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Added Value for Businesses through eContract Negotiation

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Abstract: The growing pervasion of all areas of life with information technology massively influences the way people and companies conduct business. Traditional, "manual" methods are changed or replaced, new opportunities are created, and new business models are developed. Distributed IT infrastructures or Grid systems offer basic functions needed for eBusiness, but they do not yet fulfil a number of essential requirements, e.g. regarding the definition and negotiation of electronic contracts. In this paper we analyse one specific business use case regarding novel requirements to be realised by a distributed IT infrastructure or a Grid system. We compare those requirements with the functions existing infrastructures provide and highlight the gaps which need to be bridged to realise novel business models. Based on previous work executed in European ICT projects, we propose an architecture for a service-based system that exploits Service Level Agreements, semantic techniques, and agents to provide added business values through the negotiation of eContracts.

Keywords: Grid, Service Level Agreements, Contract Negotiation

1. Introduction

With electronic business becoming ubiquitous, the traditional ways of doing commerce are changed or replaced. One area that is greatly influenced is relationships between business partners. These relationships are increasingly numerous and dynamic due to the ease of finding new partners via electronic marketplaces and establishing relationships with them by electronic means, both on a local and a global scale. To manage these relationships effectively and efficiently, adequate support by the IT infrastructure is imperative. But, although a lot of effort has been put into developing standards and software to support electronic business, current technologies for relationship management are still far from optimal.

The currently available Grid and Web Services technologies clearly do not provide the means to fulfil all requirements of companies. They focus mainly on managing and exposing resources in a stable and standardised way, but they do not provide the capabilities necessary to find all-encompassing uptake in the business world. In particular, the functions offered for supporting relationship management are minimal at best. This is especially insufficient for small and medium sized enterprises (SMEs) that are expected to gain most from migrating their businesses to electronic platforms. One reason is the large investment that is needed to participate in automated electronic service marketplaces. SMEs are reluctant to invest large amounts of money and effort into new or updated systems when the short-term benefits do not outweight initial investment and the long-term outlook is foggy due to uncertain standards adoption. But, as benefits (in terms of increased business at reduced cost) are clearly visible, we expect that the adoption of automated relationship management will increase with the reduction of integration and maintenance costs. Moreover, the adoption of automated relationship management, once it is more stable and fulfils the main requirement of industry – ease-of-use – will enable increased competitiveness on the market due to the fact that SMEs and large companies can use it with the same simplicity.

Automated relationship management comprises all software lifecycle phases. Defining and implementing the technical interoperability of internal and external components is part of the development phase. At run-time, interaction establishment, monitoring and cancellation are needed. In this paper, we use the terms "automated relationship management" and "electronic contracting" interchangeably as electronic contracts are the ideal form in which to encode business relationships. Electronic contracting also covers all lifecycle phases, including functions to state requirements on and capabilities of services, contract negotiation, and contract fulfilment.

The use of Grids for eBusiness implies a transition away from the traditional academic viewpoints to a more business-centric focus. Academic Grids are mainly designed to grant access to resources to a large user community. Business users, on the other hand, are much more concerned about managing their business relationships in an environment in which they often have to trade customer satisfaction off for revenue maximisation. Grid solutions offer a solid base for facilitating collaboration between business partners, but they do not yet provide the functions and usability necessary to let SMEs flock to them.

The main problem here is that relationship management in Grids has been handled largely in a manual fashion. Although distributing access rights via virtual organisations (VOs) has been automated, getting partners and users into such a VO is still a manual process. With the increasing dynamicity of partner relationships, the burden of managing them manually becomes unbearable. Automated solutions are required not only to handle the sheer number of relationships, but also to reduce the costs for managing them. Autonomy, automation, self-management, and self-optimisation are a must. "Ease-of-use", usability, and tool support become indispensable. Some means have already been introduced to provide some of the aforementioned properties – most notably Service Level Agreements (SLAs). However, although several approaches have already been proposed to extend existing SLA concepts and architectures to cover dynamic relationship management, developments in this area are still immature and have not really found uptake in industry.

2. Objectives

Service Level Agreements are a suitable technology for business-oriented relationship management. SLAs enable the use of Grids according to business-relevant terms that specify the rights and obligations of the involved parties. They represent contractual bindings in a (potentially) machine-processable way, which allows for automated provisioning, monitoring, evaluation and assurance of provided services.

Presenting approaches to realise the whole lifecycle of an SLA (development, negotiation, provisioning, execution, assessment, and termination), would go far beyond the scope of one paper. Some projects (e.g. the IST project TrustCoM[i] have already targeted the execution and assessment phases of Service Level Agreements in Grid environments (by automating monitoring and evaluation), but the phase of creating such electronic contracts is still on an immature level. Therefore, this paper focuses on the negotiation of SLAs, tackling the problem on a conceptual level. It has to be clear that this paper is intended to be visionary, and we primarily want to point out current deficiencies and propose steps necessary to deliver Grid solutions valuable enough to be taken up by industry.

The objective of this paper is to set the scene for a completely new type of usage scenario different from the classical “Grid-related” applications and components, to explore the needs and the musts for business usage. Based on already available results of the IST projects TrustCoM and NextGRID[ii] this work is taken to the next level where electronic contracts provide added value for companies by means of optimal resource usage, representation of the business policies of the users and the minimization of necessary interaction with the system. For that purpose we later present in this paper a business use case for Grid technologies (focussing on SLA negotiation) showing the potential of future business Grids. With this paper we clarify what the added value for business users could be when using more mature SLA Negotiation concepts.

3. The Current State of the Art in SLA-Negotiation

SLA negotiation is an essential part of relationship management. Relationships are codified in the form of SLAs. Negotiating SLAs therefore means establishing mutual agreement between business partners on the nature and the terms of their relationship. Current SLA negotiation technology is still in its infancy. Many SLA specifications only allow for a simple “take-it-or-leave-it” (accept/reject) type of protocol, which is far too simple to cover all usage scenarios in business. “Real”, multi-round negotiation is a necessity here as information that influences acceptance/rejection decisions usually only becomes available during the actual negotiation. Moreover, parallel negotiations with multiple provider candidates commonly influence each other and make multi-round negotiations a necessity (besides reflecting contract negotiations in the physical world).

In the Web Services area, WS-Agreement [1] is currently the most influential SLA specification, which has been implemented by a substantial number of projects [2]. It features a detailed XML structure for representing SLAs and a protocol for agreeing on them. The protocol is constrained to express either acceptance or rejection of an offered SLA, a property which limits the use of WS-Agreement and which motivated the Open Grid Forum’s GRAAP[iii] group and other researchers [3] to develop negotiation extensions to the protocol.

Similar to the WS-Agreement protocol, NextGRID specifies an SLA agreement protocol [4] that allows the acceptance or rejection of SLA offers, which is therefore ill suited to the dynamics of business cases such as the one sketched in Section 5.

SLA negotiation is not a Grid-specific concept. Going beyond the Grid border, we identified two different technological areas, which could deliver valuable concepts for enhancing SLA negotiation: Semantic Web and agents [5][6].

Within the agent domain, one protocol for negotiation was identified which was already initially taken for experiments in relation to Service Level Agreement negotiation – the Contract Net protocol. Contract Net uses a different approach with respect to traditional Web Services negotiation schemata. Instead of imagining a service provider publishing his offer in a repository and customers searching for potential service providers matching their needs, the Contract Net protocol turns this approach around: the customer publishes its need or problem and the service providers provide bids to the customer. This approach enables service providers to adapt their bids dynamically according to the situation of their infrastructure.

An enhancement of this protocol is the FIPA’s Iterated Contract Net Interaction Protocol (ICNIP)[iv]. This protocol supports recursive negotiation and allows with that for multi-round iterative negotiation to find an agreement, which could be of high interest and a very valuable concept for extending current technologies.

4. Methodology

The developments made and the architecture designed (cf. Sections 6 and 7) are based on a requirements analysis of the core use case of the project BREIN[v]. This use case describes a new business model for the Stuttgart Airport (cf. Section 5). We analysed the use case, which has high scaling and dynamicity demands, and derive business requirements from it that we compare to those of existing, more academically-oriented Grid applications (cf. Section 6).

Based on these requirements and already existing architectural and technological concepts (like e.g. described in [8] and [9]), we identify gaps that have to be bridged to provide added value to businesses. With that, an extended traditional Grid architecture is presented which, on a conceptual level, fulfils the requirements gathered and tries to overcome the identified gaps. The implementation of this concept has been started and results of it usage are expected to be published in about a year's time.

5. Business Case

Managing connections of flights from different airlines between different locations is a complex task, which often creates substantial enough problems for both passengers and airport operators. One airport tackling this problem is the Stuttgart Airport, that, with its large number of different companies (250 companies with 8500 employees in total), is an excellent example for a Grid-like organisation

Passengers travelling by plane are usually booking connecting flights from a single airline or from collaborating airlines, like for example partner airlines within the Star Alliance. Low-cost carriers especially are not collaborating, which causes passengers (or their travel agency) to book separate flights from different airlines taking care of proper connections themselves.

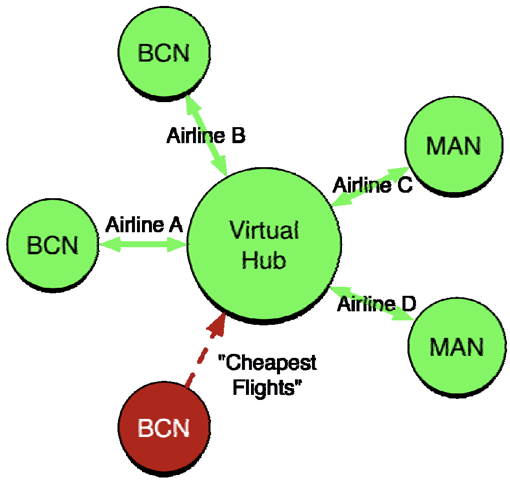

Figure 1- Extension of an existing Virtual Hub system with a new flight provider

For example, a passenger planning a flight from Barcelona (BCN) to Manchester (MAN) could find no direct connection and connecting flights are very expensive using just one airline. An alternative is to use two different low-cost carriers (e.g. A is providing a flight from Barcelona to Stuttgart and B is operating Stuttgart to Manchester).

This example introduces an opportunity for airports to extend their business. By adapting their current means of logistic operations to allow for so-called "virtual hub flights", airports could provide customers the possibility to book flights A and B as a single flight.

The scenario, as shown in Figure 1, assumes that the airport has already established a set of relationships with various low-cost carriers. Now a new airline company called

"CheapestFlights" wants to join this virtual hub organisation. For that purpose, this company has to get into a contractual relationship with the offerors of the virtual hub. As such contracts can be encoded as SLAs, joining the virtual hub means negotiating an SLA with the operator.

The negotiation between the parties must take the business objectives and goals of the respective entities into account. This means that both the airline and the airport have to consider what a contractual binding with the other party means in terms of resource allocation, obligations and risks. Both parties might have to set aside resources (e.g. passenger transportation capacity both on the ground and in the air), open their systems to the partner (e.g. reservation systems), and sacrifice other business (e.g. by not participating in a competing virtual hub). Depending on the business model of the airport, we could imagine two different types of contract negotiation: either a take-it-or-leave-it approach (only accept or reject possible) or n-phase negotiation potentially meaning extended duration due to the exchange of multiple offers and counter-offers.

6. Developments

From the above scenario we gathered the following requirements that future solutions for business grids must fulfil:

- Business relationships and electronic contracts must be codifiable as Service Level Agreements.
- SLA terms must be negotiable between business partners.
- SLA negotiation must be supported by development tools and runtime environments.
- Integration of SLA technology with existing systems must be easy and cheap.
- Business objectives of partners must be easily and seamlessly integrable.

The authors have then broken these requirements down to a finer granularity, especially with respect to possible realisations. The requirements directly fed in the further development of the previously presented Negotiation Framework Architecture [9] to contain enhancements that set it apart from existing architectures. In particular, it includes concepts coming from the Semantic Web and the multi-agent areas. The application of these enhancements to the airport scenario shows how far the Grid can be evolved to an "intelligent" Grid usable for business. The architecture is presented in Figure 2. Some important design decisions are described in the following paragraphs. These are listed here both to motivate our architecture and to influence future work in this domain.

Business objectives: Service providers have their own business objectives. These are of paramount importance in the contract negotiation phase and the service execution phase. Creating offers and evaluating counter-offers both heavily depend on the business objectives of the negotiating parties. During SLA negotiation, this means that the internal capabilities and policies have to be reconciled with the external requests, so that the business goals are met or exceeded. Such business rules can be "Prefer partner A to B", "I want full usage of my resources" but also "I want to risk violation of an SLA of a running service, if I get the opportunity to attract a more valuable customer with that". Grid infrastructures have to support such rules and have to facilitate and automate their integration into the business support systems of providers and consumers.

Resource state: Service Level Agreement negotiation has to respect the current state of the provider's resources and also its planned activities. This implies being able to answer questions like "how many of my resources are available?" or "can I provide this service at a given level at some point in time?".

Tool support: SLAs are encoded in complex structures that are not directly accessible to humans. If automation is advanced enough, humans do not need to inspect them. What they do need to supply, though, is information about requirements on SLA terms. That information must be supplied before SLA negotiation occurs and should be supported and facilitated by appropriate tools. These tools are ideally enhanced by semantic technologies that make specifying requirements on SLAs or SLA templates easy. Domain-specific as well as domain-independent knowledge must be incorporated.

Runtime support: SLA negotiation must be supported by a software system that handles most of the work needed to negotiate SLAs at system runtime. It must be easily integrable both in terms of modifications needed to existing components and to the negotiation component itself. It must be easily customizable by taking business objectives into account and by using SLA term requirements and templates from the aforementioned tools.

7. Results

Based on the requirements identified and capabilities of a relationship management system for business Grids, we extended an existing SLA negotiation platform [2] with semantic and agent capabilities. The resulting architecture is shown in Figure 2.

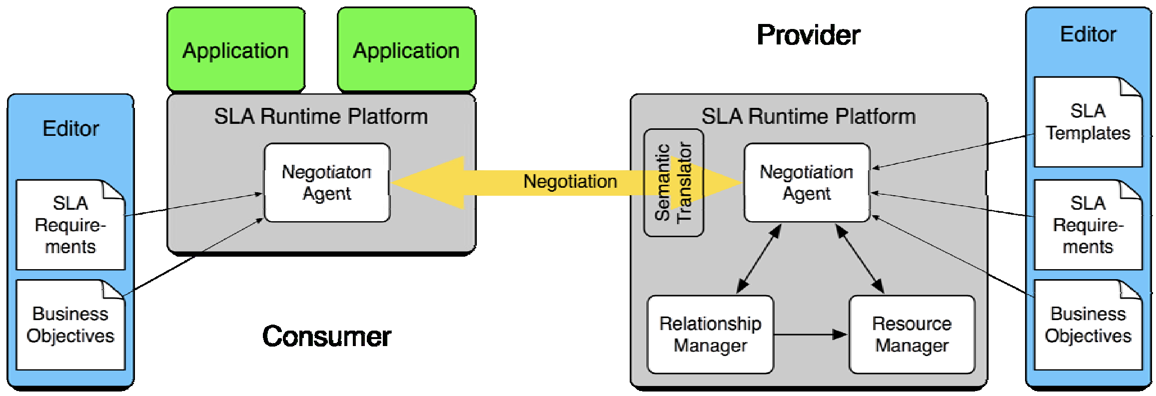

Figure 2: SLA Negotiation Architecture

This high level architecture focuses on the main components needed for relationship establishment on both the customer and the provider side. Instead of a classical Web Service / Grid Service SLA Negotiator component, we use a component called *Negotiation Agent*, which represents and acts on behalf of the respective party. However, it is important to note that the use of agents should always be seen as optional rather than obligatory, as this is a decision influenced by reliability and trust in this technology, which every business partner has to take for themselves.

The Negotiation Agent on the customer side is connected to an *Editor* component, which supports SLA negotiation by offering the capability of specifying *SLA Requirements* as well as *Business Objectives*. Both pieces of information are needed to represent the customer optimally in the eBusiness world. By intention, we have kept the complexity of the customer domain low in order to increase ease-of-use.

The architecture of the service provider domain is a bit more complex. The Negotiation Agent is again connected to an Editor. But in this case, in addition to Business Objectives and SLA Requirements, the editor also provides information about *SLA Templates* for offered services. By interacting with the *Resource Manager* (which is planned in future iterations of this approach to be also agent-based) and the *Relationship Manager*, the service provider Negotiation Agent can decide on behalf of the service provider to accept or reject an SLA proposal, or to offer a modified version of the proposal to the customer.

A new and important addition is a component called *Semantic Translator*. That component is able to translate, based on a global ontology, incoming SLA proposals to a format understandable and usable by service providers internally. The other way around, once an offer is created it gets translated into the customer terms.

8. Business Benefits

The business benefits of this conceptual approach are manifold. A generic and non-use case specific benefit is the possibility of cost-reduction for entering business relationships using SLAs. Automating SLA negotiation in itself reduces costs as it removes the need for costly manual intervention. Our architecture achieves this by introducing Negotiation Agents and associated machinery that can autonomously negotiate contracts. Agent extensions provide the means of enhanced intelligent and goal-oriented negotiation. An SLA Negotiation Agent acts on behalf of its “owner” and aligns the negotiation (and subsequently established contracts) with the business goals of the party. In the case of the service provider, this also includes knowledge about the current state of the system/resources and predictions of the system’s state, behaviour and capabilities in future negotiations.

Further cost reduction is achieved by enabling the participants to use their preferred language. So far, when negotiating SLAs, both parties have to talk the same language (e.g. both have to name CPUs as CPUs, if not, human interaction is needed). This is mainly provided by introducing the Semantic Translator concept.

The effect of these cost reductions is a lowered barrier for joining the marketplace. In particular small and medium sized enterprises are expected to benefit from that and are encouraged to propel their business to the 21st century.

9. Conclusions

Combining existing Grid Service/Web Service approaches with concepts from other domains like the agents or Semantic Web domains will increase the potential of these technologies and make them more attractive to be taken up by industry.

In this paper we identified relationship management as one of the most important issues for the broad adoption of Grid / Web Services technologies in industry. Based on this observation, we presented a blueprint of a relationship management framework for business Grids. We enhanced a traditional Grid-based SLA negotiation system with capabilities and technologies from other domains. One example is the representation of resources by agents. By using concepts from this domain, autonomy of services is inherently and easily increased.

Although the concepts show a high potential, the authors are aware of the fact that an actual implementation is needed to get more insight into the pros and maybe hidden cons of this approach. Research projects such as BREIN are currently looking at adapting multi-agent and Semantic Web concepts to frameworks like the one presented here and their results will help to accelerate the transition towards business-oriented, industrial Grids.

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