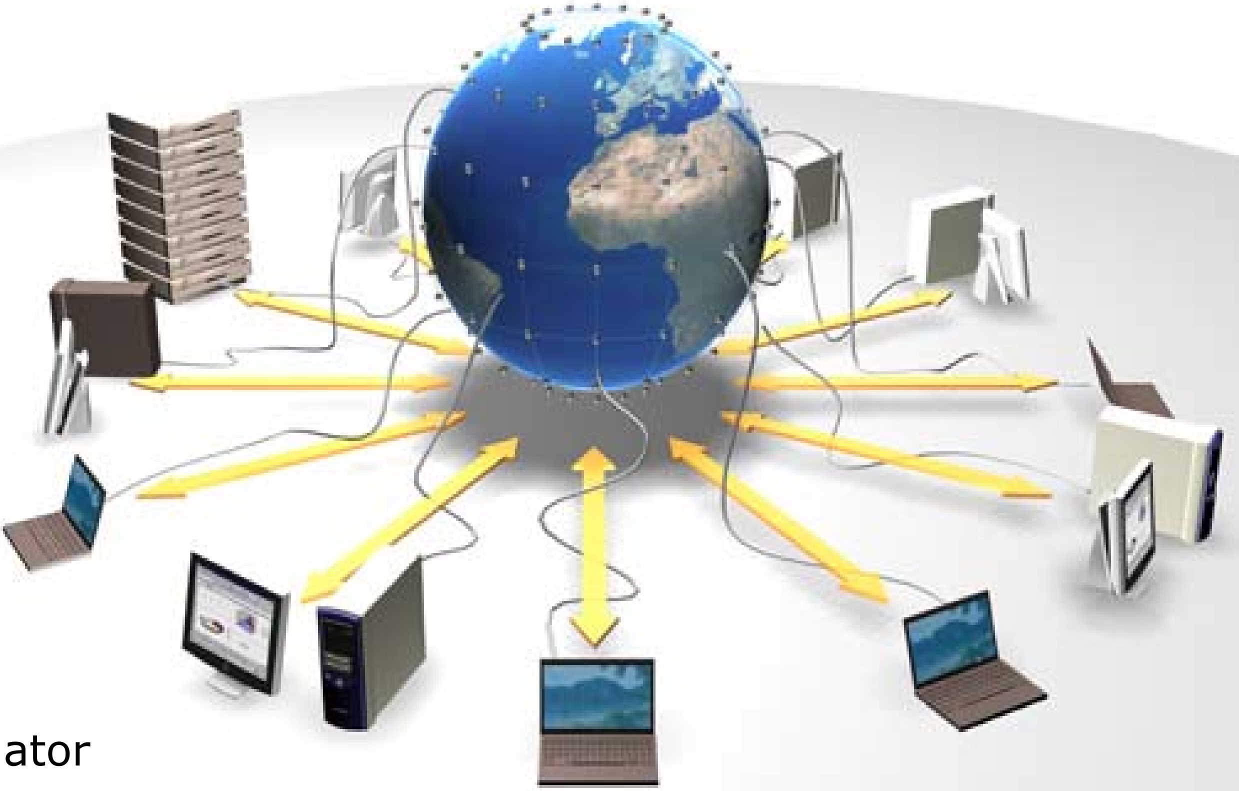
The EU DataGrid Project

Three years of research and development in Grid technologies



Erwin.Laure@cern.ch
DataGrid Technical Coordinator

DataGrid is a project funded by the European Commission
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Outline

- DataGrid at a glance
- A chronological overview
- DataGrid assets
- Lessons learned
- Summary

DataGrid at a glance

People

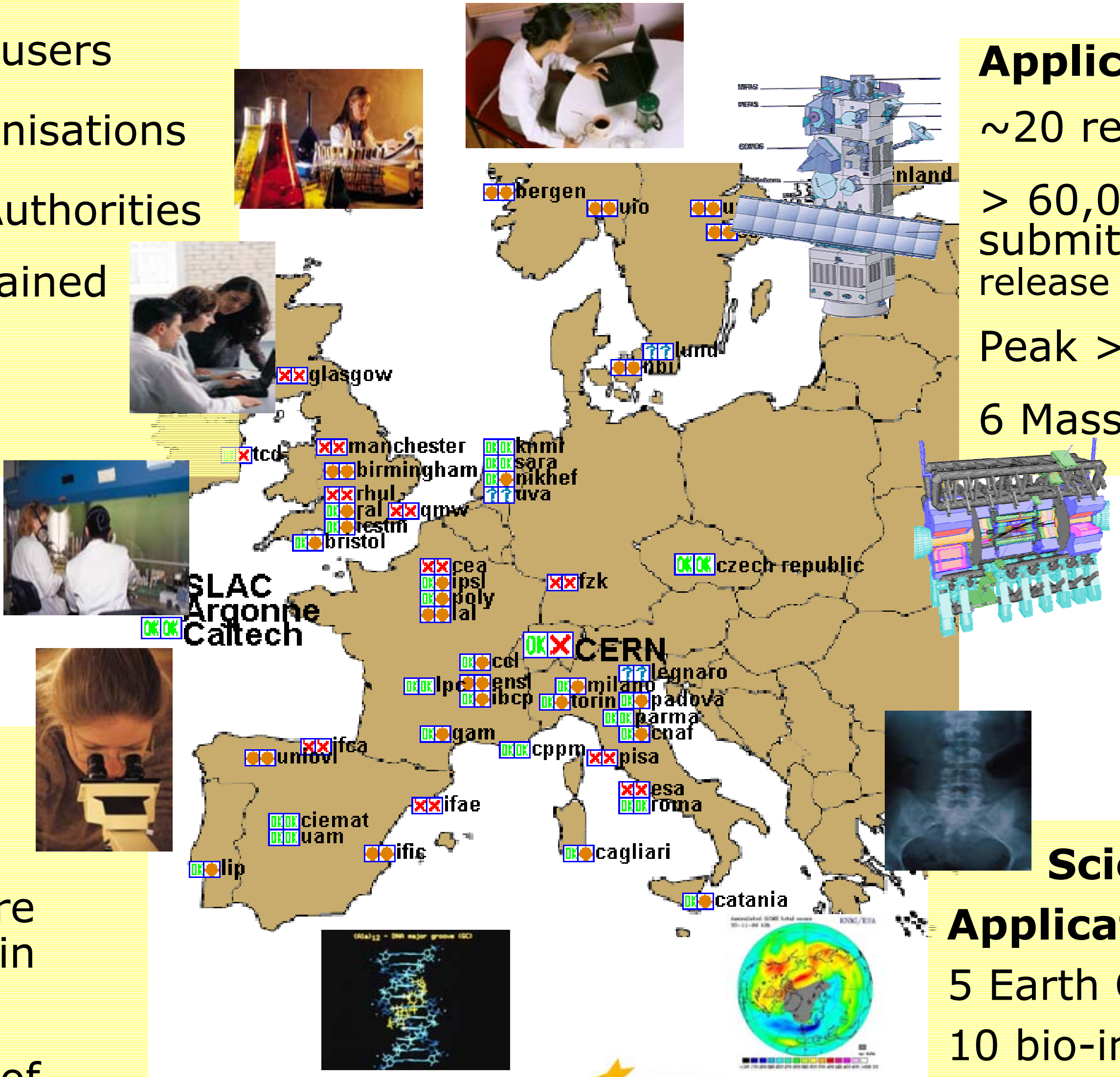
500 registered users

12 Virtual Organisations

21 Certificate Authorities

>600 people trained

456 man-years of effort
170 years funded



Application Testbed

~20 regular sites

> 60,000 jobs submitted (since 09/04, release 2.0)

Peak >1000 CPUs

6 Mass Storage Systems

Software

> 65 use cases

7 major software releases (> 60 in total)

> 1,000K lines of code

Scientific Applications

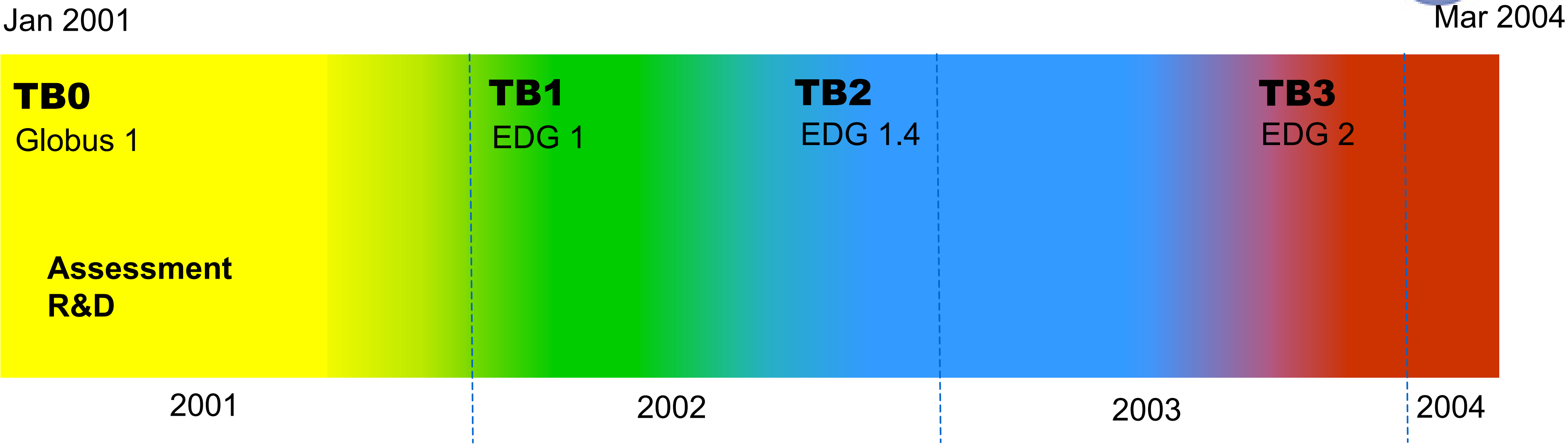
5 Earth Obs institutes

10 bio-informatics apps

6 HEP experiments

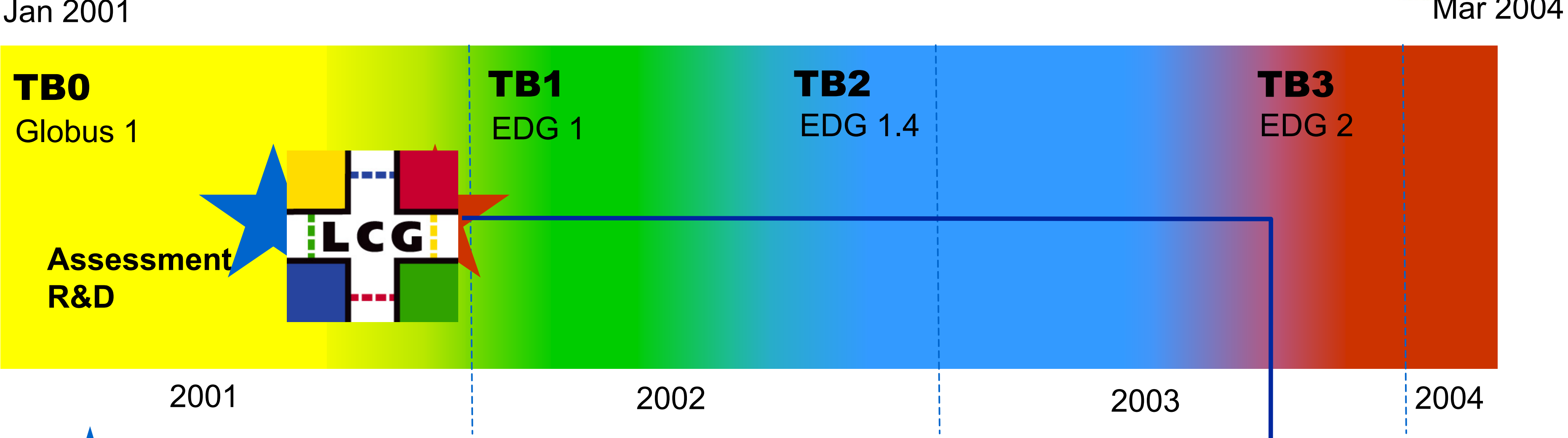
GEANT

Chronological overview



- Project started on Jan 1st 2001
- Early distributed testbed based on Globus 1
- CA infrastructure established
- Development of higher level Grid middleware started
  - Workload management ("Broker")
  - Data management (GDMP, edg-replica-manager, SE)
  - Information Services (R-GMA)
  - Fabric management (adopt LCFG)

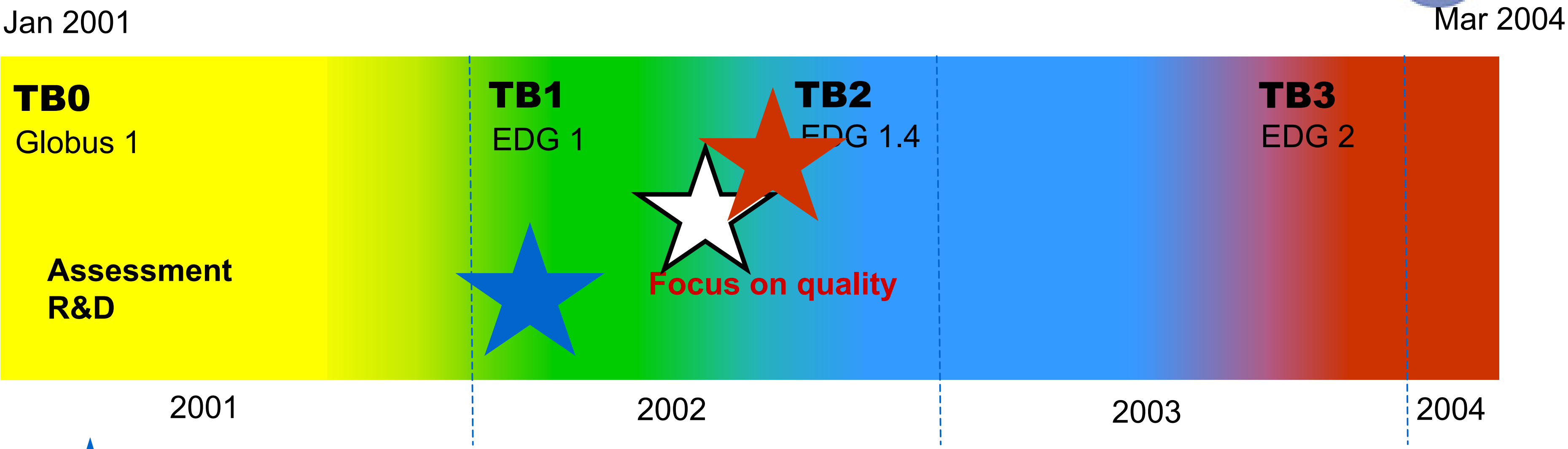
Chronological overview



- ★ Decided to base development on GT 2
  - Delayed rollout of TB1 (EDG v1.0)
- ★ TB1 deployed on 5 sites
  - CERN, NIKHEF, RAL, IN2P3, CNAF
- ◆ Application evaluation started
  - **1st HEP job run on TB1 on December 11th, 2001**

CERN launched LCG project in September 2001

Chronological overview



★ 1st EU review successfully passed on March 1st 2002

★ Evaluation by end users revealed the need to **focus on stability** rather than new functionality

- **Project retreat in August resulted in re-focus on quality**

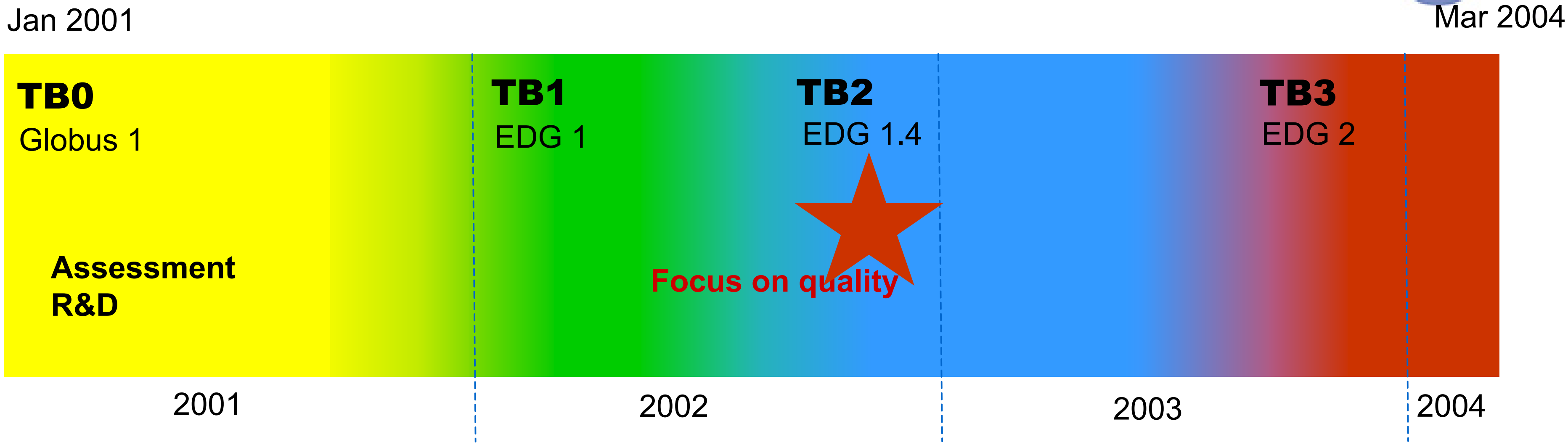
☆ **Open Source license** established in June 2002

- Served as model for globus and CrossGrid license

☆ Start of **tutorial program** in July 2002 (GGF5)

- Developed into a road-show with hands-on sessions; more than 600 people trained in over 25 events

Chronological overview



Jan 2001

Mar 2004

TB0
Globus 1

Assessment
R&D

TB1
EDG 1

TB2
EDG 1.4

Focus on quality

TB3
EDG 2

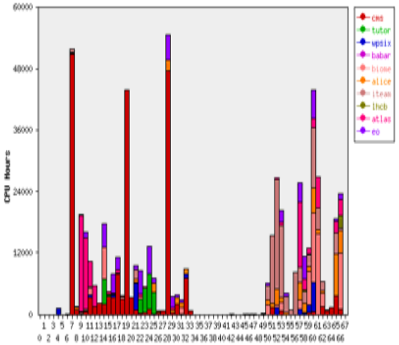
2001 2002 2003 2004

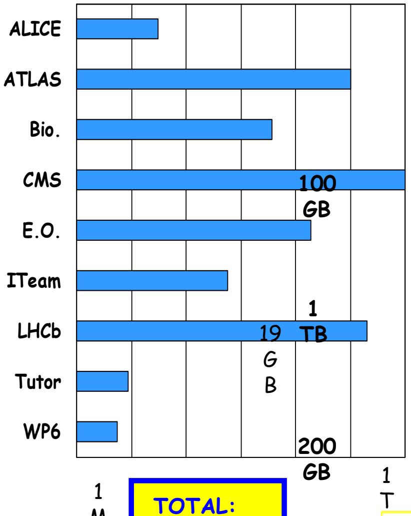
- EDG technologies widely recognized:
  - Many sites joined testbed (up to 20)
  - Software used and evaluated by other projects (e.g. CrossGrid, LCG)
  - Collaboration with sister projects demonstrated at **IST** and **SC**
- Testbed 2 (End 2002, release 1.4.x)
  - One of the largest Grid testbeds worldwide
  - Allowed first production tests by applications:
    - HEP monte-carlo simulation
    - EO grid portal developed
    - Many bio informatics applications

Evaluation of Release 1.4
(Dec 02/Jan 03)

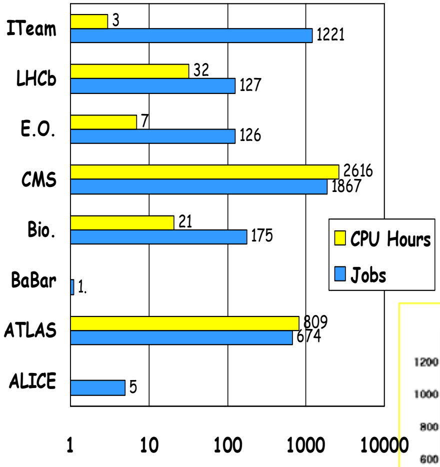
- Large increase in users
- Many sites interested in joining
- Pushing real jobs through system
- Stability and scalability not yet satisfactory
- Release 2.0 addresses the problems revealed

CPU Usage

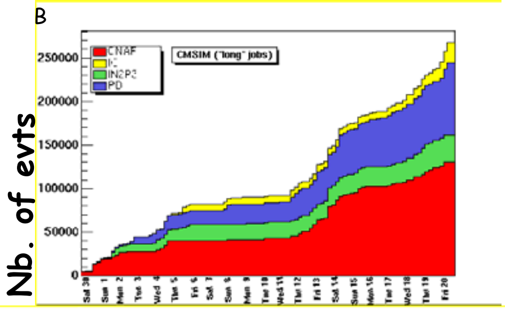


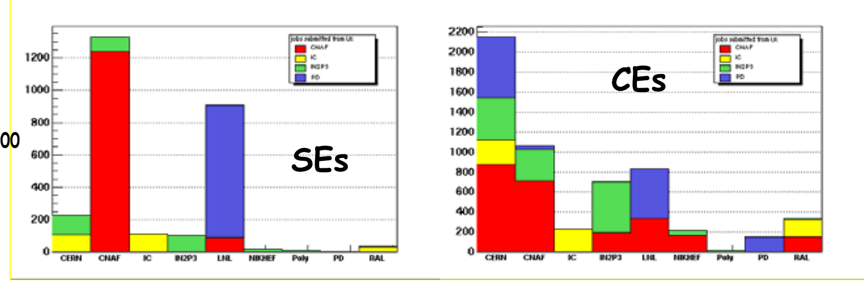


Disk Usage (CERN)

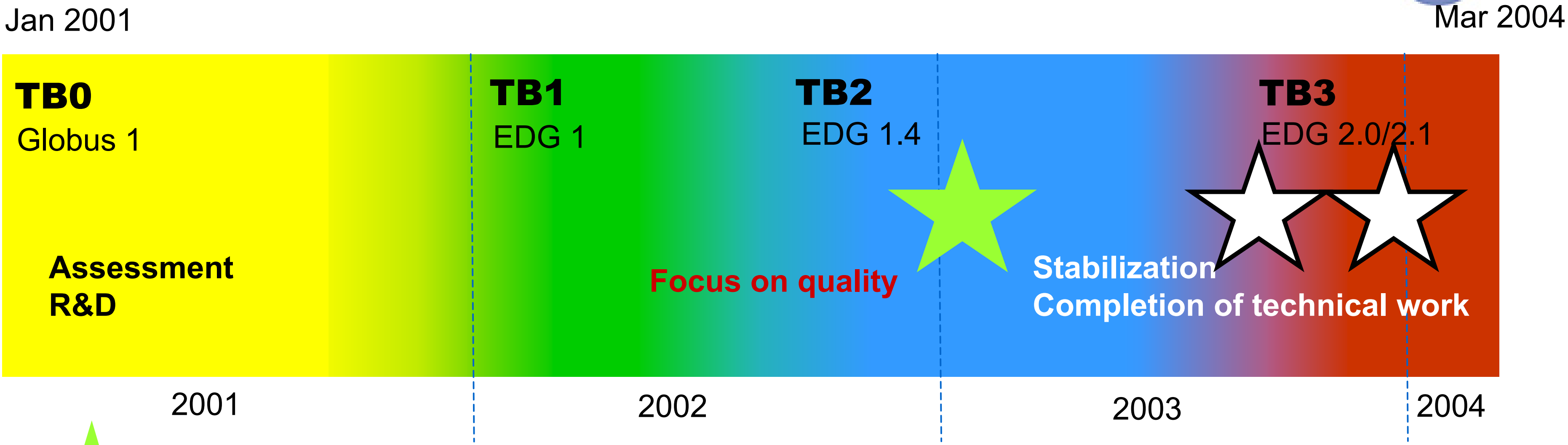


HEP Simulation





Chronological overview



Jan 2001

Mar 2004

TB0
Globus 1

Assessment
R&D

TB1
EDG 1

TB2
EDG 1.4

Focus on quality

TB3
EDG 2.0/2.1

Stabilization
Completion of technical work

2001 2002 2003 2004

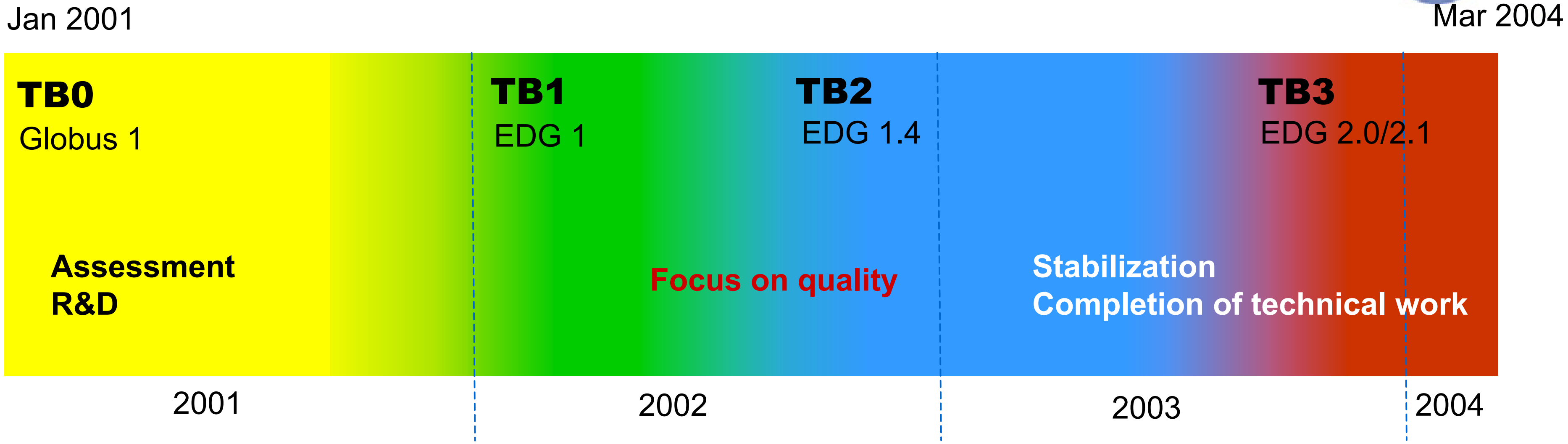
★ Successfully passed 2nd annual EU review on February 4-5

- Shortcomings identified in application tests adressed:
  - WMS re-factored
  - RLS introduced
  - Data management re-factored
  - R-GMA introduced
  - Storage Element (SE) introduced
  - VOMS based security
  - Fabric monitoring
  - Upgrade underlying software (move to VDT managed releases of Globus and CondorG

☆ Testbed 3 (release 2.x)

- Advanced functionality, better scalability and reliability
- **2.0 released end of August**
- **2.1 released in November**

Chronological overview



Jan 2001

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TB0
Globus 1

Assessment
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EDG 1

Focus on quality

TB2
EDG 1.4

Stabilization
Completion of technical work

TB3
EDG 2.0/2.1

2001

2002

2003

2004

- LCG deployed many components of EDG 2.0 in their LCG-1 service (started summer 2003) and subsequently EDG 2.1 components for LCG-2 (early 2004)
- Many other Grid projects started to use EDG software in 2003:
  - **Grace, grid.it, DutchGrid, UK e-Science programme, CERN's openlab, etc.**

DataGrid assets

- Large scale testbed continuously available throughout the project duration
  - Have gone further than any other project in providing a continuous, large-scale grid facility
- CA Infrastructure (21 CAs worldwide)
- Innovative middleware
  - Resource Broker
  - Replica Location Service and layered data management tools (Replica Manager & Optimizer)
  - R-GMA Information and Monitoring System
  - Automated configuration and installation tools
  - Access to diverse mass storage systems (StorageElement)
  - VOMS security model
- Distributed team of people across Europe that can work together effectively to produce concrete results
- Application groups are an integral part of the project contributing to all aspects of the work

Main lessons learned

- Applications need to be involved in all phases of the project
  - Grid middleware is relatively new and, despite all efforts, not yet “shrink-wrap” quality – requires skilled people to be used efficiently
  - Middleware prototypes need to be available for application testing early
    - Caveat: prototypes tend to stay longer than expected – more advanced software might be delayed.
- Cross-WP activities are essential and need to be coordinated
  - Application working group, architecture task force, integration team, security group, tutorial team, quality group.
- A sequence of (distributed) testbeds is needed
  - Developers need their own distributed testbed to test bleeding edge software
  - Managed integration/certification/application testbeds – eventually production infrastructure
- Site certification and validation needs to be automated and run regularly
  - Misconfigured sites may cause many failures
- Security needs to be an integrated part from the very beginning
  - Adding security to existing systems is hard
- Prompt hiring and retention of Personnel is critical

Summary

- **DataGrid as Grid Technology Innovator**
  - High level middleware developed in many areas (workload and data mgmt, information services, fabric mgmt)
- **DataGrid as Technology Provider**
  - Software taken up by many other Grid projects (LCG, Grace, CrossGrid, grid.it, DutchGrid, UK e-science, openlab, …)
  - Extensive training in more than 25 tutorials held in US, Europe, AP
  - Substantial contributions to standardization bodies like GGF
- **DataGrid as Demonstrator**
  - Successful evaluation of Grid technologies as production platform by High Energy Physics, Earth Observation, and Bioinformatics applications. This paved the way towards
- **Grid as next generation production infrastructure ⇒** egee