

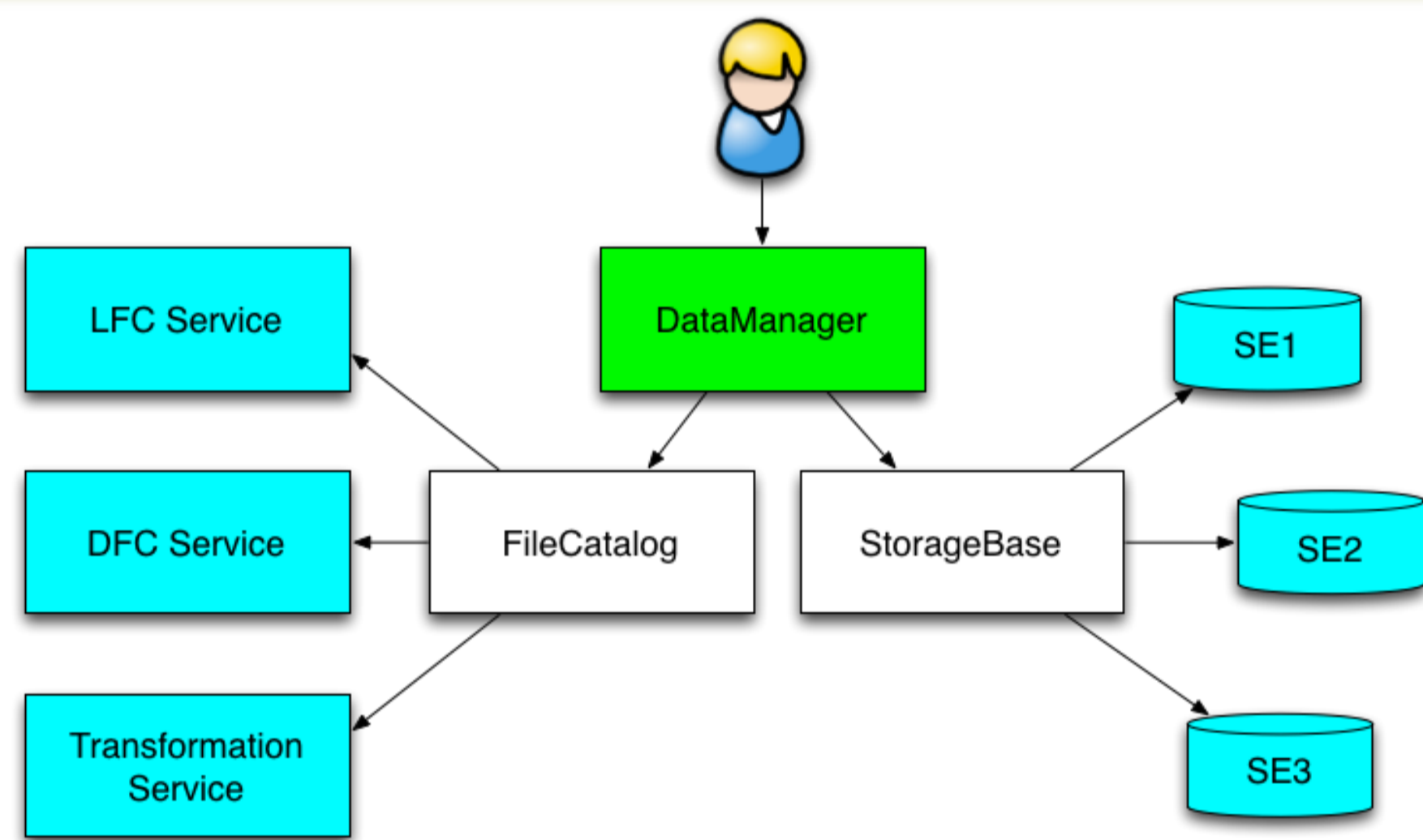
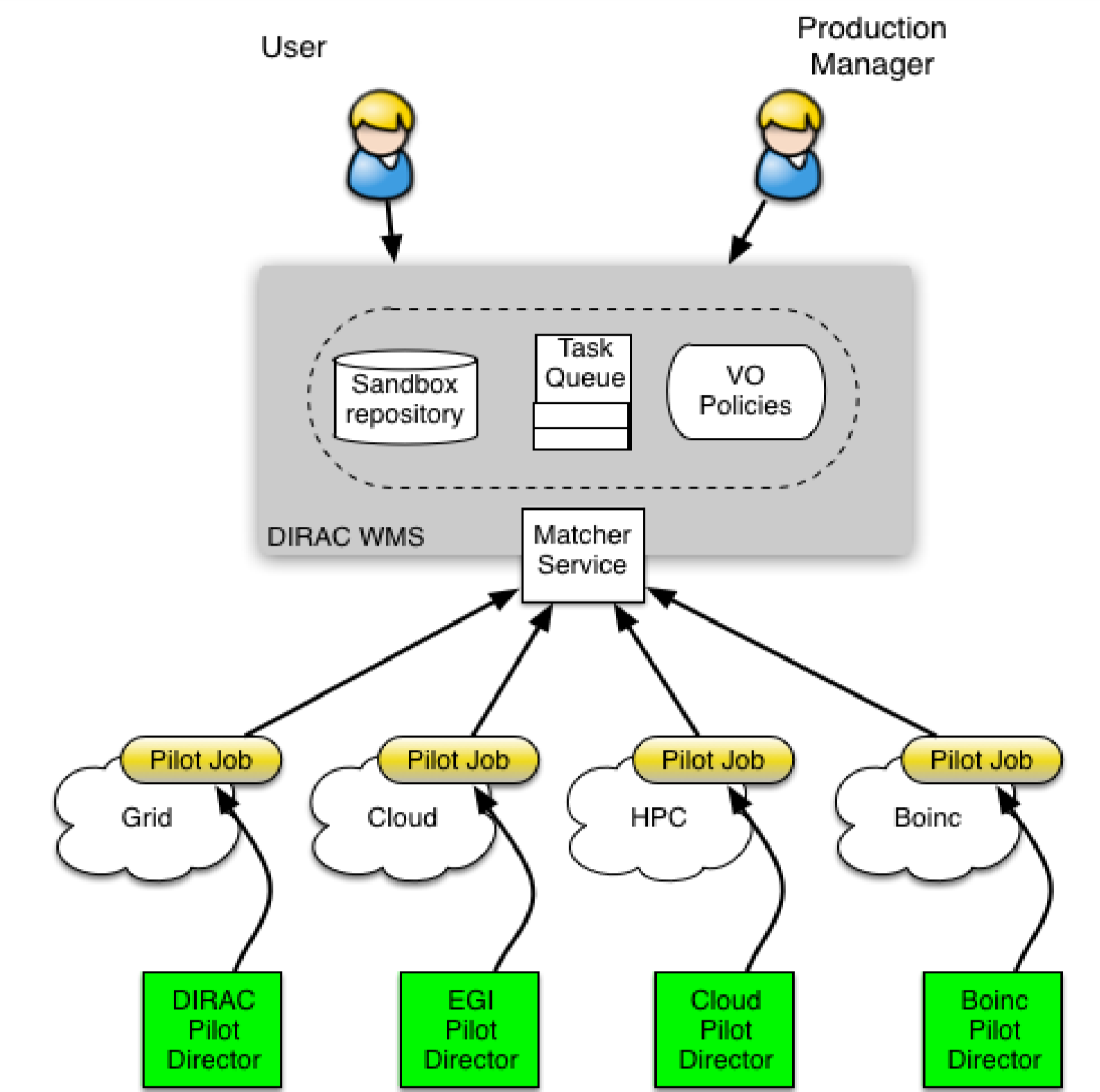
- Interware** is a layer between users and computing resources
- Software framework for building distributed computing infrastructures
 - A rich set of systems providing a complete solution for single or multiple user communities
 - Seamless integration of heterogeneous computing and storage resources
 - Friendly user interfaces hiding the complexity of the distributed infrastructure

DIRAC Workload Management System, based on the paradigm of pilot jobs, provides several crucial advantages:

- Efficient user job execution with a low failure rate
- Efficient enforcement of resource usage policies for large communities
- Easy integration of additional computing resources

Computing resources of several kinds can be integrated:

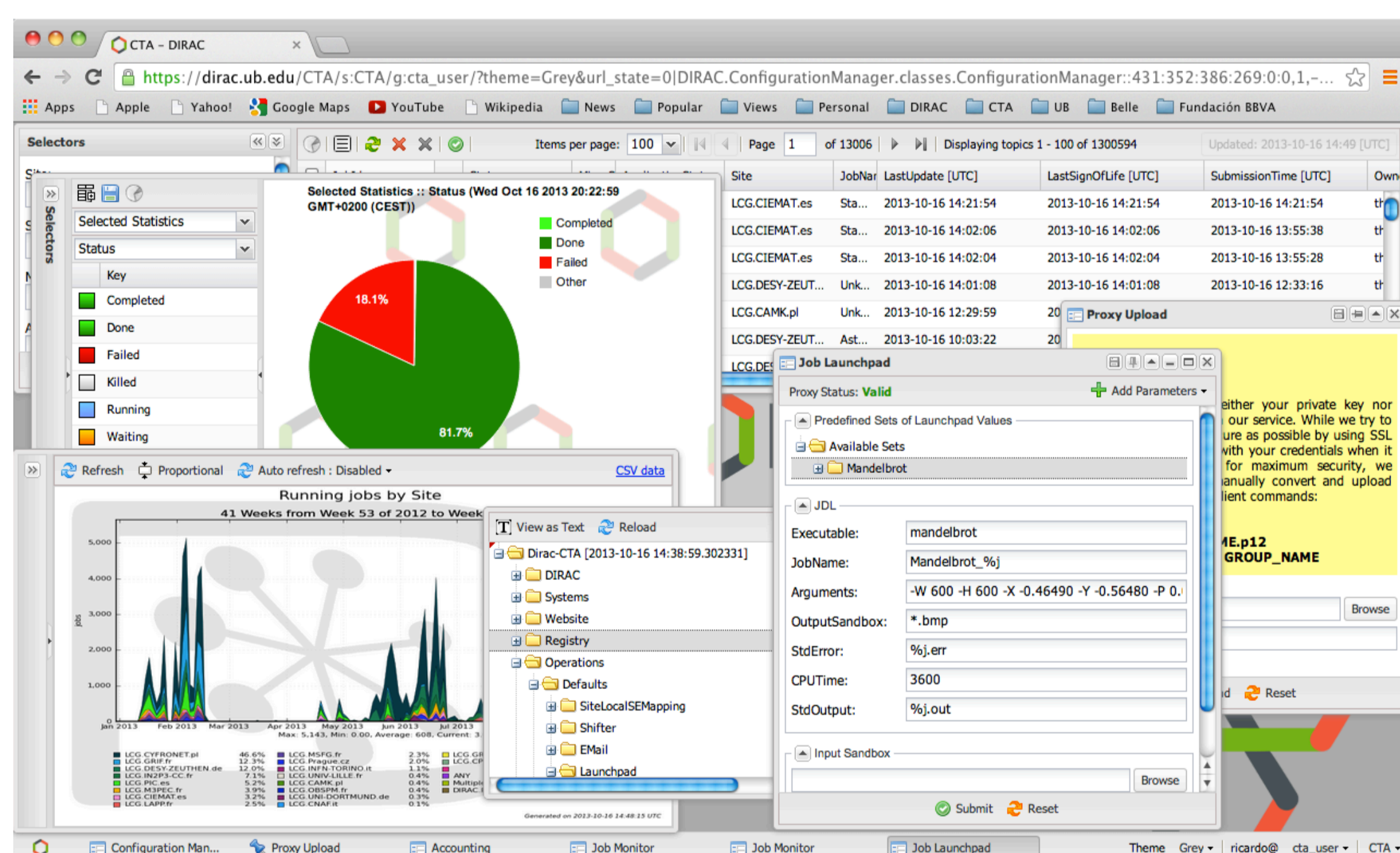
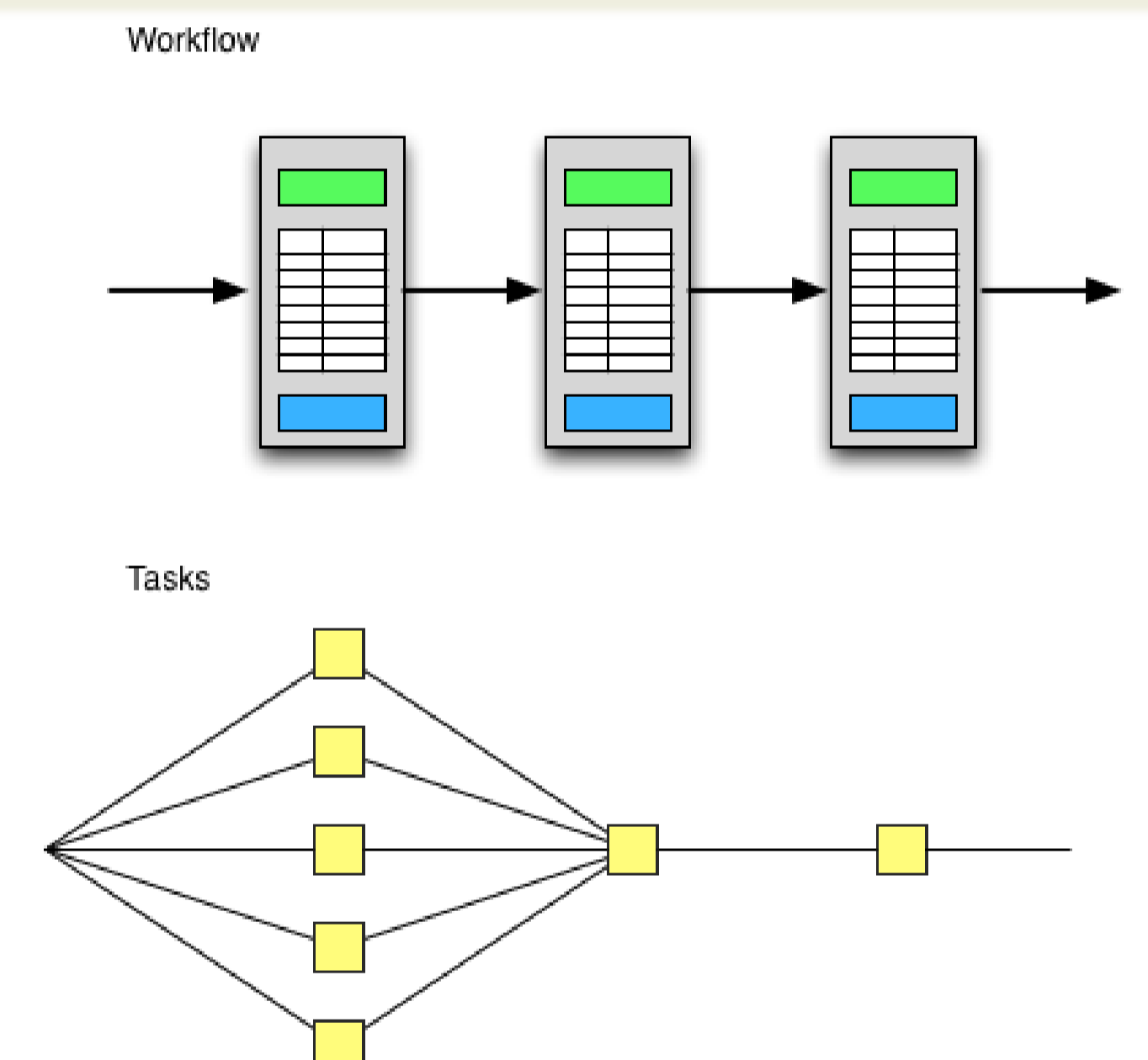
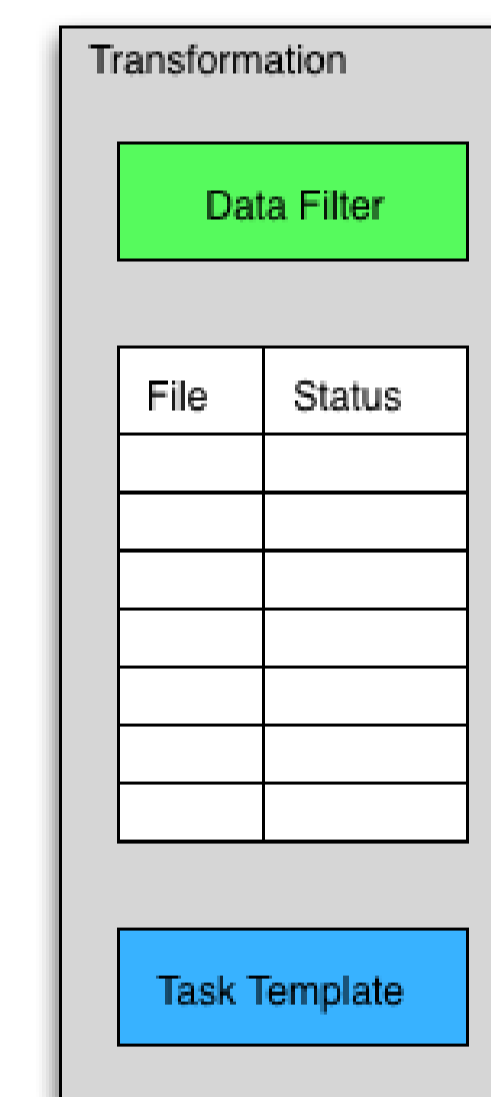
- Grids operated with various middleware
- Clouds, private and commercial, from different providers
- HPC supercomputers
- Ad hoc computing clusters or sets of worker nodes
- Volunteer resources (BOINC)



DIRAC Data Management System is based on the abstraction of *Storage Elements* and *File Catalogs*. This allows to present all the distributed user data as stored in a single logical file system.

Implementation of the abstract models is available for most of the modern data storage technologies and several file catalog services. The **DIRAC File Catalog** provides both replica and user metadata catalog functionalities allowing to implement complex data models specific for each user community.

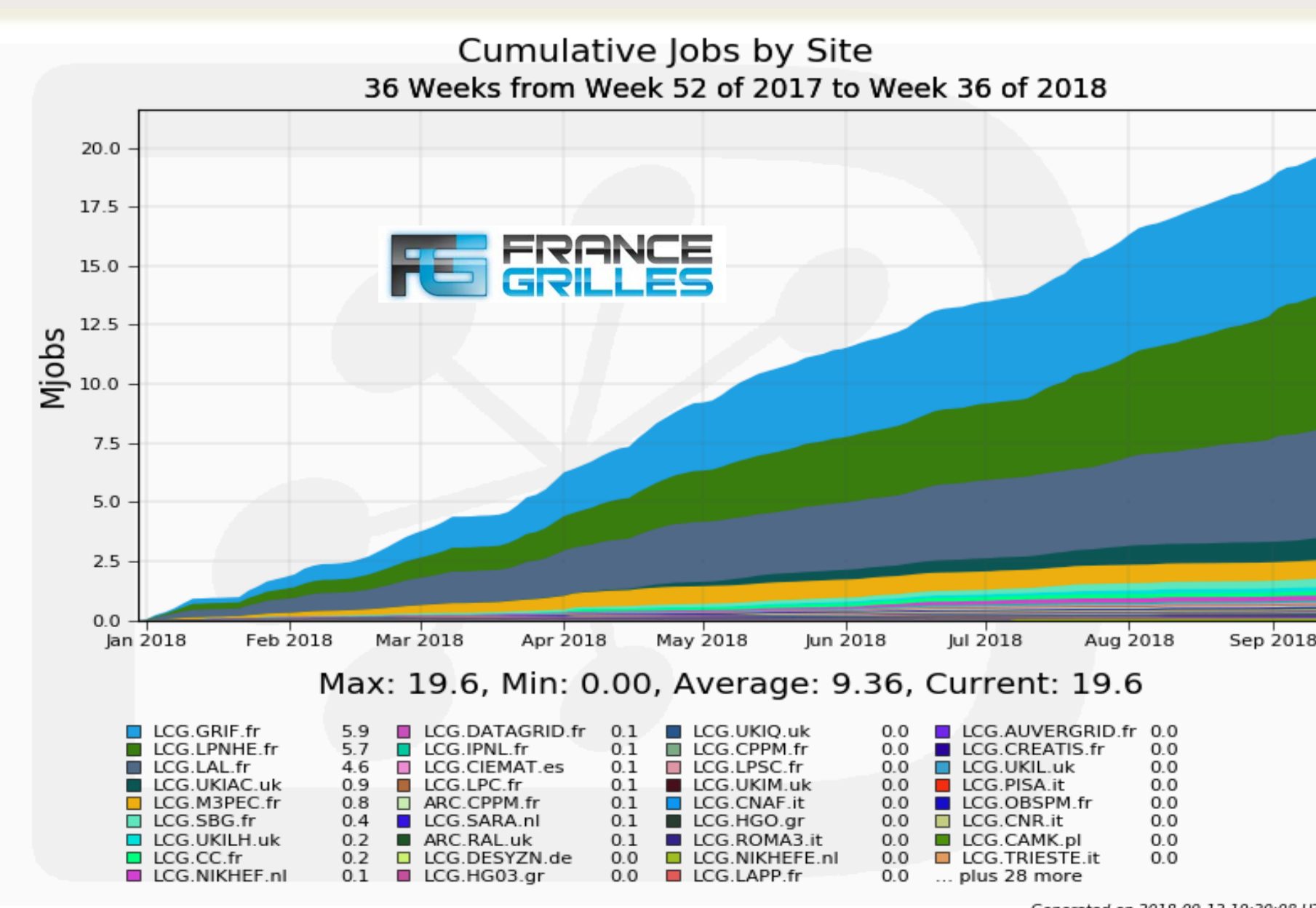
Elementary data and workload management operations can be combined in complex workflows by means of the **Transformation System**. Each transformation is a recipe to apply automatically to newly available data. Chaining multiple transformations allows to create entirely data-driven workflows of arbitrary complexity. **Production System** provides tools to create, monitor and validate complex workflows meeting the needs of computing models of various user communities.



DIRAC services are available through a variety of **user and programmatic interfaces**:

- Extensive command line tools
 - Python API
 - REST interface for an essential subset of services
 - Web Portal providing different views into the system
- DIRAC aims at providing an abstraction of a single computer for massive computational and data operations from the user perspective:
- Logical computing and storage elements (hardware)
 - Global logical name space for data (file system)
 - Desktop-like GUI

DIRAC Interware-based services are used around the world by multiple collaborations in High Energy Physics, Astrophysics and other scientific domains. One of the reasons for a wide DIRAC adoption is the software framework architecture allowing for easy extension of the core functionalities in order to satisfy requirements of specific communities.



DIRAC services are now provided by several grid infrastructure projects in several countries: France-Grilles, GridPP, EGI, JINR and others. This allows small user communities to benefit from the advantages of the DIRAC Interware without having to operate their own installation.

The France-Grilles DIRAC service was the first multi-community installation put in production in 2012:

- Hosted at CC-IN2P3
- Distributed team of administrators from several universities and CNRS labs
- Multiple active communities: biomed, complex-systems, vo.france-grilles.fr, ...
- More than 25M jobs executed in 2018 at 90 different sites

