ODM Application to Ontology Domain Modeling

ONISTT/ANSC

Presentation to OMG Semantic Technology Information Day

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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

Capabilities Needed →

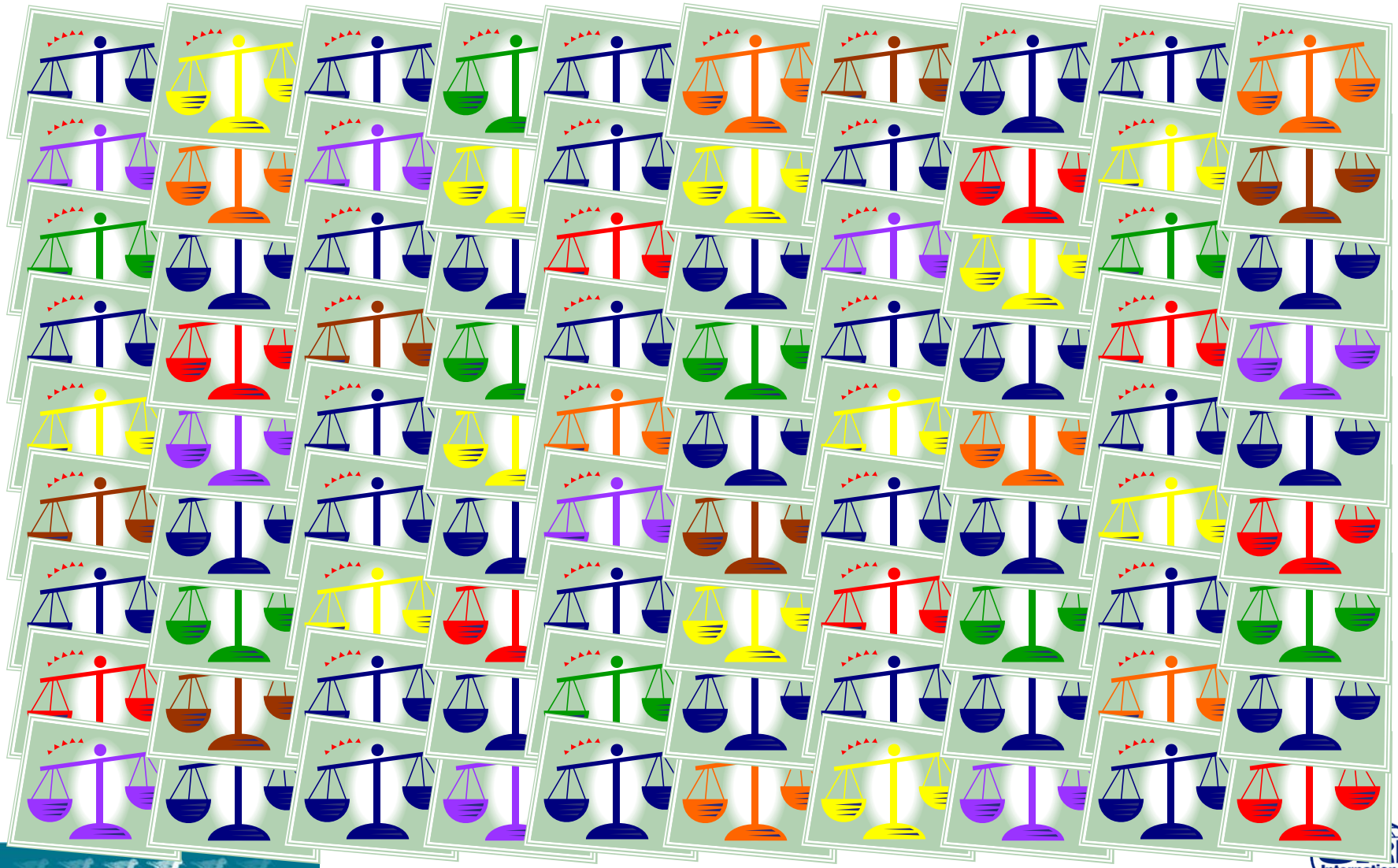
← **Capabilities Available**

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

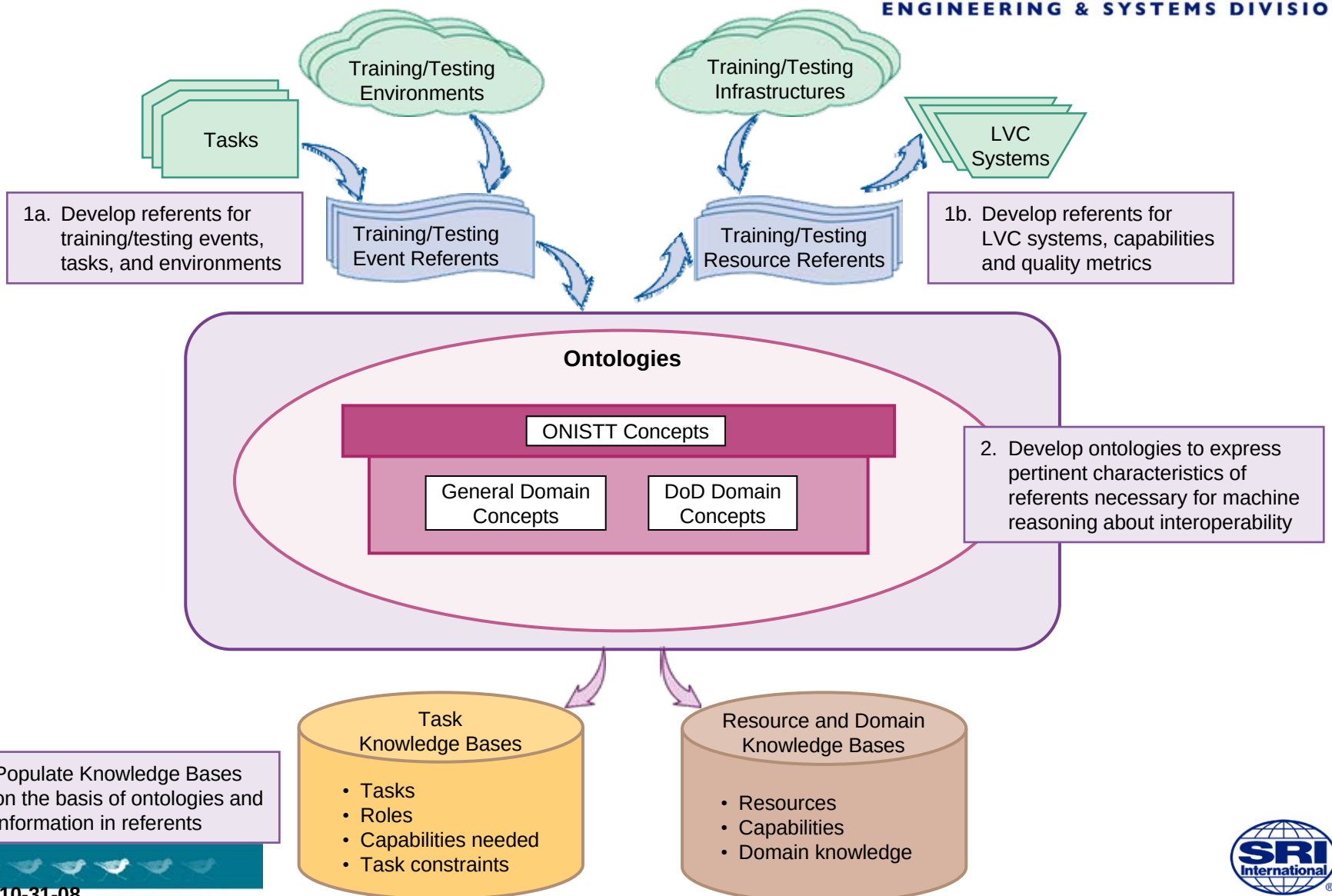
Otherwise ➔ Interoperability is problematic

However . . . The ONISTT Approach Requires Not Just One Macro-Scale "In-Balance" Assessment

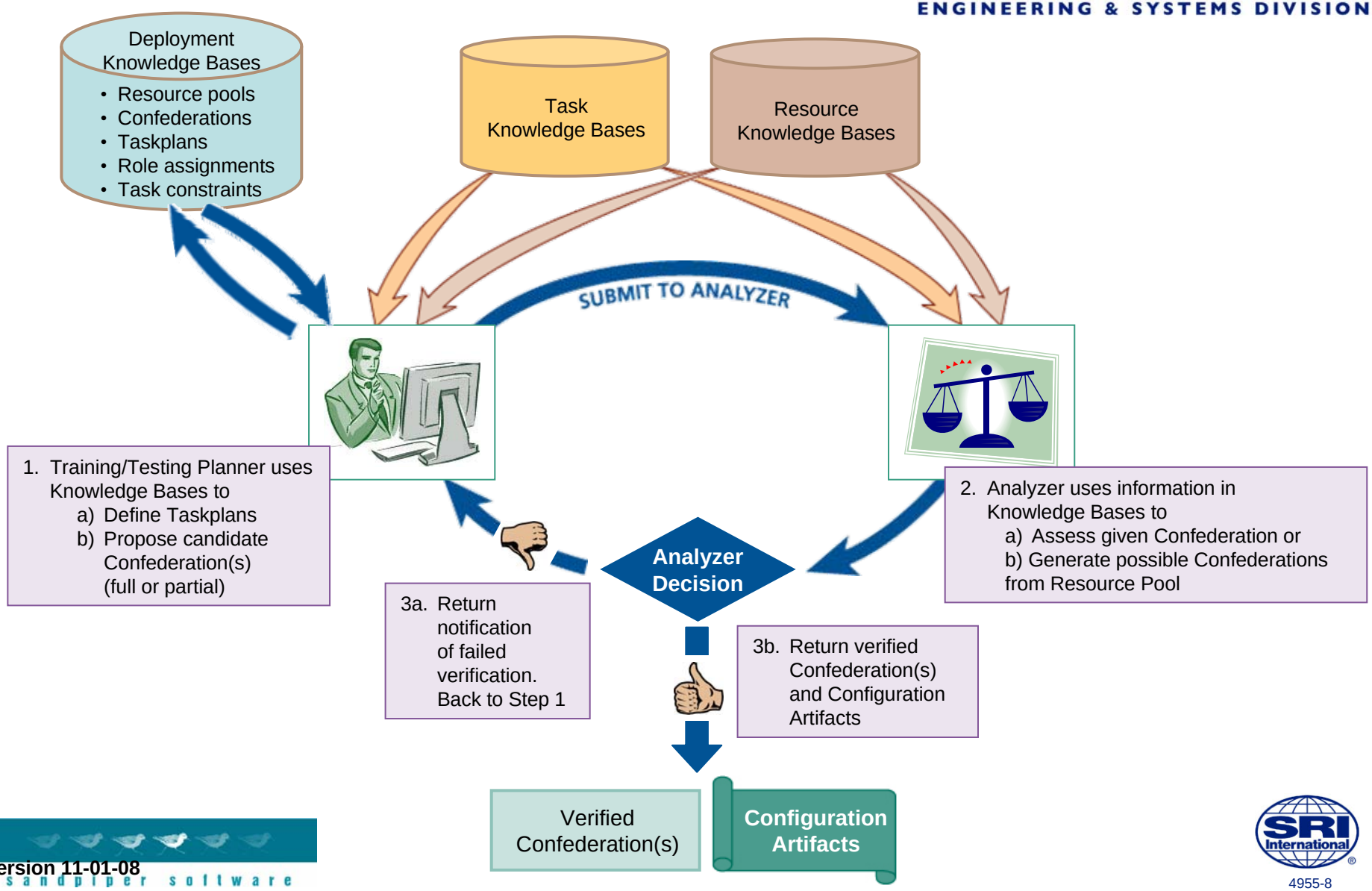
But Rather 100s (possibly 1,000s) of *Micro*-Scale "In-Balance" Assessments of Various Kinds



ONISTT: Ontology Development and Knowledge Capture Phase



ONISTT: Analyzer Employment Phase



Analyzer Implementation

- 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

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

Test Event Planner

Java Virtual Machine

UI Manager

Problem Formulation Assistant

KB Manager

OWL/Prolog Translator

Reasoning Engine

Prolog Environment

API

KB

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

- Manage access to distributed KBs
- Coordinate KB queries and updates
- Transform KB requests and responses

- Create/delete KB
- Open/query KB
- Update/delete facts

Descriptions of:

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

KB = Knowledge Base
UI = User Interaction

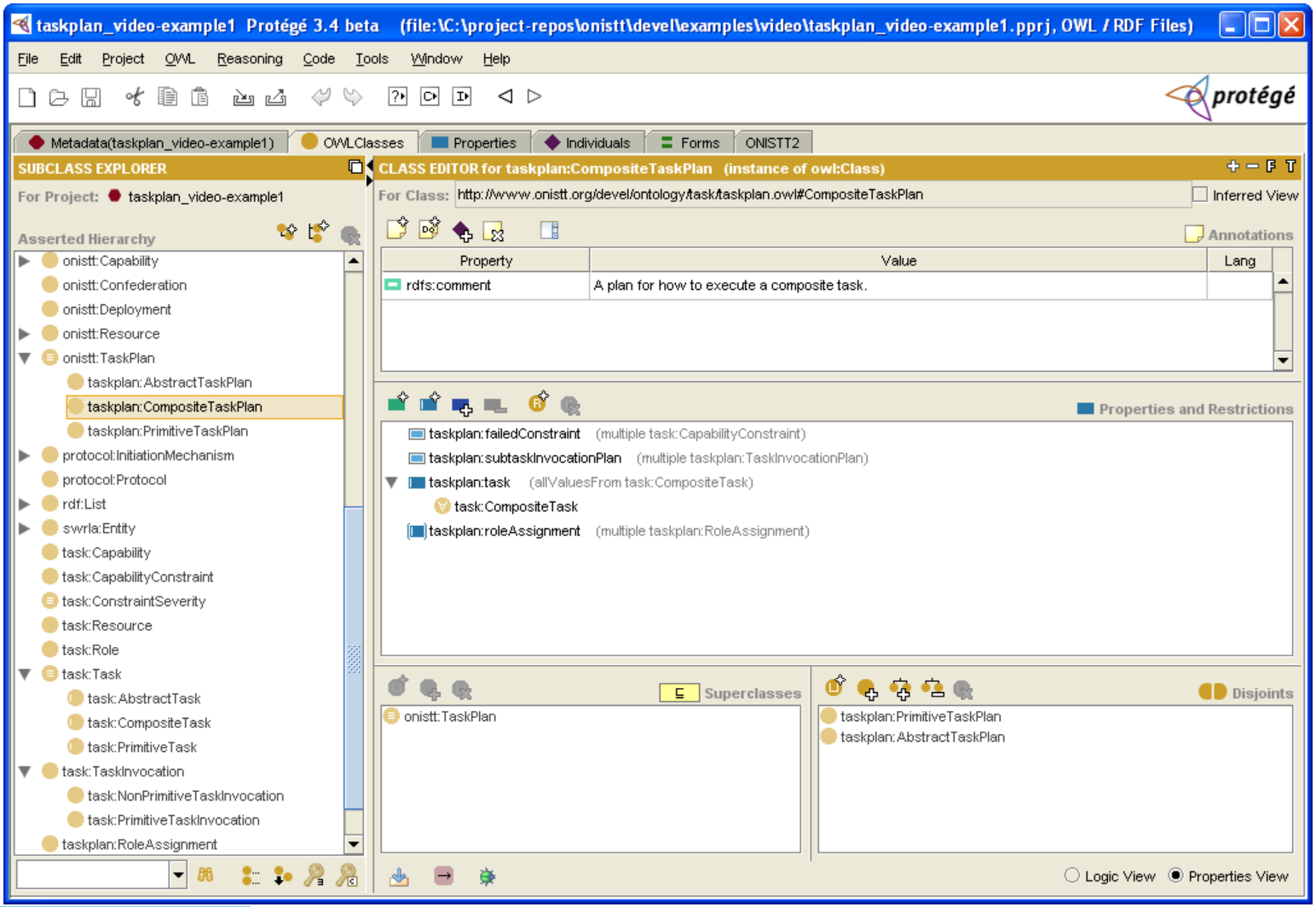
Referent and Ontology Description Languages

- **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

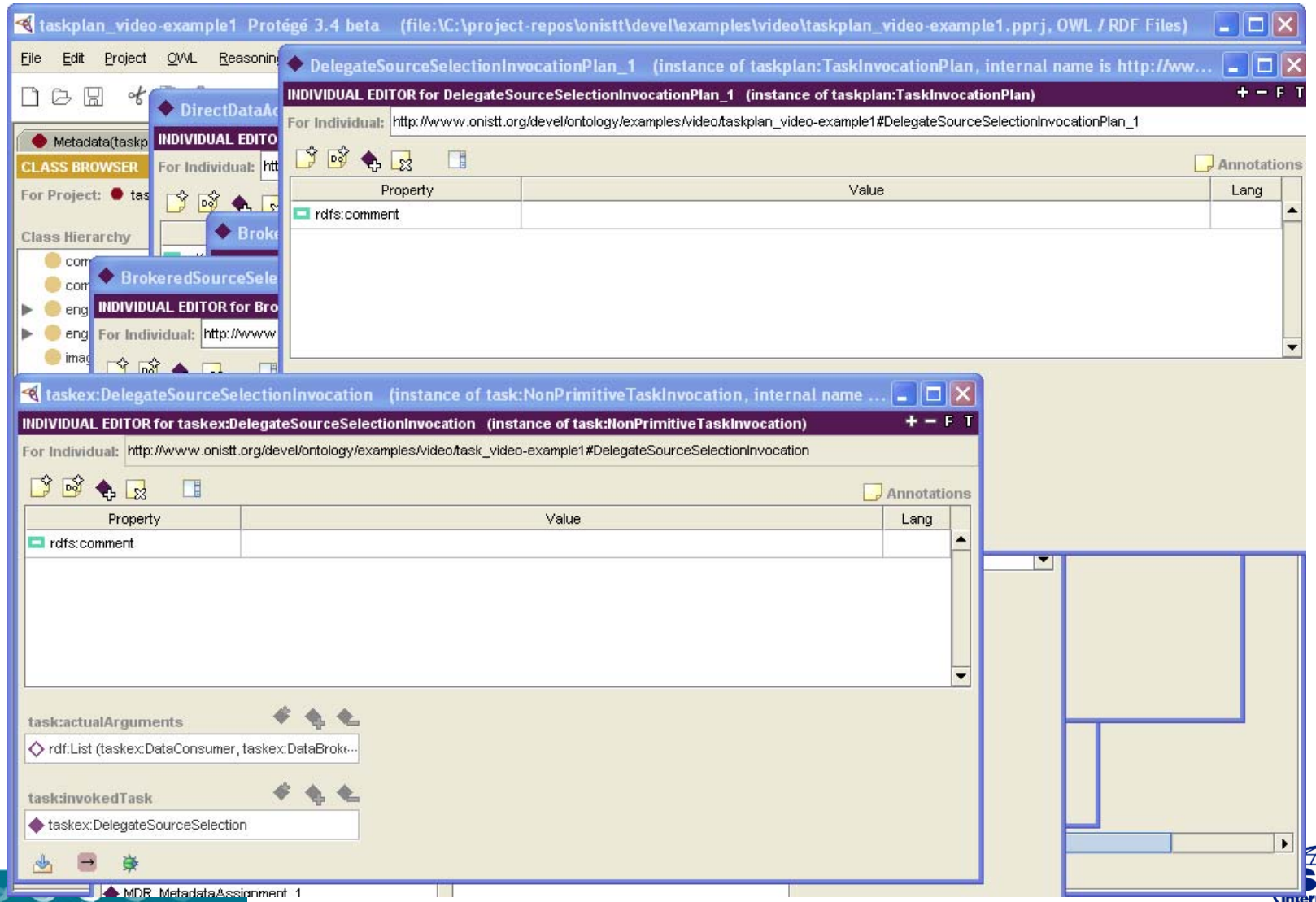
Protégé editor - hard to follow relationships among concepts



Ontologies/KBs for Demo #1

- **Namespace: www.onistt.org/ontology (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 (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**
  - resources, task, taskplan, testing

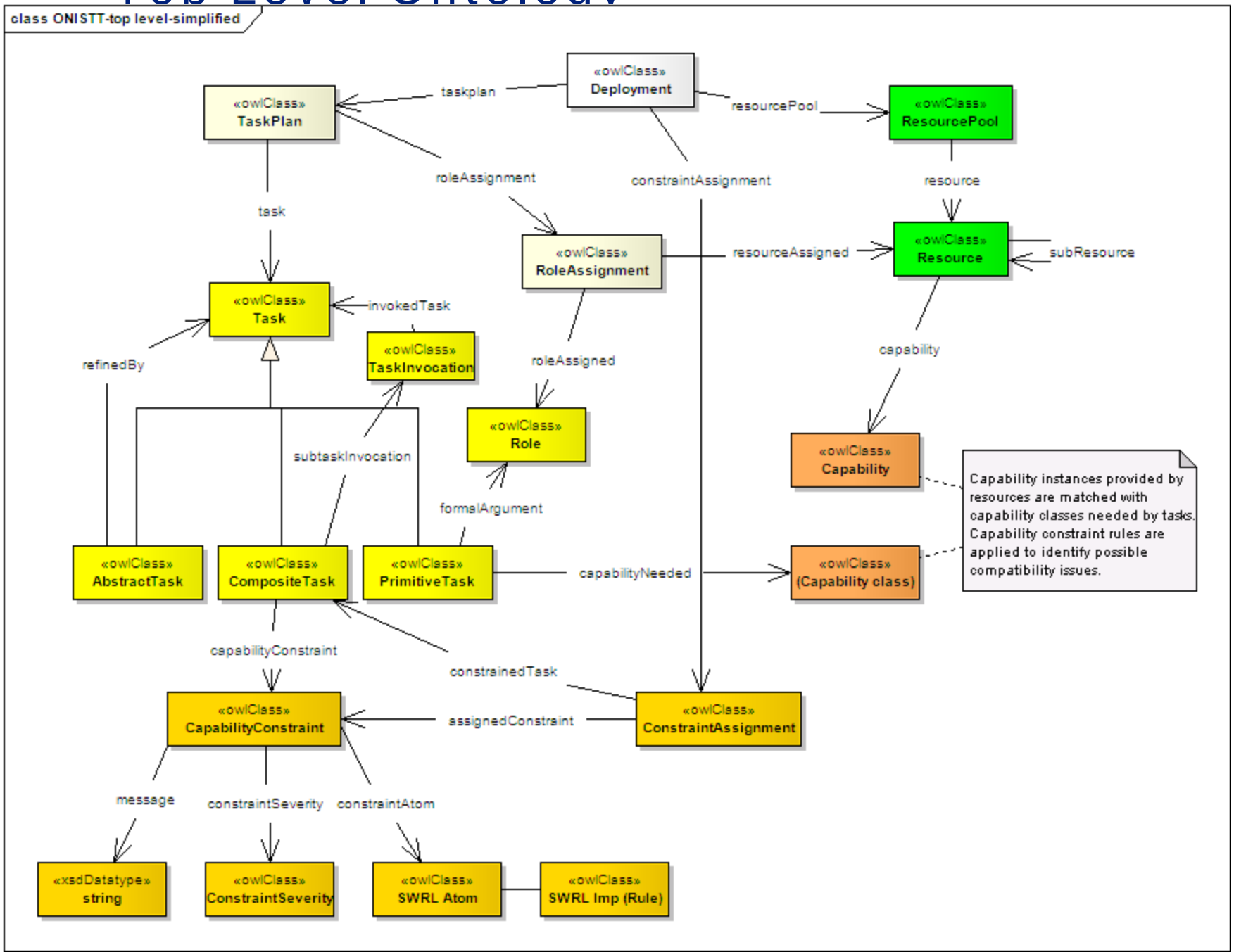
And it's worse with individuals



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**

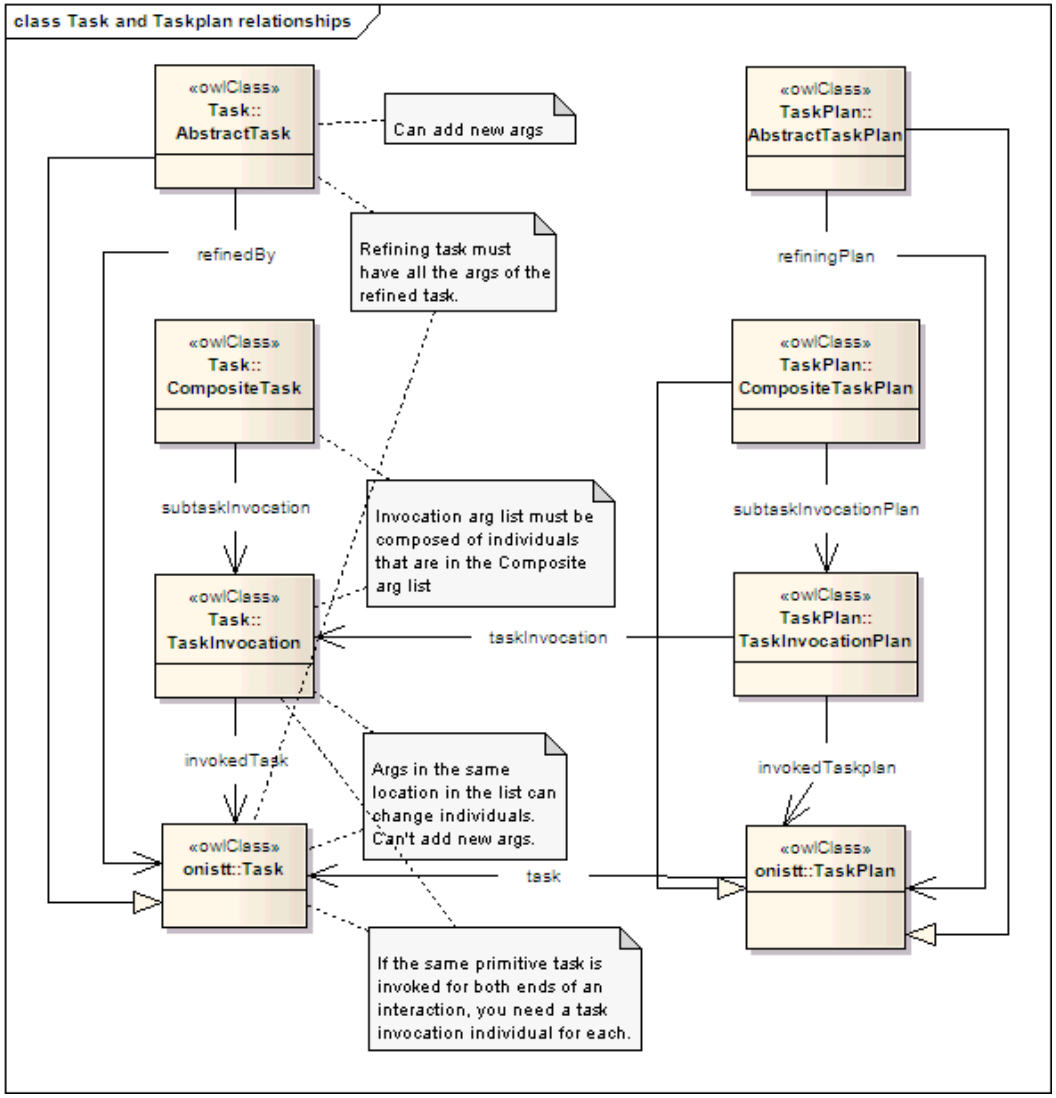
Top-Level Ontology



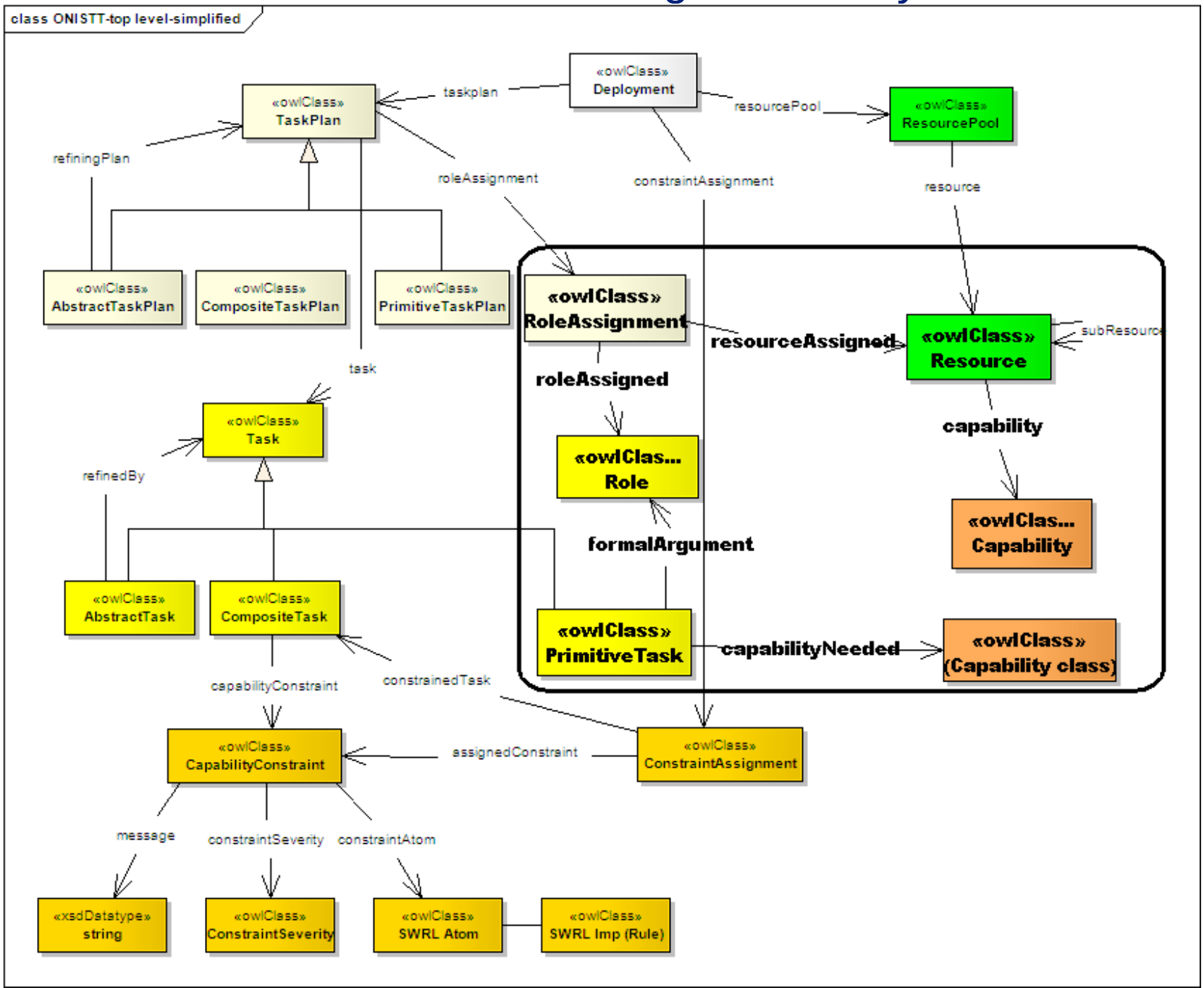
Top-Level Description of ANSC Demo #1 January 2009

- **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

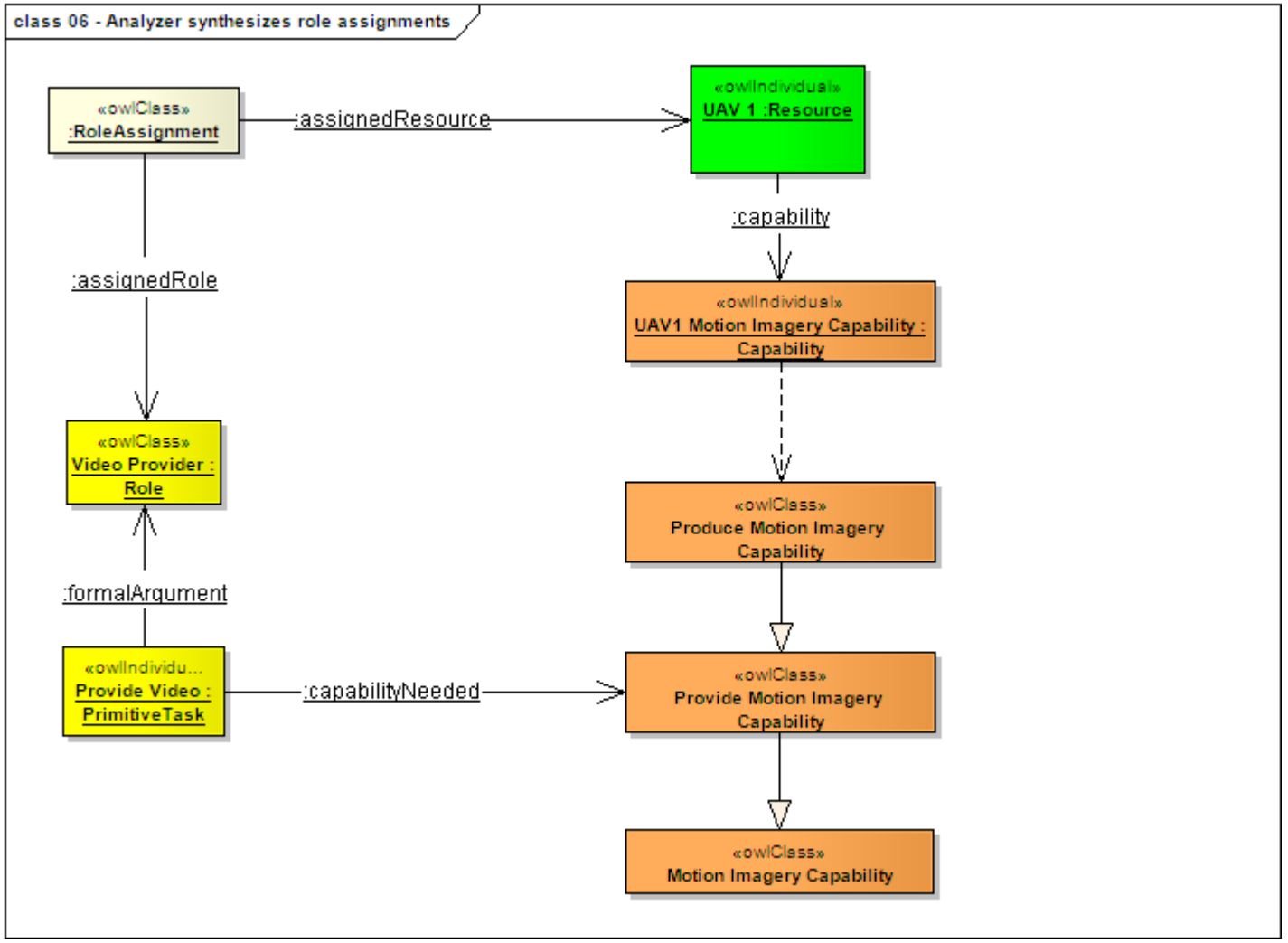
Another View of Task/Taskplan Relationships



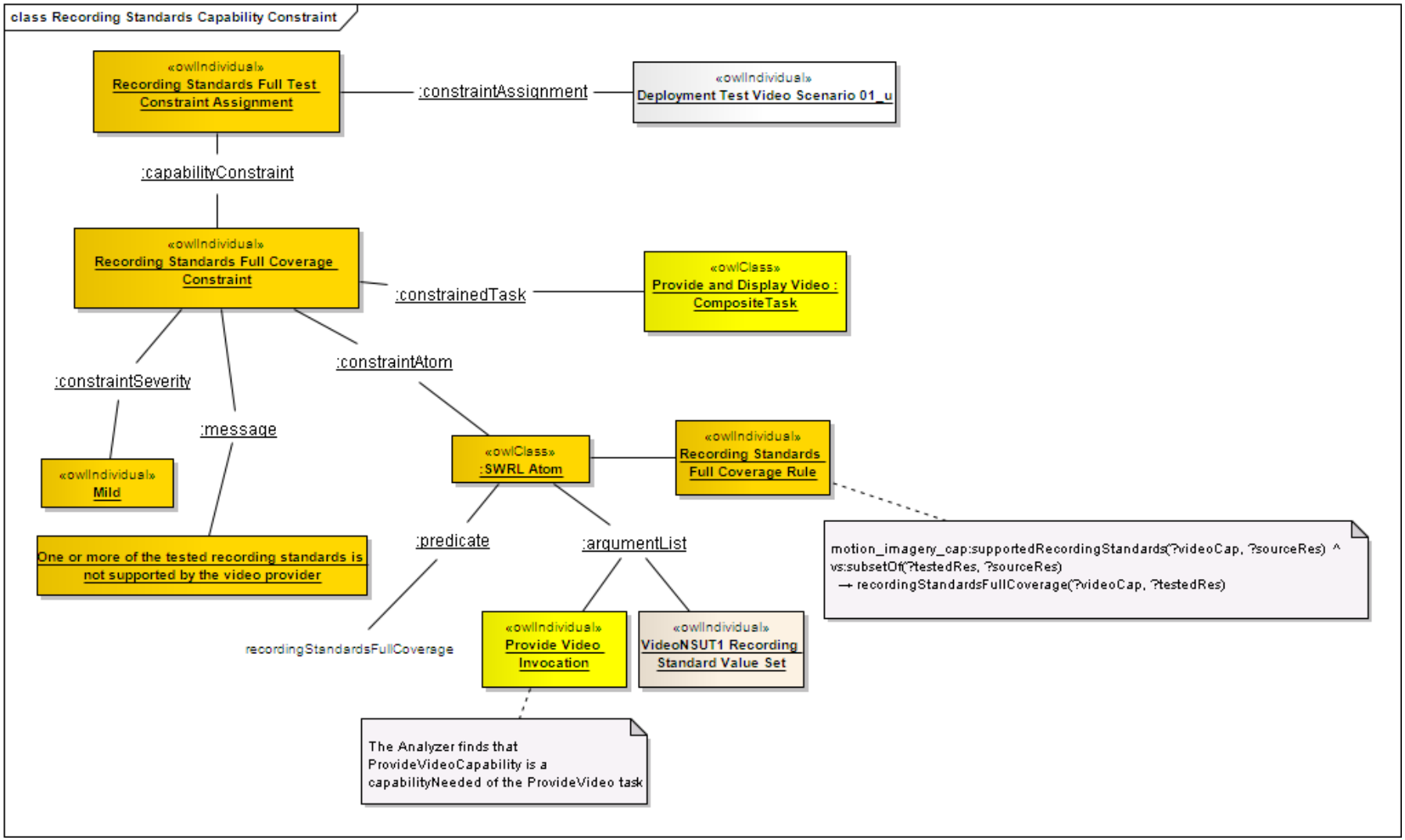
Classes used in role assignment synthesis



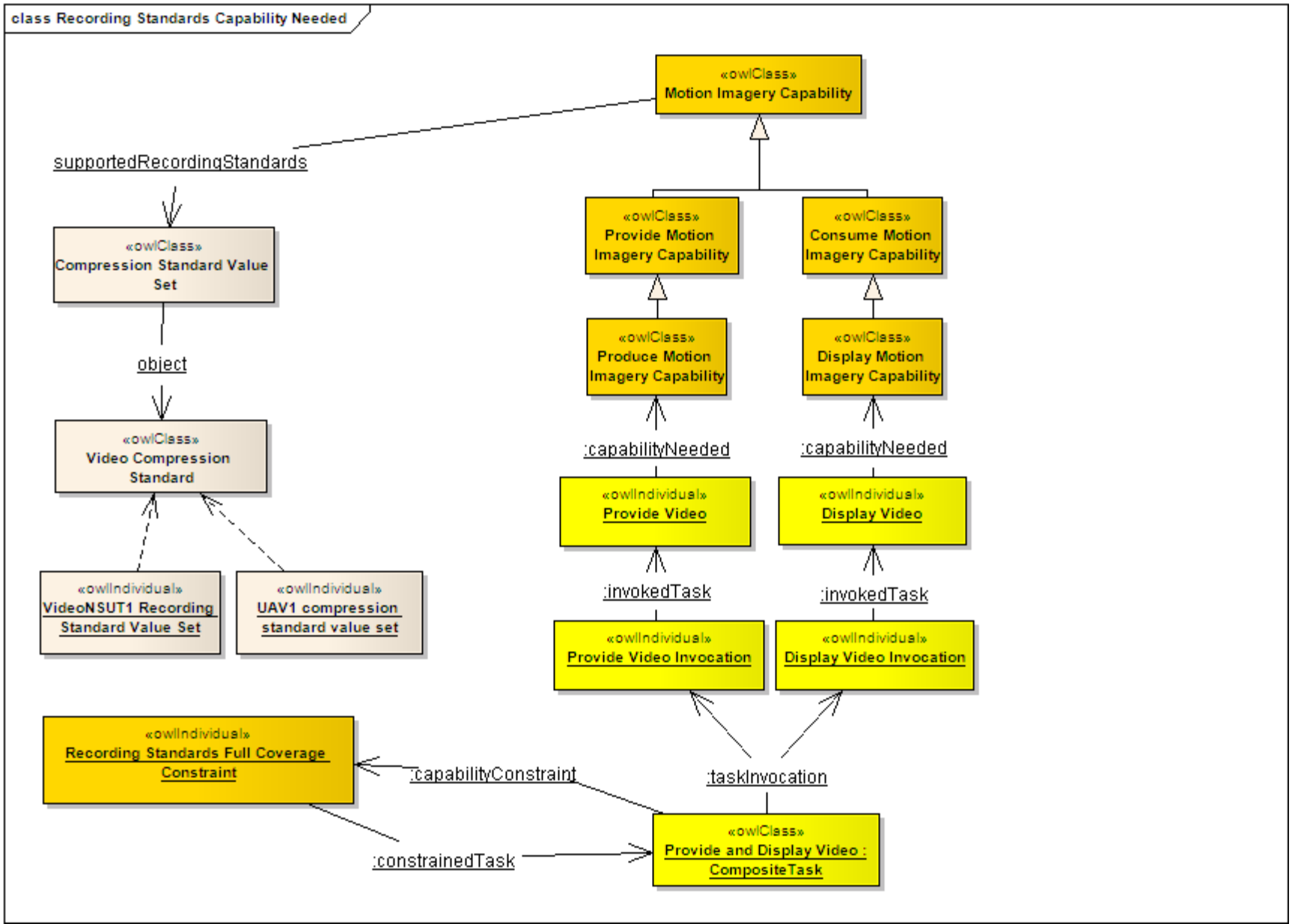
Individuals used in role assignment synthesis



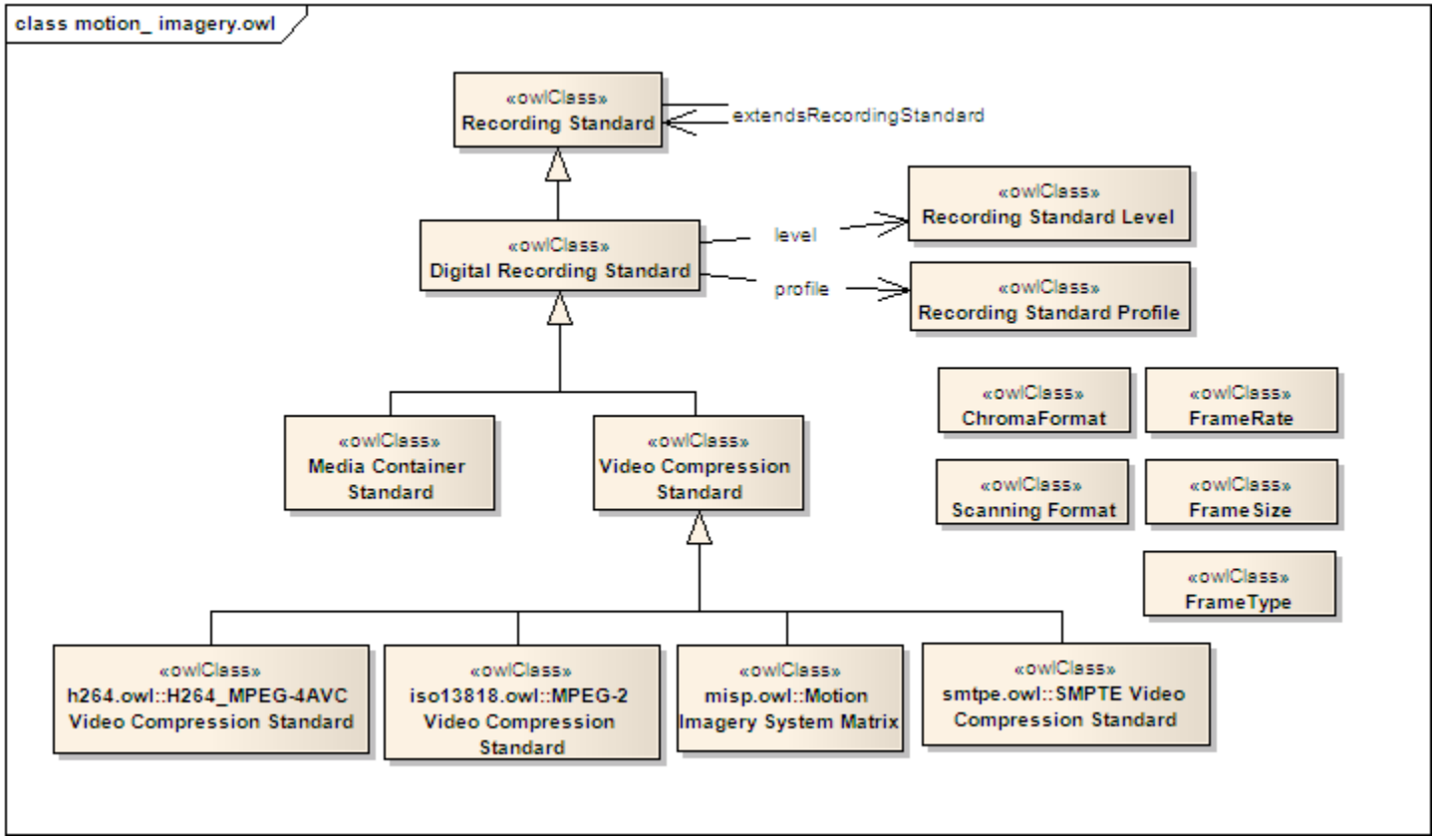
Recording standards full coverage capability constraint assignment



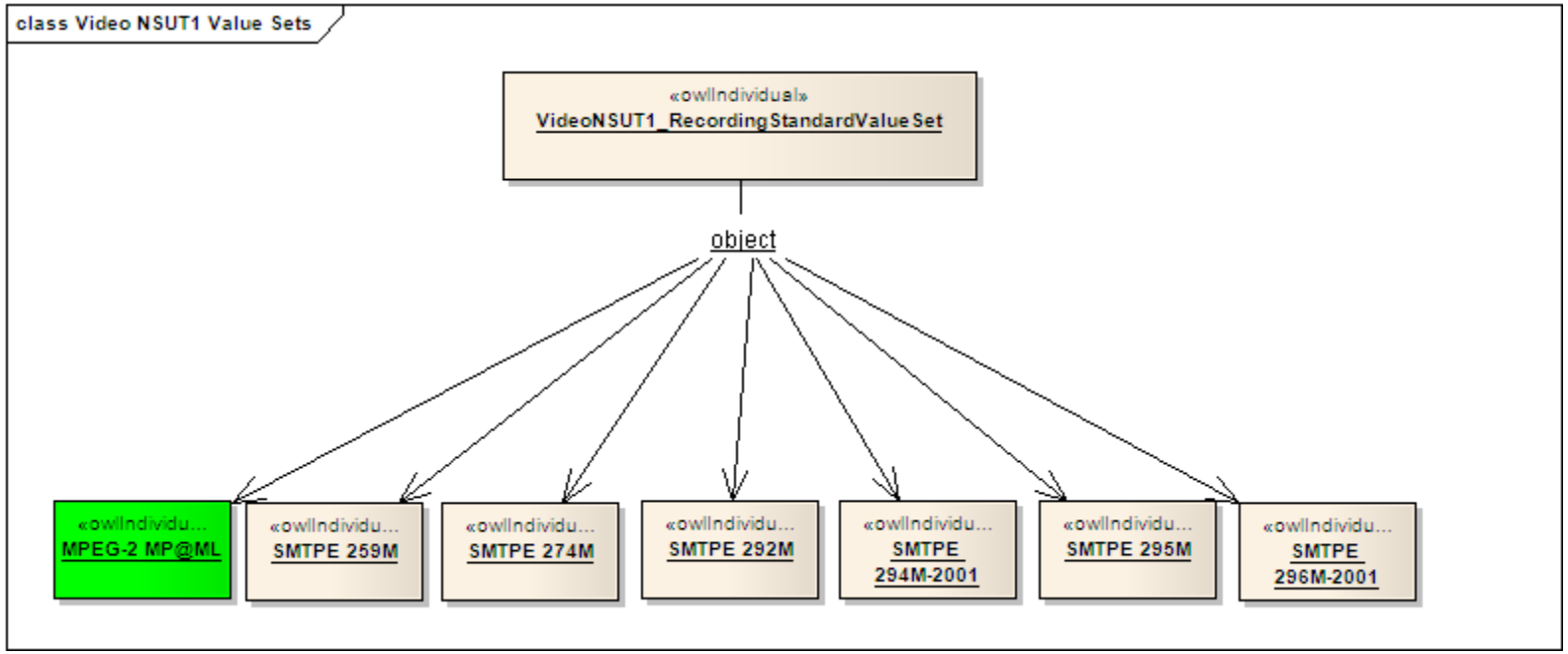
Motion imagery capability and recording standards constraint



Comparing apples and oranges standards:
Some video compression standards

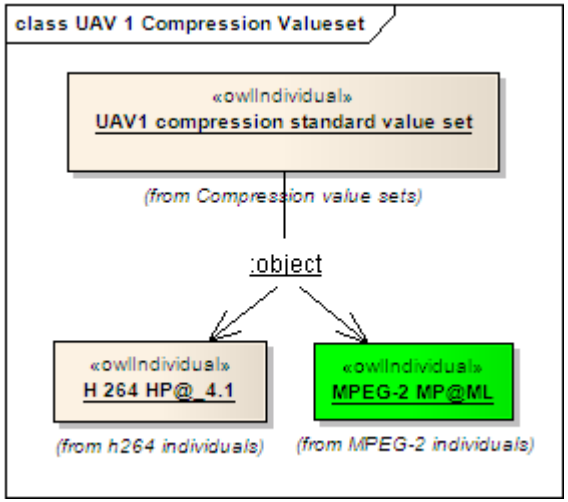


Objective: Test all recording standards supported by VideoNSUT1



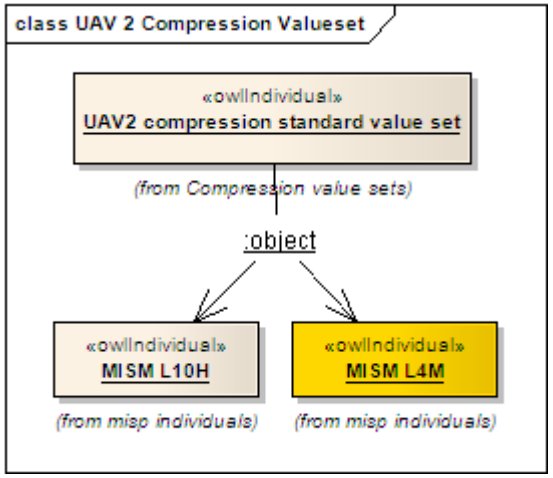
The Video Provider should support *some* of these: {2MPEG-2MP_ML, SMPTE259M, SMPTE274M, SMPTE292M, SMPTE294M-2001, SMPTE295M, SMPTE296M-2001}

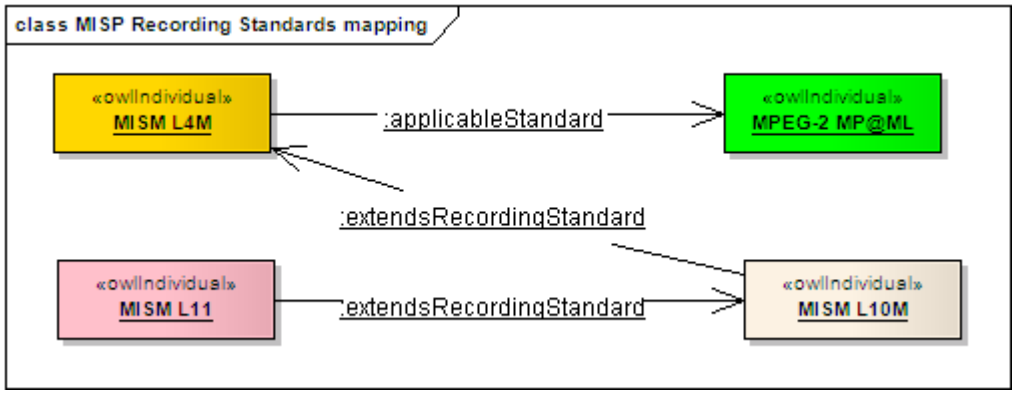
UAV1 - Apples and apples



- **UAV1 has MPEG-2 MP@ML in common with VideoNSUT1**

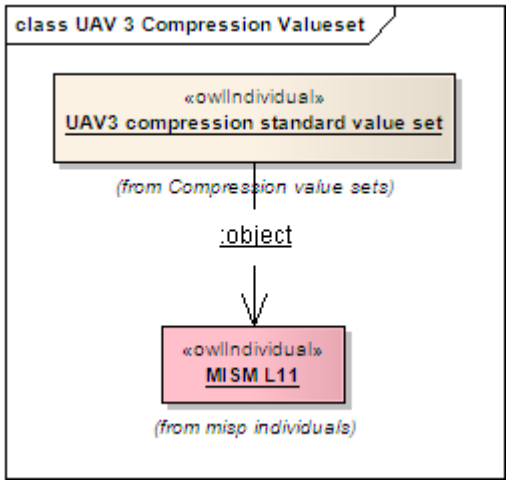
UAV2 – Apples and oranges (1)

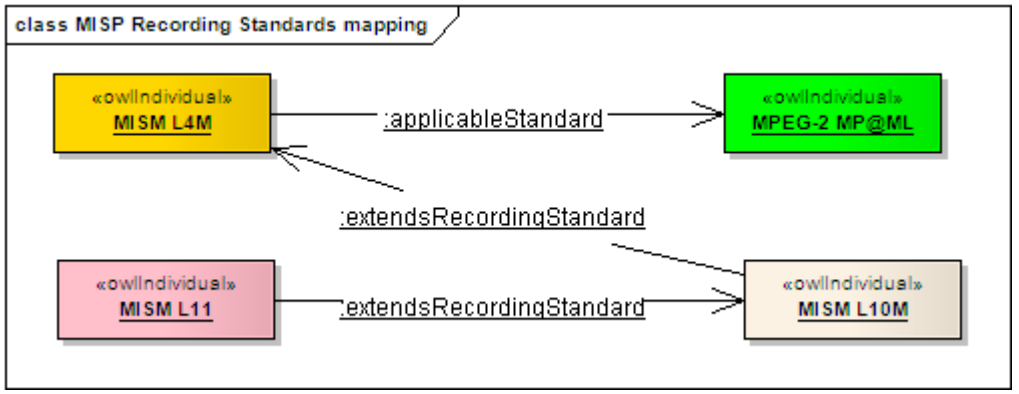




- **UAV2 *appears* not to support *any* of these, but it satisfies the constraint. Why?**
- **Because a *mapping rule* indicates the correspondence between two standards: UAV2's MISP-L4M and the MPEG-2MP_ML**
  - The mapping rule uses the *applicableStandard* property

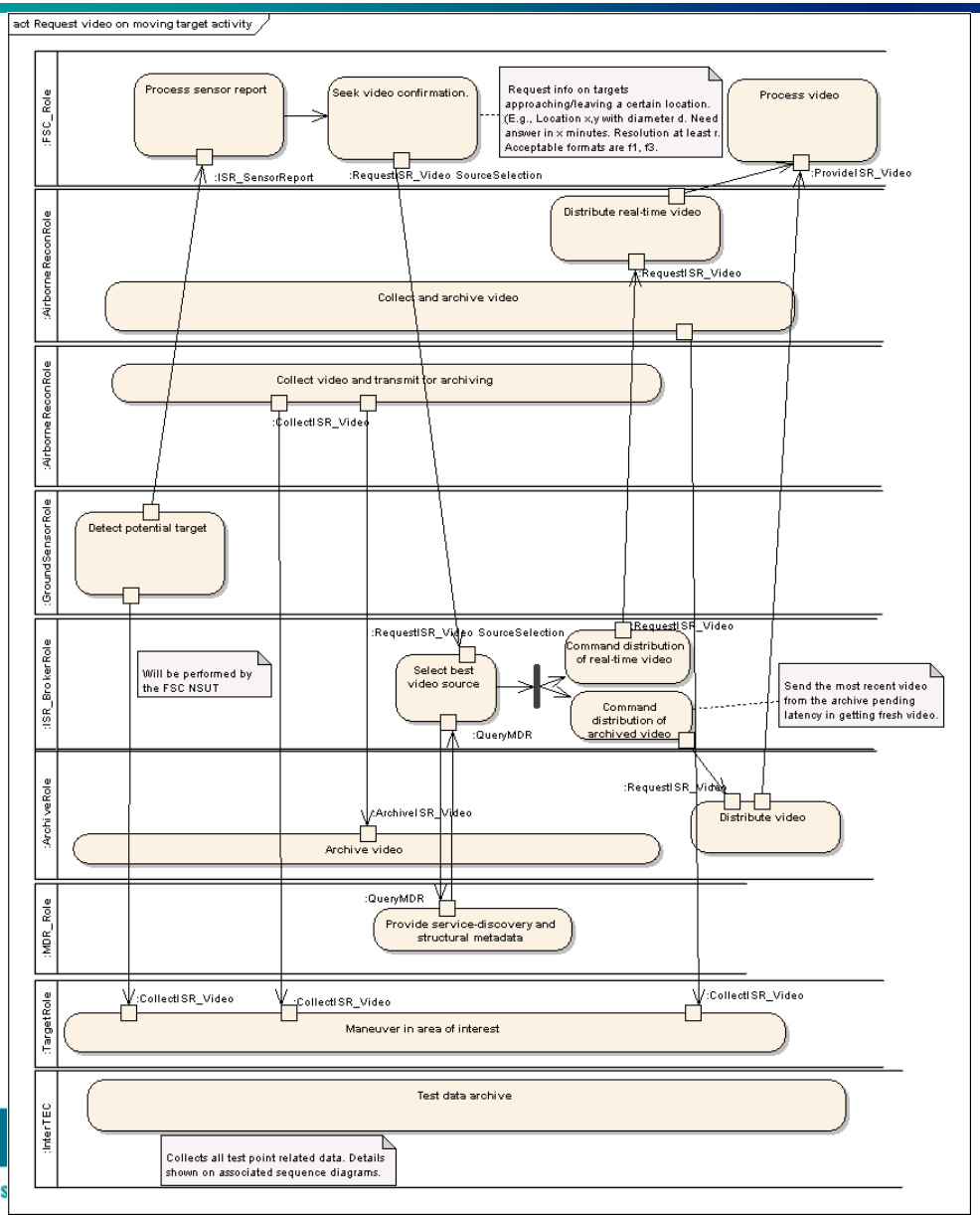
UAV3 – Apples and oranges (2)





- **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