Services for Inter-enterprise Information Management in Dynamic Virtual Enterprises

Simon Charles HARVEY
B.Sc. (Hons)
Research Fellow
Information Systems
Institute
University of Salford
Salford, United Kingdom
M5 4WT
S.Harvey@salford.ac.uk

Simon is a Research Fellow at the University of Salford's Information Systems Institute. Currently working full-time on the OSMOS project, he has also contributed to other UK and European funded IT Security projects such as 3D and GUIDeS. Further details can be found at http://www.harvster.net.

Yacine REZGUI
Senior Lecturer
ISI-University of Salford
Salford
United Kingdom
y.rezgui@salford.ac.uk

Dr Yacine Rezgui is the Associate Head of School for Funded Research at the Information Systems Institute of University of Salford. He has completed several UK and EC projects and has published extensively in the area of information management, process / object modelling, and Process Re-engineering.

Alain ZARLI
Project Manager
CSTB
Sophia Antipolis, France

Alain Zarli is a research scientist and a project manager at the CSTB CIC (*Computer Integration for Construction*) division. He has been involved in European ESPRIT projects (ATLAS, VEGA, WONDA), and is currently involved in the IST projects OSMOS, eConstruct, and Divercity.

Abdul Samad KAZI
Master of Engineering
Research Scientist
VTT
PL 1801, FIN-02044
Finland
Sami.Kazi@vtt.fi

Abdul Samad Kazi, recipient of the Mahesh Varma prize for most outstanding academic performance during his graduate education is working as a research scientist at VTT. He is currently involved in EU projects OSMOS, Procure, I-SEEC, GLOBEMEN, and eLEGAL.

Summary

State of the art research in Construction IT reveals that integration has been achieved, mostly, on static models that define the structure of shared information in the form of files or databases. This paper advocates that integration should be made through frameworks that define the semantic relationships between the interfaces of separate distributed components (and the way to make those

relationships evolve in the course of a project/process). Based on a requirements analysis of industrial partners, the OSMOS specification was made in the form of a set of information models and a set of required services packaged in the form of an OSMOS API. This paper focused on: e-mail based communication service, document cross-referencing/information management service, virtual enterprise manager, and information browser.

Virtual Enterprise, Distributed Systems, Teamwork Support, API, services,

1.   Introduction

The overall aim of the OSMOS project is to enhance the capabilities of construction enterprises, including SMEs, to act and collaborate effectively on projects by setting up and promoting value-added Internet-based flexible services that support team work in the dynamic networks of the European construction industry. An adjoining paper discusses the overall OSMOS approach in addition to providing an insight into the architecture definition and specification.

The main components of the OSMOS architecture include a set of semantic models, along with construction specific services, packaged in the form of an OSMOS API, supporting team work in a Virtual Enterprise (VE). This architecture also provides the framework for a smooth integration of existing proprietary and commercial applications used within the organisations of industrial partners, Derbi and Granlund, or any other company wishing to participate to the OSMOS VE. The business and technical requirements for setting up the OSMOS team work service providers have also been specified: the latter will have the fundamental mission of providing the IT infrastructure of the VE, including toolkits, information / document servers, and OSMOS plug-ins that would enable non co-located teams through their proprietary and commercial applications to join, and take an effective part to, the VE. Based on the above specifications, a Virtual Enterprise Management Tool (used to configure the virtual enterprise)[VEM], and a Web-based Information Browser (used to access and manipulate a wide range of information stored in the VE, along with their associated services)[WIB] have been implemented and deployed within the context of industrial partners, Granlund and Derbi.

This paper discusses the various OSMOS services in addition to providing a description of the main OSMOS low-level tools, namely the VEM and the WIB.

2.   Architecture Definition and Specification

2.1   The OSMOS Architecture and Modelling Infrastructure

To support the design and development of a coherent set of Integration Services, APIs and OSMOS Tools, the OSMOS Consortium advocate the use of robust object-oriented models that have evolved from a careful analysis of the business and information management process undertaken within the context of a Construction VE. The models that were developed within the first iteration of the OSMOS project are quite complex and are discussed elsewhere [3], however it is important to note that these models will evolve over the course of the OSMOS project, based upon the feedback of the industrial partners as they test the developed infrastructure. A more detailed description of the OSMOS Architecture and Modelling Infrastructure is presented in an adjoining paper.

2.2   OSMOS Integration Services

The OSMOS Integration Services are those facilities that provide components adapted to a specific but common use within the VE (and can be used in all industry sectors, not just the construction industry), for instance allowing the sharing and cross-referencing of information held in the VE, or the co-ordination of the work undertaken within the VE. The specification of these integration services in OSMOS encompass the description of their functionality and an API for the following set of identified teamwork services:

- Document Cross-Referencing Service (which will evolve into an Information Management Service;
- E-mail Based Communication Service;
- Building and Construction Workflow Service;

- Application Inter-Working Services;
- Scheduling Service;
- Conferencing Service.

At the time of writing, a specification has been provided for the Email-based Communication and Document Cross-Referencing services.

2.2.1 E-mail based Communication Service

The role of this service is to provide users with mechanisms for exchanging electronic information and messages, examples of which include by, electronic letters, e-mail, documents, etc., in an open environment and a seamless way. Electronic Mail services clearly are better than telephone or fax for automatic communication management within the VE, but today are either based upon (legacy) solutions from groupware software providers, or otherwise are open mail services (based on Internet standards like SMTP, POP, MIME, etc.), that lack feature-rich facilities such as automatic acknowledgement of receipt, full archiving and reports for consultation (mails received, read, forwarded, archived, etc.), built-in security during transfer, etc.

Solutions developed in OSMOS are related to some generalisation to other protocols (e.g. IMAP4) to get authenticated access to mails from any computer, and to provide with a support for contextual mailing lists as well as the future management of simplified acknowledgements of receipt. In the OSMOS 1st iteration, the API for this service provide functions for:

- The ability for actors to search and get email addresses according to specified criteria;
- The ability to send and receive email from within the actual working environment (i.e. without having to open a separate mail system);
- The ability to record, i.e. keep an archive copy of, all project-related email sent through the solution.

The open architecture developed in OSMOS for mail management within the VE is Java-based, and uses the JAMES (Java Mail Enterprise Server) component of the Avalon server framework [1]. Future iterations of the service should allow start to deal with the highlighted security issues, for example the use of S/MIME and Public Key Cryptography for encryption. The implementation of an LDAP directory to support the storage of such keys will allow the server to host a rudimentary Public Key Infrastructure (PKI) for the VE.

2.2.2 Document Cross-Referencing/Information Management Service

The role of this service is to provide users with mechanisms to relate any particular nugget of information with other information to which it relates based on its semantics (meaning), regardless of its actual form and storage format. The OSMOS Document Cross-Referencing and Information Management Service allows the end user, using his OSMOS-extended application (which is transparently invoking the functions of the following API), to store and retrieve Information Elements (e.g. documents, messages, objects, etc) to and from the OSMOS System.

The functionality of this service may include, but is not restricted to, the following features:
- The ability to upload and download Information Elements (documents, files, messages, etc) from the OSMOS architecture;
- The ability to semantically classify Information Elements into whatever groups the Virtual Enterprise desires (this would be used for defining default access rights, etc);
- The ability to locate which server a given Information Element can be downloaded from;
- The ability to add a reference from a nugget of information to a part of an Information Element, regardless of whether it is within the same or within a different Information Element;
- The ability to list all the parts that a Information Element references, or is referenced by;
- The ability to query the status of a referenced Information Element (e.g. does it exist, is it available on-line, etc.);
- The ability to maintain (or propagate) changes to referenced Information Elements in a consistent manner (for example, when a new version of a document is produced, the end user should be able to specify whether existing references point to the previous or the new version of

that document);

- Document management services in general, such as support versioning, backups, maintaining metadata about that Information Element, etc;

After an initial specification of this service in the 1st OSMOS iteration, the underlying model and API have been substantially refined in the course of the 2nd iteration based upon the feedback within the project, and the implementation of this service has now re-started.

2.3 Technological State of the Art

Within the context of the OSMOS Project, a review of the current IT state of the art has been undertaken, in order to select and specify the base technologies and architecture underlying the OSMOS system. The review related to emerging information and communication technologies and teamwork services, supporting communication, co-operation, co-ordination, and information management (including routing, cross-referencing and versioning). This addressed the need to:

- review and analyse the issues, risks and requirements specific to the Construction Industry, in addition to the emerging information and communication technologies that could be advantageous within the context of OSMOS, from both architectural and technological perspectives;

- understand the partners' existing software/ hardware infrastructures and requirements;

- make a comparison of the potential available IT solutions for the selection of the OSMOS base technology;

- and to finally select the generic OSMOS base technology based upon the results of the tasks detailed above.

The technology overview was mainly dedicated to:

- Underlying communications issues: networking (LANs, WANs, Intranets and the Internet), software architectures (2-Tier, 3-Tier and N-Tier), and available middleware technologies , such as transactional, message-oriented, procedural and object-oriented based systems & infrastructures (CORBA/IIOP, (D)COM(+), and Java-Based/RMI). The OO-based middleware seemed to offer the most promising functionality for OSMOS;

- Information exchange and data sharing technologies: semantic product modelling (such as STEP and IFC), and generic information exchange and sharing technologies (such as XML, LDAP, HTTP and SOAP technologies);

- Technologies that facilitate co-operation between actors, such as workflow, document management systems, decision support systems, and messaging technologies such as e-mail.

3. OSMOS Infrastructure Implementation

During the course of the project, the OSMOS infrastructure is to be initially implemented through the set-up of OSMOS internet-based prototype services hosted in Finland and France respectively. These will contain toolkits for the instantiation of VE projects based on implementation of the OSMOS API through different OSMOS tools.

We now provide an overview of how we envisage the OSMOS solution to be implemented in a real-world context. An organisation can act in one or more of the following three roles in an OSMOS-supported Virtual Enterprise:

- *OSMOS VE Service Provider* (Role A) companies are concerned with hosting the central infrastructure of the Virtual Enterprise. They also provide the Integration Services as discussed earlier. Role A companies may act as a host for multiple Virtual Enterprises.

- *OSMOS Third Party Service Provider* (Role B) companies provide their services (such as HVAC and FM analysis, Document Management Services, CAD plotting services, etc) to customers by making such services available via Role A companies. A Role B company can supply multiple Role A companies.

- *OSMOS Clients* are those companies that use, and take part, in an OSMOS-supported VE. One particular Role C company will administer this VE on a Role A server on behalf of the client by the use of a tool such as the *OSMOS Virtual Enterprise Management Tool*. Other clients can use

their extended applications or the *OSMOS Web-based Information Browser* to access the information held in the VE. In addition, Role C companies also make use of the Integration Services provided by the Role A company (such as E-mail based Communication and Notification.)

We shall continue by briefly describing the first implementations of the *Virtual Enterprise Management Tool* (VEM) and *Web-based Information Browser* (WIB). These tools are currently being redeveloped and enhanced based upon the feedback from the industrial partners and changes in the modelling infrastructure.

3.1   OSMOS Virtual Enterprise Management Tool

The OSMOS VEM is a small application, written in Java, which allows the registration and management of Actors, Roles, Objects, Classes and Access Rights into the OSMOS-supported Virtual Enterprise. (In OSMOS, we define Access Rights based upon access for Actors holding a particular Role when accessing a method of any object of a given Class [3]). The tool, developed on a three-tiered architecture, manages the same database that is used by the WIB (discussed below) so that the relevant access rights are enforced for an Actor holding a particular Role when browsing the information held within a Virtual Enterprise.
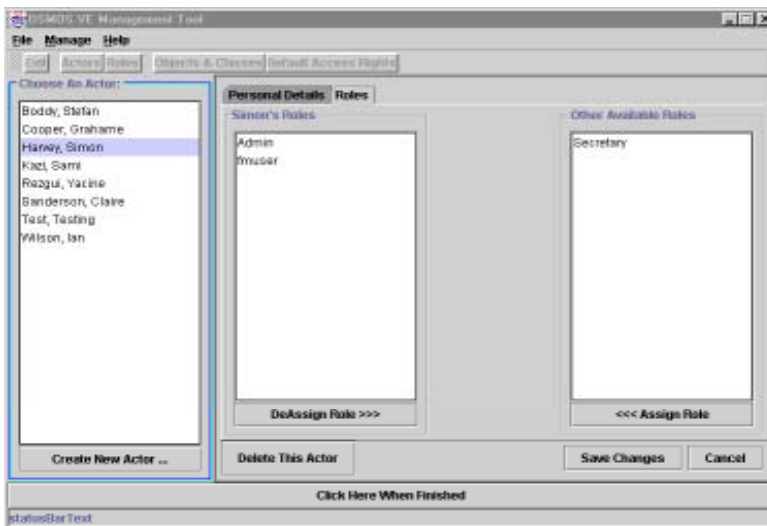

Fig. 1 The OSMOS VE Management Tool

Based upon a rapid prototyping approach, a high level of feedback was received from the industrial partners. They highlighted a number of issues, some of which with regard to the technical performance of the tool, others can be attributed to the underlying concepts and models which the tool has been developed upon. These issues have been immediately taken into account because of the incremental and iterative methodology undertaken by the OSMOS project.

Furthermore, a web-based version of the tool, implemented as a set of Java Servlets, has been produced. The tool will be enhanced to provide support for management of multiple VEs by Role A companies, as well as individual Virtual Enterprise Projects, in addition to the management of the OSMOS Integration Services and services provided by Role B companies, in the second and third iterations of the OSMOS project.

3.2   OSMOS Web-based Information Browser

The OSMOS Web-based information browser is the main entry point into the OSMOS system. The

core objective of the WIB is to expose different objects to actors holding roles that have authority to browse these objects. At the same time, the WIB exposes those services that are available to the actor for invocation.

The basic functionalities of the WIB as provided in the demonstration include:

- Ability to retrieve and make available different objects to an actor to which he/she has rights based upon the role he/she chooses to participate in

- Ability to make available those services to an object to which the actor's chosen role has access to

Fig. 2 The OSMOS Web Based Information Browser

- and the ability to pass on queries to external services based on selected object and associated method

4.   Conclusion

This paper has presented an overview of the technical aspects of the OSMOS Project, such as its architecture, services and prototype tools. The services that OSMOS will provide are expected to enable construction industry software applications to be integrated more closely while being augmented with advanced functionality supporting collaboration and teamwork on projects. It is expected that the OSMOS project will advance the state of the art in the application of CSCW (Computer Support for Co-operative Work) in the construction domain by:

- Providing construction specific, and scalable solutions, that take into account the particular organisational settings of each construction enterprise participating in the VE, including SMEs.

- Providing IT and organisational solutions that promote trust and social cohesion among the partners of a construction VE.

- Providing effective, model-based solutions, to support Communication, Co-operation, and Co-ordination between individuals and groups collaborating in a construction VE, based on the specificity and information / process requirements of the Construction domain.

- Providing models for business processes, working methods, organisation, contracts, and legal responsibilities related to CSCW in a VE.

One of the fundamental tangible objective of the OSMOS project is the ability to deploy a flexible adapted team work solution in a limited amount of time, e.g. in days or few weeks as opposed to months, as it is the case today as regards the deployment of Electronic Document Management (EDM) and Product Data Management (PDM) systems in construction companies. The project end-users, Derbi in particular, are presently involved with the deployment of the OSMOS tools within their organisation, to set up internet-based team work services. It is expected that the models and architectures described in this paper will be refined in the light and experience learnt from the evaluation of the deployment of the OSMOS infrastructures within Granlund and Derbi.

5.   Acknowledgements

University of Salford, and the Technical Research Centre of Finland (VTT).

6. References

[1] The Apache Group, *Avalon: The Java Apache Server Framework*, http://java.apache.org/framework/developer/index.html, Cited 27 January 2001.

[2] Enhydra.org, *Enhydra Java Application Server Architecture for Open Source*, http://www.enhydra.org/software/documentation/enhydra/archWhitePaper.pdf, 21 December 1998, Cited 27 January 2001.

[3] Harvey, S.C., Wilson, I.E., Rezgui, Y., and Cooper, G.S., "A Comprehensive Description of the Human, Process and Technical Requirements of a Construction Virtual Enterprise: The OSMOS Project", To appear in the *Proceedings of the 1st International Conference on Innovation in Architecture, Engineering and Construction (AEC 2001),* University of Loughborough, 2001, 18-20 July.