Management of the Business SLAs for Services eContracting

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Abstract The management of Service Level Agreements is a complex task that requires to be specialized in the different domains it involves. Since SLA management can eventually be an integral part of eContracting environments, several topics have to be tackled in this layer: third parties management, Business Level Objectives, penalties, etc. This chapter explains the foundations of such specialization in relation to the business concerns. Specifically, it describes the business terms and conditions that must be taken into account and the architecture of the business layer of the project SLA@SOI. Moreover, the roots and more innovative aspects of the business layer in the project are explained.

1 Introduction

Service-Oriented Architectures (SOAs) and the delivery of applications and resources as services have consolidated into new methods for integrating and delivering functionality from vendors and providers. In recent years, an important effort has been made to solve many of the technical and scientific challenges associated with this approach. One of the challenges — and a main rationale of SOA— is the creation of business environments in which providers and consumers can trade services. The emergence of cloud computing technologies has fostered the need to monetise the services provided, including software as a service (SaaS), platforms as a service (PaaS), infrastructures as a service (IaaS), and so on.

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Typical proposals for interaction and trading of services between providers and consumers are e-marketplaces [3], e-contracting environments and service ecosystems [1]. These frameworks usually convey different phases of the trading process. This chapter considers four such phases: information, in which the technical and commercial offer is published, shown and rated; negotiation, in which the business and technical aspects are calculated and agreed upon; contracting, in which the agreement is signed and the service provisioned; and runtime, in which the service is delivered, managed, charged, reported and terminated, etc.

Once the relationship between a provider and a consumer is based on a monetary transaction, the quality of the service provided, and the terms and conditions under which it is offered, are of vital importance. SLAs become critical in this context, and — given that elements of business are relevant to many common SLA management tasks (negotiation, agreement, management of breaches, etc.), some business guarantee terms must be natively considered in the management of services and SLAs.

This chapter covers several aspects of services e-contracting, describing existing work, including SLA management in different phases of the process, as well as explaining the functionality offered by the SLA@SOI e-contracting tools. It also describes the business layer architecture and the business model for SLAs, and highlights future work and conclusions.

2 Business SLA Management in Current e-Contracting Proposals

This section examines existing work in e-contracting. To the best of our knowledge, there is no comprehensive proposal that covers the full e-contracting life cycle. For that reason, this analysis is divided into the four above-mentioned phases (information, negotiation, contracting and runtime).

2.1 Information

The information phase of e-contracting covers all activities related to defining, publishing, browsing, searching and rating the commercial offer of a services e-marketplace. In the context of SLA management, this means integrating the business terms and conditions of an SLA model and the management of a products catalogue into a business SLA templates registry.

As described in Chapter ‘The SLA Model’, several initiatives have attempted to model automatically managed SLAs. However, these alternatives mostly focus on modelling technical issues-related service definitions and guarantee term specifications. For instance, [25] proposes a semantic model for integrating business-oriented service level management objectives with technical objectives that include pricing

and payment terms, service installation, revisions and terminations, maintenance, support, problem escalation procedures, and so on.

The Universal Service Description Language (USDL) enables modelling of business terms in its business perspective [4], supporting availability, payment, pricing, obligations, rights, penalties, bindings, security and quality. However, this specification of services is decoupled from the specification of the SLA (WS-Agreement), an approach that makes it difficult to integrate business-related elements into the SLA management tasks.

Another important aspect of the information phase is the registration and discovery of information about the service. Usual service registries are based on UDDI (Universal Description Discovery and Integration) and more recently on LDAP (Lightweight Directory Access Protocol) [7]. In the Telco environment, service descriptions are usually registered and stored in service catalogues, which are an essential component in new Operational Support Systems environments [1].

2.2 Negotiation and Offer Building

Negotiation is one of the most important and frequently tackled issues in SLA management, and is covered in Chapter 'A Generic Platform for Conducting SLA Negotiations'. SLA negotiation in an e-contracting environment requires a broad approach that takes into account business terms relevant to both providers and customers, providing a more efficient environment for partner management and services trading [11].

There are several issues to be considered when negotiating and SLA from the point of view of an e-contracting framework: better matching of providers' and consumers' business goals [11], ranking of services based on price or quality, sensibility of offers and counter-offers on different issues (price, KPIs, etc.), past transactions [3], and so on.

To increase flexibility, the negotiation process usually involves three topics [16]: the negotiation protocol, or the rules that govern the interaction (participants, states, valid actions); the negotiation objects, or the issue(s) the agreement is about; and the decision-making model, or the strategy for assessing how to proceed during the negotiation. This approach is also followed in [24] and [26], to implement state machines for different negotiation protocols (fixed price, English auction, Dutch auction, bilateral and multilateral bargaining and double auction, etc.). Depending on the protocol, customers may require strategies and tactics for the negotiation of a range of SLA terms for a given price range. Equally, providers may offer discounts to a specific category of consumers based on their contextual information (customer segment, location) or business potential (economic value, length of contracts, etc.). In [27], a policy-based approach to automatically modelling these criteria in a bargaining process is proposed.

Another important issue is offer building. Service environments are usually based on the aggregation of services; thus, the individual SLAs of the atomic services

must be taken into account in the final offer [3]. When complex value chains are created — in which a service consumer can be a provider of an aggregated service — composing the QoS elements of a number of aggregated services is a challenging task, since the nature of each parameter and the flow of aggregation [11] must be considered. In [5], several SLA aggregation patterns useful to automation of the aggregation process for cross-company hierarchical SLAs are explained. For example, terms like price or penalties must also be aggregated from a business perspective. Dynamic composition of an offer can include not only the bundling of services, but also the current supply and demand or historical data [10], as well as the parameters defined above. One added complexity when defining service prices is the pricing schema (per transaction, per period) and the relationship between the different QoS levels and price (absolute value, percentage value, etc) [19].

2.3 Contracting

Electronic contracts are used to specify the terms and conditions under which a service is provided and consumed, and they represent the basis for a business-based e-marketplace function. Even though the law-conformity of electronic SLAs is still an open issue due to its complexity, and there are still many challenges to solve, contracts are a important aspect of an e-contracting environment. A service contract is a contract associated with a specific service that involves the parties to the agreement, the service (including a description of the interfaces and expected interactions), promises about the service provision and consumption, business issues and legal procedures [13]. An important drawback of electronic contracts is information structuring and reuse, and thus many proposals for establishing e-contracts are based on contract templates: empty forms that must be filled [8].

SLAs can undoubtedly represent e-contracts, because they include, in the case of SLA@SOI model, all the information related to the service being provided, including business terms and guarantee terms. As mentioned above, there are a number of languages defined to specify electronic contracts, such as Web Service Level Agreement (WSLA) and WS-Agreement [14], and USDL [4] adds an SLA-decoupled layer to specify business terms.

Another important aspect of the contracting phase is management of the contract life cycle. Although there are already many commercial contract management tools on the market, this topic presents a number of interesting challenges that improve the efficiency when establishing a contract, help to reduce errors and risks, or improve revenue forecasts. For instance, [6] presents a flexible framework for the automation of service contracts based on standard SOA middleware and [17] shows a contract management solution for multi-tenant SaaS applications whereby contractors may customise and configure the contracted services. In [15], electronic contracting between agents is also tackled, providing interesting novelties as violation scale-up to humans, SLA versioning, SLA hierarchies, contract dependencies and termination, extension and renewal of contracts.

2.4 Runtime

The most important business-specific SLA management processes during the runtime phase are those related to calculating penalties derived from SLA breaches [22] and, if possible, the self-adjustment processes that allow spare resources to be used to prevent such violations and penalties before they happen. In [18], a method that accounts for economic penalties caused by SLA violations is proposed such that resources are monitored and allocated in the cloud with the aim of maximising a single Business Level Objective (BLO): the revenue of the provider.

In [23], the effect of economic penalties caused by SLA breaches on providers and customers is analysed. This study recommends giving priority to different SLOs to minimise the effect of an undesired penalty or contract cancellation. In any case, a third party — not the provider — must carry out the monitoring, SLA breach detection, and eventual penalty allocation.

Following these arguments, [21] presents a method for defining policies that modify the effects of SLA violations and penalties, depending on the cause of the violation (i.e., if it is not the fault of one of the parties), with the aim of improving long-term relationships.

3 An SLA-Aware e-Contracting Proposal

The business SLA management proposal of the SLA@SOI project focuses on interactions between service providers and customers. This framework includes a number of innovative features that are presented below.

3.1 Comprehesive SLA-Aware e-Contracting Suite

The SLA@SOI e-contracting layer provides a tool for the back office management of commercial offers made by service providers. This tool supports the definition and characterisation of new products and the services on which they rely. The SLAs of the atomic services that compose a customer-facing product are merged within the tool's holistic SLA framework, based on business rules that can be defined and managed by an administrator. The business SLAs can be graphically defined by the user to fit the commercial requirements of the product and the marketplace. This characterisation includes:

- The management of a catalogue of atomic services and their business SLA templates (SLATs).
- The management of a commercial products catalogue and their SLATs.
- The definition of commercial offers: prices, discounts, promotions, etc.

- The specification of policies that must be taken into account when a customer modifies some guarantee terms.
- The generation of business reports with data and graphs (SLA consumption, violations, etc.).
- The management of customer feedback.

The business SLA tool is completely integrated within the SLA@SOI architecture and information model, and interacts with two main business components: the business manager and the business SLA manager (Section 4). This framework is intended to be part of a service providers' infrastructure.

3.2 Customisation of Business SLA Definitions

An innovative aspect of this layer is the customisation of SLA definitions to consider the requirements and preferences of both customers and providers. In this sense, SLA@SOI aims to develop mechanisms for calculating the best business SLAs for both parties during the negotiation and establishment phases. The information required to carry out this business SLA assessment requires customer data to be gathered and customer profiles to be retrieved from the provider's Customer Relationship Management systems.

The preferences and profiles of the customer and provider are currently defined as promotions modelled with business rules associated with the offered products of the marketplace. This approach enables the business tool to define special conditions, depending on factors such as the socioeconomic situation of the customer, the country of origin, etc. These rules can define additional discounts on price, special SLAT options, and so on.

3.3 Business SLA Post-Sale Management

With respect to the representation and reporting of business SLA violations, the main innovation of SLA@SOI is the adoption of an architecture that separates SLA monitoring from SLA reporting and evidence representation. This separation is required since SLA guarantee terms might need to be monitored for different purposes, each with different reporting requirements. To address the diversity of reporting requirements, SLA@SOI has developed a layered architecture wherein a business SLA reporting module exists on top of the monitoring infrastructure of the SLA@SOI framework, thus managing the reporting requirements. The primary function of this component is to receive low-level monitoring information from the SLA@SOI monitoring infrastructure, and to transform this information into business SLA monitoring reports (BSLAM reports) by taking into account the requirements of the business-layer components of the SLA@SOI platform. The operation of this module is driven by business reporting policies that determine the monitored

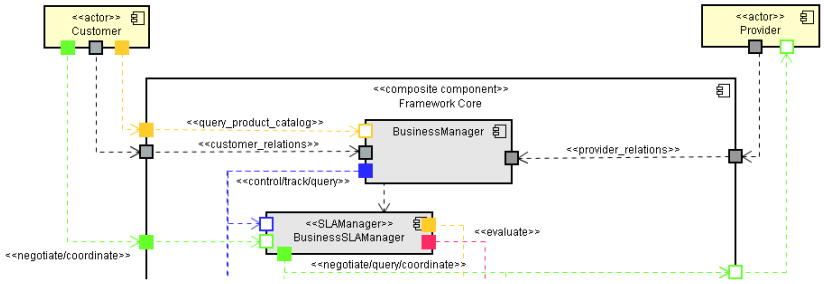

Fig. 1 Business components and interactions.

SLA terms that should be included in a BSLAM report, the types of monitoring results that should be included in the report, and the required frequency of report generation. The specification of business reporting policies is enabled by the introduction of an XML schema for specifying reporting policies and an XML schema defining the general representation structure of business-level reports.

4 Business Layer Architecture

The SLA@SOI project has designed an architectural framework for SLA management across the IT stacks. The proposed architecture is defined in 'Reference Architecture for Multi-Level SLA Management' and allocates business activities to two main components: the business manager and business SLA manager. The diagram in Figure 1 has been extracted from the general framework diagram and focuses on high-level components that implement the business logic. These components expose interactions for relationships between customers and third parties, as well as interactions for communication with other components of the framework and with external parties.

4.1 Business Manager

The business manager (BM) is the module responsible for the overall contracting and sales process. This component is necessary because business information is needed to take proper business decisions. Part of this information is private (in some countries there are specific laws for the protection of data) and therefore must not be shared among components. The responsibilities of a business manager are:

- Make overall business decisions that affect all levels based on business information.

- Make decisions at a single point based on all available information. No other component in the architecture could link with the layers and act as a collection point.

In order to achieve this, business information is needed to indicate how decisions will be taken. This information includes:

- Global prices application, rewards, promotions and discounts.
- Service provider selection based on price and customer requirements.
- Business-addressed rules based on profits and costs.

The business manager implements <<query_product_catalog>> interactions that allow the final customer to search products and services. It also implements <<customer_relations>> interactions that permit the customer to interact with the framework and lets them register and share information with the business platform. The <<provider_relations>> interaction is an additional interface in the business manager that allows providers to interact with the framework. There is another interaction called <<control/track/query>>, which connects the business layer with the SLA managers.

4.2 Business SLA Manager

The business SLA manager is the component in charge of managing the negotiation process to obtain the different agreements. This component contains the registries in which SLAs and SLATs are stored and it extends the Generic SLA Manager (GSLAM). The business SLA manager is responsible for negotiating and operating SLAs with customers and third parties, overseeing the complete set of SLAs in its domain, and providing domain-wide SLA planning and optimisation. Depending on the specific context/requirements of the use case, a separate business SLA manager may be set up for complete organisations, individual departments or individual services.

This component is connected with the BM using the POC (Planning and Optimisation Component of the GSLAM) and PAC (Provisioning and Adjustment Component of the GSLAM) components (see Chapter 'Reference Architecture for Multi-Level SLA Management'). The real functionality behind those components is inside the BM.

The business SLA manager implements the <<negotiate/coordinate>> interaction with the end customer. This interaction enables the customer to contract a product and order the provision of SLA resources (in some cases). The business SLA manager, software and infrastructure SLA managers implement <<control/track/query>> interactions. These interactions allow the business manager to communicate with the SLA managers of different layers. The aim of the communication is to query the SLA and SLAT registries, to set and retrieve policies, and to receive SLA violations and monitoring information.

5 Modelling SLA Business Terms

SLA@SOI has defined a generic SLA model that offers several extension mechanisms that can be exploited to model domain-specific SLA information. While Chapter 'The SLA Model' explains this model in depth, this section explains how information specific to the business SLA is modelled using these extension mechanisms.

Basically, an SLA is a set of agreements between two (or more) parties. These agreements are expressed with terms, each of which denotes guarantees made by, or obligations on, the various parties. Each agreement term comprises an optional constraint expression specifying the conditions under which the agreement term holds (i.e. a precondition on the term). If no preconditions are specified, then it is assumed that the term holds for the entire effective duration of the SLA. Guarantees defined in the agreement are either guaranteed states or guaranteed actions.

5.1 Business Terms Integration

At the top level, the business SLA(T) model builds on the SLA(T) model and common metrics to model business-specific information. The three main mechanisms used to extend the generic model are the extension of classes of the model, annotations, and the definition of new standard terms.

To represent all the information related to the SLA business layer, this section describes how the different terms have been integrated into the model. The parameters described in this section are those identified during the project, together with the analysis of [12] and the requirements of SLA@SOI use cases (Chapter 'Introduction to the SLA@SOI Industrial Use Cases').

5.1.1 Guarantee Terms

Guaranteed States

A guaranteed state is a guarantee made by one of the parties to the SLA that a certain state of affairs will hold: for example, Service Level Objectives (SLOs) or KPI targets. This state of affairs is defined by a constraint expression. The following guaranteed states have been identified in the business layer:

Consumer Commitment: The commitments that the customer agrees to in the contract in terms of service usage (for instance, maximum usage, peak times, or capacity usage).

Compliance: The standards and recommendations that will be supported during delivery of the services, including names, versions and dates.

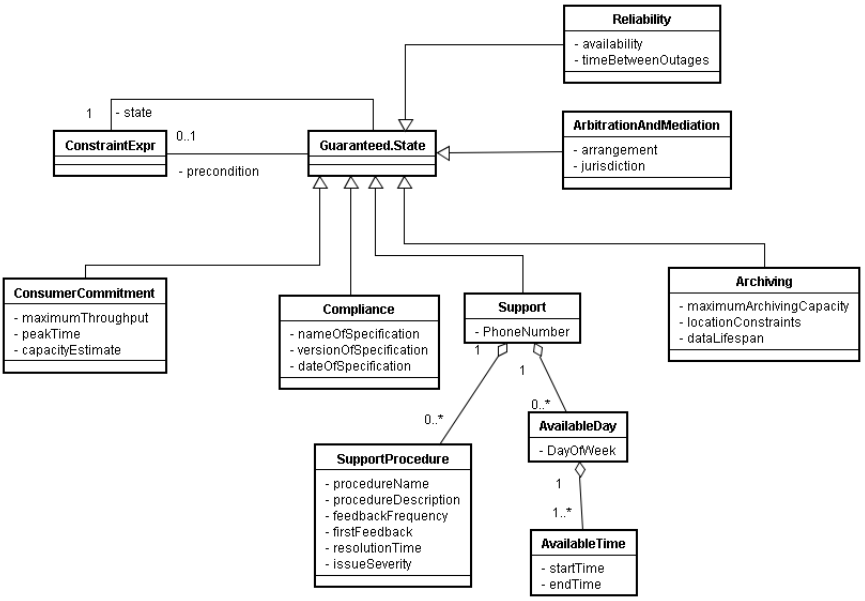

Fig. 2 Business-level guaranteed states.

Support: The manner in which the service will be supported; this can include the availability of contracted support, or a set of support procedures for different issues (e.g. when the first feedback has to be offered, feedback frequency, expected resolution time depending on severity).

Archiving: The agreements regarding archiving of data related to the service (service and historical information); this specifies the maximum capacity or lifespan of the data, and restrictions in the location of such data.

ArbitrationAndMediation: The places where legal disputes and judgments by arbitration should be arranged.

Reliability: The maximum time of service unavailability and maximum time between consecutive failures, without causing a penalty.

Guaranteed Actions

A guaranteed action is an action that one of the parties to the SLA is obligated to perform (or may perform, or is forbidden from performing) under certain, specified circumstances. The following guaranteed actions have been defined for the business layer (Figure 3):

UpdateProcess: When offering services, it is usual to bring down the service to update or manage it for short periods of time. This parameter specifies whether

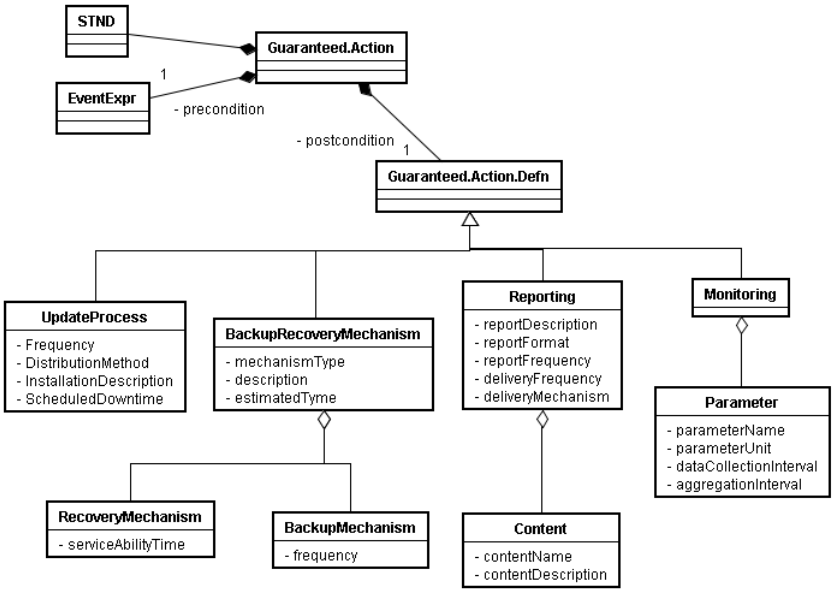

Fig. 3 Business level guaranteed actions.

this process is periodic and its frequency, how to distribute software and install software, if required, and scheduled downtimes.

BackupRecoveryMechanism: The mechanisms required to backup information essential to the service and the policies for doing so, and the agreement on the time it should take to recover from a backup in case of service outage.

Reporting: The commitment to send reports about service usage and SLA status over time. It includes information about the report itself, the format and frequency, and how to deliver it to the customer.

Monitoring: The SLA parameters that must be monitored on a continuous basis, including information on the parameters themselves, their units, and the frequency of monitoring.

The business terms related to pricing, which have been also models as guaranteed actions, are shown in Figure 4:

Termination and TerminationClause: The conditions under which any of the parties may terminate the SLA; every clause can include a notification method and a fee to be paid in case of cancellation.

Penalty: The amount of money to be paid in case of breach of another SLA term; these penalties can also be used to trigger SLA termination clauses.

ProductOfferingPrice: The required commitment of a user to pay an amount of money for the product being provided, including billing frequency and the time during which the offer is valid; the product can be divided into several compo-

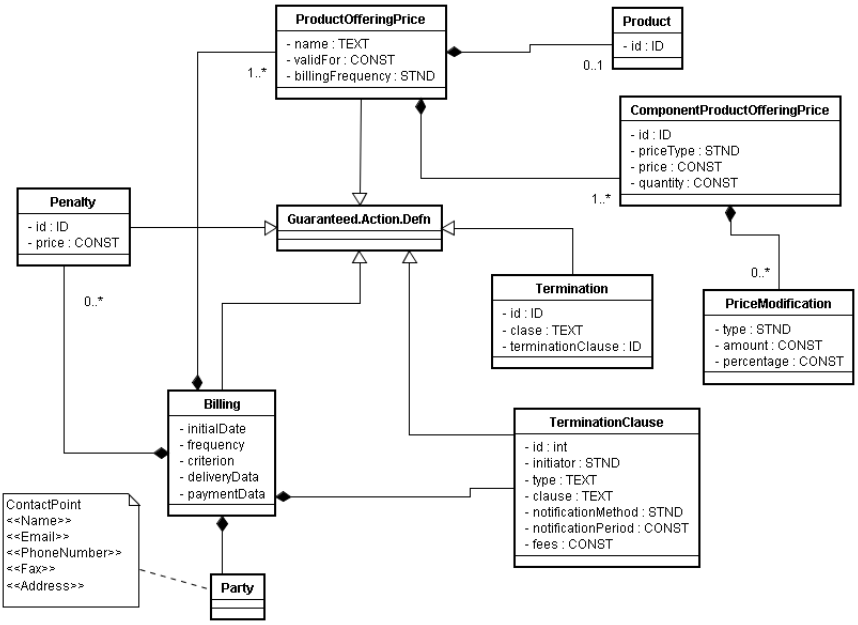

Fig. 4 Pricing business terms.

nents, each with a price type, price and amount of components that aggregate the service. These components can specify price modifications (such as discounts).

Billing: The structure, content and frequency of billing sent to the customer, including information about payment or delivery information; related to the products, penalties and termination fees.

5.1.2 Standard Terms

The SLA@SOI standard terms are the basic vocabulary used by the expressions in the classes described above. Further to this, the following standard business terms have been defined:

Standard Terms for Price Types and Billing Frequencies: Terms for specifying different types of pricing (one time charge, flat rate, etc.) and billing frequency (monthly, per request, etc.).

Standard Terms for Price Modification Types: Terms that allow modification of prices (discounts, increments) in absolute or relative figures.

Standard Terms for Business Metrics: Terms that include a count of penalties and violations.

6 Future Work

The final phase of SLA@SOI addresses two main business-related challenges: SLA negotiation and business terms aggregation.

While the SLA@SOI negotiation framework focuses on generic negotiation protocols (as described in Chapter 'A Generic Platform for Conducting SLA Negotiations'), it can be customised at the business level to tailor strategy and protocol to specific negotiation processes. For example, process and historical information (e.g. the number of negotiation rounds required in previous agreements) can be tailored to include blacklists that ban particular parties. Customers and providers can use profile information about their counterparts (such as ranks, segments, locations, business evolution, and so on.). Business objectives can be defined for particular products or providers to better align negotiation results to a particular strategy. Such objectives can cover desired sales, available resources, or risks from violations, etc. All these strategic parameters can be integrated to customise the generic negotiation mechanisms provided by the SLA@SOI framework. A complementary part of the negotiation phase will be the assessment and creation of offers and counter-offers, and consideration and implementation of new constraints, limits, conditions and relationships between guarantee terms.

Building an aggregated offer from atomic services — each of which has an independent SLA(T) — involves an intelligent and automatic merge of guarantee terms of the same type. This is a challenging problem, since different terms must be aggregated in different ways; even the workflow of the aggregation process may affect the final aggregated SLA(T). The focus of future work will therefore be on business terms related to price, penalties and violations, since they are the most important terms in the business layer. Some of the most-used KPIs might also be considered.

7 Conclusions

e-Contracting is a complex but well-known area that has been researched and developed since the start of e-commerce hype. Development in services science has renewed interest on this field, first for web-services marketplaces, and currently with cloud services and applications (app) stores. In this context, SLAs become a critical issue that must be tackled and tightly integrated within e-contracting frameworks.

However, e-contracting is a large field with many challenging facets. The business management layer of SLA@SOI covers SLA-aware management of a marketplace from a comprehensive perspective, with innovative contributions including business terms modeling and post-sales management, including penalties and violations or dynamic pricing and KPI-based negotiation.

The business-layer architecture presented in this chapter has the double function of managing business SLOs throughout SLA life cycle, and managing interactions with third parties. Thus the business components are in charge of integrating the

marketplace environment with the SLA management of software/service and infrastructure layers.

The business SLA model is presented as an extension of the generic SLA@SOI model and offers a first group of terms whose management can be (to some extent) automated and performed from an e-contracting suite. The integration of some of these terms (especially those related to pricing and penalties) into some of the SLA processes (negotiation, monitoring, reporting, etc.) shows the importance of modeling this layer.

This comprehensive approach has highlighted the need to address several challenges: First, we must find a way to intelligently merge and integrate guarantee terms from different atomic services into a final service. Second, we must find a way to build offers and counter-offers in an SLA negotiation process, linking lower-level KPIs with business terms (i.e. price vs. availability). The integration of penalties management into real settlement processes is an ongoing issue.

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