OBJECT MODELING SYSTEM - A MODELING PLATFORM

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Abstract Modeling frameworks that support simulation model development and application became more than a research topic in the academic field. Government action agencies recognize the value of frameworks to strengthen and unify modeling activities within national research and non-research programs. Model development in fields such as atmospheric research, environmental risk management, water supply forecasting, and environmental quality protection is increasingly being done within frameworks to ensure interoperability, long term maintenance, and creditability of model implementations. Over the past several years, the U.S. Department of Agriculture and the U.S. Geological Survey have been developing the Object Modeling System (OMS) as the next generation Modular Modeling System MMS (Leavesley et.al, 1996) over the past years. OMS serves as an open modeling platform for several modeling programs and activities within these agencies. This paper characterizes the major OMS tool components with their capabilities and introduces some ongoing model applications.

INTRODUCTION

The development of the Object Modeling System (David et.al, 2002) is supported by the Agricultural Research Service to address the agencies needs to (i) reduce duplication of effort in agricultural and natural resource modeling, (ii) improve the quality and currency of model code, (iii) make simulation models much easier to build, access, understand and use, (iv) facilitate long term maintainability of existing and new models, (v) increase greater consistency of modeling for particular problems and scales, and (vi) enhance response and delivery times in scientific modeling projects. By streamlining the process of model development using a modeling framework, creditability and scalability of model implementations will be ensured. Hence, the Object Modeling System was not only designed as an advanced modeling framework, it is also an integrated model development environment that offers a whole modeling tool set. It provides support for the full lifecycle of model development, starting from the model source development, individual component testing, component integration into models, model application, and deployment.

KEY CONCEPTS

The Object Modeling System was designed to enable component based modeling. Components are considered to be the scientific building blocks. They usually represent a unique concept in a model like a physical process, a management practice, or a specific data input. Their use helps to reduce the difficulty of building complex simulation models by reducing model software complexity and overcome the limitations of monolithic, highly coupled model implementations. OMS promotes the application of components as fundamental building blocks and orchestrates the interaction of scientific, control, input/output and auxiliary components. The tool set within the OMS framework was also designed around the component oriented nature of modeling.

- A *ComponentBuilder* tool allows the creation of component sources. This tool enabled the management of component source code including meta-data. Components are implemented

in the Java programming language with respect to the JavaBeans standard. However, there is also support for the automated integration of legacy code written in languages like FORTRAN and C/C++. Legacy code can be leveraged without any major rewrite.

- A *ModelBuilder* tool provides a visual interface for assembling components into models. Here, components are managed regarding their data flow requirements and meta data constraints. Model construction by component integration is the major concept for model building. A model is usually made of scientific components as well as infrastructure/auxiliary components dealing with data I/O, visualization, and control management (temporal/spatial advance, integration method, etc).
- A *ModelRuntime* tool enables the variable execution of models. This system adaptation allows the flexible integration of the OMS core system into heterogeneous application environments such as a desktop system, cluster processing, web-service environment, etc.
- A *ModelAnalysis* tool helps analyzing model performance by providing a set of scientific analysis methods. They allow statistical analysis of data, graphing of temporal and spatial data, and report functions.

The Object Modeling System is an implementation of the open source Netbeans Application Platform. Therefore the modeling specific tools are complemented by developer tools for source code development, version control, update management, or documentation/API management. The use of Netbeans enabled OMS to perform as an integrated model development environment.

APPLICATIONS

Within the USDA Conservation Effects Assessment Program (CEAP), OMS is used to develop, verify, and validate modeling methods and techniques that quantify environmental outcomes of conservation practices in major agricultural regions. It is the preferred tool for spatially and temporally distributed processed-based agricultural watershed models that will be used within the CEAP project to make local regional assessments of the impact of conservation practices in improving water quality at field, farm and watershed scales. In another effort OMS is applied to develop (i) components for a common wind and water erosion model (WWEM) for ARS that is based on WEPP and WEPPS model science (ii) and for national water supply forecasting at the NRCS National Water and Climate Center using the PRMS model (Leavesley et. al, 1983).

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