Interoperability for Enterprise Software and Applications


Edited by
Hervé Panetto
Nacer Boudjlida
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Hervé Panetto
Nacer Boudjlida
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The interoperability in enterprise applications can be defined as the ability of a system or a product to work with other systems or products without special effort from the customer or user. The possibility to interact and exchange information with internal and external collaborators is a key issue in the enterprise sector. It is fundamental in order to produce goods and services quickly, at lower cost, while maintaining higher levels of quality and customisation. Interoperability is considered to be achieved if the interaction can, at least, take place at the three levels: data, applications and business enterprise through the architecture of the enterprise model and taking into account the semantics. It is not only a problem of software and IT technologies. It implies support for communication and transactions between different organisations that must be based on shared business references.

The I-ESA conference aimed at bringing together researches, users and practitioners dealing with different issues of Interoperability for Enterprise Software and Applications. The conference focused on interoperability related research areas ranging like Enterprise Modelling to define interoperability requirements, Architecture and Platforms to provide implementation frameworks and Ontologies to define interoperability semantics in the enterprise.

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Editorial

The second I-ESA international conference, supported by the INTEROP NoE (Interoperability Research for Networked Enterprises Applications and Software Network of Excellence, http://www.interop-noe.org) and the ATHENA IP (Advanced Technologies for interoperability of Heterogeneous Enterprise Networks and their Applications, http://www.athena-ip.org) and sponsored by IFAC and IFIP, offered a workshops program comprising three workshops and a Doctorial Symposium. The objective of the workshops held on March 21st, 2006 was to strengthen some key topics related to interoperability of enterprise applications and software. The workshops organisation left time slots for brainstorming among the attendees in order to come out, at the end, with possible new research directions. The Doctorial Symposium provides an open forum for students involved in the preparation of their PhD to discuss their research issues and ideas with senior researchers.

It is a fact that enterprises need to collaborate if they want to survive in the current extreme dynamic and heterogeneous business world they are involved in. Enterprise integration, interoperability and networking have been disciplines that have studied how to enable companies to collaborate and communicate in the most effective way. Enterprise Integration consists in breaking down organizational barriers to improve synergy within the enterprise so that business goals are achieved in a more productive and efficient way. The 2nd IFAC TC 5.3 Experts Workshop on “Enterprise Integration, Interoperability and Networking” (EI2N’2006) aims to identify current research and practical issues on applications interoperability for enterprise integration.

One of the main domain related to interoperability concerns architectures. Technology such as Web services promises to facilitate the interaction between IT systems and enterprise applications. The 2nd workshop “Web Services and Interoperability” (WSI’2006) gathered researchers and practitioners in order to explore various aspects of web services and their benefits to the interoperability problem, according to a technical perspective as well as a business one. However, interoperability of enterprise software and application concerns also trust and security of the exchange process. The objective of the “Interoperability Solutions to Trust, Security, Policies and QoS for Enhanced Enterprise Systems” (IS-TSPQ’2006) workshop was to explore architectures, models, systems, and their utilization for non-functional aspects, especially addressing the new requirements for interoperability.

And finally, a Doctoral Symposium has given the opportunity for students involved in the preparation of their PhD in any area of Interoperability for Enterprise Software and Applications to present and discuss their research issues and ideas with seniors’ researchers to better understand the interoperability context and issues.

We would like to express many thanks to the workshops chairs and committees for their contribution to the scientific success of these events.

Nacer Boudjlida, LORIA UMR 7503, Nancy-University, CNRS, France
Hervé Panetto, CRAN UMR 7039, Nancy-University, CNRS, France
Entreprise Integration, Interoperability and Networks
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EI2N Workshop Chairs’ message

After the successful first edition of the workshop, in 2005, the second edition of the EI2N workshop has been organised in the context of the I-ESA06 International Conference by the IFAC Technical Committee 5.3 “Enterprise Integration and Networking”. The workshop aims to identify current research and practical issues on applications interoperability for enterprise integration that should be fully developed in the future works.

In response to the call for papers, 13 papers have been submitted; each paper has been reviewed by three reviewers, members of the international programme committee. Only 6 papers have been accepted and 5 have been presented. Other than the presentations of the accepted papers, to involve and to understand impact on the workshop participants, two groups have been organised to discuss on the topics addressed in the presented papers. These two groups have finally reported the results of the respective discussions.

The workshop has then been organised around three topics addressed by the accepted papers: UEML (Unified Enterprise Modelling Language), ontologies for application interoperability and, finally enterprise interoperability. The first two papers on UEML, i.e. UEML: systematic approach for the determination of elementary constructs and Comparison of goal-oriented languages using the UEML approach present two distinct proposals towards the definition of such a UEML. The former focuses on how to define, starting from existing modelling languages, constructs that can be considered as part of each language (and referred to as elementary constructs in the paper). The latter focuses on how to use the UEML approach 2.0 proposed in INTEROP network of excellence, for representing two languages, GRL and KAOS, well-known in the (software) requirement engineering community; then, based on the proposed ontological representation, the paper provides correspondences between the constructs belonging to these two languages.

The paper A multi-views business process ontology for flexible collaboration addresses web service ontologies and how one of these ontologies can be used for composing (in processes or business processes) web services.

Finally the two last papers, i.e. GRAI and SCOR Meta-model and Design Principles for Interoperability and Framework for enterprise interoperability address what is interoperability between enterprises and how enterprise interoperability can be characterised; specifically, the first paper is about principles (defined by using SCOR as the main reference model, well-know in supply chain, together with a decisional framework represented by a GRAI grid) to design enterprises taking part to a network. The second paper aiming at defining enterprise interoperability and structuring the related research domain, provide a framework to classify solutions and to understand barriers (conceptual and technological) to make interoperable enterprises.
It has been a great pleasure to work with the members of the international programme committee who dedicated their valuable effort for reviewing, in time, the submitted papers: we are indebted to all of them. We are also indebted to Michael Petit (Facultés Universitaires Notre-Dame de la Paix, Namur, Belgium) and Thomas Knothe (IPK-Berlin, Germany) who moderated and reported the discussions within the workshop groups, and to Nacer Boudjlida (LORIA, France) who kindly accepted to chair one session. Finally, we would like to thank the INTEROP Network of Excellence (European FP6 IST-508-011, http://www.interop-noe.org) for its great support.

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Session 1:
UEML for Enterprise Applications Interoperability
UEML: Systematic Approach for the Determination of Elementary Constructs

Matthieu Roque* — Bruno Vallespir* — Guy Doumeingts**

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ABSTRACT: Nowadays, one of the important objectives of research in the enterprise modelling domain is the development of a unified language, often called UEML (Unified Enterprise Modelling Language). This paper is focused on one of the more illuminating aspects of UEML: the comparison of the constructs of the enterprise modelling language. In previous work we identified some situations which can occur when we want to compare some modelling constructs belonging to different languages. We investigate in more detail this problem of comparison, using a formal approach based on the set theory.

KEY WORDS: Interoperability, enterprise modelling, models transformation, constructs, UEML.
1. Introduction

Since the first development in the area of enterprise modelling that started in the US in 1970s (for example, SADT, SSAD, IDEF0, Data Flow Diagram, ...), many enterprise modelling languages have been elaborated world-wide. We can mention for example, Entity Relationship model, MERISE, GRAI grid and nets, CIMOSA constructs and building blocks, OMT, IEM, ARIS method, IDEFx, ... (Petit et al., 2002), (Vallespir, 2003), (Vallespir et al., 2003), (Vernadat, 1996). It is generally recognised that there are too many heterogeneous modelling languages available in the “Market” and it is difficult for business users to understand and choose a suitable one. Main problems related to this situation are (Chen et al., 2002):

- difficulties (impossibility in some cases) in translating a model built using a language to a model expressed in another one;
- difficulties for an enterprise in using a software tool if it is based on languages which are different from the ones adopted by the enterprise;
- difficulties for a user in selecting the relevant languages to resolve a particular problem.

However, it seems that the elements behind these various languages are similar or differ only slightly in details. Thus, it is natural to think about the development of a Unified Enterprise Modelling Language. One of the principal benefits to have a Unified Enterprise Modelling Language is to be able to transform a model of an enterprise built in a language in another one (Chen et al., 2002), (Doumeingts et al., 1999), (Vallespir, 2003), (Vallespir et al., 2003), (Vallespir et al., 2001), (Vernadat, 2001). Moreover, requirements about UEML have been stated during the UEML project (IST-2001-4229) (Knothe, 2003). The third most important requirement stated was the expectation for an “invariant and unique behavioural semantic” language. Thus, the language UEML is used like a “pivot” language and thus allows avoidance of one-to-one transformation (Chen et al., 2002), (Berio, et al., 2003).

2. Roadmap

Several approaches can be considered for elaborating our unified language like the bottom-up approach which starts with an analysis and then synthesis of existing enterprise modelling languages. Indeed, for the moment, it seems to be more efficient to use the principle which consists of integrating existing languages (Chen et al., 2002), (Vallespir et al., 2003), (Vallespir et al., 2001).

This approach is composed of the following steps:

1) Choice of existing languages.
2) Build meta-models of the languages in order to have the constructs and the links between them for each language.
3) Study of the intersections between the constructs of each language in order to identify the common constructs and to allow to define the elementary constructs.
4) Do the union of elementary concepts.
5) Establishment of correspondences rules.

3. Meta-modelling

In this paper, we focus only on the determination of the common constructs in order to find the elementary constructs. Thus, only the steps 2) to 5) above are presented. In our approach, we consider the meta-modelling as a lens by which a unified enterprise modelling language may be defined. Thus, we use the meta-modelling like a technique of dialogue, by describing the constructs of the different languages. The objective is to “to exceed the terminological problems and graphic conventions, in order to identify their common points and those [that diverge]” (Oussalah, 1997). Some approaches like XML (DTDs and Schemas), MOF, Telos, can be used as meta-modelling language. These techniques are content-independent (applicable for the definition of any language). Others meta-modelling languages are content-dependent (and sometimes domain-specific): for instance, XMI is an exchange format based on the UML metamodel in XML designed for enabling exchange of UML models. Accordingly, a UEML could be defined as a content-dependent domain-specific meta-model through a content-independent meta-model. The UEML might just use content-independent meta-modelling techniques as a way for its definition (Panetto et al., 2004). Finally, the meta-modelling that we use is the UML (Unified Modelling Language) class diagram (OMG, 2003) because it seems sufficient to deal with our problem which is, in the first place, to describe the syntactical aspects of the languages. For each language, a meta-model is built with the class diagram and, all the constructs of the language and the links between them are represented. With these meta-models we can compare the constructs of the different languages.

4. Definition of the elementary constructs

In previous works, the concept of elementary construct has been introduced and we highlighted that its determination is not easy (Roque et al., 2005). The objective, of this section is to propose a formal approach in order to facilitate the determination of the elementary constructs. The definition of the elementary construct is recalled below.
A construct is an elementary construct, if it exists completely or not at all for each considered languages.

For instance, in Figure 1, we can see that all the constructs are elementary constructs except the construct C2. Indeed, all the others constructs belong completely or not all to the language A, B and C. The construct C2 belongs completely to the language A but only a part of this construct belongs to the language B. Thus, it is not an elementary construct.

4.1. Constructs comparison in the case of two constructs

If we consider the comparison of only two constructs A and B belonging respectively to two different enterprise modelling languages, we can distinguish three kinds of relationships between the two constructs. In Figure 2, Figure 3, and Figure 4, we consider the two constructs and we indicate what constructs we have to integrate in UEML.

4.1.1. Case 1: no connection

A_{UEML} \equiv A \text{ and } B_{UEML} \equiv B
4.1.2. Case 2: equivalence (A ≡ B)

![Equivalence relationship](image)

\[X ≡ A ≡ B\]

4.1.3. Case 3: A and B have a shared part

![Have a shared part relationship](image)

The three constructs X, Y and Z (Y = Shared part, X = A-Y, Z = B-Y) are created in the UEML meta-model. However, what is really the meaning of the “has a shared part” relationship. Indeed, the concept of “set” in mathematics is very general. A “set” can indicate any collection. The objects which are in a bedroom can be qualified of a set even if it is heteroclite and which is defined by the property “being an object located in the bedroom of someone at this time”. However, one can say that a person is a set, and that its arm belongs to him according to a set relationship. One can answer yes, because of the general information of the set concept; but it is not necessarily relevant because that does not correspond to what one wanted to model. When we think of our left arm, we do not consider it like an element of a set where it would be similar to others, but like an organ which belongs to an organisation or an element where it deals with her specific function, in relation to others organs. For instance, the directions of an enterprise compose the enterprise. This vocabulary can be used to qualify the link which exists between an arm and a person. It is a UML “composition” or an “aggregation” and not an inclusion in the sense of the set theory. However, in this paper, we focus only on the generalisation relationships which seem to be the more frequently relationships. In this case, the constructs X, Y and Z allow recomposing the constructs A and B by generalisation relationships.

To elaborate the UEML meta-model we have to generalise these results about two constructs to any number \(N_c\) of constructs.

---

1 In this paper each class property is considered as independent. This assumption is valid because assuming independence gives the worst case for the number of combination of constructs to be considered.
4.2. Constructs comparison in a general case

In order to define all the elementary constructs in the case of any number of constructs we use an approach based on the set theory approach. Indeed, the concept of class and the concept of set are very similar. The objects instances of a class share general characteristics, expressed in the class in the form of attributes, operations and constraints. We call $P(A)$ the characteristic property of the set $A$ corresponding to the cartesian product of “$n$” sets corresponding to the “$n$” properties of the class $A$ [1]. Thus, we have:

$$P(A) = P_1(A) \times P_2(A) \times \ldots \times P_n(A)$$  \[1\]

and $p_n(A)$ is an element of the set $P_n(A)$ and corresponding to an instance of the property $P_n(A)$.

Thus, we can write some equations in order to determine the elementary constructs in the case of a number “$N_c$” of constructs and how the constructs of each of each language can be recomposed.

4.2.1. Definition of the elementary constructs

We define in the first time the set $E$ corresponding to the union of the $N_c$ constructs [2].

$$E = \bigcup_{i=1}^{N_c} (C_i)$$  \[2\]

Thus, we can define $N_{EC}$ elementary constructs ($E_{ci}$) corresponding to all the sub-sets which is possible to create with the intersections of all constructs. To determine these elementary constructs it is useful to use a truth table as in Boolean algebra where each “0” corresponds to the complementary of the set (equal to $[E - (C_i)]$ noted $^cC_i$) in the set $E$ and each “1” corresponds to the set. Thus, each combination of the truth table defines an elementary constructs. However, the first one does not need to be considered because $^C1 \cap ^C2 \cap ^C3 = \emptyset$. In the case of 3 constructs we can define 7 elementary constructs. Then, we can write the equations corresponding to the 7 elementary constructs and their characteristic property (Table 1).

<table>
<thead>
<tr>
<th>Elementary constructs</th>
<th>Correspondences rules</th>
</tr>
</thead>
<tbody>
<tr>
<td>$E_{C1} = ^C1 \cap ^C2 \cap ^C3$</td>
<td>$C_1 = E_{C1} \cup E_{C5} \cup E_{C6} \cup E_{C7}$</td>
</tr>
<tr>
<td>$P(E_{C1}) = P(^C1) \cup P(^C2) \cup P(^C3)$</td>
<td>$P(C_1) = P(E_{C5}) \cap P(E_{C6}) \cap P(E_{C7}) \cap P(E_{C4})$</td>
</tr>
<tr>
<td>$E_{C2} = ^C1 \cap C_2 \cap ^C3$</td>
<td>$C_2 = E_{C2} \cup E_{C3} \cup E_{C6} \cup E_{C7}$</td>
</tr>
<tr>
<td>$P(E_{C2}) = P(^C1) \cup P(C_2) \cup P(^C3)$</td>
<td>$P(C_2) = P(E_{C3}) \cap P(E_{C7}) \cap P(E_{C6}) \cap P(E_{C5})$</td>
</tr>
<tr>
<td>$E_{C3} = ^C1 \cap C_2 \cap C_3$</td>
<td>$C_3 = E_{C1} \cup E_{C3} \cup E_{C5} \cup E_{C7}$</td>
</tr>
<tr>
<td>$P(E_{C3}) = P(^C1) \cup P(C_2) \cup P(C_3)$</td>
<td>$P(C_3) = P(E_{C5}) \cap P(E_{C7}) \cap P(E_{C6}) \cap P(E_{C4})$</td>
</tr>
<tr>
<td>$E_{C4} = C_1 \cap ^C2 \cap ^C3$</td>
<td>$C_4 = E_{C4} \cup E_{C6} \cup E_{C7}$</td>
</tr>
</tbody>
</table>