TOWARDS A SEMANTICALLY RICH BUSINESS MODELLING LANGUAGE FOR THE AUTOMATIC COMPOSITION OF WEB SERVICES

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As part of the construction of a Europe-wide Digital Business Ecosystem, in this paper we begin to ask several questions about how SMEs, their business processes and the services they rely upon can be modelled. For the purposes of this paper we will focus on the subset of SMEs that can be loosely described as software producers. The Digital Business Ecosystem (DBE) is a concept for an open-source distributed environment that can support the spontaneous evolution and composition of software services, components, and applications. Our purpose is to develop a Business Modelling Language (BML) that can be compiled into service specifications that include behaviours, functional interfaces and semantics. This approach is consistent with initiatives such as the Semantic Web,[1] to which we will indirectly contribute. In the construction of language, the DBE research follows a top-down approach that privileges business interactions in a digital ecosystem and service composition, both of which cannot take place without semantics.

We view BML as an essential link for enabling the participating businesses to communicate their requirements and their products to a distributed set of trading partners. Such a language should be simple as regards the composition of assertions. At the same time, it should have a syntax and enough semantics to allow, once compiled into a Service Description Languate (SDL), to provide interface specifications directly expressing the *definition* of SME Services, i.e. the representation of functionality without its implementation. The BML will also be capable of modelling and describing contracts and agreement between services, in order to make possible a direct and customised interaction between SMEs. The ensuing transactions, along with information, auditing, communication, and knowledge exchange, will be mediated by software services, components and agents offered by the DBE. The self-optimising properties of the software are simply another way of describing the evolutionary behaviour of a population of candidate components that is subjected to a selection pressure derived from the very same requirements. The self-organising properties, on the other hand, result from the ability of the software components to learn and to remember successful combinations of services.

The objectives of our work are similar to the effort of ebXML.[2] In fact, our starting point will be a review of the impressive amount of work that began in the mid-1990s with the definition of XML, Problem Solving Methods[3] and ontologies; that continued with the development of SOAP,[4] WSDL[5] and UDDI[6]; and that has more recently led to Web service process and modelling languages such as ebXML, XLANG, WSFL,[7] BPEL4WS,[8] WSMF,[9] etc. As regards the languages used to express service ontologies UML is a suitable candidate for knowledge representation. In particular, we refer to

[1] http://www.semanticweb.org/
[2] http://www.ebxml.org/
[3] V R Benjamins, "Web Services Solve Problems, and Problem Solving Methods Provide Services", IEEE Intelligent Systems, January-February 2003.
[4] http://www.w3.org/TR/SOAP/
[5] http://www.w3.org/TR/wsdl
[6] http://www.uddi.org/
[7] http://www-3.ibm.com/software/solutions/webservices/pdf/WSFL.pdf
[8] http://www-106.ibm.com/developerworks/library/ws-bpel/
[9] Bussler, C, Maedche, A, Fensel, D, "Web Services: Quo Vadis?", IEEE Intelligent Systems, January-February 2003. http://informatik.uibk.ac.at/users/c70385/wese/wsmf.iswc.pdf

UML class diagrams which provide a basic notation for defining classes, their attributes and the relationships between them. They can therefore be extended with the application of appropriate UML Profiles to model ontologies in an object-based manner. As regards the domain ontologies, the development of which needs increased expressive power, there already are some standards and languages that will be taken into account, such as DAML[10] or OWL[11]. As regards the syntactic layer, specific domain languages such as ebXML, XrML,[12] WSDL, WSFL will be taken into account. As regards the languages, the existing experience such as the Extended REA model[13] or the Enterprise Project[14] will be considered as starting points.

When XML started to be applied to data codification, it seemed to offer many opportunities to overcome obstacles in traditional electronic data interchange. XML disappointed such expectations because, while it provides a syntax that can be used for data transfer, tags do not contain semantics and their meaning is in general contained in XML vocabularies. This problem is more keenly felt in the e-business sector, where the lack of a scientific community capable of enforcing uniformity and of defining a common vocabulary and a shared ontology, as happens for instance in mathematics or chemistry, has led to the proliferation of XML-based e-business vocabularies. The B2B community feels that adding semantics to the syntactic definition of the information exchanged via XML could improve the efficiency and homogeneity of e-business communications. Therefore, rather than defining a new vocabulary specific to a single sector, the long-term goal of the DBE is to build an ontological layer able to guarantee interoperability and semantics to data.

To balance and support the above more theoretical work in this initial effort we will gather data from a small set of real SMEs. In particular, we will apply an existing method to model and classify different SME types[15] to software producer SMEs in the Tampere region. This coding system is based on three parameters that replace the traditional indicators of Size and Turnover and that describe an SME in terms of its fundamental characteristics and behaviour: Value generation, Growth stage, and Management structure. The knowledge collected in this activity will be expressed as two top-level meta-ontologies as bases for the primitives of the DBE Business Modelling Language and the Service Description Language.

We will build on the BML and SDL to address one of the most challenging tasks facing Web services today: their automatic composition. The work described here and underpinning the DBE project is based on the belief that this ambitious goal can most effectively be achieved by leveraging the semantically rich structures of language. In this paper, therefore, we begin to investigate how domain modelling, ontology design, taxonomies, and knowledge bases can be used to develop a semantically rich language that can be compiled into appropriate specifications of service chains. More broadly, we will also look at how ontologies, service registries, modelling languages, and P2P infrastructure can work together toward this common goal. Ultimately, we would like to endow the DBE with the ability to acquire and retain knowledge, and to interact with human users based on such higher-level constructs.

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[10] http://www.daml.org/
[11] http://www.w3.org/TR/2002/WD-owl-ref-20020729/
[12] http://www.xrml.org
[13] Guido L. Geertsa, William E. McCarthyb, "An ontological analysis of the economic primitives of the extended-REA enterprise information architecture"
[14] Mike Uschold, Martin King, Stuart Moralee and Yannis Zorgios (1998) "The Enterprise Ontology", *The Knowledge Engineering Review*, Vol. 13.
[15] Rathbone, N, "Shooting with a laser", presentation to the EC, 1994.