Service Delivery and Service Level Management in Grid Infrastructures

D4.2: SLM MODEL AND USE CASES – PRELIMINARY VERSION

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EXECUTIVE SUMMARY

The Service Level Management (SLM) model for grids and other federated infrastructures proposed hereafter is constituted by three primary actors, namely the Virtual Organization (VO), the Site and the Grid Initiative (GI), which in turn can be specialized in a hierarchical decomposition like National Grid Initiative (NGI) or European Grid Initiative (EGI). Other secondary actors may exist like External Partner/Supplier. GIs provide grid services to VOs that are specified through Service Level Agreements (SLAs), whereas GIs rely on resources provided by Sites and/or other GIs that are used on the grounds of contracts known as Operational Level Agreements (OLAs). Other type of contracts, identified as Underpinning Contracts (UCs) may exist between primary and secondary actors.

To specify the SLM functionality to deliver grid services we adopt a use case based approach. Each use case defines an elementary SLM function. A total of sixteen use cases have been identified as follows:

- Register new VO as customer of a GI
- Request a new service
- Publish service / add service to service catalog
- Negotiate and sign SLA
- Monitor SLA fulfilment
- Evaluate and report on SLA fulfilment
- Notify VO of SLA violation
- Early warning notification to GI
- Register new Site as resource provider within a GI
- Register new GI as member of a higher level GI
- Register new service element / instance / component to GI
- Negotiate and sign OLA
- Monitor OLA fulfilment
- Evaluate and report on OLA fulfilment
- Notify site or lower level GI on OLA violation

CAPACITIES

- Early warning notification to GI or higher level GI

The gSLM ontology consists of fourteen classes under the gSLMConcept umbrella class. These classes represent the entities and relationships of our SLM model. The ontology is written in the Ontology Web Language (OWL) and uses the Semantic Web Rule Language (SWRL) to encode decision rules aimed to perform management functions and allow for high level reasoning. In addition the resources model is aligned with GLUE 2.0

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1. INTRODUCTION

Nowadays most Grid services are offered in a best effort basis in the sense that QoS is not precisely defined nor assured. Responsibilities and penalties in case of lack of service availability or quality degradation are not established and in general all the aspects that are usually under the scope of an SLA/OLA are missing or vaguely specified. This is in contrast with well established Information Technology services where Service Delivery Management and Service Level Management are fundamental aspects of any service. The reasons for that dichotomy have to be found on the initial application of the Grid paradigm a decade around 2000. The Grid is conceived as a computation and storage environment offered by any entity having free resources and used by any other one having computation or storage needs. In short everyone can be service provider and user at a time. The role of a service provider is blurred and as a consequence the duties that are usually assigned to that role are bypassed. This situation is tolerated in part because the demand of grid services tends to be confined in academic research environments where the requirements for service assurance are not so stringent as in the industry or other social domains. Nevertheless, the challenges posed by services supported on e-infrastructures are evolving to more and more demanding and complex ones. In such scenarios a best effort or qualitative service level management can't be sustained anymore. Instead, a professional approach like that one adopted in IT services is unavoidable if we don't want to see the Grid to take a back seat in favor of other initiatives and paradigms. In [1] the authors point out the advantages that from different points of view could be achieved in case of adopting SLM and SDM concepts in the Grid.

The gSLM project is aiming at defining the steps to the horizon of a Grid with embedded SLM and SDM techniques. To do so, we have started a modeling activity which consisted of defining a set of use cases both in the area of SLM and SDM that specify the core processes that grid management systems should have to implement. In other words, we define the minimum required management functionality in terms of use cases. The reason to proceed in that way is because we have adopted the ITIL [2] framework as the reference for the targeted management approach. In fact, ITIL defines functional management processes that can be easily imported to our application domain. Use cases specify the relationships in terms of management actions that take place within the actors of our grid application domain. Therefore before starting the specification of use cases it was necessary to draw a higher level model identifying the relevant actors and depicting the most important interactions among all them.

Our approach is complemented with a glossary of terms as well as with an ontology. Both, the terminology and the ontology support the use cases in the sense that they create a common understanding and knowledge framework where any concept they deal with is clearly identified. In addition, the ontology reflects our model and the management functionality that it supports in a way that can be used by third party software applications to eventually carryout automatically management activities in the Grid.

The above presented modeling activity constitutes the scope of WP4 of the gSLM project. Its outputs will be delivered to WP5 and WP6 for further elaboration. More specifically, the use cases will be fundamental to produce a maturity model. This maturity model, which is a refinement of the COBIT v4.1[3] maturity model into our Grid domain, will be the tool to derive sets of requirements to reach determined levels of maturity and to define a roadmap to help current e-infrastructures reaching those levels .

The objective of this deliverable is presenting the gSLM modeling approach for SLM and SDM in Grids. As the glossary of terms in the fields of Service Level Management and Grid Computing was the scope of deliverable D4.1, this topic is explicitly excluded here. Therefore we concentrate in presenting the actors and their relationships (Section 2), the gSLM ontology (Section 3) and finally the use cases (Section 4). The document ends with a concluding section and cited references. As far as the level of completeness of the topics covered in the three core sections we can state that except for the SDM use cases, all the others are in their final elaboration status, although of course subjected to amendments or modifications in the course of the project lifetime span. The SDM use cases will be considered at a later stage and for this reason we have to understand the present one as a preliminary version of the model and use cases.

2. SLM MODEL

The gSLM Service Level Management model is founded in the actors intervening in the different management operations. Therefore the first step to do is towards the presentation of these actors and their generic interaction relationships. These relationships will be in turn specialized through the corresponding use cases that are the scope of the next section. This informal model has to be supported by an information model that exposes all the information entities used throughout. In that respect the gSLM project has adopted a glossary of terms and an ontology. The advantage of using an ontology instead of an information model is that it allows for reasoning activities that can be of special relevance at the time of performing the management activities meant for these type of e-infrastructures. On the other hand separating the glossary from the ontology allows us to work with a much lower number of classes in the later. In the following subsections we present the actors, the relationships and the ontology in that order.

2.1. ACTORS

The principal actors/roles of the gSLM model, i.e. a SLM model, are the Virtual Organization (VO), the Site and the Grid Initiative (GI). In addition we can consider secondary actors like External Partner/Supplier and others. Figure 1 depicts these actors along with containment relationships make explicit by means of ellipses.

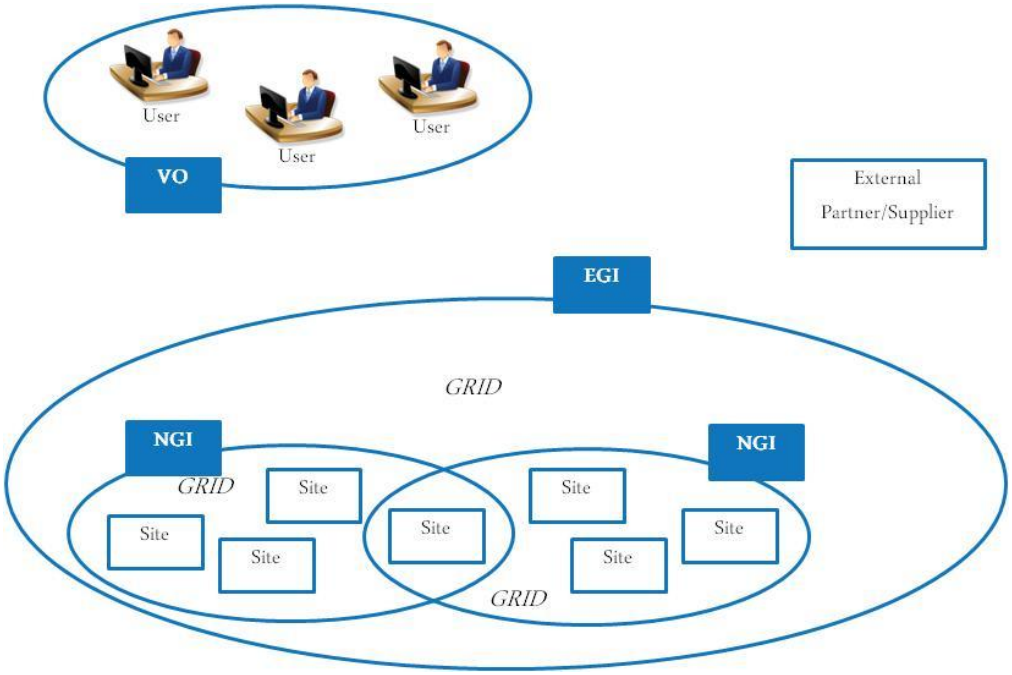

Figure 1. Actors of the SLM model adopted in gSLM

The Virtual Organization is a set of individuals and organizations (i.e. users) that cooperate by sharing resources according to a formal or informal contract, which defines the rules of cooperation. We understand that a Virtual Organization is the customer of a Grid Initiative.

A Grid Initiative (GI) is an approved body that provides grid computing services or represents grid providers in a country or in a group of countries. In the first case we talk about a National Grid initiative (NGI) and a relevant example of the second is the European Grid initiative (EGI) for EU countries. The set of infrastructures and middleware supporting a NGI or the EGI constitute a Grid. The GI is a Single Point of Contact for a VO, representing the Grid as a whole.

The added value of a GI may range from a simple aggregation (GI as "mediator") to full integration (GI as "service provider") of the underlying resources.

A VO may register with one (or more) NGI(s) and/or with the EGI. If a VO is registered with the EGI, it is "known" by the NGIs as a customer of the EGI.

The Site is the provider of the Grid Initiative. Under the gSLM point of view, Sites don't provide grid services but infrastructure and middleware that are necessary to provide such services.

An External Partner/Supplier is any entity supporting any of the above mentioned primary actors in the fulfillment of its duties.

2.2. MAIN RELATIONSHIPS BETWEEN ACTORS

In the following subsections we specify the main relationships existing among the actors and how they are formalized.

2.2.1. RELATIONSHIPS BETWEEN VO AND GI

This relationship is meant to allow the GI the provisioning of a grid service to the VO. The purpose of any Grid is to provide resources as a service to the subscribed VOs. Typical examples of resources offered through a Grid include storage and computational capacities.

The formalization of such relationship is done through a SLA. The SLA describes the Grid Service, documents Service Level Targets, and specifies the responsibilities of the GI and the VO.

As GIs can be instantiated as NGI and EGI, is then clear that SLAs can be formalized between VO and NGI and between VO and EGI. Figure 2 shows these two modalities of SLAs.

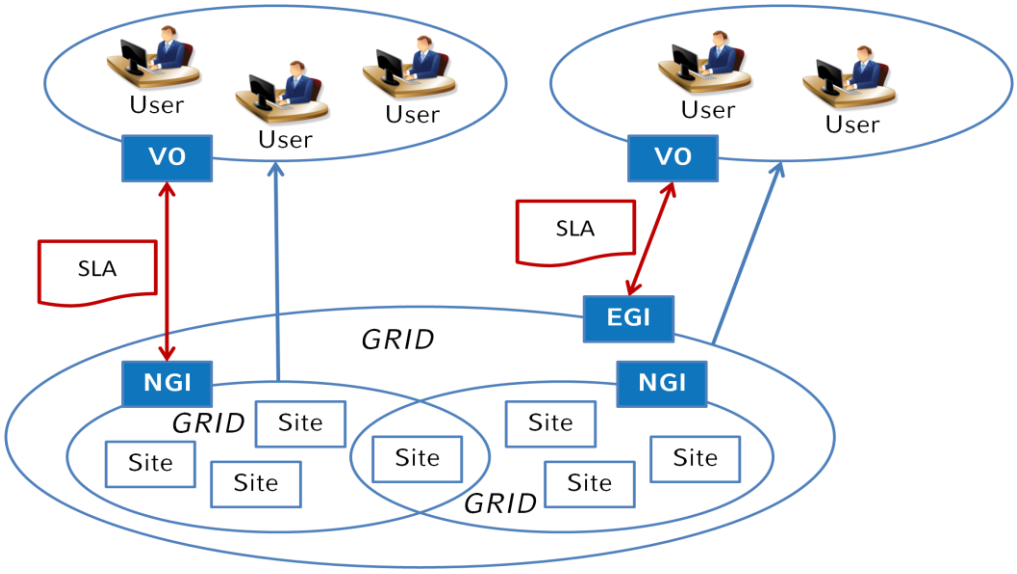

Figure 2. The SLA enforces the relationship between Vos and Gis

The role of the GI (i.e. as a simple mediator or as an integrator) affects the type of SLA. In the first case, the SLA is just an aggregation of the underlying OLAs. This means that the GI has no liability if any of these OLAs is not fulfilled. In the second case, the SLA has to be fulfilled regardless if any of the underlying OLAs is violated.

2.2.2. RELATIONSHIPS BETWEEN A GI AND ITS SERVICE/INFRASTRUCTURE SUPPORTING ENTITIES

GIs have to establish relationships with other GIs or with Sites in order to deliver services to their customers. According to our model these relationships can be instantiated between the EGI and a NGI or between a NGI and a Site. These relationships are formally described as Operation Level Agreement (OLA) as represented in Figure 3.

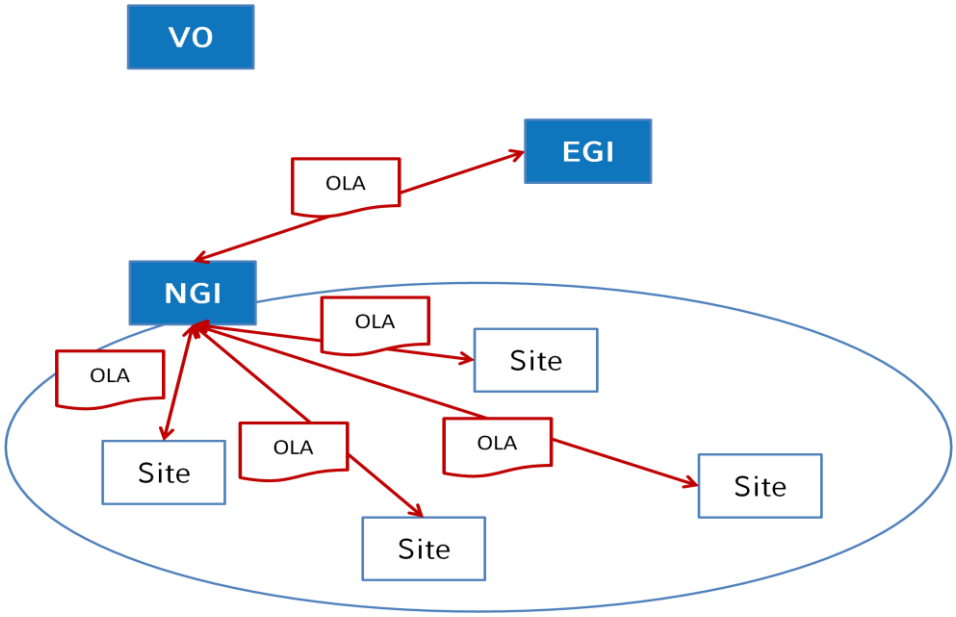

Figure 3. The OLA enforces the relationship between Gis and lower level Gis or Sites

The OLA framework within a GI supports the fulfillment of the targets agreed in the SLAs between the GI and its VOs. Hence, OLAs may be established

- in order to support one or more specific existing or intended SLAs.
- as a general and/or preparatory basis for establishing new services/SLAs.

2.2.3. RELATIONSHIP BETWEEN ANY OF THE PRINCIPAL ACTORS AND AN EXTERNAL PARTNER/SUPPLIER

The relationship between any of the principal actors and an External Partner/Supplier is formalized through an Underpinning Contract (UC). As UCs are formal contracts with external bodies they may contain references to general terms and conditions or specifications of commercial and legal details.

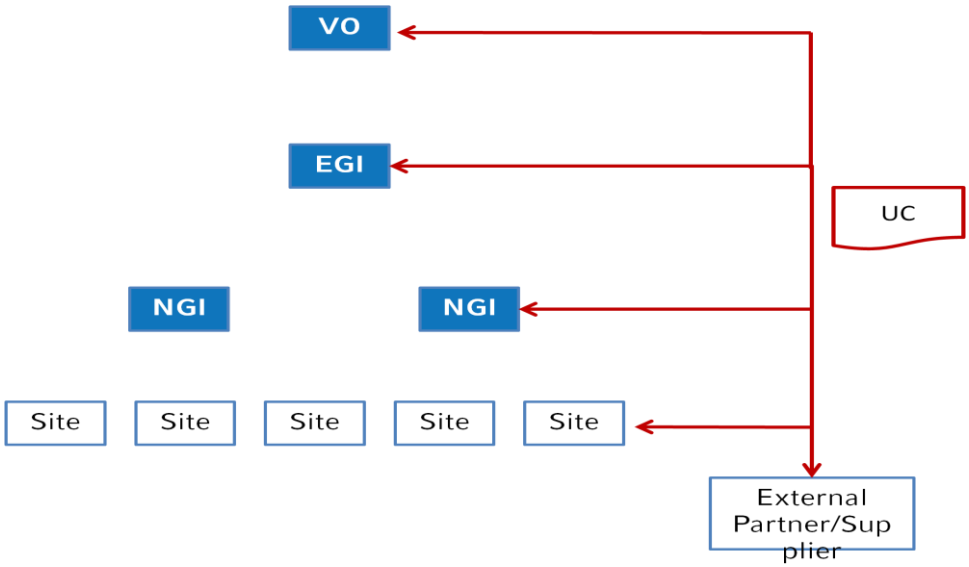

Figure 4. Ucs formalize the relationships between primary actors and External Partner/Supplier

2.3. GSLM ONTOLOGY

According to [4] an ontology is "a formal, explicit specification of a shared conceptualization"; in other words, this means representation of knowledge of a given domain in a way that can be machine readable and adopted by consensus within different parties. This definition could also be applied to information models like CIM [5] or SID [6]. Information models and ontologies are both mechanisms of knowledge representation that can look alike although substantially different especially in terms of the intended use and functionality. Like information models, ontologies include all relevant constraints between classes, attribute values, instances and relations (i.e. axioms). It is true that if the ontology only captures static knowledge it is like an information model expressed in a particular language. But the type of ontology we are looking for in service management domains go beyond the capabilities of conventional information models. Our intended ontology has to capture terms related to particular tasks and/or terms related to specific problem solving mechanisms. In that way, this ontology will allow for reasoning, i.e. inference or creation of more knowledge. This is the main difference in respect to information models and also the reason why we choose an ontology as a means of knowledge representation in gSLM.

As mentioned above, an ontology is expressed in a given language. For reasons out of scope of this document we have adopted the Web Ontology Language (OWL) [7]. This language is supported by Protegé [8], which has been used as the editor of the ontology. Also is worthy to mention that the resources are modeled according to GLUE 2.0 [9].

One of the important aspects of an ontology is its expressiveness; that is, its capacity to express restrictions both over the classes themselves and over the properties as well. In OWL these restrictions consist of axioms. To clarify its meaning let's put a few axiom examples defined within our ontology.

- "has_Service": this axiom is meant to establish a containment relationship between the ServiceCatalogue class and the classes StorageService and Computing Service
- "For_Service": this axiom is meant to link the class Agreement (whose subclasses are SLA, OLA and UC) with the classes StorageService and ComputingService. The semantics of that relationship in natural language would be "there and Agreement for the service StorageService or ComputingService"
- "Deviation_Of": this one links the class Agreement and the class Deviations. The semantics of that relationship is "A given Agreement may have deviations of the agreed QoS parameters as specified in an instance of the class Deviations"

The above are a few examples that reveal how the classes of the model are interlinked. There many other types of restrictions that configure our model. These are the conventional axioms that can be defined within OWL ontology. Based on these axioms a reasoned could infer additional knowledge. Nevertheless it is clear that the type of inference is relatively generic like for instance classification or sorting inference. By means of this restrictions would be very difficult if not impossible to express higher level logic rules. Therefore the solution passes through integrating our OWL ontology with a more powerful specification language. Our choice for the later has been the Semantic Web Rule Language (SWRL) [10]. This language permits the specification of Horn clauses in the form "antecedent → consequent" that can be also interpreted as "IF condition THEN action" as in the general rules used in Policy-based Management. To illustrate the capabilities of our ontology with embedded SWRL rules let's present the following one

- Agreement(?x) ∧ has_Agreed (?x, ?y) ∧ has_Observed(?x, ?z) ∧ hasQoSValue(?y, ?a) ∧ hasQoSValue(?z, ?b) ∧ Value(?a, ?c) ∧ Value(?b, ?d) ∧ swrl:lessThan(?d, ?c) → Violations(?x)

On the left of the arrow we have a complex antecedent clause and on the right the consequent clause. The interpretation of the antecedent is as a set of AND conditions. The semantics of the rule is that *if we have an agreement (x) on a given QoS parameter (y) that is monitored by means of the variable (z) that adopts values (a) and (b) respectively and (b) is less than (a), then the agreement (x) is violated*. In other words, the fulfillment of a set of conditions on an instance of the class Agreement detects a violation and creates the corresponding instance of the class Violations.

Having established the main foundations of our ontology, it proceeds to present it in its current status at the time of writing this deliverable.

Figure 5 is part of the window of Protégé editing tool showing on the left the main classes and their corresponding first level subclasses. In the following paragraphs we define each of the main classes.

- Extension: The Extension class provides a general mechanism to add property/value pairs to any of the gSLM classes when suitable specific attributes are not present.
- gSLMConcept: Main Class in which all the gSLM classes are contained. The only exception is the Extension Class which allows for additions/extensions of these classes.
- gSLMAccessProperty: A description of the network link quality between a Storage Service and a ComI service, and/or of a potentially dedicated access protocol that the Computing Service may use to access the Storage Service. – GLUE2.0
- gSLMAccessProtocol: Access protocol for a given Service
- gSLMActivity: An Activity is a unit of work managed by a Service and submitted via an Endpoint; when accepted by the Endpoint, then 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, in which case it shares a common context. GLUE 2.0
- gSLMActor: Class from which all actors in a grid environment inherit
- gSLMAgreement: Class with different types of Agreements that can exist between the different Actors
- gSLMDomain: Provides a classification for different actors for purposes of Providing, Enforcing and Monitoring QoS parameters that may be common to such actors and also for Policies. Specific Security, Access, Management Policies may apply to actors that belong to different Domains.
- gSLMLocation: Represents individuals that represent the Locations of the different Actors of the gSLM. It may also be applied to specific resources if special granularity of the resource is available, and is different from the Actor that provides the resource.
- gSLMPolicy: Statements, rules or assertions that specify the correct or expected behavior of entities. Two specializations are introduced: AccessPolicy related to Endpoints and MappingPolicy related to Shares. 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 the advertisement of policies using different schemes.
- gSLMQoS: Class containing different classes that are directly related the determining the QoS of the different Services.

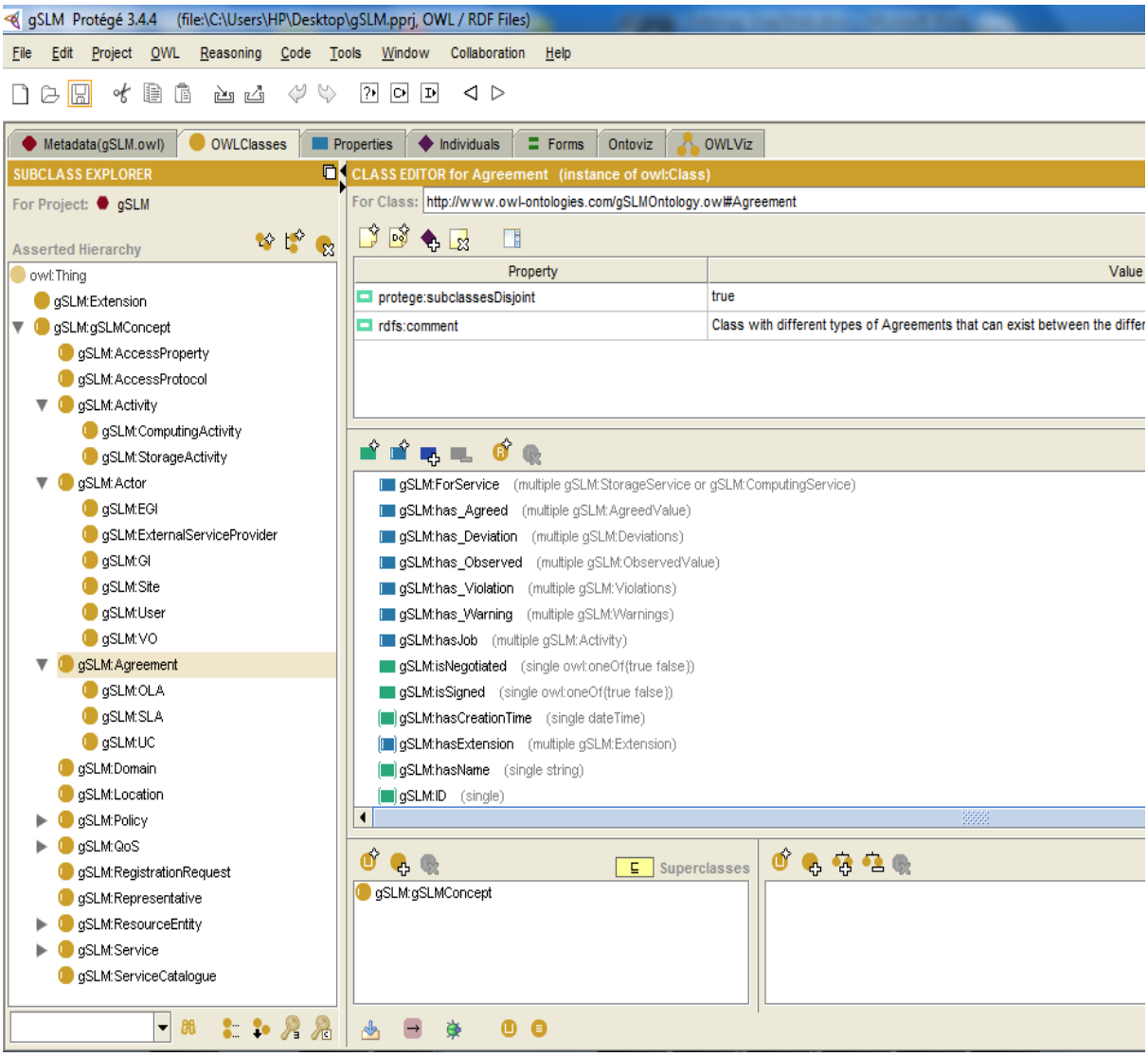

Figure 5. Ontology main classes and subclasses

- gSLMRegistrationRequest: Contains all Requests for Registration that have been received from a given Actor.
- gSLMRepresentative: Representative/Contact Person for any of the Grid Actors.
- gSLMResourceEntity: Main Class that contains all entities that are related to the Grid Resources that support provision of services. It is based on the GLUE 2.0 Specification. According to GLUE 2.0, a given Grid Service aggregates an Endpoint, a Share, a Manager and a Resource.
- gSLMService: 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 the identification of this whole set of entities providing the functionality with a persistent name. GLUE 2.0
- gSLMServiceCatalogue: Any instance of this Class contains all the services that a given Grid Actor provides

Whereas the above Figure 5 presents classes related with inheritance links, Figure 6 is a representation of the same classes with some of their property links. The semantics of these links is apparent from their names and constitute part of the axioms of this ontology.

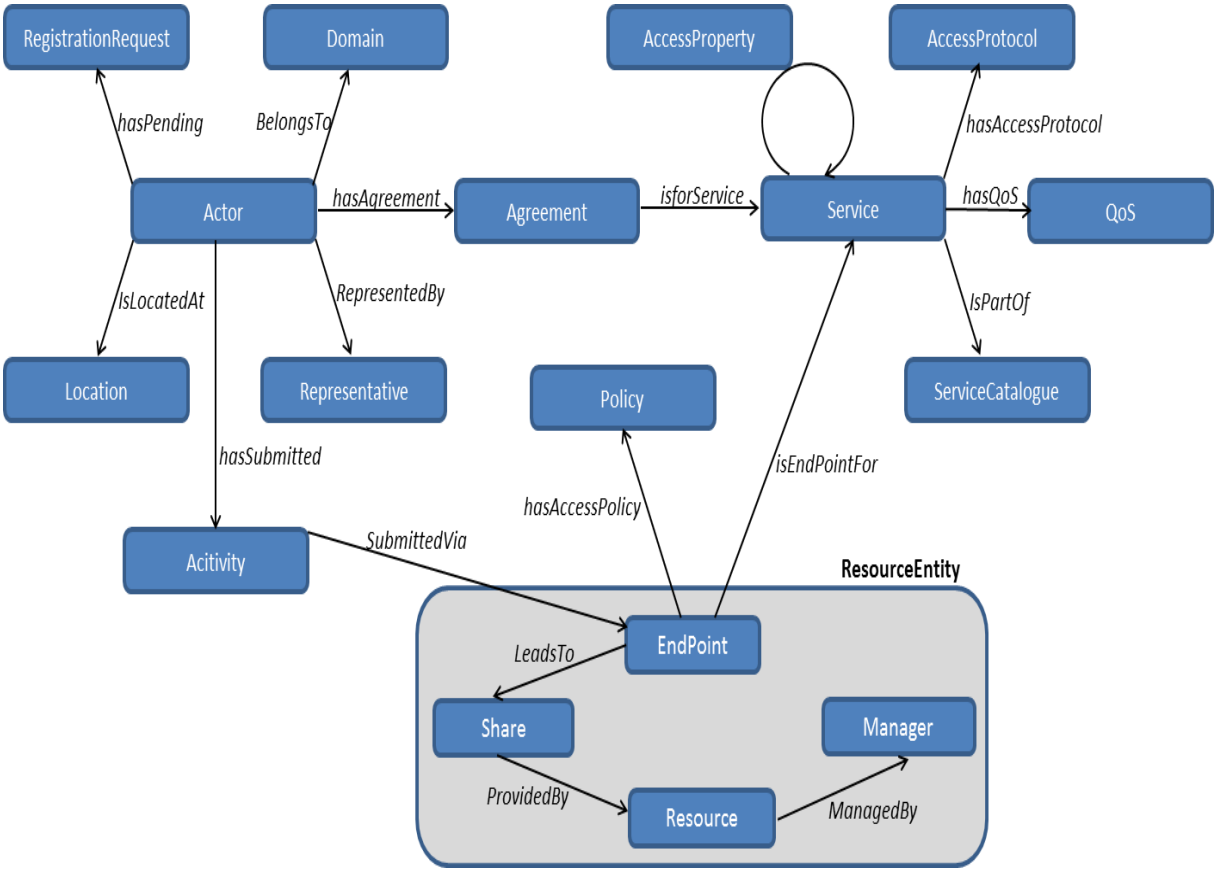

Figure 6. Ontology main classes and some of their property links

3. USE CASES

Use cases are of capital importance in the gSLM project in the sense that they define the management functionality that has to be provided in order to manage and deliver grid services. This use cases were derived from the ITIL framework and adapted to the Grid environment following the model described in Section 2 of this document.

Use cases have been classified into two broad categories according to the scope of the gSLM project. These are the SLM related use cases and the SDM related use cases. In addition a common naming structure has been adopted. This consists in a string of characters grouped in four fields, separated by colons like AAA:BBB:CCC:DDD. The AAA field consist of the characters "UCs" and is common for all. The field BB can be "SLM" or "SDM" depending on the category (i.e. SLM or SDM) of use case. The field CCC corresponds to the sub classification adopted within each category. For instance, for the SLM related use cases we have here "SLA", "OLA" or "UC". Finally, the field DDD consists of three characters which are specific for each use case.

For the definition of use cases we adopted a template. The template consists of three main fields, namely a header with 11 subfields, the Detailed Description and the Comments. The header contains most of the information characterizing the use case. Following the order as these subfields appear we have the editor's name in charge of tracking and integrating all contributions of the use case; the use case identifier according to the format described in the previous paragraph; the use case name that consist in a short description of its functionality; the scope that is meant to situate the use case within the categories of SLM or SDM and if it is concerning SLAs, OLAs or UCs for the SLM ones; the informal description and example describes in natural

language the functionality of the use case; the preconditions that is meant to specify what is assumed for the execution of the use case; the success end condition and the failed end condition describe the main result in case the use case is properly executed or not respectively; primary actors are the actors considered in our SLM model that intervene in the execution of the use case; secondary actors are any other that could be involved within the execution of the use case; finally, the trigger specifies the event or the condition that initiates the uses case. The Detailed Description specifies in sequential steps how the use case progresses. The level of granularity is such that it could allow for a clear implementation independent of the supporting technology. It is important to notice that we have considered the possibility to define branching steps associated to any of the principal steps to clarify the behaviour of the managed service. They are deviations from the main use case flow into alternative flows that due to its importance have to be highlighted. Finally, the Comments field is optional allow for additional information. The scope of this information is not restricted at all but is usually related to clarifications about the functionality or the implementation of the use case.

In the following subsections we present the use cases status as it is at the date of this document.

3.1. SLM RELATED USE CASES

3.1.1. REGISTER NEW VO AS "CUSTOMER" OF A GI

Editor	Thomas Schaaf
Use Case identifier	UCs:SLM:SLA:REG
Use Case name	Register new VO as "customer" of a GI
Scope	• Service Level Management ○ Service Level Agreement (SLA) related
Informal definition & example	A Virtual Organization is recognized as a customer by the Grid Initiative (GI). Typically, the VO will send a request via e-mail or webform to the GI. The GI needs to validate the communication channel with the VO and identify the representative(s) of the VO. The GI has to decide on whether the VO can be accepted and registered. The GI might require the VO to accept certain general rules and policies. The registration of a VO does not imply subscription or invocation of one or more specific services delivered through the Grid at this point in time.
Pre-conditions	• An existing Virtual Organization (VO) is interested in using Grid services • A Grid Initiative (GI) is coordinating the activities of a Grid offering resources as a service to their so far registered VOs • The GI is empowered to register new VOs and negotiate and close SLAs with them
Success End Condition	The regarded VO has been registered by the GI. To this end, relevant information about the VO has been recorded by the GI. For example, a record has been created and added to a database reflecting the GI's VO register.
Failed End Condition	The regarded VO has not been registered by the GI. The VO has been informed about the reasons of the rejection of their registration request.
Primary Actors	VO, GI
Secondary Actors	The registration process does not involve any other actors than the primary actors.
Trigger	This use case is usually triggered by the VO that wants to register. The trigger is a registration request by the respective VO.

DESCRIPTION	**Step**	**Action**
	01	A representative of the VO sends a registration request to the GI.
	02	GI acknowledges the reception of the request

	03	GI checks and approves the identity of the VO representative
	04	GI checks whether the identified VO representative is authorized to register in the name of his VO
	05	GI checks the request for compliance with pre-defined formal criteria
	06	GI evaluates whether the request will be accepted and the registration performed
	07	GI informs VO about the acceptance (or rejection) of their registration
	08	GI records all relevant data of the VO using a VO register
	09	GI performs all technical and administrative steps required to enable the VO to request services from the Grid and the GI to deliver these services
EXTENSIONS	**Step**	**Branching Action**
		None identified

Comments	The registration request may be in any type or form of medium, but should be recorded. The request form should cover all relevant data required to register the VO and enable their users to access the Grid services. The procedures and criteria for checking the identity of a VO representative should be defined and documented in sufficient detail. A catalog of formal criteria, that need to be fulfilled by a registration request, should be defined by the GI and made available to potential VOs, e.g. via a help text or manual as part of an electronic registration form. In addition, general acceptance criteria for a registration request need to be defined and documented. The VO register may be a suitable administrative tool or database. To make the set of use cases complete, we should consider the termination/modification of the registration by any of the parties. For reasons of simplicity and traceability, these aspects have not been included in the use cases model.

3.1.2. REQUEST NEW SERVICE FOR SERVICE CATALOGUE

Editor	Martin Metzker
Use Case identifier	UCs:SLM:SLA:REQ
Use Case name	Request new service for service catalogue
Scope	• Service Level Management ○ Service level Agreement (SLA) related
Informal definition & example	A VO requests a new service as an extension to the service catalogue from a GI. The request mainly consists of two parts: a complete set of requirements on this new service and an elaboration on which requirements cannot be met by the other services in the service catalogue. The GI may assess the request (to see if they politically want this service) before distributing the request to sites that may be able to provide the requested service. To simplify this, the initial request may already include a list of candidate sites. Sites report back to the GI, explaining their willingness and capability of providing the requested service. The report must contain an estimation of how long the site needs to prepare before this new service can be offered. With this information the GI decides whether a service will become part of the service catalogue or not. The GI tells the sites and the VO about its decision and a date on which the new service will become part of the service catalogue. Example: all services in a service catalogue are blue but a VO needs a red service. The VO requests the red service from the GI, explaining that the service needs to be red and all other services cannot satisfy this requirement because they are blue. The GI determines that red services are a good idea and forwards the request to all related sites. All sites report that they could start deploying red services by August. The GI notifies the VO and all sites that red services will be/have to be available by August.

Pre-conditions	• A service catalogue exists • The requested service is not part of the service catalogue • The GI may extent the service catalogue
Success End Condition	• Sites begin preparations for the new service • A date for the release of the new service catalogue has been published • The GI modifies the service catalogue • The VO knows when the new service can be requested for use
Failed End Condition	• The VO knows the service catalogue will not be altered • The GI is not able to augment its service catalogue
Primary Actors	VO, Site, GI
Secondary Actors	None
Trigger	The VO requesting the new service to be added to the catalog

DESCRIPTION	**Step**	**Action**
	01	VO sends a request of a service not existing in the actual service catalogue. As part of the request the VO sends a detailed set of requirements and a description where and why current services cannot meet these requirements.
	02	The GI performs an initial assessment of the request.
	03	After the assessment the GI decides it will honor the request and work towards its implementation and an extension of the service catalogue.
	04	A draft of the new service (level) description is sent to the sites the GI thinks capable of providing the new service, along with a request for an assessment of the new service's implementation. To simplify this, the initial request by the VO may already include a list of candidate sites.
	05	In their evaluations the sites determine if they are going to implement the new service and elaborate a timeline with an explicit date when the new service can be used by VOs. This information is sent back to the GI.
	06	The GI makes the final decision on the implementation of the new service and the extension of the service catalogue.
	07	The GI decides in favor of the new service, notifies the requesting VO and the implementing sites and defines a date when the service will become part of the service catalogue and consequently offered to Vos.
EXTENSIONS	**Step**	**Branching Action**
	02a	The GI immediately rejects the request without further consideration.
	02b	Having multiple definitions of almost the same service or service level may not be in the interest of having a clear and well structured service catalogue. The GI decides the requirements should be part of SLA negotiation but should not become a new service catalogue entry.
	06a	The GI rejects the request and informs the VO and sites.

3.1.3. PUBLISH SERVICE / ADD SERVICE TO SERVICE CATALOG

Editor	Spiros Koulouzis
Use Case identifier	UCs:SLM:SLA:PUB
Use Case	Publish service / add service to service catalog

name	
Scope	• Service Level Management ○ Service Level Agreement (SLA) related
Informal definition & example	The GI offers a new service (new resources provided as a service through the Grid) to its VOs. To this end, this new service is specified and defined in the service catalogue. The service catalogue belongs to the GI and is a means of informing registered and potential VOs of the services the GI is capable to offer through the Grid under its responsibility.
Pre-conditions	Sites must have the resources/services to support this service. Moreover the appropriate OLA between Site and GI must be in place.
Success End Condition	The service is ready for use with its capacity and specifications fully defined (APIs, usage, interfaces, etc.). If the EGI monitors the state of the catalogues, it becomes aware of the new service or it's informed of the change. Similarly if the VOs monitor the catalogue they become aware of the change, and/or they are informed by the GI or EGI.
Failed End Condition	The service is not ready for use. If previously the primary actors where informed for the deployment of the service, they must be informed for the failure, especially if the service was requested by any of the actors.
Primary Actors	GI
Secondary Actors	None
Trigger	• Successful completion of service request (see UCs:SLM:SLA:REQ use case). • The GI has new OLAs with sites that enable the publication of a new service. • The GI can combine current services in order to publish a new one.

DESCRIPTION	**Step**	**Action**
	01	The GI adds the new service to the catalogue.
	02	If the GI belongs to a higher level GI, it also informs for the new service.
	03	Registered VOs are informed of the change. If a specific VO requested the new service, then it is made sure that this VO informed.
EXTENSIONS	**Step**	**Branching Action**
		None identified

3.1.4. NEGOTIATE AND SIGN SLA

Editor	Bartek Kryza
Use Case identifier	UCs:SLM:SLA:NEG
Use Case name	Negotiate and sign SLA
Scope	• Service Level Management ○ Service level Agreement (SLA) related
Informal definition & example	A VO and the GI negotiate and, in case the negotiations are successful, sign an SLA for a service from the GI's service catalogue. The signing can be regarded as the successful end (outcome) of the negotiation. It will trigger (technical) some procedures of preparing and delivering the service (not in the scope of this use case). Usually, before the SLA is finally signed (and certainly before it takes effect), OLAs need to be agreed and established with the corresponding Sites in order to support the fulfillment of the service level targets agreed and specified in the SLA. (For the OLA-related activities, see the respective use cases.) Typically, the baseline for the negotiation of a new SLA is a service catalogue providing details on the services and their

	attributes/parameters as well as different packages that a VO may be interested in. This may also include different pre-defined service level packages. The negotiation usually starts with exploring the requirements from the VO and mapping these requirements to the pre-defined sets of service packages, service level packages and freely configurable parameters.
Pre-conditions	• A VO was registered with the GI (like for instance by means of the successful end of use case UCs:SLM:SLA:REG) • The service of which the SLA is going to be negotiated and signed is publicly available through the service catalog of the GI • Existence of negotiation mechanism • Agreement on SLA representation format
Success End Condition	The SLA is defined in a formal (unambiguous) manner, either textual (text document) or machine processable (e.g XML). The SLA document is signed by both parties with either paper or electronic signature, binding both sides to the contract statements. Machine processable format would be preferable, as it would support automatic configuration of GI's middleware components.
Failed End Condition	The GI and VO failed to agree on the terms of service. The reasons for that can include: lack of particular services or resources on the GI side, inability to guarantee particular QoS by the GI, insufficient priority of the VO with respect to its demands.
Primary Actors	GI, VO
Secondary Actors	Users, (Optional mediators) National Government Entities, European Commission (could be involved as mediators in case the GI and VO cannot reach agreement – for instance EC could increase the VO priority in order for the GI to respect the VO demands).
Trigger	The action is triggered by the VO which wants to gain or extend its access to particular resource or services provided by the GI.

DESCRIPTION	**Step**	**Action**
	01	VO requests access to new resources/services or requests modification of QoS parameters on currently used resources/services.
	02	VO submits to the GI a set of statements/requests specifying particular requirements.
	03	GI responds to the VO with the offer they are willing to provide for the request.
	04	VO submits a new set of statements/requests, more closely matching the GI offer.
	05	GI responds to the VO with a modified offer they are willing to provide for the request.
	06	LOOP: Steps 02-05 are repeated until the requests of the VO are within the constraints offered by the GI.
	07	In case of success, the SLA is rendered into a formal representation (text document, XML, database entry).
	08	The SLA is signed by the GI and the VO (in case the VO is not a legal entity, member institutions or representative institution, must sign the SLA).
	09	The SLA is stored in a SLA repository, and can now be used to enforce the new agreement by the middleware infrastructure (security, monitoring, accounting).
	10	The SLA is closed when the lifetime conditions become true or conditions for its invalidation emerge.
EXTENSIONS	**Step**	**Branching Action**
	06a	**VO and GI cannot come to agreement** In this case, VO can ask a mediator (NG, EC) to influence the GI to improve its offer to the VO, e.g. by increasing the VO priority within the GI.

Comments	1. **SLA representation** Important issue for this use case, is the way the requests, offers and final SLA statements are encoded. The obvious requirement is that the final SLA is stored

	in a formal and unambiguous way, i.e. all statements and resources/services/values to which it refers are precisely defined and understood by both parties. This could be one of the goals of the ontology developed within the WP4. 2. **Negotiation process** As the use case is in theory agnostic from the actual implementation, it is important to at least have some suggestions and ideas on how the process can be performed. Obviously as long as the negotiation process results in the formal SLA representation, it can be conveyed through email or phone calls, it probably is wise to suggest development of tools and technologies allowing performing the negotiations in a formal manner, which can be tracked. 3. **Scope of the SLA** Another important aspect of discussing SLA use cases, is the actual scope of what the SLA entails. Apart from the obvious QoS parameters related to resource/service usage, it is important to have some idea of other statements, for instance ISO/IEC 20000-2 (edition 2005-12-15) lists the following: ○ brief service description; ○ validity period and/or SLA change control mechanism; ○ authorization details; ○ brief description of communications, including reporting; ○ contact details of people authorized to act in emergencies, to participate in incidents and problem correction, recovery or workaround; ○ service hours, e.g. 09:00 h to 17:00 h, date exceptions (e.g. weekends, public holidays), critical business periods and out of hours cover; ○ scheduled and agreed interruptions, including notice to be given, number per period; ○ customer responsibilities, e.g. security; ○ service provider liability and obligations e.g. security; ○ impact and priority guidelines; ○ escalation and notification process; ○ complaints procedure; ○ service targets; ○ workload limits (upper and lower), e.g. the ability of the service to support the agreed number of users/volume of work, system throughput; ○ high level financial management details, e.g. charge codes etc; ○ action to be taken in the event of a service interruption; ○ housekeeping procedures; ○ glossary of terms; ○ supporting and related services; ○ any exceptions to the terms given in the SLA. 4. To make the set of use cases complete we should consider the renegotiation by any of the two parties 5. To make the set of use cases complete we should consider the cancellation of such SLA

3.1.5. MONITOR SLA FULFILLMENT

Editor	Bartek Kryza
Use Case identifier	UCs:SLM:SLA:MON
Use Case name	Monitor SLA fulfillment
Scope	• Service Level Management ○ Service Level Agreement (SLA) related
Informal definition & example	The GI repeatedly observes the Grid service instances to detect events (e.g., relevant changes in status of resources, warnings, exceptions) and to ensure that the current status is known. Typically, monitoring means to collect data from various sources and record them (e.g., in log files) for further purposes (like trend analysis, evaluation – see next use case). The monitoring

	19activities need to make sure that every target agreed/specified in the SLAs can be evaluated based on the monitoring data. Monitoring may include simple aggregation and processing (e.g., conversion) of raw data. Typically, SLA monitoring may rely to a certain extent on the monitoring of involved/associated OLAs (see resp. use case), but in general is not limited to this. Additional aspects may need to be considered with relation to the added value realized by SLAs. Remark: SLA fulfillment refers to both the GI fulfilling their obligations against the VO and the VO fulfilling their responsibilities and duties as to the agreed SLA. Thus, monitoring of SLA fulfillment through the GI may include the observation of the "right" 19behavior of the users in the VO.
Pre-conditions	1. An SLA is negotiated and signed by GI and VO, and stored in a machine processable format (by means of Use Case UCs:SLM:SLA:NEG) 2. The monitoring infrastructure is configured properly, including monitoring of complex services
Success End Condition	The success of the SLA fulfillment monitoring means that the system managed to identify all SLA violations based on the monitoring data collected within the scope of this use case.
Failed End Condition	The failure of this use case results in insufficient information which did not allow other components (UCs:SLM:SLA:EVR) to identify the SLA violation.
Primary Actors	GI, VO, Site
Secondary Actors	None
Trigger	The action is triggered by the registration of new (or modified) SLA in the GI infrastructure and lasts for the SLA lifetime.

DESCRIPTION	**Step**	**Action**
	01	The monitoring data is collected continuously and optionally aggregated in some simple manner
EXTENSIONS	**Step**	**Branching Action**
		None identified

Comments	**Monitoring complex services:** In many cases, service offered by GI can involve/depend on services and resources provided by different sites within the GI. The monitoring component must be able to automatically discover such causal dependencies (which are probably encoded in the form of other SLA's and OLA's), which can be used to resolve the original SLA violation. The question is to what extent current monitoring systems allow monitoring of SLA in such a way (i.e. on a VO level).

3.1.6. EVALUATE AND REPORT ON SLA FULFILLMENT

Editor	Joan Serrat
Use Case identifier	UCs:SLM:SLA:EVR ; Evaluate and report on SLA fulfillment
Scope	• Service Level Management ○ Service level Agreement (SLA) related
Informal definition & example	The GI continually processes the monitored data in order to periodically evaluate them with respect to the fulfillment of the signed SLAs. The GI creates periodic reports for the VOs and for itself and makes these reports available through the defined channels. SLA violations are considered in the periodic reports, but in addition an on-event-basis notification takes place (see UCs:SLM:SLA:NFY).
Pre-conditions	• Availability of monitored data for evaluation of the SLAs. In other words, a 19successful completion of the UCs:SLM:SLA:MON use case

	• Availability of resources to create/store the fulfillment reports • Availability of appropriate communication channels to send the notifications
Success End Condition	A report on SLA fulfillment is sent at the 20right time from the GI to the corresponding VO. The use case UCs:SLM:SLA:NFY is triggered as soon as an SLA violation is detected
Failed End Condition	The VO is not notified about the SLA fulfillment either at the corresponding periodicity or the UCs:SLM:SLA:NFY is not triggered in case of SLA violation detection
Primary Actors	VO, GI
Secondary Actors	None
Trigger	Event based trigger. The event can be a time epoch or the availability of new monitored data

DESCRIPTION	**Step**	**Action**
	01	For each SLA between a given GI and a given VO: waiting for event triggering an evaluation & reporting cycle
	02	Get appropriate repository data stored by UCs:SLM:SLA:MON
	03	Calculate SLA parameters
	04	For each SLA parameter: determine if it fits or not the SLA specification
	05	For each SLA parameter: write in the fulfillment report a record on each parameter
	06	Once completion of the fulfillment report: determine according relevant policy weather the SLA has been violated or not
	07	Check if it is time to notify the VO
	08	End the evaluation & reporting cycle and go to 01
EXTENSIONS	**Step**	**Branching Action**
	06a	The SLA is violated: trigger UCs:SLM:SLA:NFY
	07a	Time to notify the VO: send notification report to the VO containing SLA 20fulfillment data

Comments	1. **SLA violation** We should have some idea of possible SLA violations and ways to handle them, including deadlines (e.g. 1 hour) for handling each violation: ○ GI violation ▪ Service becomes unavailable – SLA can state what actions GI should undertake, including restarting the service, starting new instance of the service, giving VO access to secondary service instance ▪ Service cannot deliver agreed QoS – SLA can include rules about giving VO access to additional service, decrease the service price, etc. ○ VO violation ▪ VO gives access to service to unauthorized users – SLA can be dissolved ▪ VO uses the services for undisclosed purposes – SLA can be dissolved ▪ VO exceeds storage quota – data transfers for VO can be blocked ▪ VO exceeds the CPU time for job – the job can be cancelled 2. **Violation handling** Violation handling should be preferable automatized to maximal possible extent. This requires that the SLA is stored in a machine processable format, it contains rules indicating what actions can be undertaken by the middleware in order to resolve the problem, and proper middleware components exist in the infrastructure which can perform these actions.

3.1.7. NOTIFY VO OF SLA VIOLATION

Editor	Javier Rubio-Loyola

Use Case identifier	UCs:SLM:SLA:NFY
Use Case name	Notify VO of SLA violation
Scope	• Service Level Management ○ Service Level Agreement (SLA) related
Informal definition & example	The GI informs the VO via a pre-defined channel on the violation of one or more targets specified in an active SLA, as soon as this violation is foreseen, the GI is aware of the fact that the violation is unavoidable and will or already has occurred, or there is a significant risk/probability of occurrence of an event leading to an SLA violation. Typically, the communication channel selected for the notification depends on the severity/impact of the violation. Information from early warning systems should be considered, and the VO should be informed of any significant risk of an SLA violation in advance. Remark: SLA violation notifications refer to both, GIs violating obligations against the VO, and the VO violating their responsibilities and duties as to the agreed SLA. This use case deals with notifications from GIs to VOs. Notifications from VOs to GIs are described in use case UCs:SLM:SLA:EWR
Pre-conditions	• The system detects that an SLA has been violated • Communication channels supporting notifications between GI and VO are available
Success End Condition	As soon as an SLA has been violated, or the GI is aware that it will be violated with a given probability, the GI notifies the VO and the VO is aware of it
Failed End Condition	The VO is not aware that an SLA has been violated, or that an SLA is potentially to be violated.
Primary Actors	GI, VO
Secondary Actors	None
Trigger	Event based trigger. The event can be the violation or awareness of a potential SLA violation

DESCRIPTION	**Step**	**Action**
	01	Based on severity of SLA violation, determine communication channel for notification
	02	Issue SLA violation notification
EXTENSIONS	**Step**	**Branching Action**
		None identified

3.1.8. EARLY WARNING NOTIFICATION TO GI

Editor	Owen Appleton/Matti Heikkurinen
Use Case identifier	UCs:SLM:SLA:EWR
Use Case name	Early warning notification to GI
Scope	• Service Level Management ○ Service Level Agreement-related
Informal definition & example	The VO informs the GI via a pre-defined channel on the violation of an 21obligation/commitment/responsibility that is with the VO, specified in an active SLA, as soon as this violation is foreseen, the VO is aware of the fact that the violation is unavoidable and will or already has occurred, or there is a significant risk/probability of occurrence of an event

	leading to an SLA violation. For example: A significant delay occurs in the VO's readiness to start the usage of a service that is, e.g., based on reserved resources. Typically, the communication channel selected for the notification depends on the severity/impact of the violation. Information from early warning systems should be considered by the VO, and the GI should be informed of any significant risk of an SLA violation in advance. The use case could be seen as having a reciprocal nature with the use case UCs:SLM:SLA:NFY.
Pre-conditions	The VO has negotiated and signed a SLA with a GI (UCs:SLM:SLA:NEG).
Success End Condition	The VO succeeds notifying a violation or potential violation of an SLA to the GI.
Failed End Condition	The VO fails notifying a violation or potential violation of an SLA to the GI.
Primary Actors	VO, GI
Secondary Actors	None
Trigger	Either tools and mechanisms described in the "Evaluate and report on SLA fulfillment" use case (UCs:SLM:SLA:EVR) have brought the impending SLA violation into light, or the VO has become aware of an issue that prevents it from e.g. using that prevents it from e.g. using or releasing the resources of GI as planned in the SLA. The resources of GI as planned in the SLA. These issues may be internal to operations of the VO (e.g. discovery of a critical software fault in the application software used by the VO or absence of key personnel) or caused by external reasons (client-side site failure, e.g. loss of electricity or network connectivity). The latter category of triggers should be taken into account when deciding the communication channels for the communication between VO and GI – they need to have sufficient redundancy to reduce likelihood of communication failure.

DESCRIPTION	**Step**	**Action**
	01	VO becomes aware of a potential SLA violation (trigger).
	02	VO informs the GI about the issue.
	03	GI acknowledges the reception of the message.
	04	In case of success, the GI can take appropriate measures to react on the notification. In case the VO fails to inform the GI, the VO will manage failure appropriately (e.g. through re-sending the notification).

3.1.9. A SITE IS JOINING A GI

Editor	Martin Metzker
Use Case identifier	UCs:SLM:OLA:RGS
Use Case name	A site is joining a GI
Scope	• Service Level Management ○ Operational Level Agreement (OLA) related
Informal definition & example	A site registers itself with a GI to join the Grid as a resource provider. To be 22notified and accepted by the GI the site must name a representative which acts as the (single) contact to the GI. When requesting "membership" the site already supplies contact data of the representative. After that all further interactions between site and GI are direct through this role. The GI contacts the site to notify the contact data and supplies the site with specific rules, policies and requirements with which the site has to comply before being accepted as a resource provider in

	the Grid. The GI also (and most importantly) supplies the site with the GI's service catalogue. The site has to confirm compliance with the GI's requirements and provide a list of services from the service catalogue the site is capable of providing and willing to provide. This list is strictly informational and does not contain any commitment to already provide services or allocate resources. After the site has been confirmed to comply with the GI's requirements and rules and the GI has the list of services the site can provide the site is 23notified as a resource provider in the Grid.
Pre-conditions	• GI has service catalogue • site has been issued certificates and a member of the Grid as a "user"
Success End Condition	• site may close OLAs • site may be included/consulted by the GI and VOs • site can be contacted through a dedicated role
Failed End Condition	• GI does not consider the site as a resource provider • site representative cannot be involved in other use cases
Primary Actors	Site, GI
Secondary Actors	None
Trigger	The site wishes to contribute resources to the Grid

DESCRIPTION	**Step**	**Action**
	01	A site contacts the GI and requests membership as a resource provider. As part of this request the site names a representative which acts as the (single) contact to the GI. All further interactions between site and GI are direct through this role.
	02	The GI contacts the site to 23verify the contact data and supplies the site with the GI's service catalogue and specific rules, policies and requirements with which the site has to comply.
	03	The site confirms compliance with the GI's requirements and provide a list of services from the service catalogue the site is capable of providing and willing to provide. This list is strictly informational and does not contain any commitment to already provide services or allocate resources.
	04	The GI has the list of services the site can provide the site is 23recognised as a resource provider in the Grid.
EXTENSIONS	**Step**	**Branching Action**
	03a	The site is unable to meet the GIs requirements or is unable to deliver services in the service catalogue. In this case the site cannot become a resource provider.

Comments	As of now this we include only the initial registration. To make the set of use cases complete, we should consider the termination/modification of the registration by any of the parties.

3.1.10. REGISTER NEW GI AS MEMBER OF A HIGHER LEVEL GI

Editor	Adam Belloum
Use Case identifier	UCs:SLM:OLA:RGG ; Register new GI as member of a higher level GI
Scope	• Service Level Management ○ Operational Level Agreement (OLA) related
Informal definition &	A higher level GI recognizes a lower level GI as a member and potential contributor to the higher level Grid. For example, a higher level GI would be the European Grid Initiative (EGI), while a

example	lower level GI in this context was any National Grid Initiative (NGI) like PLGrid. Hierarchies covering more than two layers are, of course, possible. The registration of a lower level GI as a member of a higher Level GI allows these two entities to negotiate an OLA. Typically, the process of registration is conducted through pre-defined communication channels.
Pre-conditions	• The lower level GI coordinates resources (e.g., computation, and storage) provided by one or more Grid sites • The lower level GI is interested to join another GI to share its resources with the former • The lower level GI is able to fulfill the requirements that will be defined by the other GI (e.g. the type and size of the new resources, average availability, accessibility, supported OS, CPU architecture, etc)
Success End Condition	Upon a successful registration of the lower level GI, the technical characteristics of its provided resources are added to the pool of resources available within the other GI
Failed End Condition	A negative response to the registration has to be sent to the requesting GI explaining the reasons for not accepting
Primary Actors	GIs
Secondary Actors	none
Trigger	The registration UC is triggered by the lower level GI

DESCRIPTION	**Step**	**Action**
	01	GI sends a registration request to EGI
	02	EGI identifies the representative(s) of GI
	03	EGI requests further technical/administrative details from GI
	04	EGI sends its general rules and policies to GI
	05	GI agrees with rules and policies of the EGI
	06	EGI notifies GI of acceptance/rejection of its registration request. In the later case, the EGI sends the cause(s) to the GI
EXTENSIONS	**Step**	**Branching Action**
	02a	EGI can't identify the GI representative and sends a rejection to the GI for that cause
	05a	GI can't agree with some or the totality of EGI rules and policies

Comments	The actors of this use case are GIs of different administrative domains. For the sake of clarity of the detailed description we identify EGI and GI as the higher and lower levels GIs respectively. To considerer the full registration life cycle, we should also consider the redraw of the registration at any moment by the GI.

3.1.11. REGISTER NEW SERVICE ELEMENT / INSTANCE / COMPONENT TO GI

Editor	Thomas Schaaf
Use Case identifier	UCs:SLM:OLA:RGE
Scope	• Service Level Management ○ Operational Level Agreement (OLA) related
Informal definition & example	A site registers any element that may provide a utility in the context of delivering and supporting services from the Grid to the VOs. The implication of this registration process is to make the GI aware of the existence of the registered service components/elements and/or resources. At this

	stage, no concrete commitments, in particular with respect to warranty aspects, are made. (This is subject to the negotiation of an OLA.) Examples of "elements" registered include: computing elements (CE), storage elements (SE), workload management system (WMS), logical file catalogue (LFC)
Pre-conditions	• A successfully registered Site is willing to contribute resources to the Grid. • A Grid Initiative (GI) is coordinating the activities of a Grid offering resources as a service to their so far registered VOs. • The GI is empowered to register new service elements and negotiate and, on this basis, close OLAs with Sites offering these service elements.
Success End Condition	The regarded service element has been registered by the GI. To this end, relevant information about the service element has been recorded by the GI. For example, a record has been created and added to a database reflecting the type, status and configuration of the service element.
Failed End Condition	The regarded service element has not been registered by the GI. The Site has been informed about the reasons of the refusal of their registration.
Primary Actors	Site, GI
Secondary Actors	This process does not involve any other actors than the primary actors.
Trigger	This use case is usually triggered by the Site that wants to register a new service element. The trigger is a registration request/statement by the respective Site.

DESCRIPTION	**Step**	**Action**
	01	A representative of the Site sends a service element registration request/statement to the GI.
	02	GI acknowledges the reception of the request/statement
	03	GI checks and approves the identity of the Site representative
	04	GI checks whether the identified Site representative is authorized to register service elements in the name of his Site
	05	GI checks the request for compliance with pre-defined formal criteria
	06	GI evaluates whether the request will be accepted and the registration of the service element performed/processed
	07	GI informs Site about the acceptance (or rejection) of their registration
	08	GI records all relevant data of the service element (including its type, status and relevant configuration) using a service element register or configuration management database/system (CMDB, CMS)
	09	GI performs all technical and administrative steps required to include the new service element in the operational Grid infrastructure and services landscape and enable Vos to benefit from this service element when getting services from the Grid
EXTENSIONS	**Step**	**Branching Action**
		None identified

Comments	To make the set of use cases complete, we should consider the termination/modification of the registration by any of the parties. For reasons of simplicity and traceability, these aspects have not been included in the use cases model.

3.1.12. NEGOTIATE AND SIGN OLA

Editor	Bartek Kryza

Use Case identifier	UCs:SLM:OLA:NEG
Use Case name	Negotiate and Sign OLA
Scope	Service Level Management – Operational Level Agreement (OLA) related
Informal definition & example	A GI and a site or a higher level GI and a lower level GI negotiate and, in case the negotiations are successful, sign an OLA referring to one or more service elements that have been registered in advance by the site (with the GI) resp. by the lower level GI (with the higher level GI) (see use cases UCs:SLM:OLA:RGS and UCs:SLM:OLA:RGG). The signing can be regarded as the successful end (outcome) of the negotiation. It will trigger (technical) procedures of preparing and delivering the service element(s) that are part of the OLA. Usually, an OLA supports one or more existing or intended SLAs. (For the SLA-related 26activities, see the respective use cases.) Typically, the baseline for the negotiation of a new OLA is a register (e.g., a database or spreadsheet) of service elements providing details on the registered service elements and their attributes/parameters. The negotiation usually starts with exploring the requirements from the GI (or higher level GI) based on planned or existing SLAs and mapping these requirements to capabilities of the registered sites (or lower level GIs) and their registered service elements. All cases of negotiating OLAs need to be considered: • Potential future SLA • Requested, but not yet signed SLA • Existing and signed SLA that is not (anymore) sufficiently underpinned by OLAs
Pre-conditions	• Site is member (registered as service provider) of a GI • GI is member of a higher level GI • There is a negotiation mechanism in place • There is an agreement on the representation of the OLA
Success End Condition	The success of the OLA negotiation means that the Sites (providers) agree to provide their resources and services through the GI to the VO constituted within that GI, with respect to a set of SLA constraints (either defined precisely or within some margins subject to future negotiations between VO and GI). Thus OLA to some extent predicts the types and scope of SLA agreements between GI and VO's, which can be negotiated. Similar rules apply in case of negotiation of GI and higher level GI's.
Failed End Condition	The negotiations can be considered as a failure in several cases: • GI expectations cannot be met by the capabilities of the Site • Site requirements (e.g. price of services, security constraints) cannot be accepted by the GI
Primary Actors	GI, higher level GI, Sites
Secondary Actors	N/A
Trigger	The action is triggered by registration of new Site (GI) in the GI (higher level GI), or by necessity of amendment in the existing OLA (this can be result of request for SLA between GI and VO which is not predicted by the OLA for that service).

DESCRIPTION	**Step**	**Action**
	01	New Site (GI) is registered in the GI (higher level GI) (see use cases UCs:SLM:OLA:RGS and UCs:SLM:OLA:RGG)
	02	Site provides a portfolio of its capabilities and competencies to the GI (i.e. list of resources, services, previous experience, etc..)
	03	GI (higher level GI) specifies its list of expectations and requirements (resources, services, precise SLA and types of SLA which could be negotiated in the future with emerging VOs)
	04	Site (GI) provides its offer for the GI's (higher level GI) request.

	05	LOOP: Steps 03-04 are repeated until both GI (higher level GI) requirements are satisfied by the Site (GI) offer.
	05	The OLA is rendered in a formal representation (text document, XML) and stored in some repository.
	10	The OLA is closed when the lifetime conditions become true or conditions for its invalidation emerge.
EXTENSIONS	**Step**	**Branching Action**
	01a	Site cannot provide the service under some OLA anymore, thus GI needs to transfer the OLA to another service provider. The rest of steps are the same.

Comments	1. **OLA representation** Similar to SLA representation, the result of OLA negotiations must be rendered in some formal unambiguous form, so that both sides of the agreement will be bound to its statements and that both sides understand all concepts and statements of that agreement in the same way. 2. **Scope of OLA** Another issue is the scope of OLA, i.e. a set of possible statements which must or should be part of a binding OLA: o OLA lifetime – dates for which OLA is valid, conditions for dissolution of OLA o List of resources/services provided – the list of services the Site is willing to provide to the VO's created within the GI o List of necessary SLA parameters for every use of the service within the GI – the necessary conditions for the services provided by the Site to the GI o List of types of SLA which can be negotiated by new VO's through the GI – possible types of SLA (e.g. Service X can be provided to a single VO as long as the input data size is less than Y GB, where Y can be negotiated by each VO in the range [1-10]) o List of potential users of the service – the list can limit the potential customers of the services (e.g. scientific, public bodies, commercial, etc.) 3. To make the set of use cases complete we should consider the renegotiation by any of the two parties 4. To make the set of use cases complete we should consider the cancellation of such OLA 5. Example OLA between EGI and Resource Centers can be found in [11]. In particular the scope of that OLA is defined as: *The Resource Centre OLA covers the commitments made by a Resource Centre with respect to its Resource Infrastructure Provider and EGI, and correspondingly, the commitments that a Resource Infrastructure Provider makes to their member Resource Centres.*

3.1.13. MONITOR OLA FULFILLMENT

Editor	Bartek Kryza
Use Case identifier	UCs:SLM:OLA:MON
Use Case name	Monitor OLA fulfillment
Scope	Service Level Management – Operational Level Agreement (OLA) related
Informal definition & example	The GI (resp. the higher level GI) repeatedly observes the service elements for which OLAs have been defined, in order to detect events (e.g., relevant changes in status of resources, warnings, exceptions) and to ensure that the current status is known. Typically, monitoring means to collect data from various sources and record them (e.g., in log files) for further purposes (like trend analysis, evaluation – see next use case). The monitoring activities need to make sure that every target agreed/specified in the OLAs can be evaluated based on the monitoring data. Monitoring may include simple aggregation and processing (e.g., conversion) of raw data. In

	case of higher level GI, respectively higher level metrics will be of interest, including from questionnaires and surveys from the end users (i.e. whether the GI fulfills the goals agreed upon in the OLA between the GI and higher level GI).
Pre-conditions	• An OLA is negotiated and signed by Site (GI) and GI (higher level GI), and stored in a machine processable format (by means of Use Case UCs:SLM:OLA:NEG)
Success End Condition	The success of the OLA fulfillment means that during the OLA lifetime no violations occurred, or that all violations which occurred where successfully handled/resolved based on the conditional SLA statements (The VO was given access to secondary instance of service in case the primary service failed). The OLA violation includes cases when any of the SLA's which are under the umbrella of such OLA are violated.
Failed End Condition	The Site (GI) or GI (higher level GI) failed to fulfill the agreed OLA ,i.e. a violation occurred on either side, which couldn't be resolved within the scope of SLA's within that OLA. This can lead back to the need for OLA (re)negotiation use case UCs:SLM:OLA:NEG.
Primary Actors	Site (GI), GI (higher level GI)
Secondary Actors	N/A
Trigger	The action is triggered by one of the following events 1. the registration of new (or modified) OLA in the GI (higher level GI) 2. renegotiation/modification of existing OLA

DESCRIPTION	**Step**	**Action**
	01	The monitoring data is collected continuously and optionally aggregated in some simple manner
EXTENSIONS	**Step**	**Branching Action**
		None identified

3.1.14. EVALUATE AND REPORT ON OLA FULFILLMENT

Editor	Joan Serrat
Use Case identifier	UCs:SLM:OLA:EVR ; Evaluate and report on OLA fulfillment
Scope	• Service Level Management ○ Operational Level Agreement (OLA) related
Informal definition & example	The GI continually processes the monitored data in order to periodically evaluate them with respect to the fulfillment of the signed OLAs. The GI creates periodic reports for the sites (resp. the lower level GIs) and for itself and makes these reports available through the defined channels. OLA violations are considered in the periodic reports, but in addition an on-event-basis notification takes place (see UCs:SLM:OLA:NFY).
Pre-conditions	• Availability of monitored data for evaluation of the OLAs. In other words, a 28successful completion of the UCs:SLM:OLA:MON use case • Availability of resources to create/store the fulfillment reports • Availability of appropriate communication channels to send the notifications
Success End Condition	A report on OLA fulfillment is sent at the 28right time from the GI to the corresponding GI / Site. The use case UCs:SLM:OLA:NFY is triggered in case that an OLA violation is detected
Failed End Condition	The GI / Site is not notified about the OLA fulfillment either at the corresponding periodicity or the UCs:SLM:OLA:NFY is not triggered in case of OLA violation detection
Primary Actors	GI (high level)and GI (low level) or GI and Site

Secondary Actors	None
Trigger	Time epoch based or new data provided by UCs:SLM:OLA:MON is available

DESCRIPTION	**Step**	**Action**
	01	For each OLA between a given pair of GIs or a given GI and Site: waiting for event triggering an evaluation & reporting cycle
	02	Get appropriate repository data stored by UCs:SLM:OLA:MON
	03	Calculate OLA parameters
	04	For each OLA parameter: determine if it fits or not the OLA specification
	05	For each OLA parameter: write in the 29fulfillment report a record on each parameter
	06	Once completion of the 29fulfillment report: determine according relevant policy weather the OLA has been violated or not
	07	Check if it is time to notify the GI or the Site
	08	End the evaluation & reporting cycle and go to 01
EXTENSIONS	**Step**	**Branching Action**
	06a	The OLA is violated: trigger UCs:SLM:OLA:NFY
	07a	Time to notify the GI or the Site: send notification report to the target containing OLA fulfillment data

3.1.15. NOTIFY SITE OR LOWER LEVEL GI ON OLA VIOLATION

Editor	Javier Rubio-Loyola
Use Case identifier	UCs:SLM:OLA:NFY
Use Case name	Notify site or lower level GI on OLA violation
Scope	Service Level Management – Operational Level Agreement (OLA) related
Informal definition & example	The GI informs the site or the lower level GI via a pre-defined channel on the violation of one or more targets specified in an active OLA, as soon as this violation is discovered or foreseen or there is a significant risk/probability of occurrence of an event leading to an OLA violation. Typically, the communication channel selected for the notification depends on the severity/impact of the violation. Information from early warning systems should be considered. Warnings and notifications initiated by the site or lower level GI are not regarded in this use case (see use case UCs:SLM:OLA:EWR).
Pre-conditions	OLAs have been signed between a GI and a Site (resp. between a higher-level GI and a lower-level GI). GIs are currently monitoring and evaluating the OLAs. Middleware infrastructures have been configured to monitor OLA-related information. OLAs can be evaluated periodically and on-event basis (see use case UCs:SLM:OLA:EVR). OLAs involved/associated to the SLAs are being monitored and evaluated by the GI. The communication channels between the GI and the Site or the Lower Level GI are configured in order to transmit notifications.
Success End Condition	The Site (resp. the lower-level GI) is aware that an active OLA has been violated, or that it will be violated, or that there is a potential risk for OLA violation. The GI and the Site (resp. the higher-level GI and the lower level GI) would be able to potentially re-negotiate a new OLA UCs:SLM:OLA:NEG to accommodate new situation of the Site (resp. the lower-level GI).
Failed End Condition	The Site (resp. the lower-level GI) is not notified that an OLA has been violated, or that an OLA is potentially to be violated. No OLA re-negotiation is completed due to lack of resources or any other cause. All this will cause the GIs not be able to fulfill the agreed OLAs, and eventually the SLAs related to the former OLAs.

Primary Actors	Site (GI), GI (higher level GI)
Secondary Actors	None
Trigger	This use case is triggered by the primary actor 1, the GI that wants to notify of any OLA-violation related event. The trigger is a negative outcome of an OLA evaluation process by the respective GI.

DESCRIPTION	**Step**	**Action**
	01	Based on severity of OLA violation, determine communication channel for notification
	02	Issue OLA violation notification
EXTENSIONS	**Step**	**Branching Action**
		None identified

3.1.16. EARLY WARNING NOTIFICATION TO GI OR HIGHER LEVEL GI

Editor	Matti Heikkurinen/Owen Appleton
Use Case identifier	UCs:SLM:OLA:EWR
Use Case name	Early warning notification to GI or higher level GI
Scope	Operational Level Agreement (OLA) related
Informal definition & example	The site or lower level GI informs the (higher level) GI via a pre-defined channel on the violation of an obligation/commitment/responsibility that is with the site or lower level GI, specified in an active OLA, as soon as this violation is foreseen. The site or lower level GI is aware of the fact that the violation is unavoidable and will *or already has occurred* (*if we're calling the use case early warning, including already occurred OLA violation can be confusing – should be rename the use case by dropping the "Early"?*), or there is a significant risk/probability of occurrence of an event leading to an OLA violation. Typically, the communication channel selected for the 30notification depends on the severity/impact of the violation and the corresponding degree of redundancy/reliability required. Information from early warning systems should be considered by the site responsible for lower level GI, and the (higher level) GI should be informed of any significant risk of an OLA violation in advance. The use case is similar to GI informing VO about SLA violation (UCs:SLM:SLA:NFY), differences being the more general framework of OLA (instead of SLA) and more diverse options for recovery.
Pre-conditions	The use case assumes that either the site (UCs:SLM:OLA:RGS) or GI (UCs:SLM:OLA:RGG): • are registered as a part of a GI and • have initiated necessary monitoring (UCs:SLM:OLA:MON) and reporting (UCs:SLM:OLA:EVR) procedures (*will individual sites do evaluation and reporting? The latter use case mentions GI only*).
Success End Condition	GI receiving the notification will be able to increase available resources by adding sites (UCs:SLM:OLA:RGS) or lower level GIs (UCs:SLM:OLA:RGG) to its resource pool (by negotiating and signing an OLA with them – UCs:SLM:OLA:NEG). The warning and recovery will also be logged as described in reporting use case (UCs:SLM:OLA:EVR) by the receiving GI, warning will be also logged by the sending GI or site.
Failed End Condition	In case the GI receiving the notification is unable to add resources, it will either pass on the warning to higher level GI or trigger sending of a notification to VO about SLA violation (UCs:SLM:SLA:NFY). The warning will also be logged as described in reporting use case (UCs:SLM:OLA:EVR) by both sending and receiving parties.

Primary Actors	GI, sites
Secondary Actors	N/A
Trigger	The trigger for the use case can be external to site or GI, for example a notification of an external service failure as documented in use cases of outsourced mission-critical services of the site/GI. In case the encompassing GI can push (UCs:SLM:OLA:NEG) a higher priority OLA to GI/site as part of a chain of actions triggered by conditional SLA statements as part of the SLA fulfillment monitoring (UCs:SLM:SLA:MON), the use case may be triggered as part of the impact mitigation/recovery process.

DESCRIPTION	**Step**	**Action**
	01	Site or GI ("Initiating party" hereafter) becomes aware of an impending OLA violation on one of the OLAs it is responsible for.
	02	Initiating party notifies the other signatory of the OLA ("client" hereafter) of the OLA violation
	03	Client acknowledges the reception of the notification.
	04	In case of success, the client can take appropriate measures (e.g. initiate UCs:SLM:OLA:NEG). In case of failure, the initiating party will attempt to resend the 31notification, possibly through other channels specified in the OLA.

Comments

1. **OLA violation** Possible reasons for OLA violation:
    - Site-GI OLA
        - Site
            - Service becomes unavailable for at least one VO – Site should undertake certain actions in order to restore the service, or provide new instance of the service
            - Service does not operate with specified QoS for at least one VO – Site should undertake certain actions in order to improve the quality of service
        - GI
            - GI gives access to the service to invalid users – Site can revoke the provision of the service if it is used for purposes or Vos beyond the scope of OLA (e.g. commercial use of noncommercial data)
    - GI-higher level GI OLA
        - GI
            - GI fails to attract target users – in case OLA specified a number of end users of the services provided by the GI and the GI cannot interest enough users, it could be dissolved
            - GI fails to handle new VO requests – in case OLA specifies a deadline for processing each new VO request, and this deadline is not respected by the GI
            - GI cannot find service providers for the envisioned functionality – in case OLA defines the minimal set of services (types of services) and the GI cannot find service providers which could deliver it
2. **Violation handling** It is important to envision how the OLA can be handled, in particular how to automatize the process of resolving OLA violations.

4. CONCLUSIONS

Service Level Management (SLM) in grid services is grounded in the ITIL framework by properly adapting it to the Grid environment. The starting point in this adaptation is the identification of a model describing the actors and their relationships in the service management process. That model has been elaborated and is presented in this document. In addition, the interaction among the model actors' are constructed in terms of use cases. A total of sixteen use cases have been created, which can be understood as the specification in terms of business processes of the functionality that has to be provided in SLM of grid services. Finally, the modeling approach of the gSLM project is formalized in terms of an ontology that constitutes a further step towards the management of these services.

The use cases presented in this document have to be understood as evolvable management specifications. In many of them we have also highlighted issues that have to be sorted out through additional research. These issues include for instance the extension of the set of use cases to cover the full life cycle of management of grid services. The same comment is applicable also to the proposed ontology. Our intention in the gSLM project is by no means the creation a full ontology of SLM for e-infrastructures. This would require an effort that is not available within the project because such ontologies are in general huge models. Nevertheless, the level of completion of the modeling approach presented in this document is enough to constitute the inputs of other activities within the gSLM project and allow for its planned progression to derive specifications, assess the status of SLM in current grid scenarios and finally design a roadmap to achieve the desired goal.

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6. DOCUMENT CONTROL

6.1. GENERAL DOCUMENT INFORMATION

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