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Collaborative and cross-stakeholder ontology engineering

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- Resource Relation Model

- Evaluation (Approach)

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Motivation

The SC3 Ontology Platform

- **Semantically Connected Semiconductor Supply Chains** (SC3)
  - EC H2020, Coordination and Support Action (CSA)
  - Runtime: 01.10.2020 – 20.09.2023

- **Motivation: Semiconductor** production is a **complex industry**
  - E.g. supply chains are complicated by **short product cycles** and **strong dependencies** to further industries
  - Requires a stable generic **industrial reference communication platform**

- **Objectives:**
  - To support **collaboration of industrial and academic stakeholders** to encourage **interoperability** between semiconductor companies and further industrial domains, based on **Digital Reference (DR) Ontology**
  - To develop a framework to ensure an **agile development**, validation and refinement loop

Motivation

The SC3 Ontology Platform

- **Challenge**
  - An ontology is a joint work between **domain experts** and **knowledge engineers**
  - We need a tools to achieve a **common understanding** of the **domain** and its **formal representation**
    - Visualization of ontologies for different expert groups

- **Objective:** To understand the content of ontologies we need cross-stakeholder:
  - **Collaborative** ontology development platform
  - Ontology **visualization**.

- **Proficiency** levels considered: Novice, Intermediate, and Expert

Mapping Pipeline
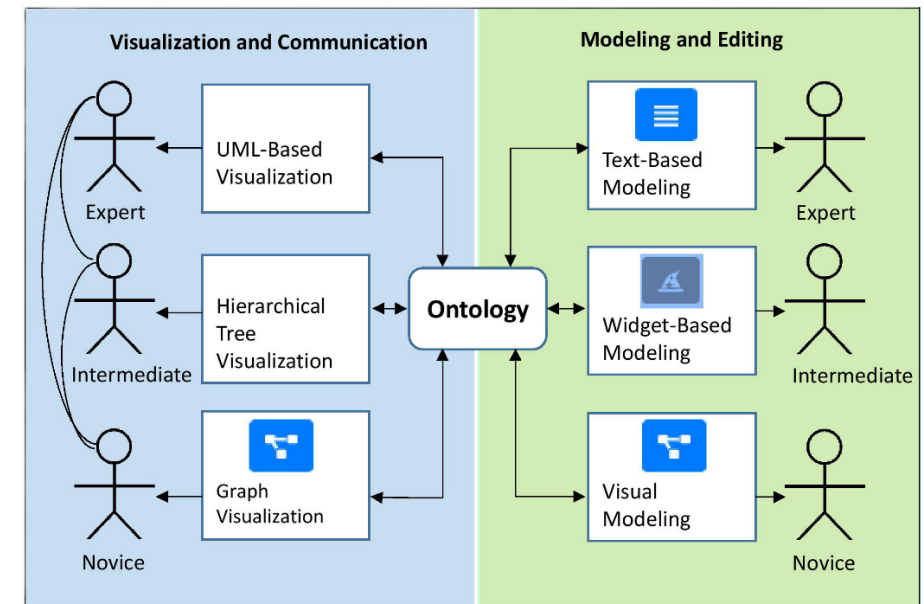
**Pipeline Components (** *@Vitalis Wiens)*

- **Data Processing Layer**
  - Pre-process data and convert to RRM
- **Resource Relation Model**
  - A data model which serves as a foundation for visualizations and synchronization between different modes of operation
  - It is a textual representation of the ontology
  - Created through pre-processing step
  - provides some re-organization of triple statements to enable different modes of operation

- **Vertex Edge Model**
  - Designed to reflect a basic graph structure using vertices and edges.
  - Vertices are derived from resources
  - Edges are derived from relations and provides source and target attributes for the connection between vertices

- **Node Link Model**
  - Modify the Graph Structure for Visualization . Merge, split and nesting mappings
  - Nodes have an id, a type, and a name.
  - Links have a source and a target node additionally to form the connections
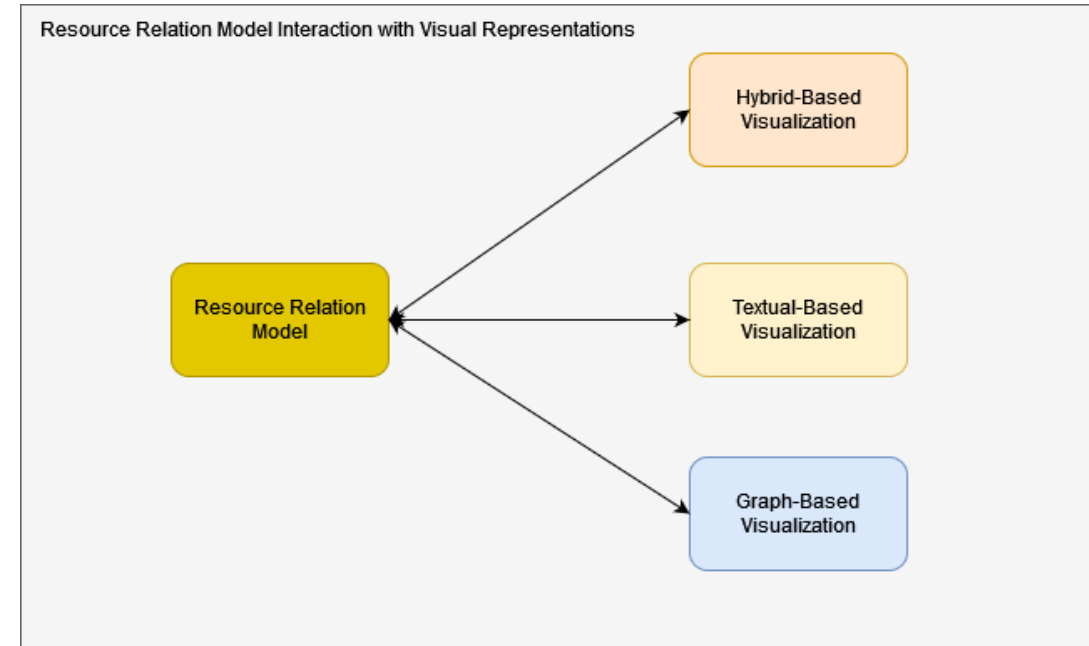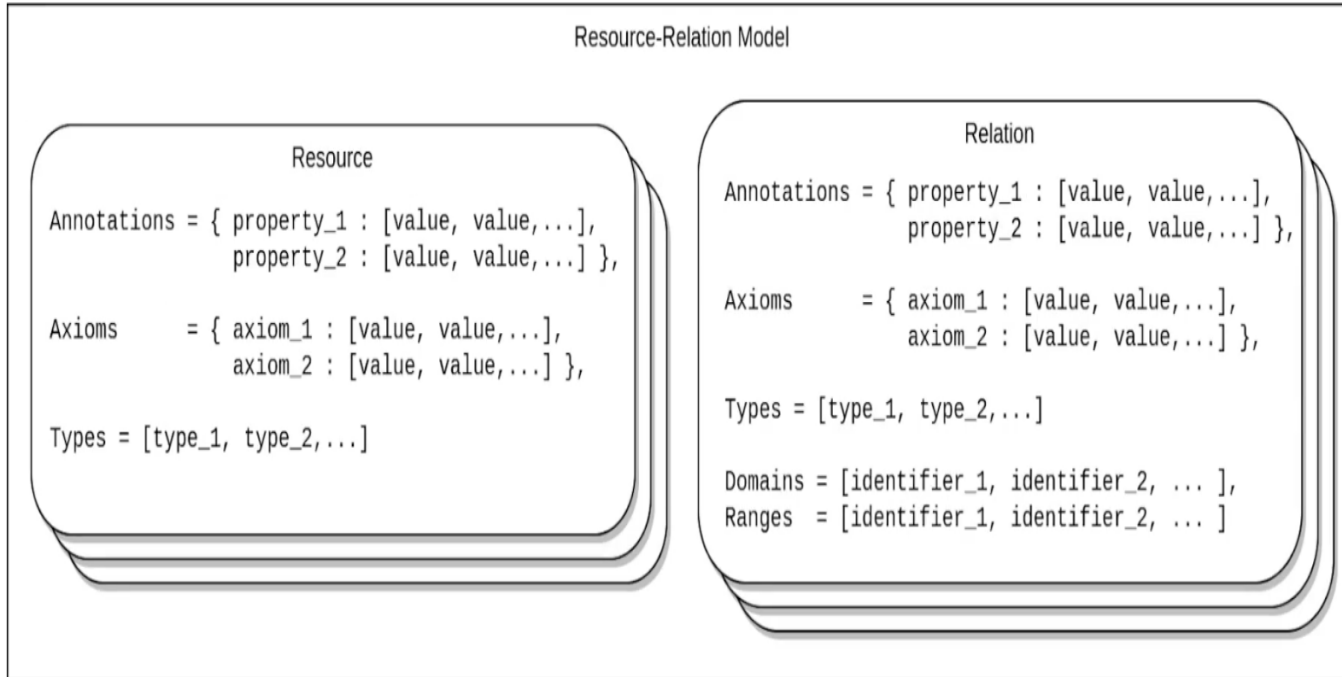
Mapping Pipeline

Pipeline (@Vitalis Wiens)
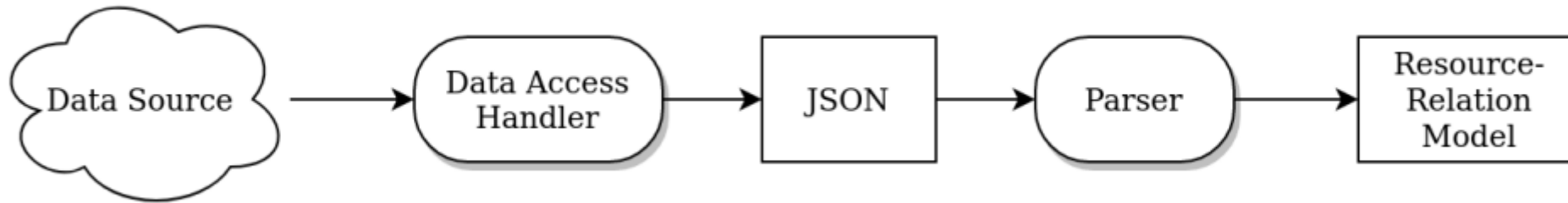
Data Processing Layer
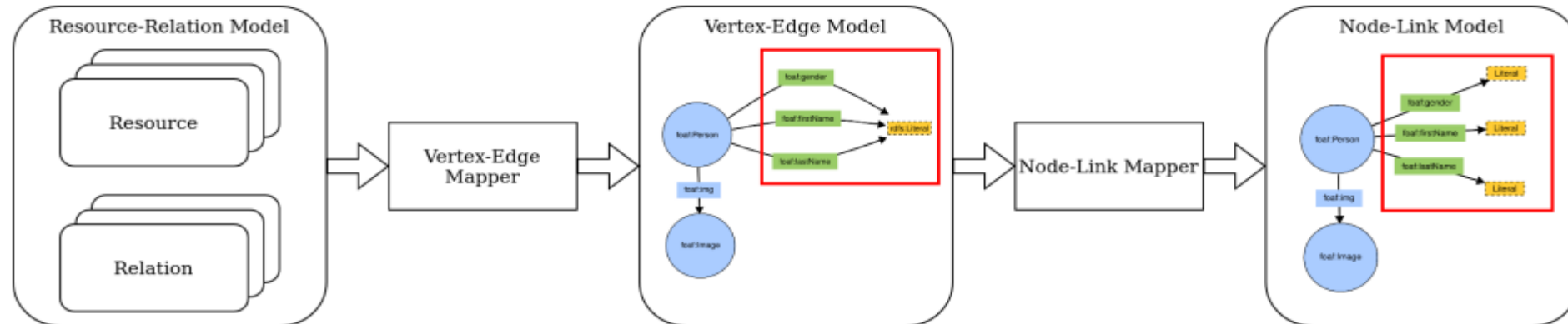
Two-fold mappings from RRM to Node-Link Model

Resource Relation Model

Resource-Relation Model

Resource

Annotations = { property_1 : [value, value,...],
                property_2 : [value, value,...] },

Axioms   = { axiom_1 : [value, value,...],
               axiom_2 : [value, value,...] },

Types = [type_1, type_2,...]

Relation

Annotations = { property_1 : [value, value,...],
                property_2 : [value, value,...] },

Axioms   = { axiom_1 : [value, value,...],
               axiom_2 : [value, value,...] },

Types = [type_1, type_2,...]

Domains = [identifier_1, identifier_2, ...],
Ranges = [identifier_1, identifier_2, ...]

Resource Relation Model Interaction with Visual Representations

Hybrid-Based Visualization

Resource Relation Model

Textual-Based Visualization

Graph-Based Visualization

RRM model and its interaction with other views in SC3 Ontology Platform

SC3 Platform evaluation (approach)

- *"Usability Evaluation **focuses on how well users can learn and use a product to achieve their goals**."*

- **Pre-test survey** as preparation for extensive evaluation (usability + mental workload)

- **Applied methodologies**
  - Usability evaluation
    - **The System Usability Scale** (SUS). Easy to scale, useful with small response sizes
    - 10 item questionnaire
    - **Scale:** strongly agree to strongly disagree
  - Subjective mental workload assessment
    - **NASA Task Load Index** (NASA-TLX)
    - *"a subjective workload assessment tool which allows users to perform subjective workload assessments"* [2]
    - **determine the MWL of a participant while they are performing a task**
    - **rates performance across six dimensions to determine an overall workload rating**

[1] https://www.usability.gov/what-and-why/usability-evaluation.html#:~:text=Usability%20Evaluation%20focuses%20on%20how,related%20to%20a%20new%20site.
[2] https://humansystems.arc.nasa.gov/groups/tlx/

SC3 Platform evaluation (approach)

The System Usability Scale (SUS)

- Consists of 6 sections
  1. About you
  2. Experience with SC3 platform
  3. Task Load
  4. About the SC3 platform approach
  5. Additional Feedback
  6. General

- radio button selections
- rating scales from 1 - 5
- Freetext fields

7 Persons took part in the pre survey

I found that various functions of the SC3 platform were well integrated *

	1	2	3	4	5	
Strongly disagree	○	○	○	○	○	Strongly agree

SC3 Platform evaluation results

The System Usability Scale (SUS) results

Participant	SUS raw score	SUS final score
1	27	67.5
2	28	70
3	26	65
4	31	77.5
5	31	77.5
6	21	52.5
7	27	67.5
Average:	27.29	68.21
Users experience with SC3 platform		

Average of all **SUS final scores** is equivalent to **68.21** that is marked as C grade (65.0 – 71.0)

1. **Users experience** with SC3 Ontology Platform
2. between **OK (51.7 – 62.6) GOOD (71.1 – 72.5).**

Only three participants have experience with using SC3 Ontology Platform which is between C+ (good) and A (excellent)

SC3 Platform evaluation results

The System Usability Scale (SUS) results

SC3 Ontology Platform functionalities / performances	Percentage of participants that agree and strongly agree
User interface is easily understandable	85.7
Hybrid mode for ontology modelling	71.5
The dropdown buttons in Hybrid mode	71.5
Easy to find the search/filter functionality valuable	85.7
Easy to interact with the graph based visualization	71.5
The interaction with the graph is clear	71.4
Easy to navigate between different views	71.5
Performance of the platform is fast in terms of ontology editing	71.4
The role of collapsible sidebars is clear	100%
Participants' opinion about SC3 Ontology Platform functionalities	

- Second column summarizes percentages of agreed and strongly agreed scores about **listed functionalities** in the first column.
- In total more than **71 percent** of participants agreed or strongly agreed on selected functionalities.
- **Critical points** in SC3 Ontology Platform functionalities which participants observed are **interaction** with graph and how the platform is **fast** in terms of ontology editing, that is in total 71.4 percent of votes.

SC3 Platform evaluation results

NASA Task Load Index (NASA-TLX) results

- amount of effort participants took to upload, visualize and modify ontology.
- **High (34.29) mental activities** is required for all users to **upload, modify and visualize** ontology when using the SC3.

Temporal results: **time pressure** that participants felt during the work with the SC3 is also **high (54.29)**

All participants **require high (41.43) amount of effort** to achieve requested level of performance when using the SC3

On individual basis, all participants, except one, needs high mental, temporal activities when using the SC3

Participant/ NASA-TLX subclasses	Mental	Physical	Temporal	Performance	Effort	Frustration	Individual score results
							Raw/Unweighted (Mean*)
1	40	-	80	90	30	10	50
2	20	-	10	100	10	10	30
3	30	-	50	80	80	100	68
4	50	-	50	50	50	50	50
5	20	-	80	100	30	20	50
6	20	-	50	50	50	80	50
7	60	-	60	70	40	40	54
Group score results Raw/Unweighted (Mean*)	34.29	-	54.29	77.14	41.43	44.29	Overall: 50.29

SC3 Platform Components

Collaboration

- **Projects List View**: Add/Delete/Edit Project, Access type

- **Ontologies List View**: Upload from Github/File system, Delete, View

Visualization: Hybrid, Graph, Text

Editing: Web protégée integration

Documentation: future release (widico integration)

Collaboration

Roles: Public User, Key User, Member, Project Admin, System Admin
Projects: Public Projects, Private Projects

Select Project mode

Collaboration

Roles: Public User, Key User, Member, Project Admin, System Admin
Projects: Public Projects, Private Projects

Select Ontology mode

Visualisations

Hybrid Mode Visualization

Textual-Based Visualization

Visualisations
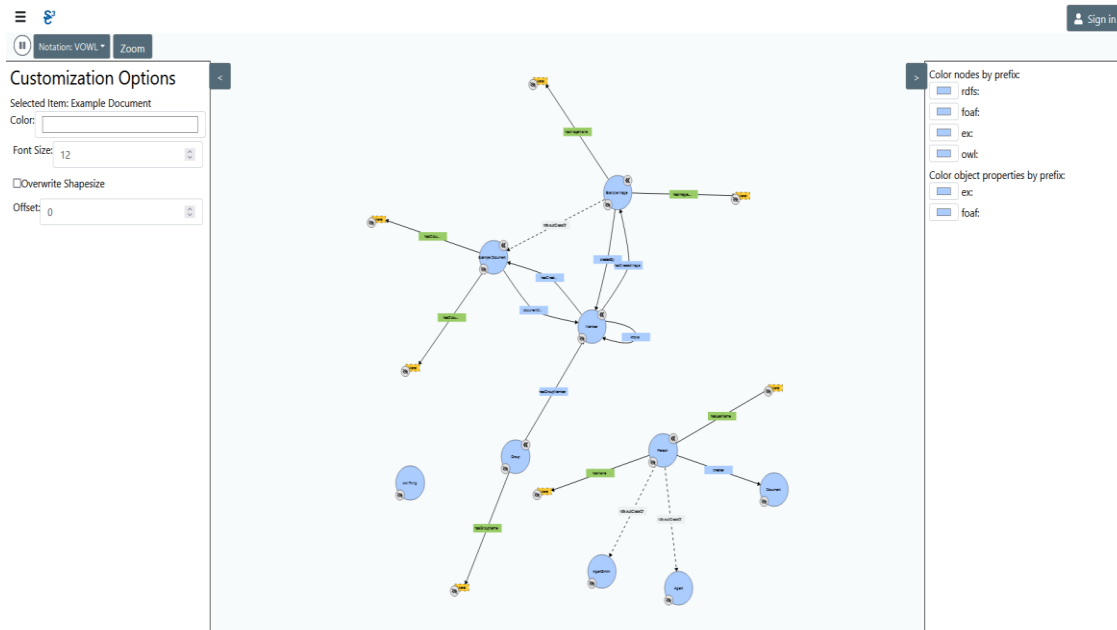
Graph-based Visualization with VOWL Notation
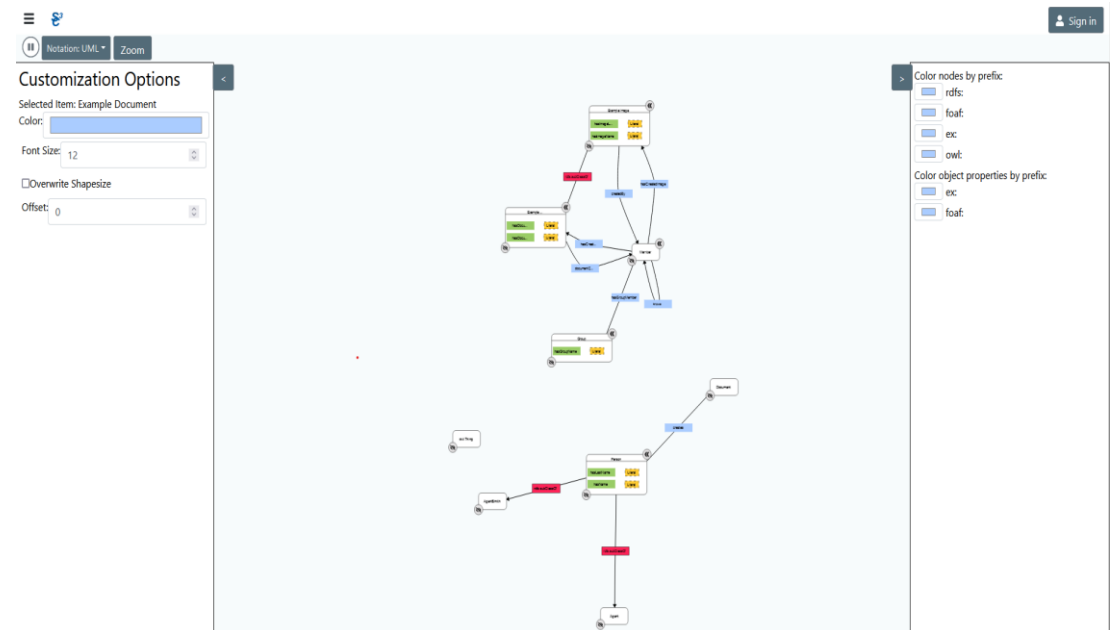
Graph-Based Visualization with UML Notation

Visualisations

Navigation left sidebar & Metadata right sidebar

Editing (Webprotege integration)

WebProtege within SC3

Thank you for your attention!

Questions!

https://service.tib.eu/sc3/