for extending the existing functionality to build high level services specific for particular user communities and architectures

http://diracgrid.org

DIRAC THE INTERWARE

Acknowledgement

This work is co-funded by EGI and the EOSC-hub project (Horizon 2020) under Grant number 777536

Useful links

- DIRAC Project site: http://diracgrid.org
- Guides: https://dirac.readthedocs.io/en/latest/
- Tutorials: https://github.com/DIRACGrid/DIRAC/wiki/DIRAC-Tutorials