Modeling, Meta-Modeling, Hybrid Wikis

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Learning objectives of this unit

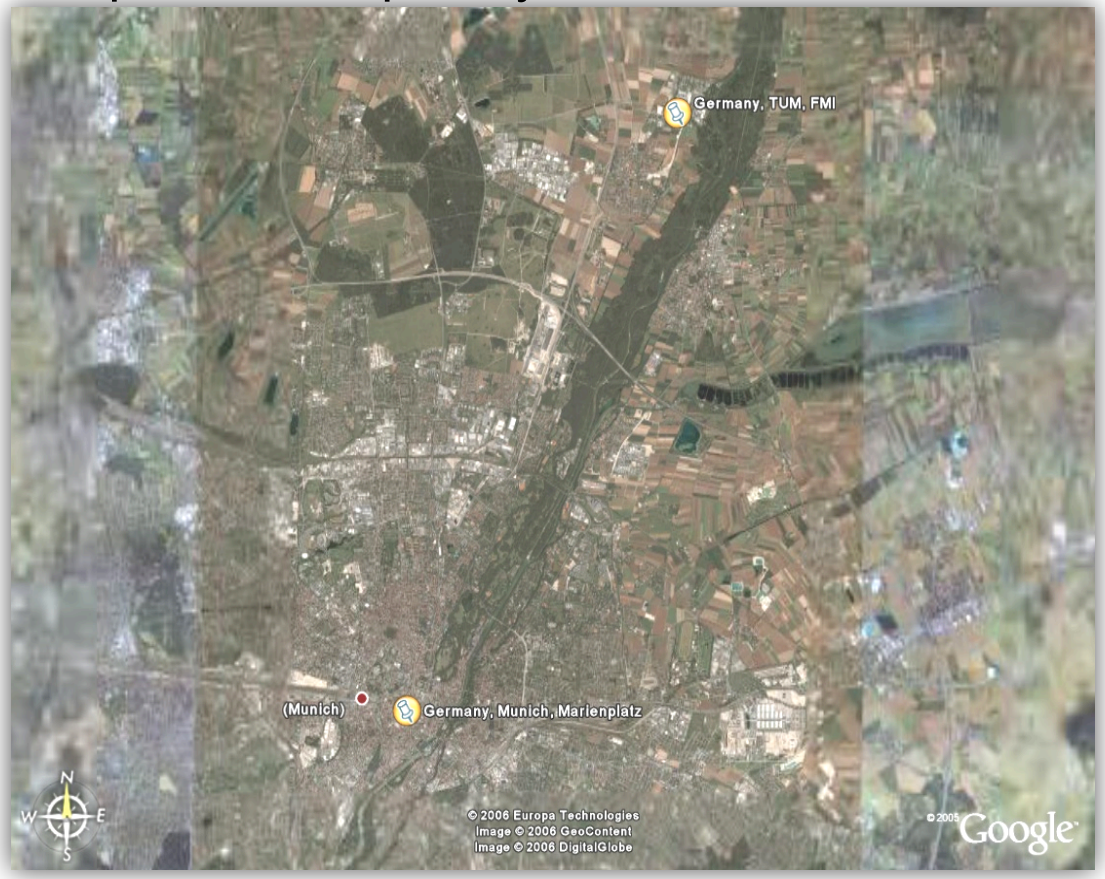
- Students
  - know the basic principles of conceptual modeling
  - can distinguish between describing and designing models and know their corresponding quality criteria
  - are able to structure a modeling language into its constituents and know different methods for describing these constituents
  - can explain the fundamentals of UML MOF
  - are able to derive the information model from a specific viewpoint
  - can apply different techniques to develop an organization-specific information model

Outline of this unit

- 3.1 An introduction to conceptual modeling
  - Models in context
  - Modeling languages and meta-models
- 3.2 EA Modeling
- 3.3 Collaborative, emergent EA modeling

Motivating example (1)

- Reality is often too complex to model or comprehend it.
  - Task: How do I get from FMI in Garching to the Marienplatz with the public transport system of the MVV?



Source: Google Earth

Motivating example (2)

- Questions
  - Do I have to know where a traffic light is?
  - Do I have to know where a tree stands?
- Result is *abstraction* and *reduction*
  - The model has to contain the important information for the user.
- Model
  - Plan of the public transport system of the MVV

Key characteristics of a (representing) model according to Stachowiak [St73]

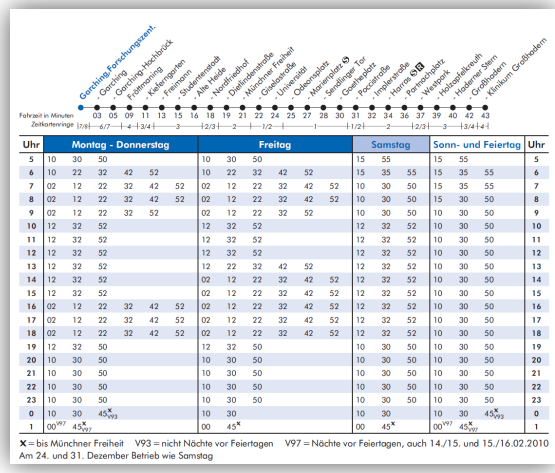
- *Models are always models of something, namely surrogates or representations of natural or artificial originals, which can be models themselves*.
  (engl. **Mapping** – dt. **Abbildungsmerkmal**)
- *Models commonly do not capture all attributes of their corresponding original, but only those, which seem to be relevant for the model creator and/or model user.* (engl. **Abstraction** – dt. **Verkürzungsmerkmal**)
- *Models are no 1:1 copies of their originals, they are surrogates for the original*
  - for certain – cognitive and/or acting, model using – subjects,
  - within given time intervals and
  - under constraints to certain mental or real operations.

  (engl. **Pragmatics** – dt. **Pragmatisches Merkmal**)

- **But:** Models may refer to yet not built originals, i.e. may be *design models*.
- ➔ Slightly different definition of model

Motivating example (ctd.) – Two more models of the MVV public transport system

- **Model 2 (Timetable):**
  - Different selection of attributes – arrival and transport times
  - Similar model pragmatics:
    - Users that want to get via MVV from FMI to Marienplatz
    - in the year 2014



Source: MVV

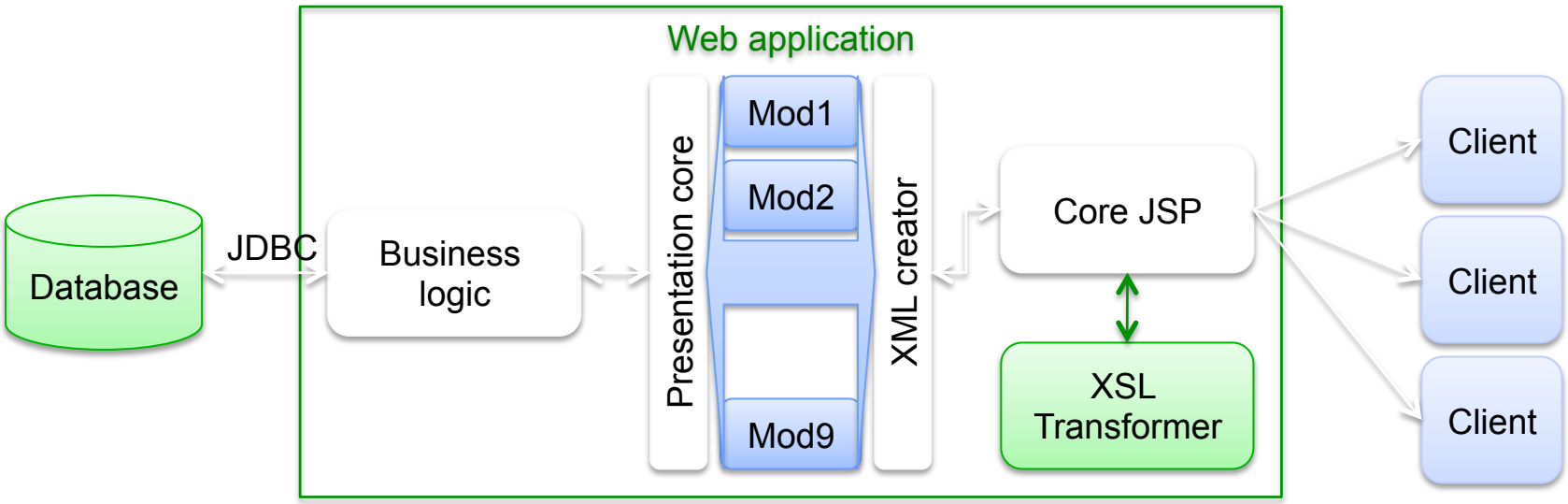
- **Model 3 (Spatial plan):**
  - Different selection of attributes – spatial info
  - Different model pragmatics:
    - Users that want to perform urban planning
    - in the year 2014

Source: Stadt München

➔ Make-up of the models depends on its users (**stakeholders**).

➔ Users might combine different models to a **view**.

A model?



- Questions:
  - Who is the intended user of the visualization? (Stakeholder)
  - What do the rectangles and colors mean? (Viewpoint)

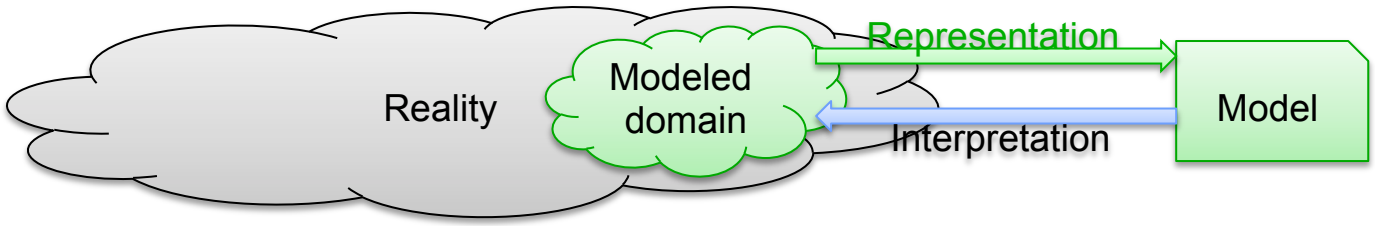
- Anecdote:

  „These pictures are meant to entertain you. There is no significant meaning to the arrows between the boxes.“

[Cle03]

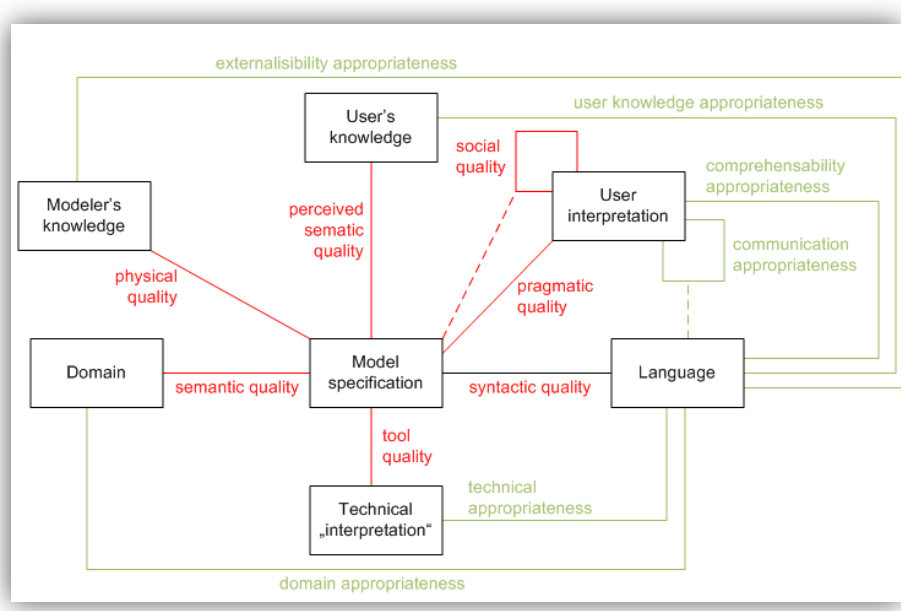
What makes a (representing) model a good one? – Conceptions of model quality [Gu01] (1)

- Connecting model and modeled domain – *representation* and *interpretation*
  - *Lucidity (dt. Klarheit)*: Every construct in the model must represent at most one object from the modeled domain. Overloaded model constructs are forbidden. (*injective representation*)
  - *Soundness (dt. Triftigkeit)*: Every construct in the model must represent at least one object from the modeled domain. Construct excess in the representation is avoided. (*surjective representation*)
  - *Laconicity (dt. Prägnanz)*: Every object from the modeled domain must "interpret" at most one construct in the model. Construct redundancy is forbidden. (*injective interpretation*)
  - *Completeness (dt. Vollständigkeit)*: Every object in the modeled domain must "interpret" at least one construct in the model. Model completeness is ensured. (*surjective interpretation*)



What makes a (design) model a good one? Conceptions of model quality [Kr02] (2)

- Different types of model quality for the model in usage context [
  - *Semantic quality*: Does the model cover the modeled domain?
  - *Pragmatic quality*: Can the model be interpreted by the model users?
  - *Physical quality*: Does the model capture the modeler's domain knowledge?
  - *Perceived semantic quality*: Does the model correspond to the users' knowledge about the domain?



  - *Social quality*: Does the model facilitate user discussions on the domain?
  - *Tool quality*: Can the model be "interpreted" by a modeling tool?
  - *Syntactic quality*: Does the model conform to a *modeling language*?

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Every model has a modeling language

- Main parts of a modeling language [Kü04]:
  - **Syntax:** Describes the set of language concepts and their relationships to each other as well as the rules for forming *correct* models.
  - **Notation:** Describes the representation of the language concepts (may be graphically or textually).
  - **Semantics:** Describes the meaning of the language concepts and of their relationships.

- A modeling language
  - incorporates *domain knowledge*,
  - reifies the *substantial laws* of the domain, and
  - determines what a *valid model* is.

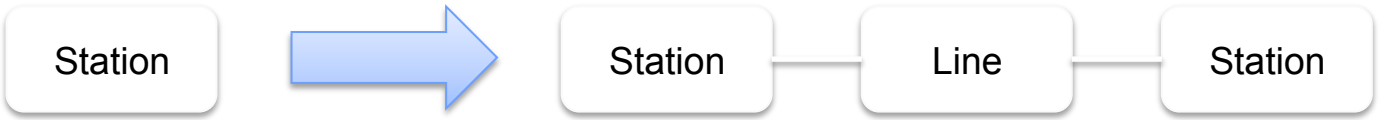
- **But**: Not all *valid models* are *sensible* models, too.

Different ways of defining the syntax (1)

Grammar-based: a grammar describes how to get from a correct simpler language element to a more complex one
For textual languages: semi-Thue system and term rewriting systems, e.g. (Extended) Backus-Naur-Form (BNF)

- For graphical languages: graph rewriting systems
- **Advantages**:
  - easy to use
  - easy to implement in a tool
- **Disadvantages**:
  - grammar rules do not necessarily reflect domain concepts
  - hardly used and taught for conceptual models

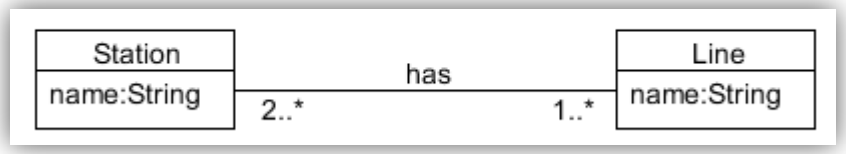
- For our example:



Different ways of defining the syntax (2)

- *Meta model-based*: a model of higher abstractness, the meta model, describes the language elements and their intended relationships
  - For object-oriented languages: MOF, UML
  - For general knowledge representations: RDF, OWL
  - **Advantages**:
    - meta model concepts reflect domain concepts
    - widely used and taught in conceptual modeling
  - **Disadvantages**:
    - meta model is expressed in (another) modeling language → infinite regress
    - meta modeling language influences conceptualization of domain

- For our example:



Modeling language syntax and model

- Syntax has two main functions:
  - Specify the admissible model constructs
  - Impose rules how the constructs can be combined

- A model can comply with a syntax on different levels:
  - “Nonsense” – does not (only) use the admissible constructs
  - “Gibberish” – uses the admissible constructs but does not comply with the rules
  - “Unintended models – uses the constructs, complies with the rules, but does not correspond to a sensible reality
  - “Intended models” – uses the constructs, complies with the rules, and is sensible

- Language expressiveness may not be sufficient to avoid unintended models:
  - ➔ *Contextual grammar rules* in grammar-based language specifications
  - ➔ *Constraints* on meta-level in meta-model based language specifications

Different ways of defining semantics

- *Textually*: language concepts are provided informal descriptions of their meanings
- *Denotational*: language concepts are mapped to mathematical concepts, e.g. sets or groups, with well-founded semantics
- *Algebraic*: language concepts form elements and operators in an algebraic structure
- (*Operational*: language concepts are operationalized via code-fragments)
- (*Axiomatic*: language concepts are complemented with logical pre- and post-conditions)

➔ For enterprise architecture modeling the first three ways are applicable

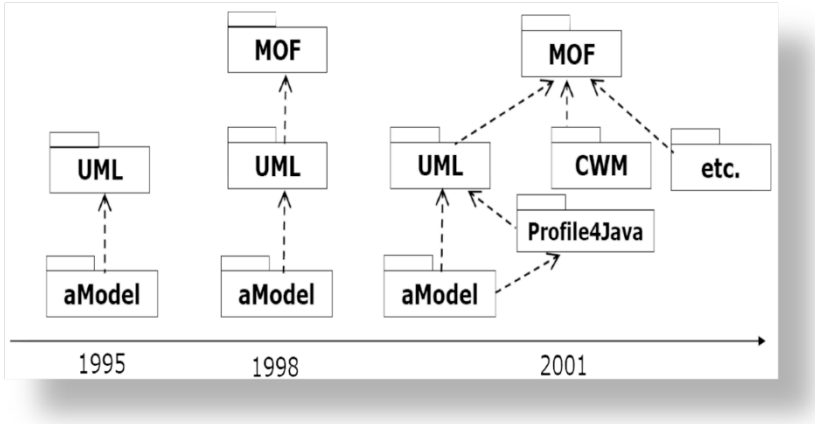
➔ Different ways are helpful for different utilization contexts

Different ways of defining notations

- Definition by *example*
  - exemplary graphical symbols representing the modeling concepts
  - rules for adapting the symbols according to concept's properties are either
    - not given (*static symbols*) or
    - given textually (*dynamic symbols*).
- Definition by *transformation*
  - transformation rules translate from modeling concepts to graphical symbols
  - strongly dependent on the expressiveness of the graphical language
    - nodes and edges visualizations (see e.g. [DV02])
    - charts and diagrams visualizations (see e.g. eclipse BIRT)
    - hierarchies, nodes and edges visualizations (see e.g. eclipse GMF)
    - visualizations with complex relative positioning (see e.g. [Er06])

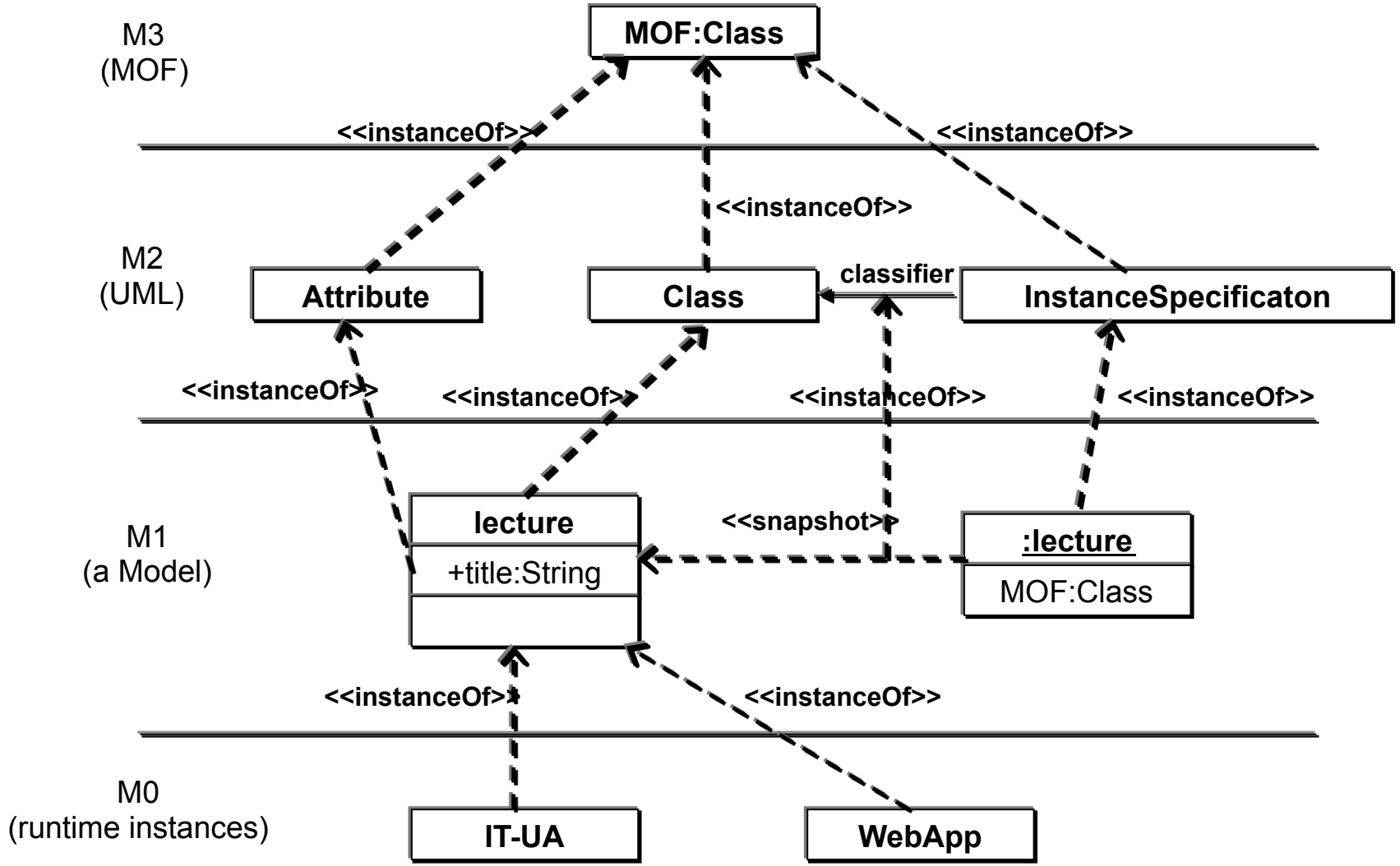
Object-oriented modeling – UML and MOF

- Development of MOF (Meta Object Facility) by the OMG was heavily influenced by the evolution of UML and the appearance of MDA (Model Driven Architecture)



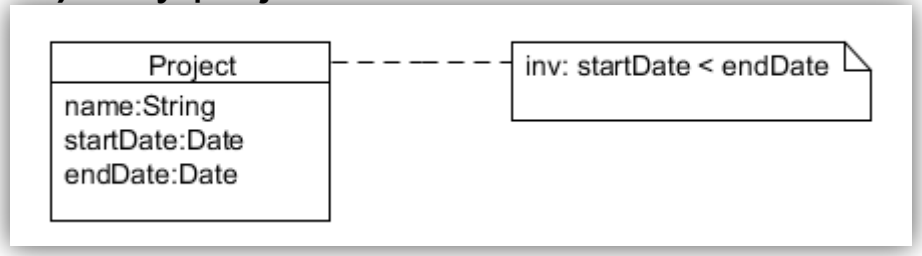
  - **4-layer architecture**
    - Instantiation is used repeatedly
      ➡ M3-, M2-, M1-, M0-layer
    - MOF on M3 layer
      ➡ “hard-wired” meta-metamodel
  - **MOF** does not “only” define the syntax
    - Possible forms of notations: MOF-Notation (~class diagram)
    - Restrictions define guidelines for the models
  - **Notation** is defined by example
    - Through notation tables
    - Possible notation options with natural language
  - **Semantics** is described in natural language
    - Additional semantic variations are defined

Language architecture of UML 2.4
4 layer architecture

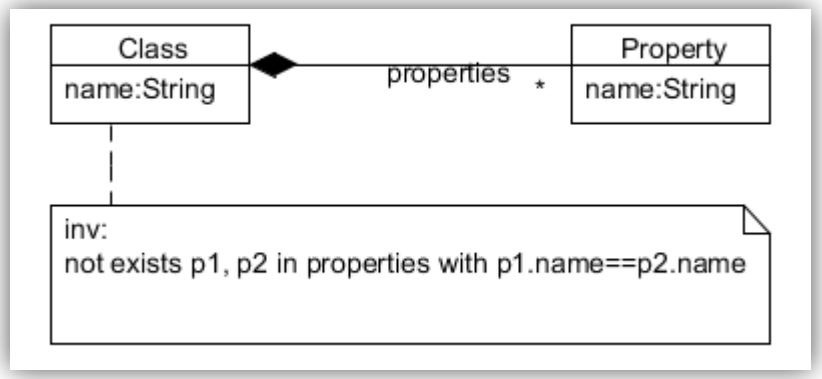


Language architecture of UML and MOF – Constraints

- The UML and MOF support the utilization of constraints
- Constraints are specified textually
  - using natural language
  - using mathematical terms
  - using the Object Constraint Language (OCL)
- **Example (M1):** any project must start before it ends



- **Example (M2):** all properties must have unique names



What UML is…
Different Diagram Types

UML Diagrams		
Structure Diagram	**Behavior Diagram**	
		Interaction Diagram
Class Diagram	Use Case Diagram	Sequence Diagram
Package Diagram	Activity Diagram	Communication Diagram
Object Diagram	State Machine Diagram	Timing Diagram
Composite Structure Diagram		Interaction Overview Diagram
Component Diagram		
Distribution Diagram		
Profile Diagram		

[Quelle: Anecon – UML for (Enterprise) Architects]

What UML is not

UML is ...

- not perfect
- not complete
- not a programming language
- not a real formal language
- not specialized on a specific application domain
- not a complete surrogate for textual descriptions
- not a method

[Quelle: Anecon – UML for (Enterprise) Architects]

Popular for Specification in OO Projects

UML Diagrams		
Structure Diagram	**Behavior Diagram**	
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Distribution Diagram		
Profile Diagram		

[Quelle: Anecon – UML for (Enterprise) Architects]

Diagrams also useful in Requirements Capturing

UML Diagrams		
Structure Diagram	**Behavior Diagram**	
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[Quelle: Anecon – UML for (Enterprise) Architects]

Diagrams important for Solution Architects & Enterprise Architects

UML Diagrams		
Structure Diagram	**Behavior Diagram**	
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Profile Diagram		

[Quelle: Anecon – UML for (Enterprise) Architects]

Issue: Business Process Modeling is not contained in UML

„Everybody“ needs Business Process Modeling – but it’s not contained in UML.

Two Possibilities

- Use Activity Diagrams plus a convention
- Use a UML Tool that also integrates BPMN (very popular: Sparx Enterprise Architect)

[Quelle: Anecon – UML for (Enterprise) Architects]

Sample: Activity Diagrams used for Business Process Modeling

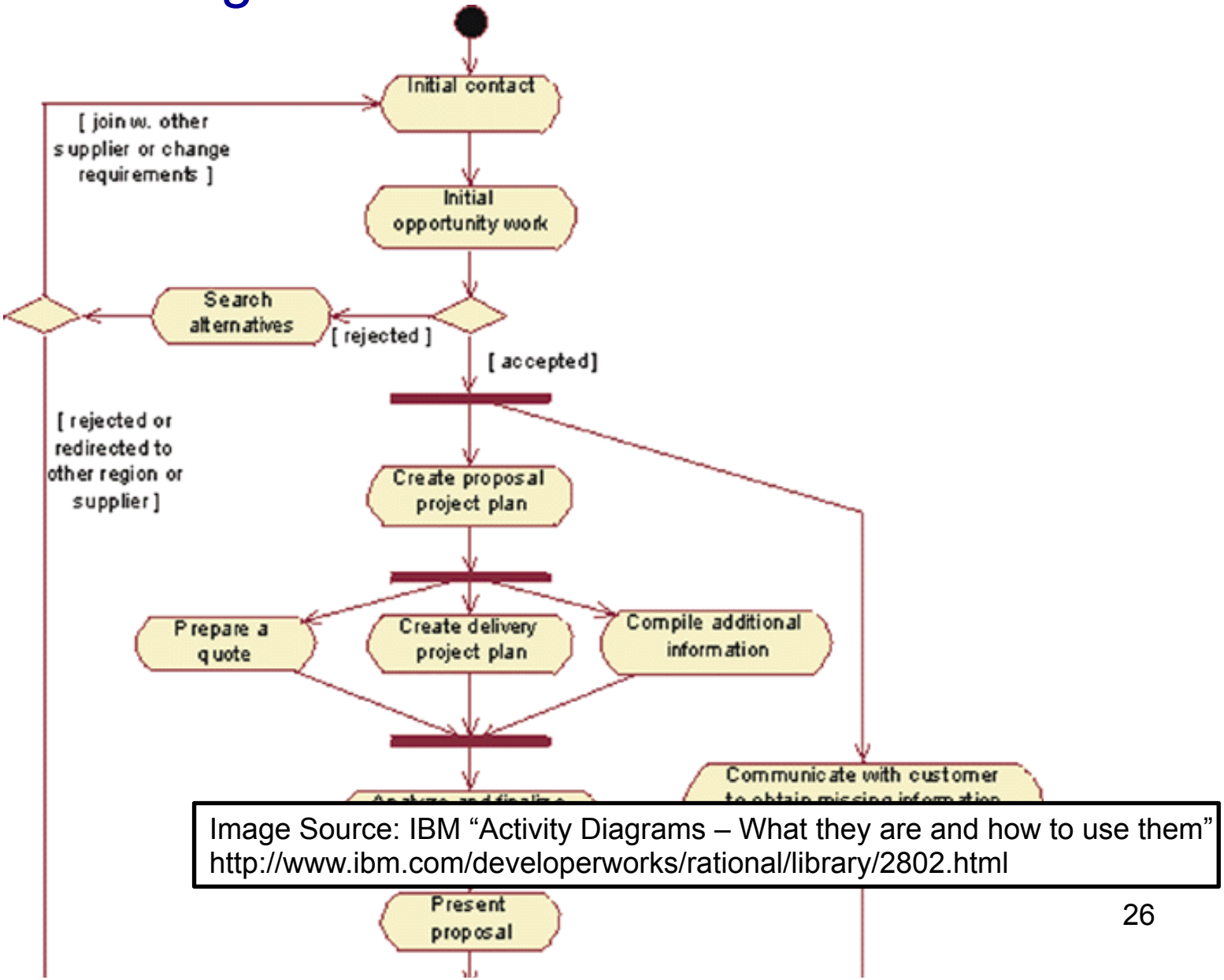

Image Source: IBM “Activity Diagrams – What they are and how to use them” http://www.ibm.com/developerworks/rational/library/2802.html

BPMN has more sophisticated modeling constructs for processes than UML activity diagrams

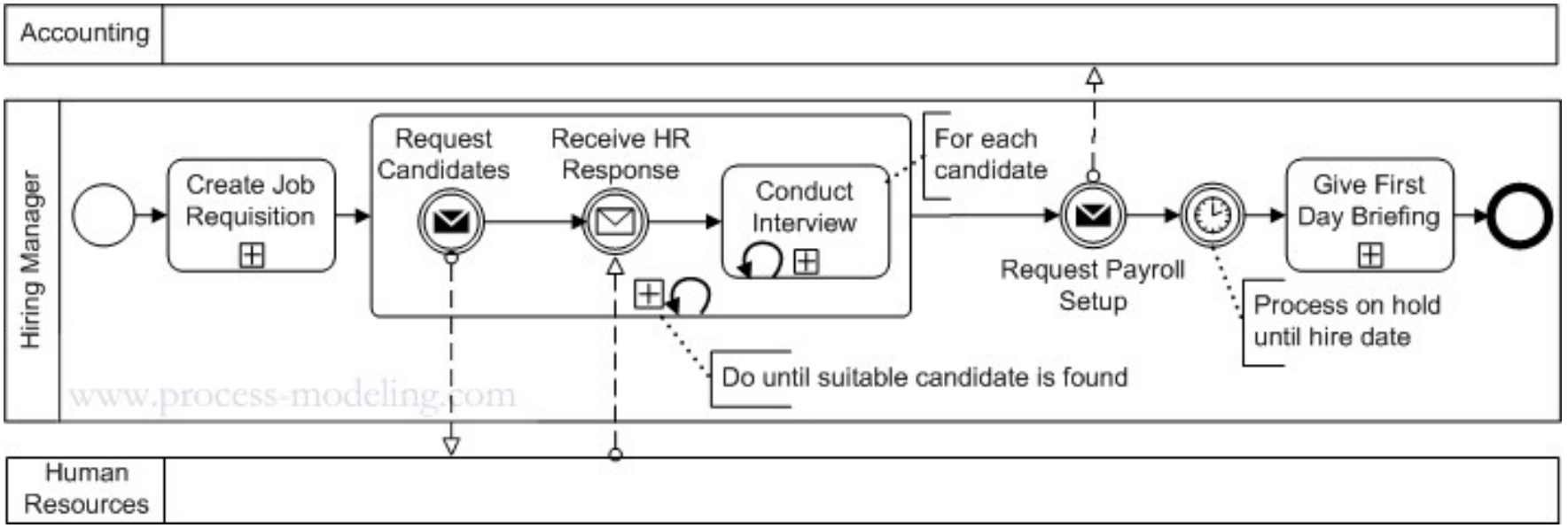

Image Source – www.process-modeling.com

Conceptual modeling beyond UML – Challenges of EA modeling

- Relevant meta-properties for types:
  - Notion of rigidity: *rigid*, *anti-rigid,* and *semi-rigid*:
    - any instance of a rigid type remains an instance of that type over its entire lifetime – example rigid type *human*
    - any instance of an anti-rigid type has not always been or will not forever be an instance of that type – example anti-rigid type *baby*
    - some instances of a semi-rigid type may forever be or have always been an instance of that type, while others not – example semi-rigid type *rich person*
  - Versioning
  - Ordering
  - Hierarchical

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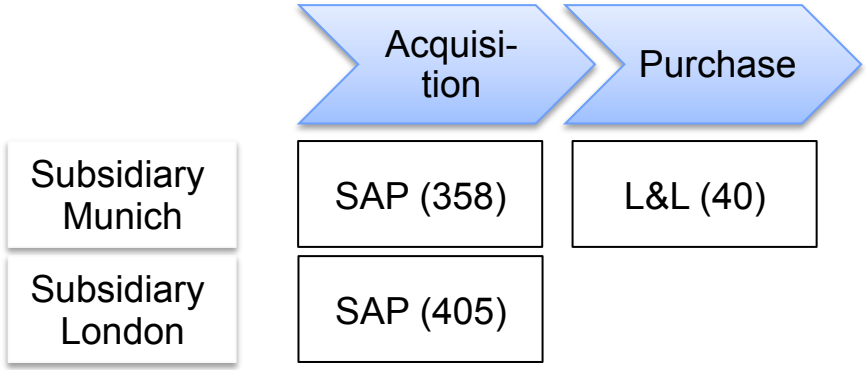
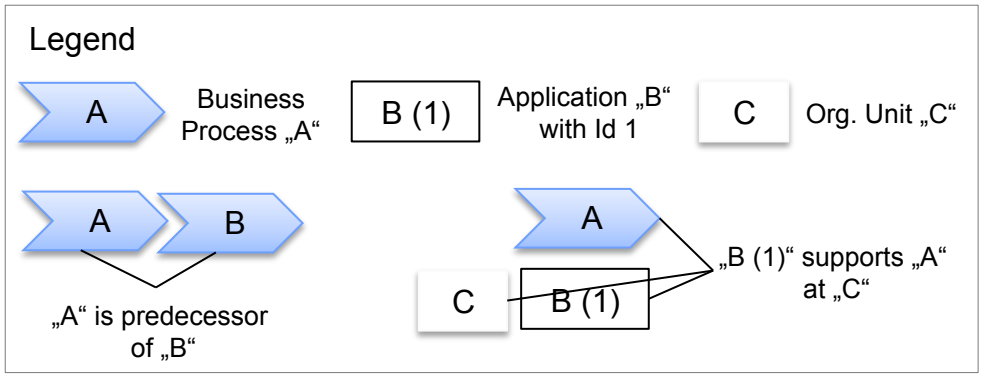
Multiple EA modeling languages – example

- **Process owner**
  - **View:**



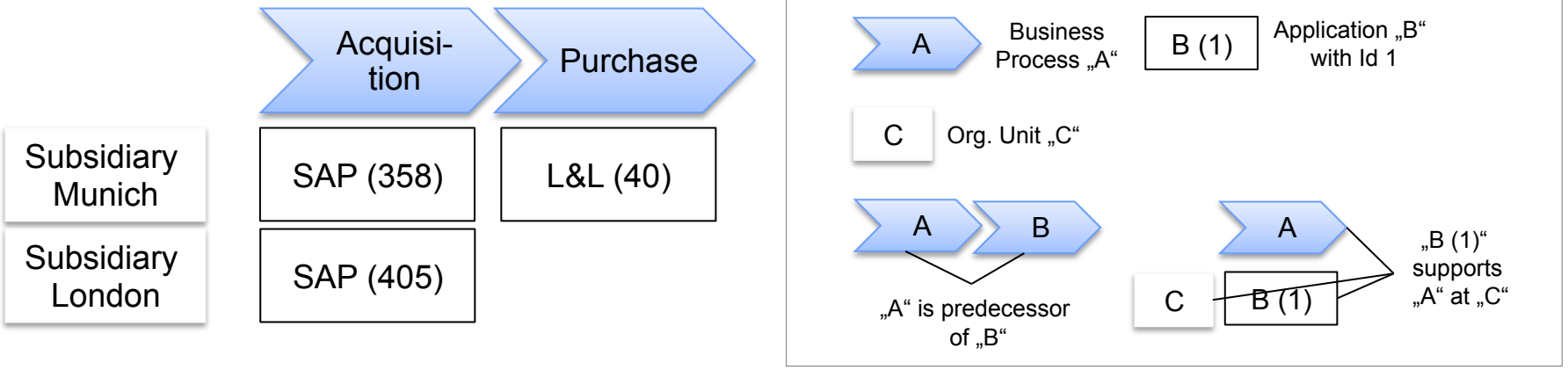


- **Project manager**
  - **View:**

	SAP v3.58	SAP v4.05	L&L 4.0
Subsidiary Munich	X		X
Subsidiary London		X	

An information model can be derived from a view

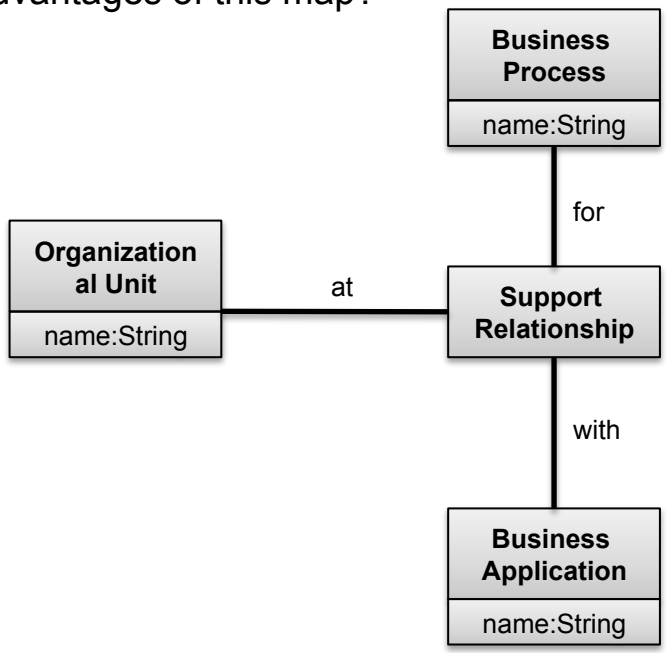
- **View:**



- **Information model:**
  <to be completed in the lecture>

Discussion of information model variants

- Can this information model be used for a process support map?
  - If not, why?
  - If yes, what would be advantages/ disadvantages of this map?



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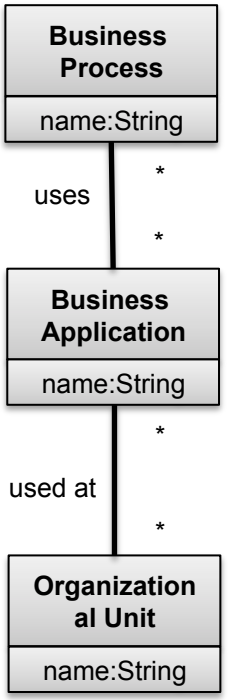

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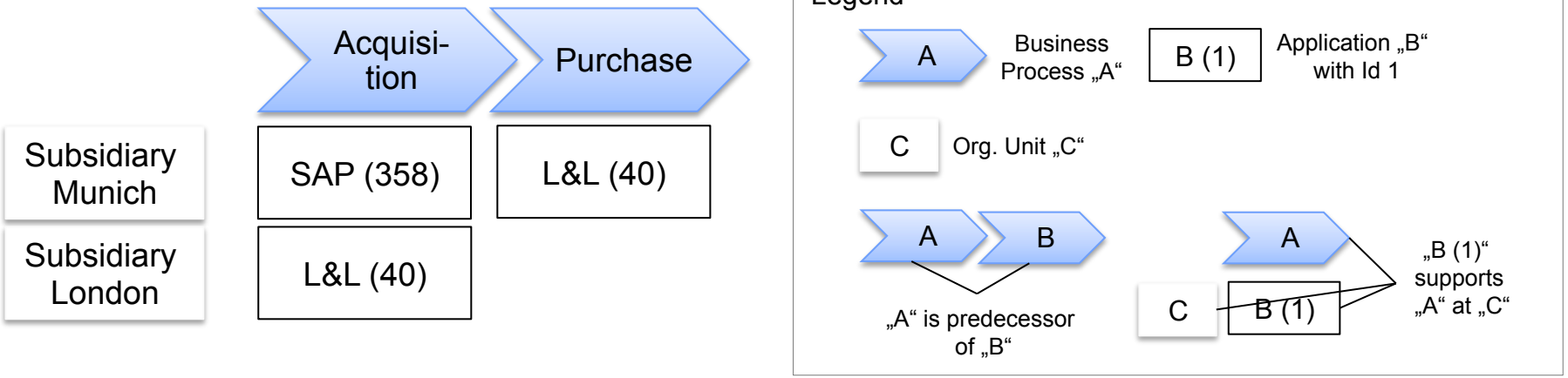
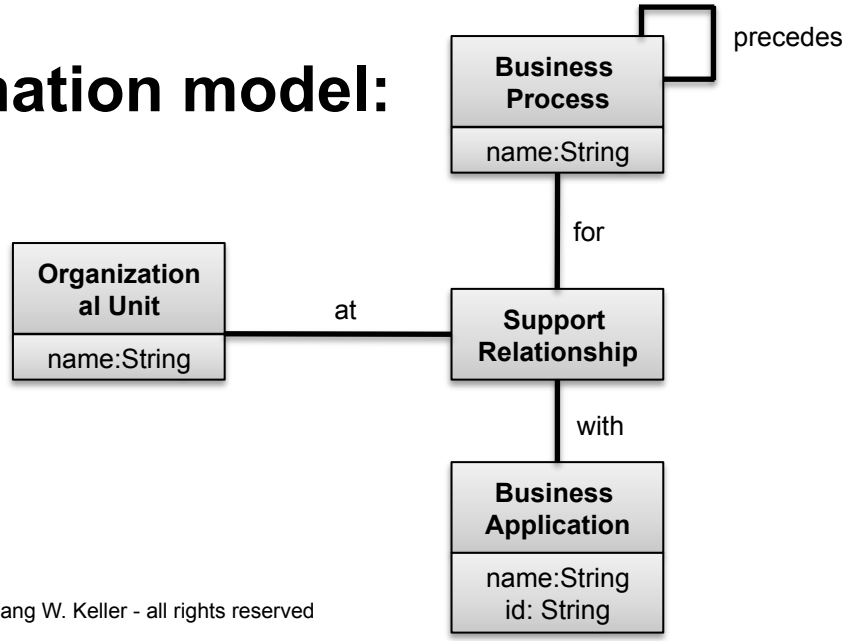
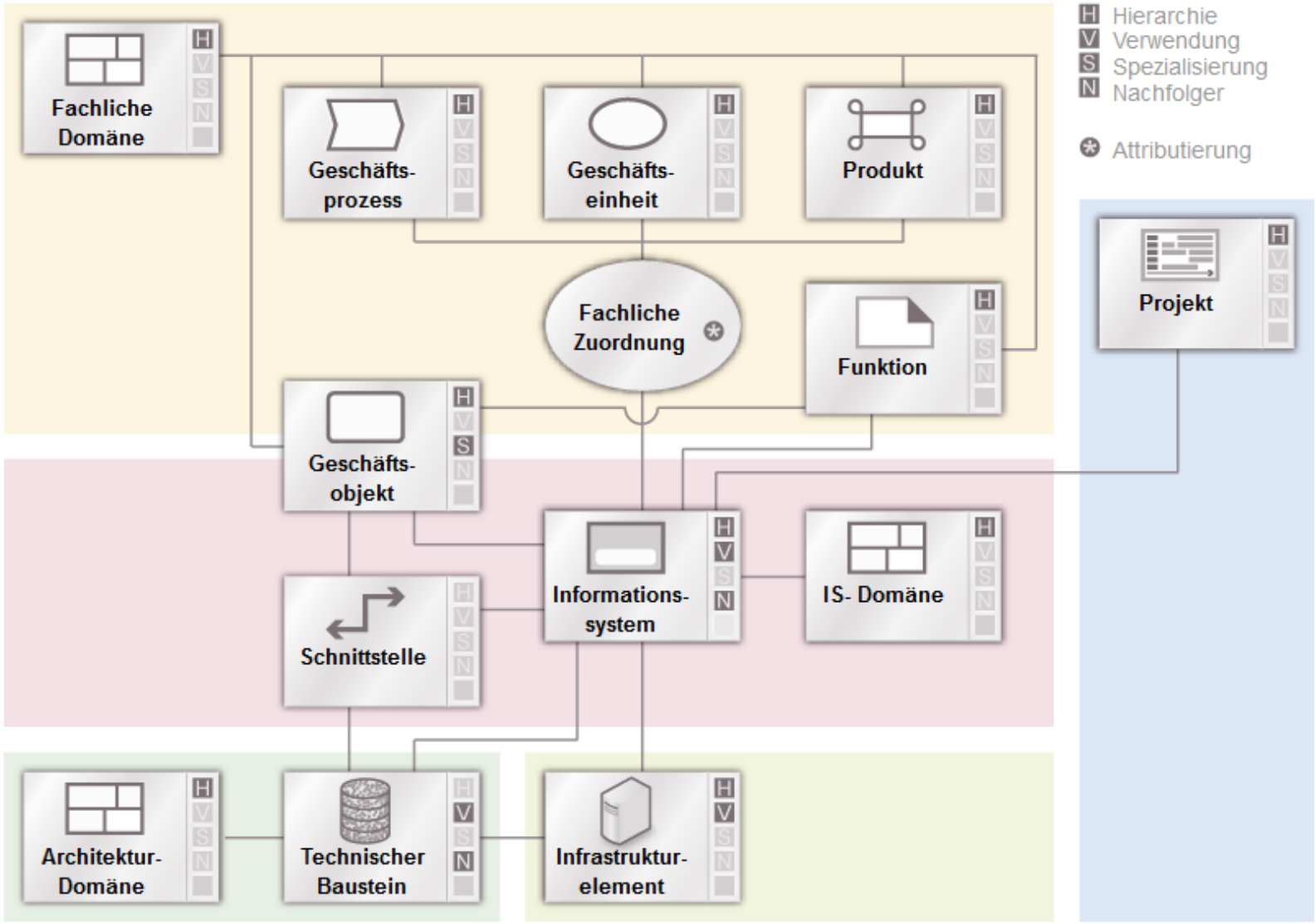
- **View:**



- **Information model:**



Der Fachlicher Bezugsrahmen bestimmt das Metamodell



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Challenges in EA modeling

- Emerging EA management initiatives often start informal using spreadsheets or text documents since
  - the development of an information model is a labor intensive task and
  - no widely-accepted standard information model exists.
- With the growing complexity of the management body and the rising number of stakeholders involved, problems arise regarding
  - scalability and
  - collaborative work.
- Introducing an EA management tool is often regarded to solve these problems.

➔How to support an evolutionary approach to EA development (esp. regarding the design of an enterprise-specific information model)?

➔How to avoid the ivory tower syndrome?

Extending wikis with templates to support structured content

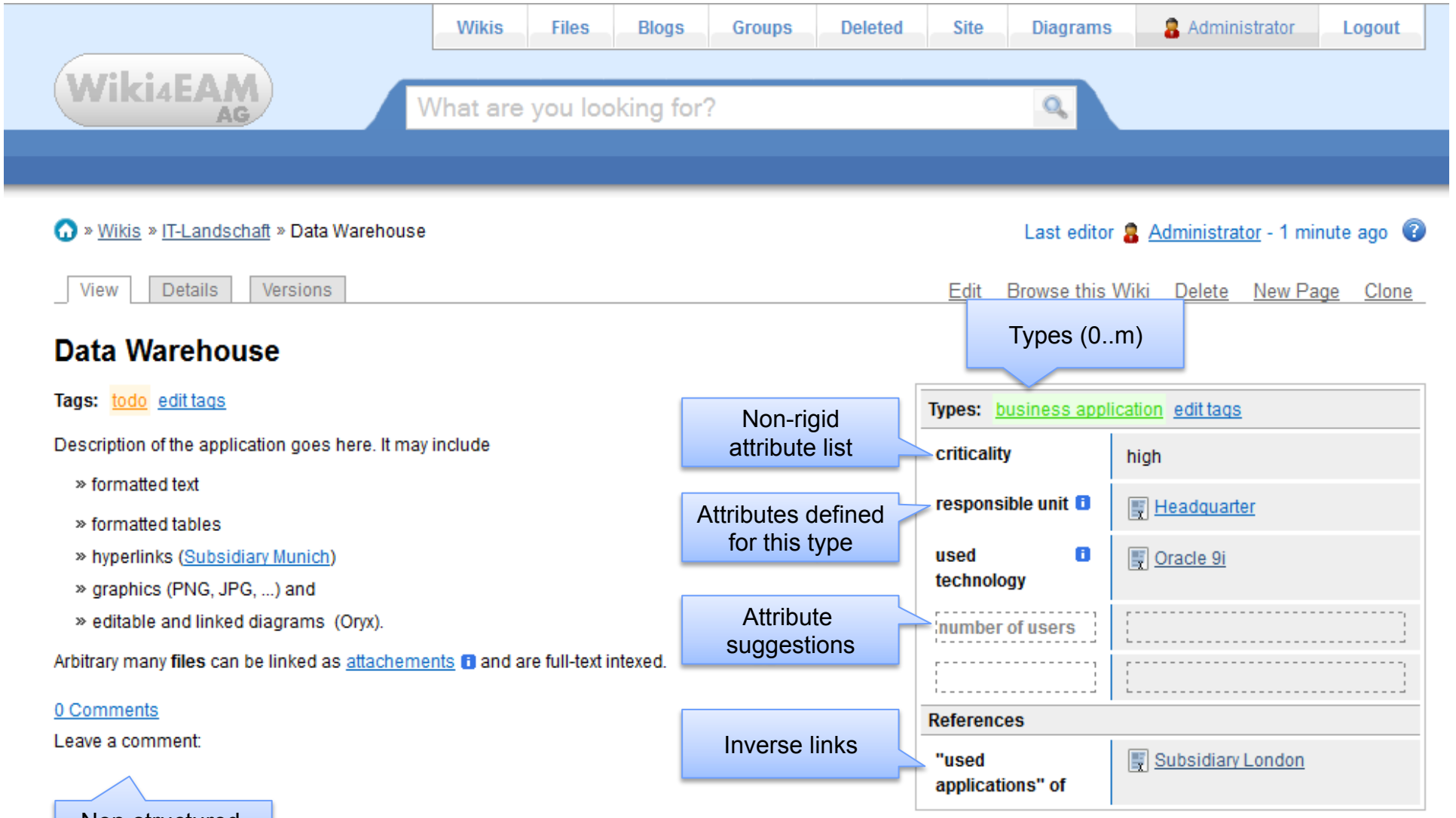
- Automated data processing and visualization, which are essential in an EA management context impose additional requirements on data representation.
  ➔ capture data in a structured form

- Existing wikis rely on text formatting conventions to express structure (e.g. www.wikipedia.org, cf. Figure), but do not offer
  native support of automated data processing.

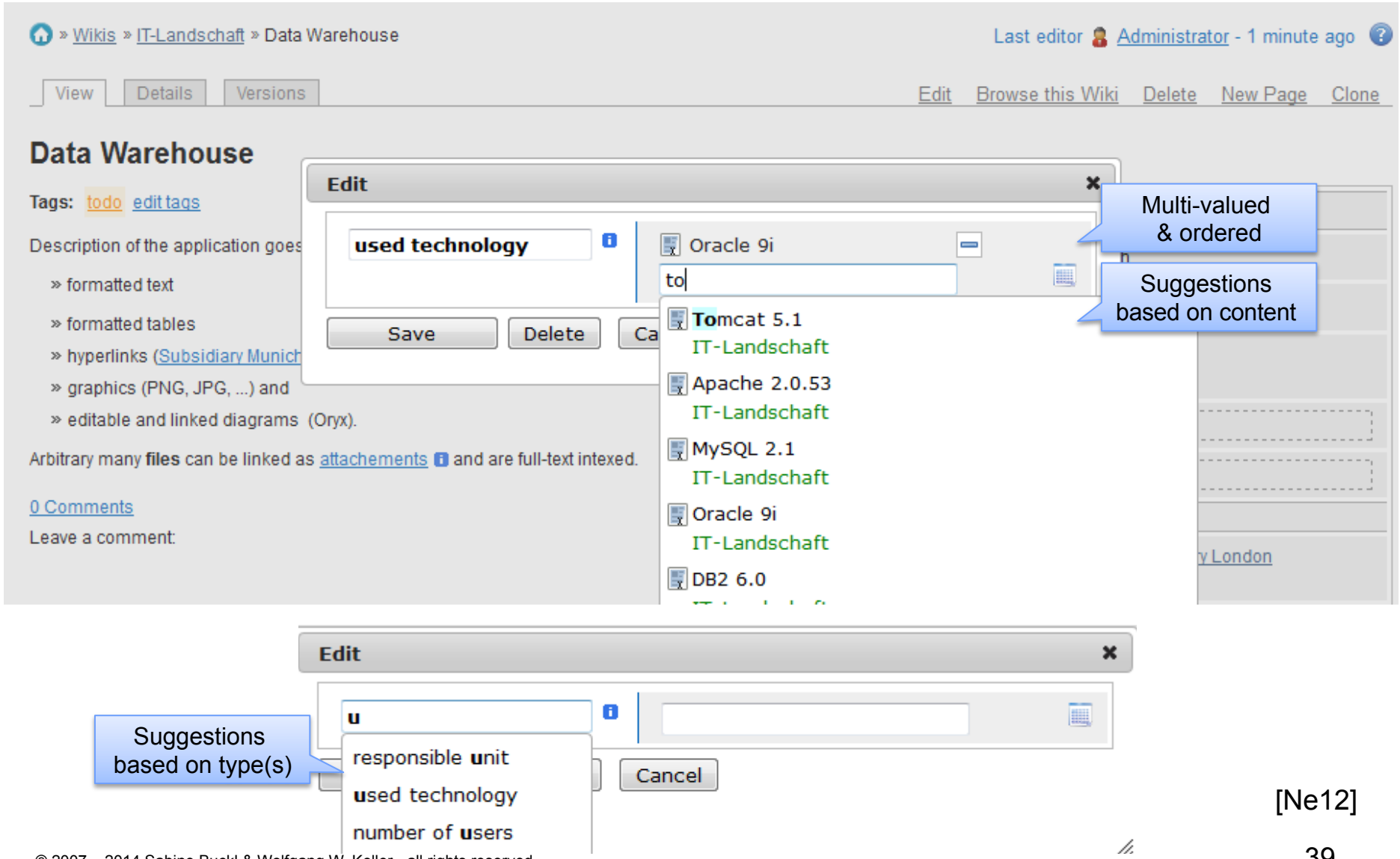
- Semantic wikis (e.g. http://semantic-mediawiki.org), try to exploit complex semantic web technologies but often lack usability.

- *Our approach:* templates provide a simple extendable table containing attributes, textual values, and links.

Capture non-structured and structured information in a unified way.

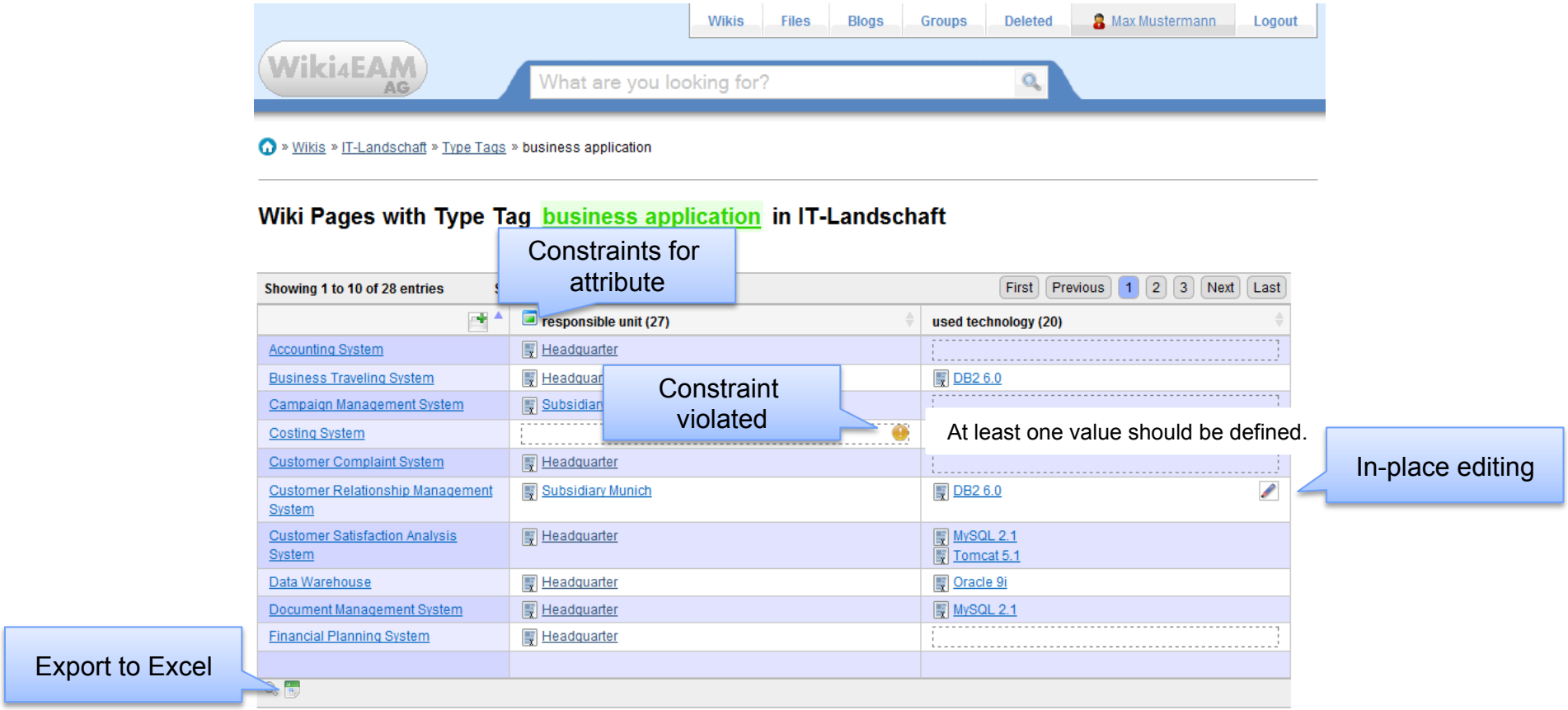


Change information and its structure any time



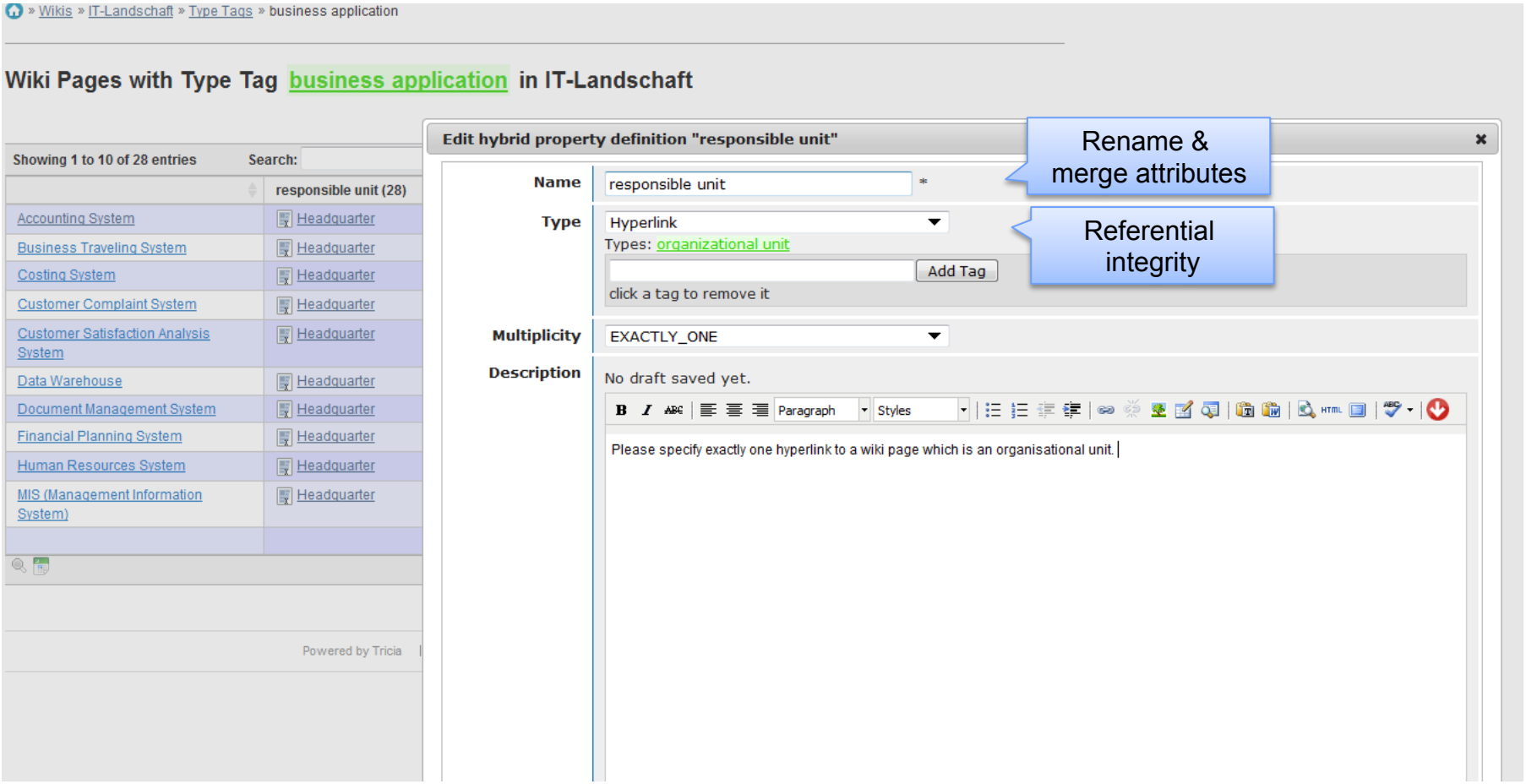
[Ne12]

Manage the evolution of the information structures to match changing business needs.



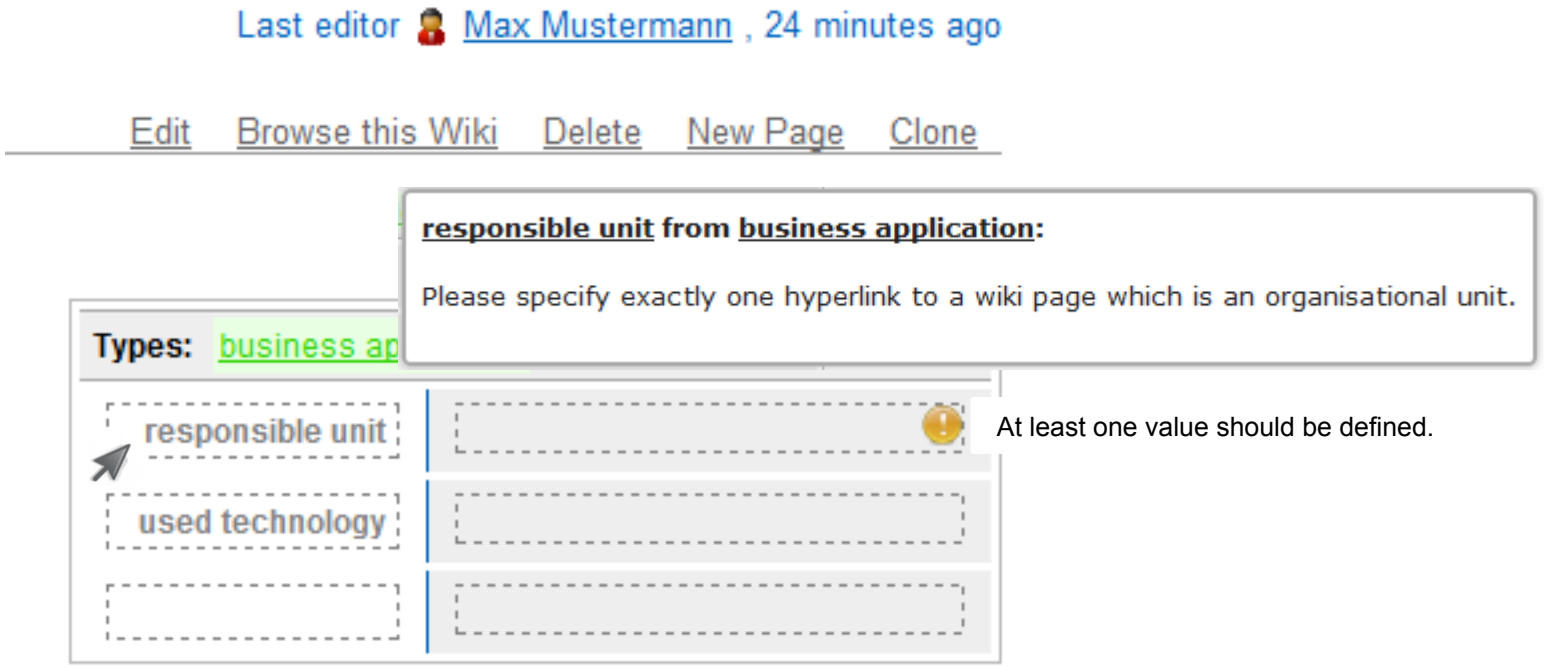
[Ne12]

Define the information model and its constraints incrementally (top-down or bottom up).



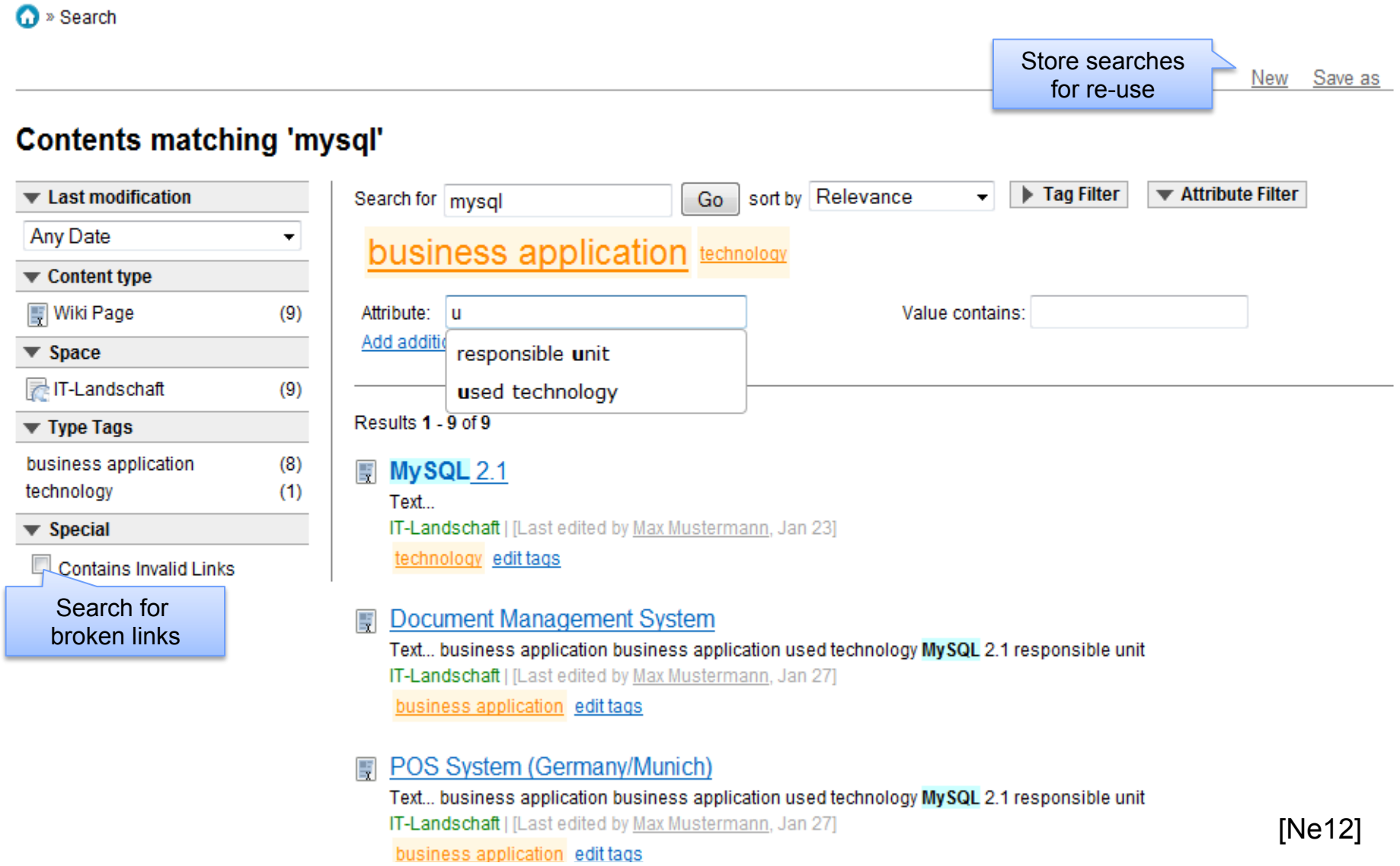
[Ne12]

Identify, understand, and cooperatively resolve constraint violations.



[Ne12]

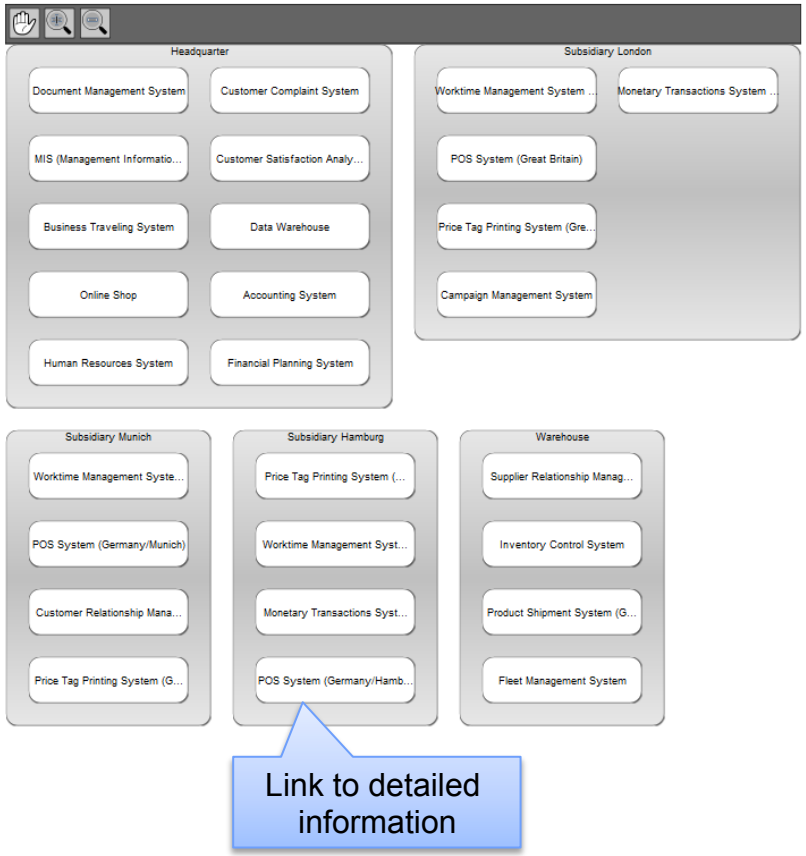
Search by full text, tags, attributes and other relevant facets in combination.



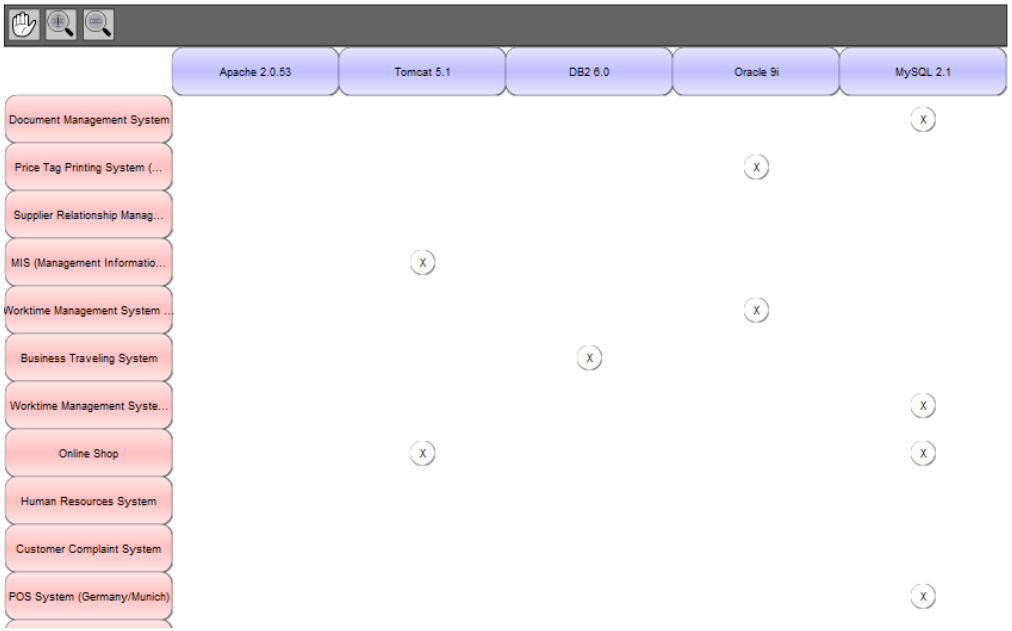
[Ne12]

Use generated lists, tables and diagrams to provide stakeholder-specific views.

Which organizational unit is responsible for which business application?



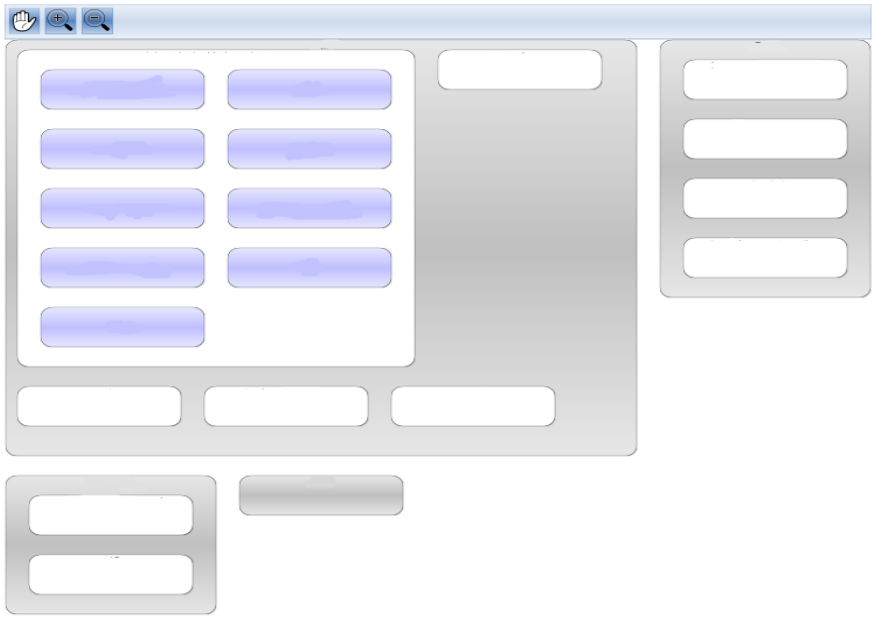
Which business application uses which technology?

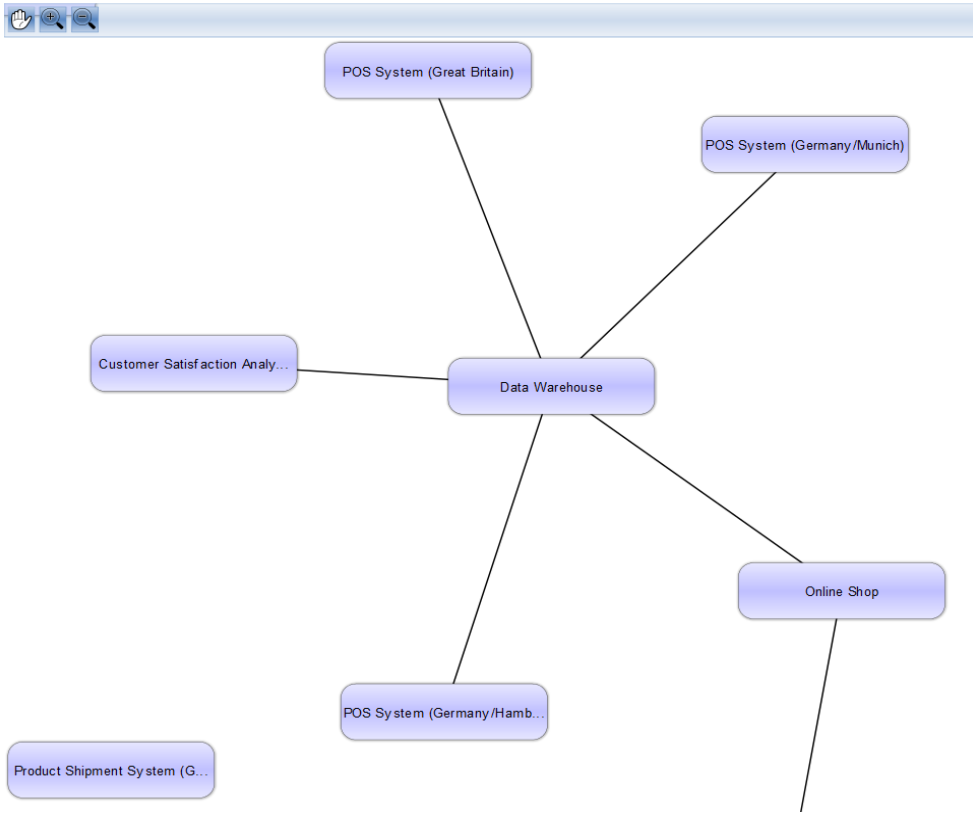


Use generated lists, tables and diagrams to provide stakeholder-specific views.

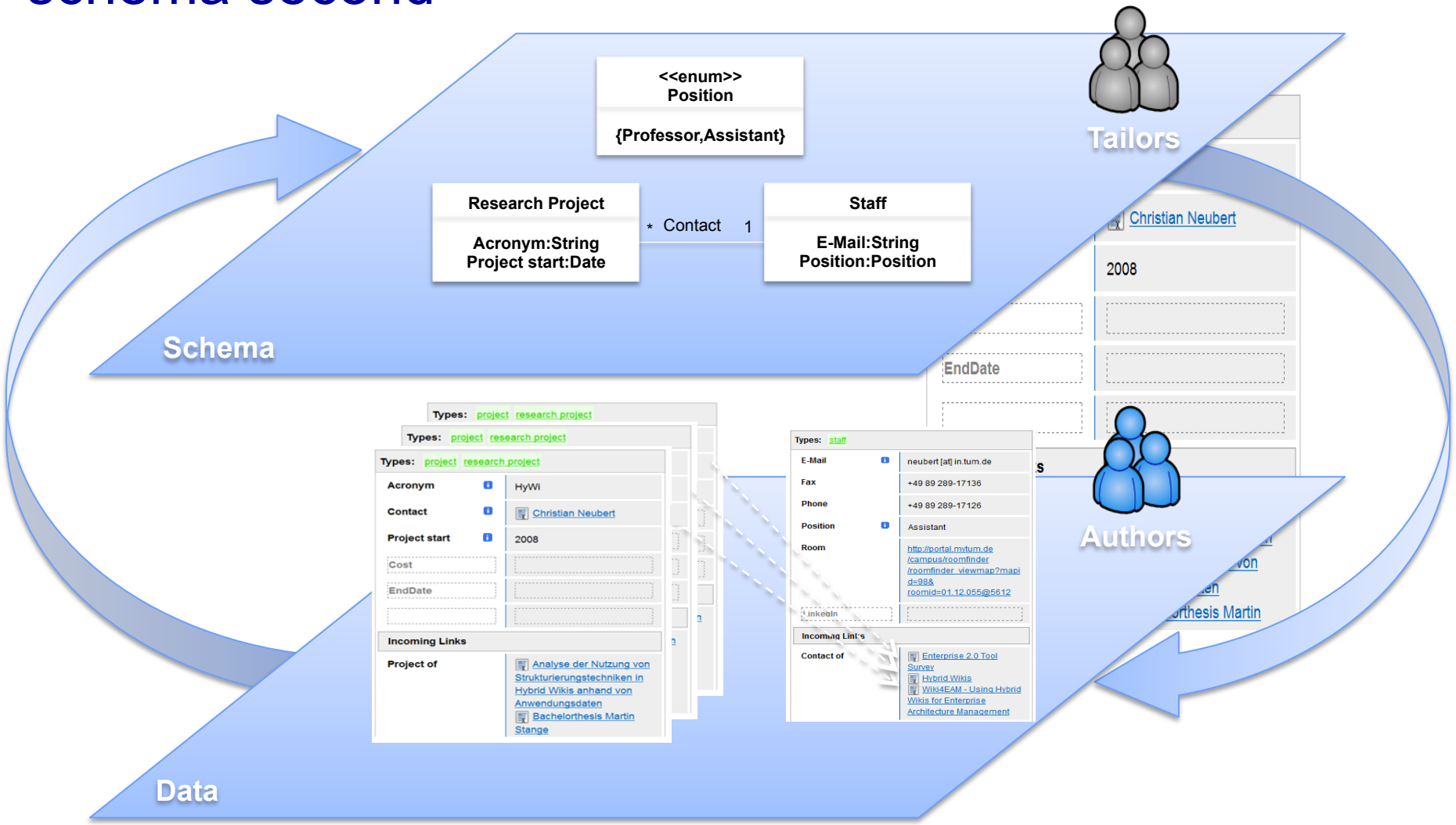
What are our domains, subdomains and business applications?

What information dependencies exist for the data warehouse?





The principle behind hybrid wikis – Data first, schema second



[For more details see www.infoasset.de]

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