

## Enhancing Workflow-Driven Ontologies: A Meta Model to Create Conceptual Workflows at Multiple Abstraction Levels

### 1 Abstract

This poster presents a meta-model to construct conceptual workflows from ontologies using the Workflow-Driven Ontologies (WDO) approach. The meta-model was designed based on experiences of using the proof-of-concept WDO-It! tool in different activities involving scientists from various domains. The intention of this preliminary meta-model is to serve as a starting point for an empirical study that will seek to understand the use of abstraction techniques in combination with software engineering practices towards creating conceptual workflows. Conceptual workflows can then be used by scientists to facilitate the management and use of Cyber-Infrastructure (CI) resources to implement complex scientific processes.

### 2 Conceptual Workflows

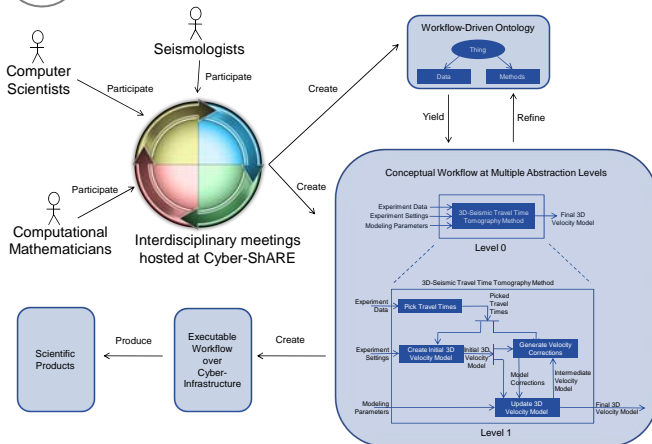


Figure 1. Creating and using a Conceptual Workflow for a Seismology application

### 3 Experiences

#### 2007 Summer Southwest Regional Cyber-Infrastructure Workshop

- Workshop hosted at The University of Texas at El Paso on August 2007
- Objective: Promote awareness about the role of CI in scientific research
- Participants included domain scientists, students, and educators from various fields of study
- Two workflow tools showcased: The Kepler Scientific Workflow Tool and WDO-It!, the proof-of-concept tool for the WDO approach
- Structured focus group conducted to identify features that worked well and shortcomings of the tools

#### The Earth Sciences Project at Cyber-ShARE

- Ongoing project housed at The Cyber-ShARE Center of Excellence
- Objective: Create sophisticated models of the subsurface of the Earth by combining models produced using multidisciplinary techniques implemented over CI
- Current participants include seismologists, computation mathematicians, and computer scientists
- The WDO-It! tool is being used to create controlled vocabularies through Workflow-Driven Ontologies, and conceptual workflows are being used to communicate among colleagues from different disciplines

#### Collaborations between NCAR and TRUST

- Ongoing collaboration between the National Center for Atmospheric Research (NCAR) group at Boulder, Colorado, and the TRUST research group at the Computer Science Department of the University of Texas at El Paso
- Objective: Document legacy systems currently used at NCAR that implement semi-automated scientific processes
- Current participants include computational scientists conducting work in atmospheric research, and computer scientists
- The WDO-It! tool is being used to create conceptual workflows that model current scientific applications with the intention of standardizing vocabularies and finding commonalities among similar applications

#### Lessons Learned

- Graphical representation of process knowledge consistently highlighted as practical by users from various disciplines
- Decision points and iteration constructs needed to express complex scientific processes
- Being able to break down workflow steps into sub-workflows or steps described at finer granularity levels eases communication among colleagues of various disciplines because it offers the opportunity of working from different perspectives
- Identifying manual steps in a workflow is important to guide the deployment efforts over CI
- Mechanisms to track provenance of executing processes is important towards adopting CI as the deployment platform

### 4 Proposed Meta-Model

A meta-model (or a model about a model) is a model about the constructs and rules used to construct a model in some domain of interest. Figure 1 shows the proposed meta-model to construct conceptual workflows from ontologies using the WDO approach.

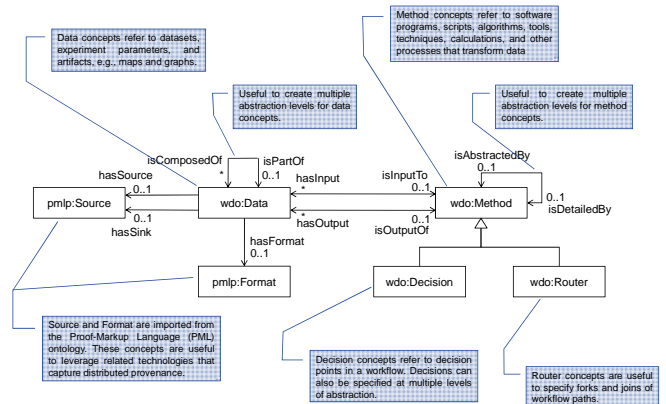


Figure 2. Proposed meta-model to enhance the WDO-It! tool

### 5 Implementation Efforts

- Implementation of the proposed meta-model using the Ontology Web Language (OWL)
- Integration of the proposed meta-model into the WDO-It! tool

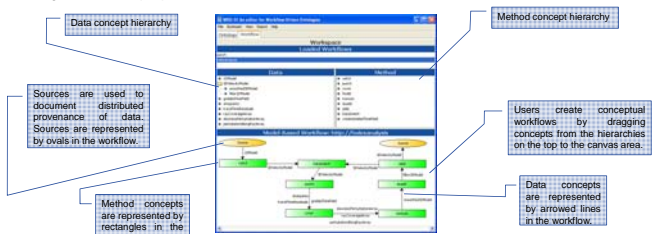


Figure 3. Snapshot of the WDO-It! tool

### 6 Ongoing Work

- Graphical notations being evaluated for new features introduced in the proposed meta-model
- Empirical study to understand the use of abstraction techniques and Software Engineering practices towards managing and using CI resources to implement complex scientific processes

### 7 References

- J. Cummings, T. Finholt, I. Foster, C. Kesselman, and K. Lawrence, *Beyond Being There: A Blueprint for Advancing the Design, Development, and Evaluation of Virtual Organizations*, final report from workshops on building effective virtual organizations, National Science Foundation, May 2008.
- L. Salayandia, P. Pinheiro da Silva, A.Q. Gates, and F. Salcedo, *Workflow-Driven Ontologies: An Earth Sciences Case Study*, *In Proc of 2nd Intl Conf on e-Science and Grid Computing*, Amsterdam, Netherlands, December 2006.
- Summer Southwest Regional Cyberinfrastructure Workshop, El Paso, Texas, August 30, 2007.
- B. Ludäscher et al., *Scientific Workflow Management and the Kepler System*, *Concurrency and Computation: Practice & Experience, Special Issue on Scientific Workflows*, 2005.
- The Geosciences Subproject at the CyberShARE Center of Excellence, El Paso, Texas [www.cybershare.utep.edu/research/gc](http://www.cybershare.utep.edu/research/gc)
- The National Center for Atmospheric Research, [www.ncar.ucar.edu](http://www.ncar.ucar.edu)
- The Trust Research Group at the University of Texas at El Paso, <http://trust.utep.edu>
- Proof Markup Language (PML) Primer, Inference Web Group, [www.inference-web.org/2007/primer](http://www.inference-web.org/2007/primer)