University of Applied Sciences and Arts Northwestern Switzerland
School of Business

Università di Camerino

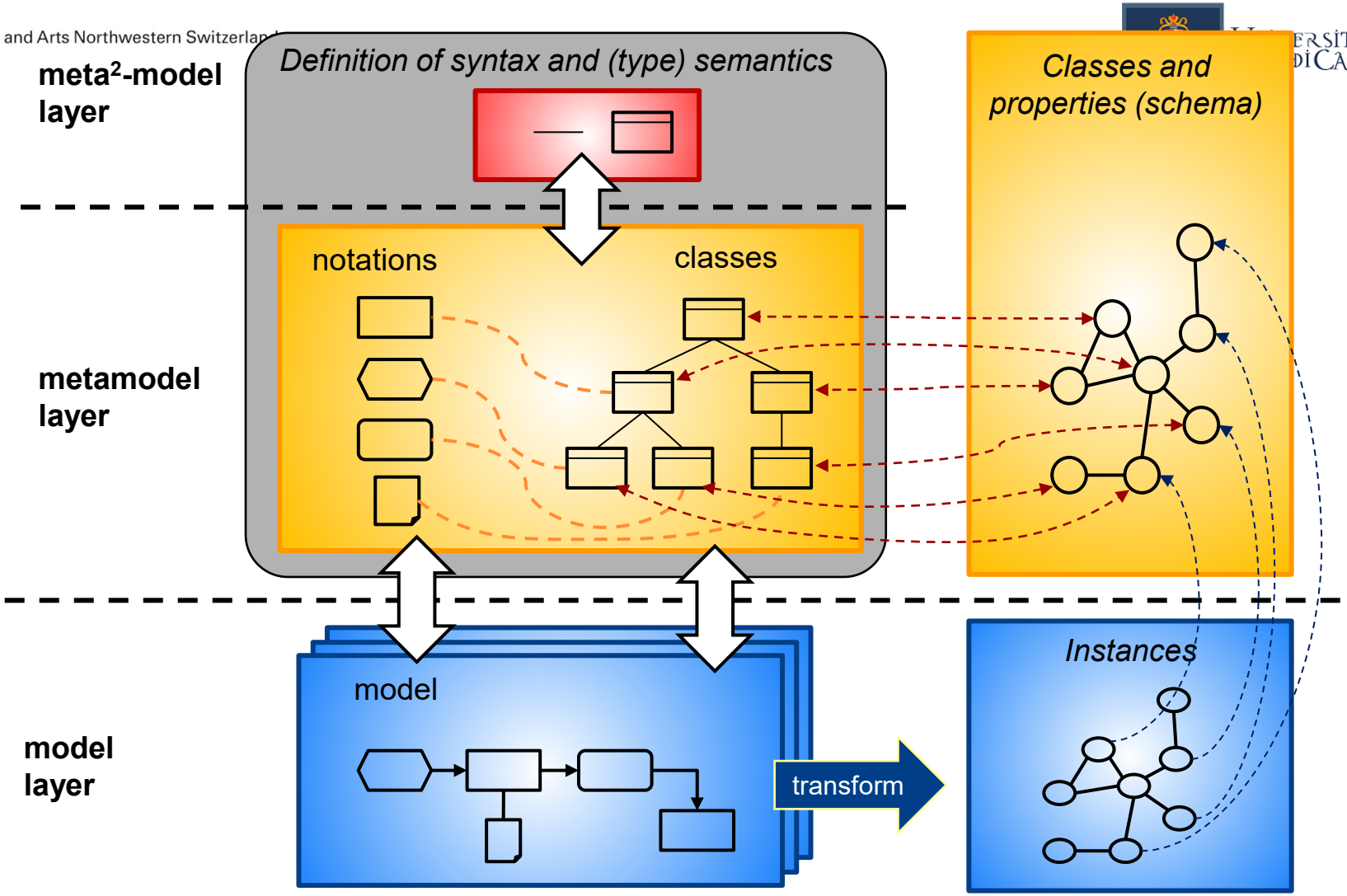
Semantic Lifting

Knowledge Engineering SS24
MSc Computer Science
Camerino, 26/05/2025
Prof. Emanuele Laurenzi

Semantic Lifting – A definition

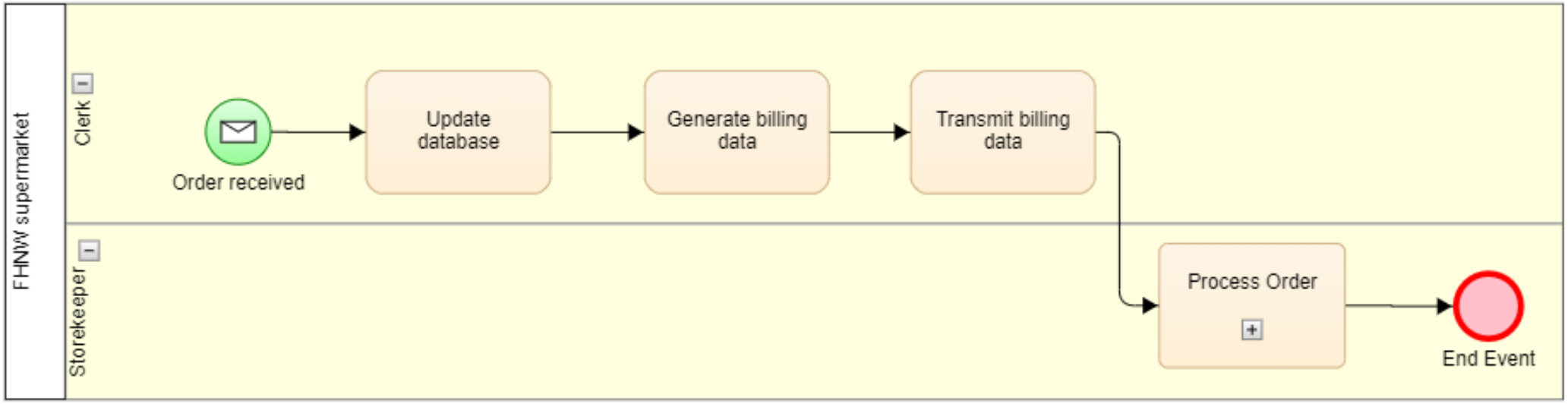
– A knowledge engineering technique that aims to annotate model constructs with ontology concepts or instances. Semantic lifting allows the formalization of the semantics of model constructs, thus enabling reasoning on and automation of knowledge contained in conceptual models.

Semantic Lifting

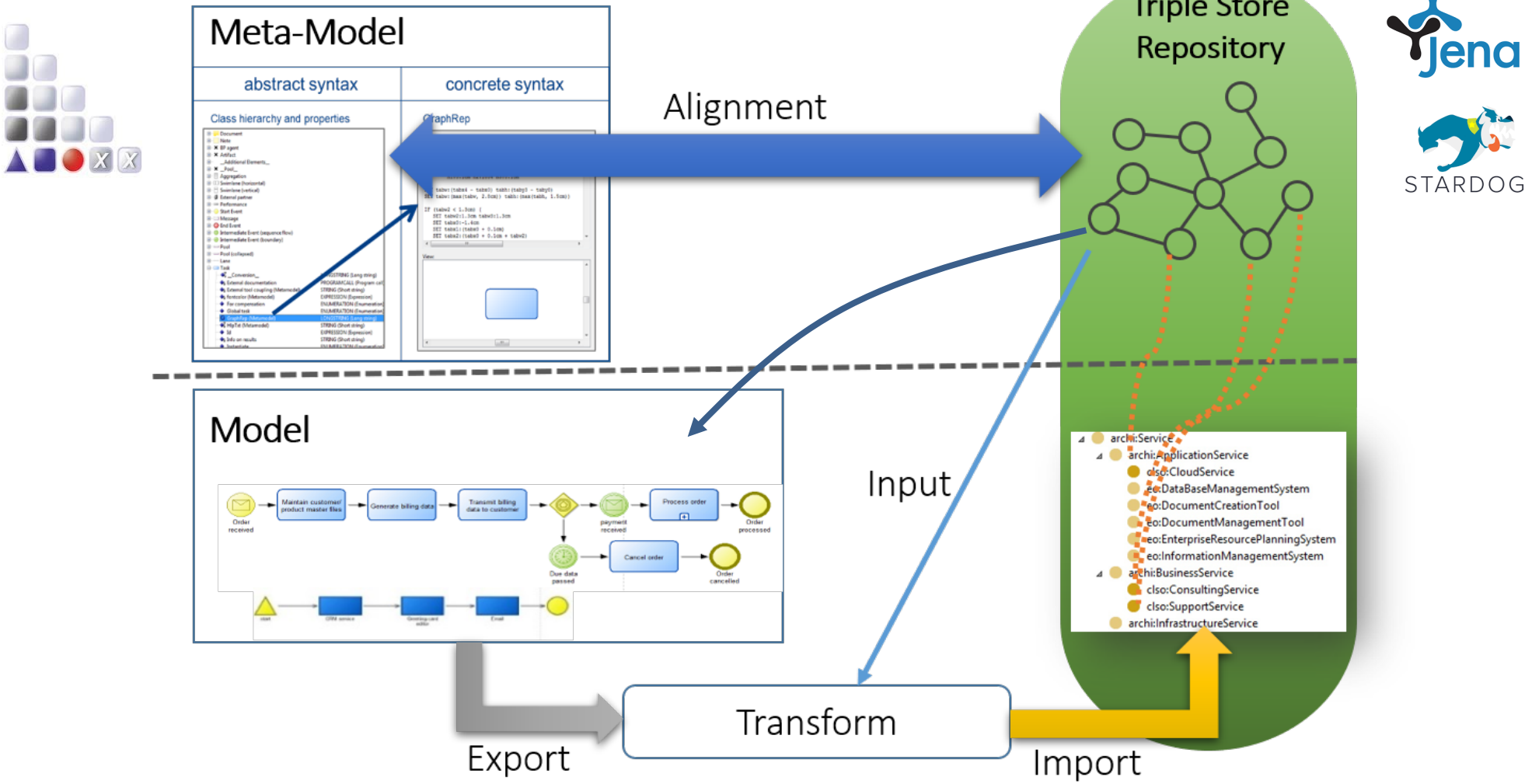


Exercise 1:

– Given the below “Order Processing” process model, create a corresponding ontology in Protégé.
  – incl. the ontology meta-model



Semantic Lifting: Implementation

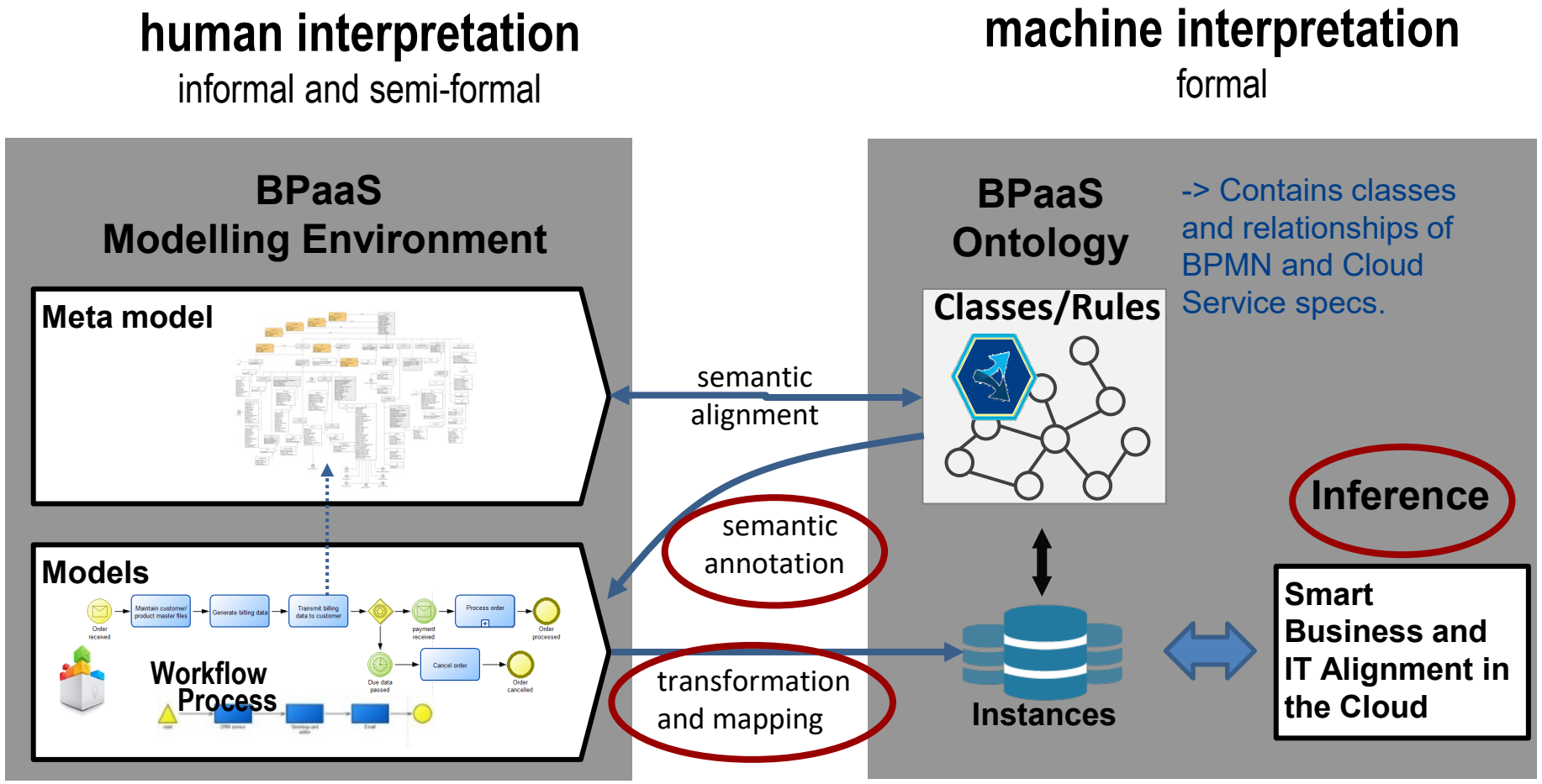


Amazon Neptune
GraphDB
Jena
STARDOG

Case: Business Process as a Service (BPaaS)

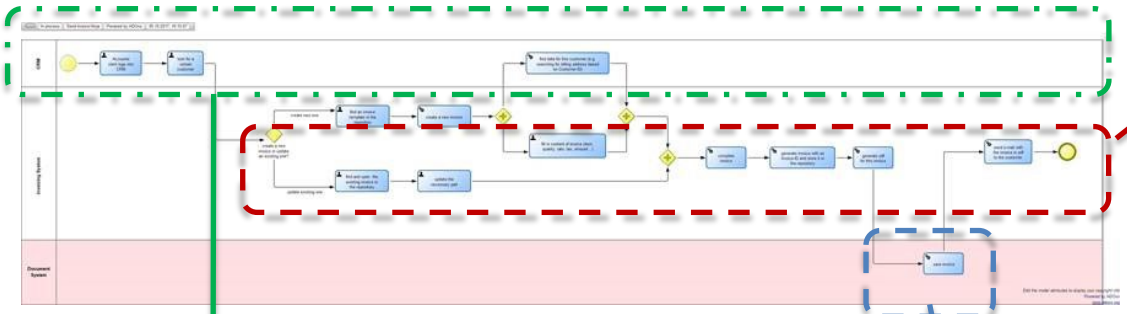
EU Research Project where Semantic Lifting was applied.

BPaaS environment



Smart Business IT Alignment in the Cloud

– Given a BPMN business process, retrieve all the Cloud Services that satisfy the functional and non-functional requirements.



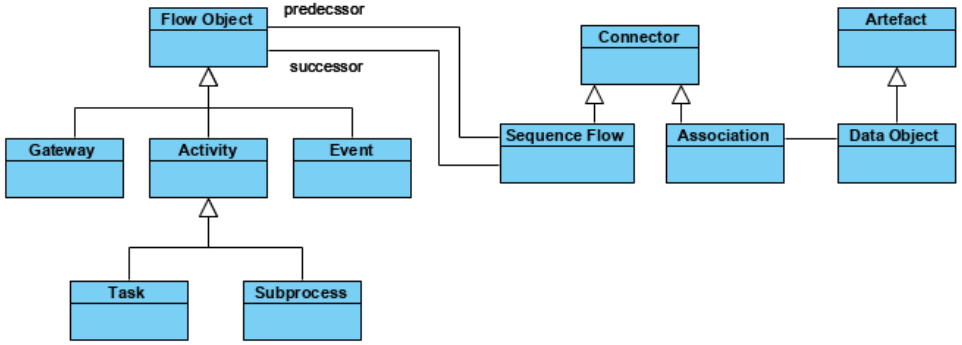
CLOUD IS NO LIMIT YMENS

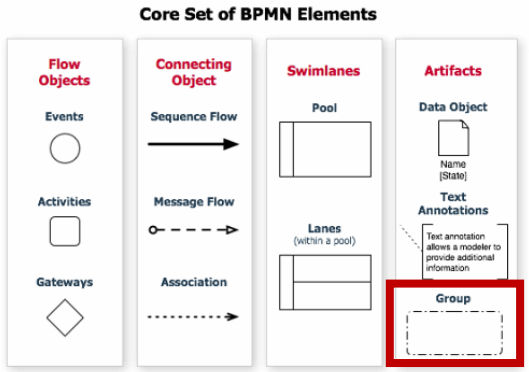
ZOHO CRM

Challenge: BPMN does not accommodate functional req. nor non-functional req. for Cloud Services.

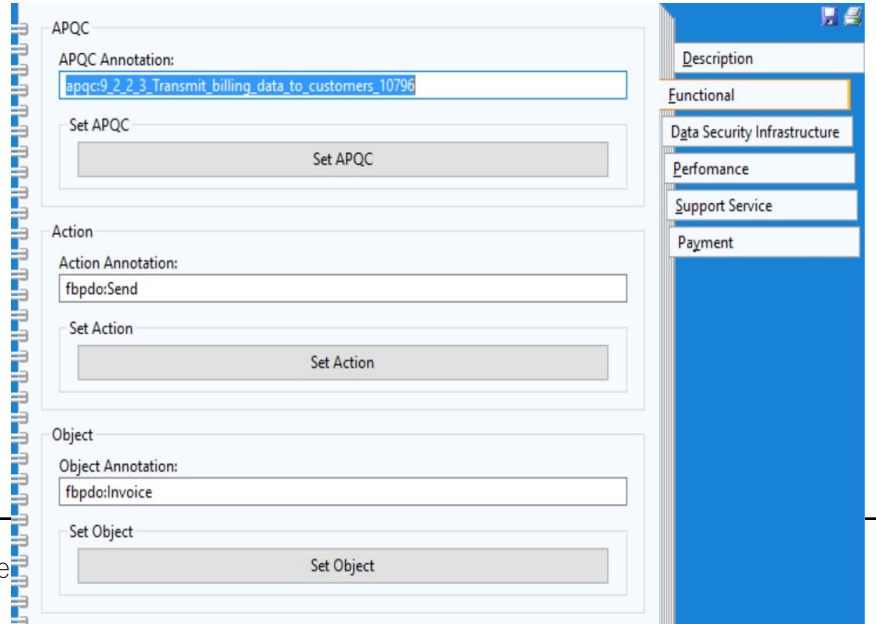
Meta-Modelling

Extend BPMN element «Group» with CS business requirements

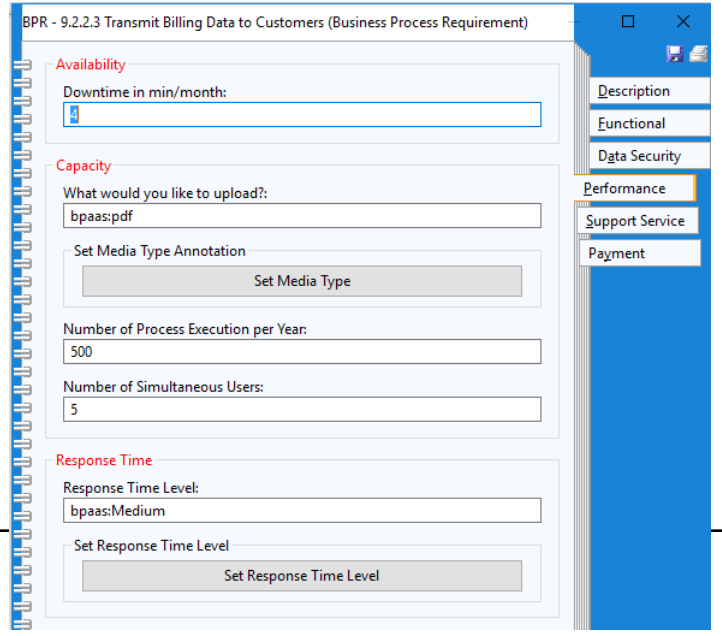




Functional Requirements

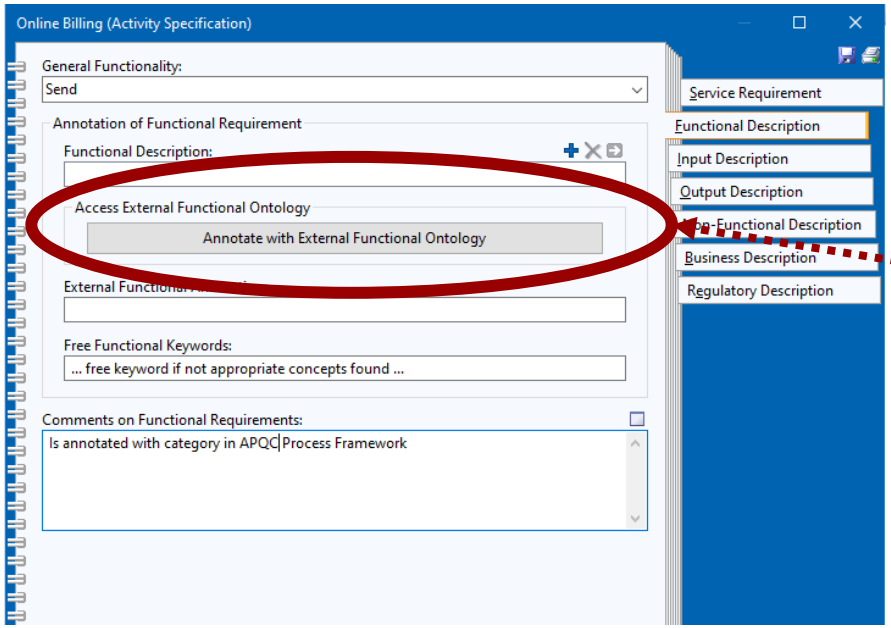


Non-Functional Requirements



Semantic Annotation

Annotate modeling elements with classes or instances from the domain ontology.
Example: Functionality of a Service

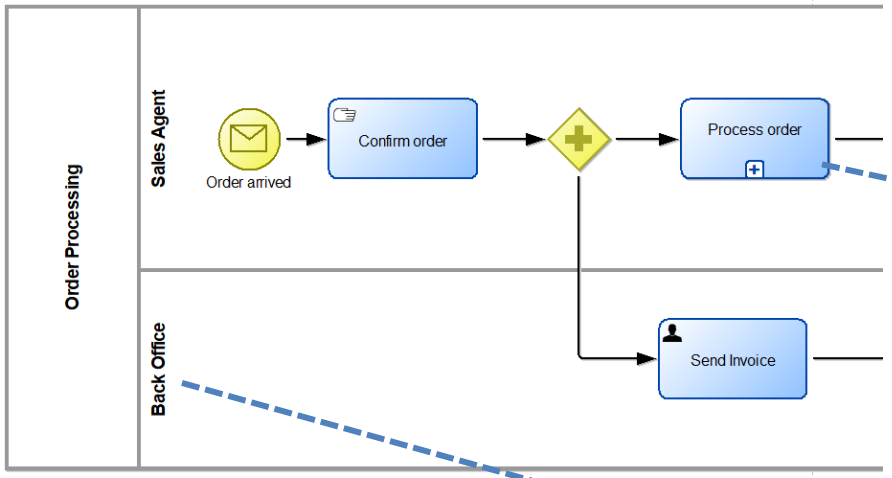


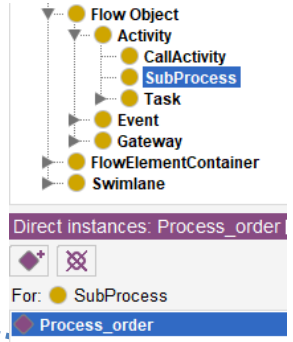
Domain Ontology:
APQC Process Classification Framework

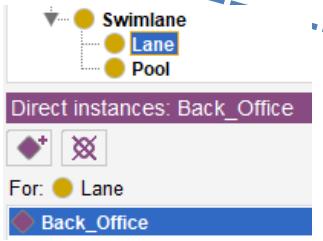
- owl:Thing
  - American Productivity and Quality Center
    - Acquire, Construct, and Manage Assets
    - Deliver Physical Products
    - Deliver Services
    - Develop and Manage Business Capabilities
    - Develop and Manage Human Capital
    - Develop and Manage Products and Services
    - Develop Vision and Strategy
    - Manage Customer Service
    - Manage Enterprise Risk, Compliance, Remediation, and Resiliency
    - Manage External Relationships
    - Manage Financial Resources
      - Manage fixed-asset project accounting
      - Manage internal controls
      - Manage international funds/consolidation
      - Manage taxes
      - Manage treasury operations
      - Perform general accounting and reporting
      - Perform global trade services
      - Perform planning and management accounting
      - Perform revenue accounting
        - Generate customer billing data
        - Post receivable entries
        - Resolve customer billing inquiries
        - Transmit billing data to customers
      - Manage and process adjustments/deductions
      - Manage and process collections
      - Process accounts receivable (AR)
      - Process customer credit
      - Process accounts payable and expense reimbursements
      - Process payroll
    - Manage Information Technology (IT)
    - Market and Sell Products and Services

Transformation and Mapping

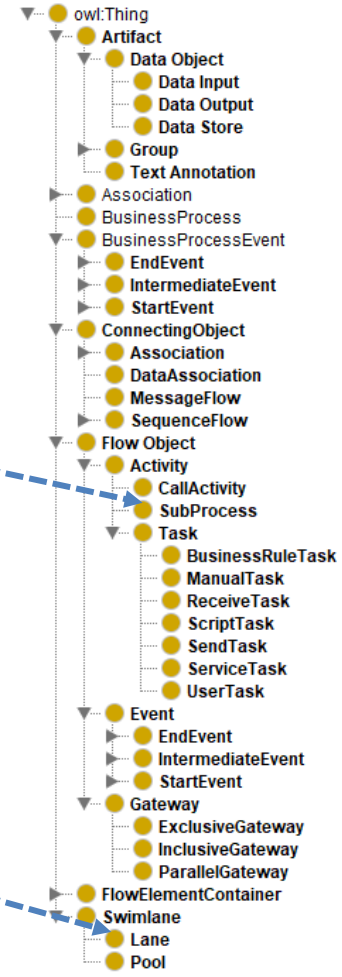
– The model elements are exported as instances of ontology classes







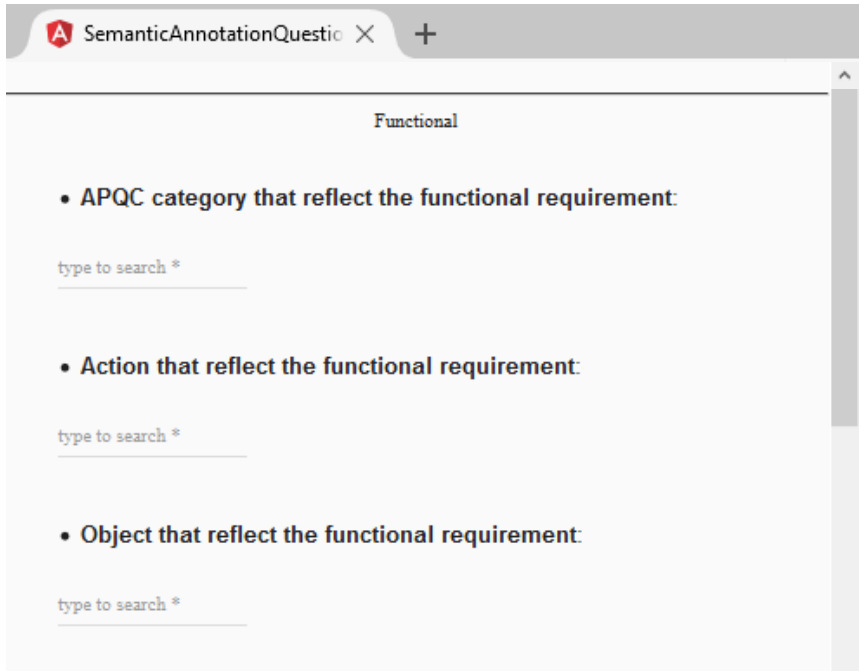
BPMN Ontology



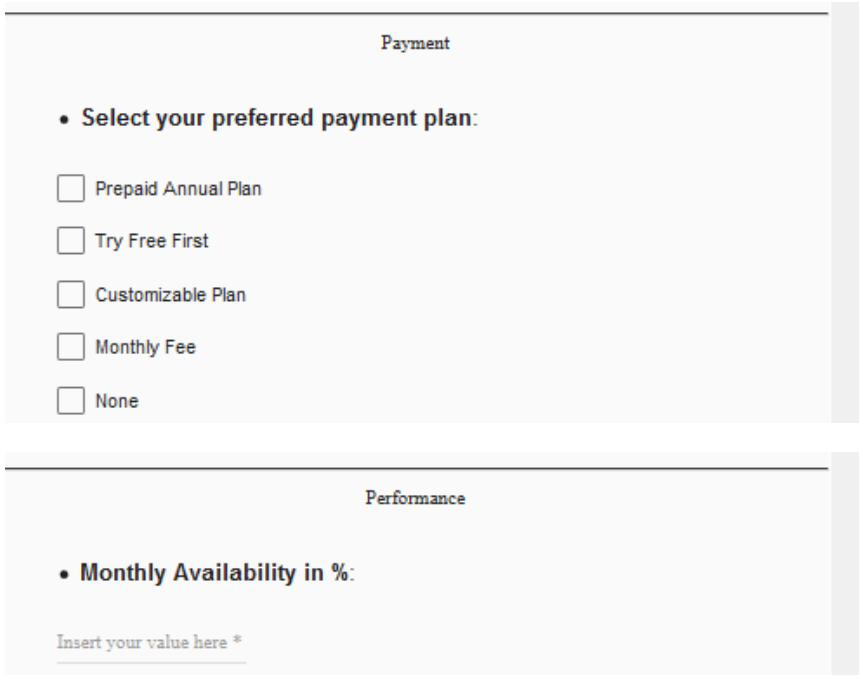
Cloud Services Specifications

– Enter the CS specifications to the triplestore via user interface

Functionality

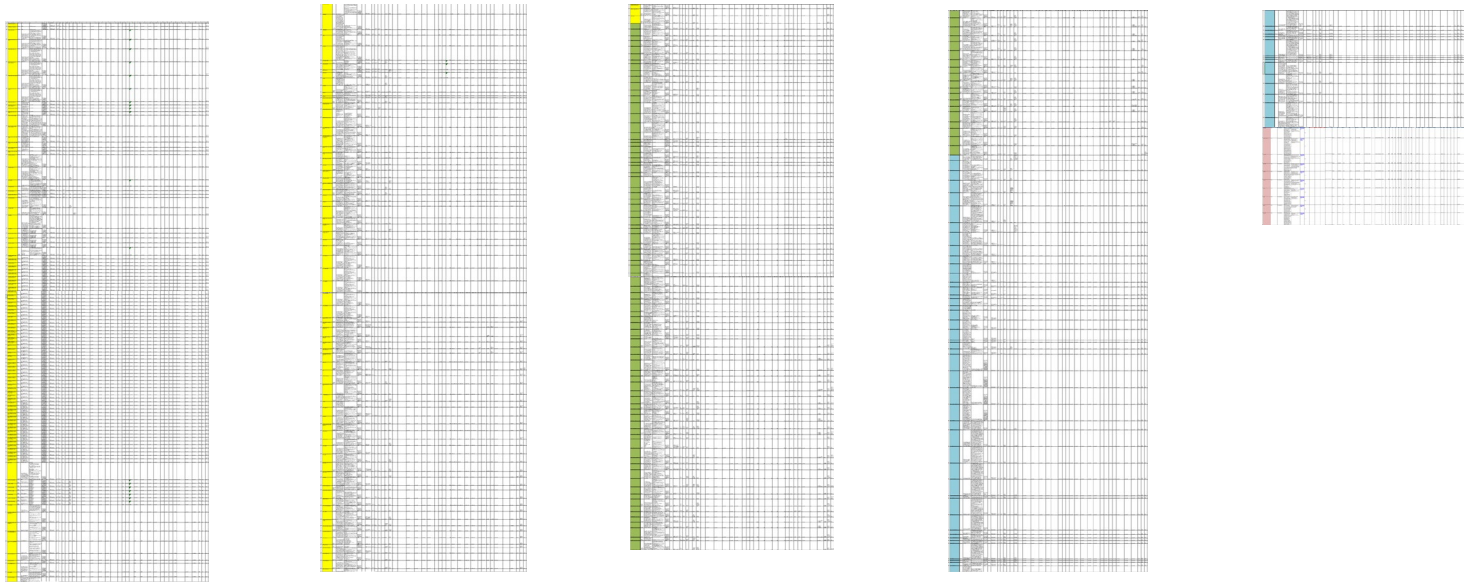


Non-functional requirements



355 Cloud Services

- 355 CSs from 4 Marketplaces – with 13.098 specs values.
  - (yellow: UK digital marketplace; green: Also marketplace; blue: IBM marketplace; rose: Ymens Marketplace)



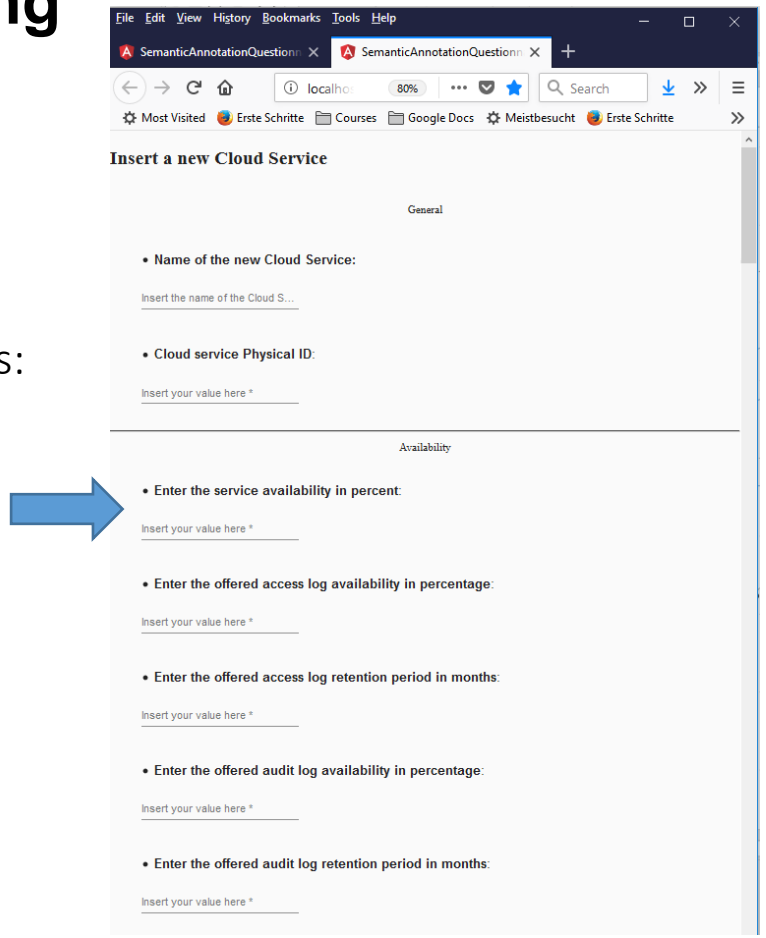
Machine Reasoning
to enable the retrieval of suitable Cloud Services

–Semantic rules (in SPARQL),

1. For Business-IT mapping
2. To make knowledge explicit

1. Semantic Rules for Business-IT Mapping

– Semantic Rule to convert CS specs in business req. e.g.
  – monthly **availability in %** to monthly downtime in minutes:



SPARQL

```
CONSTRUCT {
        ?cs bpaas:cloudServiceHasMonthlyDowntimeInMinute ?downtimeInMinute .
} WHERE {
        ?cs rdf:type bpaas:CloudService .
        ?cs bpaas:cloudServiceHasAvailabilityInPercent ?availability .
        BIND ((100-?availability)/100*43800 AS ?downtimeInMinute)
}
```

**43800 min is approx. equivalent to 1 month.*

2. Semantic Rules to make knowledge explicit

– Example: If a CS offers a backup retention time up to one year, implies also
  – Up to six months
  – Up to one month
  – Up to one week
  – Up to one day

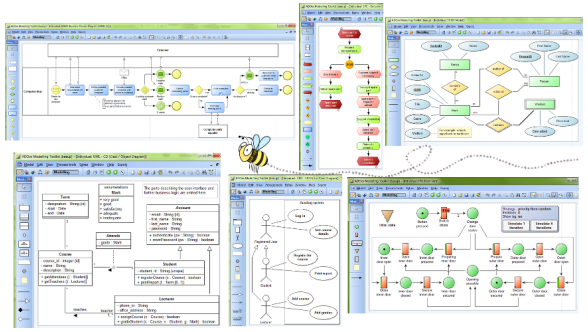
SPARQL

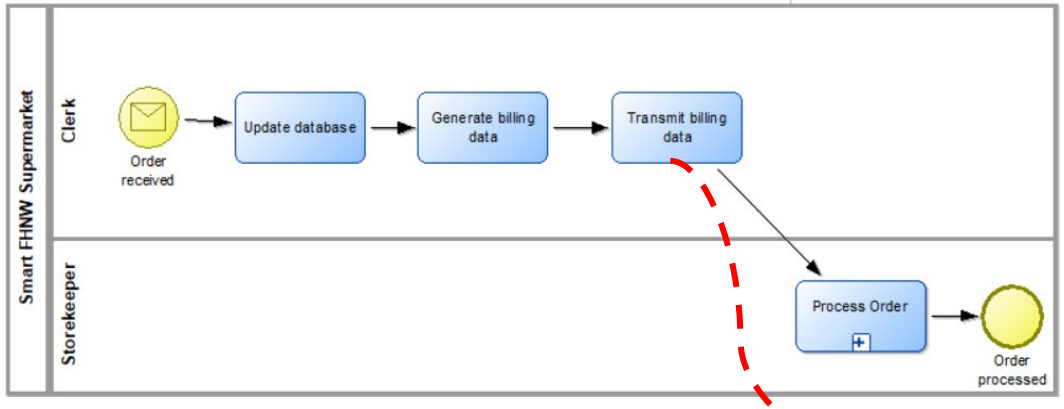
```
[CONSTRUCT {
        ?cservice bpaas:cloudServiceHasBackupRetentionTime bpaas:up_to_6_months .
        ?cservice bpaas:cloudServiceHasBackupRetentionTime bpaas:up_to_1_month .
        ?cservice bpaas:cloudServiceHasBackupRetentionTime bpaas:up_to_1_week .
        ?cservice bpaas:cloudServiceHasBackupRetentionTime bpaas:up_to_1_day .

}
WHERE{
        ?cservice rdf:type bpaas:CloudService .
        ?cservice bpaas:cloudServiceHasBackupRetentionTime bpaas:up_to_1_year .
}]
```

Exercise 2: Semantic Lifting Modelling, Automatic Transformation and Query

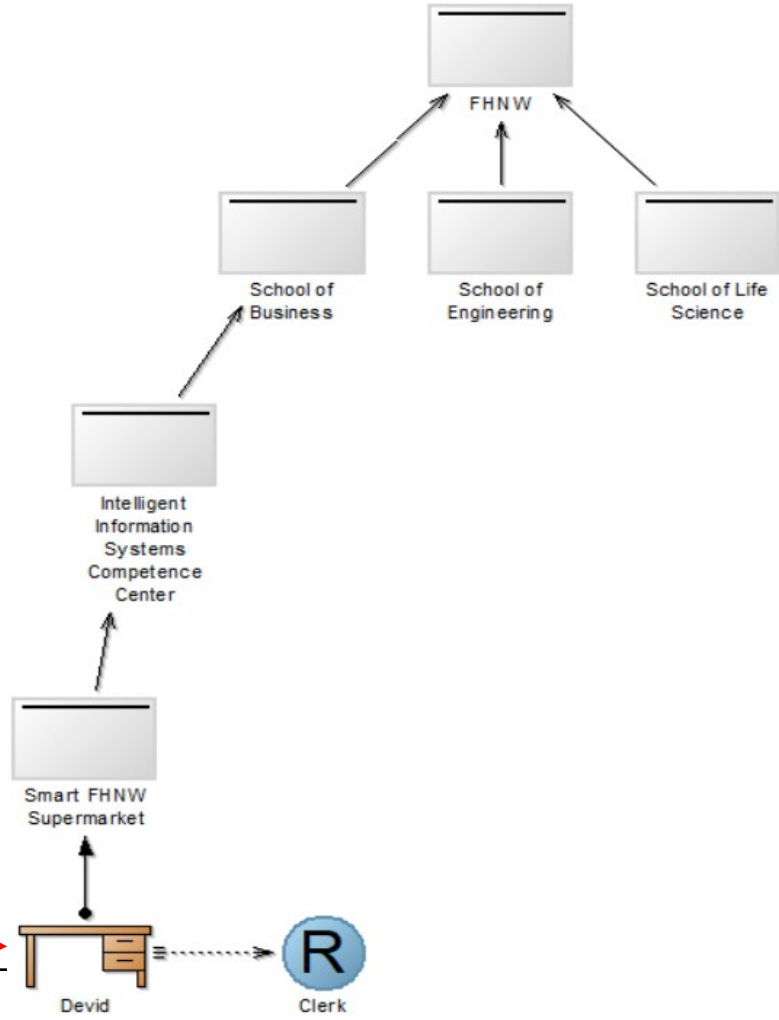
- Use the BeeUP modelling tool to model the model "Order processing" and an "Organizational Chart" for the model Order Processing.
- Add a responsible person for at least a BPMN task, through the RACI attributes.
- Export the models into an RDF(S) ontology (.ttl format)
- Create queries to retrieve the responsible persons for the BPMN tasks.
  - SELECT
    - Where { }

The BeeUP modelling tool





connect tasks to responsible performers (RACI attributes)



Discussion

What are the implications for…

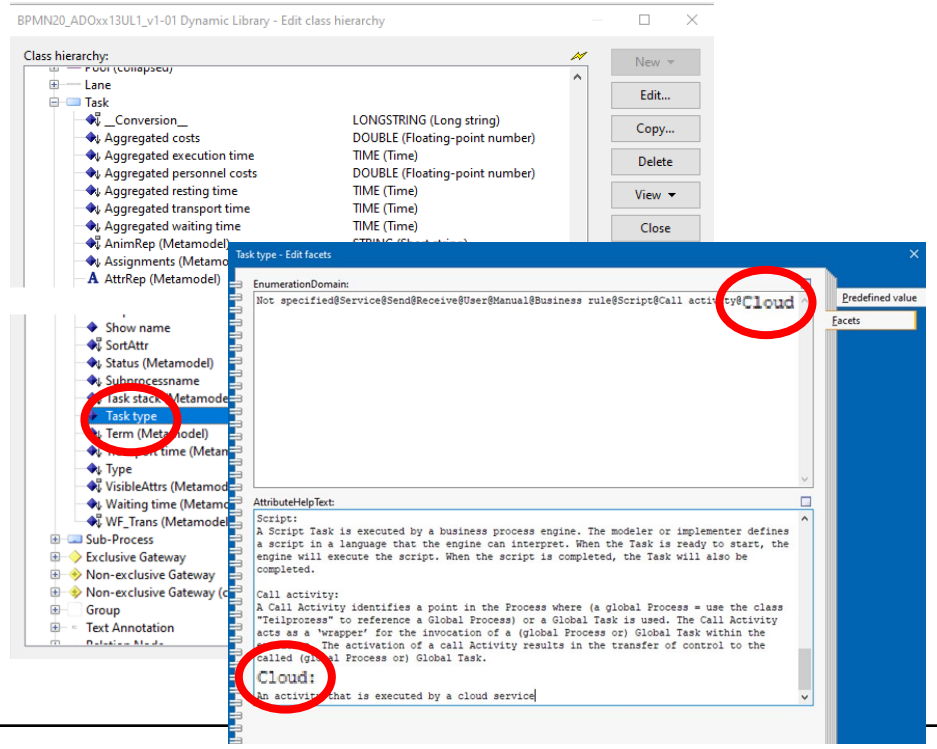
…the change of the person responsible for the BPMN tasks?

…a new modelling element is added in the language? (see next slide)

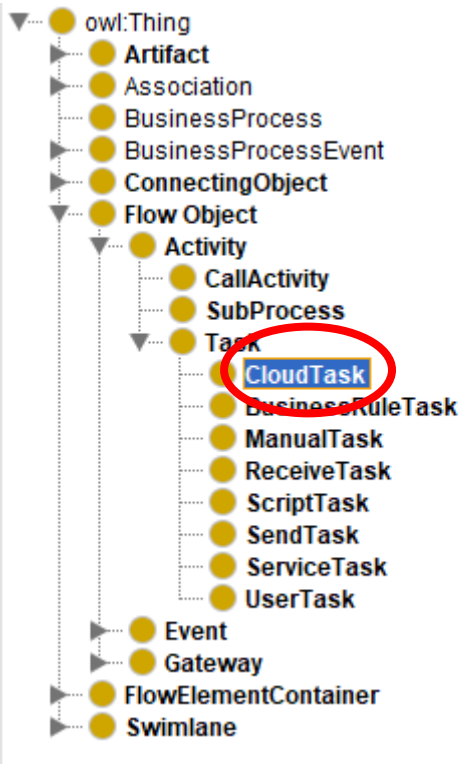
Example: New Modelling Element

– New task type: Cloud Task 

Change in the meta-model:



Change in the ontology:



Drawbacks of Semantic Lifting

- Separate Environments
  - Modelling and Metamodelling
  - Ontology
- Inconsistency
  - Metamodel and ontology must represent the same semantics but are maintained independently
  - Each change in metamodel must be reproduced in the ontology and vice versa
- Effort
  - After each change the models must be translated again into the ontology instances