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ist

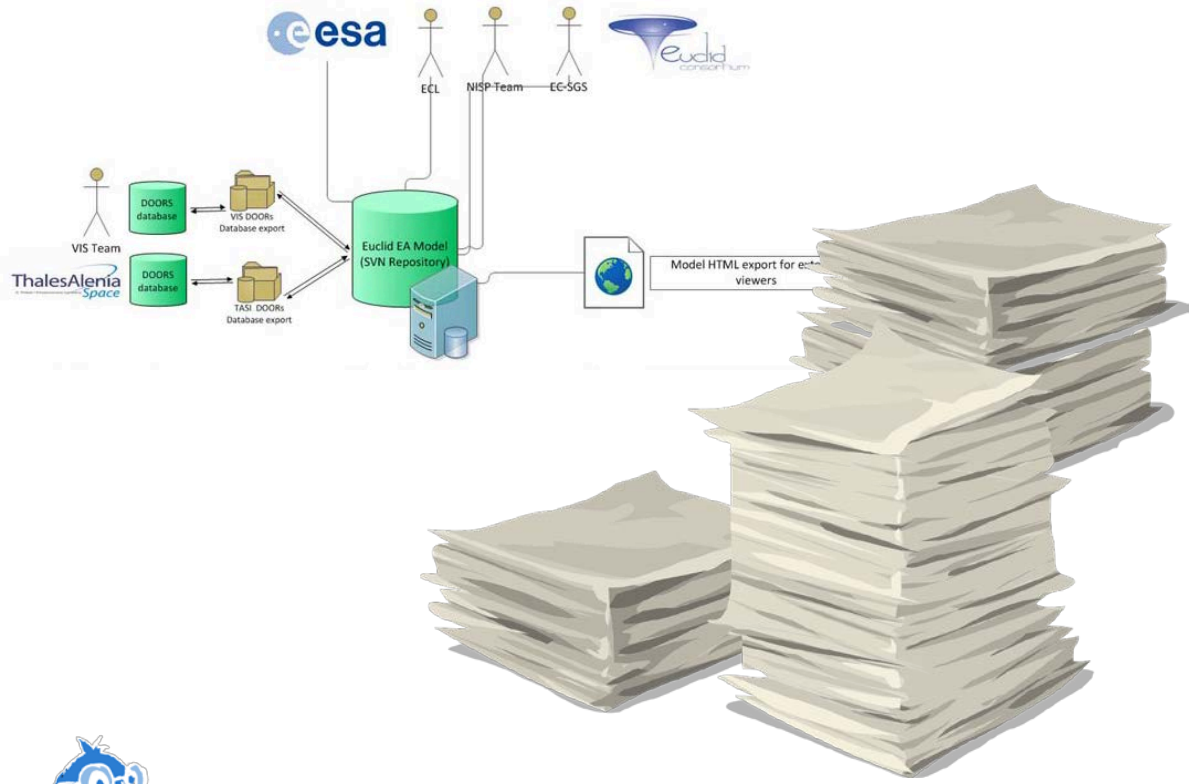
CONCEPTUALIZING REQUIREMENTS

Developing a Requirements Meta-Model for European Space with ORM

Katharina Großer, Space System Ontology Workshop, June 26th 2019

MOTIVATION

- Progress towards …
  - MBSE & Conceptual Modelling
  - But, … document centric RE approach



- RE-Challenges
  - Consistency & Completeness
  - Reviews & Verification
  - Reuse & Variability
  - Domain Knowledge Exchange and Sustainability
  - Human Readability (legal contracts)

→ **Enhance formality & quality**

Model: EUCLID Model: J. L. Alvarez et al.., "Model-based system engineering approach for the Euclid mission to manage scientific and technical complexity," in *SPIE Astronomical Telescopes+ Instrumentation*, **2016**, p. 99110C–99110C

Requirement Properties

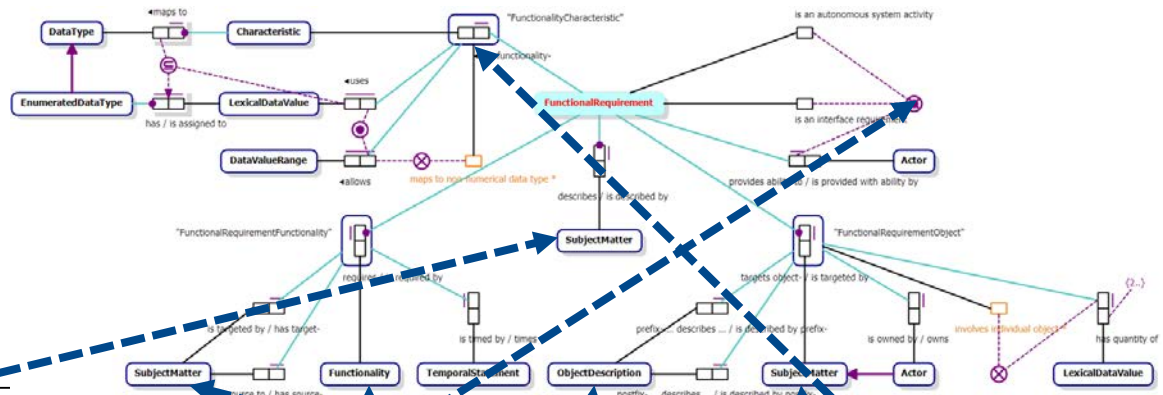
- ECSS E-ST-10-06C
- ECSS Drafting Rules
- ISO/IEC/IEEE 29148
- Old Documents
- Best-practice guides …

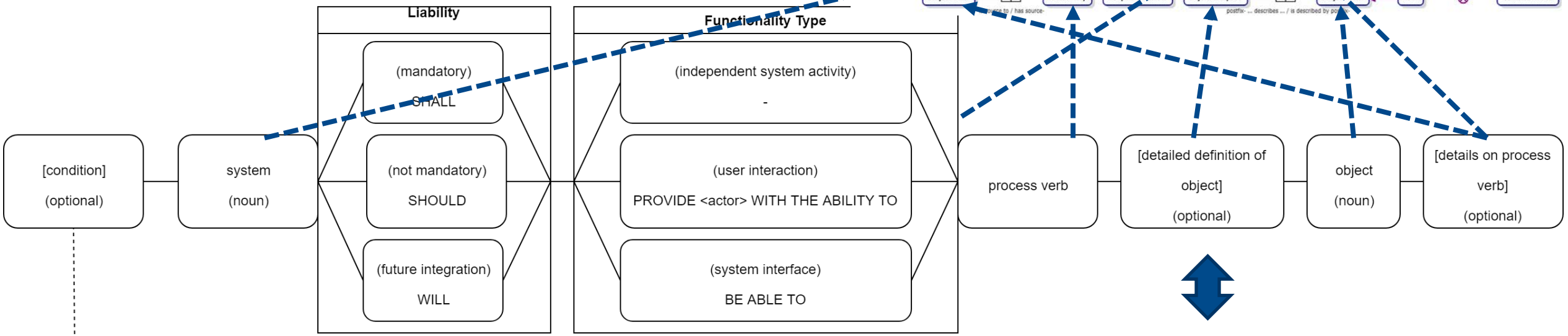
FORMALIZING THE STRUCTURE

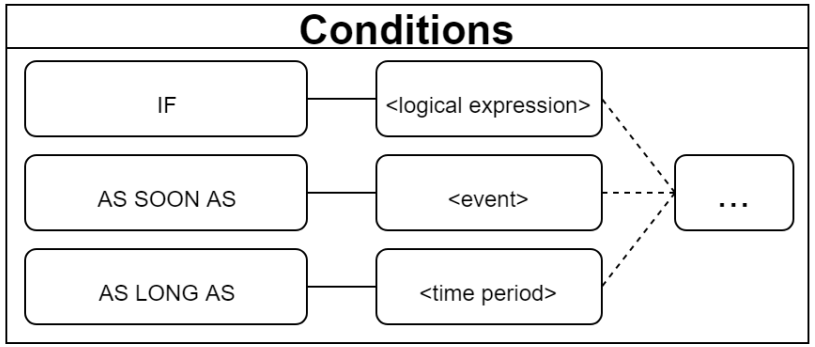
- Characterization of Requirements
- Building blocks

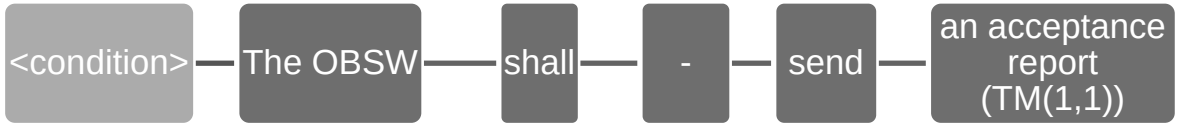
TEMPLATES

WHEN <optional preconditions> <trigger> the <system name> shall <system response>









cf. Rupp, C. & Joppich, R., Requirements-Engineering und -Management -- Aus der Praxis von klassisch bis agil, Anforderungsschablonen - der MASTER-Plan für gute Anforderungen, Carl Hanser Verlag München, **2014**, p. 215-246

Mavin, A.; Wilkinson, P.; Harwood, A. & Novak, M., Easy Approach to Requirements Syntax (EARS), Requirements Engineering Conference, 2009. RE '09. 17th IEEE International, **2009**, 317-322

QUALITY CHECKS

- Semantically rich relations

cf. Spanoudakis, G., Zisman, A.: Software traceability: a roadmap. In: Handbook Of Software Engineering And Knowledge Engineering: Vol 3: Recent Advances, pp., 395428. *World Scientic* ,**2005**

DOCUMENTS

- Old-fashioned “paper based”
- Difficult for tool support (import?)
- Difficult to ensure quality
- Difficult to version
- Unclear dependencies
- …

- Model –> View
- Structure carries semantics
- Guidance
  - Easy to define scope
  - Easy to reference
  - Defined output of processes
  - Organize your thoughts
  - Style guides / Template structure
  - Official Document (legal contracts)

- Documents as 1st class citizens
  - View definition
  - Guidance
  - Interaction
  - Reuse

RELATED DOMAINS

Requirement Meta-Model

- Quality rules
- Properties
- Trace relation types

Requirement Document Meta-Model

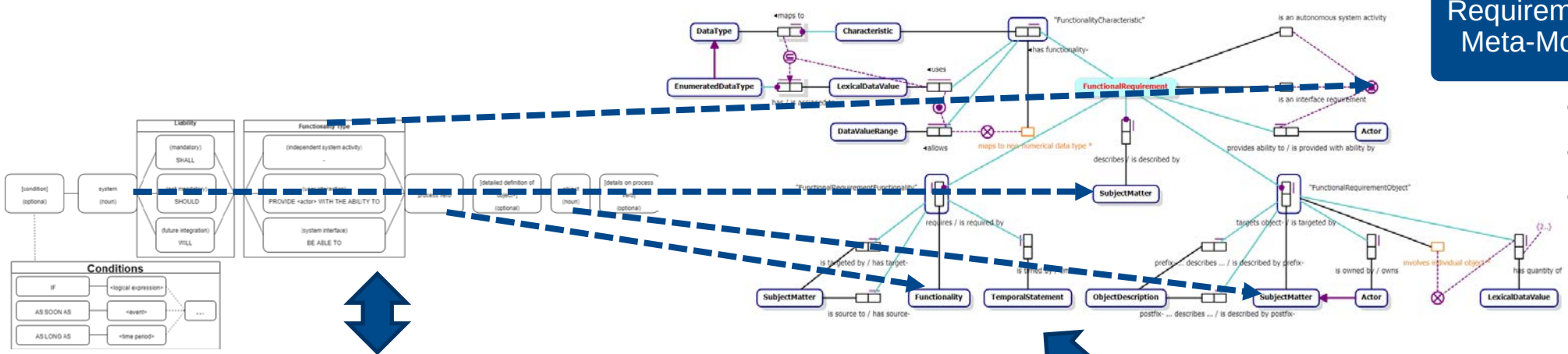
- Document structure
- Elicitation & domain knowledge acquisition techniques

Domain knowledge

- Background
- Constraints

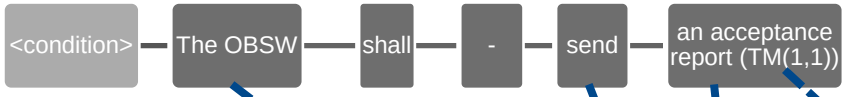
cf. Castañeda V., Ballejos, L., Caliusco, L. & Galli, R.., “The use of ontologies in requirements engineering,” *Global journal of researches in engineering*, vol. 10, no. 6, pp. 2–8, **2010**

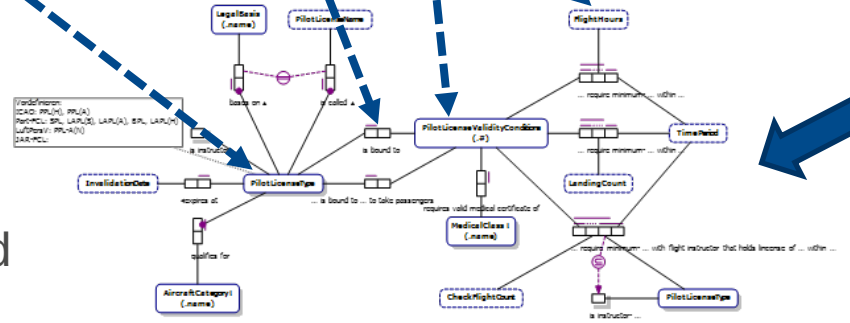
THE BIG PICTURE



Requirements Meta-Model

- Quality rules
- Properties
- Trace relation types





Domain Knowledge

- Background
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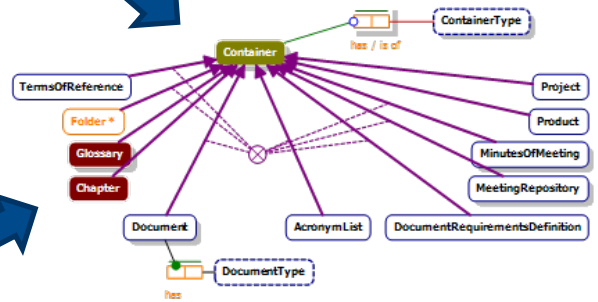


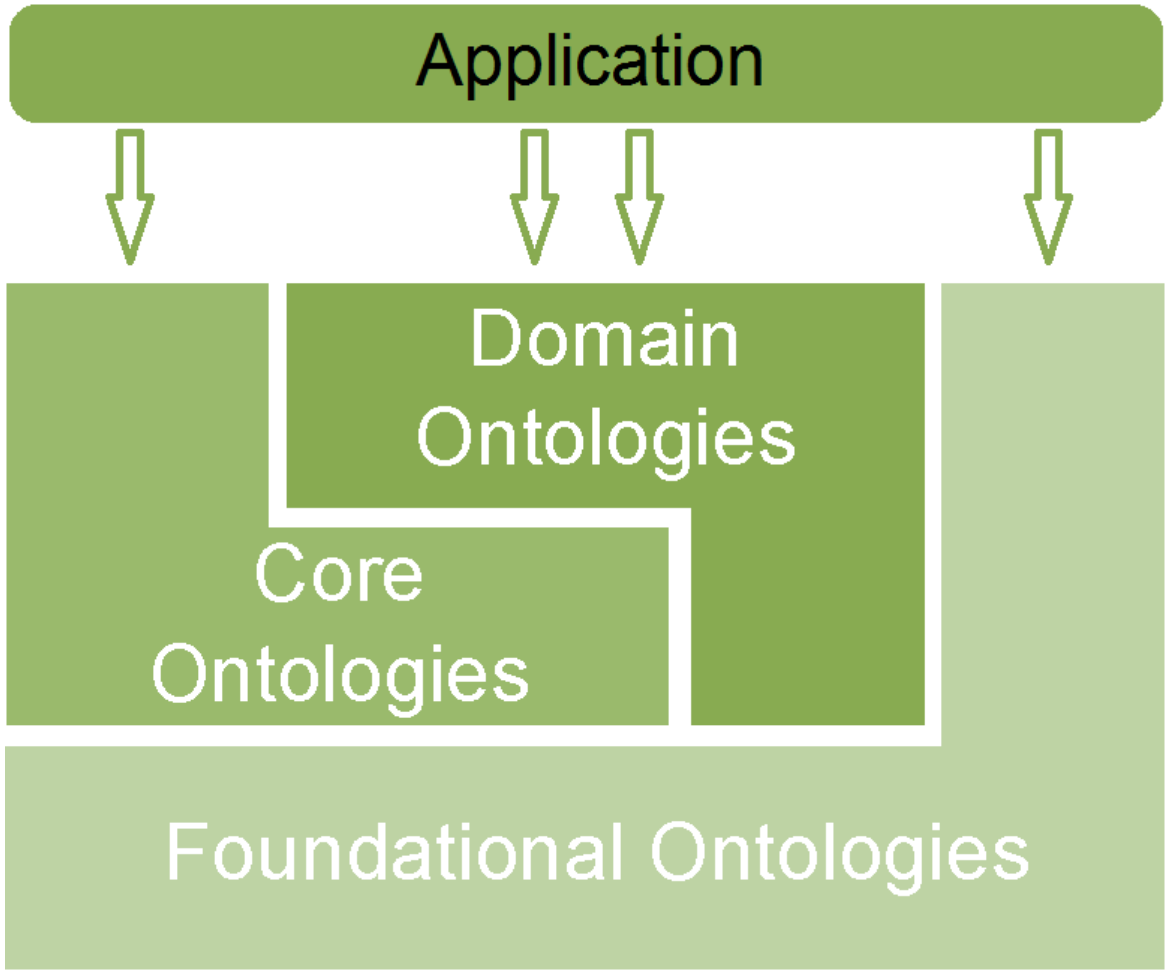
Requirements Document Meta-Model

- Document structure
- Elicitation & domain knowledge acquisition techniques

cf. Castañeda et al., "The use of ontologies in requirements engineering," *Global journal of researches in engineering*, vol. 10, no. 6, pp. 2–8, **2010**

Farfeleder, S.,. Requirements Specification and Analysis for Embedded Systems, PhD Thesis, Vienna University of Technology, **2012**

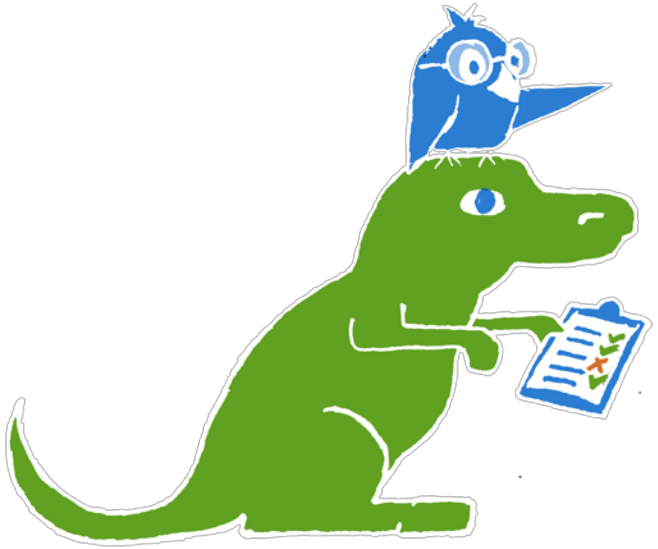
LAYERED ONTOLOGIES

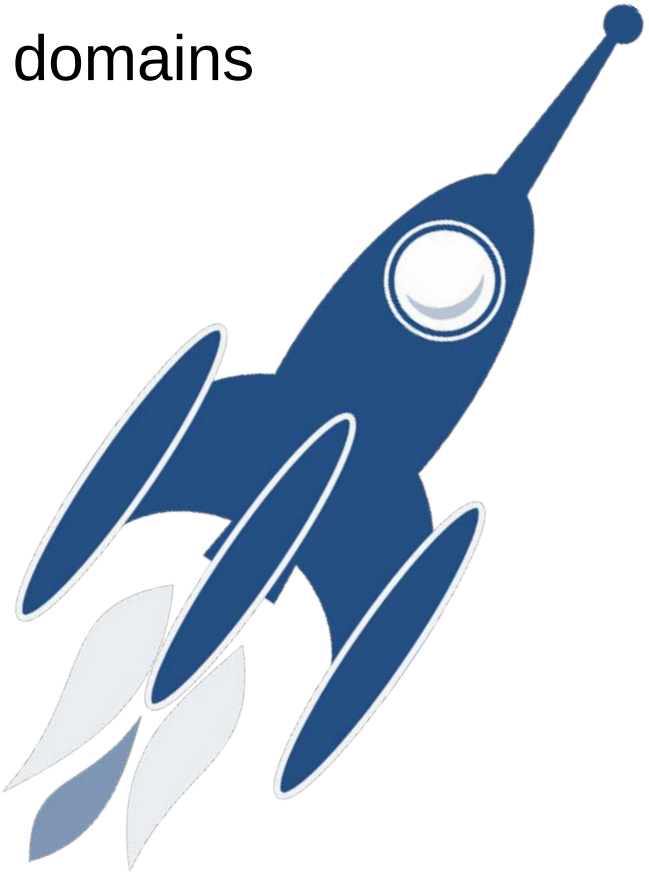


cf. Scherp, Saathoff, Franz & Staab “Designing core ontologies”, *Applied Ontology*, **2011**, 6, 177-221

FUTURE CHALLENGES

- Common standard for RE knowledge
- Conceptual knowledge exchange in different related (sub) domains
- Separation of concerns
- View concept
- Ontology Architecture





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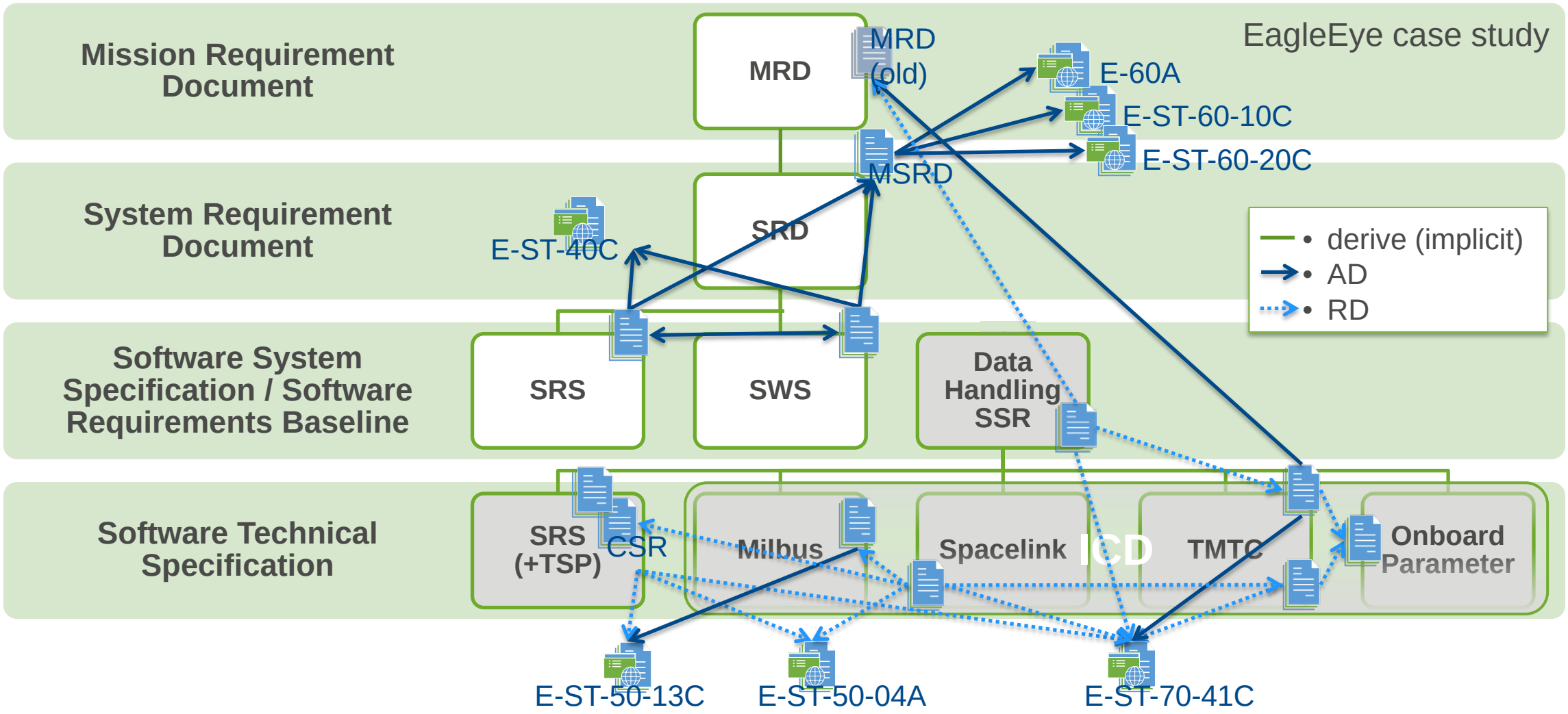
BACKUP SLIDES

… more details

TRACE DEPENDENCIES



*Thanks to Andreas Jung for explanation and feedback

CONSISTENCY

Table A-1: Requirements selection

Function/service	Subfunction	Clauses	Applicability
Physical layer		5	Always applicable.
Data link layer		6	Always applicable.
Time Distribution		8.2.1	Optional. If selected for a mission the requirements are normative for BC and for the RTs that are required to use the function
Time Synchronization		8.2.2	Optional. If selected for a mission the requirements are normative for BC and for the RTs that are required to use the function
Communication Synchronization		8.3.1, 8.3.2	Always applicable. The set of requirements to apply depends on the selection of the Time Synchronization function
	Accurate Message Transfer	8.3.3	Optional
Set Data		8.4	Optional
Get Data		8.5	Optional
Data Block Transfer		8.6	Optional. If selected for a mission the requirements are normative for BC and for the RTs that are required to use the function
Terminal Management	Data Wrap Around	8.7.4	Always applicable.
		8.7.1,	Optional

Annex B Tailoring of Applicable Standards

B.1 ECSS-E-ST-50-13C Requirements

Function/service	Subfunction	Clauses	Applicability	Compliance
Physical layer		5	Yes	Yes (hw)
Data link layer		6	Yes	Yes (drivers)
Time Distribution		8.2.1	Yes	Yes
Time Synchroniza-tion		8.2.2	Yes	Yes
Communication Synchronization		8.3.1, 8.3.2	Yes	Yes (VSRF RTB)
	Accurate Message Transfer	8.3.3	Yes	Yes, (VSRF RTB supported, but not validated with respect to accuracy require-ments (+/- 0.1%)
Set Data		8.4	Yes	Yes
Get Data		8.5	Yes	Yes
Data Block Trans-fer		8.6	Yes	Yes
Terminal Man-agement	Data Wrap	8.7.4	No	
		8.7.1, 8.7.2, 8.7.3		No

APPLICABLE ECSS STANDARD ⟷ PROJECT REQUIREMENTS

4.1.2 Elements of a performance requirement

a. The specification of a performance shall consist of:

1. The quantities to be constrained.

NOTE 1 This is usually done specifying the appropriate indices (APE, MPE, RPE, PDE, PRE) as defined in 3.2.

NOTE 2 All the elements needed to fully describe the constrained quantities are listed there; for example, the associated timescales for MPE or RPE.

2. The allowed range for each of these quantities.

3. The probability that each quantity lies within the specified range.

NOTE This is often called the confidence level. See 4.1.4;

4. The interpretation of this probability.

NOTE 1 This is often referred to as the "statistical interpretation". See annex A.1.2

NOTE 2 The way to specify the statistical interpretation is described in 4.1.4.2.

EE-MR-0255	A	F	AOCS Performance

The AOCS subsystem shall provide performances such as:

- AME in the range of 100 µrad (3σ)
- APE in the range of 1 mrad (3σ)
- Along track maneuver capability of 20 deg.
- Across track maneuver capability of 20 deg.
- Navigation accuracy in the range of 10 m.

ECSS-E-ST-50-13C, **2008**
S. U. Palm, "ATB Consolidation Central Software Requirements," TERMA, TER-ATBC-TS-REQ-001, **2014**
ECSS-E-ST-60-10C, **2008**
F. Pace, "EARTH OBSERVATION REFERENCE MISSION - SYSTEM SPECIFICATION," ESA - ESTEC, ATB-RAC-D5, **2009**