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GLUE WG
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Status of This Document

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Abstract
The GLUE specification is an information model for Grid entities described using natural language and enriched with a graphical representation using UML Class Diagrams. As a conceptual model, it is designed to be independent from the concrete data models adopted for its implementation. Rendering to concrete data models such XML Schema, LDAP Schema and SQL are provided in a separate document.

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1 Introduction

In this document, we present a conceptual information model for Grid entities described using natural language and enriched with a graphical representation using UML Class Diagrams. As a conceptual model, it is designed to be independent from the concrete data models adopted for its implementation. Rendering to concrete data models such XML Schema, LDAP Schema and SQL are provided in a separate document. From the semantic viewpoint, the concrete data models should represent the same concepts and relationships of the conceptual information model; nevertheless they MAY contain simplifications targeted at improving query performance or other aspects of interest.

This information model is based on the experience of several modeling approaches being used in current production Grid infrastructures (e.g., GLUE Schema 1.x [glue-1.x], NorduGrid schema [ng-schema], Naregi model [naregi-schema]). The main supporting use cases are collected in the use cases document [glue-usecases].

The mapping to concrete data models is defined in a separated document [glue-real] (new mappings MAY appear in the future). Profile documents SHOULD appear to define how to generate and use the information in production scenarios (e.g., a profile MAY decide that an attribute which is optional in the conceptual model, is considered mandatory in a certain Grid infrastructure; or that optional attributes are never published).

2 Notational Conventions

The key words “MUST”, “MUST NOT,” “REQUIRED,” “SHALL”, “SHALL NOT”, “SHOULD”, “SHOULD NOT”, “RECOMMENDED”, “MAY”, and “OPTIONAL” are to be interpreted as described in RFC 2119 (see http://www.ietf.org/rfc/rfc2119.txt).

3 General Statements

The Information Model and its renderings MUST be considered case-sensitive. Each GLUE entity MUST have an ID attribute (except is made for the Extension class). Every ID MUST be a URI. As a general guideline, ID's SHOULD be persistent at least for a day when assigned to an entity. It is needed for recognition or for access to the characteristics of the related entity over time and across different information sources. The ID MUST NOT be interpreted by the user or the system as having any meaning other than an identifier. In particular, there is no relationship between an ID and a network endpoint. All ID attribute values MUST be valid URIs. The usage of URN (Uniform Resource Name, a subset of Uniform Resource Identifier or URI) is RECOMMENDED. The motivations for choosing URI’s reside in the fact that Grid services are evolving towards Web-based technologies such as Web Services, therefore it is RECOMMENDED to adopt the same identification system.

As regards unit of measure, multiple of bytes MUST refer to the SI (*Le **S**ystème **I**nternational d'Unités*) prefix (http://en.wikipedia.org/wiki/SI_prefix), therefore GB is 10^9 Bytes and not 2^{30} Bytes (the latter are GibiBytes).

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Deleted: The ID is a global identifier, while the LocalID is an identifier local to a container entity which is specified in the definition.

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In Appendix A, we provide guidelines for place-holder values that MUST be used when the attributes have no good default value or when the attribute cannot be measured for some reason.

As regards the extensibility, two main approaches are introduced to extend the information associated to the existing classes: the OtherInfo attribute and the Extension class. The OtherInfo attribute is present in several classes, its type is string and is multiplicity is *. This SHOULD be used for associating a flat list of tags to a certain class instance.
The Extension class is associated to the Entity class (therefore also to all the derived classes) and enables to link key,value pairs to any GLUE class instance. This SHOULD be used when there is the need for advertising more structured information, for instance an attribute not present in the model with the related value.

Both solutions are proposed because they have a different impact in the implementations: the OtherInfo approach is easier to query, nevertheless it MAY require parsing in case of concatenation of different chunks of information (e.g., attribute name and attribute value). The Extension class offers a two-dimensional construct, nevertheless it is more complex to query.

The extensibility regarding the addition of new classes and associations is not supported at the conceptual level. We RECOMMEND to create specialization of the conceptual model and to implement them by extending the concrete data models. Such extensions MUST NOT be considered part of the GLUE specification, nevertheless we RECOMMEND submitting them to the GLUE WG for consideration."

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4 Template

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In order to enrich the UML Class Diagrams with additional information, a table for each UML class is provided. The descriptive table si composed by three parts.

The first part refers to the whole entity and presents the entity name, the entity from which it inherits and the description of what the entity is.

The second part refers to the properties of the class; for each of them, the following characteristics are described: the attribute name, the data type, the multiplicity concerning how many values are allowed (* means zero or more), the unit of measurement and a description. For easy of reading, the properties that are inherited from a parent class are also listed. As regards the multiplicity, the value of zero means that it is allowed to refrain from publishing a value for the related attribute even though this MAY be measured.

The third part refers to the associations (association, composition, aggregation or association class) that the class MAY hold with other classes. For each association, the associated class endpoint is described in terms of the associated end class and key attribute, the multiplicity (i.e., the number of instances of the associated class that are allowed) and a description. The inherited associations are also reported in the “inherited association end” if they are not redefined in the “association end”. The template structure is the following:

Entity	Inherits from			Description
Inherited Attribute	Type	Mult.	Unit	Description
Attribute	Type	Mult.	Unit	Description
Association End			Description	
Inherited Association End		Mult.	Description	

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5 Conceptual Model of the Main Entities

This section introduces the main entities of the GLUE information model. They capture the core concepts relevant in a Grid environment. The main entities SHOULD be used to derive specialized information models. In Figure 1, the classes and the related relationships are presented in the form of a UML Class Diagram.

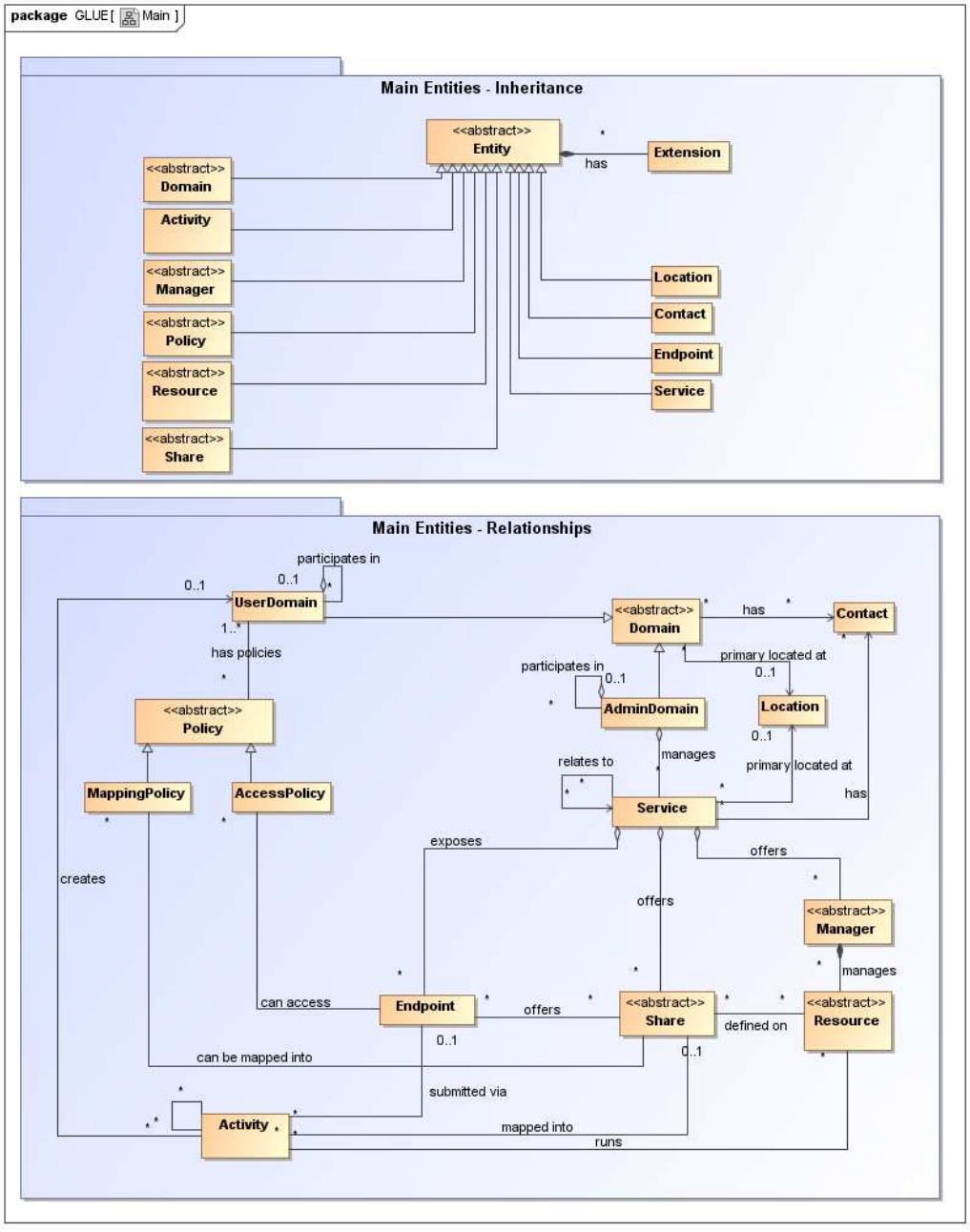

Figure 1 Entities and relationships for the Main Entities conceptual model

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5.1 Entity

Entity	Inherits from			Description
Entity <<abstract>>				Abstract root concept from which all the other concepts are derived (except the Extension class); it has metadata about information creation and validity plus a key-value pair extension mechanism
Attribute	Type	Mult.	Unit	Description
CreationTime	DateTime_t	0..1		Timestamp describing when the entity instance was generated
Validity	UInt64	0..1	s	The duration after CreationTime that the information presented in the Entity MAY be considered relevant. After that period has elapsed, the information SHOULD NOT be considered relevant
ID [key]	URI	1		A global unique ID
Name	String	0..1		Human-readable name
OtherInfo	String	*		Placeholder to publish info that does not fit in any other attribute. Free-form string, comma-separated tags, (name, value) pair are all examples of valid syntax
Association End		Mult.	Description	
Extension.Key		*	The entity MAY be associated to zero or more key-value pairs	

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This entity is the root entity from which all the GLUE classes inherit (exception is made for the Extension class). The specialized classes will inherit both the association to the Extension class and both the properties CreationTime and Validity. While the inheritance to the Extension class is reported in each table, the inheritance of the two properties is not explicitly listed.

5.2 Extension

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Entity	Inherits from			Description
Extension				A key,value pair enabling the association of extra information not captured by the model with an Entity instance
Attribute	Type	Mult.	Unit	Description
Key	String	1		An identifier local to the container class instance; typically an attribute name not present in the model; this identifier is not supposed to be unique; several instances of this class MAY hold the same value for this attribute
Value	String	1		A value for the attribute
Association End		Mult.	Description	
Entity		1	The key, value pair is associated to an entity instance	

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5.3 Location

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Entity	Inherits from			Description
Location	Entity			A geographical region where the granularity SHALL vary from an exact position to spanning different countries not necessary connected
Inherited Attribute	Type	Mult.	Unit	Description
CreationTime	*DateTime_t*	*0..1*		*Timestamp describing when the entity instance was generated*
Validity	*UInt64*	*0..1*	*s*	*The duration after CreationTime that the information presented in the Entity MAY be considered relevant. After that period has elapsed, the information SHOULD NOT be considered relevant*
ID [key]	*URI*	*1*		*A global unique ID*
Name	*String*	*0..1*		*Human-readable name*
OtherInfo	*String*	*		*Placeholder to publish info that does not fit in any other attribute. Free-form string, comma-separated tags, (name, value) pair are all examples of valid syntax*
Attribute	Type	Mult.	Unit	Description

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Address	String	0..1		Street address
Place	String	0..1		Name of town/city
Country	String	0..1		Name of the country
PostCode	String	0..1		Postal code
Latitude	Real32	0..1	degree	The position of a place north or south of the equator measured from -90° to +90° with positive values going north and negative values going south
Longitude	Real32	0..1	degree	The position of a place east or west of the primary meridian (located in Greenwich, UK) measured from -180° to +180° with positive values going east and negative values going west (the value -180° is excluded from the range)

Association End		Mult.	Description
Service.ID		*	The location is related to zero or more services
Domain.ID	<<abstract>>	*	The location is related to zero or more domains

Inherited Association End	Mult.	Description
Extension.Key	*	The entity MAY be associated to zero or more key-value pairs
ComputingService.ID	*	The location is related to zero or more computing services
StorageService.ID	*	The location is related to zero or more storage services
AdminDomain.ID	*	The location is related to zero or more admin domains
UserDomain.ID	*	The location is related to zero or more user domains

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The location entity MAY be used for describing geographical positions of domains and services. The aim is to provide a simple way to express geographical information and it is not intended to be used in complex geographical information systems. The accuracy of latitude and longitude should be defined in a future interoperability profile defined by projects adopting this specification.

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5.4 Contact

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Entity	Inherits from			Description
Contact	Entity			Information enabling to establish a communication with a person or group of persons part of a domain
Inherited Attribute	*Type*	*Mult.*	*Unit*	*Description*
CreationTime	*DateTime_t*	*0..1*		*Timestamp describing when the entity instance was generated*
Validity	*UInt64*	*0..1*	*s*	*The duration after CreationTime that the information presented in the Entity MAY be considered relevant. After that period has elapsed, the information SHOULD NOT be considered relevant*
ID [key]	*URI*	*1*		*A global unique ID*
Name	*String*	*0..1*		*Human-readable name*
OtherInfo	*String*	***		*Placeholder to publish info that does not fit in any other attribute. Free-form string, comma-separated tags, (name, value) pair are all examples of valid syntax*
Attribute	Type	Mult.	Unit	Description
URL	URI	1		URL embedding the contact information. The syntax of URI depends on the communication channel
Type	ContactType_t	1		Type of contact

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Association End		Mult.	Description
Service.ID		*	The contact is related to zero or more services
Domain.ID	<<abstract>>	*	The contact is related to zero or more domains

Inherited Association End	Mult.	Description
Extension.Key	*	The entity MAY be associated to zero or more key-value pairs
ComputingService.ID	*	The contact is related to zero or more computing services
StorageService.ID	*	The contact is related to zero or more storage services
AdminDomain.ID	*	The contact is related to zero or more admin domains
UserDomain.ID	*	The contact is related to zero or more user domains

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This entity MAY be used to represent contact information for requests related to different areas (e.g., user support, security or sysadmin). The various types of contact are identified by the Type attribute. In case of time-depend contact information, the instances of this entity should represent only the active contact information.

There are several specifications recommending how to embed contacts into URI. The following specifications SHOULD be used:

- telephone and fax: http://www.ietf.org/rfc/rfc2806.txt
- email: http://www.ietf.org/rfc/rfc2368.txt
- irc: http://www.w3.org/Addressing/draft-mirashi-url-irc-01.txt

5.5 Domain

Entity	Inherits from			Description
Domain <<abstract>>	Entity			A collection of actors that MAY be assigned with roles and privileges to entities via policies. A domain MAY have relationships to other domains.
Inherited Attribute	**Type**	**Mult.**	**Unit**	**Description**
CreationTime	*DateTime_t*	*0..1*		*Timestamp describing when the entity instance was generated*
Validity	*UInt64*	*0..1*	*s*	*The duration after CreationTime that the information presented in the Entity MAY be considered relevant. After that period has elapsed, the information SHOULD NOT be considered relevant*
ID [key]	*URI*	*1*		*A global unique ID*
Name	*String*	*0..1*		*Human-readable name*
OtherInfo	*String*	***		*Placeholder to publish info that does not fit in any other attribute. Free-form string, comma-separated tags, (name, value) pair are all examples of valid syntax*
Attribute	**Type**	**Mult.**	**Unit**	**Description**
Description	String	0..1		A description of the domain
WWW	URI	*		The URL identifying a web page with more information about the domain
Association End		**Mult.**		**Description**
Contact.LocalID		*		A domain MAY be contacted via zero or more contacts
Location.LocalID		0..1		A domain is primary located at one location
Association End		**Mult.**		**Description**
Extension.Key		*		The entity MAY be associated to zero or more key-value pairs

This is an abstract entity and it MUST NOT be instantiated. It SHOULD be used in order to derive specialized entities.

5.5.1 AdminDomain

Entity	Inherits from			Description
AdminDomain	Domain			A collection of actors that MAY be assigned administrative roles and privileges to services via policies. An AdminDomain manages services that MAY be geographically distributed, nevertheless a primary location should be identified.
Inherited Attribute	**Type**	**Mult.**	**Unit**	**Description**
CreationTime	*DateTime_t*	*0..1*		*Timestamp describing when the entity instance was generated*
Validity	*UInt64*	*0..1*	*s*	*The duration after CreationTime that the information presented in the Entity MAY be considered relevant. After that period has elapsed, the information SHOULD NOT be considered relevant*
ID [key]	*URI*	*1*		*A global unique ID*

Name	*String*	*0..1*		*Human-readable name*
OtherInfo	*String*	*		*Placeholder to publish info that does not fit in any other attribute. Free-form string, comma-separated tags, (name, value) pair are all examples of valid syntax*
Description	*String*	*0..1*		*A description of the domain*
WWW	*URI*	*		*The URL identifying a web page with more information about the domain*
Attribute	**Type**	**Mult.**	**Unit**	**Description**
Distributed	ExtendedBoolean_t	0..1		True if the services managed by the admindomain are considered geographically distributed by the administrators themselves
Owner	String	*		Identification of the person or legal entity which pays for the services and resources (no particular format is defined)
Association End		**Mult.**		**Description**
Service.ID		*		An AdminDomain manages zero or more Services
AdminDomain.ID		*		An AdminDomain aggregates zero or more AdminDomains
AdminDomain.ID		0..1		An AdminDomain participates in another AdminDomain
Inherited Association End		**Mult.**		**Description**
Extension.Key		*		The entity MAY be extended via key-value pairs
ComputingService.ID		*		An AdminDomain manages zero or more Computing Services
StorageService.ID		*		An AdminDomain manages zero or more Storage Services
Contact.LocalID		*		A domain MAY be contacted via zero or more contacts
Location.LocalID		0..1		A domain is primary located at one location

An AdminDomain MAY be composed by other AdminDomains in a hierarchical structure. This structure MAY represent a "participates in" association.

5.5.2 UserDomain

Entity	**Inherits from**			**Description**
UserDomain	Domain			A collection of actors that MAY be assigned with user roles and privileges to services or shares via policies
Inherited Attribute	**Type**	**Mult.**	**Unit**	**Description**
CreationTime	*DateTime_t*	*0..1*		*Timestamp describing when the entity instance was generated*
Validity	*UInt64*	*0..1*	*s*	*The duration after CreationTime that the information presented in the Entity MAY be considered relevant. After that period has elapsed, the information SHOULD NOT be considered relevant*
ID [key]	*URI*	*1*		*A global unique ID*
Name	*String*	*0..1*		*Human-readable name*
OtherInfo	*String*	*		*Placeholder to publish info that does not fit in any other attribute. Free-form string, comma-separated tags, (name, value) pair are all examples of valid syntax*
Description	*String*	*0..1*		*A description of the domain*
WWW	*URI*	*		*The URL identifying a web page with more information about the domain*
Attribute	**Type**	**Mult.**	**Unit**	**Description**
Level	UInt32	0..1		The number of hops to reach the root for hierarchically organized domains described by the "composed by" association (0 is for the root)
UserManager	URI	*		The Endpoint ID managing the users part of the domain and the related attributes such as groups or roles
Member	String	*		An identifier for a user in this user domain
Association End		**Mult.**		**Description**
Policy.ID	<<abstract>>	*		A User Domain has associated zero or more policies
UserDomain.ID		*		A User Domain aggregates zero or more User Domains
UserDomain.ID		0..1		An User Domain participates in another User Domain

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Inherited Association End	Mult.	Description
Extension.Key	*	The entity MAY be extended via key-value pairs
Contact.LocalID	*	The domain MAY be contacted via zero or more contacts
Location.LocalID	0..1	A domain is primary located at one location
AccessPolicy.ID	*	A User Domain has associated zero or more access policies
MappingPolicy.ID	*	A User Domain has associated zero or more mapping policies

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In the GLUE Information Model, the UserDomain class SHOULD be used to capture the concept of Virtual Organization (VO). By VO, we mean a set of individuals and/or institutions having direct access to computers, software, data, and other resources for collaborative problem-solving or other purposes. Resources utilized by a VO are expected to be accessible via network endpoints and constrained by defining utilization targets called shares. The VO MAY exhibit the internal structure in terms of groups of individuals, each of them being a UserDomain. UserDomains MAY be hierarchically structured. The "participates in" association MAY represent this structure.

As regards the UserManager, it is RECOMMENDED that its value is an Endpoint ID enabling to discover the related class instance and inherent attributes. An example of User Manager is the VOMS (Virtual Organization Membership Service, http://voms.forge.cnaf.infn.it/).

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5.6 Service

Entity	Inherits from			Description
Service	Entity			An abstracted, logical view of actual software components that participate in the creation of an entity providing one or more functionalities useful in a Grid environment. A service exposes zero or more endpoints having well-defined interfaces, zero or more shares and zero or more managers and the related resources. The service is autonomous and denotes a weak aggregation among endpoints, the underlying managers and the related resources, and the defined shares. The service enables to identify the whole set of entities providing the functionality with a persistent name.
Inherited Attribute	*Type*	*Mult.*	*Unit*	*Description*
CreationTime	*DateTime_t*	*0..1*		*Timestamp describing when the entity instance was generated*
Validity	*UInt64*	*0..1*	*s*	*The duration after CreationTime that the information presented in the Entity MAY be considered relevant. After that period has elapsed, the information SHOULD NOT be considered relevant*
ID [key]	*URI*	*1*		*A global unique ID*
Name	*String*	*0..1*		*Human-readable name*
OtherInfo	*String*	***		*Placeholder to publish info that does not fit in any other attribute. Free-form string, comma-separated tags, (name, value) pair are all examples of valid syntax*
Attribute	Type	Mult.	Unit	Description
Capability	Capability_t	*		The provided capability according to the Open Grid Service Architecture (OGSA) architecture [OGF-GFD80] (it is given by the sum of all the capabilities provided by the related endpoints)

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Type	ServiceType_t	1		The type of service according to a namespace-based classification (the namespace MAY be related to a middleware name, an organization or other concepts; org.glue and org.ogf are reserved)
QualityLevel	QualityLevel_t	1		Maturity of the service in terms of quality of the software components; the value corresponds to the highest quality level among the available endpoints
StatusInfo	URI	*		Web page providing additional information like monitoring aspects
Complexity	String	0..1		Human-readable summary description of the complexity in terms of the number of endpoint types, shares and resources. The syntax should be: endpointType=X, share=Y, resource=Z.

Association End		Mult.	Description
Endpoint.ID		*	A service exposes zero or more endpoints
Share.LocalID	<<abstract>>	*	A service offers zero or more shares
Manager.ID	<<abstract>>	*	A service offers zero or more managers
Contact.ID		*	A service has zero or more contacts
Location.ID		0..1	A service is primary located at a location
Service.ID		*	A service is related to zero or more services
Service.ID		*	A service is related to zero or more services
Inherited Association End		**Mult.**	**Description**
Extension.Key		*	The entity MAY be extended via key-value pairs

The simplest Service aggregates an endpoint, no share, no manager and no resource (e.g., a metadata catalog service). In the context of a Service, the same resource MAY be exposed via multiple endpoints based on the defined shares. For instance, in the area of storage systems, two endpoints implementing SRMv1 [srmv1] and SRMv2.2 [srmv2] interfaces respectively MAY expose the same resource via different endpoints offering different interface version; in the area of computing systems, the CREAM [cream] and GRAM [gram] endpoints MAY expose the resources locally managed by the same manager (typically a batch system). Endpoints, Shares, Managers and Resources MUST belong to precisely one service.

5.7 Endpoint

Entity	Inherits from			Description
Endpoint	Entity			A network location having a well-defined interface and exposing the service functionalities
Inherited Attribute	**Type**	**Mult.**	**Unit**	**Description**
CreationTime	*DateTime_t*	*0..1*		*Timestamp describing when the entity instance was generated*
Validity	*UInt64*	*0..1*	*s*	*The duration after CreationTime that the information presented in the Entity MAY be considered relevant. After that period has elapsed, the information SHOULD NOT be considered relevant*
ID [key]	*URI*	*1*		*A global unique ID*
Name	*String*	*0..1*		*Human-readable name*
OtherInfo	*String*	*		*Placeholder to publish info that does not fit in any other attribute. Free-form string, comma-separated tags, (name, value) pair are all examples of valid syntax*
Attribute	**Type**	**Mult.**	**Unit**	
URL	URI	1		Network location of the endpoint to contact the related service
Capability	Capability_t	*		The provided capability according to the OGSA architecture
Technology	EndpointTechnology_t	0..1		Technology used to implement the

				endpoint
InterfaceName	URI	1		Identification of a of the interface
InterfaceVersion	String	0..*		Version of the interface
InterfaceExtension	URI	*		Identification of an extension to the interface
WSDL	URI	*		URL of the WSDL document describing the offered interface (applies to Web Services endpoint)
SupportedProfile	URI	*		URI identifying a supported profile
Semantics	URI	*		URI of a document providing a human-readable description of the semantics of the endpoint functionalities
Implementor	String	0..1		Main organization implementing this software component
ImplementationName	String	0..1		Name of the implementation
ImplementationVersion	String	0..1		Version of the implementation (the syntax MAY be: major.minor.patch)
QualityLevel	QualityLevel_t	1		Maturity of the endpoint in terms of quality of the software components
HealthState	EndpointHealthState_t	1		A state representing the health of the endpoint in terms of its capability of properly delivering the functionalities
HealthStateInfo	String	0..1		Textual explanation of the state endpoint
ServingState	ServingState_t	1		A state specifying if the endpoint is accepting new requests and if it is serving the already accepted requests
StartTime	DateTime_t	0..1		The timestamp for the start time of the endpoint
IssuerCA	DN_t	0..1		Distinguished name of Certification Authority issuing the certificate for the endpoint
TrustedCA	DN_t	*		Distinguished name of the trusted Certification Authority (CA), i.e., certificates issued by the CA are accepted for the authentication process
DowntimeAnnounce	DateTime_t	0..1		The timestamp for the announcement of the next scheduled downtime
DowntimfeStart	DateTime_t	0..1		The timestamp describing when the next downtime is scheduled to start
DowntimeEnd	DateTime_t	0..1		The timestamp describing when the next downtime is scheduled to end
DowntimeInfo	String	0..1		Description of the next scheduled downtime
Association End		**Mult.**	**Description**	
Service.ID		1	An endpoint is part of a Service	
Share.LocalID	<<abstract>>	*	An endpoint MAY pass activities to zero or more Shares	
AccessPolicy.ID		*	An endpoint has associated zero or more AccessPolicies	
Activity.ID		*	An endpoint has accepted and is managing zero or more Activities	
Inherited Association End		**Mult.**	**Description**	
Extension.Key		*	The entity MAY be extended via key-value pairs	

For Grid services requiring a richer set of properties for the endpoint, specific models MAY be derived by specializing from the Endpoint entity and adding new properties or relationships. The current proposal contains the ComputingEndpoint specialization (see Section 6.2) and the StorageEndpoint specialization (see Section 7.4).

The endpoint network location MUST be encoded as a URI. When available, standard schemes for the encoding SHOULD be used (e.g., for Java Messaging Service http://www.ietf.org/internet-drafts/draft-merrick-jms-uri-03.txt).

Concerning the SupportedProfile attribute, if there is no recommended URI for the identification of a certain profile, then suggestions for choosing them are: main URL of the document specifying

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the profile or target namespace URI (in case of XML Schema representation of the profile).

5.8 Share

Entity	Inherits from			Description
Share <<abstract>>	Entity			A utilization target for a set of resources managed by a local manager and offered via related endpoints. The share is defined by configuration parameters and characterized by status information
Inherited Attribute	**Type**	**Mult.**	**Unit**	**Description**
CreationTime	*DateTime_t*	*0..1*		*Timestamp describing when the entity instance was generated*
Validity	*UInt64*	*0..1*	*s*	*The duration after CreationTime that the information presented in the Entity MAY be considered relevant. After that period has elapsed, the information SHOULD NOT be considered relevant*
ID [key]	*URI*	*1*		*A global unique ID*
Name	*String*	*0..1*		*Human-readable name*
OtherInfo	*String*	***		*Placeholder to publish info that does not fit in any other attribute. Free-form string, comma-separated tags, (name, value) pair are all examples of valid syntax*
Attribute	**Type**	**Mult.**	**Unit**	**Description**
Description	String	0..1		Description of this share
Association End		**Mult.**	**Description**	
Endpoint.ID		*	A share is consumed via one or more endpoints	
Resource.ID	<<abstract>>	*	A share is defined on one or more resources	
Service.ID		1	A share participates in a service	
Activity.ID		*	A share is consumed by zero or more activities	
MappingPolicy.ID		*	A share has zero or more mapping policies	
Inherited Association End		**Mult.**	**Description**	
Extension.Key		*	The entity MAY be extended via key-value pairs	

This is an abstract entity and it MUST NOT be instantiated. It SHOULD be used in order to derive specialized entities.

5.9 Manager

Entity	Inherits from			Description
Manager <<abstract>>	Entity			A software component locally managing one or more resources. It MAY describe also aggregated information about the managed resources.
Inherited Attribute	**Type**	**Mult.**	**Unit**	**Description**
CreationTime	*DateTime_t*	*0..1*		*Timestamp describing when the entity instance was generated*
Validity	*UInt64*	*0..1*	*s*	*The duration after CreationTime that the information presented in the Entity MAY be considered relevant. After that period has elapsed, the information SHOULD NOT be considered relevant*
ID [key]	*URI*	*1*		*A global unique ID*
Name	*String*	*0..1*		*Human-readable name*
OtherInfo	*String*	***		*Placeholder to publish info that does not fit in any other attribute. Free-form string, comma-separated tags, (name, value) pair are all examples of valid syntax*
Attribute	**Type**	**Mult.**	**Unit**	
ProductName	String	1		Name of the software product adopted as manager
ProductVersion	String	0..1		Version of the software product adopted as manager
Association End		**Mult.**	**Description**	
Service.ID		1	A manager participates in a service	
Resource.ID	<<abstract>>	1..*	A manager manages zero or more resources	
Inherited Association End		**Mult.**	**Description**	
Extension.Key		*	The entity MAY be extended via key-value pairs	

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This is an abstract entity not meant to be instantiated. It SHOULD be used in order to derive specialized entities.

The manager refers typically to a local manager service which specific details are abstracted by a middleware software component (endpoint). Examples of managers are: for computing resources, batch systems such as OpenPBS or LSF; for storage resources, GPFS.

5.10 Resource

Entity	Inherits from			Description
Resource <<abstract>>	Entity			An entity providing a capability or capacity, managed by a local software component (manager), part of a logical service, reachable via one or more endpoints and having one or more shares defined on it. A resource MAY refer to a category with summary information on the available instances.
Inherited Attribute	**Type**	**Mult.**	**Unit**	**Description**
CreationTime	*DateTime_t*	*0..1*		*Timestamp describing when the entity instance was generated*
Validity	*UInt64*	*0..1*	*s*	*The duration after CreationTime that the information presented in the Entity MAY be considered relevant. After that period has elapsed, the information SHOULD NOT be considered relevant*
ID [key]	*URI*	*1*		*A global unique ID*
Name	*String*	*0..1*		*Human-readable name*
OtherInfo	*String*	***		*Placeholder to publish info that does not fit in any other attribute. Free-form string, comma-separated tags, (name, value) pair are all examples of valid syntax*
Attribute	**Type**	**Mult.**	**Unit**	**Description**
No extra properties are defined in the specialized entity				
Association End		**Mult.**		**Description**
Manager.ID	<<abstract>>	1		A resource is managed by a manager
Share.LocalID	<<abstract>>	*		A resource provides capacity in terms of shares
Activity.ID		*		A resource runs zero or more activities
Inherited Association End		**Mult.**		**Description**
Extension.Key		*		The entity MAY be extended via key-value pairs

5.11 Activity

Entity	Inherits from			Description
Activity	Entity			An activity is a unit of work managed by a service and submitted via an endpoint; when accepted by the endpoint, than it MAY be mapped to a share and MAY be executed by a local manager via one or more resources; an activity MAY have relationships to other activities being managed by different services, therefore it shares a common context.
Inherited Attribute	**Type**	**Mult.**	**Unit**	**Description**
CreationTime	*DateTime_t*	*0..1*		*Timestamp describing when the entity instance was generated*
Validity	*UInt64*	*0..1*	*s*	*The duration after CreationTime that the information presented in the Entity MAY be considered relevant. After that period has elapsed, the information SHOULD NOT be considered relevant*
ID [key]	*URI*	*1*		*A global unique ID*
Name	*String*	*0..1*		*Human-readable name*
OtherInfo	*String*	***		*Placeholder to publish info that does not fit in any other attribute. Free-form string, comma-separated tags, (name, value) pair are all examples of valid syntax*
Attribute	**Type**	**Mult.**	**Unit**	**Description**
Association End		**Mult.**		**Description**
UserDomain.ID		0..1		An activity is managed by a user domain

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Endpoint.ID		0..1	An activity is submitted to an endpoint
Share.LocalID	<<abstract>>	0..1	An activity is mapped into a share
Resource.ID	<<abstract>>	0..1	An activity is executed in a resource
Activity.ID		*	An activity is related to zero or more activities
Activity.ID		*	An activity is related to zero or more activities
Inherited Association End		Mult.	Description
Extension.Key		*	The entity MAY be extended via key-value pairs

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Grid jobs (named Computing Activities in GLUE) are example of activities for a Computing Service. An interesting type of relationship for jobs derives from its propagation through several services. For instance, a broker service submits a Grid job to a selected execution service, upon completion the execution service submits a logging record to an accounting service. Each of these services will have associated an instance of a Grid job related to the lifecycle of the job within the service. All instances refer to the same conceptual job submitted by the user.

5.12 Policy

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Entity	Inherits from			Description
Policy <<abstract>>	Entity			Statements, rules or assertions that specify the correct or expected behavior of an entity
Inherited Attribute	Type	Mult.	Unit	Description
CreationTime	*DateTime_t*	*0..1*		*Timestamp describing when the entity instance was generated*
Validity	*UInt64*	*0..1*	*s*	*The duration after CreationTime that the information presented in the Entity MAY be considered relevant. After that period has elapsed, the information SHOULD NOT be considered relevant*
ID [key]	*URI*	*1*		*A global unique ID*
Name	*String*	*0..1*		*Human-readable name*
OtherInfo	*String*	***		*Placeholder to publish info that does not fit in any other attribute. Free-form string, comma-separated tags, (name, value) pair are all examples of valid syntax*
Attribute	Type	Mult.	Unit	Description
Scheme	PolicyScheme_t	1		Scheme adopted to define the policy rules
Rule	String	1..*		A policy rule (for the basic policy scheme, syntax is provided in the Appendix)
Association End		Mult.		Description
UserDomain.ID		1..*		A policy is related to a user domain
Inherited Association End		Mult.		Description
Extension.Key		*		The entity MAY be extended via key-value pairs

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This is an abstract entity not meant to be instantiated.

In this document, we provide the definition for a "basic" scheme (see Appendix 17.4). Such a scheme is designed to be simple and is inspired by real world scenarios in current production Grid systems. The Rule attribute implicitly contains the reference to the User Domains, therefore, in the concrete data model mapping, we RECOMMEND to not representing the association between User Domain and Access Policy or Mapping Policy explicitly since it is already captured by the Rule.

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For a given entity to which policies are associated (i.e,, Endpoint and AccessPolicy, Share and MappingPolicy), several instances of the Policy class MAY be defined. This is allowed in order to enable to advertise policies using different schemes. We RECOMMEND that only one instance per policy scheme is associated to the same entity instance. The evaluation algorithm for the rules SHOULD be defined by the policy scheme.

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If an entity instance is associated to different Policy instances, each of them based on a different scheme, then the evaluation process SHOULD consider each set of policies independently. This means that the evaluation SHOULD rely on a certain policy scheme which is selected and understood by the consumer, and not by composing policies expressed using different schemes.

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5.12.1 AccessPolicy

Entity	Inherits from			Description
AccessPolicy	Policy			Statements, rules or assertions that provide coarse-granularity information about the access by actors to an endpoint
Inherited Attribute	**Type**	**Mult**	**Unit**	**Description**
CreationTime	*DateTime_t*	*0..1*		*Timestamp describing when the entity instance was generated*
Validity	*UInt64*	*0..1*	*s*	*The duration after CreationTime that the information presented in the Entity MAY be considered relevant. After that period has elapsed, the information SHOULD NOT be considered relevant*
ID [key]	*URI*	*1*		*A global unique ID*
Name	*String*	*0..1*		*Human-readable name*
OtherInfo	*String*	***		*Placeholder to publish info that does not fit in any other attribute. Free-form string, comma-separated tags, (name, value) pair are all examples of valid syntax*
Scheme	*PolicyScheme_t*	*1*		*Scheme adopted to define the policy rules*
Rule	*PolicyRule_t*	*1..**		*A policy rule (for the basic policy scheme, syntax is provide in the Appendix)*
Attribute	**Type**	**Mult.**	**Unit**	**Description**
No extra properties are defined in the specialized entity				
Association End		**Mult.**	**Description**	
Endpoint.ID		1	An access policy is related to an endpoint	
Inherited Association End		**Mult.**	**Description**	
Extension.Key		*	The entity MAY be extended via key-value pairs	
UserDomain.ID		1..*	An access policy is related to a user domain	

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This entity MAY be used to express which UserDomains MAY access a certain service endpoint. The granularity of these policies SHOULD be coarse-grained and suitable for pre-selection of services. The actual decision on the service side is performed by an authorization component that MAY contain a finer-grained set of policy rules that in some case MAY contradict the published coarse-grained policy rules. Examples of actors involved in this entity are userDomains representing VOs or groups.

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5.12.2 MappingPolicy

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Entity	Inherits from			Description
MappingPolicy	Policy			Statements, rules or assertions that provide coarse-granularity information about the mapping of user domain requests to a share
Inherited Attribute	**Type**	**Mult**	**Unit**	**Description**
CreationTime	*DateTime_t*	*0..1*		*Timestamp describing when the entity instance was generated*
Validity	*UInt64*	*0..1*	*s*	*The duration after CreationTime that the information presented in the Entity MAY be considered relevant. After that period has elapsed, the information SHOULD NOT be considered relevant*
ID [key]	*URI*	*1*		*A global unique ID*
Name	*String*	*0..1*		*Human-readable name*
OtherInfo	*String*	***		*Placeholder to publish info that does not fit in any other attribute. Free-form string, comma-separated tags, (name, value) pair are all*

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				examples of valid syntax
Scheme	*PolicyScheme_t*	*1*		*Scheme adopted to define the policy rules*
Rule	*PolicyRule_t*	*1..**		*A policy rule (for the basic policy scheme, syntax is provide in the Appendix)*
Attribute	Type	Mult.	Unit	Description
No extra properties are defined in the specialized entity				
Association End		Mult.	Description	
Share.LocalID	<<abstract>>	1	A mapping policy is related to a share	
Inherited Association End		Mult.	Description	
Extension.Key		*	The entity MAY be extended via key-value pairs	
UserDomain.ID		1..*	An access policy is related to a user domain	

This entity MAY be used to express which UserDomains MAY consume a certain share of resources. The granularity of these policies SHOULD be coarse-grained and suitable for pre-selection of services. The actual decision on the service side is performed by an authorization component that MAY contain a finer-grained set of policy rules that in some case MAY contradict the published coarse-grained policy rules.

When evaluating the mapping to a certain share using the algorithm implied by the policy scheme, if multiple solutions are available, then the consumer SHOULD NOT make any assumption on which share will be assigned to its activity and it SHOULD request a certain share explicitly.

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6 Conceptual Model of the Computing Service

The conceptual model of the Computing Service is based upon the main entities and uses specializations of Service, Endpoint, Share, Manager, Resource, and Activity entities. Further computing related concepts such as Application Environment, Application Handle and Benchmark are introduced.

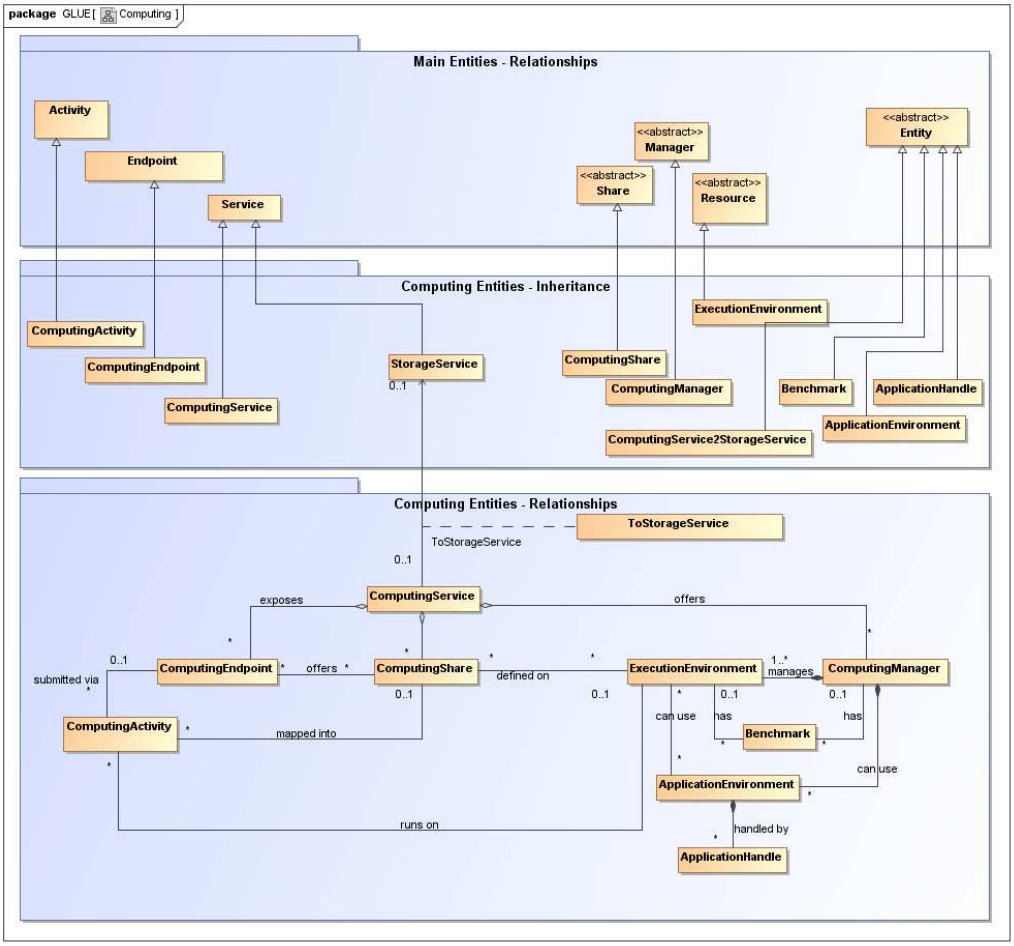

Figure 2 Entities and relationships for the Computing Service conceptual model

In this section, we extensively use the concept of physical CPU, logical CPU and slot:

- a physical CPU is defined by the socket, that means there is one physical CPU per socket; (e.g., a multi-core CPU counts as one physical CPU)
- a logical CPU corresponds to a CPU as visible by the operating system running either on a real or virtual machine
- a slot is a portion of executable time in a logical CPU offered by an execution environment instance which MAY be consumed by a job
    - usually, there is one slot per logical CPU, nevertheless a logical CPU MAY be shared across different slots

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- jobs MAY consume several slots at the same time (e.g., MPI jobs); a multi-slot job is counted as one job

Throughout the specification, we also use the concept of storage extent to mean the capabilities and management of the various media that exist to store data and allow data retrieval.

6.1 ComputingService

The ComputingService class is a specialization of the Service class for a service offering computational capacity. The ComputingService entity is the main logical unit, and aggregation point for several entities altogether modeling a computing capability in a Grid system. A ComputingService is capable executing ComputingActivities on its associated resources. The resources behind the ComputingService are described via the ComputingManager, ExecutionEnvironment, ApplicationEnvironment, ApplicationHandle and Benchmark entities. The governing policies and status of the resources are given by the ComputingShare elements. The ComputingActivities of a ComputingService are submitted and controlled via Computing Endpoint.

Entity	Inherits from			Description
ComputingService	Service			An abstracted, logical view of actual software components that participate in the creation of a computational capacity in a Grid environment. A computing service exposes zero or more computing endpoints having well-defined interfaces, zero or more computing shares and zero or more computing managers and the related execution environments. The computing service is autonomous and denotes a weak aggregation among computing endpoints, the underlying computing managers and related execution environments, and the defined computing shares. The computing service enables to identify the whole set of entities providing the computing functionality with a persistent name.
Inherited Attribute	**Type**	**Mult**	**Unit**	**Description**
CreationTime	*DateTime_t*	*0..1*		*Timestamp describing when the entity instance was generated*
Validity	*UInt64*	*0..1*	s	*The duration after CreationTime that the information presented in the Entity MAY be considered relevant. After that period has elapsed, the information SHOULD NOT be considered relevant*
ID [key]	*URI*	*1*		*A global unique ID*
Name	*String*	*0..1*		*Human-readable name*
OtherInfo	*String*	*		*Placeholder to publish info that does not fit in any other attribute. Free-form string, comma-separated tags, (name, value) pair are all examples of valid syntax*
Capability	*Capability_t*	*		*The provided capability according to the OGSA architecture (it is given by the sum of all the capabilities provided by the related endpoints)*
Type	*ServiceType_t*	*1*		The type of service according to a namespace-based classification (the namespace MAY be related to a middleware name, an organization or other concepts; org.glue and org.ogf are reserved)
QualityLevel	*QualityLevel_t*	*1*		*Maturity of the service in terms of quality of the software components*
StatusInfo	*URI*	*		*Web page providing additional information like monitoring aspects*
Complexity	*String*	*0..1*		*Human-readable summary description of the complexity in terms of the number of endpoint types, shares and resources. The syntax should be: endpointType=X, share=Y, resource=Z.*
Attribute	**Type**	**Mult**	**Unit**	**Description**
TotalJobs	UInt32	0..1	job	Number of total Grid jobs (sum of RunningJobs, WaitingJobs, StagingJobs, SuspendedJobs and

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				PreLRMSWaitingJobs); this number does not consider the local jobs
RunningJobs	UInt32	0..1	job	Number of running Grid jobs
WaitingJobs	UInt32	0..1	job	Number of Grid jobs waiting in the underlying computing managers (i.e., Local Resource Manager System or LRMS's)
StagingJobs	UInt32	0..1	job	Number of Grid jobs that are staging files in/out
SuspendedJobs	UInt32	0..1	job	Number of Grid jobs which started their execution, but are suspended (e.g., for preemption)
PreLRMSWaitingJobs	UInt32	0..1	job	Number of Grid jobs that are in the Grid layer waiting to be passed to the underlying computing manager (i.e., LRMS)

Association End	Mult.	Description
ComputingEndpoint.ID [redefines Endpoint.ID]	*	A computing service exposes zero or more computing endpoints
ComputingShare.LocalID [redefines Share.LocalID]	*	A computing service offers zero or more computing shares
ComputingManager.ID [redefines Manager.ID]	*	A computing service offers zero or more computing managers
StorageService.ID		
Inherited Association End	**Mult.**	**Description**
Extension.Key	*	The entity MAY be extended via key-value pairs
Contact.ID	*	A computing service has zero or more contacts
Location.ID	0..1	A computing service is primary located at a location
Service.ID	*	A computing service is related to zero or more services

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The simplest computing service is formed by a computing endpoint exposing an interface for job submission and control.

In case of a single computing manager whose execution environments are exposed by multiple computing endpoints, both computing manager, execution environments and computing endpoints MUST be considered as part of the same computing service. In case of a single computing endpoint exposing execution environments managed by different computing managers, then the computing endpoint, the execution environments and the related computing managers MUST be considered as part of the same computing service.

The computing service always aggregates computing endpoints, computing shares, computing managers and execution environments forming a connected set. In other words, Endpoint A exposing Execution Environment A of Manager A via Share A and Endpoint B exposing Execution Environment B of Manager B via Share B form two different computing services. On the other side, Endpoint A exposing Execution Environment A of Manager A via Share A and Endpoint B exposing Execution Environment A of Manager A via Share B form one Computing Service.

6.2 ComputingEndpoint

ComputingEndpoint is a specialization of the Endpoint class for a service possessing computational capability. The class represents an endpoint which is used to create, control and monitor computational activities. The computational specific information contains service load related parameters, staging capability and supported jobdescription. This class provides attributes that MAY be used to publish summary information of jobs submitted via a certain endpoint. Such attributes are optional and are not always measurable (e.g., in case of a stateless endpoint).

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Entity	Inherits from	Description
ComputingEndpoint	Endpoint	Endpoint for creating, monitoring, and controlling computational activities called jobs; it MAY be used to expose also complementary capabilities (e.g., reservation, proxy

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				manipulation)
Inherited Attribute	Type	Mult	Unit	Description
CreationTime	DateTime_t	0..1		Timestamp describing when the entity instance was generated.
Validity	UInt64	0..1	s	The duration after CreationTime that the information presented in the Entity MAY be considered relevant. After that period has elapsed, the information SHOULD NOT be considered relevant
ID [key]	URI	1		A global unique ID
Name	String	0..1		Human-readable name
OtherInfo	String	*		Placeholder to publish info that does not fit in any other attribute. Free-form string, comma-separated tags, (name, value) pair are all examples of valid syntax.
URL	URI	1		Network location of the endpoint to contact the related service
Capability	Capability_t	*		The provided capability according to the OGSA architecture
Technology	EndpointTechnology_t	0..1		Technology used to implement the endpoint
InterfaceName	URI	1		Identification of a of the interface
InterfaceVersion	String	0..*		Version of the interface
InterfaceExtension	URI	*		Identification of an extension to the interface
WSDL	URI	*		URL of the WSDL document describing the offered interface (applies to Web Services endpoint)
SupportedProfile	URI	*		URI identifying a supported profile
Semantics	URI	*		URI of a document providing a human-readable description of the semantics of the endpoint functionalities
Implementor	String	0..1		Main organization implementing this software component
ImplementationName	String	0..1		Name of the implementation
ImplementationVersion	String	0..1		Version of the implementation (e.g., major version.minor version.patch version)
QualityLevel	QualityLevel_t	1		Maturity of the endpoint in terms of quality of the software components
HealthState	EndpointHealthState_t	1		A state representing the health of the endpoint in terms of its capability of properly delivering the functionalities
HealthStateInfo	String	0..1		Textual explanation of the state endpoint
ServingState	ServingState_t	1		A state specifying if the endpoint is accepting new requests and if it is serving the already accepted requests
StartTime	DateTime_t	0..1		The timestamp for the start time of the endpoint
IssuerCA	DN_t	0..1		Distinguished name of Certification Authority issuing the certificate for the endpoint
TrustedCA	DN_t	*		Distinguished name of the trusted Certification Authority (CA), i.e., certificates issued by the CA are accepted for the authentication process
DowntimeAnnounce	DateTime_t	0..1		The timestamp for the announcement of the next scheduled downtime
DowntimeStart	DateTime_t	0..1		The starting timestamp of the next scheduled downtime
DowntimeEnd	DateTime_t	0..1		The ending timestamp of the next scheduled downtime
DowntimeInfo	String	0..1		Description of the next scheduled downtime
Attribute	Type	Mult.	Unit	Description
Staging	Staging_t	0..1		Supported staging functionalities
JobDescription	JobDescription_t	*		Supported type of job description language
TotalJobs	UInt32	0..1	job	Number of total Grid jobs (sum of RunningJobs, WaitingJobs, StagingJobs, SuspendedJobs and PreLRMSWaitingJobs); this number does not consider the local jobs
RunningJobs	UInt32	0..1	job	Number of running Grid jobs
WaitingJobs	UInt32	0..1	job	Number of Grid jobs waiting in the underlying computing managers (i.e., Local Resource

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				Manager System or LRMS's)
StagingJobs	UInt32	0..1	job	Number of Grid jobs that are staging files in/out
SuspendedJobs	UInt32	0..1	job	Number of Grid jobs which started their execution, but are suspended (e.g., for preemption)
PreLRMSWaitingJobs	UInt32	0..1	job	Number of Grid jobs that are in the Grid layer waiting to be passed to the underlying computing manager (i.e., LRMS)

Association End	Mult.	Description
ComputingService.ID [redefines Service.ID]	1	A computing endpoint is part of a Computing Service
ComputingShare.LocalID [redefines Share.LocalID]	*	A computing endpoint MAY pass activities to zero or more computing shares
ComputingActivity.ID [redefines Activity.ID]	*	An endpoint has accepted and is managing zero or more Activities
Inherited Association End	**Mult.**	**Description**
Extension.Key	*	The entity MAY be extended via key-value pairs
AccessPolicy.ID	*	A computing endpoint has assocated zero or more AccessPolicies

6.3 ComputingShare

The computing share is the specialization of the main share entity for computational services. A computing share is a high-level concept introduced to model the utilization target for a set of execution environments defined by a set of configuration parameters and characterized by status information. A ComputingShare carries information about "policies" (limits) defined over a set of subset of resources and describes their dynamic status (load).

In clusters managed by a batch system, the simplest way to set up a computing share is to configure a batch queue, nevertheless, the same computing share MAY be implemented using different batch system configuration strategies. In complex batch systems, a batch queue MAY be configured with different set of policies for different set of users. This implies that each set of users obtains a different utilization target. Such a scenario MAY be represented by different computing shares. In general, given a number of shares to be set up, it is possible to adopt different configuration strategies in the underlying system. Regardless the selected approach, the external behavior does not change. The main goal of the computing share concept is to abstract from such implementation choices and to represent the externally observable behavior.

The introduction of the computing share concept supports also the modelling of heterogeneity within a ComputingService by being able to have associations to different execution environments.

Entity	Inherits from			Description
ComputingShare	Share			A utilization target for a set of execution environments defined by a set of configuration parameters and characterized by status information
Inherited Attribute	**Type**	**Mult**	**Unit**	**Description**
CreationTime	*DateTime_t*	*0..1*		*Timestamp describing when the entity instance was generated*
Validity	*UInt64*	*0..1*	*s*	*The duration after CreationTime that the information presented in the Entity MAY be considered relevant. After that period has elapsed, the information SHOULD NOT be considered relevant*
ID [key]	*URI*	*1*		*A global unique ID*
Name	*String*	*0..1*		*Human-readable name*
OtherInfo	*String*	***		*Placeholder to publish info that does not fit in any other attribute. Free-form string, comma-separated tags, (name, value) pair are all examples of valid syntax*
Description	*String*	*0..1*		*Description of this share*

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In complex batch systems, a batch queue can be configured with different set of policies for different set of users. This implies that each set of users obtains a different utilization target. Such a scenario can be represented by different computing shares. ¶
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In general, given a number of shares to be set up, it is possible to adopt different configuration strategies in the underlying system. Regardless the selected approach, the external behavior does not change. The main goal of the computing share concept is to abstract from such implementation choices and to represent the externally observable behavior. ¶
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The computing share supports also heterogeneity by being able to have associations to different execution environments.

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Attribute	Type	Mult.	Unit	Description
MappingQueue	String	0..1		Name of a queue available in the underlying computing manager (i.e., LRMS) where jobs of this share are submitted (different shares MAY be mapped into the same queue; it is not foreseen that a single share MAY be mapped into many different queues)
MaxWallTime	UInt64	0..1	s	The maximum obtainable wall clock time that MAY be granted to a single-slot job upon user request (unnormalized value)
MaxMultiSlotWallTime	UInt64	0..1	s	The maximum obtainable wall clock time that MAY be granted to a multi-slot job upon user request; this value is measured from the start of the first slot up to the release of the last slot (unnormalized value)
MinWallTime	UInt64	0..1	s	The minimum wall clock time per slot for a job (unnormalized value); if a job requests a lower time, then it MAY be rejected; if a job requests at least this value, but runs for a shorter time, than it might be accounted for this value
DefaultWallTime	UInt64	0..1	s	The default wall clock time per slot allowed to a job by the computing manager (i.e., LRMS) if no limit is requested in the job submission description. Once this time is expired the job will most likely be killed or removed from the queue (unnormalized value)
MaxCPUTime	UInt64	0..1	s	The maximum obtainable CPU time that MAY be granted to the job upon user request per slot (unnormalized value)
MaxTotalCPUTime	UInt64	0..1	s	The maximum obtainable CPU time that MAY be granted to the job upon user request across all assigned slots; this attribute is a limit for the sum of the CPU time used in all the slots occupied by a multi-slot job (unnormalized value)
MinCPUTime	UInt64	0..1	s	The minimum CPU time per slot for a job (unnormalized value); if a job requests a lower time, than it MAY be rejected; if a job requests at least this value, but uses the CPU for a shorter time, than it might be accounted for this value
DefaultCPUTime	UInt64	0..1	s	The default CPU time per slot allowed to each job by the computing manager (i.e., LRMS) if no limit is requested in the job submission description (unnormalized value)
MaxTotalJobs	UInt32	0..1	job	The maximum allowed number of jobs in this share
MaxRunningJobs	UInt32	0..1	job	The maximum allowed number of jobs in running state in this share
MaxWaitingJobs	UInt32	0..1	job	The maximum allowed number of jobs in waiting state in this share
MaxPreLRMSWaitingJobs	UInt32	0..1	job	The maximum allowed number of jobs that are in the Grid layer waiting to be passed to the underlying computing manager (i.e., LRMS) for this share
MaxUserRunningJobs	UInt32	0..1	job	The maximum allowed number of jobs in running state per Grid user in this share
MaxSlotsPerJob	UInt32	0..1	slot	The maximum number of slots which could be allocated to a single job (defined to be 1 for a computing service accepting only single-slot jobs)
MaxStageInStreams	UInt32	0..1	stream	The maximum number of streams to stage files in
MaxStageOutStreams	UInt32	0..1	stream	The maximum number of streams to stage files out
SchedulingPolicy	SchedulingPolicy_t	0..1		Implied scheduling policy of the share
MaxMainMemory	UInt64	0..1	MB	The maximum RAM that a job MAY use; if the limit is hit, then the LRMS could kill the job

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GuaranteedMainMemory	UInt64	0..1	MB	The guaranteed RAM that a job MAY use
MaxVirtualMemory	UInt64	0..1	MB	The maximum RAM that a job MAY use; if the limit is hit, then the LRMS could kill the job
GuaranteedVirtualMemory	UInt64	0..1	MB	The guaranteed virtual memory that a job MAY use
MaxDiskSpace	UInt64	0..1	GB	The maximum disk space that a job MAY use in the working area
DefaultStorageService	URI	0..1		ID of the default Storage Service to be used to store files by jobs in case no destination Storage Service is explicitly stated
Preemption	ExtendedBoolean_t	0..1		True if the computing manager (i.e., LRMS) enables preemption of jobs; a preempted job is supposed to be automatically resumed
ServingState	ServingState_t	1		A state specifying if the share is open to place new requests and if it is open to offer the already present requests for execution
TotalJobs	UInt32	0..1	job	Number of total jobs in any state (sum of RunningJobs, LocalRunningJobs, WaitingJobs, LocalWaitingJobs, StagingJobs, SuspendedJobs and PreLRMSWaitingJobs); this number includes the local jobs
RunningJobs	UInt32	0..1	job	Number of running jobs submitted via any type of interface (local and Grid)
LocalRunningJobs	UInt32	0..1	job	Number of running jobs submitted via a local interface
WaitingJobs	UInt32	0..1	job	Number of jobs waiting in the underlying computing managers (i.e., LRMS's) submitted via any type of interface (local and Grid)
LocalWaitingJobs	UInt32	0..1	job	Number of jobs waiting in the underlying computing managers (i.e., LRMS's) submitted via a local interface
SuspendedJobs	UInt32	0..1	job	Number of jobs which started their execution, but are suspended, e.g., for preemption (local and Grid)
LocalSuspendedJobs	UInt32	0..1	job	Number of local jobs which started their execution, but are suspended (e.g., for preemption)
StagingJobs	UInt32	0..1	job	Number of Grid jobs that are staging files in/out
PreLRMSWaitingJobs	UInt32	0..1	job	Number of Grid jobs that are in the Grid layer waiting to be passed to the underlying computing manager (i.e., LRMS)
EstimatedAverageWaitingTime	UInt64	0..1	s	Estimated time to last for a new job from the acceptance to the start of its execution
EstimatedWorstWaitingTime	UInt64	0..1	s	Estimated worst waiting time assuming that all jobs run for the maximum wall time
FreeSlots	UInt32	0..1	slot	Number of free slots
FreeSlotsWithDuration	String	0..1	slot:s	Number of free slots with their time limits. Syntax: ns[:t] [ns:t]* where the pair ns:t means that there are *ns* free slots for the duration of *t* (expressed in seconds); the time limit information is optional
UsedSlots	UInt32	0..1	slot	Number of slots used by running jobs
RequestedSlots	UInt32	0..1	slot	Number of slots which are needed to execute all waiting and staging jobs
ReservationPolicy	ReservationPolicy_t	0..1		Type of reservation policy
Tag	String	*		UserDomain-defined tag (the values SHOULD use namespace to avoid collision)

Association End	Mult.	Description
ComputingEndpoint.ID [redefines Endpoint.ID]	*	A computing share MAY be consumed via one or more computing endpoints
ExecutionEnvironment.ID [redefines Resource.ID]	*	A computing share is defined on one or more computing resources
ComputingService.ID [redefines Service.ID]	1	A computing share participates in a computing service
ComputingActivity.ID [redefines Activity.ID]	*	A computing share is being consumed by zero or more computing activities
Inherited Association End	**Mult.**	**Description**

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Extension.Key	*	The entity MAY be extended via key-value pairs
MappingPolicy.ID	*	A share has zero or more mapping policies

As regards CPU Time and Wall Time related properties, there is the need for a way to normalize them depending on the computing capacity of the execution environment. The approach proposed in GLUE is to add two attributes in the Execution Environment (see Section 6.6) which refer to the scaling factor to be used to compute the CPU/Wall time that a job will get if it will be assigned to such an execution environment via a certain share. It is important that a job will get always at least the advertised CPU/Wall time. This means that the reference Execution Environment for the normalization should be always the fastest among those available in the whole Computing Service. For this Execution Environment, the scaling factor MUST be equal to 1. The CPU/Wall time values published by a share refer to the time that the job will get when mapped to this Execution Environment. For the other Execution Environments, the time should be normalized according to the defined scaling factors.

6.4 ComputingManager

ComputingManager is a specialization of the Manager class for the computational capability. The ComputingManager is responsible for the local control of resources and this layer is not exposed directly to external clients. The operating system MAY be the simplest case of a computing manager though the ComputingManager is often realized by means of a Local Resource Management (LRMS) "batch" system. The class provides aggregated information on controlled resources and also describes local storage extents needed for Grid enabled ComputingService.

Entity	Inherits from	Description
ComputingManager	Manager	A software component locally managing one or more execution environments. It MAY describe also aggregated information about the managed resources. The computing manager is also known as Local Resource Management System (LRMS).

Inherited Attribute	Type	Mult	Unit	Description
CreationTime	*DateTime_t*	*0..1*		*Timestamp describing when the entity instance was generated*
Validity	*UInt64*	*0..1*	*s*	*The duration after CreationTime that the information presented in the Entity MAY be considered relevant. After that period has elapsed, the information SHOULD NOT be considered relevant*
ID [key]	*URI*	*1*		*A global unique ID*
Name	*String*	*0..1*		*Human-readable name*
OtherInfo	*String*	*		*Placeholder to publish info that does not fit in any other attribute. Free-form string, comma-separated tags, (name, value) pair are all examples of valid syntax*
ProductName	*String*	*1*		*Name of the software product adopted as manager*
ProductVersion	*String*	*0..1*		*Version of the software product adopted as manager*

Attribute	Type	Mult.	Unit	Description
Version	String	0..1		Version of the computing manager (i.e., LRMS)
Reservation	ExtendedBoolean_t	0..1		True if the computing manager (i.e, LRMS) supports advance reservation
BulkSubmission	ExtendedBoolean_t	0..1		True if the computing manager (i.e,

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				LRMS) supports the bulk submission
TotalPhysicalCPUs	UInt32	0..1	Ph.CPU	Number of managed physical CPUs accessible via any of the available endpoints (there is one physical CPU per socket)
TotalLogicalCPUs	UInt32	0..1	Log.CPU	Number of managed logical CPUs accessible via any of the available endpoints (a logical CPU corresponds to a CPU visible to the operating system)
TotalSlots	UInt32	0..1	slot	Number of managed slots
SlotsUsedByLocalJobs	UInt32	0..1	slot	Number of slots used by jobs submitted via local interface
SlotsUsedByGridJobs	UInt32	0..1	slot	Number of slots used by jobs submitted via a Grid interface
Homogeneous	ExtendedBoolean_t	0..1		True if the computing manager has only one type of execution environment
NetworkInfo	NetworkInfo_t	*		Type of internal network available among the managed execution environment instances; if many values are published, then the various types of network MAY be available only within subsets of the execution environment instances; the execution environment properties SHOULD be checked
LogicalCPUDistribution	String	0..1		Classification of the managed execution environment instances aggregated by number of logical CPUs.Syntax: X*1*:Y*1*, …, X*n*:Y*n* where I is the i-*th* group of execution environments with the same number of logical CPUs, X*i* is the number of logical CPUs in each execution environment instance and Y*i* is the number of execution environment instances.
WorkingAreaShared	ExtendedBoolean_t	0..1		True if the working area is shared across different execution environment instances (i.e., cluster nodes); this attribute applies to single-slot jobs
WorkingAreaGuaranteed	ExtendedBoolean_t	0..1		True if the job is guaranteed the full extent of the WorkingAreaTotal; this attribute applies to single-slot jobs
WorkingAreaTotal	UInt64	0..1	GB	Total size of working area available to all the single-slot Grid jobs either as a shared area across all the execution environments (WorkingAreaShared is true) or local to a certain execution environment (WorkingAreaShared is false); if the computing manager supports individual quota per job/user, this is not advertised; in case of non-shared working area with different local space allocation, the advertised total size is the minimum available across all the execution environment instances
WorkingAreaFree	UInt64	0..1	GB	Free size of working area available to all single-slot Grid jobs either as a shared area across all the execution environments (WorkingAreaShared is true) or

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				local to a certain execution environment (WorkingAreaShared is false); if the computing manager supports individual quota per job/user, this is not advertised; in case of non-shared and non-guaranteed working area, this attribute represents the minimum guaranteed free working area available in any execution environment instance at the time of attribute measurement; in case of non-shared and guaranteed working area, the free area equals the total area
WorkingAreaLifeTime	UInt64	0..1	s	Guaranteed lifetime of the single-slot Grid job files present in the working area; the lifetime is related to the end time of the job; after the expiration of the lifetime, the files are not guaranteed to exist
WorkingAreaMultiSlotTotal	UInt64	0..1	GB	Total size of working area available to all the multi-slot Grid jobs shared across all the execution environments; if the computing manager supports individual quota per job/user, this is not advertised;
WorkingAreaMultiSlotFree	UInt64	0..1	GB	Free size of working area available to all multi-slot Grid jobs shared across all the execution environments; if the computing manager supports individual quota per job/user, this is not advertised; this attribute represents the minimum guaranteed free working area available in any execution environment instance at the beginning of the job execution
WorkingAreaMultiSlotLifeTime	UInt64	0..1	s	Guaranteed lifetime of the multi-slot Grid job files present in the working area; the lifetime is related to the end time of the job; after the expiration of the lifetime, the files are not guaranteed to exist
CacheTotal	UInt64	0..1	GB	If a caching functionality of input files is supported, this attribute represents the total size of a shared storage area where frequently accessed data MAY be stored for rapid access by subsequent Grid jobs; in this area, files are kept after job completion for a certain amount of time depending the caching algorithm;
CacheFree	UInt64	0..1	GB	If a caching functionality of input files is supported, this attribute represents the free size of a shared storage area where frequently accessed data MAY be stored for rapid access by subsequent Grid jobs; in the computation of the free size, files which are not claimed by any job MAY be considered as deleted
TmpDir	String	0..1		The absolute path of a temporary directory local to an execution environment instance (i.e., worker node). This directory MUST be available to programs using the

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				normal file access primitives (open/read/write/close)
ScratchDir	String	0..1		The absolute path for a shared directory available for application data. Typically a POSIX accessible transient disk space shared between the execution environment instances. It MAY be used by MPI applications or to store intermediate files that need further processing by local jobs or as staging area, specially if the execution environment instances have no internet connectivity
ApplicationDir	String	0..1		The path of the directory available for application installation. Typically a PO-SIX accessible disk space with transient to permanent allocation to the users

Association End	Mult.	Description
ComputingService.ID [redefines Service.ID]	1	A computing manager participates in a computing service
ExecutionEnvironment.ID [redefines Resource.ID]	*	A computing manager manages one or more execution environments
ApplicationEnvironment.LocalID	*	A computing manager MAY use zero or more application environments
Benchmark.LocalID	*	A computing manager has zero or more associated benchmarks
Inherited Association End	**Mult.**	**Description**
Extension.Key	*	The entity MAY be extended via key-value pairs

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As regards the WorkingArea-related attributes and single-slot jobs, four scenarios should be considered. Both scenarios and related attribute values are presented in Table 1.

Table 1 Working Area and Single-slot jobs scenarios

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Working Area	Shared	Guaranteed
one working area shared across all the execution environments and shared across simultaneous jobs	true	false
one working area shared across all the execution environments with guaranteed quota to each job	true	true
a working area local to each execution environment, but shared across all the jobs which run simultaneously in the given execution environment	false	false
a working area local to each execution environment and dedicated to each job	false	true

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In case there is a dedicated working area for multi-slot jobs, this SHOULD be represented by the WorkingAreaMultiSlot* attributes. In case there is no dedicated working area for multi-slot jobs,

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i.e., there is a common working area for both single-slot and multi-slot jobs, we RECOMMEND to publish only the attributes related to the working area for single-slot jobs.

The Operating System MAY be the simplest case of computing manager. A typical example of computing manager is a batch system (i.e., LRMS).

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6.5 Benchmark

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The Benchmark class characterizes the relative performance of the computing resource through providing the result of a specific benchmark suite executed on the computing resource behind the Computing Service. The Benchmark class provides the both the type and the value of the benchmark suite.

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Entity	Inherits from			Description
Benchmark	Entity			Benchmark information about an entity providing computing capacity
Inherited Attribute	**Type**	**Mult.**	**Unit**	**Description**
CreationTime	*DateTime_t*	*0..1*		*Timestamp describing when the entity instance was generated*
Validity	*UInt64*	*0..1*	*s*	*The duration after CreationTime that the information presented in the Entity MAY be considered relevant. After that period has elapsed, the information SHOULD NOT be considered relevant*
ID [key]	*URI*	*1*		*A global unique ID*
Name	*String*	*0..1*		*Human-readable name*
OtherInfo	*String*	***		*Placeholder to publish info that does not fit in any other attribute. Free-form string, comma-separated tags, (name, value) pair are all examples of valid syntax*
Attribute	**Type**	**Mult.**	**Unit**	**Description**
Type	Benchmark_t	1		Type of benchmark
Value	Real32	1		Value
Association End		**Mult.**		**Description**
ExecutionEnvironment.ID		0..1		A benchmark MAY be related to an execution environment
ComputingManager. ID		0..1		A benchmark MAY be related to a computing resource
Inherited Association End		**Mult.**		**Description**
Extension.Key		*		The entity MAY be extended via key-value pairs

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6.6 ExecutionEnvironment

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The ExecutionEnvironment class describes the hardware and operating system environment in which a job will run. It represents a set of homogeneous Worker Nodes, so if a computing system contains nodes with significantly different properties there MAY be several ExecutionEnvironment instances. This implies that it should be possible to request a specific environment when a job is submitted. The ExecutionEnvironment MAY refer to virtual rather than physical machines.

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As well as attributes describing a typical node, the class gives summary information about the size and usage of the set of nodes which posess those properties. However, there is no way to relate these to the information in other entities, e.g. it is not possible to know which jobs in a given ComputingShare are running on which ExecutionEnvironment.

Entity	Inherits from			Description
ExecutionEnvironment	Resource			A type of environment available to and requestable by a Grid job when submitted to a ComputingService via a Computing Endpoint; the type of environment is described in terms of hardware, operating system and network characteristics; the information about the total/available/used instances of this type of execution environment are also included
Inherited Attribute	**Type**	**Mult.**	**Unit**	**Description**
CreationTime	*DateTime_t*	*0..1*		*Timestamp describing when the entity instance*

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				was generated
Validity	UInt64	0..1	s	The duration after CreationTime that the information presented in the Entity MAY be considered relevant. After that period has elapsed, the information SHOULD NOT be considered relevant
ID [key]	URI	1		A global unique ID
Name	String	0..1		Human-readable name
OtherInfo	String	*		Placeholder to publish info that does not fit in any other attribute. Free-form string, comma-separated tags, (name, value) pair are all examples of valid syntax
Attribute	Type	Mult.	Unit	Description
Platform	Platform_t	1		The architecture platform of this execution environment
VirtualMachine	ExtendedBoolean_t	0..1		True if the execution environment is based on a virtual machine (in this case, the values of the other attributes are related to the virtualized environment and not to the hosting environment)
TotalInstances	UInt32	0..1		Number of execution environment instances
UsedInstances	UInt32	0..1		Number of used execution environment instances; an instance is used when, according to the policies of the Computing Manager (i.e., LRMS), it cannot accept new jobs because it already runs the maximum number of allowed jobs
UnavailableInstances	UInt32	0..1		Number of unavailable execution environment instances because of failures or maintenance
PhysicalCPUs	UInt32	0..1		Number of physical CPUs in an execution environment instance
LogicalCPUs	UInt32	0..1		Number of logical CPUs in an execution environment instance
CPUMultiplicity	CPUMultiplicity_t	0..1		Information about the multiplicity of both physical CPUs and cores available in an execution environment instance
CPUVendor	String	0..1		Name of the physical CPU vendor
CPUModel	String	0..1		Physical CPU model as defined by the vendor
CPUVersion	String	0..1		Physical CPU version as defined by the vendor
CPUClockSpeed	UInt32	0..1	MHz	Nominal clock speed of the physical CPU
CPUTimeScalingFactor	Real32	0..1		Factor used by the Computing Manager (i.e., LRMS) to scale the CPU time (CPU Time divided by CPUTimeScalingFactor); for the reference execution environment, this attribute is equal to 1
WallTimeScalingFactor	Real32	0..1		Factor used by the Computing Manager (i.e., LRMS) to scale the Wall time (Wall Time divided by WallTimeScalingFactor)
MainMemorySize	UInt64	1	MB	Amount of RAM (if many jobs run in the same execution environment, they compete for the total RAM)
VirtualMemorySize	UInt64	0..1	MB	The amount of Virtual Memory (RAM+Swap)
OSFamily	OSFamily_t	1		Family of the operating system
OSName	OSName_t	0..1		Name of the operating system
OSVersion	String	0..1		Version of the operating system
ConnectivityIn	ExtendedBoolean_t	1		Permission for direct inbound connectivity, even if limited
ConnectivityOut	ExtendedBoolean_t	1		Permission for direct outbound connectivity, even if limited
NetworkInfo	NetworkInfo_t	*		Type of internal network available among the execution environment instances

Association End	Mult.	Description
ComputingManager.ID [redefines Manager.ID]	1	An execution environment is managed by a computing manager
ComputingShare.LocalID [redefines Share.LocalID]	*	An execution environment provides capacity in terms of computing shares
ComputingActivity.ID [redefines Activity.ID]	*	An execution environment runs zero or more computing activities
ApplicationEnvironment.LocalID	*	An execution environment offers zero or more application environments

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Benchmark.LocalID	*	An execution environment has zero or more associated benchmarks
Inherited Association End	**Mult.**	**Description**
Extension.Key	*	The entity MAY be extended via key-value pairs

Each execution environment instance is under the responsibility of a Computing Manager (i.e., LRMS). An execution environment MAY be realized in several ways. Examples are a computing node or a virtual machine image that MAY be requested by a job (different virtual machine images MAY coexist on the same node). The description about individual software packages is considered by the ApplicationEnvironment class.

6.7 ApplicationEnvironment

The ApplicationEnvironment class describes the software environment in which a job will run, i.e. what pre-installed software will be available to it. Each Application is identified by a name (the AppName attribute); these names are not defined within the schema, but SHOULD be assigned in a way which allows applications to be uniquely identifed. The properties of installed software MAY vary substantially, but the attributes of the class cover the most common cases, in particular for licensed software. If necessary, additional information MAY be added using the OtherInfo attribute and the Extension class.

Entity	Inherits from			Description
ApplicationEnvironment	Entity			Description of the application software or environment characteristic available within one or more execution environments
Inherited Attribute	**Type**	**Mult.**	**Unit**	**Description**
CreationTime	*DateTime_t*	*0..1*		*Timestamp describing when the entity instance was generated*
Validity	*UInt64*	*0..1*	s	*The duration after CreationTime that the information presented in the Entity MAY be considered relevant. After that period has elapsed, the information SHOULD NOT be considered relevant*
ID [key]	*URI*	*1*		*A global unique ID*
Name	*String*	*0..1*		*Human-readable name*
OtherInfo	*String*	*		*Placeholder to publish info that does not fit in any other attribute. Free-form string, comma-separated tags, (name, value) pair are all examples of valid syntax*
Attribute	**Type**	**Mult.**	**Unit**	**Description**
AppName	String	1		Name of the application environment
AppVersion	String	0..1		Version of the application environment
Repository	URI	0..1		URL of a service which offers a repository and/or a name service for this application environment
State	AppEnvState_t	0..1		State about the installation
RemovalDate	DateTime_t	0..1		Date and time after which the application MAY be removed
License	License_t	0..1		The type of license
Description	String	0..1		The description of this application environment
BestBenchmark	Benchmark_t	*		Type of benchmark which best identify the sensitivity of this application to the performance aspect
ParallelSupport	ParallelSupport_t	0..1		The type of supported parallel execution framework
MaxSlots	UInt32	0..1	slot	Maximum number of slots that MAY be used to run jobs using the application environment at the same time
MaxJobs	UInt32	0..1	job	Maximum number of jobs that MAY use the application environment at the same time
MaxUserSeats	UInt32	0..1	user seat	Maximum number of user seats that MAY use the application environment at the same time
FreeSlots	UInt32	0..1	slot	Available number slots that MAY be used to run jobs using the application environment at the same time

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FreeJobs	UInt32	0..1	slot	Number of new jobs that could start their execution and use the application environment at the same time
FreeUserSeats	UInt32	0..1	user seat	Free seats for additional users that MAY use the application environment at the same time
Association End		**Mult.**	**Description**	
ExecutionEnvironment.ID		*	An application environment MAY be used in zero or more execution environments	
ComputingManager.ID		1	An application environment is part of a computing manager	
ApplicationHandle.LocalID		*	An application environment MAY be handled via zero or more application handles	
Inherited Association End		**Mult.**	**Description**	
Extension.Key		*	The entity MAY be extended via key-value pairs	

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There is no recommendation for the Name attribute of the Application Environment. In some deployment scenario, the definition of namespace-based Names or guidelines for unique application names MAY be defined; application repository services relying on the unique application names MAY be provided. This aspect is considered out of scope for GLUE.

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The Application Environment is suggested to be used also for describing application software or special environment setup in terms of a simple tag. In this case, the Name attribute should be used.

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6.8 ApplicationHandle

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The ApplicationHandle class is an extension to ApplicationEnvironment for applications which need to be set up in some way before they MAY be used. For each supported setup method a string MAY be specified, the interpretation of which is specific to the method - in the simplest case this could just be a setup script to execute.

Entity	**Inherits from**			**Description**
ApplicationHandle	Entity			Technique for bootstrapping and/or accessing the application
Inherited Attribute	**Type**	**Mult.**	**Unit**	**Description**
CreationTime	*DateTime_t*	*0..1*		*Timestamp describing when the entity instance was generated*
Validity	*UInt64*	*0..1*	*s*	*The duration after CreationTime that the information presented in the Entity MAY be considered relevant. After that period has elapsed, the information SHOULD NOT be considered relevant*
ID [key]	*URI*	*1*		*A global unique ID*
Name	*String*	*0..1*		*Human-readable name*
OtherInfo	*String*	***		*Placeholder to publish info that does not fit in any other attribute. Free-form string, comma-separated tags, (name, value) pair are all examples of valid syntax*
Attribute	**Type**	**Mult.**	**Unit**	**Description**
Type	ApplicationHandle_t	1		Type of handle for an application environment
Value	String	1		Actionable value to trigger the handle method
Association End		**Mult.**	**Description**	
ApplicationEnvironment.LocalID		1	An application handle MAY be used for one application environment	
Inherited Association End		**Mult.**	**Description**	
Extension.Key		*	The entity MAY be extended via key-value pairs	

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6.9 ComputingActivity

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The ComputingActivity class represents a single (but possibly multi-processor) job. The attributes give the job properties and state as seen by the local batch system, together with some Grid-level information.

Entity	Inherits from			Description
ComputingActivity	Activity			An activity managed by an OGSA execution capability service (the computing activity is traditionally called job)
Inherited Attribute	*Type*	*Mult*	*Unit*	*Description*
CreationTime	*DateTime_t*	*0..1*		*Timestamp describing when the entity instance was generated*
Validity	*UInt64*	*0..1*	*s*	*The duration after CreationTime that the information presented in the Entity MAY be considered relevant. After that period has elapsed, the information SHOULD NOT be considered relevant*
ID [key]	*URI*	*1*		*A global unique ID*
Name	*String*	*0..1*		*Human-readable name*
OtherInfo	*String*	***		*Placeholder to publish info that does not fit in any other attribute. Free-form string, comma-separated tags, (name, value) pair are all examples of valid syntax*
Attribute	Type	Mult.	Unit	Description
Type	ComputingActivityType_t	0..1		Type of computing activity
IDFromEndpoint	URI	0..1		The job ID as assigned by the computing endpoint
LocalIDFromManager	String	0..1		The local ID of the job as assigned by the computing manager (i.e., LRMS)
JobDescription	JobDescription_t	0..1		Job description language used to specify the job request
State	ComputingActivityState_t	1		The state of the job according to the Grid state model for jobs
RestartState	ComputingActivityState_t	0..1		The state from which a failed job MAY restart upon a client request
ExitCode	Int32	0..1		The exit code as returned by the executable of the job
ComputingManagerExitCode	String	0..1		The exit code provided by the computing manager (i.e., LRMS)
Error	String	*		Error messages as provided by the software components involved in the management of the job
WaitingPosition	UInt32	0..1		For a waiting job in the computing manager (i.e., LRMS), the position of the job in the queue
UserDomain	String	0..1		User domain selected by the job owner in the job submission request (an owner MAY belong to several user domains, it should decide which one to choose when submitting a job)
Owner	String	1		The Grid identity of the job's owner; in case of anonymity is required, the value CONFIDENTIAL should be advertised
LocalOwner	String	0..1		The local user name to which the job's owner is mapped into
RequestedTotalWallTime	UInt64	0..1	s	The total wall clock time requested by the job; for multi-slot jobs, it represents the sum of wall clock time needed in each required slot
RequestedTotalCPUTime	UInt64	0..1	s	The total CPU time requested by the job for multi-slot jobs, it represents the sum of CPU time needed in each required slot
RequestedSlots	UInt32	0..1	slot	The number of requested slots
RequestedApplicationEnvironment	String	*		Serialization of the Name and

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				Version of the requested Application Environment to match the Name and Version properties of the Application Environment (the serialization of the Name and Version is delegated to the implementers)
StdIn	String	0..1		The name of the file which is used as the standard input of the job
StdOut	String	0..1		The name of the file which contains the standard output of the job
StdErr	String	0..1		The name of the file which contains the standard error of the job
LogDir	String	0..1		The name of the directory which contains the logs related to the job and generated by the Grid layer (usually the directory is private to the job)
ExecutionNode	String	*		Hostname associated to the execution environment instance (i.e., worker node) running the job; multi-node jobs are described by several instances of this attribute
Queue	String	0..1		The name of the Computing Manager (i.e, LRMS) queue to which this job was queued
UsedTotalWallTime	UInt64	0..1	s	The totally consumed wall clock time by the job (in case of multi-slot jobs, this value refers to the sum of the wall clock time consumed in each slot)
UsedTotalCPUTime	UInt64	0..1	s	The totally consumed CPU time by the job (in case of multi-slot jobs, this value refers to the sum of the consumed CPU time in each slot)
UsedMainMemory	UInt64	0..1	MB	The RAM used by the job
SubmissionTime	DateTime_t	0..1		Time when the job was submitted to a computing endpoint
ComputingManagerSubmissionTime	DateTime_t	0..1		Time when the job was submitted to the Computing Manager (i.e., LRMS) by the Grid layer
StartTime	DateTime_t	0..1		Time when the job entered in the Computing Manager (i.e., LRMS) running state
ComputingManagerEndTime	DateTime_t	0..1		Time when the job entered its final Computing Manager (i.e., LRMS) state
EndTime	DateTime_t	0..1		Time when the job entered its final Grid state
WorkingAreaEraseTime	DateTime_t	0..1		A working area is an allocated storage extent that holds the home directories of the Grid jobs; the time when the dedicated working area of this job will be removed
ProxyExpirationTime	DateTime_t	0..1		The expiration time of the proxy related to the job, in case of proxy with attribute certificates having different expiration times, then this value represent the minimum expiration time among all the values
SubmissionHost	String	0..1		The name of the host from which the job was submitted
SubmissionClientName	String	0..1		The name of the software client which was used to submit the job
OtherMessages	String	*		Optional job messages provided by either the Grid Layer or the Computing Manager (i.e., LRMS)
Association End		Mult.	Description	

ComputingEndpoint.ID [redefines Endpoint.ID]	0..1	A computing activity is submitted to a computing endpoint
ComputingShare.LocalID [redefines Share.LocalID]	0..1	A computing activity is mapped into a computing share
ExecutionEnvironment.ID [redefines Resource.ID]	0..1	A computing activity is executed in an execution environment
Inherited Association End	**Mult.**	**Description**
Extension.Key	*	The entity MAY be extended via key-value pairs
UserDomain.ID	0..1	An activity is managed by a user domain
Activity.ID	*	An activity is related to zero or more activities
Activity.ID	*	An activity is related to zero or more activities

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In this specification, the Computing Activity refers to simple jobs or element of collections or workflow. The description of the relationships between jobs part of a collection or workflow MAY be considered in future revisions of the specification.

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As regards the State attribute and the related ComputingActivityState_t type, we notice that currently there is no commonly accepted state model. Each production Grid middleware defined and is using its own state model. As regards the standardization process, the OGSA-BES specification defines a simple state model. The middleware providers started to define their own extensions to the BES state model, nevertheless they differ and do not enable interoperability. Given the current scenario, we RECOMMEND to use namespace in state model values, so that every middleware provider MAY publish the computing activity state according to its definition. We expect that an extension to the core BES state model common to all the middleware providers and suitable for production scenarios MAY be defined by a profiling activity of the BES/ /JSDL/GLUE specifications.

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6.10 ToStorageService

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The ToStorageService class represents the case where a filesystem from a Storage Service is available to jobs running on a Computing Service via POSIX access, e.g. as an NFS mount. Each ToToragеService instance represents a single mount point. It is assumed that such mounts are available on all nodes (i.e. all Execution Environments) in the Computing Service.

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Entity	Inherits from			Description
ToStorageService	Entity			Description of a POSIX access via a file system technology enabling the computing service to access the associated storage service
Inherited Attribute	*Type*	*Mult*	*Unit*	*Description*
CreationTime	*DateTime_t*	*0..1*		*Timestamp describing when the entity instance was generated*
Validity	*UInt64*	*0..1*	*s*	*The duration after CreationTime that the information presented in the Entity MAY be considered relevant. After that period has elapsed, the information SHOULD NOT be considered relevant*
ID [key]	*URI*	*1*		*A global unique ID*
Name	*String*	*0..1*		*Human-readable name*
OtherInfo	*String*	***		*Placeholder to publish info that does not fit in any other attribute. Free-form string, comma-separated tags, (name, value) pair are all examples of valid syntax*
Attribute	Type	Mult.	Unit	Description
LocalPath	String	1		The local path of the computing service enabling to access a remote path in the associated

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				storage service (this is typically an NFS mount point)
RemotePath	String	1		The remote path in the storage service which is associated the local path in the computing service (this is typically an NFS exported directory)
Association End		**Mult.**	**Description**	
ComputingService.ID		1	Is associated to a computing service	
StorageService.ID		1	Is associated to a storage service	
Inherited Association End		**Mult.**	**Description**	
Extension.Key		*	The entity MAY be extended via key-value pairs	

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7 Conceptual Model of the Storage Service

The conceptual model of the Storage Service is based upon the main entities and uses specializations of Service, Endpoint, Share, Manager, Resource, and Activity entities. Further storage related concepts such as Storage Service Capacity, Storage Share Capacity and Storage Access Protocol are introduced.

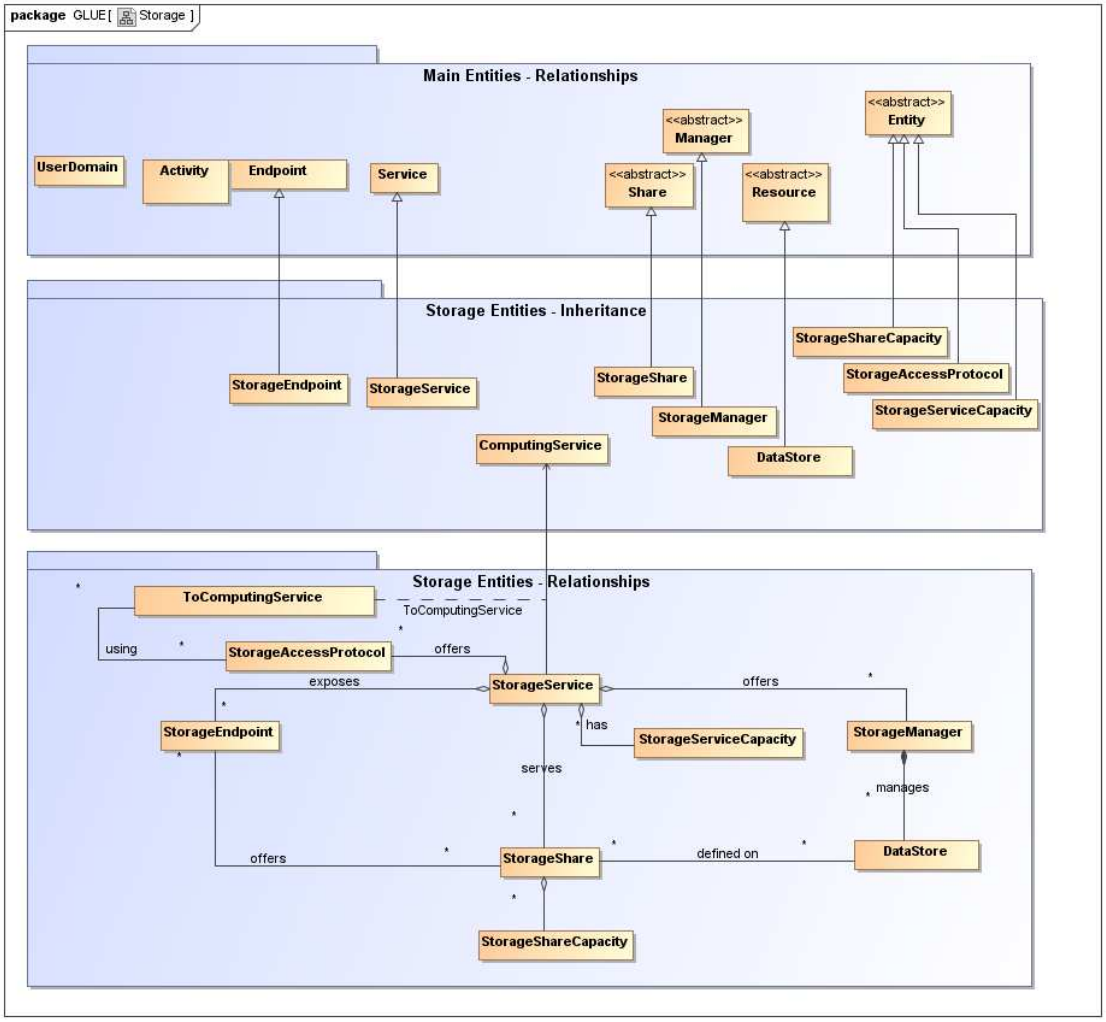

Figure 3 Entities and relationships for the Storage Service conceptual model

As explained in Section 6, we use the concept of storage extent to mean the capabilities and management of the various media that exist to store data and allow data retrieval.

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7.1 StorageService

A StorageService represents a Grid-enabled storage system, most often hosted by a single site, but possibly distributed over multiple sites. A StorageService makes StorageShares of given properties available to selected UserDomains, typically (not necessarily) through one or more explicitly identified StorageEndpoints. Data MAY be stored in or retrieved from StorageShares through one or more StorageAccessProtocols. A StorageShare is a composition of chunks from one or more DataStores. StorageShares MAY overlap. A DataStore represents a physical device that MAY hold data (e.g. a disk or a tape robot). Each DataStore is managed by a StorageManager, an instance of a particular product identified by the ProductName and ProductVersion. StorageServiceCapacity objects summarize capacity-related information for which details MAY be available associated to StorageShares and DataStores.

Entity	Inherits from			Description
StorageService	Service			An abstracted, logical view of actual software components that participate in the creation of a storage capacity in a Grid environment. A storage service exposes zero or more endpoints having well-defined interfaces, zero or more storage shares and zero or more storage managers and the related data stores. The storage service also offers zero or more storage access protocols and provides summary information about the global capacity by means of the storage service capacity The storage service is autonomous and denotes a weak aggregation among storage endpoints, storage shares, storage managers, storage access protocols and storage service capacity. The storage service enables to identify the whole set of entities providing the storage functionality with a persistent name.
Inherited Attribute	**Type**	**Mult**	**Unit**	**Description**
CreationTime	*DateTime_t*	*0..1*		*Timestamp describing when the entity instance was generated*
Validity	*UInt64*	*0..1*	*s*	*The duration after CreationTime that the information presented in the Entity MAY be considered relevant. After that period has elapsed, the information SHOULD NOT be considered relevant*
ID [key]	*URI*	*1*		*A global unique ID*
Name	*String*	*0..1*		*Human-readable name*
OtherInfo	*String*	***		*Placeholder to publish info that does not fit in any other attribute. Free-form string, comma-separated tags, (name, value) pair are all examples of valid syntax*
Capability	*Capability_t*	***		*The provided capability according to the OGSA architecture (it is given by the sum of all the capabilities provided by the related endpoints)*
Type	*ServiceType_t*	*1*		The type of service according to a namespace-based classification (the namespace MAY be related to a middleware name, an organization or other concepts; org.glue and org.ogf are reserved)
QualityLevel	*QualityLevel_t*	*1*		*Maturity of the service in terms of quality of the software components*
StatusInfo	*URI*	***		*Web page providing additional information like monitoring aspects*
Complexity	*String*	*0..1*		*Human-readable summary description of the complexity in terms of the number of endpoint types, shares and resources. The syntax should be: endpointType=X, share=Y, resource=Z.*
Attribute	**Type**	**Mult**	**Unit**	**Description**
No extra properties are defined in the specialized entity				

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Association End	Mult.	Description
StorageEndpoint.ID [redefines Endpoint.ID]	*	A storage service exposes zero or more storage endpoints
StorageShare.LocalID [redefines Share.LocalID]	*	A storage service serves zero or more storage shares
StorageManager.ID [redefines Manager.ID]	*	A storage service provides zero or more storage managers
StorageAccessProtocol.LocalID	*	A storage service offers zero or more storage access protocols
StorageServiceCapacity.LocalID	*	A storage service has zero or more storage service capacities
Inherited Association End	**Mult.**	**Description**
Extension.Key	*	The entity MAY be extended via key-value pairs
Contact.ID	*	A service has zero or more contacts
Location.ID	0..1	A service is primary located at a location
Service.ID	*	A service is related to zero or more services

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The storage service MAY expose storage endpoints enabling to manage or access different types of storage capacity. The usage of storage capacity is typically constrained by policies, thus implying service differentiation. Each homogenously constrained storage capacity is described by the storage share concept.

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The storage capacity used to create shares is locally managed by a storage manager and provided by data stores.

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7.2 StorageServiceCapacity

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A StorageServiceCapacity summarizes capacity-related information for all the StorageShares and DataStores of a given homogeneous type. The summaries MAY be compared to the sums of the relevant StorageShareCapacity attributes for the StorageShares of the given type. Capacities of overlapping StorageShares MUST only be counted once. An inconsistency between a summary value and the corresponding sum of relevant attributes MAY occur if part of the capacity is not explicitly published, or if the attributes concerned could not all be exactly determined or recorded at the same time. The summaries MAY also be compared to the sums of the relevant attributes of the DataStores of the given type, where inconsistencies MAY arise due to similar causes.

Entity	Inherits from			Description
StorageServiceCapacity	Entity			Description of the size and usage of an homogenous storage extent; the storage extent is aggregated at the storage service level by type
Inherited Attribute	**Type**	**Mult**	**Unit**	**Description**
CreationTime	*DateTime_t*	*0..1*		*Timestamp describing when the entity instance was generated*
Validity	*UInt64*	*0..1*	*s*	*The duration after CreationTime that the information presented in the Entity MAY be considered relevant. After that period has elapsed, the information SHOULD NOT be considered relevant*
ID [key]	*URI*	*1*		*A global unique ID*
Name	*String*	*0..1*		*Human-readable name*
OtherInfo	*String*	***		*Placeholder to publish info that does not fit in any other attribute. Free-form string, comma-separated tags, (name, value) pair are all examples of valid syntax*
Attribute	**Type**	**Mult.**	**Unit**	**Description**
Type	StorageCapacity_t	1		Type of storage capacity
TotalSize	UInt64	0..1	GB	Size of dedicated storage extent which is available to users (either free, used or reserved)
FreeSize	UInt64	0..1	GB	Size of free storage extent
UsedSize	UInt64	0..1	GB	Size of used storage extent
ReservedSize	UInt64	0..1	GB	Size of reserved storage extent
Association End		**Mult.**	**Description**	

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StorageService.ID	1	A storage service capacity is related to one storage service
Inherited Association End	**Mult.**	**Description**
Extension.Key	*	The entity MAY be extended via key-value pairs

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7.3 StorageAccessProtocol

A StorageAccessProtocol describes a protocol that MAY be used to store data in or retrieve data from StorageShares. The "file" protocol indicates that for ComputingServices given by ToComputingService objects the StorageShares are available through POSIX I/O. The mount point details are given by corresponding ToStorageService objects published by those ComputingServices. Most protocols require a negotiation between the client and a StorageEndpoint. For example, a StorageEndpoint implementing a version of the SRM protocol MAY be asked for a data transfer URL corresponding to a desired access protocol. An access protocol that does not require prior negotiation MAY be published as the Interface in a StorageEndpoint supporting that protocol [FIXME].

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Entity	Inherits from			Description
StorageAccessProtocol	Entity			A type of protocol available to access the available storage capacities
Inherited Attribute	**Type**	**Mult**	**Unit**	**Description**
CreationTime	*DateTime_t*	*0..1*		*Timestamp describing when the entity instance was generated*
Validity	*UInt64*	*0..1*	*s*	*The duration after CreationTime that the information presented in the Entity MAY be considered relevant. After that period has elapsed. the information SHOULD NOT be considered relevant*
ID [key]	*URI*	*1*		*A global unique ID*
Name	*String*	*0..1*		*Human-readable name*
OtherInfo	*String*	***		*Placeholder to publish info that does not fit in any other attribute. Free-form string, comma-separated tags, (name, value) pair are all examples of valid syntax*
Attribute	**Type**	**Mult.**	**Unit**	**Description**
Type	StorageAccessProtocol_t	1		The name of the protocol
Version	String	1		The version of the protocol
MaxStreams	UInt32	0..1	stream	The number of parallel streams this protocol supports
Association End		**Mult.**		**Description**
StorageService.ID		1		A storage access protocol is related to one storage service
ToComputingService		*		A storage access protocol MAY be used by zero or more computing services
Inherited Association End		**Mult.**		**Description**
Extension.Key		*		The entity MAY be extended via key-value pairs

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If a type of storage access protocol needs to be discoverable, then the storage access protocol class SHOULD be used. If a certain access protocol has a URL and this URL needs to be discoverable, then the access protocol SHOULD be also published via the storage endpoint.

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7.4 StorageEndpoint

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A StorageEndpoint represents a service that MAY be contacted by clients to manage StorageShares and to store or retrieve data. The StorageEndpoint typically implements a control protocol given by the Interface, which allows for the manipulation of StorageShares and the properties of their data content. Access to StorageShares for storing for retrieving data often has to be negotiated through the given control protocol. The available access protocols MAY be published in StorageAccessProtocol objects. The StorageEndpoint Interface MAY also indicate itself an access protocol that does not require prior negotiation [FIXME]. The StorageEndpoint

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MAY be able to serve only a subset of the StorageShares within the StorageService, in which case that subset MAY be indicated through explicit associations with those StorageShares.

Entity	Inherits from			Description
StorageEndpoint	Endpoint			Endpoint for managing storage shares or for accessing them; it MAY be used to expose also complementary capabilities part of the storage service
Inherited Attribute	Type	Mult	Unit	Description
CreationTime	*DateTime_t*	*0..1*		*Timestamp describing when the entity instance was generated*
Validity	*UInt64*	*0..1*	s	*The duration after CreationTime that the information presented in the Entity MAY be considered relevant. After that period has elapsed, the information SHOULD NOT be considered relevant*
ID [key]	*URI*	*1*		*A global unique ID*
Name	*String*	*0..1*		*Human-readable name*
OtherInfo	*String*	***		*Placeholder to publish info that does not fit in any other attribute. Free-form string, comma-separated tags, (name, value) pair are all examples of valid syntax*
URL	*URI*	*1*		*Network location of the endpoint to contact the related service*
Capability	*Capability_t*	***		*The provided capability according to the OGSA architecture*
Technology	*EndpointTechnology_t*	*0..1*		*Technology used to implement the endpoint*
InterfaceName	*URI*	*1*		*Identification of a of the interface*
InterfaceVersion	*String*	*0..**		*Version of the interface*
InterfaceExtension	*URI*	***		*Identification of an extension to the interface*
WSDL	*URI*	***		*URL of the WSDL document describing the offered interface (applies to Web Services endpoint)*
SupportedProfile	*URI*	***		*URI identifying a supported profile*
Semantics	*URI*	***		*URI of a document providing a human-readable description of the semantics of the endpoint functionalities*
Implementor	*String*	*0..1*		*Main organization implementing this software component*
ImplementationName	*String*	*0..1*		*Name of the implementation*
ImplementationVersion	*String*	*0..1*		*Version of the implementation (e.g., major version.minor version.patch version)*
QualityLevel	*QualityLevel_t*	*1*		*Maturity of the endpoint in terms of quality of the software components*
HealthState	*EndpointHealthState_t*	*1*		*A state representing the health of the endpoint in terms of its capability of properly delivering the functionalities*
HealthStateInfo	*String*	*0..1*		*Textual explanation of the state endpoint*
ServingState	*ServingState_t*	*1*		*A state specifying if the endpoint is accepting new requests and if it is serving the already accepted requests*
StartTime	*DateTime_t*	*0..1*		*The timestamp for the start time of the endpoint*
IssuerCA	*DN_t*	*0..1*		*Distinguished name of Certification Authority issuing the certificate for the endpoint*
TrustedCA	*DN_t*	***		*Distinguished name of the trusted Certification Authority (CA), i.e., certificates issued by the CA are accepted for the authentication process*
DowntimeAnnounce	*DateTime_t*	*0..1*		*The timestamp for the announcement of the next scheduled downtime*
DowntimeStart	*DateTime_t*	*0..1*		*The starting timestamp of the next scheduled downtime*
DowntimeEnd	*DateTime_t*	*0..1*		*The ending timestamp of the next scheduled downtime*
DowntimeInfo	*String*	*0..1*		*Description of the next scheduled downtime*
Attribute	Type	Mult.	Unit	Description

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No extra properties are defined in the specialized entity		
Association End	**Mult.**	**Description**
StorageService.ID [redefines Service.ID]	1	A storarge endpoint is part of a storage service
StorageShare.LocalID [redefines Share.LocalID]	*	A storage endpoint MAY pass activities to zero or more storage shares
Inherited Association End	**Mult.**	**Description**
Extension.Key	*	The entity MAY be extended via key-value pairs
AccessPolicy.ID	*	An endpoint has assocated zero or more AccessPolicies

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7.5 StorageShare

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A StorageShare is a composition of chunks from one or more DataStores. StorageShares that overlap have the same SharingID, which in that case MUST neither be empty nor the string "dedicated". A DataStore represents a physical device that MAY hold data (e.g. a disk or a tape robot). A StorageShare need not be composed of homogeneous devices. The AccessLatency gives the maximum latency category for a file stored in the StorageShare to be made available for reading. For example, if the StorageShare comprises both disk and tape, and data MAY need to be recalled from tape, the published AccessLatency is "nearline". The RetentionPolicy indicates the probability of the StorageShare losing data. For example, "custodial" represents a very low probability, while "replica" indicates that the StorageShare is not suitable for keeping the only copy of precious data, but MAY be used for keeping a replica of such data. The ExpirationMode indicates what happens to data whose lifetime has expired, if ever. The Identifier allows the StorageShare to be given a tag that is meaningful for the UserDomain(s) served by the StorageShare. For example, for version 2.2 of the SRM control protocol a StorageShare would represent a Space and the Identifier the corresponding SpaceTokenUserDescription. Capacity-related information is made available through StorageShareCapacity objects. A StorageShare need not be available through StorageEndpoints not explicitly listed.

Entity	**Inherits from**			**Description**
StorageShare	Share			A utilization target for a set of data stores defined by a set of configuration parameters and characterized by status information
Inherited Attribute	***Type***	***Mult***	***Unit***	***Description***
CreationTime	*DateTime_t*	*0..1*		*Timestamp describing when the entity instance was generated*
Validity	*UInt64*	*0..1*	s	*The duration after CreationTime that the information presented in the Entity MAY be considered relevant. After that period has elapsed, the information SHOULD NOT be considered relevant*
ID [key]	*URI*	*1*		*A global unique ID*
Name	*String*	*0..1*		*Human-readable name*
OtherInfo	*String*	***		*Placeholder to publish info that does not fit in any other attribute. Free-form string, comma-separated tags, (name, value) pair are all examples of valid syntax*
Description	*String*	*0..1*		*Description of this share*
Attribute	**Type**	**Mult.**	**Unit**	**Description**
ServingState	ServingState_t	1		A state specifying if the share is open to place new requests and if it is open to offer the already present requests for execution
Path	String	0..1		A namespace where files are logically assigned to when they are stored into this share
AccessMode	AccessMode_t	0..*		read, write, stage, scratch
SharingID	LocalID_t	1		Local ID common to the storage shares which use the same storage share capacities ('dedicated' is a reserved term and means that the storage share capacities are not shared with other storage share capacities part of different storage shares)
AccessLatency	AccessLatency_t	1		The maximum latency category for a file stored in this share to be made available for reading
RetentionPolicy	RetentionPolicy_t	*		The quality of retention, which indicates the

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				probability of the storage system losing a file
ExpirationMode	ExpirationMode_t	0..3		Support for files with infinite and/or finite lifetimes, and what actions the storage service MAY take upon the expiration of a file
DefaultLifeTime	UInt32	0..1	s	The default lifetime assigned to the file if no explicit lifetime is specified
MaximumLifeTime	UInt32	0..1	s	The maximum lifetime that MAY be requested for a file
Tag	String	0..1		An identifier defined by a user domain which identifies a share with a specific set of properties

Association End	Mult.	Description
StorageEndpoint.ID [redefines Endpoint.ID]	*	A storage share is consumed via zero or more endpoints
DataStore.ID [redefines Resource.ID]	*	A storage share is defined on zero or more data stores
StorageService.ID [redefines Service.ID]	1	A storage share participates in a storage service
StorageShareCapacity.LocalID	*	A storage share offers zero or more storage share capacities
Inherited Association End	**Mult.**	**Description**
Extension.Key	*	The entity MAY be extended via key-value pairs
MappingPolicy.ID	*	A share has zero or more mapping policies

A storage share represents a utilization target of one or more storage capacities which policies are homogeneous. If many user domains are mapped to a storage share via a mapping policy, then they compete to the usage without any differentiation. A storage share MAY have many types of storage capacities. The status of each type of storage capacity as regards the usage by the user domains is described by the StorageShareCapacity.

7.6 StorageShareCapacity

The StorageShareCapacity class provides a set of attributes related to the size of the data storage associated with a StorageShare. One StorageShare MAY have several associated StorageShareCapacity objects of different Types, which MAY be related either to the physical nature of the storage medium or to the intended use, e.g. accounting or resource discovery. It is therefore possible that the same physical storage MAY be reported in more than one object. The size information relates to the values as seen by a user of the Service, which MAY not correspond directly to the size of the physical storage media which underly it.

The semantics of this class are the same as the StorageServiceCapacity class which represent the size of the entire Storage Service, but the classes are different since the relations are different. In general it cannot be assumed that the Storage Service Capacity is the sum of all the corresponding Storage Share Capacities, both because some information at the Share level MAY not be published, and because multiple StorageShare objects MAY share the same physical storage.

Entity	Inherits from			Description
StorageShareCapacity	Entity			Description of the size and usage of an homogenous storage extent available to a storage share
Inherited Attribute	*Type*	*Mult*	*Unit*	*Description*
CreationTime	*DateTime_t*	*0..1*		*Timestamp describing when the entity instance was generated*
Validity	*UInt64*	*0..1*	*s*	*The duration after CreationTime that the information presented in the Entity MAY be considered relevant. After that period has elapsed, the information SHOULD NOT be considered relevant*
ID [key]	*URI*	*1*		*A global unique ID*
Name	*String*	*0..1*		*Human-readable name*
OtherInfo	*String*	*		*Placeholder to publish info that does not fit in any other attribute. Free-form string, comma-*

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				separated tags, (name, value) pair are all examples of valid syntax
Attribute	Type	Mult.	Unit	Description
Type	StorageCapacity_t	1		Type of storage capacity
TotalSize	UInt64	0..1	GB	Size of dedicated storage extent
FreeSize	UInt64	0..1	GB	Size of free storage extent
UsedSize	UInt64	0..1	GB	Size of used storage extent
ReservedSize	UInt64	0..1	GB	Size of reserved storage extent
OtherInfo	String	*		Placeholder to publish info that does not fit in any other attribute. Free-form string, comma-separated tags, (name, value) pair are all examples of valid syntax
Association End		Mult.	Description	
StorageShare.LocalID		1	A storage share capacity is related to one storage share	
Inherited Association End		Mult.	Description	
Extension.Key		*	The entity MAY be extended via key-value pairs	

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The storage share capacity is useful to express the usage information of a homogenous storage extent allocated to a share. Such usage information refers to the user domains which are related to the storage share via mapping policies.

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7.7 StorageManager

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The StorageManager class respresents the software system which manages the data storage media. If different media, e.g. tape and disk, are managed by different software systems there MAY be multiple StorageManager instances for a single StorageService. In some systems there MAY be a number of layers of software, but this cannot be represented. At present no attributes are defined beyond those inherited from the Manager entity, i.e. the Name and Version of the software product.

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Entity	Inherits from			Description
StorageManager	Manager			The primary software component locally managing one or more data stores. It MAY describe also aggregated information about the managed resources.
Inherited Attribute	Type	Mult	Unit	Description
CreationTime	DateTime_t	0..1		Timestamp describing when the entity instance was generated.
Validity	UInt64	0..1	s	The duration after CreationTime that the information presented in the Entity MAY be considered relevant. After that period has elapsed, the information SHOULD NOT be considered relevant.
ID [key]	URI	1		A global unique ID
Name	String	0..1		Human-readable name
OtherInfo	String	*		Placeholder to publish info that does not fit in any other attribute. Free-form string, comma-separated tags, (name, value) pair are all examples of valid syntax
ProductName	String	1		Name of the software product adopted as manager
ProductVersion	String	0..1		Version of the software product adopted as manager
Attribute	Type	Mult.	Unit	Description
No extra properties are defined in the specialized entity.				
Association End		Mult.	Description	
StorageService.ID [redefines Service.ID]		1	A storage manager participates in a storage service	
DataStore.ID [redefines Resource.ID]		*	A storage manager manages zero or more data stores.	
Inherited Association End		Mult.	Description	
Extension.Key		*	The entity MAY be extended via key-value pairs	

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7.8 DataStore

The DataStore class represents the physical storage systems underlying the Storage Service. Typically there will be one DataStore instance for each homogeneous type of storage, e.g. tape and disk. However, multiple objects of the same Type MAY be published if the storage is segmented at a high level, e.g. if there are two separate robotic tape stores.

Entity	Inherits from			Description
DataStore	Resource			Abstracted of a sufficiently homogeneous storage device providing a storage capacity, managed by a local software component (storage manager), part of a storage service, reachable via zero or more endpoints and having zero or more shares defined on it. A data store refers to a category with summary information on the capacity
Inherited Attribute	**Type**	**Mult.**	**Unit**	**Description**
CreationTime	*DateTime_t*	*0..1*		*Timestamp describing when the entity instance was generated*
Validity	*UInt64*	*0..1*	*s*	*The duration after CreationTime that the information presented in the Entity MAY be considered relevant. After that period has elapsed, the information SHOULD NOT be considered relevant*
ID [key]	*URI*	*1*		*A global unique ID*
Name	*String*	*0..1*		*Human-readable name*
OtherInfo	*String*	*		*Placeholder to publish info that does not fit in any other attribute. Free-form string, comma-separated tags, (name, value) pair are all examples of valid syntax*
Attribute	**Type**	**Mult.**	**Unit**	**Description**
Type	DataStoreType_t	1		Type of data store
Latency	AccessLatency_t	1		The actual latency category for a file stored in this resource to be made available for reading
TotalSize	UInt64	0..1	GB	Size of storage extent
FreeSize	UInt64	0..1	GB	Size of free storage extent
UsedSize	UInt64	0..1	GB	Size of used storage extent
Association End		**Mult.**		**Description**
StorageManager.ID [redefines Manager.ID]		1		A data store is managed by a storage manager
StorageShare.LocalID [redefines Share.LocalID]		*		A data store provides capacity in terms of zero or more storage shares
Inherited Association End		**Mult.**		**Description**
Extension.Key		*		The entity MAY be extended via key-value pairs

7.9 ToComputingService

The ToComputingService class describes a network connection between a Storage Service and a Computing Service which has a level of performance significantly better than the general WAN connection. It is assumed that such a connection applies to the entirety of those Services, i.e. to all Worker Nodes within the Computing Service and all storage within the Storage Service. However, the connection MAY depend on the Access Protocol used to transfer the data.

Entity	Inherits from			Description
ToComputingService	Entity			Description of the network link quality between a storage service and a computing service and of a potentially dedicated access protocol that the computing service MAY use to access the storage service
Inherited Attribute	**Type**	**Mult.**	**Unit**	**Description**
CreationTime	*DateTime_t*	*0..1*		*Timestamp describing when the entity instance was generated*

Validity	*UInt64*	*0..1*	*s*	*The duration after CreationTime that the information presented in the Entity MAY be considered relevant. After that period has elapsed, the information SHOULD NOT be considered relevant*
ID [key]	*URI*	*1*		*A global unique ID*
Name	*String*	*0..1*		*Human-readable name*
OtherInfo	*String*	***		*Placeholder to publish info that does not fit in any other attribute. Free-form string, comma-separated tags, (name, value) pair are all examples of valid syntax*

Attribute	Type	Mult.	Unit	Description
NetworkInfo	NetworkInfo_t	0..1		Type of network available among the storage service and computing service
Bandwidth	UInt32	0..1	Mb/s	The nominal bandwidth available between the storage service and computing service

Association End	Mult.	Description
StorageAccessProtocol.LocalID	*	The storage service MAY be accessed via an access protocol by a certain computing service
ComputingService.ID	1	Is associated to a computing service
StorageService.ID	1	Is associated to a storage service

Inherited Association End	Mult.	Description
Extension.Key	*	The entity MAY be extended via key-value pairs

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8 Relationship to OGF Reference Model

In this section, we describe the integration of the GLUE information model with the OGF Reference Model [rm]. The reference model defines the concept of Grid Component. In GLUE, a root concept called Entity is defined. Such a root concept MAY be defined as a specialization of the GridComponent concept, that means that all properties are inherited by the GLUE classes. In Figure 4, we represent this relationship by a UML class diagram.

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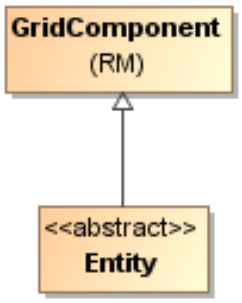

Figure 4 GLUE and Reference Model integration

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9 Security Considerations

This section considers security implications when using the GLUE 2.0 conceptual model. It follows the advice given in RFC-3552.

As the conceptual model of GLUE 2.0 provides limited scope for embedding security information many of these concerns listed here are delegated to the concrete data models and to the underlying software implementations. Nonetheless, some points are independent of which concrete data model is employed so some discussion is appropriate.

When deploying an information service conforming to the GLUE 2.0 conceptual model, consideration should be given to the points discussed below.

9.1 Communication security

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The GLUE conceptual model is independent of how information is stored and how that information is exchanged between agents. Because of this, concern for communication security is largely delegated to the underlying concrete data model and software implementations.

9.1.1 Confidentiality

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The GLUE conceptual model contains information that MAY be personal or confidential in nature. Contact details and indications of end-user activity MAY fall into this category.

Conforming implementations should identify which components of the data should be considered confidential and appropriate precautions should be in place to safeguard against disclosure to unintended audiences.

9.1.2 Data integrity

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The information within GLUE has many potential uses, from operational to accounting. How accurate the information is MAY depend on many factors, including the integrity of software agents that publish data and the transport used to propagate information.

The software used to provide an information service MAY cache GLUE information. If so, the caches provide additional points where data integrity MAY be compromised.

9.1.3 Peer Entity authentication

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No explicit description of the agents that publish information is included within the GLUE conceptual model. This prevents authentication information from being included within the abstract model.

In general, support for peer-entity authentication is delegated to the concrete data model or the underpinning software. In many cases the agents will act on behalf of some AdminDomain; if so, elements of peer entity authentication (e.g., public/private key-pairs) MAY be included using the described schema extension mechanisms provided issues with data integrity are understood.

9.2 Non-repudiation

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The GLUE conceptual model contains no explicit description of the publishing agents that provide GLUE information. This prevents explicitly support for non-repudiation. In many cases a set of publishing agents will provide information for Services in some AdminDomain. If so, then it is the AdminDomain that asserts the non-repudiation of the data the publishing agents provide.

Non-repudiation MAY require information from whoever asserts the non-repudiation of the data; for example, a cryptographic certificate of some AdminDomain. If the publishing agent is identified with an AdminDomain then this information MAY be included using the schema extension mechanisms of the AdminDomain (via OtherInfo or Extension). It is also possible for this information to be included in fields specific to the concrete data model or it MAY be provided outside of the GLUE conceptual model.

In addition, information MAY be published with corresponding non-repudiation information, such as a cryptographic signature. Signatures MAY be included using schema extensions (OtherInfo or Extension) or MAY be included in fields specific to the concrete data model.

9.3 System security

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The GLUE conceptual model intended use is to provide an abstract view of a grid system. There are many processes that MAY make use of this information, each MAY depend on the GLUE conceptual model to undertake work.

9.3.1 Unauthorized usage

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The GLUE conceptual model has no explicit description of end-users of the schema information and no explicit description of authorized usage. In general, is assumed that any authorization controls for access to the GLUE information is provided by specific concrete bindings and software implementation.

It MAY be possible to identify a UserDomain with those agents authorised to use GLUE information and embed authorization information using described schema extension mechanisms, provided issues with data integrity are understood.

9.3.2 Inappropriate Usage

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The GLUE conceptual model provides no mechanism for describing appropriate usage and does not include a data-processing model, so providing a description of inappropriate usage is considered out-of-scope.

Individual grids MAY describe what they consider appropriate usage of GLUE information and implement appropriate procedures to ensure this policy is enacted.

9.4 Specific attacks

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RFC-3552 describes several specific attacks that MUST be considered. These are detailed below.

9.4.1 Eavesdropping

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Some information described in the GLUE conceptual model MAY be sensitive in nature; this MAY include contact details and descriptions of user activity. Appropriate care should be taken to prevent unintended access or disclosure to an unintended audience.

9.4.2 Replay

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Grid operations MAY depend on information provided in the GLUE conceptual model.

If a system implementing the GLUE 2.0 conceptual model is susceptible to a replay attack then it is possible for part (possibly all) of the information in the conceptual model to be reverted to some previous state as seen by some (possible all) end users. Please note that this is a specific case of the more general modification attack.

A replay attack MAY result in disrupted service. If security attributes, such as authorization, are embedded within the GLUE conceptual model then a replay attack MAY result in inappropriate access to data.

Underlying concrete models and software implementations should prevent replay attacks.

9.4.3 Message insertion

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The ability to insert information is key to providing accurate information. However, inserting incorrect information MAY have a detrimental effect to the running systems; for example, there are attributes in the conceptual model that accept multiple values. If incorrect values are included, the systems MAY suffer.

Many aspects of GLUE provide service discovery. Inserting false information would allow unauthorised services to publish their presence and attract activity. This MAY be used as a basis for further attacks.

Underlying concrete models and software implementations should ensure that any agent's ability to insert information is limited and appropriate.

9.4.4 Deletion

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The ability to delete information from an information service could interfere with normal operations; for example, if Services are removed then activity that would use those services MAY be affected; if AdminDomains are removed then normal operation procedures MAY be impossible; if security components are removed (such as X509 certificates) then facilities such as non-repudiation MAY become ineffectual.

Underlying concrete models and implementing software should ensure that any ability of an agent to delete information is limited and appropriate.

9.4.5 Modification

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The ability for an agent to modify information stored in an information service is key to providing accurate information. However, concrete data models and software implementation should place limits such that the agents' ability to modify information is controlled and appropriate.

9.4.6 Man-in-the-middle

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For a system implementing the GLUE conceptual model, a successful man-in-the-middle attack MAY lead to arbitrary modification of data (see 9.4.5). It MAY also allow deleting existing data (see 9.4.4) or adding additional data (see 9.4.3). This MAY have severe influence on the systems based on GLUE information.

Underlying concrete models and implementing software should understand the risk from man-in-the-middle attacks and provide appropriate security against them.

9.4.7 Denial of service attacks

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A Denial of Service attack is one that attempts to prevent normal operation of systems. Perhaps, the most obvious is to prevent or corrupt the flow of information.

Systems using the GLUE conceptual model should understand the consequences of a partial or complete lack of information. Appropriate measures should be taken to ensure the systems continue to run to the extent possible.

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11 Contributors & Acknowledgements

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Please refer to RFC 3552 (http://www.ietf.org/rfc/rfc3552.txt) for guidance on writing a security considerations section. This section is required in all documents, and should not just say "there are no security considerations." Quoting from the RFC: ¶
¶
"Most people speak of security as if it were a single monolithic property of a protocol or system, however, upon reflection, one realizes that it is clearly not true. Rather, security is a series of related but somewhat independent properties. Not all of these properties are required for every application.¶
¶
We can loosely divide security goals into those related to protecting communications (COMMUNICATION SECURITY, also known as COMSEC) and those relating to protecting systems (ADMINISTRATIVE SECURITY or SYSTEM SECURITY). Since communications are carried out by systems and access to systems is through communications channels, these goals obviously interlock, but they can also be independently provided."¶

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[XSRL] NorduGrid XRSL (Extended Resource Specification Language) - http://www.nordugrid.org/documents/xrsl.pdf
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Place-holder values for unknown data

Whilst people endeavor to provide accurate information, there MAY be situations where specific GLUE attributes MAY be assigned place-holder (or dummy) values. These place-holder values carry some additional semantic meaning; specifically, that the correct value is currently unknown and the presented value should be ignored. This appendix describes a set of such place-holder values.

Some attributes within the GLUE schema are required whilst others are optional. If the attribute is optional and the corresponding information is unavailable, the information provider MUST either
publish a place-holder or not to publish the attribute. If the attribute is required, then the information MUST either publish a place-holder value or refrain from publishing the GLUE object.

If a place-holder value is published, it MUST conform to the scheme described in this appendix. This is to increase the likelihood that software will understand the nature of the information it receives.

This appendix describes place-holder values that have be chosen so they are obvious "wrong" to humans, unlikely to occur under normal operation and valid within the attribute type. This also allows for detection of failing information provider components.

16.1 Use cases

There are two principle use-cases for place-holder values, although others MAY exist.

Scenario 1. a static value has no good default value and has not been configured for a particular site.

Some provisions for GLUE Schema provide templates. These templates MAY contain attributes that have no good default value; for example, supplying the correct value MAY require site-specific knowledge. Whilst it is expected that these attributes be configured, it is possible that this does not happen, so exposing the attributes' default values.

Scenario 2. information provider is unable to obtain a dynamic value.

A dynamic value is provided by an information provider by querying the underlying grid resources. This query will use a number of ancillary resources (e.g., DNS, network hardware) that might fail; the grid services might also fail. If an attribute is required and the current value is unobtainable, a place-holder value MUST be used.

16.2 Place-holder values

This section describes a number of values that MAY be represented within a given address space (e.g., Strings/UTF-8, Integers, FQDNs, IPv4 address space). Each of the different types are introduced along with the place-holder value and a brief discussion on usage, rational
and any other considerations.

16.3 Extended booleans

The reserved value “undefined” SHOULD be used. The way to express that no value is published MUST be defined in the documents defining the realization to concrete data models (e.g., [glue-real]).

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16.4 Simple strings

(ASCII/UTF-8) should use "UNDEFINEDVALUE" or should start "UNDEFINEDVALUE:"

Upper-case letters make it easier to spot and a single word avoids any white-space issues. A short error message MAY be incorporated into the message by appending the message after the colon.

Examples:
UNDEFINEDVALUE
UNDEFINEDVALUE: unable to contact torque daemon.

Using UNDEFINEDVALUE is a default option for strings that have no widely-known structure. If a value is of a more restrictive sub-type (e.g., FQDNs, FQANs, URIs) described below, then the rules for more restrictive form MUST be used.

16.5 Fully qualified domain names

They MUST use a hostname ending either "example.org" for scenario 1, or "invalid" for scenario 2.

RFC 2606 defines two second-level domains: "example.org" and "example.com". These domains have the advantage of ending with a recognisable TLD, so are recognisable as a DNS name. Default configuration (scenario 1, above) MUST use DNS names that end "example.org"

RFC 2606 also reserves the "invalid" Top-Level-Domain (TLD) as always invalid and clearly so. For dynamic information gathering, a value ending "invalid" MUST be used.

In both cases, additional information MAY be included by specifying a prefix to "example.org" or "invalid". This MAY be used to specify the class of machine that should be present. For dynamic infomation, if the class of machine is not published then the FQDN "unknown.invalid" MUST be used.

Examples:
www.example.org
your-CE.example.org
unknown.invalid
site-local-BDII.invalid

16.6 IPv4 address

It MUST use 192.0.2.250

There are several portions of IPv4 addresses that should not appear on a network, but none that are reserved for documentation or to specify a non-existent address. Using any address leads to the risk of side-effects, should this value be used.

The best option is an IP address from the 192.0.2.0/24 subnet. This subnet is defined in RFC 3330 as "TEST-NET" for use in documentation and example code. For consistency, the value 192.0.2.250 MUST be used.

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16.7 IPv6 addr

It MUST use 2001:DB8::FFFF

There is no documented undefined IPv6 address. RFC 3849 reserves the address prefix 2001:DB8::/32 for documentation. For consistency, the address 2001:DB8::FFFF MUST be used.

16.8 Integers

It MUST use "all nines"

For uint32/int32 this is 999,999,999
For uint64/int64 this is 999,999,999,999,999,999

For integers, all numbers expressible within the encoding (int32/uint32/etc.) are valid so there is no safe choice.

If an unsigned integer is encoded as a signed integer, it is possible to use negative numbers safely. However, these numbers will be unrepresentable if the number is stored as an unsigned integer. For this reason a negative number place-holder MUST not be used.

The number was chosen for three reasons. First, attribute scales are often chosen to reduce the likelihood of overflow: numbers towards MAXINT (the large number representable in an integer domain) are less likely to appear. Second, repeated numbers stand out more clearly to humans. Finally, the statistical frequency of measured values often follows Benford's law, which indicates that numbers starting with "1" occur far more frequently than those starting with "9" (about six times more likely). For these reasons, information providers MUST use all-nines to indicate a `place-holder`.

16.9 File path

It MUST start either "/UNDEFINEDPATH" or "\UNDEFINEDPATH".

As with the simple string, a single upper-case word is recommended. The initial slash indicates that the value is a path. Implementations MUST use whichever slash is most appropriate for the underlying system (Unix-like systems use a forward-slash). Software should accept either value as an unknown-value place-holder.

Additional information MAY be encoded as data beyond the initial UNDEFINEDPATH, separated by the same slash as started the value. Additional comments should not use any of the following characters: \ [ ] ; = " : | , * .

Examples:
/UNDEFINEDPATH
\UNDEFINEDPATH
/UNDEFINEDPATH/Path to storage area
/UNDEFINEDPATH/Broker unavailable

16.10 Email addresses

It MUST use an undefined FQDN for the domain.

RFC 2822 defines emails addresses to have the form: <local-part> '@' <domain>

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The <domain> MUST be an undefined FQDN; see above for a complete description. For email addresses, information providers should use "example.org" for scenario 1. and "unknown.invalid" for scenario 2.

The <local-part> MAY be used to encode a small amount of additional information; for example, it MAY indicate the class of user to whom the email address should be delivered. If no such information is to be encoded the value "user" MUST be used.

Examples:

user@example.org
user@unknown.invalid
site-local-contact@example.org
local-admin@example.org

16.11 Uniform Resource Identifier (URI)

It is schema-specific

RFC 3986 defines URIs as a "federated and extensible naming system." All URIs start with a schema-name part (e.g., "http") and no schema-name has been reserved for undefined or documenting example values.

For any given URI schema ("http", for example), it MAY be possible to define a place-holder value within that name-space. If a GLUE value has only one valid schema, the undefined value MUST be taken from that schema. If several schemata are possible, one MUST be chosen from the available options. This should be the most commonly used.

Take care with the URI encoding. All place-holder URI values MUST be valid URIs. If additional information is included, it MUST be encoded so the resulting URI is valid.

For schemata that MAY include a FQDN (e.g., a reference to an Internet host), an undefined URI MUST use an undefined FQDN; see above for details on undefined FQDNs.

URI schemata that reference a remote file (e.g., "http", "ftp", "https"), additional information MAY be included as the path. The FQDN indicates that the value is a place-holder, indicating an place-holder value, so information providers should not specify "UNDEFINEDPATH".

For "file" URIs, the path part MUST identify the value as unknown and MUST use the forward-slash variant; see above for details on undefined paths.

For "mailto" URIs [RFC 2368] encapsulates valid email addresses with additional information (such as email headers and message body). Place-holder mailto URIs MUST use an unknown email address (see above). Any additional information MUST be included in the email body.

There MAY be other schemata in use that are not explicitly covered in this section. A place-holder value should be agreed upon within whichever domain such schemata are used. This place-holder value should be in the spirit of the place-holder values described so far.

Examples:

http://www.example.org/
httpg://your-CE.example.org/path/to/end-point
httpg://unknown.invalid/User%20certificate%20has%20expired
mailto:site-admin@example.org
mailto:user@maildomain.invalid?body=Problem%20connecting%20to%20WLMS
file:///UNDEFINEDPATH

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file:///UNDEFINEDPATH/path%20to%20some%20directory

16.12 X.509 Distinguished Names

It MUST start O=Grid CN=UNDEFINEDUSER

X.509 uses a X.500 namespace, represented as several Relative Domain-Names (RDNs) concatenated by commas (we refer to syntax defined in IETF RFC 4514). The final RDN is usually a single common name (CN), although multiple CNs are allowed.

Unknown DN values MUST have at least two entries: an initial O=Grid followed immediately by CN=UNDEFINEDUSER.

Additional information MAY be encoded using extra CN entries. These MUST come after CN=UNDEFINEDUSER.

Examples:

O=Grid CN=UNDEFINEDUSER
O=Grid CN=UNDEFINEDUSER/CN=Your Grid certificate DN here
O=Grid CN=UNDEFINEDUSER/CN=Cannot access SE

16.13 Fully Qualified Attribute Name (FQAN)

It MUST use a VO of "vo.example.org" (for scenario 1.) or "unknown.invalid" (for scenario 2).

The "VOMS Credential Format" document,

http://edg-wp2.web.cern.ch/edg-wp2/security/voms/edg-voms-credential.pdf

states that FQANs MUST have the form:

/VO[/group[/subgroup(s)]][/Role=role][/Capability=cap]

Where VO is a well-formed FQDN. Unlike FQDNs, VO names MUST be lower-case. The place-holder value for FQAN is derived from the place-holder FQDN (see Section 16.5). It MUST have no subgroup(s) or Capability specified.

Any additional information MUST be encoded within a single Role name. Care should be taken that only valid characters (A-Z, a-z, 0-9 and dash) are included.

Examples:

/vo.example.org
/vo.example.org/Role=Replace-this-example-with-your-FQAN
/unknown.invalid
/unknown.invalid/Role=Unable-to-contact-CE-Error-42

16.14 Geographic locations

It MUST use longitude 0 degrees, latitude 0 degrees.

Meridians of longitude are taken from (-180,180] degrees, whilst parallels of latitude are taken from [-90,90] degrees. For a place-holder value to be a valid location, it MUST also be taken from these ranges.

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By a happy coincidence, the (0,0) location is within the Atlantic Ocean, some 380 miles (611 kilometers) south of the nearest country (Ghana). Since this location is unlikely to be used and repeated numbers are easier for humans to spot, (0,0) MUST be used to specify an place-holder location.

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17 Data Types

This section contains the definition of attribute types defined within this model. The enumeration types MAY be either closed or open. For properties which type defines a closed enumeration, one of the defined values MUST be chosen; any other value is not valid. For properties which type defines an open enumeration, one of the defined values MAY be chosen, nevertheless any other value compatible with the string type and with the recommended syntax is allowed.

The enumeration values MUST be lower-case.

17.1 ExtendedBoolean_t

Closed enumeration

Value	Description
False	boolean false
True	boolean true
undefined	the value cannot be measured

17.2 LocalID_t

The base type is the string with the following restrictions:

- first char in a-zA-Z
- following characters in [\w\-\.\:]
  - \w = [a-zA-Z_0-9]

17.3 ContactType_t

Open enumeration

Value	Description
general	Contact for persons to ask about general issues
security	Contact for persons responsible for the security
Sysadmin	Contact for the system administration
usersupport	Contact for the user support

17.4 PolicyScheme_t

Open enumeration

Value	Description
basic	The basic scheme
gacl	GridSite Access Control List

A policy scheme is defined by a syntax for rules and by a matching algorithm defining how a string MAY be matched against the published rules. For the *basic* policy scheme, the following syntax MUST be used (defined in EBNF form [EBNF]):

- BASIC RULE ::= (DN_NAME | VO_NAME | 'ALL')
- DN_RULE ::= 'dn:' DN_NAME
- VO_RULE ::= 'vo:' [a-zA-Z0-9-_\.]+
- DN_NAME ::=

As a matching algorithm, the basic scheme adopts the exact match (if at least one rule provides an exact match or the rule 'ALL' is present, then the subject is authorized to be mapped into the related share). More complex policy schemes SHOULD be defined in profile documents.

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basic rule ::= ['DENY:']
(DN_RULE | FQAN_RULE |
'ALL')¶
<#>DN_RULE ::= 'dn:'
DN_NAME ¶
<#>FQAN_RULE ::= 'fqan:'
VO_NAME ('/' GROUP_NAME
)* ('/Role=' ROLE_NAME)? ¶
<#>VO_NAME ::= [a-zA-Z0-9-
_\.]+¶
<#>GROUP_NAME ::=
VO_NAME¶
<#>ROLE_NAME ::=
VO_NAME¶

Examples of policies expressed using the basic syntax are:

- `dn:/C=XX/O=YYYY/OU=Personal Certificate/L=ZZZZ/CN=NAME SURNAME`
  - matches the user proving to have a certificate identified by this DN
- `vo:/vo_a`
  - matches all the users proving to be part of the vo_a

17.5 DN_t

Distinguished Name as defined by RFC 4514 (http://www.rfc-editor.org/rfc/rfc4514.txt). X.509 uses a X.500 namespace, represented as several Relative Domain-Names (RDNs) concatenated by forward-slashes. The final RDN is usually a single common name (CN), although multiple CNs are allowed.

17.6 Capability_t

List of values initially drafted from [omii-jra2-djra2.1, OGF-GFD80]. Open enumeration.

Value	Description
data.access.flatfiles	capacity of providing access to a flat file
data.access.relational	capacity of providing access to a relational data source
data.access.xml	capacity of providing access to an XML data source
data.management.replica	capacity of managing the creation of file replicas upon request
data.management.storage	capacity of managing a storage resource, from simple systems like disk-servers to complex hierarchical systems
data.management.transfer	capacity of managing a transfer of files from the start to the completion
data.naming.resolver	capacity of resolving one name to another (for example, search the associated abstract name to a certain human-oriented name)
data.naming.scheme	capacity of attaching names to data resources. (To evaluate if it should moved to the main category infrastructure instead of data). In OGSA, a three-level naming scheme is defined: (1) human-oriented name, (2) abstract name and (3) address
data.transfer	capacity of moving a file from one network location to another. It refers to the actual transfer (e.g., as performed by protocols like FTP, GridFTP, or HTTP)
executionmanagement.candidatesetgenerator	capacity of determining the set of resources in which a unit of work MAY execute
executionmanagement.dynamicvmdeploy	capacity of dynamically deploying a virtual machine image in a worker node
executionmanagement.executionandplanning	capacity of building schedules for jobs, that is, the capability of defining mappings between services and resources, possibly with time constraints
executionmanagement.jobdescription	capacity of letting users be able to describe a job submission request based on a machine-processable language
executionmanagement.jobexecution	capacity of executing a job or set of jobs.
executionmanagement.jobmanager	capacity of managing the execution of a job or set of jobs from start to finish
executionmanagement.reservation	capacity of managing reservation of resources for future usage
information.discovery	capacity of locating unknown resources or services, possibly satisfying a set of requirements
information.logging	capacity of recording data, often chronologically
information.model	capacity of modelling resources based on a community accepted definition
information.monitoring	capacity of periodically observing measurements, transform them and make available to users or other applications
information.provenance	capacity of providing long-term storage of information related to Grid activity and to let this information be accessed by users or other applications.
security.accounting	capacity of systematically recording, reporting, and analyzing the usage of resources
security.attributeauthority	capacity of associating a user with a set of attributes in a trusted manner to a relying party, by way of digitally signed assertions
security.authentication	capacity of providing authentication mechanisms for Grid users machine and services

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Deleted: `<#>fqan:/vo_a/group_a`¶
<#>matches all the users proving to be part of group_a or one of its subgroups¶
`<#>fqan:/vo_a/group_a/Role=prod`¶
<#>matches all the users proving to be part of group_a and having the Role prod¶
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security.authorization	capacity of handling authorization aspects, making authorization decisions about the subject and the requested mode of access based upon combining information from a number of distinct sources
security.credentialstorage	capacity of providing an online credential repository that allows users to securely obtain credentials when and where needed
security.delegation	capacity for a user to give a service the authority to undertake specific activities or decisions on its behalf
security.identymapping	capacity of mapping Grid-level credentials to local level credentials (e.g., mapping a user X.509 certificate into a UNIX account).

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17.7 ServiceType_t

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The RECOMMENDED syntax is in reverse-DNS style. The first element is a top-level domain, while the second element is a namespace (the namespace MAY be related to a middleware name, an organization or other concepts; org.glue and org.ogf are reserved). Open enumeration.

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Value	Description
org.glite.fts	gLite File Transfer Service
org.glite.lb	gLite Logging and Booking Service
org.glite.wms	gLite Workload Management Service
org.nordugrid.arex	NorduGrid Resource Coupled Execution Service
org.nordugrid.isis	NorduGrid Information Index Service
org.nordugrid.storage	NorduGrid Storage Service
org.teragrid.gridftp	TeraGrid GridFTP
org.teragrid.condor-g	TeraGrid Condor-g
org.teragrid.globus-mds4	TeraGrid Globus MDS 4
org.teragrid.gpfs	TeraGrid GPFS
org.teragrid.gsi-openssh	TeraGrid gsi-enabled openssh
org.teragrid.prewsgram	TeraGrid pre-WS Globus GRAM
org.teragrid.rft	TeraGrid Reliable File Transfer
org.teragrid.srb	TeraGrid Storage Resource Broker
org.teragrid.ws-delegation	TeraGrid WS-Delegation Service
org.teragrid.ws-gram	TeraGrid WS-GRAM Service
org.teragrid.ws-ogsadai	TeraGrid OGSA-DAI

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17.8 QualityLevel_t

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Closed enumeration

Value	Description
development	The component is under active development both in functionalities and interfaces
pre-production	The component has completed the development and passed the testing phase; it is being used in real world scenarios
production	The component completed the development and is considered stable for real world scenarios
testing	The component has completed the development phase and is under testing

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17.9 EndpointTechnology_t

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Open enumeration.

Value	Description
corba	The endpoint is implemented using CORBA technologies
jndi	The endpoint is implemented using JNDI
webservice	The endpoint is implemented as a Web Service

Deleted: webservice ... [45]

17.10 EndpointHealthState_t

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Closed enumeration

Value	Description
critical	It was possible to check the state of the endpoint and either it was not running

	or it was above some "critical" threshold
ok	It was possible to check the state of the endpoint and it appeared to be functioning properly
other	It was possible to check the state of the endpoint, but this is not covered by the defined states
unknown	It was not possible to check the state of the endpoint
warning	It was possible to check the state of the endpoint, but it appeared to be above some "warning" threshold or did not appear to be working properly

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17.11 ServingState_t

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Closed enumeration

Value	Description
closed	The endpoint is not accepting request nor is serving them
draining	The endpoint is not accepting requests, but is serving requests in the queue
production	The endpoint is both accepting and serving requests
queueing	The endpoint is accepting requests, but is not serving them

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17.12 DateTime_t

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The DateTime_t is based on the extended ISO 8061 format:

- [-]CCYY-MM-DDThh:mm:ss[Z|(+|-)hh:mm]

This data type maps the dateTime XSD simple type. We restrict this syntax to UTC time zone as follows:

- yyyy '-' mm '-' dd 'T' hh ':' mm ':' ss 'Z'

17.13 Staging_t

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Closed enumeration:

Value	Description
none	No staging of files supported
stagingin	Automatic staging in of files supported
staginginout	Automatic staging in and out of files supported
stagingout	Automatic staging out of files supported

Deleted: none ... [48]

17.14 JobDescription_t

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Open enumeration:

Value	Description
condor	Condor
egee:jdl	EGEE Job Description Language
globus:rsl	Globus RSL
nordugrid:xrsl	Nordugrid XSRL [XSRL]
ogf:jsdl:1.0	Job Description Submission Language 1.0

Deleted: ogf:jsdl:1.0 ... [49]

17.15 SchedulingPolicy_t

Formatted: Bullets and Numbering

Open enumeration:

Value	Description
fairshare	Statistically guarantees the allocated share
fifo	First-In First-Out
random	Random choice

Deleted: fairshare ... [50]

17.16 ReservationPolicy_t

Formatted: Bullets and Numbering

Closed enumeration:

Value	Description
mandatory	Jobs MUST be submitted only via advance reservation
none	No reservation is supported
optional	Jobs MAY be submitted via advance reservation, but this is not required

Deleted: none ... [51]

17.17 ComputingManagerType_t

Formatted: Bullets and Numbering

Open enumeration:

Value	Description
bgs	CC-IN2P3 Batch Queue System
condor	Condor
fork	Based on fork primitive
loadleveler	IBM LoadLeveler
lsf	Platform Load Sharing Facility
openpbs	Open PBS
sungridengine	Sun Grid Engine
torque	Torque
torquemaui	Torque with MAUI

Deleted: lsf ... [52]

17.18 NetworkInfo_t

Formatted: Bullets and Numbering

Open enumeration

Value	Description
100megabitethernet	Network based on 100 MBit/s Ethernet technology
gigabitethernet	Network based on 1 GBit/s Ethernet technology
infiniband	Network based on Infiniband technology
myrinet	Network based Myrinet technology

Deleted: 100megabitet ... [53]

17.19 Benchmark_t

Formatted: Bullets and Numbering

Open enumeration

Value	Description
bogomips	BogoMips
cfp2006	SPEC CFP 2006 floating point benchmark
cint2006	SPEC CINT 2006 integer benchmark
linpack	LINPACK benchmark
specfp2000	SPECfp2000 floating point benchmark
specint2000	SPECint2000 integer benchmark

Deleted: specint2000 ... [54]

17.20 Platform_t

Formatted: Bullets and Numbering

Open enumeration:

Value	Description
amd64	AMD 64bit architecture
i386	Intel 386 architecture
itanium	Intel 64-bit architecture
powerpc	PowerPC architecture
sparc	SPARC architecture

Deleted: i386 ... [55]

17.21 CPUMultiplicity_t

Formatted: Bullets and Numbering

Closed enumeration:

Value	Description
multicpu-multicore	The execution environment is run by multiple physical CPUs with a multiple cores each
multicpu-singlecore	The execution environment is run by multiple physical CPUs with a single core each
singlecpu-multicore	The execution environment is run by a single physical CPU with multiple cores
singlecpu-singlecore	The execution environment is run by a single physical CPU with a single core

Deleted: singlecpu-sin ... [56]

17.22 OSFamily_t

Formatted: Bullets and Numbering

Open enumeration:

Value	Description
linux	Family of operating systems based on Linux kernel
macosx	Family of operating systems based on MacOS X
solaris	Family of operating systems based on Solaris
windows	Family of operating systems based on Windows

Deleted: linux ... [57]

17.23 ParallelSupport_t

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Open enumeration:

Value	Description
mpi	Parallel execution based on mpi library
none	No supported parallel execution
openmp	Parallel execution based on openmp library

Deleted: mpi ... [58]

17.24 AppEnvState_t

Formatted: Bullets and Numbering

Open enumeration:

Value	Description
installable	The application environment is not installed, but MAY be dynamically installed
installationfailed	The application environment was being installed, but the installation process failed
installedbroken	The application environment is installed, but the verification failed
installednotverified	The application environment is installed, but not yet verified
installedverified	The application environment is installed and successfully verified
installingautomatically	The application environment is not installed, but is being installed automatically
installingmanually	The application environment is not installed, but is being installed manually
notinstallable	The application environment is not installed and not installable
pendingremoval	The application environment is installed, but is due to be removedwill be removed as soon as possible
removing	The application environment is installed, but it is being removed

Deleted: notinstallable ... [59]

17.25 ApplicationHandle_t

Formatted: Bullets and Numbering

Open enumeration:

Value	Description
executable	Access based on running directly the main executable of the application (this MAY require set-up of the environment)
module	Access based on loading modules via Environment Modules (http://modules.sourceforge.net/)
Path	Access based on using an explicit path where the software is installed on the file system
softenv	Access based on loading SoftEnv keys (http://www.mcs.anl.gov/systems/software/softenv/softenv-intro.html)

Deleted: module ... [60]

17.26 OSName_t
Open enumeration:

Formatted: Bullets and Numbering

Value	Description
aix	AIX
centos	CentOS
debian	Debian
fedoracore	RedHat Fedora
gentoo	Gentoo Linux
leopard	Mac OS X 10.5 (Leopard)
linux-rocks	
mandrake	Mandrake
redhatenterpriseas	RedHat Enterprise Server
scientificlinux	Scientific Linux
scientificlinuxcern	Scientific Linux CERN
suse	SUSE
ubuntu	Ubuntu
windowsvista	Microsoft Windows Vista
windowsxp	Microsoft Windows XP

Deleted: scientificlinux ... [61]

17.27 License_t

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Open enumeration:

Deleted: Closed

Value	Description
commercial	Commercial license
opensource	Open Source license approved by the OSI (Open Source Initiative)
unknown	Unknown license type

Deleted: opensource ... [62]

17.28 ComputingActivityType_t

Formatted: Bullets and Numbering

Closed enumeration:

Value	Description
collectionelement	A job submitted as part of a collection of individual jobs which do not communicate among them
parallelelement	A job submitted as part of a collection of individual jobs which communicate among them
single	An individual stand-alone job
workflownode	A job submitted as part of a workflow

Deleted: single ... [63]

17.29 ComputingActivityState_t

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For the values of this type, we RECOMMEND the following syntax:

- namespace:state
- namespace:state:substate

Open enumeration:

Value	Description
bes:failed	(a terminal state): the activity has failed due to some system error/failure event, such as failure of a computational resource that the activity was running on
bes:finished	(a terminal state): the activity has terminated successfully. Successful termination implies that the activity exited of its own accord rather than due to some failure in the BES or of the computational resources on which the activity was running. Note that a successfully terminating activity MAY nevertheless return an error code as its return value
bes:pending	the service has created a record for an activity but not yet instantiated it on a suitable computational resource or enabled it to start execution on such a resource
bes:running	the activity is executing on some computational resource
bes:terminated	(a terminal state): the client – which might be some system administrator

	(and hence not necessarily the client who originated the request to create the activity) – has issued a TerminateActivity request

Deleted: bes:pending ... [64]

For more information on the BES state model, see [BES].

This attribute type is an open enumeration. Examples of additional values are:

Deleted: property

- a middleware provider is using its own state model defined before the BES specification:
  - NorduGrid defines the state *accepting* which MAY be represented as (see [ng-schema], page 28):
    - nordugrid:accepting
  - gLite WMS defines the state *scheduled* which MAY be represented as:
    - glite-wms:scheduled
  - gLite CREAM defines the state *registered* which MAY be represented as:
    - glite-cream:registered
    - (see https://edms.cern.ch/document/595770)
- a middleware provider defined an extension of BES state model which is not part of an official OGF specification
  - NorduGrid defined an extension the bes:pending by adding two substates:
    - nordugrid-bes:pending:accepting
    - nordugrid-bes:pending:accepted

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Deleted: can

17.30 StorageCapacity_t

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Open enumeration:

Value	Description
online	Available
installedonline	Available + unavailable
nearline	Available
installednearline	Available + unavailable
offline	
cache	

Comment [SA1]: Add definitions

Deleted: Nearline

17.31 StorageAccessProtocol_t

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Open enumeration:

Value	Description
afs	Andrew File System protocol
dcap	DCache access protocol
file	POSIX access
gsidcap	DCAP with GSI authentication
gsiftp	FTP with GSI authentication
gsirfio	RFIO with GSI authentication
http	HyperText Transfer Protocol
https	Secured HyperText Transfer Protocol
nfs	Network File System protocol
rfio	Remote File Input/Output protocol
root	File transfer protocol for the ROOT framework
xrootd	xrootd protocol

Deleted: gsiftp ... [65]

17.32 AccessLatency_t

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Closed enumeration:

Value	Description
nearline	A file MAY have its only copies in a "nearly online" component of the storage system, typically a fully automated tape robot, but also a remote storage system could fit this qualification. Such a facility will need an unspecified amount of time to make a copy of the file available on the disk component of the container under consideration. When a file is not in use, its disk copies MAY be removed. Hence the system cannot guarantee that a file will be

	immediately available on disk
offline	A file MAY have its only copies in an offline component of the storage system, for example a tape library that is not connected to an automated tape robot. Hence an operator intervention MAY be needed to make a copy of a file available that has a lower latency
online	Files are always on disk, hence cannot have their latency improved

Deleted: online ... [66]

17.33 RetentionPolicy_t

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Open enumeration:

Value	Description
custodial	Low probability of loss
output	An intermediate level and is appropriate for data which MAY be replaced by lengthy or effort-full processes
replica	The highest probability of loss, but is appropriate for data for which a certain amount of loss MAY be tolerated, in particular when other copies MAY be accessed in a timely fashion

Deleted: custodial ... [67]

17.34 ExpirationMode_t

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Closed enumeration:

Value	Description
neverexpire	Support for files with infinite lifetime: they MAY only be removed by authorized clients, not by the storage system itself
releasewhenexpired	Support for files that have finite lifetimes and on expiration will be removed by the storage system
warnwhenexpired	Support for files that have finite lifetimes, but on expiration cannot be removed by the storage system itself. The data content of an expired file MAY be deleted if it MAY be recovered from an archive. New store operations MAY fail for certain clients until (some of the) expired files have either been removed by authorized clients, or have had their lifetimes increased

Deleted: neverexpire ... [68]

17.35 StorageManagerType_t

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Open enumeration:

Value	Description
castor	CERN Advanced STOrage manager, disk and tape management system
dcache	Disk Cache, disk managing system with ability to control tape backends (e.g., Enstore)
enstore	Tape Storage system, tape management system
gpfs	General Parallel File System, disk management system
sse	Smart Storage Element, disk management system
tsm	IBM Tivoli Storage Manager, disk and tape management system

Deleted: castor ... [69]

17.36 DataStoreType_t

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Deleted: StorageResource

Open enumeration:

Value	Description
disk	The storage capacity is provided by magnetic disks
optical	The storage capacity is provided by optical disks
tape	The storage capacity is provided by magnetic tapes

Deleted: disk ... [70]

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LocalID	LocalID_t	1		An opaque identifier local to the associated Service or Domain
Name	String	1		A human-readable name

Page 9: [2] Deleted **Sergio Andreozzi** **2/1/2009 9:18:00 PM**

LocalID	LocalID_t	1		An opaque identifier local to the associated Service or Domain

Page 9: [3] Deleted **Sergio Andreozzi** **12/3/2008 1:00:00 PM**

OtherInfo	String	*		Placeholder to publish info that does not fit in any other attribute. Free-form string, comma-separated tags, (name, value) pair are all examples of valid syntax

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ID [key]	URI	1			A global unique ID
Name	String	0..1			Human-readable name

Page 10: [5] Deleted **Sergio Andreozzi** **12/3/2008 1:00:00 PM**

OtherInfo	String	*		Placeholder to publish info that does not fit in any other attribute. Free-form string, comma-separated tags, (name, value) pair are all examples of valid syntax

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OtherInfo	*String*	*		*Placeholder to publish info that does not fit in any other attribute. Free-form string, comma-separated tags, (name, value) pair are all examples of valid syntax*
PropertyAttribute	Type	Mult.	Unit	Description

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ID [key]	URI	1			A global unique ID
Name	String	0..1			Human-readable name

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OtherInfo	String	*		Placeholder to publish info that does not fit in any other attribute. Free-form string, comma-separated tags, (name, value) pair are all examples of valid syntax

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ID [key]	URI	1			A global unique ID
Name	String	0..1			Human-readable name

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LocalID [key]	LocalID_t	1		An opaque identifier local to the associated Service
Name	String	0..1		Human-readable name

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Property	Type	Mult.	Unit	Description
ID [key]	URI	1		A global unique ID
Name String 0..1 Human-readable name				

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Name	String	0..1		Human-readable name

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LocalID	LocalID_t	1		An opaque identifier local to the Service to which the associated entity belongs to

Page 18: [14] Deleted **Sergio Andreozzi** **2/1/2009 9:22:00 PM**

LocalID	*LocalID_t*	*1*		*An opaque identifier local to the Service to which the associated entity belongs to*

Page 18: [15] Deleted **Sergio Andreozzi** **2/1/2009 9:22:00 PM**

LocalID	*LocalID_t*	*1*		*An opaque identifier local to the Service to which the associated entity belongs to*

Page 21: [16] Deleted **Sergio Andreozzi** **2/1/2009 9:22:00 PM**

ID [key]	*URI*	*1*		*A global unique ID*
Name	*String*	*0..1*		*Human-readable name*

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OtherInfo	*String*	*		*Placeholder to publish info that does not fit in any other attribute. Free-form string, comma-separated tags, (name, value) pair are all examples of valid syntax*
PropertyAttribute	Type	Mult	Unit	Description

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MaxMemory	UInt64	0..1	MB	The maximum RAM that a job can use

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StagingJobs	UInt32	0..1	job	Number of jobs that are staging files in/out

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Type	ComputingManagerType_t	1		Type of the computing manager (i.e., LRMS)

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WorkingAreaShared	Boolean	0..1		A working area is an allocated storage extent that holds the home directories of the Grid jobs; this property is true if the working area is shared across different execution environment instances (i.e., cluster nodes)

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OtherInfo	String	*		Placeholder to publish info that does not fit in any other attribute. Free-form string, comma-separated tags, (name, value) pair *are all examples of valid syntax*

Page 31: [23] Deleted **Sergio Andreozzi** **2/2/2009 2:11:00 AM**

LocalID	LocalID_t	1		An opaque identifier local to the Computing Service

Page 33: [24] Deleted **Sergio Andreozzi** **2/1/2009 9:23:00 PM**

LocalID	LocalID_t	1		An opaque identifier local to the Computing Service

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LocalID	LocalID_t	1		An opaque identifier local to the Computing Service

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Name	String	0..1		Human-readable name as specified by the user in the job description document

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LocalID	LocalID_t	1		An opaque identifier local to the Computing Service

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OtherInfo	*String*	*		*Placeholder to publish info that does not fit in any other attribute. Free-form string, comma-separated tags, (name, value) pair are all examples of valid syntax*
PropertyAttribute	Type	Mult	Unit	Description

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LocalID	LocalID_t	1		An opaque identifier local to the Storage Service

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TotalSize	UInt64	0..1	GB	Size of dedicated storage extent

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OtherInfo	String	*		Placeholder to publish info that does not fit in

				any other attribute. Free-form string, comma-separated tags, (name, value) pair *are all examples of valid syntax*

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LocalID	LocalID_t	1		An opaque identifier local to the Storage Service

Page 42: [33] Deleted **Sergio Andreozzi** **12/3/2008 1:01:00 PM**

OtherInfo	String	*		Placeholder to publish info that does not fit in any other attribute. Free-form string, comma-separated tags, (name, value) pair are all examples of valid syntax

Page 43: [34] Deleted **Sergio Andreozzi** **2/2/2009 1:46:00 AM**

ID [key]	*URI*	*1*		*A global unique ID*
Name	*String*	*0..1*		*Human-readable name*

Page 45: [35] Deleted **Sergio Andreozzi** **12/3/2008 1:01:00 PM**

OtherInfo	String	*		Placeholder to publish info that does not fit in any other attribute. Free-form string, comma-separated tags, (name, value) pair are all examples of valid syntax

Page 46: [36] Deleted **Sergio Andreozzi** **2/2/2009 1:46:00 AM**

LocalID	LocalID_t	1		An opaque identifier local to the Storage Service

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Version	String	0..1		Version of the storage manager
OtherInfo	String	*		Placeholder to publish info that does not fit in any other attribute. Free-form string, comma-separated tags, (name, value) pair are all examples of valid syntax

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OtherInfo	String	*		Placeholder to publish info that does not fit in any other attribute. Free-form string, comma-separated tags, (name, value) pair are all examples of valid syntax

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LocalID	LocalID_t	1		An opaque identifier local to the Storage Service

Page 48: [40] Deleted **Sergio Andreozzi** **12/3/2008 1:02:00 PM**

OtherInfo	String	*		Placeholder to publish info that does not fit in any other attribute. Free-form string, comma-separated tags, (name, value) pair are all examples of valid syntax

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security	Contact for persons responsible for the security
sysadmin	Contact for the system administration
usersupport	Contact for the user support
general	Contact for persons to ask about general issues

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security.authentication	Capacity of providing authentication mechanisms for Grid users machine and services
security.credentialstorage	Capacity of providing an online credential repository that allows users to securely obtain credentials when and where needed
security.delegation	capacity for a user to give a service the authority to undertake specific activities or decisions on its behalf
security.authorization	capacity of handling authorization aspects, making authorization decisions about the subject and the requested mode of access based upon combining information from a number of distinct sources
security.identymapping	capacity of mapping Grid-level credentials to local level credentials (e.g., mapping a user X.509 certificate into a UNIX account).
security.attributeauthority	capacity of associating a user with a set of attributes in a trusted manner

	to a relying party, by way of digitally signed assertions
security.accounting	capacity of systematically recording, reporting, and analyzing the usage of resources
data.transfer	capacity of moving a file from one network location to another. It refers to the actual transfer (e.g., as performed by protocols like FTP, GridFTP, or HTTP)
data.management.transfer	capacity of managing a transfer of files from the start to the completion
data.management.replica	capacity of managing the creation of file replicas upon request
data.management.storage	capacity of managing a storage resource, from simple systems like disk-servers to complex hierarchical systems
data.naming.resolver	capacity of resolving one name to another (for example, search the associated abstract name to a certain human-oriented name)
data.naming.scheme	capacity of attaching names to data resources. (To evaluate if it should moved to the main category infrastructure instead of data). In OGSA, a three-level naming scheme is defined: (1) human-oriented name, (2) abstract name and (3) address
data.access.relational	capacity of providing access to a relational data source
data.access.xml	capacity of providing access to an XML data source
data.access.flatfiles	capacity of providing access to a flat file
information.model	capacity of modelling resources based on a community accepted definition
information.discovery	capacity of locating unknown resources or services, possibly satisfying a set of requirements
information.logging	capacity of recording data, often chronologically
information.monitoring	capacity of periodically observing measurements, transform them and make available to users or other applications
information.provenance	capacity of providing long-term storage of information related to Grid activity and to let this information be accessed by users or other applications.
executionmanagement.jobexecution	capacity of executing a job or set of jobs.
executionmanagement.jobdescription	capacity of letting users be able to describe a job submission request based on a machine-processable language
executionmanagement.jobmanager	capacity of managing the execution of a job or set of jobs from start to finish
executionmanagement.executionandplanning	capacity of building schedules for jobs, that is, the capability of defining mappings between services and resources, possibly with time constraints
executionmanagement.candidatesetgenerator	capacity of determining the set of resources on which a nit of workcan execute
executionmanagement.reservation	capacity of managing reservation of resources for future usage
executionmanagement.dynamicvmdeploy	capacity of dynamically deploying a virtual machine image in a worker node

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org.glite.wms	gLite Workload Management Service
org.glite.lb	gLite Logging and Booking Service
org.glite.fts	gLite File Transfer Service
org.nordugrid.arex	NorduGrid Resource Coupled Execution Service
org.nordugrid.isis	NorduGrid Information Index Service
org.nordugrid.storage	NorduGrid Storage Service
org.teragrid.condor-g	TeraGrid Condor-g
org.teragrid.globus-mds4	TeraGrid Globus MDS 4
org.teragrid.gpfs	TeraGrid GPFS
org.teragrid gridftp	TeraGrid GridFTP
org.teragrid.gsi-openssh	TeraGrid gsi-enabled openssh
org.teragrid.prewsgram	TeraGrid pre-WS Globus GRAM
org.teragrid.srb	TeraGrid Storage Resource Broker
org.teragrid.ws-delegation	TeraGrid WS-Delegation Service
org.teragrid.ws-gram	TeraGrid WS-GRAM Service
org.teragrid.ws-ogsadai	TeraGrid OGSA-DAI
org.teragrid.rft	TeraGrid Reliable File Transfer

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development	The component is under active development both in functionalities and interfaces
testing	The component has completed the development phase and is under testing
pre-production	The component has completed the development and passed the testing phase; it is being used in real world scenarios
production	The component completed the development and is considered stable for real world scenarios

Page 72: [45] Deleted	Sergio Andreozzi	12/3/2008 3:48:00 PM
webservice	The endpoint is implemented as a Web Service	
jndi	The endpoint is implemented using JNDI	
legacy	The endpoint is implemented using legacy technologies	
corba	The endpoint is implemented using CORBA technologies	

Page 65: [46] Deleted	Sergio Andreozzi	12/3/2008 3:48:00 PM
ok	It was possible to check the state of the endpoint and it appeared to be functioning properly	
warning	It was possible to check the state of the endpoint, but it appeared to be above some "warning" threshold or did not appear to be working properly	
critical	It was possible to check the state of the endpoint and either it was not running or it was above some "critical" threshold	
unknown	It was not possible to check the state of the endpoint	
other	It was possible to check the state of the endpoint, but this is not covered by the defined states	

Page 65: [47] Deleted	Sergio Andreozzi	12/3/2008 3:49:00 PM
production	The endpoint is both accepting and serving requests	
draining	The endpoint is not accepting requests, but is serving requests in the queue	
queueing	The endpoint is accepting requests, but is not serving them	
closed	The endpoint is not accepting request nor is serving them	

Page 65: [48] Deleted	Sergio Andreozzi	12/3/2008 3:49:00 PM
none	No staging of files supported	
stagingin	Automatic staging in of files supported	
stagingout	Automatic staging out of files supported	
staginginout	Automatic staging in and out of files supported	

Page 65: [49] Deleted	Sergio Andreozzi	12/3/2008 3:49:00 PM
ogf:jsdl:1.0	Job Description Submission Language 1.0	
egee:jdl	EGEE Job Description Language	
nordugrid:xrsl	Nordugrid XSRL [XSRL]	
globus:rsl	Globus RSL	
condor	Condor	

Page 65: [50] Deleted	Sergio Andreozzi	12/3/2008 3:49:00 PM
fairshare	Statistically guarantees the allocated share	
fifo	First-In First-Out	
random	Random choice	

Page 66: [51] Deleted	Sergio Andreozzi	12/3/2008 3:49:00 PM
none	No reservation is supported	
mandatory	Jobs must be submitted only via advance reservation	
optional	Jobs can be submitted via advance reservation, but this is not required	

Page 66: [52] Deleted	Sergio Andreozzi	12/3/2008 3:49:00 PM
lsf	Platform Load Sharing Facility	
sungridengine	Sun Grid Engine	
openpbs	Open PBS	
torque	Torque	
torquemaui	Torque with MAUI	
bqs	CC-IN2P3 Batch Queue System	
condor	Condor	
loadleveler	IBM LoadLeveler	
fork	Based on fork primitive	

Page 66: [53] Deleted	Sergio Andreozzi	12/3/2008 3:49:00 PM
100megabitethernet	Network based on 100 MBit/s Ethernet technology	
gigabitethernet	Network based on 1 GBit/s Ethernet technology	

myrinet	Network based Myrinet technology
infiniband	Network based on Infiniband technology

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specint2000	SPECint2000 integer benchmark
specfp2000	SPECfp2000 floating point benchmark
cint2006	SPEC CINT 2006 integer benchmark
cfp2006	SPEC CFP 2006 floating point benchmark
bogomips	BogoMips
linpack	LINPACK benchmark

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i386	Intel 386 architecture
amd64	AMD 64bit architecture
itanium	Intel 64-bit architecture
powerpc	PowerPC architecture
sparc	SPARC architecture

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singlecpu-singlecore	The execution environment is run by a single physical CPU with a single core
singlecpu-multicore	The execution environment is run by a single physical CPU with multiple cores
multicpu-singlecore	The execution environment is run by multiple physical CPUs with a single core each
multicpu-multicore	The execution environment is run by multiple physical CPUs with a multiple cores each

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linux	Family of operating systems based on Linux kernel
macosx	Family of operating systems based on MacOS X
windows	Family of operating systems based on Windows
solaris	Family of operating systems based on Solaris

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mpi	Parallel execution based on mpi library
openmp	Parallel execution based on openmp library
none	No supported parallel execution

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notinstallable	The application environment is not installed and not installable
installable	The application environment is not installed, but can be dynamically installed
installingmanually	The application environment is not installed, but is being installed manually
installingautomatically	The application environment is not installed, but is being installed automatically
installationfailed	The application environment was being installed, but the installation process failed
installednotverified	The application environment is installed, but not yet verified
installedverified	The application environment is installed and successfully verified
installedbroken	The application environment is installed, but the verification failed
pendingremoval	The application environment is installed, but will be removed as soon as possible
removing	The application environment is installed, but it is being removed

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module	Access based on loading modules via Environment Modules (http://modules.sourceforge.net/)
softenv	Access based on loading SoftEnv keys (http://www.mcs.anl.gov/systems/software/softenv/softenv-intro.html)
path	Access based on using an explicit path where the software is installed on the file system
executable	Access based on running directly the main executable of the application (this may require set-up of the environment)

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scientificlinux	Scientific Linux
scientificlinuxcern	Scientific Linux CERN
ubuntu	Ubuntu
debian	Debian
centos	CentOS
fedora	RedHat Fedora
rhes	RedHat Enterprise Server
mandrake	Mandrake

suse	SUSE
leopard	Mac OS X 10.5 (Leopard)
windowsxp	Microsoft Windows XP
windowsvista	Microsoft Windows Vista

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opensource	Open Source license approved by the OSI (Open Source Initiative)
commercial	Commercial license
Other	Other type of license not matching any of the available values
unknown	Unknown license type

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single	An individual stand-alone job
collectionelement	A job submitted as part of a collection of individual jobs which do not communicate among them
parallelelement	A job submitted as part of a collection of individual jobs which communicate among them
workflownode	A job submitted as part of a workflow

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bes:pending	the service has created a record for an activity but not yet instantiated it on a suitable computational resource or enabled it to start execution on such a resource
bes:running	the activity is executing on some computational resource
bes:finished	(a terminal state): the activity has terminated successfully. Successful termination implies that the activity exited of its own accord rather than due to some failure in the BES or of the computational resources on which the activity was running. Note that a successfully terminating activity may nevertheless return an error code as its return value
bes:failed	(a terminal state): the activity has failed due to some system error/failure event, such as failure of a computational resource that the activity was running on
bes:terminated	(a terminal state): the client – which might be some system administrator (and hence not necessarily the client who originated the request to create the activity) – has issued a TerminateActivity request

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gsiftp	FTP with GSI authentication
file	POSIX access
nfs	Network File System protocol
afs	Andrew File System protocol
rfio	Remote File Input/Output protocol
gsirfio	RFIO with GSI authentication
dcap	DCache access protocol
gsidcap	DCAP with GSI authentication
root	File transfer protocol for the ROOT framework
https	Secured HyperText Transfer Protocol
http	HyperText Transfer Protocol

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online	Files are always on disk, hence cannot have their latency improved
nearline	A file may have its only copies in a "nearly online" component of the storage system, typically a fully automated tape robot, but also a remote storage system could fit this qualification. Such a facility will need an unspecified amount of time to make a copy of the file available on the disk component of the container under consideration. When a file is not in use, its disk copies may be removed. Hence the system cannot guarantee that a file will be immediately available on disk
offline	A file may have its only copies in an offline component of the storage system, for example a tape library that is not connected to an automated tape robot. Hence an operator intervention may be needed to make a copy of a file available that has a lower latency

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custodial	Low probability of loss
output	An intermediate level and is appropriate for data which can be replaced by lengthy or effort-full processes
replica	The highest probability of loss, but is appropriate for data for which a certain amount of loss can be tolerated, in particular when other copies can be

	accessed in a timely fashion

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neverexpire	Support for files with infinite lifetime: they can only be removed by authorized clients, not by the storage system itself
warnwhenexpired	Support for files that have finite lifetimes, but on expiration cannot be removed by the storage system itself. The data content of an expired file may be deleted if it can be recovered from an archive. New store operations may fail for certain clients until (some of the) expired files have either been removed by authorized clients, or have had their lifetimes increased
releasewhenexpired	Support for files that have finite lifetimes and on expiration will be removed by the storage system

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castor	CERN Advanced STOrage manager, disk and tape management system
gpfs	General Parallel File System, disk management system
dcache	Disk Cache, disk managing system with ability to control tape backends (e.g., Enstore)
tsm	IBM Tivoli Storage Manager, disk and tape management system
sse	Smart Storage Element, disk management system
enstore	Tape Storage system, tape management system

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disk	The storage capacity is provided by magnetic disks
tape	The storage capacity is provided by magnetic tapes
optical	The storage capacity is provided by optical disks