The role of the Object Modeling System (OMS) for integrated assessments of conservation on agricultural land in the United States

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Introduction

Operators of approximately 2.1 million farms, ranches, and small woodlands make daily decisions to manage a combined 1.1 billion acres of private land, about 50% of the land base of the United States. Federal and state conservation programs deliver technical and financial assistance to help operators to sustain the health of the land to maintain its productivity over the long term. Federal programs deliver about $3 billion annually to help defray the cost of installing and maintaining practices contained in the operator's conservation plan. These practices reduce erosion, control nutrient and pesticide leaching and runoff, increase soil tilth, prevent overgrazing, improve wildlife habitat, and provide other ecosystem services.

U.S. Department of Agriculture (USDA) agencies deliver conservation program services through a network of approximately 3,000 offices at the state, area, and county levels. Field conservationists work with farm operators to develop conservation plans, and the national database system contains 1.4 million active plans covering 300 million acres. These plans provide the basis for financial assistance through 200,000 active program contracts, also maintained in the system.

Up to 35 thousand conservation plans are serviced each work day. About 5,000 field conservationists use the system each week, and during peak periods, the system accommodates as high as 2,000 concurrent sessions. Each night data is summarized and processed to a data mart for daily reporting to agency managers on the progress with delivering program services. Although the system can measure this progress, it cannot yet adequately evaluate its impact on improving the health and sustainability of the land.

The 2002 Farm Bill established the Conservation Effects Assessment Project (CEAP), which uses existing stand alone agro-environmental models for evaluating program effectiveness. However, current efforts do not yet meet the CEAP vision of a consistent national integrated assessment process.

Methods

CEAP analysts at multiple locations must be able to run calibrated and certified agro-environmental models deployed to a centralized platform. Achieving an integrated assessment infrastructure for CEAP involves (1) adopting a modeling framework; (2) establishing a high performance model run-time platform; (3) creating an integrated assessment model base; and (4) provisioning data for all areas in the national assessment. The analyses performed examined recent developments in cloud computing, multi-threading support to on-line commercial applications, lightweight non-invasive programming framework technology, semantic web technology, service oriented architecture (SOA), and opportunities to leverage existing resources and capabilities within participating agencies. The findings were applied to define an improved integrated assessment infrastructure.

Results and discussion

In February, 2008 USDA agencies adopted the Object Modeling System (OMS) framework (Figure 1) to support integrated assessment, through formal agreement to manage it as part of an approved technical architecture. OMS (Ahuja et al 2005, David and Ahuja 2006) developed in Java on the NetBeans platform contains a component builder, model builder, repository, core framework services, data access and visualization tools. A Java Annotation Specification is being added to remove model component dependency on the framework API. Model components will be developed using Plain Old Java Objects (POJOs) and bound to the framework at run time. Therefore model components can be more easily adapted to other frameworks, and their longevity expected to increase.

The OMS team has defined a run-time platform that enables multi-threading and deploying models and components as services in an elastic computing cloud. The platform supports the situation when many analysts across the country run a model concurrently and the situation of the modeler spooling many model runs concurrently for sensitivity analysis.

The CEAP strategy has established the concept of a model base, containing related models and components. The integrated assessment model base contains core components from J2Ks, a combination of the J2000 and SWAT models, with components added from other models as requirements evolve. The architecture supports the CEAP analyst running models tailored to particular scenarios and region. A knowledge base will help ensure consistency in assessments across regions.

The OMS team is defining a data provisioning architecture, featuring a data mart with web services designed to support the requirements of the model base. Data stewardship responsibility will be organized by integrated assessment regions.

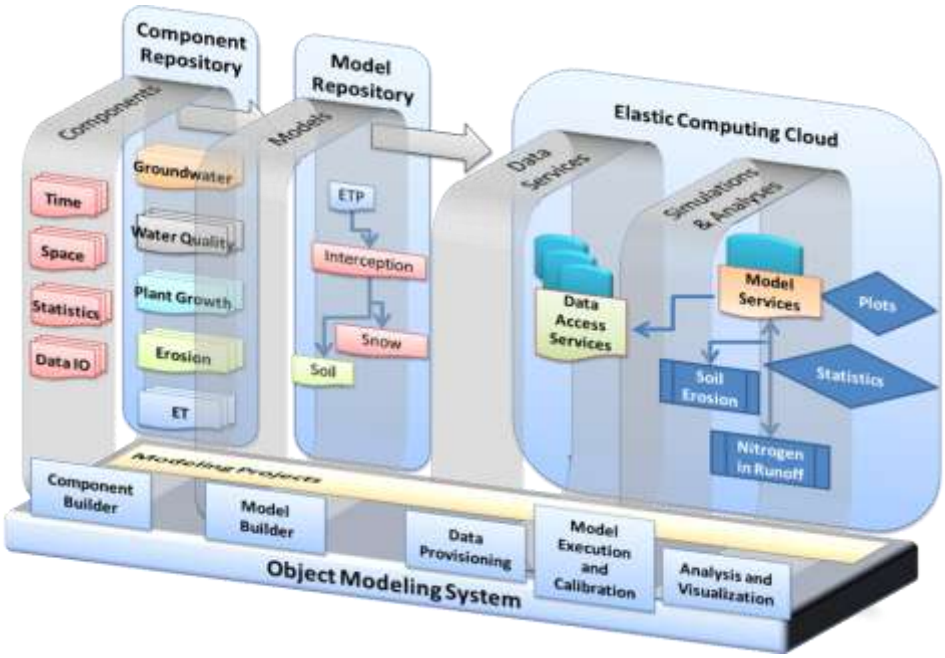

Figure 1. High-level OMS architecture

References

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