INCOSE International Symposium
Philadelphia, PA
June 24-27, 2013

Bridging the Gap between Human Thinking and Machine Processing in Developing and Maintaining Domain Knowledge

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Human vs. *Machine*…

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During your next flight, who should be in charge of…

- Double-checking the maintenance status?	***Human***
- Speaking to Air Traffic Control?	***Human***
- Controlling cruising altitude, course and speed?	***Machine***
- Calculating the remaining fuel?	***Machine***
- Dealing with a drunk passenger on board?	***Human***
- Making an announcement?	***Human*** / ***Machine***
- Serving a hot meal?	***Human***
- Detecting smoke in the lavatories?	***Machine***
- Landing in difficult conditions?	***Human***
- Smiling and saying goodbye when you leave?	***Human***

Mind mapping

(Supporting human thinking)

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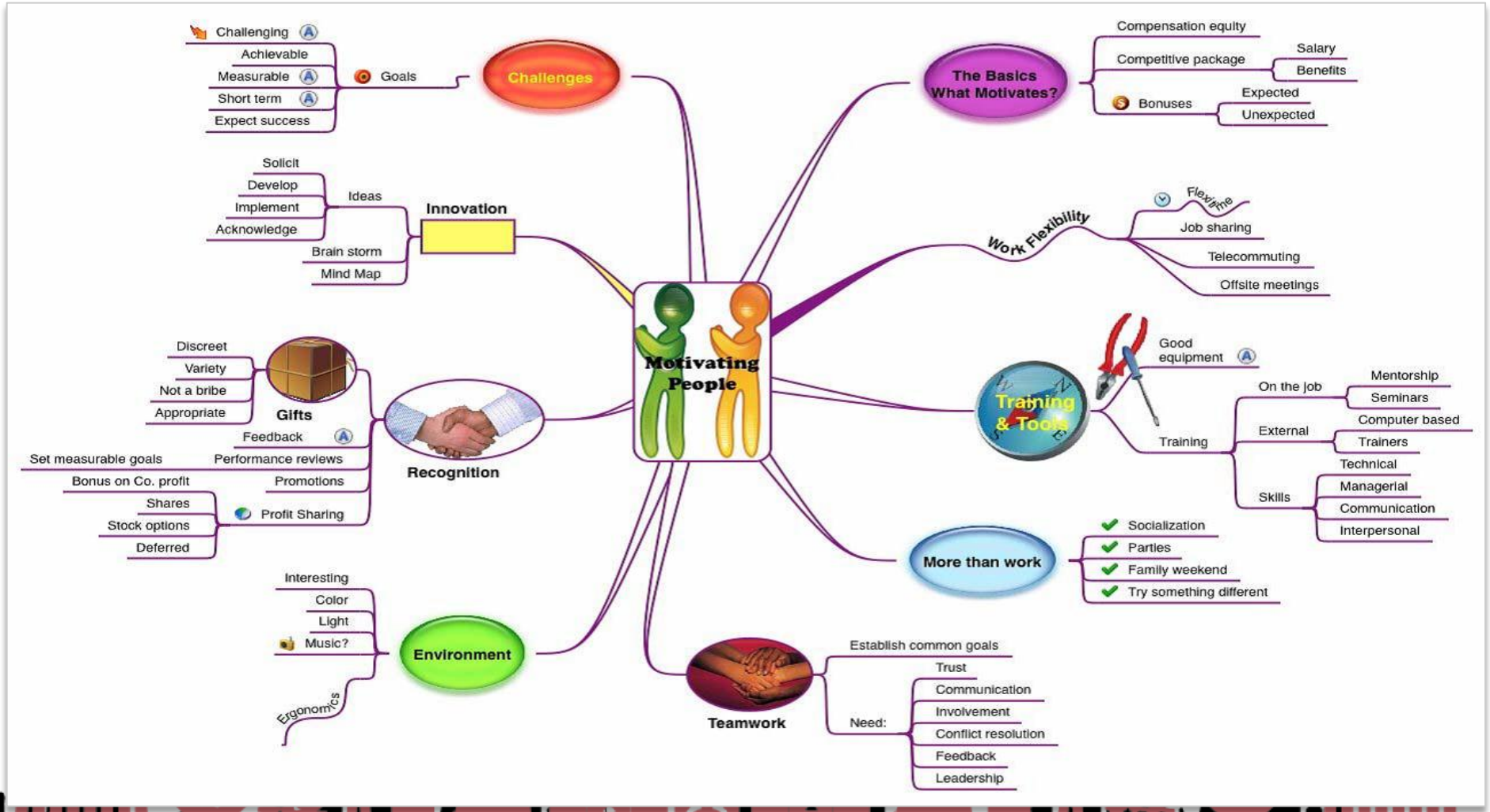

Mind mapping for RE

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Eliciting and updating domain knowledge that is needed for the development and maintenance of requirements:

- Capturing information (e.g. lessons learnt)
- Re-structuring and refining information
- Visually linking information items
- Critically reviewing information (with multiple relevant stakeholders and domain experts)
- Visualising characteristics of information (e.g. type, origin, priority, criticality, use and status)

Ontology

(Supporting machine processing)

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Ontology is a specification of a conceptualization. *Specification* means a formal and declarative representation. *Conceptualization* means an abstract, simplified view of the world. (Gruber, 1993)

An ontology defines a common vocabulary for researchers who need to share information in a domain. It includes machine-interpretable definitions of basic concepts in the domain and relations among them. (Noy et al., 2000)

```
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Ontology for RE

Formally structuring, specifying and analysing domain knowledge that is needed for the development and maintenance of requirements:

- Identifying logical inconsistencies of a domain's information meta model (e.g. classes and properties)
- Formal representation of a domain's terminology
- Analysing instances of classes of the domain's meta model for correctness, completeness and consistency

OntoREM

Ontology-driven **R**equirements **E**ngineering **M**ethodology

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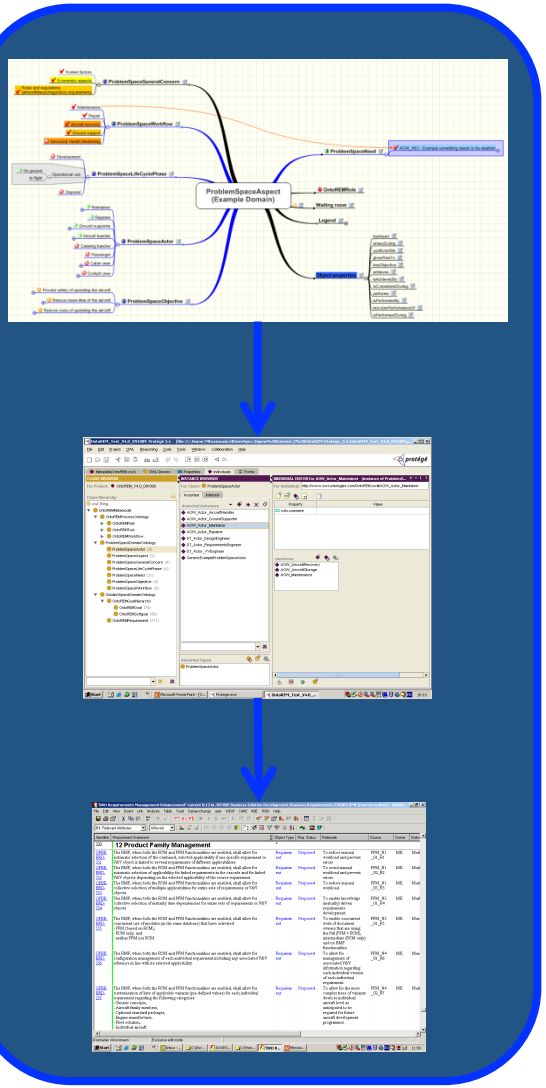

OntoREM

(1) Iterative 1-1 sessions with identified relevant stakeholders and domain experts.

(2) Off-line specification of domain ontology including requirements with systematic validation of intermediate results by relevant stakeholders.

(3) Validated requirements in requirements database.

Advantages:

- ✓ Only short time required in flexible one-to-one meetings with each relevant stakeholder and domain expert.
- ✓ Mindmapping greatly enhances these meetings (info traceable and can be commented, updated and re-structured).
- ✓ Specification of rich domain knowledge including requirements that will be used throughout the project and in the future.
- ✓ Change impact analysis enabled via traceability in the domain ontology.
- ✓ Progress can be easily monitored at any time.
- ✓ High requirements quality.
- ✓ Low requirements development cost.

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An example of **Knowledge-Driven** Requirements Engineering

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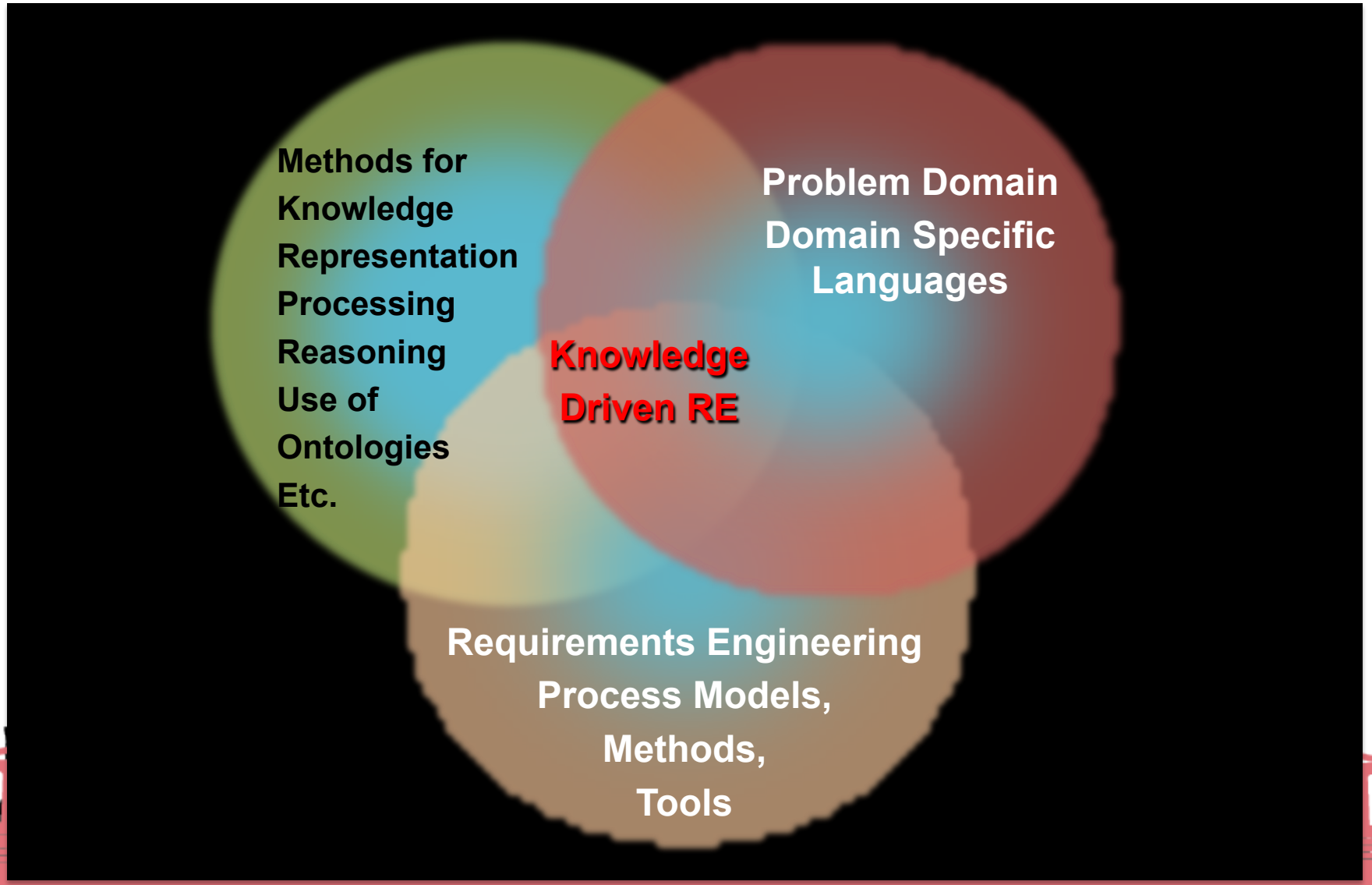

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An example of **Knowledge-Driven** Requirements Engineering

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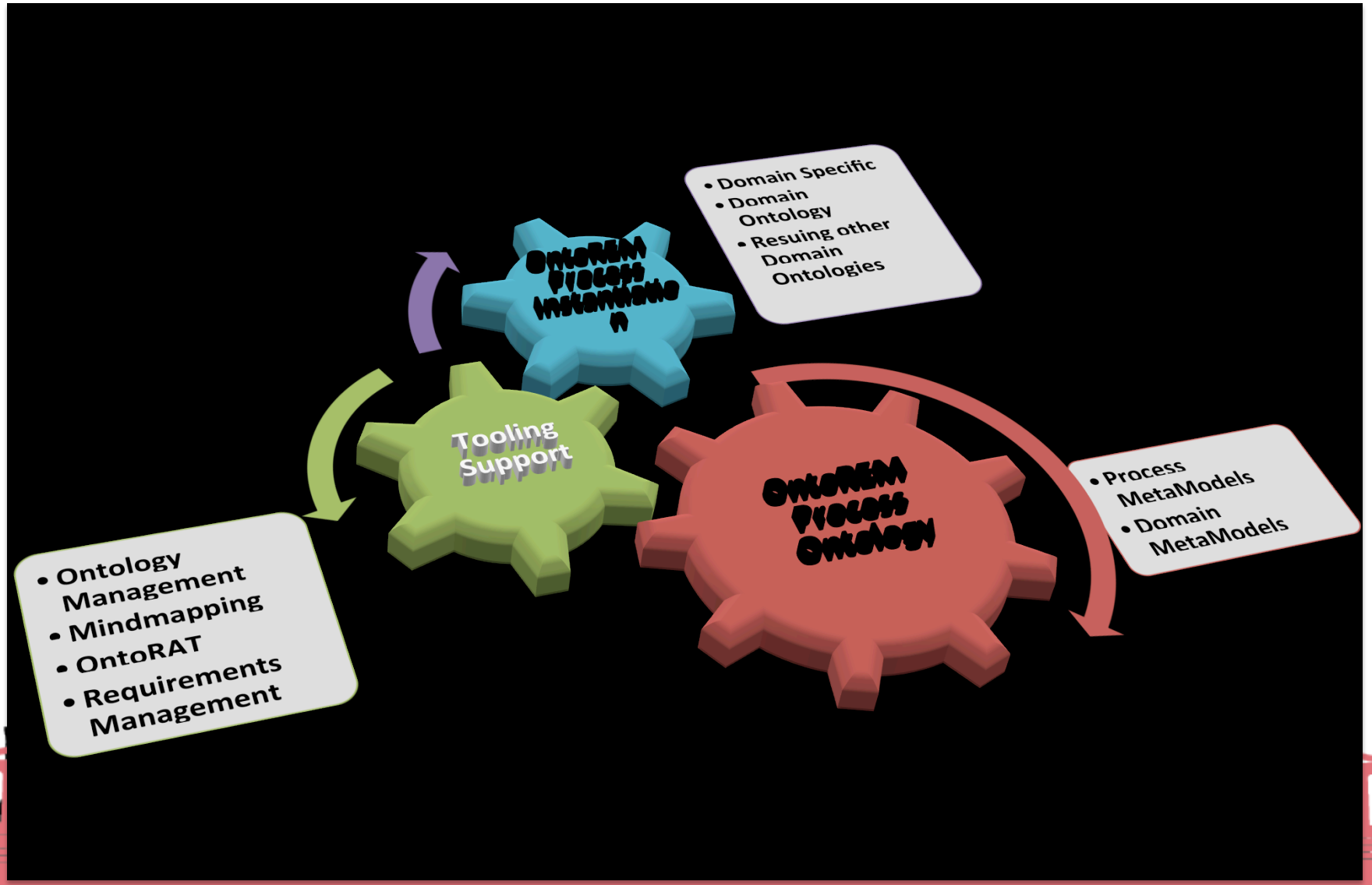
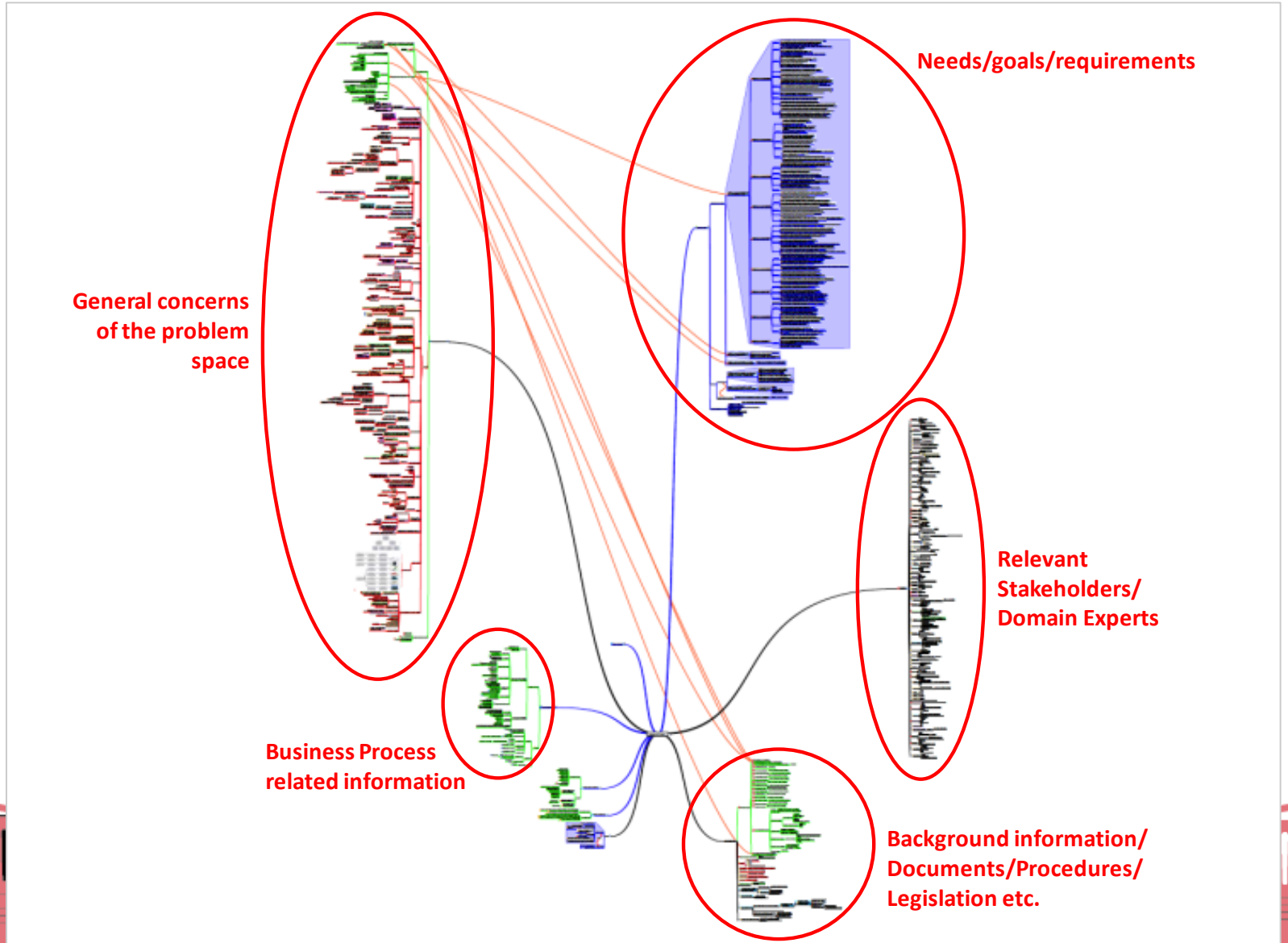


OntoREM (example)



OntoREM Mind-Mapper

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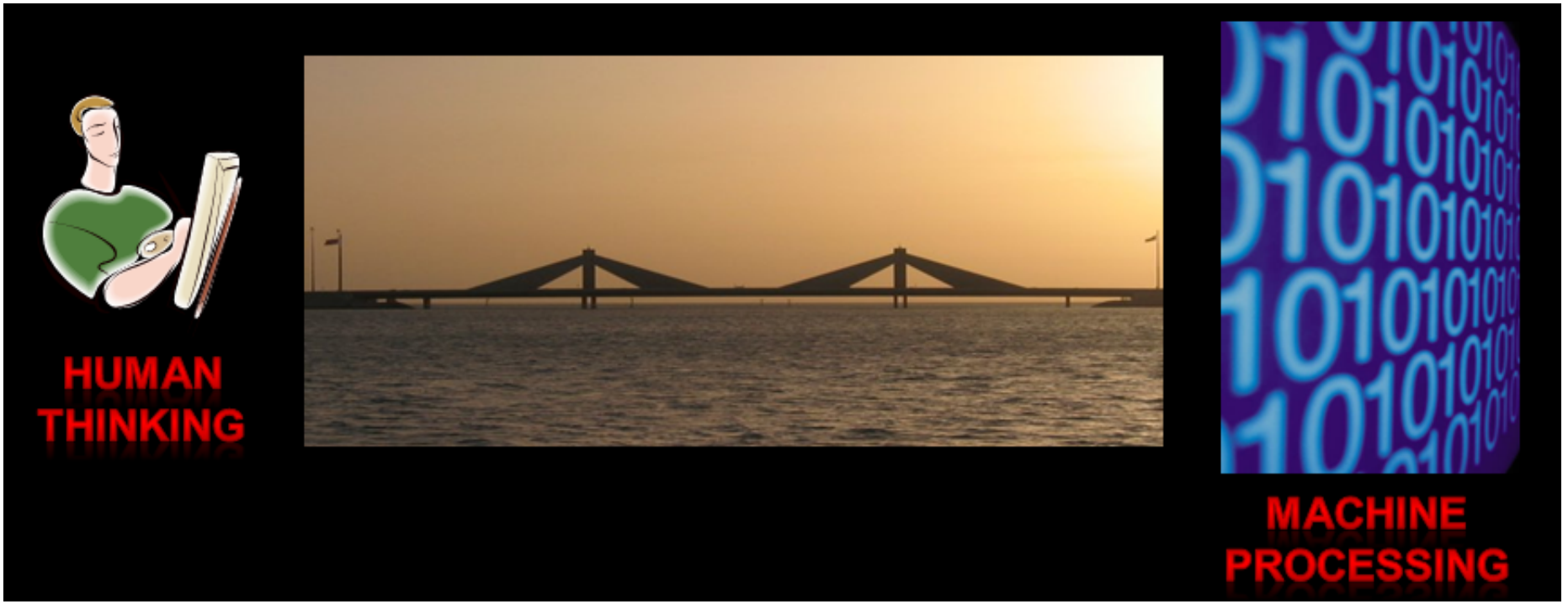
Bridging the gap…



OntoREM Mind-Mapper

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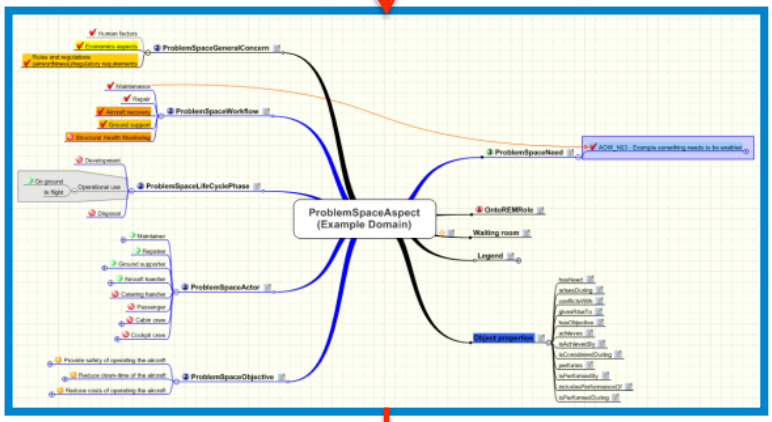
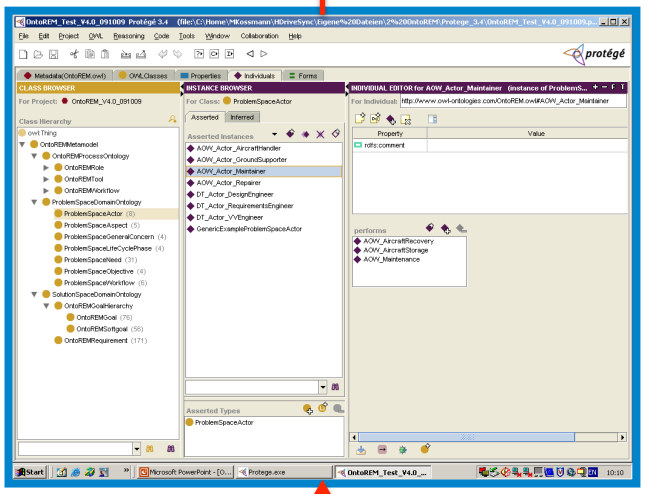
Deriving mind maps





Updating Domain Ontology

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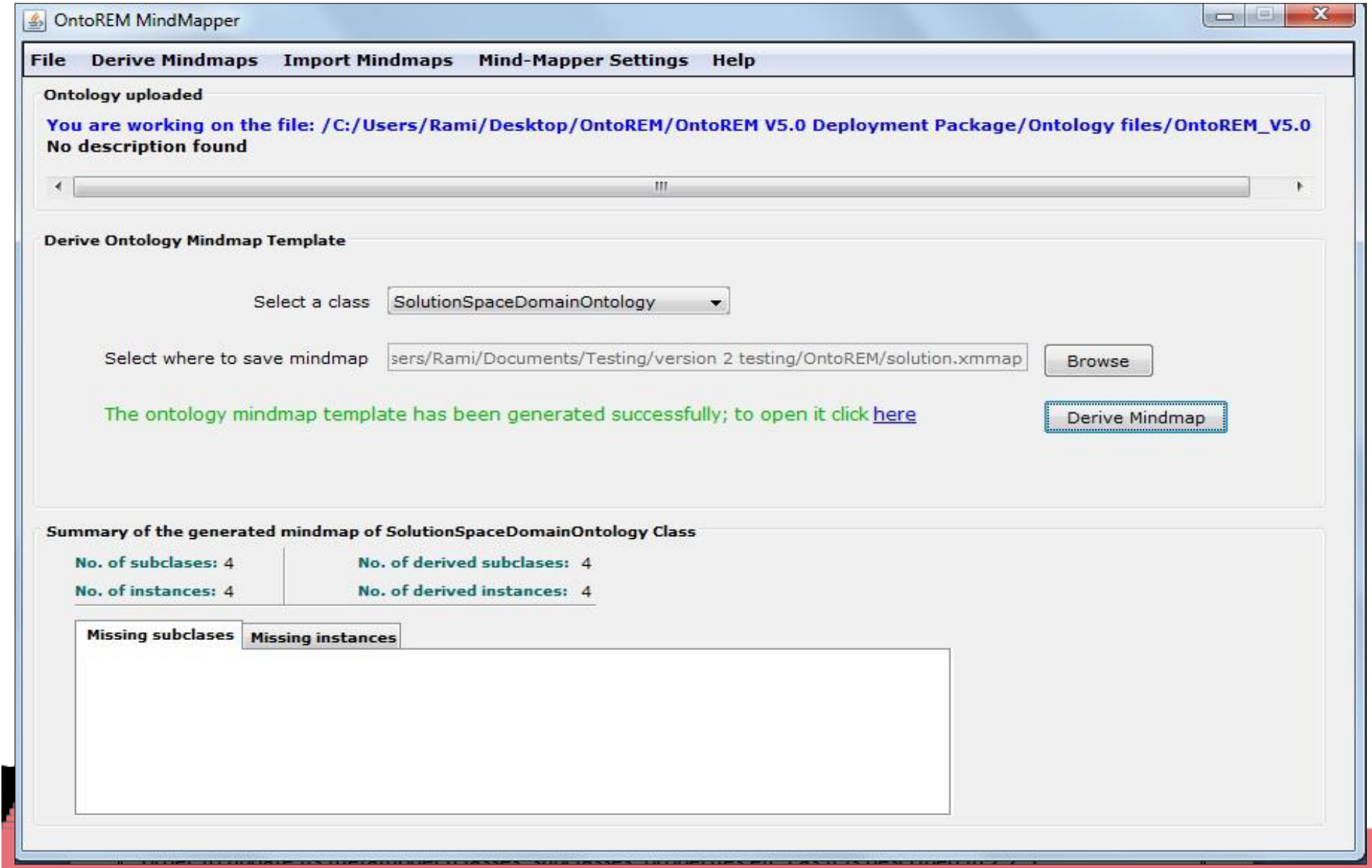

OntoREM Mind-Mapper

(Problem space mind maps)

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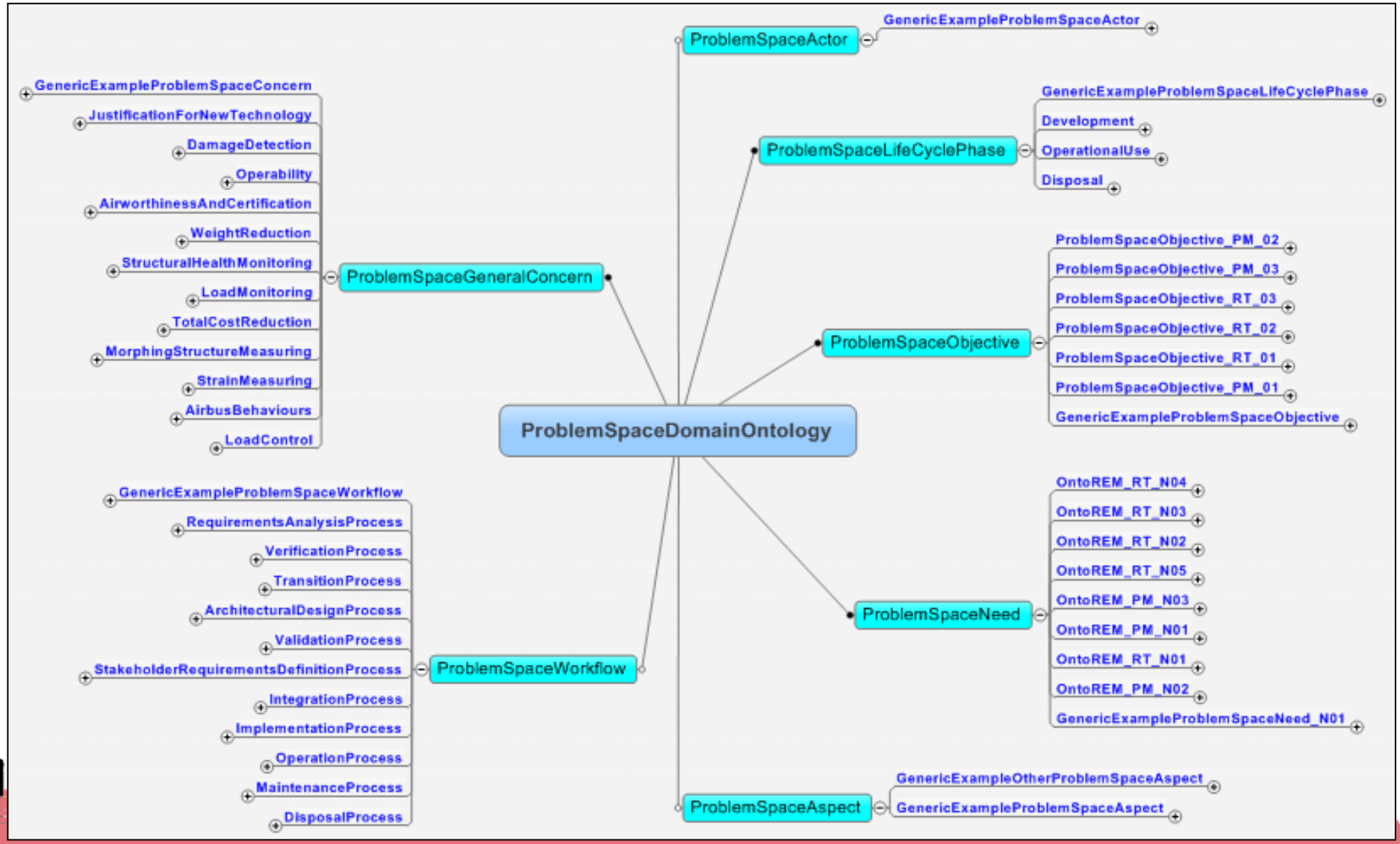

OntoREM Mind-Mapper

(Solution space mind maps)

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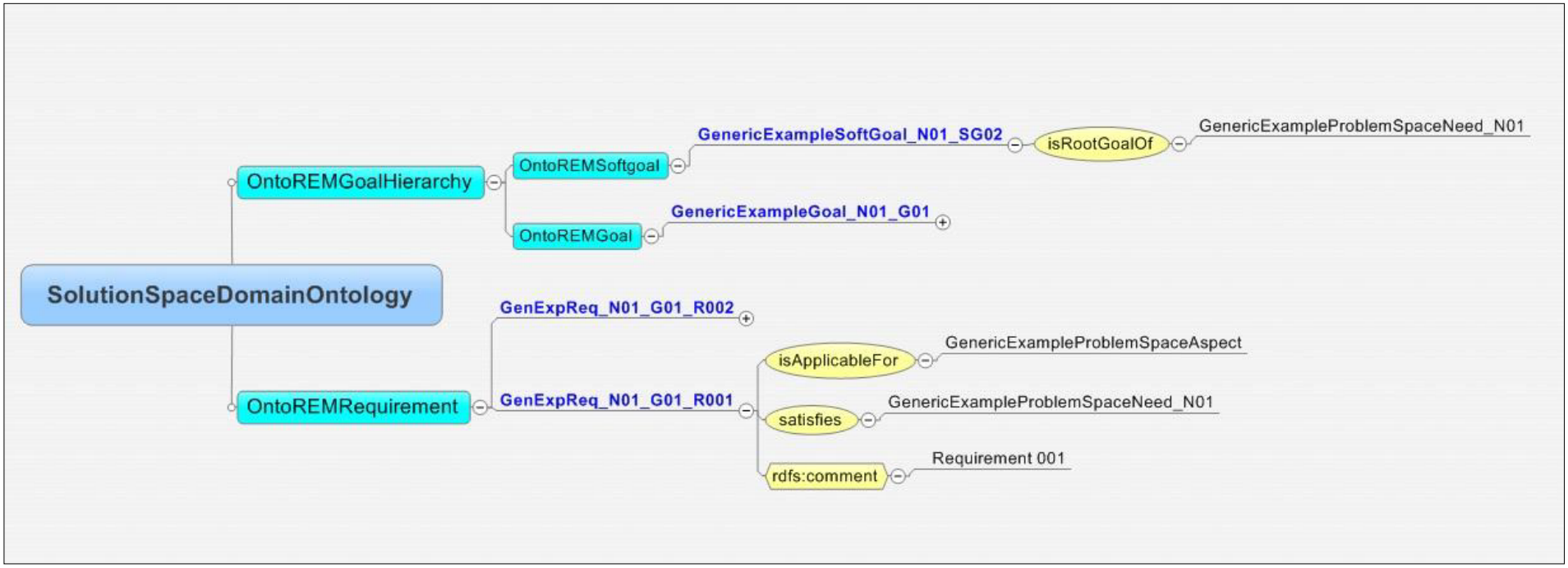

OntoREM Mind-Mapper

(Traceability mind maps)

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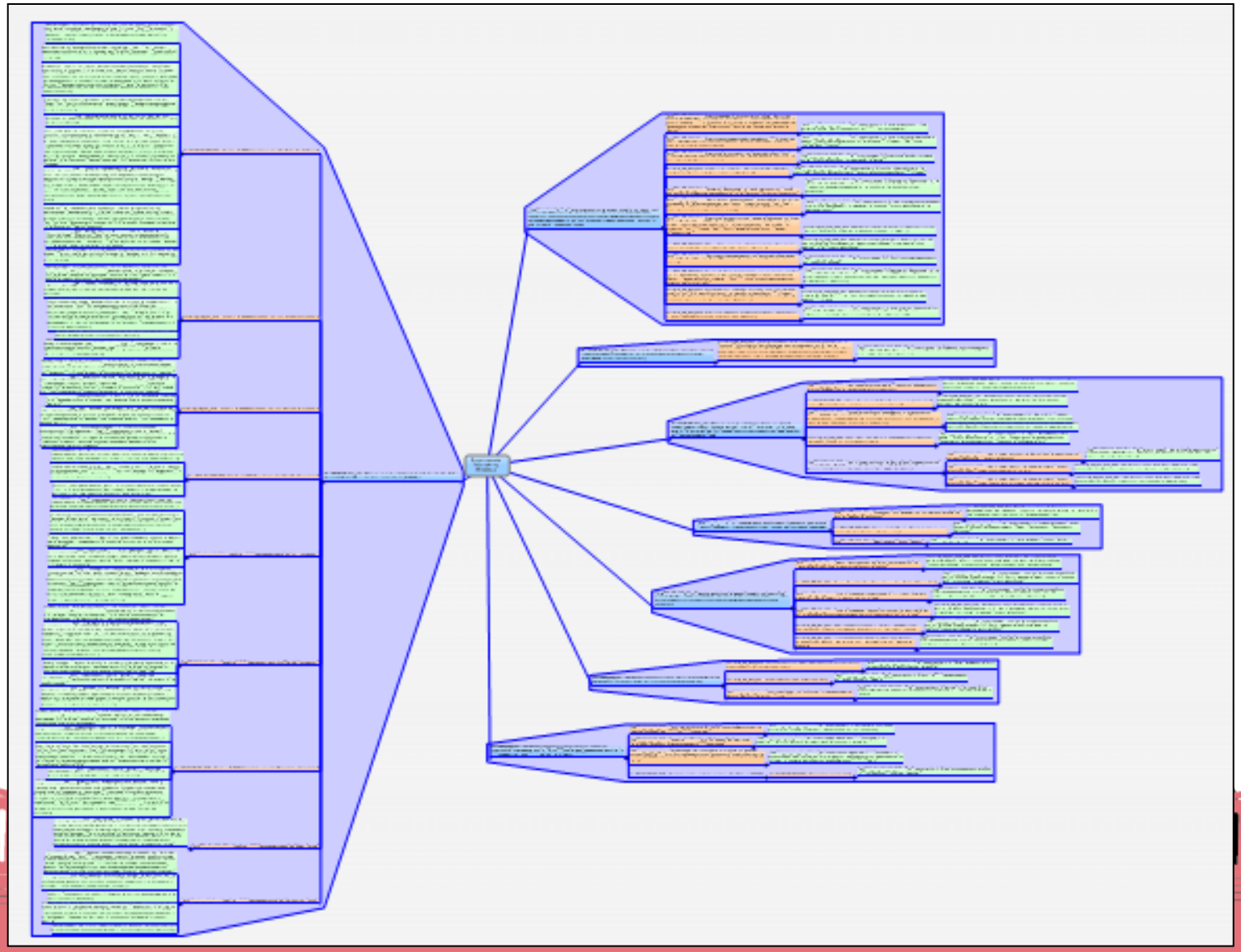

Conclusions

- OMM may be considered as a key step towards bridging the gap between human thinking and machine processing, as validated in a recent case study within Airbus, i.e. the Photonics Project.
- In the context of OntoREM, OMM enables controlled and automated bi-directional translations of domain knowledge between mind maps and ontologies.
- Outside the context of OntoREM, complex ontologies or parts thereof can be visualised in a manner suitable to humans (that no longer have to be experts in ontology), updated in the mind map format, and re-imported into the ontology format.
- Great potential to enhance other SE life cycle processes (not only RE), in particular architectural design, verification, integration, transition and validation.

Thank you…

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