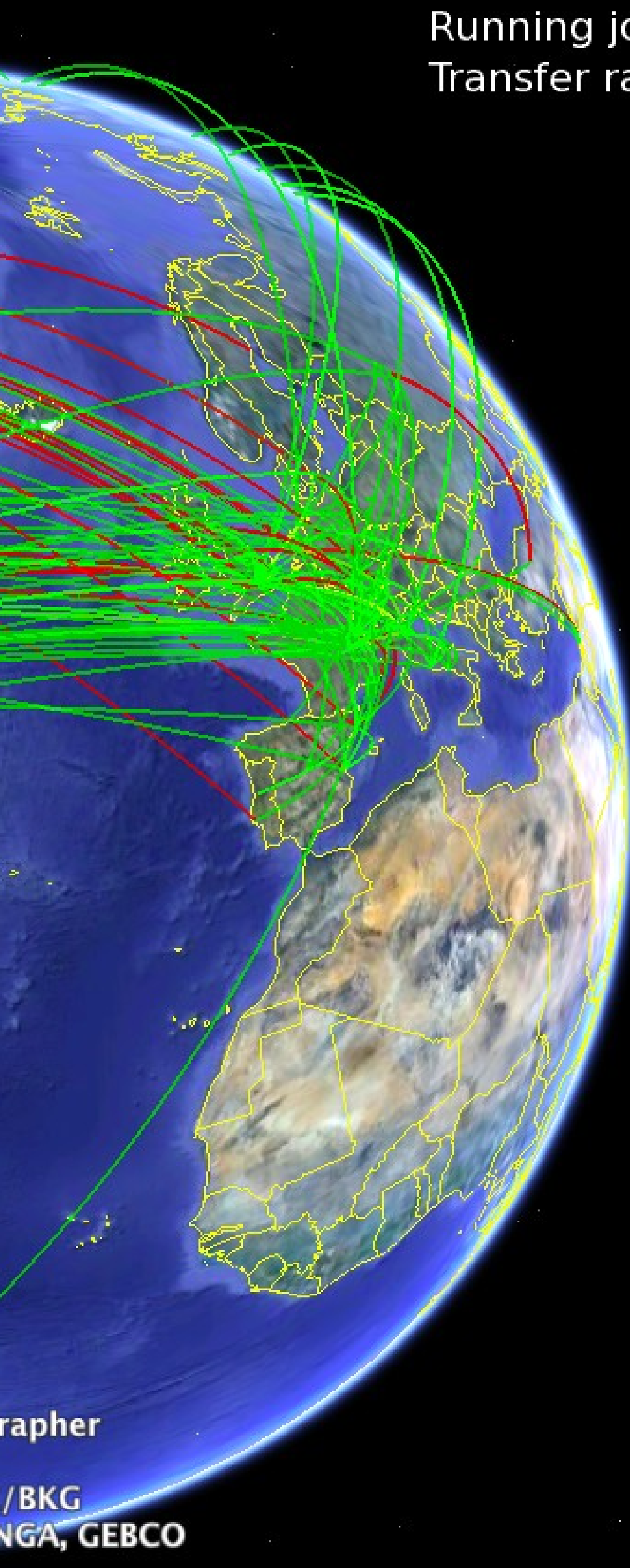


# Grid computing and forward

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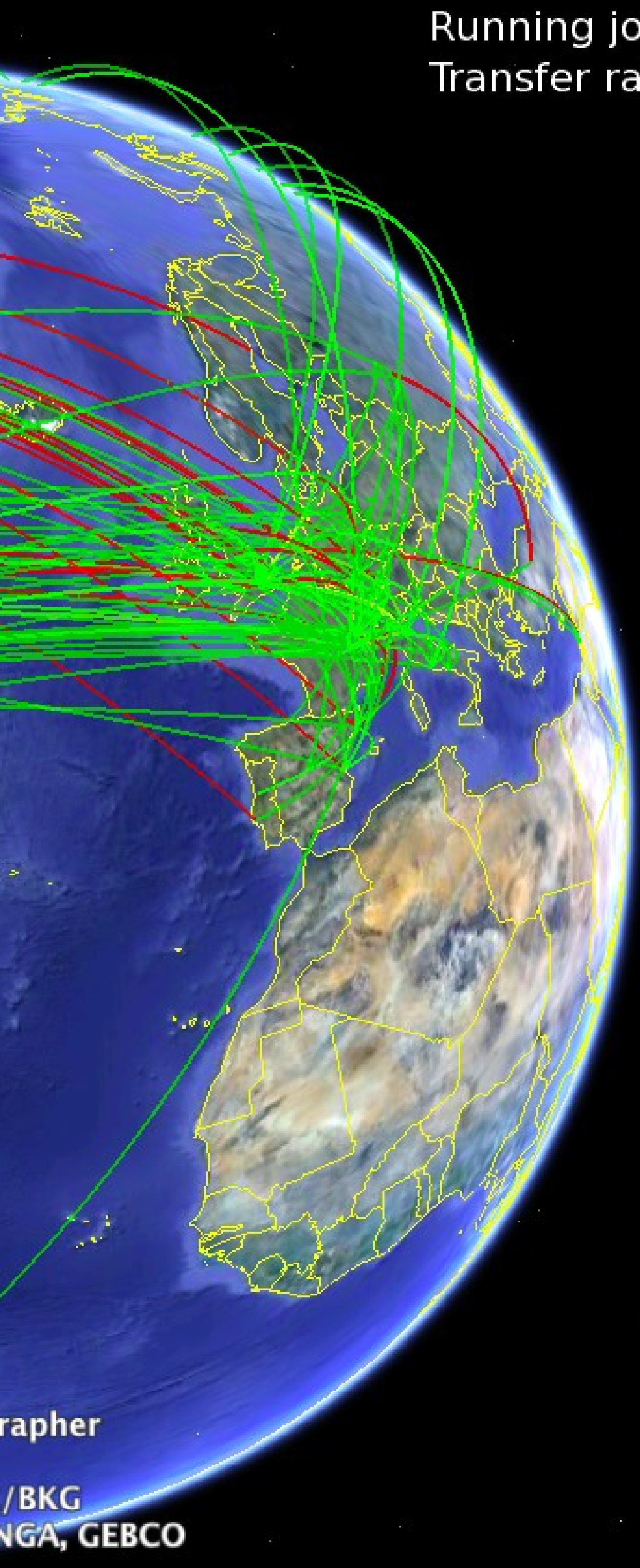
**Laboratoire de Physique Subatomique et de Cosmologie de Grenoble**

IN2P3/CNRS, Université Grenoble-Alpes, INPG (France)

ESIPAP, the European School in Instrumentation for Particle and Astroparticle Physics
March 14th 2018, Archamps, France




# Today, Together

- **Why grid computing**
  - A success story: the grid for the LHC
- **Other Grids**
- **Behind the scenes**
  - Technical details
- **Going forward**
  - Standards, simplicity, clouds
- **Accessing the grid**

# A few words on the speaker

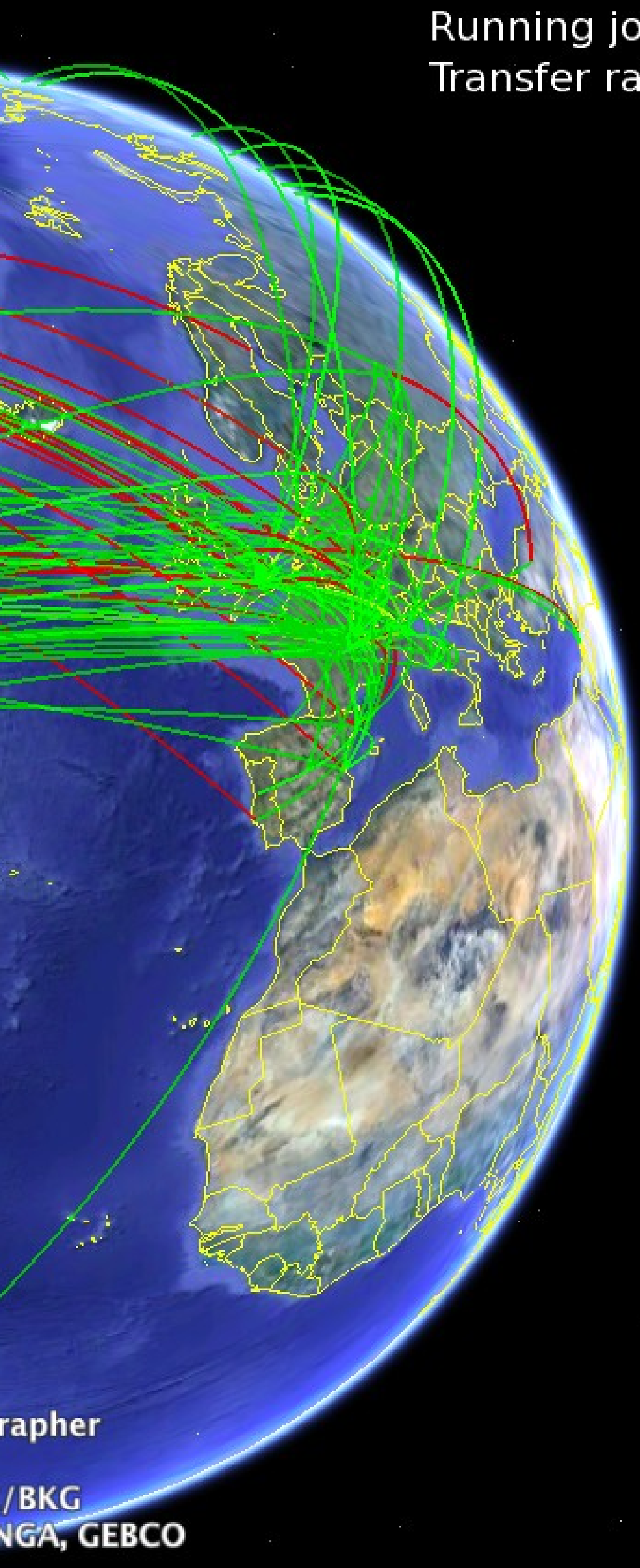
- Before 2011: experimental particle physicist (colliders)

Detector in US, Chicago, ppbar collider Tevatron $\sqrt{s}$ = 2 TeV
- calorimetry, simulation, SUSY search

Detector at CERN, Geneva, pp collider LHC $\sqrt{s}$ = 14 TeV
- calorimetry, non standard Higgs boson search
- responsible for the ATLAS computing activities in a major centre (T1)

- Since 2011: Research engineer in computing at IN2P3 (National Institute for Nuclear and Particle Physics in France), part of CNRS (National Centre for Scientific Research)

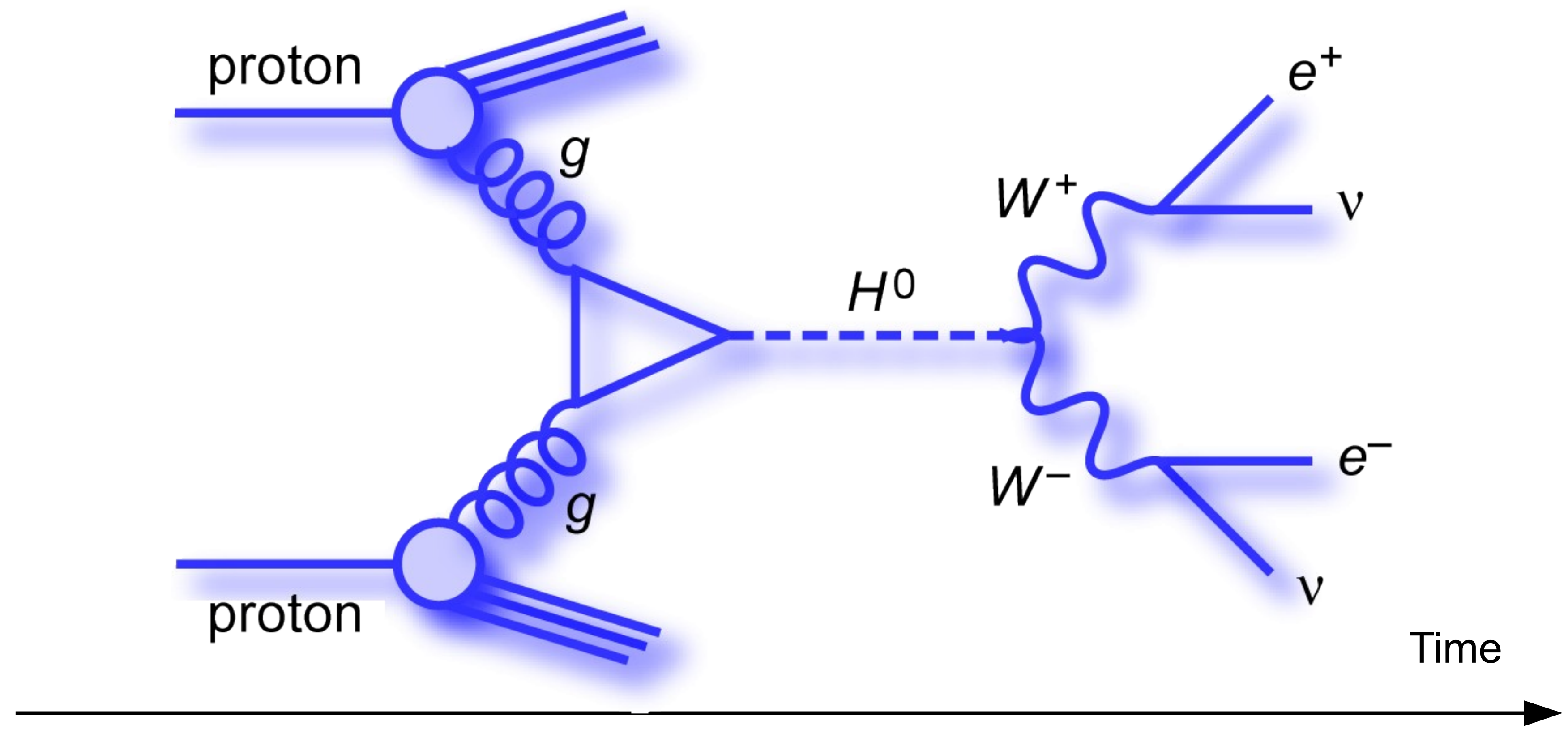
  - Grid computing
  - Application porting
  - Technical coordination LCG-France




# Why grid computing ?

# Searching for the Higgs

The Higgs boson could be produced in the collision of two protons



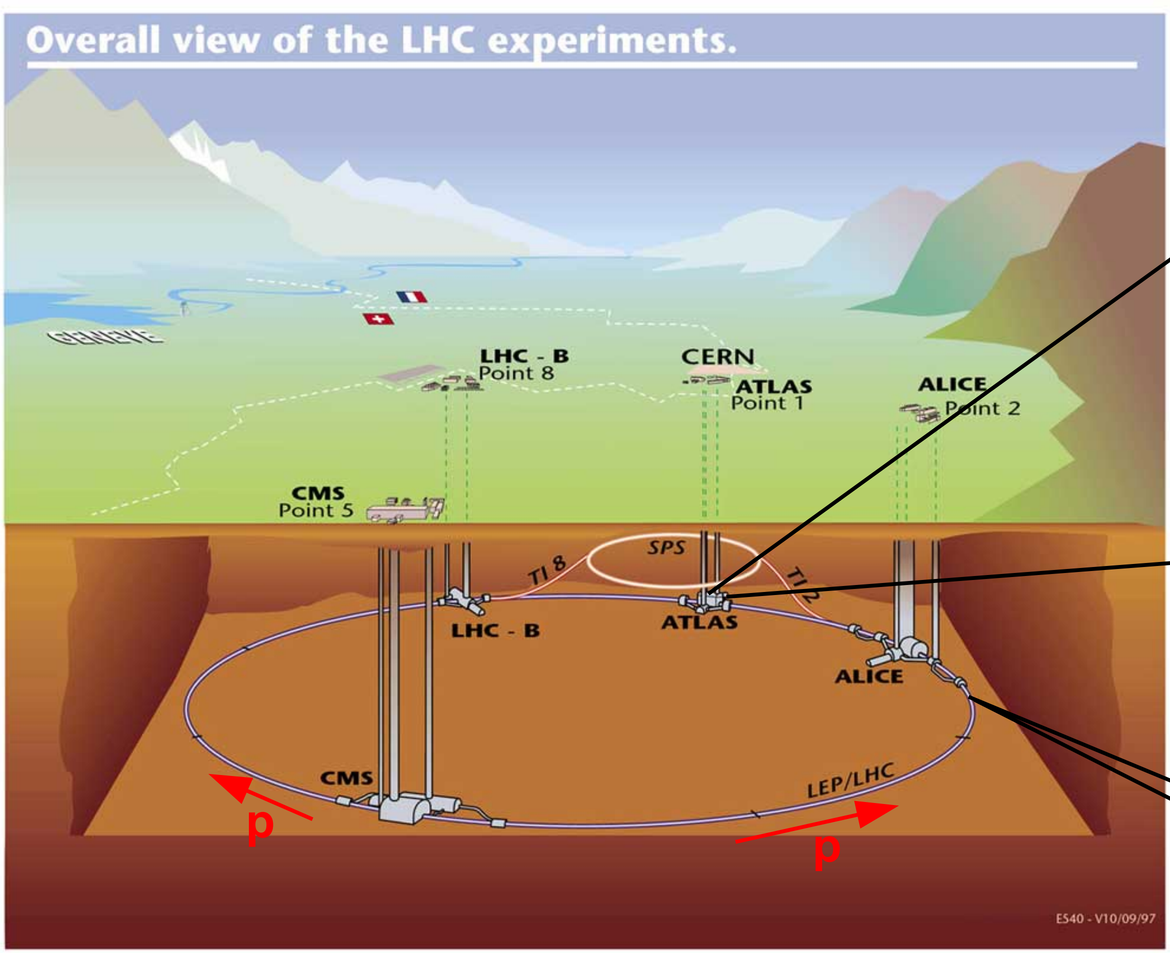

Two protons collide

Two gluons (constituents Of the protons) do fusion and a Higgs boson gets created

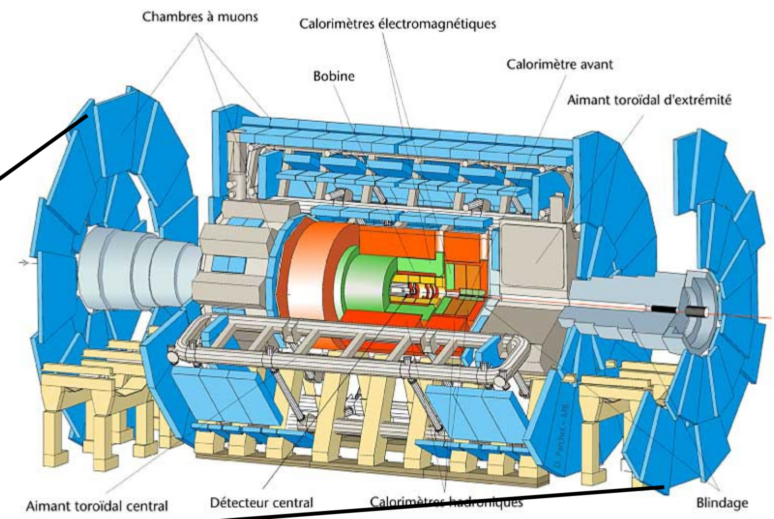
The Higgs decays instantaneously in a W boson pair (which decay themselves further)

The stable particles in the final state (here e, ν) get to the detector

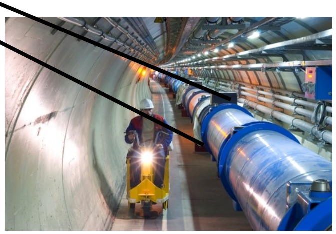
# In practice



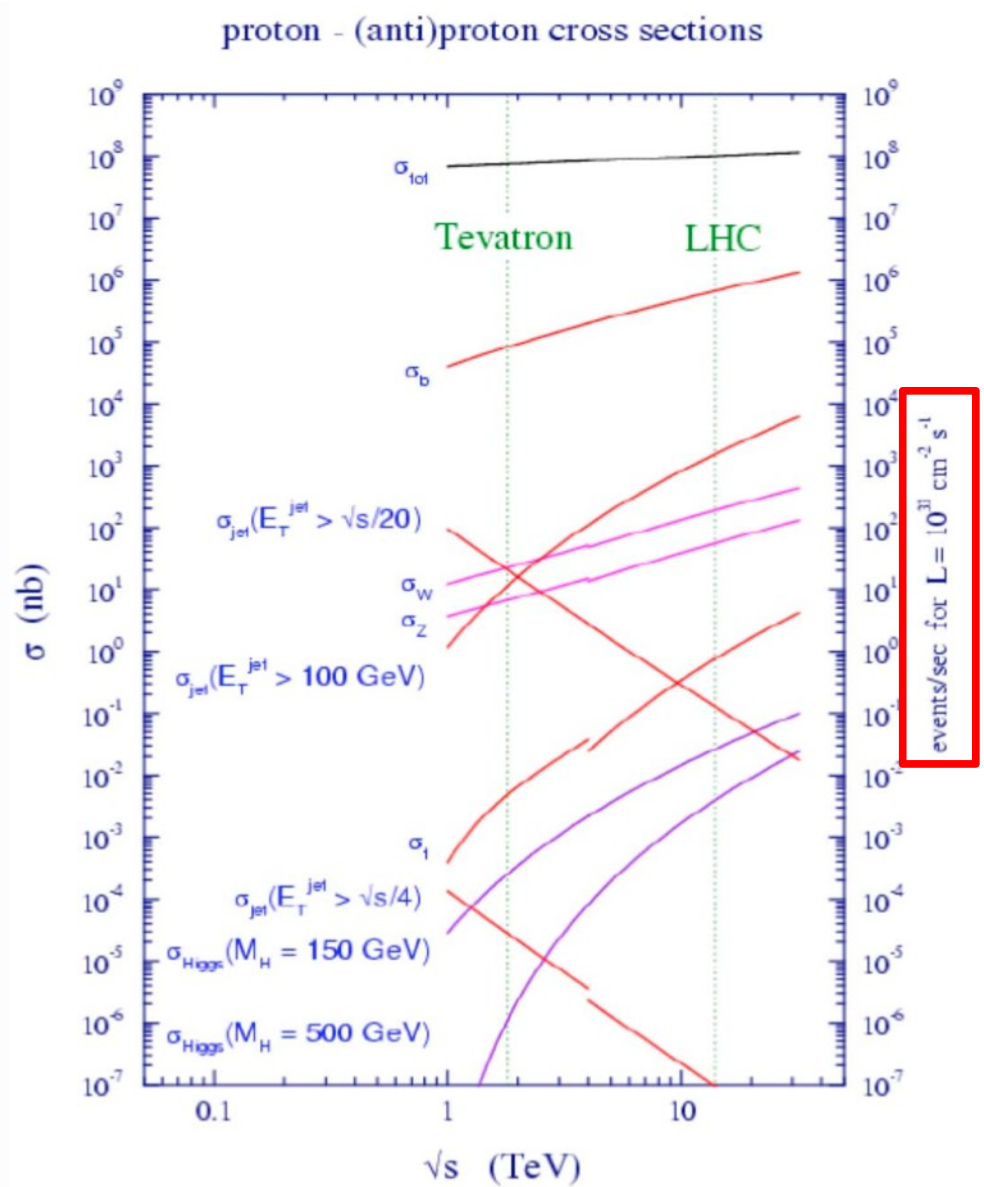
Overall view of the LHC experiments.
GENEVE
LHC - B
Point 8
CERN
ATLAS
Point 1
ALICE
Point 2
CMS
Point 5
SPS
TI 8
TI 2
LHC - B
ATLAS
ALICE
CMS
LEP/LHC
p
p
ES40 - V10/09/97

Chambres à muons
Calorimètres électromagnétiques
Bobine
Calorimètre avant
Aimant toroïdal d'extrémité
Aimant toroïdal central
Détecteur central
Calorimètres hadroniques
Blindage

# Event production rate at the LHC




- Bunch crossing: 40 MHz
  - 100 000 CDs written / s
  - Distance (moon-earth) /3 months

- Expensive to store
- Difficult to share
- Long to analyse

- But: all events do not carry the same interest for physics

- First selection at the experiment level before storage
  - Trigger (very fast electronic and algorithms)

# Quantity of stored data

- Let's do a quick calculation
  - Each experiment stores ~100 events /s
  - Each event counts for ~1-2 MB

→ several PB of data produced per year and per experiment

  - equivalent to 600 000 DVDs movies produced per experiment and per year

1 MB
1 digital picture
1 dictionnaire
1 CD = 650 MB

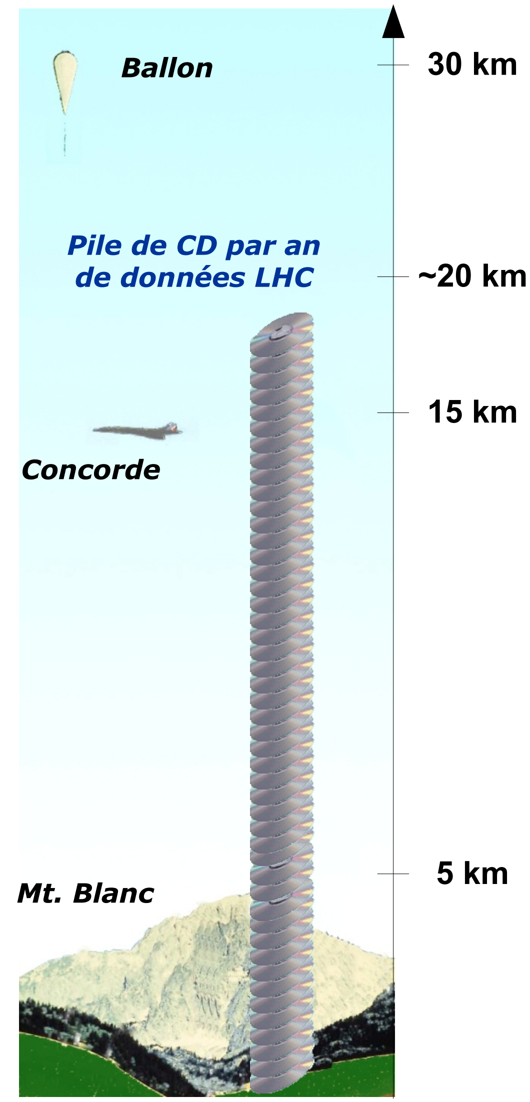
1 GB = 1000 MB
5GB = 1 DVD movie

1TB = 1000 GB
Livres produits par an

1PB = 1000 TB
Production par an de
1 expérience LHC

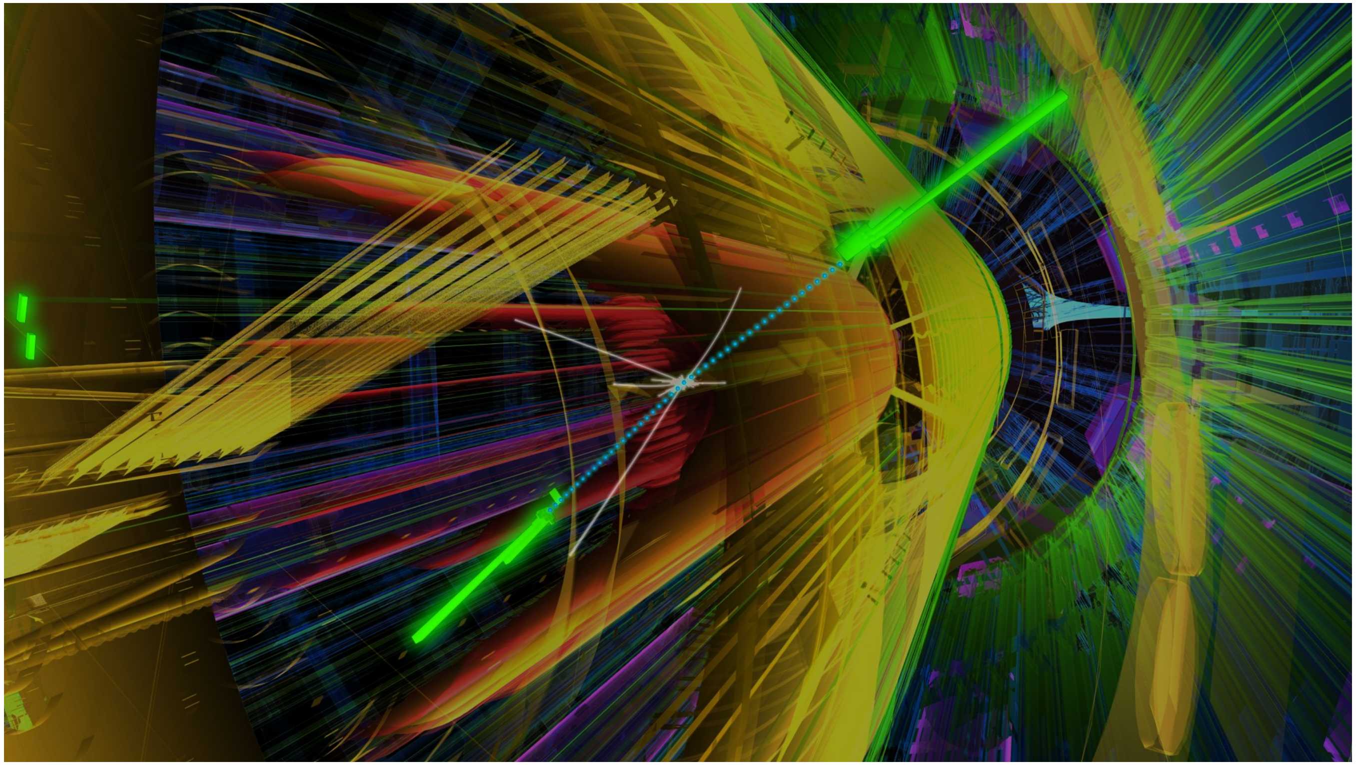
1 EB = 1000 PB
Production mondiale
d'information en 1 an

Enormous amount of data to analyse and to store;
No single computing centre could manage it alone.

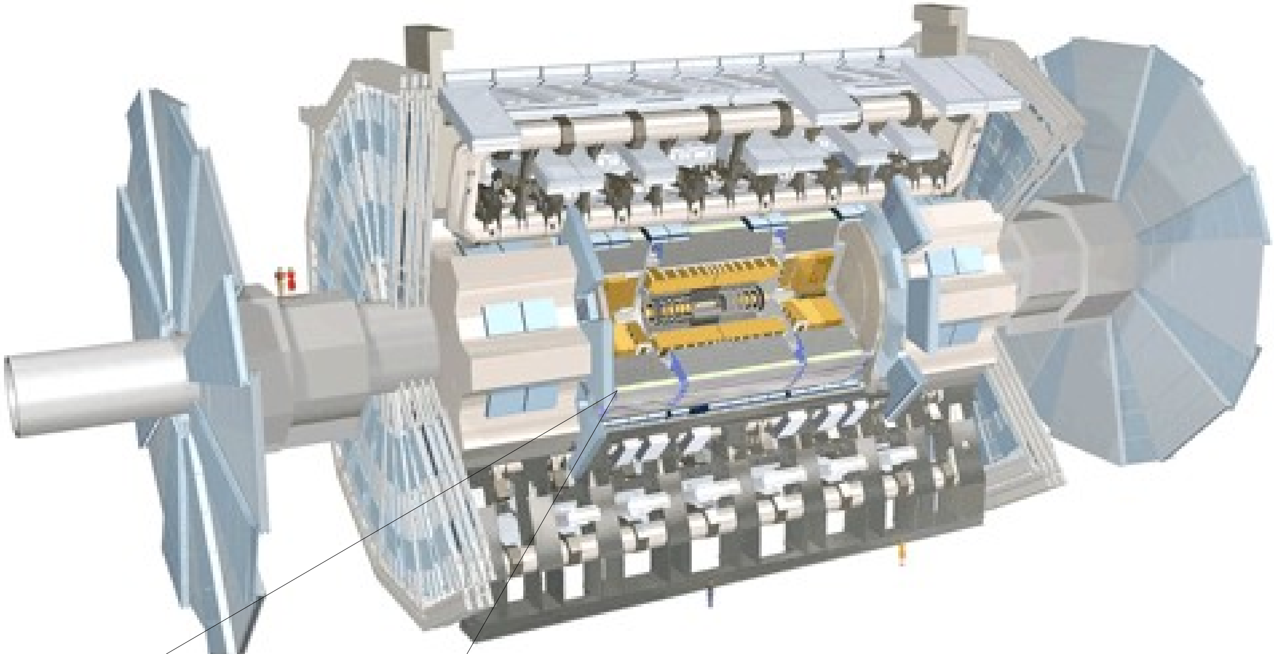


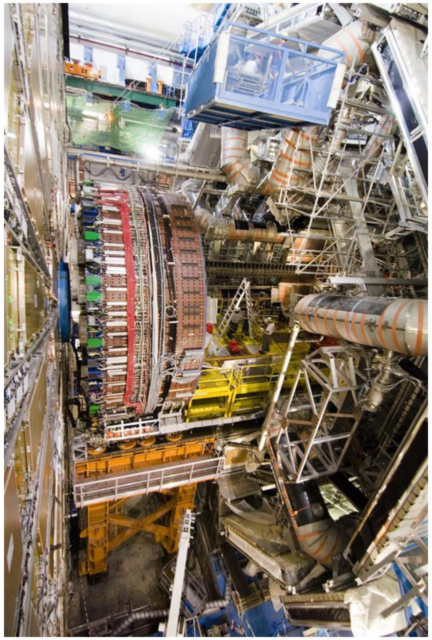
# “Events”

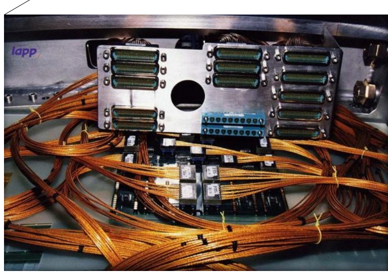
- Data are organised in “events”
  - A “picture” of a collision
  - With millions of sensors
- Each event is independent from other events
  - And it is quite small
- Algorithms process events one by one

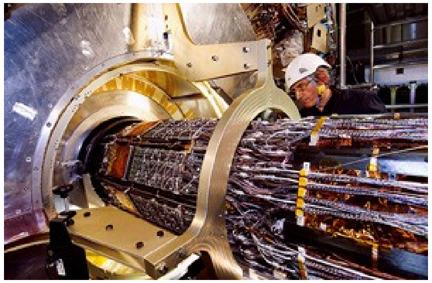


# Raw data









```
101100 101011 010001
110111 001011 001100
100001 111100 100110
110101 110011 100101
001010 101000 001010
111001 100101 000011
010111 001001 010100
100010 010100 101111
100100 101001 001010
000010 100101 111001
```

Pixels → yes/no
Calo → voltage

Stored on tape
at CERN

# How do we look into data

**Size/event** | **Data Format** | **Processing step**

1.6 MB

1) RAW: raw data
- Signal from detector channels

Reconstruction
- Hits → tracks
- 1-3 times a year
- improved Calibration

0.8 MB

2) E.S.D.: “event summary data”
- Object lists and channel details
- Detail studies of detector performances

Object Identification
- Known interactions

0.2 MB

3) A.O.D.: “analysis object data”
- List of physics object
- Useful for the further selection of interesting events

Analysis of reconstructed events
- Event selection
- 10 times a day

0.01 MB

n) ntuples: format plat
- Used to do the “final plot”
- Structure: same as AOD
- Keep part of events / objects

# How do we look into data

**Size/event** | **Data Format** | **Processing step**

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0

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0

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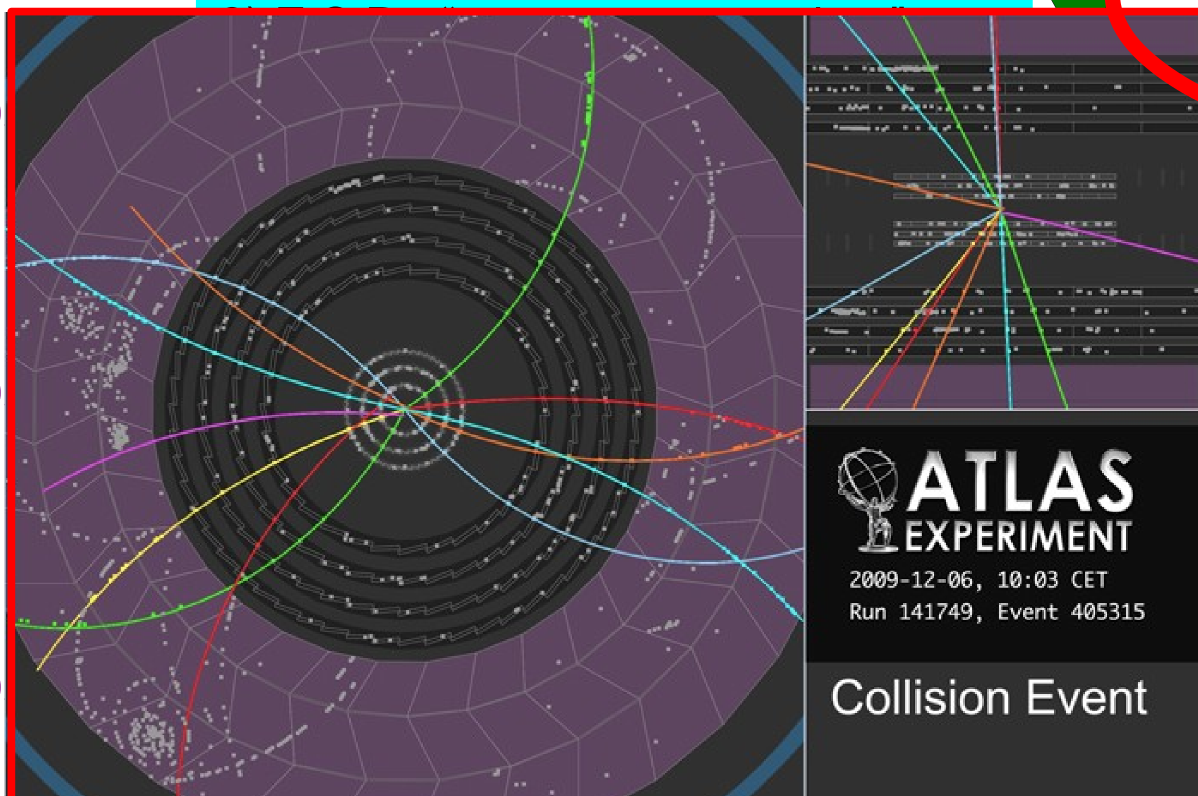
0




http://atlas.web.cern.ch/Atlas/public/EVTDISPLAY/events.html

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**Size/event** | **Data Format** | **Processing step**

~1.6 MB

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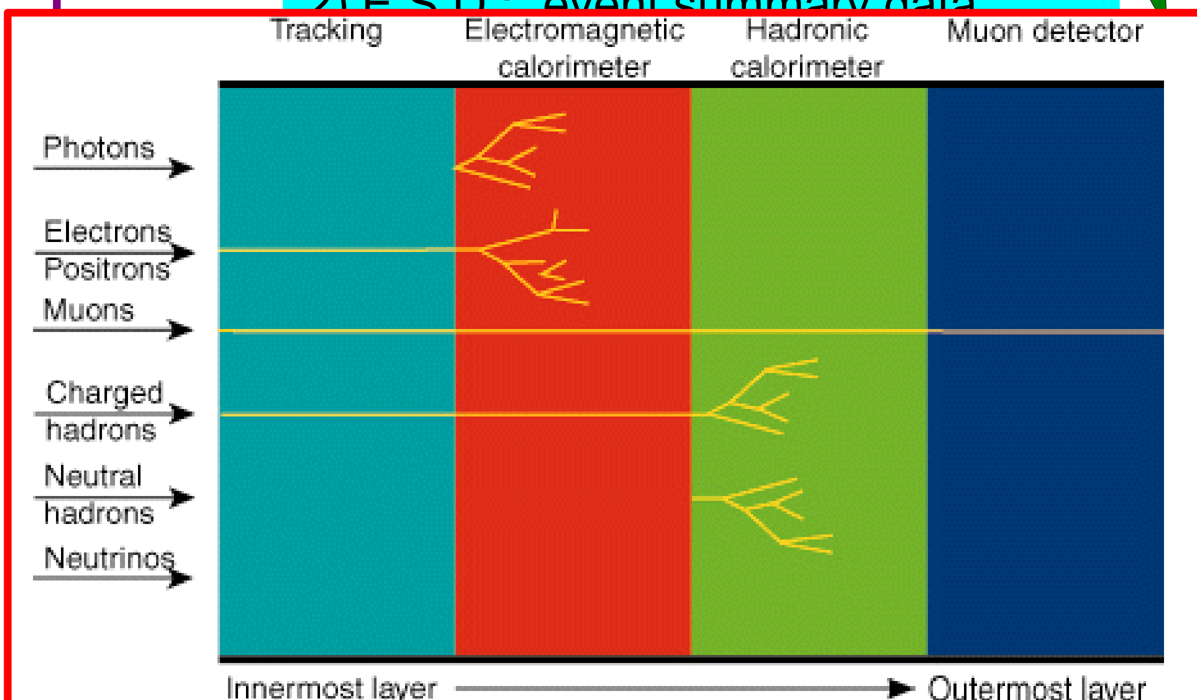


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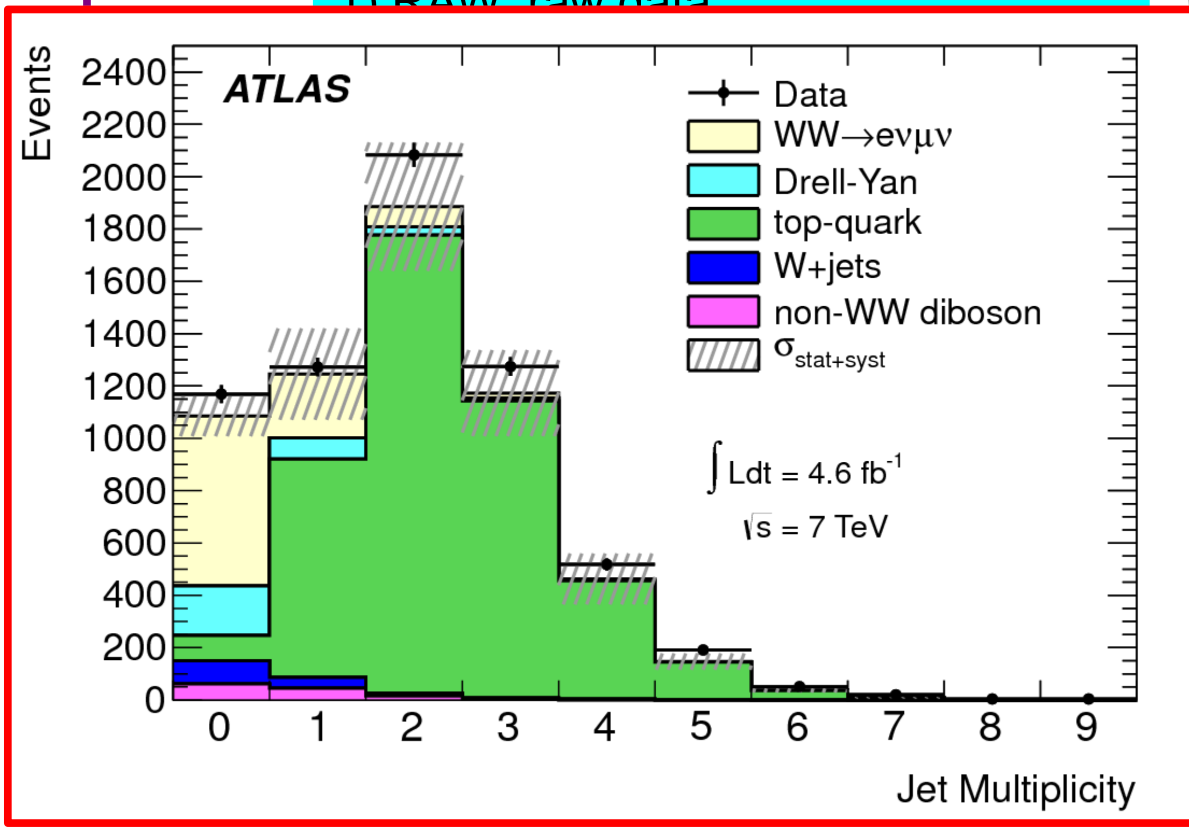


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- Hits → tracks
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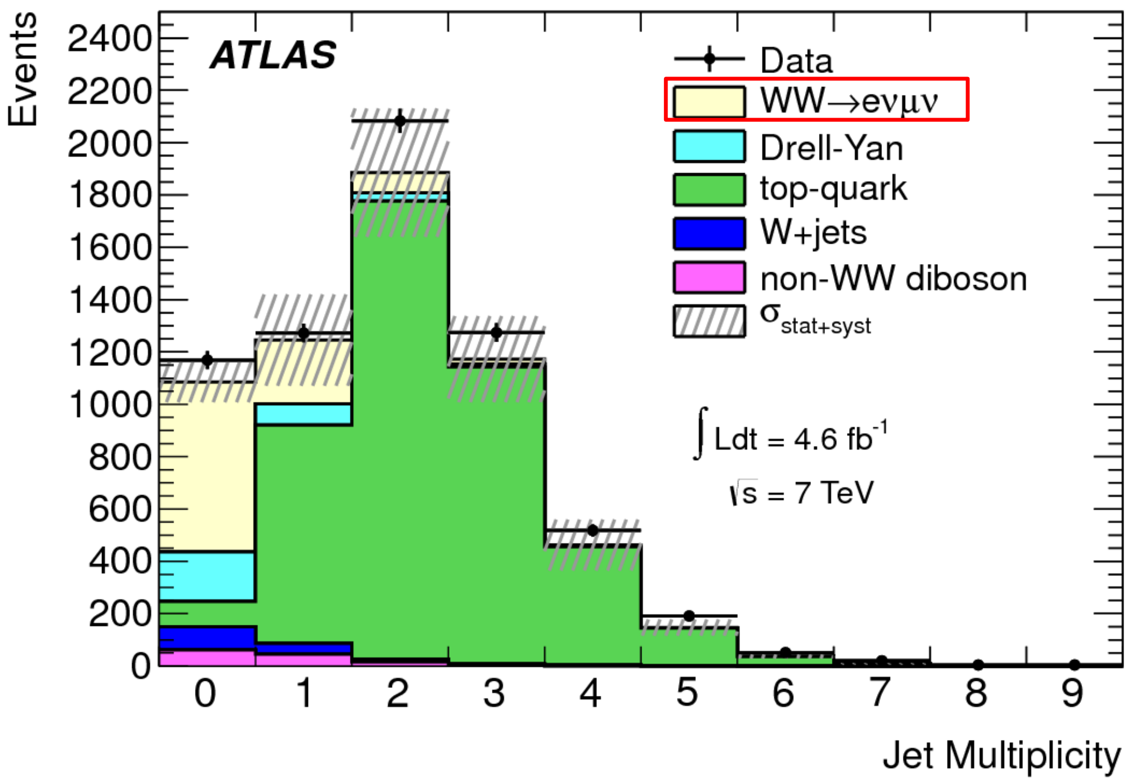
~0.01 MB

n) ntuples: format plat
- Used to do the "final plot"
- Structure: same as AOD
- Keep part of events / objects

# Interpreting data




In other words:

**Compare the data with a model (MS).**

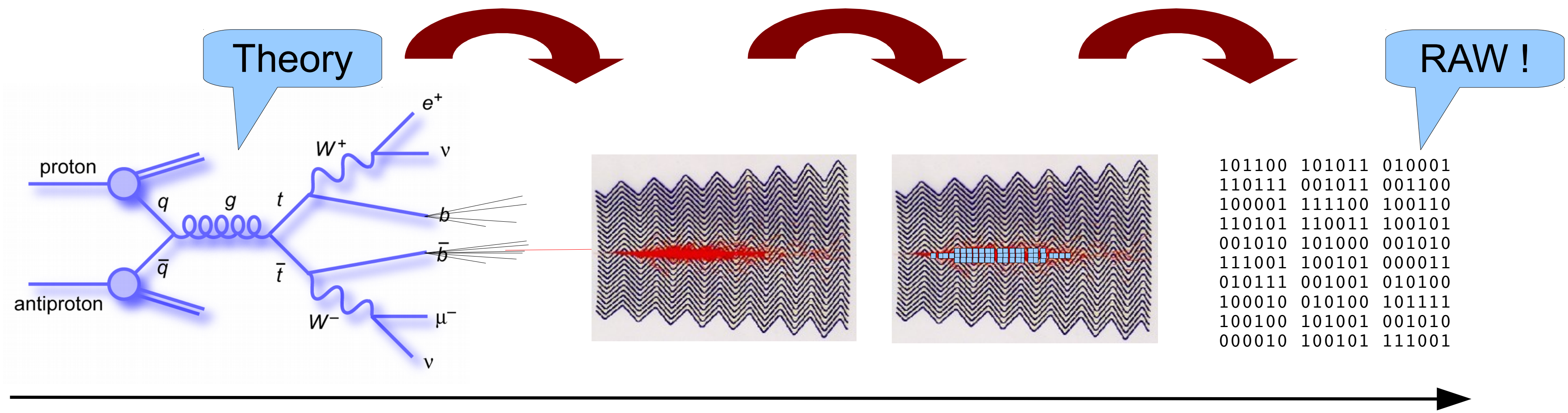
- Agreement data/simulation (understanding of the detector)
- Find deviations (discovery of new phenomena)

Getting results from an experiment: no way without simulation !

# Simulation of RAW data

Three ingredients :

1) “Physics” modelisation (collisions, hard process, ...)
2) Particle/matter interactions in the detector layout
3) Signals transmitted by the detector



# Summary

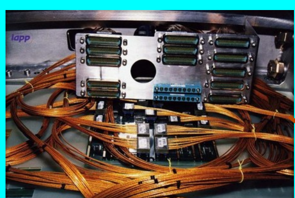
## Centralised operations

## group/individual

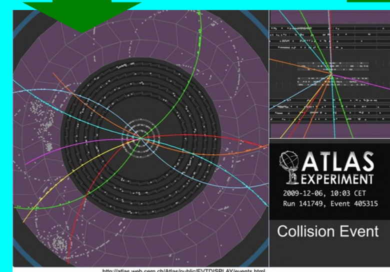
**Reconstruction**

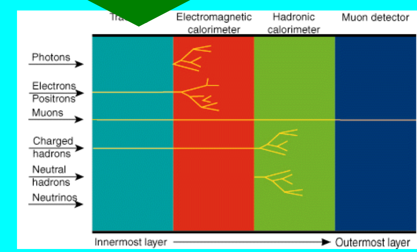
**Identification**

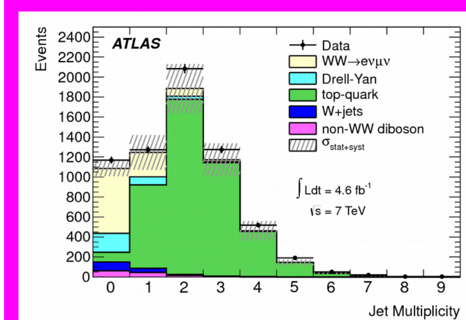
**Final analysis**
**(n times / day)**



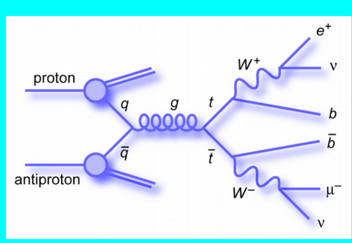
101100 010001
110111 001100
111100 100110
110101 110011
001010 001010
100101 000011
010111 010100



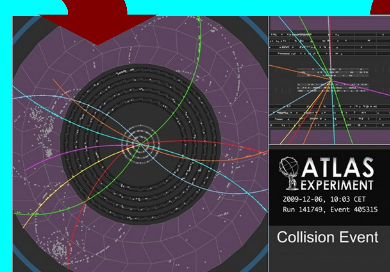



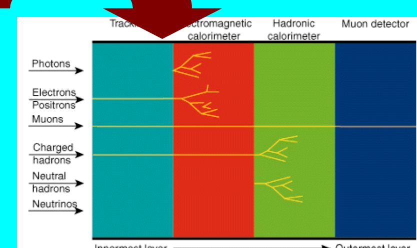




**Simulation**

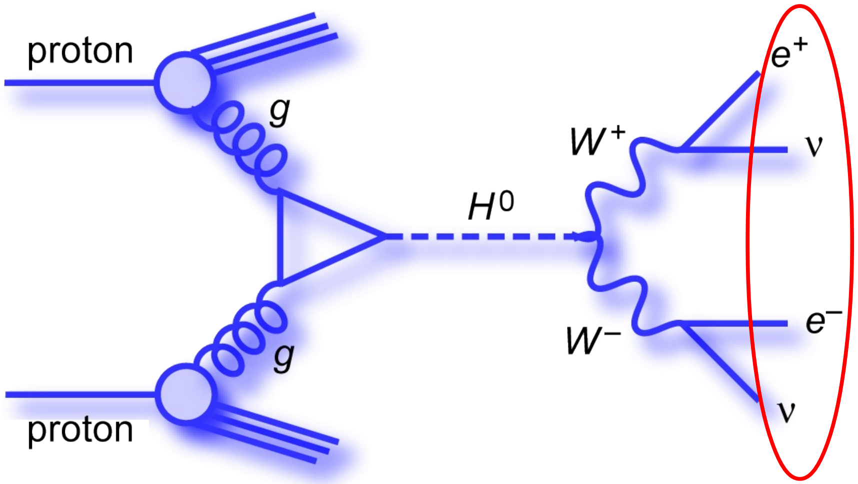



101100 010001
110111 001100
111100 100110
110101 110011
001010 001010
100101 000011
010111 010100



# Search for a rare process

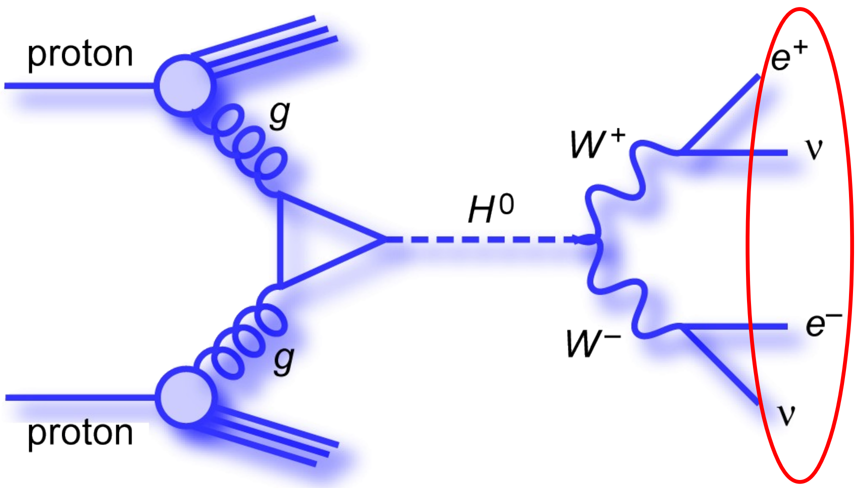



We have already discussed this process.

For the Higgs search, it is
"the signal".

NB : only the stable particles in the final state reach the detector.

# Search for a rare process

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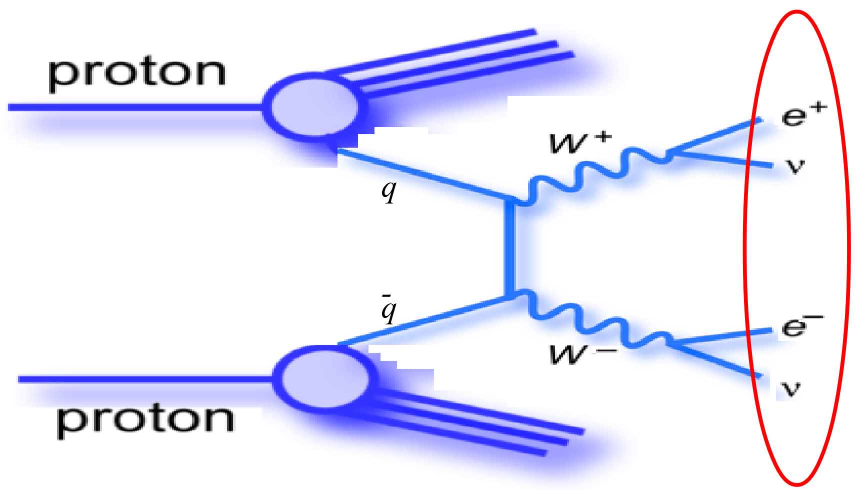
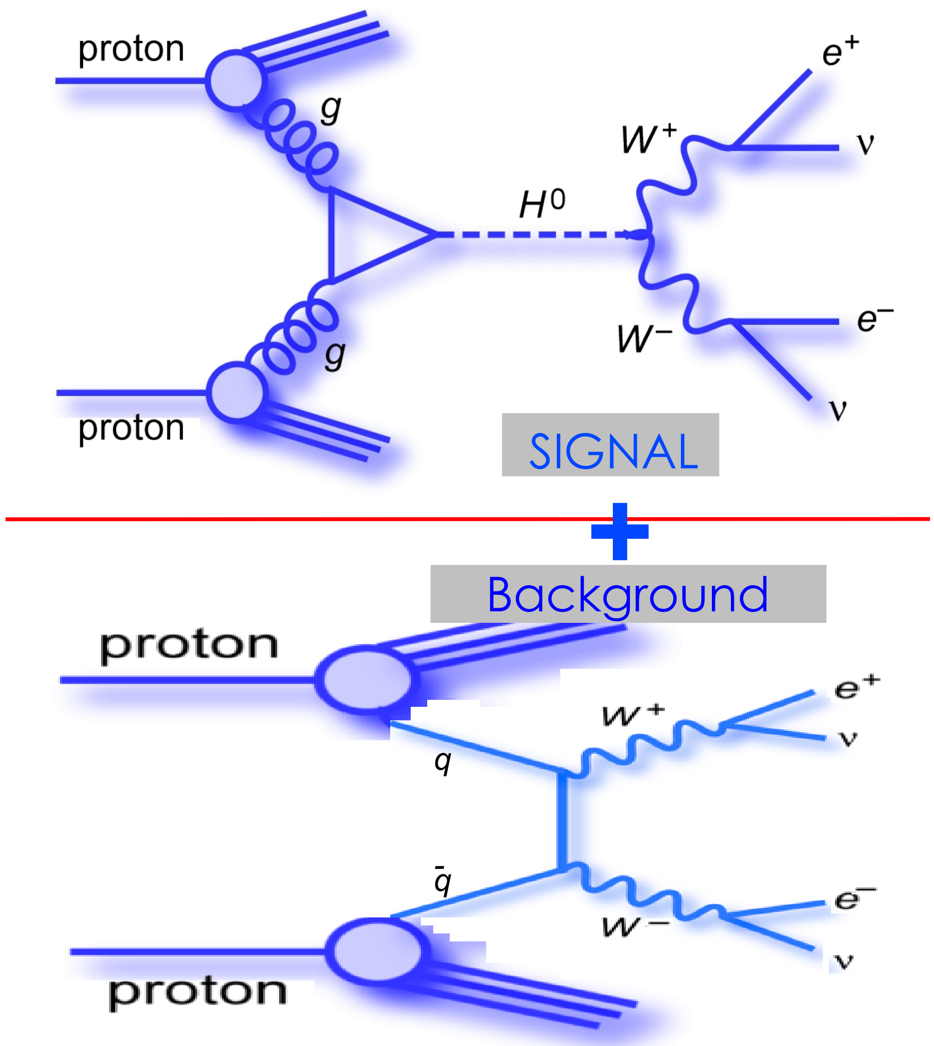



Unfortunately, other processes do exist and lead to the sale final state – and they do exist even if The Higgs boson would not exist !!

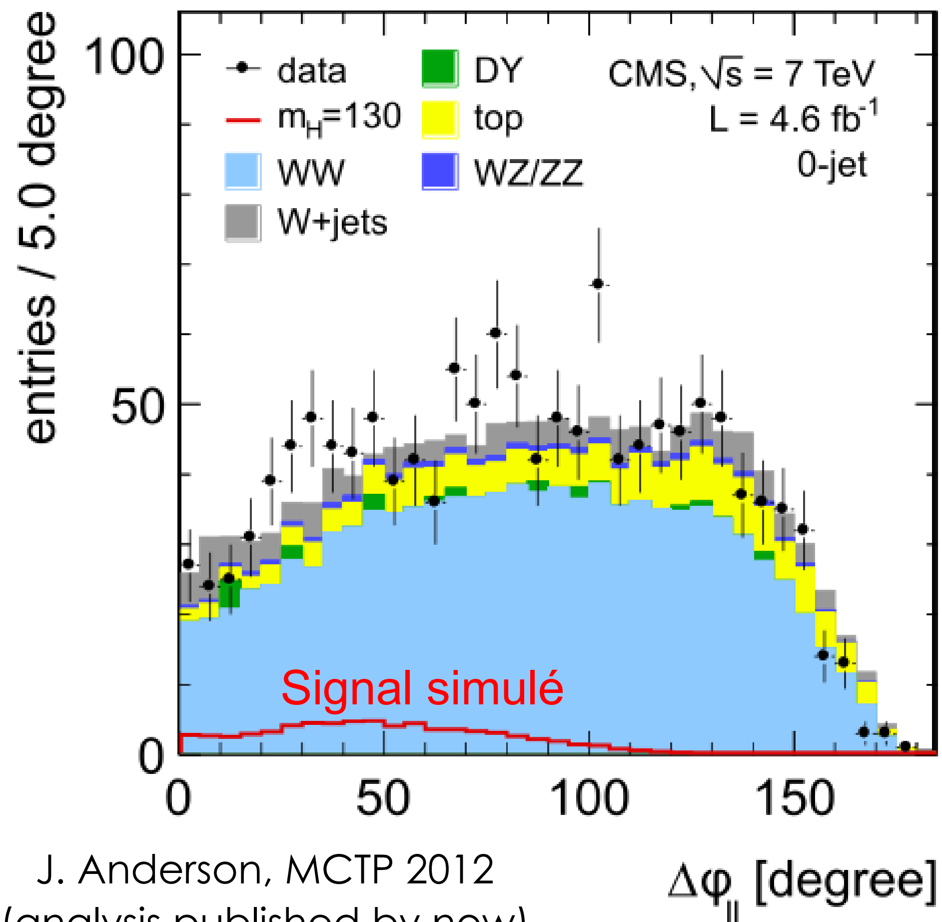
For the Higgs boson search, they represent
"a background".

What is even worse: this kind of process is far more abundant than the signal.

# "Signal" and "background"



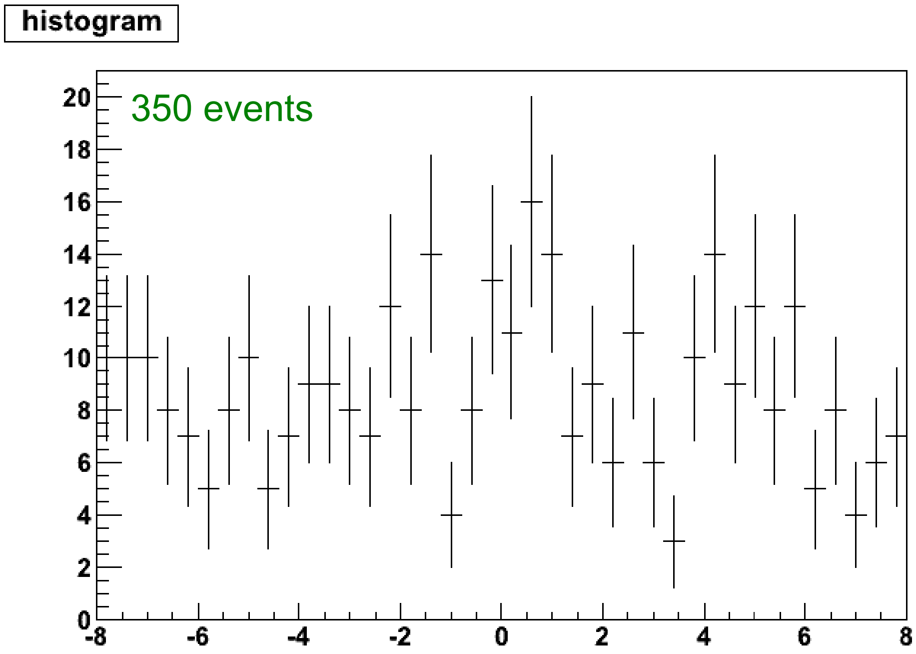

After a selection set:
is this collision data (the truth)
**compatible** with the **hypothesis**
background only or Bckgd+signal ?

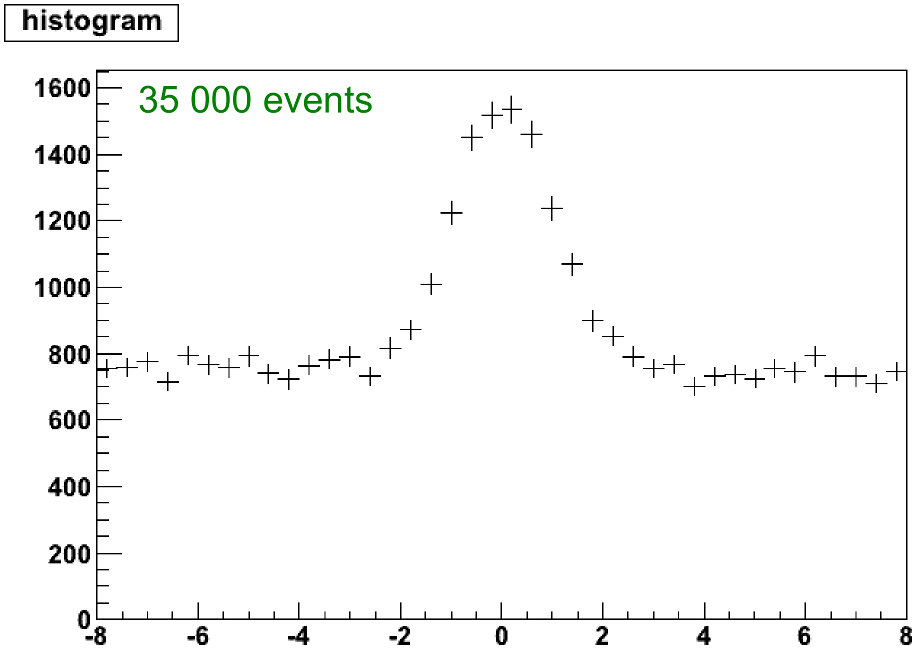



J. Anderson, MCTP 2012
(analysis published by now)

# Some words about statistics

The two plots below show the exact same distribution.
Left: with a low number of events ; right : with a factor of 100 more events.

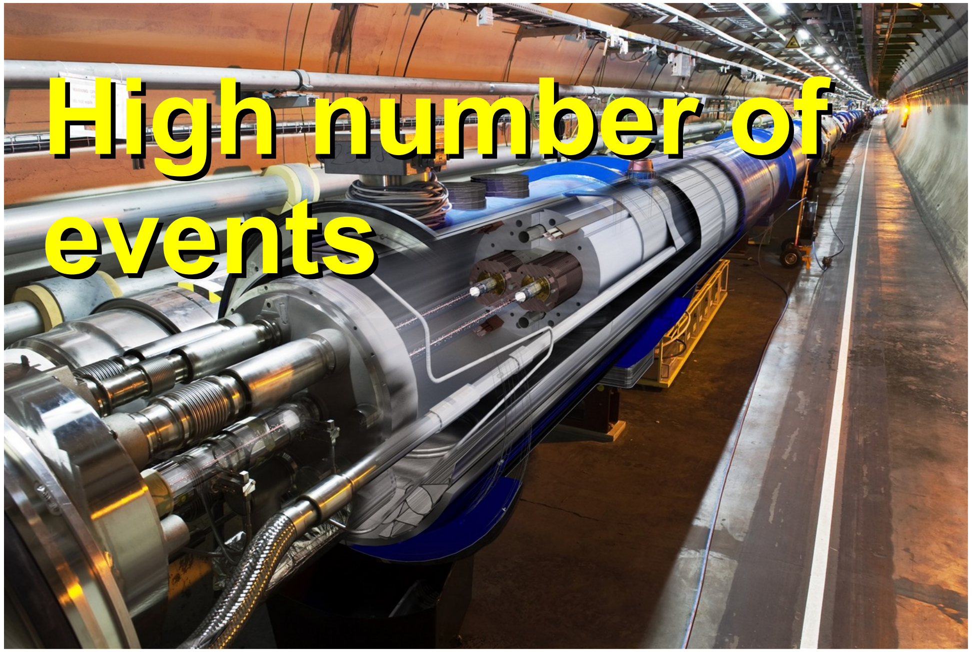


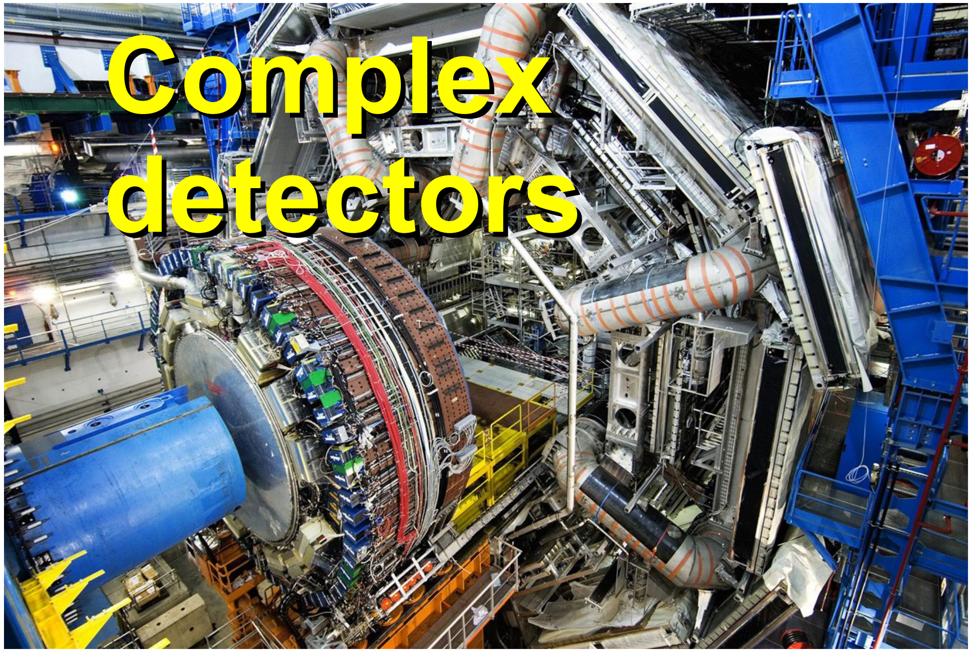



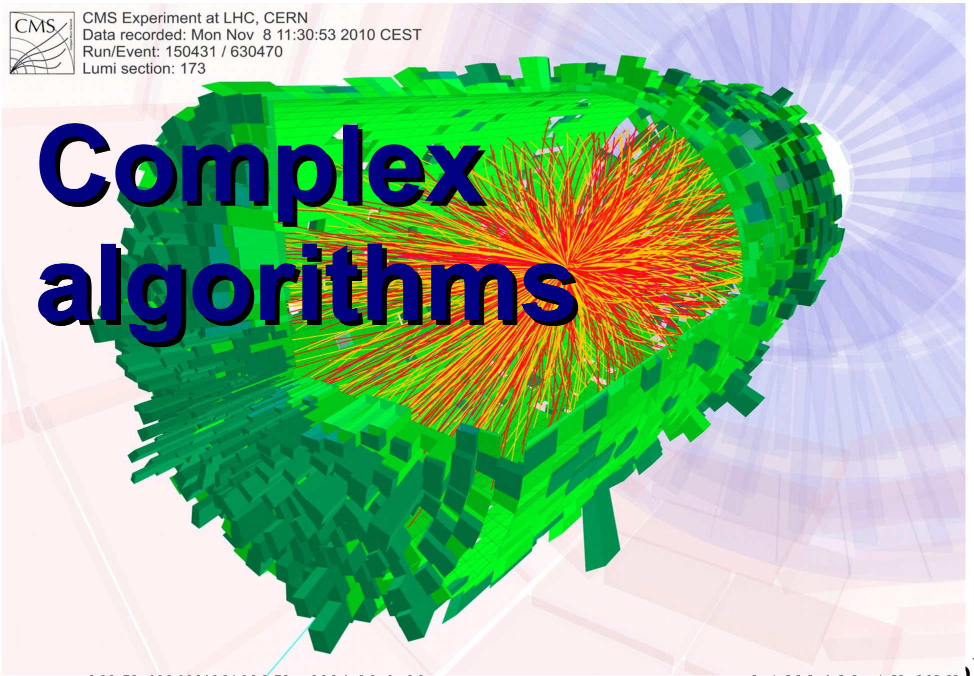

With a low number of events, the situation is not so clear:
- is it simply a flat distribution ?
- is there a spike somewhere ?

With a high number of events, we clearly see the structure: a flat spectrum (coming from the background) and a spike on top (coming from the Higgs).

# A new order of magnitude



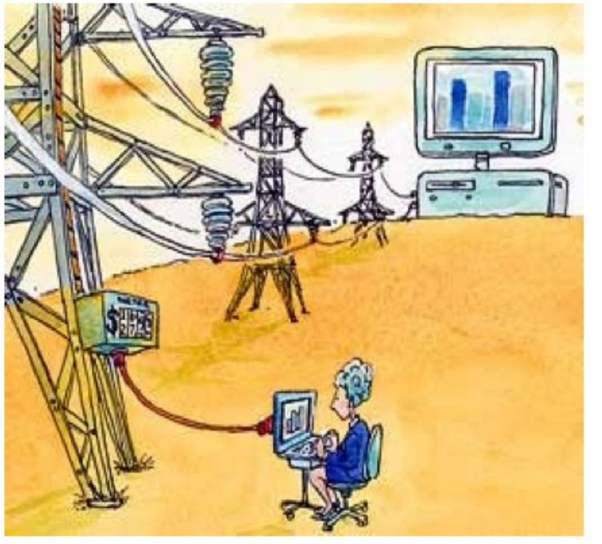




# A new Challenge

- No new concepts, but new orders of magnitude

→ one single site could not do all the computing alone (e.g. resources, cooling, money)

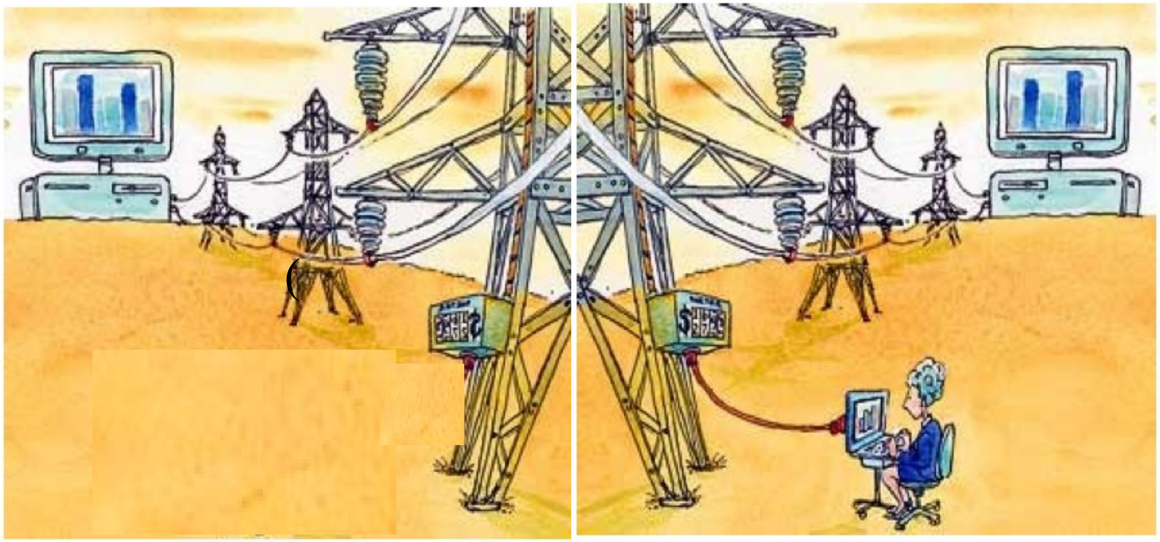
- Though,
  - Computing centers already existing worldwide
    - Often shares between several communities
  - Founding is provided locally



Term taken from the "electric power grid"

→ decision (technical & political) to build a grid infrastructure for the LHC compu

# The computing grid

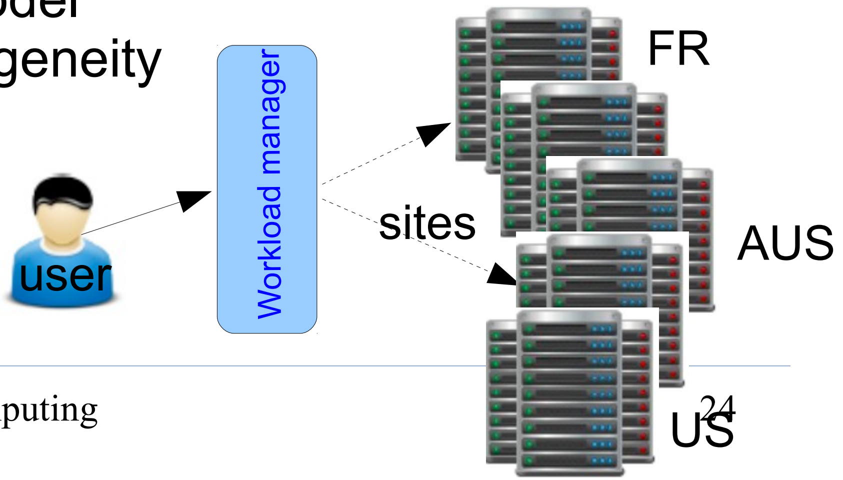


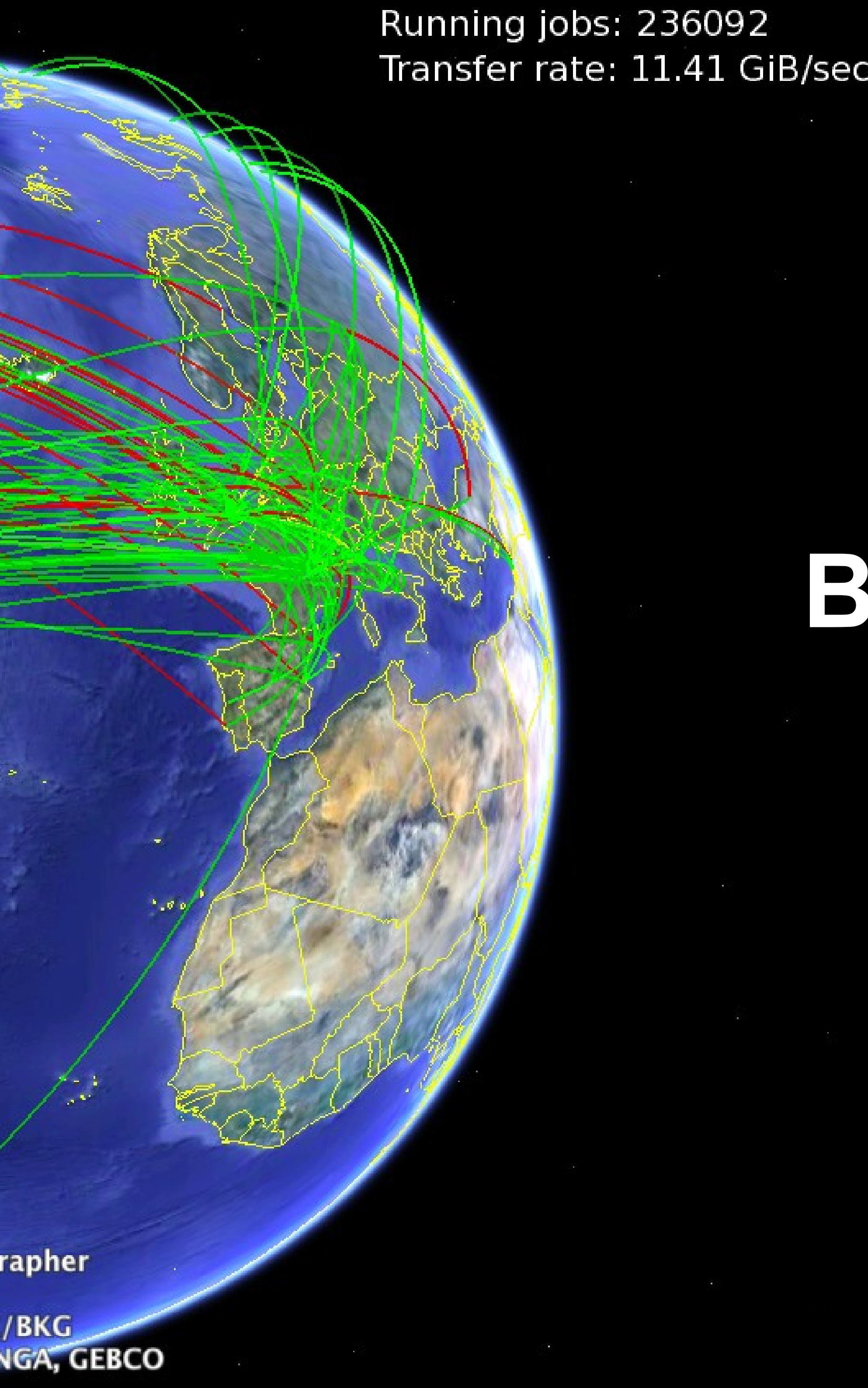
Decision taken to build a grid infrastructure for the LHC computing needs

- Share of resources from several units for a common goal
- Well adapted to our needs (small independant events)

Concepts of grid computing fits to the HEP model

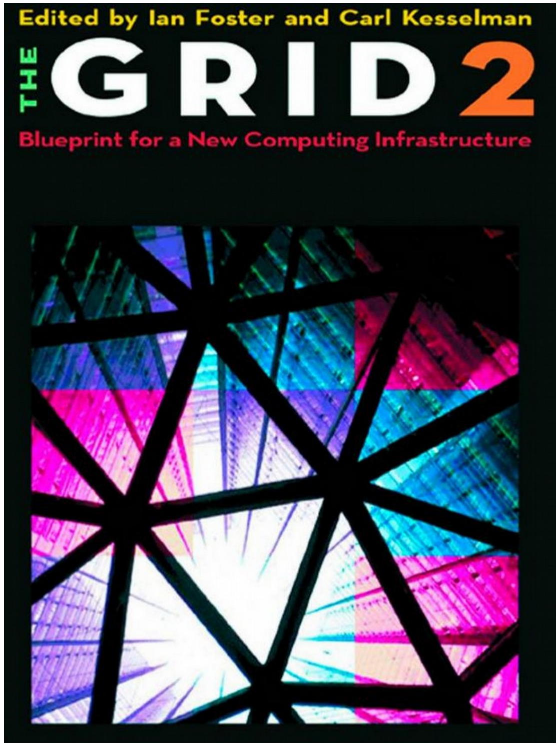
- Authentication / trust / solutions for heterogeneity






# Building WLCG

# Grid Computing concepts



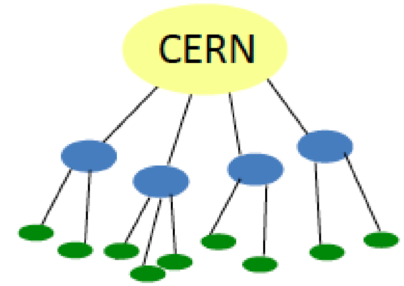

**The Grid: 1998 and 2003 (2nd Ed.)**
*Grid is used by analogy with the electric power grid…*
*has had a dramatic impact on human capabilities…*

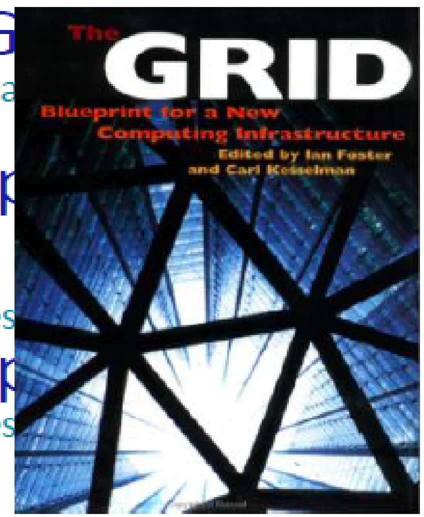
- Coordination of resources not centrally managed
- Use of standards protocols
- Access rights

Catalyser: development of high rate and extended networks (GEANT in 2000)

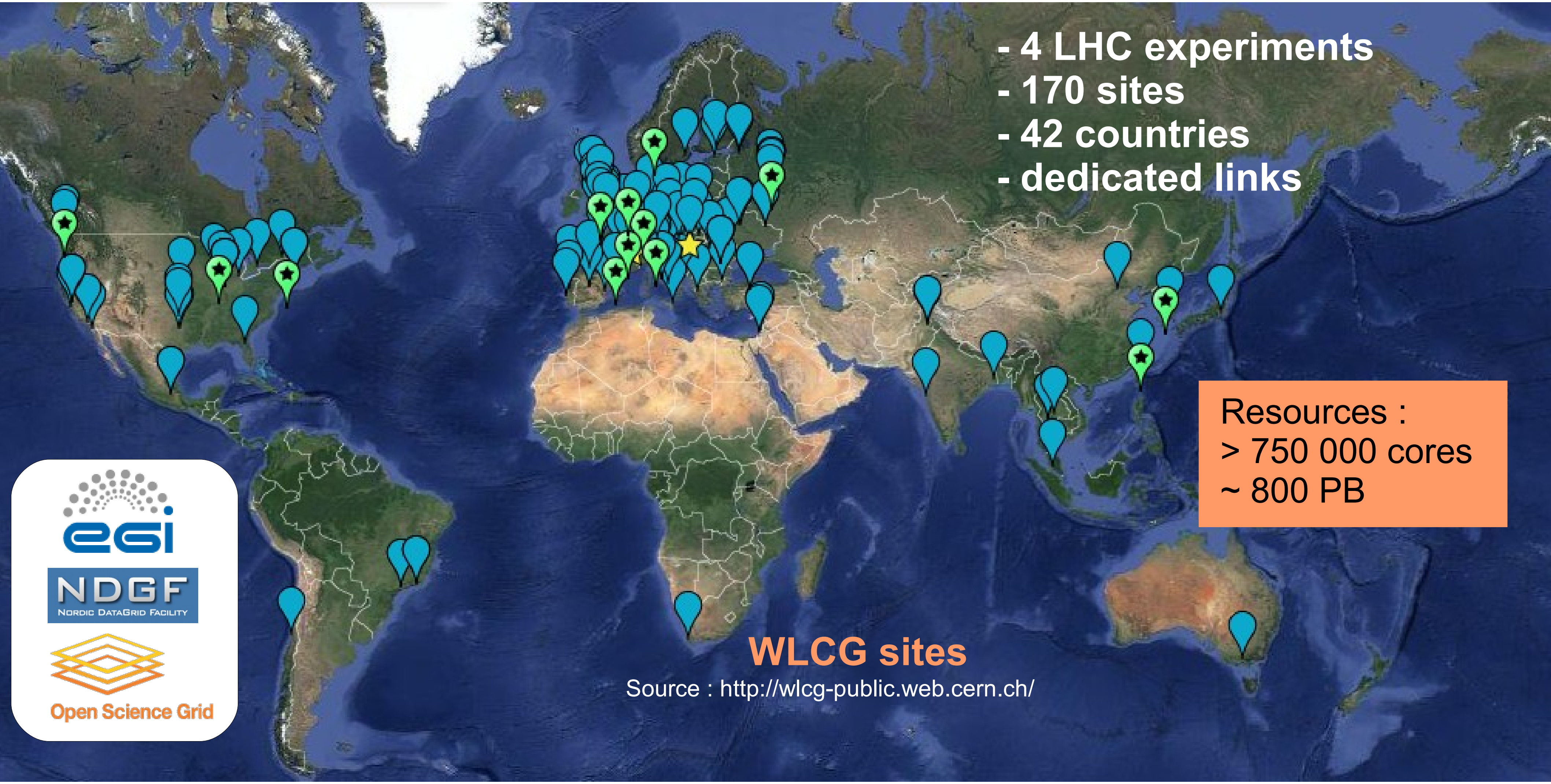
# A few words about history

- 1999 - MONARC project
  - First LHC computing architecture – hierarchical distributed model, focus on network control
- 2000 – growing interest in grid technology
  - HEP community main driver in launching the DataGrid project
- 2001-2004 - EU DataGrid project
  - middleware & testbed for an operational grid
- 2002-2005 – LHC Computing G
  - deploying the results of DataGrid to provide a production facility for LHC experiments
- 2004-2006 – EU EGEE project p
  - starts from the LCG grid
  - shared production infrastructure
  - expanding to other communities and sciences
- 2006-2008 – EU EGEE project p
  - expanding to other communities and sciences
  - Scale and stability
  - Interoperations/Interoperability
- 2008-2010 – EU EGEE project phase 3
  - More communities
  - Efficient operations
  - Less central coordination
- 2010 – 201x EGI and EMI
  - Sustainable infrastructures based on National Grid Infrastructures
  - Decoupling of middleware development and infrastructure
  - Merging middleware stacks in europe

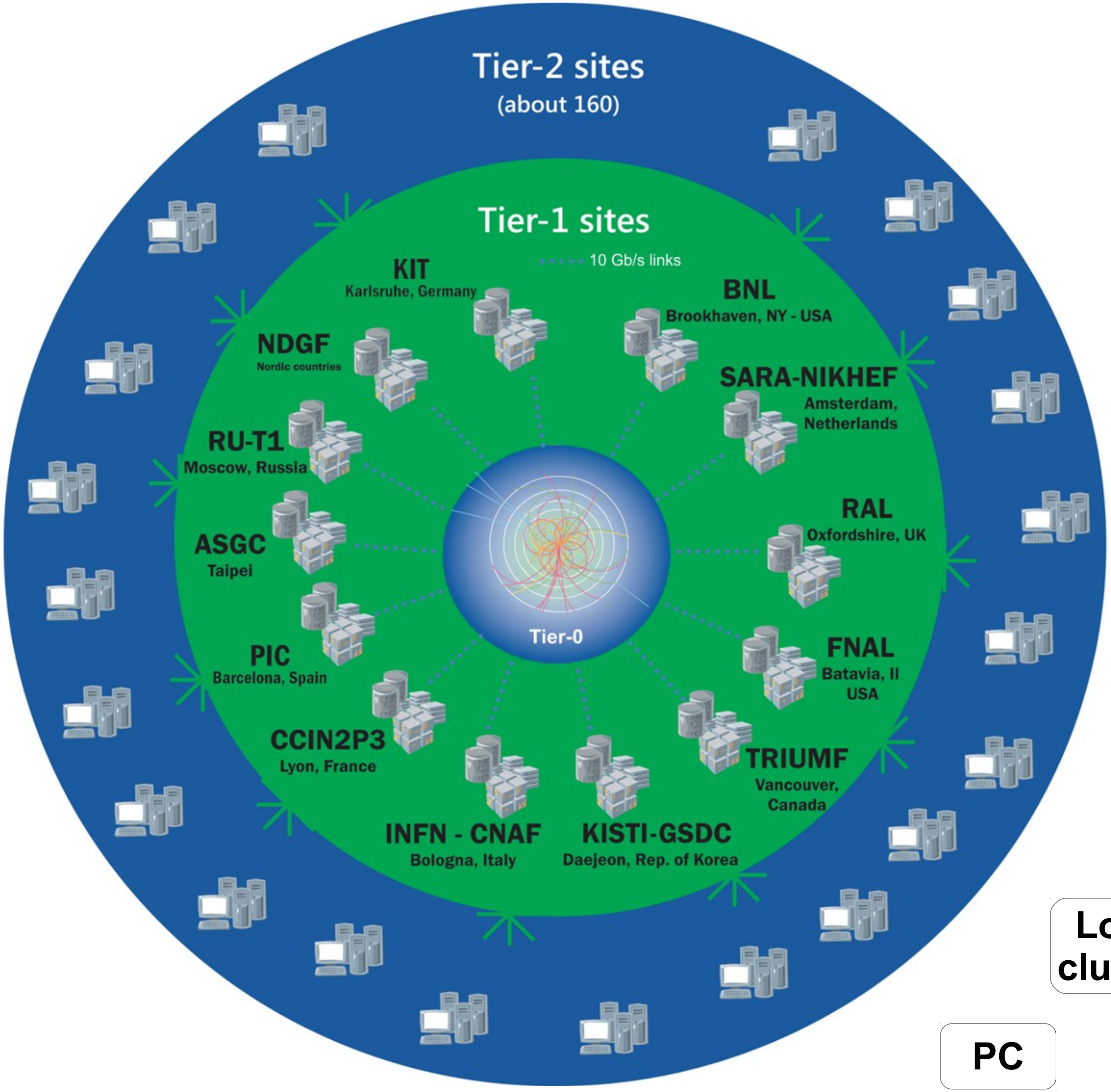


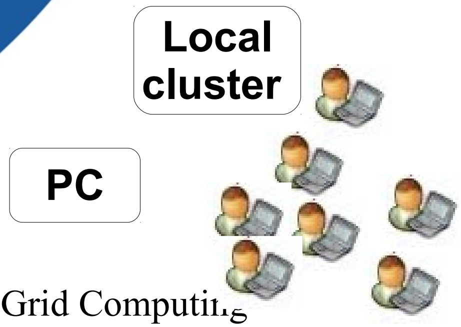



# Sites around the world



# Sites hierarchy




**Tier0 (CERN):**
- Raw data storage
- Initial reco pass
- Data distribution

**Tier-1:**
- Permanent storage
- Subsequent reco passes

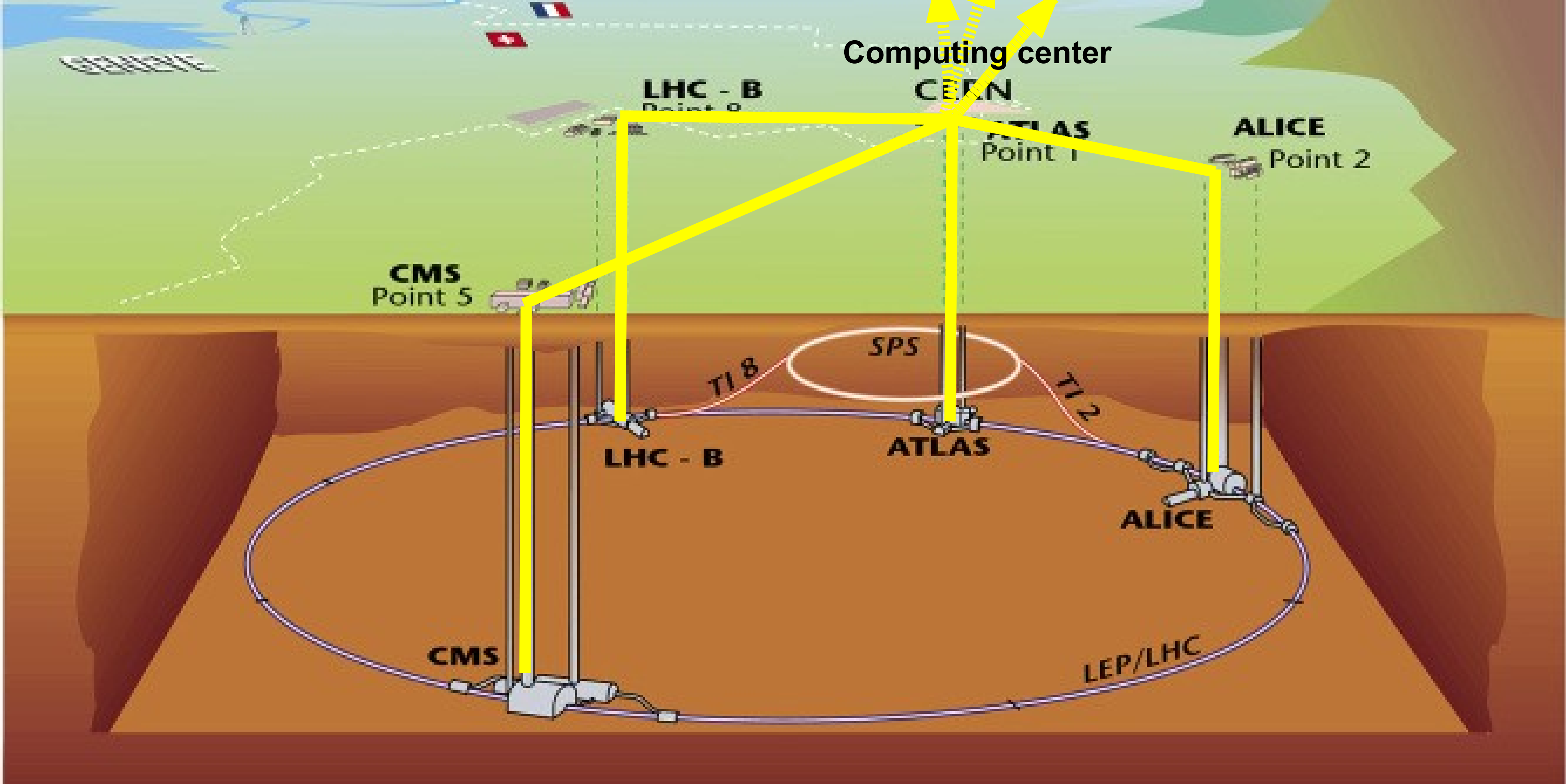
**Tier-2:**
- Simulation
- End user analysis

In addition (end user analysis):
- Tier-3
- Local clusters

# Overall view of the LHC experiments. Data flow

## T0 at CERN

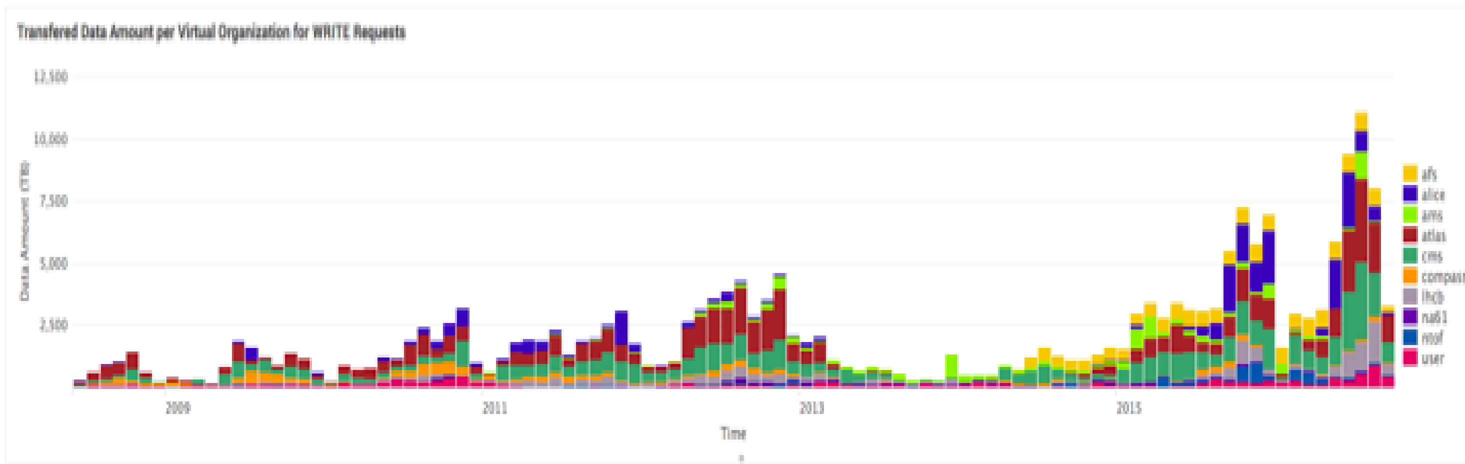
- First pass processing
- Storage (data flow ~300 MB/s)
- Transfer data to T1s

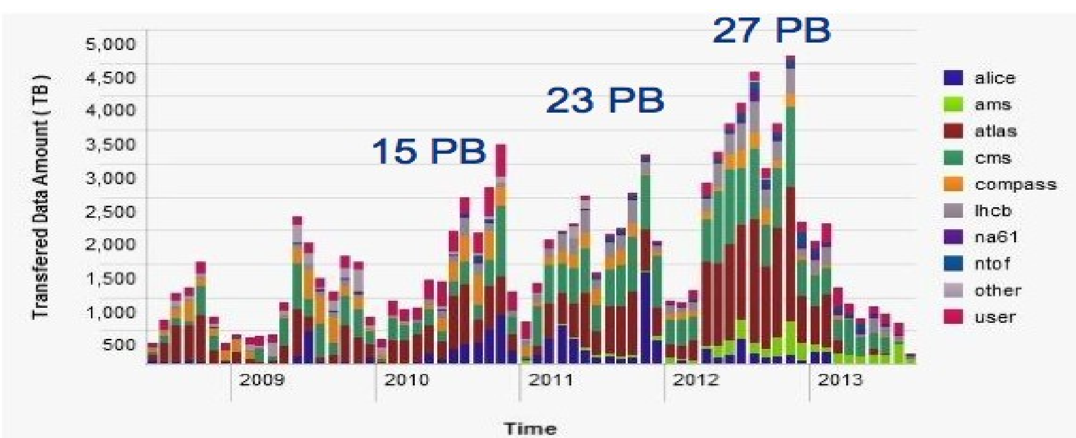


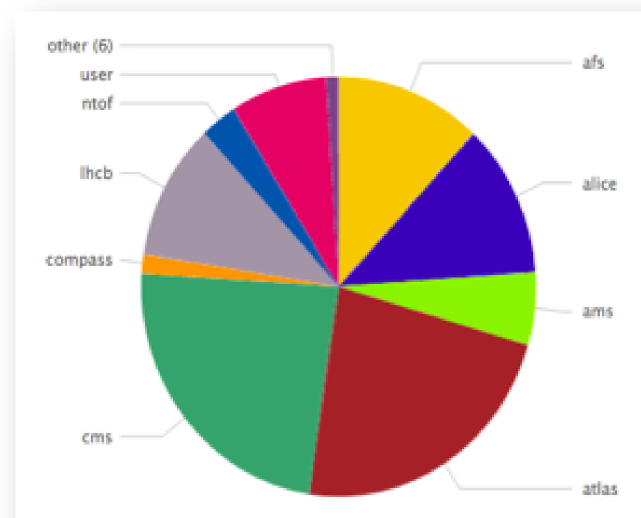
# CERN tape writes

CERN tape writes

June-July 2016:
> 500 TB per day



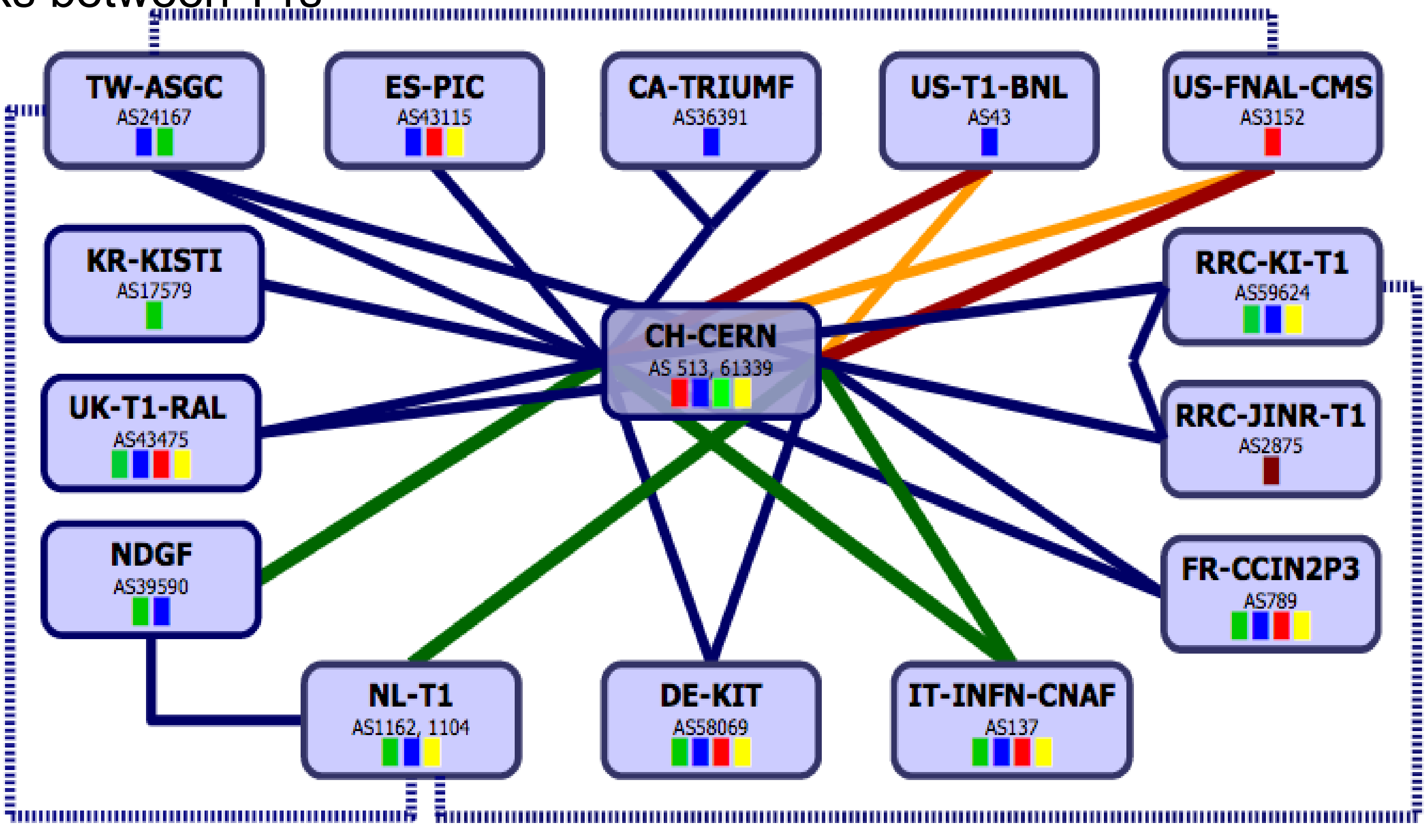



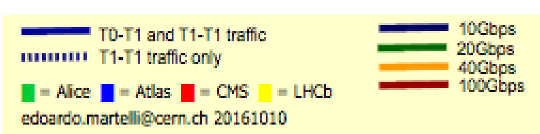




2016 data acquired

# LHC Optical Private Network (T0-T1)

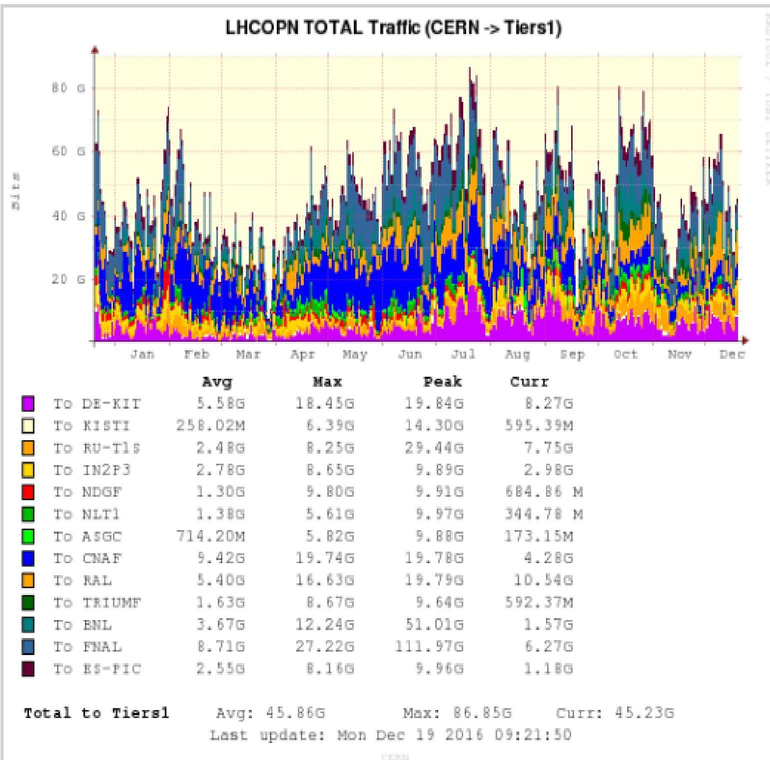
Agreements to provide
back-up links between T1s



# LHC Optical Private Network (T0-T1)

## 2016 traffic statistics




**~180PB moved in 2016**

**70% increase compared to 2015 (was ~105PB)**

# In Europe

- 1-9 Gbps
- multiples of 10 Gbps
- multiples of 100 Gbps

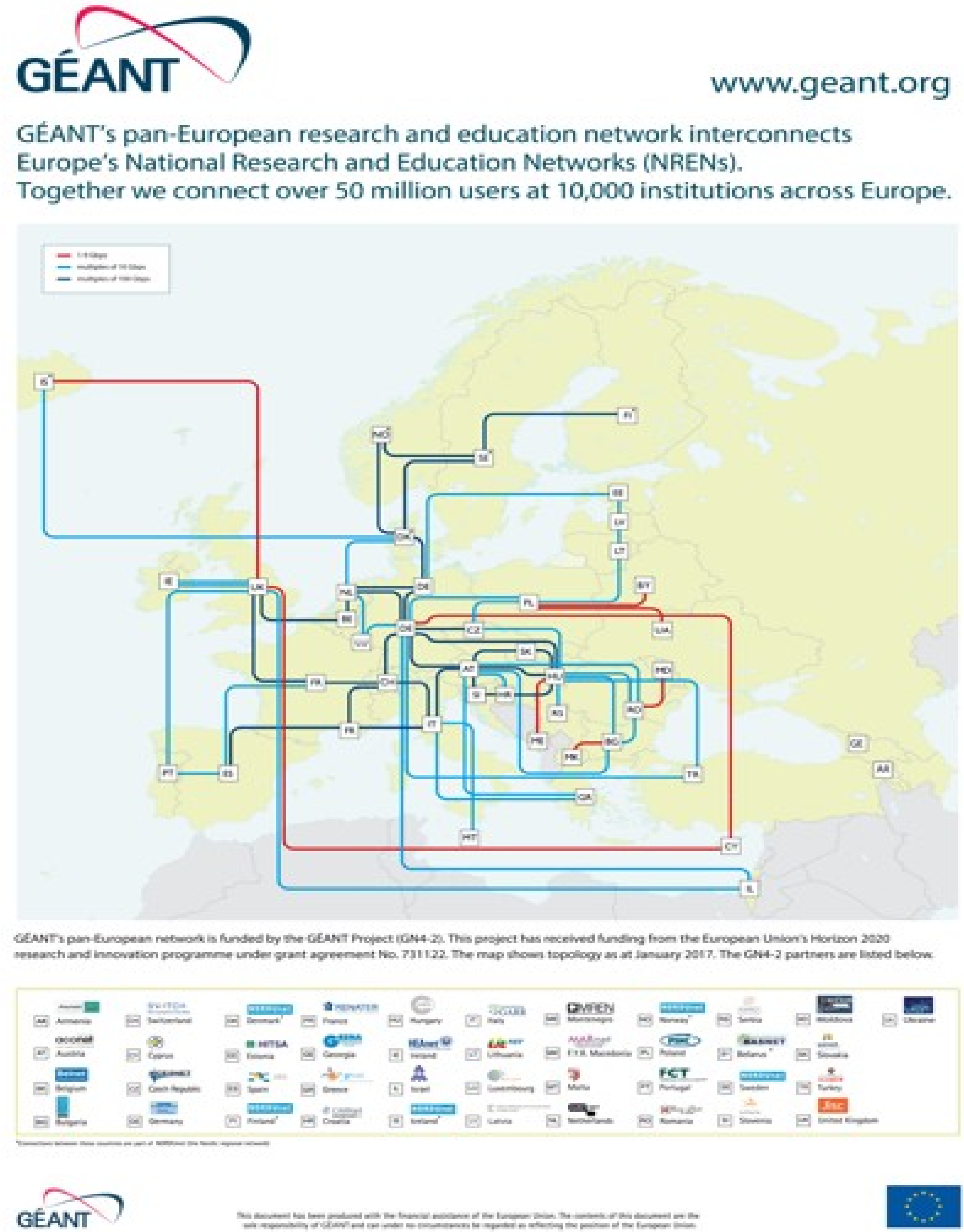
https://www.geant.org/

DFN

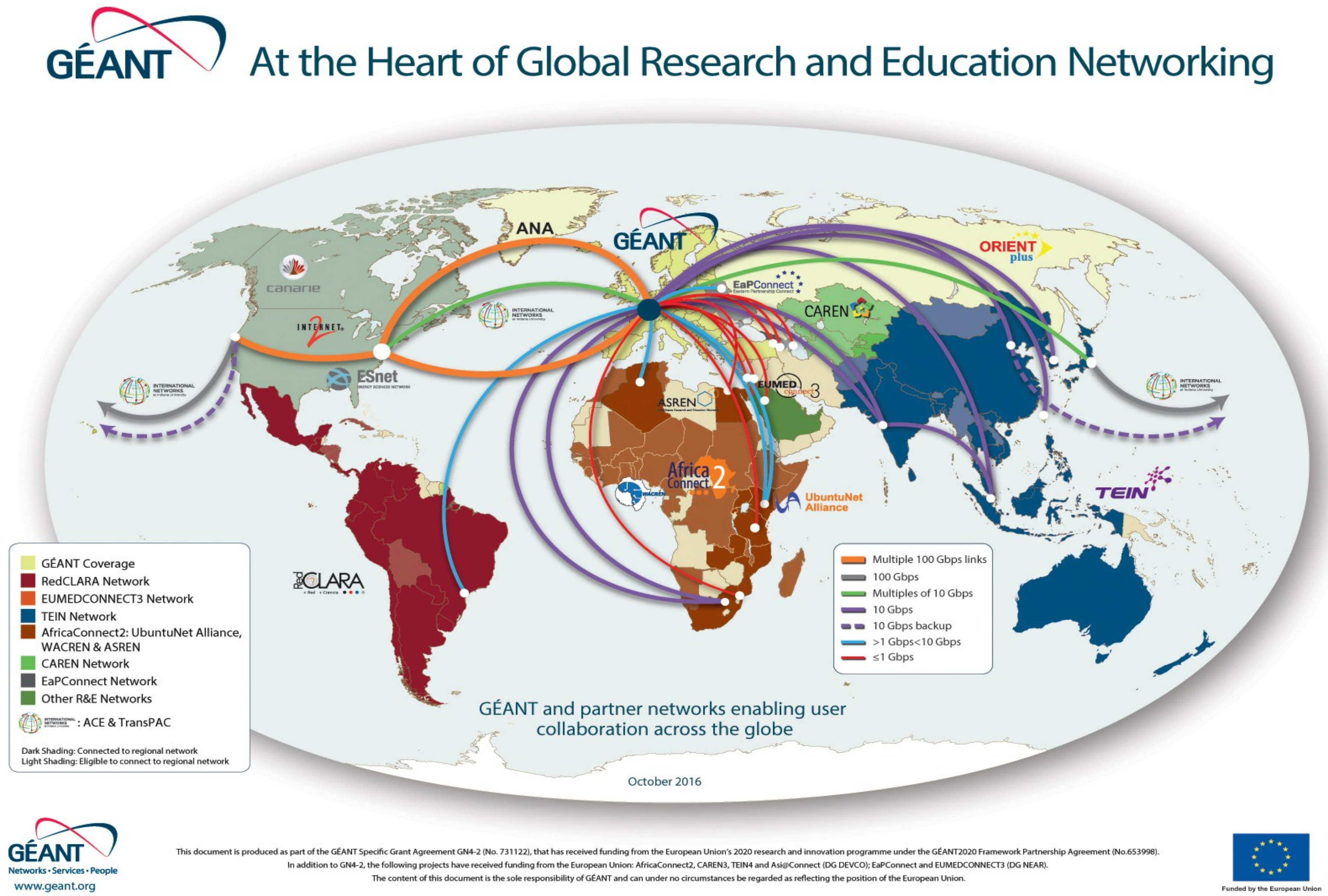
DE Germany

RENATER

FR France

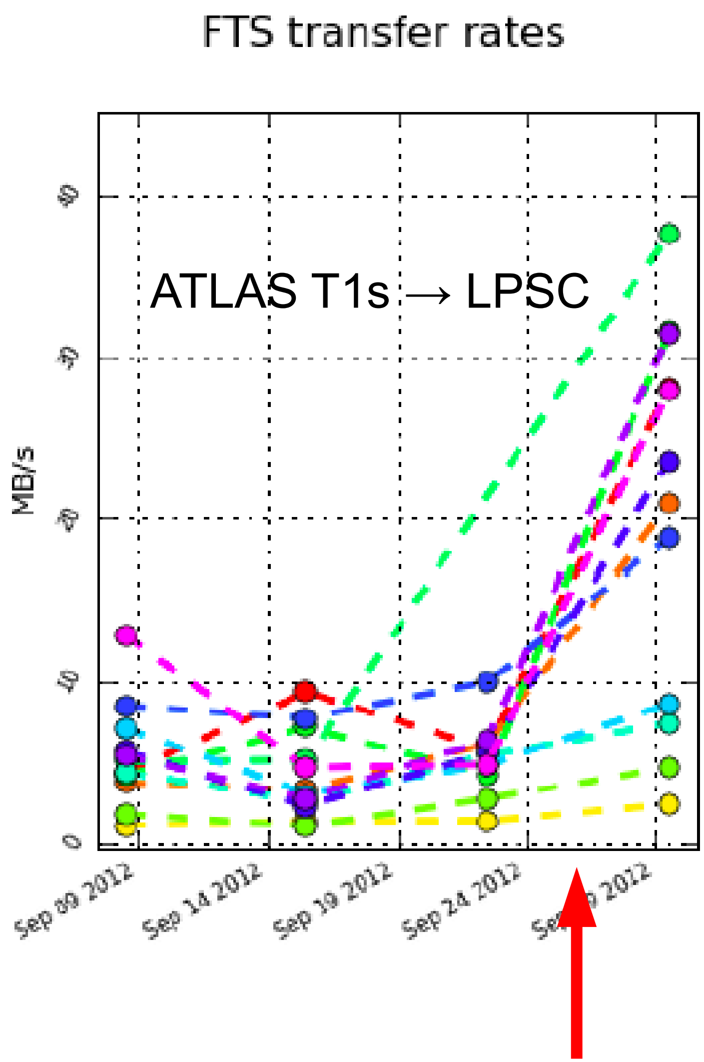


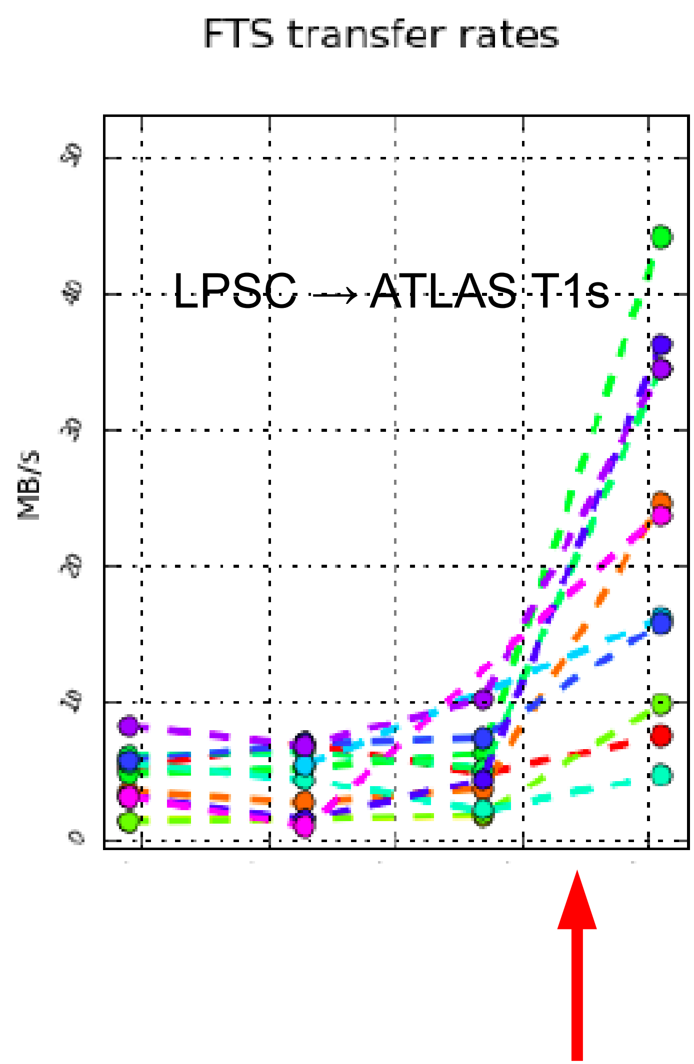
# Connect to the world



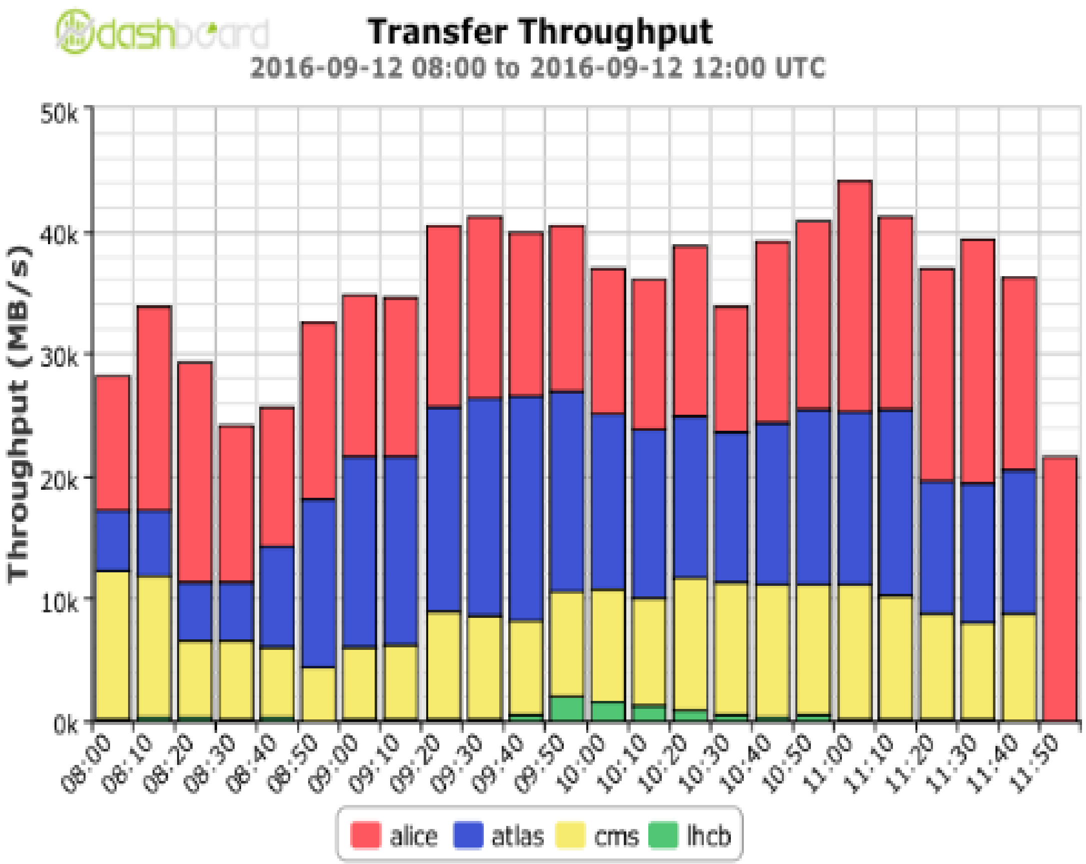
# Upgrading the network

LPSC site, a WLCG Tier-2, serves ALICE and ATLAS
Network upgrade from 700Mb/s to 5Gb/s



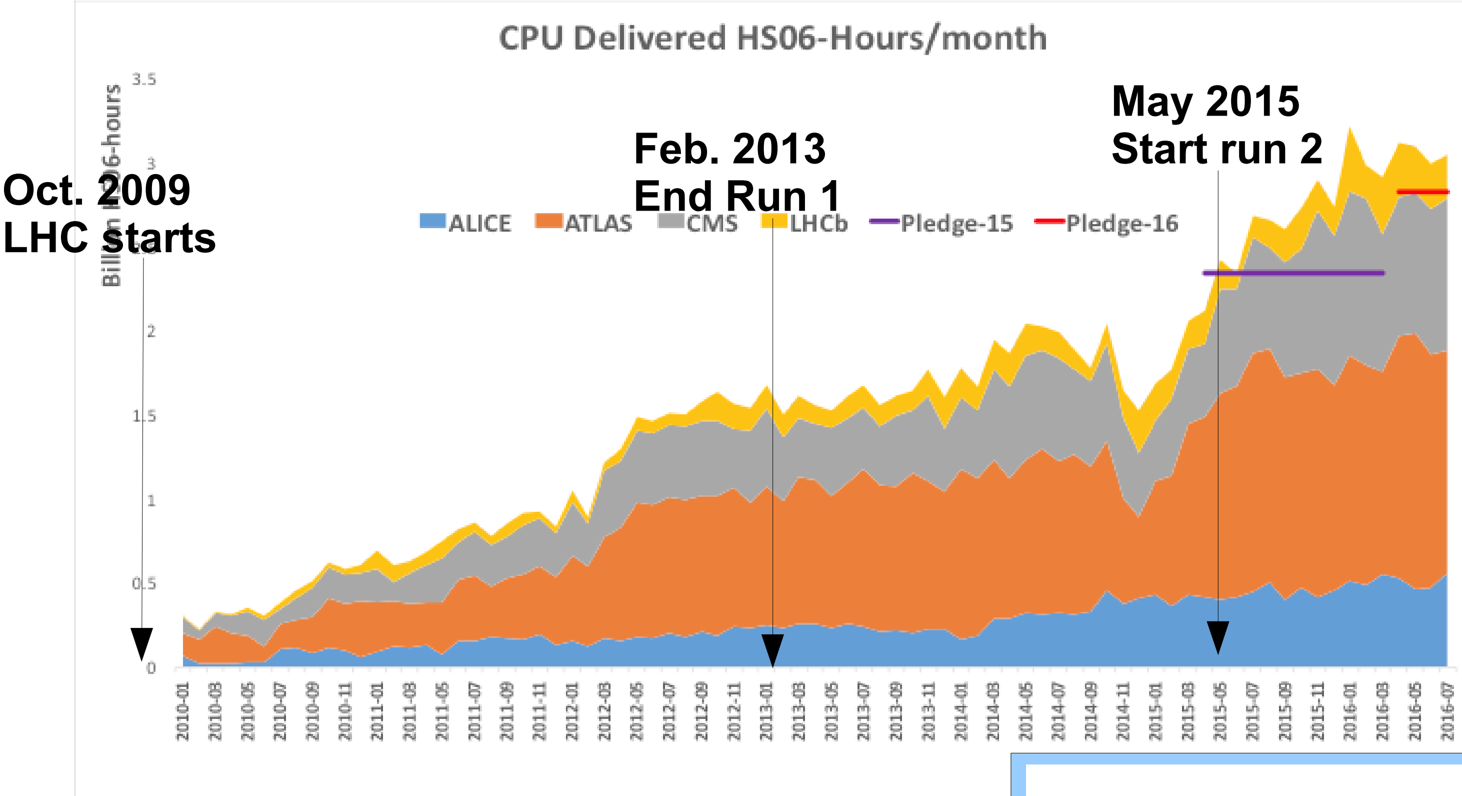
# Global transfers



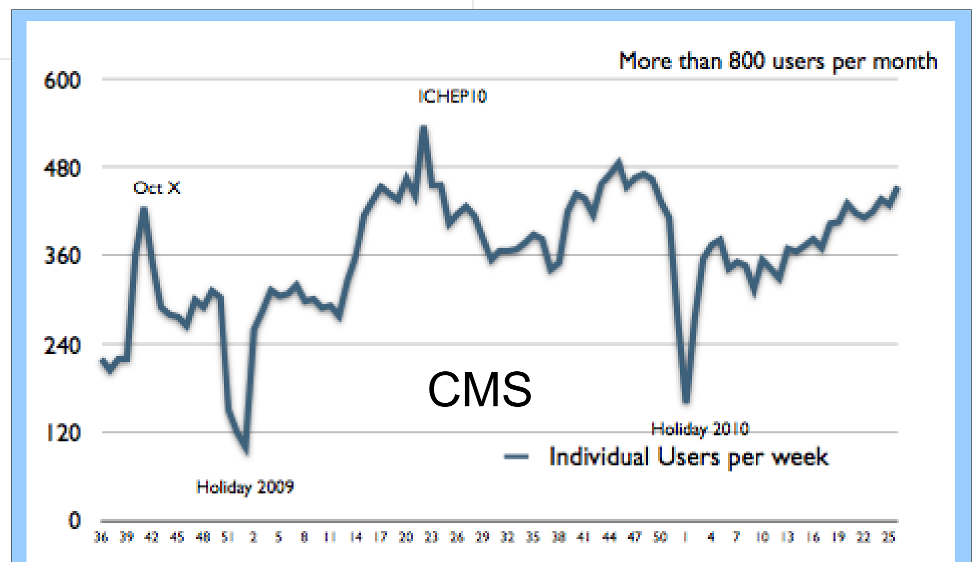

Data transfer rates > 40 GB/s

Regular transfers of > 80 PB/month

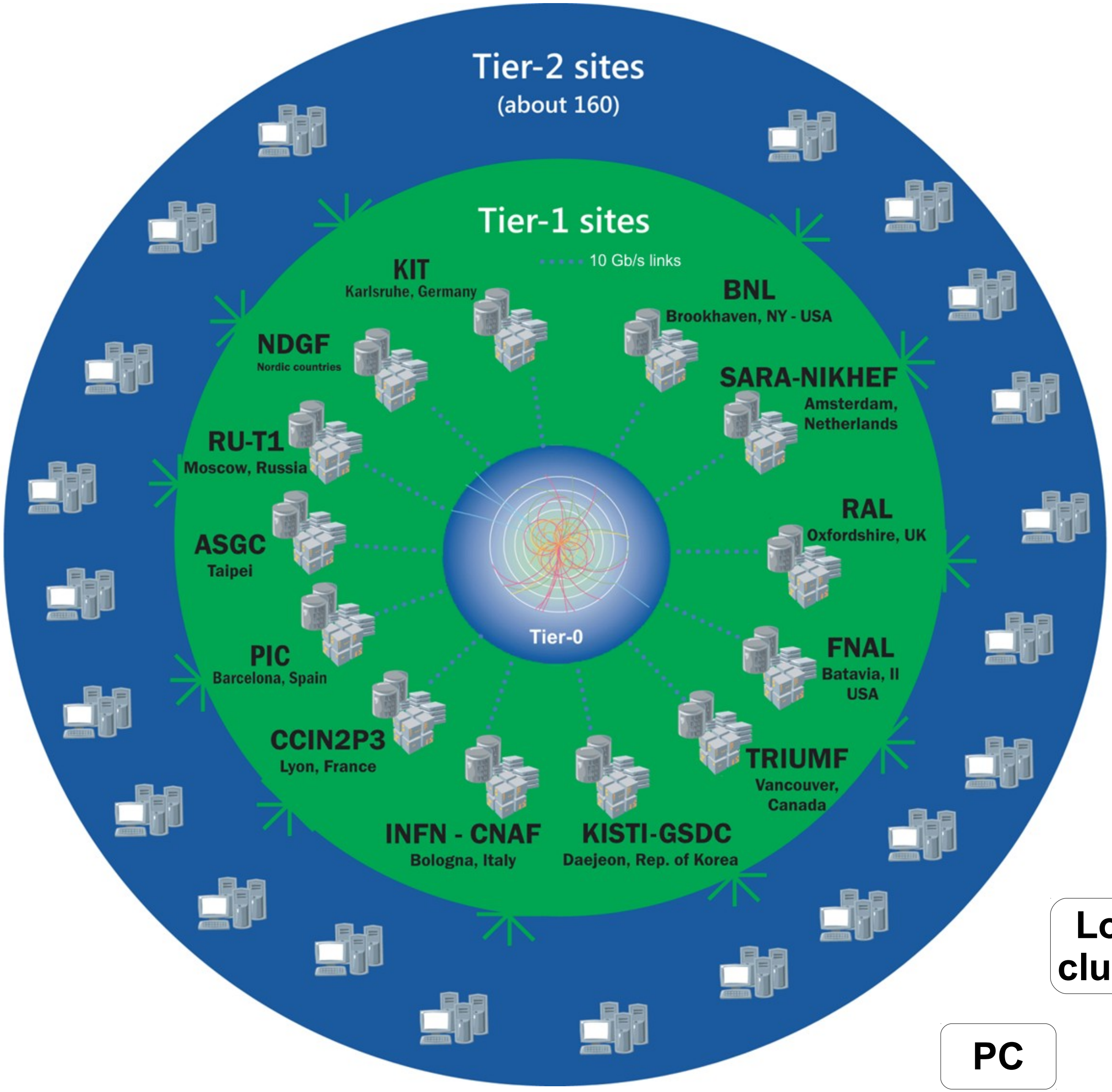
# CPU delivered




Ref :
http://accounting.egi.eu/



# Sites hierarchy

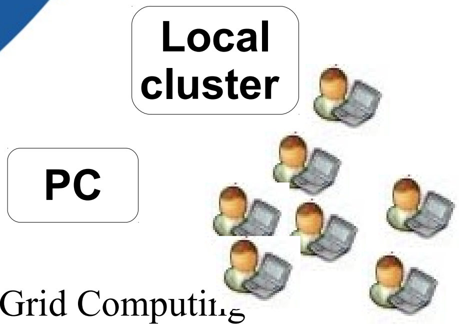



Tier0 (CERN):
- Raw data storage
- Initial reco pass
- Data distribution

Tier-1:
- Permanent storage
- Subsequent reco passes

Tier-2:
- Simulation
- End user analysis

In addition (end user analysis):
- Tier-3
- Local clusters



# MoU requirements

## T1 centres

Memorandum of Under-standing between CERN and the institutions participating in WLCG

(CERN-C-RRB-2005-1/ Rev. April 2009)

Only an extract !

| Service | Maximum delay in responding to operational problems | | | Average availability[5] measured on an annual basis | |
|---|---|---|---|---|---|
| | Service interruption | Degradation of the capacity of the service by more than 50% | Degradation of the capacity of the service by more than 20% | During accelerator operation | At all other times |
| Acceptance of data from the Tier-0 Centre during accelerator operation | 12 hours | 12 hours | 24 hours | 99% | n/a |
| Networking service to the Tier-0 Centre during accelerator operation | 12 hours | 24 hours | 48 hours | 98% | n/a |
| Data-intensive analysis services, including networking to Tier-0, Tier-1 Centres outwith accelerator operation | 24 hours | 48 hours | 48 hours | n/a | 98% |
| All other services[6] – prime service hours[9] | 2 hour | 2 hour | 4 hours | 98% | 98% |
| All other services[6] – outwith prime service hours[9] | 24 hours | 48 hours | 48 hours | 97% | 97% |

The response times in the above table refer only to the maximum delay before action is taken to repair the problem. The mean time to repair is also a very important factor that is only covered in this table indirectly through the availability targets. All of these parameters will require an adequate level of staffing of the services, including on-call coverage outside of prime shift.

# MoU requirements

## T2 centres

- Less constraints
  - Receive no data from detectors
- Availability > 95%

Availability: time site is available / total time

Reliability: time site is available / (total time – scheduled downtime)

Test suit per experiment with monthly report

**Tier-2 Availability and Reliability Report**

**ATLAS**

**February 2014**

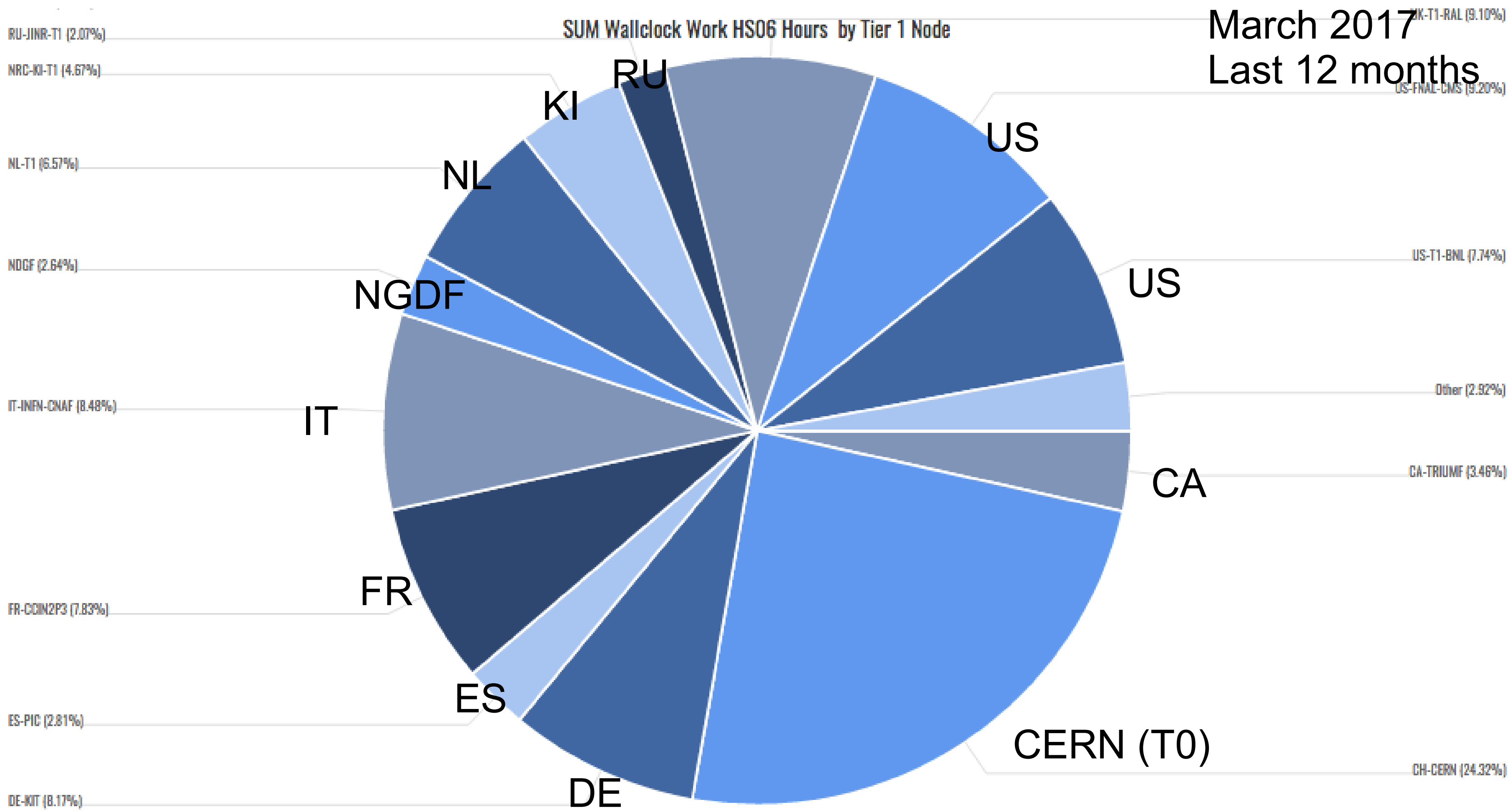
Federation Details

Colour coding : N/A <30% <60% <90% >=90%

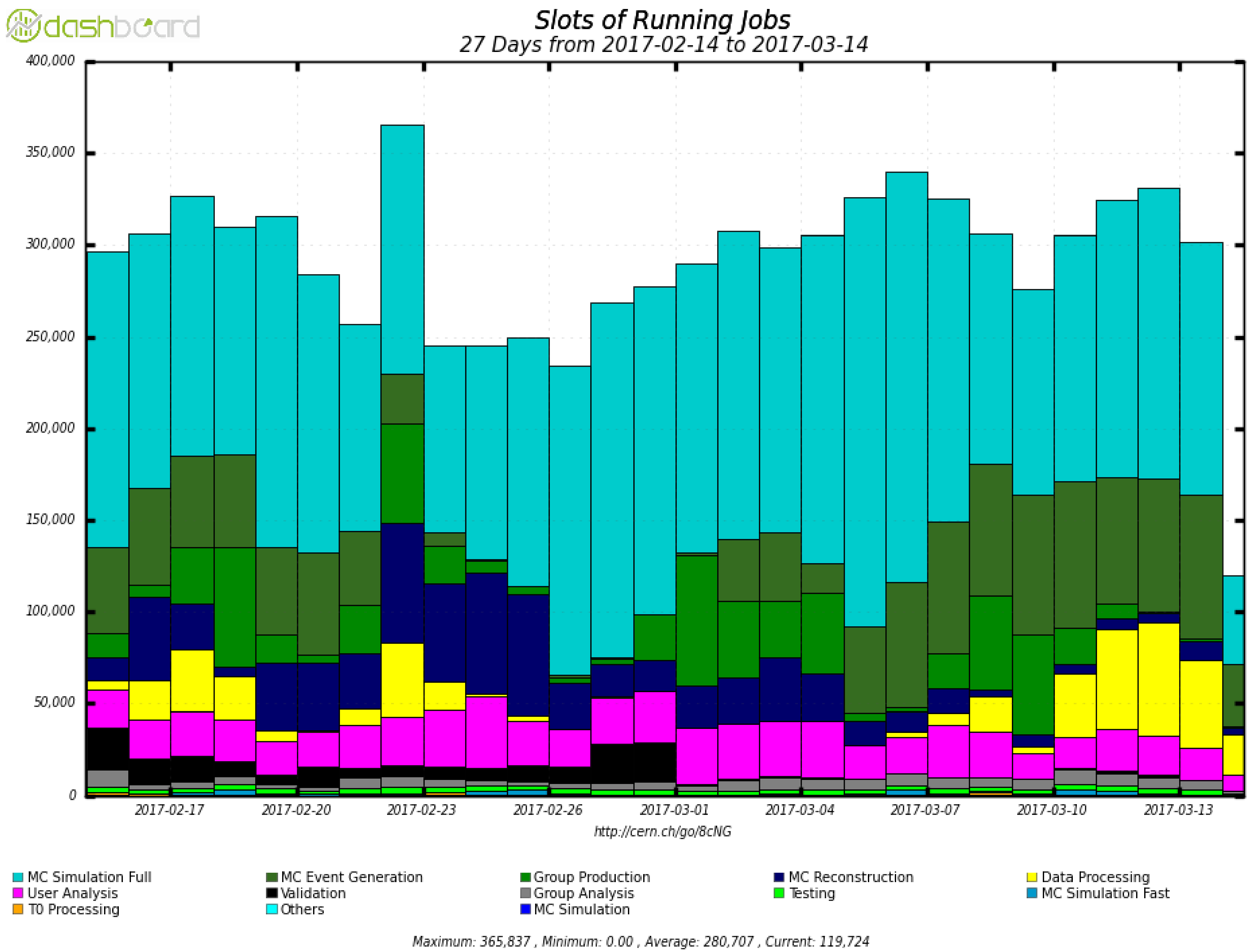
Availability Algorithm: (OSG-CE + CE + CREAM-CE ) * (SRMv2 + OSG-SRMv2)

| Federation | Site | Phy-CPU | Log-CPU | HS06 | Availability | Reliability | Unknown | Availability History Nov 2013 | Dec 2013 | Jan 2014 |
|---|---|---|---|---|---|---|---|---|---|---|
| FR-IN2P3-LPSC | | | | | | | | | | |
| | IN2P3-LPSC | 136 | 660 | 5399 | 99 % | 99 % | 3 % | 93 % | 100 % | 94 % |

# Tier-1

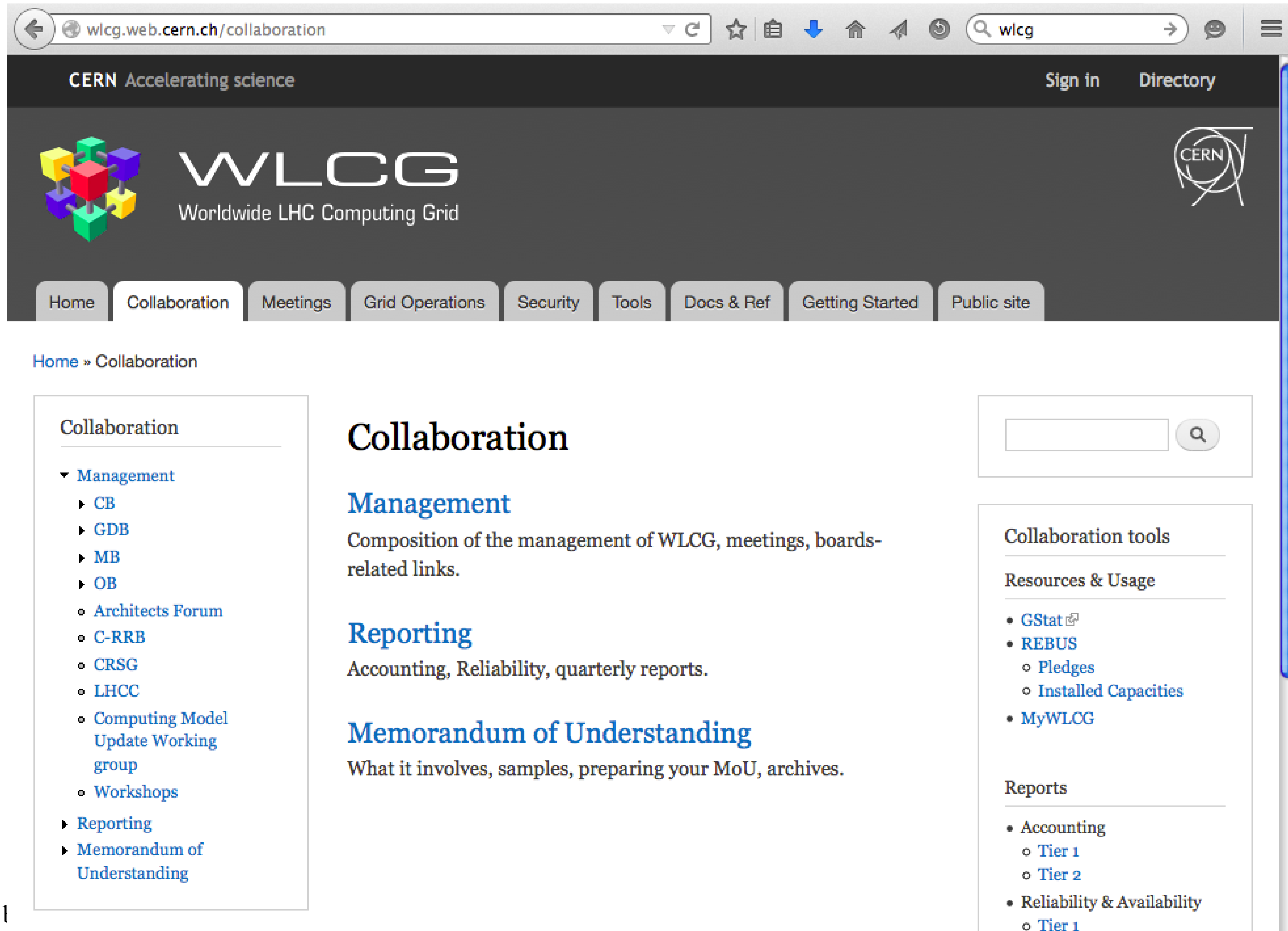

SUM Wallclock Work HS06 Hours by Tier 1 Node
March 2017
Last 12 months
RU-JINR-T1 (2.07%)
NRC-KI-T1 (4.67%)
NL-T1 (6.57%)
NDGF (2.64%)
IT-INFN-CNAF (8.48%)
FR-CCIN2P3 (7.83%)
ES-PIC (2.81%)
DE-KIT (8.17%)
UK-T1-RAL (9.10%)
US-FNAL-CMS (9.20%)
US-T1-BNL (7.74%)
Other (2.92%)
CA-TRIUMF (3.46%)
CH-CERN (24.32%)
RU
KI
NL
NGDF
IT
FR
ES
DE
US
US
CA
CERN (T0)

# ATLAS alone




Average/ day:
1 Million job
completed

# WLCG Collaboration



# Pledges

https://wlcg-rebus.cern.ch/apps/pledges/summary/

WLCG REsource, Balance & USage — WLCG Home | Contact | GGUS | Admin Login

## REBUS: Pledge Summary

Topology | Pledges | Capacities | Report | Trends | Accounting

Pledges > Pledge Summary

**Year:** 2016

Note: Sorting by multiple columns at the same time can be activated by 'shift' clicking on the column headers which they want to add to the sort. Hovering mouse over the column headers to get descriptions of table columns.

All Tiers | Tier 0 | Tier 1 | Tier 2

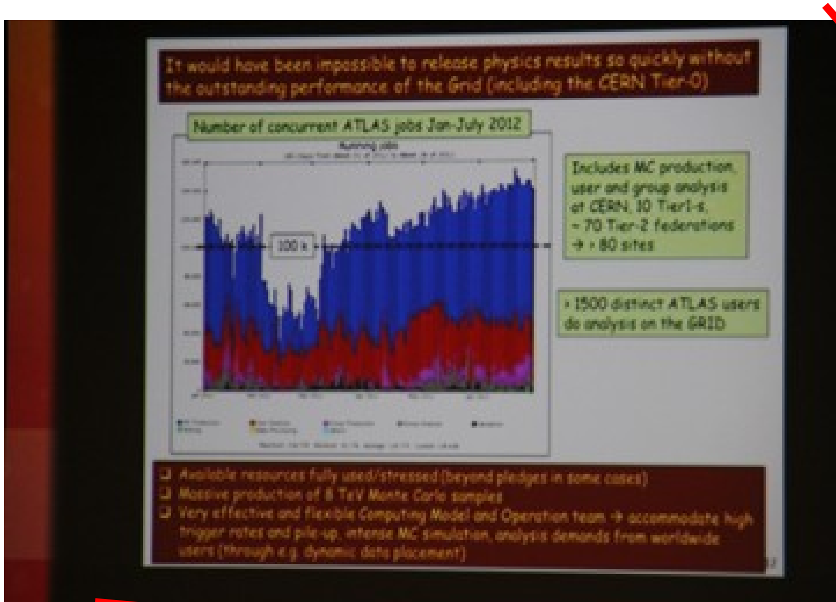
Search:

| Tier | Pledge Type | ALICE | Required | Balance | ATLAS | Required | Balance | CMS | Required | Balance | LHCb | Required | Balance | SUM | Required | Balance |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Tier 0 | CPU (HEP-SPEC06) | 215,000 | 215,000 | 0% | 257,000 | 257,000 | 0% | 317,000 | 317,000 | 0% | 51,000 | 48,000 | 6% | 840,000 | 837,000 | 0% |
| Tier 0 | Disk (Tbytes) | 16,800 | 16,800 | 0% | 17,000 | 17,000 | 0% | 16,400 | 16,000 | 3% | 7,600 | 5,800 | 31% | 57,800 | 55,600 | 4% |
| Tier 0 | Tape (Tbytes) | 21,600 | 21,600 | 0% | 42,000 | 42,000 | 0% | 44,000 | 44,000 | 0% | 20,600 | 15,000 | 37% | 128,200 | 122,600 | 5% |
| Tier 1 | CPU (HEP-SPEC06) | 177,038 | 157,000 | 13% | 571,060 | 520,000 | 10% | 377,800 | 400,000 | -6% | 165,252 | 146,000 | 13% | 1,291,150 | 1,223,000 | 6% |
| Tier 1 | Disk (Tbytes) | 18,955 | 21,000 | -10% | 52,683 | 47,000 | 12% | 30,683 | 33,000 | -7% | 15,902 | 14,900 | 7% | 118,223 | 115,900 | 2% |
| Tier 1 | Tape (Tbytes) | 17,776 | 15,600 | 14% | 119,044 | 116,000 | 3% | 88,200 | 100,000 | -12% | 35,044 | 25,800 | 36% | 260,064 | 257,400 | 1% |
| Tier 2 | CPU (HEP-SPEC06) | 231,157 | 237,000 | -2% | 633,509 | 566,000 | 12% | 716,455 | 700,000 | 2% | 88,626 | 81,000 | 9% | 1,669,747 | 1,584,000 | 5% |
| Tier 2 | Disk (Tbytes) | 18,518 | 26,100 | -29% | 68,885 | 72,000 | -4% | 40,822 | 38,000 | 7% | 2,719 | 2,800 | -3% | 130,944 | 138,900 | -6% |

Showing 1 to 8 of 8 entries

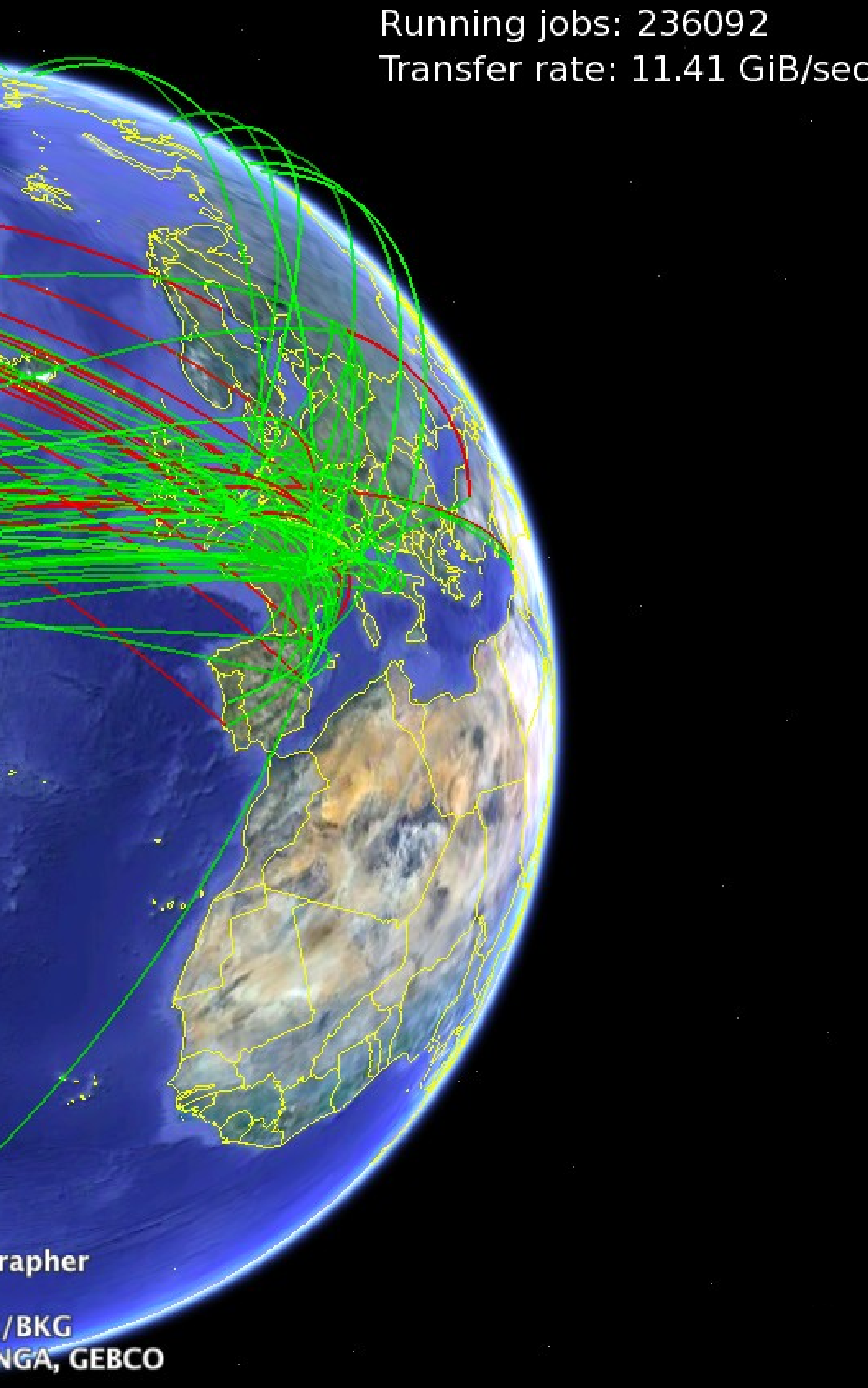
Found a bug?

# “Computing enables physics”




Photography: C. Biscarat

CERN seminar, July 4th 2012, retransmitted at ICHEP (Melbourne)


Running jobs: 236092
Transfer rate: 11.41 GiB/sec
rapher
/BKG
NGA, GEBCO

# Other grids

# European Grid Initiative

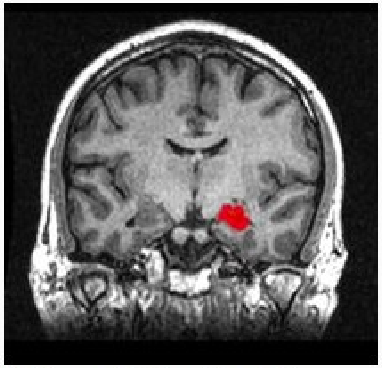
- The WLCG shares the infrastructures with EGI
  - Organised in National Grid Initiative

- EGI project (and ancestors)
  - Build a large scale production grid
  - Secured and robust
  - Promote international collaboration
  - For sciences and technologies

- ~ 300 different user communities
- Large spectra of scientific domains
- Tail of sciences

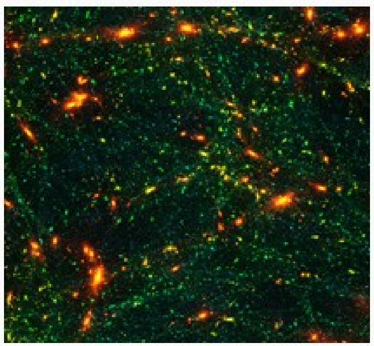
EGI web site: http://www.egi.eu/

# Many sciences



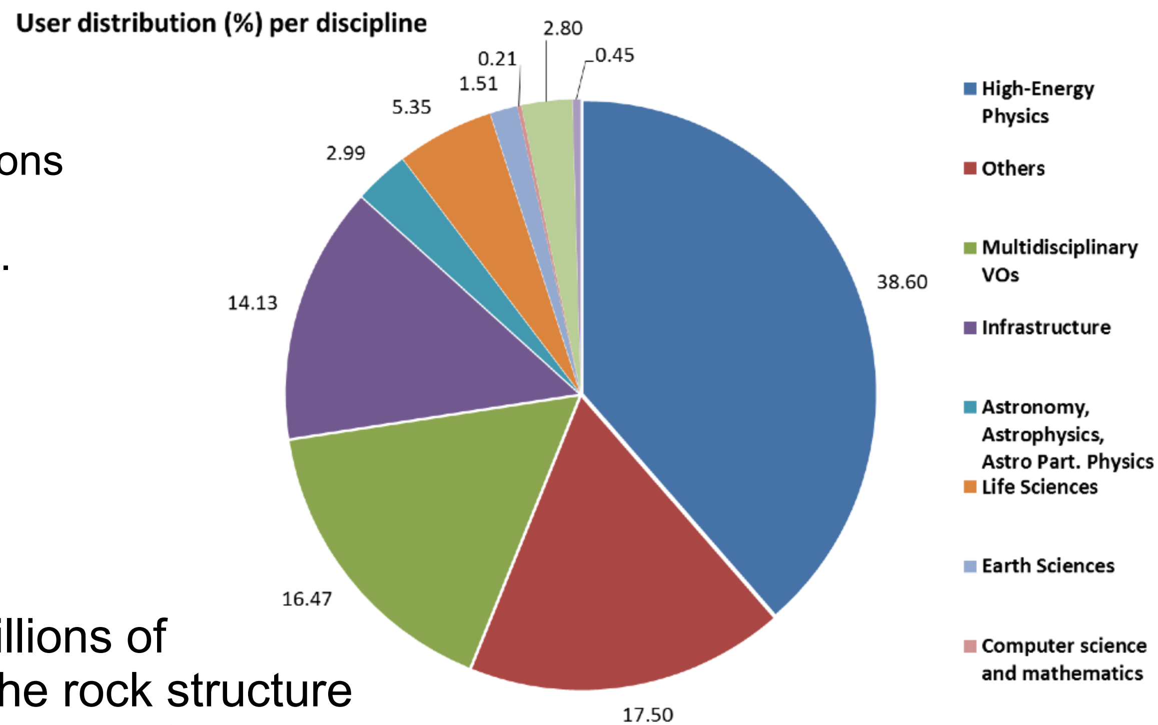
MRI scan with location of the hippocampus
*Image: Amber Rieder, Jenna Traynor (wikicommons)*

Medical and Health Sciences
Processing of thousands of MRI scans from patients with Alzheimer's disease



Seventy million elements of a cosmological N-body simulation using VisIVO and Splotch.

Physical Sciences
Creation of 3D visualisations of astronomical data on unprecedented scales.

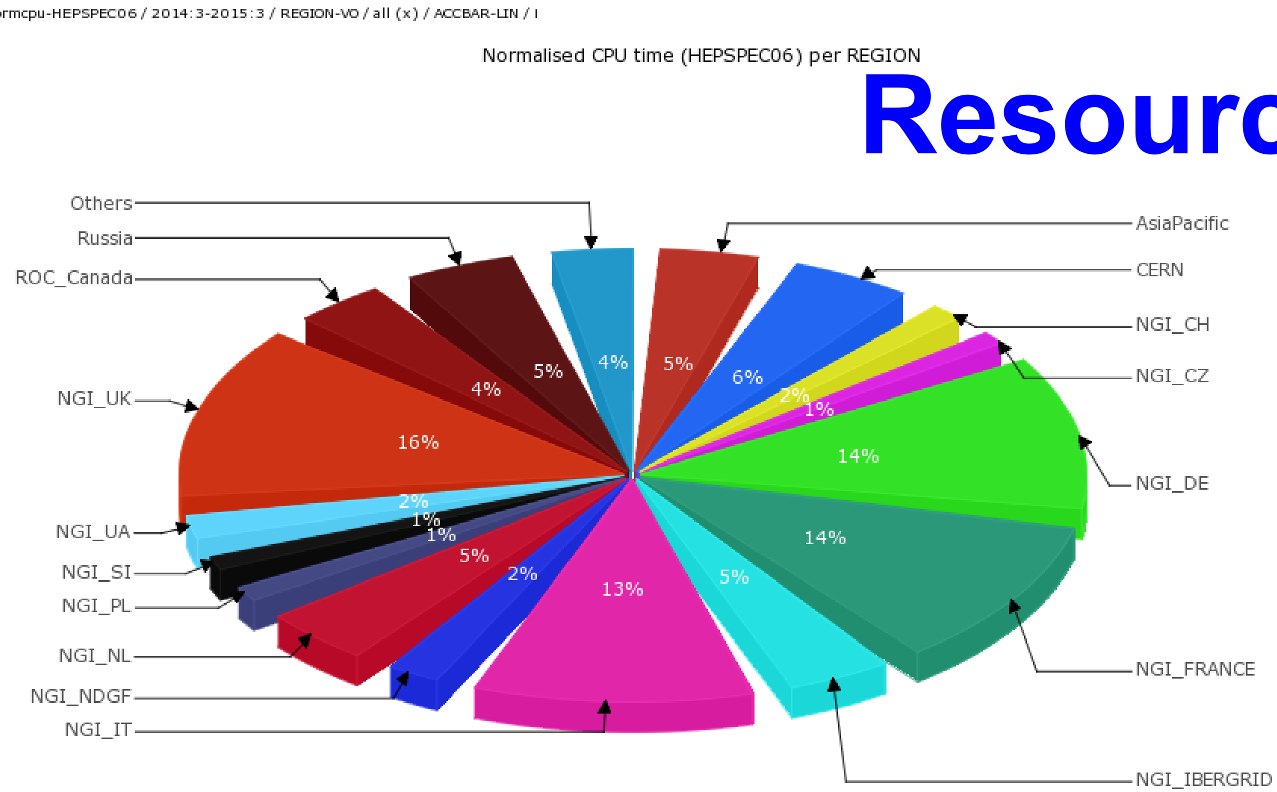



Oil exploration in the North Sea depends on a good knowledge of the underground rock structure. Grid computing helps scientists to make sense of all the seismic data.

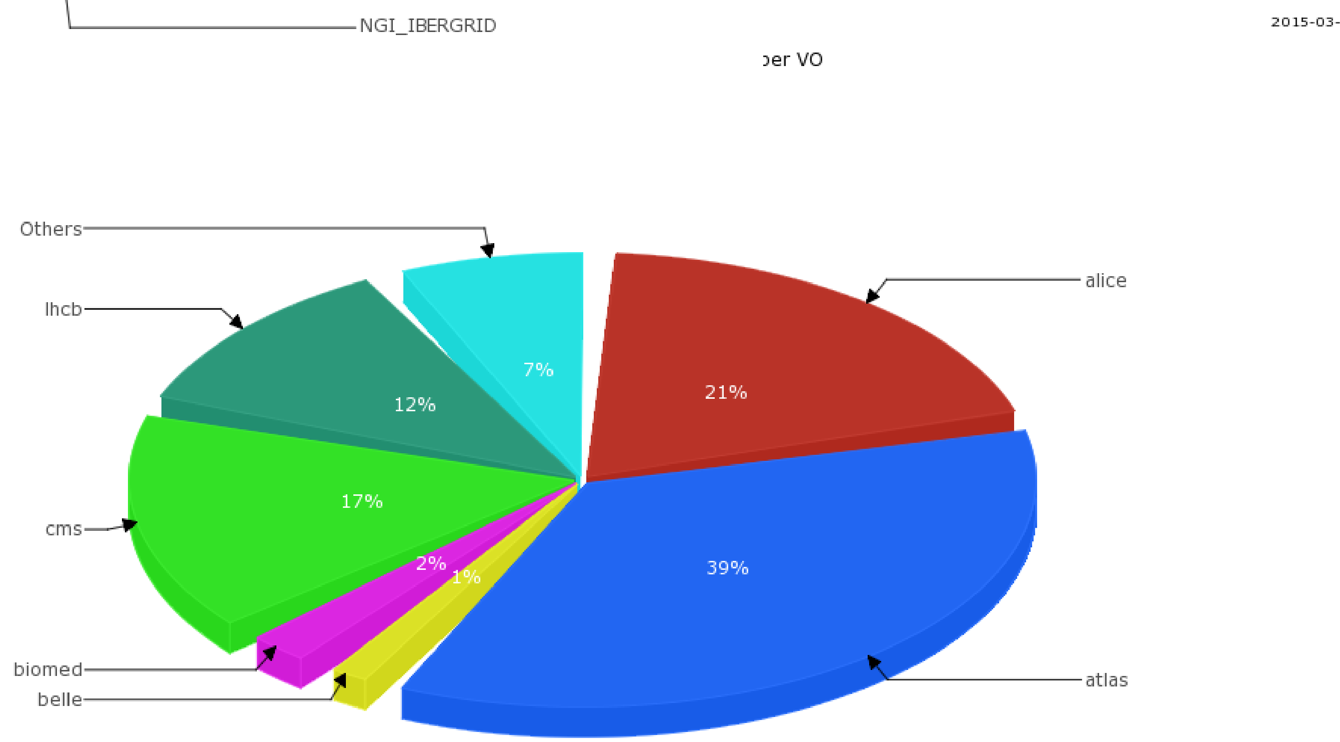
Natural sciences
Correlate data from millions of calculations to unveil the rock structure of an oil field under the North Sea.

From ISGC 2013

# Resource consumption




Normalised CPU time
March '14- March '15
- Per region
- Per VO




https://accounting.egi.eu/

biscarat@lpsc.in2p3.fr

# A few user example

Pierre Auger Observatory
studying the universe's highest energy particles

ilc international linear collider

cta cherenkov telescope array

An observatory for ground-based gamma-ray astronomy

ATLAS EXPERIMENT

DØ

CDF II

H.E.S.S.
High Energy Stereoscopic System

LHCb

ICECUBE
SOUTH POLE NEUTRINO OBSERVATORY

Compact Muon Solenoid experiment at CERN's LHC

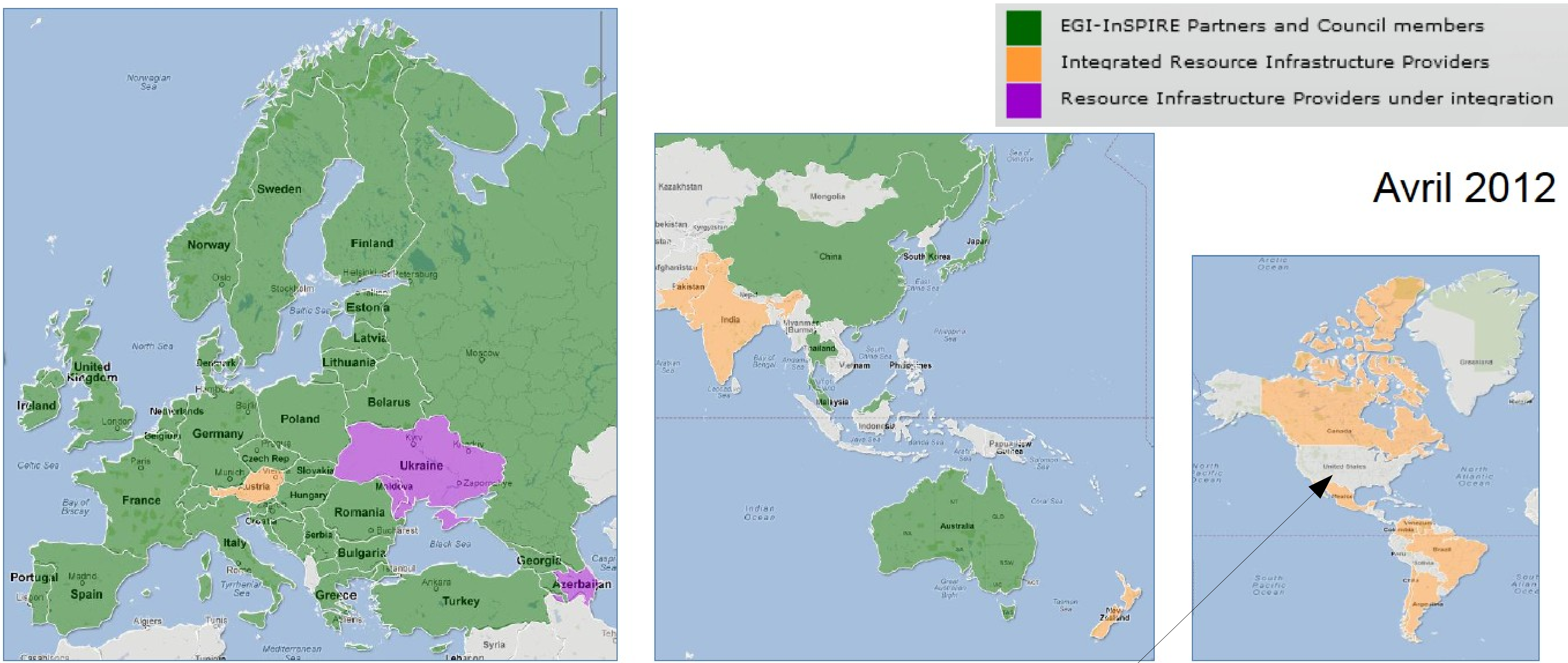
CMS

ALICE

T2K

# EGI partners and resource providers

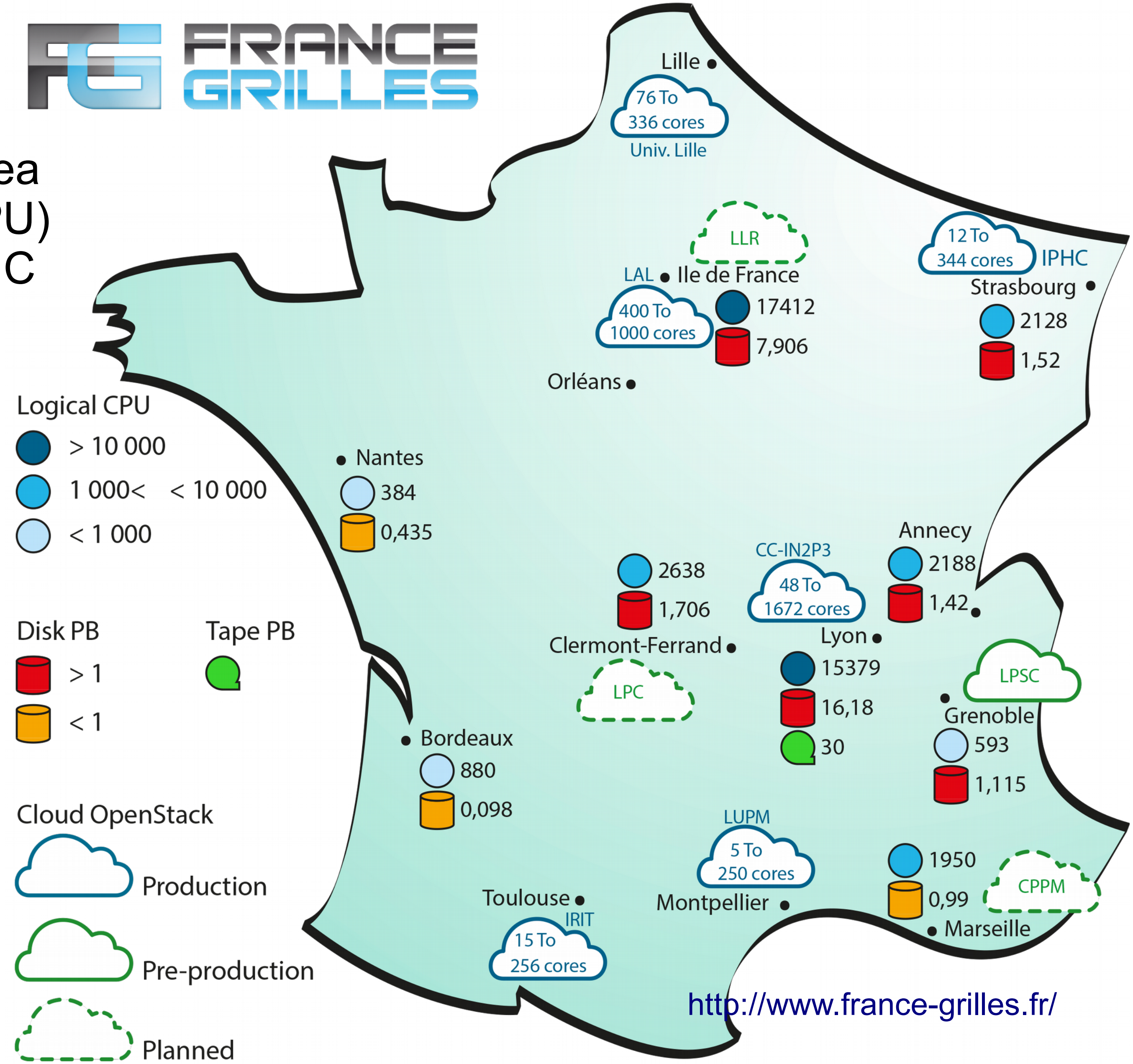
- The most extended grid infrastructure, 35 countries.



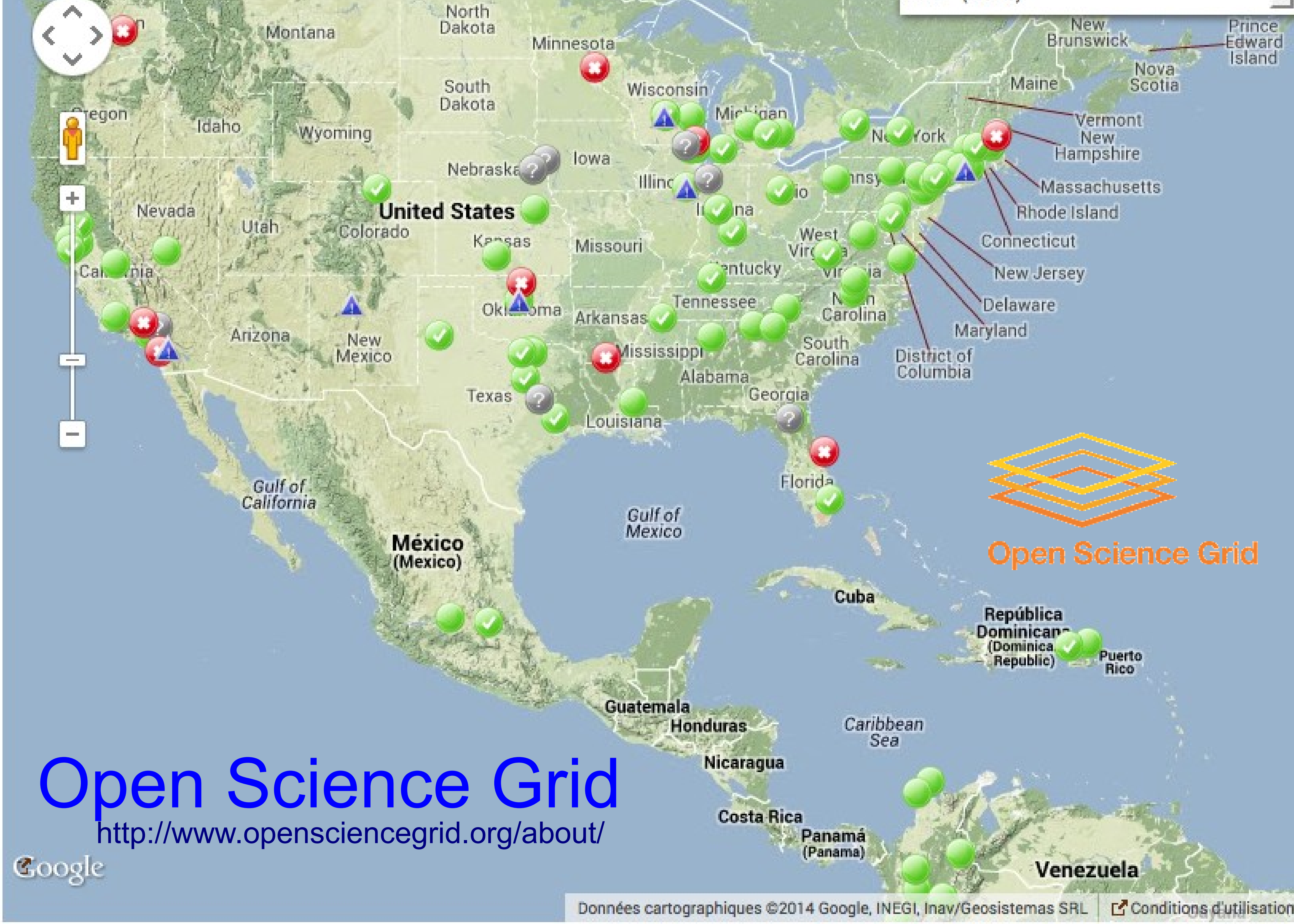

Open Science Grid (OSG)
Own operations tools and procedures,
compatible policies

# French NGI

- Open to any scientific area
- 18 sites (storage and CPU)
  - Half of them serves LHC




http://www.france-grilles.fr/




# Open Science Grid

http://www.opensciencegrid.org/about/

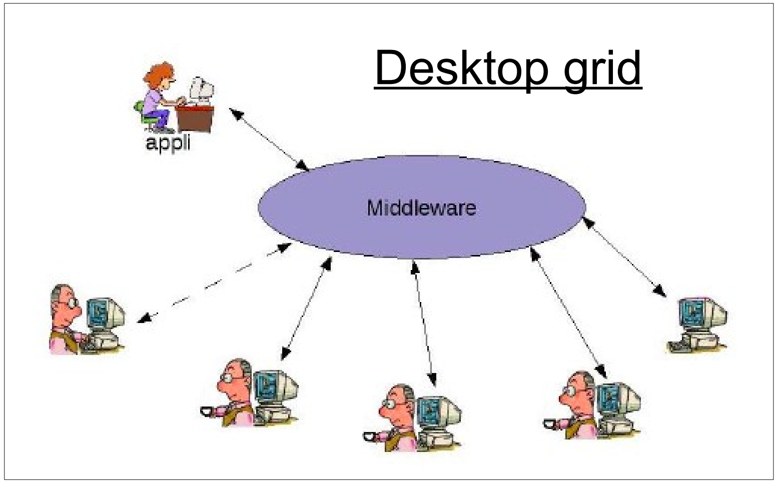
# Many kinds of grids

They might have different goals:

- Production grid
  - Shared resources for a common goal, known users
  - Shared “interfacing” software (middleware)
- Development grid (Grid5000 in France)
  - Shared resources for a common goal, known users
  - Testing grid software
- Volunteer grid (BOINC)
  - Resources given to a project with unknown users

They may differ in heterogeneity:

- Desktop grid (BOINC,...)
- Service grid (EGI, OSG,...)
- HPC grid (DEISA, TeraGrid, CNGrid...)



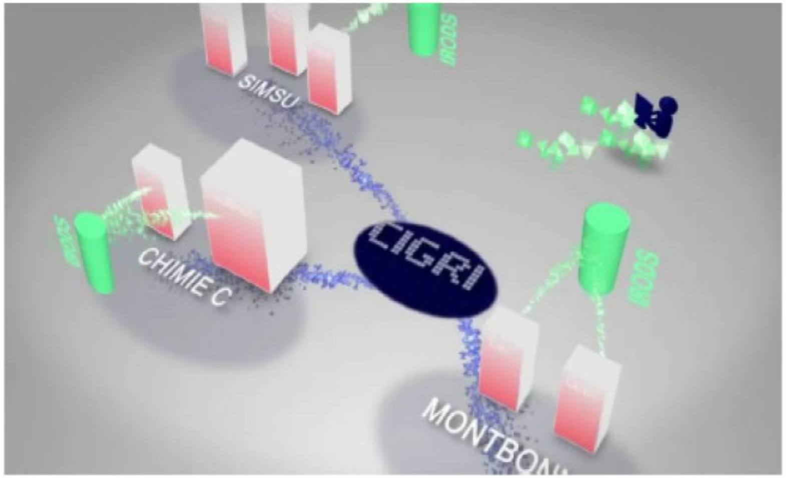

They may be interoperable (EGI+OSG)

# Many kinds of grids

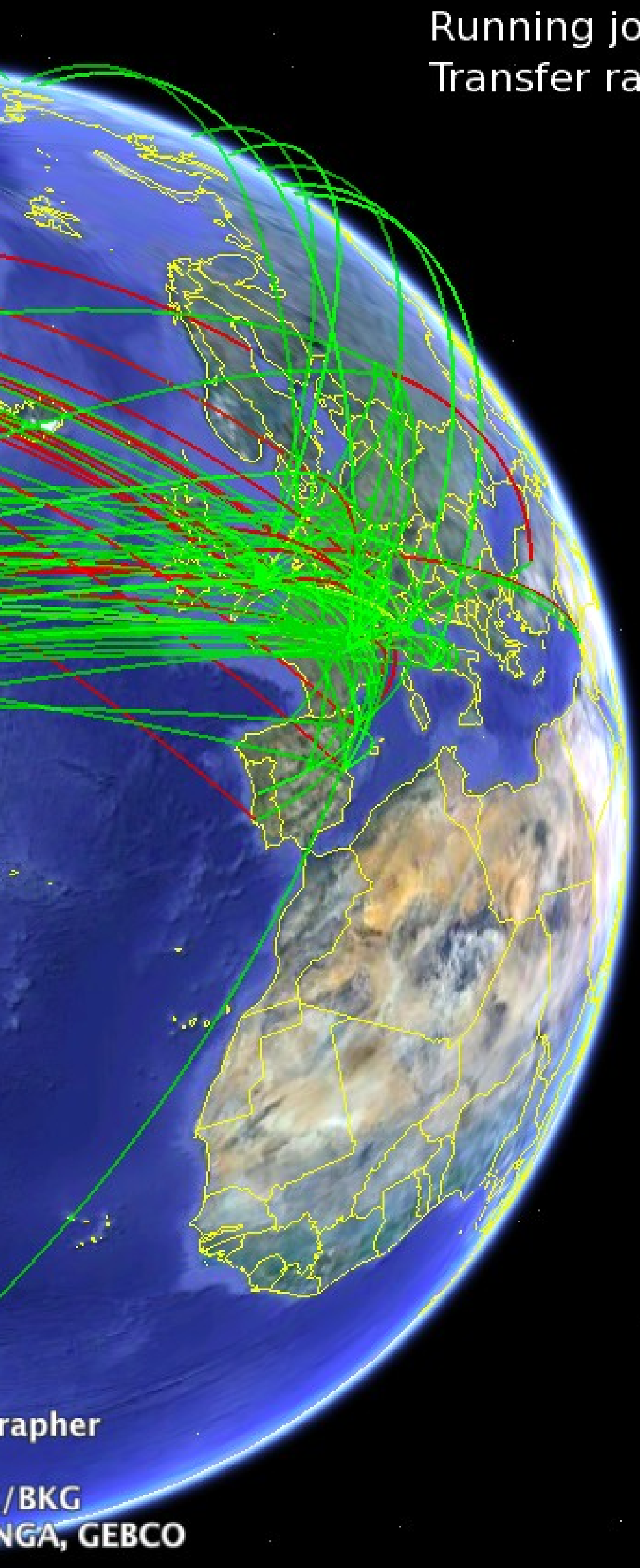
Geographically:
- International grid
- Regional grid
-

In term of science field:
- Thematic grid
- Multidisciplinary grid


GRISBI: bioinformatic (France)



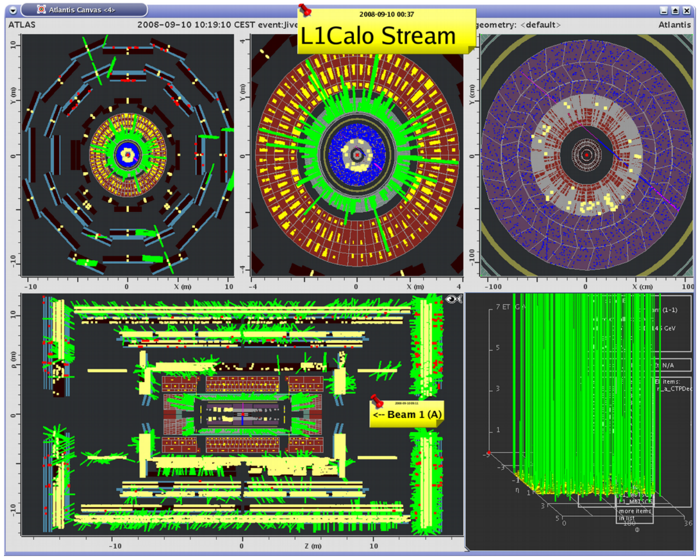

CIGRI: grid on top of T2 HPC clusters (Grenoble Universities, INPG, and National research labs) – opportunistic usage




# Behind the scenes

# D-day « LHC first beam »

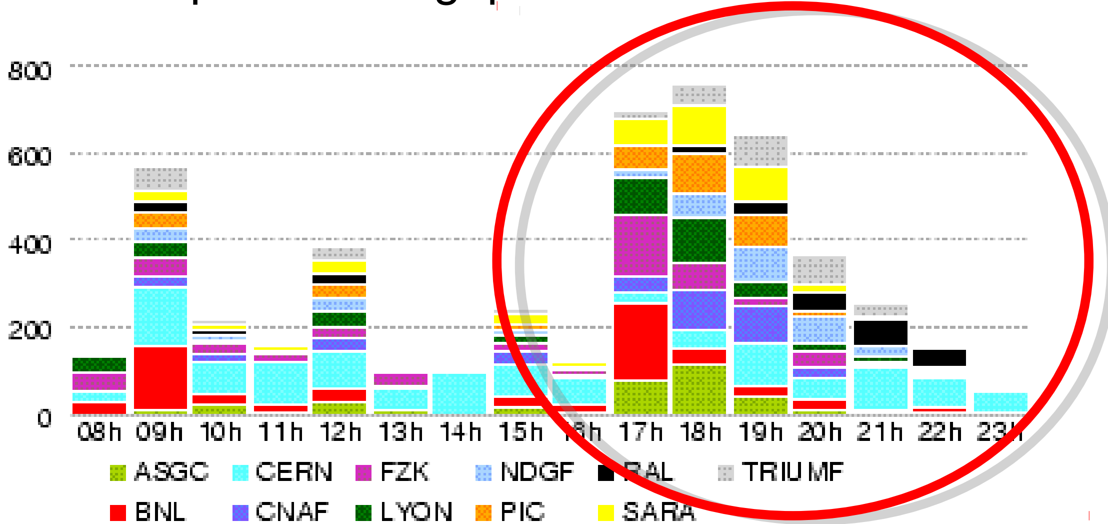
- Sept. 10$^{th}$ 2008



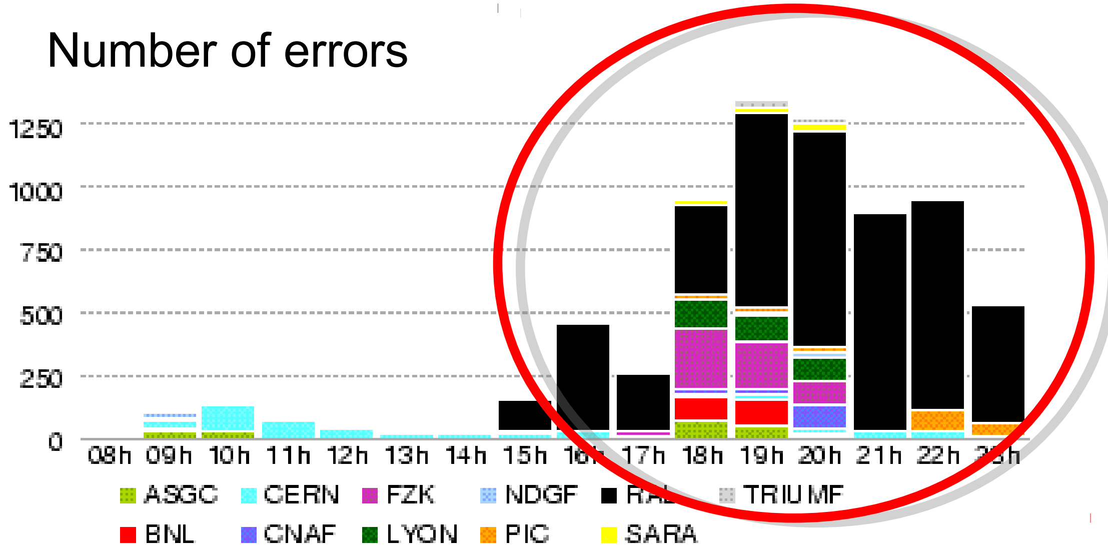

# D-day « LHC first beam »

**In the Computing control room ($2^{nd}$ floor)**

Data Exports Throughput in MB/s



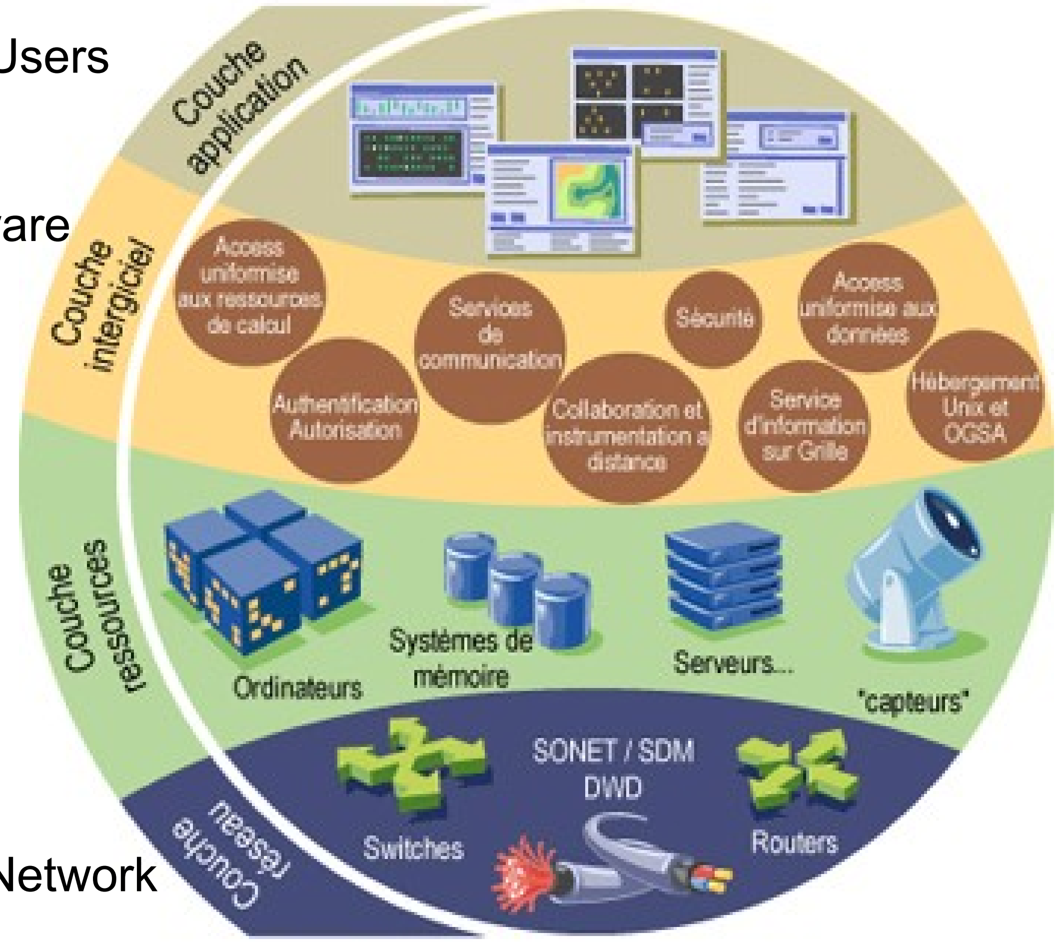

Number of errors




Concurrent access
to data on central servers
by the end-users

# Middleware

- Heterogeneity of the sites
  - Batch systems
  - Storage
  - Operating systems
  - Worker nodes capacity
  - Authentication



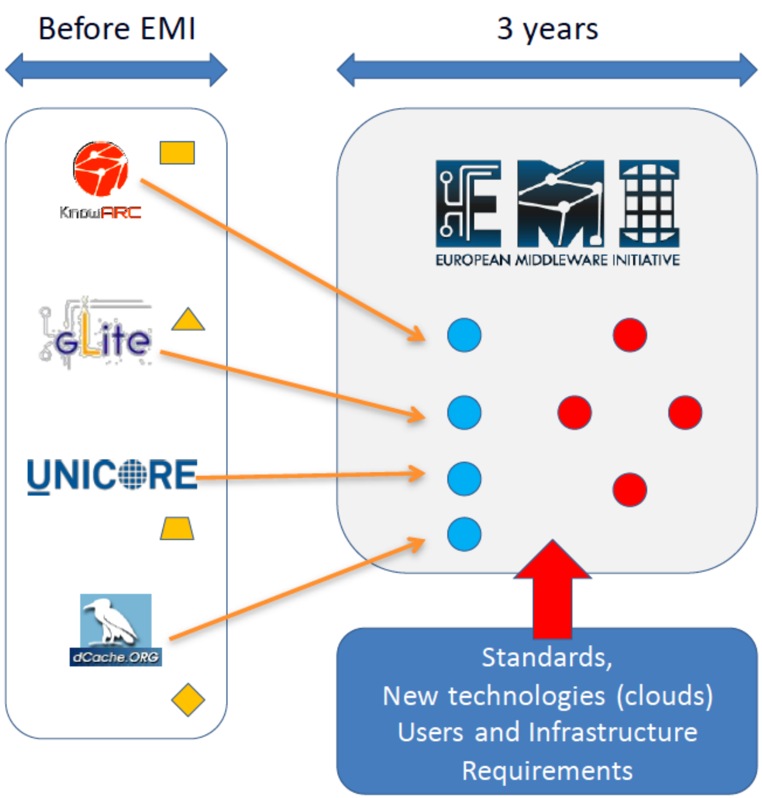

Ref : gridCafe

**Middleware**

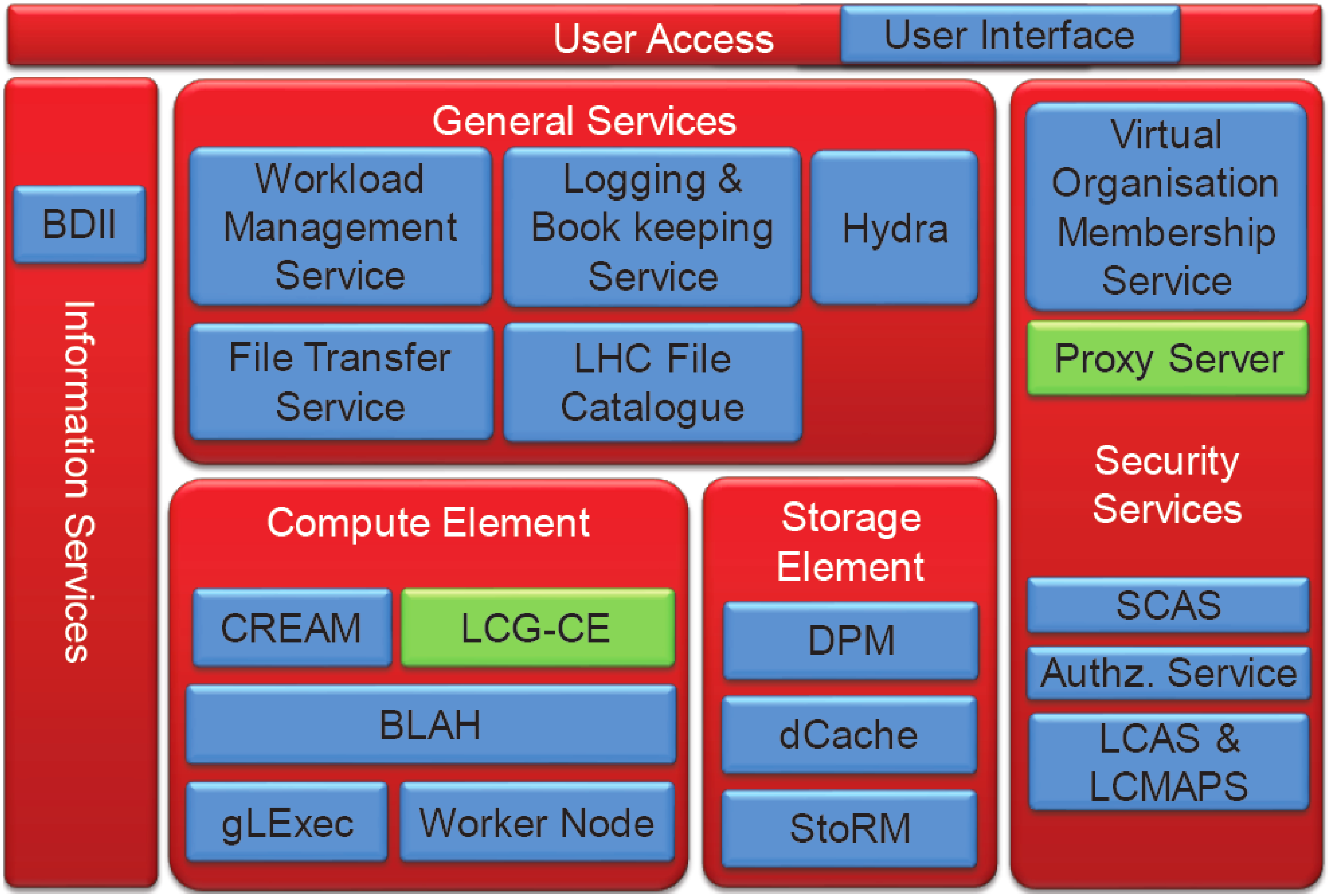
- Software layer
- Hiding and simplifying
  - No local user registration
  - Abstraction of resources
  - Interface to user applications

# Towards standardisation

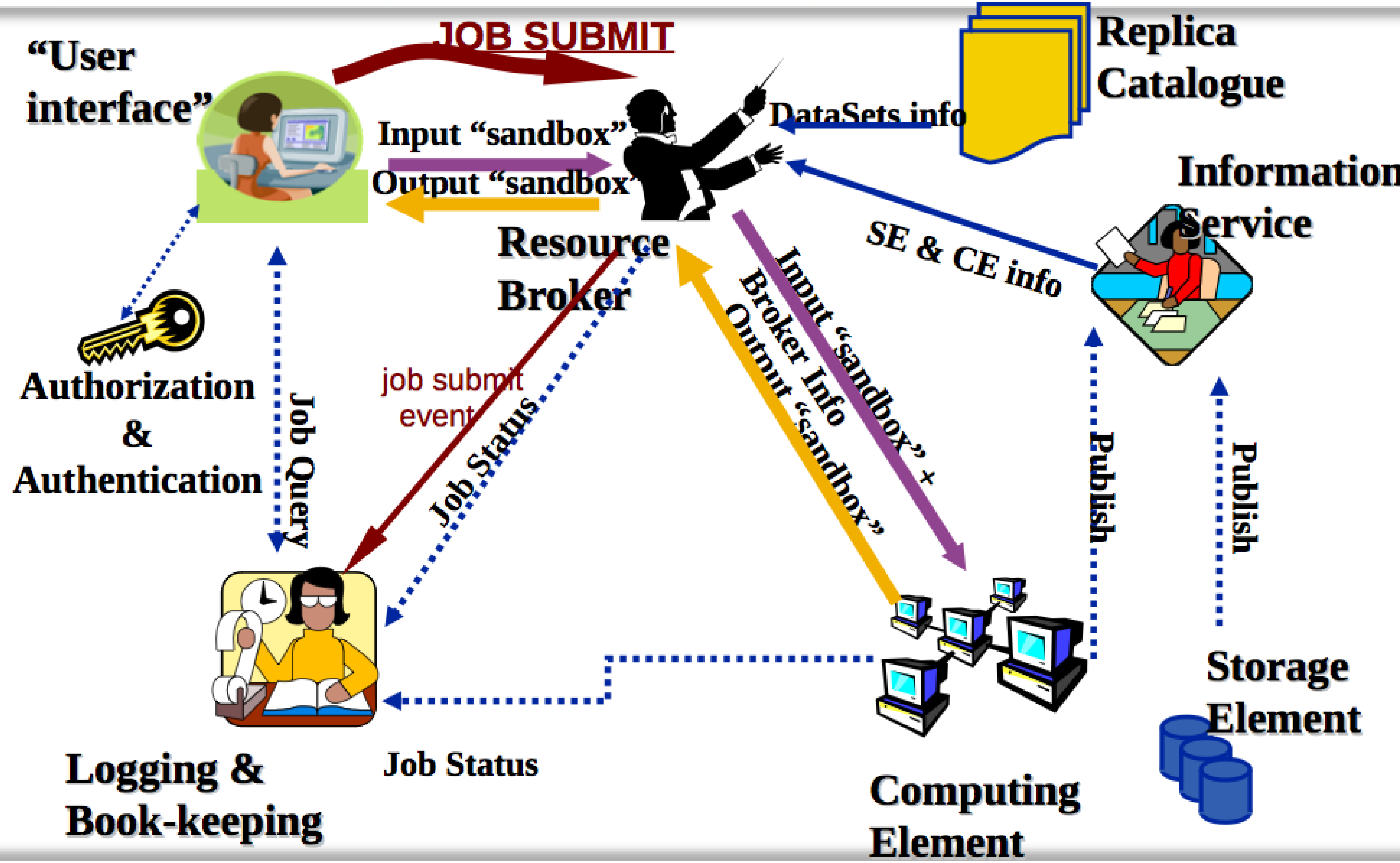
- Origin
  - Idea became popular in 1998 with the book “The Grid” (I. Foster & K. Kesselman )
  - Globus: the first middleware (1998) – evolution to globustoolkit-5
- Now : hundreds of middleware, tentative for standardisation
- In EGI: develop and use of EMI (European Middleware Initiative)



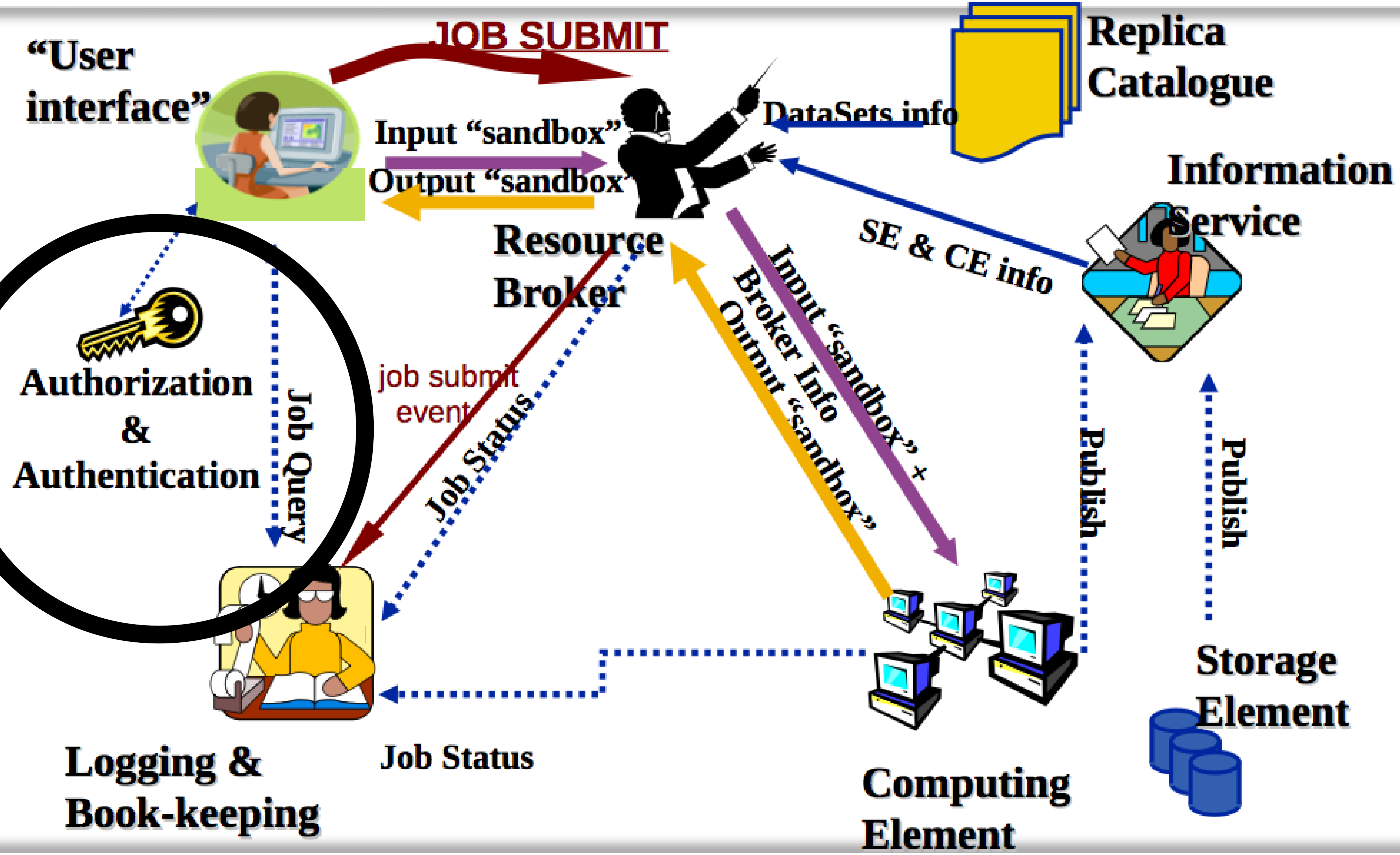
# Major EMI services



# Putting it all together



# A word on

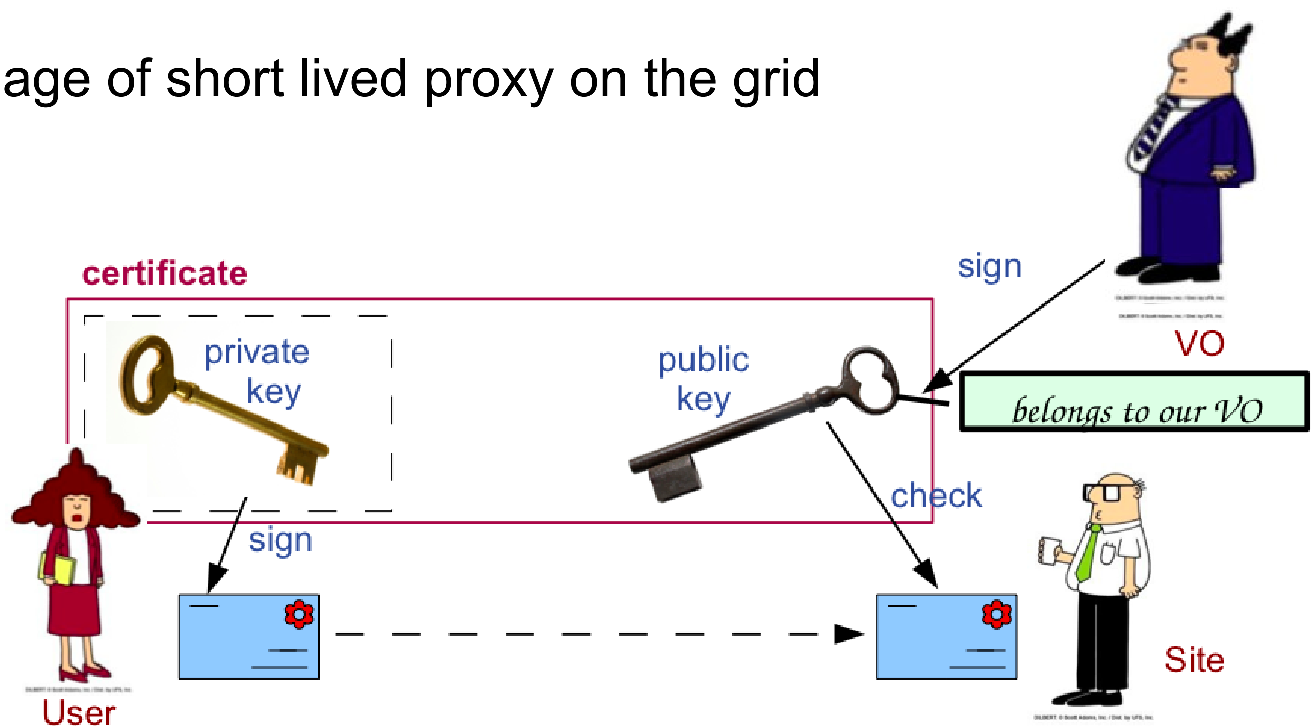


JOB SUBMIT
"User interface"
Input "sandbox"
Output "sandbox"
DataSets info
Replica Catalogue
Information Service
SE & CE info
Resource Broker
Authorization & Authentication
Job Query
job submit event
Job Status
Input "sandbox" + Broker Info
Output "sandbox"
Publish
Publish
Logging & Book-keeping
Job Status
Computing Element
Storage Element

# Authentication

- The grid is large and (almost) nobody knows you

- **Authentication : who you are**
  - Certificate authority delivers certificate (long lived)
    - What you may already use in your web browser
  - Based on a public/private pair of keys
  - X509
  - For security, usage of short lived proxy on the grid



# Authorisation

- **Authorisation: what can you do**

- Users are organised in Virtual Organisation (VOs)
  - They generally belong to different organisations
  - They have a common goal / accept to share resources
  - Examples: one VO per LHC experiment, CTA, biomed, france-grilles, …

- VOMS (virtual Organisation MemberShip)
  - Delivered by your VO
  - Allow groups and roles (capabilities)

→ additional attributes to your personal certificate

- Authorisation system must be agreed with all partners

- Key ingredient : trust

# EGI virtual organisations

| | | | | |
|---|---|---|---|---|
| **Data to graph:** | Active VO | Information about Active VOs | | |
| **Period:** | Start year: 2013 | | Start month: 4 | |
| | End year: 2014 | | End month: 3 | |

**Official VOs:**

| | | | |
|---|---|---|---|
| aegis | alice | armgrid.grid.am | astro.vo.eu-egee.org |
| atlas | auger | balticgrid | bbmri.nl |
| belle | biomed | calice | cdf |
| cernatschool.org | cesga | chem.vo.ibergrid.eu | cms |
| compchem | d4science.research-infrastructures.eu | dech | desy |
| drihm.eu | dteam | dzero | earth.vo.ibergrid.eu |
| eng.vo.ibergrid.eu | enmr.eu | env.see-grid-sci.eu | envirogrids.vo.eu-egee.org |
| epic.vo.gridpp.ac.uk | esr | eumed | fusion |
| gaussian | geant4 | ghep | gilda |
| glast.org | gridmosi.ici.ro | gridpp | hermes |
| hone | hungrid | iber.vo.ibergrid.eu | icecube |
| ict.vo.ibergrid.eu | ific | ilc | infngrid |
| lhcb | life.vo.ibergrid.eu | lofar | lsgrid |
| magic | meteo.see-grid-sci.eu | mice | na62.vo.gridpp.ac.uk |
| ncf | nw_ru | ops | pheno |
| phys.vo.ibergrid.eu | planck | prod.vo.eu-eela.eu | projects.nl |
| pvier | see | shiwa-workflow.eu | snoplus.snolab.ca |
| superbvo.org | t2k.org | theophys | trgridb |
| tut.vo.ibergrid.eu | twgrid | uniandes.edu.co | verce.eu |
| virgo | vlemed | vo.agata.org | vo.aginfra.eu |
| vo.apc.univ-paris7.fr | vo.complex-systems.eu | vo.cta.in2p3.fr | vo.formation.idgrilles.fr |
| vo.france-asia.org | vo.france-grilles.fr | vo.general.csic.es | vo.grand-est.fr |
| vo.grif.fr | vo.hess-experiment.eu | vo.ifisc.csic.es | vo.ipnl.in2p3.fr |
| vo.ipno.in2p3.fr | vo.irfu.cea.fr | vo.landslides.mossaic.org | vo.llr.in2p3.fr |
| vo.londongrid.ac.uk | vo.lpnhe.in2p3.fr | vo.mcia.fr | vo.msfg.fr |
| vo.mure.in2p3.fr | vo.neugrid.eu | vo.northgrid.ac.uk | vo.panda.gsi.de |
| vo.paus.pic.es | vo.plgrid.pl | vo.rhone-alpes.idgrilles.fr | vo.sbg.in2p3.fr |
| vo.scotgrid.ac.uk | vo.southgrid.ac.uk | vo.u-psud.fr | vo.up.pt |
| voce | xenon.biggrid.nl | zeus | |

https://accounting.egi.eu/egi.php

# VO ID Card

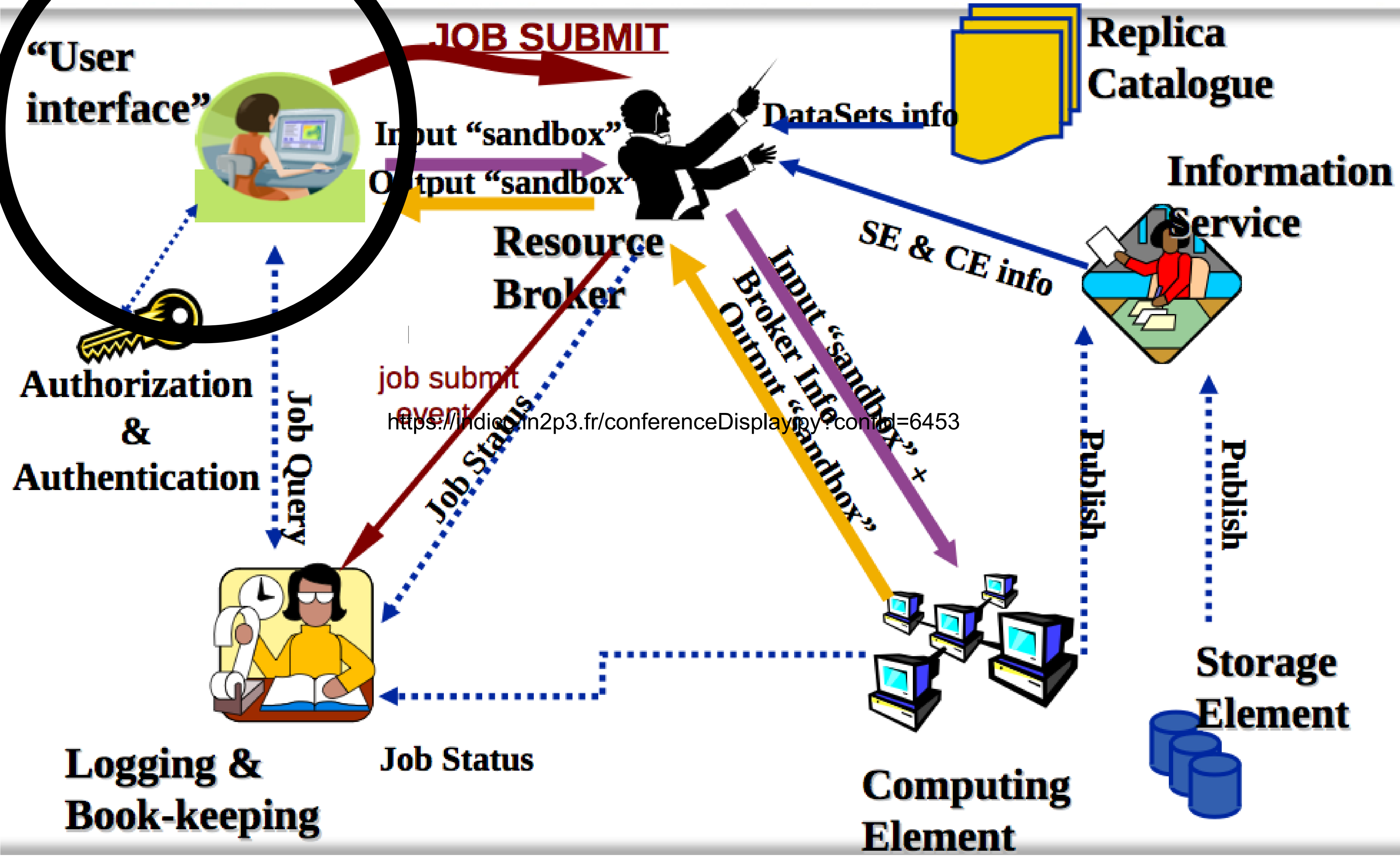
http://operations-portal.in2p3.fr/vo/view/voname/atlas

## Groups and Roles

| Group/Role | Type | Description | VO share(%) | Used for account generation |
|---|---|---|---|---|
| /atlas/alarm | Other | Team members | 0 | |
| /atlas/calib-muon | Other | Muon calibration group | 0 | |
| /atlas/Role=pilot | | Analysis pilots | 0 | ✔ |
| /atlas/it | | Italian users | 0 | |
| /atlas/Role=software | | US software manager | 0 | |
| /atlas/Role=root | | Not used | 0 | |
| /atlas/Role=lcgadmin | | LCG software manager | 0 | ✔ |
| /atlas/Role=AMIWriter | | AMI writer | 0 | |
| /atlas/Role=AMIManager | | AMI Manager | 0 | |
| /atlas/de | | German users | 0 | |
| /atlas/nl | | Netherland users | 0 | |
| /atlas/Role=production | | Production | 0 | ✔ |
| /atlas/au | | Australian users | 0 | |
| /atlas | | ATLAS users | 0 | ✔ |
| /atlas/ca | | Canadian users | 0 | |
| /atlas/det-indet | | Inner detector | 0 | |
| /atlas/det-larg | | Liquid Argon calorimeter | 0 | |
| /atlas/det-muon | | Muon spectrometer | 0 | |
| /atlas/det-tile | | Tile calorimeter | 0 | |
| /atlas/fr | | French users | 0 | |

General informations
Acceptable Use Policy
Resources
Generic Contacts
Mailing lists
Groups and Roles

# A word on


JOB SUBMIT
"User interface"
Input "sandbox"
Output "sandbox"
Resource Broker
DataSets info
Replica Catalogue
Information Service
SE & CE info
Authorization & Authentication
Job Query
job submit event
Job Status
Input "sandbox" + Broker Info
Output "sandbox"
Publish
Publish
Logging & Book-keeping
Job Status
Computing Element
Storage Element
https://indico.in2p3.fr/conferenceDisplay.py?confId=6453

# User Interface

- For the user to access to the Middleware
- Sites generally provides a UI machine
- Installed:
  - Command lines
  - Applications

```
voms-proxy-init --voms vo.france-grilles.fr
glite-ce-job-submit -a -r lpsc-ce.in2p3.fr:8443/cream-pbs-france_grilles test.jdl
glite-ce-job-list lpsc-ce.in2p3.fr:8443
glite-ce-job-status  https://lpsc-ce.in2p3.fr:8443/CREAM050473948

#with

bash-3.2$ cat test.jdl
Executable = "/bin/sleep";
arguments="180";
StdOutput = "std.out";
StdError = "std.err";
bash-3.2$
```

# Job Description Language

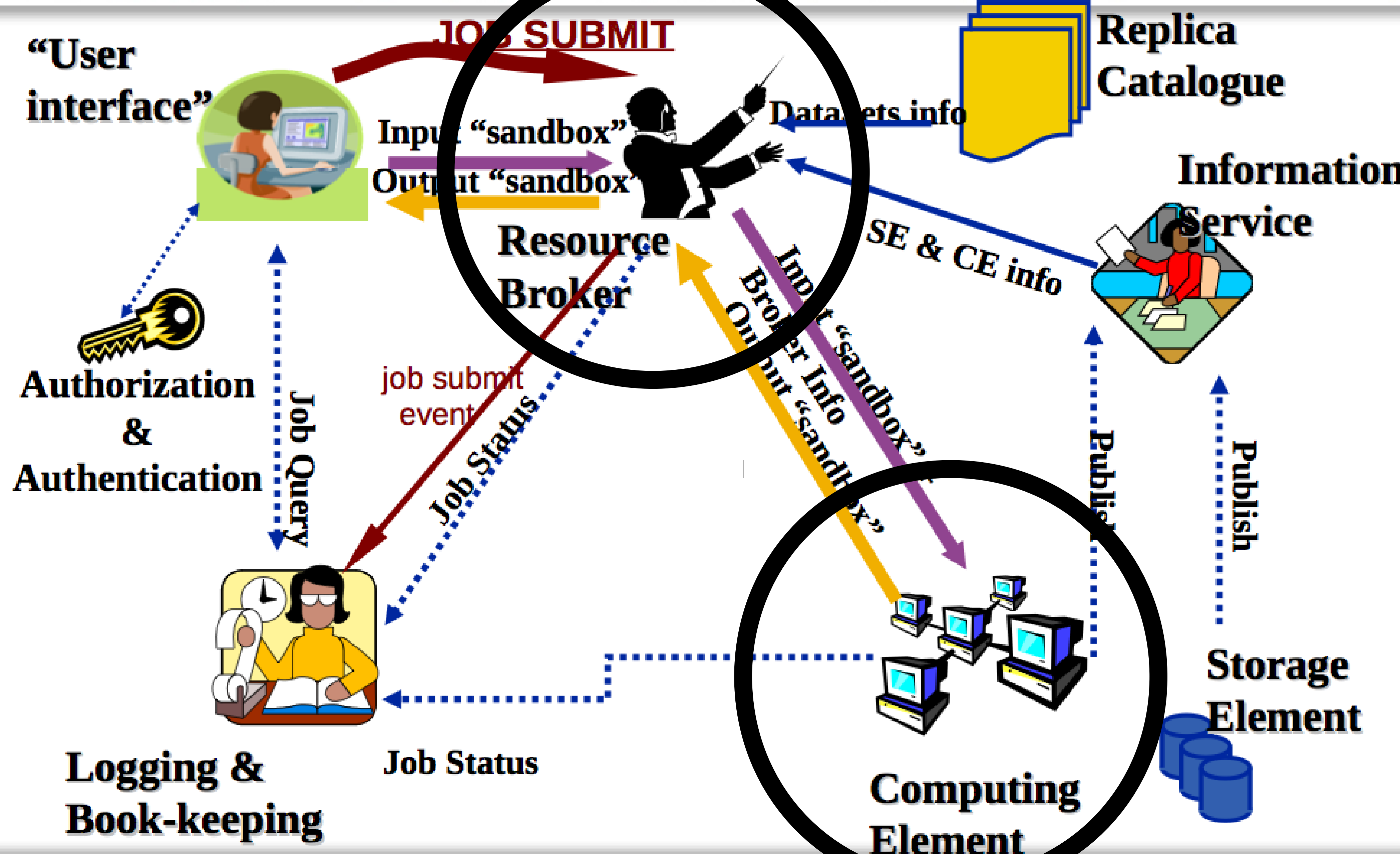
attribut job

attribut données

attributs ressources

```
Executable = “gridTest”;
StdError = “stderr.log”;
StdOutput = “stdout.log”;
InputSandbox = {“/home/joda/test/gridTest”};
OutputSandbox = {“stderr.log”, “stdout.log”};
InputData = “lfn:testbed0-00019”;
DataAccessProtocol = “gridftp”;
Requirements = other.Architecture==“INTEL” && \
        other.OpSys==“LINUX” && other.FreeCpus\
   >=4;
Rank = other.GlueHostBenchmarkSF00;
```

# A word on



JOB SUBMIT
"User interface"
Input "sandbox"
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Datasets info
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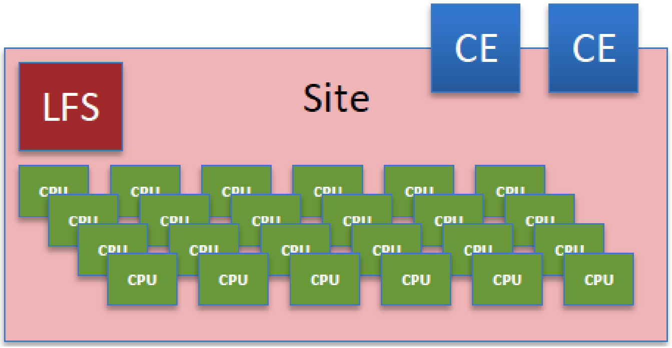
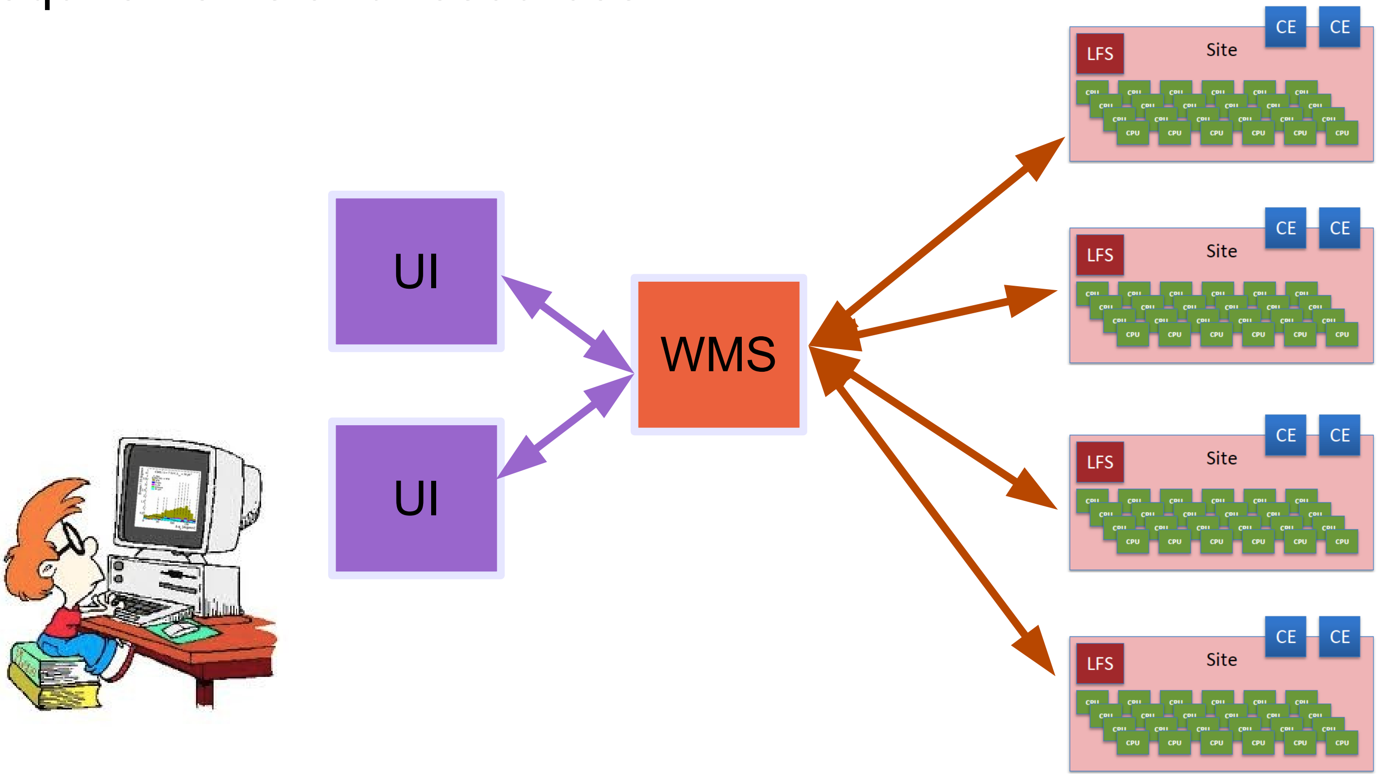
Job Query
job submit event
Job Status
Input "sandbox"
Broker Info
Output "sandbox"
Publish
Publish
Storage Element
Logging & Book-keeping
Job Status
Computing Element

# Workload management

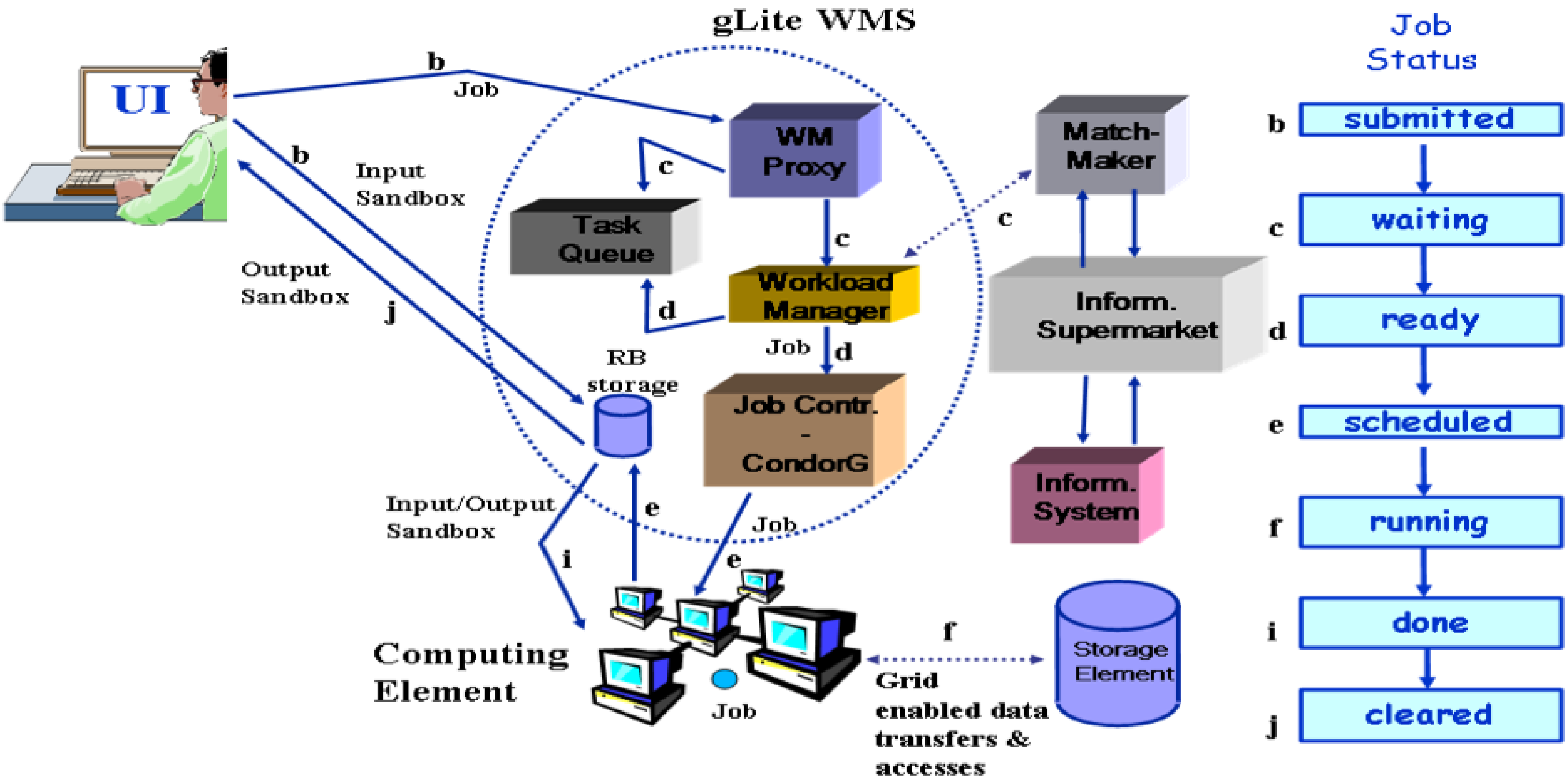
- Computing elements
  - Gateways to the local computing resources




- Workload management system
  - akas Resource broker
  - Matches requirements and resources

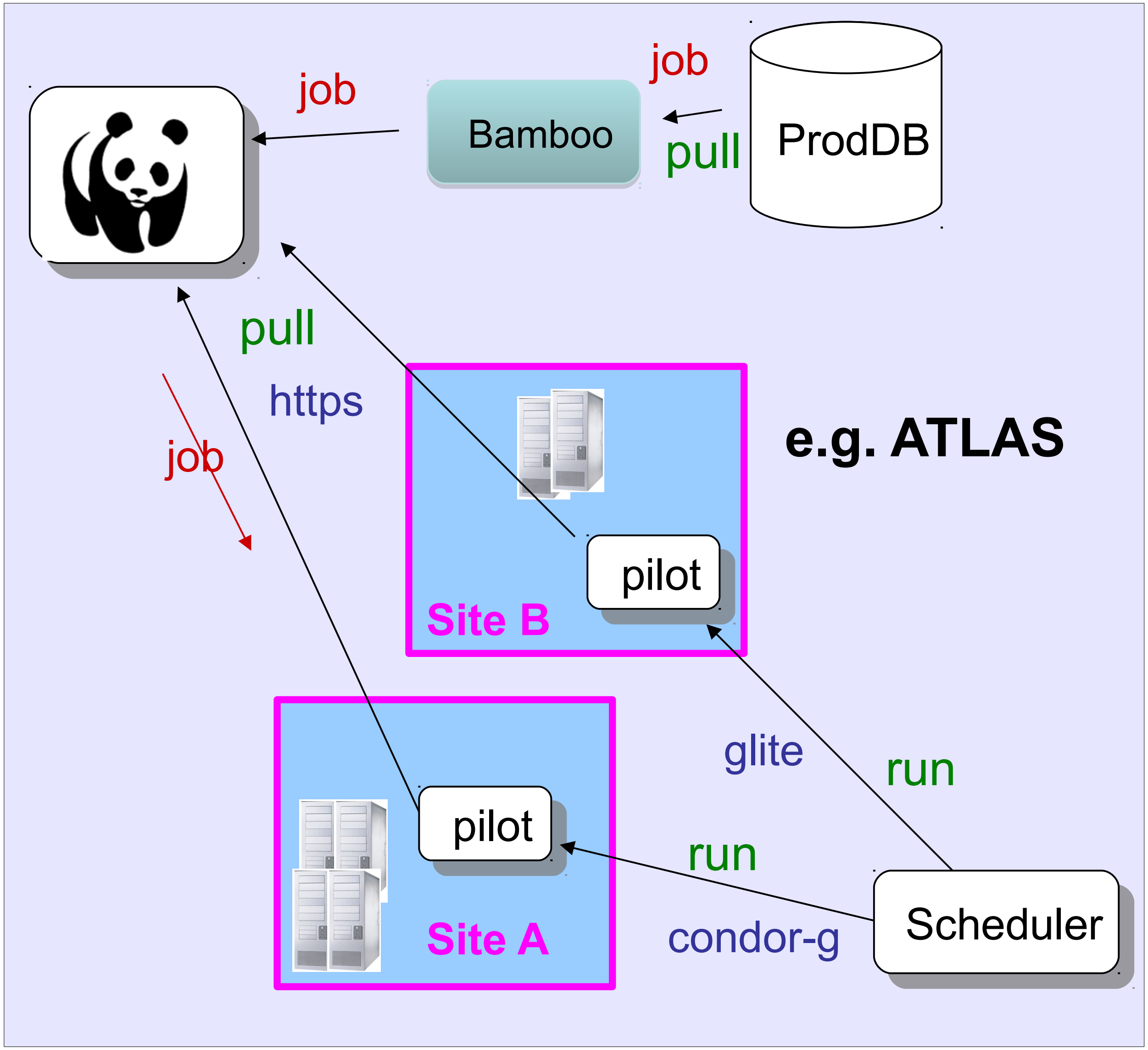


# WMS – jobs route



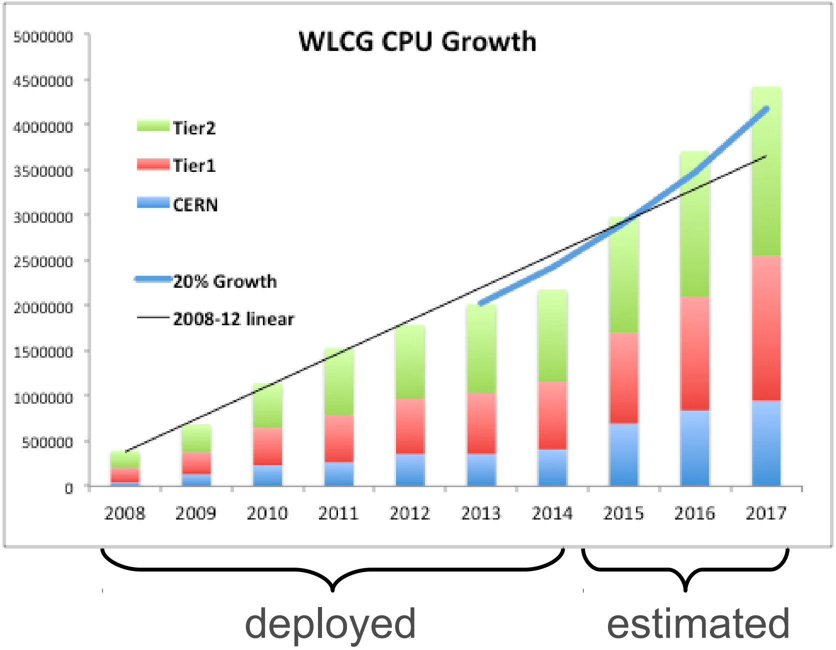
# Pilot job mechanism

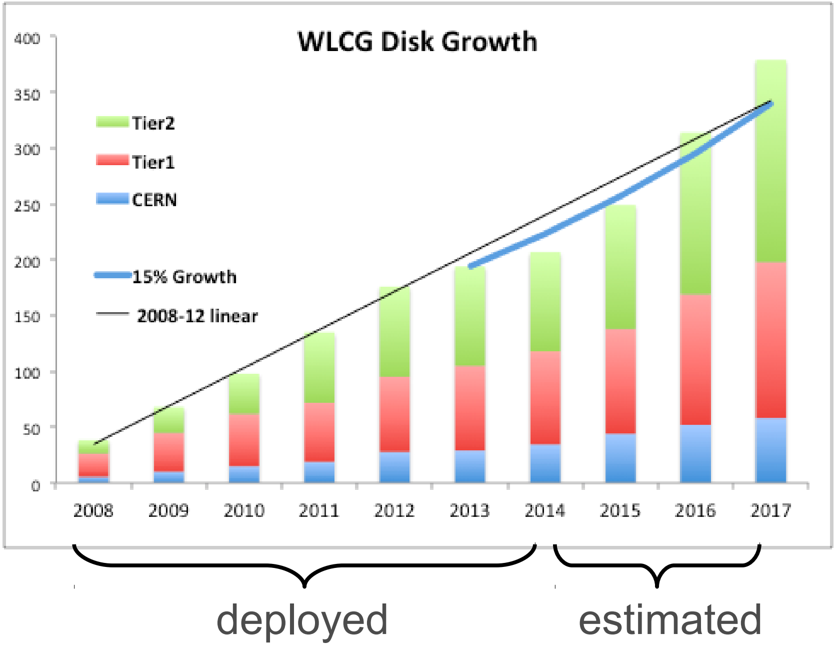
- Place holder jobs get queued at the sites
- Real jobs get puled according to the available resources and the environment
- Each LHC experiment uses pilot jobs




# Going forward

# Growing needs




- Behind the success of the grid
  - High complexity
  - High human resource demand

- We have gained in experience and we are still improving
  - Very stable network → new data model
  - Federated storage
  - Building common tools/interfaces

# Network

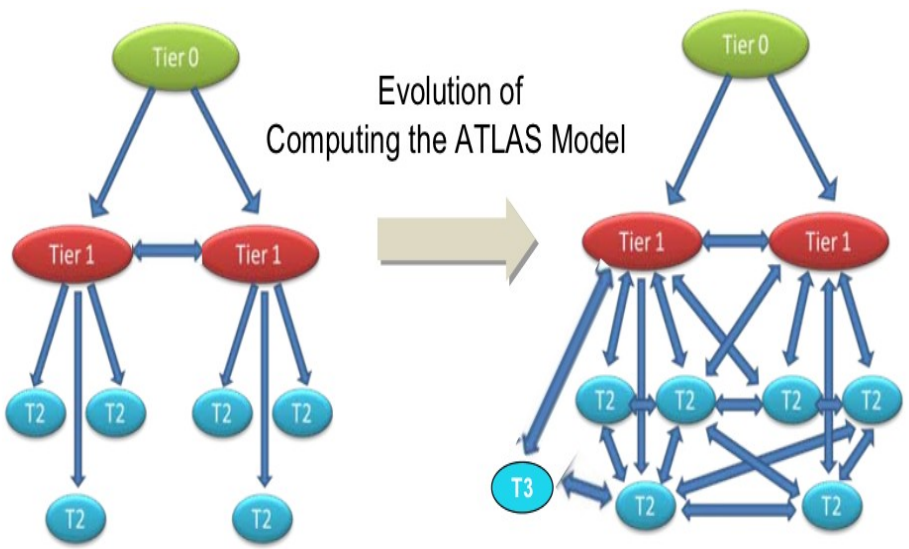
"The Network infrastructure is the most reliable service we have"

"Network Bandwidth (rather than disk) will need to scale more with users and data volume"

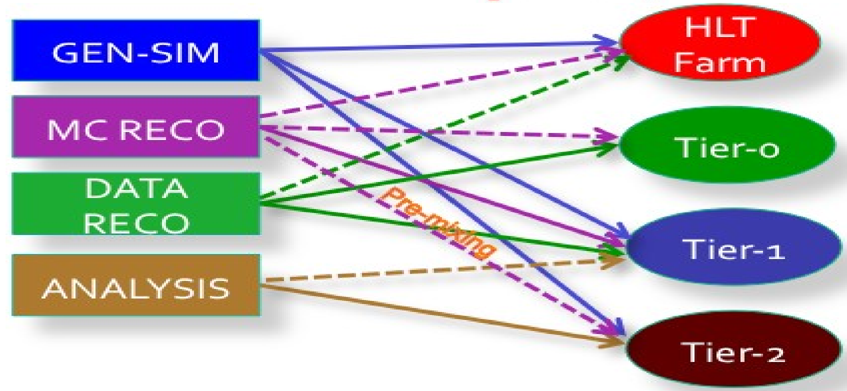
*Ian Bird, WLCG project leader*

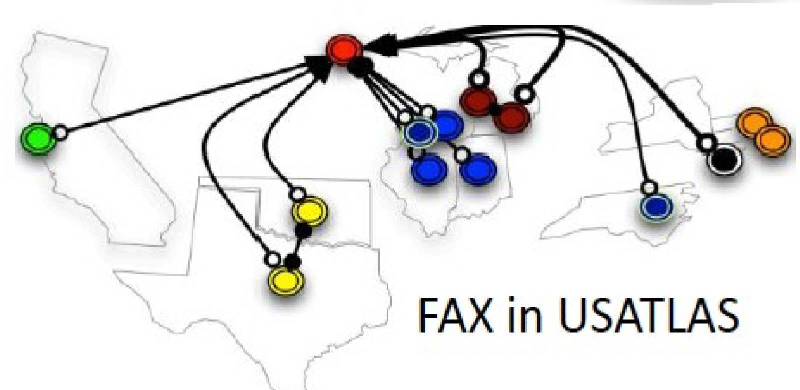
## LHC Open Network Environment (LHCONE)

The T0/T1/T2 hierarchy is wiped out

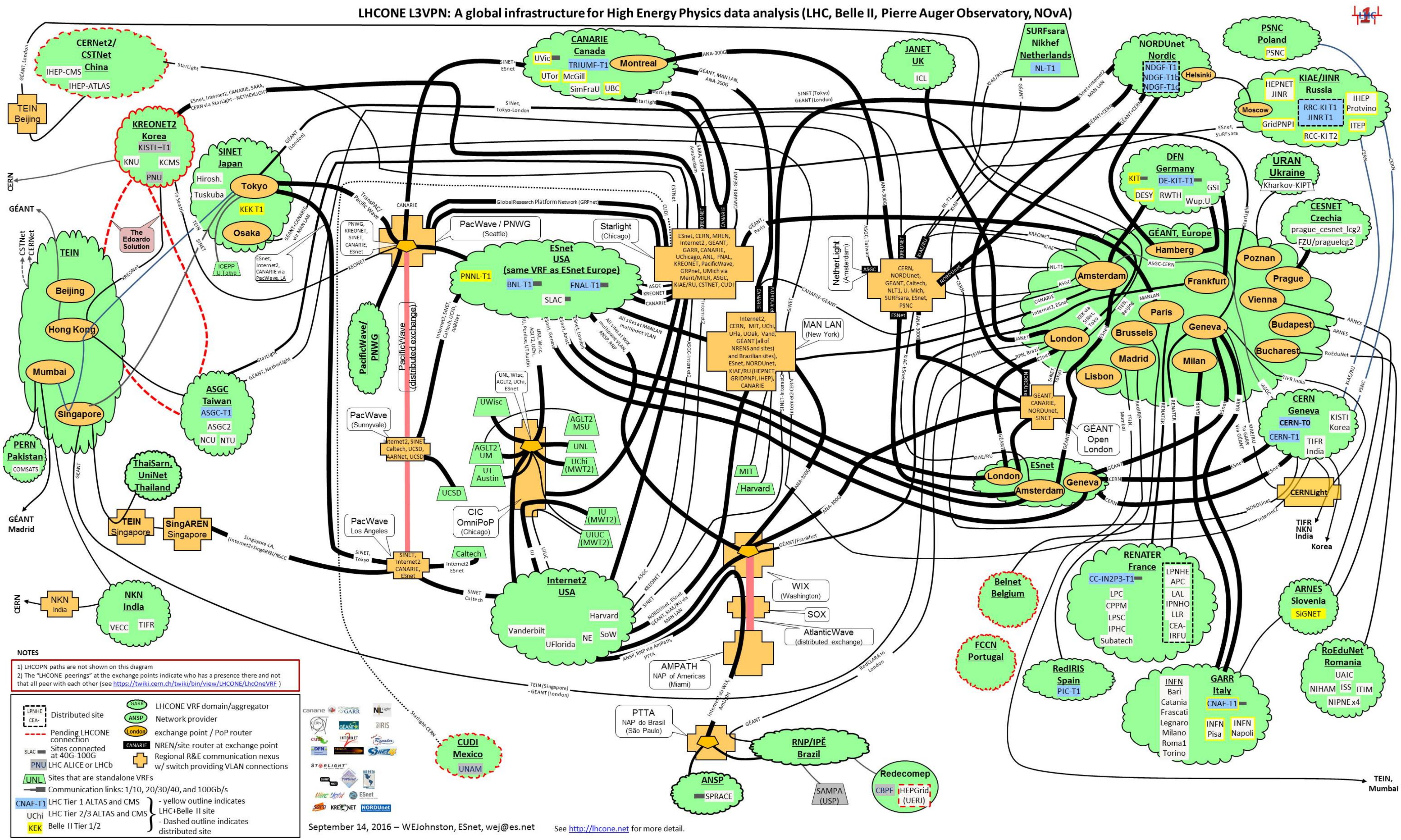



"monarch" hierarchy "loosened" hierarchy



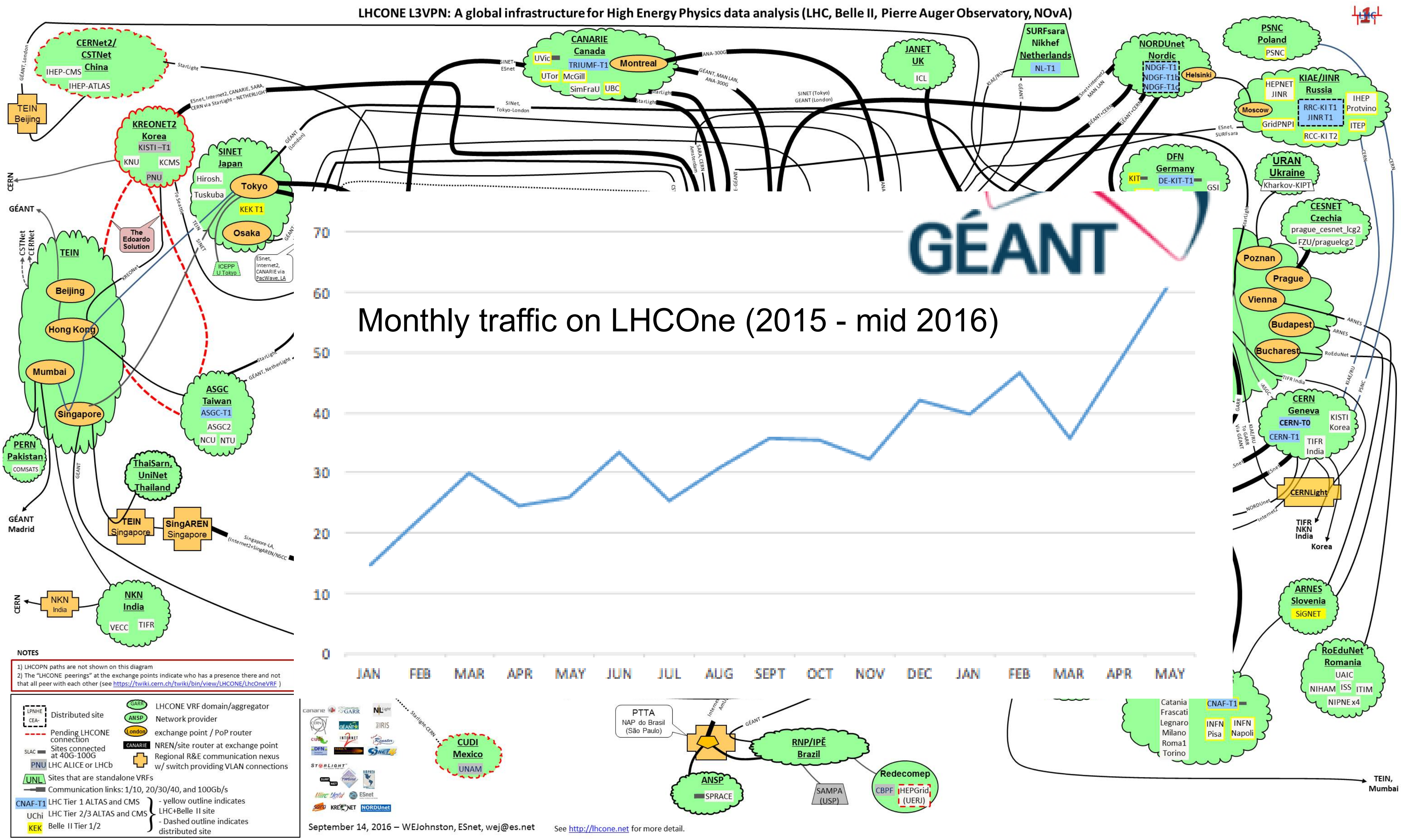



# LHCOne



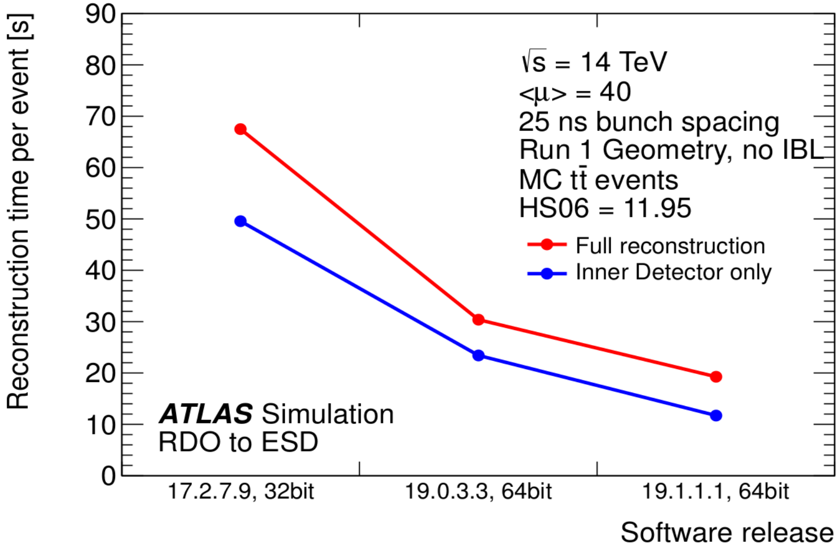
LHCONE L3VPN: A global infrastructure for High Energy Physics data analysis (LHC, Belle II, Pierre Auger Observatory, NOvA)
CERNet2/ CSTNet China
IHEP-CMS
IHEP-ATLAS
TEIN Beijing
KREONET2 Korea
KISTI –T1
KNU
KCMS
PNU
SINET Japan
Hirosh.
Tuskuba
Tokyo
KEK T1
Osaka
ICEPP U Tokyo
The Edoardo Solution
CANARIE Canada
UVic
TRIUMF-T1
Montreal
UTor
McGill
SimFraU
UBC
JANET UK
ICL
SURFsara Nikhef Netherlands
NL-T1
NORDUnet Nordic
NDGF-T1a
NDGF-T1b
NDGF-T1c
Helsinki
PSNC Poland
PSNC
KIAE/JINR Russia
HEPNET JINR
Moscow
RRC-KI T1
JINR T1
IHEP Protvino
GridPNPI
ITEP
RCC-KI T2
URAN Ukraine
Kharkov-KIPT
DFN Germany
KIT
DE-KIT-T1
GSI
DESY
RWTH
Wup.U
CESNET Czechia
prague_cesnet_lcg2
FZU/praguelcg2
GÉANT, Europe
Hamberg
Poznan
Prague
Amsterdam
Frankfurt
Vienna
Paris
Budapest
London
Brussels
Geneva
Bucharest
Madrid
Milan
Lisbon
TEIN
Beijing
Hong Kong
Mumbai
Singapore
PERN Pakistan
COMSATS
ASGC Taiwan
ASGC-T1
ASGC2
NCU
NTU
ThaiSarn, UniNet Thailand
TEIN Singapore
SingAREN Singapore
NKN India
VECC
TIFR
PacWave / PNWG (Seattle)
Starlight (Chicago)
ESnet USA (same VRF as ESnet Europe)
PNNL-T1
BNL-T1
FNAL-T1
SLAC
PacificWave/ PNWG
PacificWave (distributed exchange)
PacWave (Sunnyvale)
PacWave Los Angeles
UCSD
CIC OmniPoP (Chicago)
UWisc
AGLT2 MSU
UNL
AGLT2 UM
UT Austin
UChi (MWT2)
IU (MWT2)
UIUC (MWT2)
Caltech
Internet2 USA
Harvard
Vanderbilt
NE
SoW
UFlorida
MAN LAN (New York)
NetherLight (Amsterdam)
MIT
Harvard
WIX (Washington)
SOX
AtlanticWave (distributed exchange)
AMPATH NAP of Americas (Miami)
PTTA NAP do Brasil (São Paulo)
RNP/IPÊ Brazil
ANSP
SPRACE
SAMPA (USP)
Redecomep
CBPF
HEPGrid (UERJ)
CUDI Mexico
UNAM
ESnet
London
Amsterdam
Geneva
GÉANT Open London
CERN Geneva
CERN-T0
CERN-T1
KISTI Korea
TIFR India
CERNLight
RENATER France
CC-IN2P3-T1
LPC
CPPM
LPSC
IPHC
Subatech
LPNHE
APC
LAL
IPNHO
LLR
CEA-IRFU
Belnet Belgium
FCCN Portugal
RedIRIS Spain
PIC-T1
GARR Italy
INFN
Bari
Catania
Frascati
Legnaro
Milano
Roma1
Torino
CNAF-T1
INFN Pisa
INFN Napoli
ARNES Slovenia
SiGNET
RoEduNet Romania
UAIC
NIHAM
ISS
ITIM
NIPNE x4
NOTES
1) LHCOPN paths are not shown on this diagram
2) The "LHCONE peerings" at the exchange points indicate who has a presence there and not that all peer with each other (see https://twiki.cern.ch/twiki/bin/view/LHCONE/LhcOneVRF )
Distributed site
Pending LHCONE connection
Sites connected at 40G-100G
LHC ALICE or LHCb
Sites that are standalone VRFs
Communication links: 1/10, 20/30/40, and 100Gb/s
LHC Tier 1 ALTAS and CMS
LHC Tier 2/3 ALTAS and CMS
Belle II Tier 1/2
LHCONE VRF domain/aggregator
Network provider
exchange point / PoP router
NREN/site router at exchange point
Regional R&E communication nexus w/ switch providing VLAN connections
- yellow outline indicates LHC+Belle II site
- Dashed outline indicates distributed site
September 14, 2016 – WEJohnston, ESnet, wej@es.net
See http://lhcone.net for more detail.

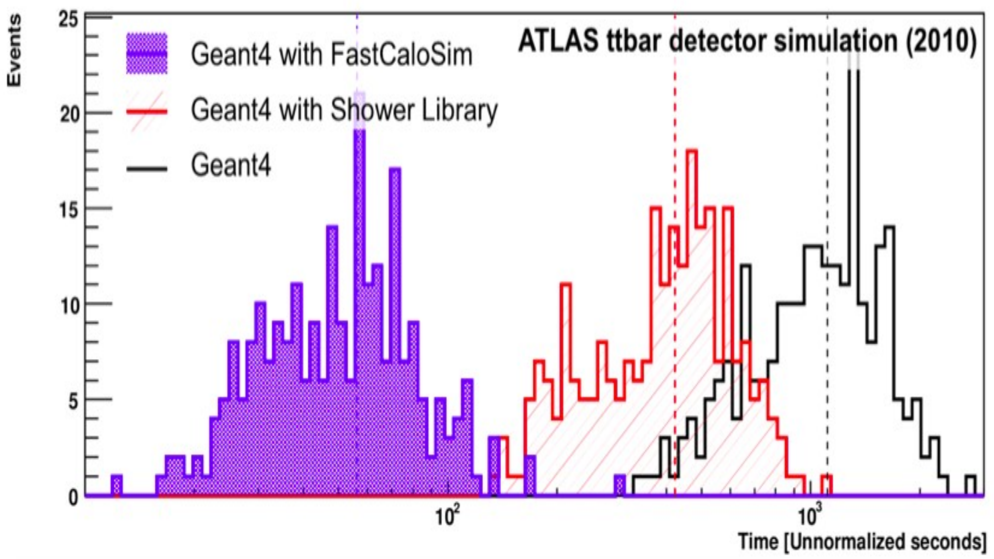
# LHCOne



LHCONE L3VPN: A global infrastructure for High Energy Physics data analysis (LHC, Belle II, Pierre Auger Observatory, NOvA)
Monthly traffic on LHCOne (2015 - mid 2016)
GÉANT
70
60
50
40
30
20
10
0
JAN FEB MAR APR MAY JUN JUL AUG SEPT OCT NOV DEC JAN FEB MAR APR MAY
September 14, 2016 – WEJohnston, ESnet, wej@es.net
See http://lhcone.net for more detail.

# Saving CPU time

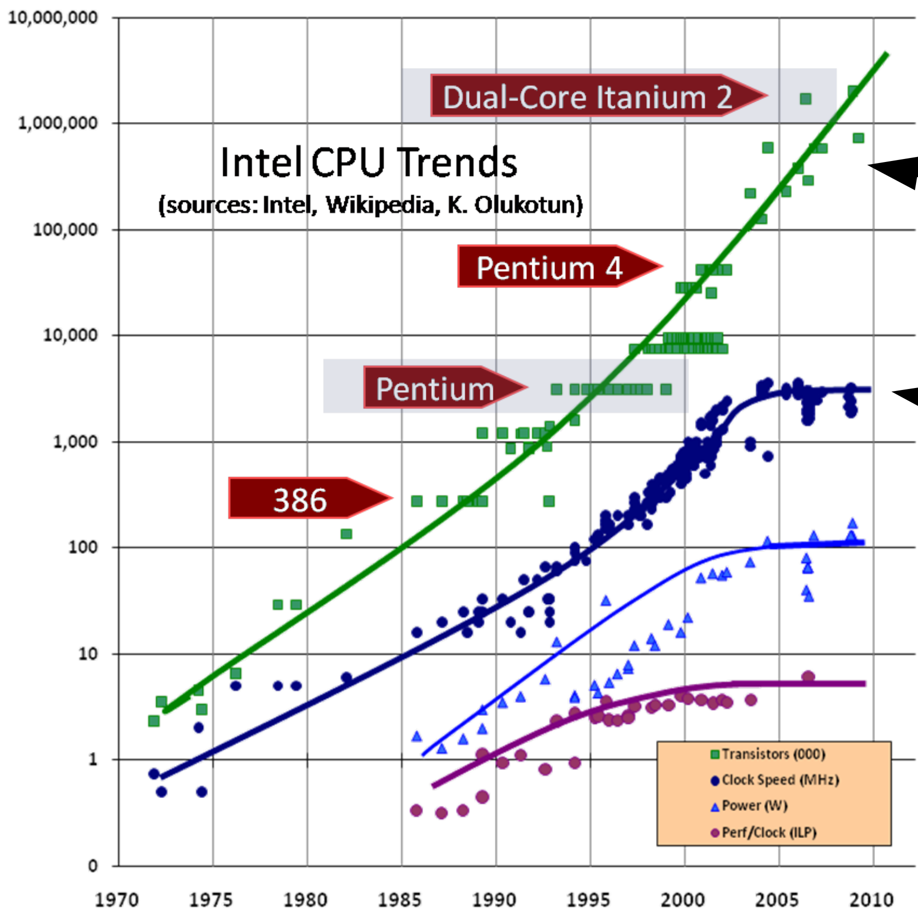



CHEP2013

# 2005: "The free lunch is over"

- Performance of standard CPU does not improve anymore
- Since HEP needs increase, we must get ready for the new architectures: multi-cores, many-cores, GPU (games consoles)



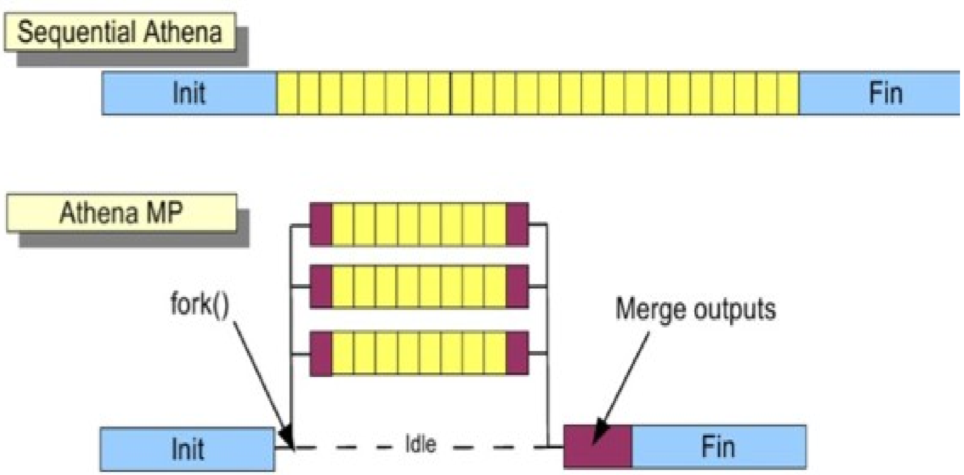

Nowadays multi-cores

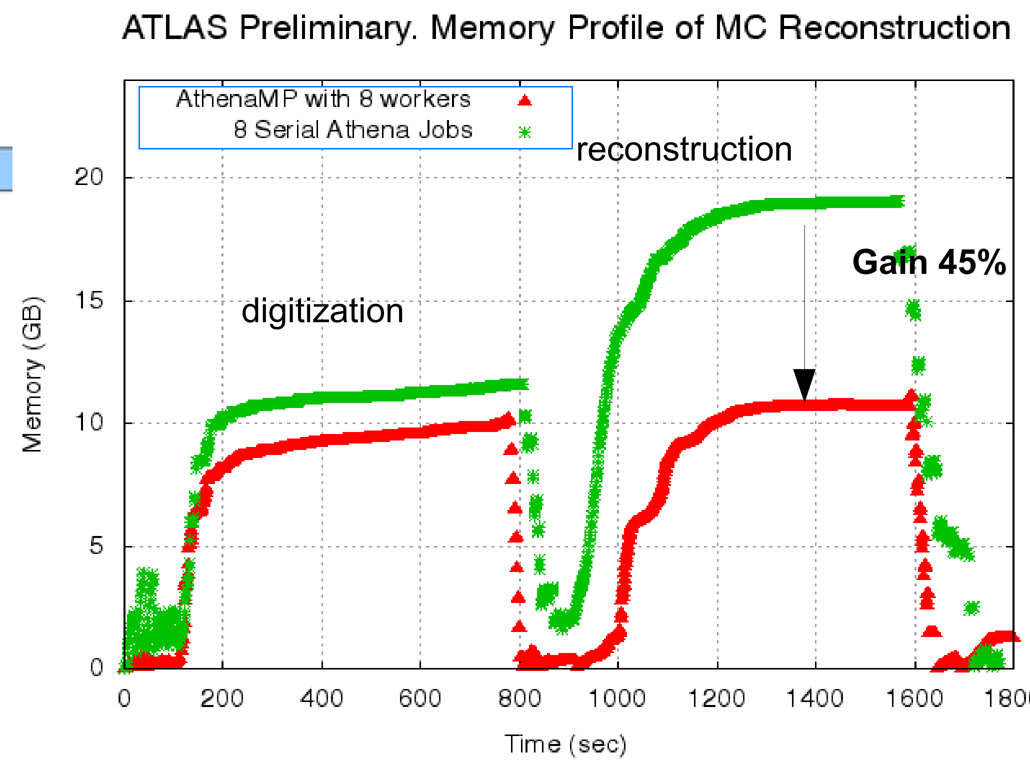
- Memory / core /IO per IO is limited

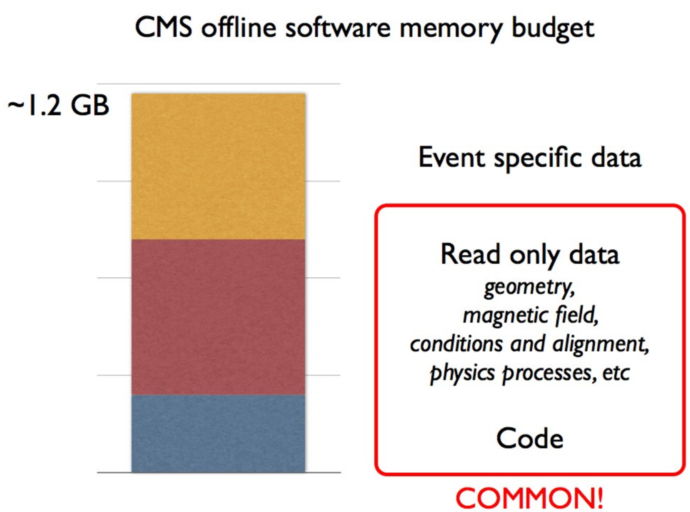
CPU clock reaches a plateau

# Saving Memory

ATLAS

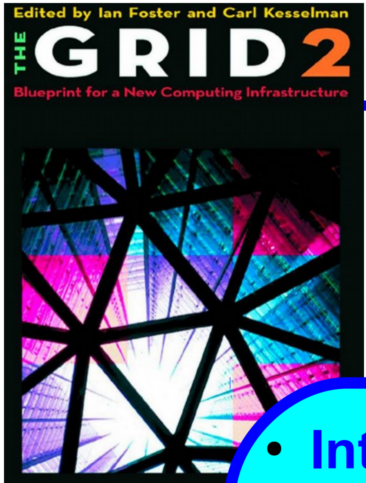



CMS is going further and making parallelism at the algorithm level.

# The "Cloud"

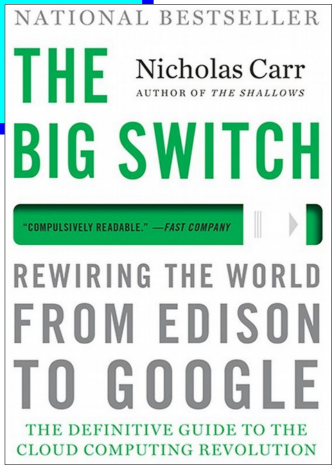



**The Grid: 1998 and 2003 (2nd Ed.)**
*Grid is used by analogy with the electric power grid…*
*has had a dramatic impact on human capabilities…*

- **Introduces the concept of virtualisation**
  - Isolates the user software (virtual) from physical hardware (real)
  - Remember that grid sites are heterogenous

- Flexible and dynamic resource sharing
- On-demand usage of resources

- Virtualisation already proved to be helpful "on the grid" (CVMFS)
- Clouds already successfully used by experiments
  - In many domains



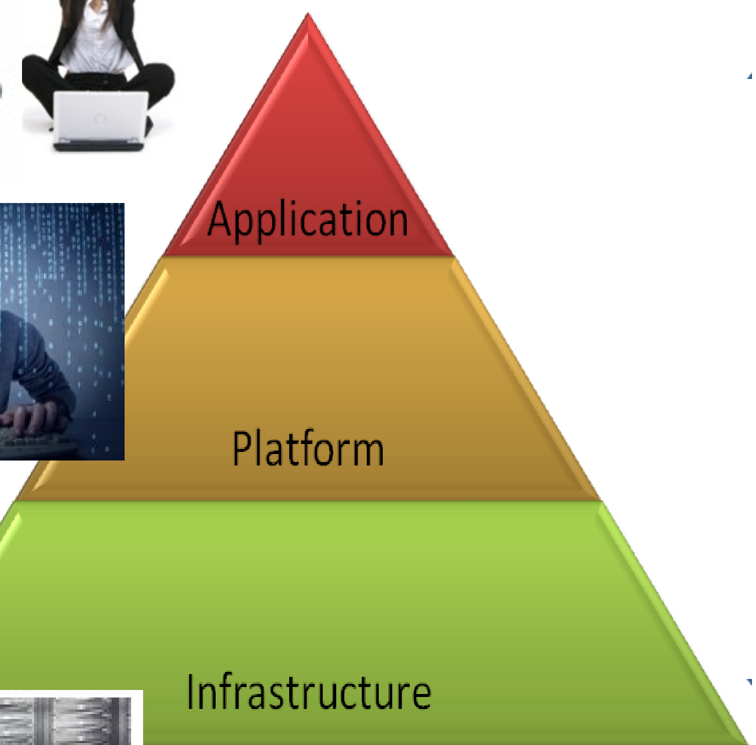

**The Big Switch [to the Cloud]: 2009**
*Computing is turning into a utility… will ultimately change society as completely as cheap electricity did…*

# Which types of Services?

**Software-as-a-Service (SaaS)**
Applications are available on demand (e.g. email)

**Platform-as-a-Service (PaaS)**
One can develop ones own applications on top of services (e.g. web servers)

**Infrastructure-as-a-Service (IaaS)**
A virtual machine is given, one installs owns own image (e.g. compute power)



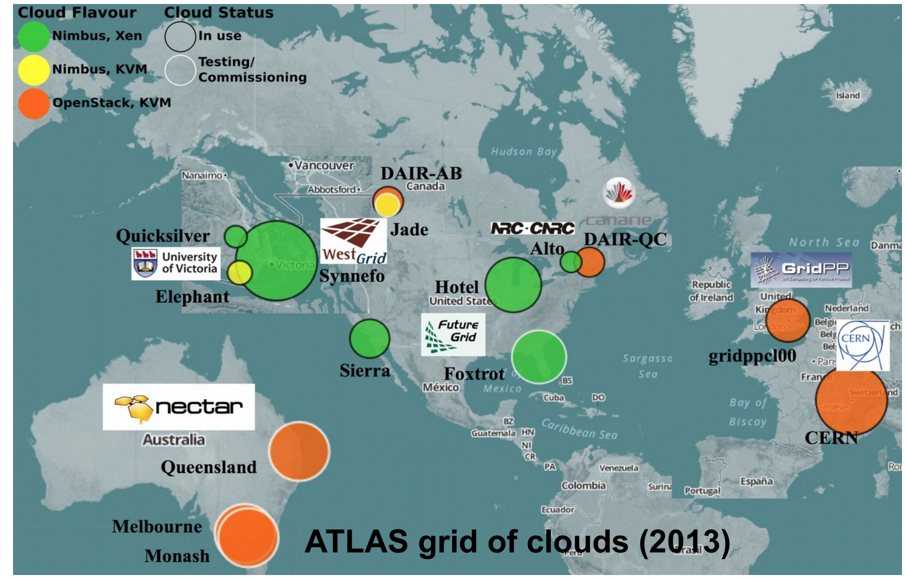

# Grid sites can be clouds

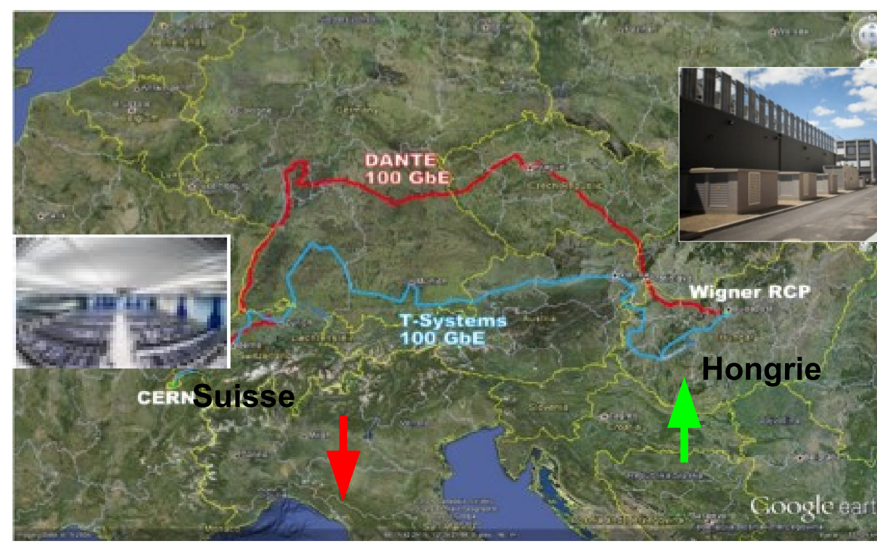
**Advantages**
- Decoupling HW and SW
- Flexibility

**Integrated in the experiments workflow**
- Private or academic
- Overhead < 5% (tuning)
- Looking at containers

**The Tier-0 is extended**
- Resources orchestrated in a cloud
- > 125 000 cores

**Farms dedicated to event triggering**
- Additional layer for a raid switch online/ offline (LHC shutdowns, inter-fill)



# Opportunistic resources

## Commercial clouds - Elasticity

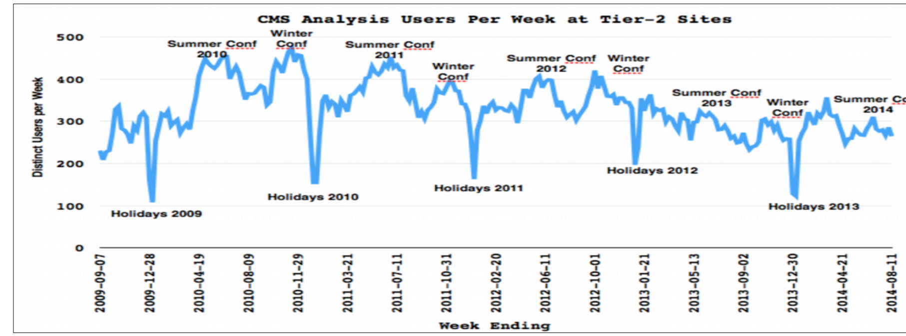
- Some experience : Google, HELIXNebula, Amazon Web Service
- In Europe, HNSciCloud (2016)
  - Prototype of *cloud* public/privé
  - Comprendre et maitriser les coûts

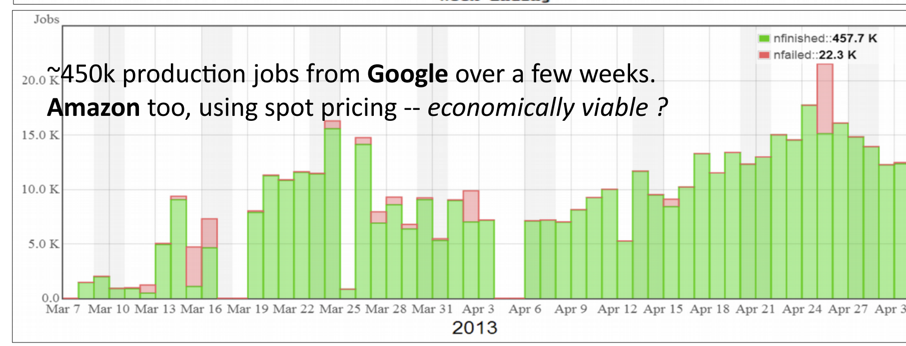
## BOINC and the @home projects

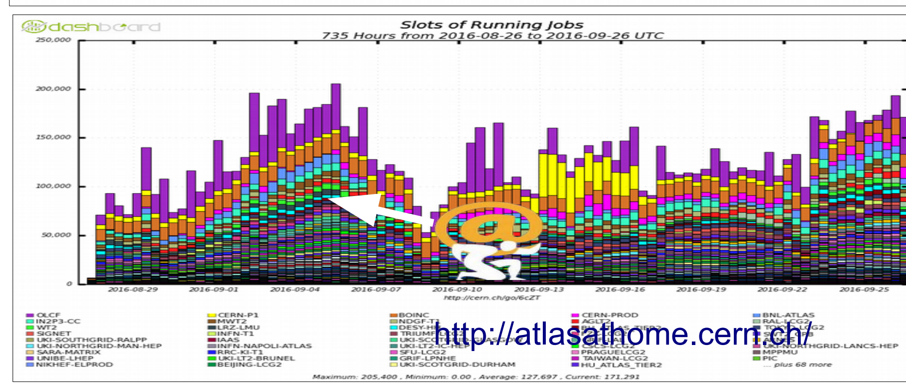
- Same model as SETI@home
- First initiative for the LHC: ATLAS@home

## Supercomputers

- HEP: no genuine needs for supercomputers
- Some of the biggest HPC centers are interfaced with WLCG and the grid stack




- Preferred payloads : IO intensive, interrupt tolerant

# Supercomputers

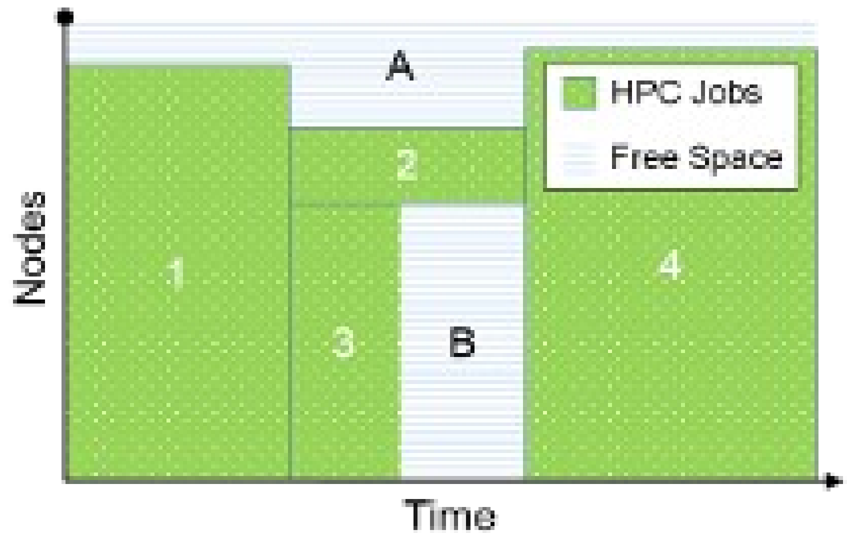
**Remember**

- Grid is ideal for a large number of independent jobs (High Throughput Computing)

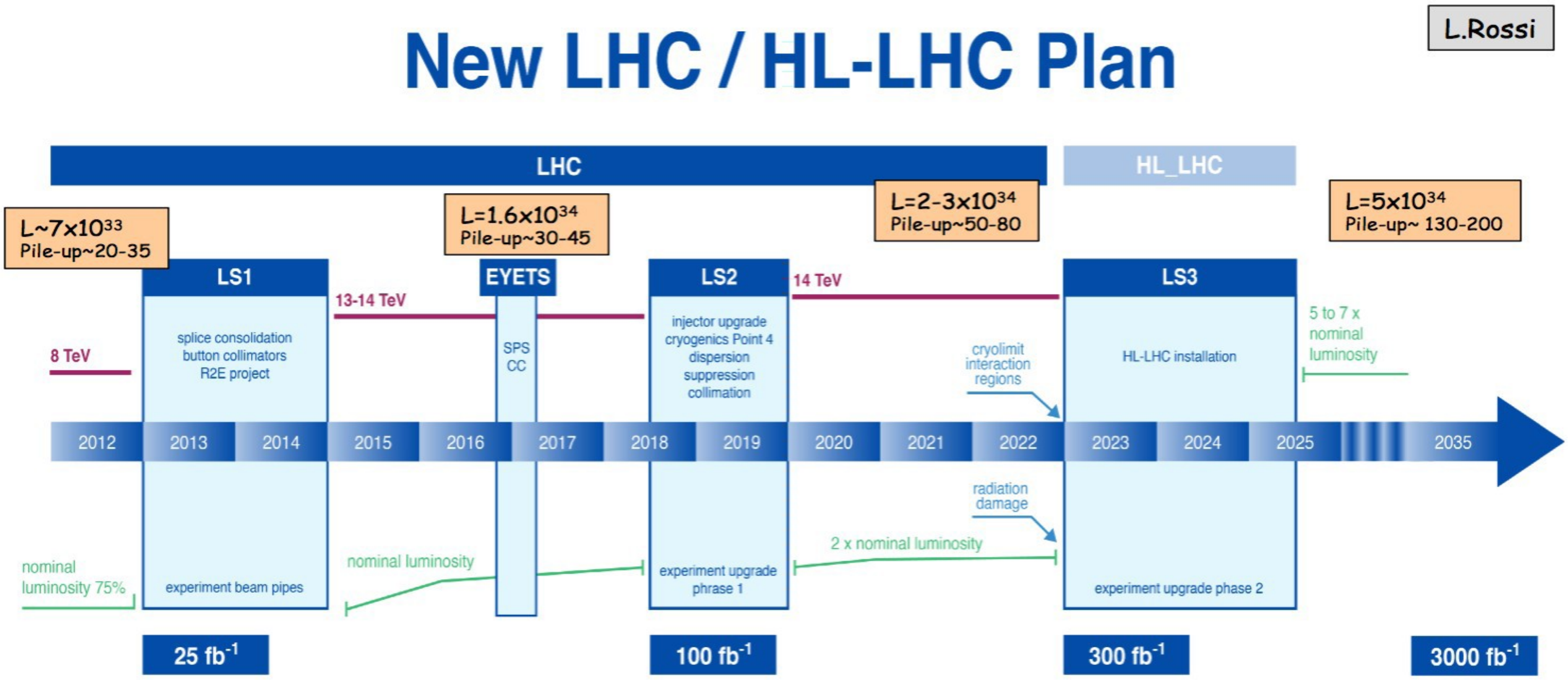
**Needs for supercomputers**

- One task must be executed on hundreds of cores
  - Very fast communication between cores
  - Large available memory
- HPC (High Performance Computing)
- Pyramidal Tiers-0/1/2 in Europe
  - France: “Curie” with 92 000 cores
- Seismology, mathematics, chemistry, aerodynamics … + astro particles
- By construction, difficult to fill the machines leaving empty cycles



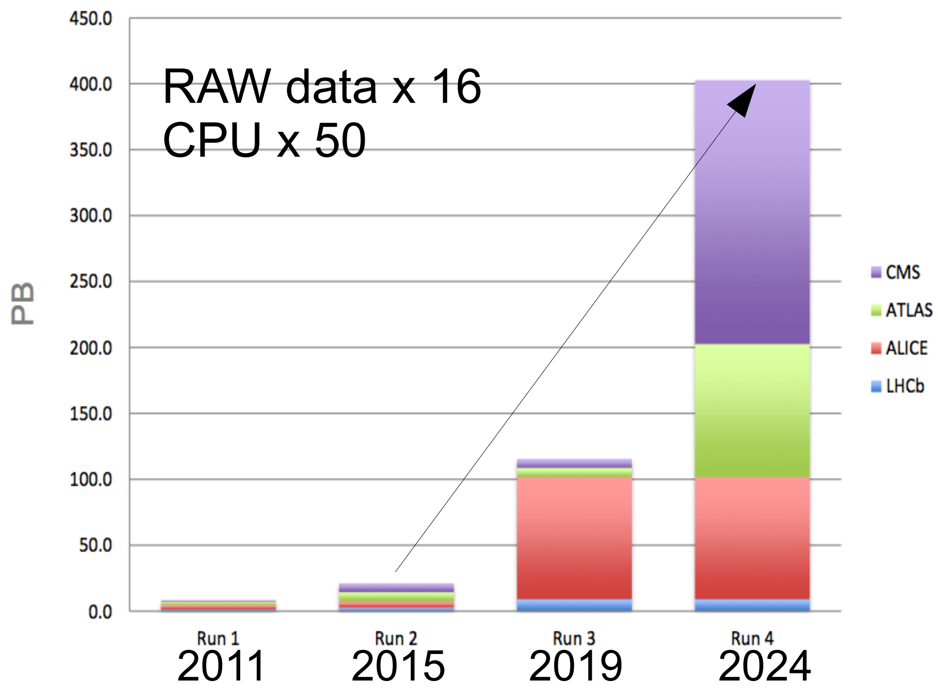


# The end ?




Pile-up : event complexity
Integrated Lumi.: nb of events

# Further challenges




Evolution of RAW data set size for the LHC experiments

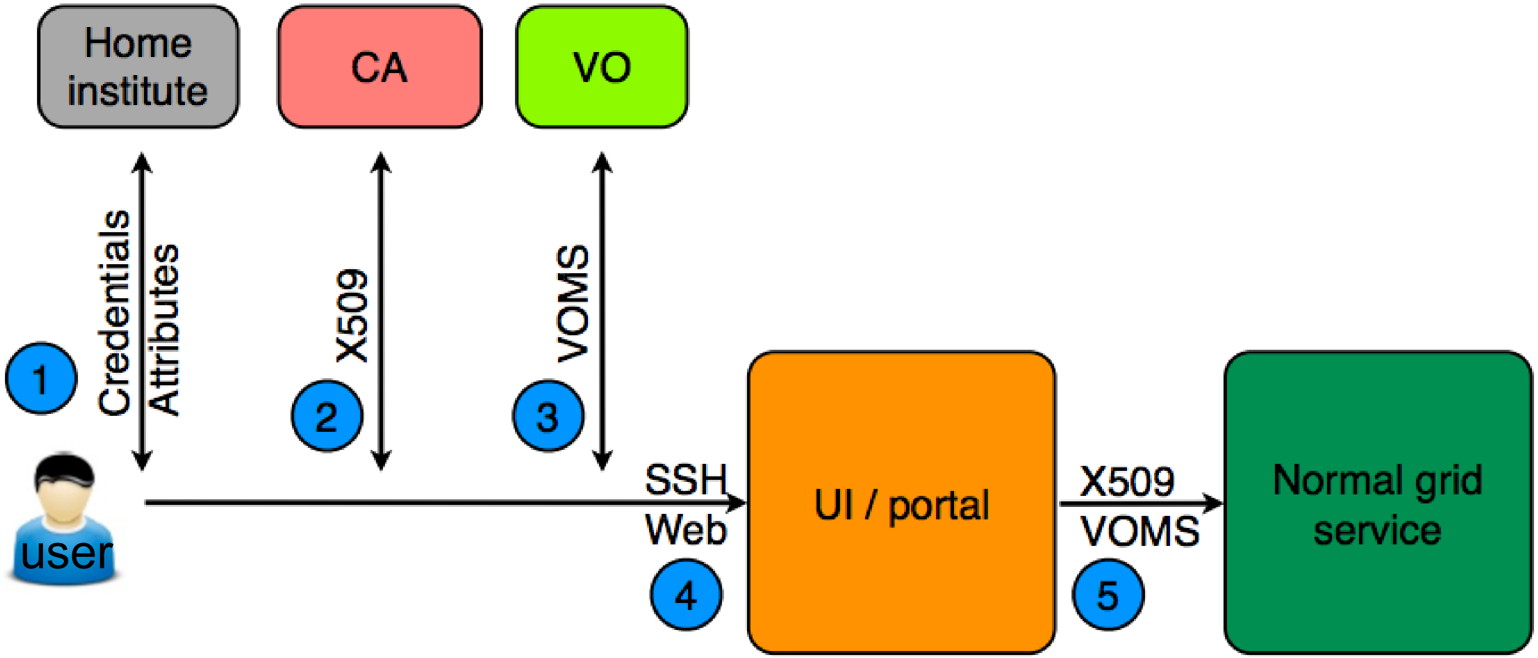
- derived data is not included
- cleaning of deprecated data is included

0.5 to 1 Exabytes of RAW data / year

- Run 3: ALICE and LHCb detector upgrades
  - Calibration and reconstruction online
- Run 4: ATLAS and CMS detector upgrades : we miss a factor of 5-10
  - New HW
  - New computing models
  - New CPU/disk/network balance


# Accessing “the” grid

# Authentication + User Interface



# Global Grid User Support

GGUS

Did you know...

Documentation

Registration

Search ticket

Submit ticket

Support staff

Hello Catherine Biscarat on prod-cn.ggus.eu

## GGUS - the EGI Helpdesk

WLCG egi

### Tickets

- Submit a new ticket via browser
- Submit a new ticket via email

**Tickets from Catherine Biscarat (access via certificate)**

| ID | Status | Last Update | Info |
|---|---|---|---|

You don't have tickets in the system

- Show my complete ticket list (open/closed/subscribed)
- Search ticket database

**Open tickets of all users**

| ID | VO | Info |
|---|---|---|
| 101871 | ops | [Rod Dahboard] Issues detected at IN2P3-LPSC |
| 101870 | ops | [Rod Dahboard] Issues detected at IN2P3-LPSC |
| 101869 | ops | [Rod Dahboard] Issues detected at IN2P3-LPSC |
| 101868 | other | CREAM_Job Errors on Bologna |
| 101867 | ops | [Rod Dahboard] Issues detected at IN2P3-IRES |
| 101866 | ops | [Rod Dahboard] Issues detected at IN2P3-SUBATECH |
| 101865 | ops | [Rod Dahboard] Issues detected at IN2P3-SUBATECH |
| 101864 | ops | RO-14-ITIM down apel gap |
| 101863 | ops | NAGIOS *emi.cream.glexec.WN-gLExec-/ops/Role=pilo... |
| 101862 | ops | NAGIOS *emi.cream.glexec.WN-gLExec-/ops/Role=pilo... |
| 101861 | ops | NAGIOS *emi.cream.CREAMCE-JobSubmit-ops* failed o... |
| 101860 | ops | NAGIOS *org.apel.APEL-Pub* failed on ce01.mosigri... |
| 101859 | ops | NAGIOS *org.sam.WN-Rep-ops* failed on grid03.spac... |
| 101858 | ops | NAGIOS *org.sam.SRM-GetSURLs-ops* failed on grid0... |
| 101857 | dteam | update email address in operations-portal |

- Show all open tickets

### News

No news at the moment.

### Info

**GGUS tools/reports**

- GGUS ticket timeline tool - TTT
- Report Generator
- WLCG Reports

**GGUS development plans**

- Browse current open features
- Description of development procedures
- Ongoing worklist & Release Notes
- Submit a request for a new feature to GGUS

**GGUS Search**

- Documentation
- GGUS ticket search
- Special GGUS hints

### Ticket Search

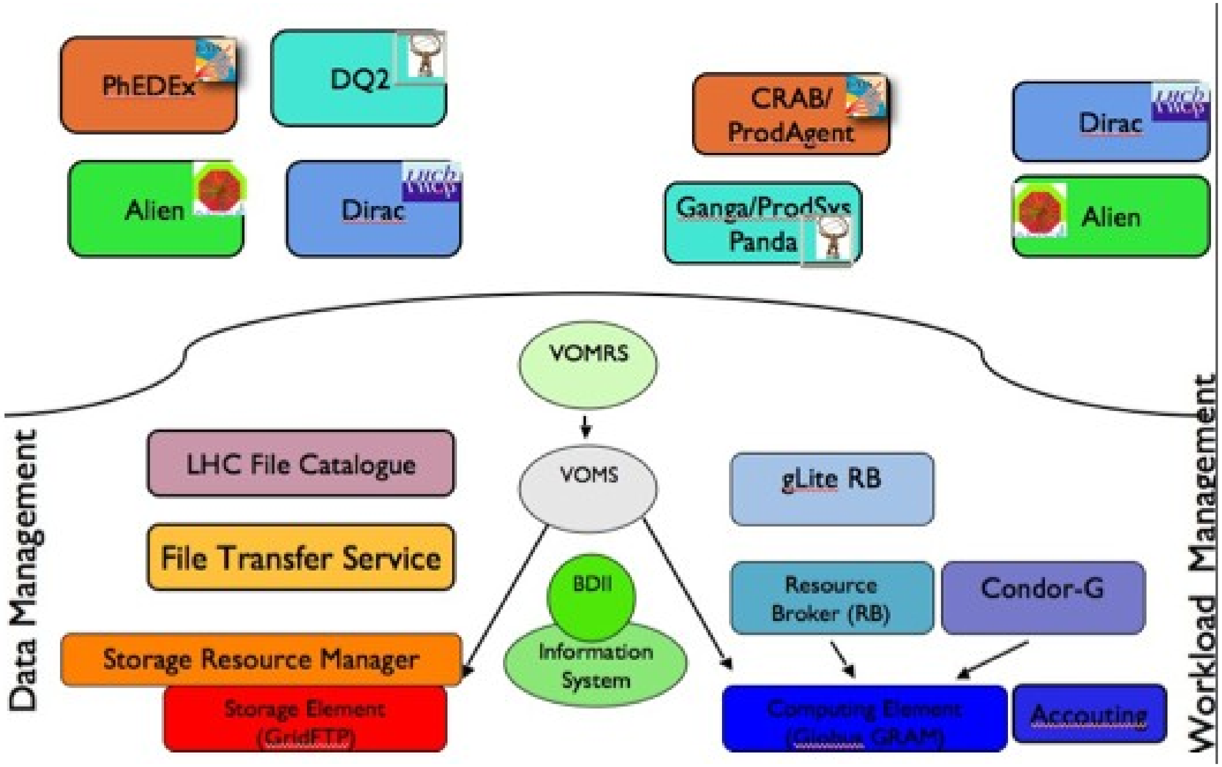
- Search ticket by ID: [ ] Go

# Experiments own Middleware

- HEP experiments pioneered the massive use of grids
- CERN Director General Rolf Heuer about the Higgs discovery:

  "*It was a global effort and it is a global success. The results today are only possible because of the extraordinary performance of the accelerators, including the infrastructure, the experiments, and the Grid computing.*"

- Large VOs have developed their own Middleware
  - Easy to use interfaces
  - Better control

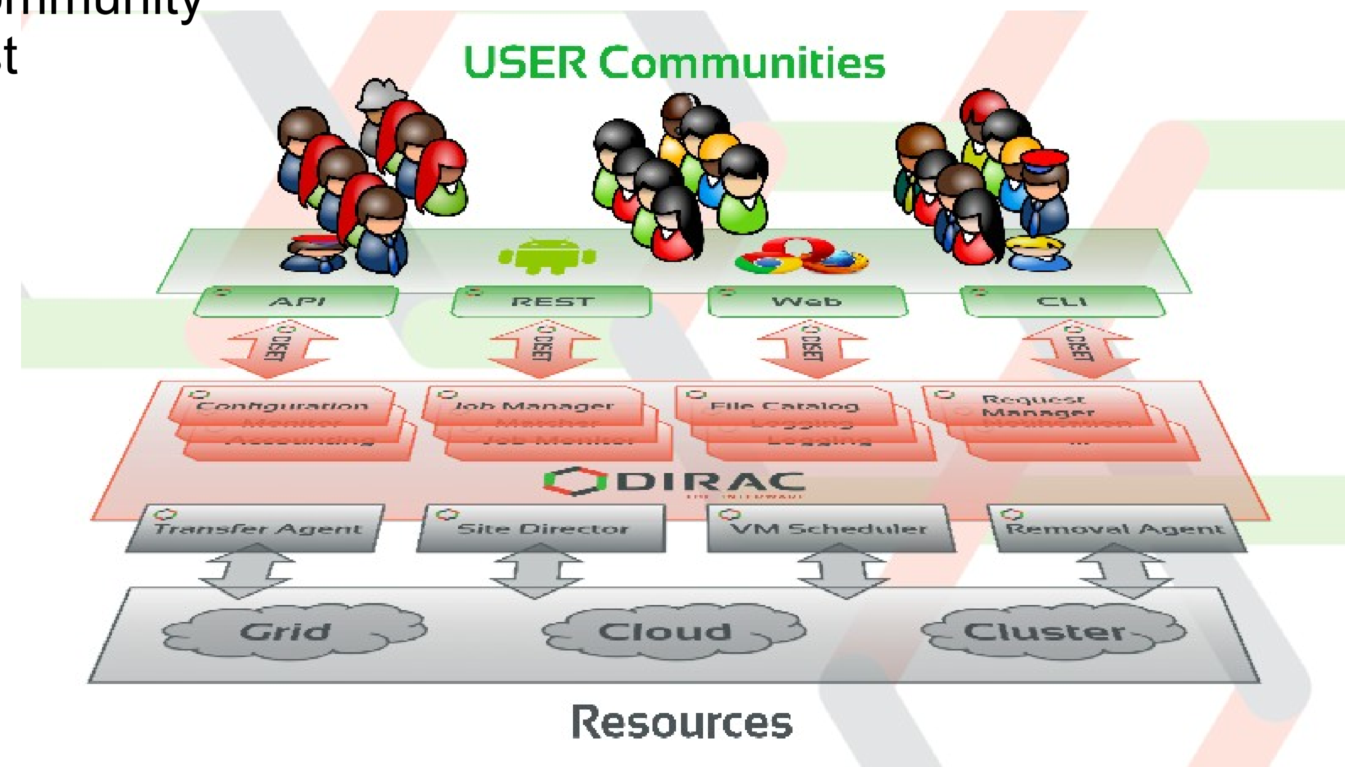


DIRAC

THE INTERWARE

- Initially developed by the LHCb experiment (LHC)
- In 2009 decision to generalise the software
  - Separate specific LHCb functionalities
- 2013: DIRAC consortium

- DIRAC is now a general-purpose Middleware, offering services to any scientific community
  - Fermi-LAT, Glast
  - LSST
  - CTA
  - …
  - Has replaced the resource broker



# EGI Federated Cloud

https://www.egi.eu/services/cloud-compute/

SERVICES | FEDERATION | USE CASES | BUSINESS | ABOUT

EGI / SERVICES / CLOUD COMPUTE

## Cloud Compute

Run virtual machines on-demand with complete control over computing resources

REQUEST THIS SERVICE

ASK FOR INFORMATION

Cloud Compute gives you the ability to deploy and scale virtual machines on-demand. It offers guaranteed computational resources in a secure and isolated environment with standard API access, without the overhead of managing physical servers.

Cloud Compute offers the possibility to select pre-configured virtual appliances (e.g. CPU, memory, disk, operating system or software) from a catalogue replicated across all EGI cloud providers.

With Cloud Compute you can:

- Execute compute- and data-intensive workloads (both batch and interactive)
- Host long-running services (e.g. web servers, databases or applications servers)
- Create disposable testing and development environments on virtual machines and scale your infrastructure needs
- Select virtual machine configurations (CPU, memory, disk) and application environments to fit your requirements
- Manage your Cloud Compute resources in a flexible way with integrated monitoring and accounting capabilities

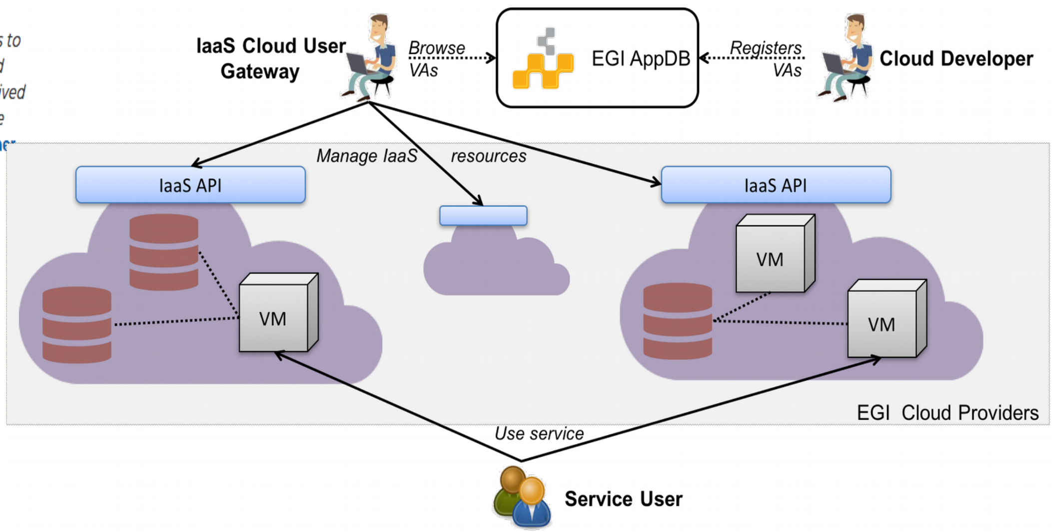
### First person

*"EGI Cloud Compute helped us to handle computational demand peaks when new data sets arrived and by that sped up the whole process significantly."* K. Förstne

### More services

Cloud Container Compute

High-Throughput Compute




# Today, Together

- Why grid computing

  A success story : the grid for the LHC

- Other Grids

- Behind the scene

  Technical details

- Going forward

  Standards, simplicity, clouds

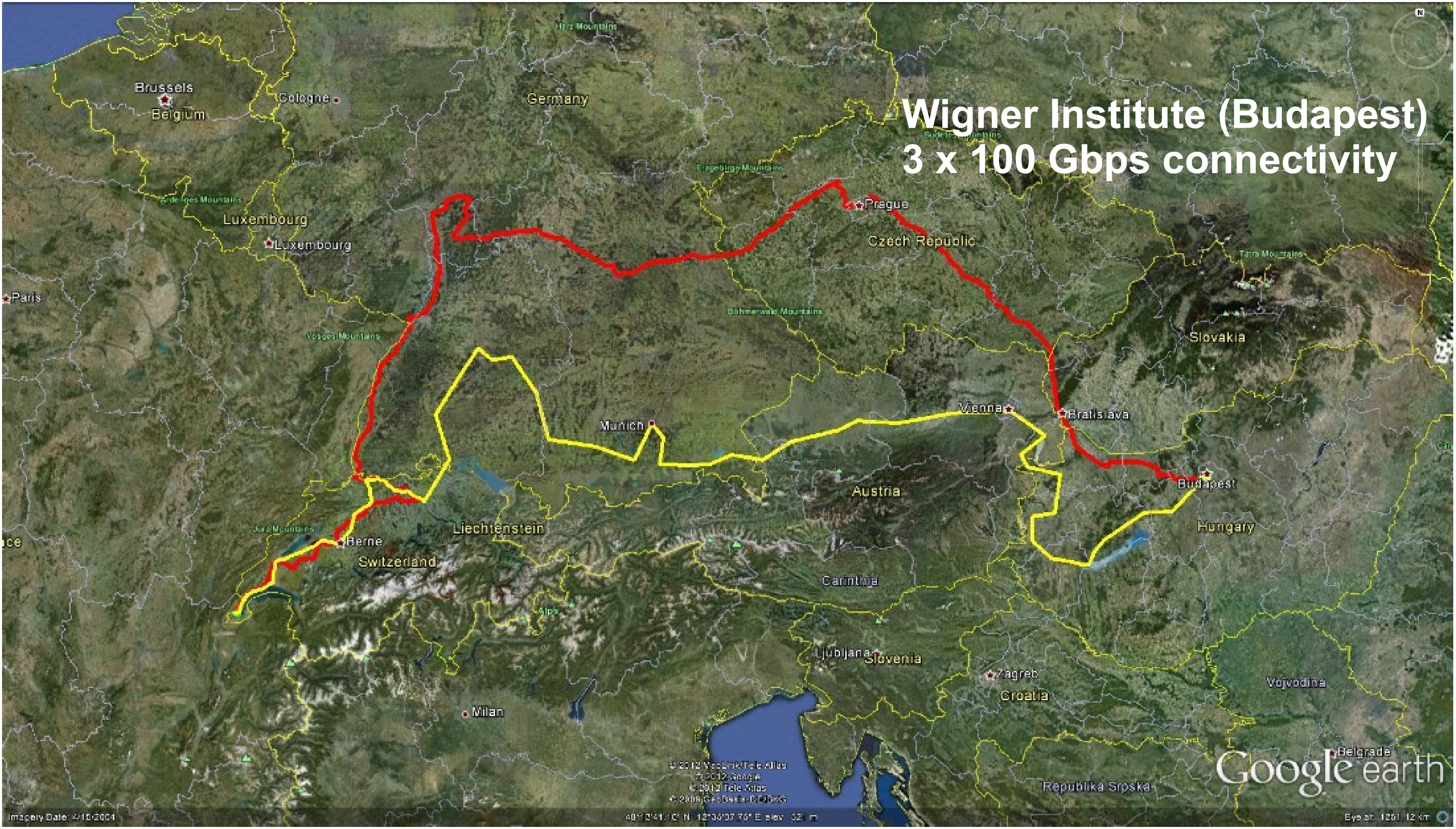
- Accessing the grid

# References

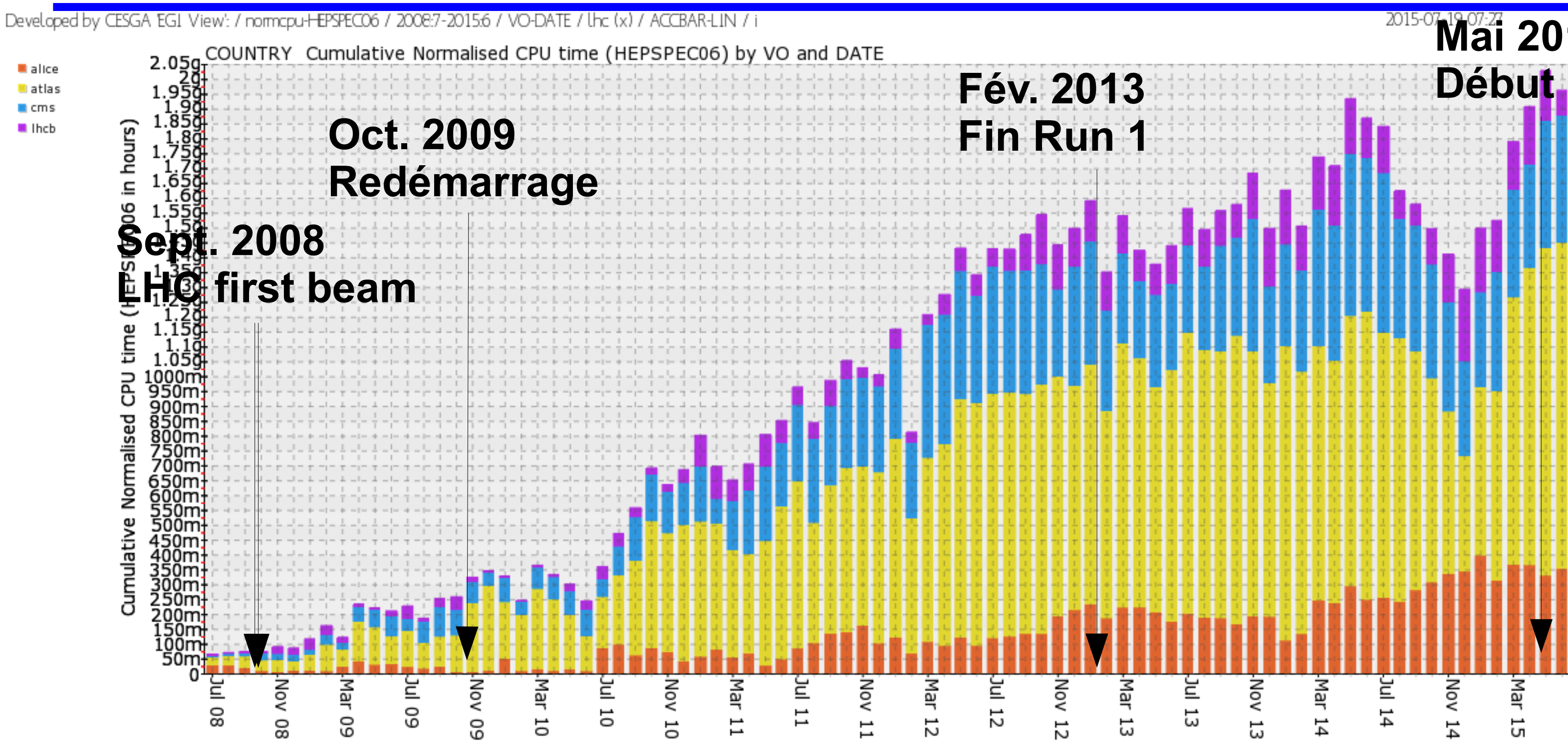
- International Conference on Computing in High Energ§y and Nuclear Physics (CHEP): http://www.chep2013.org/
- French summer school “Rencontres de physique de l'infiniment grand à l'infiniment petit”:
  - https://indico.in2p3.fr/conferenceDisplay.py?confId=7293
- French meeting “Les Journées réseaux” : https://conf-ng.jres.org/2013
- “Formation utilisateurs France-Grilles”: https://indico.in2p3.fr/conferenceDisplay.py?confId=6453
- International Symposium on Grids and Clouds (ISGC) 2013: http://indico3.twgrid.org/indico/conferenceDisplay.py?confId=370
- French Tutorial about the EGI usage: https://indico.in2p3.fr/conferenceDisplay.py?confId=6453
- CERN Summer Student Lecture 2011: https://indico.cern.ch/event/134624/

# Additional material

# Remote Tier-0

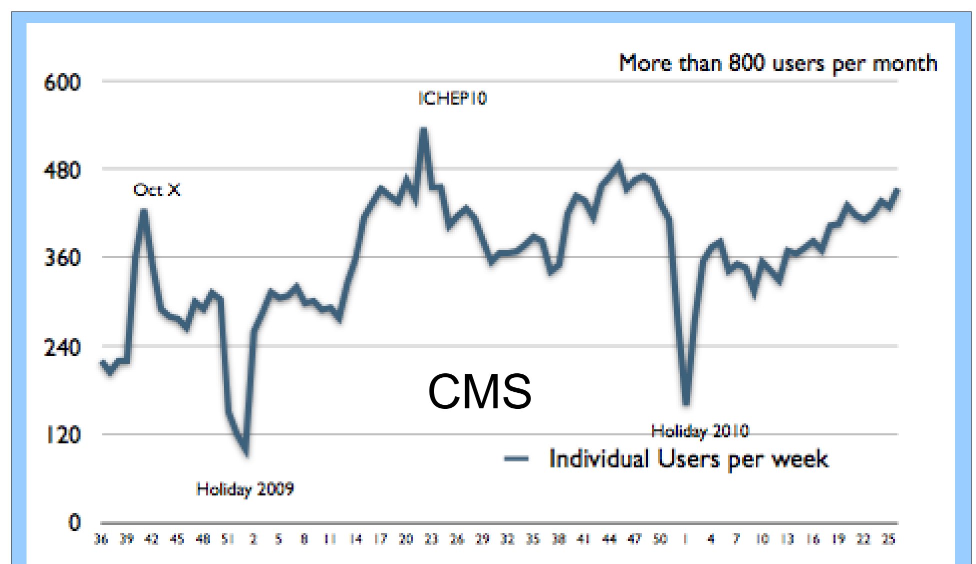


# CPU delivered




**CPU normaliseé**

Ref :
http://accounting.egi.eu/



# Specialised tasks


1 Tier-0
First processing
of raw data

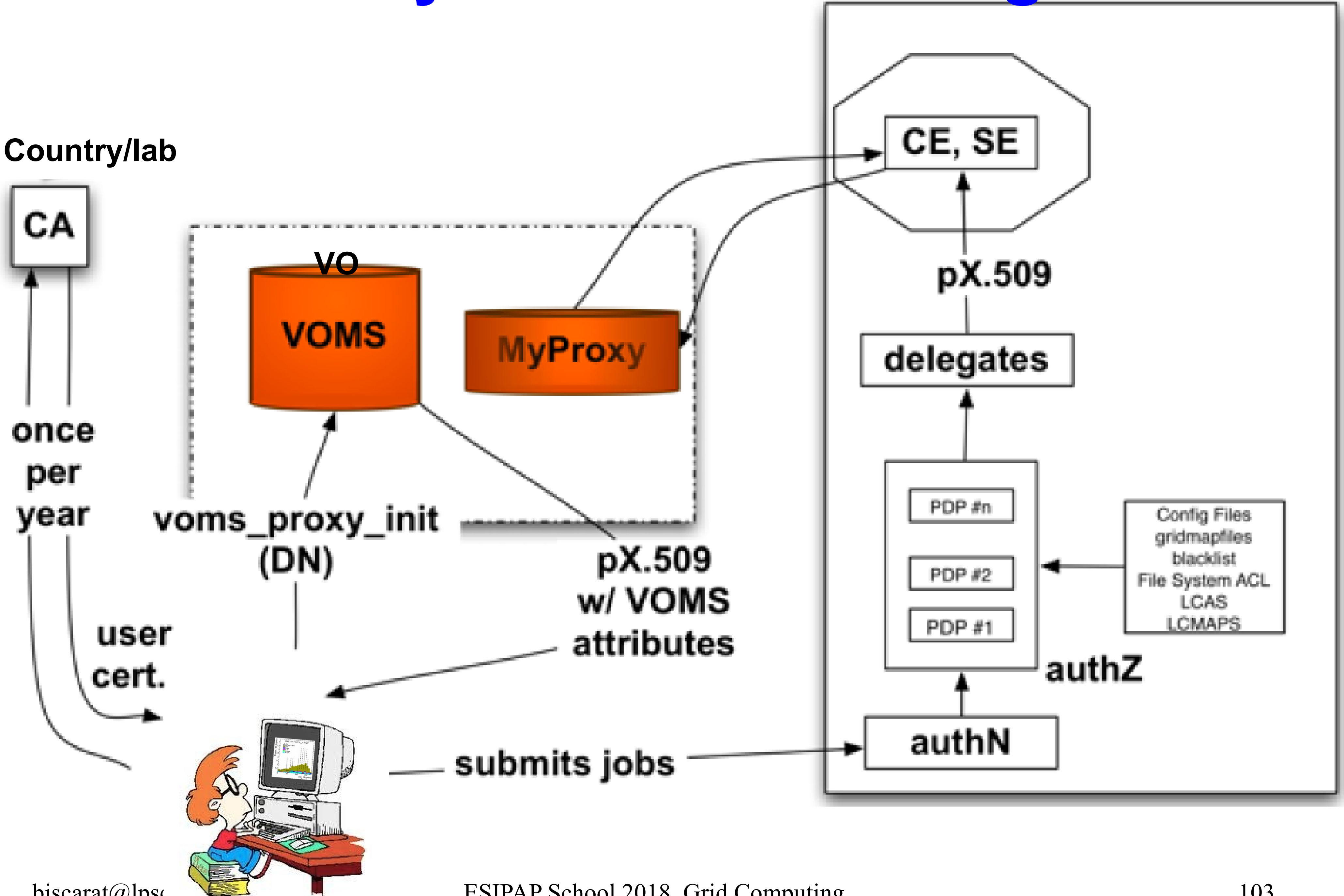
13 Tier-1
storage, re-construction
of raw data

150 Tier-2
Simulation

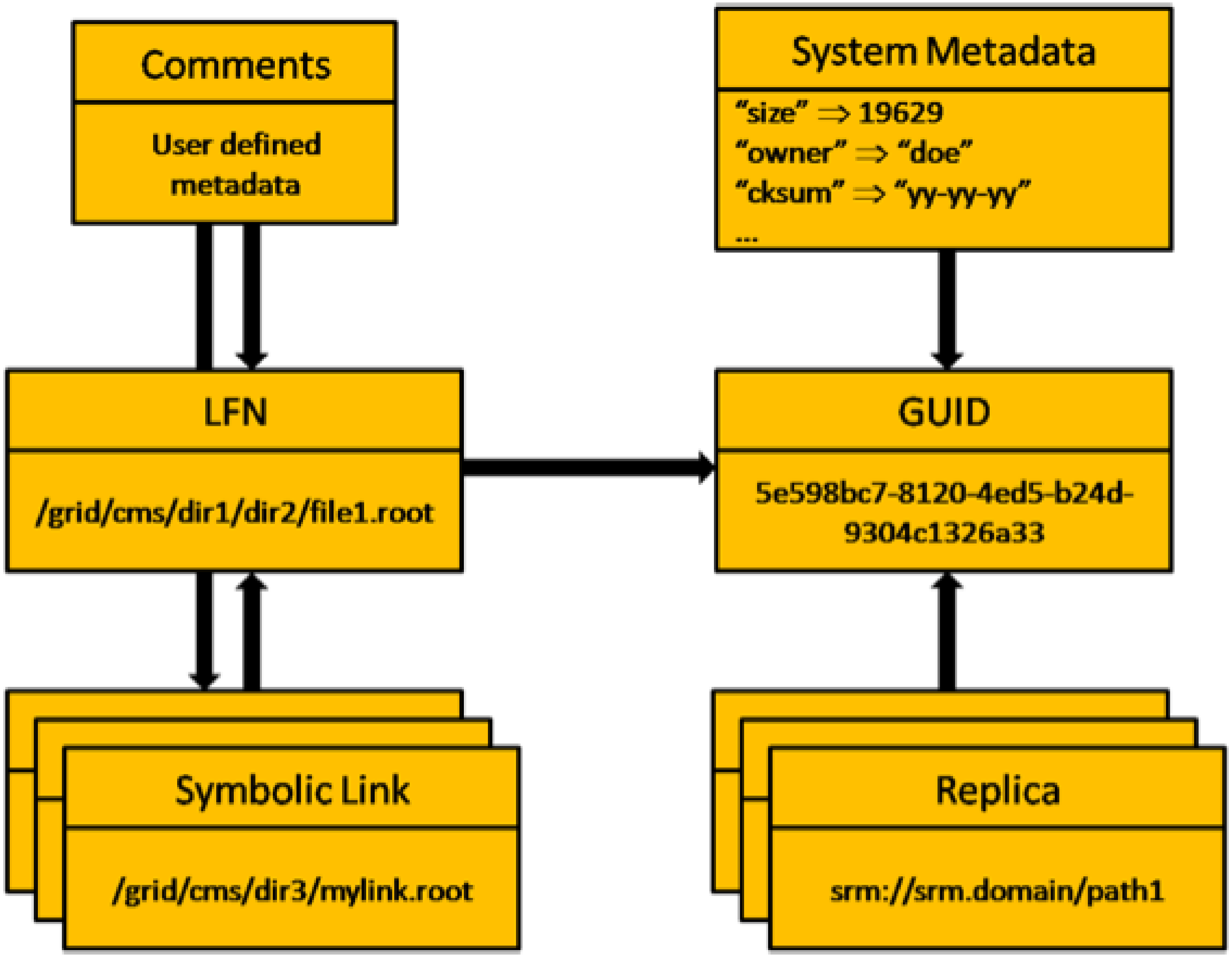
Tier-3
End-user analysis

Outside the grid
Final plot

# Security: the root of the grid



# LFC architecture

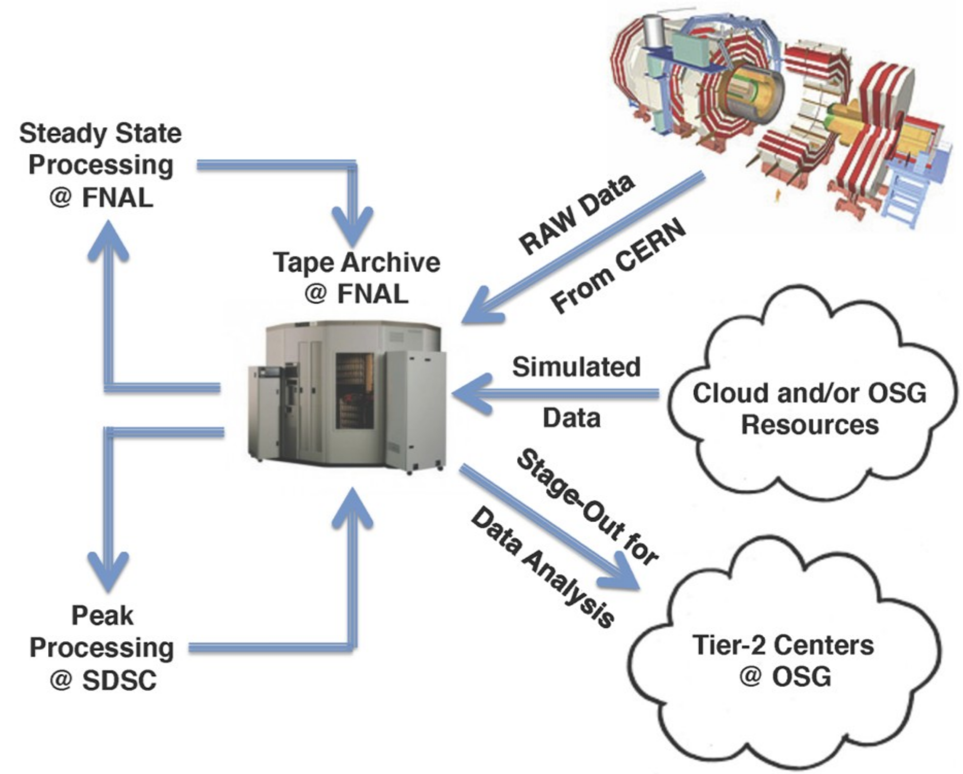


# Usage of HPC centres for LHC

## CMS using SDSC's Gordon Supercomputer

1024 Sandy Bridge nodes, 16 cores/node, 4 GB/core
Plus large memory supernodes
300 TB SSD storage

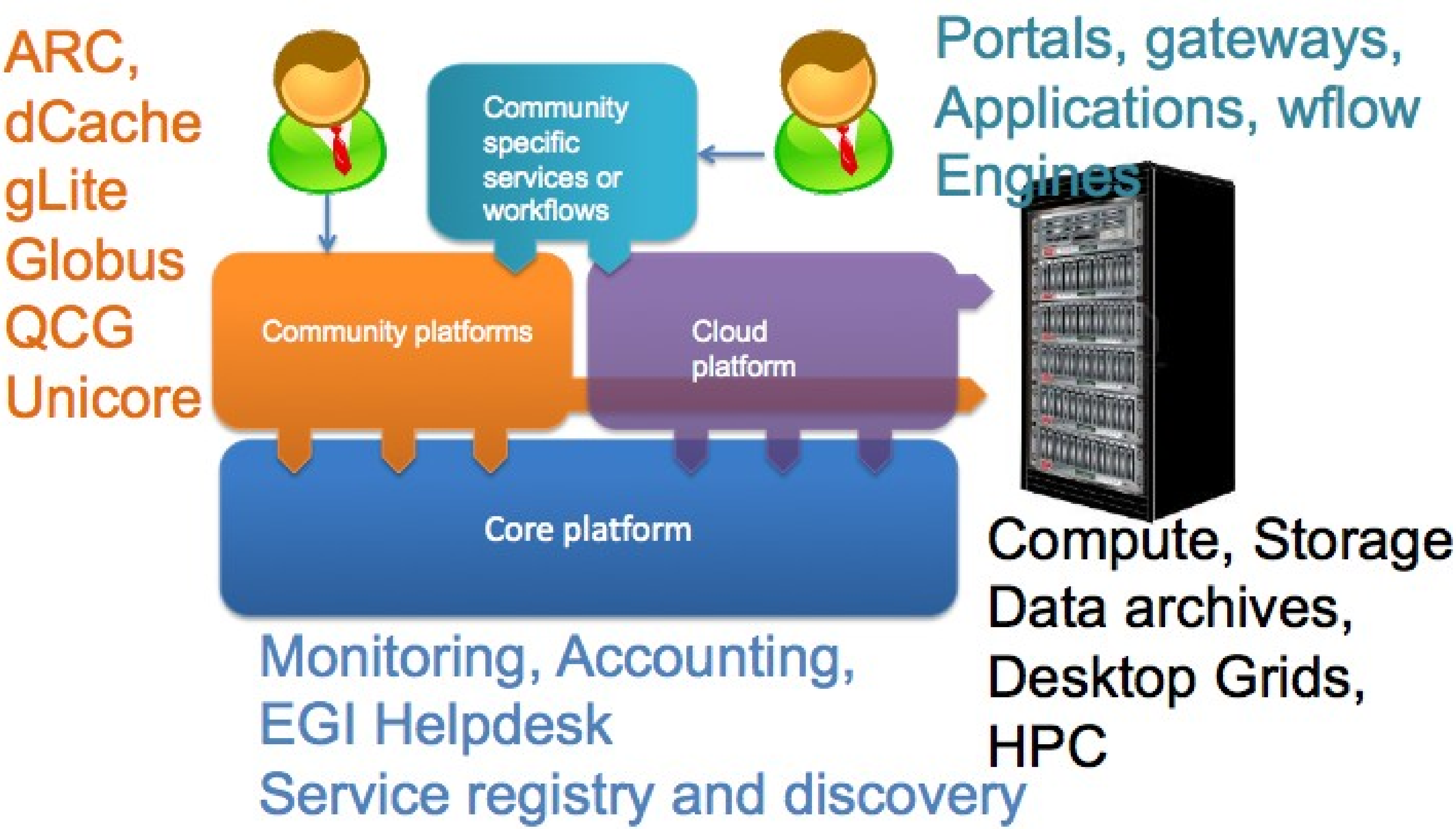
- early processing of 2012 parked data
- 125 TB in → 150 TB out




## Number of HPC T2s

→ many other initiatives in this area

# EGI platforms



# EGI service evolution

- ‘Old’ Model
  - Isolated Technology Platforms
  - High Throughput Computing
- ‘Current’ Model
  - Integrated Technology Platforms
  - HPC, HTC, Data
- ‘Future’ Model
  - Federated Cloud Platform
  - Community Platforms

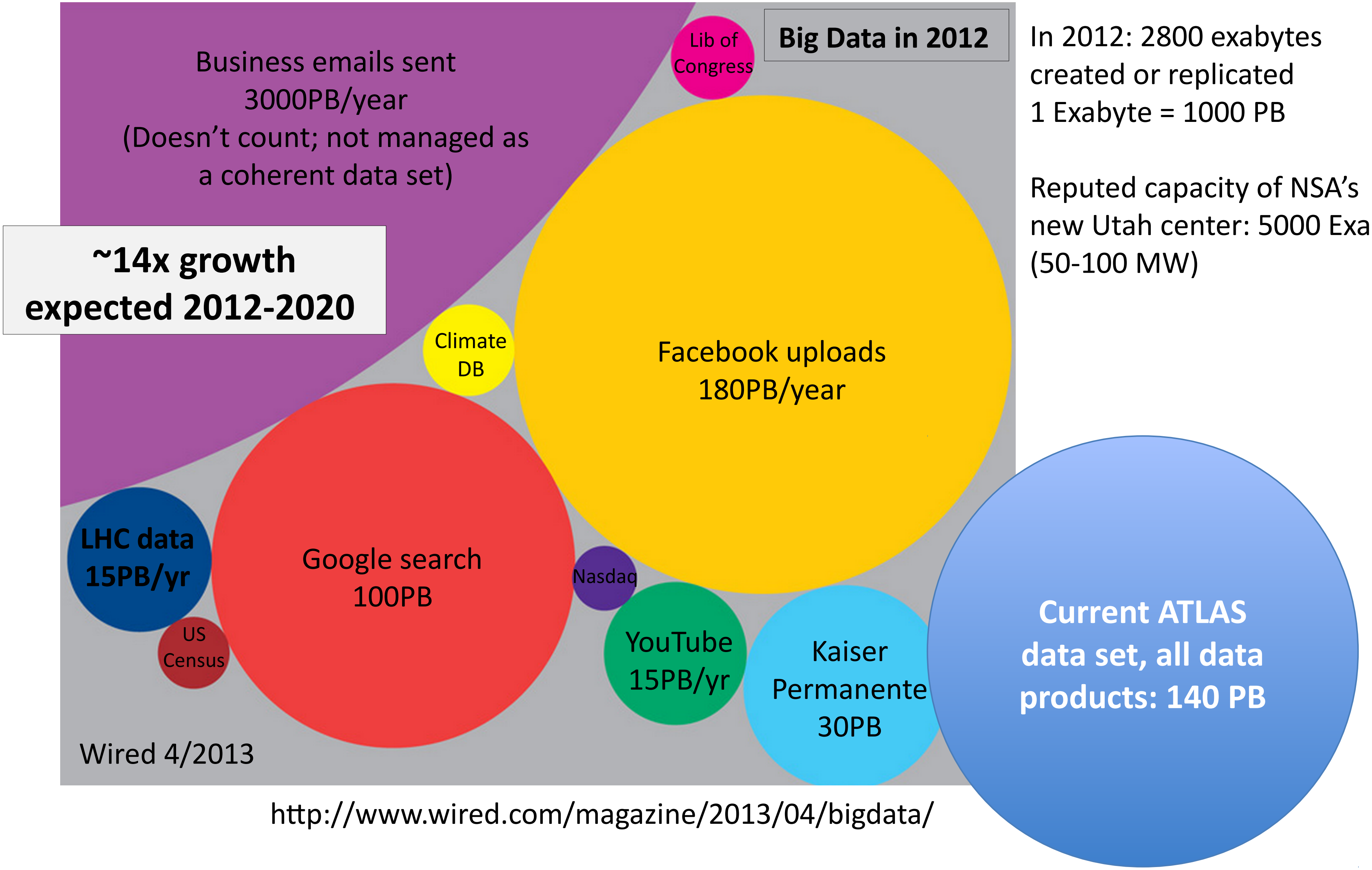
# Still improving

- Behind the success of the grid
  - High complexity
  - High human resources

- We have gained in experience and we are still improving
  - Very stable network → new data model
  - Federated storage
  - Building common tools/interfaces

- Meanwhile we were developing the grid
  - Other areas do treat enormous amount of data
  - Standards tools have been developed
  - The “cloud” is born

# Data set sizes

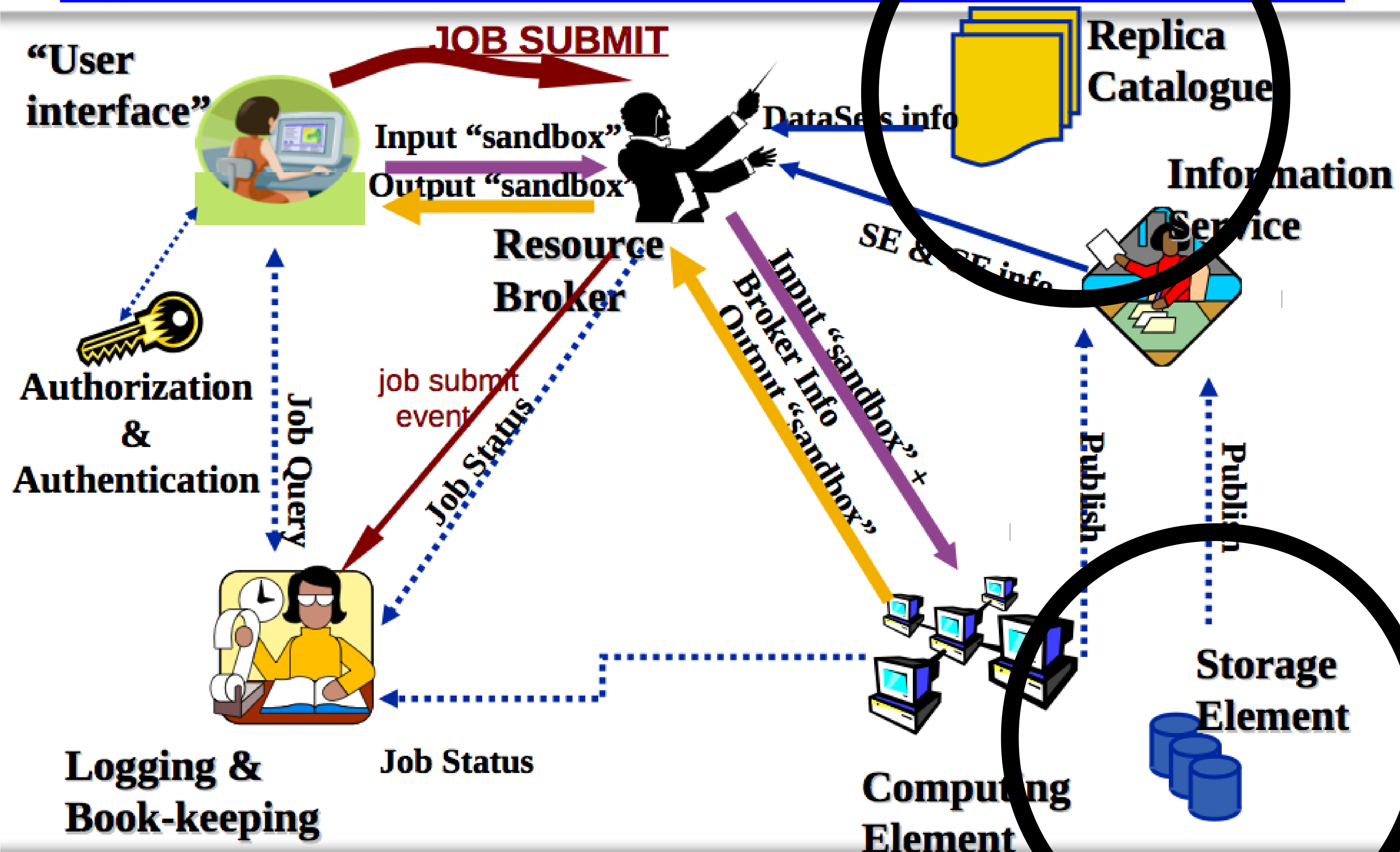



In 2012: 2800 exabytes created or replicated
1 Exabyte = 1000 PB

Reputed capacity of NSA's new Utah center: 5000 ExaB (50-100 MW)

http://www.wired.com/magazine/2013/04/bigdata/

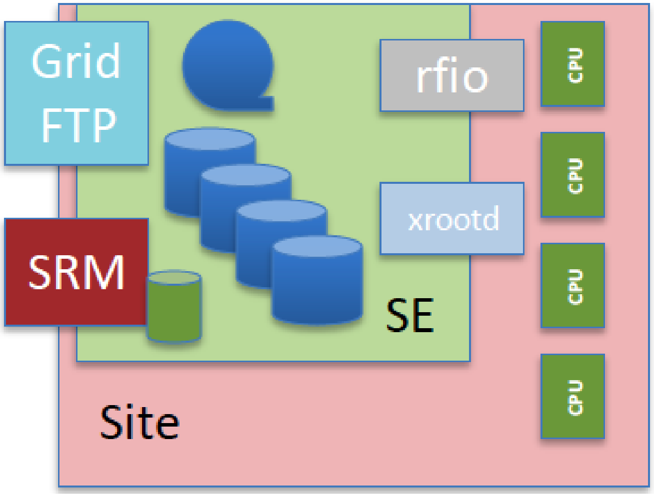
# A word on



"User interface"
JOB SUBMIT
Input "sandbox"
Output "sandbox"
DataSets info
Replica Catalogue
Information Service
SE & CE info
Resource Broker
Authorization & Authentication
Job Query
job submit event
Job Status
Input "sandbox" + Broker Info
Output "sandbox"
Publish
Publish
Logging & Book-keeping
Job Status
Computing Element
Storage Element

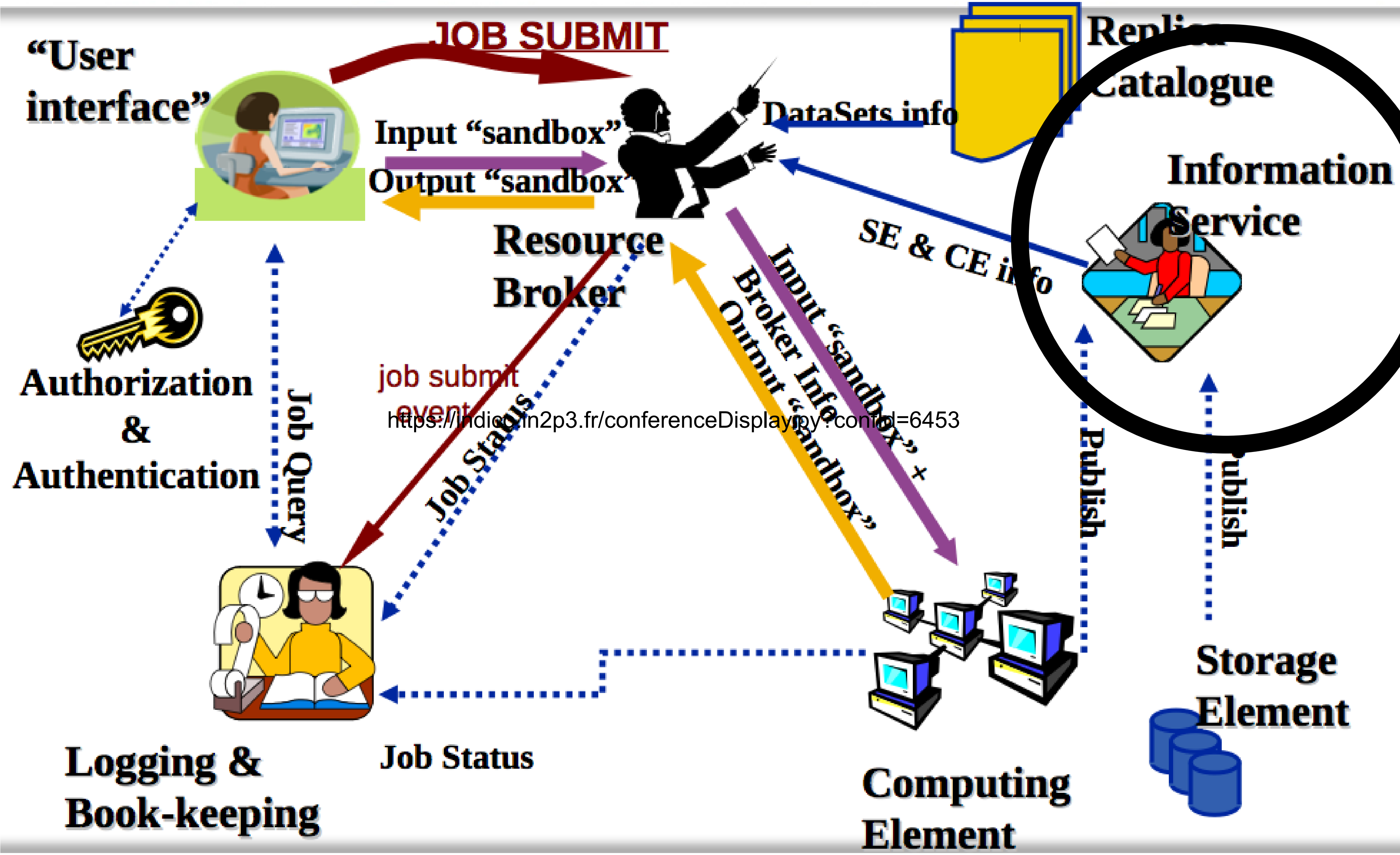
# Data management

- **Storage elements (SE)**
  - External interface to physical storage at sites
  - Different protocols (rfio, srm, )
  - Different storage system (dCache, xrootd, ...)




- **Storage resource manager (SRM)**
  - Hide heterogeneous systems
  - Handle authorisation
- **Local File Catalog (LFC)**
  - Locate files on the grid
  - Keep track of the file (user's name ↔ file location)
- **File Transfer Service (FTS)**
  - Multi-VO service
  - Handles prioritisation

# A word on



JOB SUBMIT
"User interface"
Input "sandbox"
Output "sandbox"
Resource Broker
DataSets info
Replica Catalogue
Information Service
SE & CE info
Authorization & Authentication
Job Query
job submit event
Job Status
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Output "sandbox"
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Logging & Book-keeping
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Computing Element
Storage Element
https://indico.in2p3.fr/conferenceDisplay.py?confId=6453

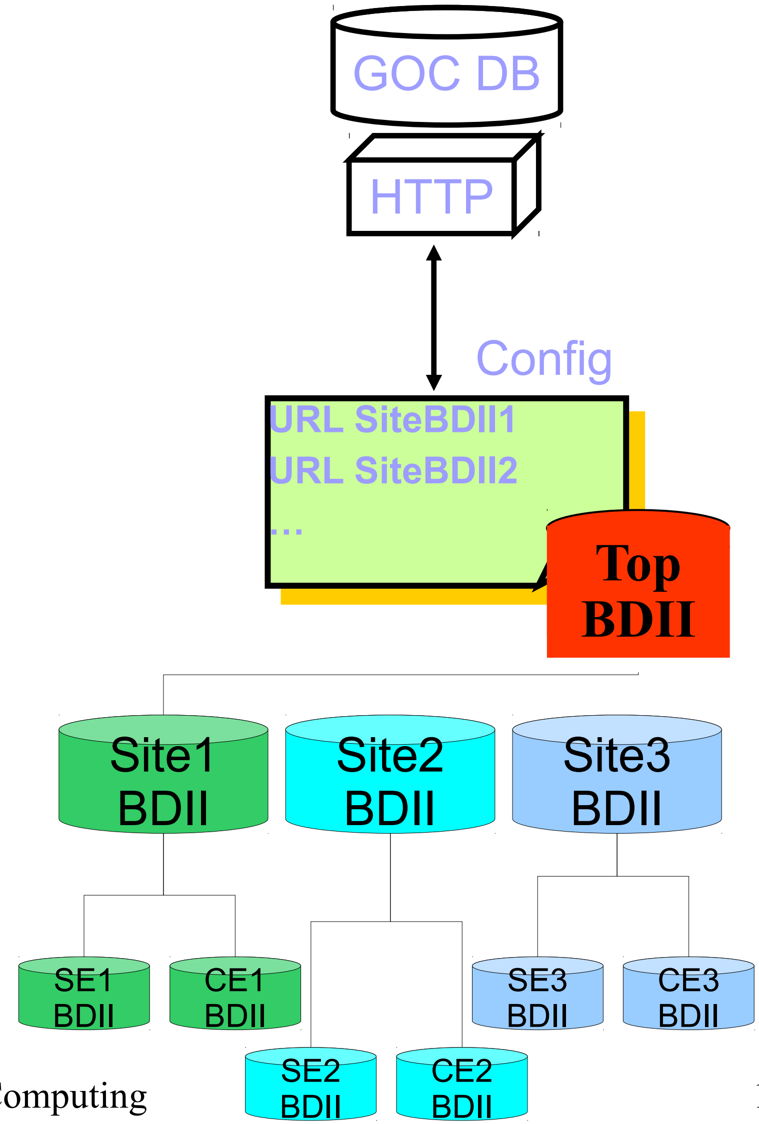
# Information system

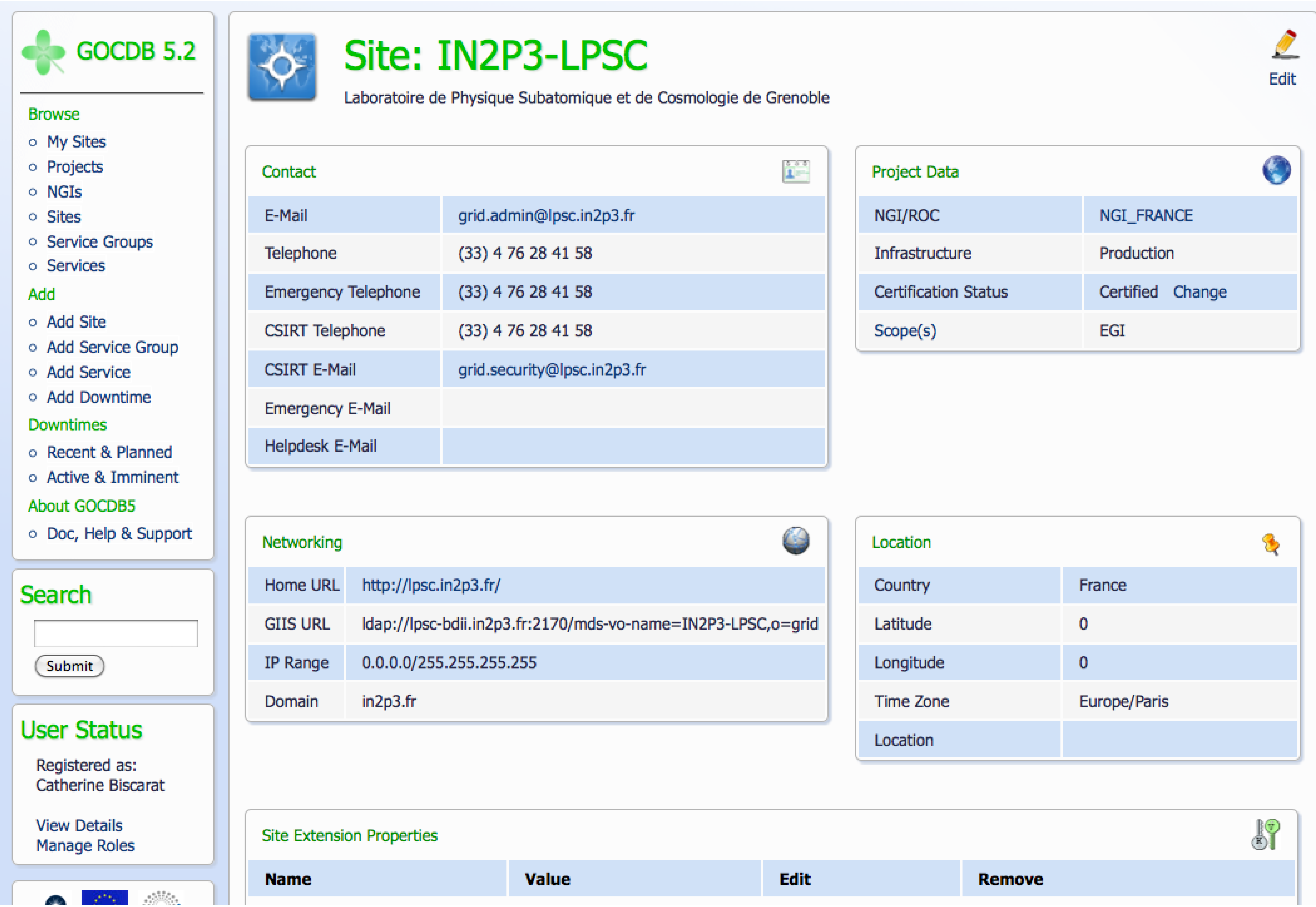
- In charge of collecting the information on the status of the site and services
  - Format understandable by both parties

- Sites publish:
  - Status of the services
  - Their resources
- VOs publish:
  - The software installed on the sites

- BDII (GlueSchema):
  - Sites BDII
  - Top BDII
  - Commands:
    - Ldapsearch
    - lcg-infosites

- GOC DB: reference for all the EGI sites
  http://goc.egi.eu/





GOCDB 5.2

Browse
- My Sites
- Projects
- NGIs
- Sites
- Service Groups
- Services

Add
- Add Site
- Add Service Group
- Add Service
- Add Downtime

Downtimes
- Recent & Planned
- Active & Imminent

About GOCDB5
- Doc, Help & Support

Search

Submit

User Status

Registered as:
Catherine Biscarat

View Details
Manage Roles

# Site: IN2P3-LPSC

Laboratoire de Physique Subatomique et de Cosmologie de Grenoble

Edit

Contact

| | |
|---|---|
| E-Mail | grid.admin@lpsc.in2p3.fr |
| Telephone | (33) 4 76 28 41 58 |
| Emergency Telephone | (33) 4 76 28 41 58 |
| CSIRT Telephone | (33) 4 76 28 41 58 |
| CSIRT E-Mail | grid.security@lpsc.in2p3.fr |
| Emergency E-Mail | |
| Helpdesk E-Mail | |

Project Data

| | |
|---|---|
| NGI/ROC | NGI_FRANCE |
| Infrastructure | Production |
| Certification Status | Certified Change |
| Scope(s) | EGI |

Networking

| | |
|---|---|
| Home URL | http://lpsc.in2p3.fr/ |
| GIIS URL | ldap://lpsc-bdii.in2p3.fr:2170/mds-vo-name=IN2P3-LPSC,o=grid |
| IP Range | 0.0.0.0/255.255.255.255 |
| Domain | in2p3.fr |

Location

| | |
|---|---|
| Country | France |
| Latitude | 0 |
| Longitude | 0 |
| Time Zone | Europe/Paris |
| Location | |

Site Extension Properties

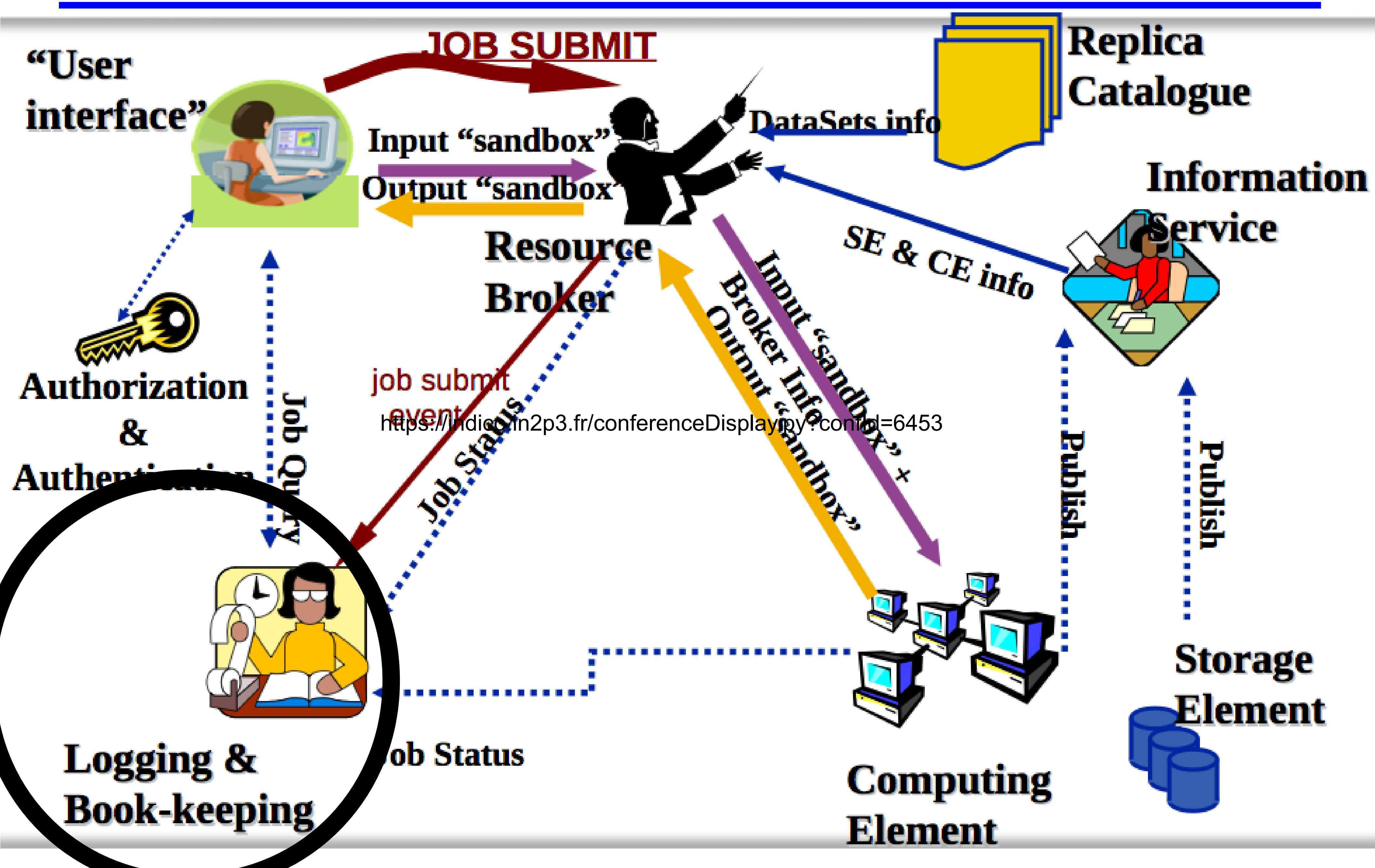
| Name | Value | Edit | Remove |
|---|---|---|---|

Services

| Hostname (service type) | URL | Production | Monitored | Scope(s) |
|---|---|---|---|---|
| lpsc-cream-ce.in2p3.fr (APEL) | | ✔ | ✔ | EGI |
| lpsc-bdii.in2p3.fr (Site-BDII) | | ✔ | ✔ | EGI |
| lpsc-vobox.in2p3.fr (VO-box) | | ✔ | ✔ | EGI |
| lpsc-ce.in2p3.fr (CREAM-CE) | | ✔ | ✔ | EGI |
| lpsc-cream-ce.in2p3.fr (CREAM-CE) | | ✔ | ✔ | EGI |
| lpsc-se-dpm-server.in2p3.fr (SRM) | | ✔ | ✔ | EGI |
| lpsc-ce.in2p3.fr (gLExec) | | ✔ | ✔ | EGI |
| lpsc-cream-ce.in2p3.fr (gLExec) | | ✔ | ✔ | EGI |
| lpsc-ce.in2p3.fr (eu.egi.MPI) | | ✔ | ✔ | EGI |
| lpsc-cream-ce.in2p3.fr (eu.egi.MPI) | | ✔ | ✔ | EGI |
| lpsc-perfsonar.in2p3.fr (net.perfSONAR.Bandwidth) | | ✔ | ✔ | EGI |
| lpsc-perfsonar2.in2p3.fr (net.perfSONAR.Latency) | | ✔ | ✔ | EGI |
| lpsc-ce2.in2p3.fr (CREAM-CE) | | ✔ | ✔ | EGI |
| lpsc-ce2.in2p3.fr (eu.egi.MPI) | | ✔ | ✔ | EGI |
| lpsc-ce2.in2p3.fr (gLExec) | | ✔ | ✔ | EGI |

Add Service

# A word on



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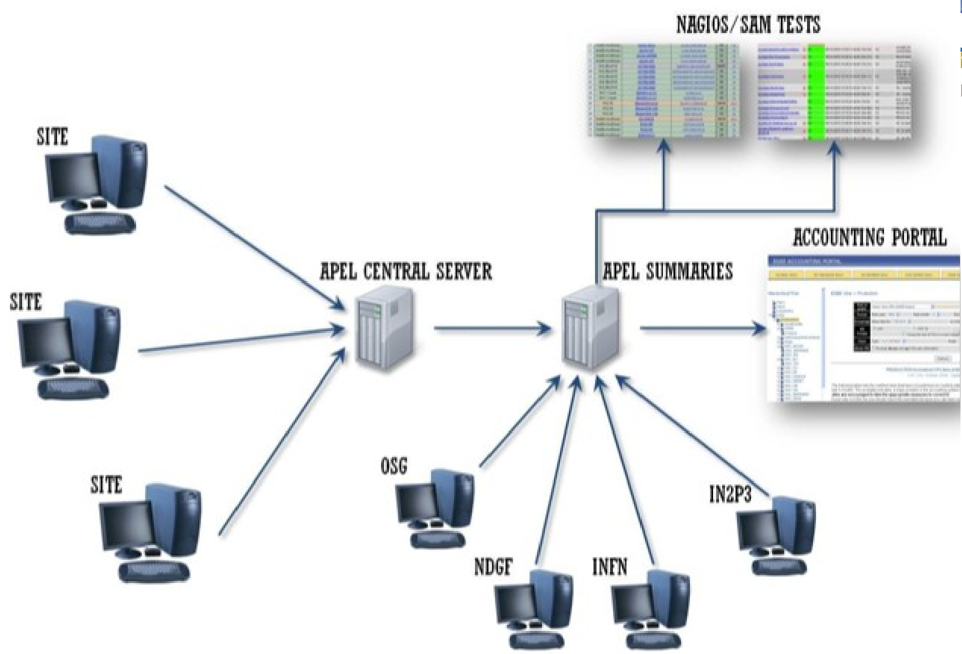
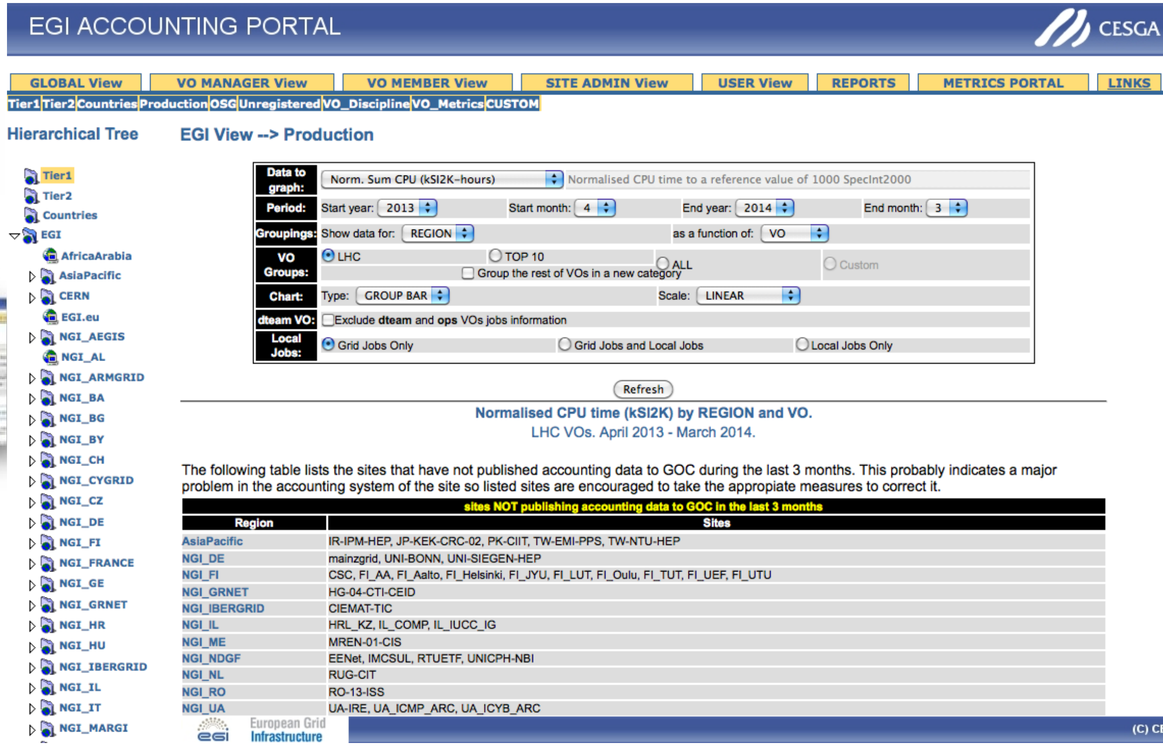
Publish
Publish
Storage Element
Logging & Book-keeping
Job Status
Computing Element
https://indico.in2p3.fr/conferenceDisplay.py?confId=6453

# Accounting

- Accounting for the computing and storage resources
  - Sites share VOs
  - MoU signed with “pledges”




http://accounting.egi.eu/egi.php