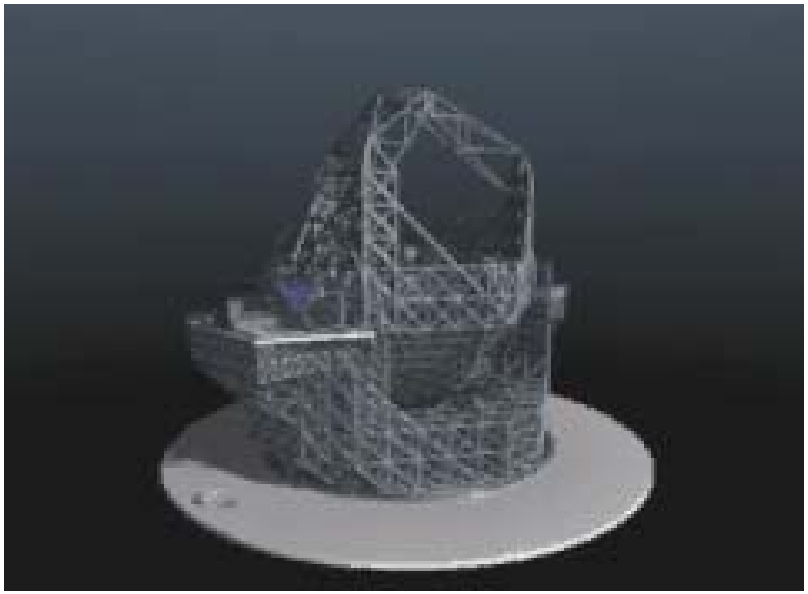
SysML for Telescope System Modeling



SysML for Telescope System Modeling Proceeding I – 2008-10-01

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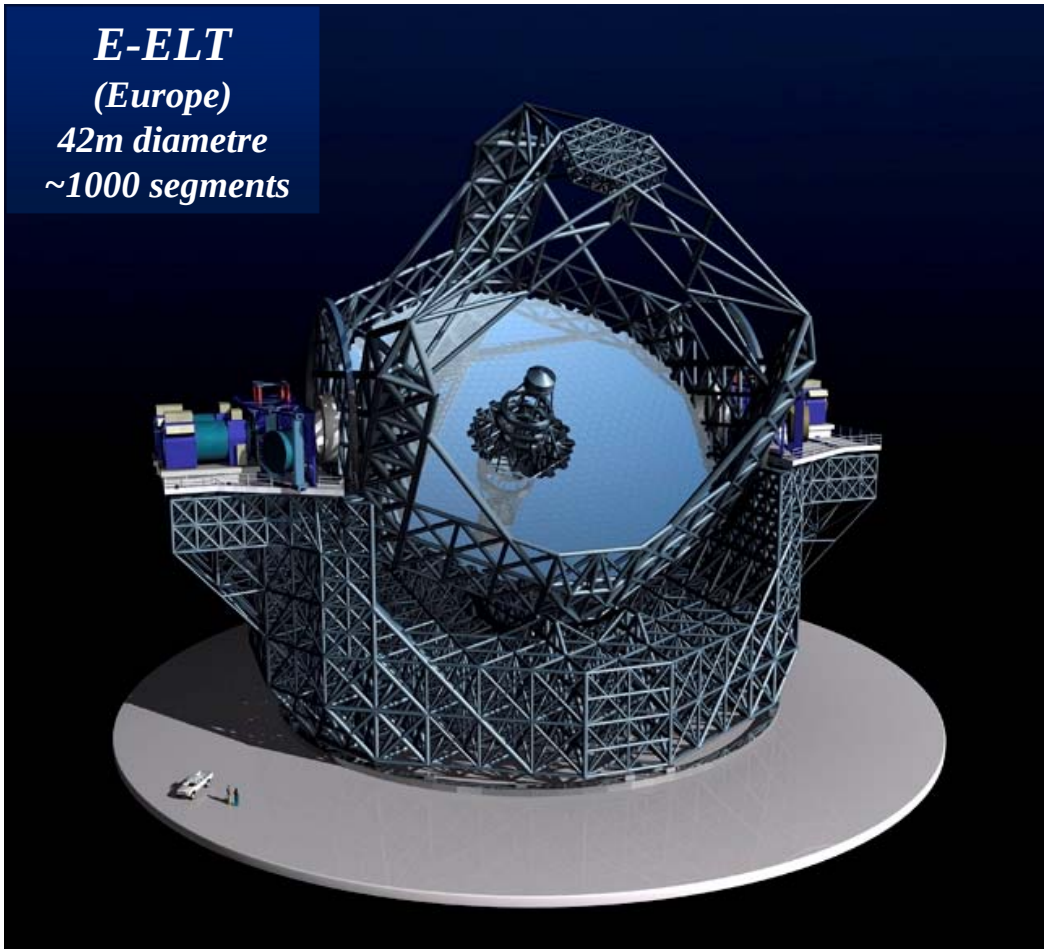
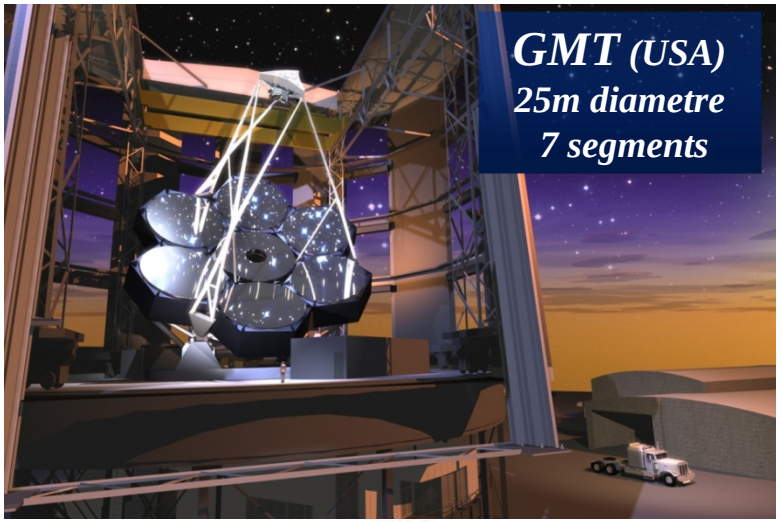
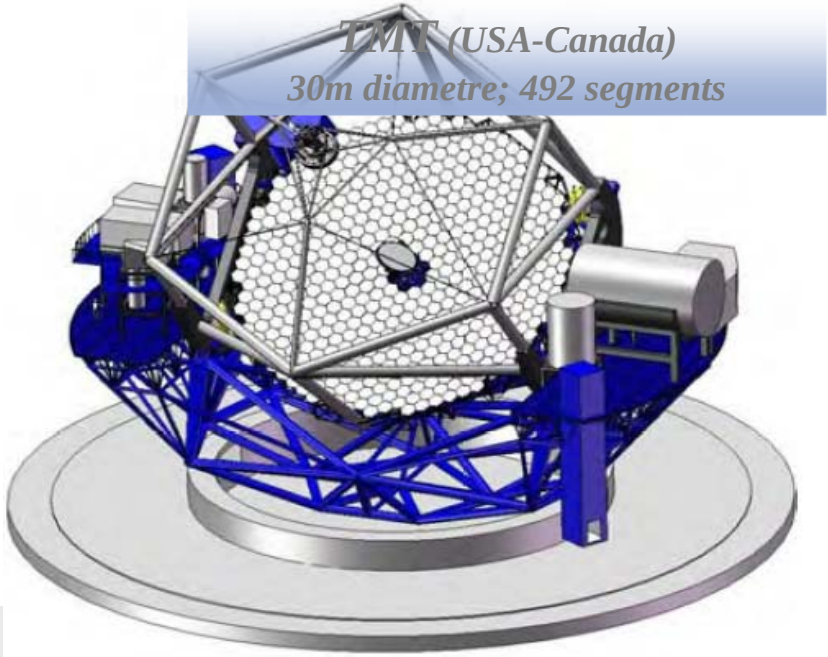
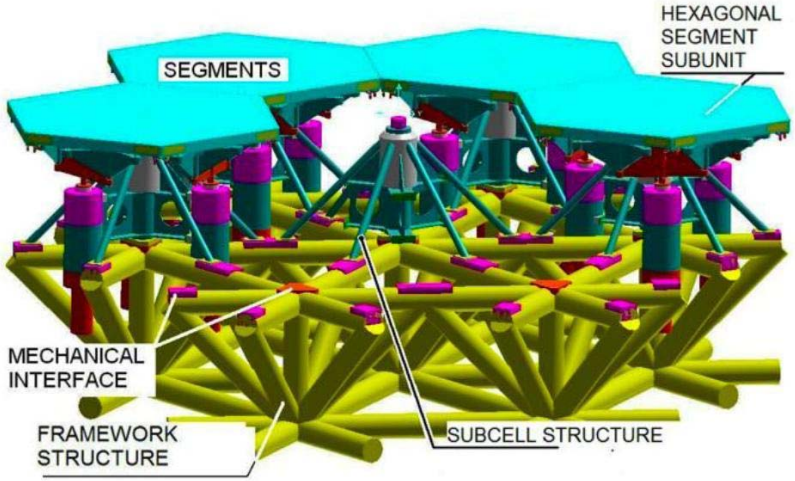
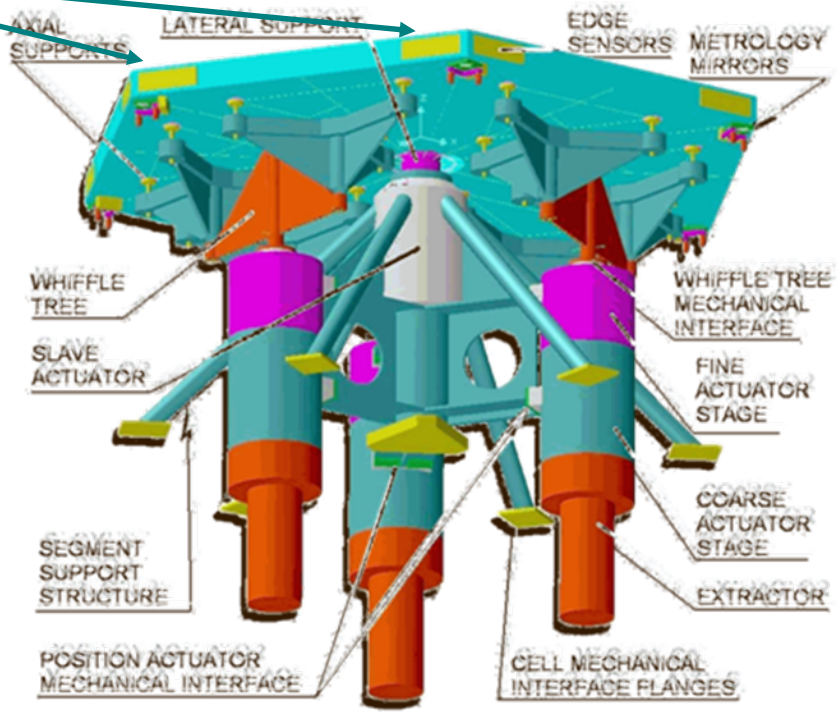




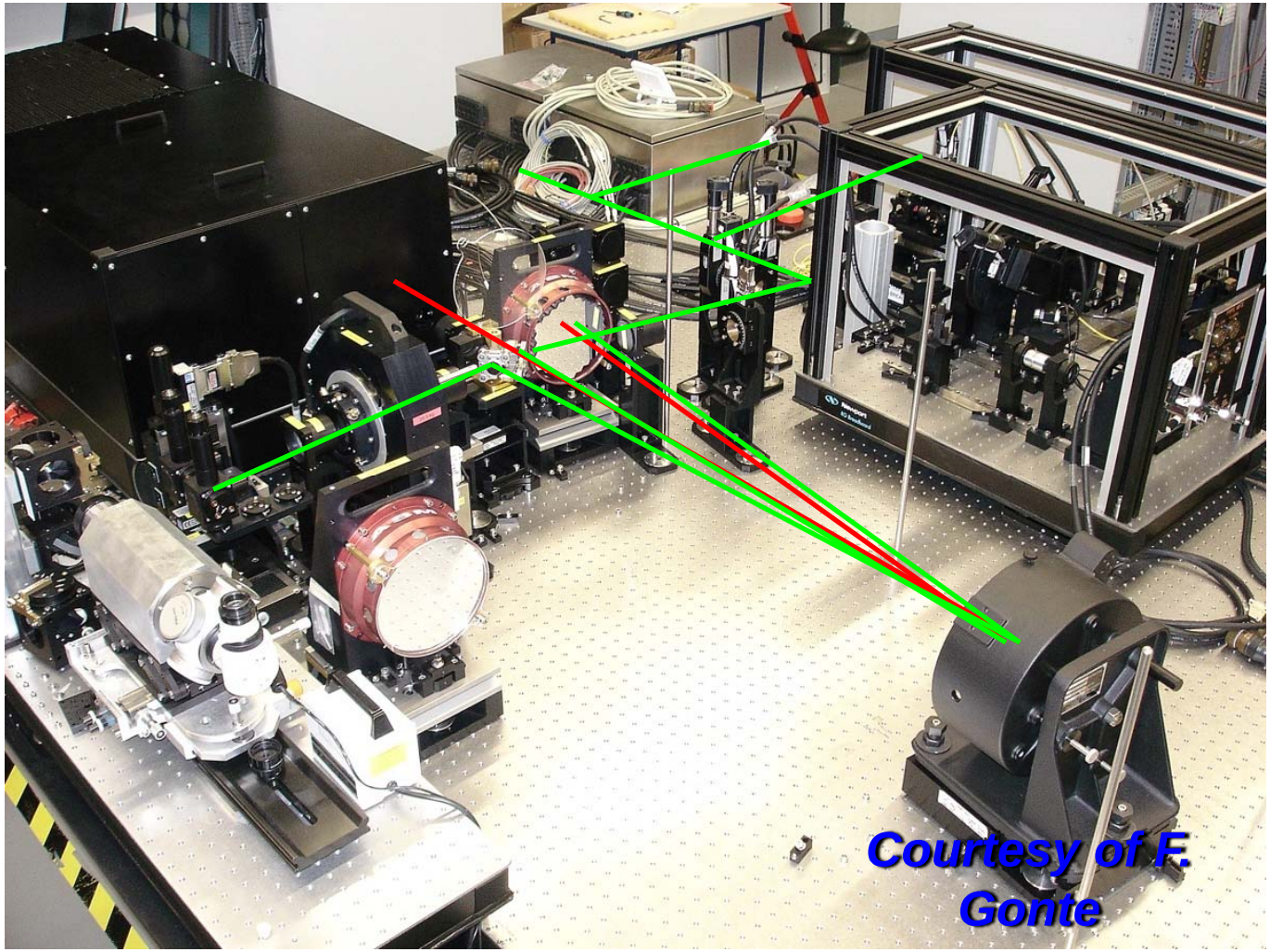


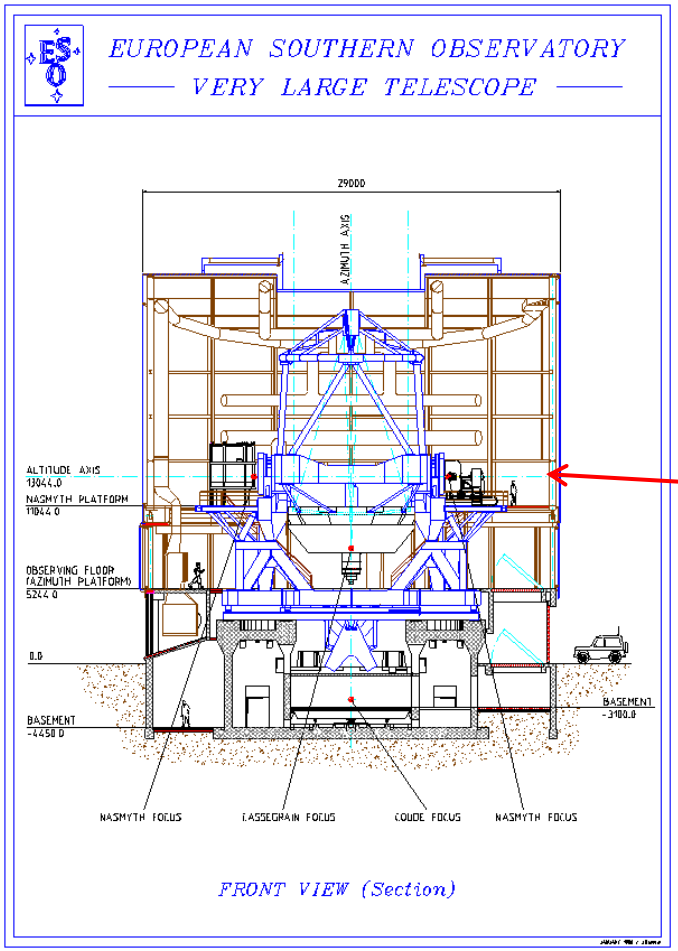
Edge Sensors

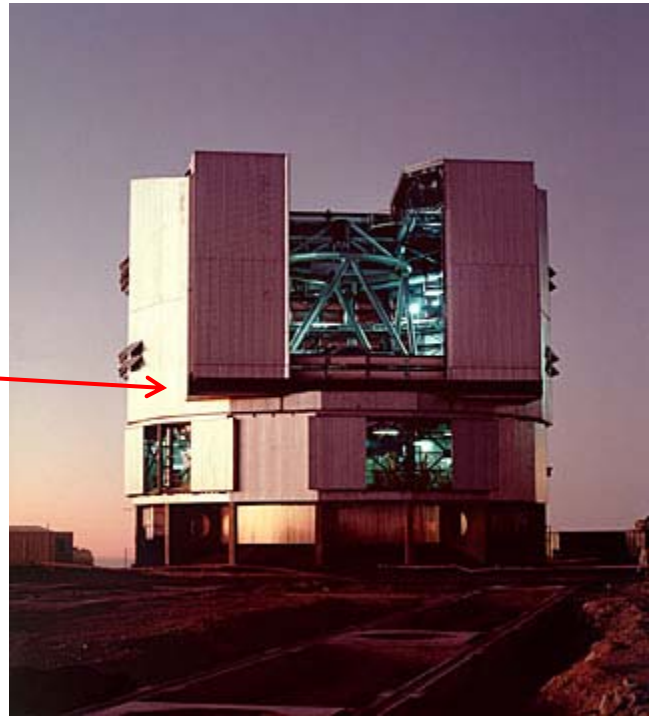




Detect nanometers of phasing error in micrometers of turbulence with Phasing Wave Front Sensors (~20 nm RMS)







APE will be installed at the telescope in the Chile desert.

Deliverables:
Generic SysML modelling FAQ: Excerpt 1/2

- General modeling guidelines
  - How should I name model elements?
  - What rules should I follow when creating diagrams
  - How should I document the model?
  - How do I use different types of annotations in the model?
  - How should I structure the model by using packages?
  - How do I include external references?
- Guidelines for necessary system models and aspects
  - What system views should my (structural) model contain?
  - How many levels of abstraction do I need?
- Guidelines for modeling the system requirements
  - How should I use dependency matrices?
  - How do I model relationships between requirement and design element?

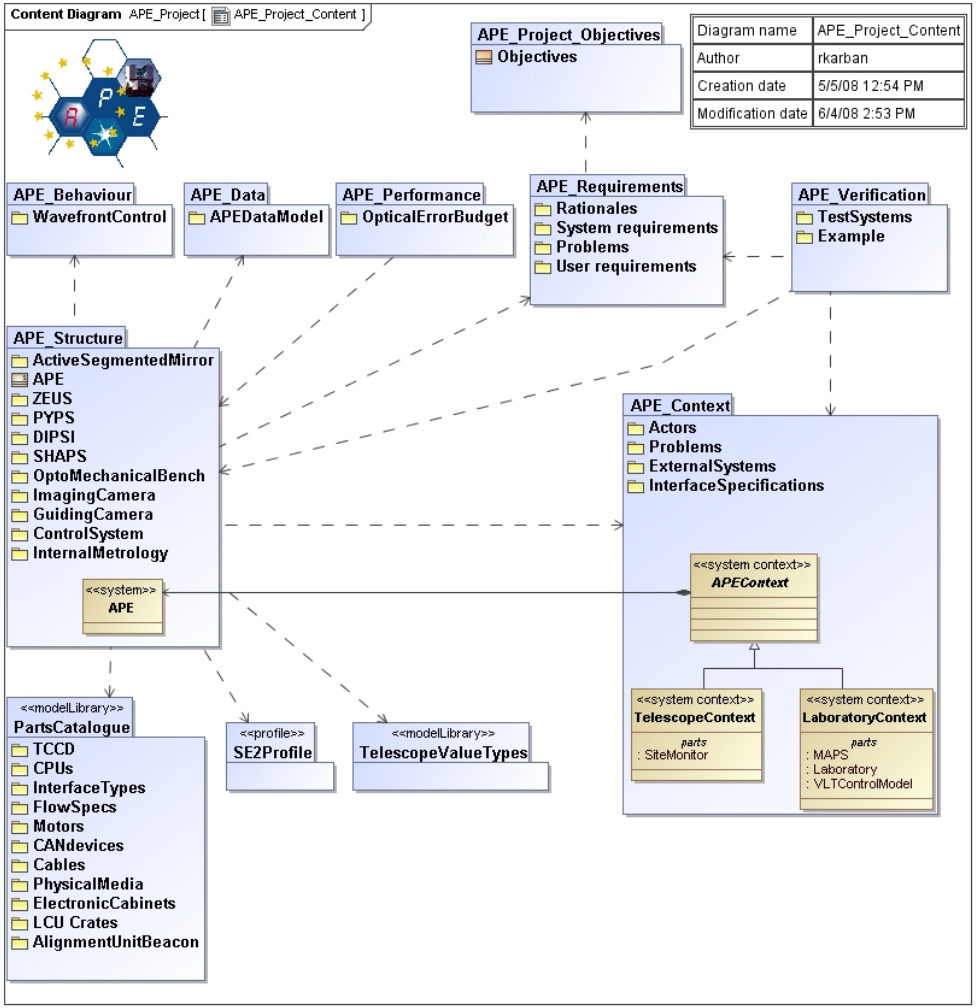
Deliverables:
Generic SysML modelling FAQ: Excerpt 2/2

- Guidelines for modeling the system structure
  - How do I distinguish a sub structure and an assembly?
  - How do I model different contexts?
  - Where do I put systems which are part of the project and needed in different contexts but nor part of the system itself?
  - When should I use block, data or value types?
  - How do I model re-usable parts, like a catalogue of building blocks?
  - Where do I put (new) domain specific model elements, like stereotypes?
  - How do I model domain specific values and types?
  - How do I model design variants?
  - How do I define system hierarchies?

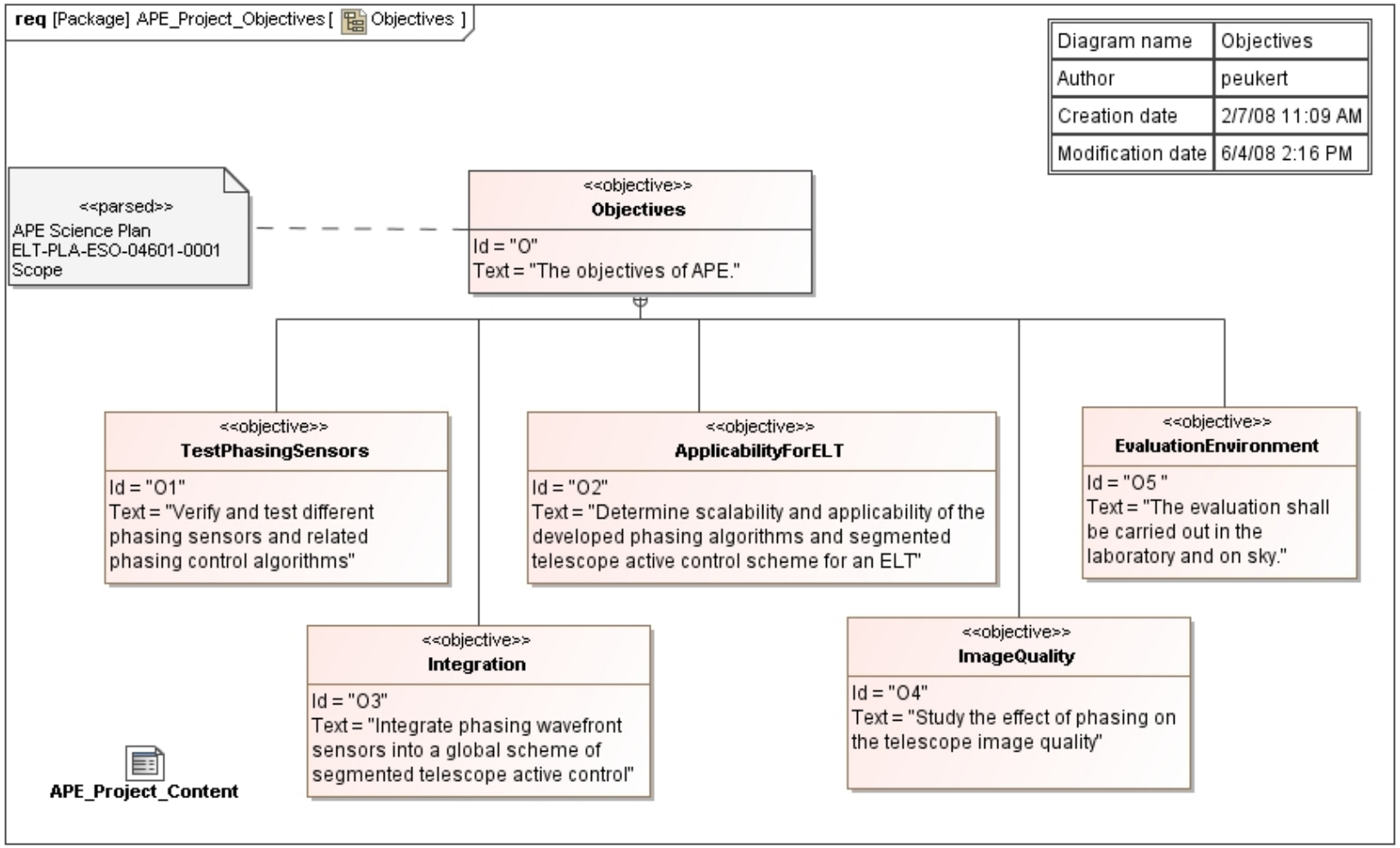
Deliverables:
SysML model for the APE project

- Three major model parts:
  - Actual system model: APE (with all mentioned system aspects)
  - Catalogue model: standard parts, library of block prototypes
  - Modelling profile: additional stereotypes
- Main characteristics:
  - Scalable model structure and organisation
  - Includes model annotations, external references
  - Various examples of ports and flows to model interfaces
- Abstraction levels
  - Functional, Structural, Deployment
- Preliminary results are available at **http://mbse.gfse.de**

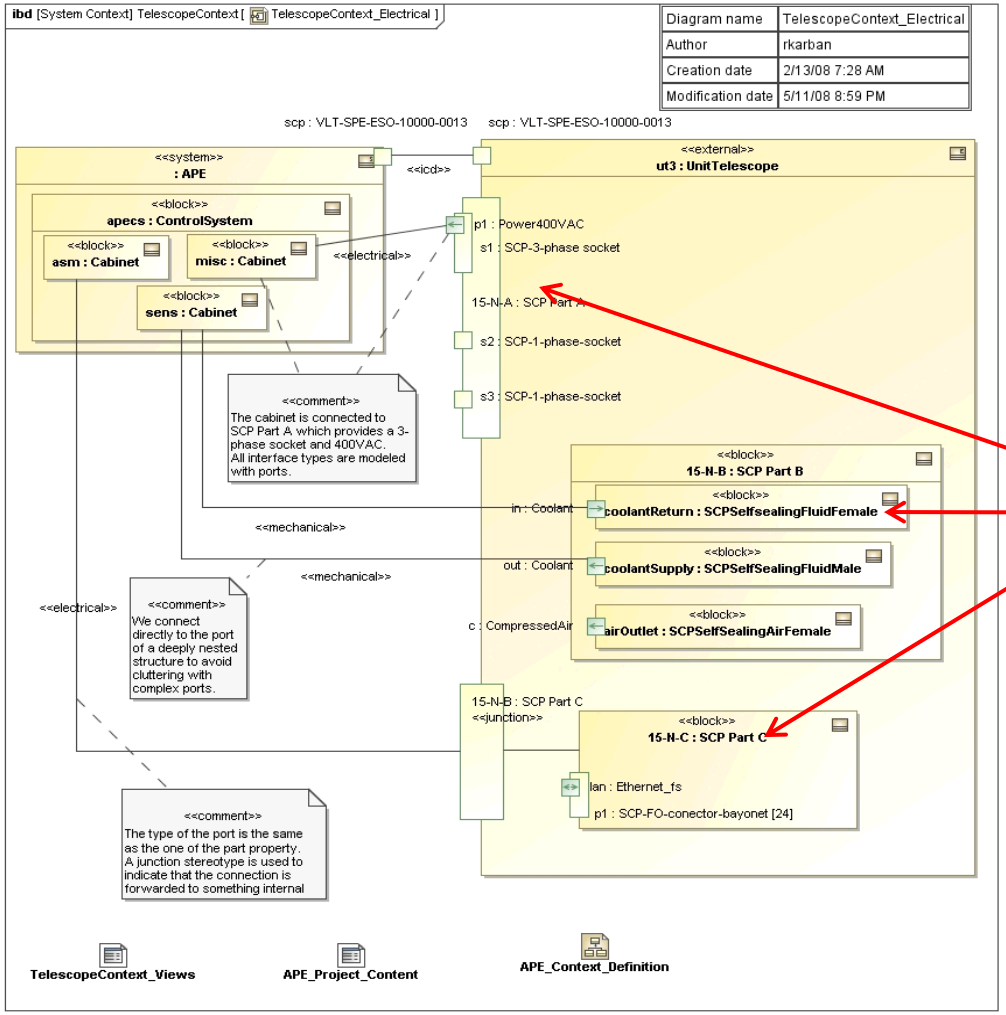
APE project : Overview



APE project: Objectives / requirements



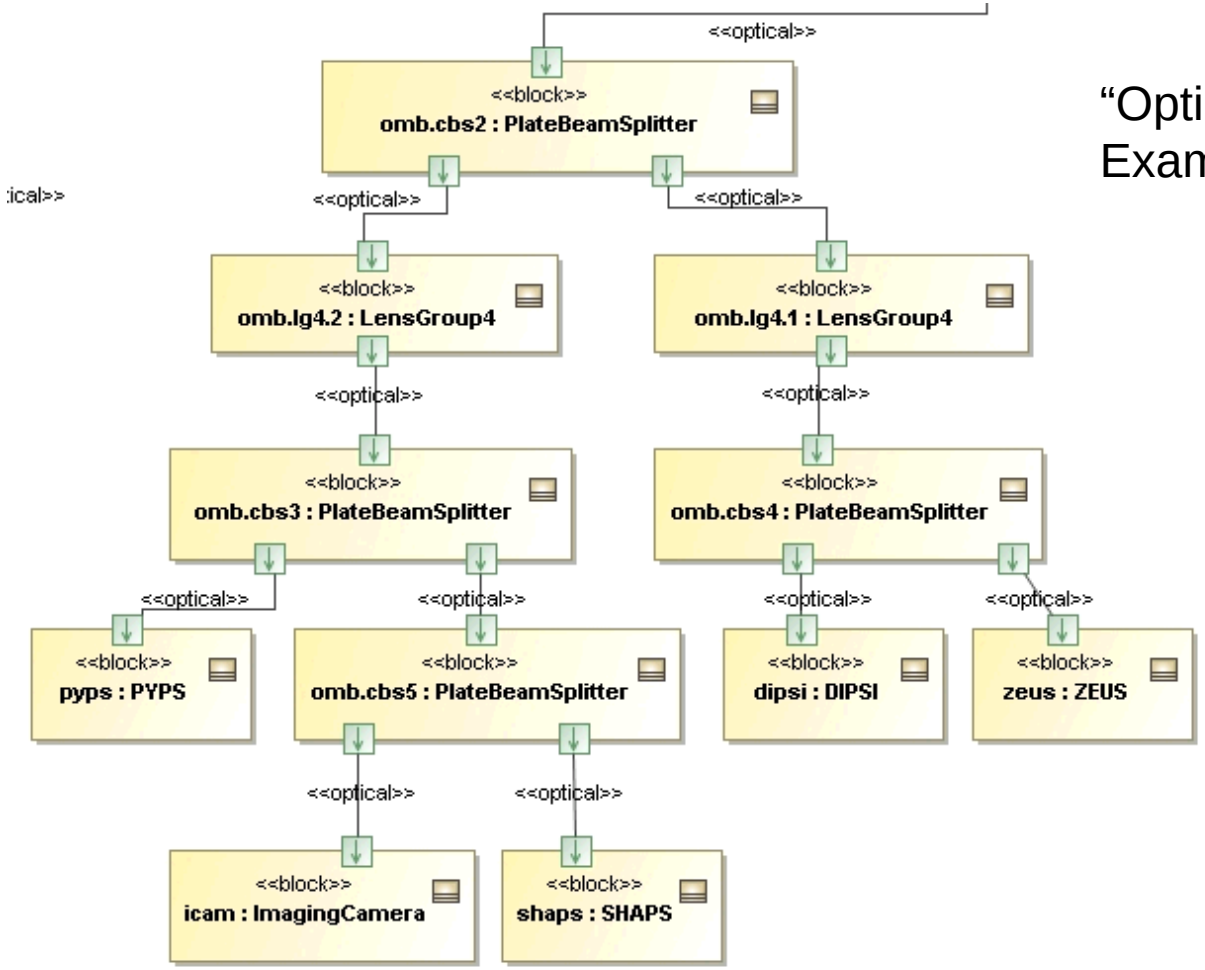
APE system model: System context



3 modeling approaches for interfaces

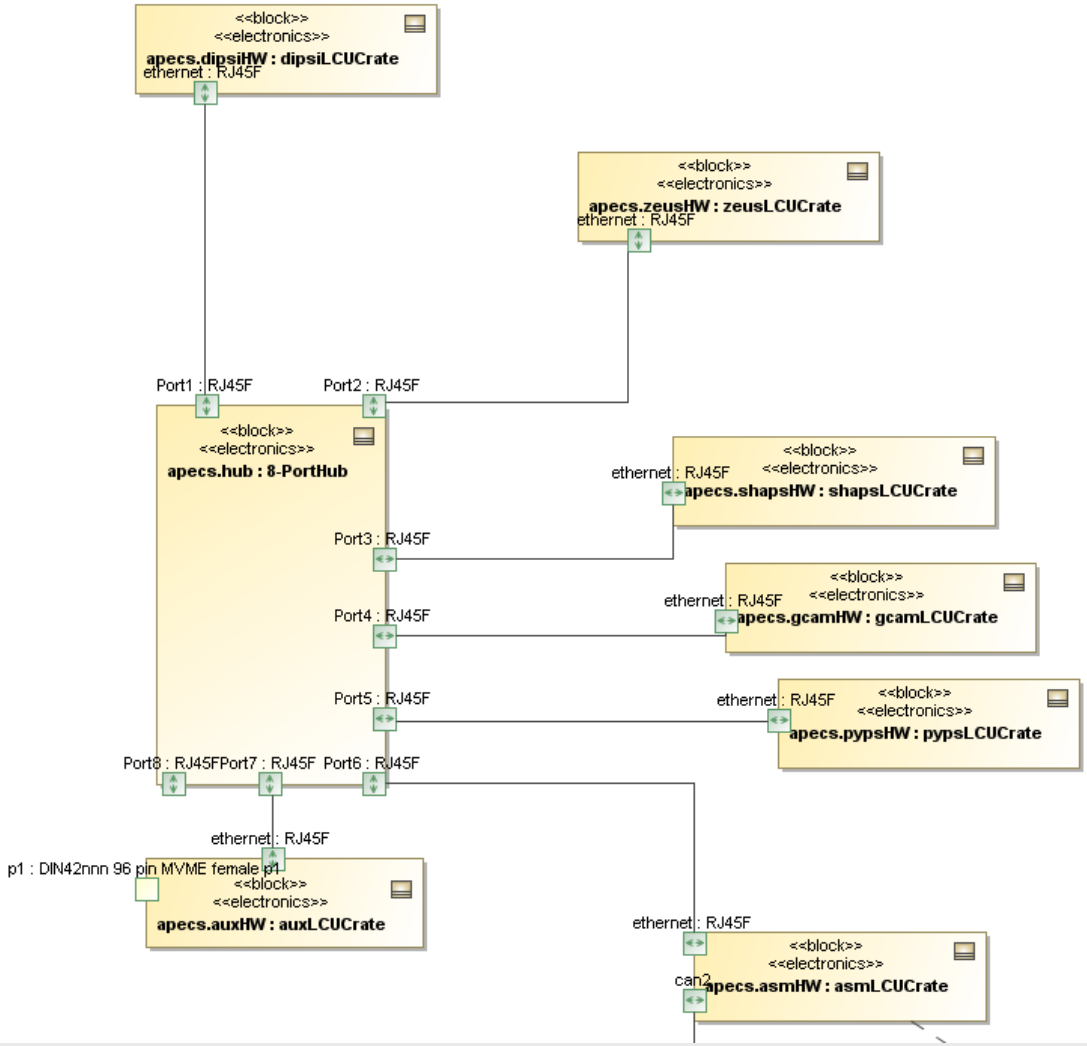
➔ treated later in challenges

APE system model: Structure: Internal structure



"Optical view" of APE:
Example for using nested parts

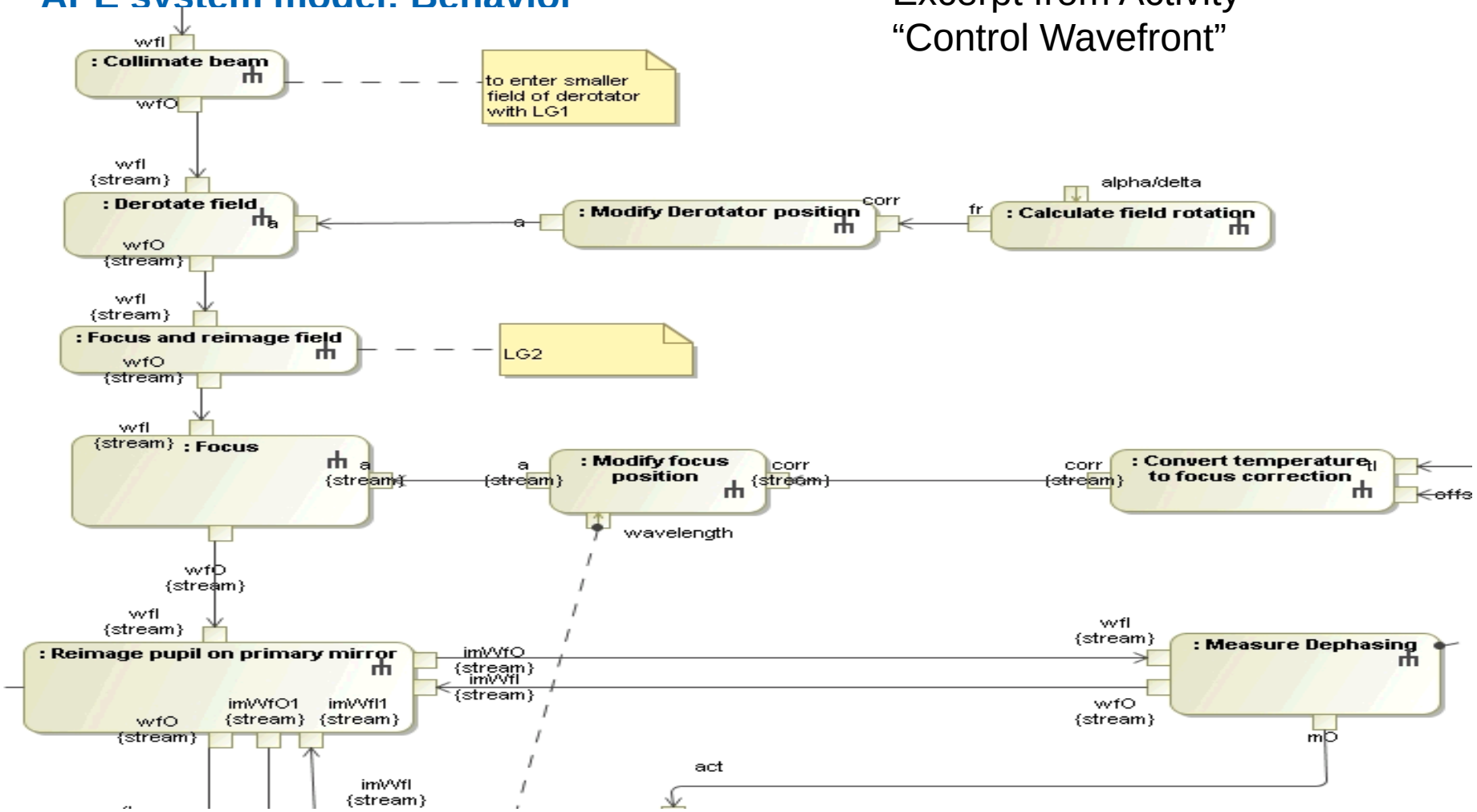
APE system model: Structure: Internal structure



"Electrical view" of APE

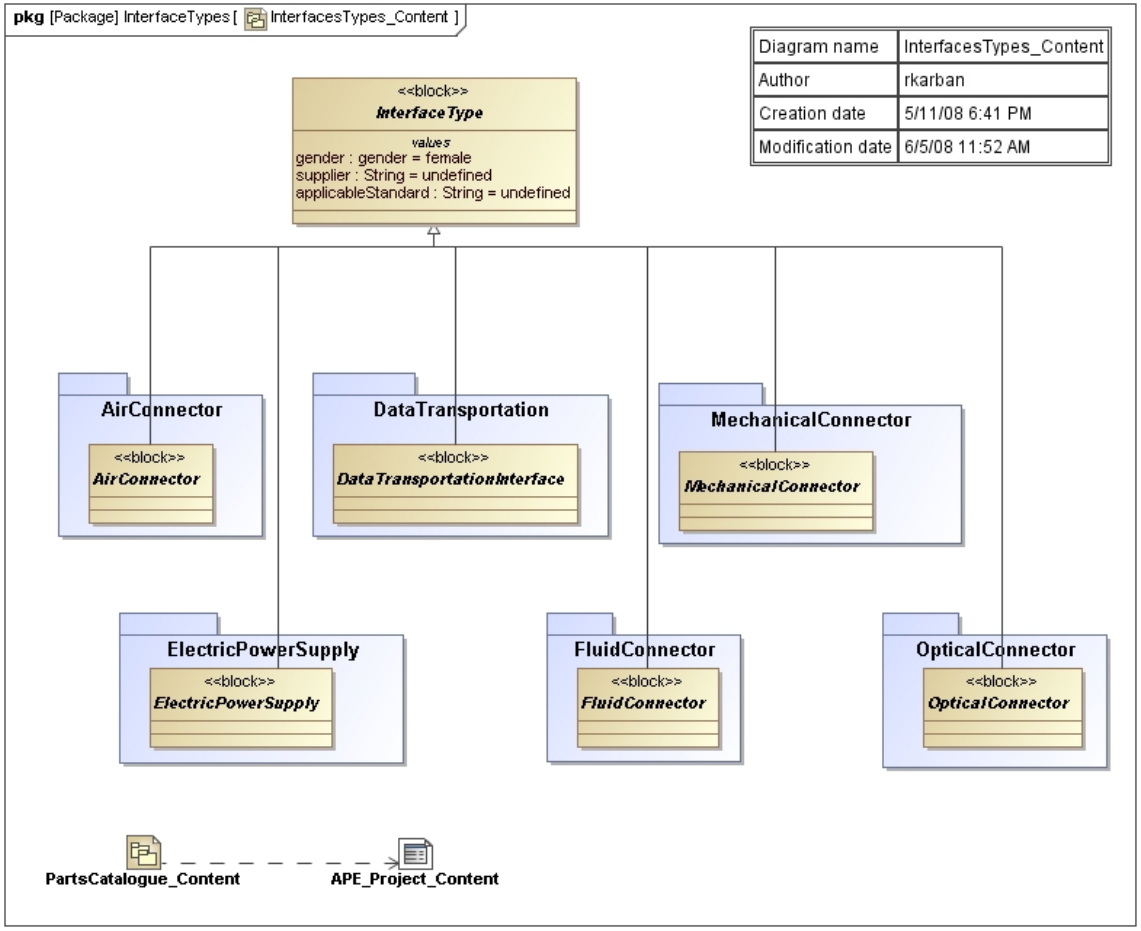
APE system model: Behavior

Excerpt from Activity
“Control Wavefront”



Catalogue model: Abstract types

Example for catalogue:

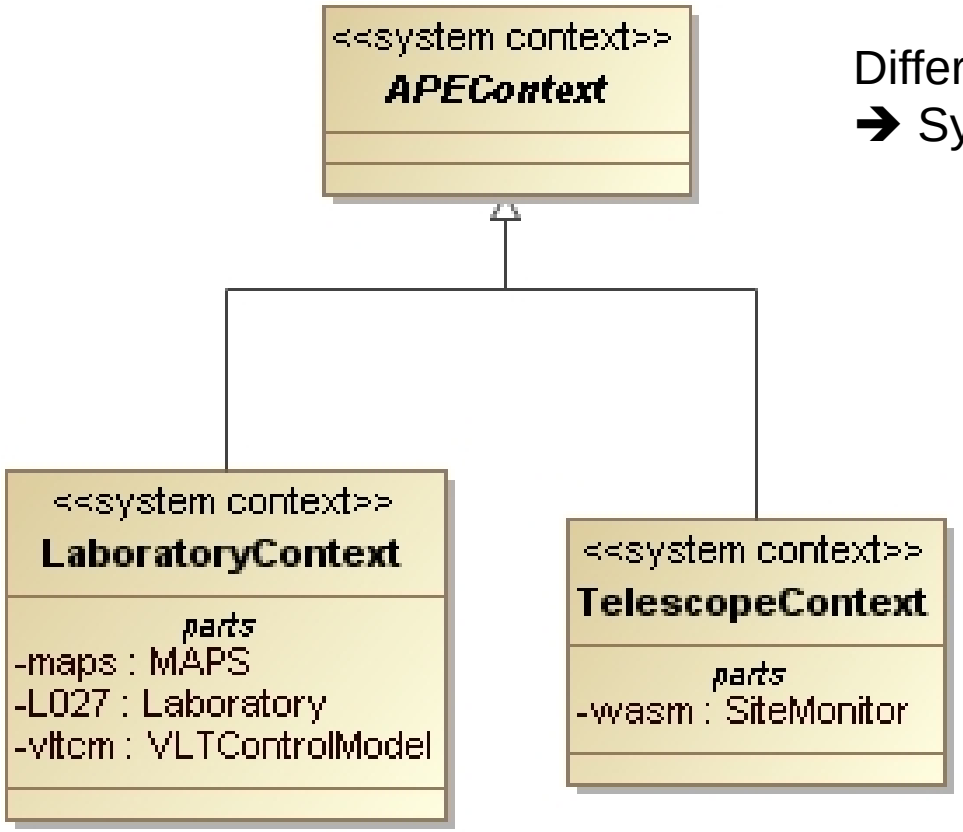


Challenges identified at IS08

- **Variant modeling**
- **Connection of nested blocks**
- **Grouping of interfaces with nested ports**
- **Logical vs. Physical decomposition**
- **Functional multi-layer abstraction**
- **Reuse of blocks, allocation and instances**
- Structural multi-layer abstraction
- Defining Quality of Service (QoS)
- Transition to UML for software
- Usage of name spaces
- Configuration Control
- Navigability

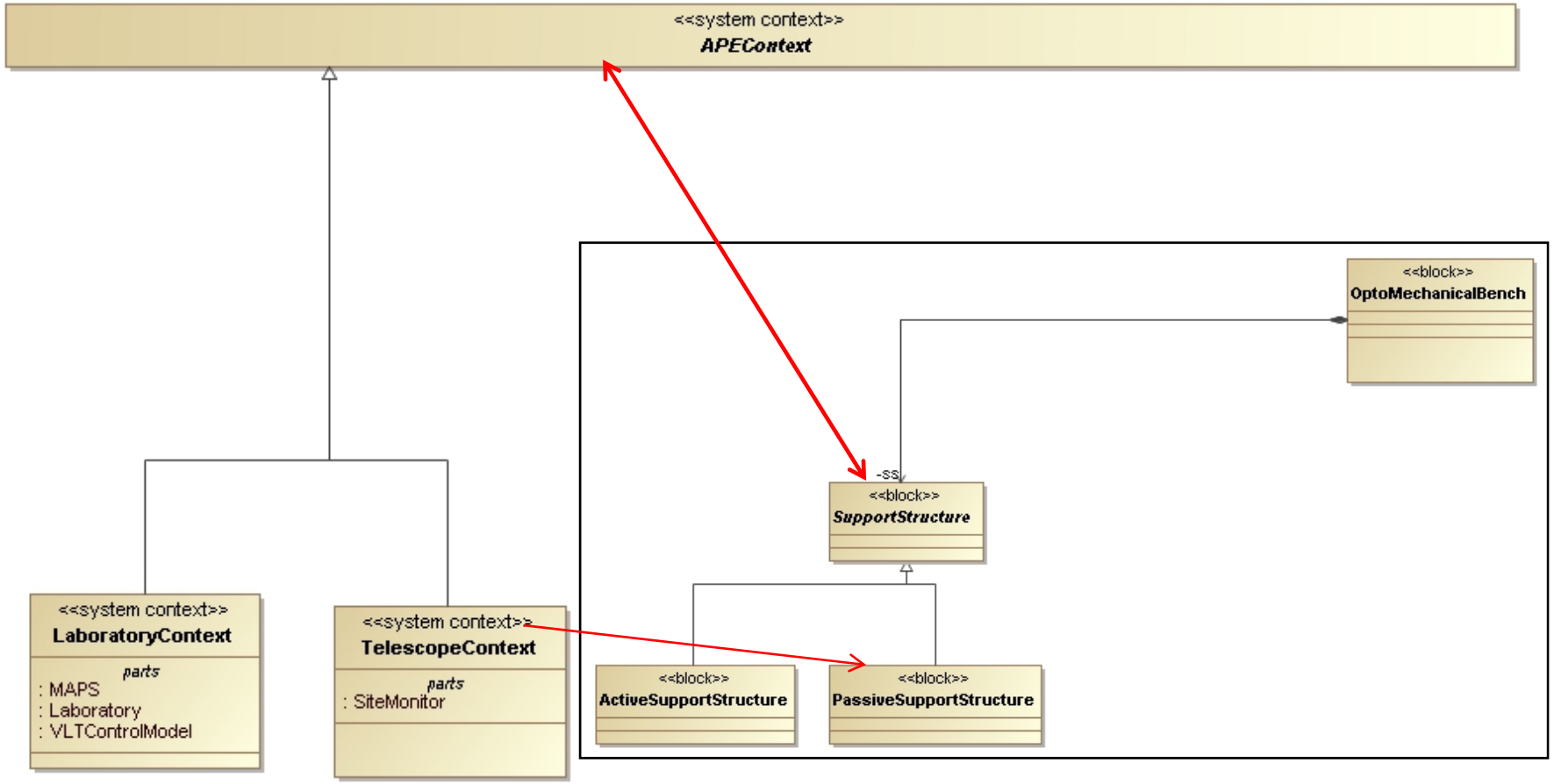
Note: *Order has no meaning, e.g. priority*

SysML challenge: Variant modeling – Example (1/2)

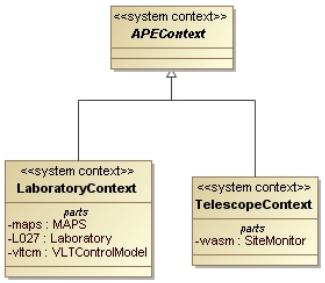


Different contexts imply different design
➔ System variants

SysML challenge: Variant modeling – Example (2/2)



SysML challenge: Variant modeling – Characteristics



Notion

- It‘s an objective of SysML to support evaluation of different system
- Variants are common in system modeling, e.g. different deployment, allocation, connection, parts

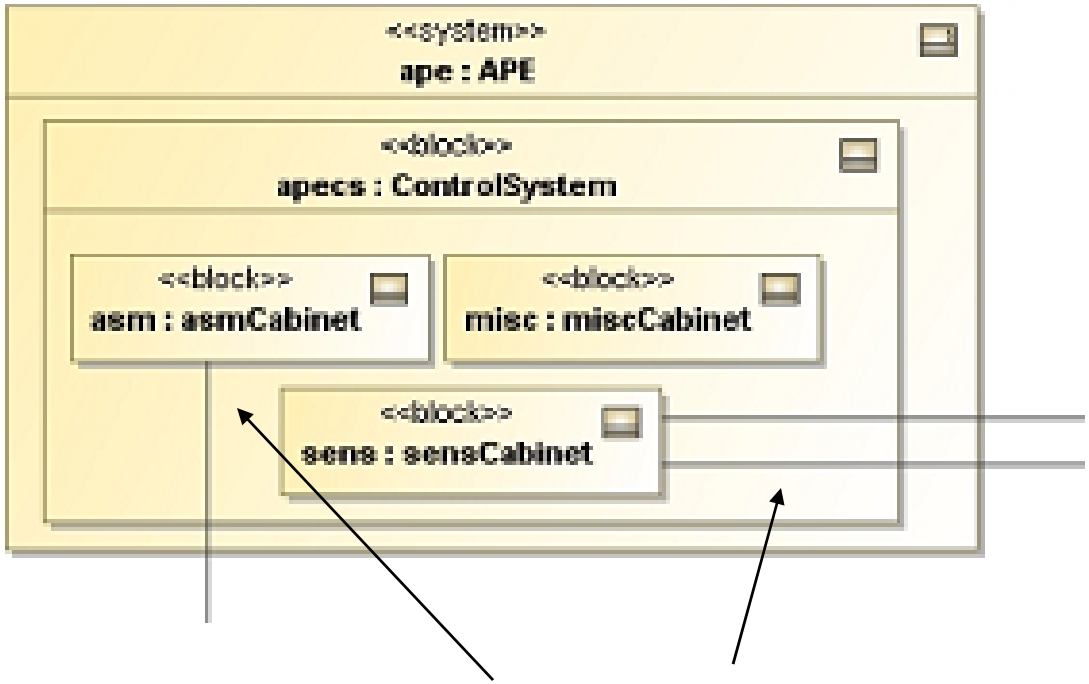
How to

- Generalization
- Profile with stereotypes for variants.
- Tags for identifying parts and associated variants

SysML status

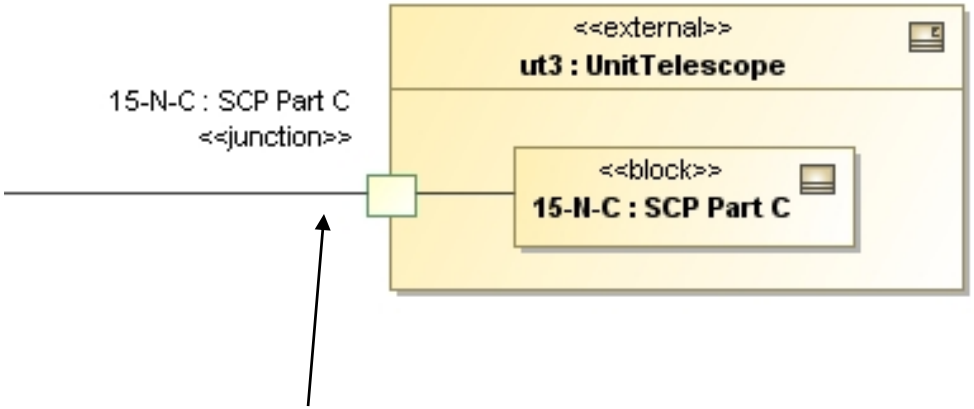
- Variant modeling is not officially supported by OMG SysML 1.1.
- Intentionally left out in OMG SysML.
- Planned feature for OMG SysML 2.0.

SysML challenge: Connection of nested blocks – Example (1/2)

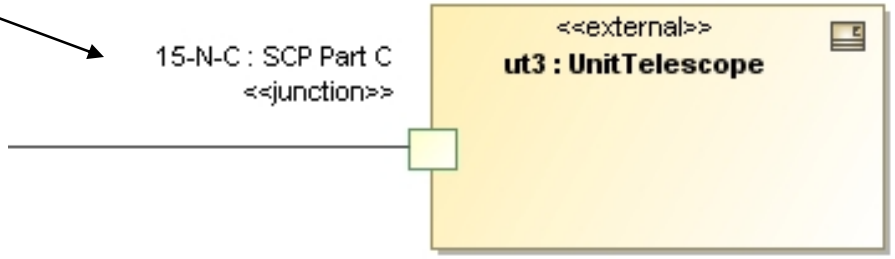


Nested blocks are connected directly with blocks outside.
Problem: Hiding internal blocks hides also the relationships.

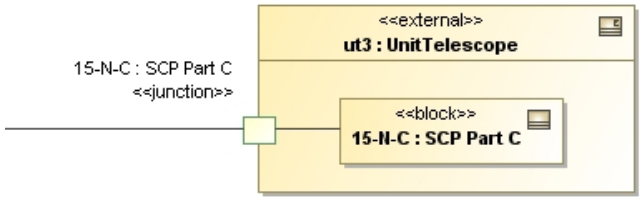
SysML challenge: Connection of nested blocks – Example (2/2)



Use a junction port as a proxy for the internal block.
Hiding nested blocks doesn‘t effect the relationships.



SysML challenge: Connection of nested blocks – Characteristics



Notion

- It must be possible to hide nested blocks without loosing the view on their relationships to external blocks.

How to

- Use ports with stereotype as a proxy for a nested block.

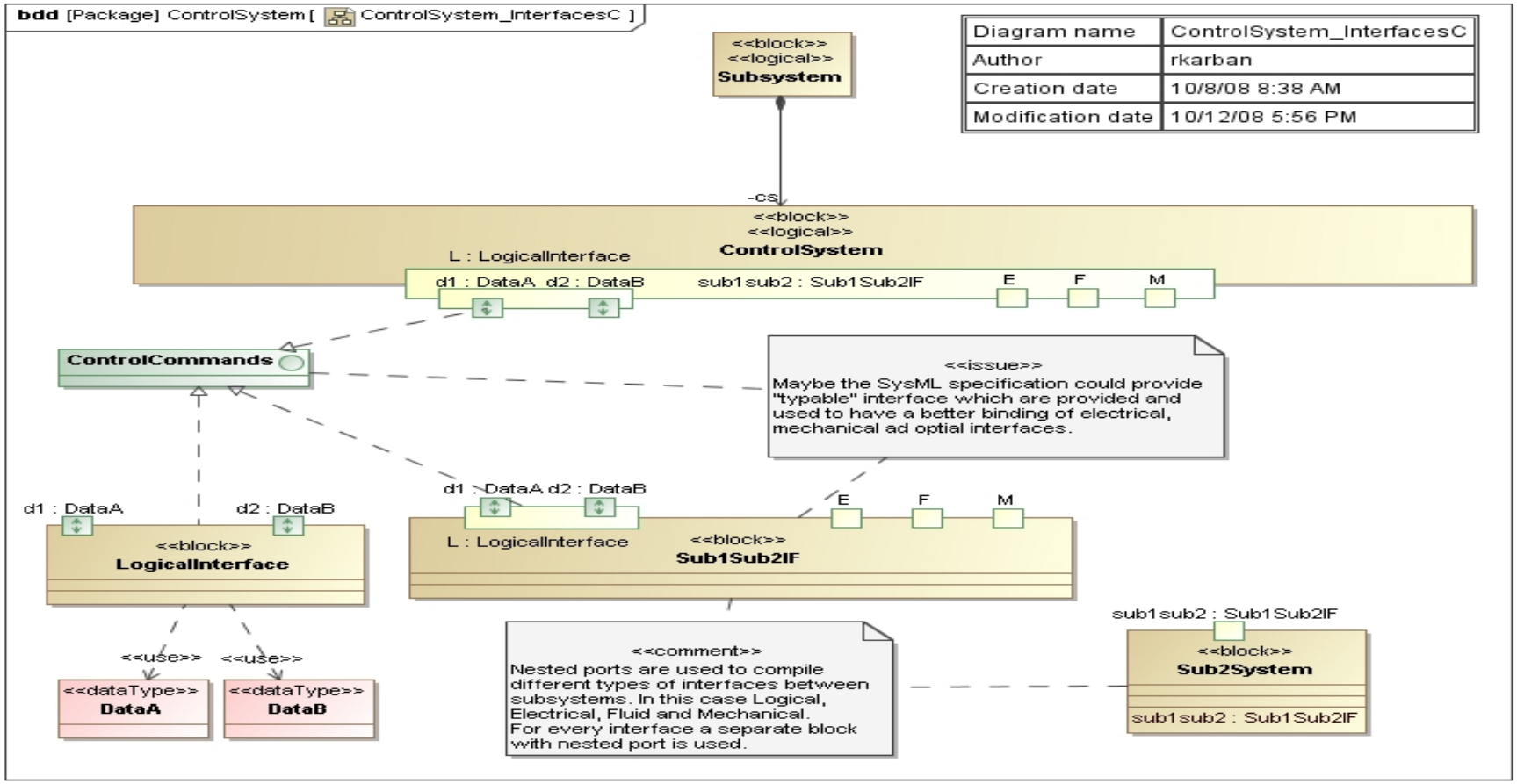
Problem

- Text of stereotypes clutters the diagram. Symbol for junction port is needed

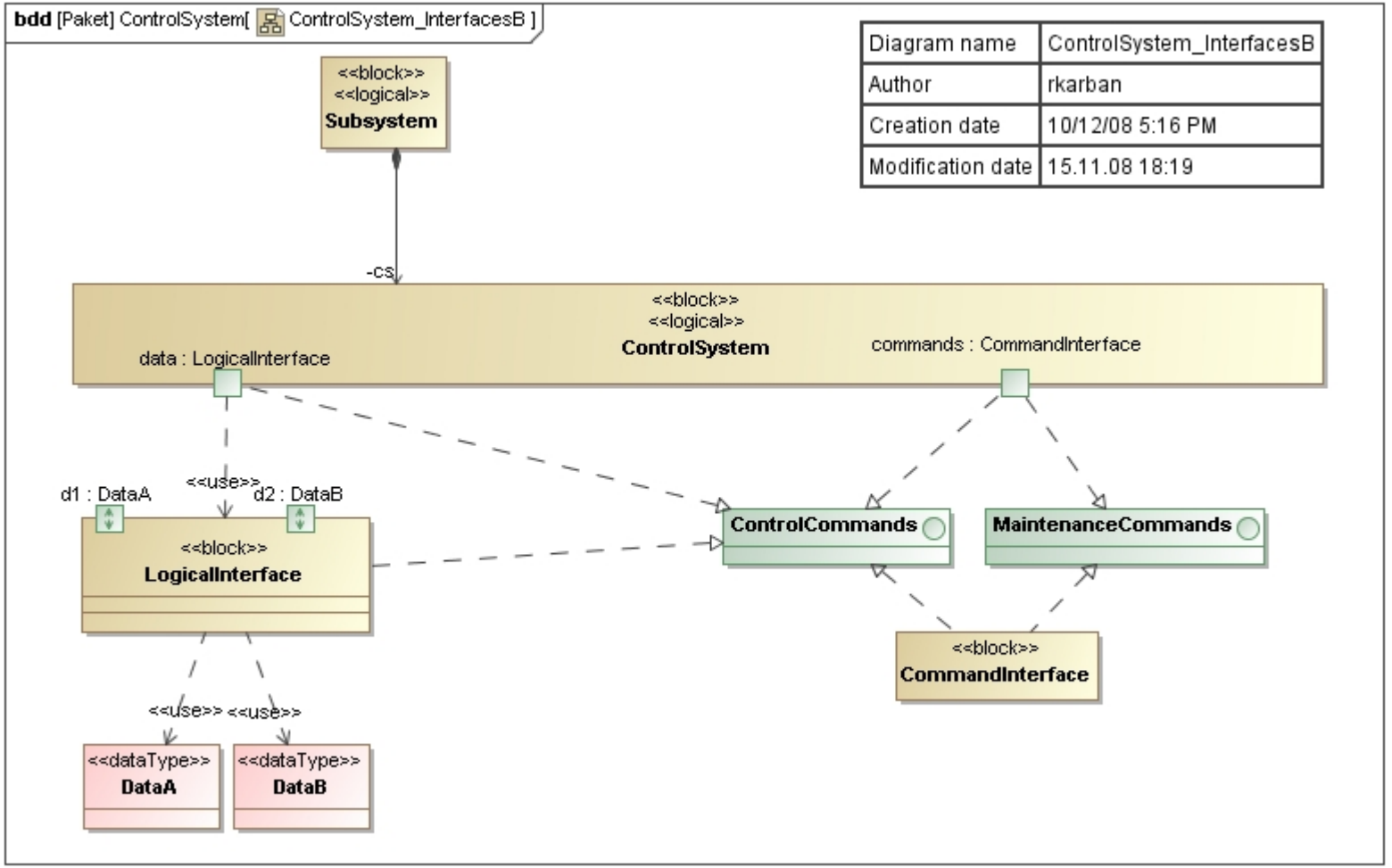
SysML status

- The probelm is recognized by the SysML working group.
- Issue for SysML 1.1, but deferred for future versions.

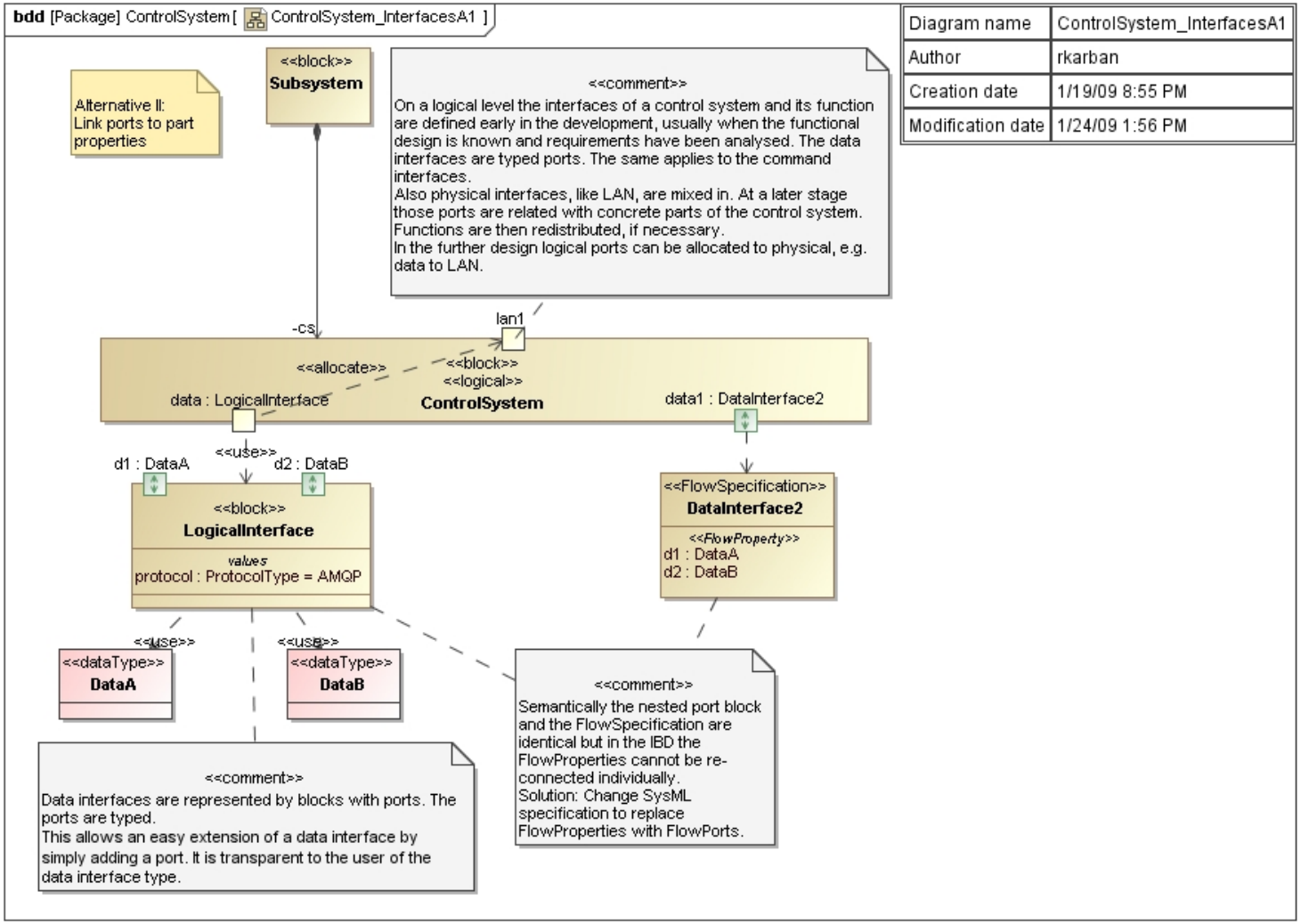
SysML challenge: Grouping of interfaces with nested ports (Example 1/5)



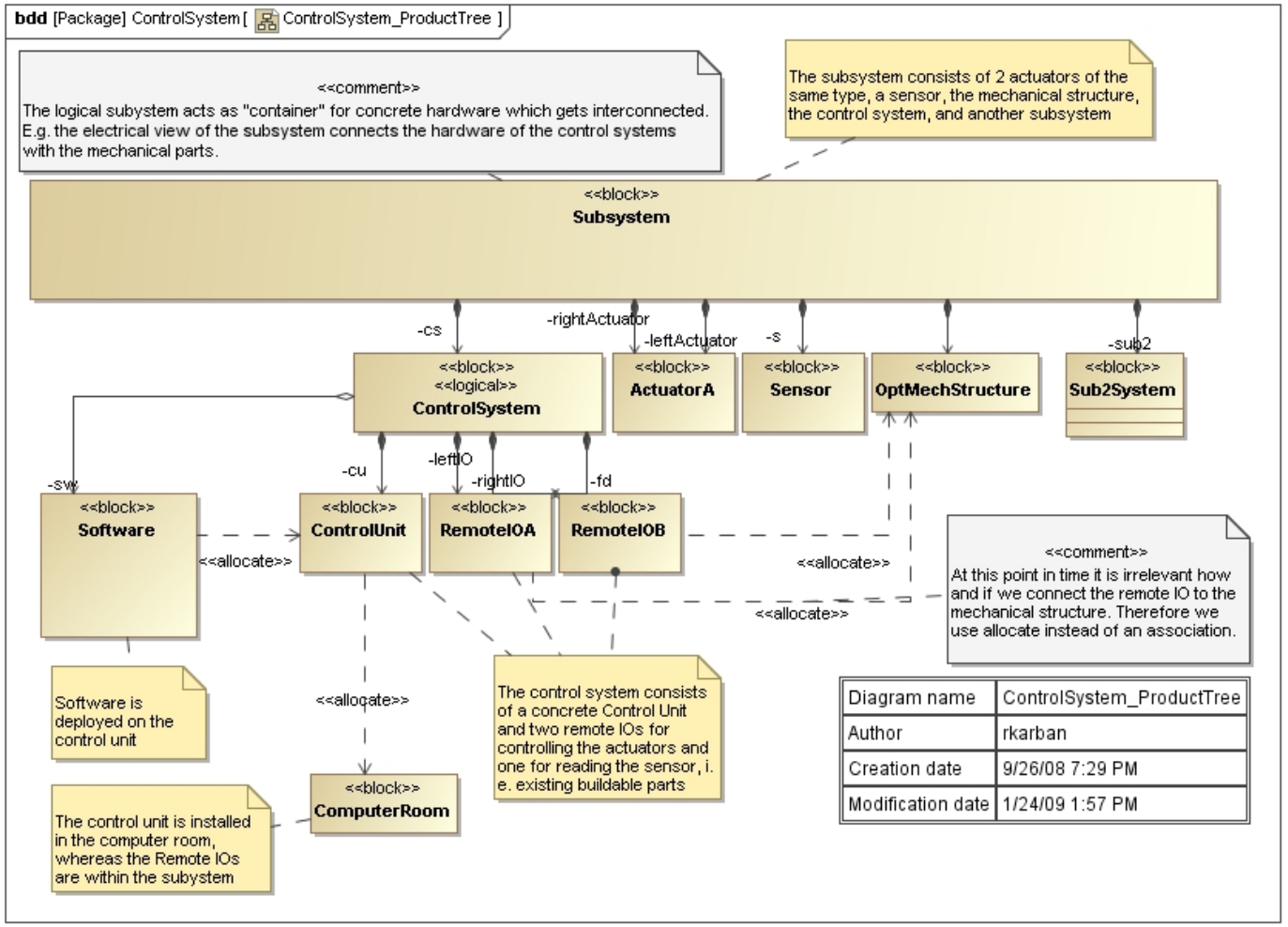
SysML challenge: Grouping of interfaces with nested ports (Example 2/5)



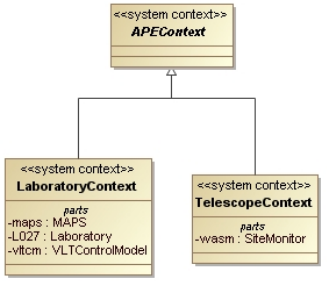
SysML challenge: Grouping of interfaces with nested ports (Example 3/5)



SysML challenge: Grouping of interfaces with nested ports (Example 4/5)



SysML challenge: Grouping of interfaces with nested ports – Characteristics



What to do

- Identify and describe unambiguously interfaces between systems, namely the provided and required part.
- Relay connections from outside to parts inside

How to do

- Create a nested block, which types a port, by grouping ALL interfaces between two components.
- Use FlowSpecifications to model nested, reusable flows

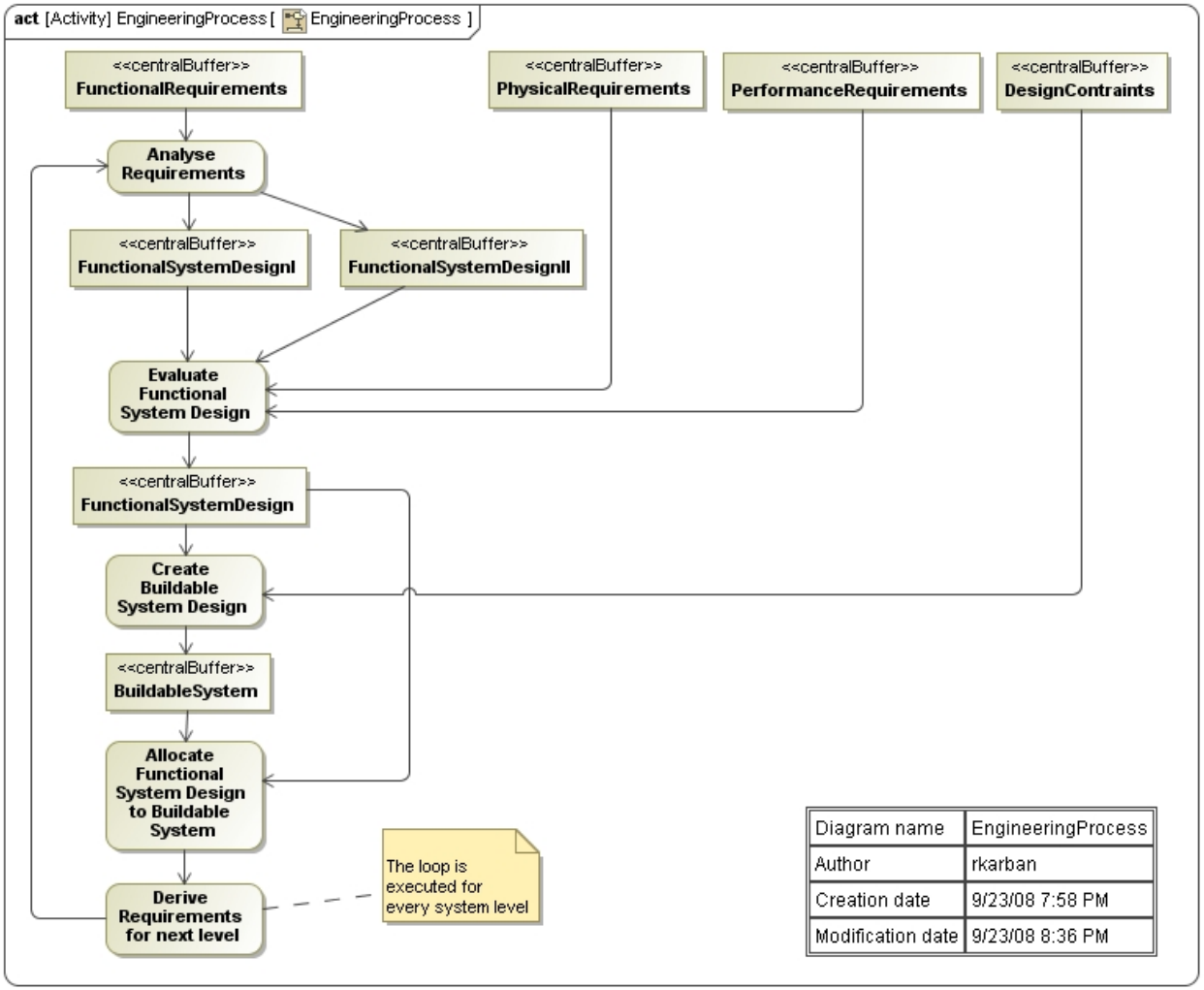
SysML issue

- FlowProperties cannot be connected in IBDs

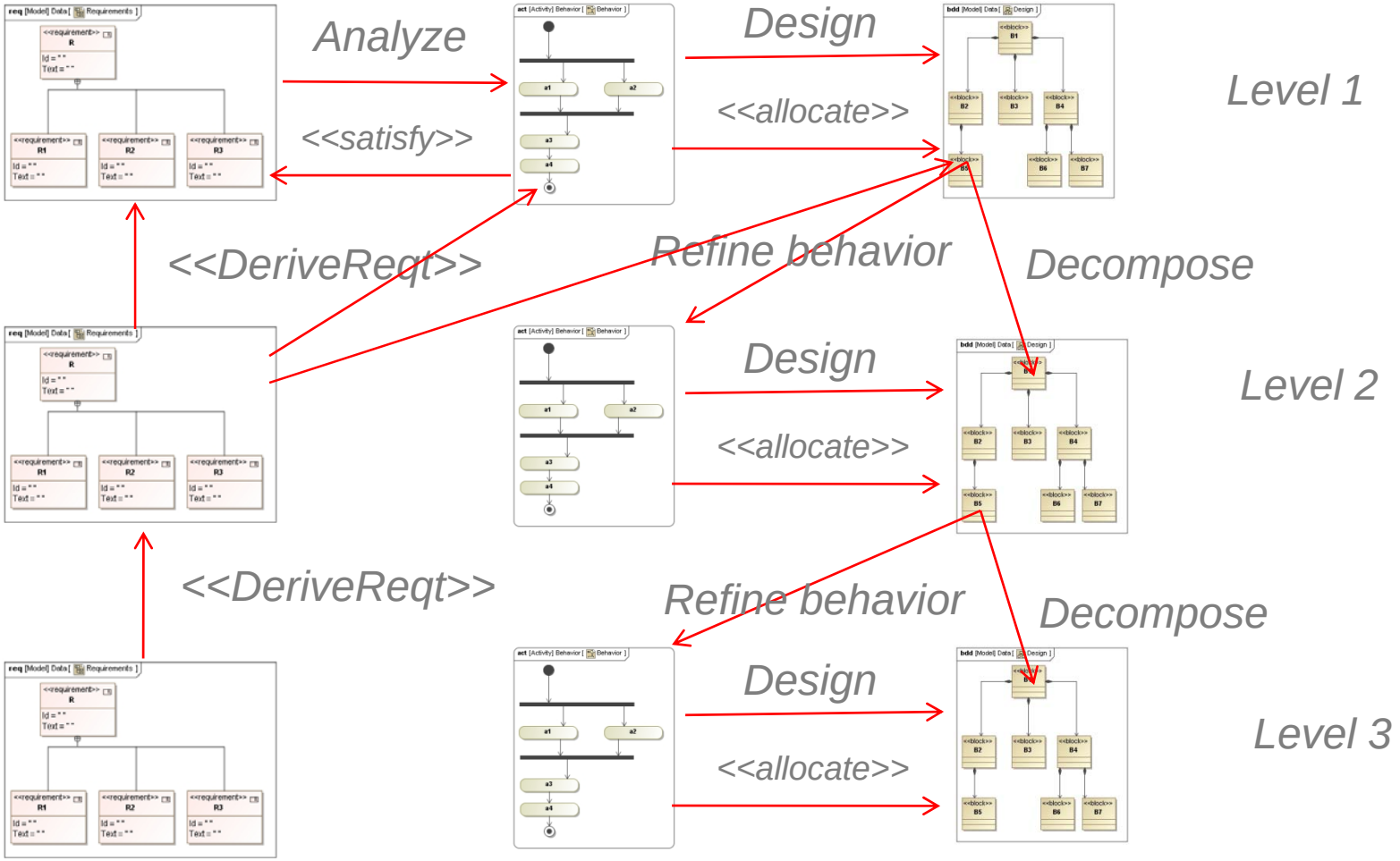
SysML status

- A request to the RTF will be submitted to enhance the definition of FlowSpecifications

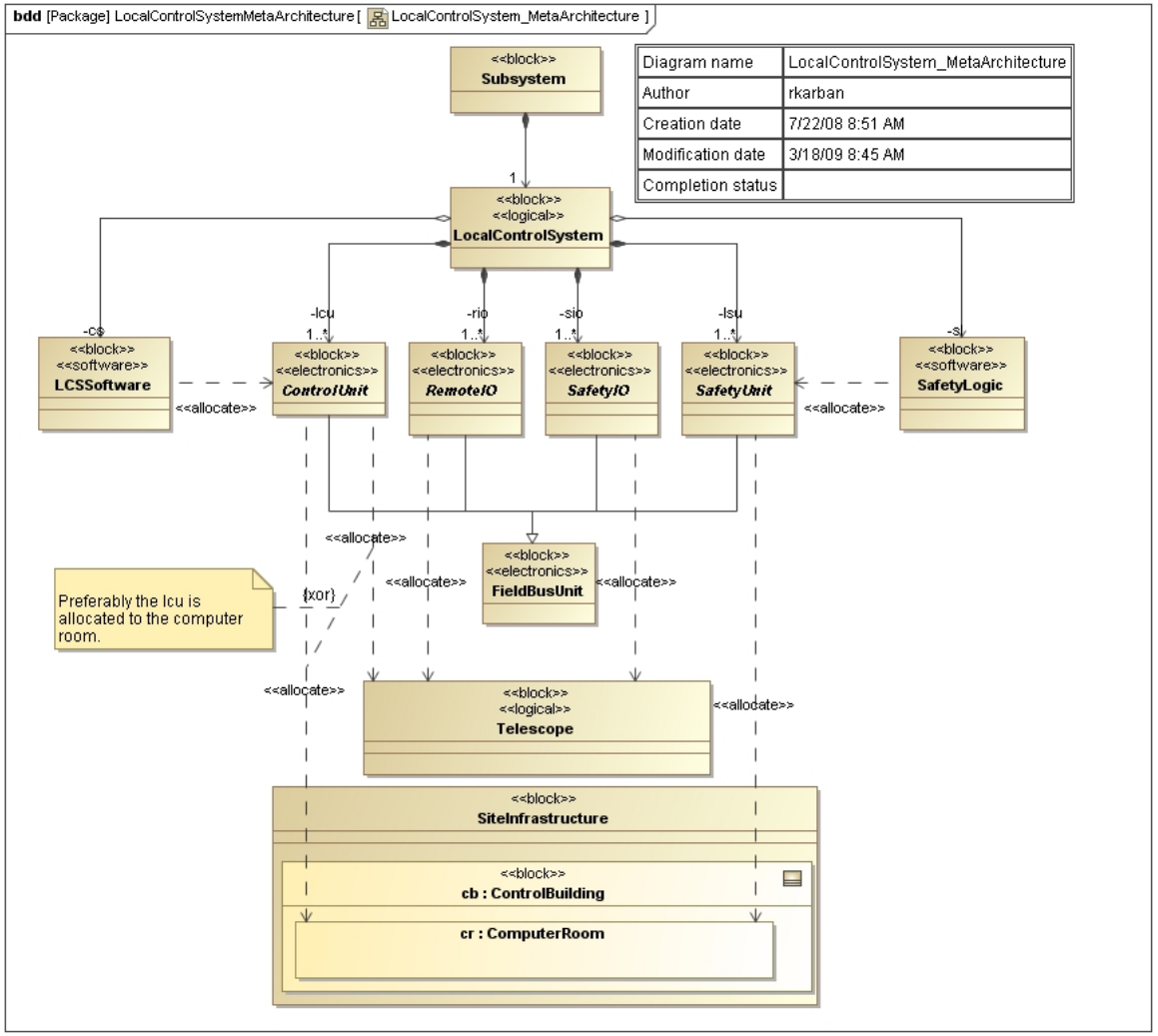
SysML challenge: Logical vs. Physical decomposition – Wymore like



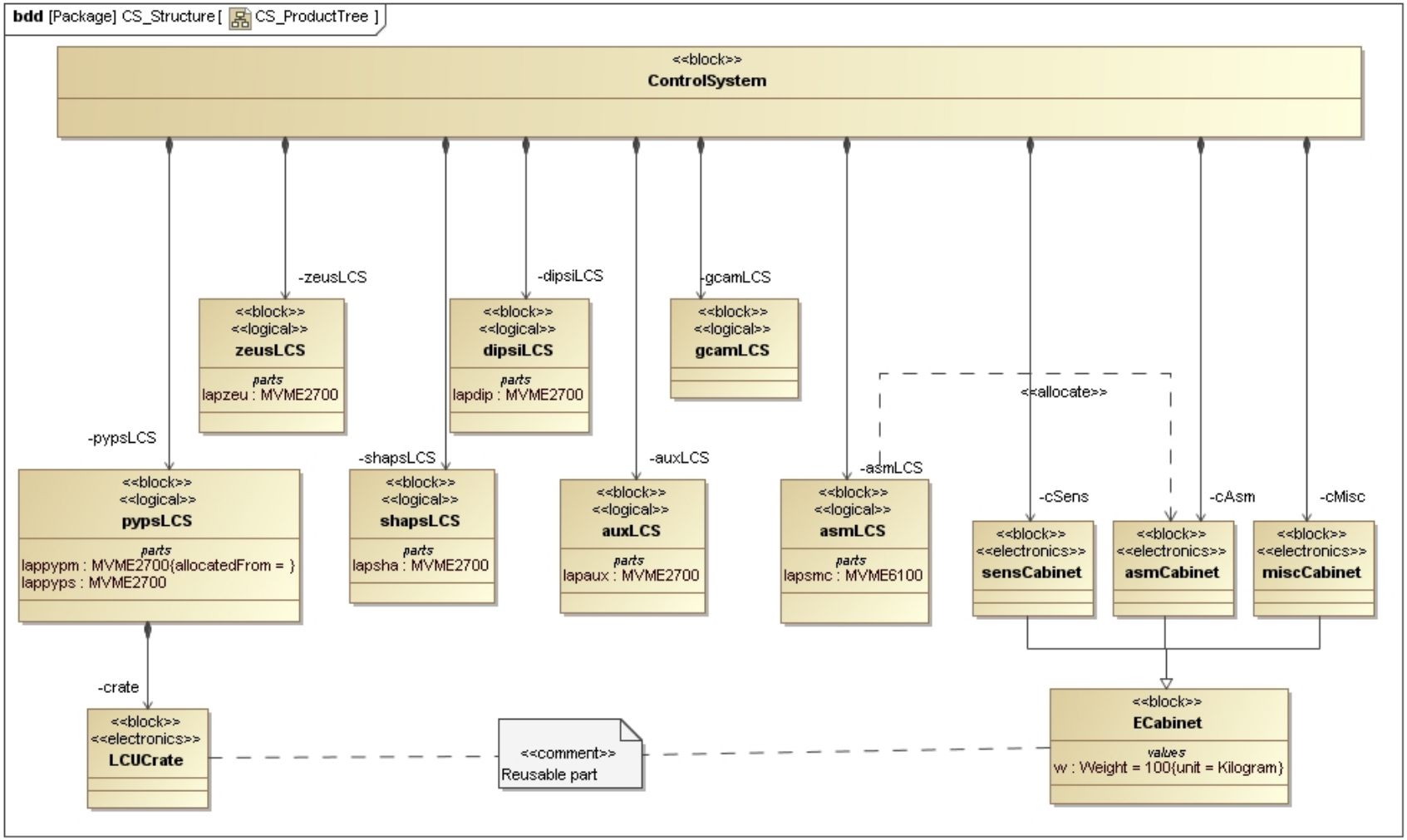
SysML challenge: Iterative Logical to Physical multi-layer allocation



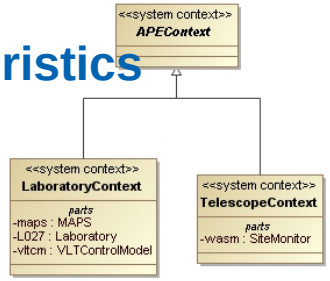
SysML challenge: Logical vs. Physical decomposition – Example (2/4)



SysML challenge: Logical vs. Physical decomposition – Example (3/4)



SysML challenge: Logical vs. Physical decomposition – Characteristics



What to do

- Model and trace requirements, functional design, logical design and buildable system without separation of logical and buildable design to reduce modelling overhead.

How to do

- Describe functional design with activity diagrams and state machines
- Use logical blocks to describe main architecture and is interfaces
- Allocate functions to logical blocks
- Use logical blocks as context for concrete blocks
- Re-Allocate functions to concrete blocks
- Allocate blocks if connectors are irrelevant or still unknown and configuration changes easily, i.e. blocks are loosely coupled.

Summary

What we have tried

- Check the usability of SysML for space observation domain
- Reach the limits of SysML for system engineering of
  - Requirements
  - Structure
  - Behavior

Our current conclusion

- SysML can be used to model space observation systems
- SysML offers not much built-in opto-electronical engineering
- We have reach some limits of SysML
- However: Do not use to much fancy SysML constructs
  - Common understanding of all system engineering stakeholders is the most important value