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Middleware Reengineering (JRA1)

Frédéric Hemmer, JRA1 Manager, CERN
On behalf of JRA1
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www.eu-egee.org

Information Society

Enabling Grids for E-sciencE

- **This presentation highlights the organization, processes and achievements of JRA1 (Middleware Engineering and Integration)**

  – Overview

  – Services

  – Processes & Tools

- **Provide robust, supportable middleware components**
  - Select, re-engineer, integrate identified Grid Services
  - Evolve towards Services Oriented Architecture
  - Adopt emerging OGSI standards[*]
  - Multiple platforms
- **Selection of Middleware based on requirements of**
  - The Applications (Bio & HEP)
    - In particular requirements from LCG's ARDA & HepCALII
  - The Operations
    - E.g. deployment, updates, packaging, etc..
- **Support and evolve the middleware components**
  - Evolution towards OGSI[*]
  - Define a re-engineering process
  - Address multiplatform, multiple implementations and interoperability issues
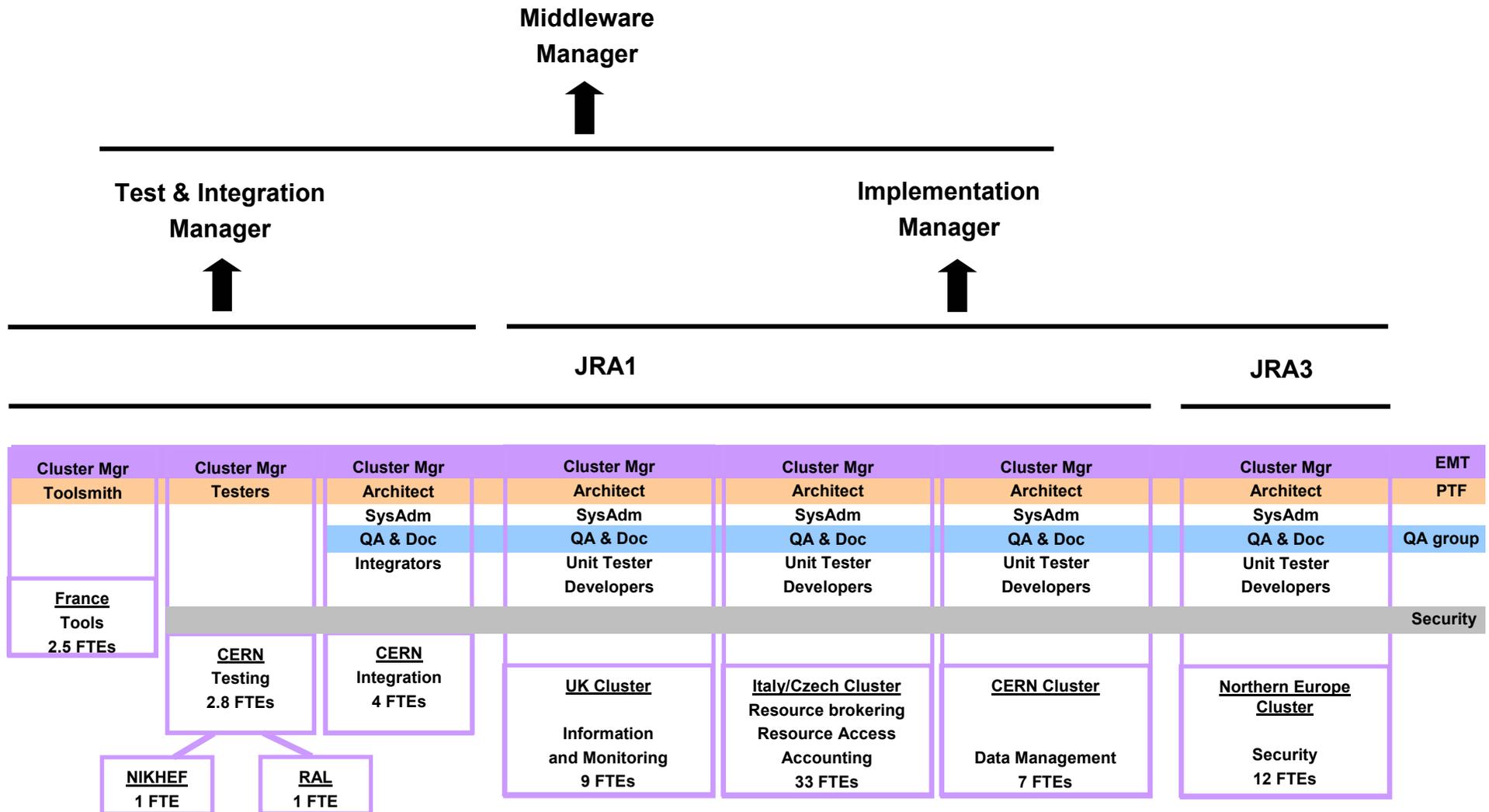 - Define defect handling processes and responsibilities

[*]: Challenged by the WSRF announcement on January 20, 2004. The strategy is to use plain Web Services (WS-I compliant) and review the situation when implementation(s) become available (GT4-WRSF::Lite).

Software Clusters

- **Hardening and re-engineering of existing middleware functionality, leveraging the experience of partners**

- **Activity concentrated in few major centers and organized in "Software clusters"**

- **Key services:**
  - Data Management (CERN)
  - Information and Monitoring (UK)
  - Resource Brokering, Accounting (Italy-Czech Republic)
  - Quality Assurance (France)
  - Grid Security (Northern Europe)
  - Middleware Integration (CERN)
  - Middleware Testing (CERN)

- Middleware Integration and Testing Centre
- Middleware Re-engineering Centre
- Quality and Security Centres

- **Clusters collaborate with US partners**
  - University of Chicago
  - University of Southern California
  - University of Wisconsin Madison

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Enabling Grids for E-sciencE

Middleware Manager

↑

Test & Integration Manager

Implementation Manager

↑   ↑

JRA1

JRA3

Cluster Mgr	Cluster Mgr	Cluster Mgr	Cluster Mgr	Cluster Mgr	Cluster Mgr	Cluster Mgr	EMT
Toolsmith	Testers	Architect	Architect	Architect	Architect	Architect	PTF
		SysAdm	SysAdm	SysAdm	SysAdm	SysAdm	
		QA & Doc	QA & Doc	QA & Doc	QA & Doc	QA & Doc	QA group
		Integrators	Unit Tester	Unit Tester	Unit Tester	Unit Tester	
			Developers	Developers	Developers	Developers	

Security

France						
Tools						
2.5 FTEs						

	CERN	CERN	UK Cluster	Italy/Czech Cluster	CERN Cluster	Northern Europe Cluster
	Testing	Integration		Resource brokering		
	2.8 FTEs	4 FTEs	Information	Resource Access		
			and Monitoring	Accounting	Data Management	Security
			9 FTEs	33 FTEs	7 FTEs	12 FTEs

NIKHEF	RAL
1 FTE	1 FTE

Middleware Reengineering

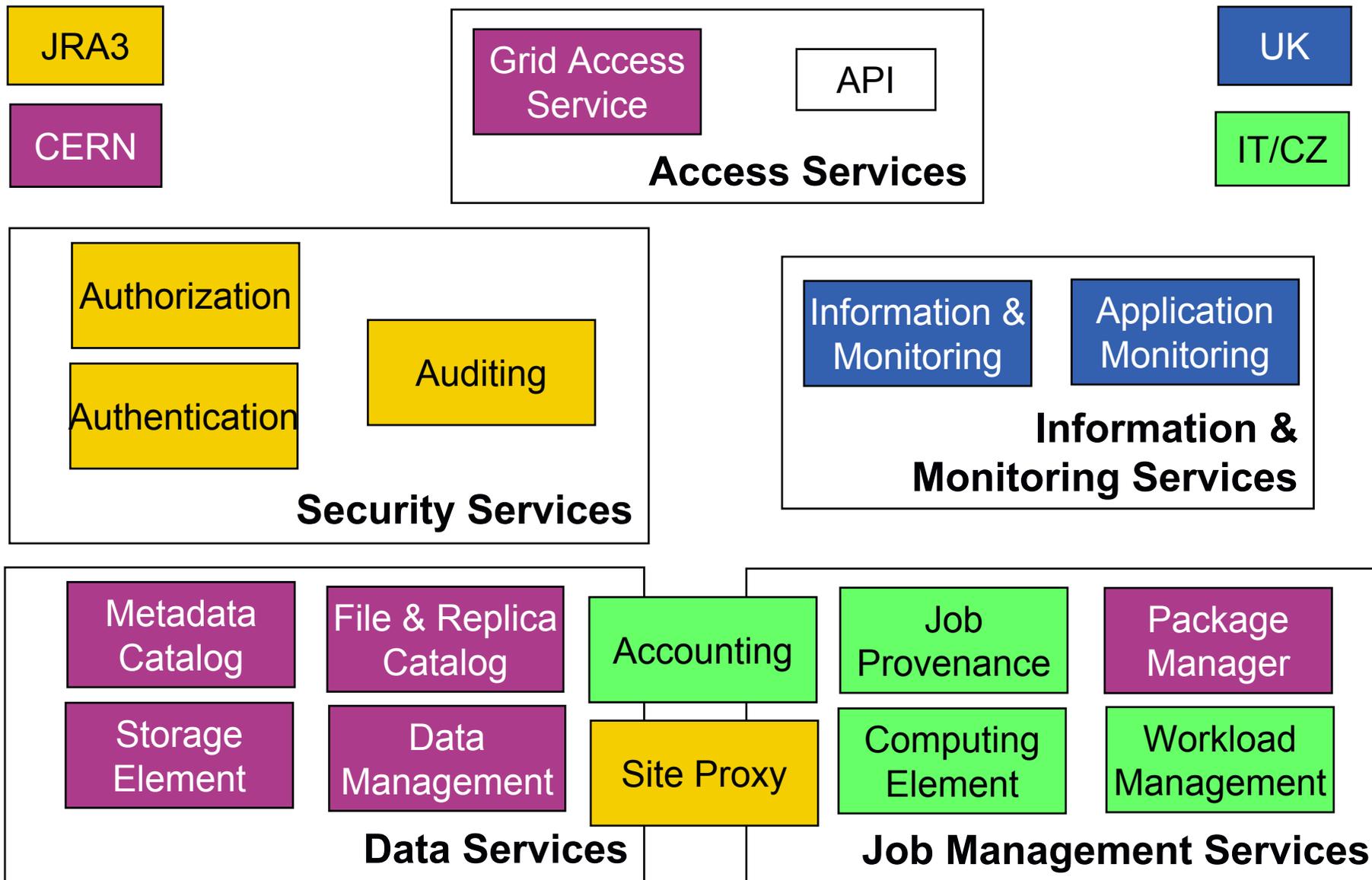*Services*

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Enabling Grids for E-sciencE

- **Lightweight (existing) services**
  - Easily and quickly deployable
  - Use existing services where possible
    - Condor, EDG, Globus, LCG, …
  - Interoperability
- **Performance/Scalability & Resilience/Fault Tolerance**
  - Large-scale deployment and continuous usage
  - Comparable to deployed infrastructure
- **Portable**
  - Being built on Scientific Linux and Windows
- **Co-existence with deployed infrastructure**
  - Reduce requirements on participating sites
  - Flexible service deployment
    - Multiple services running on the same physical machine (if possible)
  - Co-existence with LCG-2 and OSG (US) are essential for the EGEE Grid services
- **Security**

| VDT | EDG | . . . |

| AliEn | LCG | . . . |

gLite
Lightweight Middleware for Grid Computing
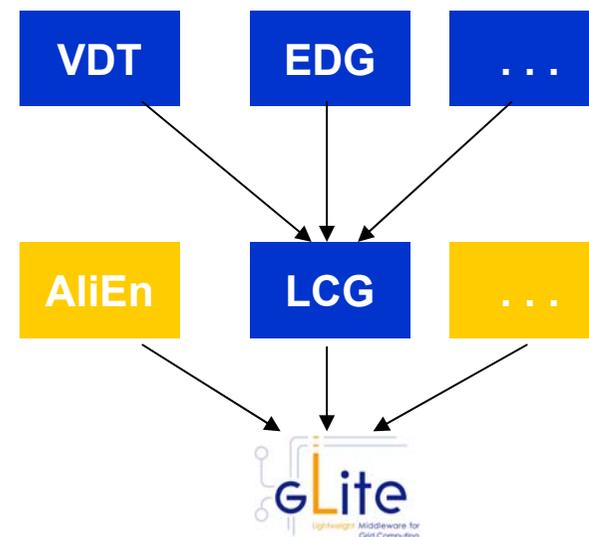
- **Service oriented approach**
  - Allow for multiple implementations
  - Follow WSRF standardization
  - No mature WSRF implementations exist to-date so start with plain WS
    - WSRF compliance is not an immediate goal, but we follow the WSRF evolution
    - WS-I compliance is important
- **Site autonomy**
  - Reduce dependence on 'global, central' services
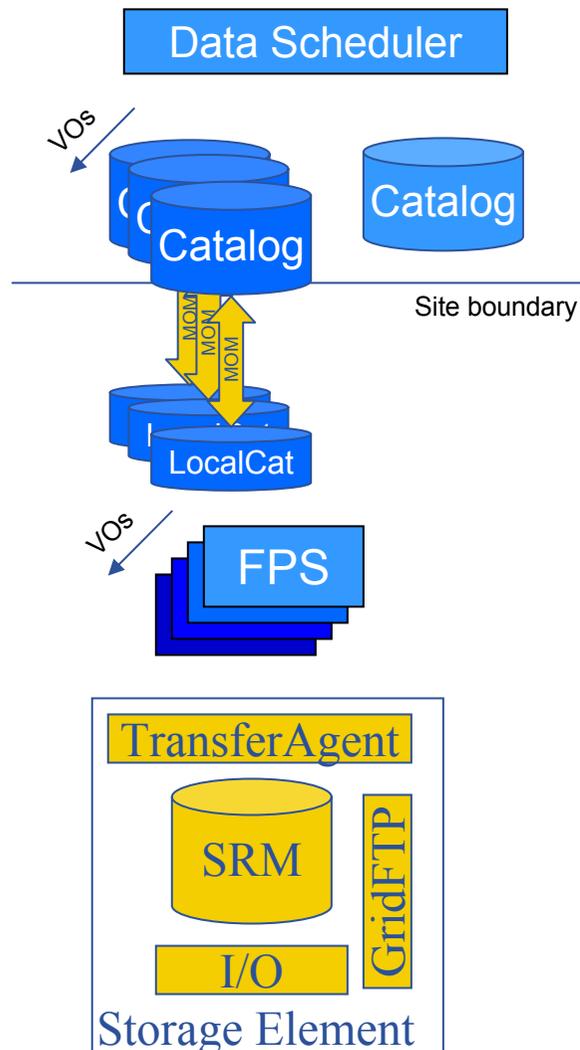- **Open source license**

Enabling Grids for E-sciencE

- **Design team** including representatives from Middleware providers (AliEn, Condor, EDG, Globus,…) including US partners produced middleware architecture and design.

- **Takes into account input and experiences from applications, operations, and related projects**

- **DJRA1.1 – EGEE Middleware Architecture (June 2004)**
  - https://edms.cern.ch/document/476451/

- **DJRA1.2 – EGEE Middleware Design (August 2004)**
  - https://edms.cern.ch/document/487871/

- **Much feedback from within the project (operation & applications) and from related projects**
  - Being used and actively discussed by OSG, GridLab, etc. Input to various GGF groups

JRA3

CERN

UK

IT/CZ

Access Services

Grid Access Service

API

Security Services

Authorization

Authentication

Auditing

Information & Monitoring Services

Information & Monitoring

Application Monitoring

Data Services

Metadata Catalog

File & Replica Catalog

Storage Element

Data Management

Accounting

Site Proxy

Job Management Services

Job Provenance

Package Manager

Computing Element

Workload Management

- **Efficient and reliable scheduling of computational tasks on the available infrastructure**

- **Started with LCG-2 Workload Management System (WMS)**
  - Inherited from EDG
  - Support partitioned jobs and jobs with dependencies
  - Support for different replica catalogs for data based scheduling
  - Modification of internal structure of WMS
    - Task queue: queue of pending submission requests
    - Information supermarket: repository of information on resources
    - Better reliability, better performance, better interoperability, support push and pull mode
  - Under development
    - Web Services interface supporting bulk submission (after V1.0)
      - *Bulk submission supported now by use of DAGs*
    - Distributed superscheduling (interaction among multiple WMSs)

Enabling Grids for E-sciencE

- **Computing Element (CE)**
  - Service representing a computing resource
    - CE moving towards a VO based local scheduler
    - Incorporates new technologies provided by Condor and Globus
  - Web service interfaces
    - job management requests (run, cancel, suspend, resume, …)
      - *Still under development*
    - Policy based notifications on changes of the CE (pull model)

- **Job Provenance**
  - Keeps track of definition of submitted jobs, execution conditions and job life cycle for a long time

- **Grid Accounting (DGAS)**
  - Accumulates Grid accounting information about the usage of Grid resources by users / groups (e.g. VOs) for billing and scheduling policies.

- **VOMS**
  - Virtual Organization Membership Service

- **Advanced Reservation service under development**

- **Assured backward compatibility (to facilitate migration from current SA1 infrastructure)**

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Enabling Grids for E-sciencE

- **Efficient and reliable data storage, movement, and retrieval on the infrastructure**

- **Storage Element**
  - Reliable file storage (SRM proposed standard based storage systems)
  - Posix-like file access (gLite I/O)
  - Transfer (gridFTP)
- **File and Replica Catalog**
  - Resolves logical filenames (LFN) to physical location of files (URL understood by SRM) and storage elements
  - Hierarchical File system like view in LFN space
  - Single catalog or distributed catalog (under development) deployment possibilities
- **File Transfer and Placement Service**
  - Reliable file transfer and transactional interactions with catalogs
- **Data Scheduler**
  - Scheduled data transfer in the same spirit as jobs are being scheduled taking into account e.g. network characteristics (collaboration with JRA4)
  - Under development
- **Metadata Catalog**
  - Limited metadata can be attached to the File and Replica Catalog
  - Interface to application specific catalogs have been defined

Enabling Grids for E-sciencE

Data Scheduler

VOs

Catalog

Catalog

Catalog

MOM

MOM

MOM

Site boundary

LocalCat

VOs

FPS

TransferAgent

SRM

GridFTP

I/O

Storage Element

- **Storage Elements are managed by Site administrators and serve many VOs.**

- **File Placement Service is deployed per site per VO.**

- **There are only a few Data Schedulers, not every site needs one.**

- **Catalogs may be deployed in a distributed manner (Local Catalogs at each site, Global Catalogs (Indices) at 'large' sites). Communication through Message Oriented Middleware.**

- **A VO may choose to set up the Catalog as a single central instance.**

- **Efficient and reliable provision of Grid information and Grid and Application monitoring data**

- **R-GMA (Relational Grid Monitoring Architecture)**
  - Implements GGF GMA standard
  - Development started in EDG, deployed production infrastructure for accounting

Enabling Grids for E-sciencE
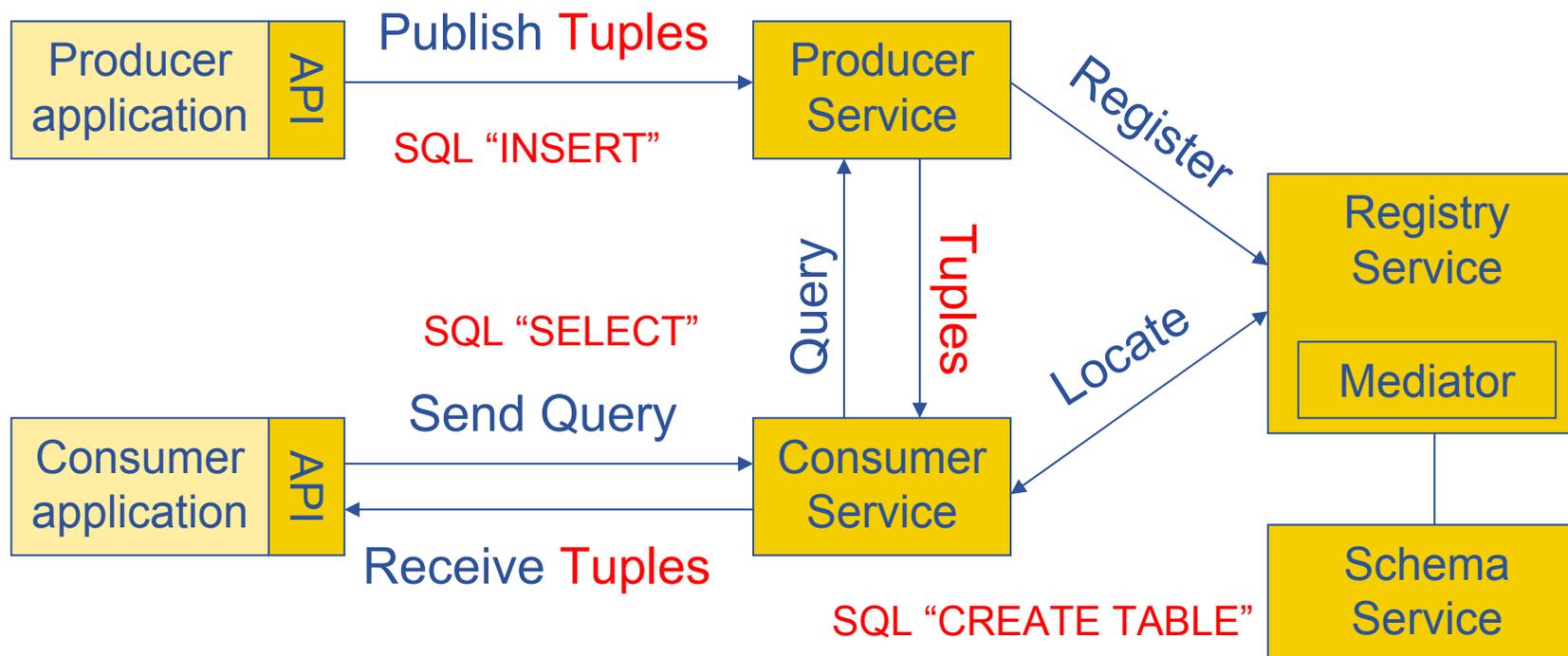
- **Producer, Consumer, Registry and Schema services with supporting tools**
  – Registry replication
  – Simpler API – matching the next (WS) release
    ▪ Provides smooth transition between old API and WS
  – A lot of work has gone into avoiding problems caused by poorly configured networks, firewalls, MySQL corruptions etc – i.e. coping with life on the Grid
  – Some predefined indices for performance

- **Generic Service Discovery API**

- **Under development**
  – Web Service version
  – File (as well as memory and RDBMS) based Producers
  – Native python interface
  – Fine grained authorization
  – Schema replication

- **Prototypes of Grid Access Service and Package Manager implemented in the AliEn framework**

- **Grid Access Service**
    - Acts on user's behalf
    - Discovers and manages Grid services for the user

- **Package Manager**
    - Provides dynamically distribution of application software needed
    - Does not install Grid middleware

Enabling Grids for E-sciencE

- **Job Management Services**
  - WMS, LB, and CE implement authorization based on ~~~ s VO, groups, and user information
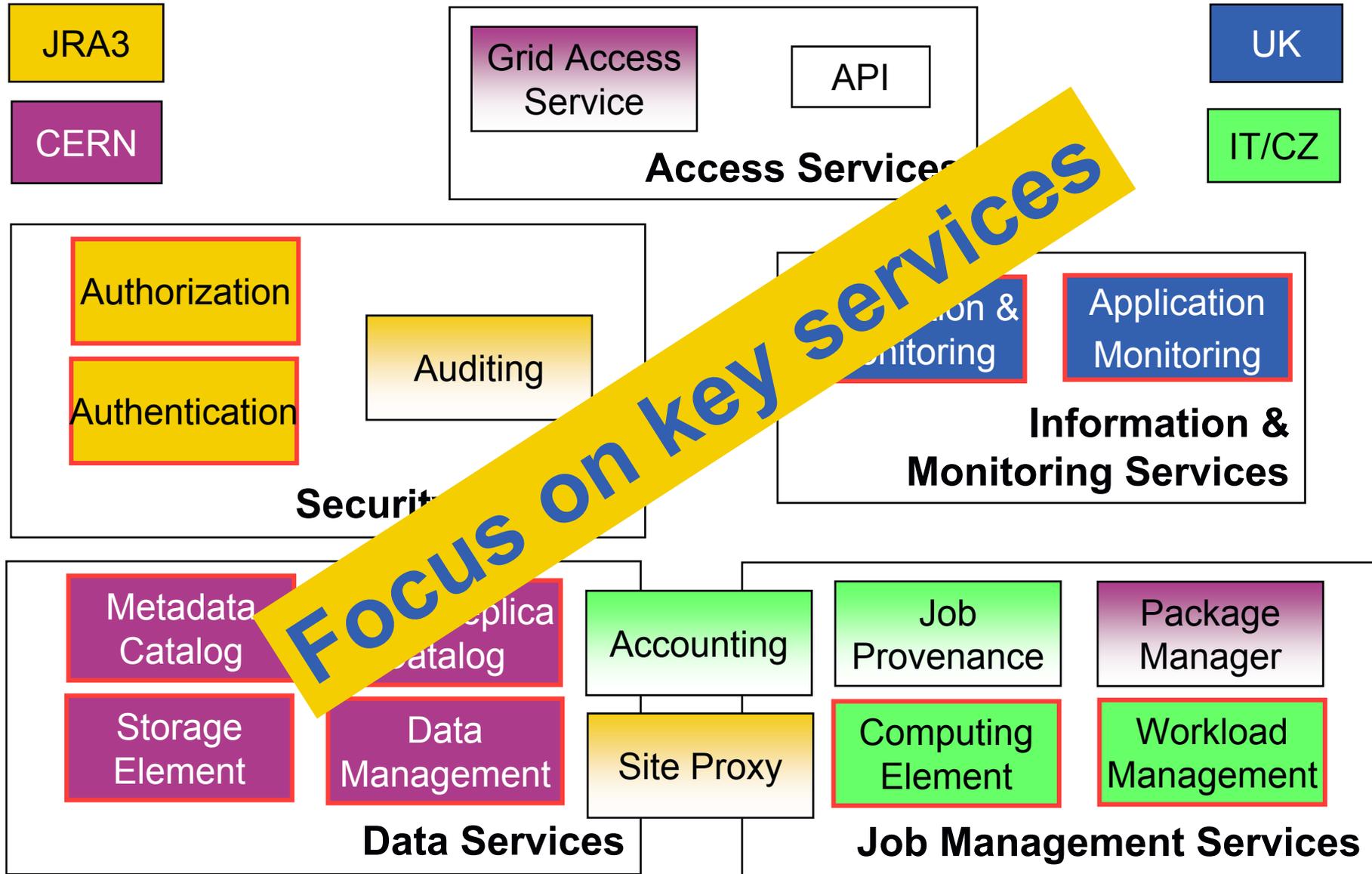
- **Data Services**
  - Authorization: ACL and (Unix) ~~~ ons
  - Fine-grained ACL on data ~~~ through gLite-IO and Catalogs
  - Catalog data itself ~~~ orized through ACLs
    - Currently s ~~~ through DNs
    - VOMS ~~~ tion being developed

- **In~~~tion Services**
  - ~~~ne grained authorization based on VOMS certificates being implemented

Following talk by Ake Edlund will give more details

JRA3

CERN

UK

IT/CZ

Grid Access Service

API

Access Services

Authorization

Authentication

Auditing

Security

Application Monitoring

Information & Monitoring Services

Focus on key services

Metadata Catalog

Replica Catalog

Storage Element

Data Management

Data Services

Accounting

Site Proxy

Job Provenance

Package Manager

Computing Element

Workload Management

Job Management Services

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Enabling Grids for E-sciencE

- **Workload Management System** works in push and pull mode

- **Computing Element** moving towards a VO based scheduler guarding the jobs of the VO (reduces load on GRAM)

- Distributed and re-factored **file & replica catalogs**

- **Secure catalogs** (based on user DN; VOMS certificates being integrated)

- Scheduled **data transfers**

- **SRM** based storage

- **Information Services:**
  R-GMA with improved API and
  registry replication

- **Prototypes of additional services**
  – Grid Access Service (GAS)
  – Package manager
  – DGAS based accounting system
  – Job provenance service

- **Move towards Web Services**

gLite

Lightweight Middleware for Grid Computing

Enabling Grids for E-sciencE

- **Web Services Fast moving area**
  - Follow WSRF and related standards but are not early adopters
  - WS-I compatibility is a target
    - Challenging to write WSDL which is WS-I compatible AND can be processed by all the tools
  - Industry strength tooling not always available
  - Trying to keep back from the bleeding edge

- **Work on standards bodies**
  - Active contributions to
    - GGF OGSA-WG
      - *GMA in OGSA*
      - *Data Design team*
    - GGF INFOD-WG
    - OASIS WS-N
    - GGF GSM-WG (SRM)
      - *Co-chairing WG*
    - Replica Registration Service
  - And following many, many others
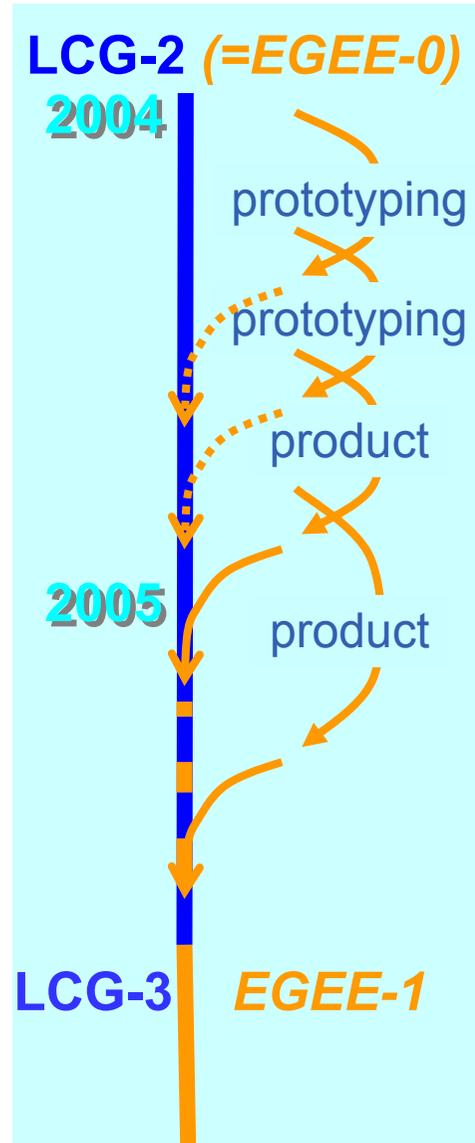 - Adopting mature standards is a goal

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Middleware Reengineering

Processes and tools

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Enabling Grids for E-sciencE

LCG-2 *(=EGEE-0)*

2004

prototyping

prototyping

product

2005

product

LCG-3 *EGEE-1*

- **Fast prototyping** approach allowing end users for rapid feedback

- **Provide individual components to SA1 for deployment on the pre-production service**
  - See Markus Schulz talk on Certification and Deployment process

- **These components need to go through integration and testing**
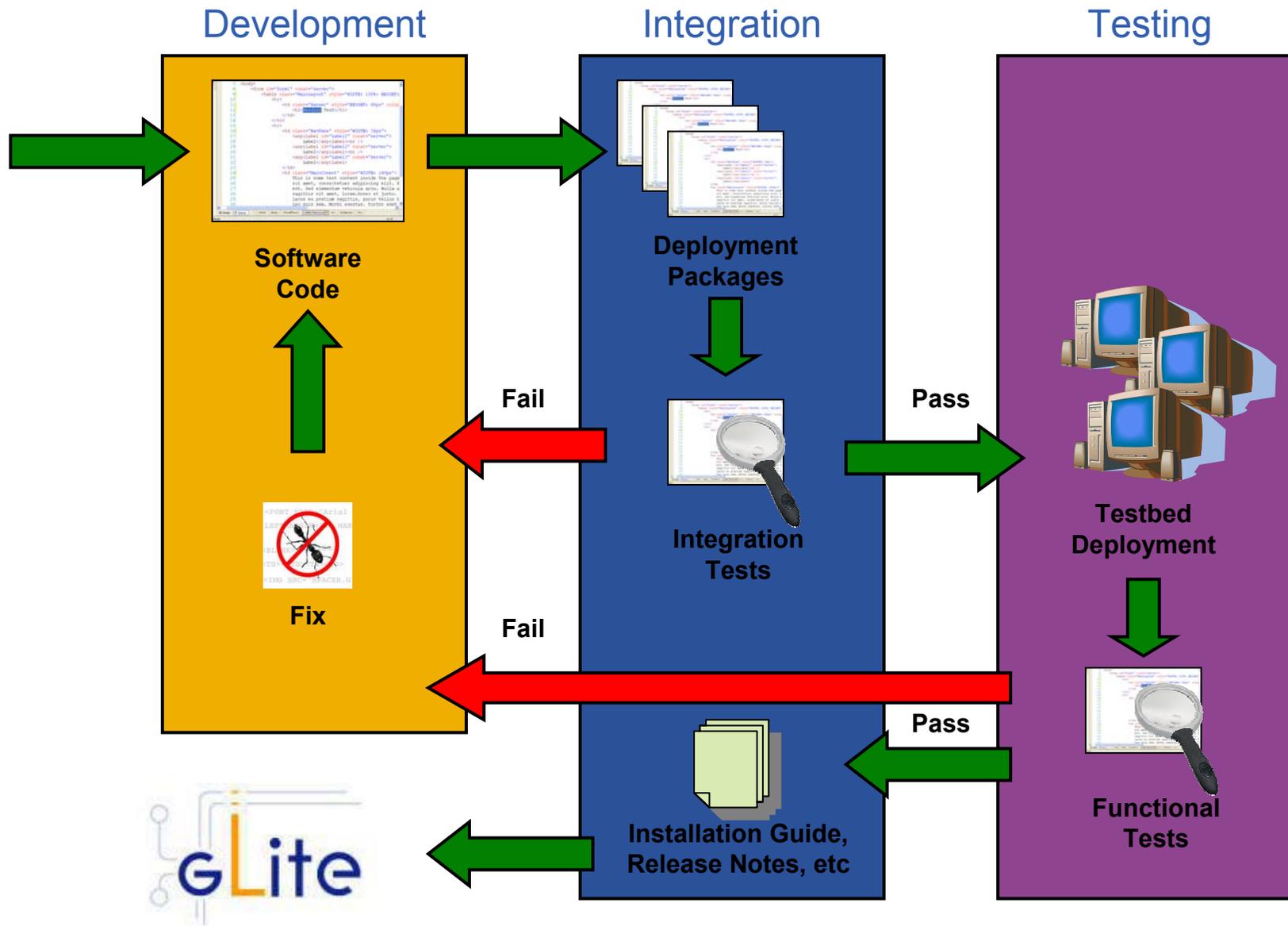 - To ensure they are deployable and basically work

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- **Started an early prototyping activity (was not in the original workplan) on applications request**
    - Small scale testbed
        - CERN, Univ. Wisconsin later also INFN and NIKHEF
        - Started with only 3 WNs, now 35 WNs (further expansion planned)
    - Many ideas of architecture & design inspired by AliEn system hence
    - Started from AliEn with additional components successively added
    - Get user feedback on service semantics and interfaces
        - HEP ARDA project
        - Biomed applications

    - ~70 users registered

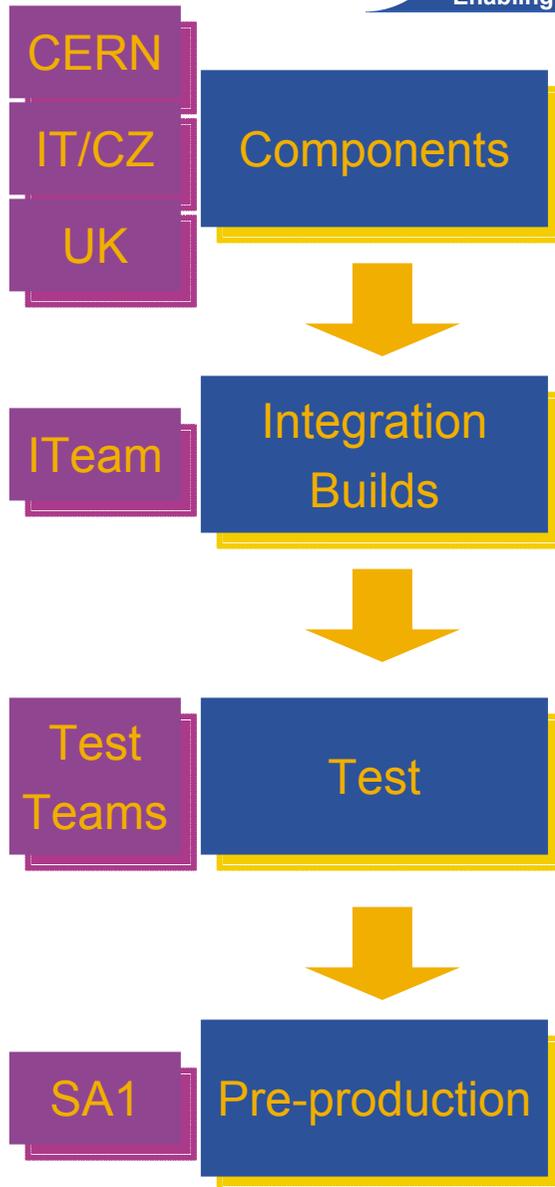   - Second VO has been set up (core services at Wisconsin)
        - Uses Globus RLS

- **JRA1 Software Process is based on an iterative method**

- **It comprises two main 12-month development cycles divided in shorter *development-integration-test-release* cycles lasting 1 to 4 weeks**

- **The two main cycles start with full Architecture and Design phases, but the architecture and design are periodically reviewed and verified.**

- **The process is fully documented in a number of standard documents:**
    - Software Configuration Management Plan
    - Test Plan
    - Quality Assurance Plan
    - Developer's Guide

- **The SCM Plan is the core document of the Software Process**

- **It contains a description of the processes and the procedures to be applied to the six SCM activity areas:**
    - Software Configuration and Versioning, tagging and branching conventions
    - Build Systems
    - Release Process
    - Change Control and the Change Control Board (CCB)
    - Bug Tracking
    - Process Auditing and QA Metrics
- **It is based on a number of standard methods and frameworks including:**
    - ISO 10007:2003 - Quality management systems -- Guidelines for configuration management, ISO, 2003
    - IEEE Software Engineering Guidelines (http://standards.ieee.org/reading/ieee/std/se)
    - The Rational Unified Process (http://www-306.ibm.com/software/awdtools/rup)
- **Standard best-practice solutions[1] have been adopted**

[1]S.P. Berczuk, Software Configuration Management Patterns, Software Patterns Series, Addison-Wesley, 2002
A. Di Meglio et al., A Pattern-based Continuous Integration Framework for Distributed EGEE Grid Middleware Development, Proc. CHEP 2004

Enabling Grids for E-sciencE

Development

Software Code

Fix

Integration

Deployment Packages

Integration Tests

Installation Guide, Release Notes, etc

Testing

Testbed Deployment

Functional Tests

Fail

Pass

Fail

Pass

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CERN

IT/CZ

UK

Components

ITeam

Integration Builds

Test Teams

Test

SA1

Pre-production

Developers announce every Friday what components are available for a release according to the development plan. Components are tagged, list is sent to Integration Team

ITeam put together all components, verifies consistency and dependencies and add/update the service deployment modules (installation and configuration scripts). The build is tagged as IyyyyMMdd

The integrated build is deployed in the testbeds and validates with functional and regression tests, test suites are updated, packaged and added to the build.

If the build is suitable for release, release notes and installation guides are updated, the build is retagged (RCx, v.0.x.0) and published on the gLite web site for release to SA1

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- **Several QA and SCM Metrics are mandated by the SCM and QA Plans**

- **Metrics are calculated periodically and published on the gLite web site**

- **Total complete builds done: 180**

- **Number of subsystems: 10**
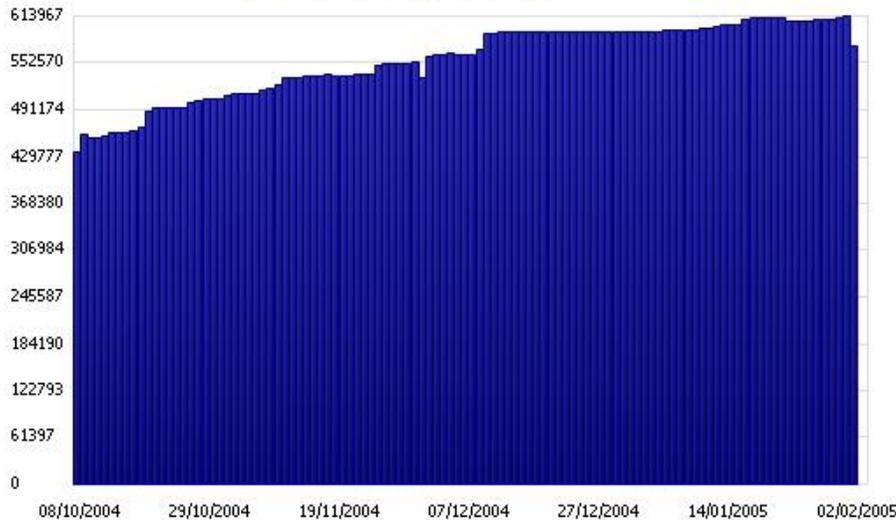
- **Number of CVS modules: 235**

Enabling Grids for E-sciencE

Total Physical Source Lines of Code (SLOC)

- **SLOC = 574487 (as of 2 February 2005)**

Total SLOC by language (dominant language first)
- **C++**   **174903 (30.45%)**
- **Java**   **169019 (29.42%)**
- **Ansi C**   **133296 (23.20%)**
- **Perl**   **60972 (10.61%)**
- **Python**   **19364 (3.37%)**
- **sh**   **12012 (2.09%)**
- **Yacc**   **3635 (0.63%)**
- **jsp**   **640 (0.11%)**
- **Lex**   **335 (0.06%)**
- **csh**   **217 (0.04%)**

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Enabling Grids for E-sciencE

Code Size (SLOC)

The Code Size chart shows the changes in total number of SLOCs during the life of the project
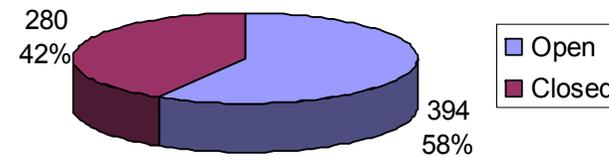
The Code Stability chart shows the change rate of code size during the life of the project.
As the project nears completion the rate should approach 0
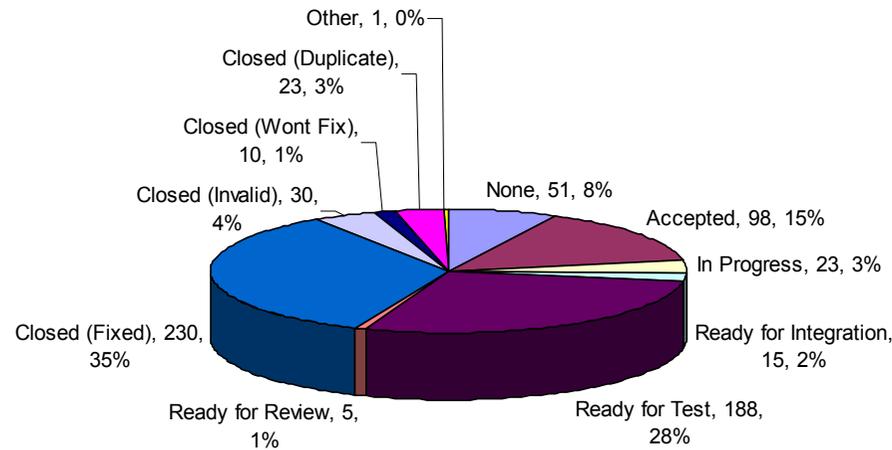
Code Stability (dSLOC/dt)

Total open/closed bugs
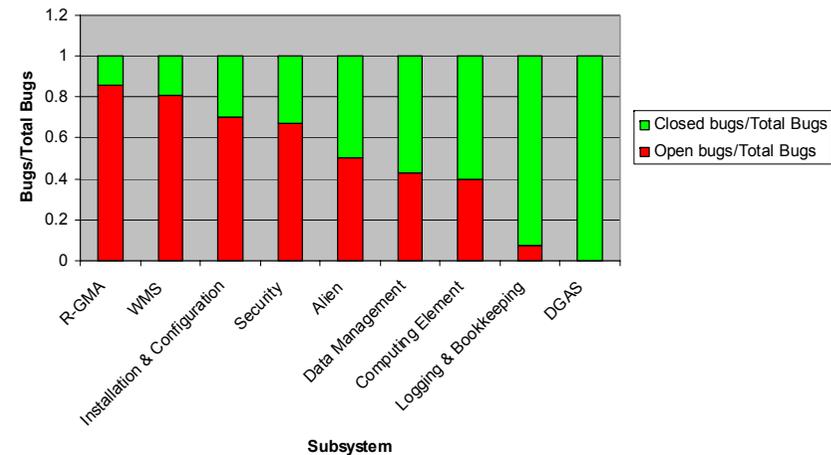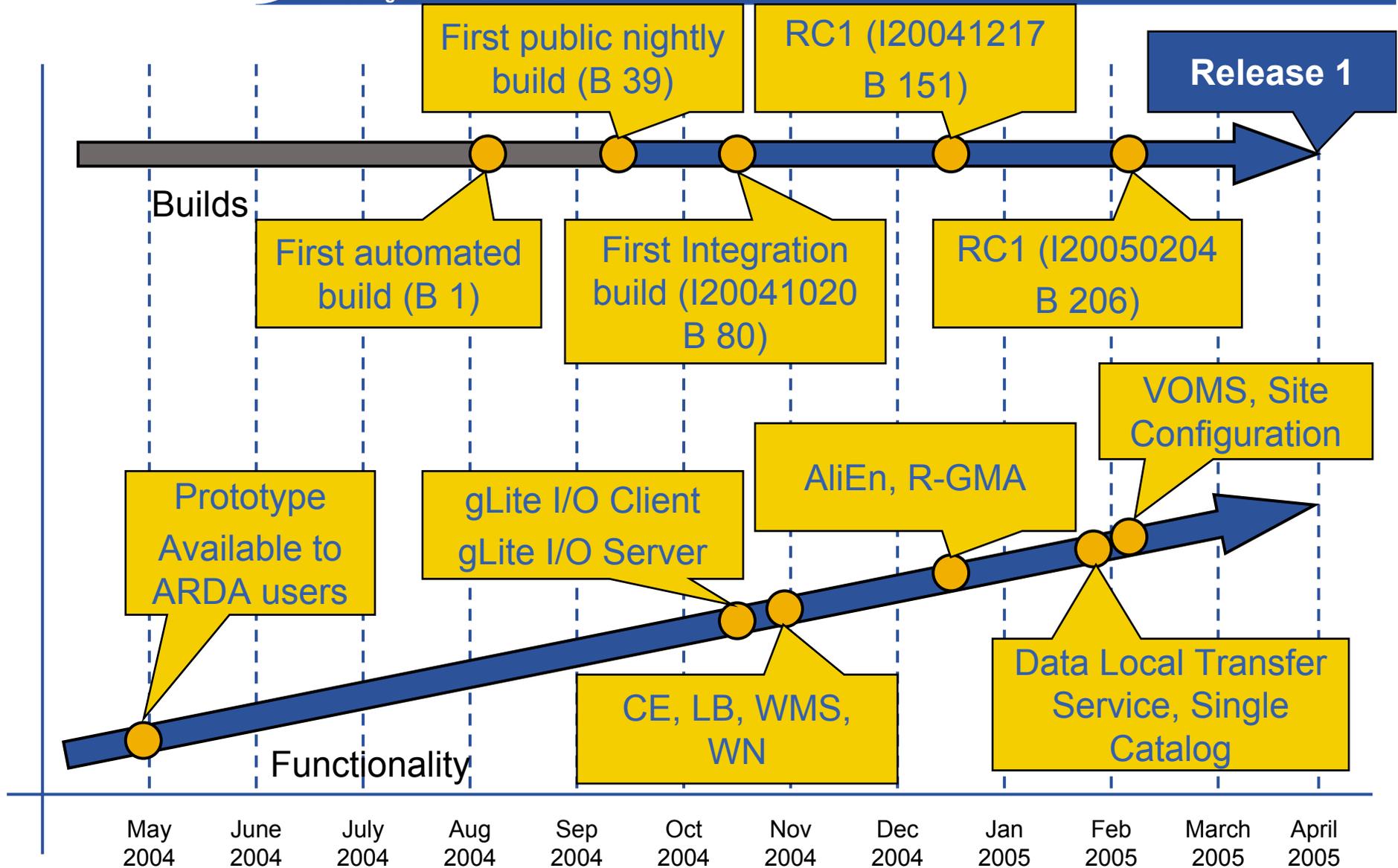**(Total = 674)**

Bugs by status

Relative bug status

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Builds

First public nightly build (B 39)

RC1 (I20041217 B 151)

Release 1

First automated build (B 1)

First Integration build (I20041020 B 80)

RC1 (I20050204 B 206)

VOMS, Site Configuration

AliEn, R-GMA

Prototype Available to ARDA users

gLite I/O Client gLite I/O Server

CE, LB, WMS, WN

Data Local Transfer Service, Single Catalog

Functionality

May 2004	June 2004	July 2004	Aug 2004	Sep 2004	Oct 2004	Nov 2004	Dec 2004	Jan 2005	Feb 2005	March 2005	April 2005

- **The process is documented in the Test Plan document (https://edms.cern.ch/document/473264)**
    - Organization of the testing activity: members and infrastructure
    - Features tested
    - Testing environment
    - Test methodologies and phases
    - Test development and execution
    - Schedule
    - Relationship with other testing activities
- **Distributed testbed, 3 sites, different variations of RH Enterprise Linux**
    - CERN: 20 machines
    - NIKHEF: 6 machines
    - RAL: 6 machines
- **Testing activities are coordinated with NA4 and SA1**

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Test suites for core components available:

- **Job Management**
  - The LCG WMS test suite (a part of the LCG certification test suite) has been ported, packaged and documented in collaboration with LCG to work with the gLite job submission components. Test suite and report will be included in the I20050128 release.
  - Regression and stress tests being developed

- **Data Management**
  - Testing done in collaboration of ARDA
  - gLite I/O: Basic functional test suite exists, including regression and stress test cases. Run after each release. Test suite and report included in the release.
  - FPS: test suite being developed
  - Catalog: test suite being developed

- **R-GMA**
  - Test cases defined; test suite being implemented

- **Security**
  - Test cases being worked out

- **When available, in collaboration with LCG Software Process Infrastructure (SPI)**
  - Avoiding duplication of efforts and tools
    - Used by many EGEE activities and other projects
  - Savannah
    - Bug tracking
    - Task Management
    - Automatic Generation of QA reports
  - CVS
    - Code repository
    - Change tracking and control
  - QMTest, CppUnit, pyUnit (Testing tools)
  - CodeWizard (Code checking Tool)

- **Other Tools used:**
  - Build Tools: Ant, CruiseControl
  - Testing Tool: jUnit
  - Code checking Tool: Jalopy

Relationship to related projects

- **Condor**
  - Member of the Design Team
  - Specific Condor developments for the CE
  - Evaluating Stork for Data Management
  - Part of development testbed
- **Globus**
  - Member of the Design Team
  - Specific Globus developments for CE
- **GridPP**
  - Metadata
- **NMI**
  - Discussions on processes and potential common testing
- **OMII & NGS**
  - Mutual software evaluations on-going
  - Discussions on standards
- **OSG**
  - Architecture & Design documents used for OSG blueprint
  - Discussions on common strategies and software
- **Many other interactions with DILIGENT, GridLab, GEMSS, MammoGrid, Unicore, …**

Accomplishments

- **Produced gLite Architecture and Design documents**
  - Already referenced outside EGEE

- **Software development processes in place**
  - being exercised by SA1 on the Pre-Production Service

- **Software available to pilot Applications and SA1**

- **Actively following and contributing to emerging standards (GGF, OASIS, etc.), but not early adopters**

- **Produced all deliverables but MJRA1.4 (one month slip) in time**

Issues

- **Disagreement on what software is made available**
  - Being handled via a Management Task Force

- **Web Services technologies fulfilling requirements of EGEE applications**
  - Web Services industry support (tooling)
  - Standards are not yet mature, and do not always have a robust implementation

- **Staffing in Testing/Integration under pressure at this stage**
  - Being handled with partners

- **Communication with software clusters not optimal (difficult to follow each other's work)**
  - Make better use of tools

Enabling Grids for E-sciencE

- **PM12: Release 1**
- **Incremental releases (bug fixes) are foreseen on a regular basis for the whole period**
- **PM14: Revision of the architecture document.**
- **PM15: Revision of the Design document.**
- **PM18: Test plan for Release 2**
- **PM19: Functionality of Release 2 will be frozen.**
- **PM20: Integration of Release 2**
- **PM21: Release 2 delivered to SA1**
- **PM24: Final report including assessment of work completed and outstanding issues**

Enabling Grids for E-sciencE

- **Despite there are still some open issues, JRA1**

  – Has produced the gLite architecture, design and release plan

  – Has a software process in place which is being exercised by SA1 on the Pre-Production Service

  – Plan to produce gLite release 1.0 with key functionalities implemented by end of March according to the schedule
    - Moving towards Web Services