Ontology Engineering for Simulation Component Reuse

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ABSTRACT

Commercial-off-the-shelf (COTS) Simulation Packages (CSP) are widely used in industry primarily due to economic factors associated with developing proprietary software platforms. Regardless of their widespread use, CSPs have yet to operate across organizational boundaries. The limited reuse of CSPs is affected by the same semantic issues that restrict the inter-organizational use of software components and Web services. The current representations of Web components are predominantly syntactic in nature lacking the fundamental semantic underpinning required to support discovery on the emerging Semantic Web. We present new research that partially alleviates the problem of limited semantic interoperability and reuse of simulation components in CSPs. Semantic models, in the form of ontologies, utilized by Web service discovery and deployment architecture provide one approach to support simulation model reuse. Although specific to CSPs this work has wider implications for the simulation community.

Keywords: semantic matching; simulation and modeling IS; supply chain management; Web architecture

INTRODUCTION

Commercial-off-the-shelf (COTS) Simulation Packages (CSPs) offer an interactive and visual modeling development environment for creating computer models of existing and proposed systems as well as for experimenting with the models themselves. Simulation practitioners in industry exten-
sively use CSPs such as Simul8 (Concannon, 2003), Witness, AnyLogic, AutoMod and Arena to model their simulations. These packages allow reuse of standard simulation components like workstations, queues, conveyors, resources, and so on, thereby provide the building blocks which facilitate the creation of larger models. As these models grow larger and more complex the prospect of simulation model reuse is appealing as it has the potential to reduce the time and cost incurred in developing future models. An extension of model reusability is the concept of separate development and user groups, whereby models are developed and validated by one group and then used to specify simulations by another group (Bortscheller & Saulnier, 1992). In this article we look at the discovery and import of CSP-created models across organizational boundaries within the context of industrial supply chains, thus enabling development and user groups to exist in different organizations. This approach does not allow model information hiding between enterprises and contrasts with the distributed simulation approach to model reuse that enables an organization to hide model specific information and data from the other participants.

Supply Chain Management (SCM) consists of a series of tasks such as manufacturing, transport and distribution that are undertaken by organizations with the aim of delivering products to their customers. Simulation of the supply chain can identify manufacturing bottlenecks, resources required for on-time delivery, adequate stock levels for distribution, and so on and help to improve the performance of the underlying supply chain. Each organization that forms a part of the supply chain normally develops models that simulate their own part of the supply chain using CSPs (Fujimoto, 2000). Assuming that all necessary individual simulation components are available then the question is how to link them together. Distributed simulation offers one such solution. Distributed simulation can be defined as the distribution of the execution of a single run of a simulation program across multiple processors (Taylor, Sudra, Janahan, Tan, & Ladbrook, 2001). It allows each organization to run its model within its own site (thereby encapsulating model details within the organization itself) and participating with other sites through information exchange using distributed simulation middleware (Gan, Liu, Jain, Turner, Cai, & Hsu, 2000). Boer, Verbraeck, and Veeke (2002); Mertins, Rabe, and Jaekel (2000); Gan, Yoke, Low, Wang, and Turner, (2005); and Mustafee and Taylor (2006) are examples of successful distributed simulation using CSPs. There is a growing body of research dedicated to creating distributed simulation with CSPs and the High Level Architecture (HLA), the IEEE 1516 standard for distributed simulation. In an attempt to unify this research, the COTS Simulation Package Interoperability Product Development Group (CSPI-PDG), a Simulation Interoperability Standards Organization (SISO) standardization group, began operation in October 2004 (http://www.csip-pdg.org/).

The distributed simulation approach to achieving reusability in the context of CSPs faces the following challenges: (1) A lack of widespread demand for distributed simulation in industry has meant that the CSP vendors have not currently incorporated distributed simulation support into their products. Consequently, the organizations that want to use this approach do not have readymade solutions; (2) Research projects that create CSP-based distributed simulation do not have access to the source code and...
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