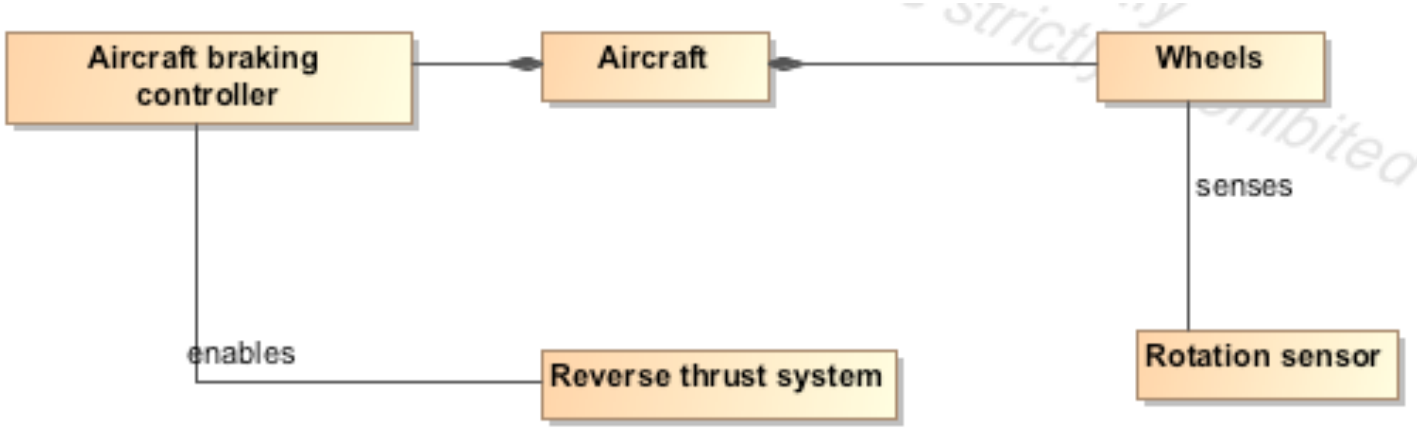
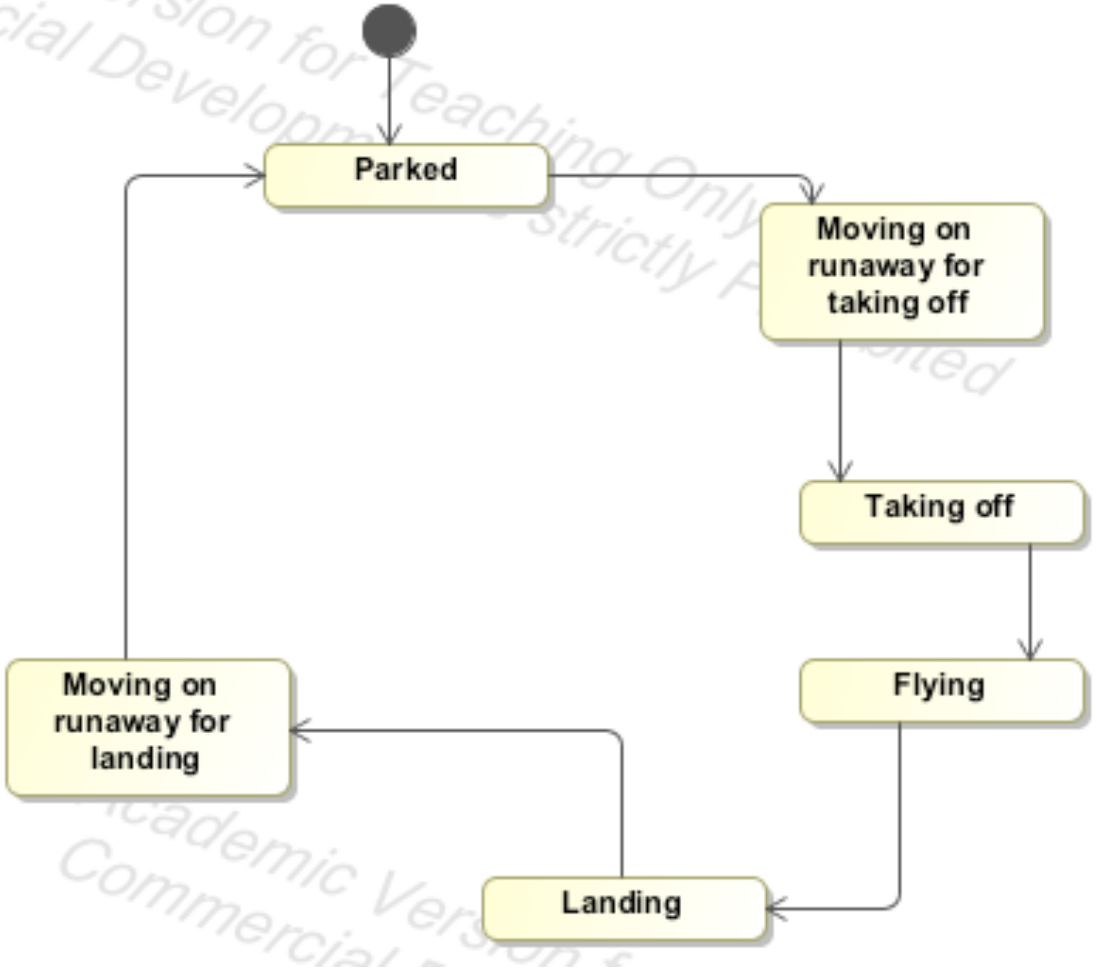
Modeling the Airbus braking logic with UML

What can we model?
What not?

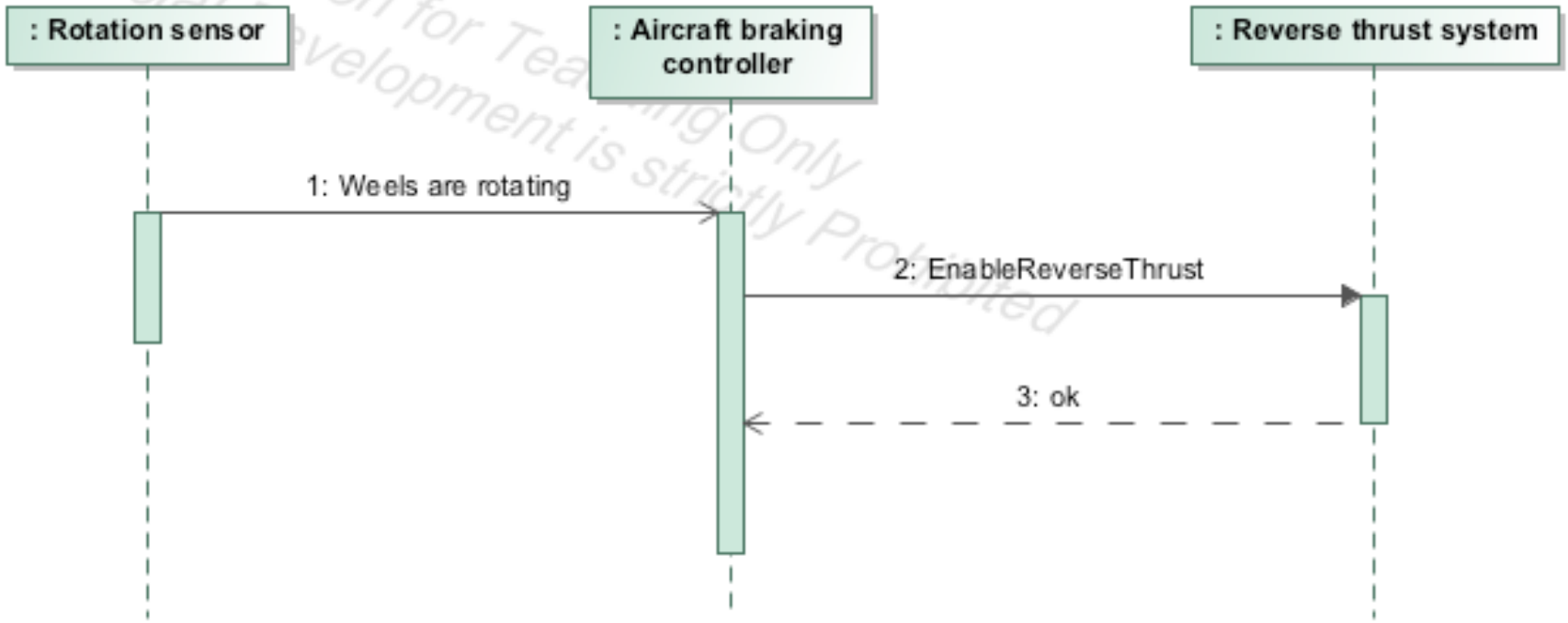
Domain modeling: main entities and relationships



Domain modeling: states of an aircraft



Dynamic behavior: enabling reverse thrust when wheels are rotating



Is the UML spec complete?

- We have described all phenomena
  - Aircraft, wheels, sensor, reverse thrust system
- … and a use case EnablingReverseThrust
- Are we missing something?
- Are we representing goals, domain properties and requirements?
  - Goal
    - Reverse_enabled ⇔ Moving_on_runway
  - Domain properties
    - Wheel_pulses_on ⇔ Wheels_turning
    - Wheels_turning ⇔ Moving_on_runway
  - Requirements
    - Reverse_enabled ⇔ Wheels_pulses_on

Is the UML spec complete?

- Pure UML does not help us in expressing assertions
- We can complement its usage with
  - Some formal or informal description of these assertions

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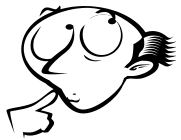
Requirements Analysis and Specification Document (RASD)

RASD

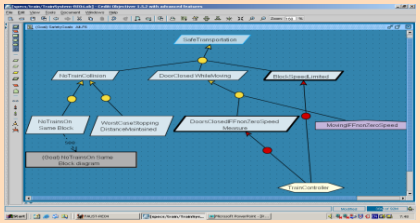
existing systems

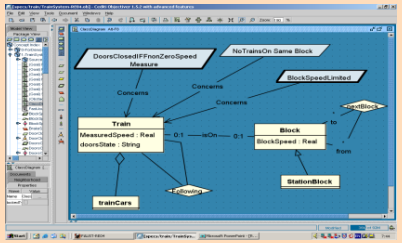
documents

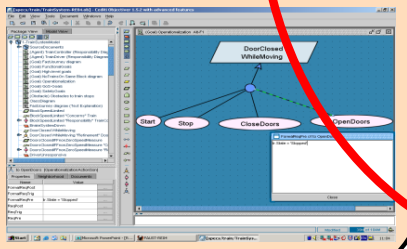
elicitation & modelling



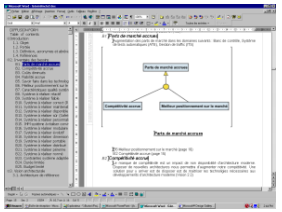
Requirements Models







generation of RE deliverables



requirements document

analysis & validation

Purposes of the RASD

- Communicates an understanding of the requirements
  - explains both the application domain and the system to be developed
- Contractual
  - may be legally binding!
- Baseline for project planning and estimation (size, cost, schedule)
- Baseline for software evaluation
  - supports system testing, verification and validation activities
  - should contain enough information to verify whether the delivered system meets requirements
- Baseline for change control
  - requirements change, software evolves

(slide: Steve Easterbrook)

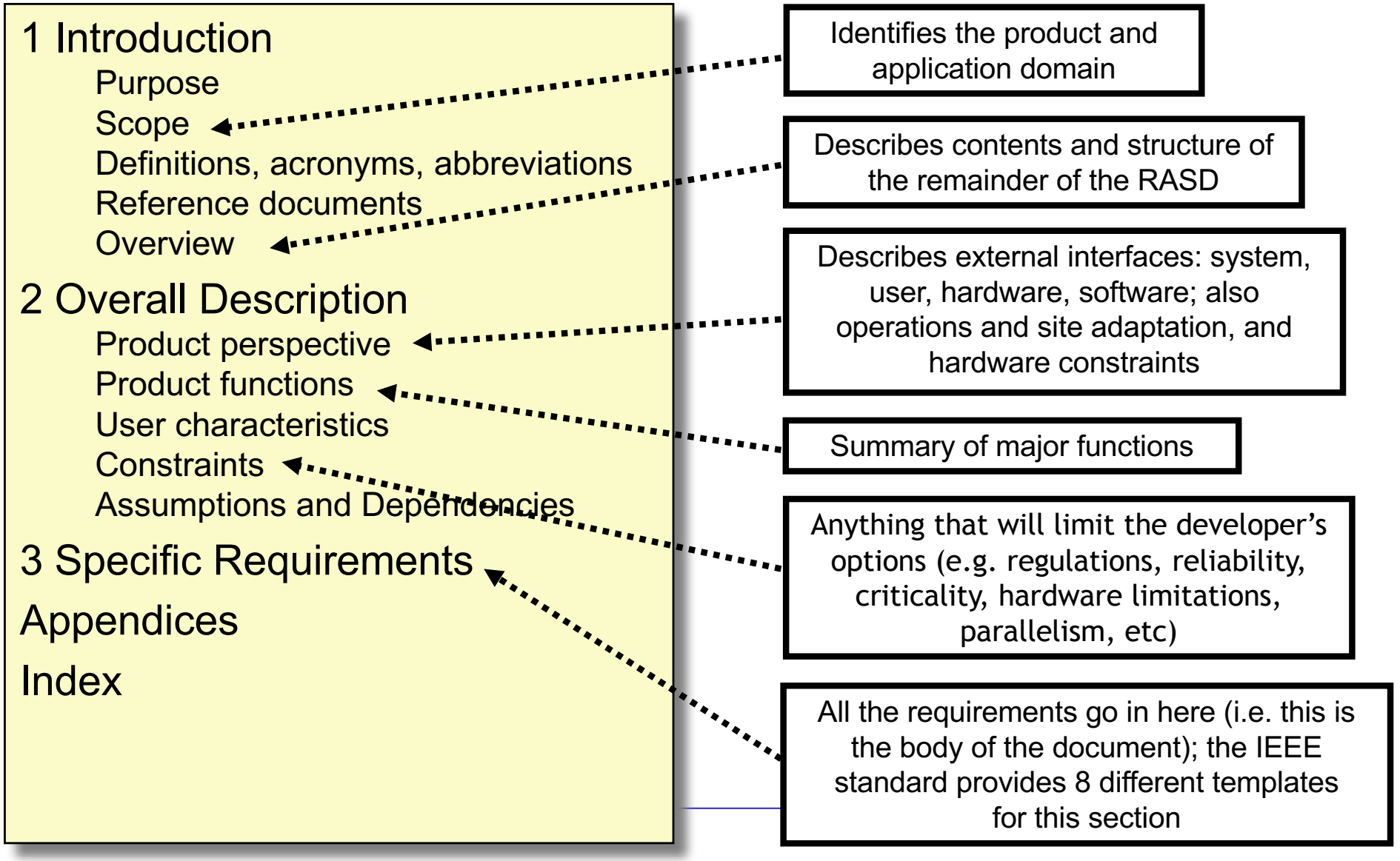
Audience of the RASD

- Costumers & Users
  - most interested in validating system goals and high-level description of functionalities
  - not generally interested in detailed software requirements
- Systems Analysts, Requirements Analysts
  - write various specifications of other systems that inter-relate
- Developers, Programmers
  - have to implement the requirements
- Testers
  - determine that the requirements have been met
- Project Managers
  - measure and control the analysis and development processes

(slide: Steve Easterbrook)

IEEE Standard for RASD

Source: *Adapted from ISO/IEC/IEEE 29148 dated Dec 2011*



(slide: Steve Easterbrook)

IEEE STD Section 3 (example)

Source: *Adapted from ISO/IEC/IEEE 29148 dated Dec 2011*

3.1 External Interface Requirements
- 3.1.1 User Interfaces
- 3.1.2 Hardware Interfaces
- 3.1.3 Software Interfaces
- 3.1.4 Communication Interfaces

3.2 Functional Requirements

this section organized by mode, user class, feature, etc. For example:

3.2.1 User Class 1

3.2.1.1 Functional Requirement 1.1

…

3.2.2 User Class 2

3.2.1.1 Functional Requirement 1.1

…

...

3.3 Performance Requirements

3.4 Design Constraints

3.4.1 Standards compliance

3.4.2 Hardware limitations

etc.

3.5 Software System Attributes
- 3.5.1 Reliability
- 3.5.2 Availability
- 3.5.3 Security
- 3.5.4 Maintainability
- 3.5.5 Portability

3.6 Other Requirements

(slide: Steve Easterbrook)

Target qualities for a RASD (1)

- Completeness
  - w.r.t. goals: the requirements are sufficient to satisfy the goals under given domain assumptions

    Req and Dom |= Goals
    - all Goals have been correctly identified, including all relevant quality goals
    - Dom represent valid assumptions; incidental and malicious behaviours have been anticipated
  - w.r.t. inputs: the required software behaviour is specified for all possible inputs
  - Structural completeness: no TBDs

(slide: adapted from A. van Lamsweerde)

Target qualities for a RASD (2)

- Pertinence
  - each requirement or domain assumption is needed for the satisfaction of some goal
  - each goal is truly needed by the stakeholders
  - the RASD does not contain items that are unrelated to the definition of requirements (e.g. design or implementation decisions)
- Consistency
  - no contradiction in formulation of goals, requirements, and assumptions

(slide: adapted from A. van Lamsweerde)

Target qualities for a RASD (3)

- Unambiguity
  - unambiguous vocabulary: every term is defined and used consistently
  - unambiguous assertions: goals, requirements and assumption must be stated clearly in a way that precludes different interpretations
  - verifiability: a process exists to test satisfaction of each requirement
  - unambiguous responsibilities: the split of responsibilities between the software-to-be and its environment must be clearly indicated

(slide: adapted from A. van Lamsweerde)

Target qualities for a RASD (4)

- Feasibility
  - the goals and requirements must be realisable within the assigned budget and schedules
- Comprehensibility
  - must be comprehensible by all in the target audience
- Good Structuring
  - e.g. highlights links between goals, reqts and assumptions
  - every item must be defined before it is used
- Modifiability
  - must be easy to adapt, extend or contract through local modifications
  - impact of modifying an item should be easy to assess

(slide: adapted from A. van Lamsweerde)

Target qualities for a RASD (5)

- Traceability
  - must indicate sources of goals, requirements and assumptions
  - must link requirements and assumptions to underlying goals
  - facilitates referencing of requirements in future documentation (design, test cases, etc.)

(slide: adapted from A. van Lamsweerde)

RASD: In which sections do we include all we have learnt about requirements?

- The RASD does not necessarily follow the order of our mental process to the requirements
- Section 1
  - Purpose part -> goals
  - Scope part -> analysis of the world and of the shared phenomena
- Section 2
  - Product perspective -> Further details on the shared phenomena and a domain model (class diagrams and statecharts)
  - Product functions -> Requirements
  - User characteristics -> Anything that is relevant to clarify their needs
  - Assumptions and dependencies -> Domain assumptions

RASD: In which sections do we include all we have learnt about requirements?

- Section 3
  - More details on all aspects in Section 2 if they can be useful for the development team
  - Section 3.2 -> Definition of use case diagrams, use cases and associated sequence/activity diagrams

A note on traceability

- Use cases are related to some requirements
- Keep track of this relationship through proper identifiers
  - E.g. RE.3 is associated to UC.3.1 and UC.3.2
- We may also have use cases that refer to multiple requirements
  - E.g., UC.3.1 may refer also to RE.2
    - …even thought the main relationship is with RE.3
  - Make this explicit in the presentation
    - E.g., you could build a traceability matrix

Traceability matrix

Raw ID	Goal ID	Req ID	Use Case ID	Comments
r1	G.1	RE.3	UC.3.1	
r2	G.1	RE.2	UC.3.1	

- This may grow during the development process, example:

Raw ID	Goal ID	Req ID	Use Case ID	Test case ID	Comments
r1	G.1	RE.3	UC.3.1	TC.3.1.1	
r2	G.1	RE.2	UC.3.1		

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