AN EXTENSIBLE MARKUP LANGUAGE (XML)-BASED SOFTWARE ARCHITECTURE ENABLING MODEL FUSION FOR THE BATTLE INFOSPHERE

University of Florida

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AN EXTENSIBLE MARKUP LANGUAGE (XML)-BASED SOFTWARE ARCHITECTURE ENABLING MODEL FUSION FOR THE BATTLE INFOSPHERE

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XML (eXtensible Markup Language) is the ubiquitous low-level language of the World Wide Web, and forms the primary structure for the emerging Semantic Web. The Semantic Web is the vision, and ongoing implementation, of how the web will transform over time to connect disparate pieces of knowledge, data, and resources. Our purpose in this contract was to create a foundation for the Semantic Web, suitable for deployment within the Air Force Infosphere project. The concept behind the Infosphere is one of rapid data and knowledge interchange, between physical objects, models, and computational processes. In our work, we created two XML schemas, defining two applications: MXL and DXL. MXL (Multimodeling eXchange Language) defines dynamic system models at a fairly high level of abstraction, and DXL (Dynamics eXchange Language) defines a low-level, block-oriented, language for a wide variety of simulation applications. With initial results in 2001, these two languages represented the first thorough implementations of XML in simulation, and they led the way to subsequent, higher level ontology studies.
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ACKNOWLEDGMENTS

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CONTRACTUAL ITEMS

The following items are specifically requested in the contract, and are addressed below:

1. **Accomplishments compared to goal objectives**: the accomplishments far exceed the original goal, which was to create an XML “presence” for use in the battle infosphere. We not only created two XML languages, schemas, and implementations around them, we also have extended this work to ontology definitions and use in the user interface. We constructed a comprehensive 3D dynamic model authoring environment, linking dynamic model with geometric model components.

2. **Reasons why established goals were not met if appropriate**: N/A.

3. **Cumulative list of publications**: see the Results & Discussion section.

4. **List of professional personnel**: Paul Fishwick (PI) and students. Students are listed toward the end of this report. Requested info for the PI is PhD Computer and Information Science, University of Pennsylvania, 1986. Thesis title: “Hierarchical Reasoning: Simulating Complex Processes over Multiple Levels of Abstraction”.

5. **Papers presented at meetings**: See the comprehensive list under Results & Discussion.

6. **Consultive and advisory functions**: N/A.

7. **Inventions and Patents**: The software that we have constructed (SimPackJ, SimPackP, and RUBE) is open source.

INTRODUCTION

For the past four years, we have developed a software framework called RUBE. RUBE’s purpose is to provide a modeler with a way in which to better integrate the phenomenon being modeled and the model itself. This integration is done using multiple visual modes of display, allowing the dynamic models, as well as the phenomena, to be displayed in 3D. Figure 1 displays the RUBE architecture. Our use of ontologies within the RUBE project is founded on two approaches: (1) schema definitions and XML files for model types and model files; and (2) an OWL representation of a sample air reconnaissance scene. We proceed with these in sequence.

RUBE begins its process with two types of interfaces: a 2D interface using the SodiPodi tool, and a 3D one using Blender, which is a tool for authoring and animating 3D scenes. The simulation analyst builds a scene to be simulated, and then builds dynamic models of that scene. The dynamic models are translated into MXL (Multimodel eXchange Language). MXL contains an ontology (or XML schema) defining certain model types and how they are defined. For example, a Finite State Machine contains an initial state, a set of states, and transitions. DXL (Dynamics eXchange Language) is a lower-level homogeneous block-model language capable of describing both synchronous and asynchronous execution of block networks. As such, DXL networks reflect behaviors such as those found in digital circuits as well as more loosely connected data flow networks. Both MXL and DXL are XML languages. Each has a schema, defining the language as an ontology.

Returning to the process defined in Figure 1, a model is converted into MXL and then DXL, and finally into a target language such as Java or Javascript. This Javascript code is then reinserted into the scene. This is done by first exporting the Blender scene into an X3D (eXtensible 3D) file and then defining the Javascript in X3D script nodes. The final X3D scene file, intact with both geometric and dynamic properties, is then executed to yield the simulation. In addition to the work performed in RUBE, we have recently started to create an ontology that attempts to bring all knowledge about an application domain together. Figure 2 shows a network relating elements of a scene (JSTARS, F15, and UAV) with the geometry and dynamics of
these objects we have listed the defined styles that might be required during the formatting process. The idea here is that we can use RUBE to generate objects, that are then updated in the ontology. Moreover, we can add to the ontology manually, if necessary, to express the semantic relations. We are using OWL for expressing the network, and the Stanford Protégé tool for managing the links. There is a two-way connection between Blender and Protégé so that information can be entered in Protégé and then appear in Blender, and vice versa.

Figure 1: RUBE Framework, from Interface to Code Generation
Figure 2: An Ontology Defining an Air Battle Scene with Reconnaissance and Surveillance Aircraft
RESULTS & DISCUSSION

This contract has resulted in a comprehensive set of published results which are defined below. We list the books completed, archival journal articles, and conference articles published. The contract also permitted three students to earn their doctoral degrees.

Multimedia Collections

- Paul A. Fishwick, Dynamic Systems Modeling, 3 CDs overviewing the nature of dynamic models, and why they are created.

Books


Archival Journal Articles


**Refereed Conference Articles**


• Barton, Russ, Fishwick, Paul, Henriksen, James, Sargent, Robert and Twomey, Janet
``Simulation - Past, Present, and Future'', Proceedings of the 2003 Winter Simulation
Conference, S. Chuck, P. J. Sanchez, and D. J. Morrice, Editors, New Orleans, December
2003.

• Miller, J. A., Baramidze, Gregory T., Fishwick, Paul A. and Sheth, Amit P., ``Investigating
Ontologies for Simulation Modeling: An Experiment with Generalized Semi-Markov
Processes'' Proceedings of the 37th Annual Simulation Symposium (ANSS'04), Arlington,
Virginia, April 2004.

• Fishwick, P.A. and Miller, J. A. ``Ontologies for Modeling and Simulation: Issues and
Approaches'' Proceedings of the 2004 Winter Simulation Conference, Washington, DC,

• Park, Minho and Fishwick, P. A. ``An Integrated Environment Blending Dynamic and
Geometry Models'' presented at the 2004 Artificial Intelligence, Simulation and Modeling in
LNAI 3397, Ed. Tag Gon Kim, pp. 574-584.