International Council on Systems Engineering
A better world through a systems approach

Solving the Selfish Octopus Problem with the Reusable Asset Specification (RAS) 3.0

Matthew Hause - SSI

Sriram Krishnan – Istari Digital

Mike Shearin – GTRI

Mike Petrotta – SSI

Tomas Vileiniskis Dassault

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Agenda

- The Octopus Problem - From Individual Knowledge to Collective Intelligence
- Aspiration for Model Based Acquisitions
- The case for Reusable Asset Specifications
- Approach and timeline to update RAS 3.0

Goal for RAS 3.0 update is reuse and discoverability, a key enabler of digital engineering

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Knowledge and Skills Transfer in Animals

Essential for survival for all animals

Hunting for food

Evading predators

Recognizing poisonous plants

Transfer Methods

Copying behavior (monkey see, monkey do)

Positive and negative reinforcement

Natural Instinct/DNA

Complex Social Skills

Dominant male behavior

Social bonding

Acceptable play

In person, in the moment, and synchronous

Lost knowledge is costly to reacquire

May take generations

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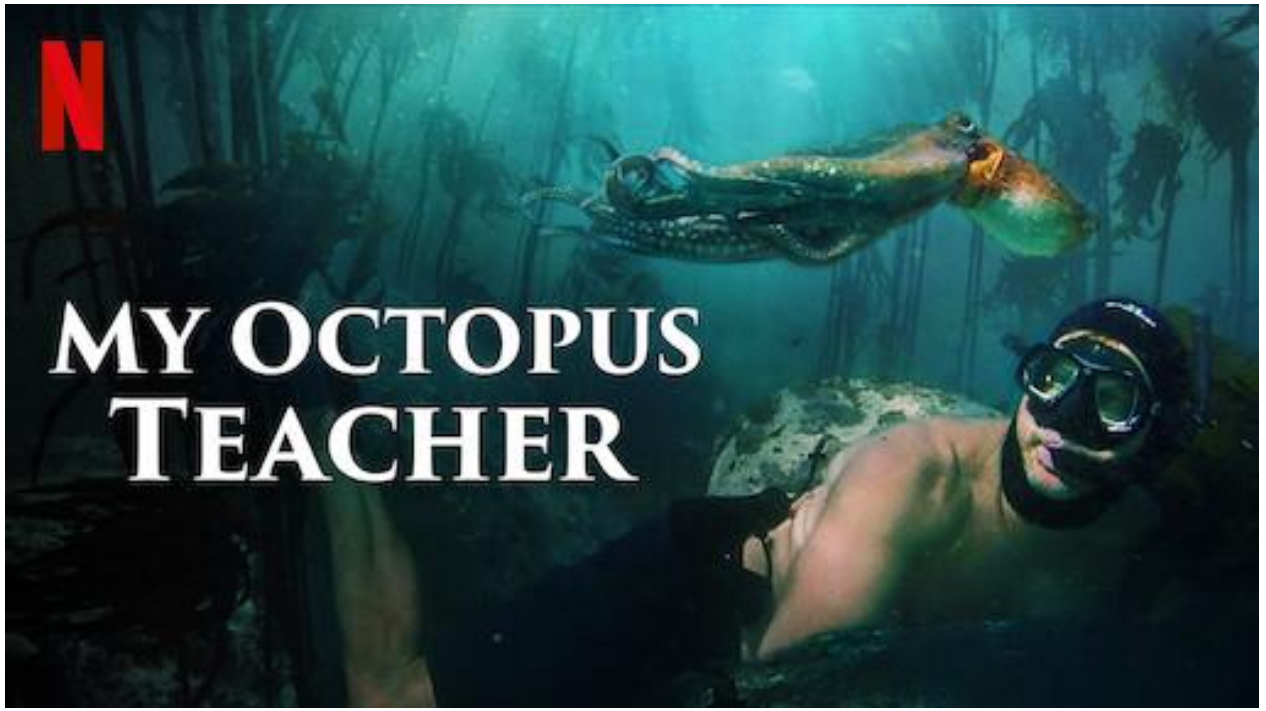
Exception: The Octopus

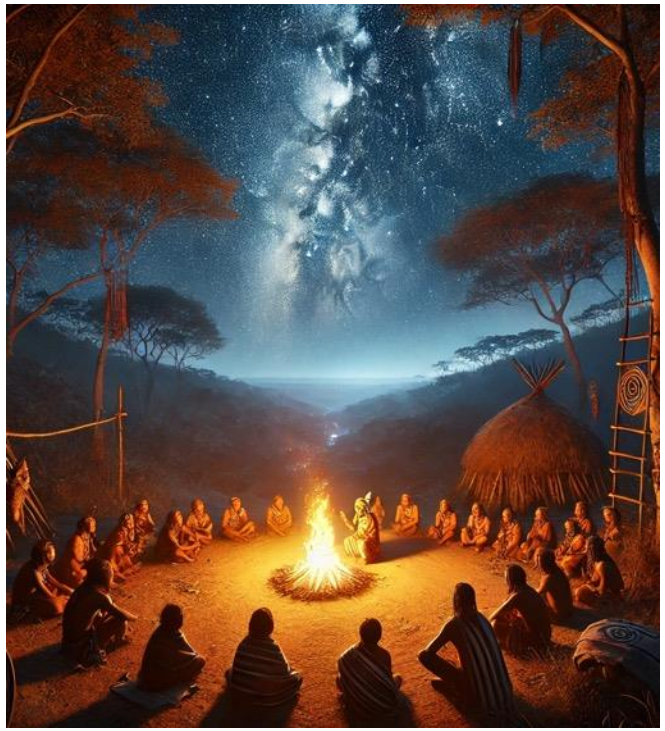
- Intelligent, excellent at problem solving, uses tools, etc.
- Solitary, with no means of knowledge transfer
- Information skills acquired by one octopus is lost when it dies

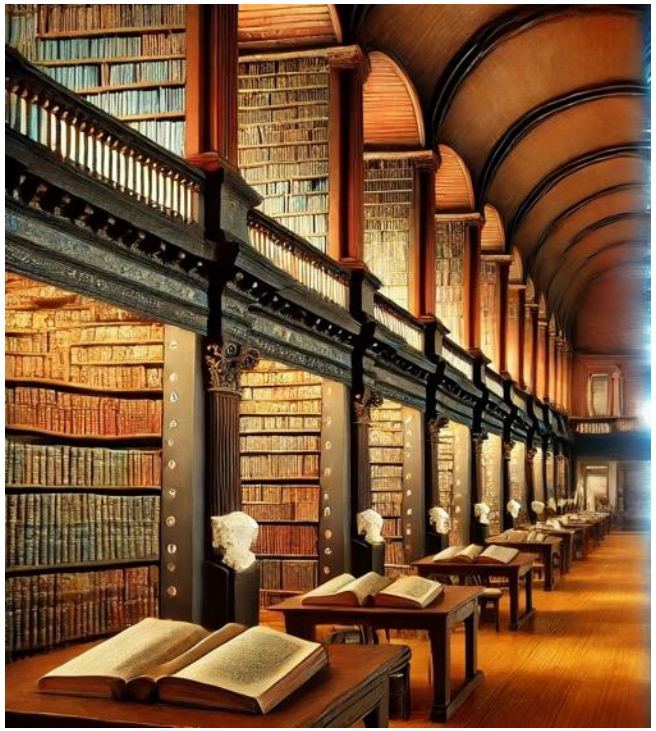


Another Metaphor

Human knowledge transfer

Ranges from oral to written to digitized, and seeks to preserve the human experience for future





Synchronous Methods

Animal methods previously listed
Spoken Language (Epic poems, Conversations, etc.)
Apprenticeships
Song and social events
Schools and education

Asynchronous Methods

Written language (Scrolls, Books, Letters, Notes, etc.)
Libraries – general, technical, philosophy, architecture, science, etc.
The internet – All human knowledge and information both true and false

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Advancement builds on past knowledge

- "*If I have seen further [than others], it is by standing on the shoulders of giants." (Newton, 1675)*

- **Past knowledge can be across (m)any of these stores**
  - SysML profiles and domain specific languages
  - SysML libraries and patterns (QUVD for instance)
    - SysML V2 emphasizes libraries over profiles
  - MATLAB libraries
  - CAD Models
  - Complex computer simulations
  - Technical journals and presentations
  - Ontologies
  - Systems Engineering models
  - UAF NIST Security Controls Library

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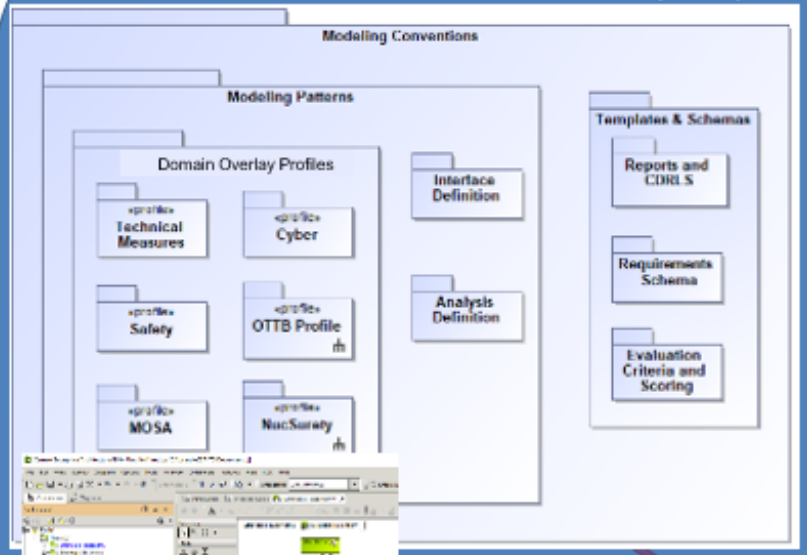
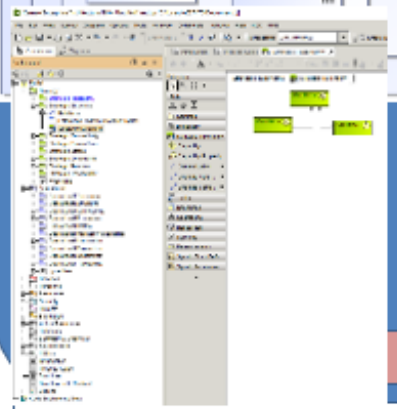
Model-Based Acquisition

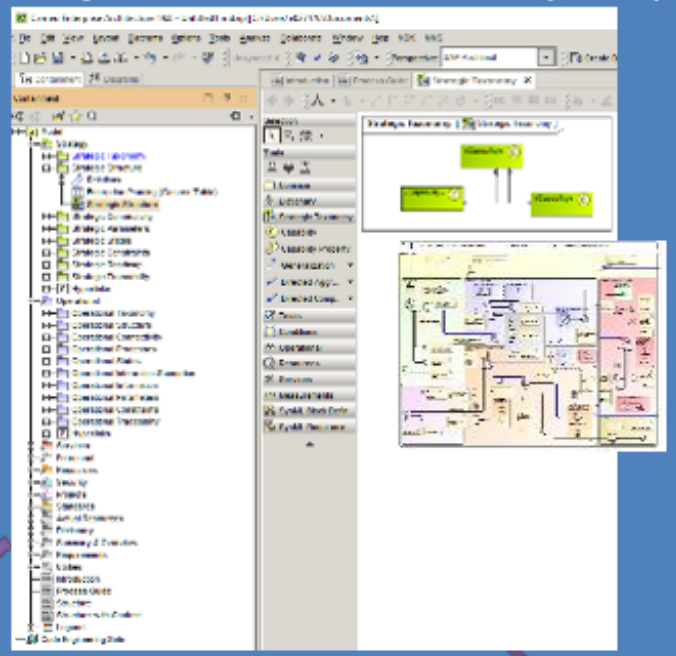
1. Architecture Evaluation Criteria (AEC)





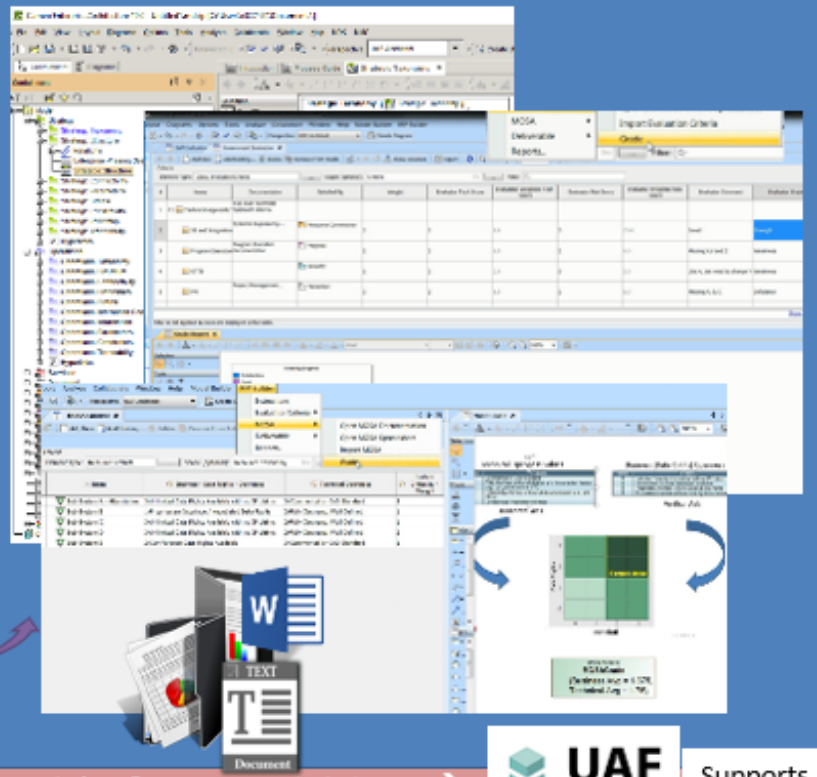
AEC & (OAD)

2. Objective Architecture Description (OAD)



Populated with Program & contract Data

3. Model-based RFP Package



← 4. Unified Architecture Framework (UAF) Process Guide for Acquisition →

UAF OMG UNIFIED ARCHITECTURE FRAMEWORK™ Supports DoDAF

1. The AEC provides model structure for RFP content and evaluation tools:
- Modeling Patterns
  - DO Profiles (i.e. MOSA, Data Rights, certs)
  - Interface & Analysis Definitions
- Templates & Schemas
  - Evaluation Criteria & Scoring (Section K, L, M)
  - Reports & CDRLS

2. The OAD is a descriptive model containing the program requirements, constraints and context
- High-level Capabilities, mapped to Operational scenarios, traced to requirements (e.g. CDD, SRD, Conops)
- Technical performance measures (i.e. KPPs, KSAs, MOEs..)
- Any required architectural partitioning including structural and functional

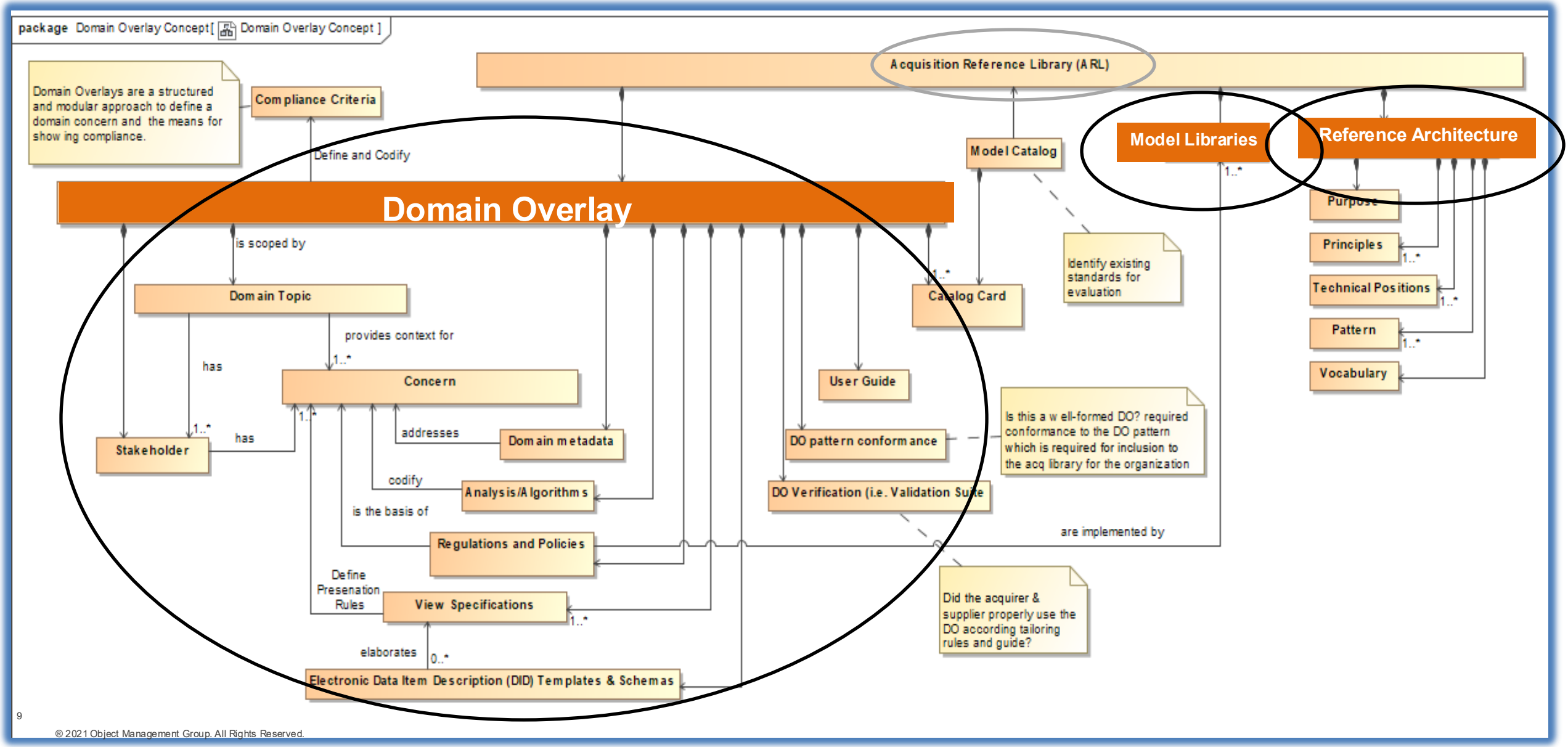
(Based on UAF acquisition process guide and template)

3. The Model-based RFP model contains the populated OAD&AC providing **RFP evaluation content, CDRL definitions** for documentation generation and **scoring tools** for solution validation and evaluation

4. UAF Process Guide provides the Acquisition Guidance for using MBAcq **to create, respond and evaluate a Model-based RFP.**

SOURCE: Laura Hart, MITRE 2017

Standardized Concepts for Reusable Content

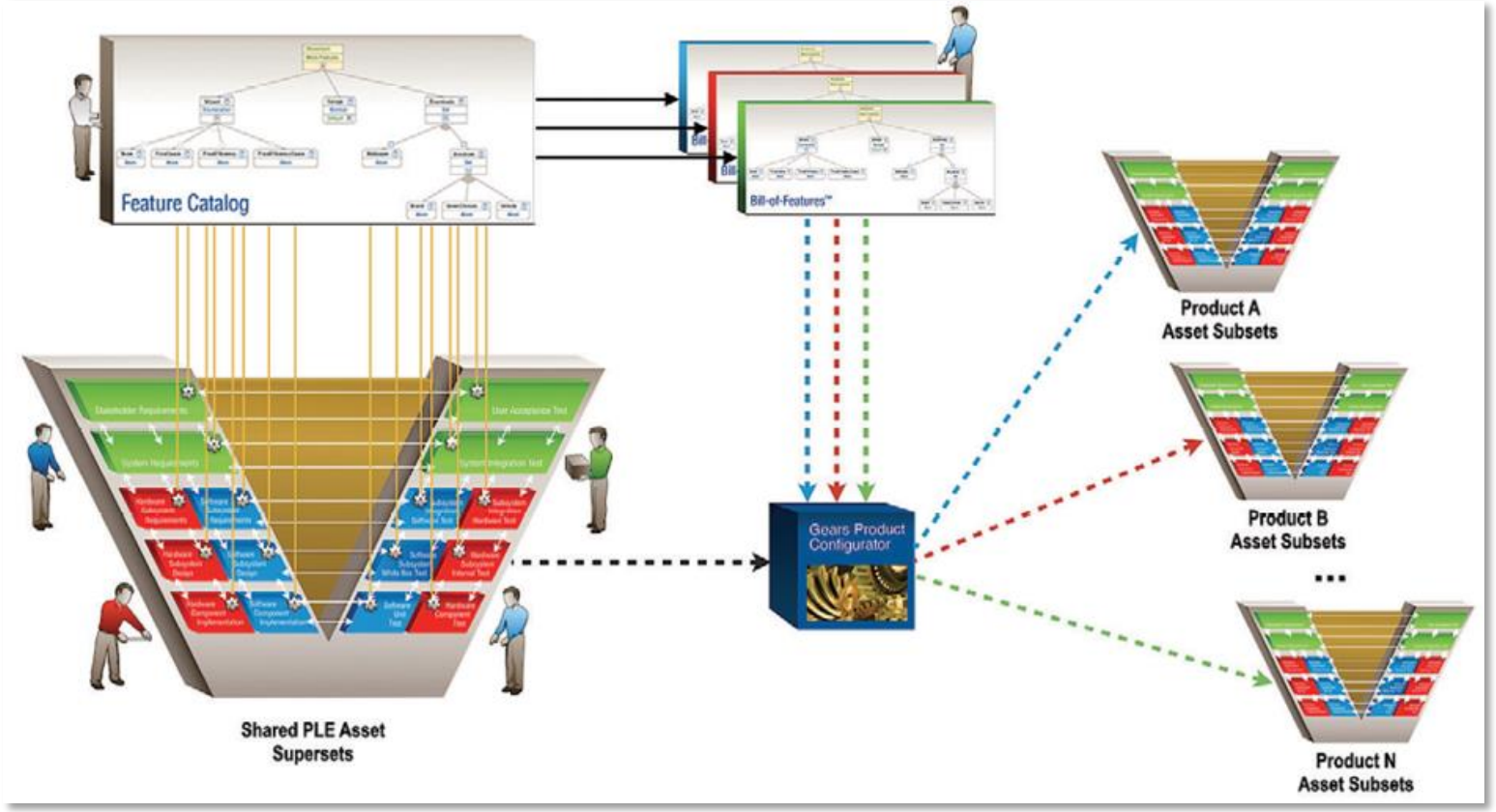


What is PLE?

Product Line Engineering (PLE) is the engineering and management of a group of related products using a shared set of assets and a means of design and manufacturing.
PLE can include system and software assets and involves all aspects of engineering including electrical, electronic, mechanical, chemical, etc. Model-based Product Line Engineering (MB-PLE) combines the best of MBSE and PLE.

PLE requires:

1) A Feature Model
2) A Product Model
3) An Asset Library



https://www.aerospacemanufacturinganddesign.com/article/what-is-product-line-engineering-ple/

Octopus problem in Digital engineering

- Problem: Our digital models remain isolated in historical storage, forcing every system to relearn, reteach, or reinvent models that already exist.
- Key questions:
  - How can we efficiently curate and retrieve digital models?
  - What mechanisms enable search, reuse, and updates across different model libraries?
  - How do we standardize the sharing of:
    - Models & Model Libraries
    - Reference Architectures
    - Components & Interfaces
    - Types & Patterns
    - Keywords & Solution Elements?

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Reusable Assets and Model Curation Approach and Timeline

8/5/2025

A Few Requirements – NOT A COMPLETE LIST!!

- Searchability & Discovery
  - Enable advanced search using keywords, types, purpose, and domain.
  - Support interest registration and update notifications for model changes.
  - Ensure global element IDs for consistency across models.
  - Define standardized catalogues and cards

- Scalable & Configurable Library Management
  - Support multiple hosted libraries (Local, Department, Enterprise, Global, OMG, INCOSE….).
  - Implement configuration management for models, elements, and patterns.
  - Ensure compatibility with multiple formats (UML, SysML, UAF, vendor-independent).

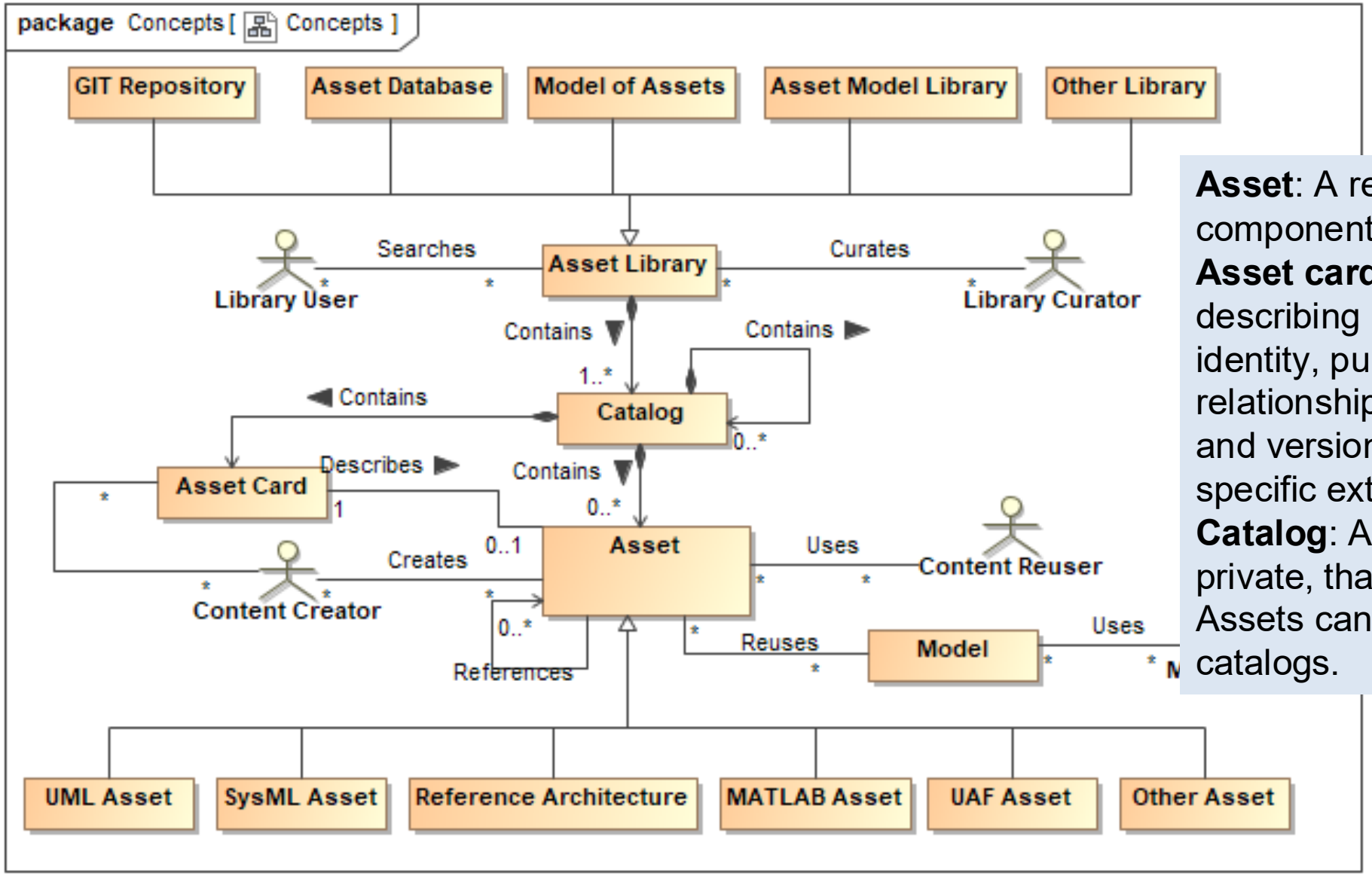
- Curation & Access Control
  - Provide a standardized API (e.g., Extended SysML v2 API).
  - Implement multi-level access control (Library, Element, etc.).
  - Enforce role-based permissions (Curator, User, Creator, Owner).
  - Enable secure sharing (Black Box & White Box) and collaborative versioning

Two Level Data Model

Effective asset discoverability requires a two-level data model:

- **Conceptual layer** that defines what an asset is and how it relates to catalogs, repositories, curators, taxonomies, and lifecycle phases;
- **Physical layer** that governs how this information is stored, accessed, and exchanged. In RAS 3.0, taxonomy and lifecycle states are treated as first-class concepts – essential for enabling faceted search, maturity tracking, and provenance queries.

RAS Concept Model



Asset: A reusable model, pattern, or component.
Asset card: The asset's self-describing metadata, including identity, purpose, status, owner, relationships, license/access, tags, and versioning, with optional domain-specific extensions.
Catalog: A curated index, public or private, that enables faceted search. Assets can appear in multiple catalogs.

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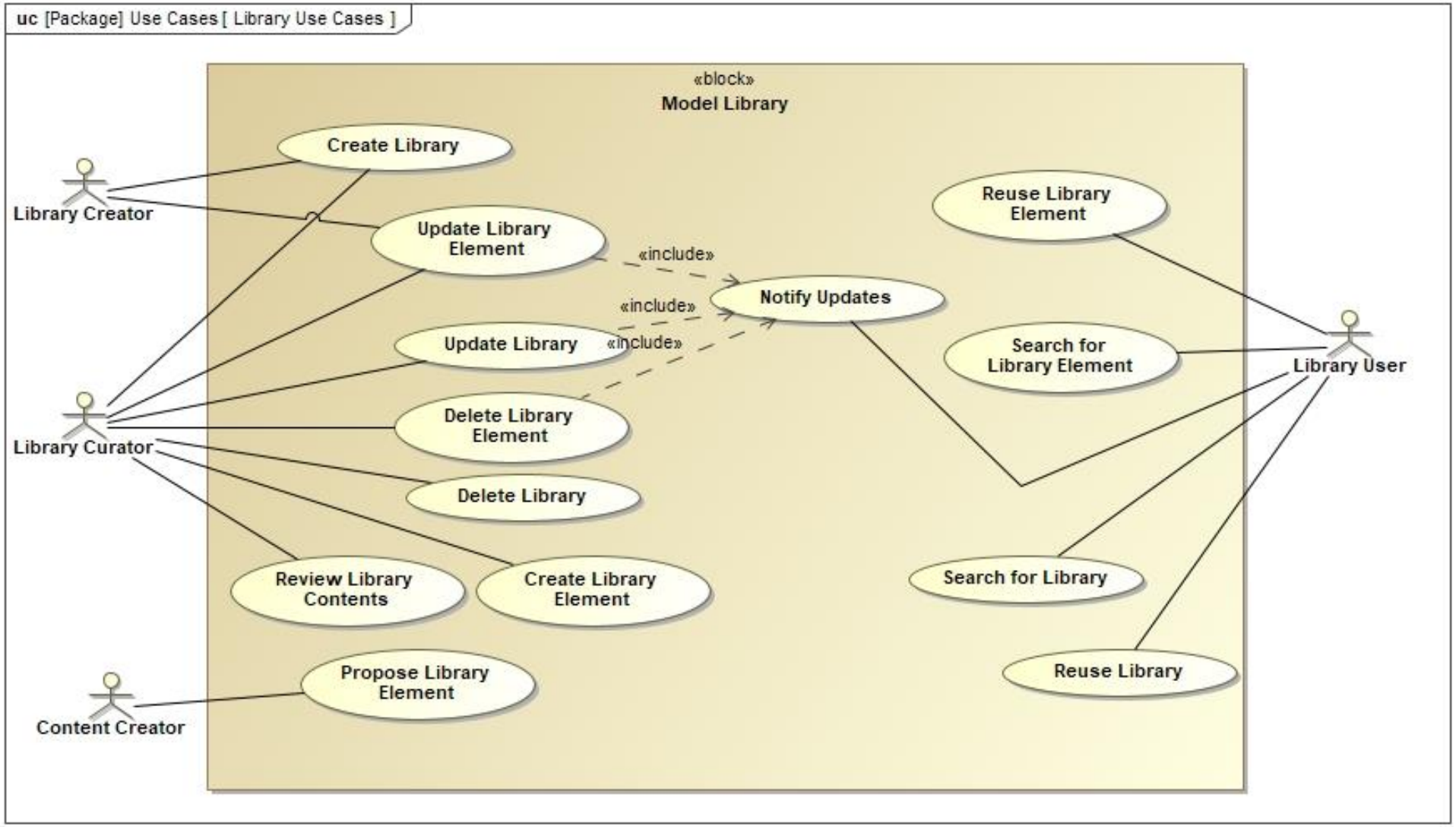
RAS Physical Model

RAS 3.0 seeks to implement the conceptual model via standard APIs for discovery and access

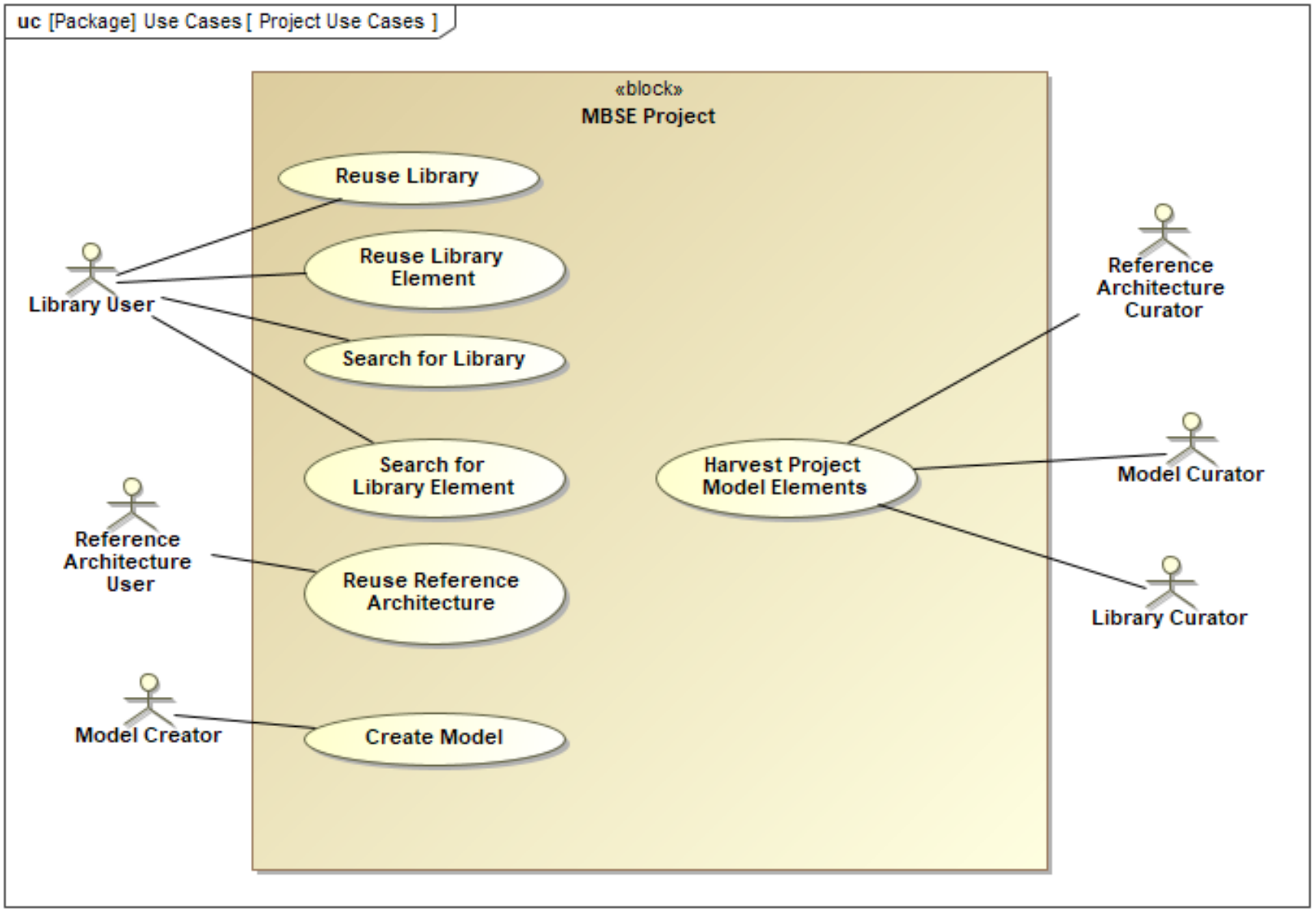
Alternative: for git-based stores standard file formats primarily JSON with JSON Schema to support validation, extensibility, and machine-processability

- This ensures that physical asset metadata remains portable, predictable, and interoperable across tools, repositories, and domains.

A Few Model Library Use Cases – In Progress



A Few Project Use Cases – In Progress



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Comparison of options

RAS 3.0 seeks to build upon and simplify the current RAS 2.2, DPROD, and DOD MSC-DMS specifications

	RAS 2.2 (OMG)	DPROD (OMG)	MSC-DMS (DoD)
	Reusable Asset Specification	*Data Product standard*	*Modeling and Simulation (M&S) Community of Interest (COI) Discovery Metadata Specification (DMS)*
Purpose	Standardize reusable software assets for greater reuse	Enable discovery and interoperability of data products with standard metadata	Discovery and reuse of modelling and simulation assets (within DoD)
Design principles	• Consistency • Minimalism • Extensibility	• Semantic web principles • Decentralization • Data governance	• Comprehensive description • Discovery metadata • Security & trust levels for assets

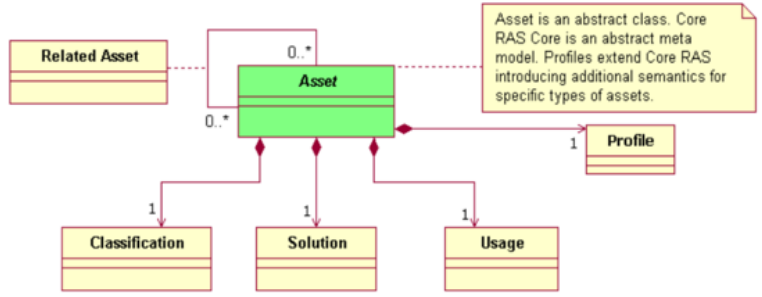
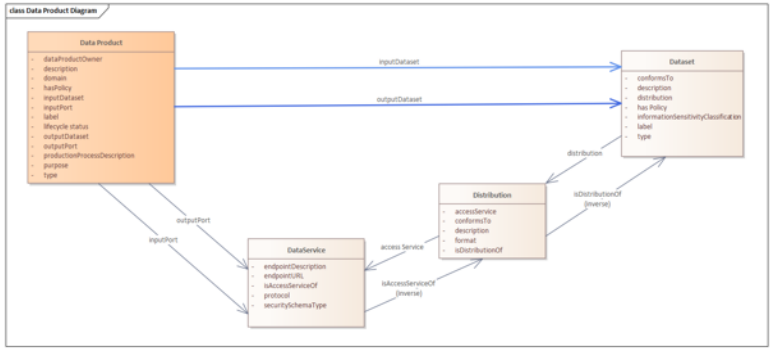


Figure 9 - Core RAS Domain Model - Major Sections



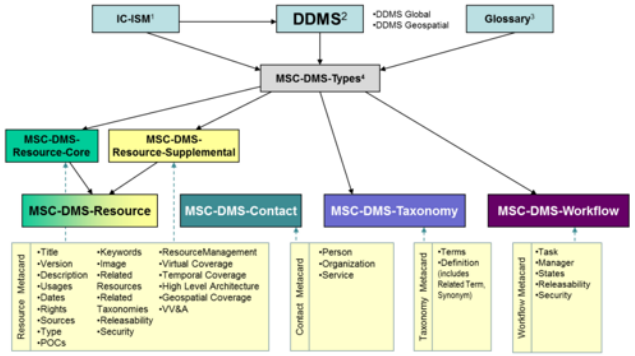


Figure 2-1 Organization Structure for the M&S COI Discovery Metadata Specification

Comparison of options

RAS 3.0 seeks to build upon and simplify the current RAS 2.2, DPROD, and DOD MSC-DMS specifications

	RAS 2.2 (OMG) *Reusable Asset Specification*	DPROD (OMG) *Data Product standard*	MSC-DMS (DoD) *Modeling and Simulation (M&S) Community of Interest (COI) Discovery Metadata Specification (DMS)*
Common metadata	Asset Identification: Name, Unique ID Versioning & Status Asset Relationships	Descriptive Summary Ownership/Contacts	Classification & Keywords Usage Constraints/Rights
Unique metadata	• Solution/Artifacts List • Variability Points (Customization options) • Asset Profiles (e.g., Default Profile) • Asset Lifecycle state (draft, certified)	• Data Product Owner (prov:Agent) • Input/Output Ports & detailed pipeline metadata • ODRL-based Usage Policies • Domain Context & Lifecycle Status	• Detailed Point of Contact Information • Security Classification & Constraints • Verification, Validation, Accreditation (VV&A) status • Configuration Management Metadata & Taxonomy Citations • Resource Relationships (e.g., federation)
Structural difference	• Internal artifact packaging & XML manifest approach. • Metadata extensibility via asset profiles	• Semantic web ontology (W3C DCAT profile) • Decentralized schema • Emphasis on data lineage.	• Federated search focus • Structured metadata sets (core, security, taxonomy) • No direct asset packaging.

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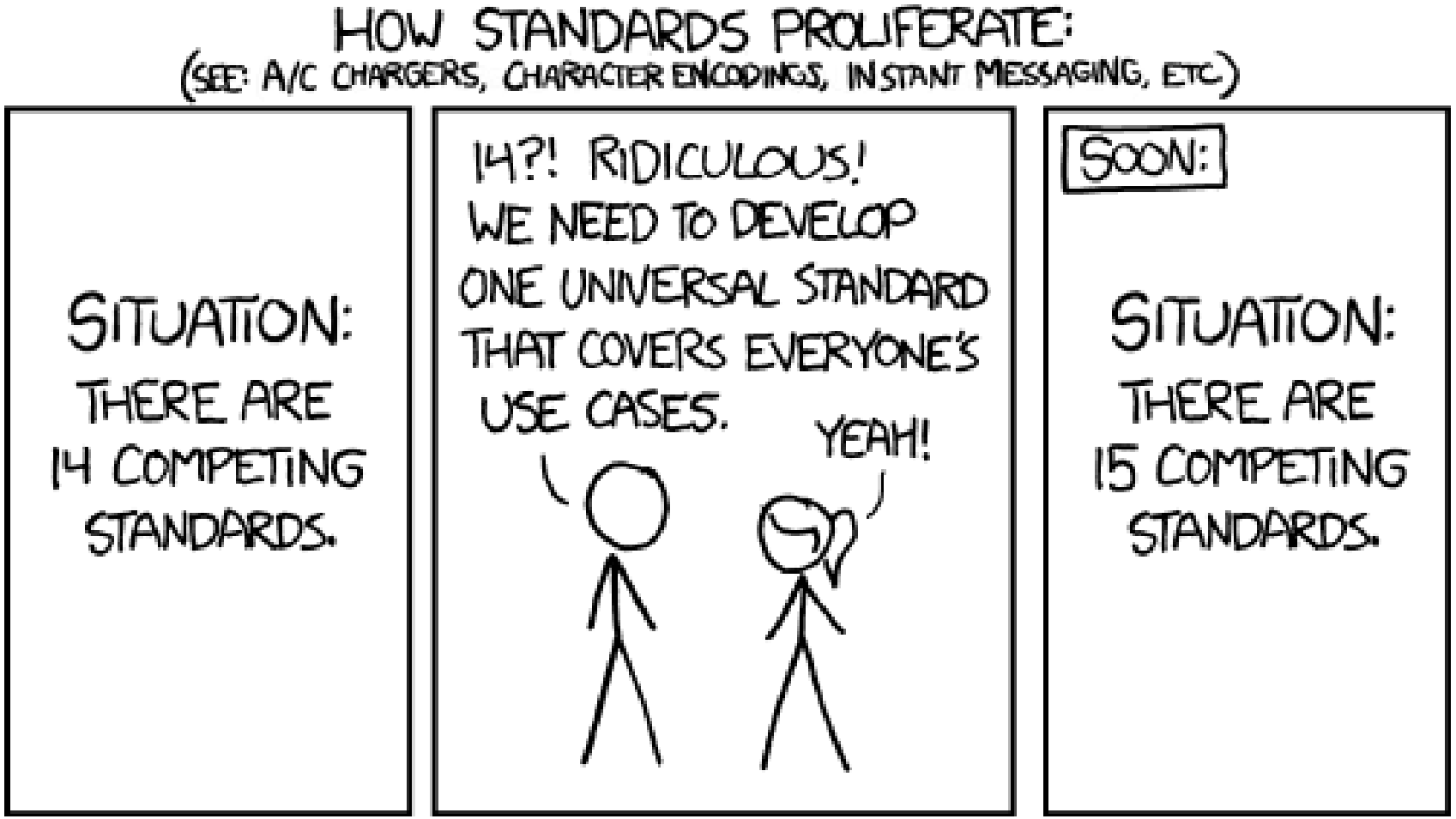
Caution...



https://xkcd.com/927/

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Plan for 2025, with a goal to submit RAS 3.0 spec to OMG

Objectives

1. Update RAS to be suitable for reuse and discoverability
2. Enhance participation and engagement in RAS WG
3. Learn from and coordinate with related efforts

Target outcomes

1. Data model and representative use cases to test RAS metadata options
2. Outreach to different industry groups and events
3. Coordinate with Cascade, DEMI and related efforts

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Use Case Topics to Test the Core metadata options for RAS 3.0 Specification

Asset reuse across organizations	A product owner must package a model or component for use by a team in another organization. Reuse depends on shared metadata for structure, license, and provenance.
Curation of an internal asset library	An internal asset librarian needs to track and maintain digital assets across repositories. They rely on metadata to support search, lifecycle management, and relevance curation.
Building a reference architecture	Before designing a new technology stack, a team searches for existing models or reference architectures. Discoverability depends on standardized topics, tags, and usage annotations.
Reusing models for a new simulation study	A simulation team requires agent-based models for a novel study involving human–autonomous vehicle interactions. Reuse depends on metadata describing modeling approach, validation, and context.
Managing technical debt while modernizing legacy systems	A team updating legacy mechanical systems needs access to both old and new design artifacts. Effective comparison depends on consistent metadata for identity, lineage, and format.

Do you have any other use cases to test reuse and discoverability?

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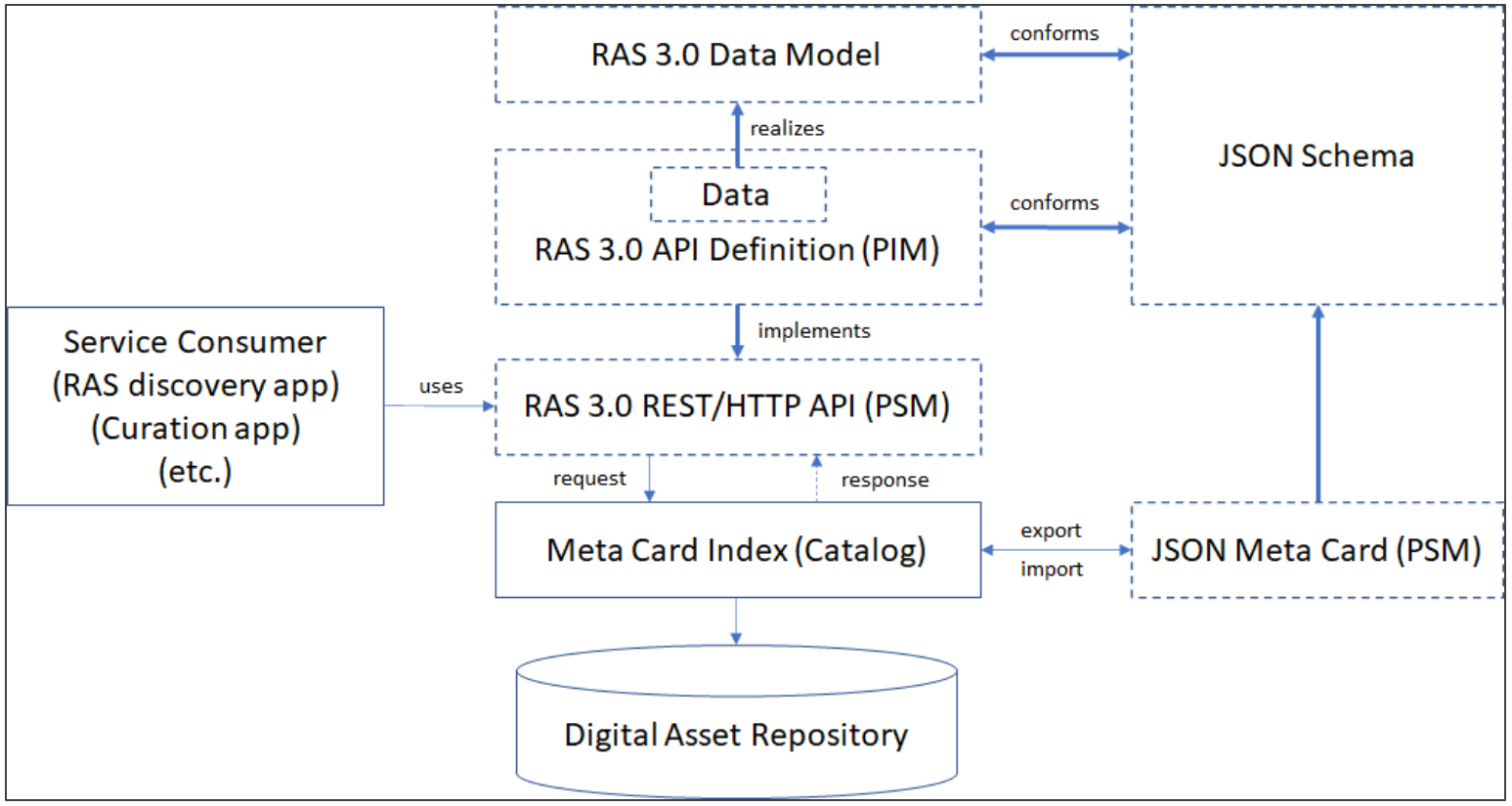
Proposed API services for RAS 3.0

Optional API services seeks to improve a range of discovery services such as faceted search and query, retrieval of asset cards and catalog metadata, submission and update of assets, etc.



RAS 3.0 API and Services architecture

- Platform independent model (PIM) service set mapped 1:1 to RAS data model
- REST/HTTP specification as Platform-specific model (PSM)
- Governance, Security, Portability as first-class concerns

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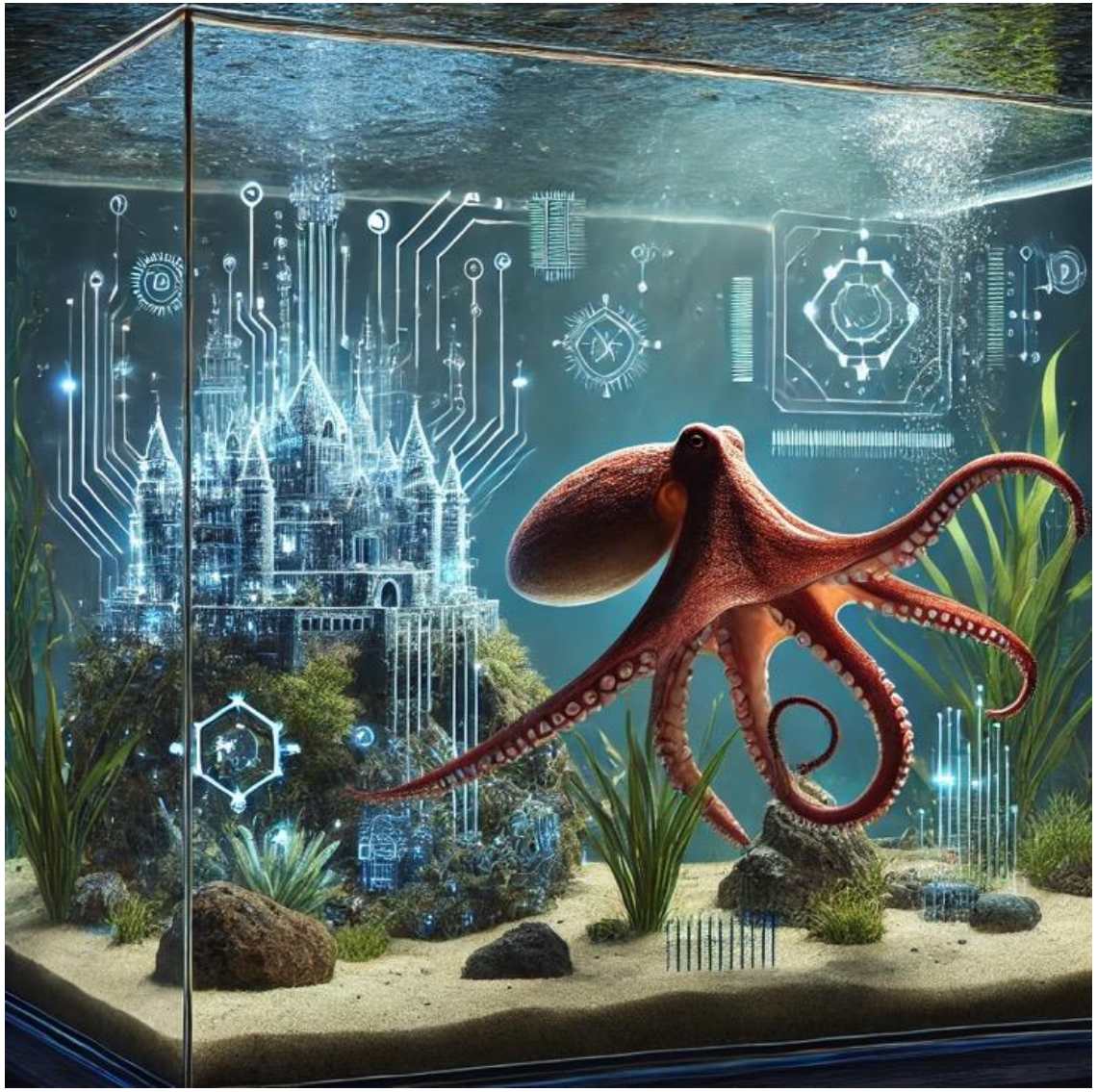
Action items / decisions

- Raise awareness of RAS 3.0 efforts
  - Clear narrative: Use cases → Data model → Format options → API services
  - Invitation for feedback (e.g. this presentation, upcoming INCOSE Insight publication)

- Synergy with other OMG efforts
  - Proposed workshop at OMG Q3 quarterly meeting in Leeds, UK (Sept 17th)

- Next steps towards a RAS 3.0 specification
  - Breaking change to the current spec, and to follow an RFC process
  - Outreach to tool vendors for Letters of Intent
  - Open invite for all participants to engage with the OMG RAS WG

Don’t be a selfish Octopus; Share Your Knowledge!



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Want to help shape RAS 3.0?

Questions?

Contact

Matthew Hause, mhause@systemxi.com
Sriram Krishnan, skrishnan@istaridigital.com
Mark Petrotta, mpetrotta@systemxi.com
Michael Shearin, Michael.Shearin@gtri.gatech.edu
Tomas Vileiniskis, tomas.vileiniskis@3ds.com

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Thank You!

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Backup

RAS 2.2 – Core RAS Domain model & UML Model

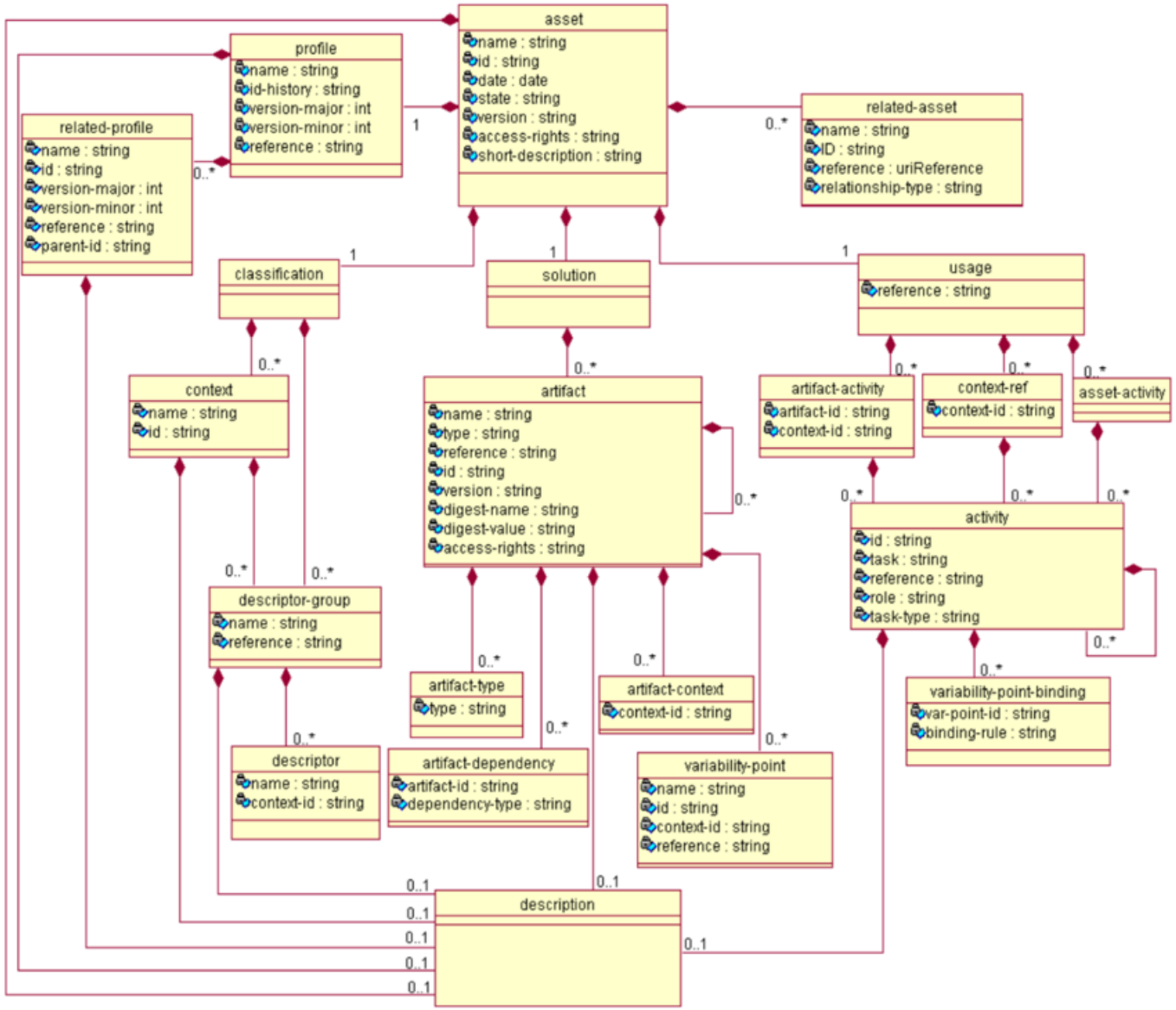

Figure 10 - Core RAS UML Model for XML Schema

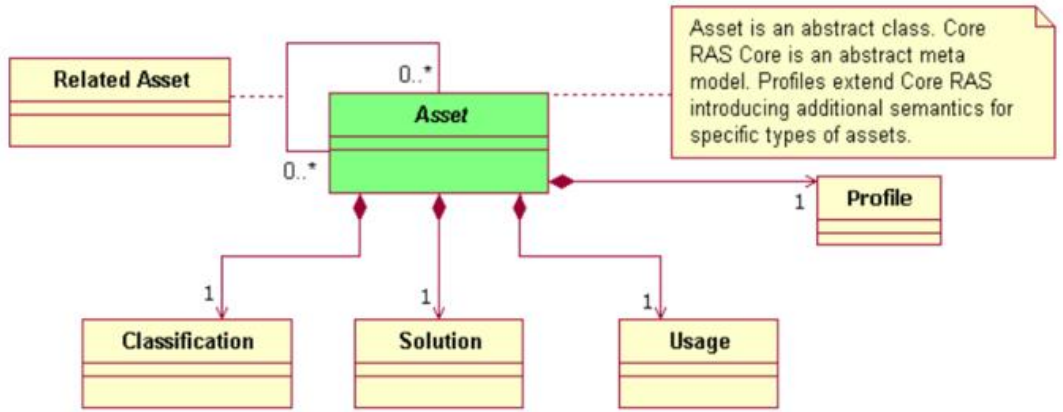

Figure 9 - Core RAS Domain Model - Major Sections

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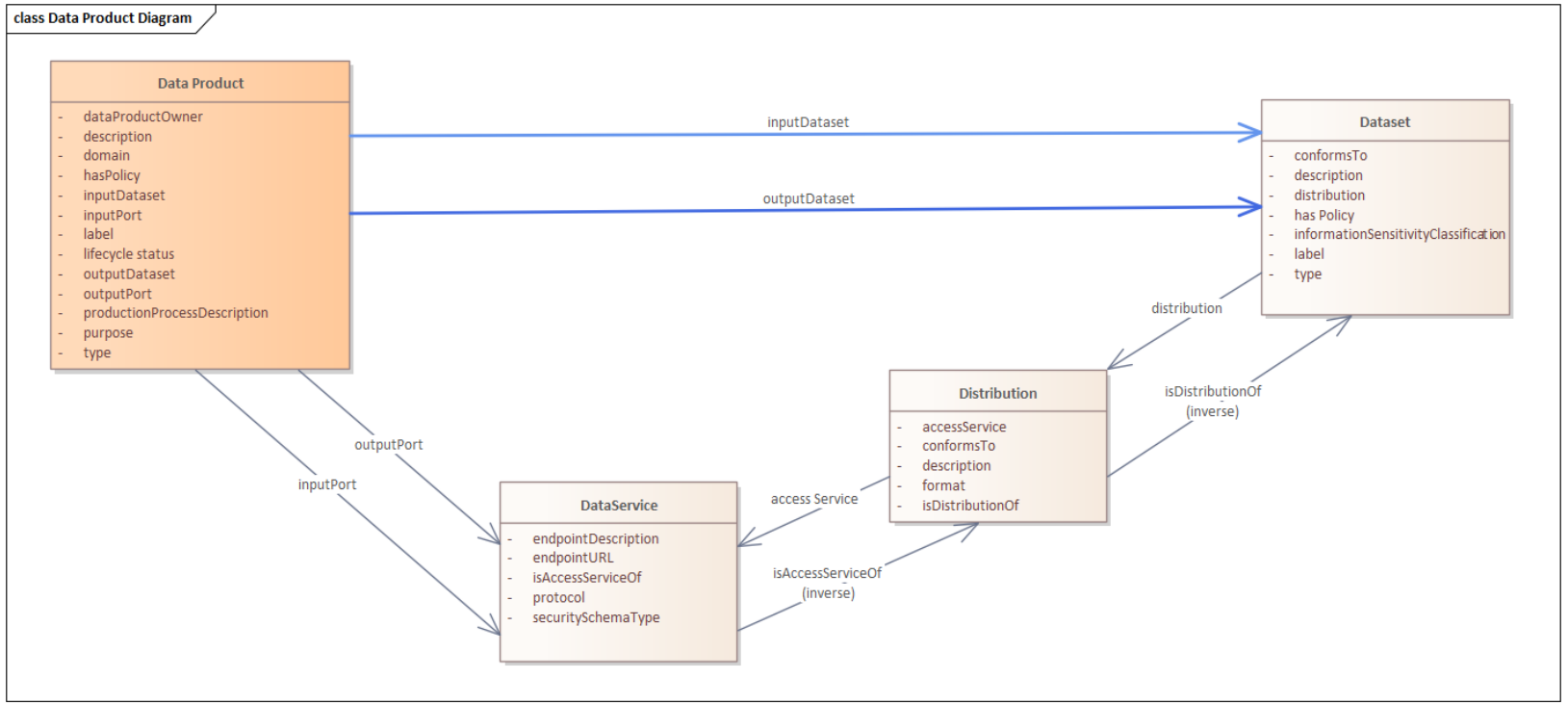
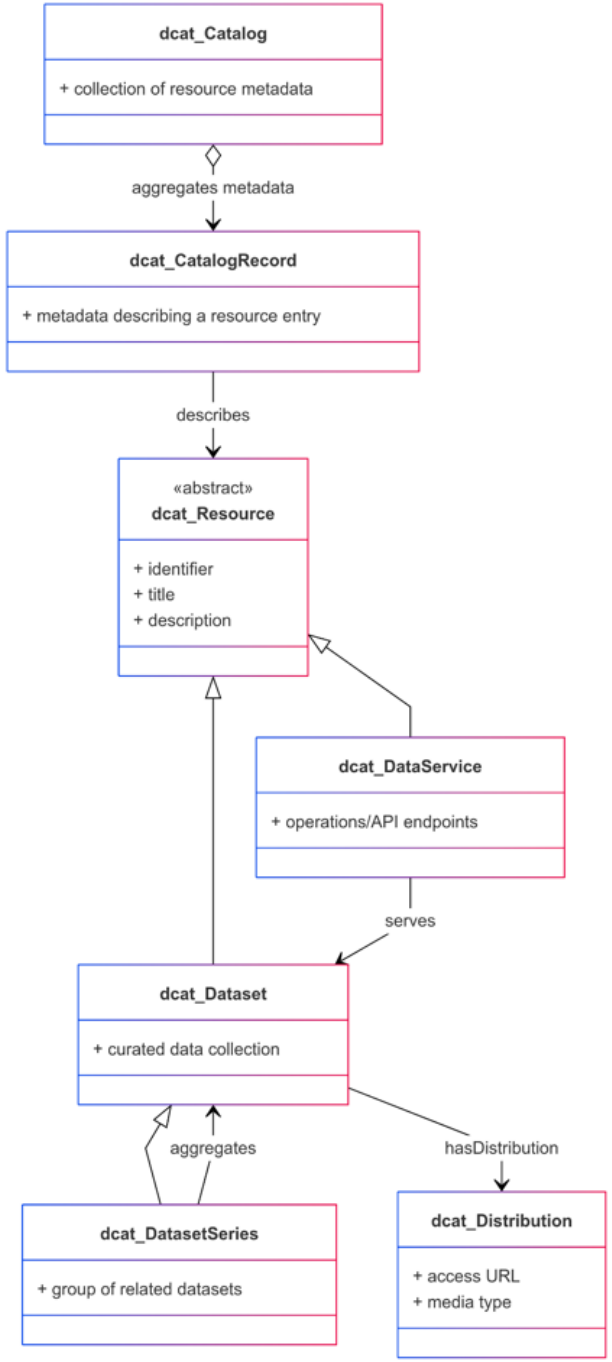
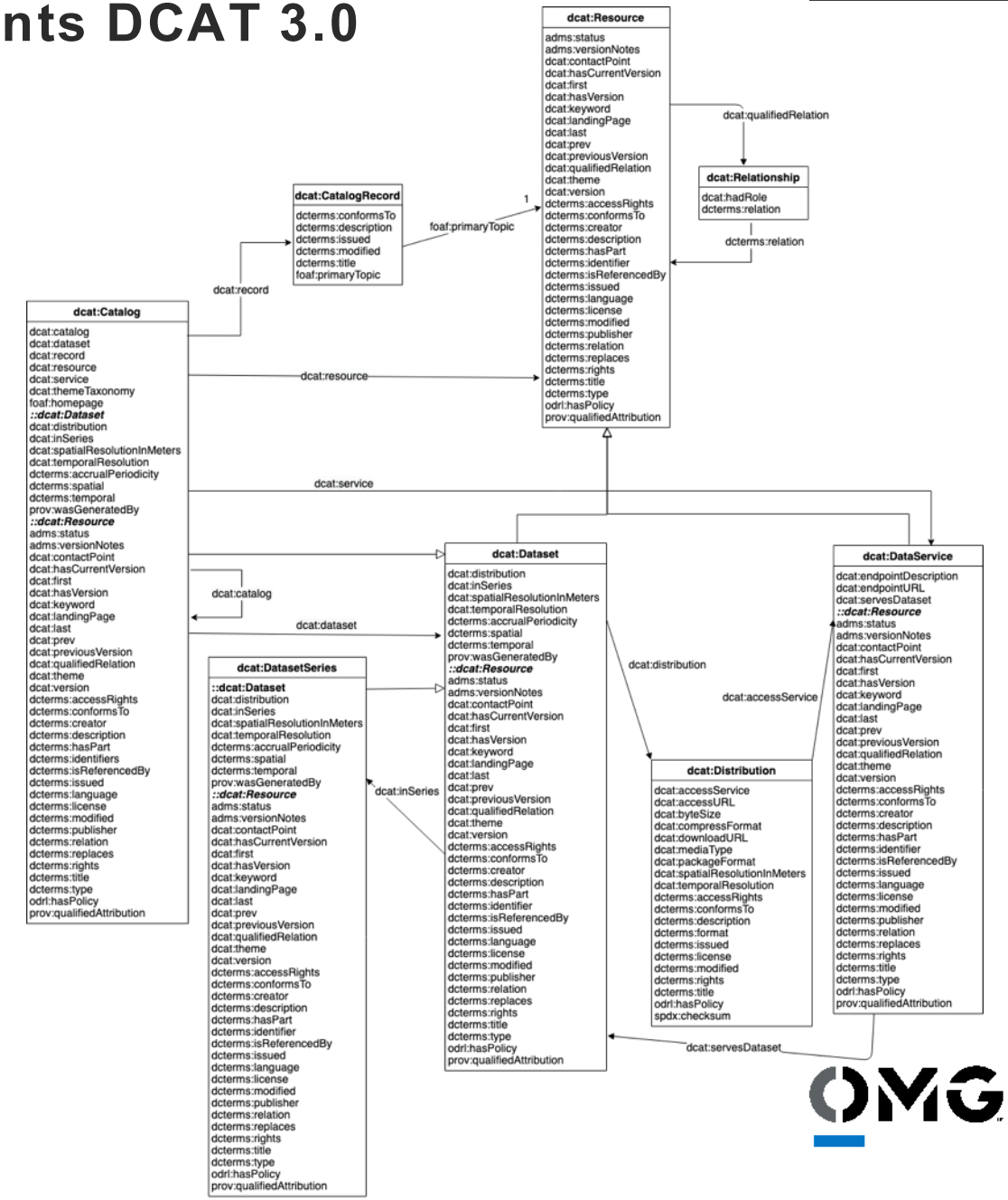
DPROD



- Data Mesh (`dcat:Catalog`) - collection of Data Products
- Data Product (`dprod:DataProduct`) - includes metadata, code and input/output ports
- Port (`dcat:DataService`) - A digital interface that provides access to a Dataset. The can be a HTTP URL, a Database or a FileShare etc
- Distribution (`dcat:Distribution`) - A specific representation of a dataset (CSV, JSON, ADLS etc) which can conform to a physical model
- Dataset (`dcat:Dataset`) - A collection of related data that can conform to a logical model

PROD implements DCAT 3.0





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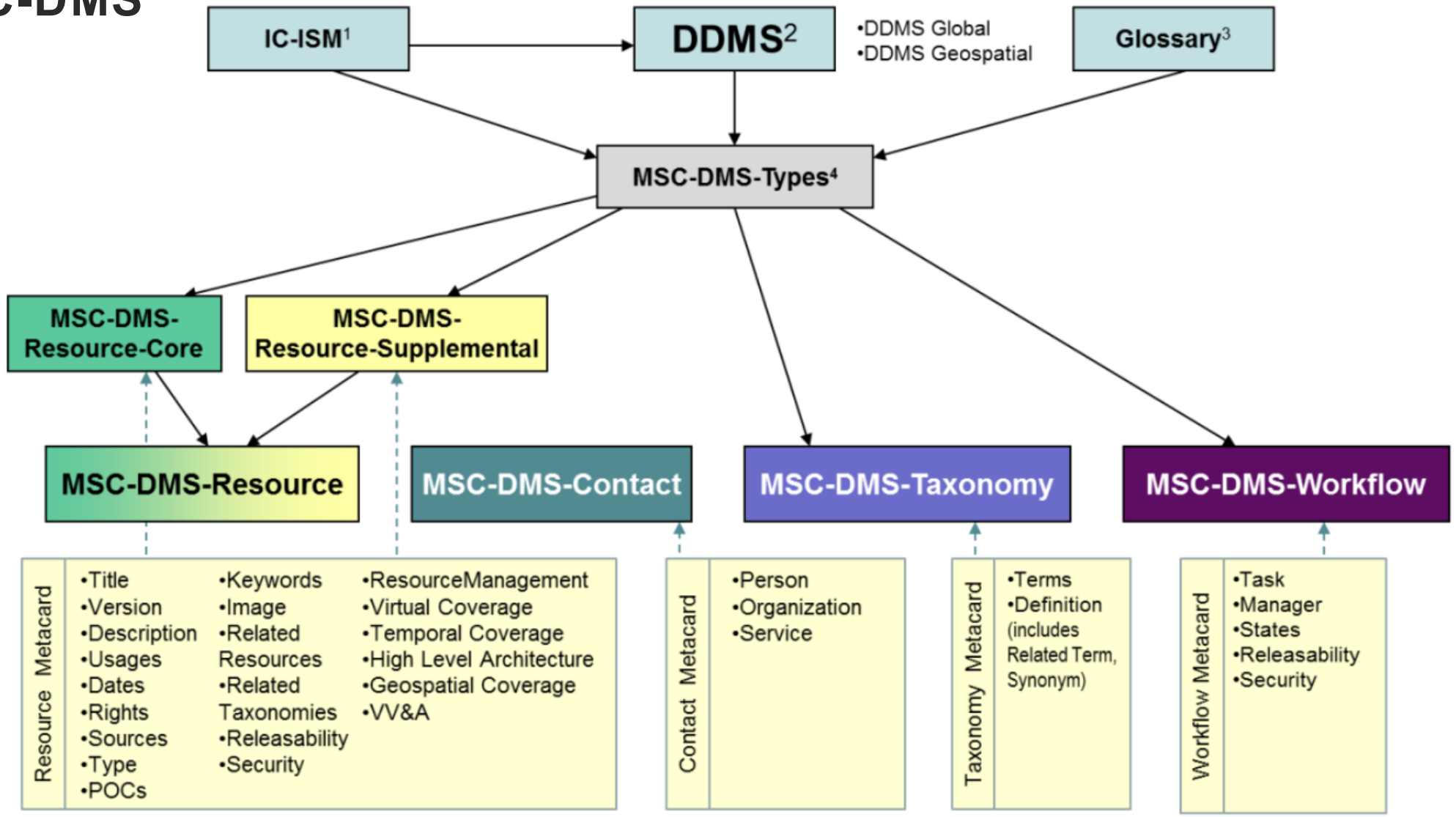
MSC-DMS



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35th Annual INCOSE international symposium

hybrid event

Ottawa, Canada

July 26 - 31, 2025