GRISINO - An Integrated Infrastructure for Semantic Web Services, Grid Computing and Intelligent Objects

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Abstract. Future information, knowledge and content infrastructures which provide highly automated support in fulfilling users goals will most likely rely on some form of GRID computing. In combination with Semantic Web technologies and Semantic Web Services, such infrastructure will be much enhanced to form the Semantic Grid. Last but not least, the content, which can range from multimedia data to intelligent objects, can and must be interpreted by the services of the Semantic Grid. In this demo we will detail the GRISINO Common Infrastructure, an integrated infrastructure for Semantic Web Services, Intelligent Content Objects and Grid, that are brought together in the search for an emerging solution for next generation distributed applications.

1 Introduction

The aim of GRISINO [6] is to combine three leading edge technologies which complement each other, for the definition of intelligent and dynamic business processes:

1. **Semantic Web Services (SWS)** as the future standard for the declaration of web-based semantic processes.
2. **Intelligent Content Objects** as the unit of value which can be manipulated by SWS, and
3. **Grid Computing** as a pervasive service distribution infrastructure for a future, ambient intelligence space.

Semantic Web Services: The vision of Semantic Web Services (SWS) is to describe the various aspects of a Web Service using explicit, machine-understandable semantics, that can enable automatic discovery or composition of complex Web Services or facilitate seamless interoperability between different Web Services.

Intelligent Content: The term Intelligent Content (IC) [1] is a notation for content containing information with explicit semantic descriptions of its properties which might include technical metadata, subject matter information, how the content is typically used or what rights apply to it.

Grid Computing: A grid as defined in [3] is a system that coordinates resources that are not subject to centralized control, using standard, open, general-purpose protocols and interfaces. Grid Computing is a means of multiple independent computing clusters offer online computation and storage services for the creation of virtual companies.

Each of the three technologies plays a crucial role and has a defined scope in the integrated GRISINO platform as follows:

- The **scope of SWS technology** in GRISINO is to offer a business infrastructure which exposes and manages functionalities as services. Using SWS technology, the application development of GRISINO applications becomes compliant with the Service Oriented Architectures (SOA) - paradigm. Services are expected to use the computational and storage power provided by the Grid in order to provide their business value. Additionally the information they are going to exchange will be semantically annotated thus having a meaningful content.
- The **scope of (Semantic) Grid** is to provide a computational/ organizational infrastructure on which SWS are hosted. On one hand the (Semantic) Grid will provide the resource backbone of GRISINO in terms of computational and storage power.
- The **scope of Intelligent Content Objects** it to provide a content infrastructure for GRISINO. Intelligent Content is content that carries semantic information that can (and must) be interpreted by the services of the (Semantic) Grid. This might include descriptions about properties of the content or descriptions on how to handle the content. Intelligent Content Objects provide the intelligent data paradigm that can be seen as an intelligence and metadata wrapper for (rich) media content ranging from text files to multimedia objects.

GRISINO aims to develop an experimental test-bed combining advanced prototypes of each of the three technologies: Knowledge Content Objects (KCOs) as a model for the unit of value together with its management framework KCCA (Knowledge Content Carrier Architecture)¹ that can deal with KCOs, WSMO/L/X ([5],[2],[4]) as a framework for the description and execution of SWS and Globus² as the Grid infrastructure for managing resources and hosting services.

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² <http://www.globus.org/toolkit/>

2 System Description

The GRISINO system architecture is shown in Figure 1. It provides a set of APIs and the implementation of these APIs that shall ease the handling and development of applications which intend to use the three technologies together:

- the GRISINO API providing application developers easy access to the combined functionality of the three technologies.
- the Transformer API including protocol transformations between the technologies.
- the Selector API issuing calls to Transformer or Foundation API.
- the Foundation API is an abstracted view of the APIs of core components.

Fig. 1. GRISINO Architecture

The rest of this paper focuses on the integration of the technologies which is mainly done through the transformer components. The three technologies are integrated in a service oriented manner and the communication is realized via Web services. Furthermore the integration is supported and enhanced by using semantic technologies.

2.1 SWS-Grid Integration

The main intention of the integration of SWS and Grid technologies is to enhance Grid technology with semantics to achieve the vision of the Semantic Grid, in which Grid services can be automatically discovered, invoked and composed. To integrate the two SWS and Grid systems, namely WSMX and KCCA, we have taken a service-based integration approach. We have deployed a set of state-full Grid services using the Globust toolkit. For each of these services semantic annotations in WSML has been provided. The integration approach is as follows:

1. A formal WSML goal description is submitted to WSMX.
2. The WSML description is translated to an XML format and a SOAP message is created with data from the goal.
3. The SOAP message is sent to the endpoint specified in the grounding part of the WSML service description.
4. The grid service deployed in the Globus Toolkit is invoked and a SOAP response is created and sent back to WSMX.
5. A lifting mechanism (based on XSLT transformation) is used to construct out of the SOAP message a WSML description containing the response.

2.2 SWS-KCO Integration

The aim of the integration of WSMX and KCCA is to enable automatic discovery of KCCA services and to be able to execute KCO plans through the invocation of Web services. To integrate SWS and Intelligent Objects systems, namely WSMX and KCCA, we follow a service-based integration approach extended with semantic features. The integration approach is as follows:

1. A formal SWS request in the form of a WSML goal description is submitted to WSMX
2. The WSML description is translated to an XML format and a SOAP messages are created with data from the goal.
3. The SOAP message is sent to the endpoint specified in the grounding part of the WSML service description.
4. The KCCA Web service is invoked and a SOAP response is created and sent back to WSMX.
5. A lifting mechanism (based on XSLT transformation) is used to construct out of the SOAP message a semantic representation in WSML of the KCCA response.

3 Demonstration

The proposed system demo will present the basic interaction between Semantic Web services, Grid Computing and Intelligent Objects technologies.

We use the exhibition generation scenario to demonstrate the functionality of the system. The scenario involves multimedia objects, multimedia processing

services and computational resources for video and image processing. The first use case of this scenario will be demonstrated during the system demo. It shows the process of a digital catalog creation which involves the use of various services: (1) getting artifacts from different sources (artifacts specifying), (2) building catalogs based on Semantic Web Services technology (digital catalog producing) and (3) registering intelligent objects (digital catalog registering). These services are deployed as Grid services using a Globus toolkit container. For each of these services a Semantic Web service has been created and deployed in WSMX. Last but not least simple Intelligent Objects are exchanged between above mentioned services.

The visitor interested in the demo will have the chance to see how the three fundamental technologies for distributed computing can be integrated in a service oriented manner. We will show, using the previous mentioned scenario, how calls are made between the three systems: WSMX, Globus and KCCA, what kind of data is passed between them and how semantics enables and supports this integration.

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