Web-Based Modeling System Using Metadata Concepts and Databases

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1. INTRODUCTION

Researchers at Drexel University, with funds provided by National Ocean Partnership Program (NOPP) and NSF have developed a Web-based modeling system, or **WBS,** that can be used for any number of codes, model domains, users, and multiple run executions. The system is comprised of a wrapper environment for legacy codes, a client-server framework, and a database that stores all modeling domain relevant data sets, including the output. The system has been applied to a 2D FEM code and modeling domain comprising the upper Potomac Estuary to demonstrate the feasibility of the concept and its ability to include legacy codes.

2. WBS OVERVIEW

Key Objectives
One of the key objectives for the development of the WBS was to use open source and open standard components so the system could i) be more easily adapted to changing technologies, and ii) be deployed free of charge. In addition, the system needed to be accessible through the web (Browser the only requirement) and also be able to accommodate several different legacy codes and model domains typical to a community modeling environment. Finally, to overcome the use of data files, the system needed to be connected to a relational data base system that managed all I/O data requests.

Metadata
Since model data is largely geo-referenced (modeling data is typically identified at grid nodes or for elements comprising the grid) the International Organization for Standardization (ISO) Geographic Information metadata norm, ISO 19115, has been chosen to describe the WBS modeling data. This standard is also attractive because of its extent and adequacy to describe geospatial data, and flexibility to extend the coverage. For better machine readability the metadata descriptions were encoded using the Web Ontology Language (OWL) web, which permitted to easily use the extension rules of the ISO 19115 for the creation of an extensive metadata profile to describe hydrodynamic modeling data.

Domain Ontology
In order to define a conceptualization of how the various data categories and variables relate to each other, we have developed an ontology, Fig. 1, whose implementation (in OWL) is actively used by the WBS to manage and track its flow of data sets.
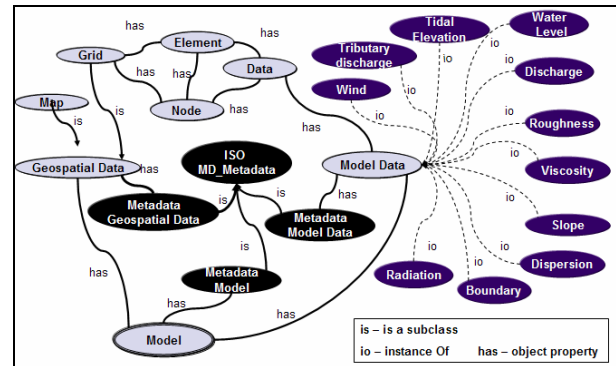

Figure 1 WBS domain ontology

There are two main classes in the ontology; the "*GeoSpatialData*" and the "*ModelData"* class. The base geospatial data set is the numerical grid, which is represented as "*Grid*" class in the ontology. Model-data includes data that is related to geospatial-data and is represented as "*ModelData*" class in the ontology. In this instance, model-data includes but is not limited to wind, discharge, velocity, water elevation, viscosity coefficient, boundary types, Manning's roughness coefficient, dispersion coefficients, tidal elevation, and tributary discharge. In addition to representing the data flow and its description within the

WBS, it is necessary to define additional metadata blocks (identified with the prefix "metadata") that concerns the model execution itself and are used to keep track of each model run within the WBS and its storage in the attached data base.

3. WBS ARCHITECTURE

Model-View-Controller (MVC)
The performance of simulation systems can be improved if the model or business logic is separated from the model views or presentation logics. This design concept has been known as Model View Controller (MVC) architecture. The MVC approach suggests to divide the system into three components (1) *Model*, (2) *View* and (3) *Controller*. A *Model* is the representation of the simulation domain; *Views* are the visual representations of the *Model*; and *Controllers* manage the user interactions with the model (Fig. 2).
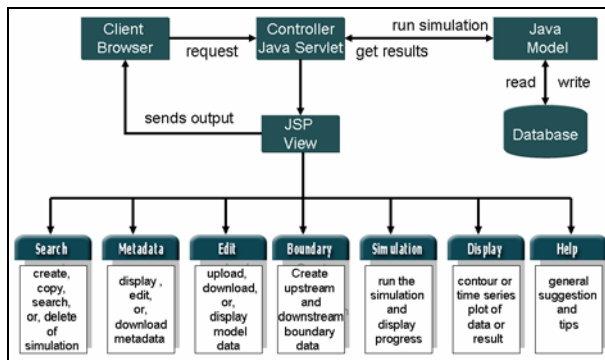

Figure 2 WBS architecture based on Model-View-Controller (MVC) concept

User Interfaces
Seven different graphical user interfaces or *Views* are registered to display the different components of the WBS system. The *Search View* is used to search for any pre-existing model run, or instance of the WBS system. The *Metadata View* is used to create, display, edit, or delete metadata for a specific hydrodynamic model run. In *Display View* mode the user can display model results as contour, vector, or as time series plots at selected points in the flow domain (Fig. 3). The *Edit View* mode permits the display, creation, edit or deletion of model data

while the *Boundary View* is used to specify the water level and discharge boundary conditions of the model run. The *Simulation View* tracks the execution of the model for the desired length of the simulation and the *Help View* provides suggestions and help to the user about the WBS environment.
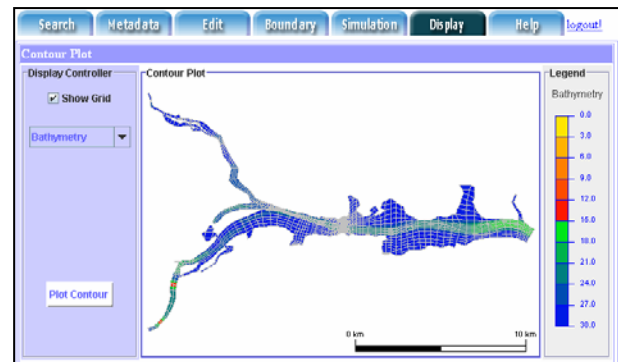

Figure 3 WBS showing the *Bathymetry*

WBS Implementation
The WBS system has been implemented on a single server machine, more specifically we are using the Apache-Jakarta TOMCAT servlet container version 5.x (JAVA Server Pages, JSP, version 2.0 and Servlet 2.4) on a SUN Microsystems SUNBlade 2000 workstation (dual 64 bit processor SPARC III) running SOLARIS 9. We selected and installed the postgreSQL (version 7.x) object-relational database management system, which is, as are the other software components we use, open source. The WBS portal and the login page is served to the client via the APACHE Web server (version 2.0.52) also installed on the same machine. Finally, all JAVA components have been developed using the JAVA 2 Standard Edition SDK version 1.4.2 (J2SE). More information can be found at:http://loki.cae.drexel.edu/wbs/

4. ACKNOWLEDGEMENTS