



# EGI-InSPIRE

## STANDARDS ROADMAP

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#### Abstract

This document contains an overview of the relevant standards activities taking place in the EGI landscape, both internally within the operational tools and through external technology providers as described in the UMD roadmap. It also analyses the EGI standardisation activity in relationship with the EU policies on standardisation (Digital Agenda for Europe and European Interoperability Framework).



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## IV. APPLICATION AREA

This document is a formal deliverable for the European Commission, applicable to all members of the EGI-InSPIRE project, beneficiaries and Joint Research Unit members, as well as its collaborating projects.

## V. DOCUMENT AMENDMENT PROCEDURE

Amendments, comments and suggestions should be sent to the authors. The procedures documented in the EGI-InSPIRE “Document Management Procedure” will be followed: <https://wiki.egi.eu/wiki/Procedures>

## VI. TERMINOLOGY

A complete project glossary is provided at the following page: <http://www.egi.eu/about/glossary/>.



## VII. PROJECT SUMMARY

To support science and innovation, a lasting operational model for e-Science is needed – both for coordinating the infrastructure and for delivering integrated services that cross national borders. The EGI-InSPIRE project will support the transition from a project-based system to a sustainable pan-European e-Infrastructure, by supporting ‘grids’ of high-performance computing (HPC) and high-throughput computing (HTC) resources. EGI-InSPIRE will also be ideally placed to integrate new Distributed Computing Infrastructures (DCIs) such as clouds, supercomputing networks and desktop grids, to benefit user communities within the European Research Area.

EGI-InSPIRE will collect user requirements and provide support for the current and potential new user communities, for example within the ESFRI projects. Additional support will also be given to the current heavy users of the infrastructure, such as high energy physics, computational chemistry and life sciences, as they move their critical services and tools from a centralised support model to one driven by their own individual communities. The objectives of the project are:

1. The continued operation and expansion of today’s production infrastructure by transitioning to a governance model and operational infrastructure that can be increasingly sustained outside of specific project funding.
2. The continued support of researchers within Europe and their international collaborators that are using the current production infrastructure.
3. The support for current heavy users of the infrastructure in earth science, astronomy and astrophysics, fusion, computational chemistry and materials science technology, life sciences and high energy physics as they move to sustainable support models for their own communities.
4. Interfaces that expand access to new user communities including new potential heavy users of the infrastructure from the ESFRI projects.
5. Mechanisms to integrate existing infrastructure providers in Europe and around the world into the production infrastructure, so as to provide transparent access to all authorised users.
6. Establish processes and procedures to allow the integration of new DCI technologies (e.g. clouds, volunteer desktop grids) and heterogeneous resources (e.g. HTC and HPC) into a seamless production infrastructure as they mature and demonstrate value to the EGI community.

The EGI community is a federation of independent national and community resource providers, whose resources support specific research communities and international collaborators both within Europe and worldwide. EGI.eu, coordinator of EGI-InSPIRE, brings together partner institutions established within the community to provide a set of essential human and technical services that enable secure integrated access to distributed resources on behalf of the community.

The production infrastructure supports Virtual Research Communities (VRCs) – structured international user communities – that are grouped into specific research domains. VRCs are formally represented within EGI at both a technical and strategic level.



## VIII. EXECUTIVE SUMMARY

The realisation of the EGI vision requires the ability to cross both organisational and technical boundaries. Such an aspect is usually referred to as interoperability, i.e., the ability of systems, people and organisations to provide services to and accept services from other systems, people and organisations and to use the services so exchanged to enable them to operate effectively together.

Reaching interoperability amongst organisations and technologies is a long-term activity, which requires reaching consensus through compromises and refactoring/rebuilding systems or procedures according to them. Interoperability can be addressed at different levels leading to the identifications of different interoperability types. In the past, many classifications have been proposed. Given the international reach of EGI, we adopt the classification defined in the European Interoperability Framework [R2] that envisions five levels of interoperability: 1) political context, 2) legal interoperability 3) organisational interoperability, 4) semantic interoperability and 5) technical interoperability.

This document focuses on the adoption of standards for the interoperability amongst the systems participating in EGI (e.g., computing clusters, storage systems). By systems, we mainly consider the software abstraction layer (middleware) needed to expose the functional and operational interfaces outside the organisational boundaries together with the security mechanisms needed by the EGI infrastructure. Within this scope, standards relate mainly to the semantic and technical interoperability levels.

An analysis of the alignment of the EGI standardization activity with the European-wide policies such as the Digital Agenda for Europe and the European Interoperability Framework is also provided. In response to the comments from the first year review of the EGI-InSPIRE project, this document was expanded towards a more well-formed road-map, in particular: 1) three life-cycles respectively for standards development, implementation and adoption are identified and described; 2) the most relevant standards for Distributed Computing Infrastructures have been linked to the UMD capabilities and their development status, implementation and adoption plans have been summarised; 3) areas of standardization gaps have been also identified.

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## 1. INTRODUCTION

EGI is a secure integrated federated computing infrastructure constructed from national and domain specific resource providers. Such an infrastructure needs to be open to scientists and researchers from Europe and worldwide to support their day-to-day work. Different computing models should be supported as well as access to different types of distributed resources (high-throughput, high-performance, desktop, virtualised, etc.) linked to physically remote data stores.

The realisation of the EGI mission requires the ability to integrate processes across both organisational and technical boundaries. Such an aspect is usually referred to as interoperability. Given the complexity of our context, we favour the following broad definition inspired by activity in the military area [R1]: “Interoperability is the ability of systems, people and organisations to provide services to and accept services from other systems, people and organisations and to use the services so exchanged to enable them to operate effectively together”.

Reaching interoperability amongst organisations and technologies is a long-term activity, which requires reaching consensus through compromises and refactoring/rebuilding systems or procedures according to them. Interoperability can be addressed at different levels leading to the identifications of different interoperability types. In the past, many classifications have been proposed. Given the international reach of EGI, we adopt the classification defined in the European Interoperability Framework [R2] that envisions five levels of interoperability: 1) political context, 2) legal interoperability 3) organisational interoperability, 4) semantic interoperability and 5) technical interoperability.

For each type of interoperability, proper actions should be taken in order to enable it. At the technical level, there are two main approaches: adapter-based and standards-based interoperability. The former envisions that adapters between interacting parties are built to translate the specific requests from one side to the equivalent format and protocol on the other side. The latter envisions the definition of a common interface and message format as an open standard. In the case of adapters, it is known that such an approach raises the issue of maintenance overheads due to the necessary transformation logic, including, in some cases, a loss of functionality and/or semantic correctness. In the case of standards, the parties are expected to refactor or appropriately extend their systems in order to comply with the common specification. In addition, it is widely recognised that standardisation is one of the key facilitators for interoperability of networks, services and equipment [R6].

This document focuses on the adoption of standards for the interoperability amongst the systems participating in EGI (e.g., computing clusters, storage systems). By systems, we mainly consider the software abstraction layer (middleware) needed to expose the functional and operational interfaces outside the organisational boundaries together with the security mechanisms needed by the EGI infrastructure. Standards are mapped into the UMD (Unified Middleware Distribution) capabilities [R5], technology providers implementation plan is listed and the EGI adoption status is reported. This document represents an evolving roadmap that will be officially updated and published every twelve months, while always being open for contributions.

## 2. DEFINITIONS

Term	Definition	src
<b>European Interoperability Strategy</b>	The European Interoperability Strategy (EIS) provides the basis for defining the organisational, financial and operational framework (including governance) needed to ensure on-going support for cross-border and cross-sector interoperability, as well as the exchange of information among European public administrations.	[R2]
<b>European Public Service</b>	A cross-border public sector service supplied by public administrations, either to one another or to European businesses and citizens'.	[R2]
<b>Interoperability</b>	Interoperability is the ability of systems, people and organisations to provide services to and accept services from other systems, people and organisations and to use the services so exchanged to enable them to operate effectively together	[R1]
<b>Interoperability Framework</b>	An interoperability framework is an agreed approach to interoperability for organisations that wish to work together towards the joint delivery of public services. Within its scope of applicability, it specifies a set of common elements such as vocabulary, concepts, principles, policies, guidelines, recommendations, standards, specifications and practices.	[R2]
<b>Interoperability Levels</b>	The interoperability levels classify interoperability concerns according to who/what is concerned and cover, within a given political context, legal, organisational, semantic and technical interoperability	[R2]
<b>Open Standard</b>	A standard is open if meets the following criteria: All stakeholders have the same possibility of contributing to the development of the specification and public review is part of the decision-making process; The specification is available for everybody to study; Intellectual property rights related to the specification are licensed on FRAND (Fair, Reasonable, and Non-Discriminatory) or royalty-free terms in a way that allows implementation in both proprietary and open source software.	[R2]
<b>Public Administration</b>	Refers to either national public administrations (at any level) or bodies acting on their behalf, and/or EU public administrations	[R2]
<b>Standard</b>	A document, established by consensus and approved by an SDO, which provides, for common and repeated use, rules, guidelines or characteristics for activities or their results, aimed at the achievement of the optimum degree of order in a given context. Compliance is not compulsory.	
<b>Standards Developing Organisation (SDO)</b>	A chartered organisation tasked with producing standards and specifications, according to specific, strictly defined requirements, procedures and rules. Standards developing organisations include: <ul style="list-style-type: none"> <li>Recognised standardisation bodies such as 1) international standardisation committees such as the International Organisation for Standardisation (ISO), 2) the three European Standard Organisations: the European Committee for Standardisation (CEN), the European Committee for Electrotechnical Standardisation (CENELEC) or the European Telecommunications Standards Institute (ETSI), 3) national standardization organisations such as ANSI</li> <li>fora and consortia initiatives for standardisation such as the Open Grid Forum (OGF) or the Organisation for the Advancement of Structured Information Standards (OASIS).</li> </ul>	[R2]



### 3. INTEROPERABILITY

Interoperability is an intrinsic requirement for organisations and systems that need to operate effectively together. Interoperability is not a merely technical aspect, but it is also relevant at the human interaction level. The EGI interoperability conceptual model is inspired by the EIF 2.0 that considers five levels of interoperability (see Table 1). The practical implementation of the conceptual model requires each of these levels to be taken into account. This document addresses mainly the semantic and technical levels, as they are addressed by technical standards definition.

**Table 1 - Interoperability Levels**

Interoperability level	Description	Tools
<b>Political Context</b>	The establishment of a European e-infrastructure requires a political support and sponsorship; furthermore cross-border interoperability needs to be facilitated via strategic policies that provide common vision and focus on the goals to achieve. The EGI interoperability efforts are in alignment with the new EU Strategic policies - Europe 2020 Strategy, European Standardisation Policy and the Digital Agenda for Europe.	Definition of strategic policies
<b>Legal interoperability</b>	EGI operates across national borders and different national legal frameworks. Legal initiatives on the European level are needed in order to remedy incompatibilities between legislation in different Member States. Aligned and “interoperable” legislation is necessary so that exchanged data has proper legal validity (e.g. data protection legislation).	Legislation (e.g., EU directives and their transposition into national legislation)
<b>Organisational Interoperability</b>	In the organisational area, interoperability can be achieved by defining common organisational policies and procedures regulating the way different organisations or group of persons interact. Organisational interoperability implies integrating business processes and related data exchange. Organisational interoperability also aims to meet the requirements of the user communities by making EGI services available, easily identifiable, accessible and user-focused.	MoUs, SLAs, best practices
<b>Semantic Interoperability</b>	Semantic interoperability enables organisations to process information from external sources in a meaningful manner. It ensures that precise meaning of exchanged information that is preserved and understood by all parties.	Agreements on reference taxonomies, schemes, code lists, data dictionaries.
<b>Technical Interoperability</b>	Technical interoperability covers aspects of linking IT services. The adoption of open standards can facilitate interoperability and avoid vendor lock-in by infrastructure providers while providing users with more choices of service providers and less overhead in integrating/maintaining their applications into the e-infrastructure.	Agreements on interface specifications, communication protocols, messaging specifications, data formats or security specifications.



### **3.1. Relationship to the Digital Agenda for Europe**

The Europe 2020 Strategy [R3] is the growth strategy for the coming decade for the EU to become a smart, sustainable and inclusive economy. It has been established by the European Commission through its flagship initiatives, such as the “Digital Agenda for Europe” [R7]. The Digital Agenda for Europe deals with the ways to develop and gain the benefits from enhancing interoperability of IT solutions in Europe, promote a better use of standards and establish a single digital market and high-speed broadband Internet. Therefore, the Digital Agenda provides an opportunity for the EGI community to play an important role in achieving some of the key objectives defined in this strategy and to benefit from it.

One of the problem areas that are identified and addressed by this strategic policy document is a lack of effective interoperability and standard setting in public services. Weaknesses in standard setting, public procurement and coordination between European public authorities prevent digital services and devices working across national borders as well as they should. Action on interoperability is therefore needed in order to maximise social, market and economic potential of ICT. In other words, Europe needs effective interoperability between IT products and services to build a truly digital society.

On this matter, the Action 24 of the Digital Agenda states: Promote interoperability by adopting a European Interoperability Strategy and European Interoperability Framework. This action is related to two documents adopted by the EC in December 2010: the European Interoperability Strategy (EIS) 1.0 [R2] and the European Interoperability Framework (EIF) 2.0 [R4].

The European Interoperability Strategy provides the basis for defining the organisational, financial and operational framework (including governance) needed to ensure on-going support for cross-border and cross-sector interoperability, as well as the exchange of information among European public administrations. The European Interoperability Framework provides guidance to European public administrations as regards the definition, design and implementation of European public services.

### **3.2. What is an Open Standard?**

In the first edition of the EGI Standards Roadmap [R8], EGI has defined “standard” as a “document, established by consensus and approved by a recognized body, which provides, for common and repeated use, rules, guidelines or characteristics for activities or their results, aimed at the achievement of the optimum degree of order in a given context”.

According to the EU legislation, also as referenced by the EIF, a standard is “a technical specification approved by a recognised standardisation body for repeated or continuous application, with which compliance is not compulsory and which is one of the following: 1) International standard: a standard adopted by an international standardisation organisation and made available to the public; 2) European standard: a standard adopted by a European standardisation body and made available to the public; 3) National standard: a standard adopted by a national standardisation body and made available to the public” (Article 1, paragraph 6, of Directive 98/34/EC) [R9].

This definition is too strict for today's market as many systems rely on the use of specifications developed by other organisations such as fora and consortia. This leads to the problem that fora and consortia standards cannot currently be referenced in public procurement of ICT in Europe (see Problem 3 in [R13]). In order to mitigate this aspect, while complying with the EU legislation, the EIF introduces the concept of “formalised specification”, which is either a standard pursuant to Directive 98/34/EC or a specification established by ICT fora and consortia.

In addition, EIF defines the openness principle for the “formalised specification” and introduces the concept of “open specifications”. According to the EIF, open specifications need to meet the following criteria:

1. All stakeholders have the same possibility of contributing to the development of the specification and public review is part of the decision-making process;
2. The specification is available for everybody to study;
3. Intellectual property rights related to the specification are licensed on FRAND (Fair, Reasonable, and Non-Discriminatory) or royalty-free terms in a way that allows implementation in both proprietary and open source software. [R2]

By meeting this criteria, organisations working under various business models can compete on an equal conditions when providing solutions to public administrations while administrations that implement the standard in their own software (software that they own) can share such software with others under an open source licence if they so decide. According to the EC, the term “open specification” used in the EIF, on the one hand, avoids terminological confusion with the Directive 98/34/EC and, on the other, states the main features that comply with the basic principle of openness laid down in the EIF for European Public Services.

The previous version of the EGI Standards Roadmap referred to the EICTA White Paper on Standardisation and Interoperability [R6] for defining the principle of ‘openness’. According to the mentioned white paper, a standard is open when it meets the following four criteria:

1. *Control*: the evolution of the specification should be set in a transparent process open to all interested contributors;
2. *Completeness*: the technical requirements of the solution should be specified completely enough to guarantee full interoperability;
3. *Compliance*: there is a substantial standard-compliant offering promoted by proponents of the standard;
4. *Cost*: fair reasonable and non-discriminatory access is provided to all implementers.

EICTA itself provided a detailed feedback on a public draft of the EIF 2.0 [R10]. The concept of openness is compared in Table 2.

**Table 2 - Open Standard vs. Open Specification**

Aspect	Openness in EIF 2.0 [R4]	Openness in EICTA White Paper [R6]
Control	All stakeholders have the same possibility of contributing to the development of the specification and public review is part of the decision-making process. The specification is available for everybody to study	The evolution of the specification should be set in a transparent process open to all interested contributors
Cost	Intellectual property rights related to the specification are licensed on FRAND (Fair, Reasonable, and Non-Discriminatory) or royalty-free terms in a way that allows implementation in both proprietary and open source software.	Fair reasonable and non-discriminatory access is provided to all implementers.
Completeness	/	The technical requirements of the solution should be specified completely enough to guarantee full interoperability
Compliance	/	There is a substantial standard-compliant offering promoted by proponents of the standard

It should be noted that the EIF 2.0 does not strictly mandate the usage of open specification by stating that “public administrations may decide to use less open specifications, if open specifications do not exist or do not meet functional interoperability needs. ... When establishing European public services, public administrations should prefer open specifications, taking due account of the coverage of functional needs, maturity and market support” [R4]. Furthermore, the EIF does not include the strong requirement of being royalty-free and mentions FRAND as appropriate approach provided that the implementation in open source is possible.

Regarding the adoption of the terminology within EGI, we decided to expand the EC definition of standards to include also fora and consortia. The motivation is the presence of a large number of specifications approved by industry associations or community-driven bodies that are being used in EGI and that are called standards. This direction is also reinforced by a communication from the European Commission concerning the European Standardization policy [R12]. Concerning the “openness” of a standard, we adopt the EIF 2.0 definition.

## 4. STANDARDS RELEVANT TO EGI

In this section, we present the relevant standards that are relevant to EGI. Section 4.1 describes the three main lifecycles of standard development, implementation and adoption by EGI. Section 4.2 lists the standards together with the mapping to the related UMD capabilities, their maturity level, the implementation plans by the technology providers and the following adoption roadmap by EGI. Table 3 will be expanded in the future and maintained as a live document.

### 4.1. *Standard Development and Adoption Life-Cycles*

Different settings bodies develop standards and may follow different paths to reach the final product. While in one case, a group of stakeholders may gather together within an SDO with the explicit intention to design and agree on a novel standard for a particular purpose, in another case a technology may retroactively be turned into a standard after being successfully implemented before. Despite such heterogeneity, we can identify a number of relevant phases that characterise the lifecycle of a standard (see Figure 1).



**Figure 1 - Standard Development Lifecycle**

The phases for this lifecycle are:

1. GAP (Gap): the needs for a standard have been identified, but no activity has started
2. PRE (Preparation): the needs for a standard have been identified, partnering among stakeholders is on-going as well as the identification of an appropriate SDO
3. DEV (Development): a working group within an SDO has accepted to work on a standard and the development of the specification, potentially starting from use cases, is started
4. APP (Approval): a specification has been approved within an SDO and is available to the public
5. REF (Reference Implementation): reference implementation is available
6. REP (Replaced/Revised): the approved standard specification has been superseded by a revision or replaced by a new standard

In order to identify the implementation status of standards interesting for EGI by technology providers, we need to define the various phases composing such a process. A standard may be implemented after it is finally released or compliant software components may be released based on draft versions. In any case, we can identify a number of phases that are common to the implementation process as identified in Figure 2.



**Figure 2 - Standard Implementation Lifecycle for Technology Providers**

The phases for this lifecycle are:

1. PLA (Planned): the implementation of the standard has been planned, but no activity has started
2. IMP (Implementation): implementations of the standard have been started, but no production-quality software implementation is available
3. REL (Release): production-quality software components implementing the standards have been released
4. COM (Compliance): the compliance with the standard is verified (e.g., through compliance test suits)
5. RET (Retired): the standard is not anymore supported by software components maintained by the technology provider

Once software components supporting standards are available, they can be considered by EGI for inclusion in UMD. In order to identify the adoption status of standards within EGI, we identify the phases presented in Figure 3.



**Figure 3 - EGI Standard Adoption Lifecycle**

The phases for this lifecycle are:

1. PLA (Planned): the adoption of software components implementing the standard has been planned
2. INC (Inclusion): production-quality components implementing standards have been verified and included in the EGI UMD release
3. DEP (Deployment): production-quality software components implementing a standard have been installed by at least an EGI resource centre from the EGI UMD repositories
4. USE (Use): the standards-based functionalities of components are being used as primary functionalities replacing the legacy ones in day-to-day activity by at least one virtual organisation
5. RET (Retired): the standard is not anymore supported by software components deployed in the EGI infrastructure

## 4.2. Roadmap

**Table 3 - Standards Development, Implementation and Adoption Roadmap**

Standard	Source	Capability	DEV	IMP: EMI	IMP: IGE	IMP: SAGA	IMP: StratusLab	ADO: EGI
AMQP 1.0	AMQP WG	Information.Messaging	REF	PLA			REL (Virtual Machine Management plugin for state change notifications) PLA as service Q4/12 (Extension to other services; Collector Service for internal collection of monitoring/acct. information)	PLA
LDAPv3	IETF	Information.Messaging	REF	REL (BDII)		REL as client (saga-adaptor-glite)		USE
GLUE 2.0 Conceptual	OGF GFD.147	Information.Model	REF	REL				USE
GLUE 2.0 LDAP	OGF draft	Information.Model	DEV	REL (WMS, BDII, ARC-InfoSystem, dCache, DPM, FTS, LFC, SAGA-SD-RAL, StoRM), PLA(ARGUS, EGIIS, VOMS)		REL as client (saga-adaptor-glite)	IMP Q4/11 (Service Information Providers for static service information)	USE
GLUE 2.0 XML	OGF draft	Information.Model	DEV	REL (A-REX, UNICORE, CREAM)	IMP (IIS)		IMP Q4/11 (Service Information Providers for static service information)	USE
CDMI 1.0	SNIA	Storage.Management	REF	n/a	n/a	n/a	IMP Q4/11 (Persistent Storage Service)	PLA
SRM 2.2	OGF	Storage.Management	REF	REL (StoRM, dCache, DPM) PLA (UNICORE)		REL as client		USE

Standard	Source	Capability	DEV	IMP: EMI	IMP: IGE	IMP: SAGA	IMP: StratusLab	ADO: EGI
GridFTP v2	OGF GFD.47	Storage.FileTransfer	REF	REL (dCache, FTS)	REL (GridFTP)	REL as client		USE
NFS 4.1	IETF	Storage.FileAccess	REF	REL (StoRM, dCache, DPM)				USE
WebDAV	IETF	Storage.FileAccess	REF	REL (dCache), PLA (DPM, StoRM)				
IPv6	IETF	Network.Transport	REF		REL (GridFTP) IMP (GRAMS)		IMP Q4/11 (Evaluation of all StratusLab services for IPv6 compliance; later for IPv6 compatible implementations)	PLA (Q2/12 testbed)
TCloud 1.0	Telefonica	VirtualMachine.Management	REF				REL (Claudia Service Manager)	
OVF 1.0	DMTF	VirtualMachine.ImageFormat	REF				PLA Q1/12 (OpenNebula Virtual Machine Manager)	PLA (Q2/12 testbed)
SAGA Core API	OGF GFD.90	Client.API	REF			COM (saga-core, saga-binding-python)		PLA (Q2/12 testbed)
SAGA Advert API	OGF GFD.177	Client.API	REF			REL (saga-core, saga-binding-python)		PLA (Q2/12 testbed)
SAGA Service Discovery API	OGF GFD.144	Client.API	REF			REL (saga-core, saga-binding-python)		PLA (Q2/12 testbed)
SAGA C++ Language Bindings	OGF draft	Client.API	REF			REL (saga-core)		PLA (Q2/12 testbed)
SAGA Information Service Navigator API Extension	OGF draft	Client.API	IMP	REL (SAGA-SD-RAL)		REL (saga-core, saga-binding-python)		PLA (Q2/12 testbed)
SAGA Python Language Bindings	OGF draft	Client.API	IMP			REL (saga-binding-python)		PLA (Q2/12 testbed)



Standard	Source	Capability	DEV	IMP: EMI	IMP: IGE	IMP: SAGA	IMP: StratusLab	ADO: EGI
SAGA Message API extension	OGF GFD.178	Client.API	REF			PLA		PLA (Q2/12 testbed)
Checkpoint and Recovery API	OGF GFD.93	Client.API	REF			PLA		PLA (Q2/12 testbed)
DRMAA V2	OGF draft	Client.API	REF			REL		
BES	OGF	Compute.JobExecution	REF	REL (UNICORE)	REL (GridSAM) IMP for IGE 2.1 (GridWay)	REL as client (saga-adaptor-bes)		
HPC-Basic Profile	OGF	Compute.JobExecution	REF	REL (UNICORE)	REL (GridSAM) IMP for IGE 2.1 (GridWay)	REL as client (saga-adaptor-bes)		
HPC File Staging Profile	OGF	Compute.JobExecution	REF	REL (UNICORE)	REL (GridSAM)	REL as client (saga-adaptor-bes)		
JSDL	OGF GFD.136	Compute.JobExecution	REF	REL (A-REX, CREAM, UNICORE)		REL (saga-adaptor-bes)		
JSDL HPC	OGF GFD.111	Compute.JobExecution	REF	REL (UNICORE)		REL (saga-adaptor-bes)		
JSDL SPMD	OGF GFD.115	Compute.JobExecution	REF	REL (UNICORE)		REL (saga-adaptor-bes)		
EMI-ES	EMI	Compute.JobExecution	DEV	IMP for EMI 2				
OpenMP	OpenMP ARB	Compute.ParallelJobExecution	REF	REL (UNICORE)				USE
MPI	MPI-Forum	Compute.ParallelJobExecution	REF	REL (UNICORE)	REL (GridSAM, GRAMS)			USE
OCCI Core	OGF GFD.185	VirtualMachine.Management	REF			PLA	PLA Q1/12 (Virtual Machine Manager, Networking Services, Persistent Disk Service)	PLA (Q2/12 testbed)



Standard	Source	Capability	DEV	IMP: EMI	IMP: IGE	IMP: SAGA	IMP: StratusLab	ADO: EGI
OCCI Infrastructure	OGF GFD.186	VirtualMachine.Management	REF			PLA	PLA Q1/12 (Virtual Machine Manager, Networking Services, Persistent Disk Service)	PLA (Q2/12 testbed)
OCCI HTTP Rendering	OGF GFD.187	VirtualMachine.Management	REF			PLA		PLA (Q2/12 testbed)
X.509	IETF	Security.Authentication	REF	REL	REL (GridFTP, GRAM5, GSISSE, MyProxy, GridSAM, GridWay, OGSA-DAI, AdHoc)	REL (saga-adaptor-x509)	REL (Authentication Proxy)	USE
X.509 Proxy Certificate	IETF RFC3820	Security.Authentication	REF	REL	REL (GridFTP, GRAM5, GSISSE, MyProxy, GridSAM, GridWay)	REL	REL (Authentication Proxy)	USE
SAML 2.0	OASIS	Security.Authentication	REF	REL	IMP for IGE 2.0 (via LCAS/LCMAPS, VOMS)			USE
SAML 2.0	OASIS	Security.Authorization	REF	REL (UNICORE, UVOS, VOMS), PLA in EMI ES for EMI 3	IMP for IGE 2.0 (via LCAS/LCMAPS, VOMS)			PLA
XACML 2.0	OASIS	Security.Authorization	REF	REL (ARGUS, UNICORE) PLA( A-REX, CREAM)	IMP for IGE 2.0 (via LCAS/LCMAPS)			USE
Compute extension to OGF UR 1.0	EMI	Operations.Accounting	DEV	PLA (A-REX, CREAM, UNICORE)	PLA Q2/12 (GridSAFE)			PLA
STAR	EMI	Operations.Accounting	DEV	PLA (dCache, DPM, FTS, StoRM)				PLA
UR 1.0	OGF	Operations.Accounting	REF	REL	IMP for IGE 2.1 (GridSAFE)		PLA Q2/12 (Prototype implementations for all services)	USE
UR 2.0	OGF	Operations.Accounting	DEV	PLA in EMI 3	PLA Q1/13 (GridSAFE)			PLA



## 5. AREAS OF STANDARDISATION GAPS

### 5.1. *Job Management*

Standards for job management in Grid exist; nevertheless they do not cover more complex use cases needed by the Grid community and EGI specifically. This gap limited the adoption in production systems. The PGI, BES and JSDL working groups from OGF have been working to extend these specifications to address the identified gaps. In parallel, the EMI project has been working on an internal specification for job management called EMI Execution Service [R14].

### 5.2. *Accounting*

Job accounting is covered by the OGF Usage Record format, nevertheless extensions are required to cover more complex use cases. Accounting for storage is also required and in this area the EMI project has been working on preparing an internal specification [R15]. The OGF UR working group is working on extending the current specification to cover new use cases emerged from production systems

### 5.3. *Common Network Management Interface*

In the cloud sector, the most important missing standards concern networking services, in particular standards for describing and managing the networking environment of a virtual machine like firewalls and VLANs. This standard should be coupled with APIs for creating (and changing) those environments could be provided.

### 5.4. *Information Discovery*

An essential capability of a distributed system such as the Grid is related to being able to discover available services. A common information model has been standardized in the context of OGF (GLUE 2.0 specification). The conceptual data model was mapped into XML Schema, SQL and LDAP. A common interface to be used to discover services or to publish information is not yet available. For discovery, the most prominent interface in EGI is the LDAP protocol that is bound to the LDAP data model used to publish the information about Grid services. With the evolution of technologies embracing Web services and HTTP-based interfaces, there is the need to define a generic interface for information publishing and discovery.



## 6. CONCLUSION

Interoperability is a key requirement for EGI because participating systems and organizations require the ability to cross each other's boundaries in order to operate effectively together. It is widely recognised that open standards are key enablers for interoperability of networks, services and equipment.

With this document, we provided context and alignment of the EGI standardisation activity with the European-wide policies such as the Digital Agenda for Europe and the European Interoperability Framework. In particular, the proposed classification of interoperability level was adopted, while the alignment to the terminology "open specification" has been addressed by proposing a wider definition of "open standard" as this matching better the EGI context.

Concerning the roadmap, three lifecycles respectively for standards development, implementation and adoption have been identified and described. The most relevant standards for Distributed Computing Infrastructures have been linked to the UMD capabilities and their development status, implementation and plans have been summarised including also standards related to the cloud and virtualisation context. An implementation roadmap by technology providers as well expectations for inclusions in UMD has been also captured. Areas of standardisation gaps have been also identified.

## 7. REFERENCES

R1	M. Hura et Al., <i>A Broad Definition of Interoperability (Chapter 2) in Interoperability: A Continuing Challenge in Coalition Air Operations</i> , RAND Monograph Report, 2000, <a href="http://go.egi.eu/rand-interoperability-definition">http://go.egi.eu/rand-interoperability-definition</a>
R2	European Interoperability Strategy (EIS) for European Public Services, Annex 1, <a href="http://ec.europa.eu/isa/documents/isa_annex_i_eis_en.pdf">http://ec.europa.eu/isa/documents/isa_annex_i_eis_en.pdf</a>
R3	Europe 2020 Strategy <a href="http://ec.europa.eu/europe2020/index_en.htm">http://ec.europa.eu/europe2020/index_en.htm</a>
R4	European Interoperability Framework (EIF) for European Public Services, Annex 2, <a href="http://ec.europa.eu/isa/documents/isa_annex_ii_eif_en.pdf">http://ec.europa.eu/isa/documents/isa_annex_ii_eif_en.pdf</a>
R5	UMD Roadmap, EGI-InSPIRE D5.4, <a href="https://documents.egi.eu/document/612">https://documents.egi.eu/document/612</a>
R6	EICTA White Paper on Standardisation and Interoperability - <a href="http://www.eicta.org/fileadmin/user_upload/document/document1166544474.pdf">http://www.eicta.org/fileadmin/user_upload/document/document1166544474.pdf</a>
R7	Digital Agenda for Europe, <a href="http://ec.europa.eu/information_society/digital-agenda/index_en.htm">http://ec.europa.eu/information_society/digital-agenda/index_en.htm</a>
R8	EGI Standards Roadmap, D2.5, <a href="https://documents.egi.eu/document/206">https://documents.egi.eu/document/206</a>
R9	Directive 98/34/EC of the European Parliament and of the Council laying down a procedure for the provision of information in the field of technical standards and regulation and of rules on information society services, <a href="http://ec.europa.eu/enterprise/tris/consolidated/index_en.pdf">http://ec.europa.eu/enterprise/tris/consolidated/index_en.pdf</a>
R10	EICTA Comments on the draft EIF 2.0 <a href="http://ec.europa.eu/idabc/servlets/Doc61eb.pdf?id=31915">http://ec.europa.eu/idabc/servlets/Doc61eb.pdf?id=31915</a>
R11	European Standardisation Policy <a href="http://ec.europa.eu/enterprise/policies/european-standards/standardisation-policy/index_en.htm">http://ec.europa.eu/enterprise/policies/european-standards/standardisation-policy/index_en.htm</a>
R12	A strategic vision for European standards: Moving forward to enhance and accelerate the sustainable growth of the European economy by 2020 <a href="http://ec.europa.eu/enterprise/policies/european-standards/files/standardization/com-2011-311_en.pdf">http://ec.europa.eu/enterprise/policies/european-standards/files/standardization/com-2011-311_en.pdf</a>
R13	<a href="http://ec.europa.eu/enterprise/policies/european-standards/files/standardization/sec-2011-671_en.pdf">http://ec.europa.eu/enterprise/policies/european-standards/files/standardization/sec-2011-671_en.pdf</a>
R14	EMI Execution Service: <a href="https://twiki.cern.ch/twiki/bin/view/EMI/EmiExecutionService">https://twiki.cern.ch/twiki/bin/view/EMI/EmiExecutionService</a>
R15	EMI Storage Accounting <a href="https://twiki.cern.ch/twiki/bin/view/EMI/StorageAccounting">https://twiki.cern.ch/twiki/bin/view/EMI/StorageAccounting</a>



## 8. ANNEX: SOURCES OF STANDARDS

In this section, we list the main Standards Developing Organisations (SDOs) that produce standards useful to EGI (see Section 4.1.1). We consider also other entities that are not formal SDOs, but that have developed specifications to cover gaps in the current standard landscape. It is likely that successful specifications will be later submitted for standardisations to the appropriate SDOs (see Section 4.1.2). A more comprehensive list can be found also in <http://cloud-standards.org/>.

### 8.1. *Standard Bodies*

In this section, we list the main Standards Developing Organisations (SDOs) that produce standards output useful to enable an integrated and federated e-Infrastructure and the engagement of the EGI community with the bodies.

#### 8.1.1. W3C

The World Wide Web Consortium (W3C) [R4] is an international community where Member organizations, a full-time staff, and the public work together to develop Web standards. Led by Web inventor Tim Berners-Lee and CEO Jeffrey Jaffe, W3C's mission is to lead the Web to its full potential by developing protocols and guidelines that ensure Web long-term growth.

#### 8.1.2. OASIS

The Organization for the Advancement of Structured Information Standards (OASIS) [R7] is a not-for-profit consortium that drives the development, convergence and adoption of open standards for the global information society. The consortium produces standards for Web services, security, e-business, for both the public sector and for application-specific markets. OASIS is distinguished by its transparent governance and operating procedures. Members themselves set the OASIS technical agenda, using a lightweight process expressly designed to promote industry consensus and unite disparate efforts.

#### 8.1.3. WS-I

The Web Services Interoperability Organization (WS-I) [R5] was an open industry organization chartered to establish Best Practices for Web services interoperability, for selected groups of Web services standards, across platforms, operating systems and programming languages. WS-I comprised a diverse community of Web services leaders from a wide range of companies and standards development organizations (SDOs). WS-I committees and working groups created Profiles and supporting Testing Tools based on Best Practices for selected sets of Web services standards. Since November 2010, WS-I has transitioned its assets, operations, and mission into a Member Section of OASIS (Organization for the Advancement of Structured Information Standards).

#### 8.1.4. IETF

The Internet Engineering Task Force (IETF) [R6] is a large open international community of network designers, operators, vendors, and researchers concerned with the evolution of the Internet architecture and the smooth operation of the Internet. It is open to any interested individual. The actual technical work of the IETF is done in its working groups, which are organized by topic into several areas (e.g., routing, transport, security). Much of the work is handled via mailing lists. The IETF holds meetings three times per year.



#### **8.1.5. OGF**

The Open Grid Forum (OGF) [R8] is an open community committed to driving the rapid evolution and adoption of applied distributed computing. Applied Distributed Computing is critical to developing new, innovative and scalable applications and infrastructures that are essential to productivity in the enterprise and within the science community. OGF accomplishes its work through open forums that build the community, explore trends, share best practices and consolidate these best practices into standards.

#### **8.1.6. DMTF**

The Distributed Management Task Force (DMTF) [R9] enables more effective management of millions of IT systems worldwide by bringing the IT industry together to collaborate on the development, validation and promotion of systems management standards. The group spans the industry with 160 member companies and organizations, and more than 4,000 active participants crossing 43 countries. The DMTF board of directors is led by 15 innovative, industry-leading technology companies. With this deep and broad reach, DMTF creates standards that enable interoperable IT management. DMTF management standards are critical to enabling management interoperability among multi-vendor systems, tools and solutions within the enterprise.

#### **8.1.7. SNIA**

SNIA is a registered non-profit trade association. Members are dedicated to developing and promoting standards, technologies, and educational services to empower organizations in the management of information. The SNIA works toward this goal by forming and sponsoring Technical Work Groups (TWGs), producing the Storage Networking World (SNW) Conference series, building and maintaining a vendor neutral Technology Center in Colorado Springs, and promoting activities that expand the breadth and quality of the storage and information management market. The SNIA's ability to accomplish these goals is directly attributed to the dedication and hard work of hundreds of volunteers from the member companies.

#### **8.1.8. IEEE**

IEEE [R11] is the world's largest professional association dedicated to advancing technological innovation and excellence for the benefit of humanity. IEEE and its members inspire a global community through IEEE's highly cited publications, conferences, technology standards, and professional and educational activities. IEEE is led by a diverse body of elected and appointed volunteer members. The governance structure includes boards for operational areas as well as bodies representing members in the 45 societies and technical councils and ten worldwide geographic regions.

#### **8.1.9. AMQP Working Group**

AMQP Working Group (WG) is a consortium of over twenty firms, including demanding users of integration technology and leading solution providers, who worked together to create AMQP. The objective of the group is to formalise AMQP as a recognised International Standard. AMQP technology is totally open.



## **8.2. Other Sources**

### **8.2.1. EMI**

The European Middleware Initiative (EMI) is a European funded project among the three major middleware providers, ARC, gLite and UNICORE, and other specialized software providers like dCache. The project's mission is to deliver a consolidated set of middleware components for deployment in EGI (as part of the Unified Middleware Distribution - UMD), PRACE and other DCIs, extend the interoperability and integration with emerging computing models, strengthen the reliability and manageability of the services and establish a sustainable model to support, harmonise and evolve the middleware, ensuring it responds effectively to the requirements of the scientific communities relying on it.

### **8.2.2. Telefónica I+D**

Telefonica I+D is the research and development company of the Telefónica Group. Founded in 1988, its mission is to contribute to the Group's competitiveness and modernity through technological innovation. To achieve this aim, the company applies new ideas, concepts and practices in addition to developing products and advanced services.