
The DIRAC interware

current, upcoming and planned capabilities
and technologies

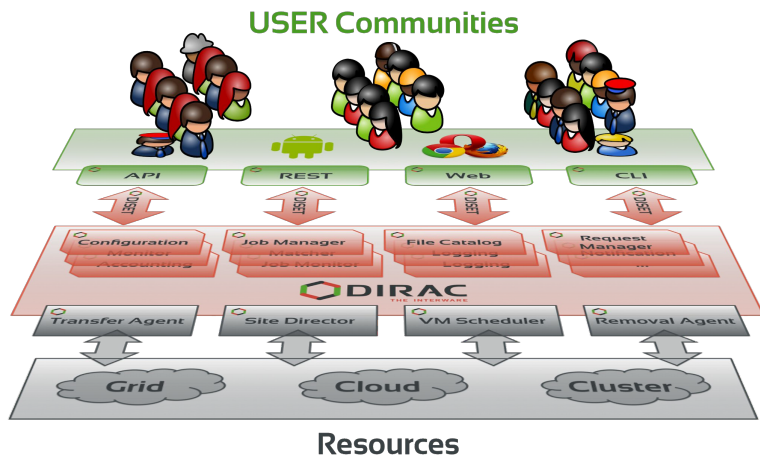


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on behalf of the DIRAC consortium

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DIRAC: the interware

- A software framework for distributed computing
- A **complete** solution to one (or more) user community
- Builds a layer between users and resources



- Started as an LHCb project, experiment-agnostic in 2009
- Developed by communities, for communities
 - Open source (GPL3+), [GitHub](#) hosted
 - Python 2.7 (python 3 in development)
 - No dedicated funding for the development of the “Vanilla” project
 - Publicly [documented](#), active [assistance forum](#), yearly [users workshops](#), open [developers meetings](#) and [hackathons](#)
- The DIRAC consortium as representing body

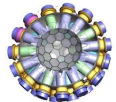


A *framework* shared by multiple experiments/projects,
both inside HEP, astronomy, and life science

Experiment agnostic

Extensible

Flexible



Jobs and files

WMS and DMS

[WMS] resources federation

**Pilots are the
“federators”**

Send them

as “pilot jobs” (via a CE)

Or just **Run them!**

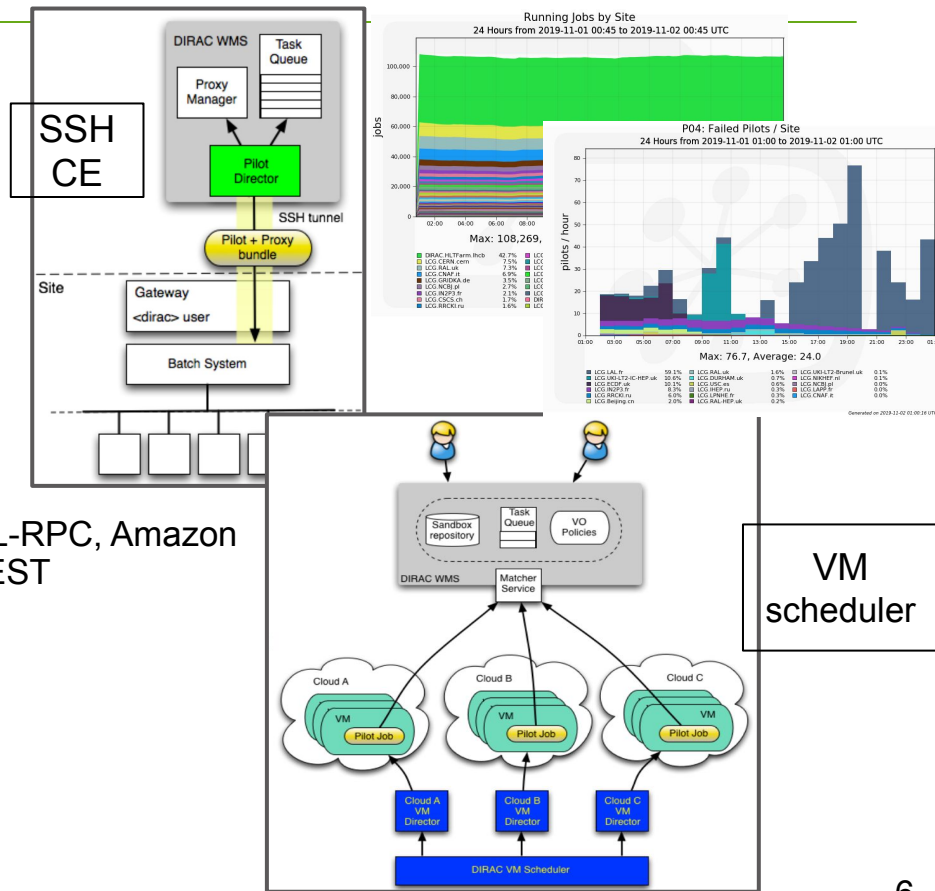
e.g. as part of the contextualization of a (V)M

OR

“Make a machine a pilot machine, and you are done”

[WMS] Computing resources

- **Grids** (EGI, OSG, NorduGRID)
 - CREAM, HTCondor, ARC
- **Clusters** behind a BS
 - access through SSH/GSISSH tunnel
 - a really thin layer that we call “SSH CE”
- **Vacuum:**
 - VAC/vcycle resources
 - BOINC Volunteer resources
 - HLT farm (LHCb)
- **VMs scheduler:**
 - Openstack, Keystone v2 & v3, OpenNebula XML-RPC, Amazon EC2 (boto2), Apache libcloud, rocci cli, OCCl REST
 - Contextualization from standard images
 - with, at least, the DIRAC pilot
- **HPC sites**
 - see later



Basics of DMS:

- **LFNs**: 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)

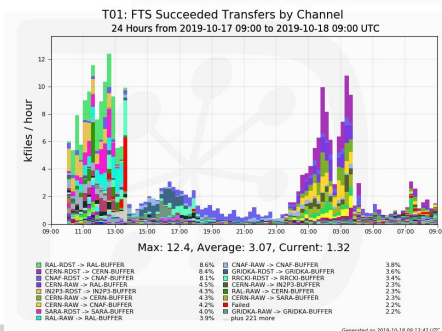
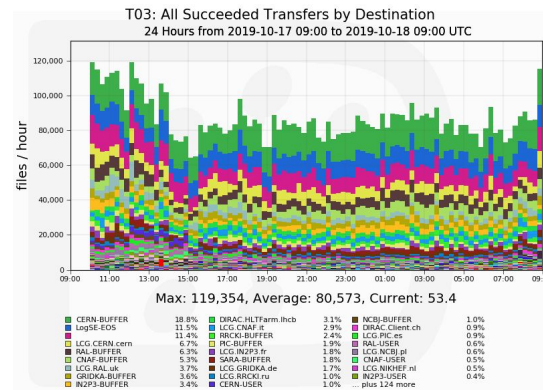
- LFNs *may* have **PFNs**, stored in **SEs**.

Physical File Name on Storage Elements

(and SEs are monitored, within the DIRAC Resource Status System)

- You can access those PFNs with several protocols.

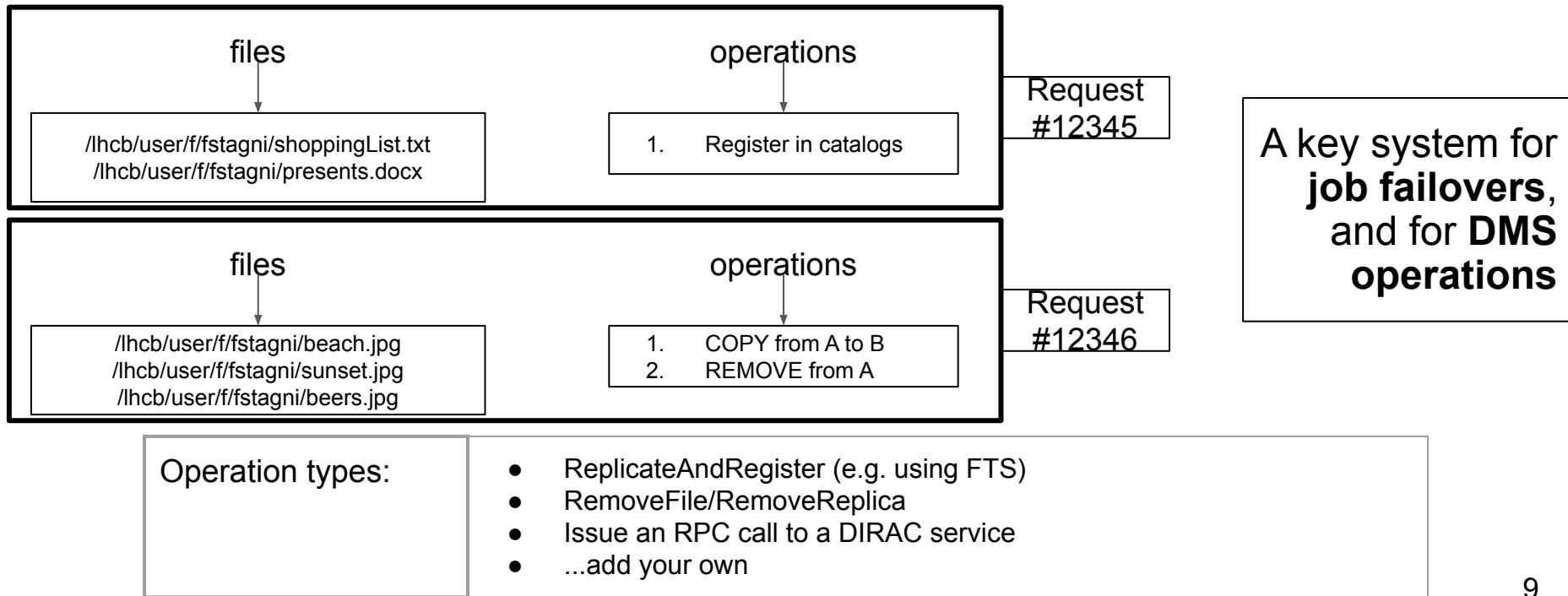
e.g. root, gsiftp, srm, http, file, dip
(and can also be brought online - i.e. staged)



Productions and datasets

Request management system

A generic, flexible system, which can be used for queueing *operations* (on files, but not only)
like a to-do list



A generic system for queueing similar *operation types* on certain *datasets* and forward them to the appropriate *systems*

An *operation type* can be, e.g.:

- a simulation workflow
- a reconstruction workflow
- a replication
- a removal
- ...

A *dataset* is split into groups, based on criterias defined by *plugins*, e.g.:

- split by size
- by destination
- by metadata
- ... [code it]

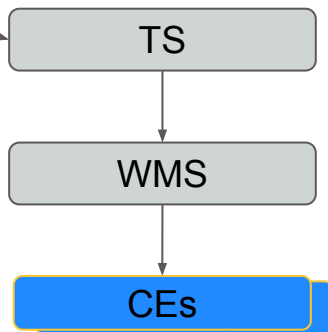
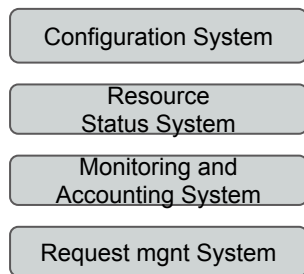
A *system* is either (today) the DIRAC WMS (for productions) or the DIRAC RMS (for dataset management operation types)

[DMS] example (for dataset management): Take all my holidays pictures from 2018 with tag='sunset', make sure that there is one copy on tape and one on disk, distributed on all the sites according to free space, and group the operations by group of at most 100 files.

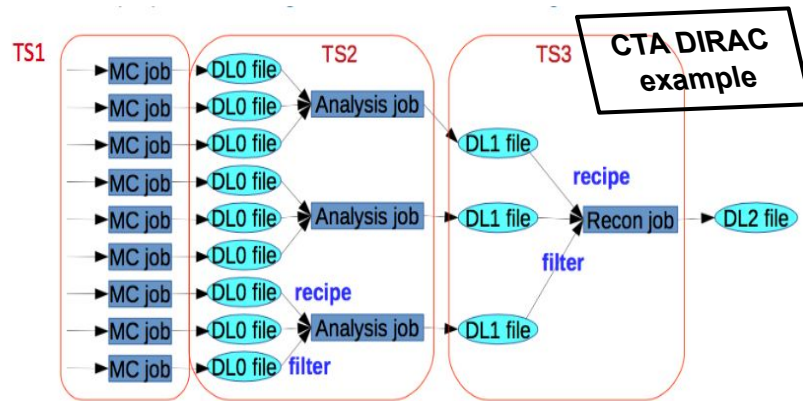
[WMS] example (for jobs productions): Take all my holidays pictures from 2018 with tag='sunset', make sure to run (only once) the 'red-enhancer' workflow on each one of them, using only Tier2 sites.

DIRAC Transformation System + WMS: for single productions

(Transformation APIs)



DIRAC Productions System: chaining job productions together



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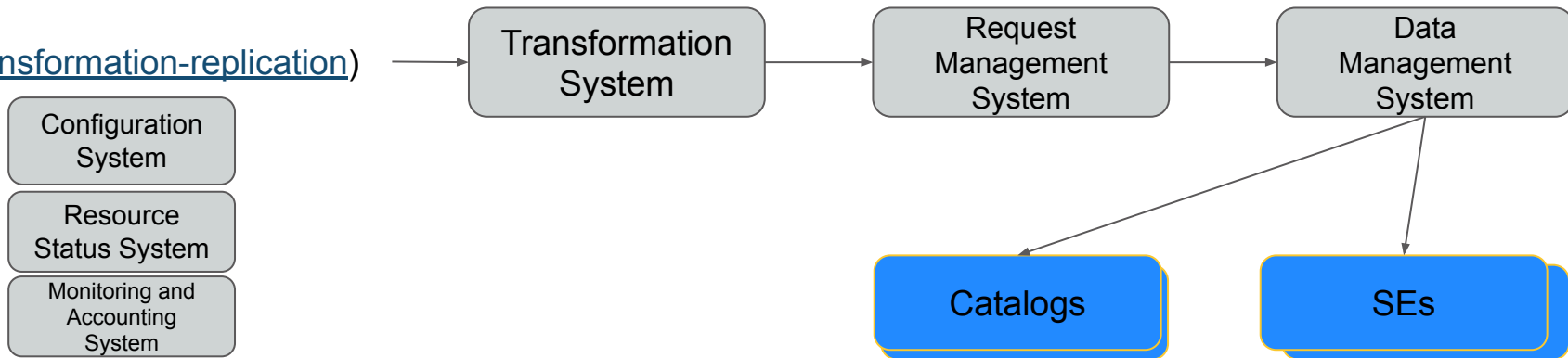
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[DMS] Dataset management

([dirac-transformation-replication](#))



Selections:

Status:

Agent Type:

Type:

Group:

Plugin:

Time span:

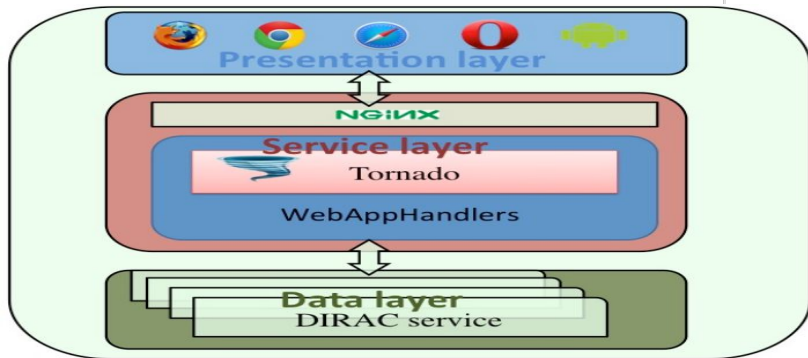
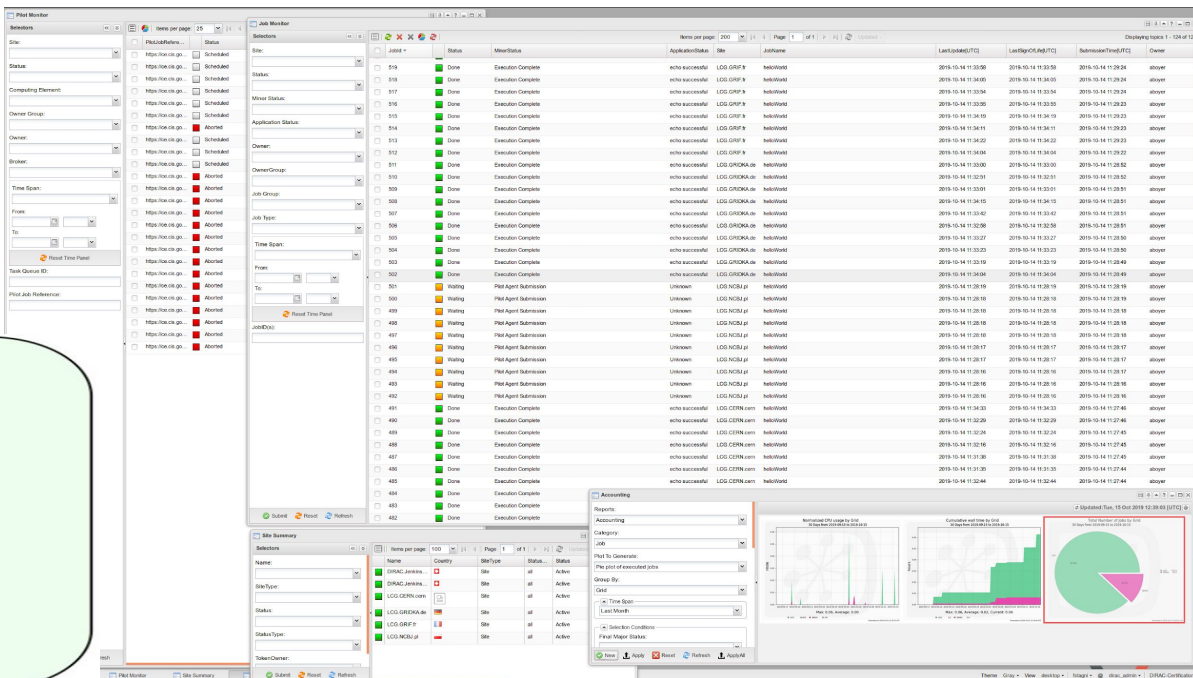
ProductionIDs:

RequestIDs:

Status	Agent Type	Type	Name	Files	Processed (%)	Created	Total Created	Submitted	Matched	Checking	Waiting	Staging	Rescheduled	Killed	Running	Scheduled	Done	Completed	Failed
Active	Automatic	Replication	Replication...	186670	57.2	0	186670	0	0	0	0	0	0	0	0	0	0	0	0
Active	Automatic	Replication	Replication...	388731	99.1	0	388731	0	0	0	0	0	0	0	0	0	0	0	0
Idle	Automatic	Replication	Replication...	28	100.0	0	28	0	0	0	0	0	0	0	0	0	0	0	0
Idle	Automatic	Replication	Replication...	216	100.0	0	216	0	0	0	0	0	0	0	0	0	0	0	0
Idle	Automatic	Replication	Replication...	2216	100.0	0	2216	0	0	0	0	0	0	0	0	0	0	0	0
Idle	Automatic	Replication	Replication...	6	100.0	0	6	0	0	0	0	0	0	0	0	0	0	0	0
Idle	Automatic	Replication	Replication...	6	100.0	0	6	0	0	0	0	0	0	0	0	0	0	0	0
Idle	Automatic	Replication	Replication...	18	100.0	0	18	0	0	0	0	0	0	0	0	0	0	0	0
Idle	Automatic	Replication	Replication...	589	100.0	0	589	0	0	0	0	0	0	0	0	0	0	0	0
Idle	Automatic	Replication	Replication...	914	100.0	0	914	0	0	0	0	0	0	0	0	0	0	0	0
Idle	Automatic	Replication	Replication...	176	100.0	0	176	0	0	0	0	0	0	0	0	0	0	0	0
Manual	Manual	Replication	Replication...	322	100.0	0	322	0	0	0	0	0	0	0	0	0	0	0	0
Manual	Manual	Replication	Replication...	1338	100.0	0	1338	0	0	0	0	0	0	0	0	0	0	0	0
Manual	Manual	Replication	Replication...	16	100.0	0	16	0	0	0	0	0	0	0	0	0	0	0	0
Manual	Manual	Replication	Replication...	16	100.0	0	16	0	0	0	0	0	0	0	0	0	0	0	0
Active	Automatic	Replication	Replication...	93	92.4	0	78	0	0	1	0	0	0	0	0	0	0	0	0
Active	Automatic	Replication	Replication...	3874	99.0	0	3874	0	0	0	0	0	0	0	0	0	0	0	0
Active	Automatic	Replication	Replication...	11659	99.9	0	1411	0	0	0	0	0	0	0	0	0	0	0	0
Active	Automatic	Replication	Replication...	15	100.0	0	2	0	0	0	0	0	0	0	0	0	0	0	0
Active	Automatic	Replication	Replication...	311	100.0	0	7	0	0	0	0	0	0	0	0	0	0	0	0
Active	Automatic	Replication	Replication...	1302	99.9	0	195	1	0	0	0	0	0	0	0	0	0	0	0
Active	Automatic	Replication	Replication...	541	100.0	0	9	0	0	0	0	0	0	0	0	0	0	0	0
Active	Automatic	Replication	Replication...	1700	97.2	0	543	0	0	0	0	0	0	0	0	0	0	0	0
Active	Automatic	Replication	Replication...	349	100.0	0	16	0	0	0	0	0	0	0	0	0	0	0	0
Active	Automatic	Replication	Replication...	771	100.0	0	70	0	0	0	0	0	0	0	0	0	0	0	0
Active	Automatic	Replication	Replication...	189	100.0	0	4	0	0	0	0	0	0	0	0	0	0	0	0
Active	Automatic	Replication	Replication...	738	100.0	0	23	0	0	0	0	0	0	0	0	0	0	0	0
Active	Automatic	Replication	Replication...	21341	99.9	0	866	1	0	0	0	0	0	0	0	0	0	0	0
Active	Automatic	Replication	Replication...	40	100.0	0	19	0	0	0	0	0	0	0	0	0	0	0	0
Active	Automatic	Replication	Replication...	264	100.0	0	15	0	0	0	0	0	0	0	0	0	0	0	0
Active	Automatic	Replication	Replication...	179	100.0	0	22	0	0	0	0	0	0	0	0	0	0	0	0
Active	Automatic	Replication	Replication...	662	99.9	0	29	0	0	0	0	0	0	0	0	0	0	0	0
Active	Automatic	Replication	Replication...	101	100.0	0	11	0	0	0	0	0	0	0	0	0	0	0	0
Active	Automatic	Replication	Replication...	32	100.0	0	14	0	0	0	0	0	0	0	0	0	0	0	0
Active	Automatic	Replication	Replication...	603	100.0	0	36	0	0	0	0	0	0	0	0	0	0	0	0
Active	Automatic	Replication	Replication...	656	99.8	0	245	0	0	0	0	0	0	0	0	0	0	0	0
Active	Automatic	Replication	Replication...	392	100.0	0	285	0	0	0	0	0	0	0	0	0	0	0	0

- Web users' interface
- Frontend: ExtJS6
- Backend: tornado, NGINX

- Each system has its own Web application

The screenshot displays the DIRAC WebApp interface, which is a complex web application for monitoring and managing jobs. It features several panels and a large data table.

Job Monitoring Panel: This panel shows a list of jobs with columns for Name, Country, Site, JobType, Status, and StatusType. The jobs are listed in a table with a search bar and filters on the left.

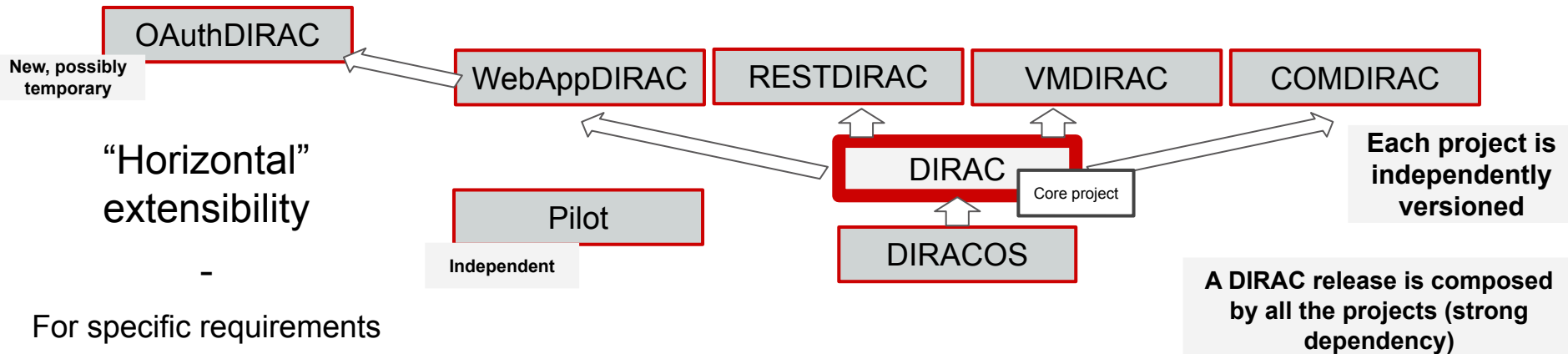
Job Summary Panel: This panel provides a summary of the jobs, including a bar chart showing the distribution of jobs by site and a pie chart showing the distribution of jobs by status.

Job Details Panel: This panel shows the details of a specific job, including its status, progress, and a list of related jobs.

Job Log Panel: This panel shows the log of a specific job, including the application status, owner, and owner group.

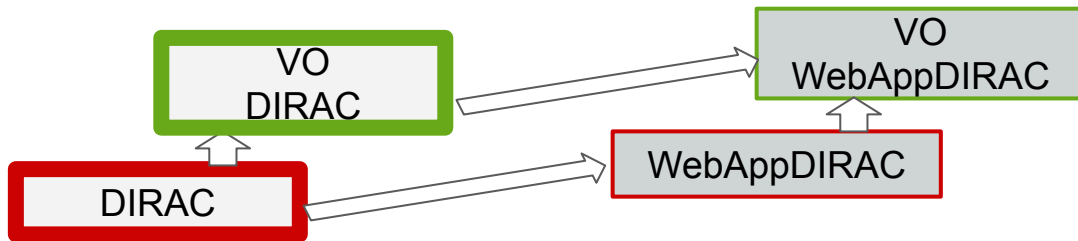
Job Summary Table: The main table in the interface, listing jobs with columns for Name, Country, Site, JobType, Status, StatusType, ApplicationStatus, ApplicationName, ApplicationID, ApplicationOwner, ApplicationGroup, ApplicationStatus, ApplicationName, ApplicationID, ApplicationOwner, ApplicationGroup, ApplicationStatus, ApplicationName, ApplicationID, ApplicationOwner, ApplicationGroup.

Experiment agnostic, and extensibility



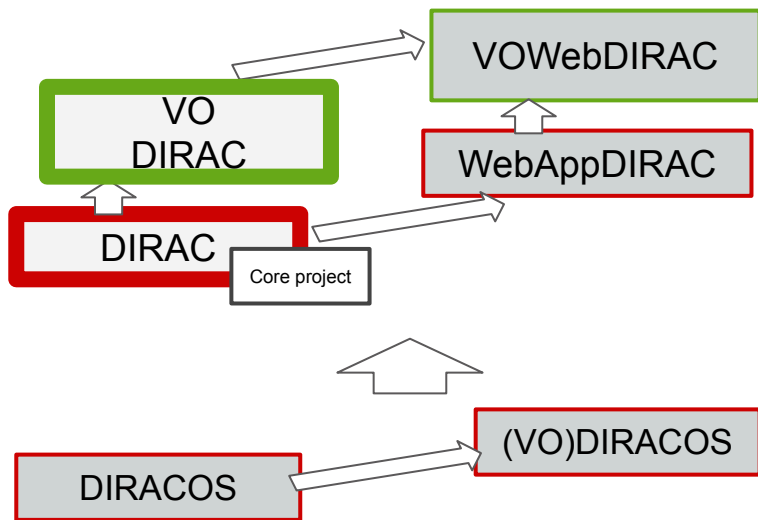
Vertical extensibility

Community driven



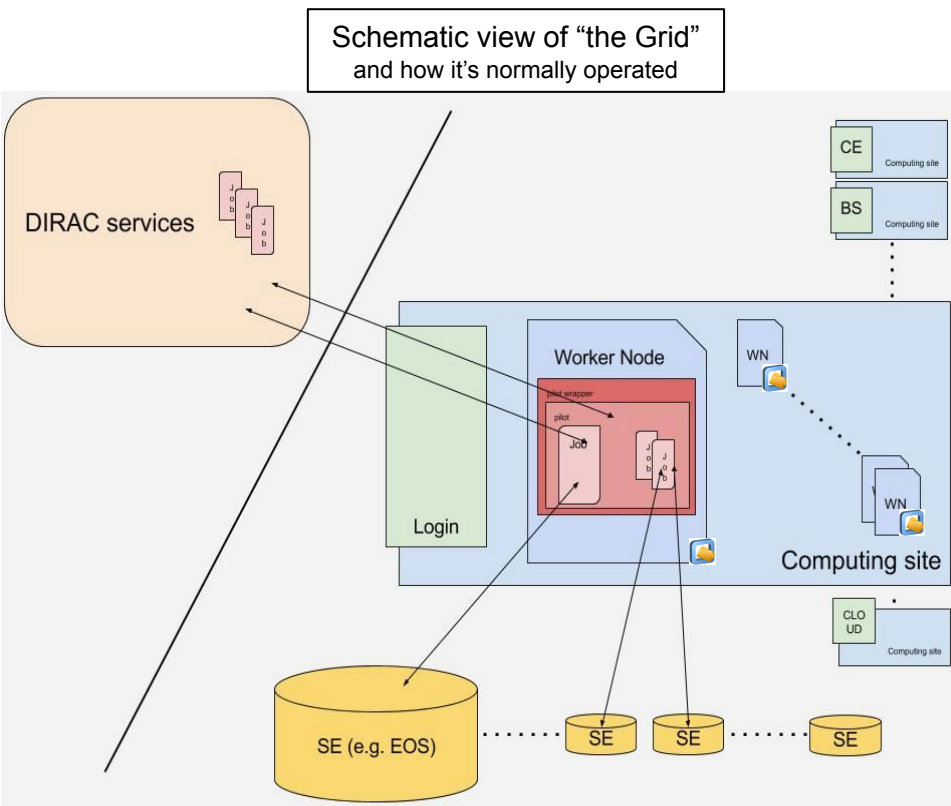
Recent and ongoing developments

DIRACOS



- New way of packaging (VO)DIRAC dependencies
- Based on Fedora Mock and Yum repo
- Simple grammar
- Extensible
- Testable
- Automated build
- ...already thinking at v2 with Conda
- On [github](#)
- More in this [pres](#)

General HPC challenges: distributed computing



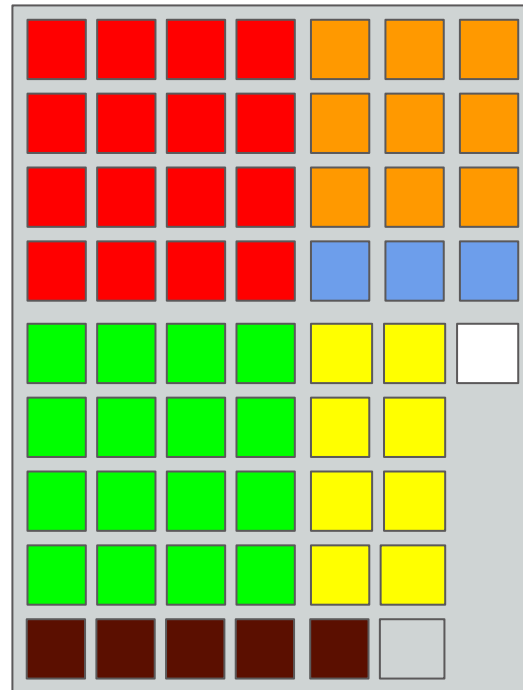
~easy integration when:

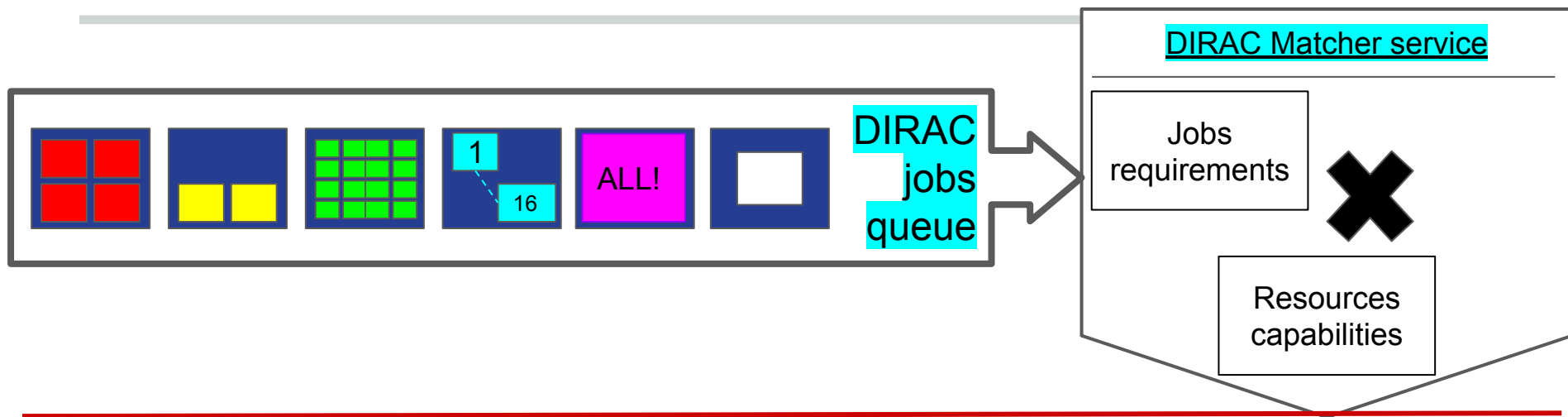
1. WNs have outbound connectivity
2. CVMFS endpoint(s) mounted on the WNs
(this is pretty common req)
3. SLC6 or CC7 "compatible", or Singularity. x86.
(this might or might not apply to you)

If some of the above is missing, work need to be done to address it. DIRAC has partial solutions for case 1.

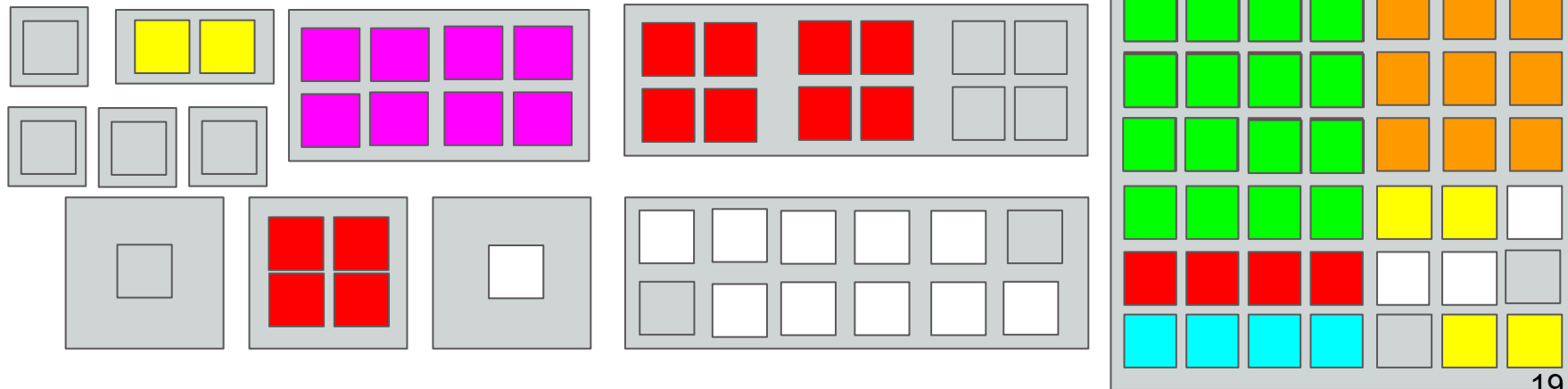
The case of fat nodes

- Exploiting many-core architectures
[LHCb has a case for running on nodes with 272 logical processors (CINECA)]
- DIRAC needs to “partition” the node for optimal memory and throughput (and maybe only use a subset of the logical processors)
 - Use DIRAC “Pool”, an [“inner Computing Element”](#)
 - Parallel jobs matching





Resources (1 pilot per box)



DIRAC

Jobs

Everything's (now) possible

from DIRAC v7r0p4

will be useful not only for HPCs

Reso

Until “yesterday”: X509 certificates, DIRAC groups, proxies, VOMS

- DIRAC can delegate AuthN to an external server
 - ensure provisioning of X509 certificate proxies
- Focus: OAuth/OIDC as “industry standards”
 - Use case: [EGI Check-in](#) SSO hub





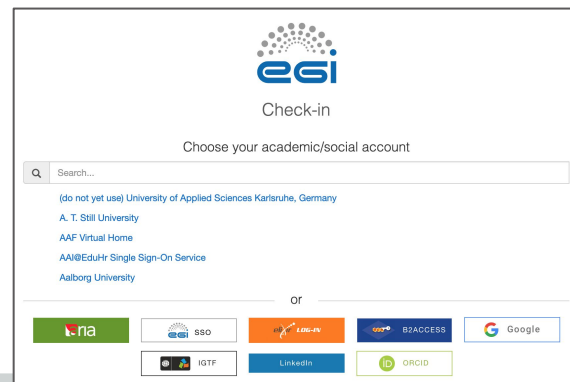
Web portal authentication

CLI authentication

```
[dirac@ce-emi pro]$ python DIRAC/FrameworkSystem/scripts/dirac-proxy-init.py -O CheckIn -g training_user -q
OAuth authentication from CheckIn.
Use link to authentication:
https://ce-emi.bitp.kiev.ua:9943/oauth2/oauth?getlink=MZ7Xn04yMYTx9Vw2wkpBbHrm30z8f

Waiting 3.0 minutes when you authenticated...

Proxy generated:
subject      : /DC=org/DC=upgrid/O=people/O=BITP/CN=Andrey Litovchenko/CN=3461819742
issuer       : /DC=org/DC=upgrid/O=people/O=BITP/CN=Andrey Litovchenko
identity     : /DC=org/DC=upgrid/O=people/O=BITP/CN=Andrey Litovchenko
timeleft     : 23:59:59
DIRAC group  : training_user
rfc          : True
path         : /tmp/x509up_u3318
username     : allitov
```



- `dips://` → `https://`
 - dips: proprietary protocol for RPC calls
 - http: frameworks already exists in python 2&3 for server-side (tornado) and client side (requests)
- Python 3
 - Migration started, first production release next year
 - DIRAC Pilot will move first (also b/c of CentOS8)
- Interfacing with INDIGO IAM (“after VOMS”)
- DIRAC ↔ Rucio bridge
- Containerizations (several)

Development and testing

~5 FTE as core developers, a dozen contributing developers

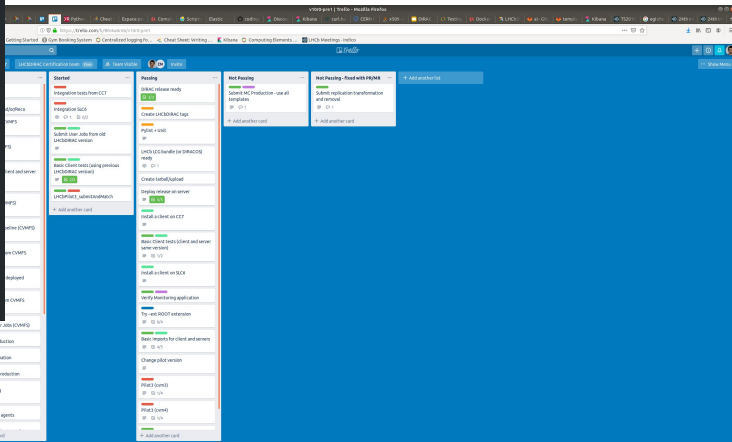
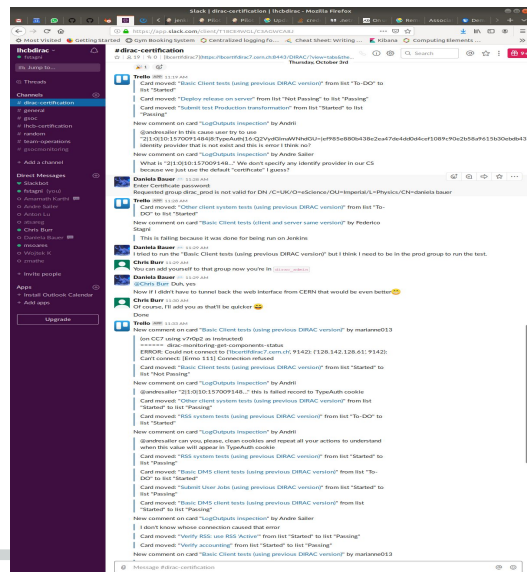
Tests, certification, integration process is a daily work.

- We use GitHub Actions, GitLab CI/CD (Travis, Jenkins...)
- We run certification hackathons

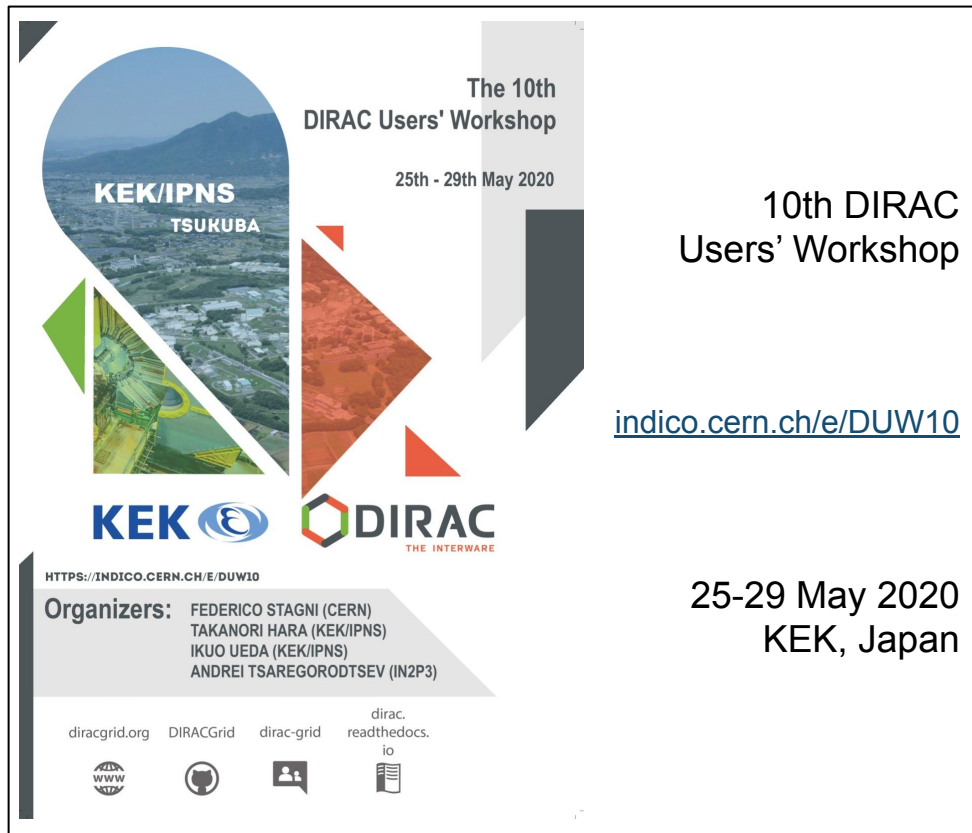
```

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2 successful 2 hours ago in 18m 7s
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```

- diracgrid.org
- dirac.readthedocs.io
 - including [code documentation](#)
- Ops and general questions: Google [forum](#)
- Dev and DevOps issues: on [github](#)
- Bi-weekly developers meetings (and/or hackathons): [BILD](#)



The 10th
DIRAC Users' Workshop

25th - 29th May 2020

KEK/IPNS
TSUKUBA

indico.cern.ch/e/DUW10

10th DIRAC
Users' Workshop

25-29 May 2020
KEK, Japan

[HTTPS://INDICO.CERN.CH/E/DUW10](https://indico.cern.ch/e/DUW10)

Organizers: FEDERICO STAGNI (CERN)
TAKANORI HARA (KEK/IPNS)
IKUO UEDA (KEK/IPNS)
ANDREI TSAREGORODTSEV (IN2P3)

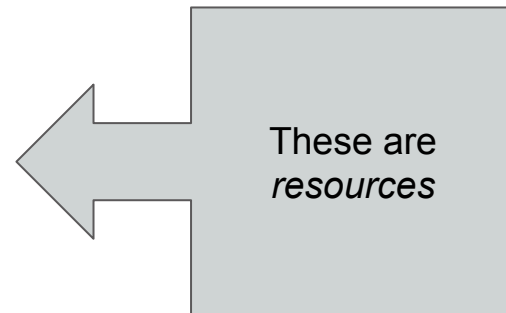
diracgrid.org [DIRACGrid](#) [dirac-grid](#) dirac.readthedocs.io

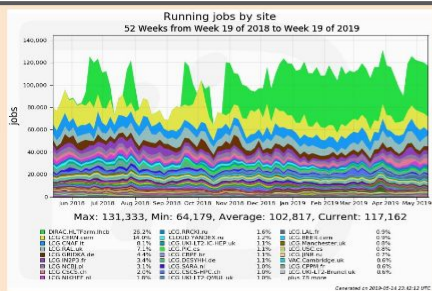
?

... a few examples of what DIRAC can be used for

- sending jobs to “the Grid”
 - the obvious one...
 - interfacing with different *sites*
 - with different *computing elements*
 - and *batch systems*
 - with different *storage elements*
 - interfacing with different *information systems*
 - interfacing with different *catalogs*
 - interfacing with different *MQs, DBs*
 - authenticate through different *providers*
-
- managing “productions” (e.g. reconstruction, simulation...)
 - managing dataset transfers
 - and removals...
 - providing a failover system
 - your jobs won’t fail because a certain SE is down, nor because of central service are down
 - transfer data from the experiment to a Grid SE
 - monitor your resources with a policy-based system
 - ... and more

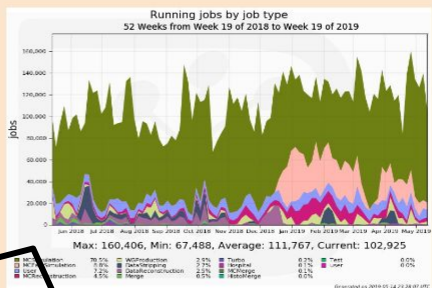
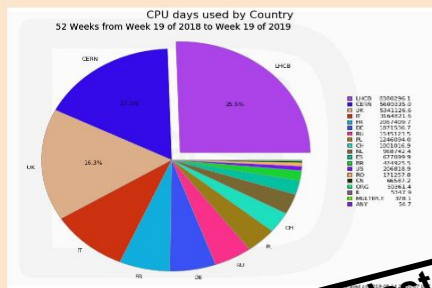


- **Computing**
 - **CEs**: ARC, CREAM, HTCondor, “SSH” for standalone BS, ...
 - **Batch**: LSF, BQS, SGE, PBS/Torque, SLURM, Condor,...
 - Clouds, BOINC, HPC, “desktops”
- **Storage**
 - SRM2, GSIFTP, XRoot, http, DIPs, ...
 - EOS, Castor, DPM, dCache, StoRM, ECHO, CTA, ...
- **Catalog**
 - DIRAC FC, LFC, (Rucio), [LHCb Bookkeeping], ...
- **Information services**
 - BDII, GOCDB, CRIC...
- **IdProviders**
- **ProxyProviders**
 - VOMS, OAuth2, PUSP...
- **DBs, MQs, LogBackends**
 - MySQL, Oracle, ElasticSearch
 - stomp → ActiveMQ, RabbitMQ
 - file, MQ, ES
 - and logs centralization is easy to set up



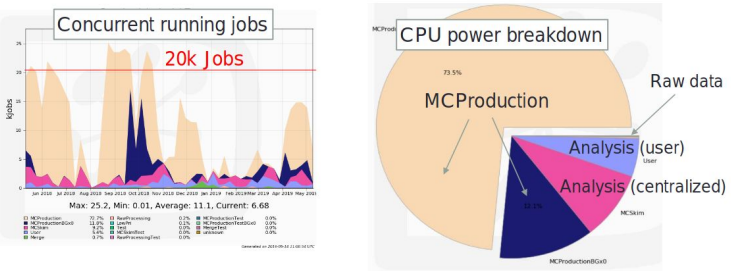
LHCb activities in the last year

- HLTfarm works even during data taking
- LHCb 25%
- CERN
- UK, IT, FR, DE
- RU, PL, CH,



- MCSimulation
- MCFastSimulation
- User
-

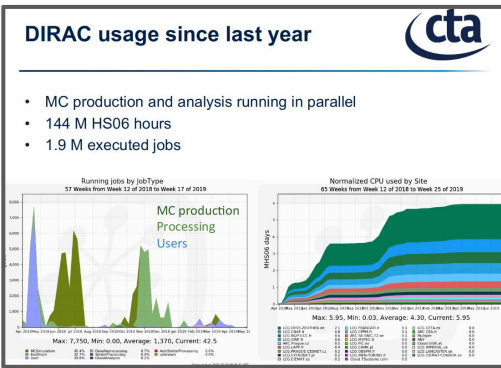
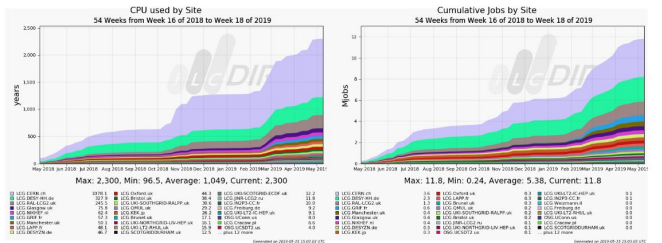
Belle II computing performance in a year



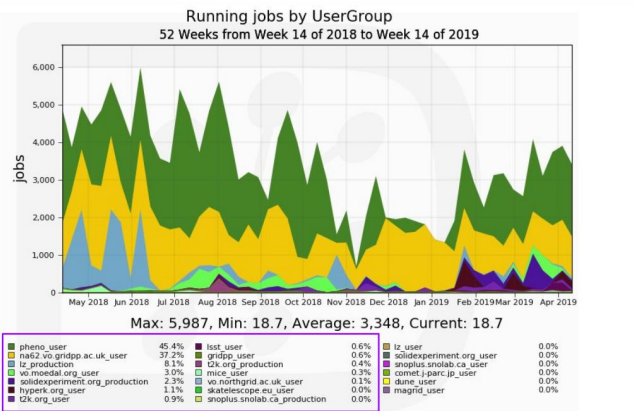
- Consumed CPU power is not so different from last year
- Resource usage is getting practical
 - Increasing analysis jobs
 - Increasing raw (beam and cosmic ray) data processing

From last DIRAC users' workshop

Usage



Business as usual - just more of it (Success!)



2.3k CPU Years, 11.8M Jobs