09 Modeling, Metamodeling, Hybrid Wikis

Vorlesung IT-Unternehmensarchitektur

Dr. Sabine Buckl

Software Engineering for Business Information Systems (sebis)
wwwmatthes.in.tum.de

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

sebis

3.1 An introduction to conceptual modeling

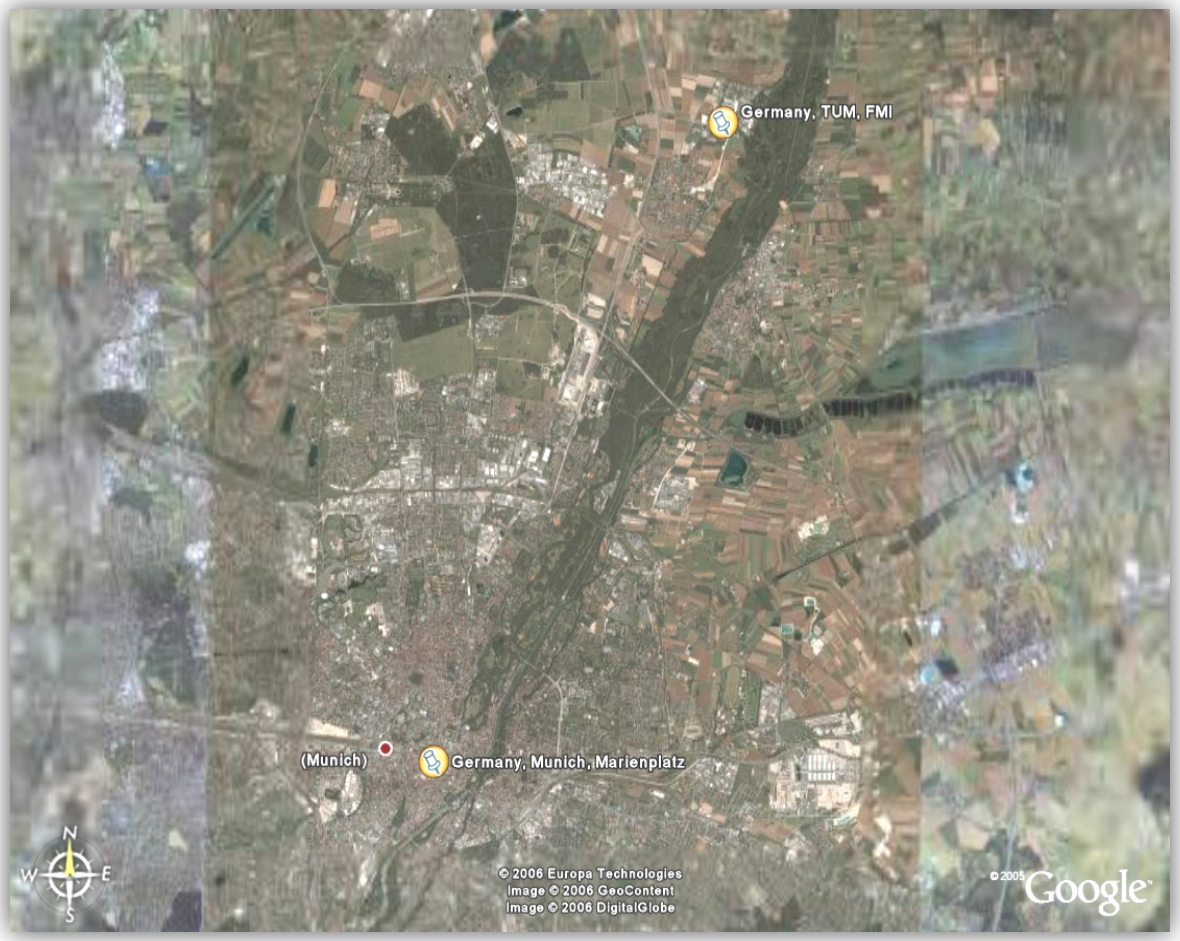
- Models in context
- Modeling languages and meta-models

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

Source: MVV

Key characteristics of a model

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**)

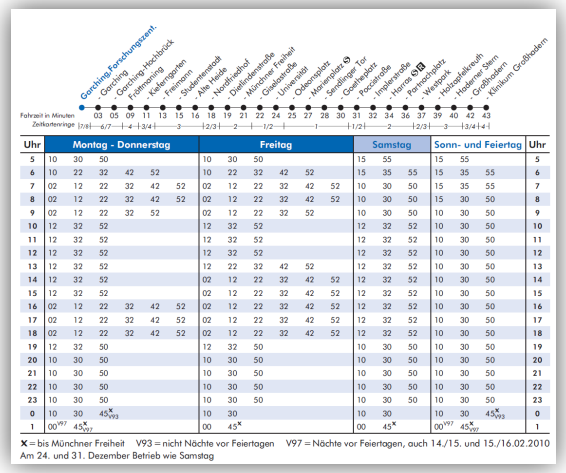
But: Models may refer to yet not built originals, i.e. may be *design models*.

➔ 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 2012



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x = bis Münchner Freiheit V93 = nicht Nächte vor Feiertagen V97 = Nächte vor Feiertagen, auch 14./15. und 15./16.02.2010
Am 24. und 31. Dezember Betrieb wie Samstag

Source: MVV

Model 3 (Spatial plan):

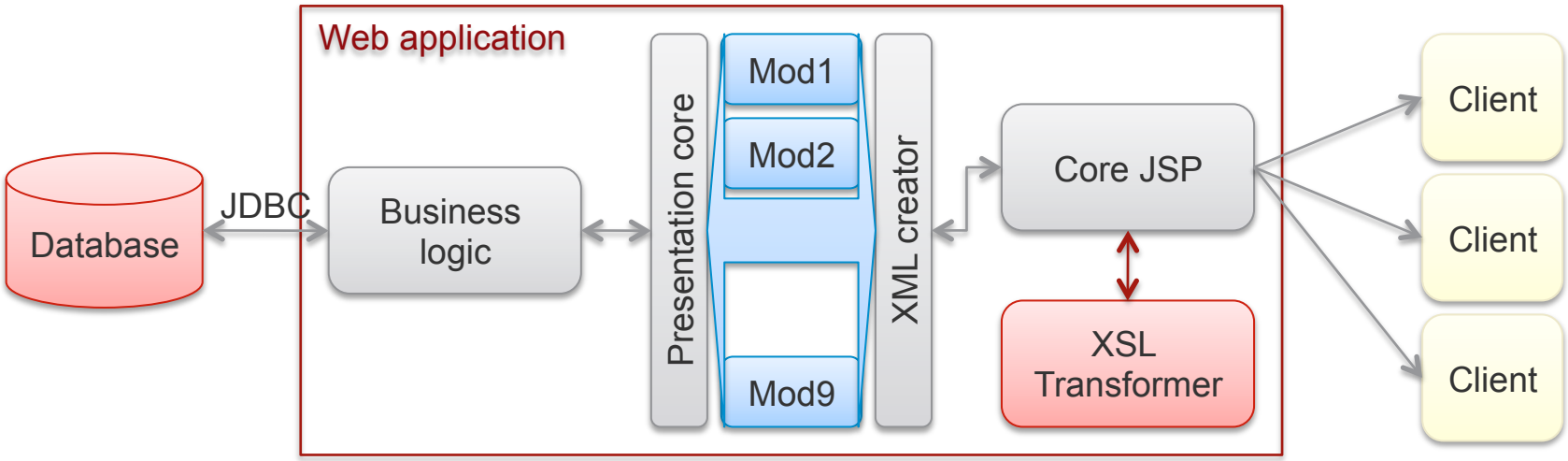
- Different selection of attributes – spatial information
- Different model pragmatics:
  - Users that want to perform urban planning
  - in the year 2012

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:

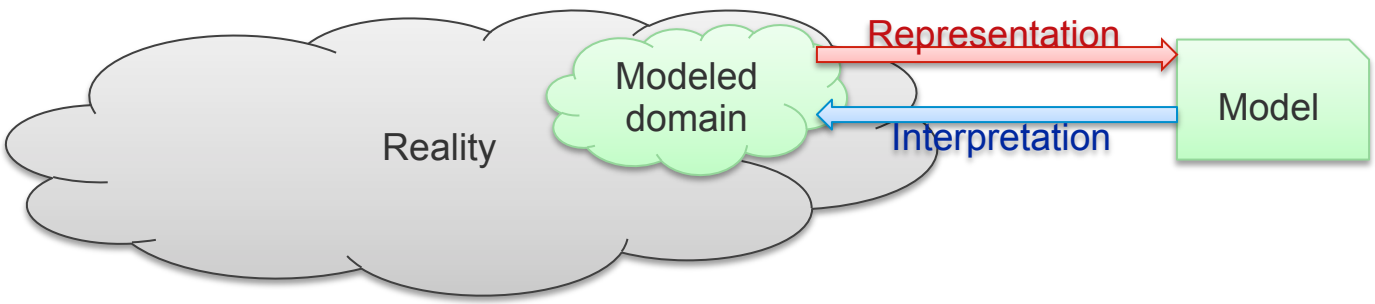
„These pictures are meant to entertain you. There is no significant meaning to the arrows between the boxes.“

[Cle03]

What makes a (representing) model a good one? Conceptions of model quality (1)

Connecting model and modeled domain – *representation* and *interpretation* [Gu05]:

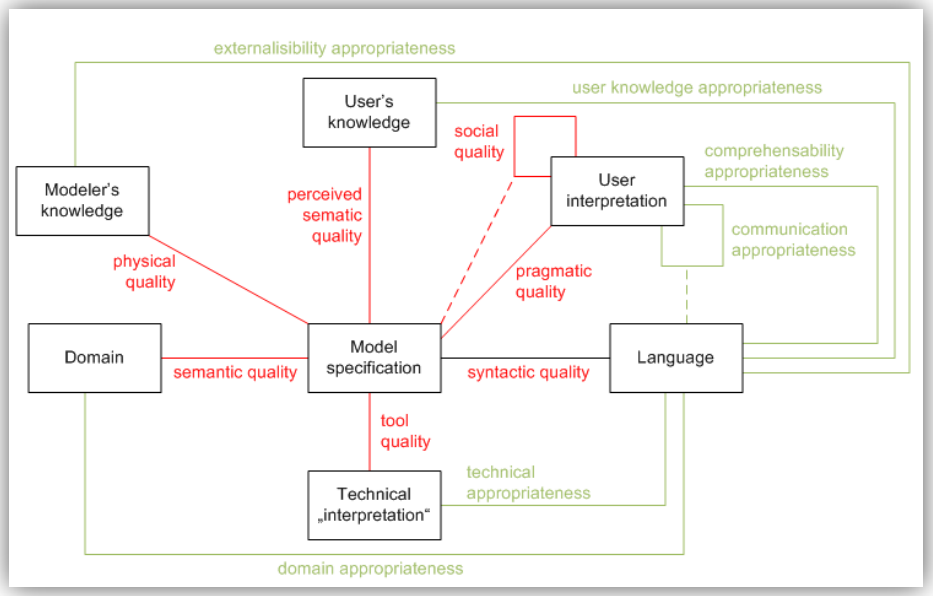
- *Lucidity*: Every construct in the model must represent at most one object from the modeled domain. Overloaded model constructs are forbidden. (*injective representation*)
- *Soundness*: Every construct in the model must represent at least one object from the modeled domain. Construct excess in the representation is avoided. (*surjective representation*)
- *Laconicity*: Every object from the modeled domain must "interpret" at most one construct in the model. Construct redundancy is forbidden. (*injective interpretation*)
- *Completeness*: 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 (2)

Different types of model quality for the model in usage context [Kr02]:

- *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 – examples:

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

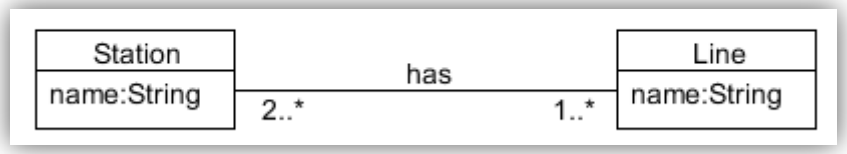
For our example:

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*

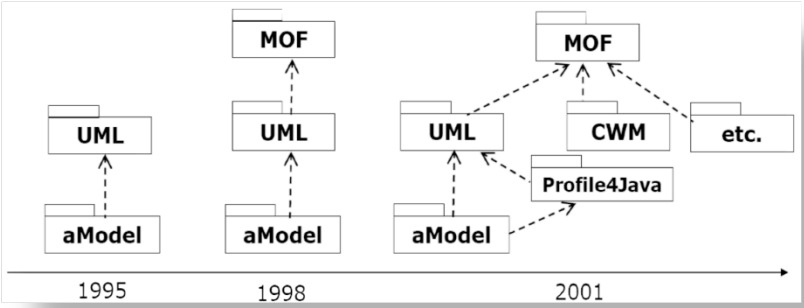
- exemplary graphical symbols representing the modeling concepts
- rules for adapting the symbols according to concept's properties are either
  - not given (*static symbols*) or
  - given textually (*dynamic symbols*).

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])

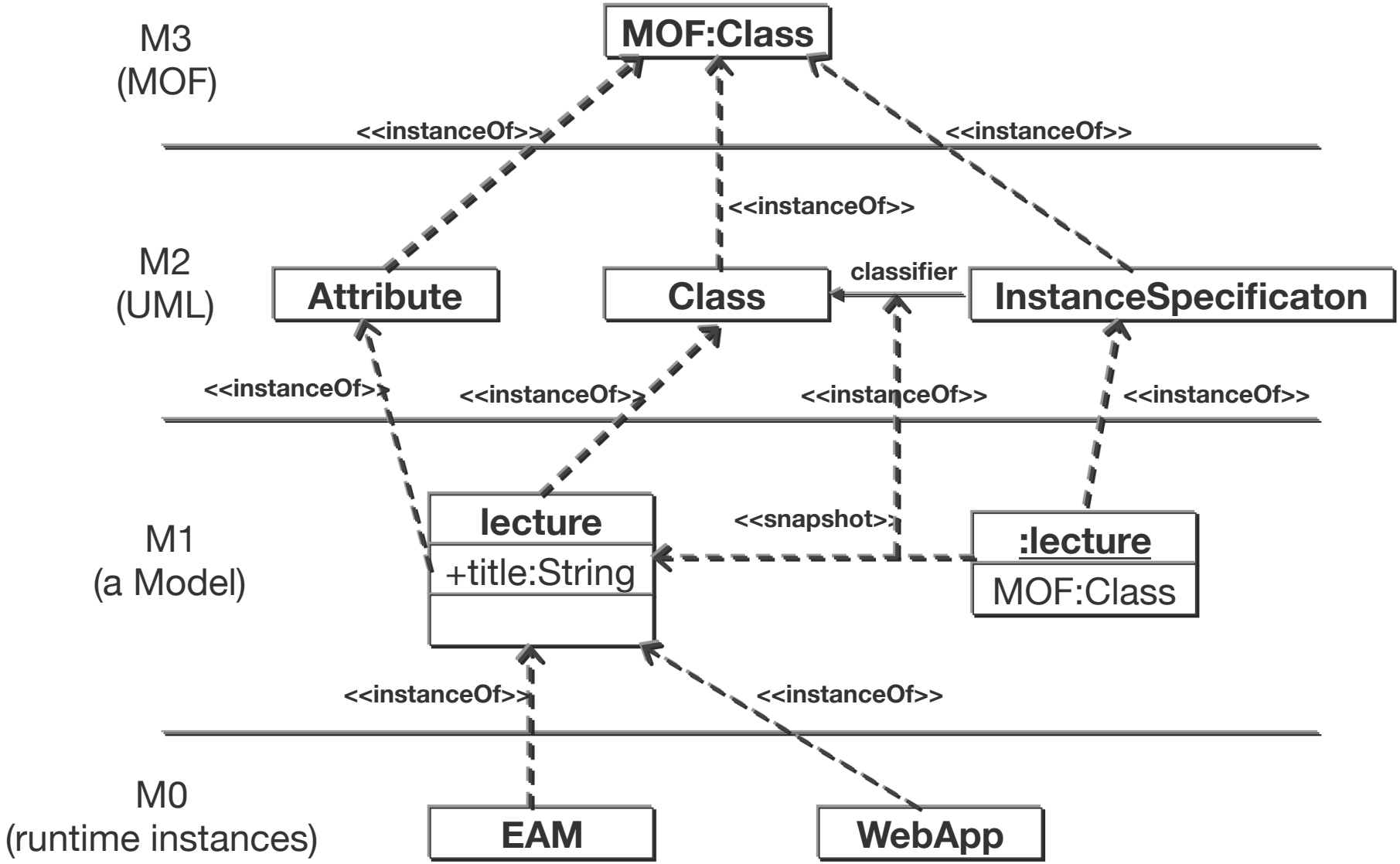
Object-oriented modeling – UML and MOF

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)



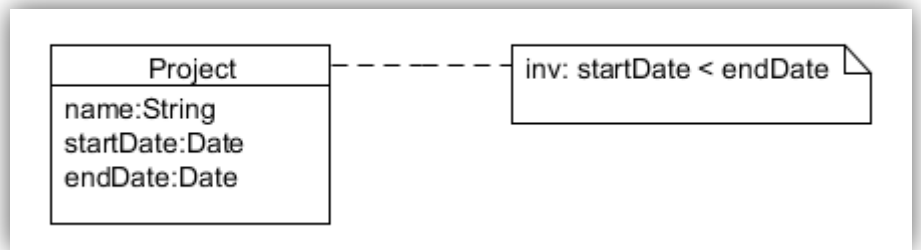
- **4-layer architecture**
  - Instantiation is used repeatedly
    ➡ M3-, M2-, M1-, M0-layer
  - MOF on M3 layer
    ➡ “hard-wired” meta-metamodel
- **MOF** does not “only” define the syntax
  - Possible forms of notations: MOF-Notation (~class diagram)
  - Restrictions define guidelines for the models
- **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

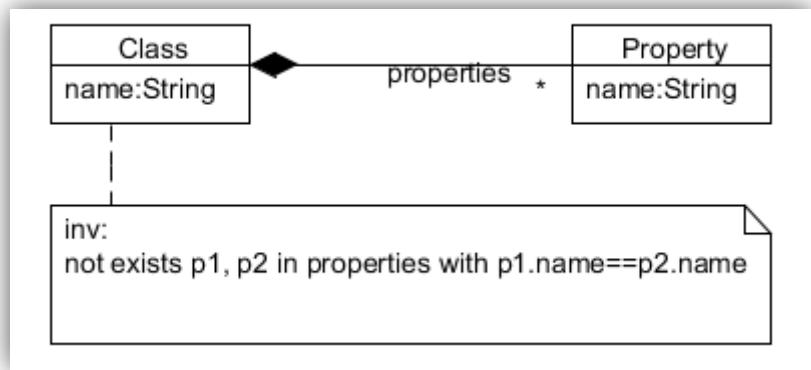


Language architecture of UML and MOF – Constraints

- 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



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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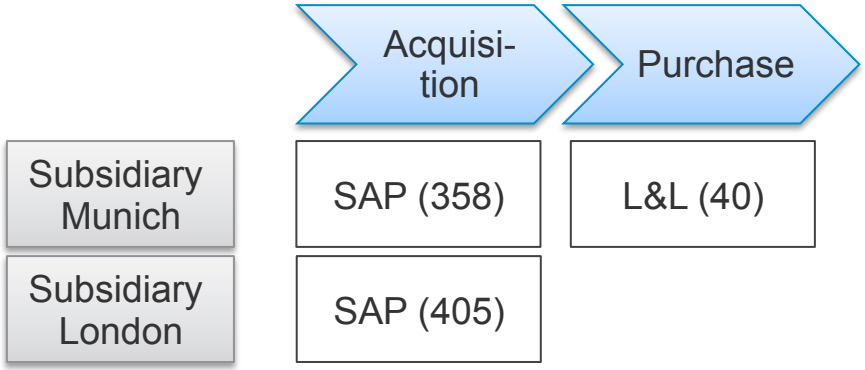
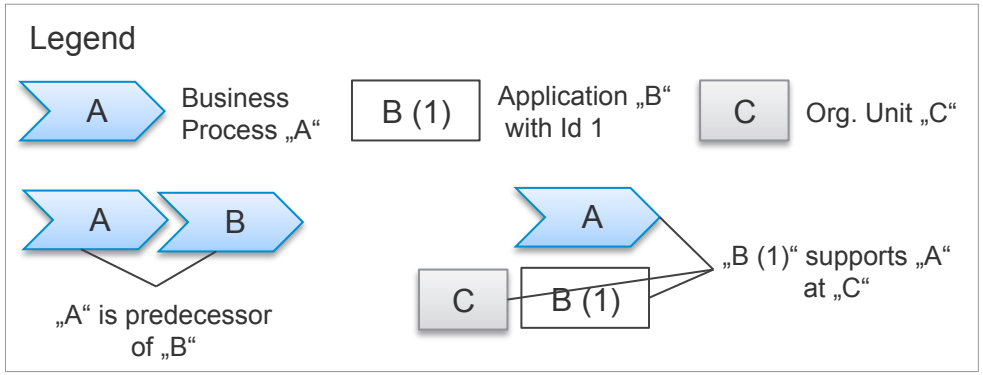
Multiple EA modeling languages – example

Process owner

- **View:**





Project manager

- **View:**

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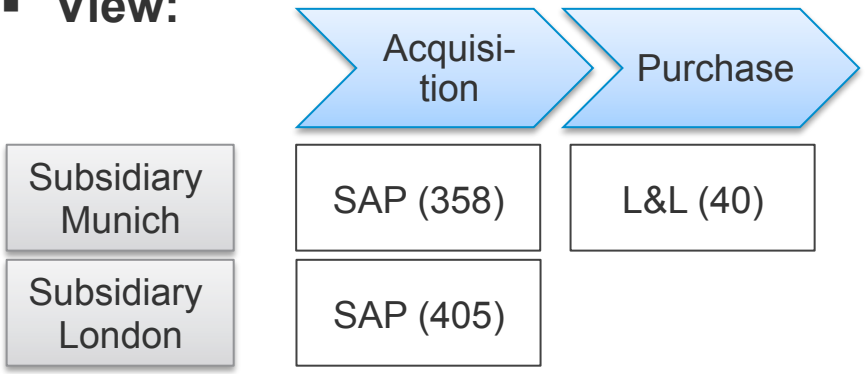
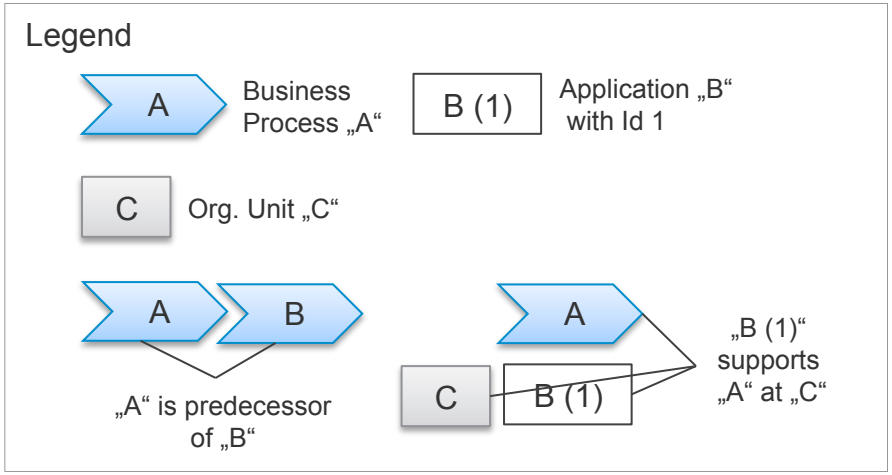
Subsidiary Munich	X		X
Subsidiary London		X	

An information model can be derived from a view

- **View:**

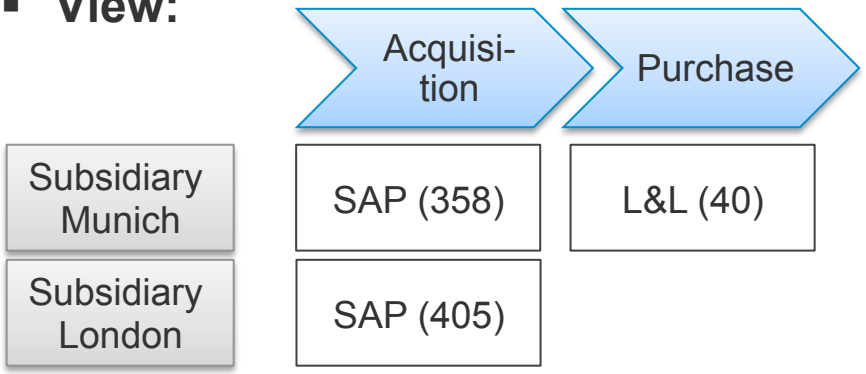


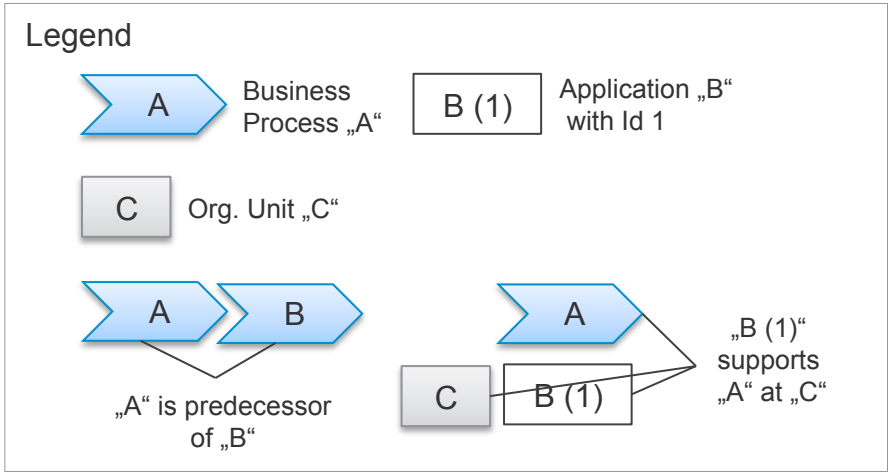


- **Information model:**
  <to be completed in the lecture>

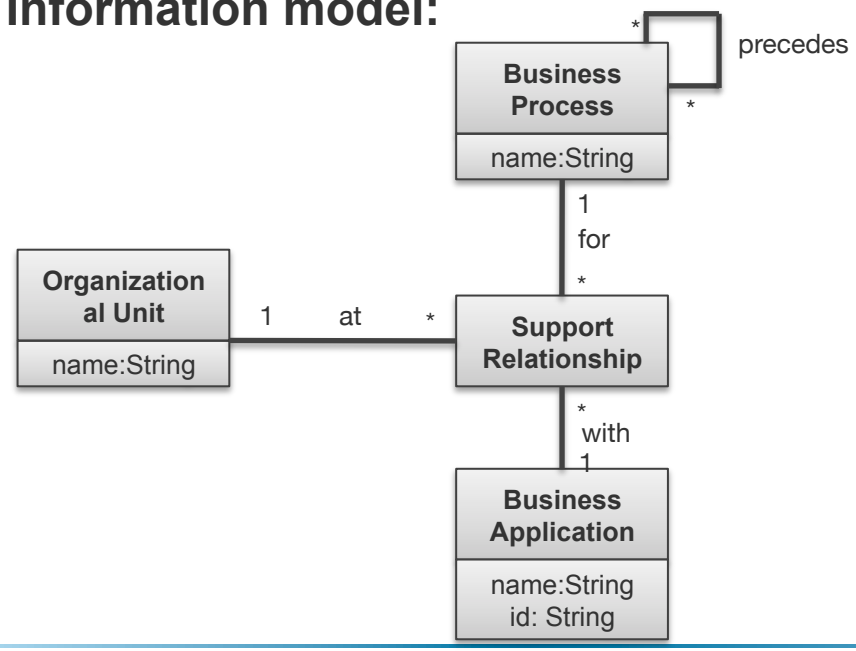
An information model can be derived from a view

- **View:**





- **Information model:**

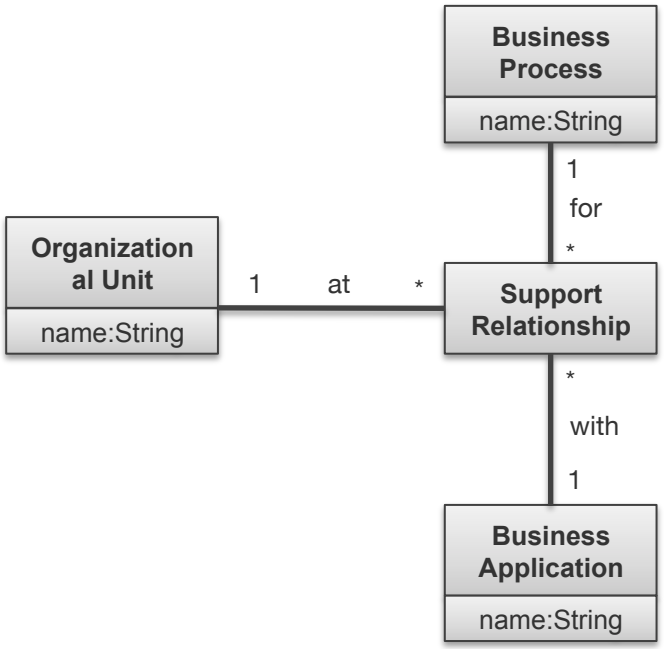


Discussion of information model variants

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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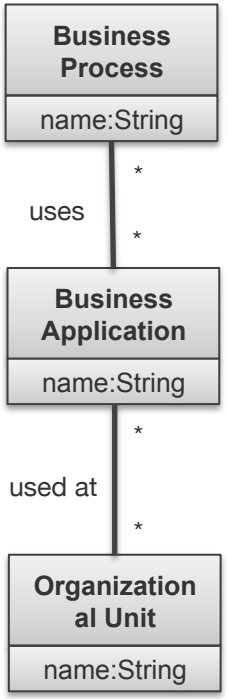

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Challenges in EA modeling

- 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.

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Data Warehouse

Tags: todo edit tags

Description of the application goes here. It may include

- » formatted text
- » formatted tables
- » hyperlinks (Subsidiary Munich)
- » graphics (PNG, JPG, ...) and
- » editable and linked diagrams (Oryx).

Arbitrary many **files** can be linked as attachements and are full-text intexed.

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Types (0..m)

Non-rigid attribute list

Attributes defined for this type

Attribute suggestions

Inverse links

Types: business application edit tags	
criticality	high
responsible unit	Headquarter
used technology	Oracle 9i
number of users	
References	
"used applications" of	Subsidiary London

Non-structured information

[Ne12]

Change the information and its structure at any time.

» Wikis » IT-Landschaft » Data Warehouse

Last editor Administrator - 1 minute ago

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used technology

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Tomcat 5.1
IT-Landschaft

Apache 2.0.53
IT-Landschaft

MySQL 2.1
IT-Landschaft

Oracle 9i
IT-Landschaft

DB2 6.0

Multi-valued & ordered

Suggestions based on content

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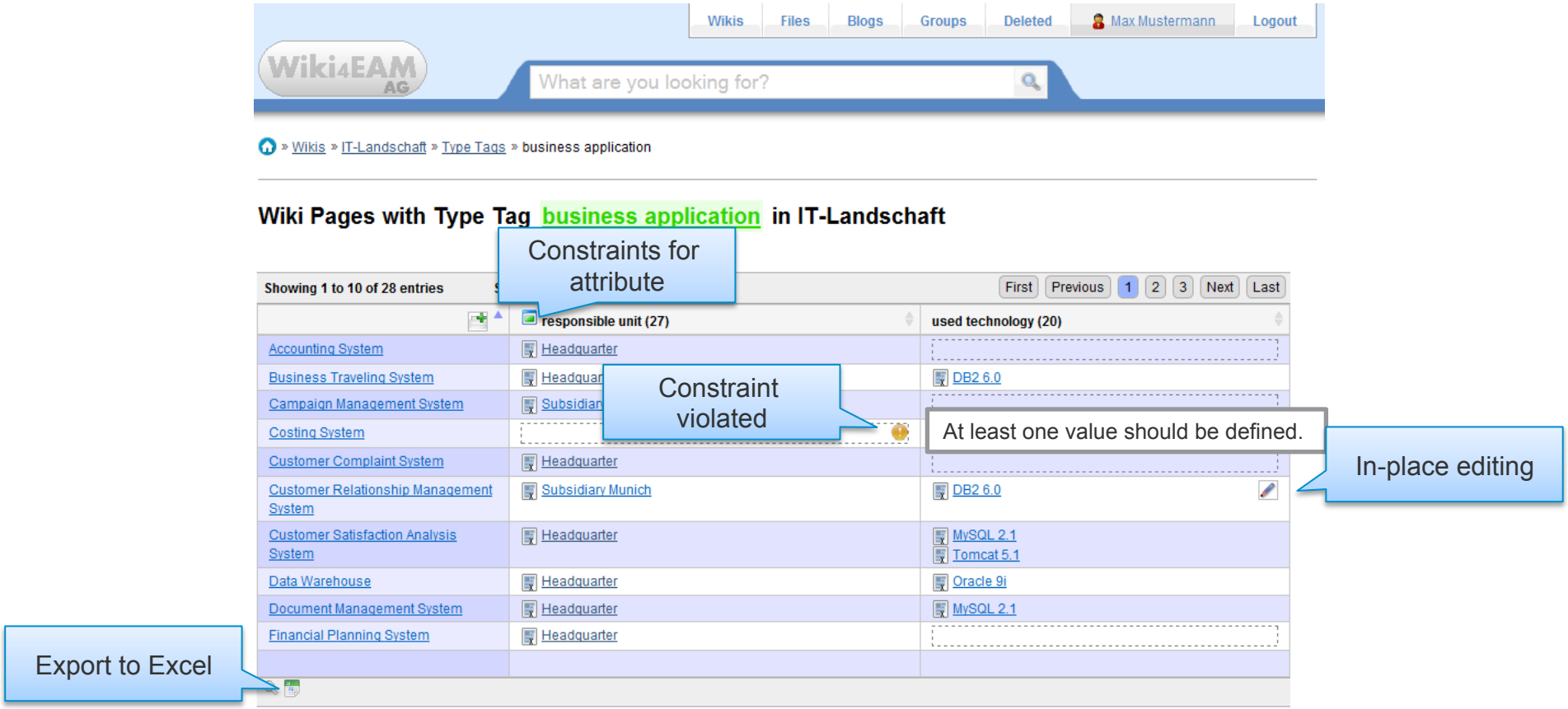
Suggestions based on type(s)

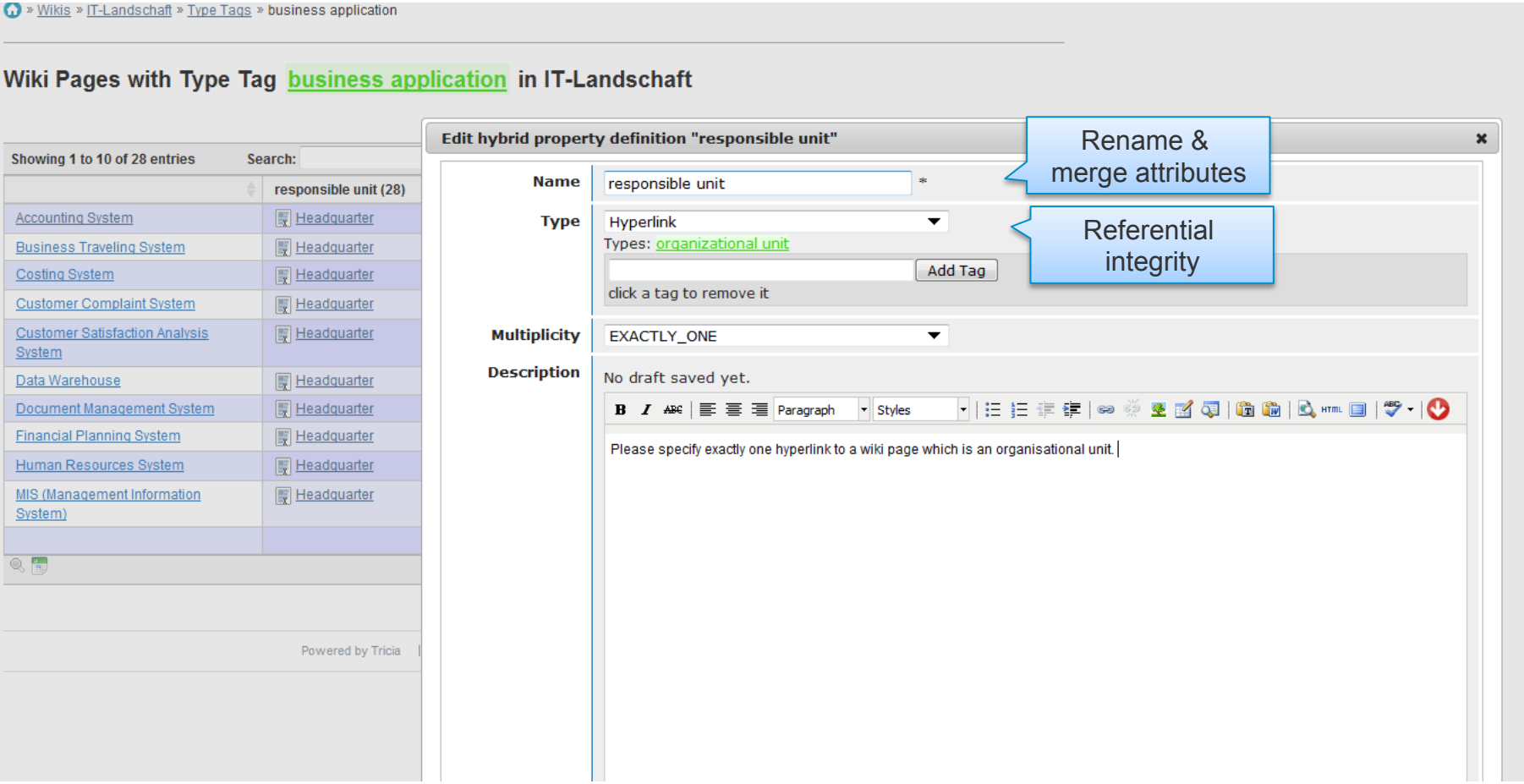
[Ne12]

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



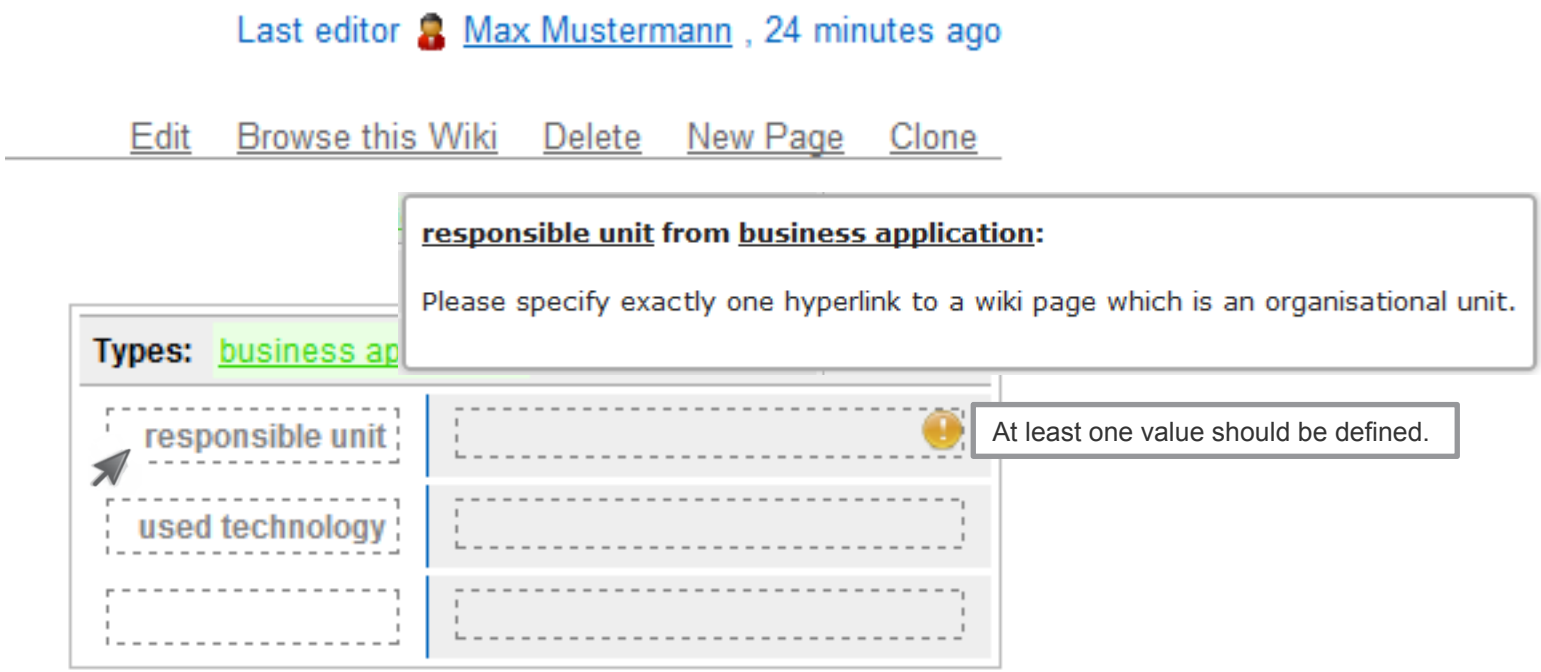
[Ne12]

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.

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Document Management System
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IT-Landschaft | [Last edited by Max Mustermann, Jan 27]
business application edit tags

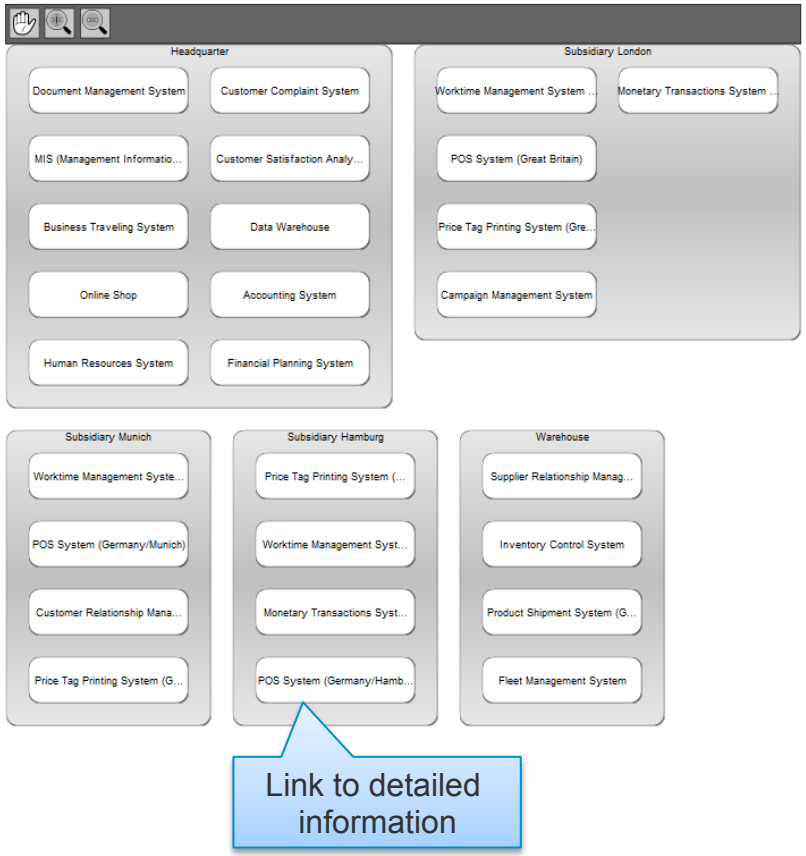
POS System (Germany/Munich)
Text... business application business application used technology MySQL 2.1 responsible unit
IT-Landschaft | [Last edited by Max Mustermann, Jan 27]
business application edit tags

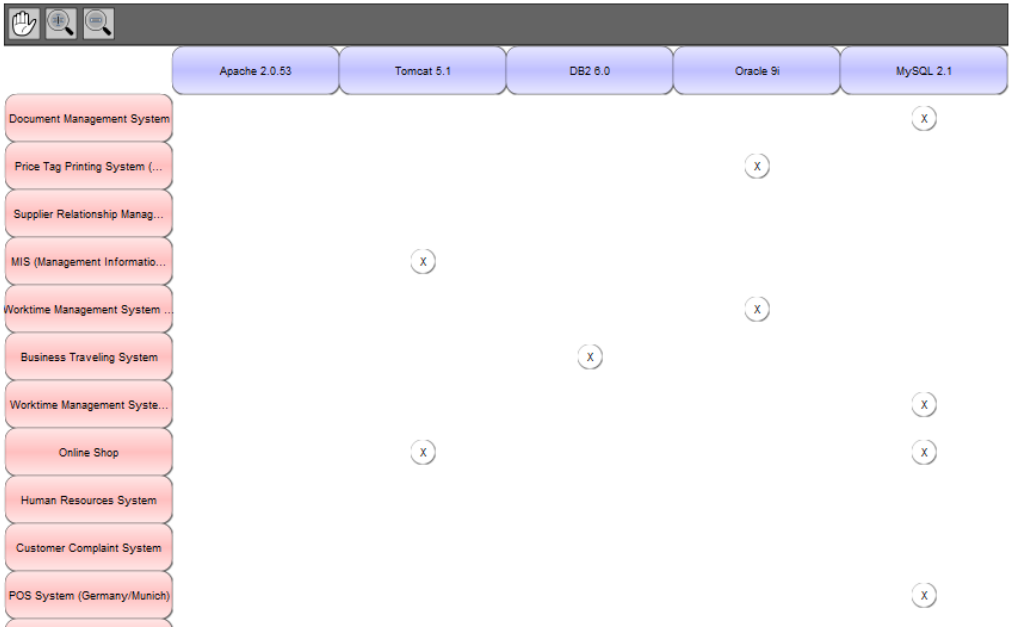
[Ne12]

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?

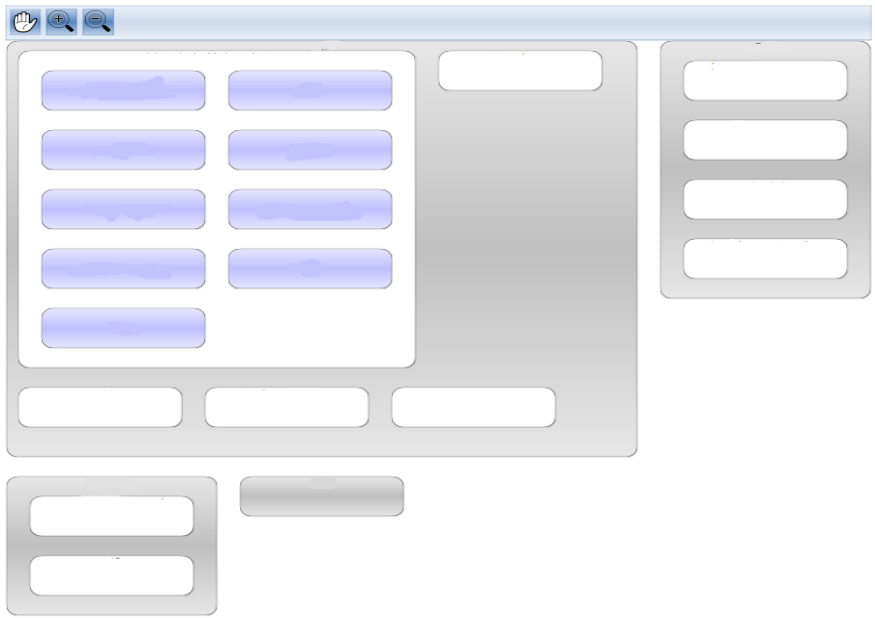


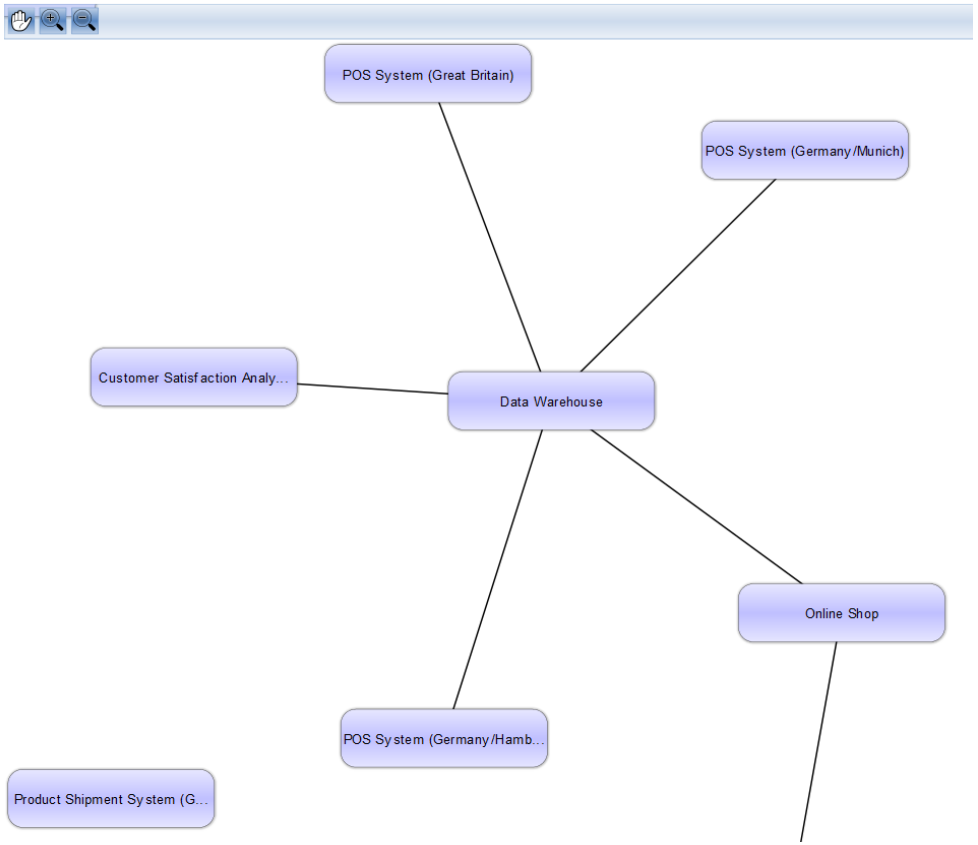


Use generated lists, tables and diagrams to provide stakeholder-specific views.

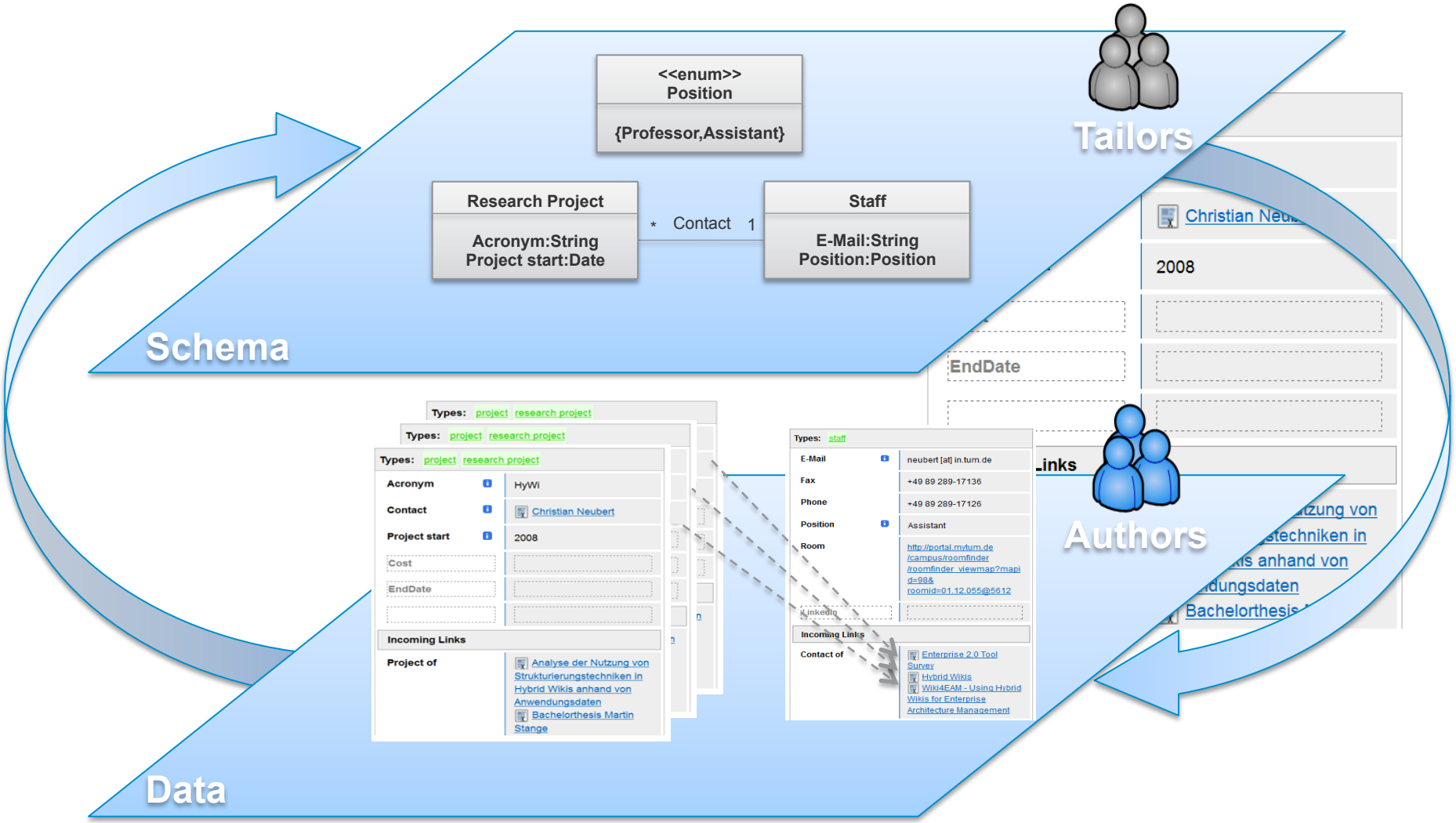
What are our domains, subdomains and business applications?

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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