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Executive Summary

This document represents an overview of the achievements of the **JRA3 Infrastructure Integration Activity** with special focus on the **Task 2–Infrastructure Integration Task**. It covers the time period since the project start (May 2006) until Month 12 (April 2007): the **first year of the OMII–Europe project**. In short, the nature of Task 2–Infrastructure Integration is to establish and test interoperability among the different Grid middleware platforms within OMII–Europe. A more comprehensive description about Task 2 in the context of the OMII–Europe project can be found in the Introduction. The work described in this deliverable **is based on the outcome of the JRA1–Re-engineering of Services activities** and therefore it might be beneficial for readers to consult the deliverables of these activities beforehand. Furthermore, some aspects of it is also related to the common security profile developed within **JRA3–Task 1–Common Security Infrastructure**. Therefore, readers that are not familiar with security challenges during Grid interoperability are referred to the Task 1 deliverables.

The fundamental idea of JRA3-Task 2 is to bring all the software components (reengineered within OMII–Europe) together into one **multi-platform Grid infrastructure (Milestone M:JRA3.4)** to establish and test interoperability between all of them. After an initial requirement analysis of what is necessary to initially enable Grid interoperability, we identified several phases for integration that basically cover all the functional components developed within JRA1. Therefore, JRA3-Task 2 has developed a roadmap for **the integration of these components along different integration phases (aka sub-tasks)**, including an addition of an information foundation phase that was revealed as necessary functionality during the requirement analysis. In order to address this additional requirement, the demand was given as an input into the JRA2–New Services activity to include also information modeling/services components into the multi-platform Grid infrastructure in the year 2 of the project. Since several months, all integration phases according to the roadmap have been started and therefore the infrastructure already has a lot of components running for interoperability tests even if most JRA1 components are still in an alpha implementation. To conclude, initial interoperability among the components has been reached in typical deployments.

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1. Introduction

The intention of this section is to clarify the difference between compliance testing, interoperation and interoperability and to set these topics in the context of JRA3–Task 2. Closer integration of Grid middleware platforms and higher levels of interoperability are essential if the Grid is to find wider use across science and industry, particularly when used in a production environment. At the time of writing, the production Grids have started to interoperate in a pair-wise fashion (e.g. DEISA and TeraGrid GPFS interoperation), but there is a major difference between interoperation and interoperability: Interoperation is specifically defined as what needs to be done to get production Grids to work together in a fast short-term achievement using existing technologies available today. Hence, this is not the perfect solution and different than interoperability that is defined as the native ability of Grids and Grid middleware platforms to interact directly via common open standards. Such standards are specified by standardization bodies such as OGF, OASIS, IETF, W3C or DMTF. Recently, compliance test suites have been developed (e.g. used in SA2 of OMII–Europe) that are testing components for their compliance with the specifications released by the standardization bodies. This standard compliance is necessary and a precondition for interoperability scenarios; however, there is still a difference between standard compliance and interoperability within Grids using these standards.

This is how JRA3–Task 2 comes into play. The deliverables and milestones for Task2 during the first year are

No.	Title	Date	Completed
M:JRA3.4	First prototype of the multi-platform Grid infrastructure	M12	M12
D:JRA3.5	First report on all the sub-tasks of the Infrastructure Integration task	M12	M12

Task2 milestones and deliverables for the next 12 months are summarized by

No.	Title	Date
M:JRA3.5	Final version of the multi-platform Grid infrastructure	M24
D:JRA3.6	Second report on all sub-tasks of the Infrastructure Integration task	M24

Compliance testing is about testing a certain component or interface (e.g. OGSA-BES endpoint) against a dedicated specification (e.g. OGSA-BES specification or the HPC-Profile). This is a necessary precondition for interoperability, which typically is more than compliance testing, because in real Grid deployments such a component is often integrated into a larger set of components that need to be interoperable or required to work with each other (e.g. the use of OGSA-BES endpoints in conjunction with VOMS servers). Thus, in realistic interoperability scenarios it is typically not this “vanilla OGSA-BES” interface provided; instead such a component is integrated with security policies (e.g. usage of TLS and VOMS in combination with XACML policy validation or authentication with the UNICORE Gateway) or other components (e.g. schedulers). Therefore, the JRA3–Task 2 aims together with JRA3–Task 1 at a simulation of a future multi-platform Grid infrastructure to enable the developers of JRA1 to test their components in more realistic Grid deployments. Finally, according to the description of work, the efforts described here focuses on interoperability of UNICORE and gLite (EGEE) although resources have been allocated to address GLOBUS and CROWN as well.

2. Progress

This section gives an overview of the achievements of the first year of the OMII–Europe project. The actual status can be obtained from the internal JRA3 Wiki [1]. More technical details can be found in the Milestone document M:JRA3.4.

2.1. *Requirements Analysis for the Multi-Platform Grid Infrastructure*

As described in the official description of work, the activity performed a requirement analysis for the multi-platform Grid infrastructure in order to establish interoperability between the different platforms. In particular, the requirement analysis was focused on the identification of atomic services to be integrated in the interoperable Grid infrastructure. In this context, the *interoperability layer* as described in the description of work refers to an interoperable vertical overlay of components over the existing non-interoperable basic Grid platforms. The results of the requirement analysis shown below took technologies from UNICORE, gLite (EGEE), Globus Toolkits and CROWN into account and also investigated the state-of-the art in terms of interoperability within the broader Grid community.

2.1.1. Investigations in the broader Grid community

Many production Grid projects have begun to offer their services via a dedicated Grid middleware (e.g. UNICORE, gLite, Globus Toolkits, CROWN) to their end-users during the past several years. The problem of having non-interoperable Grid platforms is not new and therefore the Open Grid Forum (OGF) has started the **Grid Interoperation Now (GIN)–Community Group (CG)** [2]. The focus of this group is to plan and implement **interoperation** in five specific areas such as authorization and identity management (GIN-AUTH), data management and movement (GIN-DATA), job description and submission (GIN-JOBS), information services and schema (GIN-INFO), and operations experience of pilot test applications (GIN-OPS). Hence, this OGF group provides much experience feedback for OMII–Europe JRA3–Task 2 coming out of production Grid interoperation. By taking the experience of GIN into account, **OMII–Europe JRA3–Task 2 works in the area of interoperability via common open standards to establish a multi-platform Grid infrastructure.**

Along with the investigations of the GIN efforts, members of OMII–Europe (Steven Newhouse: chair GIN-JOBS, Morris Riedel: GIN Secretary) participate within GIN to gain feedback from the production Grid interoperation on the one hand and to disseminate OMII–Europe activities within the broader Grid community. The group demonstrated several interoperation scenarios at the Supercomputing 2006 conference in Tampa (USA). JRA3–Task 2 has analyzed several outputs of this interoperation demos and concluded a deep analysis in November 2006. This analysis in turn provided many important foundations for the approach of JRA3–Task 2. For more information about the deep analysis, please refer to the GIN factsheet in the OMII–Europe Intranet (GIN @ SC 2006). A former European project named as Grid Interoperability Project (GRIP) [3] was also investigated during the requirement analysis. This investigation reveals that most of the components are unfortunately out of date. For instance, several solutions in that project are based on Globus Toolkit 2.4 and UNICORE 5 and are therefore of not much of interest for JRA3–Task 2 that basically deals with interoperability between Globus Toolkit 4 and UNICORE 6 via new Web services-based standards.

2.1.2. Identified Integration Phases to Address the Requirements

The investigation within GIN revealed that its areas (AUTH, JOBS, DATA, OPS, INFO) are close to the areas of atomic services required to set up a multi-platform Grid infrastructure, although their focus is more on interoperation instead of interoperability. Therefore, we identified several phases (aka sub-tasks) for the integration process within JRA3–Task 2, influenced from the production experience of GIN, but taking also the context of OMII–Europe platforms into account.

- **Integration Phase 1: Information Foundation**

The requirement analysis of the GIN-INFO area of OGF revealed that there is a demand for an information model and service that represents the initial contact point when components want to interoperate. We identified that such a service is absolutely necessary since gLite is typically using an information service (BDII) for job submission which is the most basic functionality within Grids. Investigations of the GLUE schema [4] reveal that it has the potential to be the base schema for the information systems that lay the foundation for interoperability in JRA3–Task 2, providing pieces of information about interoperable service registries, contacts and resources. As a side remark, GLUE was also one schema of choice within the GIN-INFO area (see FactSheet GIN @ SC2006 on the Intranet). Because no JRA1 activity currently reengineers this important atomic service towards open standards, the demand was given as an input to the JRA2–New Services activity. Recently, it was decided (and accepted by the EU) that this services will be reengineered in JRA2 and thus perfectly fill the gap within the multi-platform Grid infrastructure of JRA3–Task 2.

- **Integration Phase 2: Job Management**

This phase solves interoperability issues between different Grid middleware platforms and their implementations of the OGSA-BES specification. This phase is related to the GIN-JOBS area of OGF and is based on components of the JRA1–Job Submission and Monitoring activity. More details can be found in the correspondent JRA1 deliverable.

- **Integration Phase 3: Virtual Organization Membership**

Integration Phase 3 focuses on the interoperability of VOMS with all the major Grid middleware platforms within OMII-Europe. This phase is related to the GIN-AUTH area of OGF and is based on components of the JRA1–Virtual Organization Membership activity. For more details about VOMS please refer to the correspondent JRA1 deliverable.

- **Integration Phase 4: Portals**

This phase is about the usage of portals with respect to different underlying standard compliant Grid middleware platforms. It is partly related to the GIN-OPS area wherein portals are used and is based on components of the JRA1–Portal Interface activity. For more details about the used GridSphere portals please refer to the JRA1 deliverable of M12.

- **Integration Phase 5: Database Access**

Integration Phase 5 focuses on the interoperability of different OGSA-DAI implementations of Grid middleware platforms within OMII-Europe. It has no relationship to GIN, but is widely accepted as one of the atomic services within Grids and therefore of interest for the multi-platform Grid infrastructure. The components of the JRA1–Database Access activity are used within this phase and thus additional detail about OGSA-DAI can be found in the correspondent JRA1 deliverables.

- **Integration Phase 6: Accounting**

Finally, Integration Phase 6 aims at interoperability of different OGSA-Resource Usage Services (RUS) of Grid middleware platforms. Also this phase has no relationship to GIN, but is especially important in cross-Grid interoperability scenarios to distinguish between end-users of different Grids. Components of the JRA1–Accounting activity are used and more technical details about OGSA-RUS can be found in the JRA1 deliverables.

Finally, the integration phases can be seen as the conclusion of the requirement analysis. However, there were several other atomic services identified such as Storage Management and Data Transfer, e.g. within the GIN-DATA area several production Grids tried to interoperate using SRB/SRM. In this context, the Grid platforms are not interoperable and do not support a widely accepted common standard. The OGSA-DMI [5] work in OGF as well as SRM interfaces may be an option for future interoperability in terms of data transfers and storage management. Furthermore, another required service is the discovery service that looks up the right service for a given problem taking user requirements into account. Also, in terms of this service, all platforms are currently not interoperable. Taking the limited funding of OMII–Europe into account, it is out of scope of this project to address all these identified atomic services, also within JRA3–Task 2. However, these topics should be considered to be part of OMII–Europe 2 to enable broader and more complex interoperability scenarios in future cross-Grid deployments.

2.2. First Prototype of the Multi-Platform Grid Infrastructure

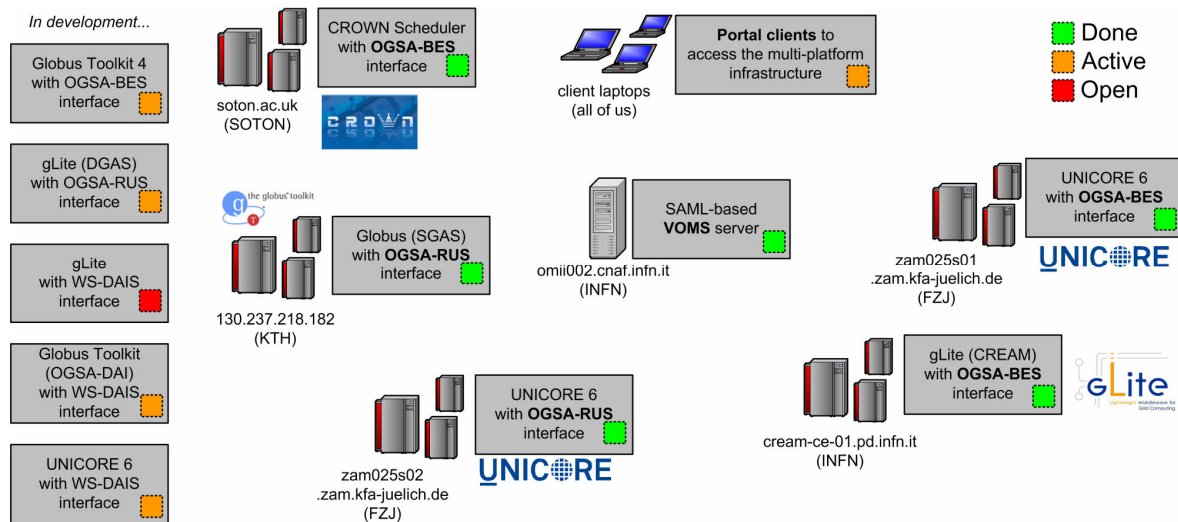


Figure 1: Overview of the multi-platform Grid infrastructure for interoperability scenarios. Active sub-tasks are on-going and Open sub-tasks have not yet been started.

One of the major goals of JRA3–Task 2 is to develop a multi-platform Grid infrastructure prototype at Month 12 (Milestone M:JRA3.4) and a final version at Month 24 (Milestone M:JRA3.5). This infrastructure integrates and also identifies atomic services of the requirement analysis for maturing and hardening of the Grid middleware platforms during interoperability scenarios and thus improves their robustness and resilience. Also, the development of the infrastructure along the identified phases includes re-analysis and update of the initial requirements and identification of additional functionality. All in all, the multi-platform Grid infrastructure simulates a future (production) Grid infrastructure with interoperating components of the base platforms of OMII–Europe and thus provides intensive feedback to the reengineering activities of JRA1.

2.2.1. Overall Overview of the Multi-Platform Grid Infrastructure

Error! Reference source not found. illustrates the current status of the Multi-platform Grid infrastructure and shows how the different phases fit together in one future Grid infrastructure. More details in the next paragraph. In parallel to these efforts, the Chinese partners have started to interoperate between GOS and CROWN. CROWN and GOS are both important Grid platforms in China and when they are able to interoperate, OMII-Europe will be able to interoperate with both via common open standards.

2.2.2. Status of the Different Integration Phases

A more detailed status of the illustrated phases is given in more technical detail in M:JRA3.4.

- **Integration Phase 1: Information Foundation**

The components will be further reengineered in year 2 of OMII-Europe in JRA2, therefore their integration is planned for the second year. Initial interoperability experiences lead to the usage of different information models (CIM, GLUE) and different information services (gLite BDII, Globus MDS4, UNICORE TargetSystemRegistry Service)

- **Integration Phase 2: Job Management**

On the all-hands meeting at FZJ we demonstrated the successful interoperable job submission to the OGSA-BES implementations of UNICORE and CREAM (gLite). Interoperability experiences lead to the usage of different JSDL document descriptions and different versions of the emerging OGSA-BES standards specification. However, both agreed to move their version to the latest specification version 33.

- **Integration Phase 3: Virtual Organization Membership**

A new SAML-based VOMS server is deployed and we successfully demonstrated early interoperability between CREAM (gLite), UNICORE and VOMS at the all hands meeting at FZJ, which includes the interoperability scenarios of a VOMS-based job submission. Re-analysis and update of the initial requirements reveal that in terms of VOMS-based authorization a component (PDP) is missing within the Grid middleware platforms. However this problem will be more described within the JRA3-Task 1 deliverable.

- **Integration Phase 4: Portals**

The portal integration is an ongoing process that includes OGSA-BES and VOMS client solutions developed within JRA3-Task 2 and security technologies revealed within JRA3-Task 1. Proof of concept solutions showed the usage of proxy certificates in UNICORE.

- **Integration Phase 5: Database Access**

The integration of OGSA-DAI endpoints is delayed until the components become available. See the deliverables of OGSA-DAI for more details.

- **Integration Phase 6: Accounting**

Initial multi-platform interoperability between a DGAS RUS client and an SGAS RUS server was shown at the all hands meeting at FZJ. Furthermore, a use-case application on top of the RUS interface for UNICORE named as LLView was demonstrated.

3. Conclusion

Until now the achievements of JRA3-Task 2 have nearly fulfilled the objectives of the description of work, except the integration of the delayed OGSA-DAI services (see the correspondent deliverables). Furthermore, within the multi-platform Grid infrastructure there are still components missing that are coming from the Chinese partners. However, initial cooperation has been started

with the JRA1–Chinese Components Exchange activity in order to integrate the OGSA-BES-enabled scheduler of CROWN into the infrastructure. All in all, the first prototype of the multi-platform Grid infrastructure is up and running and is already used for initial interoperability tests and scenarios such as the VOMS-enabled job submission via alpha implementations of the OGSA-BES interfaces within the different platforms. Also, we tested the interoperability among DGAS and SGAS. In this context, we recently started investigations of more realistic use cases for other interoperability scenarios.

The future roadmap of JRA3–Task 2 is very clear and can be described as follows. First, whenever a new development version of components of the JRA1 activities becomes available, JRA3–Task 2 has to include it into the multi-platform Grid infrastructure (e.g. the delayed OGSA-DAI services). This is in particular necessary to test their interoperability with all other deployed components and thus provides feedback whether the new components are still standard compliant and are able to be integrated in realistic Grid deployments. When the alpha versions of JRA1 are tested and are able to be built with ETICS, JRA3–Task 2 will have more collaboration between the SA activities of OMII–Europe to ensure that end-users of the OMII–Europe repository have access to components that are compliance tested and usable in realistic interoperability scenarios. This directly leads to the next focus of the next year of OMII–Europe within JRA3–Task 2 that is about the identification and testing of more interoperability scenarios. Recently, we have started to test the interoperability of the different OGSA-BES implementations of JRA1 in conjunction with the new SAML-based VOMS server of JRA1. Hence, the interoperability scenarios will address realistic Grid jobs on top of the multi-platform production Grid infrastructure and will include more than one “standalone component” of JRA1. Hence, while the SA2 activities providing standard compliance tests in terms of specification compliance for one specific component, JRA3–Task 2 will have a focus on testing their compliance among different sets of components typically used within production Grids today (e.g. VOMS authorization with job submission).

In order to reach the final version of the multi-platform Grid infrastructure, JRA3–Task 2 will further cooperate with GIN, the EGEE Middleware Security Group (MWSG) and also with JRA3–Task 1, especially in the context of security. The integration of new security technologies of JRA3–Task 1 will lead to new interesting and more realistic interoperability scenarios, especially those that raise the demand for delegation mechanisms. To disseminate our solutions, we plan to participate in the Supercomputing 2007 interoperability demos together with JRA1 Job Submission and Monitoring and furthermore we will continue the GIN work and give interoperability demonstrations at events such as OGF20 in Manchester. In summary, these efforts describe how the core building blocks of JRA1 fit into the OMII–Europe framework within JRA3–Task 1 and 2.

4. References

- [1] **Internal JRA3 Wiki**
<http://tjasse.pdc.kth.se/omii-europe/jra3security/jr3infra/>
- [2] **OGF Grid Interoperation Now (GIN)–Community Group (CG)**
<https://forge.gridforum.org/sf/projects/gin>
- [3] **Grid Interoperability Project (GRIP)**
<http://www.gridstart.org/GRIP.shtml>
- [4] **GLUE schema**
<http://forge.gridforum.org/sf/projects/glue-wg>
- [5] **OGSA–Data Movement Interface (DMI)**
<https://forge.gridforum.org/sf/projects/ogsa-dmi-wg>