ValueGrids: Using Grids in Dynamic Service Value Networks


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Abstract
In recent years, Grid infrastructures have proven to be invaluable in the area of scientific computing and high-performance computing (HPC). However, the use of Grid infrastructures in complex business scenarios remains an open research topic. A major goal of the ValueGrids project, funded by the German Federal Ministry of Education and Research (BMBF) as part of the German Grid initiative (D-Grid), is the development of a concept to demonstrate how Grid infrastructures can substantially support complex business scenarios. This position paper describes the vision of the ValueGrids project as well as an approach to provide sustainability of Grid infrastructures.

1 Introduction
Nowadays, business processes need to be extremely flexible due to an increasing innovation rate, highly dynamic markets, as well as more and more complex and specific customer expectations. In order to meet these requirements, companies tend to focus on their core competencies and engage in inter-organizational partnerships to deliver complex services in networked economies. In a similar way, Software-as-a-Service (SaaS) providers compose services from different software, infrastructure, and service providers to jointly create an integrated solution while forming a specific type of networked economies – so called Service Value Networks (SVNs) [4]. To express the conditions of service delivery between the stakeholders in an SVN, Service Level Agreements (SLAs) have become a common means for establishing a legal and contractual basis. Thus, SaaS providers require support for managing SLAs relating to multiple service types and stakeholders in an SVN throughout their entire lifecycle.

Within the last years, SLA Management has attracted significant attention and has been a highly active research area (see e.g. [11]). Nevertheless, there are still a lot of open issues regarding the management of SLAs in SVNs, both from an economic as
well as technical perspective. As one example, the integration of Grid infrastructures and the identification of the requirements to be fulfilled by a Grid infrastructure provider are challenging unresolved tasks. Recent work on integrating Grids in business scenarios is done by research projects such as Biz2Grid [14] and BIS-Grid [7]. However, these projects focus on commercializing specific applications using the Grid in an isolated way and do not consider the bigger picture of service value networks, where grid-based services are only one of many building blocks, which together form a complex business service.

The major goal of the ValueGrids project is to develop concepts and tools for an integrated SLA management framework for supporting service integrators in SVNs, also enabling the integration of grid-based services in complex business processes and considering economic aspects during decision making processes. This particularly includes service, SLA and dependency modeling, negotiation and monitoring support tailored to complex value networks. These functions are offered in combination with decision support functionalities for consumers as well providers regarding the choice of appropriate services and business partners, which enables a continuous improvement of the SVN.

To this end, we plan to provide support for the translation of technical service level requirements for provided services into consumed services along the horizontal service chain as well as the aggregation of SLAs for complex services from lower-level services, on the one hand. On the other hand, we target the development of an economic dependency analyzer component, supporting a continuous evaluation of potential agreements based on risk assessments. The comprehensive runtime monitoring information about instantiated SLAs required for these functions are thereby provided by provider- and consumer-side monitoring components. For assessing technical dependencies, in particular regarding Quality of Service (QoS) properties, we provide a systematic approach using automated tests and benchmarks. Thereby, organizational boundaries between different partners make it necessary to employ a black-box approach.

This position paper provides a general overview to the ValueGrids SLA management framework architecture and briefly introduces its major components. Section 2 discusses related work. In section 3 we give an overview on our approach for an SLA Management Framework in Service Value Networks. Section 4 outlines the industrial use case we want to investigate within the project. Finally, section 5 concludes the paper and points out directions for future research.

2 Related Work

Service Value Networks (SVN) include the technical composition of Web services to complex services such as insurance brokering, travel planning, insurance liability services or package tracking, which has been discussed intensively in recent years. While [10] propose different technologies for Web service composition, [5] focus on a semantic way to combine Web service by introducing a Generic Service Ontology. The emergence of SVNs fostered through a value-adding composition of services, is discussed in [4]. The value-adding combination of services, either technical composition or a more loosely coupled aggregation of services to bundles, represents the starting point for the SLA management framework presented in this paper.
SLA management has been discussed from different points of view in literature. In [12, 13], the life cycle of an SLA from creation through monitoring of service execution and reaction on failures is understood as SLA Management. These works mainly discuss the description’s formalization as well as control of SLAs and the respective execution. Similarly, [3] present a framework that facilitates verification and validation of SLAs. Formalization is the focus here, but aspects like the specification of threshold values and SLA decomposition are considered as well. However, these approaches focus on the SLA-driven management of single services and barely support management of complex services and relationships in SVNs. Especially economic aspects and support for infrastructure or grid services are not considered at all.

Today, the most popular framework for modeling and managing single service offerings and SLAs is WS-Agreement as proposed in [1]. Based on such formalized SLAs, [6] propose a novel approach for modeling and analyzing interrelations between services that form a complex service and the SLAs that are concluded on the quality of these services. Here, dependencies are described by means of Petri-Nets. This approach may be feasible for a limited number of services but does not necessarily scale in case of numerous, dynamically changing participants.

A possibility for SLA management in cross-business scenarios is introduced in [15]. The translation of “business SLAs” into individual configurations of network devices is a main point of interest here. According to [15] “business SLAs” constitute a description of services and involved parties as well as the definition of a class of service that defines quality of service by means of reaction times. The above mentioned work constitutes the basis for SLA management as introduced in the project ValueGrids.

By contrast, risk-based SLA management had little influence in cross-business scenarios. Approaches of measuring risk have mainly been applied in the context of security portfolios as in [8]. An overview on risk measures and their requirements is given in [2].

A first approach that introduces risk as a proxy for optimizing an SLA portfolio is presented in [9]. Here, the semi-variance of relative failure of a certain SLA combination is used as a representative for risk and is weighted by agreed penalties.

3 ValueGrids SLA Management Framework

This section introduces the ValueGrids SLA management framework, which particularly supports service integrators in managing their complex services. The proposed framework comprises three major components and is instantiated by each service integrator in the SVN. The Service Repository (see section 3.1) represents the central data store for each service integrator and contains all models required for establishing and analyzing complex SVNs, including service descriptions, corresponding SLA templates, agreed SLAs as well as technical and economic (risk-based) dependency information. The Dependency Analyzer (see section 3.2) extends the Service Repository with analysis functionalities such as detection of service dependencies, detection of SLA dependencies, and determination of risk indicators. This component mainly accounts for providing decision support during service and
provider selection which is continuously improved based on historic information. Finally, the Management Cockpit (see section 3.3) offers a graphical user interface to instances of the ValueGrids SLA Management Framework, in particular the above mentioned components. In addition to this, it visualizes the current state of the SaaS provider’s SLA landscape to support a manual analysis of complex dependencies.

3.1 Service and SLA Repository

The service and SLA repository contains a collection of fundamental models and services. On the one hand, this includes models that describe the offered service. Thereby, the corresponding meta-model provides the possibility to create service descriptions of all different service types in a SVN. Furthermore, it includes a meta-model for the specification of SLAs between service providers and their customers. Again, the meta-model supports modeling SLAs for each service type in the SVN.

On the other hand, the repository comprises additional models for explicitly capturing multiple types of dependencies. First, the dependencies between multiple service offers can be expressed in order to be able to define valid service offer combinations. This network of service offers is a precondition for the selection of services at deployment time (e.g. based on risk indicators). Second, it is possible to specify dependencies between SLA instances in order to express relationships between SLAs offered by different service providers. The dependencies between SLAs are derived by performing automated black-box tests and used for SLA aggregation or SLA translations during negotiation.

3.2 Dependency Analyzer

The data stored in the service repository forms the basis for calculations carried out with the aid of the dependency analyzer, which provides participants with a decision support for SLA conclusion. The dependency analyzer’s recommendation is calculated on basis of historical data on SLA fulfillment stored in the service repository of the querying party. In order to calculate the risk stemming from a new agreement, a utility that incorporates the expected profit as well as the semi-variance as a proxy for risk of failure as introduced in [9] is calculated.

The recommendation that is offered may be either on the conclusion of an additional SLA (for service providers) or on the selection of contractual partners for the provision of a complex service (for intermediaries that integrate several services to a complex one).

A service provider invokes the dependency analyzer each time a customer or integrator requests a service with a specific service level. From the Service Repository, the historical observations on SLA fulfillment are retrieved. Then, the risk for the current set of SLAs and the risk for the SLA combination containing the additionally requested SLA are calculated.

For a service integrator, the dependency analyzer supports the decision on the service providers to be requested for service provisioning. Therefore, the feasible service providers and their respective performance in SLA combinations are retrieved from the service repository. Then, the dependency analyzer is used to compute a ranking of provider combinations and the provider combination incurring the lowest risk on the intermediary will be recommended for service provision.
3.2 Management Cockpit

The Management Cockpit constitutes the frontend of the ValueGrids SLA Management Framework and provides its functionality to the service provider. The cockpit combines the functionality of the Dependency Analyzers and the Service Repository into an integrated view on the SVN covering technical and economical data.

To enable easy usability and efficient applicability in existing corporate systems, the management cockpit is developed as light weight web application utilizing state-of-the-art software concepts. First, the cockpit services support an online processing and evaluation of monitoring data of the service value network with an explicit focus on the implications of the interconnected contracts between network participants. Furthermore, the management cockpit provides tools to intuitively visualize endogenous risks and non-trivial dependencies within and between service level agreements in a SVN.

To enable flexibility and extensibility for future requirements the management cockpit follows a modular design and we intend to support various interfaces. Supporting Mashup technology for instance enables to connect the management frame to other information services and to derive thorough management decisions. This also includes the manipulation, filtering as well as evaluation of the online state of the system in real-time. In summary, the management cockpit provides an economical as well as technical holistic view on the state of the SVN.

4 Industrial Use Case

The industrial use case of the project ValueGrids is set in an e-learning scenario for an ERP solution. The following figure shows the players in this use case, their services and SLAs between them.
The SaaS provider on top offers a variety of e-learning business use cases to its customers. This SaaS provider primarily appears as an integrator, as he combines two SaaS services from other SaaS providers without much technical integration. He rather combines the services in a business sense, offers consulting and support for the composite service and ensures quality and transparency for his customers by granting them access to the results of his service level monitoring for the underlying SaaS services as well as for the composite service. For selecting suitable services based on the requirements of the customer and the reliability of the SaaS providers, the SaaS integrator draws on the ValueGrids SLA Management Framework.

The other underlying SaaS providers offer the actual SaaS offerings aggregated by the SaaS Integrator. The provider on the left performs substantial technical integration of web services, applications and infrastructure from different parties. He also draws on the ValueGrids SLA Management Framework but uses an extended scope of it in order to integrate SLAs from all the different layers. Concretely, he integrates ERP web services from one provider, a software application for optimization from another and infrastructure services – either cloud- or Grid-based – from further providers. He deploys the optimization software with one of the latter infrastructure providers and adds it to a business process of ERP web services. The composite services are presented in a GUI offered by the SaaS provider. The ERP web services are operated by a web service provider who himself draws on another infrastructure provider. SLAs are considered between all parties with a provider-consumer-relationship.

The SaaS provider on the right contributes a SaaS application that is not composed of other services. One application is developed by this SaaS provider, run on his infrastructure and as such integrated in the reseller's business use case. Hence, the corresponding SLAs are only internal and not considered by the ValueGrids SLA Management Framework. Customers eventually use the composite ERP service as a demo for comprehending in practice what they learn from the e-learning service in theory. They interact with the two SaaS services of the business use case in a very similar way, and the depth of integration remains hidden to them.

5 Conclusion and Outlook

The components proposed by this project provide a means for service providers to define and actively manage service level agreements horizontally, across different providers in an SVN. Potential SLAs can be identified, defined and managed for different service types and between multiple providers and consumers.

With respect to D-Grid, this complements the scope of the SLA4D-Grid Project, which addresses Service Level Management for Grid resources and services. This will increase the sustainability of grid infrastructures by integrating the offered resources into more complex commercial scenarios.

The proposed components will enable service providers to participate in dynamic service value networks. Participation in these networks requires leaving total planning reliability and work towards to a more dynamic service aggregation based on calculated risk.

The results of this project serve as basis for further research on the integration of Grid Infrastructures in business scenarios.
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