ELECTRONIC CONTRACT NEGOTIATION AND RENEGOTIATION USING FEATURES

Daniel Avila Vecchiato, Maria Beatriz Felgar de Toledo
Institute of Computing, State University of Campinas, Av. Albert Einstein, 1251, Campinas, SP, Brazil

Marcelo Fantinato
School of Arts, Sciences and Humanities, University of São Paulo, R. Arlindo Béttio, 1000, São Paulo, SP, Brazil

Itana Maria de Souza Gimenes
Department of Informatics, State University of Maringá, Av. Colombo, 5.790, Maringá, PR, Brazil

Keywords: Business process management, e-Contracts, Contract negotiation/renegotiation, e-Services, Quality of service.

Abstract: Electronic contracts (e-contracts) usually describe cross-organizational business processes defining electronic services to be provided and consumed as well as constraints on service execution such as, for instance, Quality of Service (QoS). Due to market dynamism, it is common that organizations involved in a cooperation need to do some adjustments in a pre-established e-contract. These changes should be allowed through renegotiation of contractual clauses after the e-contract is already signed and being enacted. In this paper, feature modeling is used to represent electronic services (e-services), QoS attributes and control operations to be applied when QoS attribute levels are not met. In addition, an execution environment is proposed to support contract establishment, business process execution, service monitoring and contract renegotiation.

1 INTRODUCTION

The current Business Process Management (BPM) scenario includes: i) one or more organizations that provide and/or consume electronic services (e-services) using internet; ii) negotiation and establishment of electronic contracts (e-contracts), including quality of service (QoS) attributes and levels; iii) definition, enactment, monitoring, and auditing of business process; and, iv) process analysis and optimization. The competitiveness and increasing demand have driven organization to the adoption of organizational models and business processes increasingly complex and interconnected, which requires the computational support provided by BPMS.

E-contracts between two or more partners interested in an inter-organizational business process establish the activities to be performed and the obligations, permissions and rights related to each involved party. During contract enactment, if a party is unable to fulfill contractual clauses, a contract renegotiation may be triggered.

In this paper, a complete BPM infrastructure is proposed comprising the e-contract life cycle from negotiation, establishment and enactment to renegotiation. The main contributions of this paper are: i) an extension of a pre-existent feature metamodel to include the control operations to be performed in case of e-contract violation (Fantinato et al., 2008); ii) an extended infrastructure to support e-contract negotiation and renegotiation; and, iii) more efficient management, organization and reuse of information necessary for the establishment and renegotiation of e-contracts.

The feature modeling technique is used for the representation of e-services and QoS attributes. Some advantages of this technique are (Fantinato et al., 2008): flexibility in the use of rules for e-services specification; modularization facilities

Avila Vecchiato D., Beatriz Felgar de Toledo M., Fantinato M. and Maria de Souza Gimenes I.
ELECTRONIC CONTRACT NEGOTIATION AND RENEGOTIATION USING FEATURES.
DOI: 10.5220/0002800203130318
In *Proceedings of the 6th International Conference on Web Information Systems and Technology (WEBIST 2010)*, page
ISBN: 978-989-674-025-2

particularly for QoS attributes specification; and, structured representation of the optional and mandatory WS-contract elements. Taking these concerns into account, feature modeling may also be successful applied in the representation of control operations for contract renegotiations.

The paper is organized as follows: Section 2 briefly discusses the basic concepts of this work; in Section 3 some related work are presented; the extended feature metamodel is presented in Section 4 and the BPM infrastructure approach is showed in Section 5; Section 6 presents some lessons learned; and, finally, Section 7 concludes the paper.

2 BACKGROUND

This section presents basic concepts related to Web services, e-contracts, contract negotiation and feature modeling.

2.1 Web Services

Web Services have spread as a promising technology for the effective automation of cross-organizational interactions (Alonso et al., 2003) (Papazoglou, 2007). The major benefits of this technology is the wide standardization including: a language to describe service interfaces (Web Services Description Language – WSDL) (W3C, 2006), a service directory structure and APIs for service publication and discovery (Universal Description, Discovery, and Integration – UDDI) (OASIS, 2004) and a communication protocol (Simple Object Access Protocol – SOAP) (W3C, 2007) for exchanging structured information in the eXtensible Markup Language (XML) (W3C, 2008).

2.2 e-Contracts

It is common to find organizations that are acting in a cooperative way to reach business objectives through the implementation of cross-organizational processes. The organizations interested in internet business partnerships must define details of the business process to be enacted. This could be done with e-contracts (Fantinato et al., 2008). An e-contract defines details about the collaborative organizations, the activities to be executed and the contractual clauses that must be met during process enactment (Grefen et al., 2001).

The clauses could be of three distinct types: obligations, rights and prohibitions (Fantinato et al., 2008). The obligation clauses include QoS of e-services within the inter-organizational process. In addition to the functional aspect of e-contracts, there is also the legal aspect that will not be considered is this paper.

2.3 Contract (Re)Negotiation

The negotiation process consists in agreeing about structure and properties of the contract model, as well as property values (Bacarin et al., 2008). These properties and values can be predefined in the model, negotiated or even set during contract enactment. In the latter case, a range of values must have been previously agreed.

The e-contract establishment has to aggregate some process value to the involved organizations. Contract negotiation requires offers and counter-offers between partners disposed to collaborate (Hanson and Milosevic, 2003). This process can be initiated by either sides, the receiving part interprets the offer and may refuse, agree or generate a counter proposal (Angelov and Grefen, 2008b).

Negotiation can include aspects about the model, clauses and variable values. Many protocols have been proposed to achieve automatic contracting establishment such as bargain, auction and ballot (Bacarin et al., 2008).

Renegotiation may be used when some contractual clauses are broken or when changes in the business process are required. Instead of applying renegotiation, other possible alternatives are: termination and/or rollback of the process and judicial dispute. This paper mainly addresses renegotiation.

2.4 Feature Modeling

Feature modeling captures and manages common points and variabilities in software product lines (Czarnecki et al., 2005). A feature model represents properties of some entity of interest. It can denote any functional or non-functional property in the requirement, architectural or other level. Features can be mandatory, optional or alternative. They are organized into a tree-like diagram in which a node represents a feature and each feature can be described by a set of sub-features represented as descendant nodes.

A feature model describes a system family. A family member can be configured by selecting the desired characteristics from the feature model within the variability limits of the model. This process is called feature model configuration.

3 RELATED WORK

The CrossFlow project is pioneer in the area of cross-organizational business process (Grefen et al., 2001). Like some other earlier works, they use metamodels to facilitate e-contract establishment.

More recently, Angelov and Grefen (2008b) defined an e-contract metamodel with different perspectives. The function perspective supports designers in the specification of contract activities. The communication perspective supports information exchange between parties and defines restrictions in activities execution. The negotiation activities are part of the communication perspective.

Bacarin *et al.* (2008) put forth a negotiation protocol with some primitive actions to assign property values, to send offers, request for proposal (RFP) and votes. They identify the following phases: negotiation announcement, leader determination, objective announcement, negotiation setup, restriction announcement, core negotiation, commit attempt, contract (re)construction.

Angelov and Grefen (2008a) define a reference architecture to contract systems development, using a component-based approach. This architecture provides a component for each phase of electronic contracting (information, pre-contracting, contracting and enactment).

Hanson and Milosevic (2003) propose a negotiation model that can be applied at different levels: contract model, clauses and variables. During negotiation, the contractual clauses can be modified using insertions, updates or deletions. Values can also be assigned to variables. The renegotiation process is similar, but only clauses or variables can be reassigned.

Some works use e-contract templates to facilitate the reuse of previously established e-contracts (Angelov and Grefen, 2008b) (Bacarin et al., 2008) (Grefen et al., 2001) (Hanson and Milosevic, 2003). Feature models are used in the present work to generate the e-contract template and manage the obligations, permissions and prohibitions of each part. They facilitate e-contract information organization and reuse through the use of common and variable points.

In a general way, the renegotiation issue is still not completely addressed in a proper way. Some architectures and frameworks allow contract update during process execution (Angelov and Grefen, 2008a) (Bacarin et al., 2008). However, none of them specifies the actions to be performed in the case of contract violation. The proposed framework addresses this issue.

4 FEATURE METAMODEL

The BPM context involves providers and consumers of e-services that can be composed into a business process. This collaboration must be regulated by an e-contract between the involved parties. In the proposed infrastructure, the e-services are implemented as Web Services and the e-contract is called WS-Contract (E-Contract for Web Services) according to the metamodel presented in Figure 1 (Fantinato et al., 2008). A WS-Contract is composed of: parties, e-services, contractual clauses and a business process.

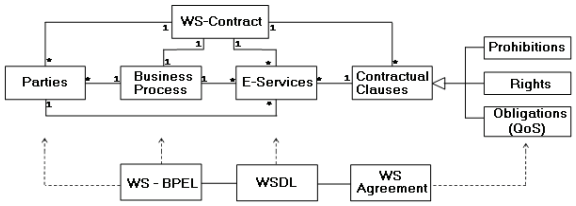

Figure 1: WS-Contract Meta model.

WS-BPEL (Web Services Business Process Execution Language) (OASIS, 2007) is used to define the involved parties and the orchestration of the e-services within the inter-organizational process. E-services and QoS attributes are described in WSDL and WS-Agreement (OGF, 2007) respectively. A complete view of the WS-Contract Metamodel can be seen in (Fantinato et al., 2008).

Since different e-contracts can be reused between different cooperation opportunities, a useful strategy explored in this approach is using contract templates. E-contracts templates are defined only once, and different – but similar – contract instances can be created. To facilitate the creation of e-contract templates, this approach uses feature models that are used to represent in a high level of abstraction the information to be provided by the involved organizations and which will be used in such templates.

The feature metamodel for e-contracts has been proposed by Fantinato et al. (2008). It originally consisted of two sub-trees, e-services and QoS-attributes, but it has been extended to include a Control-operations sub-tree. The feature diagram structure and sub-trees are shown in Figure 2. Each sub-tree is described as follows:

- **e-Services Sub-tree:** this root feature is mandatory. It contains features representing the e-services offered by an involved organization;

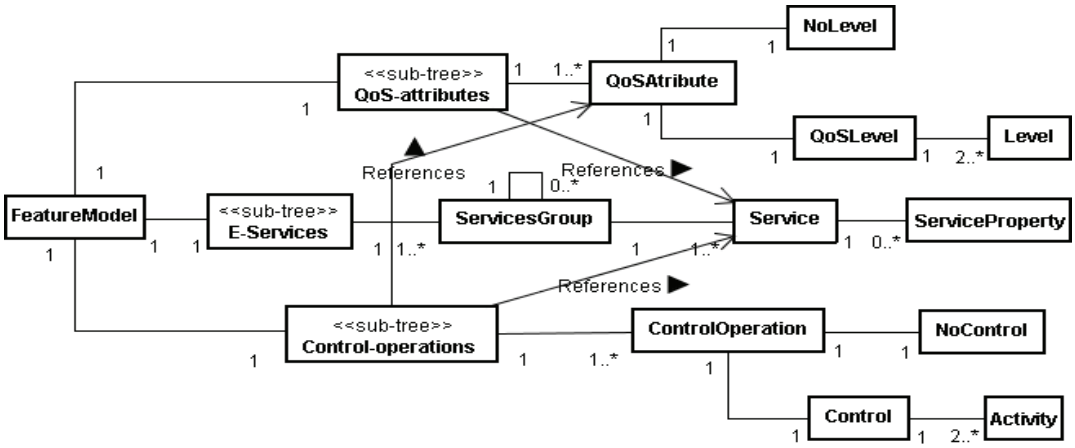

Figure 2: Feature Metamodel for E-services, QoS and Control Operations.

- **QoS-attributes Sub-tree:** this root feature is optional. It contains features that represent the QoS attributes. These attributes are attached to e-services defined into the E-Services sub-tree. It includes choices of QoS attribute levels;
- **Control-operations Sub-tree:** this root feature is optional. It specifies control operations to be executed when QoS attribute levels are not met. Some of the control operations may be: Contract Renegotiation of clause, variable or price, Process Terminate, Process Rollback, Process Suspend, Administrator/User Notification or Penalty Application.

The control operation sub-tree can be associated directly to an e-service or to specific QoS attributes of the e-service. The former case is used as a default option whereas the latter case is used as a specialization option. When a QoS attribute is not met, if there are control operations settings defined specifically for it, they are triggered to answer its non-fulfillment; otherwise, it is verified if there are control operations settings defined generically for the associated e-service which should be triggered.

With this feature structure support, a unique set of control operations options, defined only once, can be reused by all the QoS attributes and levels associated to all the e-services. During feature model configuration, specific control operations options can be selected for each QoS attribute or for each e-service.

When the Contract Renegotiation operation is chosen, a negotiation protocol must be specified. It will be performed after a notification is sent by the monitor to the collaborating parties. Other operations such as Process Terminate, Process Rollback and Process Suspend will be executed by the WS-BPEL server. The monitor and WS-BPEL server are elements of the proposed infrastructure described in section 5.

Figure 3 presents an example of a feature model configuration elaborated through the feature model plug-in (Antkiewicz and Czarnecki, 2004). This example is related to flight services provided by an airline company to a travel agency.

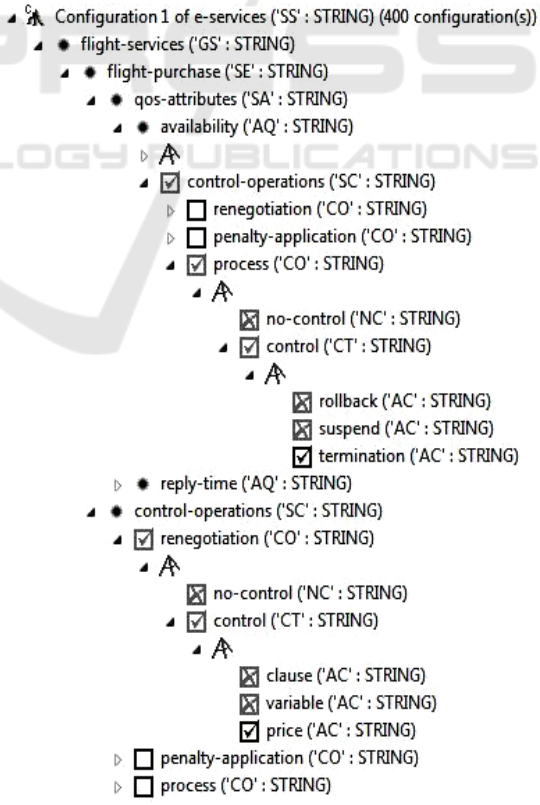

Figure 3: Flight Services Example.

The control-operations sub-tree is associated to the e-service flight-purchase and its QoS attributes availability and reply-time. The renegotiation of price is defined as the default control operation for the flight-purchase service, which must be triggered if any QoS attribute – for which there is no specialized control operation – is not met. Specifically for the availability attribute, there is a control operation specialization: if this attribute is not met, the business process must be terminated.

5 BPM INFRASTRUCTURE

The proposed BPM infrastructure is shown in Figure 5. It comprises four organizations: consumer, supplier, negotiator and monitor. The **Consumer Organization** include: i) a structure called **WS-Contract Definition** responsible for negotiation and establishment of WS-Contracts based on features; ii) a structure **WS-Contract Execution** responsible for the business process execution; and, iii) a **SOC System** necessary if the consumer services are part of the business process to be executed. In the **Provider Organization,** the **SOC System** control the Web Services subcontracted by the consumer. The **Monitor Organization** has one structure **WS-Contract Monitoring** that follows the business process execution using a set of web services monitors. The monitors use the QoS terms contained in the WS-contract for service monitoring. The **Negotiator Organization** has one structure WS-Contract Negotiation that uses a set of predefined protocols responsible to negotiation/renegotiation of contracts between providers and consumers.

To establish cooperation (Figure 4), a negotiation is initiated between the Consumer and Provider generating the feature model diagram (1) and the WS-contract defined according to those feature models and their respective feature model configurations (2). Contract parts are sent to the interested organizations (3 and 4). The WS-BPEL server interprets the business process (5), and invokes local (6) or contracted (7) Web Services. If monitoring is specified, the monitor organization is notified (8) and QoS terms, represented by WS-Agreement, in the WS-contract are identified (9). The monitor services will follow the invoked services execution to ensure that the contracted QoS levels are met (10 and 11). If any contracted term is not satisfied, the control operation, as specified in the contract, is performed. For negotiation/ renegotiation (12), the WS-Contract Negotiation uses a set of predefined protocols (13), if the contract has to be finalized the WS-BPEL server is informed to stop the enactment (14).

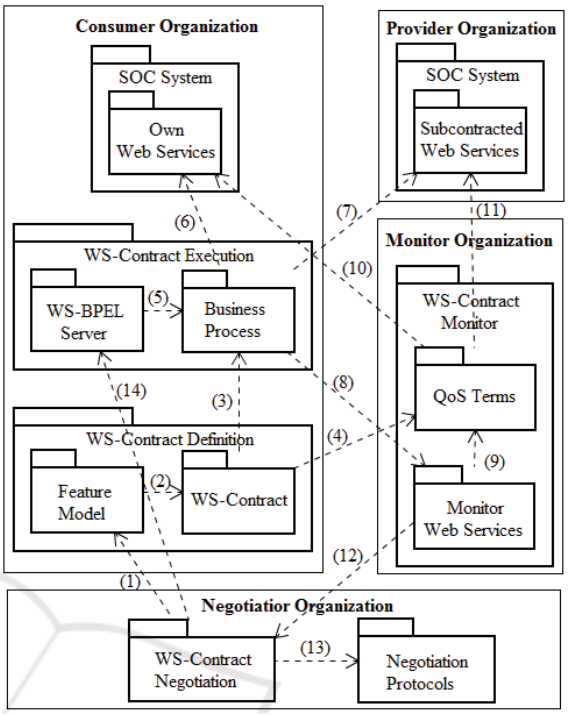

Figure 4: The Proposed Infrastructure.

Some prototypes have already been developed to support this infrastructure. For the WS-Contract Definition, the FeatureContract toolkit (Fantinato et al., 2008) uses the feature plug-in (Antkiewicz and Czarnecki, 2004) – a tool developed by other research group. The Negotiator Organization support tool is being treated inside the scope of this work. Moreover, another work is dealing with the WS-Contract Monitor tool.

6 LESSONS LEARNED

The use of feature models during the renegotiation of e-contracts makes this process easier to understand, simple and systematic. The approach improves information and artifact reuse. Common points and variabilities provided by feature modeling represent control operations, triggerable in case of contract violation, in a controlled and structured way. As well as in the original approach (Fantinato et al., 2008) which was extended here, distinct stakeholders, at different levels, can benefit from the proposed approach.

However, some disadvantages or limitations of the approach can be pointed out: i) necessity of

knowledge about the feature modeling technique; ii) lack of direct support for agreements between more than two parties; and, iii) negotiation is made in an offline way; negotiation protocols have not yet been included to automatically perform negotiation.

7 CONCLUSIONS AND FUTURE WORK

This paper has presented an infrastructure that supports e-contract negotiation, establishment, enactment and renegotiation. More specifically, the approach advantages are: i) more efficient information management, organization and reuse that is necessary for the negotiation and renegotiation of e-contracts; ii) better understanding of the renegotiation process through identifying all possible alternatives to dynamically adjust the e-contract; and, iii) better information organization and presentation of e-services and QoS attributes linked with control operations using feature modeling.

Future works, besides focusing on the weaknesses cited in Section 6, include: full implementation of the WS-Contract Negotiation element with some example protocols; extension of the WS-Contract metamodel to include the control operations elements already supported by the feature models; and integration with the WS-Contract monitoring tool which has been developed by the same research group.

ACKNOWLEDGEMENTS

This work was supported by The State of São Paulo Research Foundation (FAPESP) and The National Council for Scientific and Technological Development (CNPq), Brazil.

REFERENCES

Alonso, G., Casati, F., Kuno, H., and Machiraju, V. 2003. *Web Services: Concepts, Architectures and Applications*. Springer-Verlag, Berlin, Germany.

Angelov, S. and Grefen, P. 2008a. An e-contracting reference architecture. *J. Syst. Softw.*, 81(11):1816–1844.

Angelov, S. and Grefen, P. 2008b. Supporting the diversity of b2b e-contracting processes. *Int. J. Electron. Commerce*, 12(4):39–70.

Antkiewicz, M. and Czarnecki, K. 2004. FeaturePlugin: feature modeling plug-in for Eclipse. *Proceedings of the 2004 OOPSLA workshop on eclipse technology eXchange*, pages 67–72.

Bacarin, E., Madeira, E., and Medeiros, C. 2008. Contract e-negotiation in agricultural supply chains. *Int. J. Electron. Commerce*, 12(4):71–98.

Czarnecki, K., Helsen, S., and Eisenecker, U. 2005. Staged configuration through specialization and multi-level configuration of feature models. *In Software Process Improvement and Practice*, page 2005.

Fantinato, M., de Toledo, M. B. F., and de Souza Gimenes, I. M. 2008. Ws-contract establishment with qos: an approach based on feature modeling. Int. *J. Cooperative Inf. Syst.*, 17(3):373–407.

Grefen, P., Aberer, K., Hoffner, Y., and Ludwig, H. 2001. CrossFlow: Cross-Organizational Workflow Management for Service Outsourcing in Dynamic Virtual Enterprises. *Data Engineering Bulletin*, 24(1):52–57.

Hanson, J. E. and Milosevic, Z. 2003. Conversation oriented protocols for contract negotiations. *In EDOC'03: Proceedings of the 7th International Conference on Enterprise Distributed Object Computing*, page 40, Washington, DC, USA. IEEE Computer Society.

OASIS 2004. Uddi version 3.0.2. http://uddi.org/pubs/uddi-v3.0.2-20041019.htm.

OASIS 2007. Business process execution language for web services version 2.0. http://docs.oasis-open.org/wsbpel/2.0/OS/wsbpel-v2.0-OS.html.

OGF 2007. Web services agreement specification (ws-agreement). http://www.gridforum.org/documents/GFD.107.pdf.

Papazoglou, M. 2007. *Web Services: Principles and Technology*. Prentice Hall, 1 edition.

W3C 2006. Web services description language(wsdl) version 2.0 part 1: Core language. http://www-mit.w3.org/TR/2006/CR-wsdl20-20060327/wsdl20-z.pdf.

W3C 2007. Soap version 1.2 part 1: Messaging framework (second edition). http://www.w3.org/TR/soap12-part1/.

W3C 2008. Extensible markup language(xml) 1.0 (fifth edition). http://www.w3.org/TR/2008/REC-xml-20081126/.