A Conceptual and Practical Framework for Web-based Processes in Multi-agent Systems

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Abstract

The Internet provides possibilities for distributed execution of Business processes and Web services. These Web services might be composed to accomplish arbitrary complex tasks. Agents can compose these Web services as long as they know their semantics. Here process ontologies offer a way to give agents an understanding of the services offered.

In this paper we discuss an approach to map the service descriptions from a process ontology given in OWL-S to reference nets, high-level Petri nets that can be executed within a simulator. These nets will be executed by agents in a FIPA-compliant multi agent framework enabling them to interact with Web services. Our conceptual framework is supported by the tool DAGEN.

Keywords: High-level Petri nets, nets within nets, reference nets, RENEW, workflow, web service, business process, OWL-S, multi-agent system

1. Introduction

Web services offer possibilities to access services in distributed environments. While the specification of the actual call is covered by broadly established standards like SOAP and WSDL, the discovery of services and the description of composite services is still an area of investigation [8]. Different approaches are currently discussed. Among those OWL-S [2] is the most widespread one allowing for a semantic description of a service based on ontologies. This allows agents to combine and execute services autonomously.

Descriptions of composite (or complex) processes in OWL-S are workflows with Web services as their activities, so that they are fully executable. In order to represent and model workflows, Petri nets have been thoroughly investigated (cf. [1]). Apart from their graphical visualization, they offer means to verify certain properties of workflows like liveness or the absence of deadlocks [4].

The basis for this paper is a framework to support the development of distributed application concentrating on processes. Our approach consists of the following parts:

- multi-agent systems as a structuring technique for system architecture,
- agents for the implementation of Web service architectures as in the Agentcities.net context,
- the use of Web services defined in the context of (process) ontologies,
- a process-oriented view on applications,
- the use of workflow technologies for Web application,
- the use of high-level Petri nets for workflows (offering formal semantics and sophisticated tool support),
- Petri net-based multi-agent framework (MULAN / CAPA),
- conceptual integration of Web services into the MULAN-framework, (by translating OWL-S descriptions into reference nets),
- support of the conceptual integration by the DAGEN-tool.

This paper presents an approach to convert process descriptions in OWL-S to Petri nets. These Petri nets can than be executed within the simulator RENEW, which results in the execution of the corresponding Web services described in OWL-S. Additionally these generated nets can be embedded in the Petri net based multi-agent platform MULAN [5] or its FIPA-compliant extension CAPA [3] respectively. The latter is supported by the DAGEN-tool [6].

The multi-agent system (MAS) MULAN as well as the modelling of the Web services is based on reference nets – high-level Petri nets. By simulating reference nets with the RENEW-tool [7] it is possible to execute arbitrary Java-Code through inscriptions attached to the transitions of a Petri net. Through this, it is possible to model and execute workflows and to verify their soundness [1].
2. MAS and Web services

For the dynamic composition of distributed services we consider ontologies as well as agents to be crucial. Web services provide a standardized interface to access a service and workflows are needed to describe the composition of these services.

By using reference nets we strive to merge all these parts under a single formalism which is extended by description logics in the area of ontologies. Reference nets have been successfully applied in the area of multi agent systems. By converting OWL-S descriptions to reference nets using the DaGEN-tool, we can execute those nets in the multi-agent framework MULAN/CAPA. This offers us a practical framework to evaluate the benefits and the shortcomings of this approach in concrete scenarios.

Currently an agent in MULAN can ask an ontology agent for instances of a given class of OWL-S services. From these services, the agent can pick the one best suited for its purpose. This service can than be executed by the agent. Here, however, we only take input and output parameters into consideration, due to the fact that OWL-S does not yet specify how pre- and postconditions have to be stated. Besides this, the process model is translated into a reference net by DaGEN. This net can be separated, visualized and modified if needed and can be executed separately as well.

3. Conclusion and Outlook

A special kind of high-level Petri nets called reference nets is used as the basic description technique and formalism. As a structuring concept we use agents and for the application area we can combine them with workflows for which Petri nets can be seen as a major modeling technique. By generating Petri nets from OWL-S descriptions, we can verify those descriptions with the tools offered by the workflow community.

The major contribution here is to show that the concept of ontologies from the Web service community is integrated into our approach. This is done by relating OWL-S as a major representative for the description of process ontologies in the Web service field. Again we achieve a mapping to our reference nets for models described as such. This is done by an automatic translation from OWL-S into reference models, allowing for the use of now (partially) verified process descriptions within reference nets environments. Therefore, we have achieved a smooth integration of all areas mentioned above.

What is missing now, is the generation of process ontologies e.g. OWL-S files from reference nets representing workflows. This allows for the publication of Web services on the Internet based on reference nets. As a next step, we plan to have OWL-S descriptions generated from these verified Petri nets representing workflows.

Petri nets have been successfully applied to the field of multi-agent systems and to the field of workflow engineering. By dynamically reading the process description of a process ontology and composing a reference net thereof, reference nets can be used to describe multi-agent systems and to dynamically invoke services. With the dynamic generation and execution of reference nets out of process descriptions from an ontology, a single formalism can be used to model the entire scenario.

In further research we will study the possibilities and limitations of Petri nets agents and workflows as well as description logics in the field of dynamic service discovery.

References