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The REUSE Company



excited to be presenting at the

16th Modelica & fmi Conference

The Fundamental Modeling Practices and Specifications to support the Preservation and Reuse of Analytical Simulations

Lucerne, Switzerland
September 8 -10

The Fundamental Modeling Practices and Specifications to support the Preservation and Reuse of Analytical Simulations

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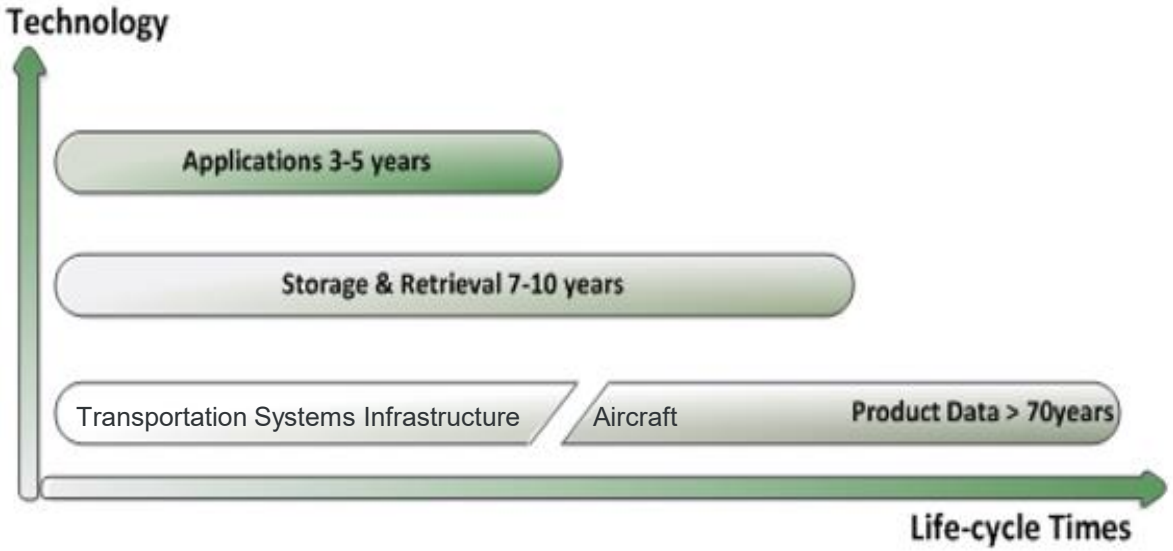
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Overview

- Motivation: Why model data preservation?
- LOTAR: an overview over planned standards
- Process overview
- Tooling prototypes
- Opportunities for Synergies
- Conclusion

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Why Model Preservation? (Long Term Archiving and Retrieval)



The tools don't survive, but models & data can live forever!

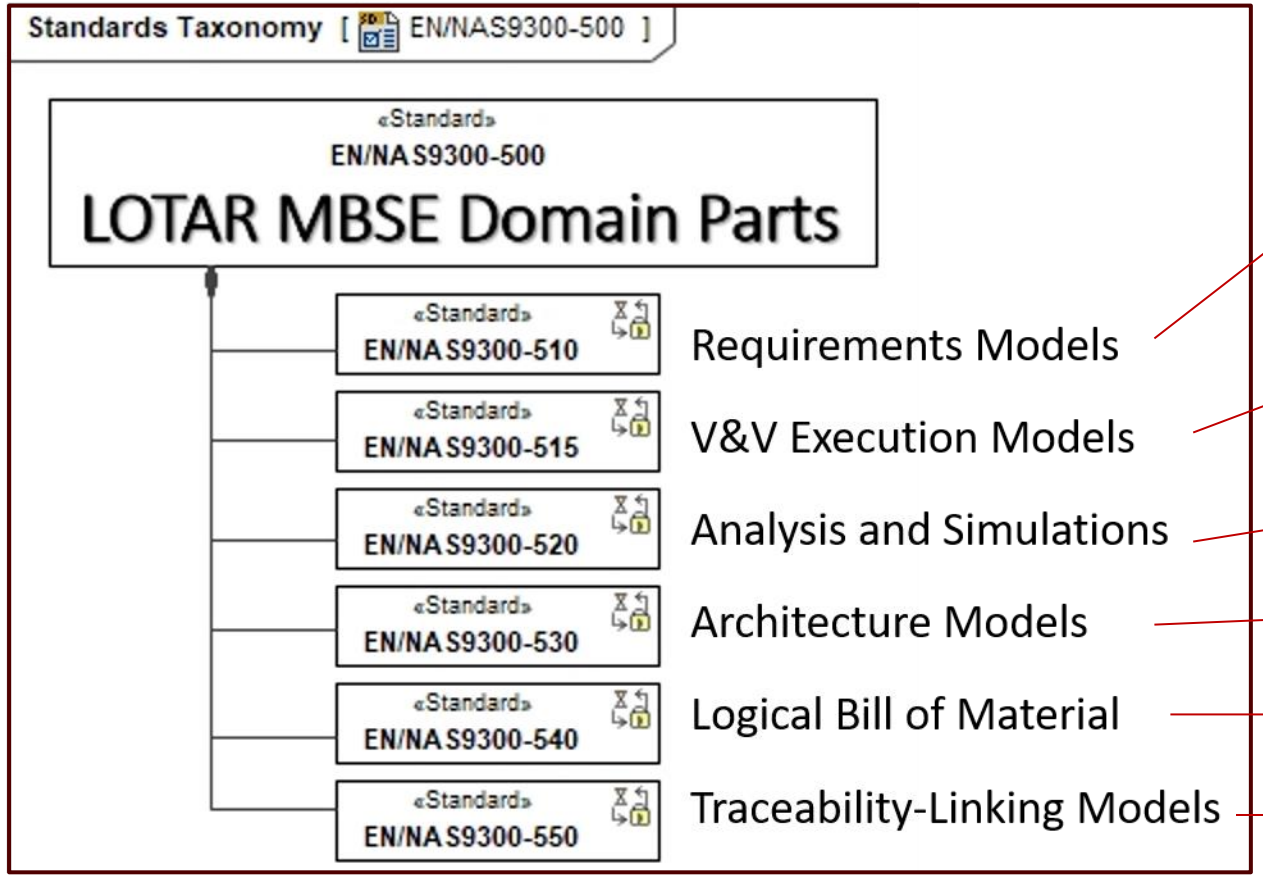
Business Use Cases

- Data & model reuse – manage risks
- Regulatory requirements Accident investigations
- Product support-modifications
- Fixing Bugs/Errors
- Part/design obsolescence
- Support for changing tools

Emphasize models! And combination with requirements & operational context
B52: 100 year platform

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LOTAR - Preservation **Process** for Multiple Model Types



Requirements Models

V&V Execution Models

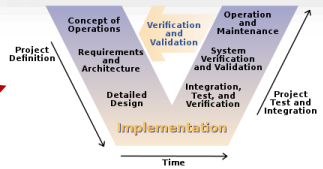
Analysis and Simulations

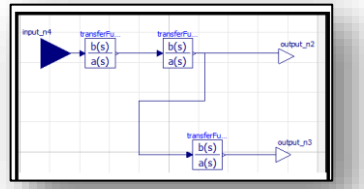
Architecture Models

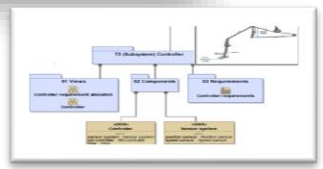
Logical Bill of Material

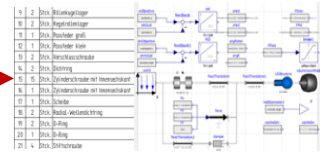
Traceability-Linking Models

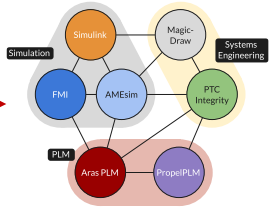






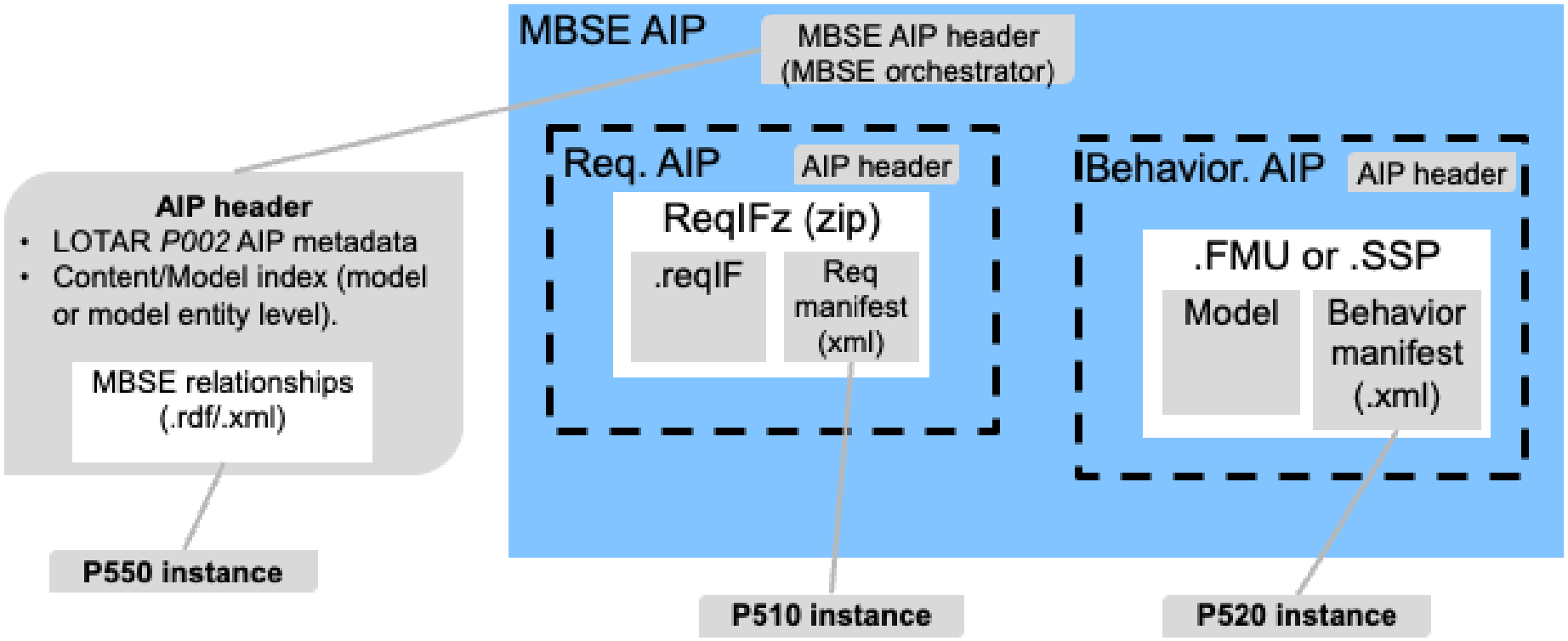






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MBSE Archive Information Package (Example)



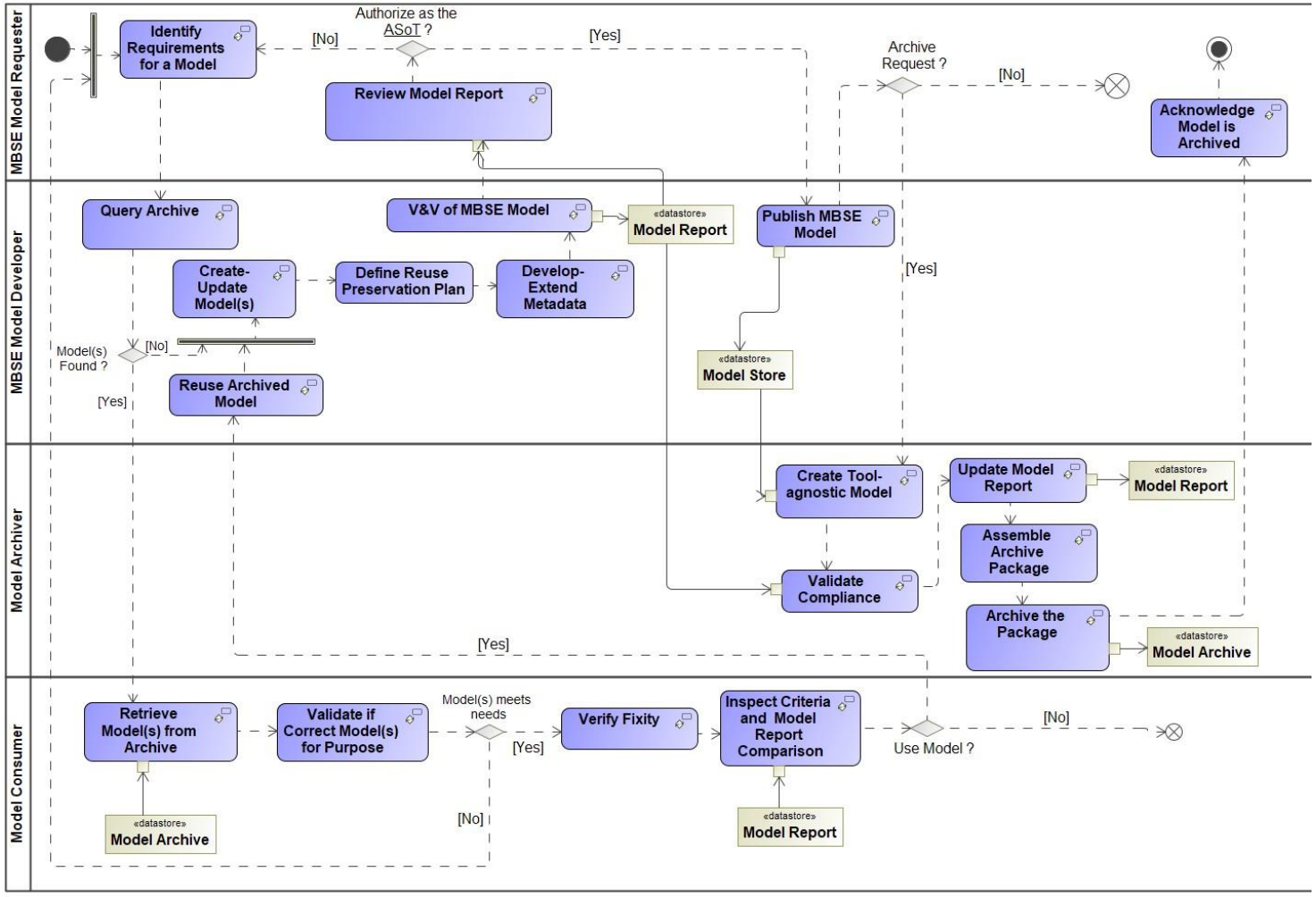
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Process Overview

Roles and Swimlanes

Create and utilize a Data Preservation Process



Model Reuse and Archive Workflow Dependencies

- *Model Metadata Manifests*
- *Model Validation Reports*
- *Configuration Management*
- *Dedicated Archives*

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Manage the Process and adapt to Lifecycle Changes

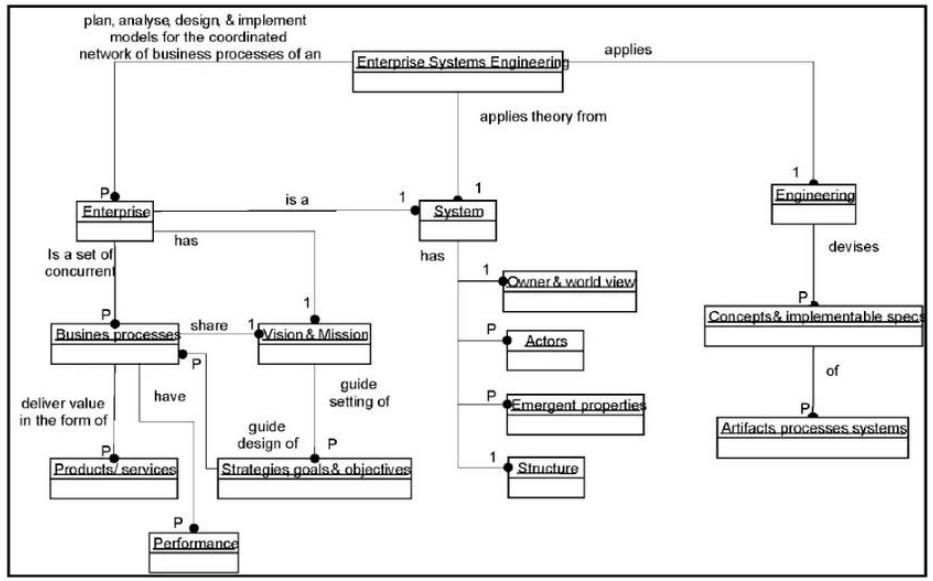
REQUIRED ACTIVITIES

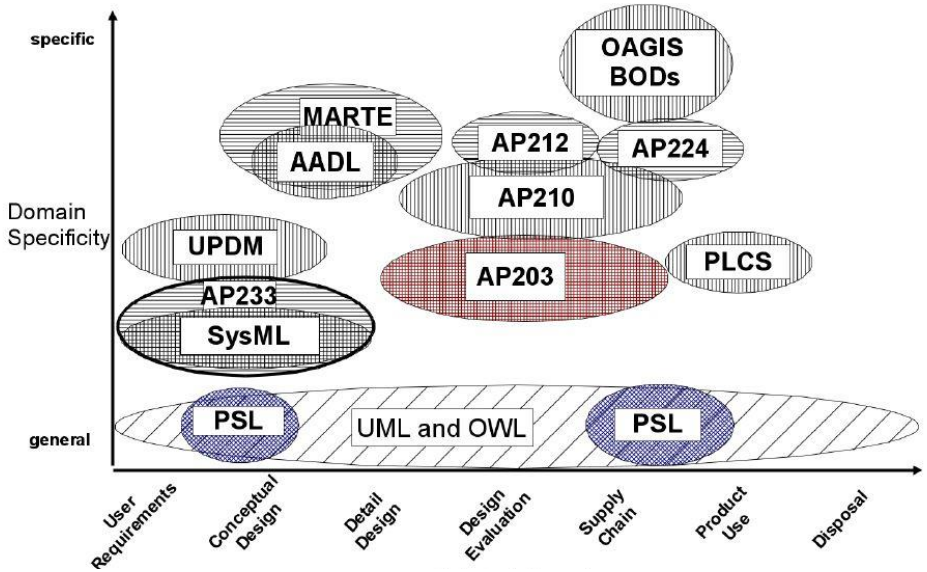
Measure the Preservation Process

Capture each Model's Metadata

Generate Validation Reports

Utilize integrated data standards





PSL: Process Specification language

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The Value of Model Metadata

- Supports model identification and creation process
- Information for observers, model initiators and reviewers
- Captures context, history, pedigree and provenance
- Supplements multi-model integration
- Avenue for model automation and change notification

MoSSEC – Modeling and Simulation information in a collaborative Systems Engineering Context, an API for model integration using web services, based on ISO 10303-243

MIC–Core is a legacy metadata representation in an XML format managed by SystemX

Decision Task Meta Data (DTMD) is an XML format representing process-relevant information, as defined by the Credible Decision Process, with a file extension ending in dtmd.

Simulation Task Meta Data (STMD) is an XML format representing model-relevant information, as defined by the Credible Simulation Process, with a file extension ending in stmd.

Simulation Resource Meta Data (SRMD) is an XML format representing metadata for resources, with file extension ending in srmd. Note that there is a mapping from MIC-Core to SRMD.

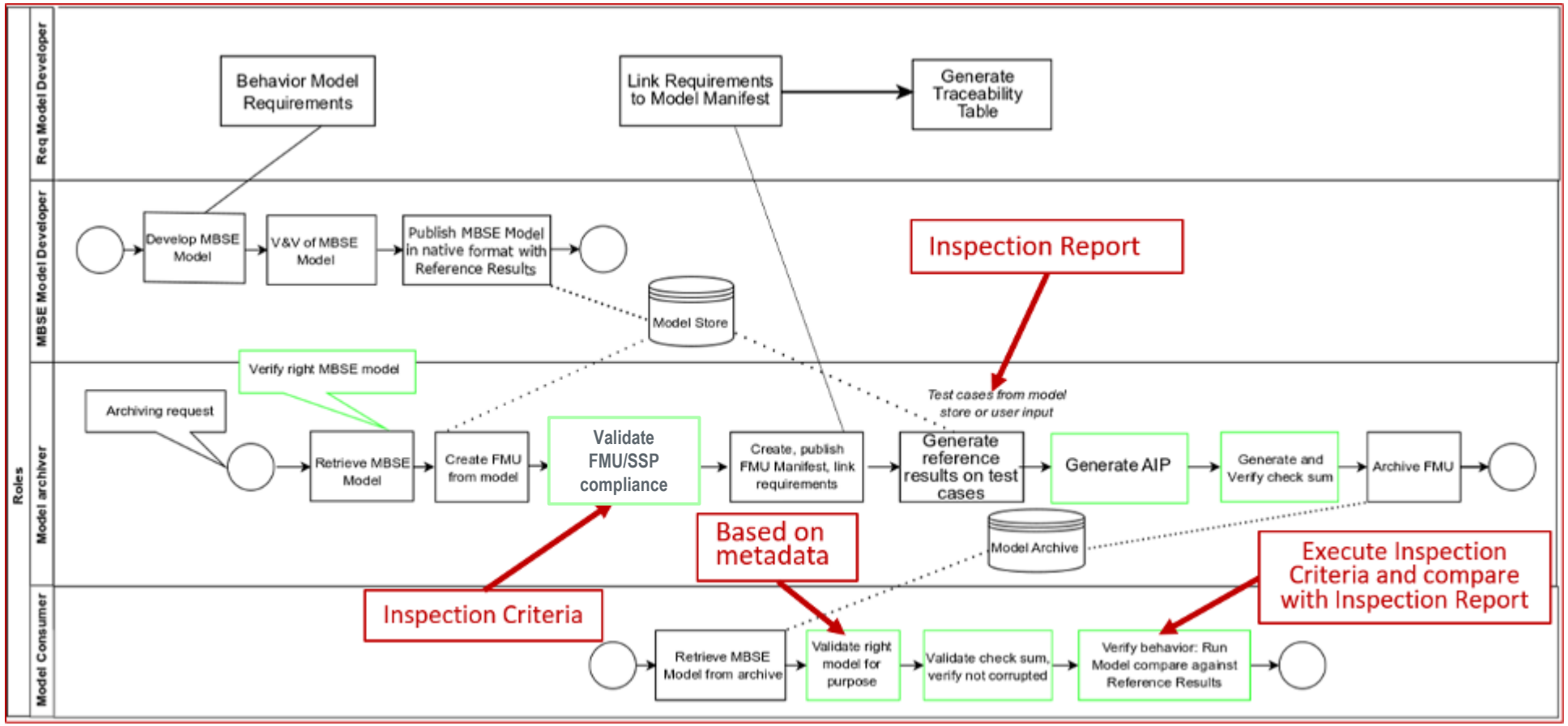
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Tooling prototypes

- Traceability for all P5XX standards – LOVO tool
- Schema, Artifact Definition and Workflow automation for P515 (Verification and Validation)

Archive creation and validation workflow



The upcoming FMI-LS-REF standard could be a great for for standardized reference results

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LOVO – LOTAR ValidatiOn (purpose)



Provide a reference implementation for the P5XX MBSE Manifests



Provide a set of utilities to effectively work with P5XX MBSE Manifests

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LOVO: capabilities

Validation of

- P5xx Manifests and packages
- Traceability links and missing links
- Traceability link content
- Archiving process from Git-based repositories

Cross-checking of PLM vs Archive repositories

Transformation of P5xx manifests into RDF triples and LPG

Generation of:

- Metapackages
- Validation reports
- HTML-based documentation

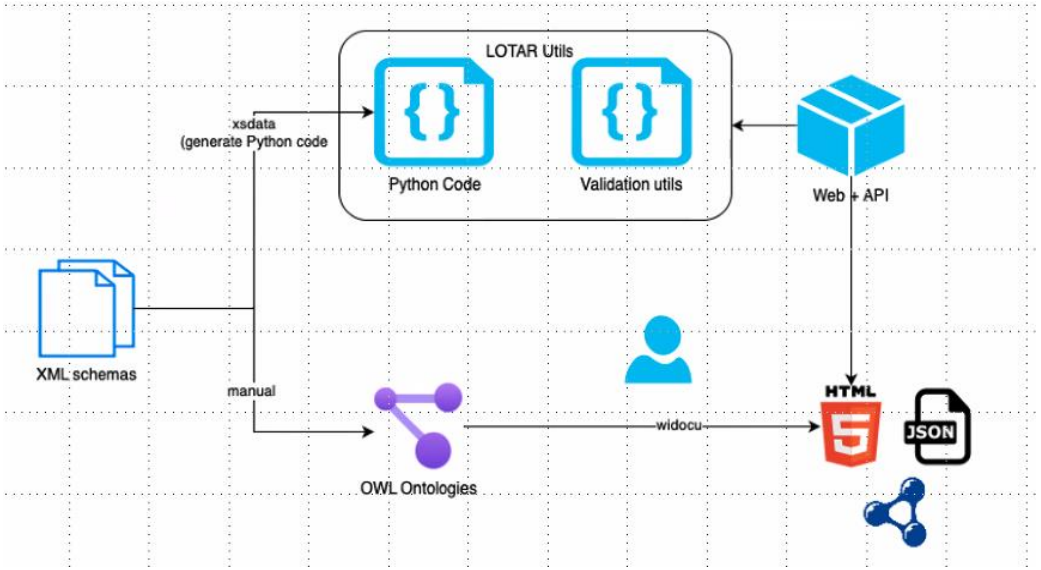
RDF: Resource Description Framework

LPG: Labeled Property Graph

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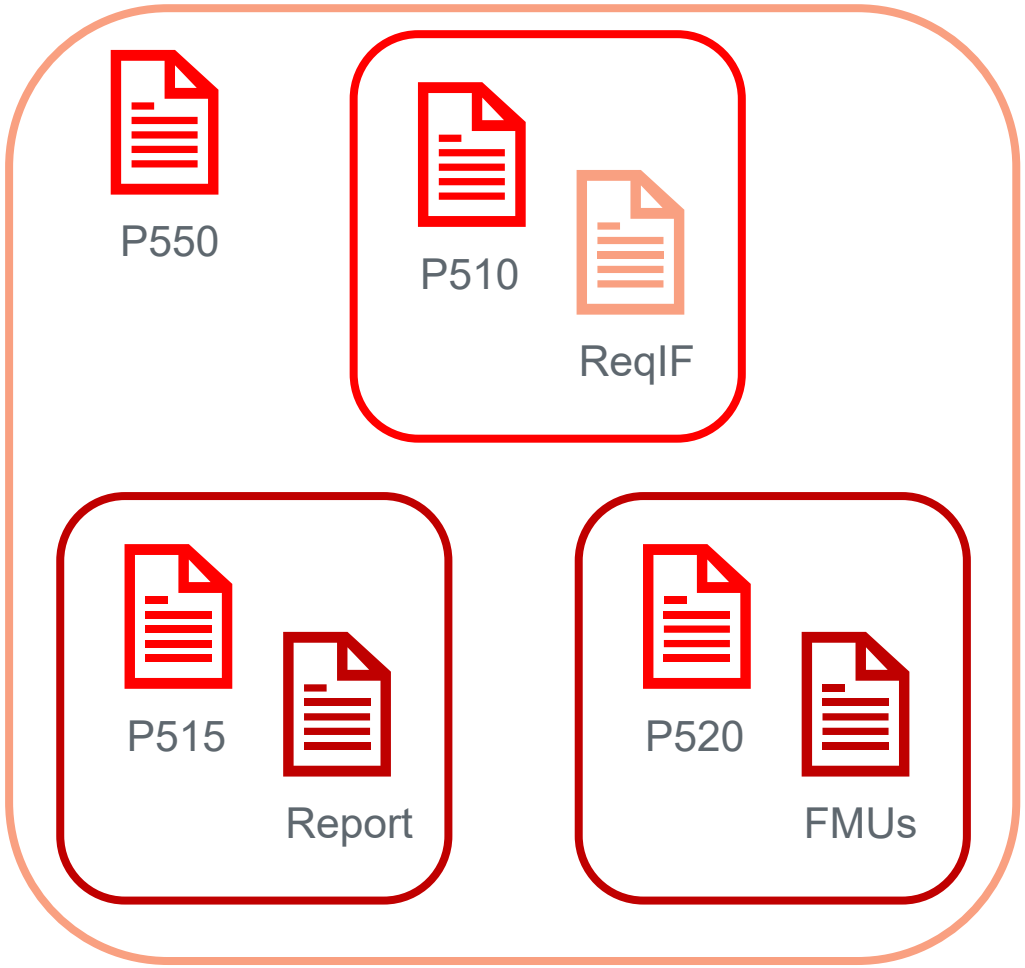
LOVO: components and development

- lotar-validation-utils: Core validation logic & schema support
- lotar-api: RESTful interface via OpenAPI/Swagger
- lotar-web: Simple graphical user interface (React.js)



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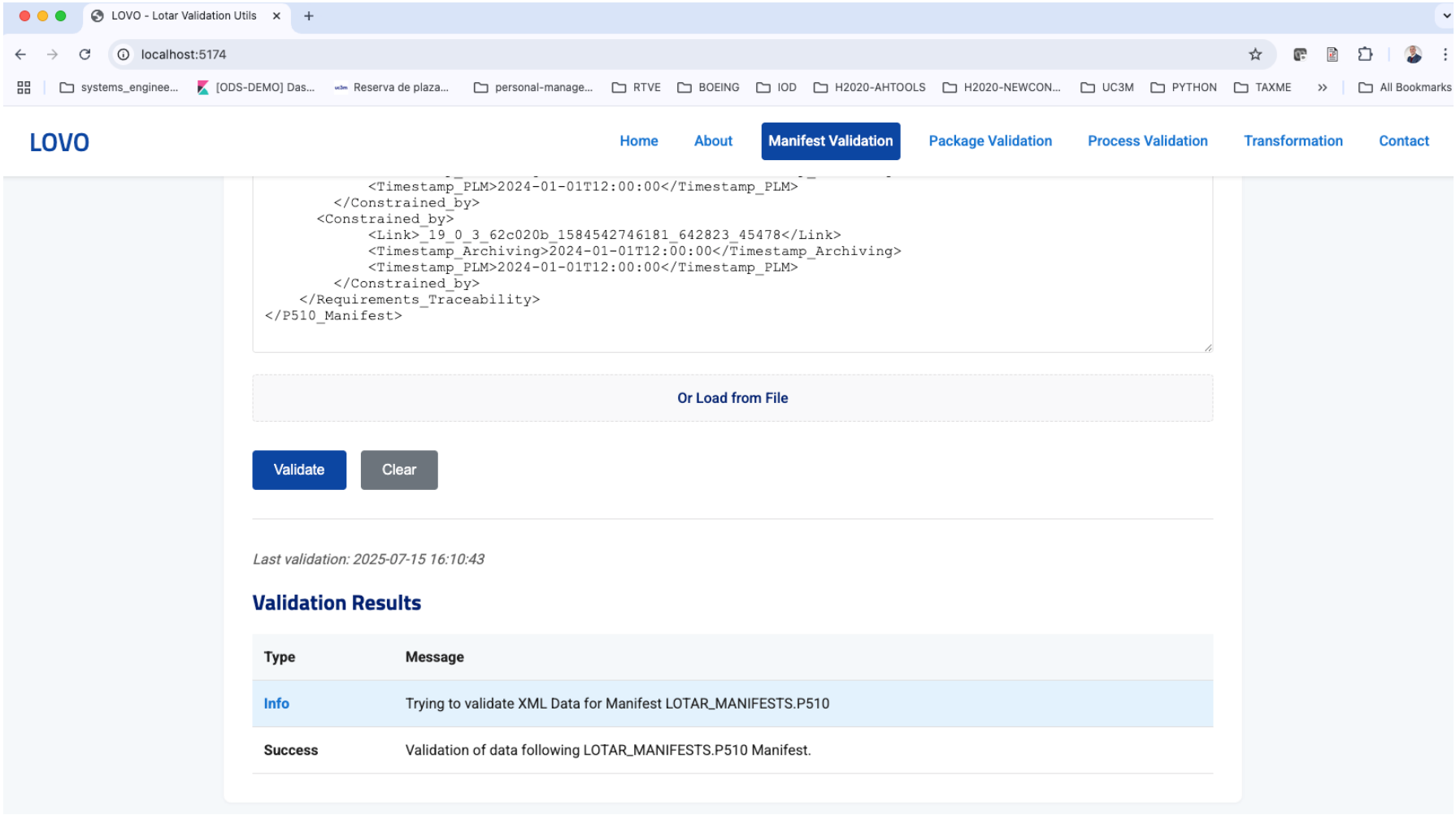
Example with Stratoliner data



- Get AIP package
- Load P550.xml
  - Validate P550 Manifest
- Access all traces
  - Check trace exists
- Access model package
  - Load P5xx file
  - Validate P5xx manifest
  - Validate content
    - ReqIF
    - FMU

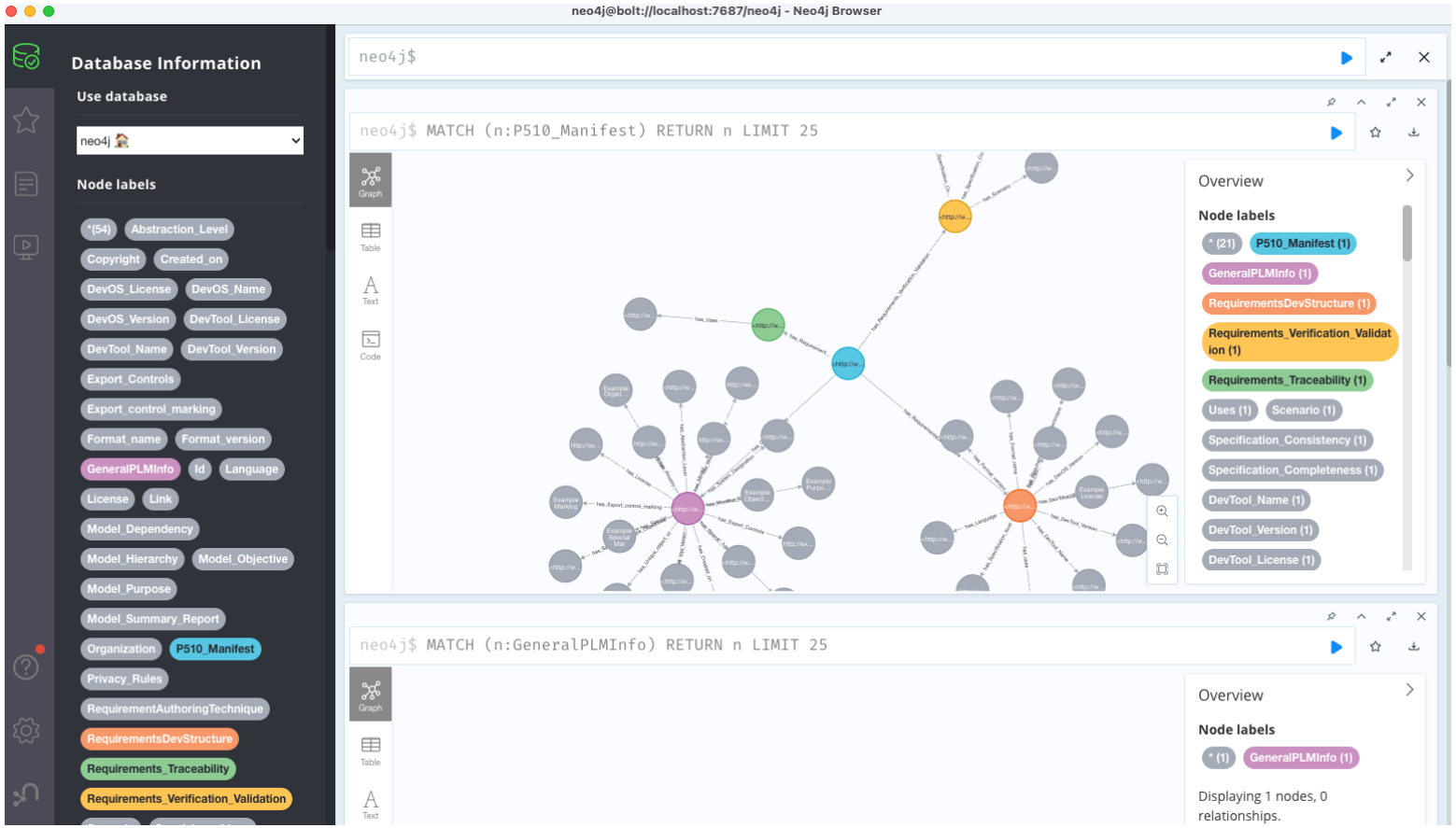
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Manifest validation: result



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LOVO - Model Metadata in Neo4J



An RDF version is also available (see next slide with a SPARQL query)

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Example of P510 in SPARQL endpoint

“Give me all scenarios that have a verification credibility level ‘Low’”

```
PREFIX rdf: <http://www.w3.org/1999/02/22-rdf-syntax-ns#>
PREFIX rdfs: http://www.w3.org/2000/01/rdf-schema#
PREFIX p510: <http://www.w3.org/2000/01/rdf-schema#>

SELECT ?scenario ?literal WHERE {
  ?manifest <http://www.lotar.org/schemas/mbse/p510#has_Requirements_Verification_Validation> ?modelVnV.
  ?modelVnV <http://www.lotar.org/schemas/mbse/p510#has_Scenario> ?scenario.
  ?scenario <http://www.lotar.org/schemas/mbse/p510#has_Verification_Credibility_Level> ?value.
  ?value rdf:value ?literal.
  FILTER(str(?literal)="Low")
} LIMIT 10
```

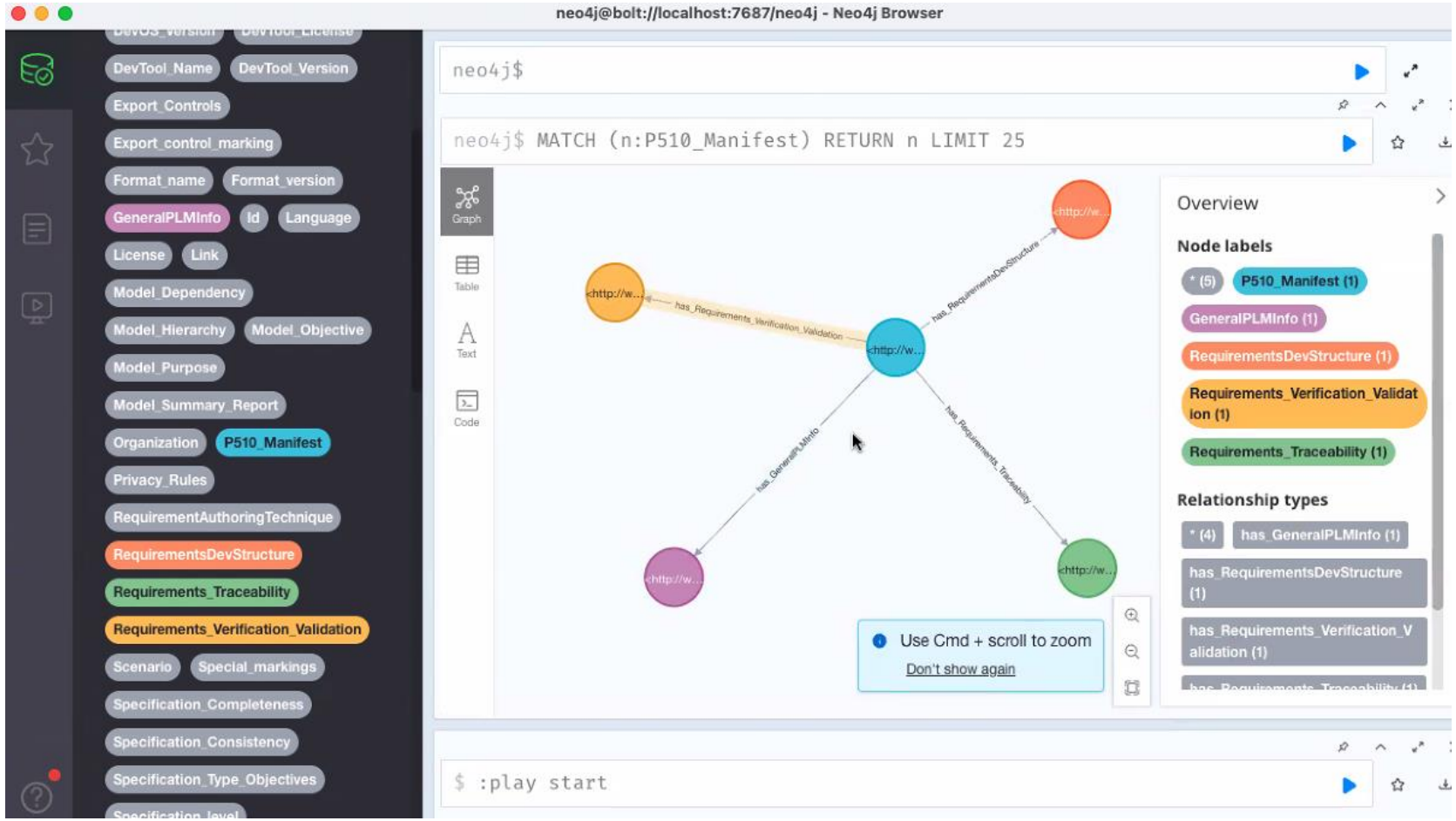
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LOVO Knowledge Graphs

Use the graph for complex queries, and requirements traceability.

Identify model2model dependencies

Verify common attributes and parameter values



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P515 Prototype implementation, in Modelon Impact



- Schema prototype for V&V artifacts & information (in JSON to be finalized as XML)
- Based on system models in SSP-format, with components as FMUs



- Formalizes the V&V process used for Modelica models by Modelica Association
- Creates, updates, and validates a **Behavioral Model Report (BMR)**
  - Add/remove test cases
  - Create reference result files
  - Verify reference files
  - Create completed model report

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P515 Prototype implementation, in Modelon Impact

- Implemented as Python scripts, which is the integrated scripting in Modelon Impact.
- Creates and updates model manifests inside the FMUs and SSP, in the ”extra”-folder, using the standardized extension mechanism for FMI/SSP under org.lotar-international as extension namespace.
- Can verify that contents are unmodified from archived version using hashes

  - Note: Closely related to ongoing effort FMI-LS-REF! to store reference results, and the parameter sets that create them, inside FMUs.
  - Possibility to replace the BMR with FMI-LS-Ref final specification.



Call to action: Collaboration between MA and LOTAR-PDES for further unification and use of common standards!

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Conclusions

- Process standards for LOTAR (long term archiving) of system models are under development through collaboration between industry (PDES, AIAA, Prostep) and engineering organizations (INCOSE)
- Long term archiving of models is an important use case for data standards such as the MA standards
- The current draft standards make heavy use of and reference the current MA standards, and layered standards
- Collaboration between the MA and the PDES-LOTAR Group could create further synergies

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