

Towards Autonomous Brokered SLA Negotiation

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Abstract: Today the whole contract lifecycle in eBusiness is handled manually. Contracts are not only written and agreed upon by humans, they have to be manually translated into technical terms to become an electronic contract. More and more research activities in eBusiness focus on the usage of electronic contracts (in particular Service Level Agreements) and how they can be created and enforced autonomously. So far, proposed solutions were not taken up by business users because of low flexibility, poor usability and high maintenance costs. This paper presents a proposal how “traditional” approaches can be extended to a broker-based solution valuable to business users, in particular small and medium-sized enterprises. The focus is on one of the main phases in the SLA-lifecycle – the negotiation phase. The paper describes how SLA negotiation can be outsourced to third parties and what the benefits and difficulties of such an approach would be.

1. Introduction

Service Level Agreements (SLAs) are an essential instrument for service providers to advertise their services’ quality, as well as to manage their resources. Service customers on the other hand use SLAs to formalise guarantees on service quality properties. Looking at past and currently running projects (e.g. funded by the European Commission), one observes an increasing number of research activities in the SLA area. In addition, different communities, e.g. the Grid Resource Allocation Agreement Protocol Working Group (GRAAP-WG [1]) at the Global Grid Forum [3], are working towards the goal of making SLAs an integral part of future generation Grid systems.

Based on our experiences from projects like NextGRID [4] and TrustCoM [5], we generally aim at contributing to the discussion on SLA-based service customer-provider relationships. In this paper, however, we elaborate particular technical aspects related to support and automation of the negotiation of Service Level Agreements. In addition, we consider business needs and demands of such a solution.

Our approach towards the support of SLA negotiation is based on the introduction of a brokered solution that can be embedded in already existing negotiation frameworks. The main aim of this framework is to strengthen the position of Small and Medium-sized Enterprises (SMEs) by reducing the effort needed for SLA negotiation. Furthermore, this paper shows the potential of this proposal by using a real-life use case. It also points out difficulties and challenges on the road towards a business-oriented solution.

Starting with the definition of the main objectives of our paper in Section 2, we describe our approach towards autonomous brokered SLA negotiation in Section 3. Using a real-life business use case taken from the IST project SIMDAT [6], Section 4 presents how our proposal can be put into practice and which consequences (benefits) this would have. Section 5 is intended to give an overview of the technology that in our eyes would be valuable for the realization of the broker-based approach. The last section concludes the paper and summarizes its main contributions.

2. The Challenge of Supporting SMEs

In its SLA Management Handbook [2], the TeleManagement Forum worked out a split-up SLA lifecycle, consisting of six distinct phases: Development, Negotiation, Implementation, Execution, Assessment, and Decommission. Whilst the major part of SLA research concentrated on management issues of Service Level Agreements, the negotiation between customer and provider and therefore the creation of an agreement itself was not or only insufficiently considered. According to the authors, negotiation of the actual “contractual” details must be considered one of the most important phases of an eBusiness based collaboration, since it will define the conditions and terms that the service provider (and potentially customer) has to maintain during the lifetime of the collaboration. As such, both provider and customer want to have their main requirements defined in the SLA. This paper focuses on steps needed to enable automated SLA negotiation supported by a third party as part of the SLA creation lifecycle.

Our proposed model is based on initial solutions developed by current research projects like NextGRID and TrustCoM. So far, research has focused on proposals that put the whole burden of negotiation on all parties involved. Each of the parties has to make sure that the necessary negotiation support is available within their domain. Whereas such an approach is valid from a mere technical standpoint, it implicitly poses additional difficulties for small and medium-sized enterprises. Compared to large enterprises, it is a big challenge for SMEs to provide the expertise and financial support to acquire and maintain negotiation facilities.

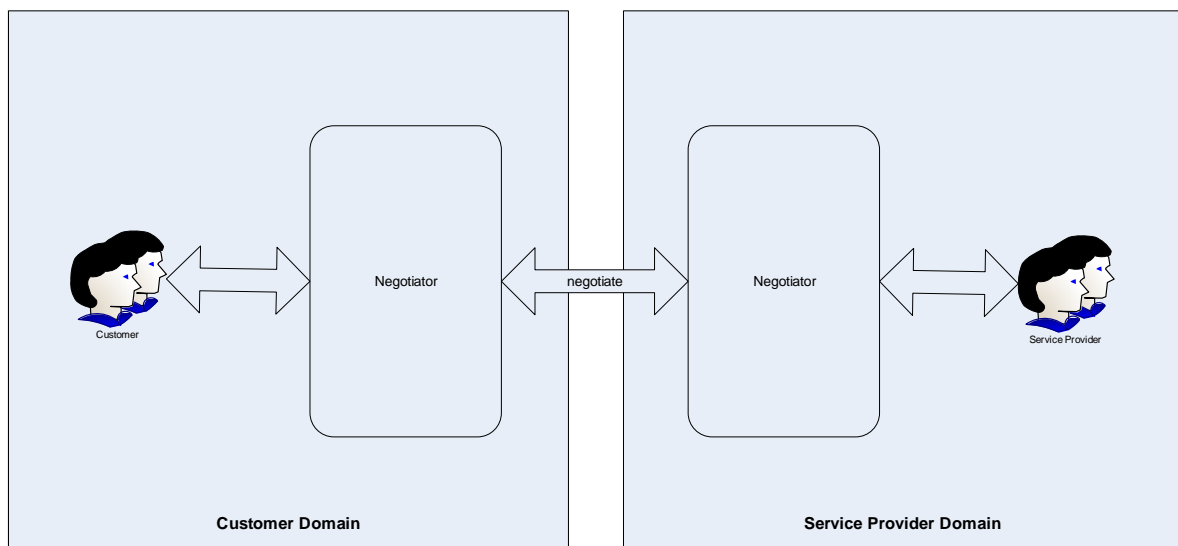


Figure 1: “Traditional” Negotiation

Figure 1 shows a high level picture of a “traditional” negotiation framework, which requires negotiation components (bundled under the term “Negotiator” here) on both the customer’s as well as on the service provider’s side. Whilst large enterprises may be able to invest money and effort into developing a negotiation system that meets their respective requirements best, smaller enterprises cannot afford such investment. They would rather

profit from other providers' expertise – namely the ones providing the third party broker: these business entities may invest the profit from providing this service in realising a flexible, intelligent negotiation component. From the viewpoint of this paper's authors, the burden of maintaining negotiation components is one of the issues that prevent business participants to use and rely on SLAs. It is of great importance to provide acceptable, usable and economical solutions for automated business execution to foster the uptake of SLA concepts within the business area. Looking beyond SMEs, we should not forget that the establishment of service access with low overhead in both financial and administrative costs is a goal of all business partners independent of the size of the company.

The introduction of third parties, e.g. in TrustCoM, who provide support services, showed that the outsourcing of services can often be of high value (cf. [13]). No local software components are required, which implies a reduction of administrative costs. Initial set-up costs are largely reduced as less software licenses or hardware have to be acquired. (Although service-oriented architecture principles foresee a very loose coupling between components, making "local" availability unnecessary, there still may exist certain business considerations to reduce the amount of outsourced resources – see [13] for more details.) Costs are only incurred for negotiation services that are actually used. An architecture involving third parties that perform the process of SLA negotiation for customers and providers therefore seems to perfectly fulfil the needs of SMEs.

To overcome these limitations the authors propose to evolve existing solutions towards "brokered negotiation". With the introduction of a component provided by a third party – the so-called *SLA Negotiation Broker* – SMEs could "outsource" negotiation tasks in order to keep their effort low and at the same time receive the desired quality of service. The main goal of this paper is to show how an SLA Negotiation Framework could be realised based on the SLA Negotiation Broker, what technical issues the approach raises, and how they could be addressed. In addition, we examine the business requirements implied by such an approach, in particular when it comes to confidentiality and security.

3. Towards a Broker-based Solution

The development of our proposed solution is based on results and experiences from a number of EC-funded Grid projects, in particular TrustCoM and NextGRID. The authors intend to show how current solutions can be extended in order to encourage the uptake of SLAs in eBusiness by making their handling (in particular regarding negotiation) less complex for service providers as well as customers.

From our perspective, uptake of SLA negotiation in eBusiness can only be increased by enhancing usability and lowering costs and effort of SLA-based frameworks. For this purpose we examined how "traditional" SLA negotiation approaches could take advantage of benefits commonly attributed to outsourcing (e.g. cost reduction and productivity gains).

3.1 Basic Architecture

Our suggestion is to outsource negotiation functionalities to a third party which can be seen as an intermediary (or rather a representative) in the overall negotiation process. With the introduction of this new role – the Negotiation Broker – we see the chance to free service providers and customers from integrating and maintaining costly negotiation soft- and hardware in their domain. Besides this, a new market niche would appear for companies that specialize in the provision of such brokered services. In addition to monetary benefits, users of broker services will profit (via the broker) from future developments in the areas of artificial intelligence, business negotiation, and optimisation processes, as it will be in the interest of the broker to always provide state-of-the-art technology.

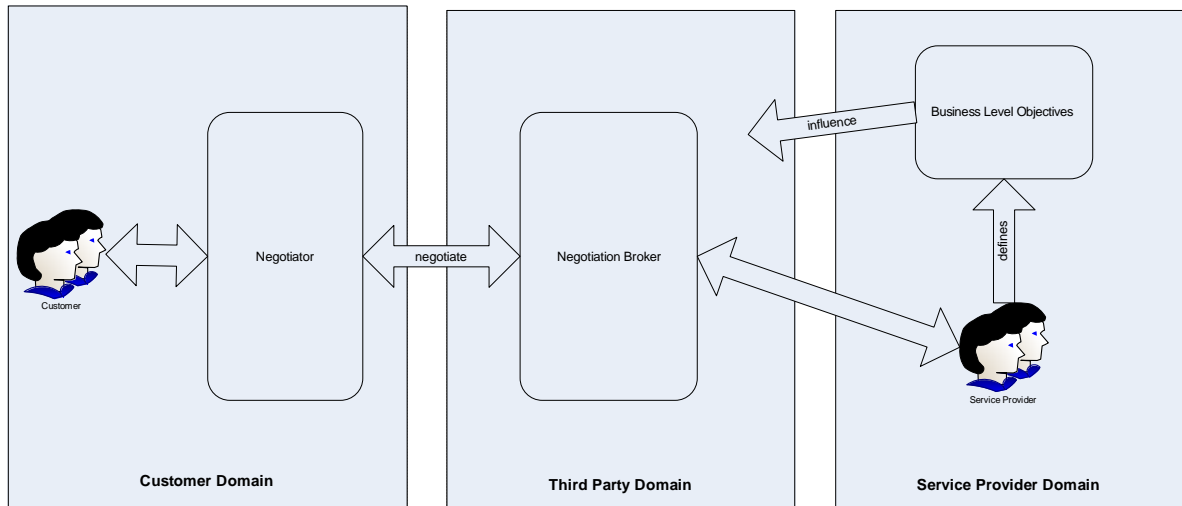


Figure 2: Negotiator - Negotiation Broker Interaction

Figure 2 shows the high-level design of our broker-based negotiation framework. Compared to the traditional approach (cf. figure 1) the service provider is now using a Negotiation Broker provided by a third party. The customer on the other hand still has negotiation components on his side. We call this the NB-negotiation (Negotiator – negotiation Broker) process. In general, our framework is intended to support all possible combinations like NN, BN, and BB. Every participant in an SLA negotiation is free to use a third party broker or to perform negotiation by himself. The business partner will not know the difference and is not affected by this choice. Our solution therefore guarantees autonomy of individual business entities and allows for gradual migration towards brokered negotiation. For brevity, we only show the NB example in Figure 2.

When changing to a broker-based framework, an important question is how to describe and inform the Negotiation Broker about the individual “business objectives” of the respective parties, i.e. what the respective entity aims at during negotiation – the most obvious objectives will consist of something like “maximise profit” on provider side and “minimise cost” on the customer side. These objectives serve as a “steering guide” for the negotiation process to ensure that boundaries are maintained, policies are respected, optimisation can be achieved with respect to the entity’s requirements, etc. Our framework contains a component which represents the respective “business objectives”. With that input available, the Negotiation Broker is able to fulfil its job (make offers, verify offers, and decide whether to accept or decline offers) according to the user’s premises. In the long run, business objectives will have to cover *abstract* information about services, availability of resources, and at the same time premises like “prefer partner X to partner Y”, “maximise usage of my resources”, “keep costs low”, etc. How these aspects affect negotiation decisions is currently investigated in the IST projects NextGRID and TrustCoM and their representation will be part of research, mainly in the area of Semantic Web, in the upcoming IST-project BREIN [7].

In our negotiation framework, the Negotiation Broker’s clients can be service providers as well as service customers. The interaction with both parties has a lot of similarities, yet one important difference: whereas a client asks for the negotiation of a single SLA, a service provider uses a broker for a longer period of time during which multiple SLAs are negotiated. In addition to this, the provider will be bound not only to his objectives but also to the actual resources available for providing a particular service, so that the Negotiation Broker may have to query the service provider for resource-related details. Notably, some customers are service providers themselves (as in the concept of Virtual Organisations [14]).

From the viewpoint of clients of external brokers, outsourcing has an important effect on the negotiation protocol. As it is now entirely up to the broker (or rather the respective third party providing the brokering service) to decide which protocols to offer, customers and providers do not have to care about this issue anymore. As soon as a broker supports a particular protocol, it will be usable by every customer of the brokered service, which results in increased flexibility of business conduct.

3.2 *Dealing with Confidentiality*

When changing from the “traditional” approach to a brokered solution we face some challenges concerning confidentiality and security, mainly on side of the service provider. Whilst in current systems the SLA Negotiator typically has direct access to all data from the service provider/customer (as it is part of the respective party), a business user would surely not want a third party broker to have unrestricted access to and knowledge of his system. Future work on the Negotiation Broker approach therefore has to concentrate on the representation of business objectives in a way that keeps confidential data out of non-confidential data structures. For the purpose of the presentation of our approach we assume that such a solution exists. We expect adaptation mechanisms based on Semantic Web technologies to help pursue this goal (cf. Section 5).

4. Using the Broker in Practice

To motivate the development of the SLA Negotiation Framework we demonstrate a real-life business scenario in this section. The scenario is taken from the pharmaceuticals sector of the SIMDAT project and is centred on the drug discovery process [15].

Drug discovery is a costly undertaking. Even large companies cannot afford to develop and keep all the required specialist knowledge in-house. Pharmaceutical companies therefore regularly make use of the know-how of external partners which are usually small to medium-sized enterprises specialising in a certain field, e.g. certain families of proteins.

In our sample scenario a drug development company wants to make use of the knowledge of an external partner. The company wants to have protein sequences analysed and subsequently annotated with information from the partner’s internal databases. Before the company (customer) can use the external partner’s services (provider), it has to negotiate access terms, including, for example, the number of requests and the price. To do this, both partners must use negotiation components. Traditionally (cf. Figure 1), a Negotiator is an integral part of both the customer’s system and the provider’s service.

To operate services, a provider (the SME in our example) must not only set up access methods to his data (e.g. via Web Service technology), he also has to have a negotiation component that negotiates terms of access with potential customers. In a traditional setting, the SME therefore needs to acquire the specialist knowledge of setting up and running such a Negotiator. Besides incurring additional direct costs, the introduction of new services might be delayed, resulting in lost revenue.

When using our proposed negotiation framework, the SME does not need to have its own negotiator component anymore. Instead, it outsources SLA negotiation to an external entity. Setting up this collaboration requires the transfer of certain data to the Negotiation Broker, including defaults and restrictions on terms for service access. For example, the suggested default value for the number of protein sequence analysis requests is four per hour, while the maximum is 60 per hour, as the computing power of the provider does not allow for more than that.

When a pharmaceuticals company requires external help from the SME service provider, it will start negotiating an SLA with the provider. But instead of talking to the provider directly, it negotiates with the external Negotiation Broker. This is of no difference

to the customer, but the provider himself is not involved in the negotiation process at all. In an ideal framework, the provider can choose if he fully relies on the Broker to perform negotiation, or wants to retain a certain amount of control of the negotiation. In the first case he would only be notified when an SLA has been established.

The provided example clearly shows how outsourcing of negotiation to a third party could support an SME. The SME can focus on its core business of providing its services (protein sequence analysis and annotation in our example) and at the same time lower its overhead in both financial and administrative costs, as it does not need to care about negotiation protocols and components anymore.

5. Towards the Implementation of the Architecture

The technical aspects of the negotiation protocol are an important topic for brokers and therefore for our implementation. During our research, we identified the absence of a mature specification dealing with interaction protocols capable of negotiating SLAs in a Web Services setting. WS-AgreementNegotiation [8] has been proposed by the GGF as a complement to WS-Agreement [9] but no “complete” specification exists to date. We nevertheless used WS-Agreement (both the protocols and the data structures) as a starting point for developing our framework.

As described in Section 3, Negotiation Brokers can be used equally by customers and service providers. Although there is an important difference in the interaction patterns, the more interesting difference is the information that is passed to the broker by the two parties (cf. Figure 3).

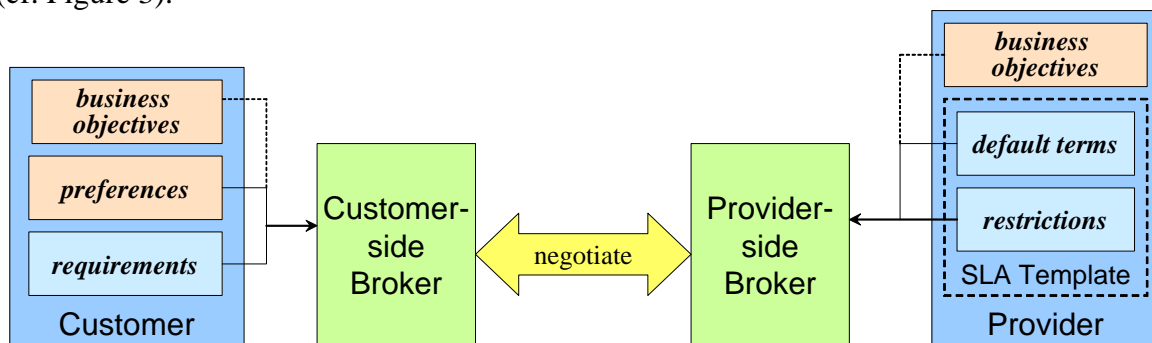


Figure 3: Data structures used

a) Customer Side

The most important information that service customers transfer to a broker are the requirements on terms within SLAs. Typically those requirements are statements like “results must be ready by noon tomorrow”, “average bandwidth must be at least 10 Mbit/s”, etc. WS-Agreement defines an SLA creation constraints data type that allows the specification of such requirements (using XML datatypes [10]). Requirements are usually specified as an open interval or a set of possible values. In addition to the requirements, clients often have preferences concerning the actual value. Although the minimum required bandwidth might be 10 Mbit/s, the preferred value could be 100Mbit/s. Similarly, the preference for the execution time might be to minimise it. For useful SLA negotiation, the broker needs to know such preferences. As WS-Agreement does not specify any data structures for preferences, new structures had to be invented, capable of expressing preference for minimisation, maximisation, or a certain value.

b) Service Provider Side

On the other side, service providers transfer a different set of information to brokers. The most important data here are the restrictions on SLA terms. These are similar to the requirements of service customers. Restrictions mirror the limits on SLA terms that a provider is able or willing to provide. Typical restrictions are “maximum bandwidth is

1Gbit/s” or “minimum processing time is one hour”. WS-Agreement supports the representation of restrictions with the same data structures as the requirements of customers. Similar to the preferences of customers, service providers can specify default values for SLA terms. These will be put into SLA templates which represent non-binding service proposals and can be used as a base for negotiation.

Both service providers and customers are also expected to transfer business objectives to the Negotiation Broker, as discussed in the preceding sections – currently abstract objective descriptions are not supported by the broker, so that more concrete policy-like information is required. As already stated, the granularity of business objectives as well as their representation is still under discussion.

Evaluation of Semantic Web technologies as tools for supporting business objectives is currently under way. We expect that results and outputs of currently running IST projects in the Semantic Web area like ATHENA [12], OntoGRID [11], and the upcoming BREIN project will close this gap in our framework.

6. Conclusions and Outlook

This paper described a novel approach to Service Level Agreement negotiation. Today, SLA negotiation is typically performed by a Negotiator component that is an integral part of a service provider or a customer application. We showed that this traditional approach entails a lot of disadvantages, in particular for small and medium-sized enterprises. Most important, the overhead involved in setting up and maintaining negotiation components can be prohibitively large.

To overcome this lack of business-usability, the paper introduced a solution which is based on the idea of outsourcing negotiation functionality to third parties acting on behalf of their respective clients. With this approach Service Level Agreements can be established in an efficient and cost-effective way. Although we advocate the adoption of external brokers we designed our architecture in a way that every participant in an SLA negotiation process is free to use a third party broker or to perform negotiation on his own. The business partner will not know the difference and is not affected by this choice. In particular, his selection of direct negotiation or the involvement of a broker is not affected. Our solution therefore guarantees autonomy of individual business entities and presents a smooth migration path towards broker-assisted negotiation.

Despite the obvious financial advantages, a broker-based solution also introduces new challenges. We identified confidentiality as a possible issue and started to address it by defining the needed data structures. Furthermore, while developing the design and concepts of the framework, we came to the conclusion that our proposal is not sufficient when relying on the common Grid / Web Service technologies only. We believe that, in order to provide a generally applicable and adequate solution, subsequent versions of the design will involve the adoption of Semantic Web technologies and agent-based concepts. We expect the respective models, patterns, and languages to provide the means to solve the issues related to the automatic conversion and mapping of business objectives; tasks which in general have to be performed when dealing with SLAs in electronic form and when outsourcing SLA negotiation. The ultimate goal here is to enable the Negotiation Broker’s client to define his business policies in a (for him) natural way while letting the system understand and convert them in a sensible manner.

It is important to stress that while outsourcing SLA negotiation shifts negotiation effort to a third party, it implies a certain loss of control at the same time. Mechanisms are therefore needed to define boundaries for the negotiation process, which state when a negotiation has ended, independent of whether an agreement was reached or not. Such a boundary could be the duration of the negotiation process (time, number of negotiation round-trips) or the costs of the negotiation process itself (if the third party charges for it).

Our experiences so far show that a broker-based approach is feasible but there is still a long way to go – not only in the technical area but also regarding market acceptance of a brokered solution. The authors are nevertheless confident that with the issues discussed in this paper it will be easier to focus future research activities in the SLA area.

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