Teil V: Werkzeuge für spezifische Zwecke
70. Werkzeuge zur Anforderungsanalyse

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1) Requirements Management
2) Requisite Pro
3) Ontology-Driven Requirements Engineering (ODRE)
4) Traceability to other Artefacts

References

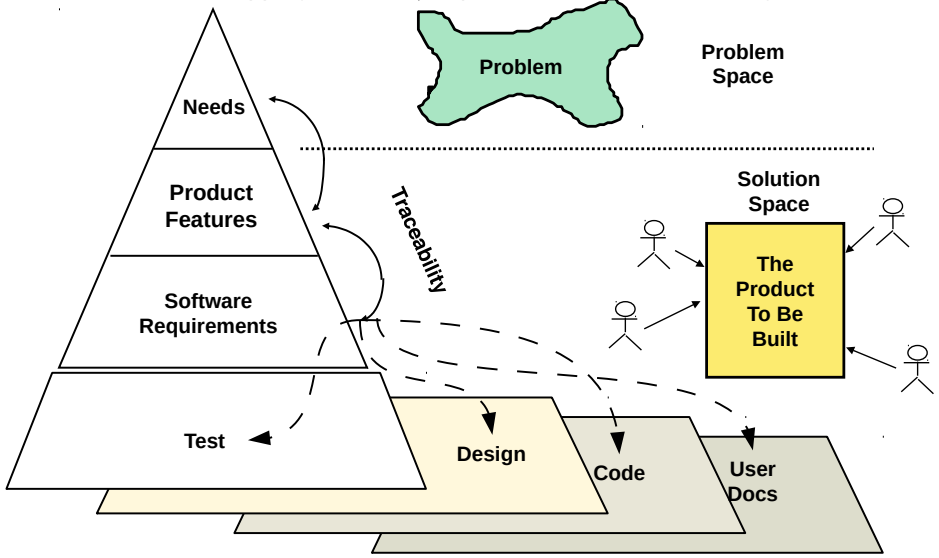
- Katja Siegemund, Edward J. Thomas, Yuting Zhao, Jeff Pan, and Uwe Assmann. Towards Ontology-driven Requirements Engineering. Semnatic Web Enabled Software Engineering (SWESE) Workshop at ISWC 2011, Koblenz
  - http://iswc2011.semanticweb.org/fileadmin/iswc/papers/workshops/swese/4.pdf
- [Mylopoulos1999] John Mylopoulos, Lawrence Chung, and Eric Yu. From Object-oriented to Goal-oriented Requirements Analysis. Communications of the ACM, 42(1):31 37, 1999.
- [Zowghi2002] Didar Zowghi and Vincenzo Gervasi. The Three Cs of Requirements: Consistency, Completeness, and Correctness. In Proceedings of 8th International Workshop on Requirements Engineering: Foundation for Software Quality, (REFSQ'02), 2002.
- [Lamsweerde2000] Axel van Lamsweerde. Requirements Engineering in the year 00: A Research Perspective. In International Conference on Software Engineering, pages 5, 19, 2000.
- Grady, Robert; Caswell, Deborah (1987). Software Metrics: Establishing a Company-wide Program. Prentice Hall. pp. 159. ISBN 0-13-821844-7.

Tool References

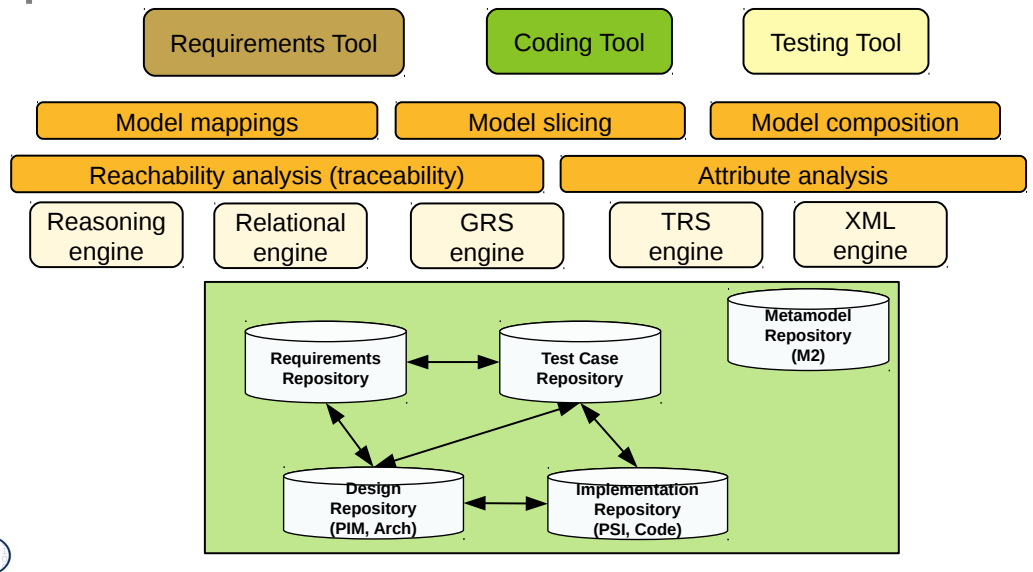
- [RPro] Requisite Pro User's Guide
  - ftp://ftp.software.ibm.com/software/rational/docs/v2003/win_solutions/rational_requisitepro/reqpro_user.pdf
- Dominic Tavassoli, IBM Software. Requirements Definition and Management - Ten steps to better requirements management. June 2009
  - ftp://ftp.software.ibm.com/software/emea/de/rational/neu/Ten_steps_to_better_requirements_management_EN_2009.pdf
- Tools: http://www.jiludwig.com/Requirements_Management_Tools.html
- Free community-licensed tool Axiom (Windows, Linux): http://www.iconcur-software.com/
  - http://d60f31wukcdjk.cloudfront.net/docs/Axiom_4_User_Manual.pdf
- Teach videos of Axiom
  - http://www.iconcur-software.com/resources.html
  - Video on linking matrix (traceability matrix) http://iconcur-software.com/tutorials/matrix.htm

Introduction to Requirements Management (RM)

- RM bridges the needs of the customer to testing, design, coding, and documentation
- RM relies on model mappings between requirements, test cases, design, and code



Tools in an Integrated Development Environment (IDE)

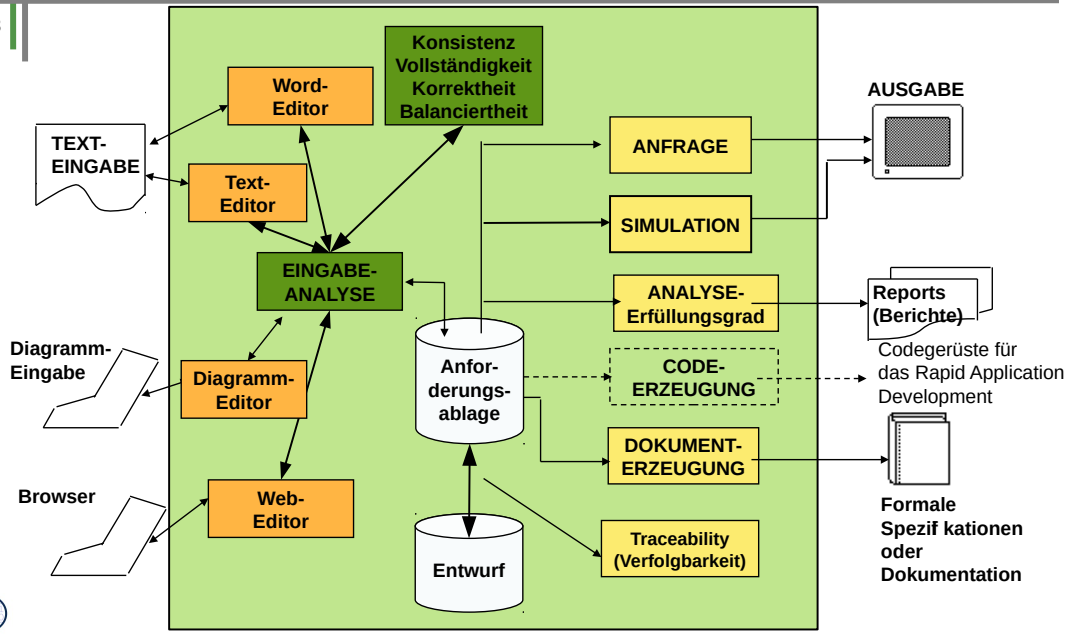


Deficiencies of Current RE Methods

- Relationships among requirements are inadequately captured
  - Causal relationship between consistency, completeness and correctness [Zowghi2002]
  - Completeness and consistency are not verified
- Requirement problems (e.g. conflicts, incompleteness) are detected too late or not all
- Relationships between requirements and dependent artifacts are insufficiently managed (test, documentation, design, code)
- Desirable:
  - Models for RE need richer and higher-level abstractions (goals, problems, needs) to validate that they are fulfilled [Mylopoulos1999]
  - **Model mappings (direct and indirect)** between the artifacts (design, code) and the goals, problems, needs of the customer
  - Requirements are consistently managed with design, code, and documentation

70.1 Tool-Based Requirements Management

Requirements Tools on the Requirement Database



Metamodeling of Requirements

- Generell empfiehlt sich die Metamodellierung von Requirements, da
  - sich viele Domänen und Anwendungsbereiche unterscheiden
  - die Granularität der Requirements unterschiedlich ist (Balancing)
  - die Requirements dann als Modellelemente exisiteren und über Model mappings in den Entwurf, die Architektur und den Code verfolgt werden können (**traceability, Verfolgbarkeit)**
  - Verfolgbarkeit wird über Modellabbildungen (model mappings) hergestellt
- Many requirement tools are metamodel-controlled
  - die die Requirements typisieren
  - und Requirements verlinken

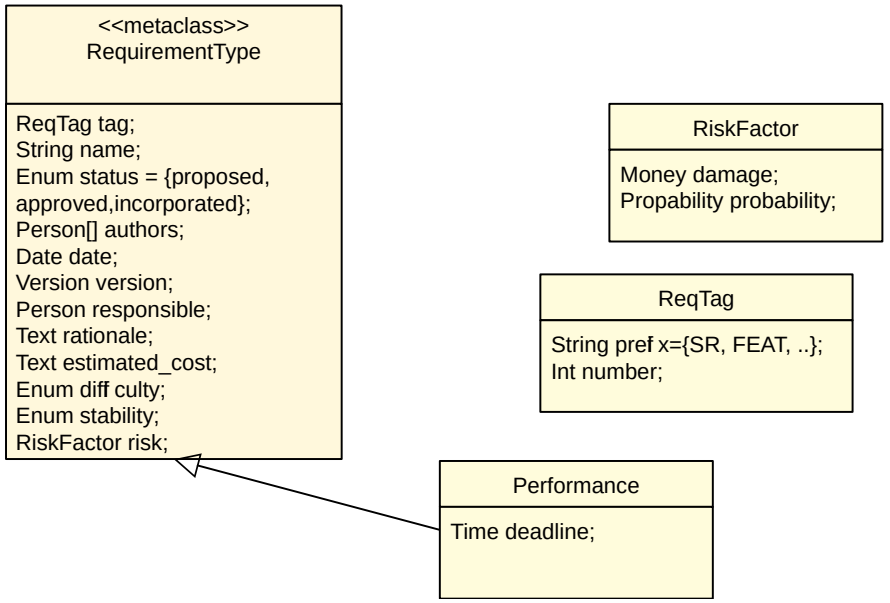
70.2 Requisite Pro

RequisitePro (IBM)

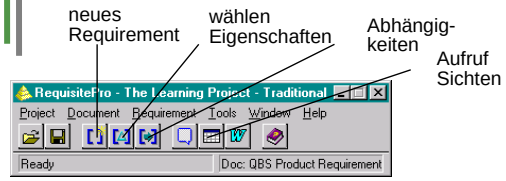
- Aufbau einer **metamodellgesteuerten Anforderungsdatenbank**:
  - Formulargesteuerte Erstellung eines Metamodells für die Anforderungen (**requirement types)** (Metasprache ERD)
    - Spezifikation von Anforderungsattributen, wie Status, Priorität, Schwierigkeit, Stabilität, Kosten
    - Anforderungsabhängigkeiten und -verknüpfungen
    - Möglichkeit der hierarchischen Verfeinerung, sowie unterschiedlicher Sichten auf Anforderungsverknüpfungen
  - Anfragen und Querying möglich
  - Konfigurationsmanagement/Änderungsverwaltung: Revisionsstände, Abhängigkeiten, Historie
  - Unterstützung gruppenorientierten Arbeitens
  - Integration in Vorgehensmodelle und SEU, z. B. Rational Unified Process mit Rational Rose, ClearCase sowie MS Project.
- **Verfolgbarkeit:** in einer "Traceability Matrix" können Requirements mit den Testfälle verknüpft werden
- Erstellen von **Anforderungsdokumenten mit Word-Vorlagen:**
  - Dokumente strukturiert nach (Standard-)Vorlagen (templates)
  - Unterschiedliche Typen von Anforderungen werden unterstützt (z.B. Produkt-, Software-, Test- und Anwendungsfall-Anforderungen).

http://www-142.ibm.com/software/products/de/de/reqpro/
ftp://ftp.software.ibm.com/software/rational/docs/v2003/win_solutions/rational_requisitepro/reqpro_user.pdf
http://public.dhe.ibm.com/common/ssi/ecm/en/rad10955usen/RAD10955USEN.PDF

Metaclass RequirementType (Ex.)

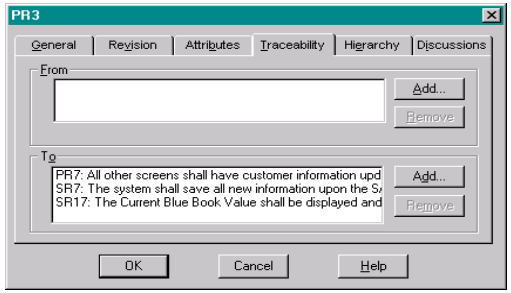


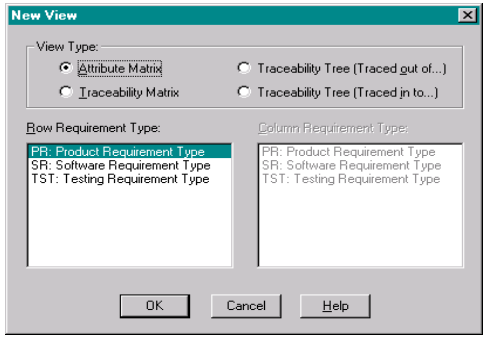
RequisitePro - Hauptansichten



Auswahl unterschiedlicher Sichten und Requirementtypen

Beschreibung des Requirements **PR3**





FURPS Classification of Requirements

FURPS delivers RequirementTypes for RequisitePro

[Wikipedia] [Grady/Caswell] in Hewlett-Packard

- **Functionality** - Feature set, Capabilities, Generality, Security
- **Usability** - Human factors, Aesthetics, Consistency, Documentation
- **Reliability** - Frequency/severity of failure, Recoverability, Predictability, Accuracy, Mean time to failure
- **Performance** - Speed, Efficiency, Resource consumption, Throughput, Response time
- **Supportability** - Testability, Extensibility, Adaptability, Maintainability, Compatibility, Configurability, Serviceability, Installability, Localizability, Portability

Attribute Matrix of Requisite Pro

- The attribute matrix is a hierarchical table (relation) of requirement objects and their attributes
  - Super and subrequirements
  - Priority and Status, and other attributes

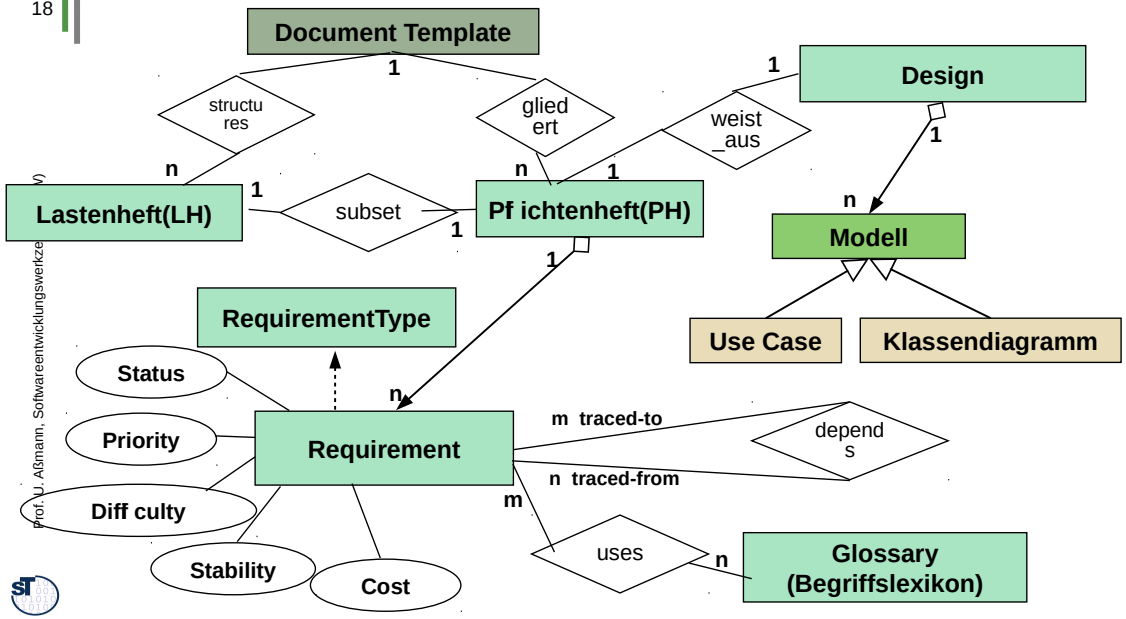
Formalizing Requirement Texts

- If requirements are entered in Word text, they can be **formalized by text mining** with
  - Verb-noun-analysis
  - Keyword identification: MUST, MAY, SHALL, SHOULD, WILL, CUSTOMER
  - Markup information, such as section headers, emphasizing, etc.
  - Concept recognition by looking up nouns in domain models (glossaries, taxonomies, ontologies)
- Requirements can also be recognized from Word tables [RPro]

Traceability with Model Mappings

- The Traceability Matrix connects and relates requirements by **direct traces** and **indirect traces** over **trace_to** and **trace_from** relationships
  - The trace relationship is a model mapping within the requirements model
  - External projects can be imported, and traces to their public requirements can be defined
- Direct traces are entered
  - into a form
  - into the corresponding bitfield of the traceability matrix
- If somebody changes the requirements later, the trace links become **suspect** and should be checked

Begriffe des Requirements Managements in RequisitePro



Tools

CaliberRM	Borland	http://www.borland.com/us/products/caliber/index.aspx
DOORS	IBM	http://www-01.ibm.com/software/awdtools/doors/ http://www.docstoc.com/docs/90794258/Getting-the-most-out-of-DOORS-for-requirements---NJIT-Computer
Siehe auch Test Tools		

70.3 Ontology-Driven Requirements Engineering (ODRE)

Uwe Aßmann[1], Katja Siegemund[1], Edward J. Thomas[2], Jeff Pan[2], Yuting Zhao[2]

1 Technische Universität Dresden, Germany

2 University of Aberdeen, UK

SWESE Oct 24, 2011

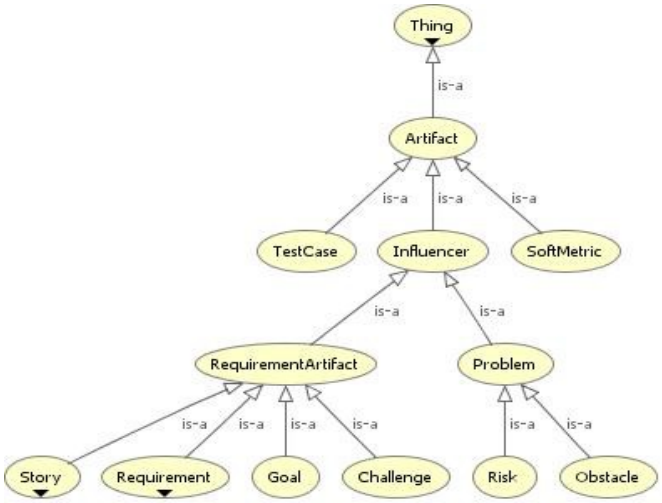
Why Ontology-Driven Requirements Engineering (ODRE)?

- Use graph-logic isomorphism to store requirements and their requirement types in logic, more precisely, in an OWL ontology
  - Provide a metamodel (T-Box of requirements ontology) with a huge set of relevant metadata and requirement relationships
- Use reasoning services to
  - provide meaningful checks for completeness and consistency, e.g., as queries to the A-Box with SparQL
  - Make specific suggestions to repair inconsistencies and incompleteness
- Ontology consists of T- and A-Box
  - TBox (Terminological Box) provides metadata
  - ABox (Axiom Box, Fact Base) provides requirements, goals, relationships,...

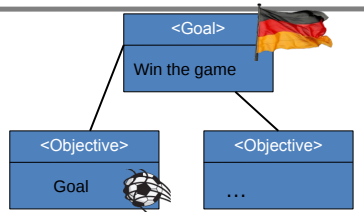
ODRE Needs Goal-Oriented RE (GORE)

- Lamsweerde defines **goals** as "declarative statements of intent to be achieved by the system under consideration" [Lamsweerde2000]
- Benefits of explicit specification of goals in GORE:
  - Goals drive the identification of requirements
  - Goals provide a criterion for sufficient completeness of a requirement specification
    - Specification of pertinent requirements
    - Relationships between goals and requirements can help to choose the best one
  - Concrete requirements may change over time whereas goals pertain stable

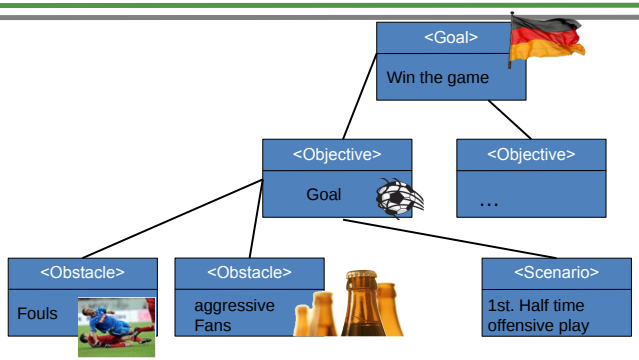
Goal-Oriented Requirements Engineering (GORE) – TBox of GORE Ontology



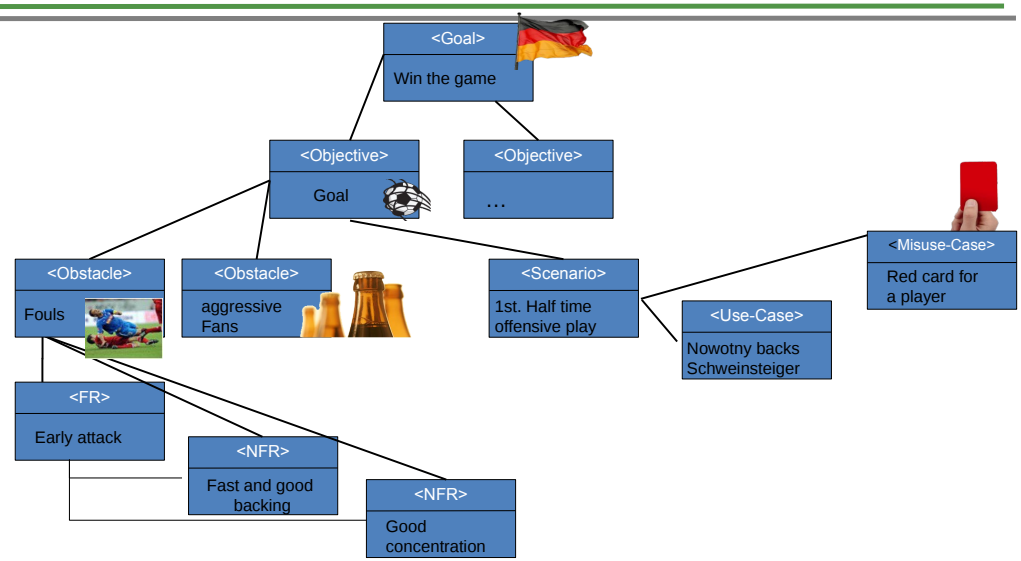
Goal-Oriented RE (Motivation Example)



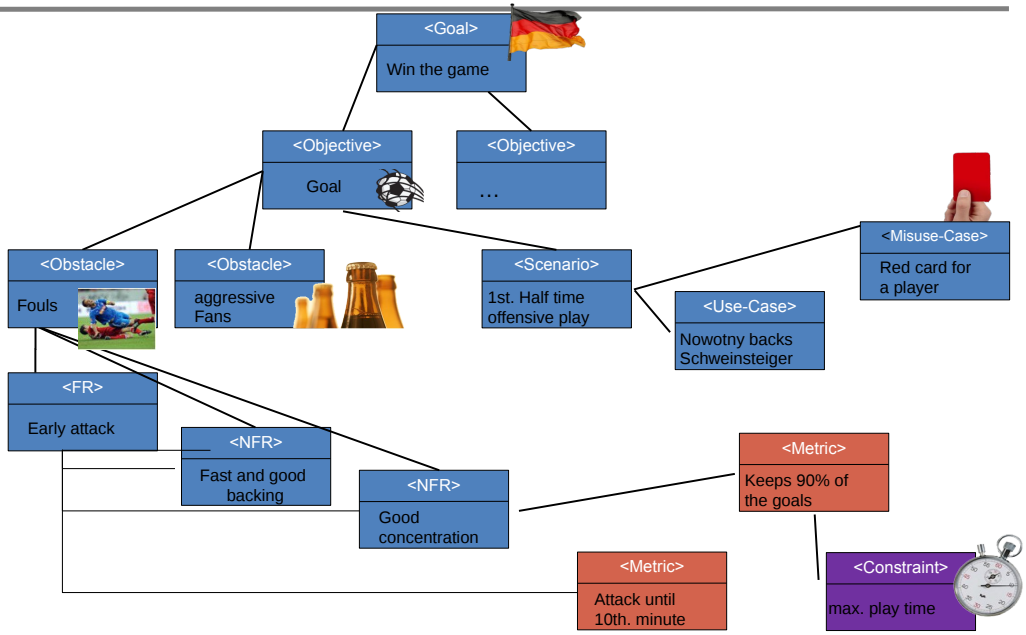
Goal-Oriented RE (Motivation Example)



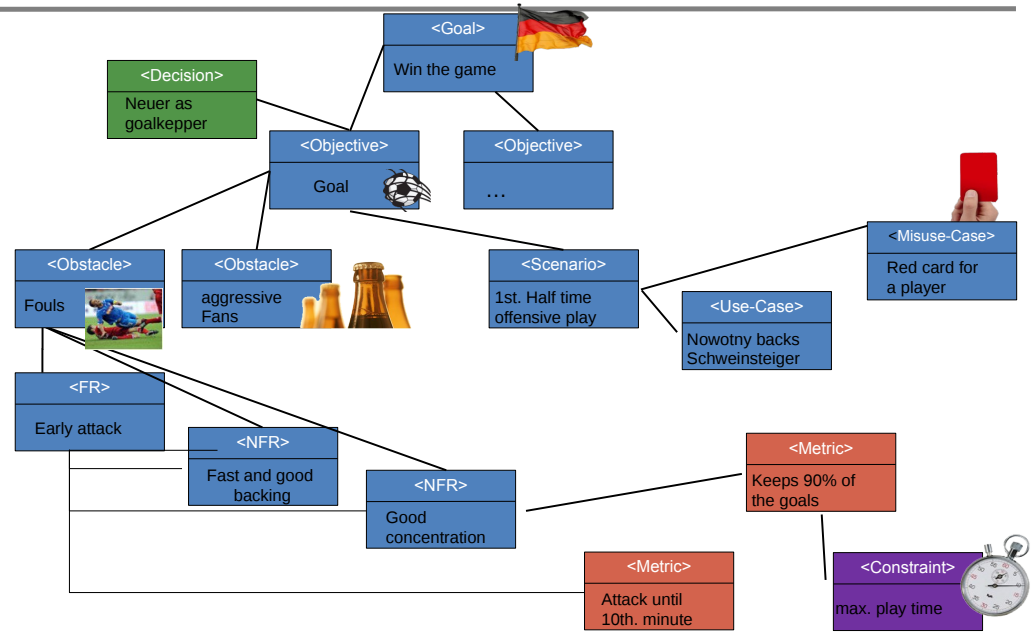
Goal-Oriented RE (Motivation Example)



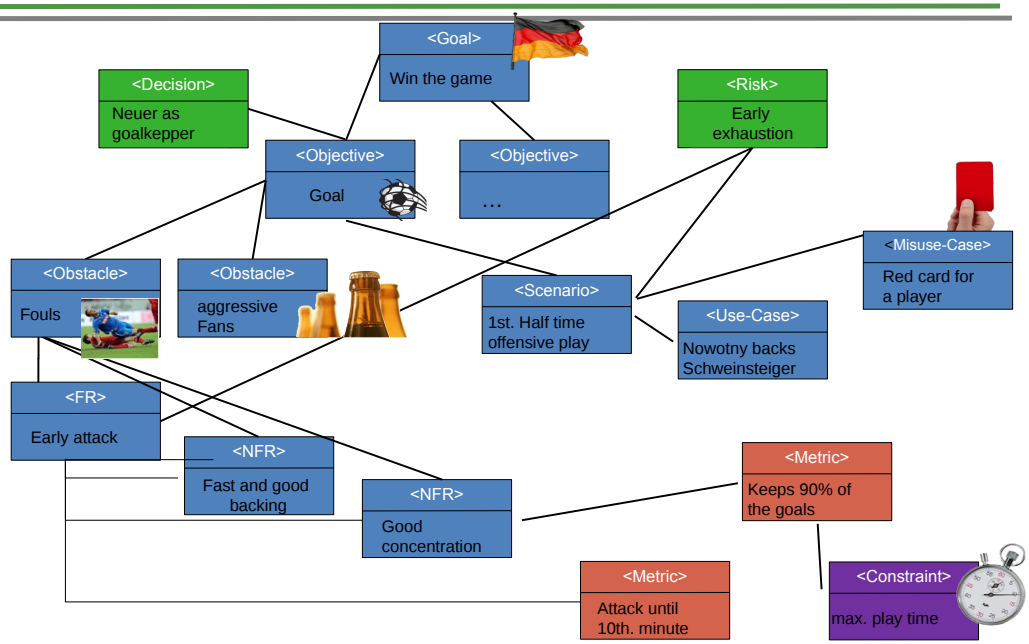
Goal-Oriented RE (Motivation Example)



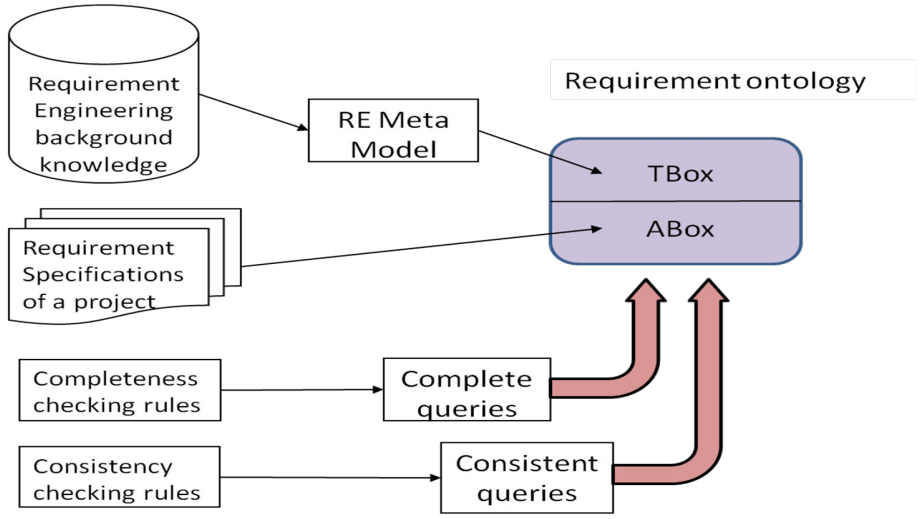
Goal-Oriented RE (Motivation Example)



Goal-Oriented RE (Motivation Example)



Architecture for ODRE Tool



Reasoning for RE – Completeness Check

- Example of Completeness Rule:

> "Every Functional Requirement (FR) must define whether it is mandatory or optional. "

- The GORE ontology of Lambsweerde needs 46 completeness rules
  - Implemented as SPARQL queries on the A-Box
  - The requirements model is deemed incomplete if a specific rule fails
  - Reasoning Strategy: Closed World Reasoning (for negation as failure)
    - supported by SPARQL 1.1 and TrOWL reasoner

Reasoning for RE – Completeness Check (Example)

> "Every Functional Requirement (FR) must define whether it is mandatory or optional. "

- SPARQL rule:

```
IF FR is NOT mandatory AND NOT optional THEN
     Print error: "You did not specify whether
       the following FRs are mandatory or optional:
       [FR_n].“
     "Please specify whether these FRs are mandatory
       or optional."
```

Reasoning for RE – Completeness Check (Example)

- Extract of individuals and relationships of the A-Box from the SPARQL analysis :

isRelatedTo(Goal2;UseCase7)
NonFunctionalRequirement (NonFunctionalRequirement1)
IsOptional(NonFunctionalRequirement1; true)
FunctionalRequirement(FunctionalRequirement1)

Error.
You did not specify whether the following FR are mandatory or optional:
FunctionalRequirement1. Please specify this attribute for the FR:
FunctionalRequirement1. Every FR must specify AT LEAST ONE requirement relationship.

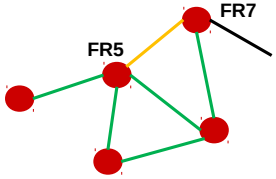
Reasoning for RE – Consistency Check

- GORE needs 6 consistency rules among requirement artefacts (valid relations between requirement artefacts)
  - Based on a chosen subset of requirement artefacts
  - Consistency rules are encoded as DL axioms in the A-Box
- Instance specific error messages resulting from validation displayed by Guidance Engine

Reasoning for RE – Consistency Check (Example)

- Extract of individuals and relationships of the A-Box from the SPARQL analysis :

isExclusionOf (FunctionalRequirement5; FunctionalRequirement7)
ChosenRequirement(FunctionalRequirement5)
ChosenRequirement(FunctionalRequirement7)



Error.
The following requirements exclude others:
FunctionalRequirement5.
Please choose one of the following options:

Suggestion.
Exclude the following requirements from the chosen requirement set: FunctionalRequirement5. **OR**
Find alternatives for: FunctionalRequirement5 or
Revise the requirement relationships of(FunctionalRequirement5, FunctionalRequirement7).

Reasoning for RE – Verification Methods (Example)

- **Consistency check of requirement selection (6 rules)**

Excluding requirements must not be included in one set.

IF excluding requirements are included in one set
THEN print *error*: "The following requirements exclude
    Others: [R_n]."
"Please choose one of the following options:
Exclude the following requirements: [R_n],
Find alternatives for [R_n] or
Revise the requirement relationships of [[R x, R y],...]."

Status of ODRE

- All Requirement artefacts and meaningful relationships can be captured within an Ontology Metamodel
- ODRE Approach detects **inconsistent** and **incomplete** requirements
- Standard tooling (reasoners) are useful
  - Specification of requirements uses OWA
  - Verification needs CWA
- First evaluation proves applicability for medium requirement specifications
  - Problem: available requirement specifications do not provide sufficient information (much less than could be captured by ODRE)
  - Primary evaluation within MOST Project
    - Capture all requirement artefacts
    - Detect all inconsistencies and incomplete metadata
  - Main evaluation planned for PhD Thesis of Katja Siegemund (2012)

70.4 Traceability to other Artefacts

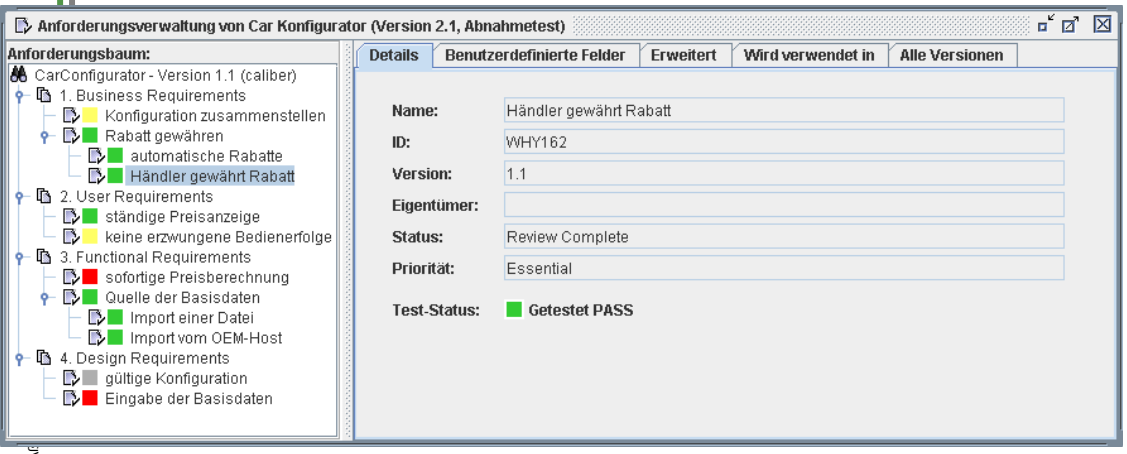
Direct Traceability

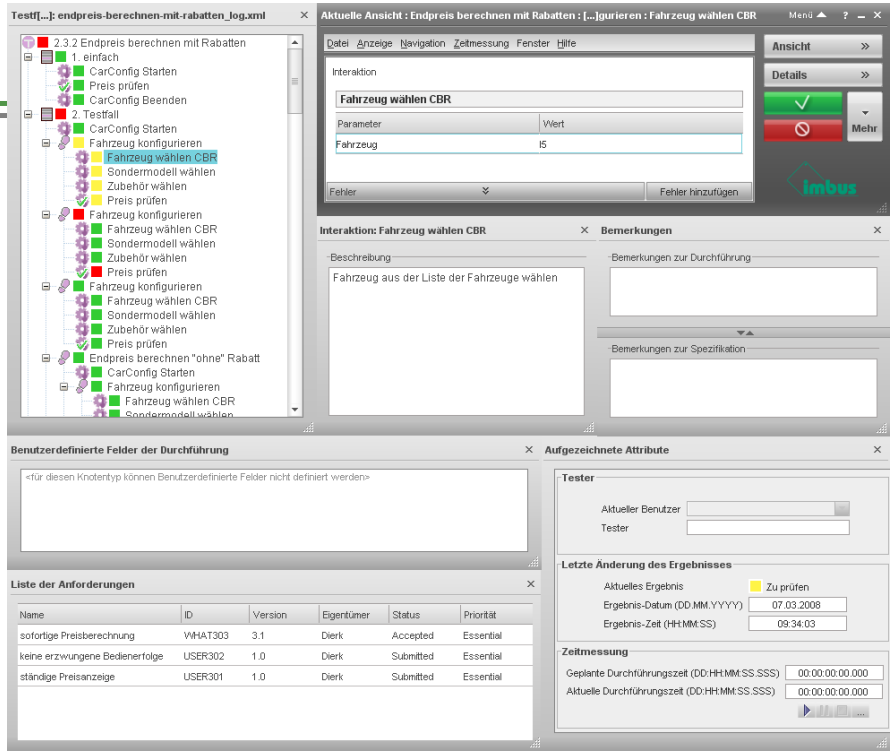
- With a **direct model mapping**, a requirements model can be linked
  - to a test case specification
  - to a documentation
  - to an architectural specification
  - via the architectural specification, to the classes and procedures in the code

Example: imbus TestBench

http://www.imbus.de/produkte/imbus-testbench/hauptfunktionen/

Requirements get “red-yellow-green” Test Status Attribute





The End