

OMiLAB4FoF workshop,
June 27 2016, Troyes, France
(in conjunction with the 8th IFAC MIM Conference)

The Modelling of Requirements for Mobile Maintenance

- results from the ComVantage FP7 project (<http://comvantage.eu>)-

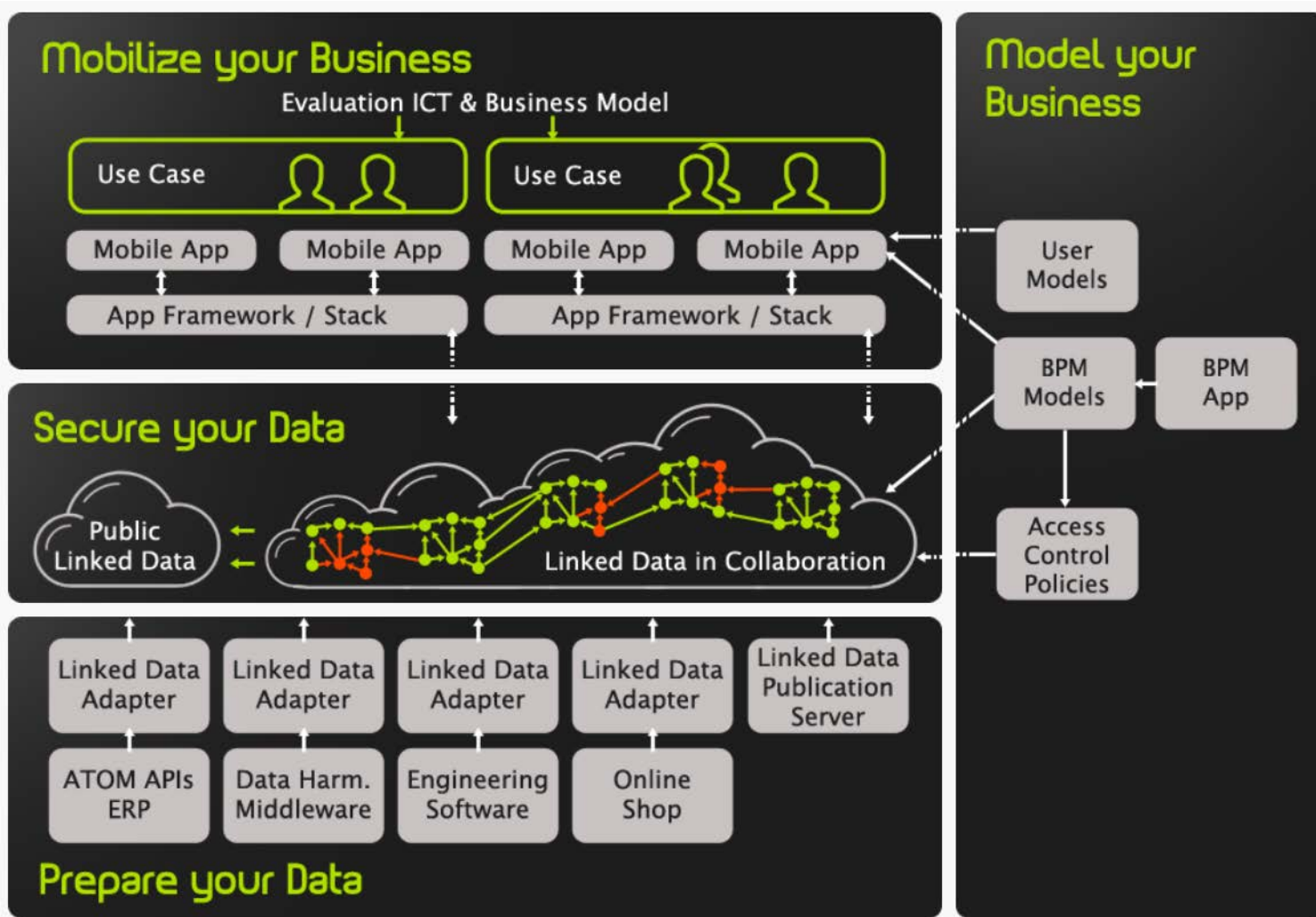
Robert Buchmann

*University Babeş-Bolyai of Cluj Napoca, Romania
University of Vienna, Austria*

Agenda

- **The Context**
 - The Project: ComVantage
 - The Scenario: Mobile Maintenance
- **Concepts and Technologies**
 - The Modelling Method concept
 - The Metamodelling technology: ADOxx
 - The Linked Data technology: RDF
- **Approach and Examples**
 - The ComVantage modelling prototype
 - Semantic linking of models
 - Metamodelling and Linked Data
 - RDF vocabulary for model description
 - Demo examples
- **Enablers**
 - The Environment: OMiLAB
 - The Framework: AMME
- **Conclusions**

The Project: ComVantage*



*<http://comvantage.eu>

The Scenario: Mobile Maintenance

Phase 1.

Remote sensor checking through URIs

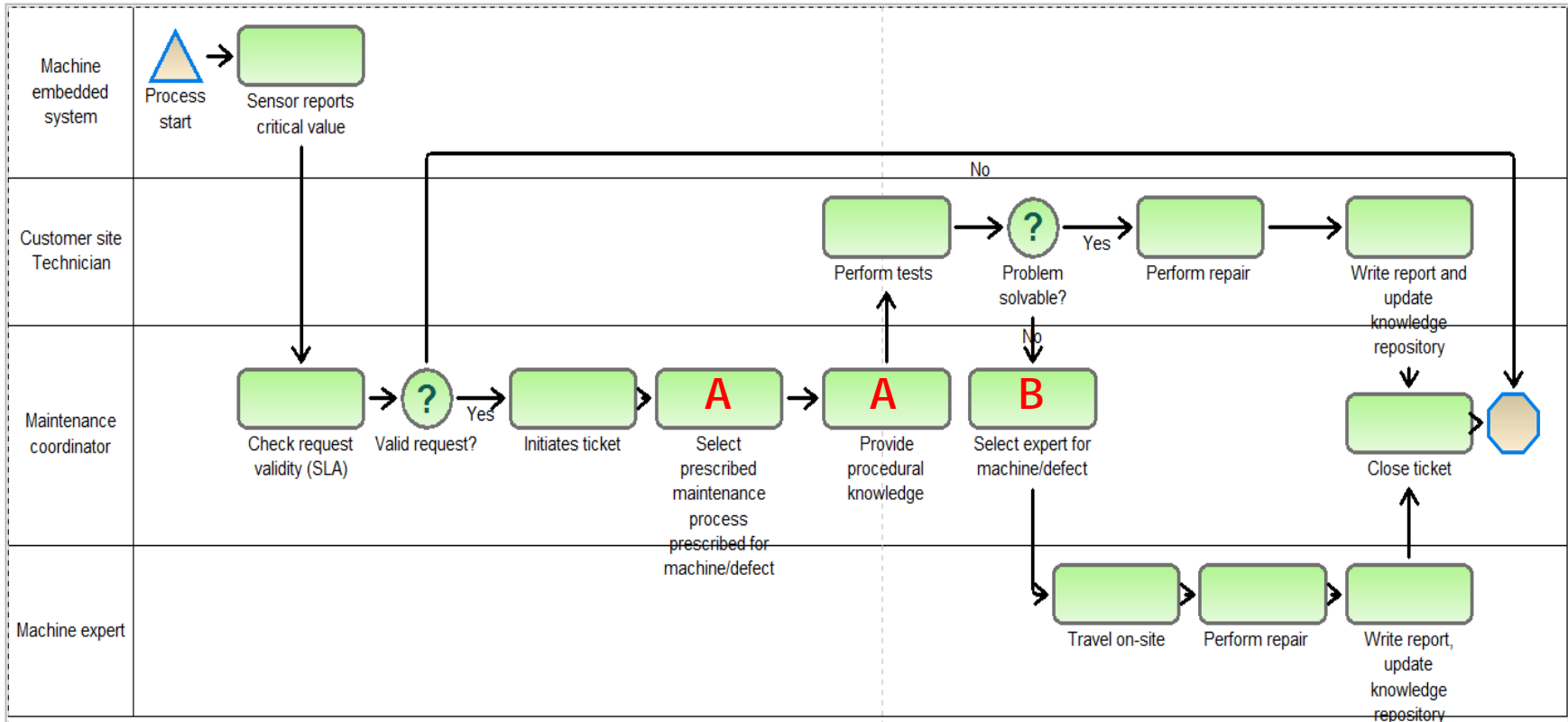


Phase 2.

Deployment of human resources and repair procedures



The Scenario: Mobile Maintenance



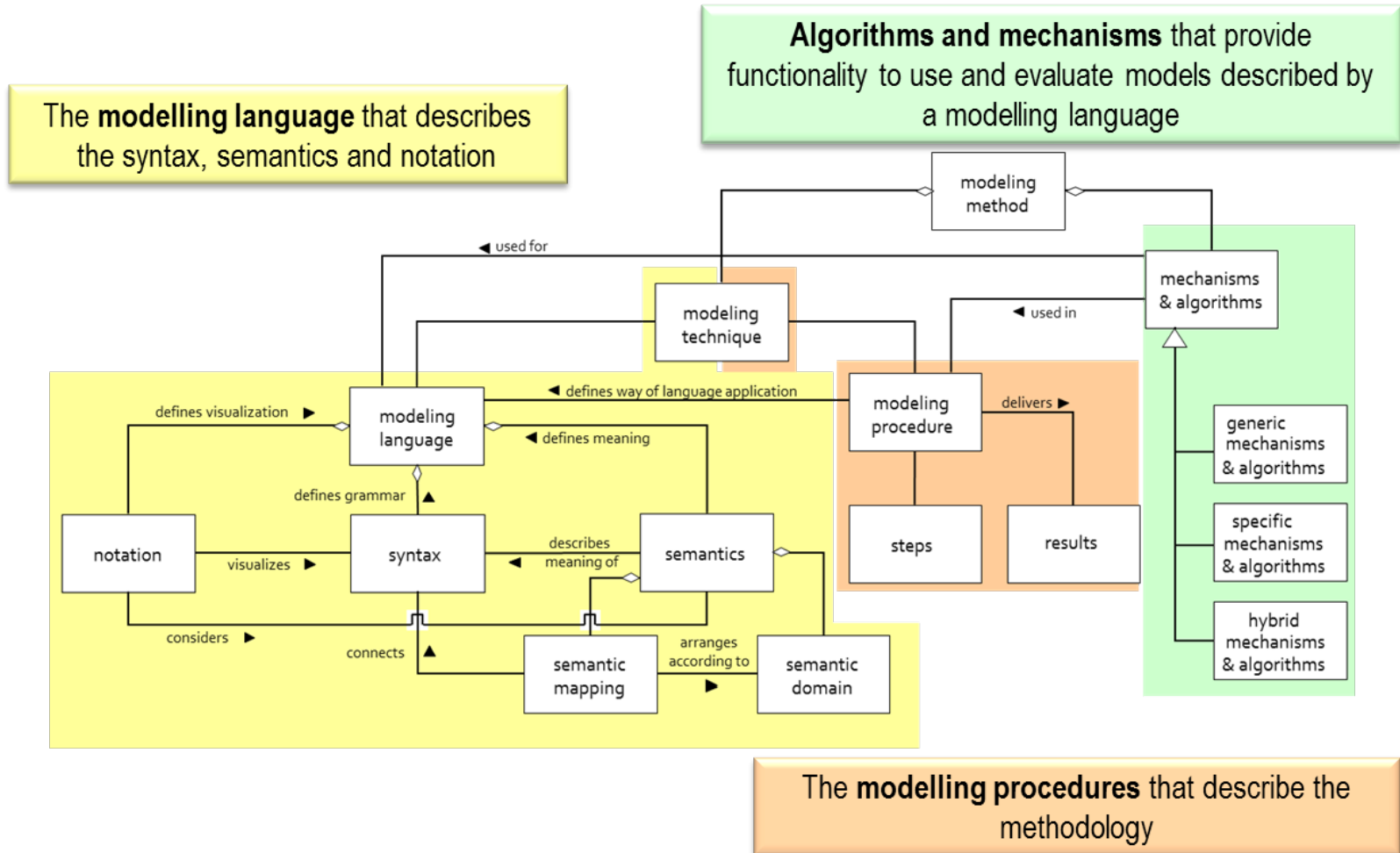
Challenges:

- A. automatically recommend maintenance procedures
- B. automatically select & notify relevant technician

Agenda

- **The Context**
 - The Project: ComVantage
 - The Scenario: Mobile Maintenance
- **Concepts and Technologies**
 - The Modelling Method concept
 - The Metamodeling technology: ADOxx
 - The Linked Data technology: RDF
- **Approach and Examples**
 - The ComVantage modelling prototype
 - Semantic linking of models
 - Metamodeling and Linked Data
 - RDF vocabulary for model description
 - Demo examples
- **Enablers**
 - The Environment: OMiLAB
 - The Framework: AMME
- **Conclusions**

The Modelling Method concept



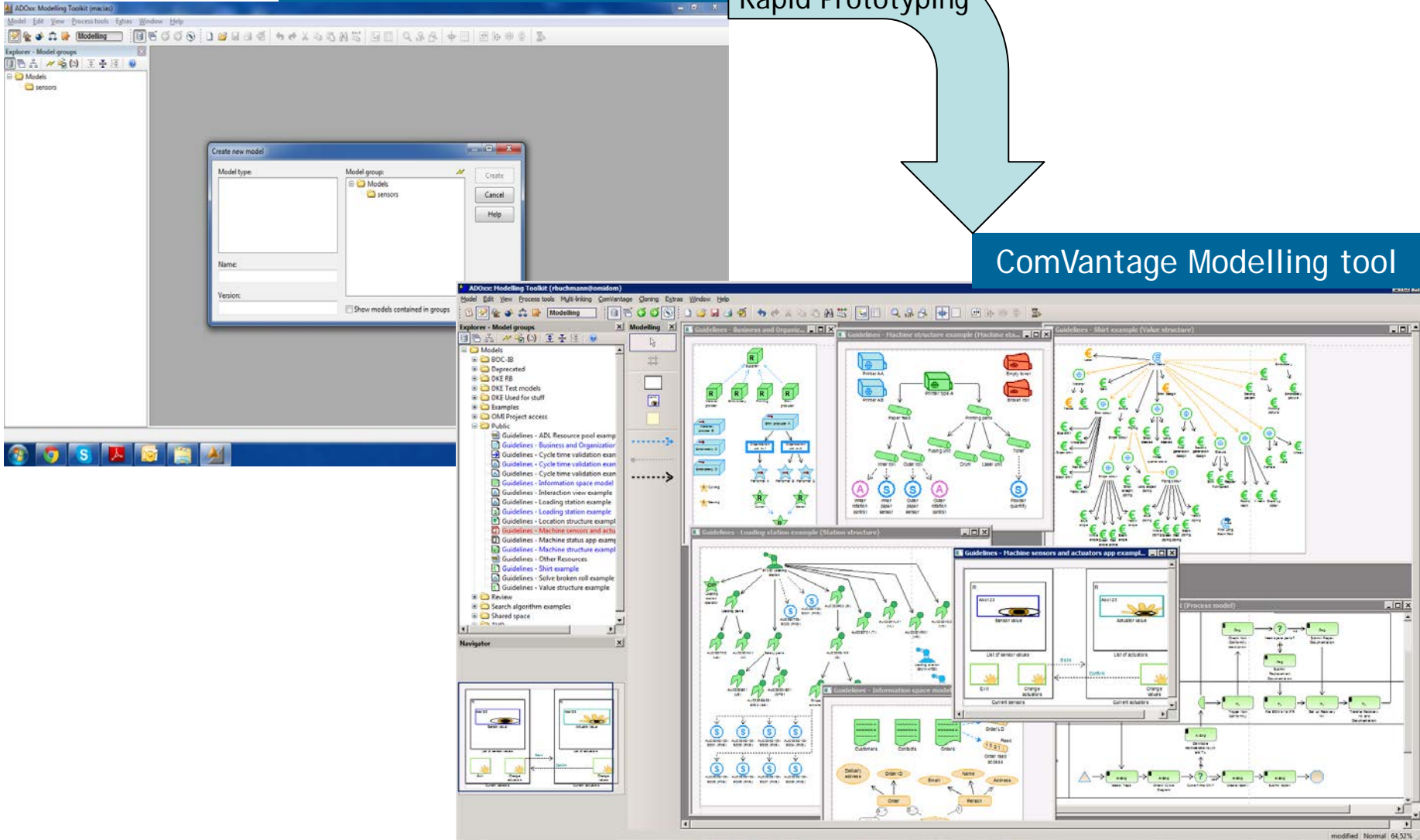
cf. Karagiannis, D., Kühn, H.: Metamodeling platforms. In: Bauknecht, K., Tjoa, A.M., Quirchmayr, G. (eds.), Proceedings of the Third International Conference EC-Web 2002 - DEXA 2002. LNCS 2455, pp 182, Springer (2002)

The Metamodelling Technology: ADOxx

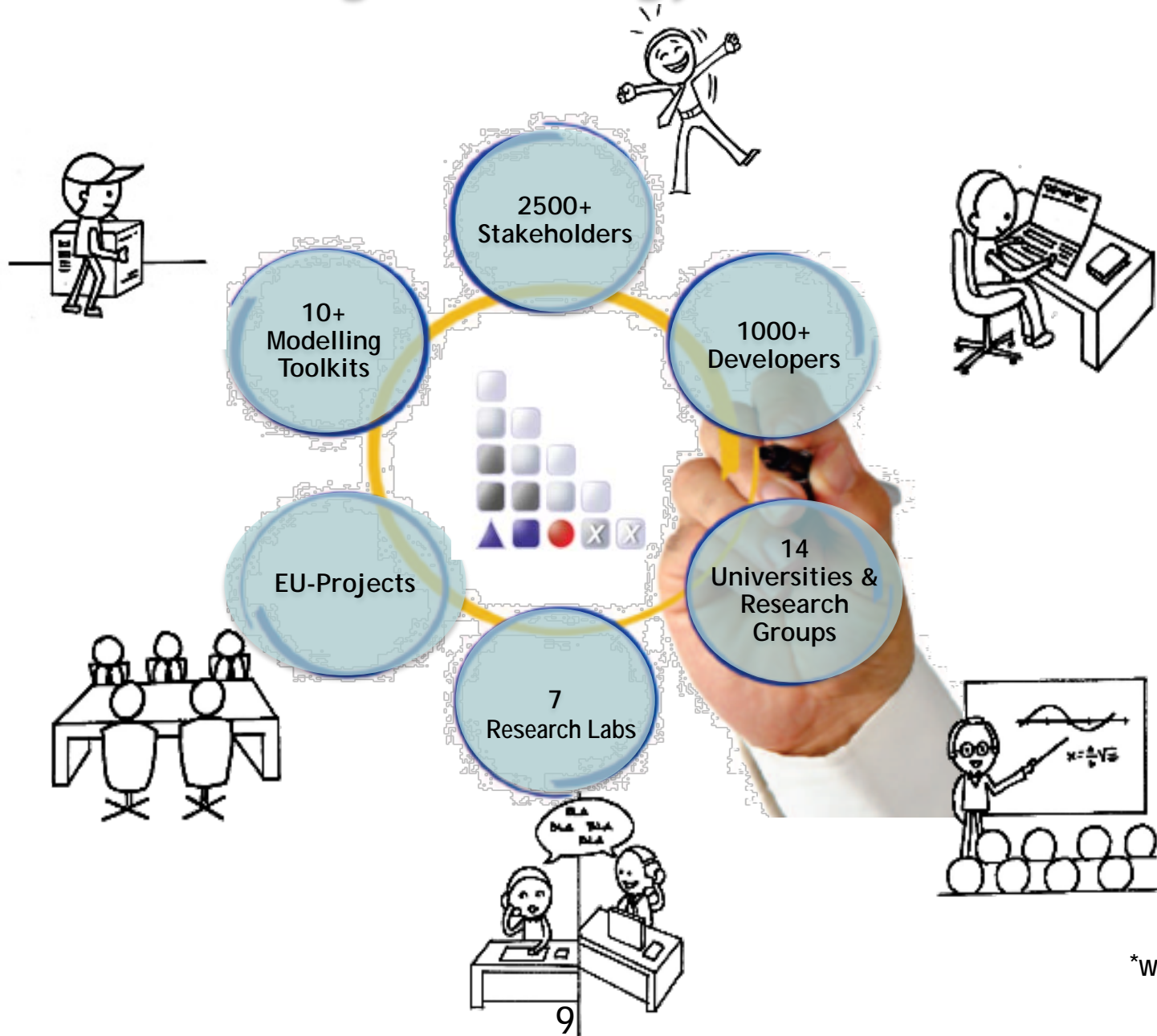
ADOxx

Rapid Prototyping

ComVantage Modelling tool

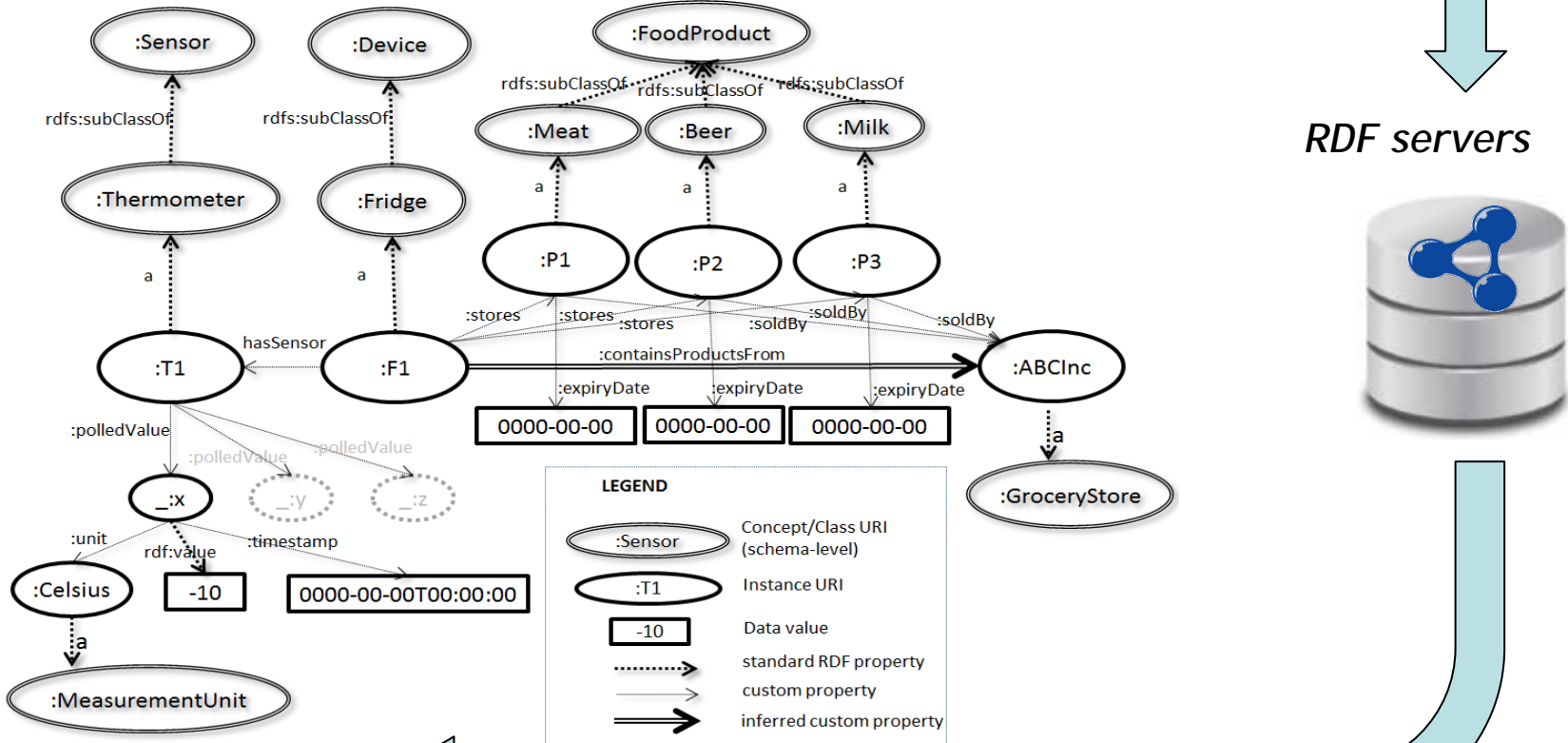


The Metamodelling Technology: ADOxx*

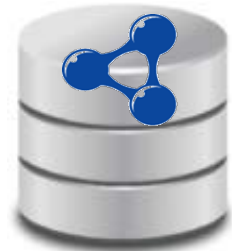


The Linked Data Technology

The RDF data model (graph-based):



RDF servers



SPARQL queries:

Retrieval query: **SELECT ?d WHERE { :F1 :stores/ :expiryDate ?d }**

Rule query: **CONSTRUCT { ?x :containsProductsFrom ?y } WHERE { ?x :stores/ :soldBy ?y }**

Agenda

- **The Context**
 - The Project: ComVantage
 - The Scenario: Mobile Maintenance
- **Concepts and Technologies**
 - The Modelling Method concept
 - The Metamodelling technology: ADOxx
 - The Linked Data technology: RDF
- **Approach and Examples**
 - The ComVantage modelling prototype
 - Semantic linking of models
 - Metamodelling and Linked Data
 - RDF vocabulary for model description
 - Demo examples
- **Enablers**
 - The Environment: OMiLAB
 - The Framework: AMME
- **Conclusions**

The ComVantage modelling prototype*

*<http://www.omilab.org/web/comvantage>

The screenshot displays the ADOxoc Modelling Toolkit interface, which is used for creating and managing models. The main window is divided into several panes:

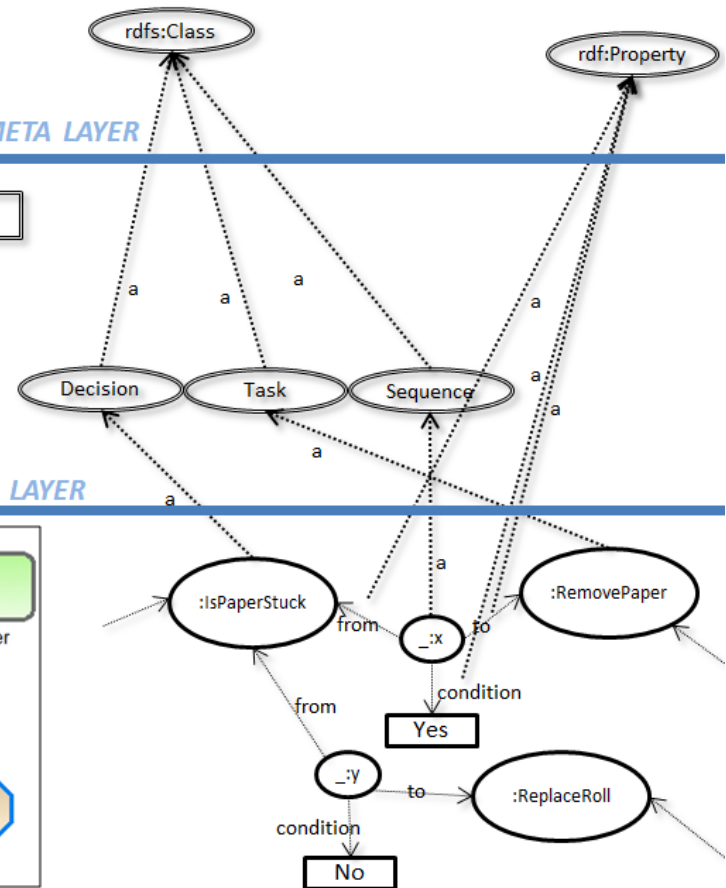
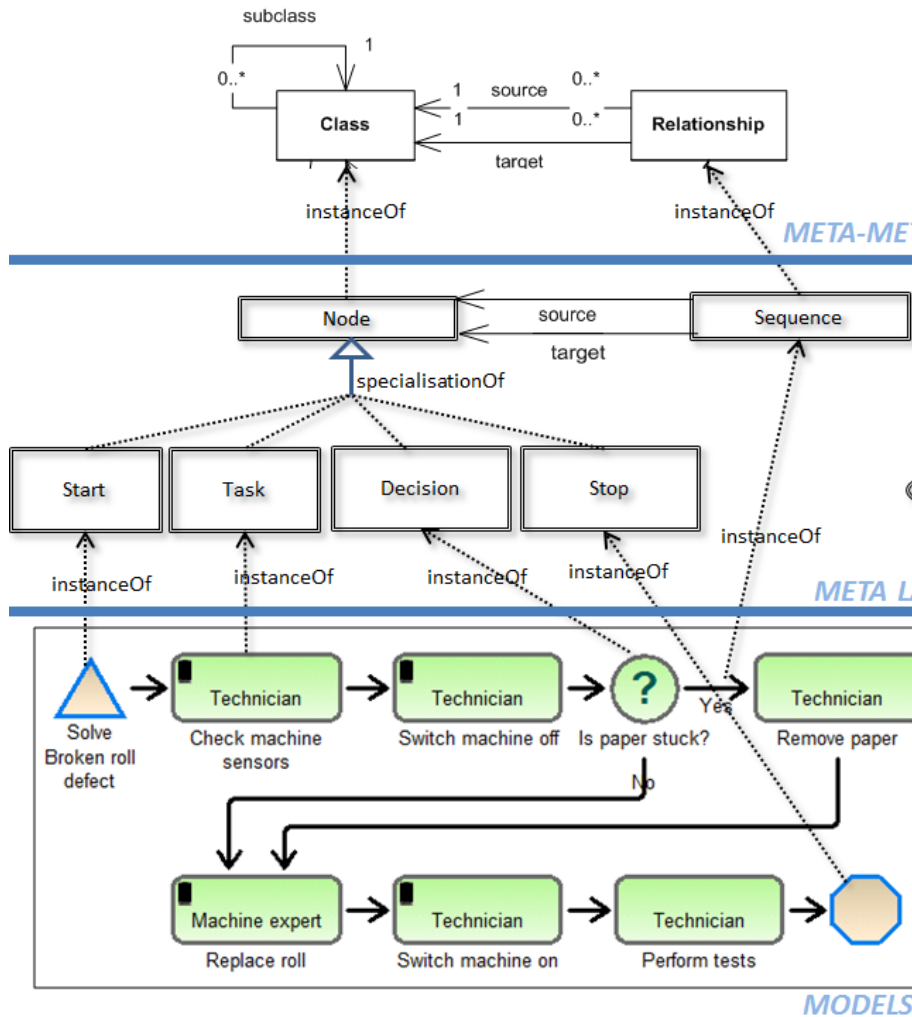
- Explorer - Model groups:** A tree view on the left showing the project structure, including models like BOC-IB, Depreciated, and various Guidelines.
- Modelling:** A central workspace containing several model windows:
 - Guidelines - Business and Organization:** A hierarchical tree diagram showing organizational units and their relationships.
 - Guidelines - Machine structure example (Machine sta...):** A diagram showing the components of a machine, such as Paper feed, Printing parts, and Toner, and their interactions.
 - Guidelines - Shirt example (Value structure):** A complex network diagram showing the value structure of a shirt, including components like Neck, Sleeve, and Collar.
 - Guidelines - Loading station example (Station structure):** A diagram showing the structure of a loading station, including components like Loading parts and Loading station.
 - Guidelines - Machine sensors and actuators app exampl...:** A diagram showing the interaction between sensors and actuators, including a list of sensor values and a list of actuators.
 - Guidelines - Information space model:** A diagram showing the information space model, including entities like Customers, Contacts, Orders, and Person.
- Navigator:** A pane at the bottom left showing a detailed view of the selected model, including a list of sensor values and a list of actuators.
- (Process model):** A diagram at the bottom right showing a process model with various steps and transitions, including a flow from 'Check item' to 'Submit Repair'.

Approach:

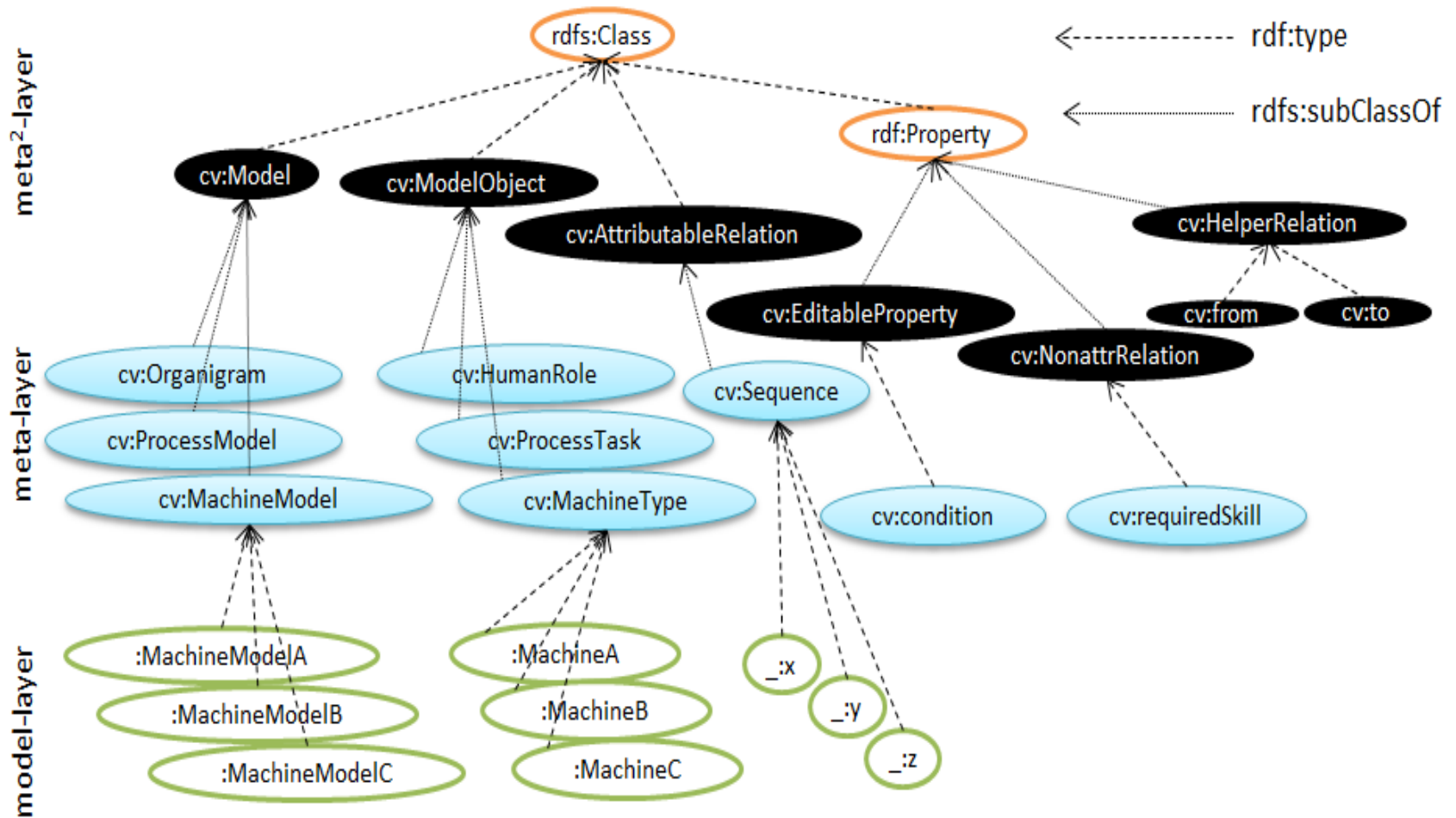
Conversion of diagrammatic models to RDF graphs

METAMODELLING ABSTRACTIONS

LINKED DATA ABSTRACTIONS



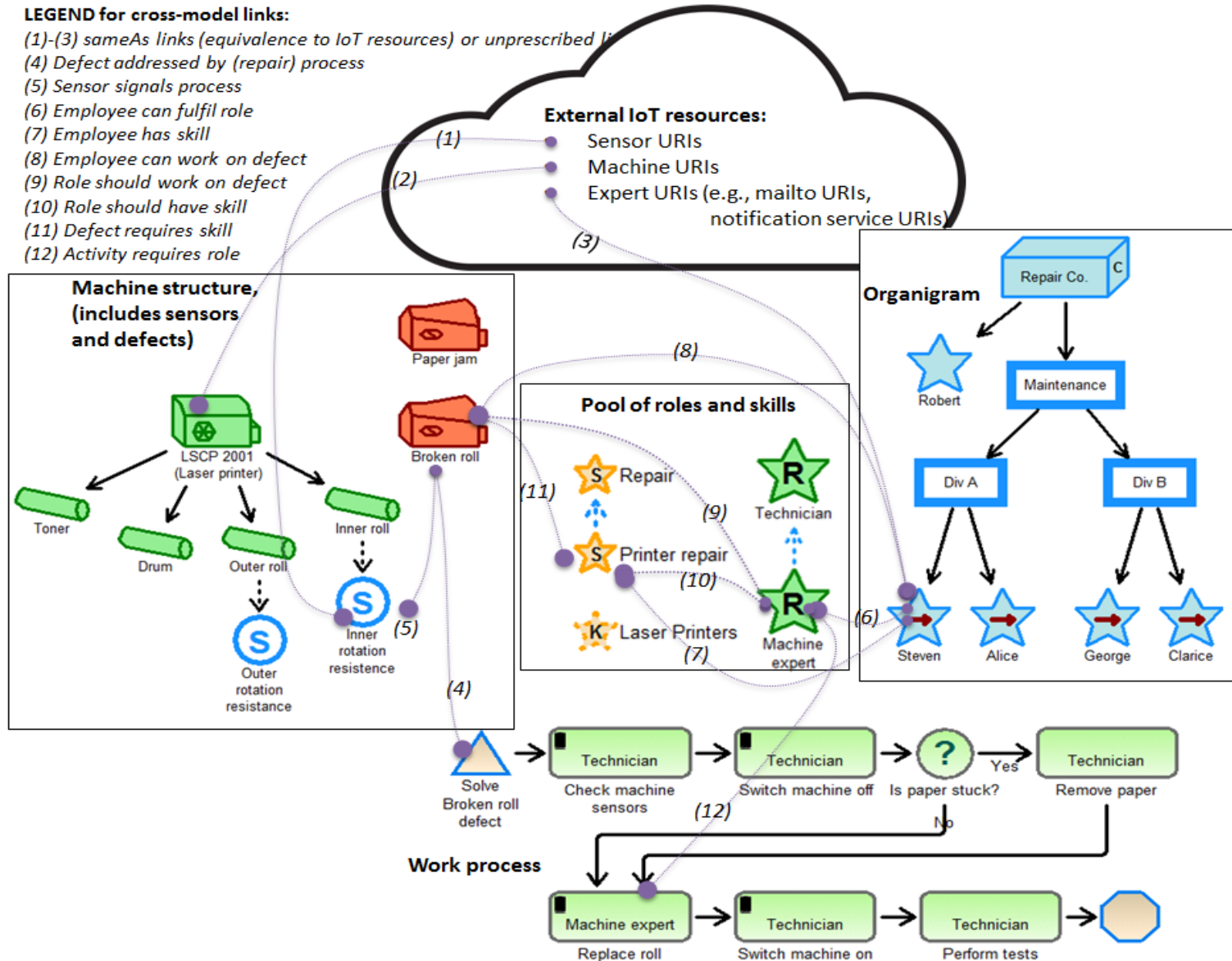
RDF vocabulary for Model Description



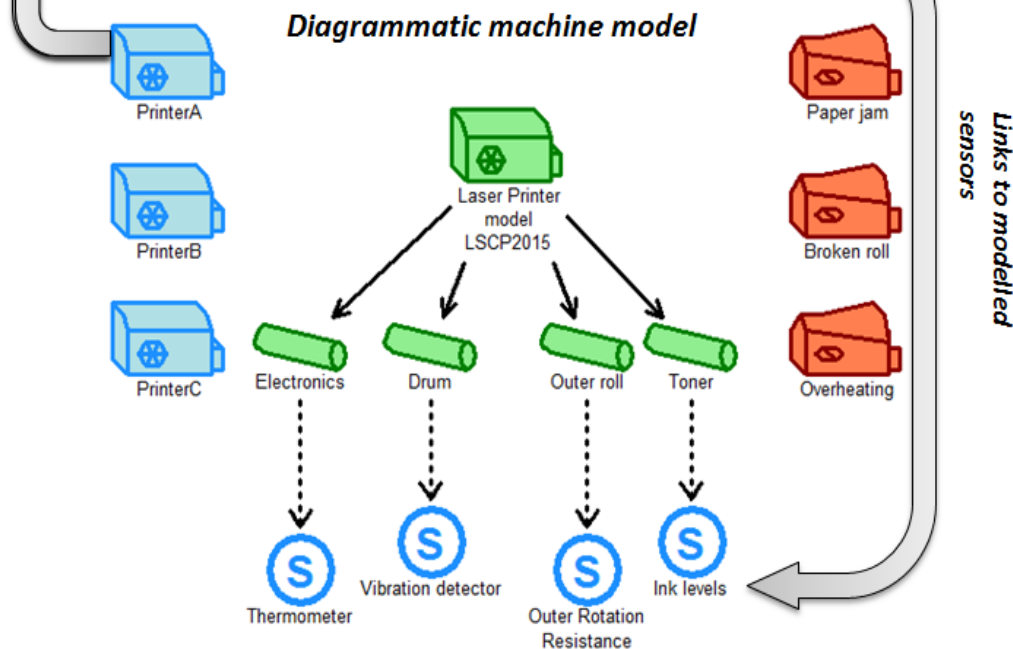
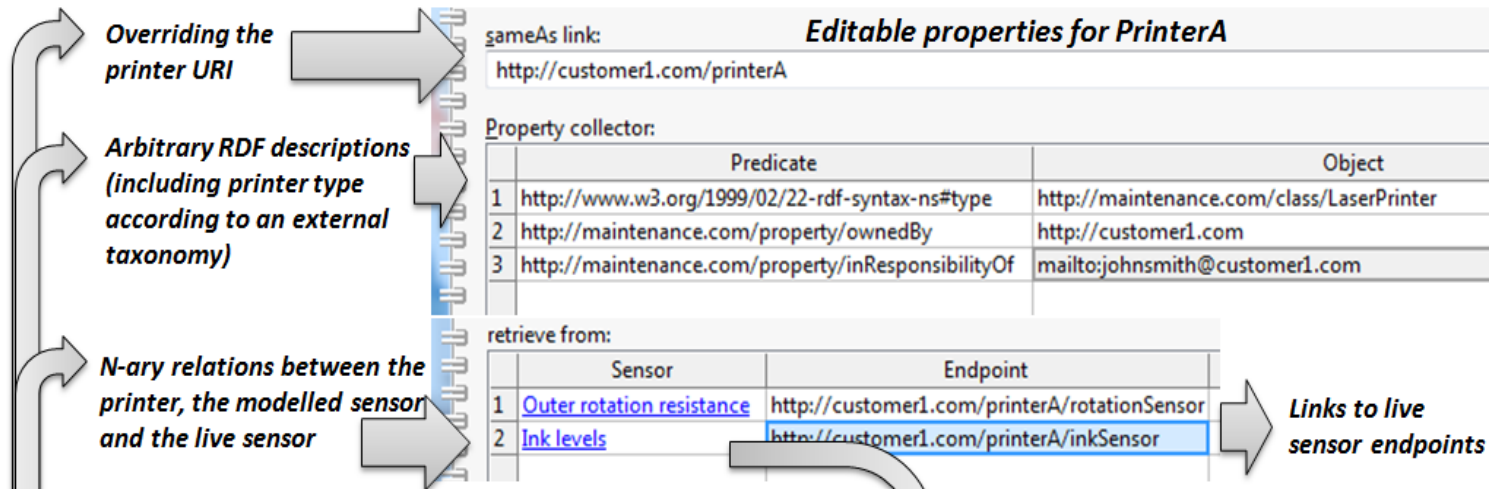
Cross-model Semantic Linking

LEGEND for cross-model links:

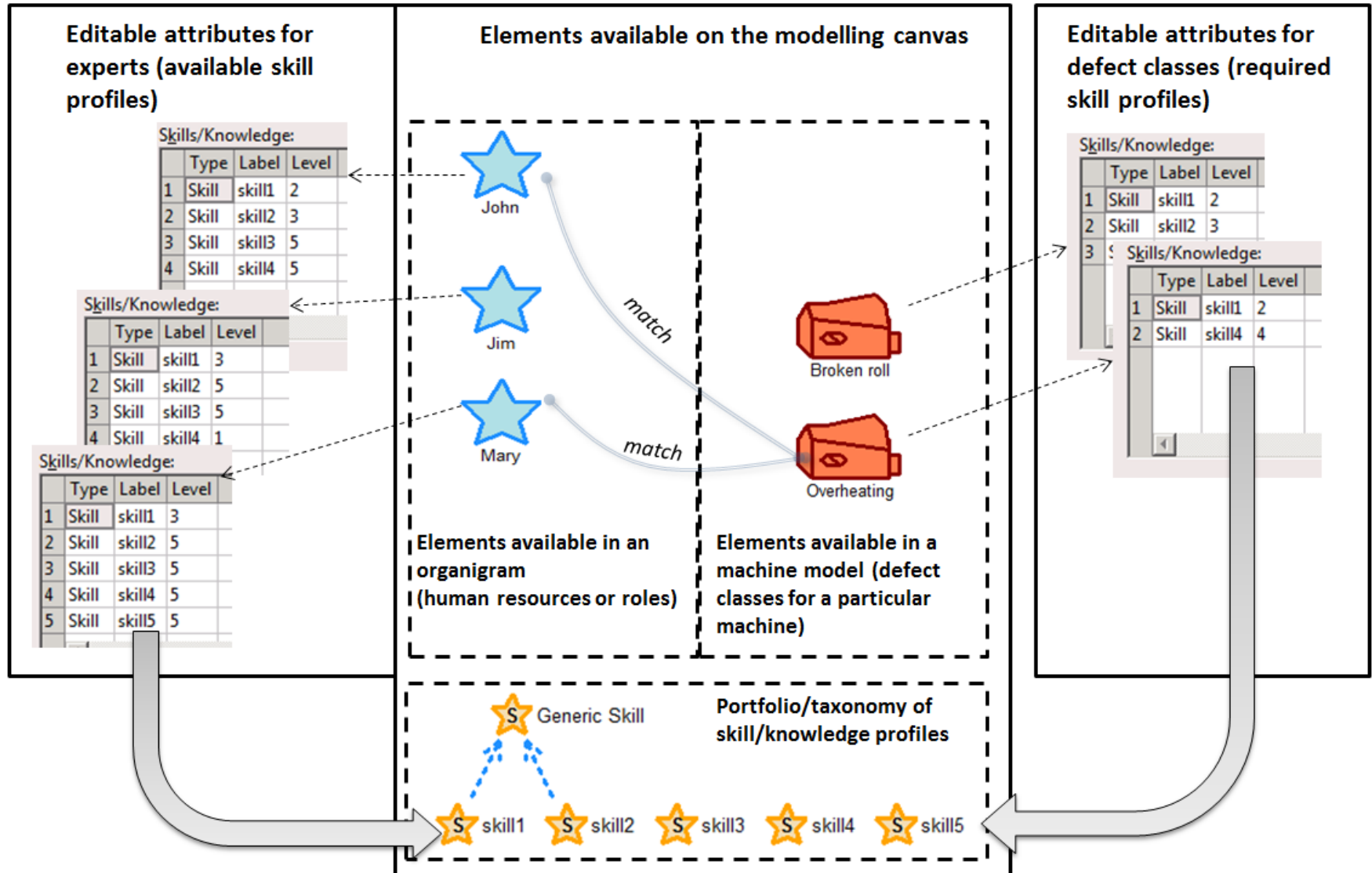
- (1)-(3) sameAs links (equivalence to IoT resources) or unprescribed links
- (4) Defect addressed by (repair) process
- (5) Sensor signals process
- (6) Employee can fulfil role
- (7) Employee has skill
- (8) Employee can work on defect
- (9) Role should work on defect
- (10) Role should have skill
- (11) Defect requires skill
- (12) Activity requires role



Linking Models to live Sensor Networks



Minimal running example: Skill profile matching



SPARQL* query to perform the match

```
SELECT ?def ?reqCount ?perf (COUNT(?avaSkill) AS ?avaCount)
```

```
WHERE {
```

The inner query counts how many skills are required by the defect class

```
{  
  SELECT ?def (COUNT(?reqSkill) AS ?reqCount)  
  WHERE {
```

The BIND statement provides (in the ?def variable) the URI of the defect class that requires an expert with matching skills (higher than the required ones)

```
    BIND (<http://test.org#MachineType-365603-Machine_1> AS ?def)
```

```
    ?def cv:SkillsKnowledge ?reqList .  
    ?reqList rdf:rest*/rdf:first ?reqSkill .
```

```
  }  
  GROUP BY ?def  
}
```

The next lines find what specific skills are required by the defect class

Notice that the skill table is captured as an RDF ordered list of records

```
?def cv:SkillsKnowledge ?reqList .  
?reqList rdf:rest*/rdf:first ?reqSkill .  
?reqSkill cv:Type ?reqSkillTyp .  
?reqSkill cv:Label ?reqSkillLab .  
?reqSkill cv:Level ?reqSkillLev .
```

The next lines find the experts with matching skills (skill levels higher than those required)

```
?perf rdf:type cv:Performer .  
?perf cv:SkillsKnowledge ?avaList .  
?avaList rdf:rest*/rdf:first ?avaSkill .  
?avaSkill cv:Type ?avaSkillTyp .  
?avaSkill cv:Label ?avaSkillLab .  
?avaSkill cv:Level ?avaSkillLev .  
FILTER(?avaSkillTyp = ?reqSkillTyp)  
FILTER(?avaSkillLab = ?reqSkillLab)  
FILTER(?avaSkillLev >= ?reqSkillLev)  
}
```

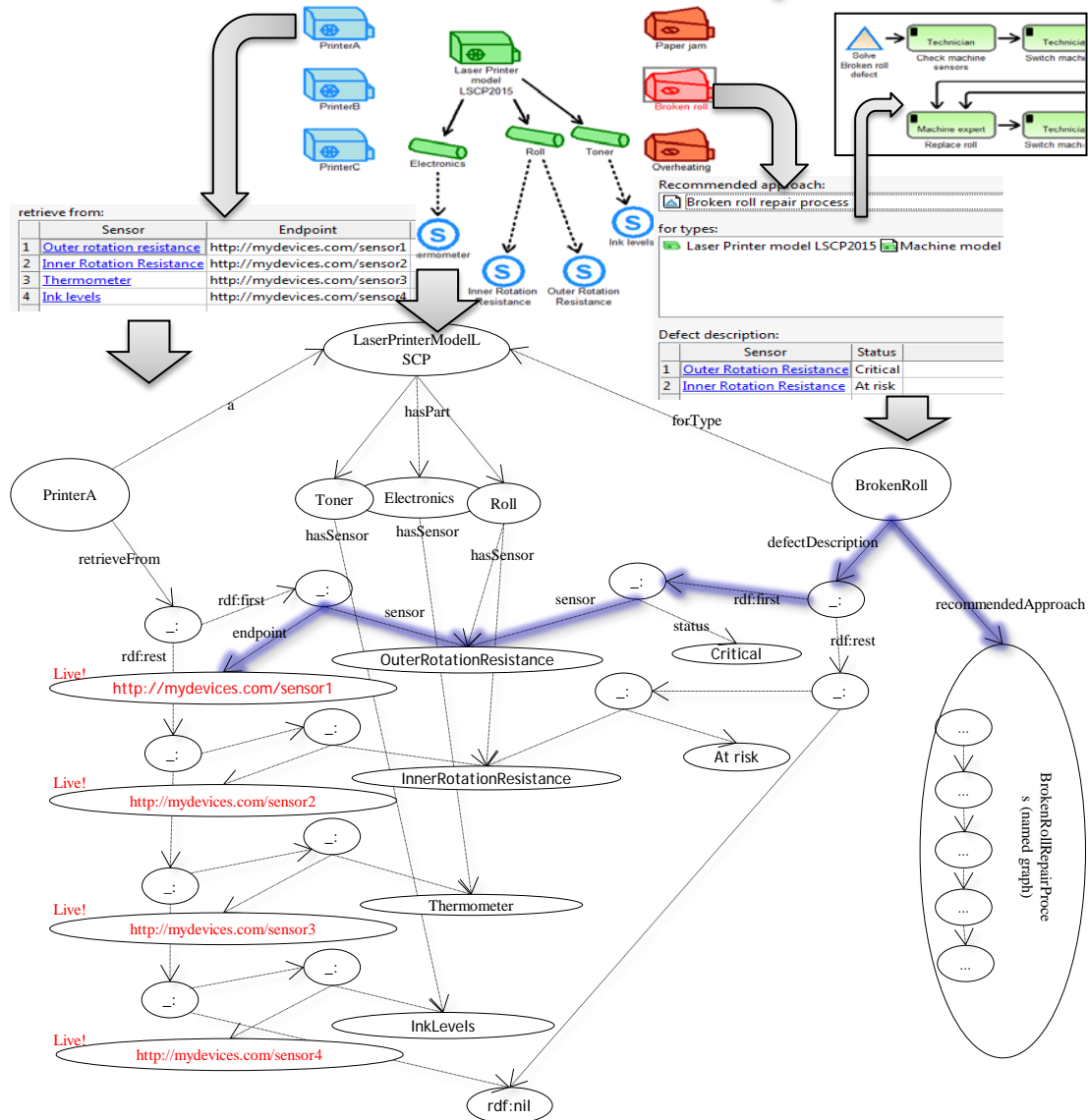
```
GROUP BY ?perf ?def ?reqCount
```

```
HAVING (COUNT(?avaSkill) = ?reqCount)
```

The last line keeps only the results where the number of required skills is equal to the count of matching skills (from experts)

*see <https://www.w3.org/TR/sparql11-overview/>

Traversing the RDF graph from live sensor to maintenance procedure



Agenda

- **The Context**
 - The Project: ComVantage
 - The Scenario: Mobile Maintenance
- **Concepts and Technologies**
 - The Modelling Method concept
 - The Metamodeling technology: ADOxx
 - The Linked Data technology: RDF
- **Approach and Examples**
 - The ComVantage modelling prototype
 - Semantic linking of models
 - Metamodeling and Linked Data
 - RDF vocabulary for model description
 - Demo examples
- **Enablers**
 - The Environment: OMiLAB
 - The Framework: AMME
- **Conclusions**

The Environment: OMiLAB

- Physical and virtual research laboratory for the conceptualisation, development and deployment of modelling methods and the models designed with them.
- Project space for Associated Organisations interested in the engineering of modelling methods and tools
- Community of researchers and practitioners sharing a common understanding about model value
- Repository of reusable resources for AMME

Organization:

University of Vienna,
Faculty of Computer Science

Research Group:

Knowledge Engineering

OMiLAB[®]

www.omilab.org

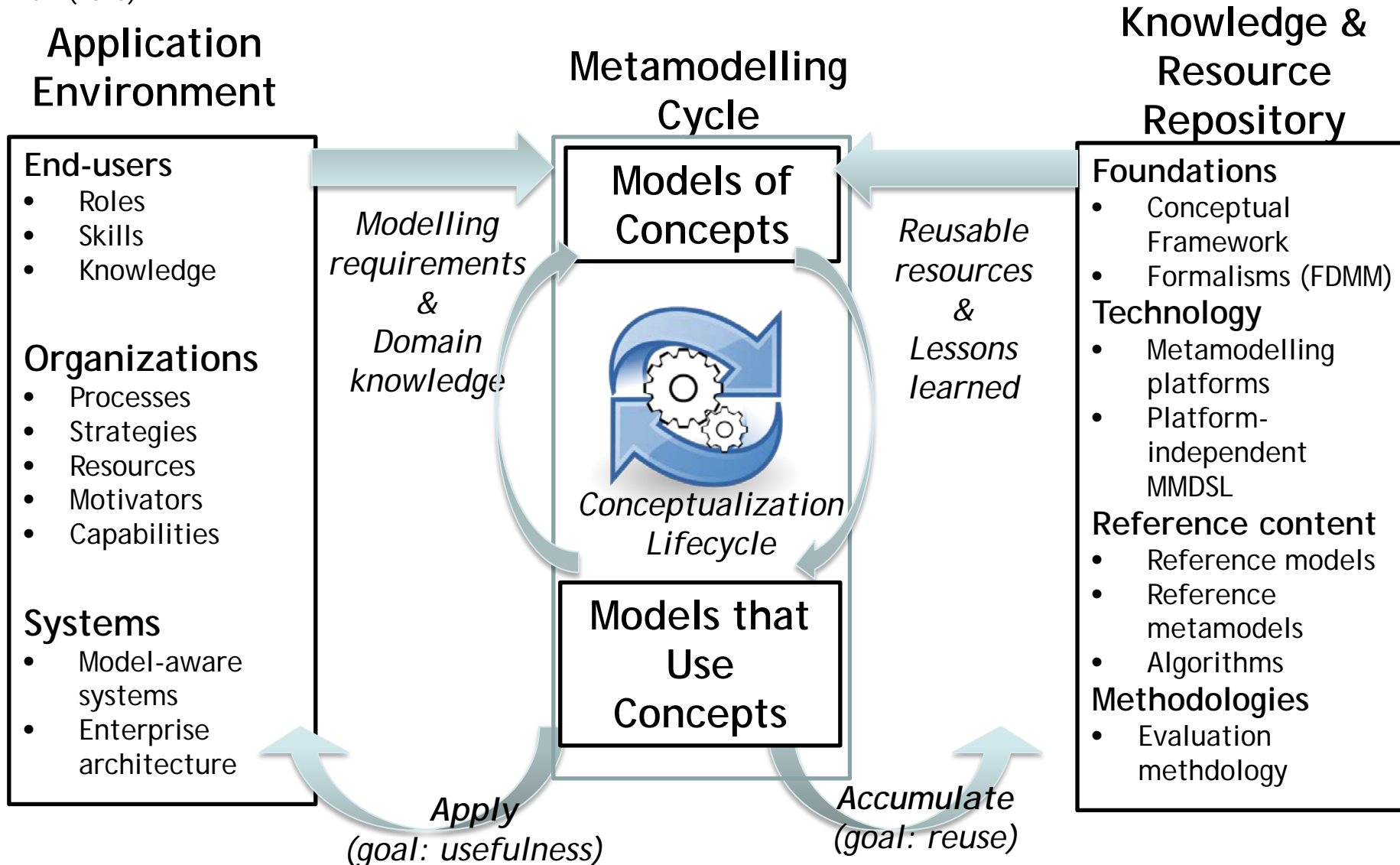


OMiLAB@Faculty of Computer Science
Währinger Str. 29, 1090 Vienna, Austria

Bot

The Framework: Agile Modelling Method Engineering*

*cf. Karagiannis, D.: Agile Modeling Method Engineering. In: Proceedings of PCI 2015, Athens Greece, p. 5-10, ACM (2015)



Conclusions

- The proposal enriches run-time data with design-time diagrammatic semantics (requirements models may drive execution)
- Exporting diagrammatic models as RDF semantic graphs opens a wide array of opportunities for mashing-up data and model information (even in the absence of fully-fledged ontologies)
- The iterative application of AMME will evolve the modelling language semantics to fit requirements propagating from "model-aware clients"