

# Collaborative modeling of processes and ontologies

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# What is all about?

Develop a theoretical and practical framework that:

Supports the **integrated modeling** of Processes and Ontologies;

Fosters the **collaboration** between domain experts and knowledge engineers.

## WHY?

need of a **comprehensive model** which requires the description of both the **dynamic** component (processes) and the **static** component (ontology);

need for an **agile collaboration** between domain experts and knowledge engineers. Need to actively **involve the domain experts** in the modeling process.

# The research vision - architecture



# Outline of the presentation

Formal representation of processes and ontologies

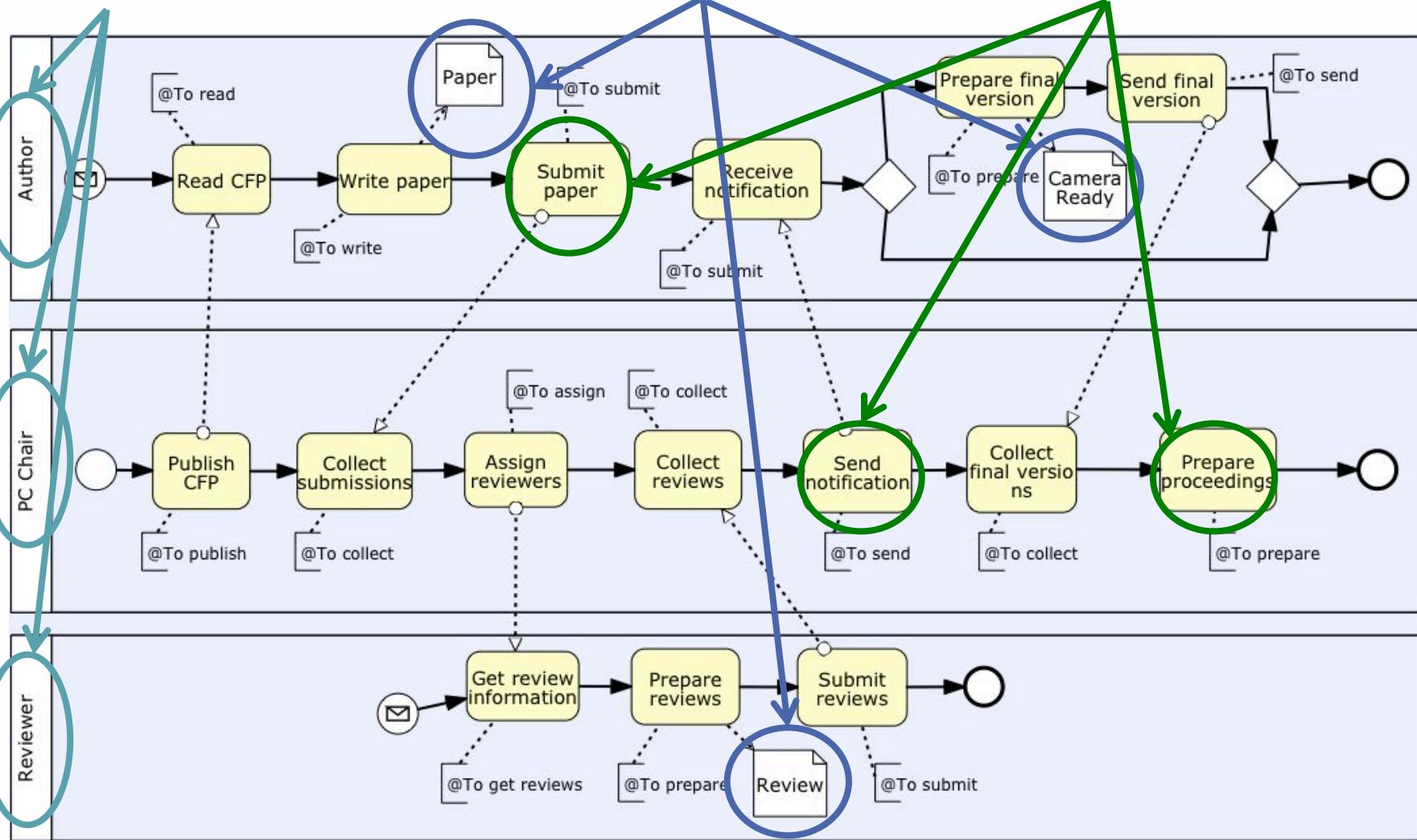
Architecture for collaborative conceptual modeling in wikis

MoKi and some of its real usages

# FORMAL REPRESENTATION OF PROCESSES AND ONTOLOGIES

# Integrating processes and ontologies

## Roles / Organization



# Integrating processes and ontologies

Example of queries and reasoning that involves both ontological and process knowledge:

*What are the activities performed by a certain role (e.g. PC Chair)?*

*Where are documents (e.g. reviews, notifications) produced?*

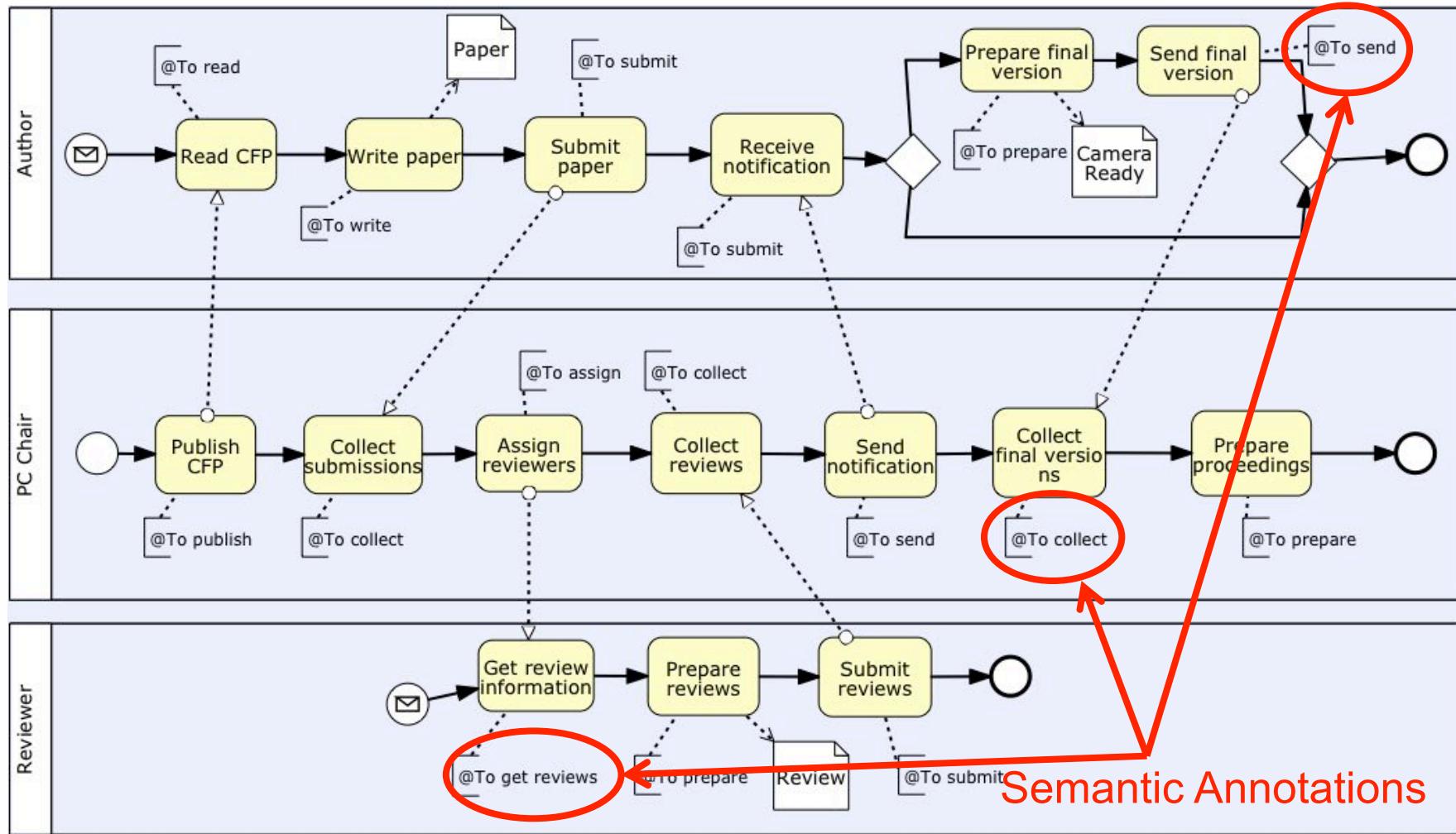
*What are the activities where something is published? What are the activities where something is sent out?*

*What are the activities an author perform right before submitting something?*

Example of application that requires querying for both ontological and process knowledge:

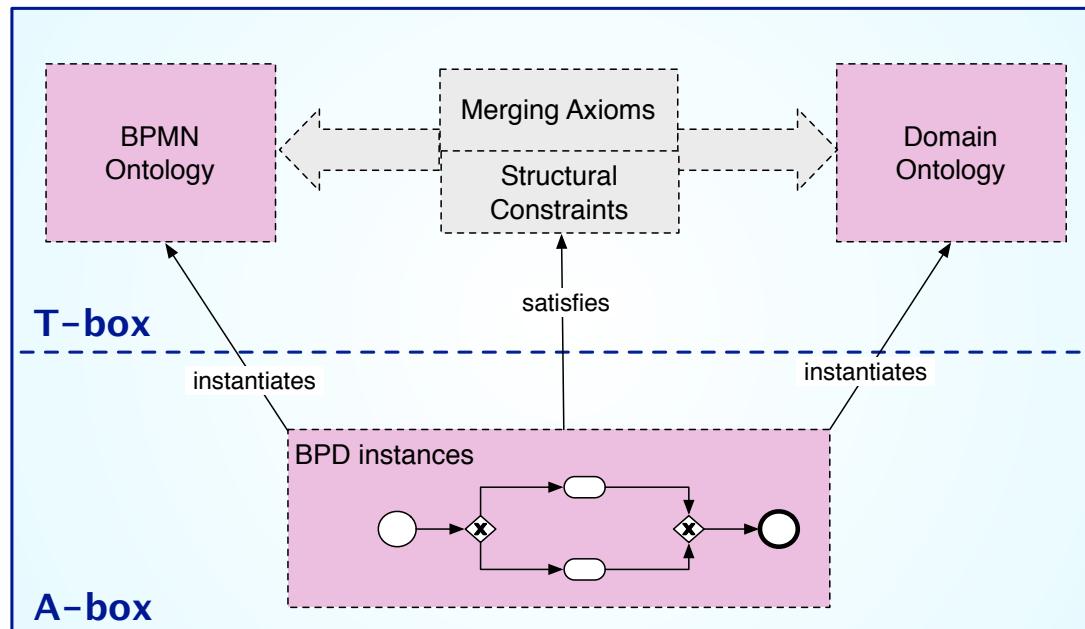
*Managing cross-cutting concerns in business processes.*

# Integrating processes and ontologies



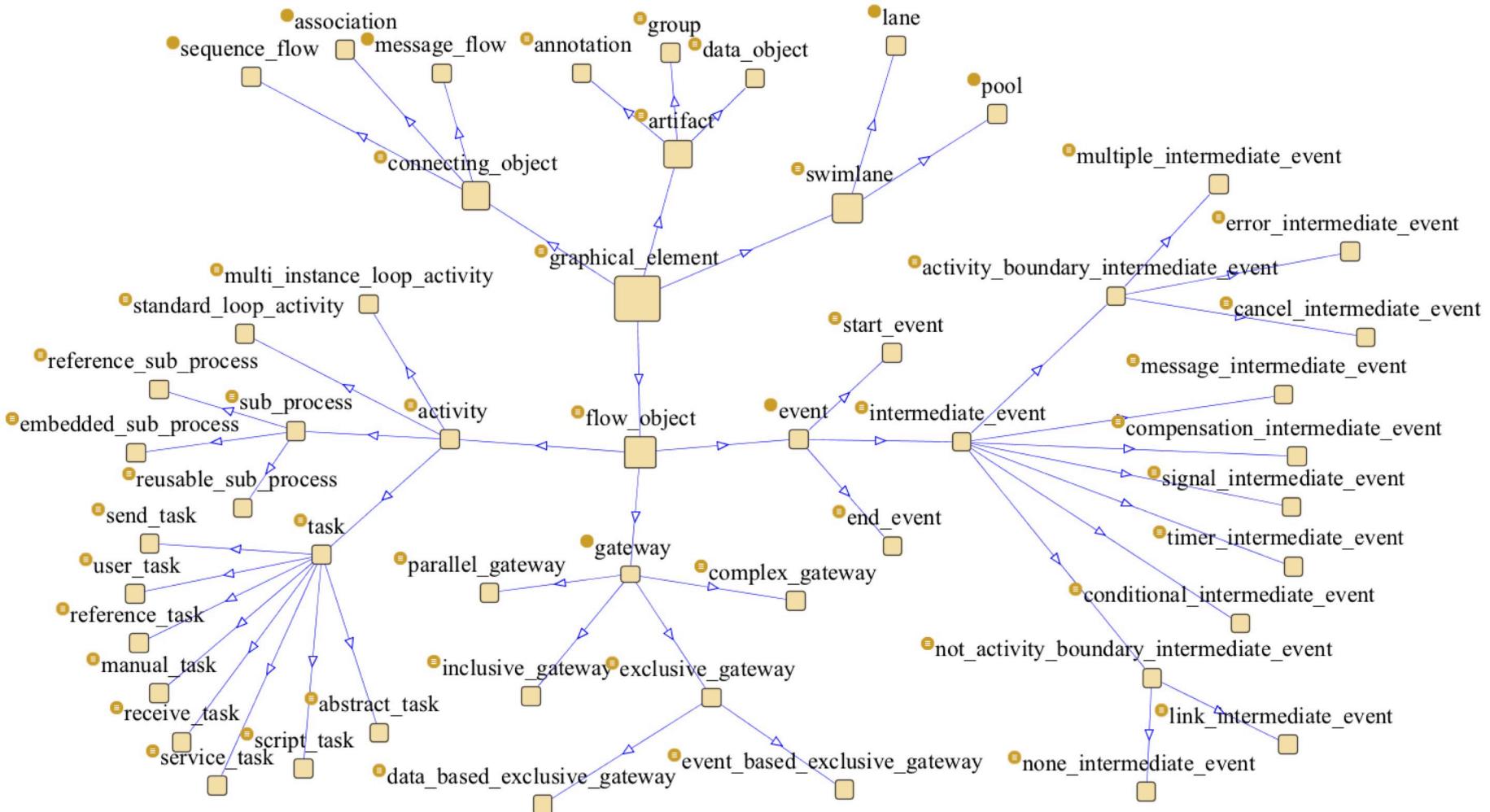
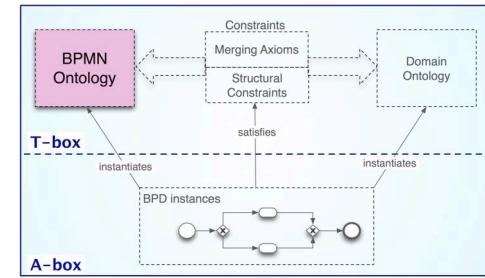
# Semantically Annotated Business Processes

Semantically annotated business processes are encoded into a logical knowledge base implemented in OWL

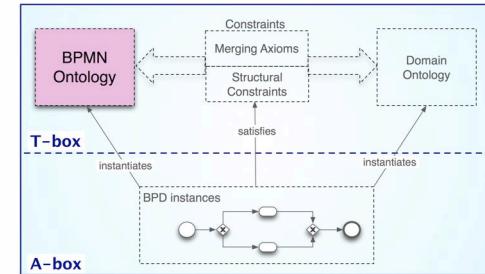


Note: Business Process Diagrams (BPDs) are specified using the Business Process Modelling Notation (**BPMN**).

# BPMN Ontology

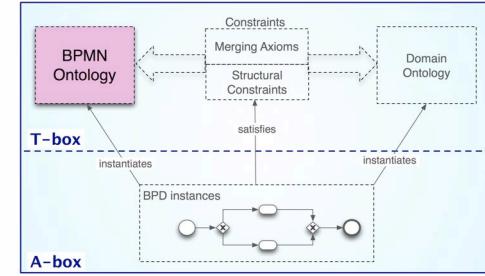


# BPMN Ontology



Feature	Value
DL Expressivity	$\mathcal{SHOIN}(\mathcal{D})$
Classes	117
Object Properties	123
Datatype Properties	48
Individuals	104
Class Axioms	463
Object Property Axioms	236
Datatype Property Axioms	96
Individual Axioms	250
Annotation	504

# BPMN Ontology



Current version based on v1.1 of the BPMN specifications by OMG (ontology for v2.0 almost ready)

It is not intended to model the dynamic behaviour of business process diagrams.

*If there are multiple outgoing Sequence Flow then only one Gate (or the DefaultGate) SHALL be selected during performance of the Process.*

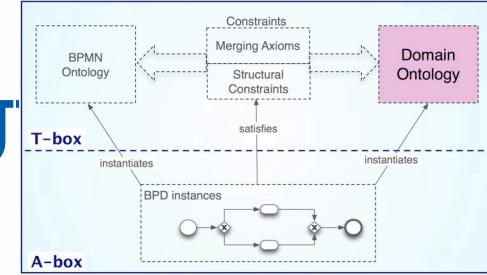
There are a few documented properties which are not represented due to expressiveness limitation imposed by Description Logics.

*The ConditionExpression attribute MUST be unique for all the outgoing Sequence Flows connected to an Inclusive Gateway*

Available for download at:

[http://dkm.fbk.eu/index.php/BPMN\\_Ontology](http://dkm.fbk.eu/index.php/BPMN_Ontology)

# Business Domain Ontology



Represents the (specific) business domain.

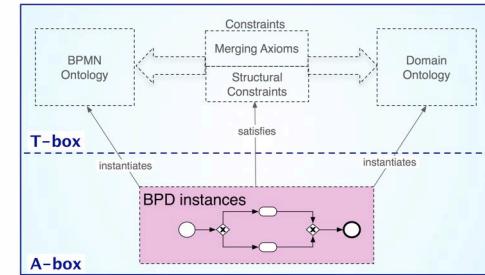
Used to annotate the elements of the business process diagram.

Can be composed of:

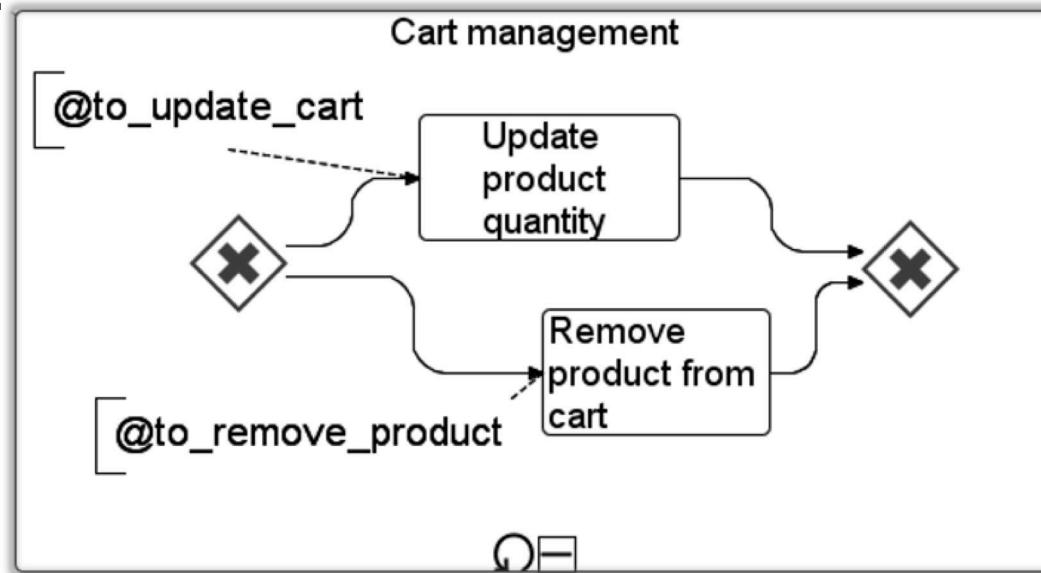
Top level ontologies, such as DOLCE;

Domain-specific ontologies.

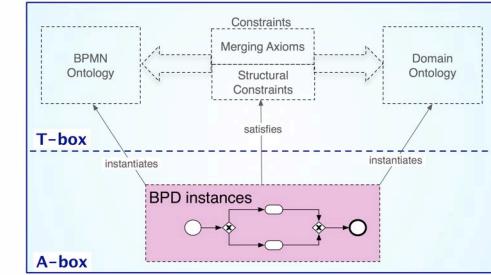
# BPD Instances



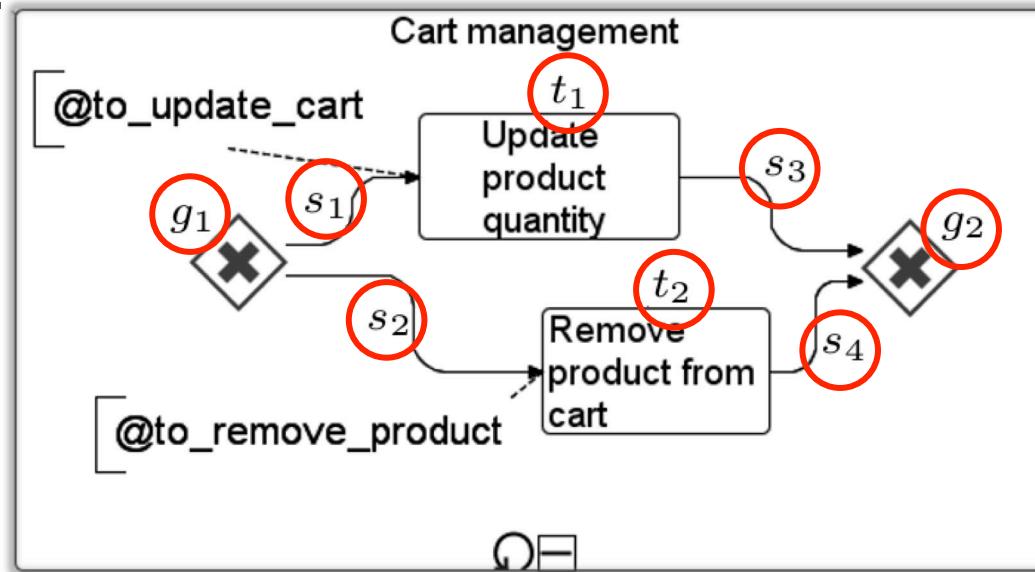
Represents the specific annotated business process diagram.



# BPD Instances



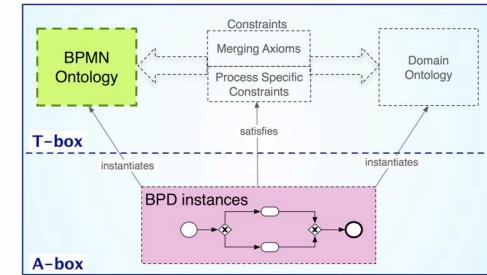
Represents the specific annotated business process diagram.



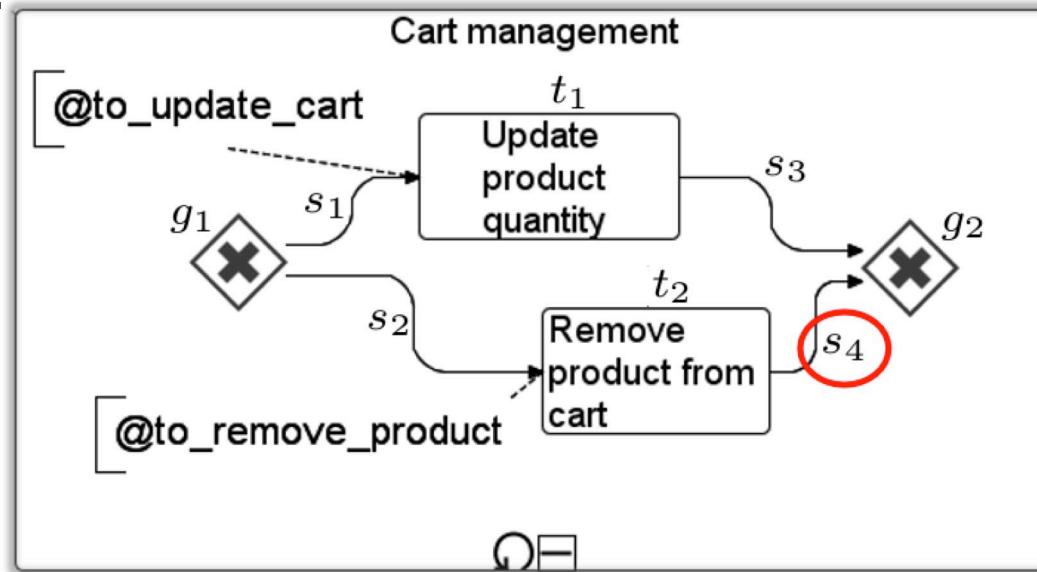
Create an individual for each graphical element of the business process.

$s_1, s_2, s_3, s_4, t_1, t_2, g_1, g_2$

# BPD Instances



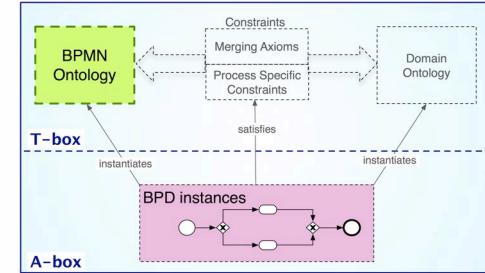
Represents the specific annotated business process diagram.



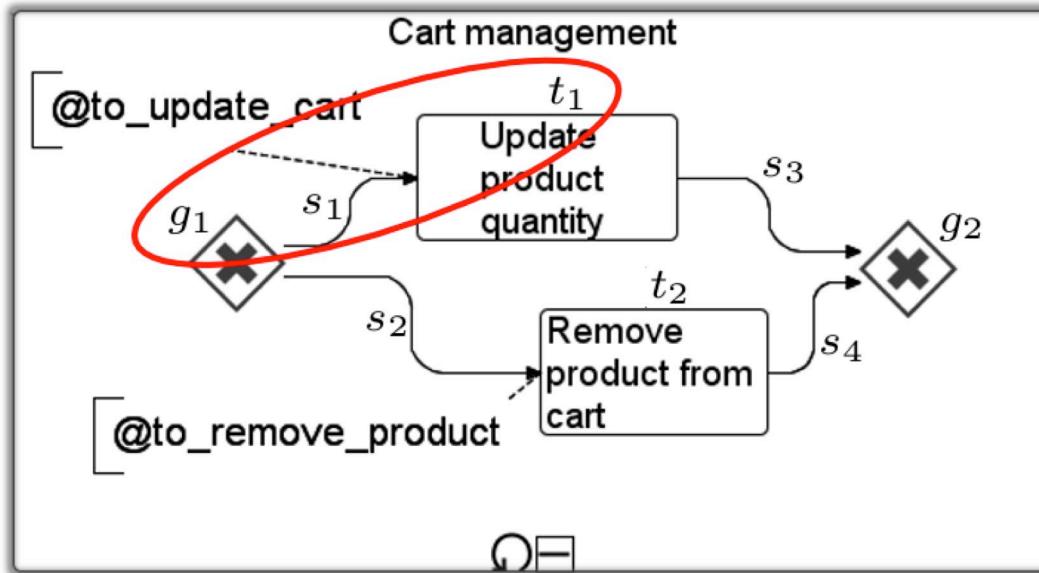
**BPMN-type assertions:** for every graphical element  $g$  of BPMN type  $T$  occurring in the process, we add the assertions  $T(g)$ .

$\text{sequence\_flow}(s_4)$

# BPD Instances



Represents the specific annotated business process diagram.

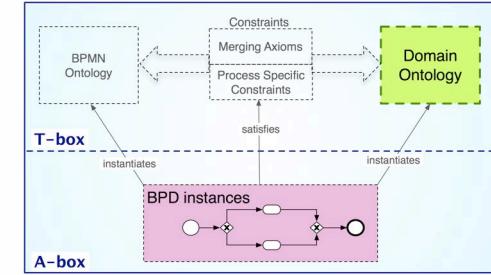


**BPMN-structural assertions:** For every connecting object  $c$ , going from  $a$  to  $b$ , we add assertions of the form  $\text{source}(c, a)$  and  $\text{target}(c, b)$ .

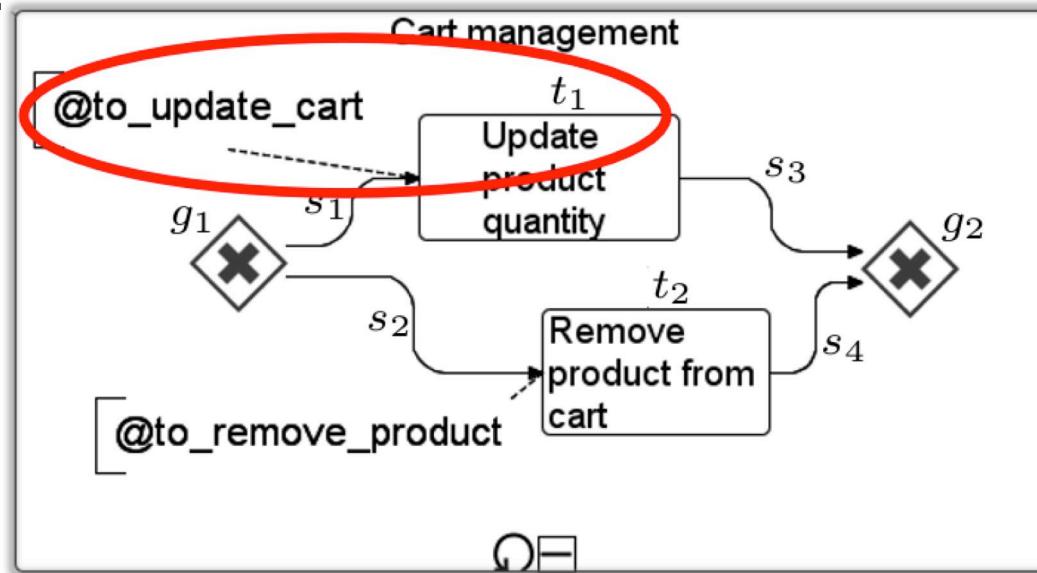
$\text{has\_sequence\_flow\_source\_ref}(s_1, g_1)$

$\text{has sequence flow target ref}(s_1, t_1)$

# BPD Instances



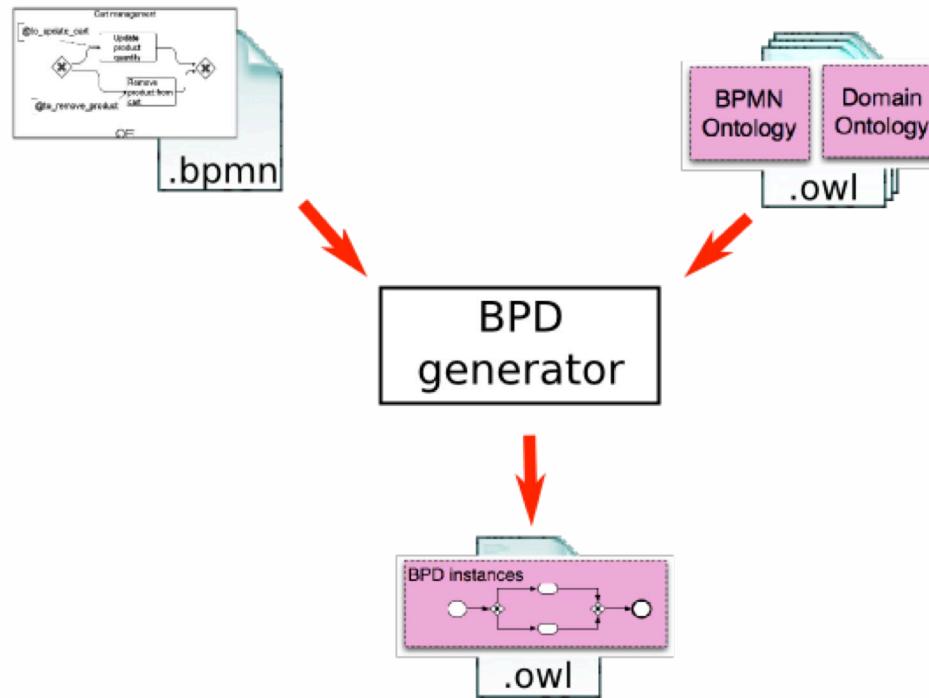
Represents the specific annotated business process diagram.



**Semantic assertions:** For every graphical element  $g$  of the process which is annotated with  $C$  (where  $C$  is a complex concept expression of the domain ontology), we add the assertion  $C(g)$ .

# Automatic OWL A-box generation

The transformation of an annotated Business Process Diagram into an OWL A-box is performed automatically.



Available for download at:

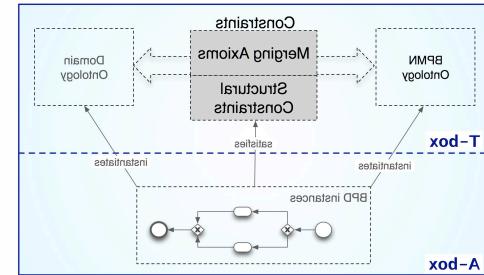
<http://selab.fbk.eu/dfrancescomarino/SemanticBPM/>

# Querying the Business Process Knowledge Base

Return all the **activities** that **buy** products and for which there exists at least a **path**, consisting **of sequence flows**, that connects a **to check product availability activity** to the given activity.

```
PREFIX bpmn:<http://dkm.fbk.eu/index.php/BPMN_Ontology#>
PREFIX rdf: <http://www.w3.org/1999/02/22-rdf-syntax-ns#>
PREFIX p: <http://exampleOntology#>
SELECT ?a1 ?a2
WHERE { ?a1 rdf:type bpmn:activity.
          ?a1 rdf:type p:to_check_product_availability.
          ?a1 (bpmn:has_sequence_flow_source_ref_inv/bpmn:has_sequence_flow_target_ref)* ?a2.
          ?a2 rdf:type bpmn:activity.
          ?a2 rdf:type p:to_buy_product.
}
```

# Process Constraints



The framework also enables to define constraints for:

correct/incorrect annotation of business process graphical elements:

- *A BPMN activity is annotatable only with actions of the domain ontology (and not e.g., with documents);*

valid critical patterns:

- **containment constraints:** *the activity of managing a shopping cart is a sub-process which contains an activity of removing products from the cart;*
- **precedence constraints:** *the activity of providing personal data is immediately preceded by an activity of reading the policy of the organization;*
- **exception handling constraint:** *the activity of reserving products in the On-line Shop pool has always to catch a èproduct unavailabilityê error event;*

Using DL-reasoning we can:

Check compatibility of process constraints:

# Integrating processes and ontologies

## Selected publications:

*Semantics based aspect oriented management of exceptional flows in business processes* – C. Ghidini, C. Di Francescomarino, M. Rospocher, P. Tonella, L. Serafini - IEEE Transactions on Systems, Man and Cybernetics. Part C: applications and reviews

*A framework for the collaborative specification of semantically annotated business processes* - C. Di Francescomarino, C. Ghidini, M. Rospocher, L. Serafini, P. Tonella - Journal of Software Maintenance and Evolution: Research and Practice

*Semantically-aided business process modeling* - C. Di Francescomarino, C. Ghidini, M. Rospocher, L. Serafini, P. Tonella - International Semantic Web Conference (ISWC'09)

*Reasoning on semantically annotated processes* - C. Di Francescomarino, C. Ghidini, M. Rospocher, L. Serafini, P. Tonella - International Conference on Service Oriented Computing (ICSOC'08)

**Next steps: extension to the dynamics of executions.**

# **AN ARCHITECTURE FOR COLLABORATIVE CONCEPTUAL MODELING IN WIKIS**

# Why a wiki-based conceptual modeling tool?

Wikis support **collaborative** editing;

Users are quite **familiar** with viewing/editing wiki content (e.g. Wikipedia);

Only a **web-browser** is required on the client side;

Wikis provide a **shared knowledge repository** accessible by users spread all over the world;

Wikis can provide a **uniform tool/interface** for the specification of different model types (e.g. ontologies, processes, ...);

# An architecture for collaborative conceptual modeling in wikis

1. One element  One page

each element of the model is represented by a page in the wiki;

Concept “Mountain” 

Mountain

A **mountain** is a large [landform](#) that stretches above the surrounding land in a limited area usually in the form of a peak. A mountain is generally steeper than a [hill](#).

The highest mountain on earth is the [Mount Everest](#)



# An architecture for collaborative conceptual modeling in wikis

## 2. Unstructured and structured descriptions

each page contains both structured and unstructured content;

### Mountain

A **mountain** is a large [landform](#) that stretches above the surrounding land in a limited area usually in the form of a peak. A mountain is generally steeper than a [hill](#).

The highest mountain on earth is the [Mount Everest](#)



(unstructured content)

$\sqsubseteq Landform$

$\sqsubseteq \neg Hill \sqcap \neg Plain$

$\sqsubseteq \forall madeOf(Earth \sqcup Rock)$

$\sqsubseteq \exists height. \geq 2500$

*Mountain(Mt.Everest)*

*Mountain(Mt.Kilimanjaro)*

(structured content)

# An architecture for collaborative conceptual modeling in wikis

## 3. Different views to access the model:

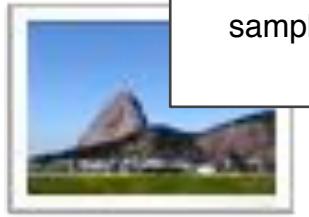
different views to support different modeling actors;

### Mountain

#### Mountain

A **mountain** is a large [landform](#) stretches above the surrounding a limited area usually in the form peak. A mountain is generally steeper than a [hill](#).

The highest mountain on earth is the [Mount Everest](#)



(unstructured view)

is a [landform](#)

different from [hill](#), [plain](#)

made of [earth](#)

made of [rock](#)

height at least 2,500m

samples [Mt. Everest](#)  
[Mt. Kilimanjaro](#)

(semi - structured view)

### Mountain

$\sqsubseteq \text{Landform}$

$\sqsubseteq \neg \text{Hill} \sqcap \neg \text{Plain}$

$\sqsubseteq \forall \text{madeOf}(\text{Earth} \sqcup \text{Rock})$

$\sqsubseteq \exists \text{height}. \geq 2500$

$\text{Mountain}(\text{Mt.Everest})$

$\text{Mountain}(\text{Mt.Kilimanjaro})$

(fully - structured view)



the Modelling WiKi ---

# **AND SOME OF ITS REAL USAGES**

Wiki-based modeling tool;

Supports the integrated modeling of Processes and Ontologies;

Provides modeling support both for domain experts and knowledge engineers, fostering the collaboration between them;

Based on the framework presented so far.



FONDAZIONE  
BRUNO KESSLER

**MoKi**

the Modelling WiKi ---

**DEMO**



IP FP6 EU Project [03/2006 – 02/2010]

**Purpose: modeling of tasks/processes in an enterprise and of the topics related to that task (*competencies*)**

Used by:

4 SMEs

3 Universities

several related summer schools and university courses



STREP FP7 EU project [01/2010 – 12/2012]

**Purpose: build/revise an environmental ontology**

Developed the new key concepts extraction functionalities

Used to automatically create part of the ontology (pollen)



Organic.Edunet

eContentplus EU Project [09/2007 – 08/2010]

**Purpose: build/revise an ontology of organic agriculture and agroecology**

Used to foster collaboration between domain experts (FAO) and knowledge engineers

Follow-up: Organic.Lingua (FP7 Pilot Tipe B EU project [36 months])

Extend MoKi to multilingua models and interface



Italian national project [01/2010 – 12/2011]

**Purpose: model processes for analysis/revision and dematerialization**

Used by 7 Italian regions:

Piemonte, Emilia Romagna 1 & 2, Puglia, Liguria, Marche, Trentino

Medium size models produced in around 2 weeks.

## OncоАure

Funded by Fondazione Caritro, Trento [2007 – 2008]

**Purpose: modeling breast cancer clinical protocols  
encoded in Asbru.**

Customized version of the tool

Actively used mainly by KE

Positive feedback by the doctor who produced the clinical guidelines in “reviewing” the model created.

## eOnco

FBK Joint Research Project [2009 - 2013]

**Purpose: modeling of nurse activities in an oncology ward.**

Collaboration between “observer” and KEs for the creation of the process diagrams

Planning to integrate ontological information soon

# Lessons learned

Wikis can be a powerful way to **lower the entrance barrier** for modeling tools and to share knowledge;

**Real need to integrate** processes and ontologies, and to include in processes organizational aspects taken from a formal description (ontology);

Collaboration **happens** and is **helpful**;

Need to **guide domain experts** by providing schemata of representations; e.g., what characterize a document?

# Evaluation

Performed within **ProDe** project (to be presented @ ISWC2011);

Users: **14 Public Administration employees distributed across 6 teams creating different integrated models;**

Research questions considered:

RQ1: *Is MoKi easy to use for domain experts?*

RQ2: *Is MoKi useful for collaboratively modeling domain knowledge?*

RQ3: *Are all the provided views useful or is there a best view among the different interface views provided by MoKi for: (a) getting the model overview? (b) navigating the model? (c) creating new entities?*

Analyses performed:

**Quantitative analysis** of the data on the usage of MoKi (editing 43 logs, web-server logs, ...);

# Evaluation Results

## RQ1 (ease of use):

The users perceive the tool as **more than easy to use**:

- 72% of employees spent only less than two days to learn how to use tool;
- the same percentage learned it autonomously.

## RQ2 (usefulness for collaborative modeling):

The users **positively perceive the overall usefulness** of the tool for the collaborative modeling of documents and processes:

- Correlation between the size of the subject's team and his/her feedback about tool usefulness for collaborative purposes (esp. in team with 3+ or more users).
- Result further validated by the intensive usage of collaborative functionalities by people in large team.

## RQ3 (usefulness of provided views):

All the views provided by the tool **have their own usefulness**.

# Current & Future Works

**Fully implement** the formal framework for integrating processes and ontology (preliminary prototype now ready)

Develop **ad-hoc templates to guide DE** in modeling activities

describing an artifact is different than describing a role

Support **usage of ontology patterns**

to speed up modeling activities, and limit modeling errors

**Extend** key-concepts extraction functionalities

Support extraction / identification of semantic relation in text (e.g. "isA") between concepts

Publications and demos:

ISWC2011, EKAW2010, ISWC2010, SemWiki2009, ESWC2009, ...

Released Open Source in July 2010 (version 1.2 – GPL2)

MoKi WebSite:

URL: <http://moki.fbk.eu>

On-line demos, code download, documentation, news, support...

# Joint work with...

On all this stuff...:

**Chiara Ghidini, Lucian Serafini.**

Semantically Annotated Business Processes:

**Paolo Tonella, Chiara Di Francescomarino**

MoKi:

**Nahid Mahbub, Gaetano Calabrese, Mauro Dragoni, Rakebul Hasan, Musawar Saeed**

eHealth Applications:

**Claudio Eccher**

Term Extraction (for ontology building / evaluation):

**Sara Tonelli, Emanuele Pianta**

# Thank You!

## Questions?