ODM Application to Ontology Domain Modeling

ONISTT/ANSC

Presentation to OMG Semantic Technology Information Day
Reginald Ford, SRI International
March 26, 2009
Agenda

- Background – ONISTT/ANSC ontologies and Analyzer
- Why do we need UML to assist in ontology modeling?
- ODM applied to ONISTT/ANSC modeling
- Next Steps
ONISTT/ANSC

- **Open Net-centric Interoperability Standards for Training & Testing (ONISTT)**
  - DUSD/R-RTPP (Training Transformation)
- **Analyzer for Net-centric System Test Confederations (ANSC)**
  - USD/AT&L-TRMC (S&T Portfolio)
- **Objective**
  - Facilitate planning T&E and training events that employ improvisational Live, Virtual, and Constructive (LVC) confederations
- **Approach**
  - Adapt technology emerging from the *Semantic Web* initiative (sponsored by the World Wide Web Consortium [W3C]), to extend the currently envisioned NCO/NCDS capabilities
Purpose-Aware Interoperability

If the Capabilities Available provide a “reasonable match” to the Capabilities Needed, Interoperability may be achieved

Otherwise \( \Rightarrow \) Interoperability is problematic
However . . . The ONISTT Approach Requires Not Just One Macro-Scale “In-Balance” Assessment
But Rather 100s (possibly 1,000s) of Micro-Scale “In-Balance” Assessments of Various Kinds
ONISTT: Ontology Development and Knowledge Capture Phase

1a. Develop referents for training/testing events, tasks, and environments

1b. Develop referents for LVC systems, capabilities, and quality metrics

2. Develop ontologies to express pertinent characteristics of referents necessary for machine reasoning about interoperability

3. Populate Knowledge Bases on the basis of ontologies and information in referents

- **Tasks**
- **Roles**
- **Capabilities needed**
- **Task constraints**

- **Resources**
- **Capabilities**
- **Domain knowledge**
ONISTT: Analyzer Employment Phase

1. Training/Testing Planner uses Knowledge Bases to
   a) Define Taskplans
   b) Propose candidate Confederation(s) (full or partial)

2. Analyzer uses information in Knowledge Bases to
   a) Assess given Confederation or
   b) Generate possible Confederations from Resource Pool

3a. Return notification of failed verification. Back to Step 1

3b. Return verified Confederation(s) and Configuration Artifacts

Deployment Knowledge Bases
- Resource pools
- Confederations
- Taskplans
- Role assignments
- Task constraints

Task Knowledge Bases

Resource Knowledge Bases

Analyzer Decision

Verified Confederation(s)

Configuration Artifacts
Analyzer Implementation

Descriptions of:
- Test events
  - Tasks, roles, interactions,
  - capabilities needed
- Resources/systems
  - Capabilities, subresources

- Manage access to distributed KBs
- Coordinate KB queries and updates
- Transform KB requests and responses
- Create/delete KB
- Open/query KB
- Update/delete facts

- Verifying role → resource assignments
- Generate role → resource assignments
- Complete task plans
- Discover interoperability issues
- Discover test coverage issues
- Create configuration artifacts

• Prompt user for missing elements of test event setup
• Automatic checks of consistency/completeness as specifications are developed
• Formulate problem for Reasoning Engine
• Formulate Reasoner results for presentation in UI

- Wizards supporting test event setup
- Specialized views to browse test events (task plans), candidate solutions, resources, etc.
- Visualization of ontologies
- Intuitive look and feel

KB = Knowledge Base
UI = User Interaction
Referent and Ontology Description Languages

• Referents
  • Natural language
  • UML (Unified Modeling Language)
• Ontologies/Knowledge bases (KBs)
  • OWL (Web Ontology Language)
  • SWRL (Semantic Web Rule Language)

Bridging between UML and OWL

• ONISTT team (SRI, PivotPoint, Sandpiper) developed OWL “profile” for UML per ODM
  • Implemented in Enterprise Architect (EA) and MagicDraw
  • Recommendations were adopted by the OMG as improvements to the ODM specification
• Mapped ONISTT ontology scenario-related concepts (task, role, interaction) to UML activity diagram elements
Protégé editor - hard to follow relationships among concepts
Ontologies/KBs for Demo #1

- **Namespace: [www.onistt.org/ontology](http://www.onistt.org/ontology) (onistt)**
  - /onistt: onistt
  - /task: task, taskplan
  - /capability: imagery_capability, motion_imagery_capability, mdr_capability, communication_capability, cc_capability, tspi_capability, isr_capability, weather_capability
  - valueset
- **Namespace: [www.onistt.org/ontology](http://www.onistt.org/ontology) (domain)**
  - /quantity: quantity, engineering_value, engineering_unit, iec8000-13
  - /imagery: imagery, motion_imagery, h264, iso13818, misp, smpte
  - /communication: communication, architecture, dis, dis_pdu, dis_protocol, tena, usmtf
  - /behavior: behavior, protocol
  - /environment: weather
- **Namespace: [www.onistt.org/examples/video](http://www.onistt.org/examples/video)**
  - resources, task, taskplan, testing
And it’s worse with individuals
Ontology Definition Metamodel (ODM)

- ODM is Object Management Group’s standard for model driven ontology development
- Adopted as an OMG standard in October 2006
- A family of metamodels
  - Supports exchange of models developed independently in different modeling languages
  - Provides standard profiles for ontology development in UML
  - Enables consistency checking and validation of models in general
- Grounded in formal logic enabling reasoning engines to understand, validate, and apply ontologies developed using the ODM
- Sandpiper Software is a primary editor & Ontology PSIG co-chair
- Other contributors include NIST, Raytheon, IBM, Adaptive, HP, No Magic
Top-Level Description of ANSC Demo #1
January 2009

- Demonstrated an automated tool with a capability to perform reasoning about:
  (a) A collection of complex functions that need doing
  (b) A pool of resources available for doing them
- The tool synthesizes various combinations of resources from the pool as candidate confederations for performing the functions, and:
  (a) Rank the goodness of the candidate confederations
  (b) Identify the issues that led to those rankings
- The Analyzer is a general solver needs-resources problems
  - No special-purpose software related to the “content” of the demo
  - Demo driven by information captured declaratively in the KBs
  - Analyzer was applied to a blood transfusion compatibility example without changing a single line of code
Another View of Task/Taskplan Relationships

- Task
  - AbstractTask
    - Can add new args
    - Refining task must have all the args of the refined task

- CompositeTask
  - Invocation arg list must be composed of individuals that are in the Composite arg list

- TaskInvocation
  - InvokedTask
    - If the same primitive task is invoked for both ends of an interaction, you need a task invocation individual for each
Classes used in role assignment synthesis
Individuals used in role assignment synthesis
Recording standards full coverage capability constraint assignment

One or more of the tested recording standards is not supported by the video provider.

The analyzer finds that ProvideVideoCapability is a capability needed of the ProvideVideo Task.

The image shows a UML class diagram with relationships and constraints between classes and instances. The diagram illustrates how recording standards full coverage capability constraint is assigned and constrained tasks.
Motion imagery capability and recording standards constraint
Comparing apples and oranges standards: Some video compression standards
Objective: Test all recording standards supported by VideoNSUT1

The Video Provider should support some of these: {2MPEG-2MP_ML, SMPTE259M, SMPTE274M, SMPTE292M, SMPTE294M-2001, SMPTE295M, SMPTE296M-2001}
UAV1 - Apples and apples

- UAV1 has MPEG-2 MP@ML in common with VideoNSUT1
UAV2 – Apples and oranges (1)

- UAV2 appears not to support any of these, but it satisfies the constraint. Why?
- Because a mapping rule indicates the correspondence between two standards: UAV2’s MISP-L4M and the MPEG-2MP_ML
  - The mapping rule uses the applicableStandard property
For UAV3, another rule finds that MISP L11 extends MISP L10M, and MISP L10M extends MISP-L4M.

- The extends rule uses the extendsRecordingStandards property.
- Then the mapping rule is applied as for UAV2.
Task scenario
Looking Forward

- **Auto-translation OWL->UML and UML->OWL**
  - Will likely result in broader range of OWL language elements expressed in our diagrams (e.g., restrictions, namespaces)

- **Visual notation for rules**
  - E.g., mapping to the UML Profile for Production Rule Representation (PRR) with extension for RIF/SWRL

- **Automatic translation of behavioral (activity) diagrams**
  - Specific mapping from scenario pattern to ONISTT ontology concepts (Task, Role, Capability)
  - Outside purview of ODM