Automatic Data Processing with DIRAC: from LHCb to Astroparticles

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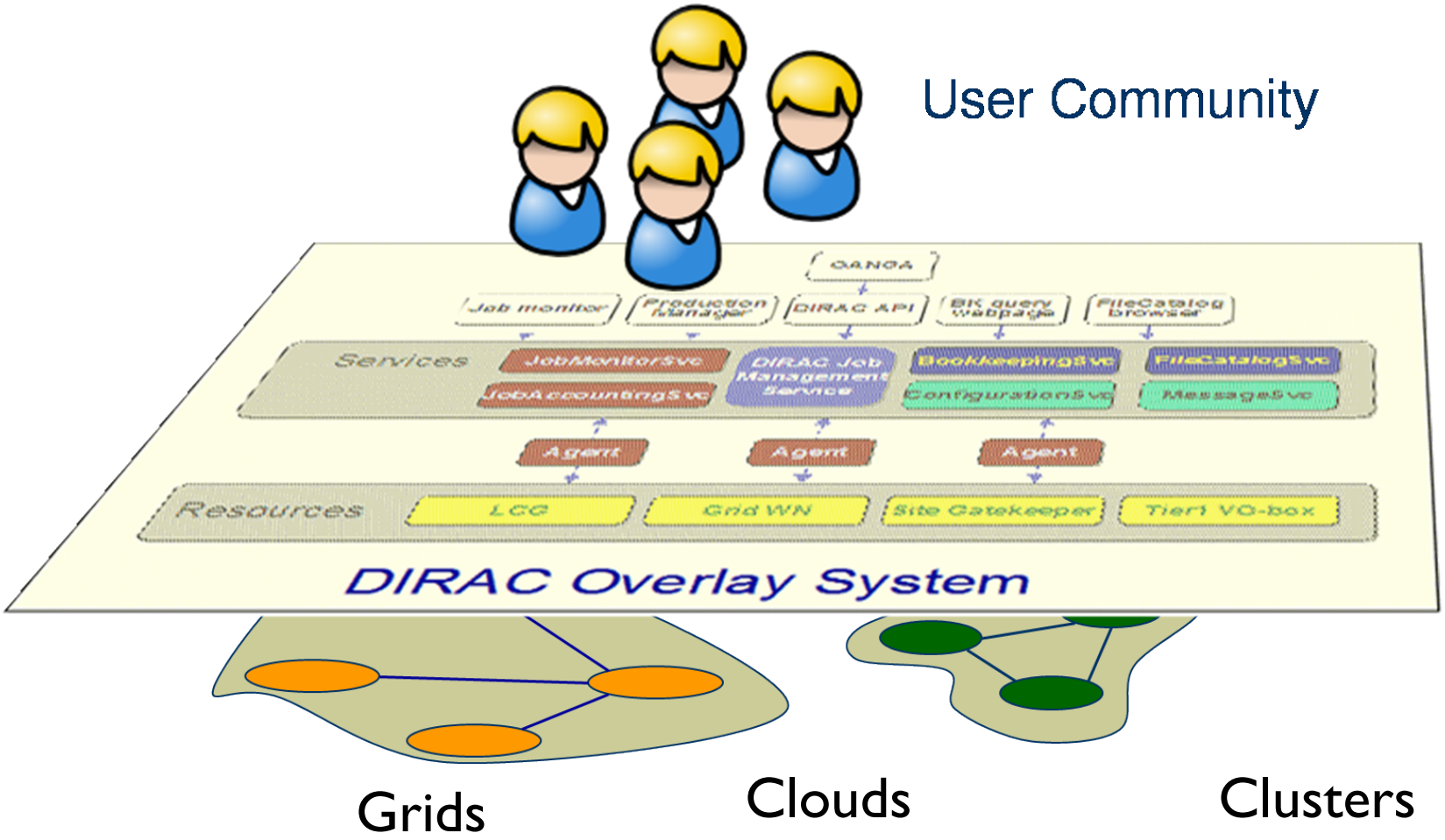
- Introduction
- What is DIRAC?
- Automated Data Processing in DIRAC
- Conclusion

Introduction

- The scale of computing in scientific research increases every day.
- Requires access to large amount of distributed resources:
  - CPU
  - Storage
- The challenge is to coordinate the use of all these resources for a given purpose.
  - Heterogeneous resources
  - Make processed data available to large number of scientists.

What is DIRAC?

- DIRAC is a framework for distributed computing:
  - A flexible and scalable framework to build distributed systems
- Has been developed to fulfill LHCb computing needs:
  - Detector data distributed reconstruction
  - Selection and redistribution of physics data
  - Analysis of data
  - Simulation of physics and detector
- Generalized for other use cases.
  - http://diracgrid.org

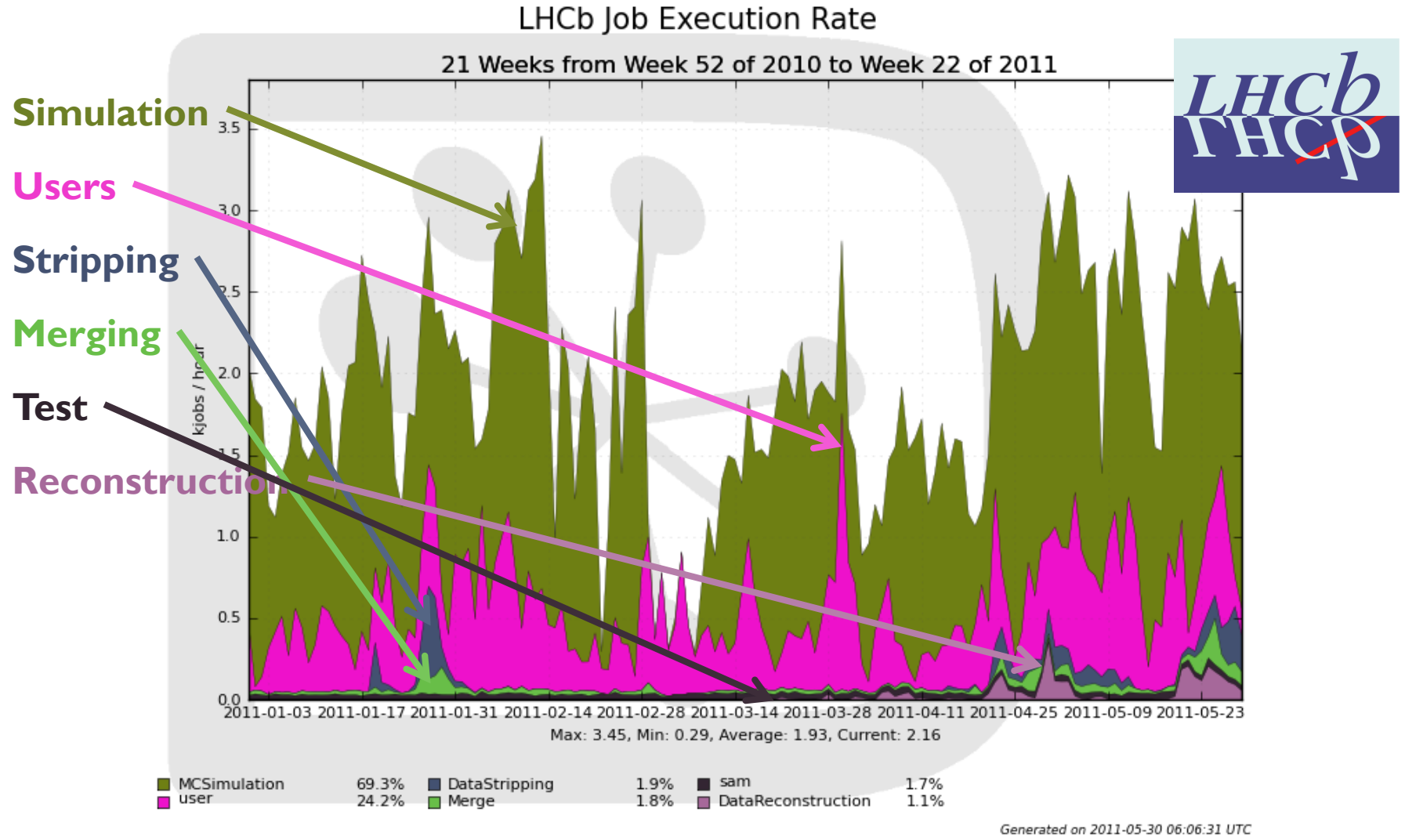

User Community
DIRAC Overlay System
Grids
Clouds
Clusters

DIRAC framework

- Common access to heterogeneous resources:
  - Grids
  - Clouds
  - Clusters
- Built-in:
  - Security model with authentication and authorization
  - Expandable Accounting and Monitoring tools
  - Flexible Job Workflow description mechanism
  - Command line, Python and Web interfaces

Workload Management

- Efficient use of CPU to process data
- Late resource to payload binding
  - Using of pilot jobs
  - Allows full control of priorities and shares
- Combine activities
  - Optimizes use of resources
- Dynamically adapts to resources and load


LHCb Job Execution Rate
21 Weeks from Week 52 of 2010 to Week 22 of 2011
Simulation
Users
Stripping
Merging
Test
Reconstruction
kjobs / hour
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
2011-01-03 2011-01-17 2011-01-31 2011-02-14 2011-02-28 2011-03-14 2011-03-28 2011-04-11 2011-04-25 2011-05-09 2011-05-23
Max: 3.45, Min: 0.29, Average: 1.93, Current: 2.16
MCSimulation 69.3%
user 24.2%
DataStripping 1.9%
Merge 1.8%
sam 1.7%
DataReconstruction 1.1%
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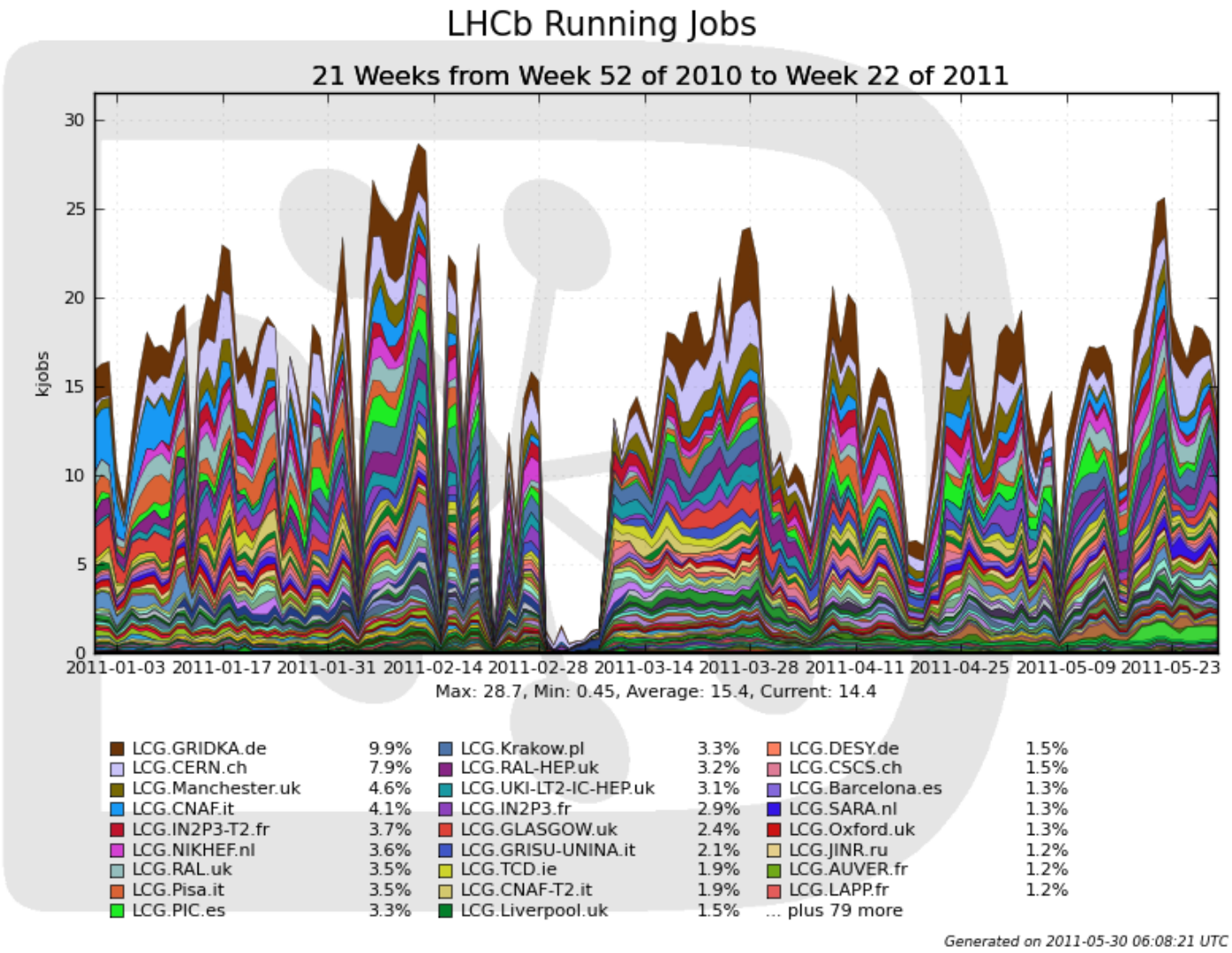
LHCb Running Jobs
21 Weeks from Week 52 of 2010 to Week 22 of 2011
kjobs
30
25
20
15
10
5
0
2011-01-03 2011-01-17 2011-01-31 2011-02-14 2011-02-28 2011-03-14 2011-03-28 2011-04-11 2011-04-25 2011-05-09 2011-05-23
Max: 28.7, Min: 0.45, Average: 15.4, Current: 14.4
LCG.GRIDKA.de 9.9%
LCG.CERN.ch 7.9%
LCG.Manchester.uk 4.6%
LCG.CNAF.it 4.1%
LCG.IN2P3-T2.fr 3.7%
LCG.NIKHEF.nl 3.6%
LCG.RAL.uk 3.5%
LCG.Pisa.it 3.5%
LCG.PIC.es 3.3%
LCG.Krakow.pl 3.3%
LCG.RAL-HEP.uk 3.2%
LCG.UKI-LT2-IC-HEP.uk 3.1%
LCG.IN2P3.fr 2.9%
LCG.GLASGOW.uk 2.4%
LCG.GRISU-UNINA.it 2.1%
LCG.TCD.ie 1.9%
LCG.CNAF-T2.it 1.9%
LCG.Liverpool.uk 1.5%
LCG.DESY.de 1.5%
LCG.CSCS.ch 1.5%
LCG.Barcelona.es 1.3%
LCG.SARA.nl 1.3%
LCG.Oxford.uk 1.3%
LCG.JINR.ru 1.2%
LCG.AUVER.fr 1.2%
LCG.LAPP.fr 1.2%
... plus 79 more
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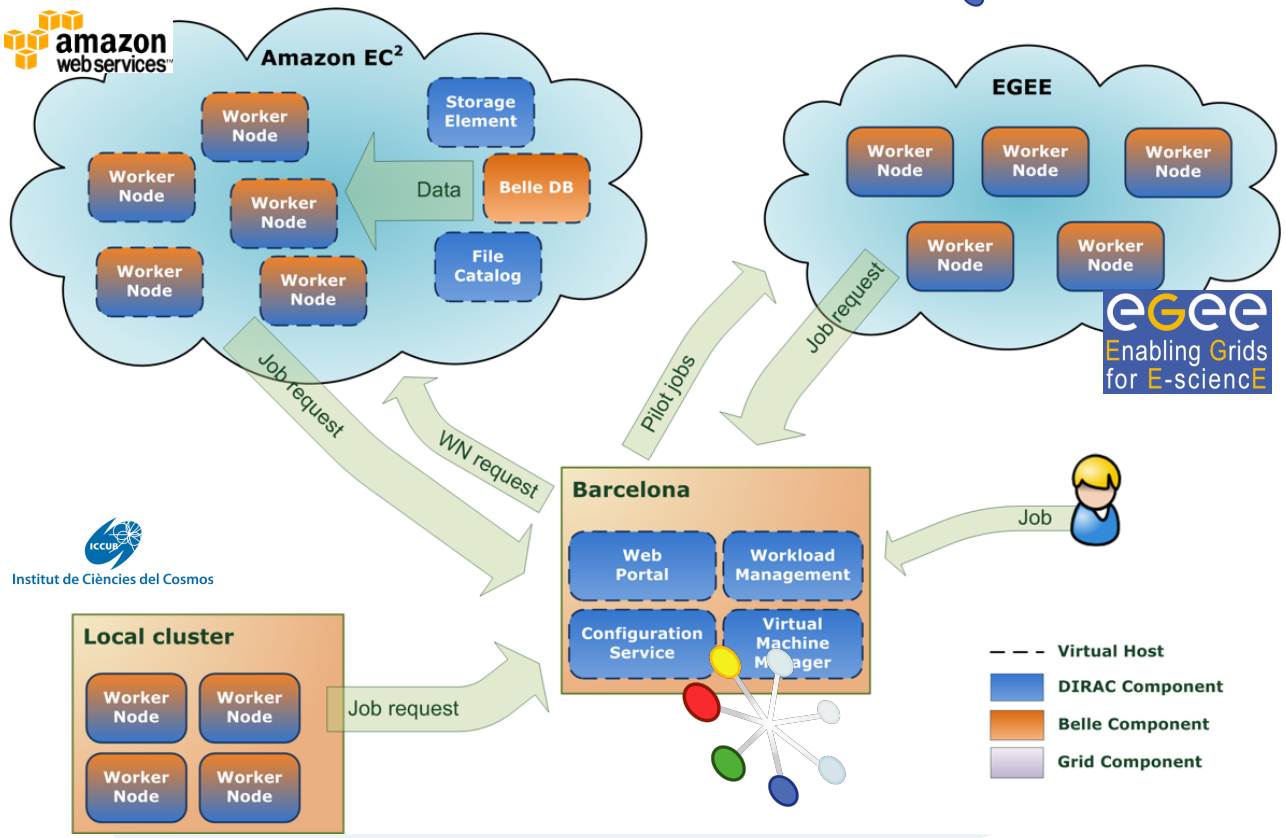
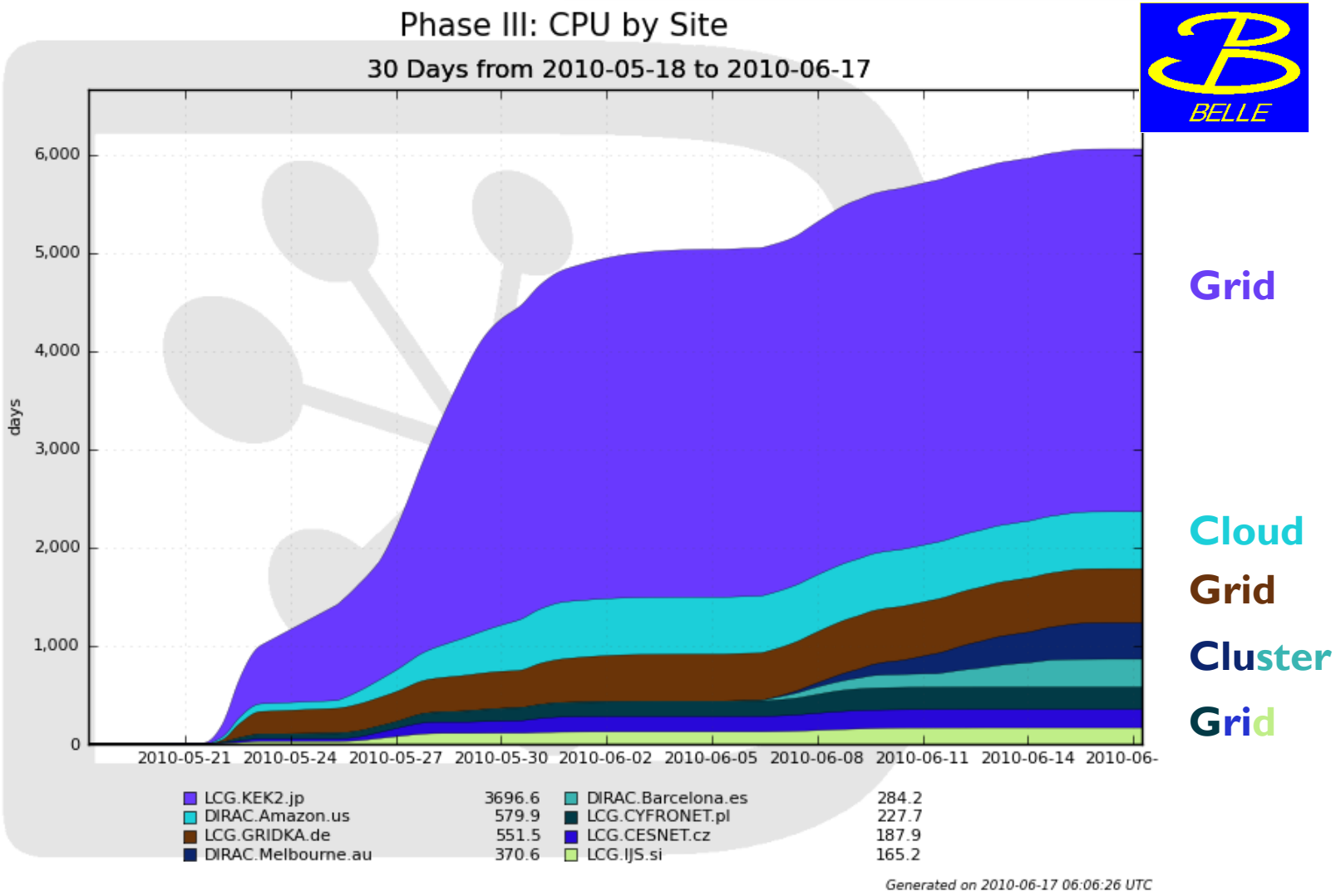
Next steps


amazon web services
Amazon EC2
Worker Node
Worker Node
Worker Node
Worker Node
Worker Node
Worker Node
Storage Element
Belle DB
File Catalog
Data
EGEE
Worker Node
Worker Node
Worker Node
Worker Node
Worker Node
eGee
Enabling Grids for E-sciencE
Job request
WN request
Pilot jobs
Job request
Barcelona
Web Portal
Workload Management
Configuration Service
Virtual Machine Manager
Job
Institut de Ciències del Cosmos
Local cluster
Worker Node
Worker Node
Worker Node
Worker Node
Job request
Virtual Host
DIRAC Component
Belle Component
Grid Component



Grid

Cloud

Grid

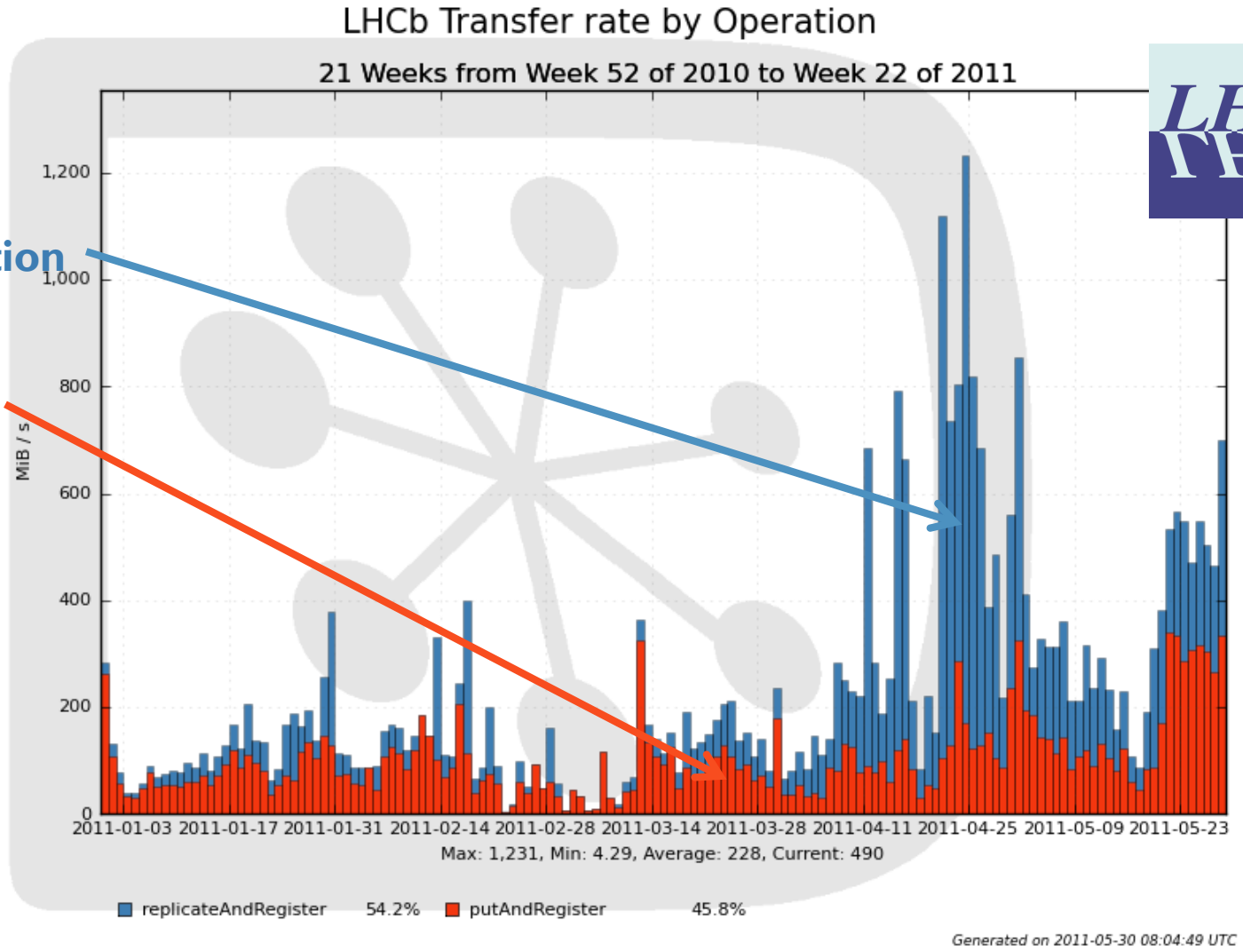
Cluster

Grid

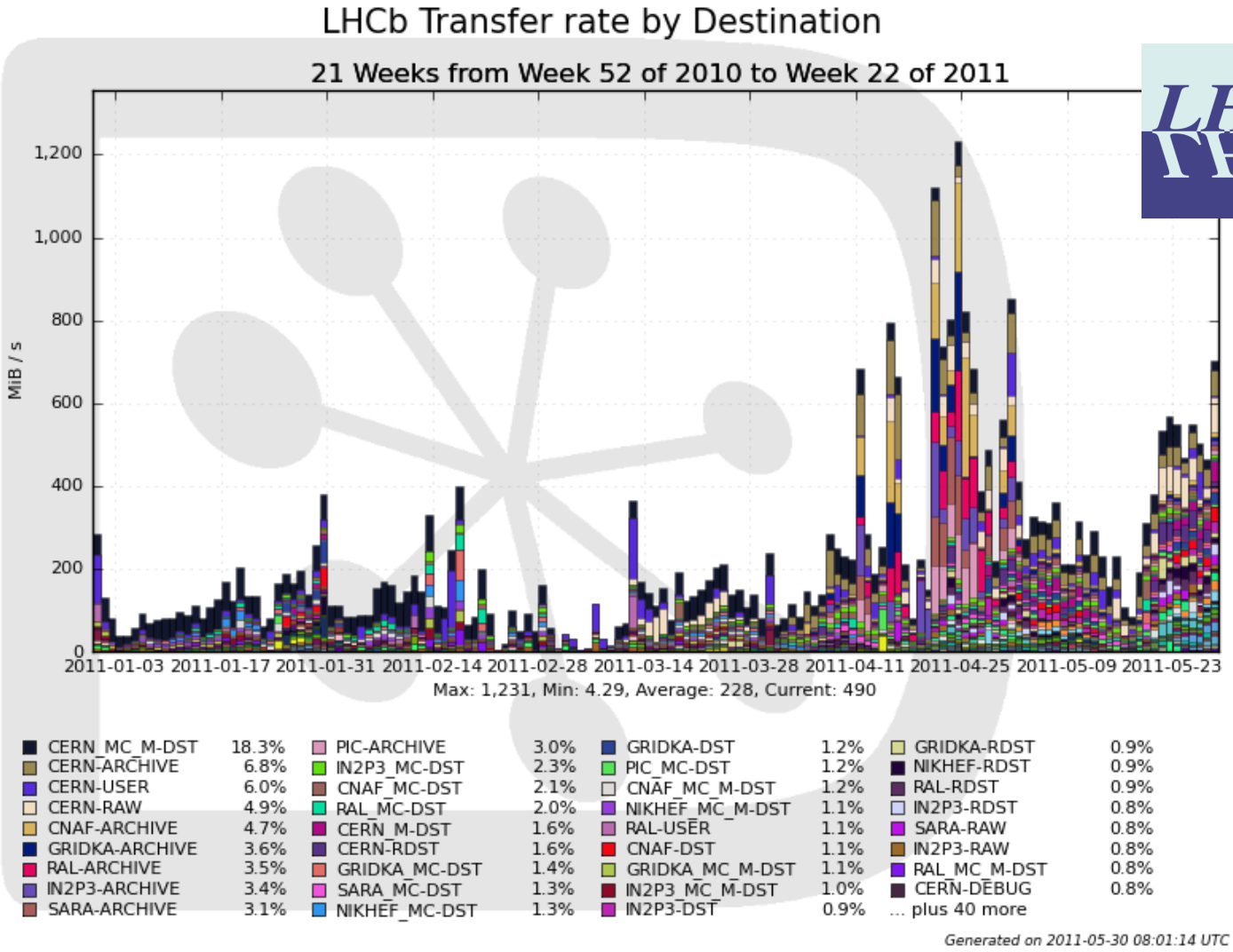
Data Management

- Place the data where needed
- RAW data distributed to be processed
- Simulated or Reconstructed data uploaded
- Replication of interesting data
- Removal of old/obsolete data

Upload & Replication



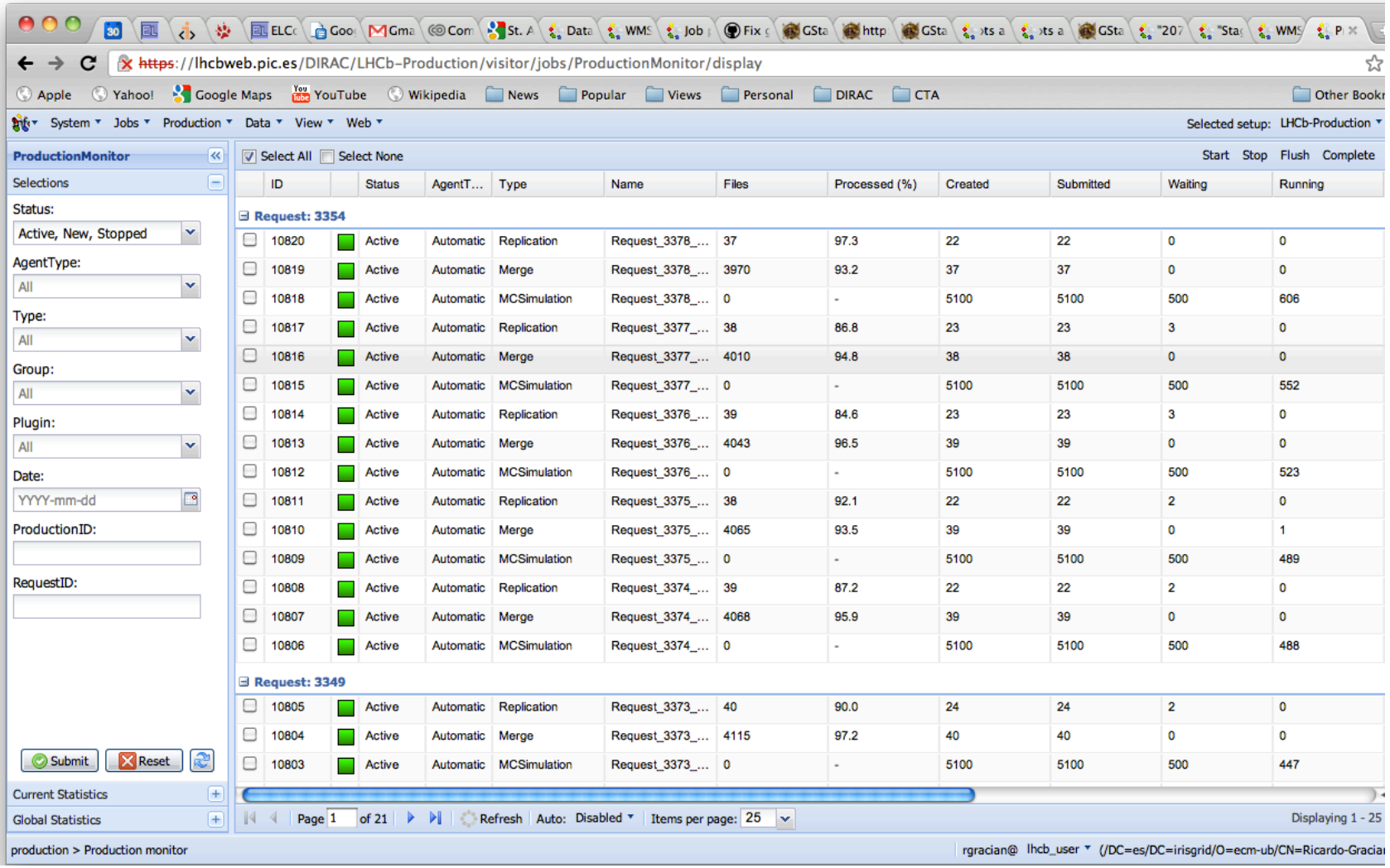
It becomes very complex



Transformations

- Automated "data-driven" tasks
  - New detector data:
    - Upload RAW data (DMS)
    - Calibration/DQ stream (WMS)
  - Calibration/DQ OK:
    - RAW Data OK:
      - Reconstruction (WMS)
      - Selection (WMS)
      - Upload reconstructed data (DMS)
  - Reconstruction done:
    - Replicate (DMS)
    - Ready for analysis (WMS)
- Driven by data or metadata
- Can also be used for tasks w/o input (i.e. simulations)

Transformations



Highly customizable

- Tasks are created using "plug-in" modules
- Allow full customization of the logic:
  - Define software & version to use
  - Define additional options, calibrations, alignments,..
  - Define granularity (number of files, size, etc.)
  - Number of replicas
  - Location of replicas
  - Extra archival
  - Create the Task
- Monitor the execution of the Tasks
  - Retry & error recovery mechanism

From LHC to Astroparticles

- The data and applications are different
- Both require large amounts of data to be
  - Distributed
  - Processed
  - Made available
- Both require access to multiple resources
- Both require complex job and data workflows
  - Beyond what middleware can provide

Conclusion

- DIRAC is a framework for distributed computing
- DIRAC offers advanced WMS and DMS functionality
- Provides flexible data driven "Transformations" to automate complex data processing scenarios
- Hope the HEP experience can be useful for you.
- Thank you