Introduction to SysML

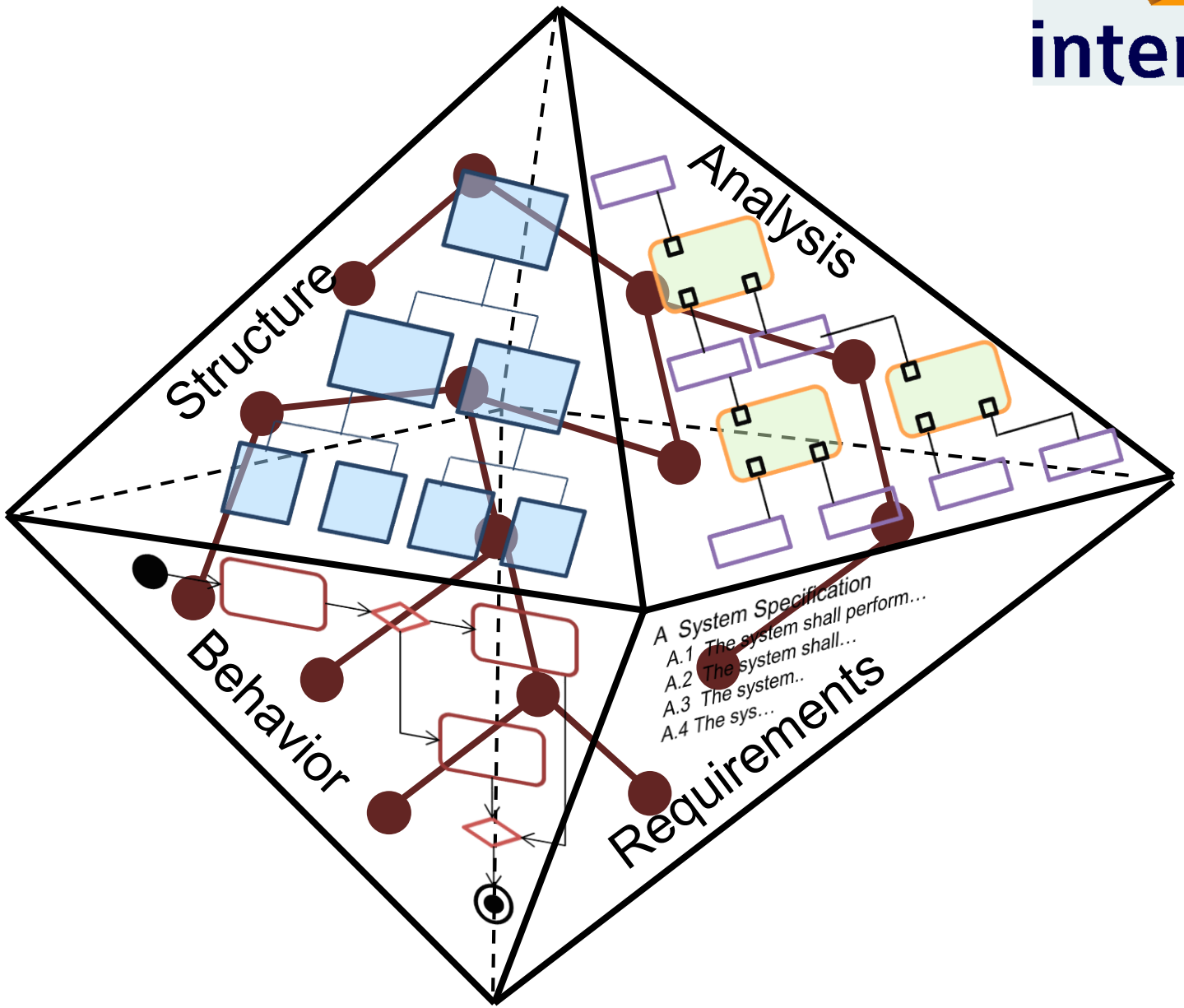
Part 5.0: Analysis and Parametric Diagrams

With tutorial exercises using MagicDraw

MBSE

- Analysis just as important as Description

- Analysis with external tools (e.g. spreadsheets) works against the goal of MBSE – a single unified model



Approaches to MBSE Analysis

- SysML Parametrics
  - Direct incorporation of a network of equations in a SysML model
- Activity and State Machine Simulation
  - Testing behavior logic, numbers and equations may be involved
- Interfacing to Functions and Models in External Tools
  - Wrapping analysis and simulation models as SysML elements
- Model Transformation
  - Sharing analysis models between tools

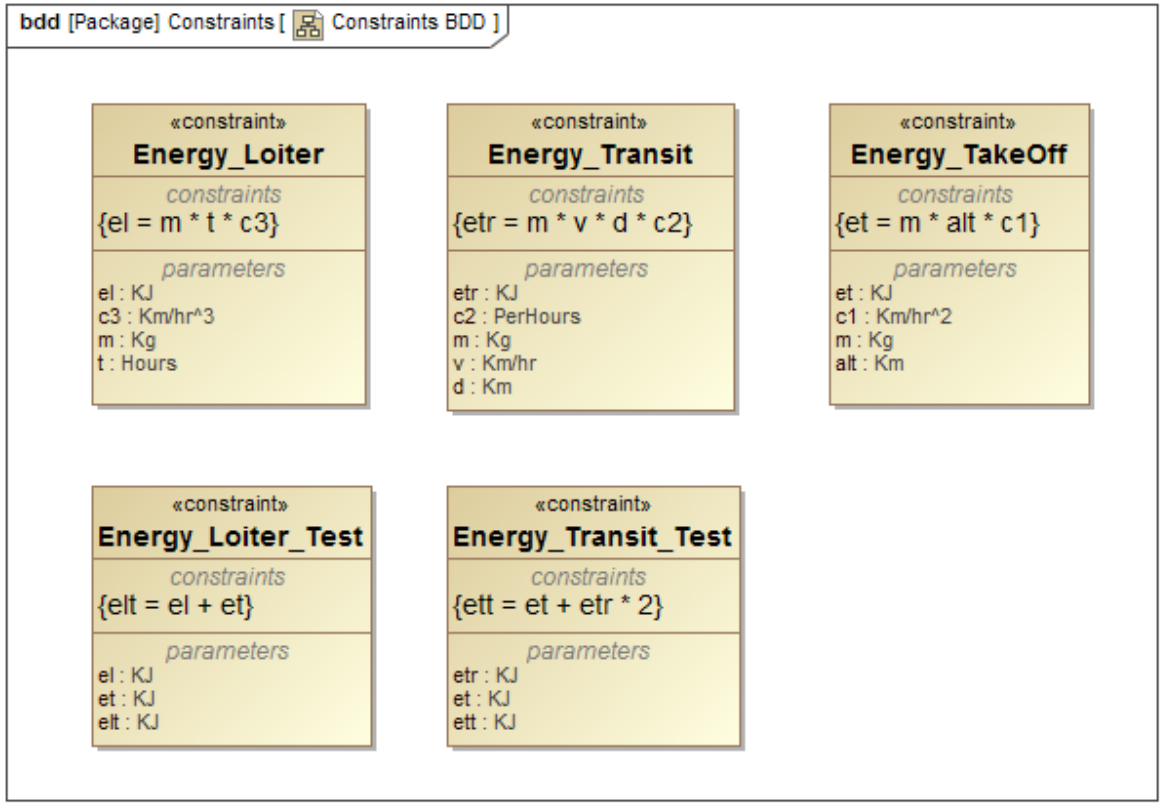
Learning Objectives

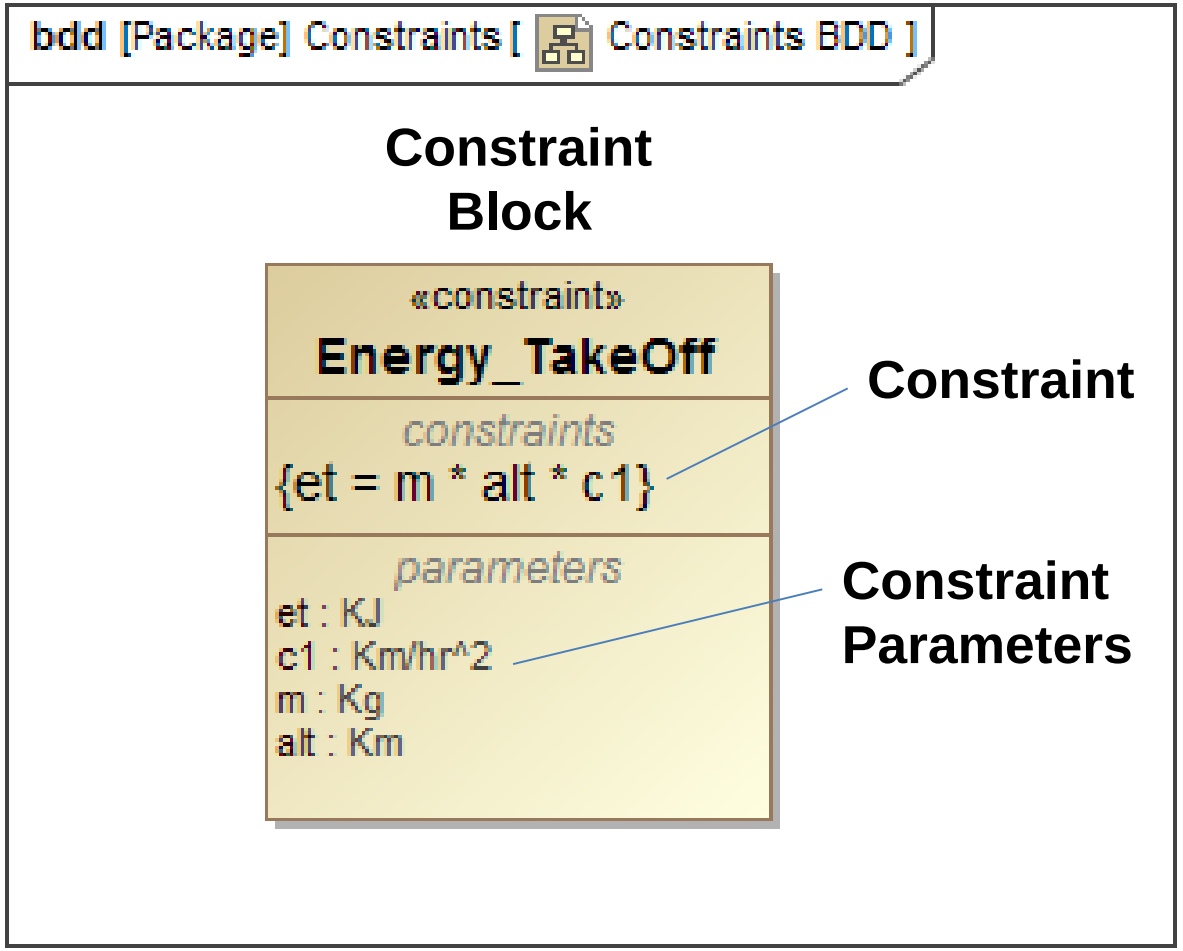
- MBSE Analysis Objectives and Approaches
- Constraint Properties and Parametric Diagrams
- Instances of SysML Structural Models
- First Exercise, building a parametric diagram, creating an instance, and solving the model
- Complex Aggregates
- Second Exercise, mass roll-up with multiple instances
- External Analysis Blocks, Reference Properties
- Third Exercise, performance analysis

Uses of SysML Parametrics

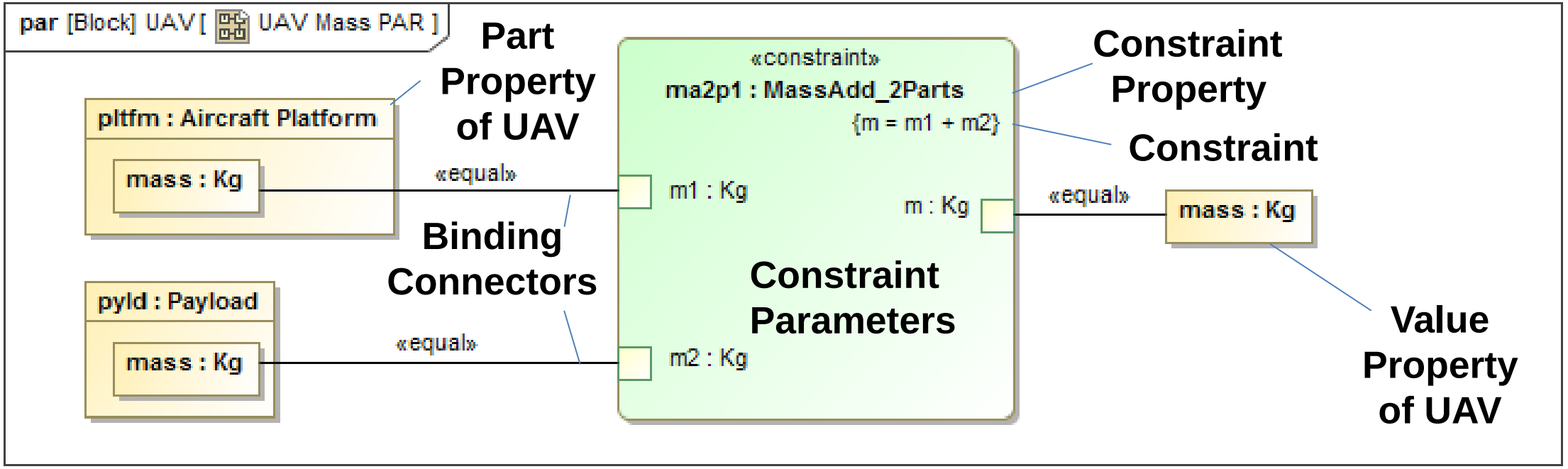
- Enforcement of Constraints
- Evaluation of Variants
- Verification of Requirements
- Conversion of Data Structures
- SysML parametrics work best where calculations are simple and repetitive

Constraint Blocks



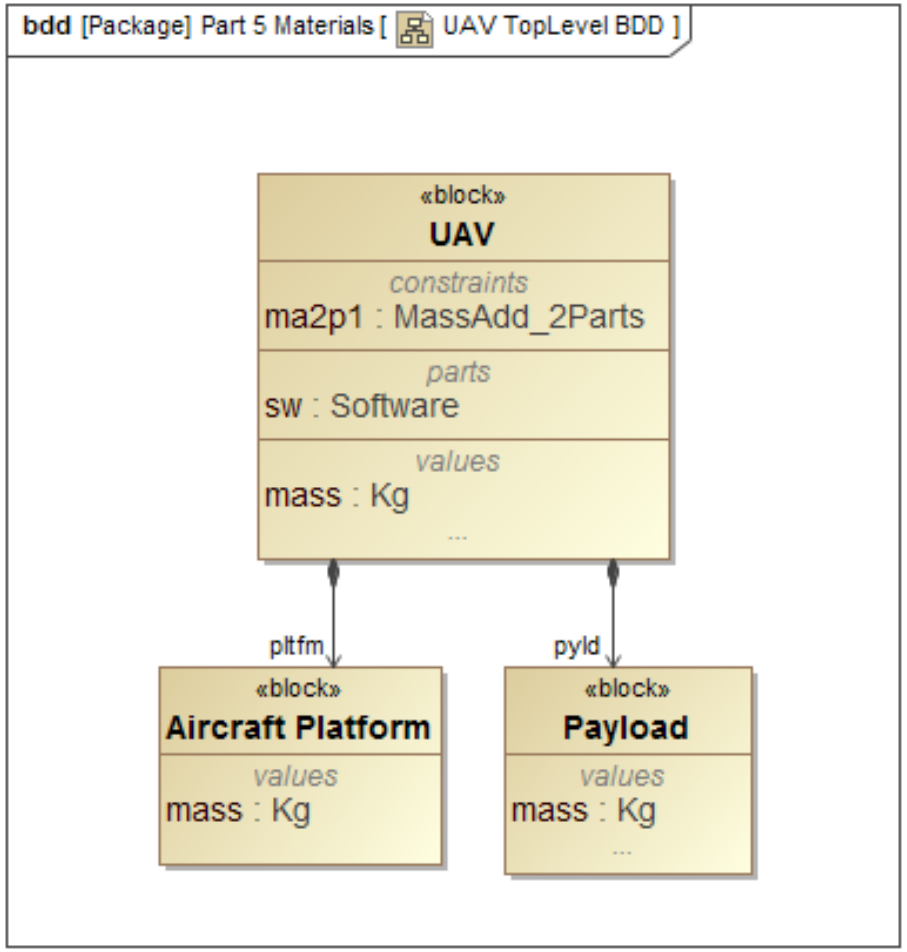


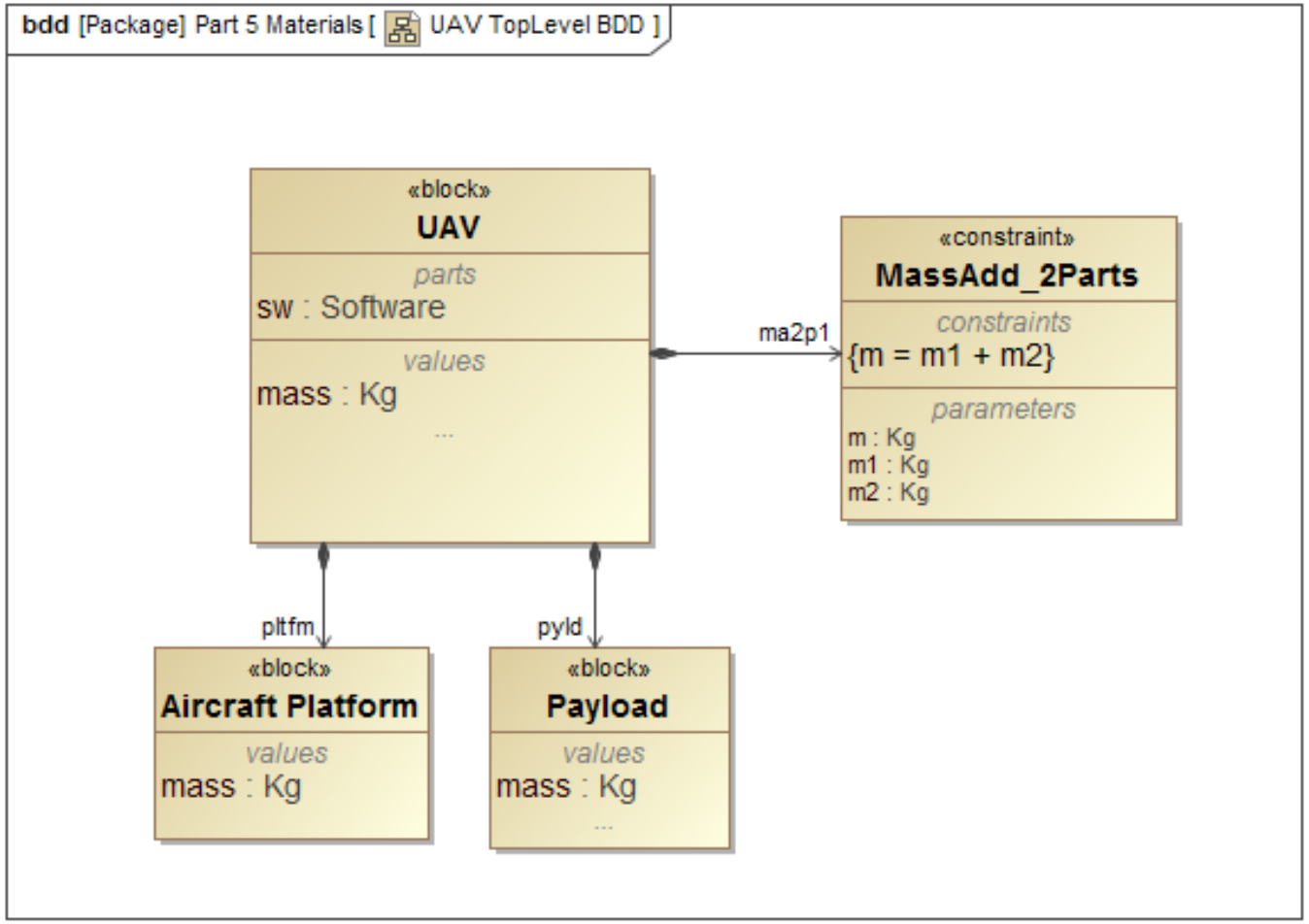
Parametric Diagram



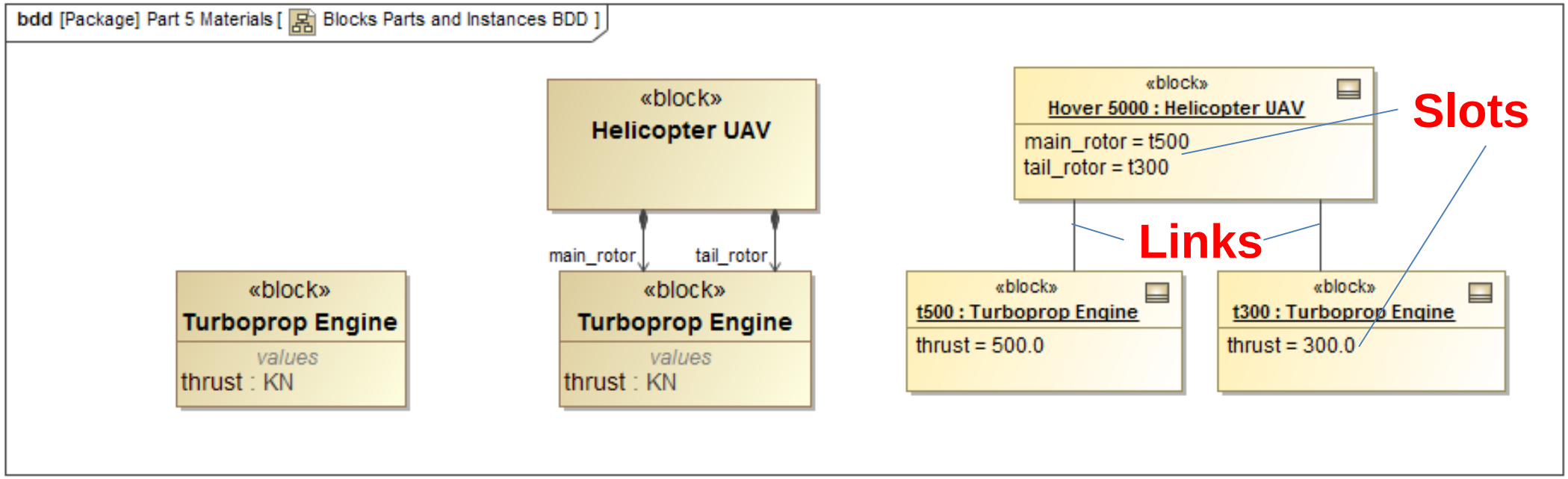
A Parametric Diagram usually belongs to a Block. It shows how the constraint properties and value properties of the block are connected.

Parametric Diagram



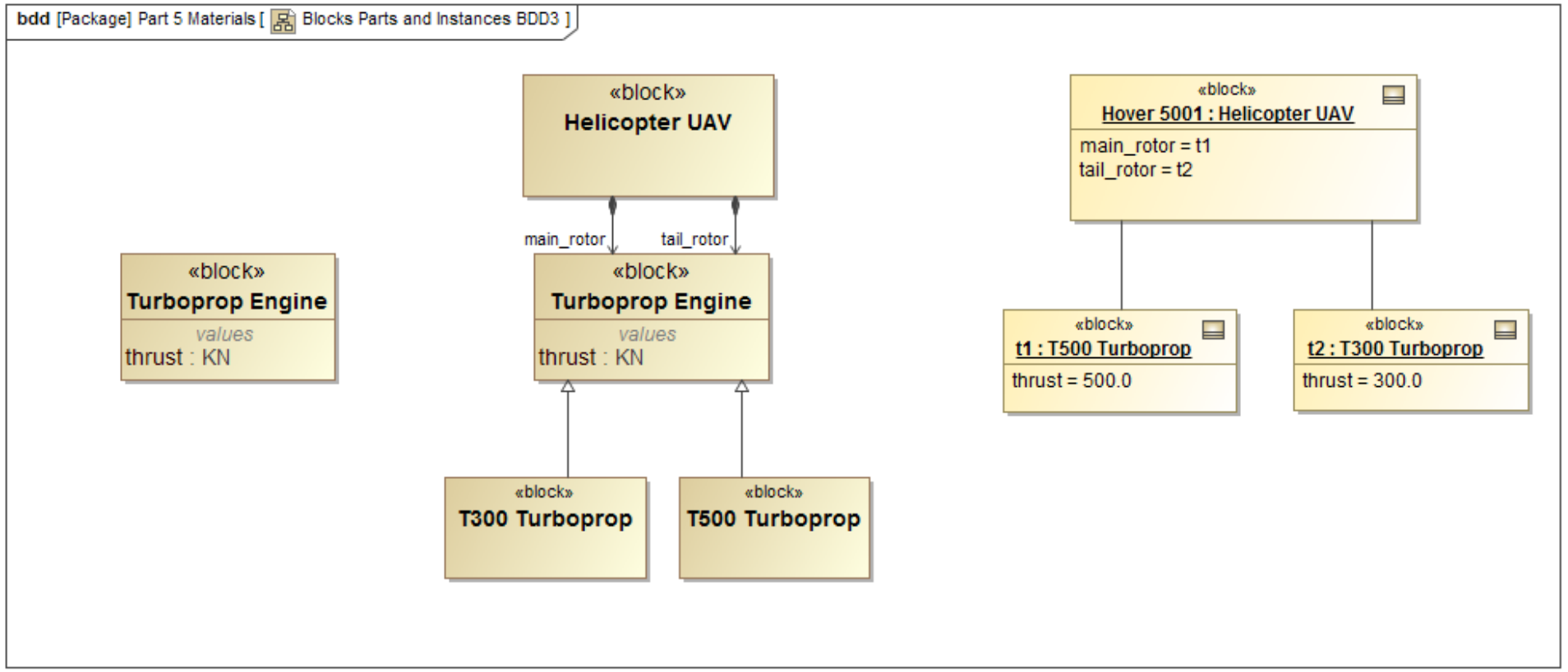


Instances



Blocks Part Properties Instances

Instances – Other Approaches



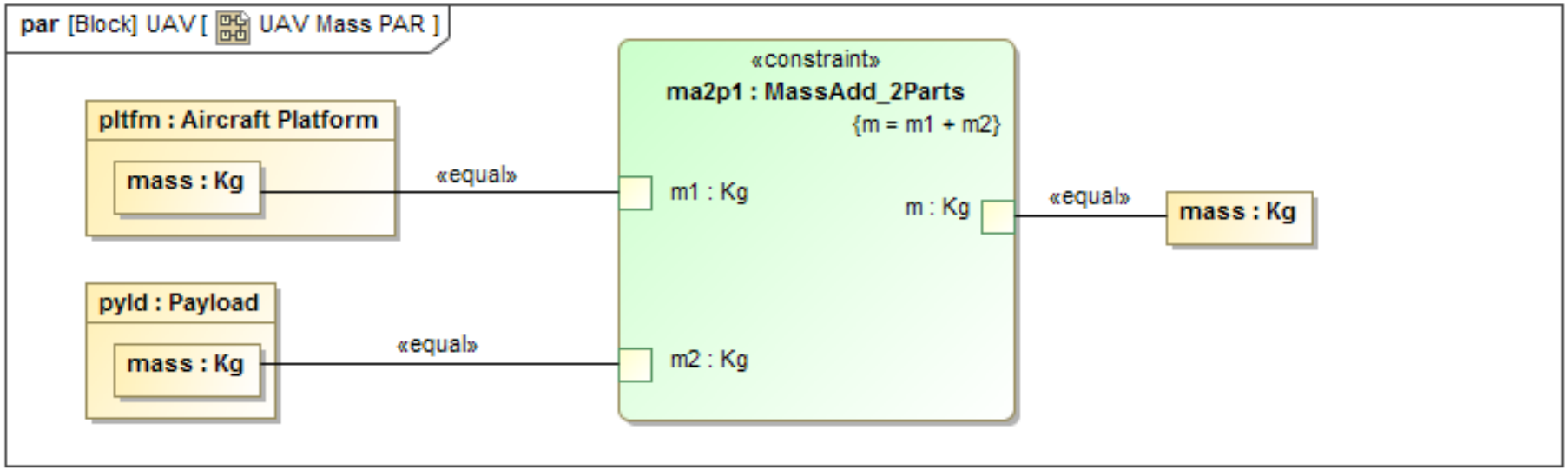
Blocks Specializations Instances

Parametric Execution

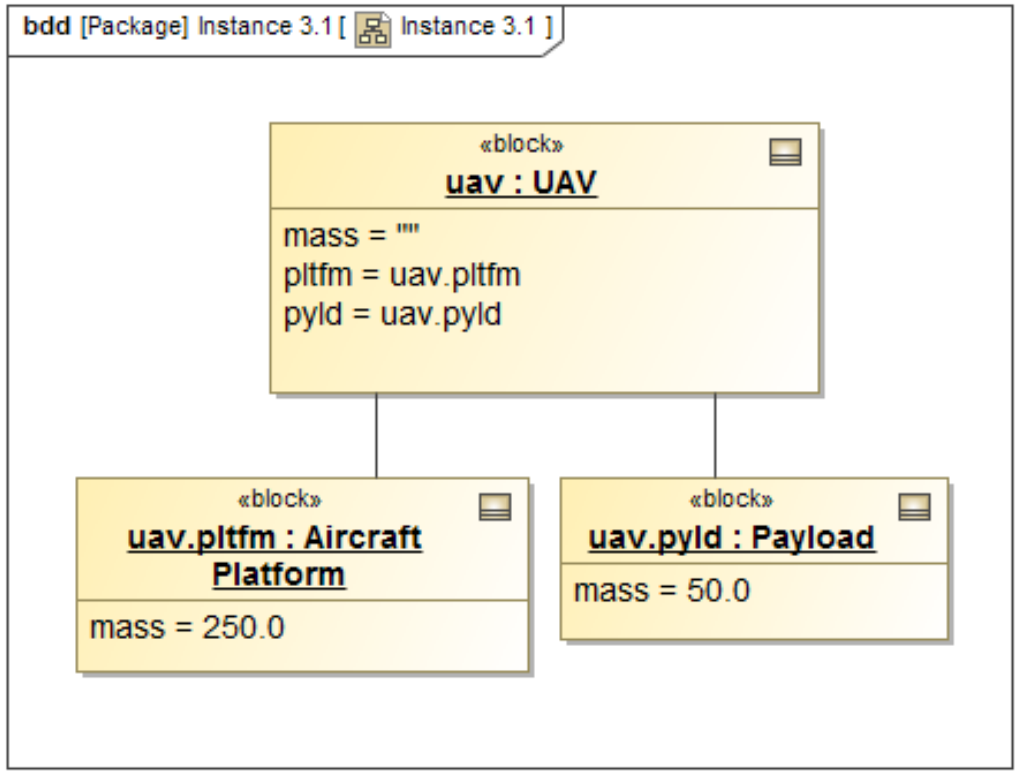
- Convert Syntax
- Add Causality
- Launch Math Engine
- Write Results to SysML Model

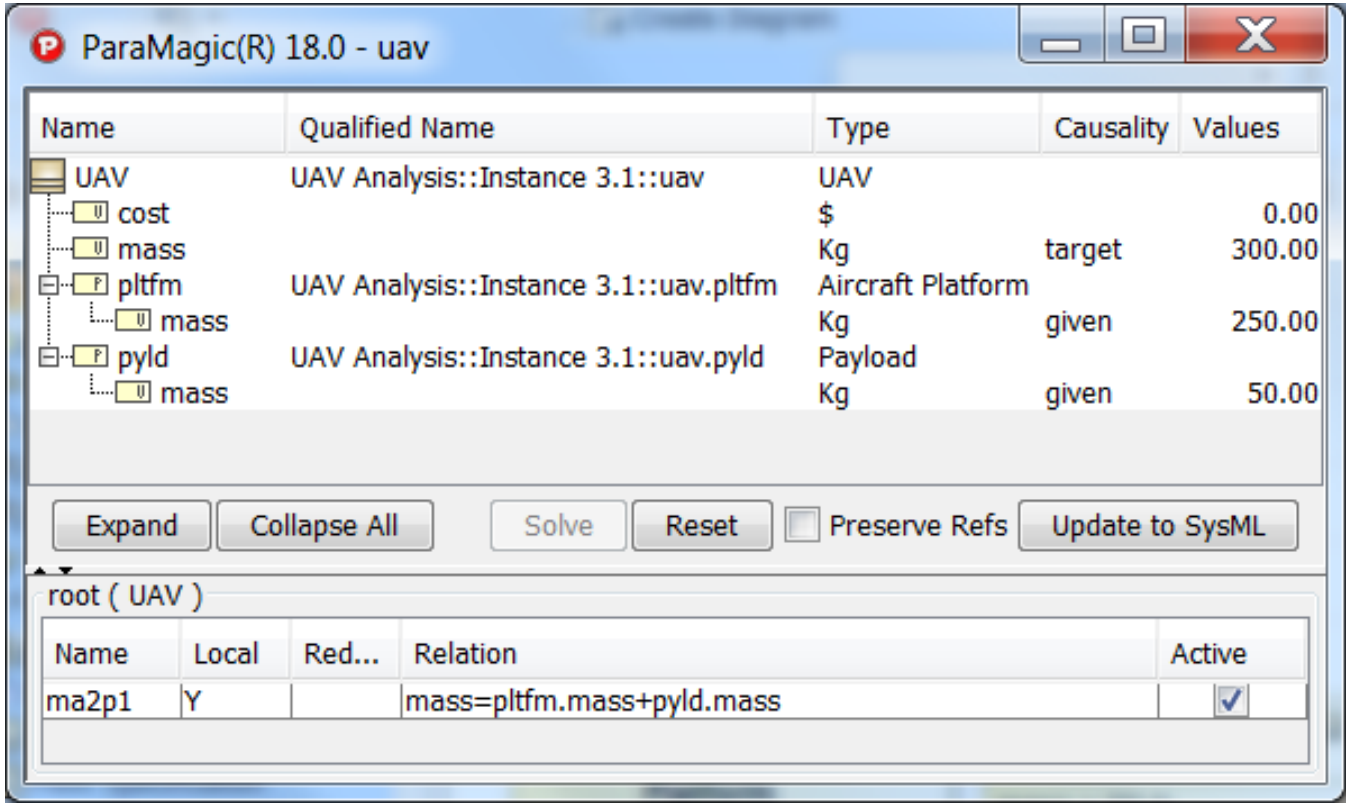
First Exercise

- The objectives of this exercise are to
  - Create a Parametric Diagram for the UAV to calculate mass.
  - Use the ParaMagic tool to validate the parametric model.
  - Create an Instance of the UAV assembly
  - Use the ParaMagic tool to edit values and causality in the Instance.
  - Solve the Instance for mass roll-up

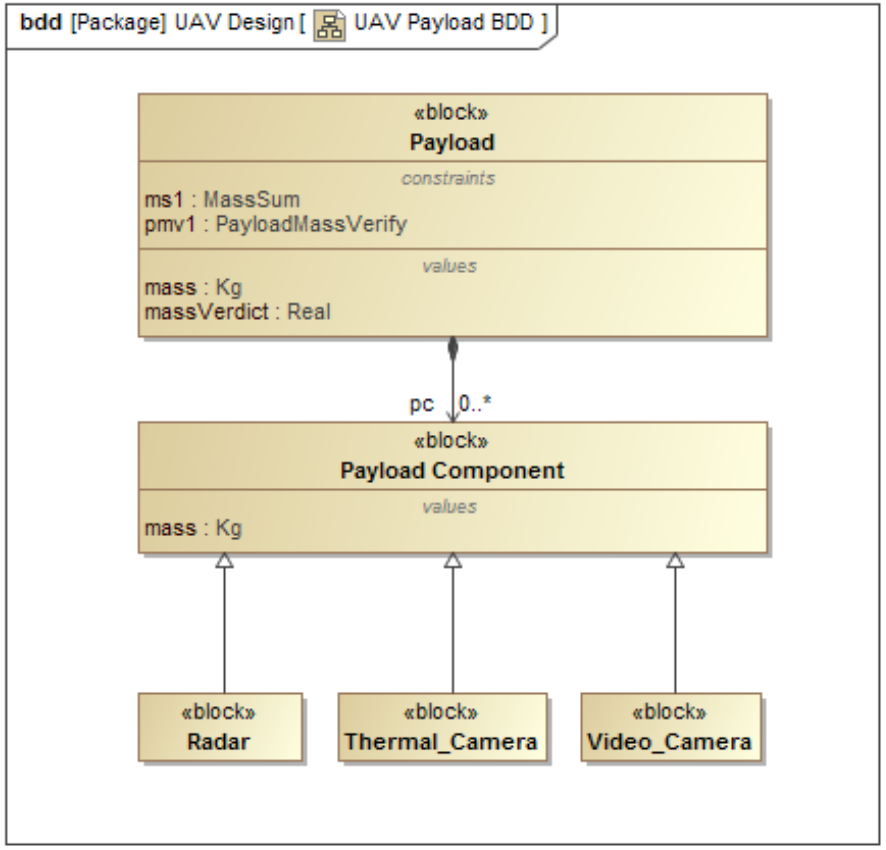


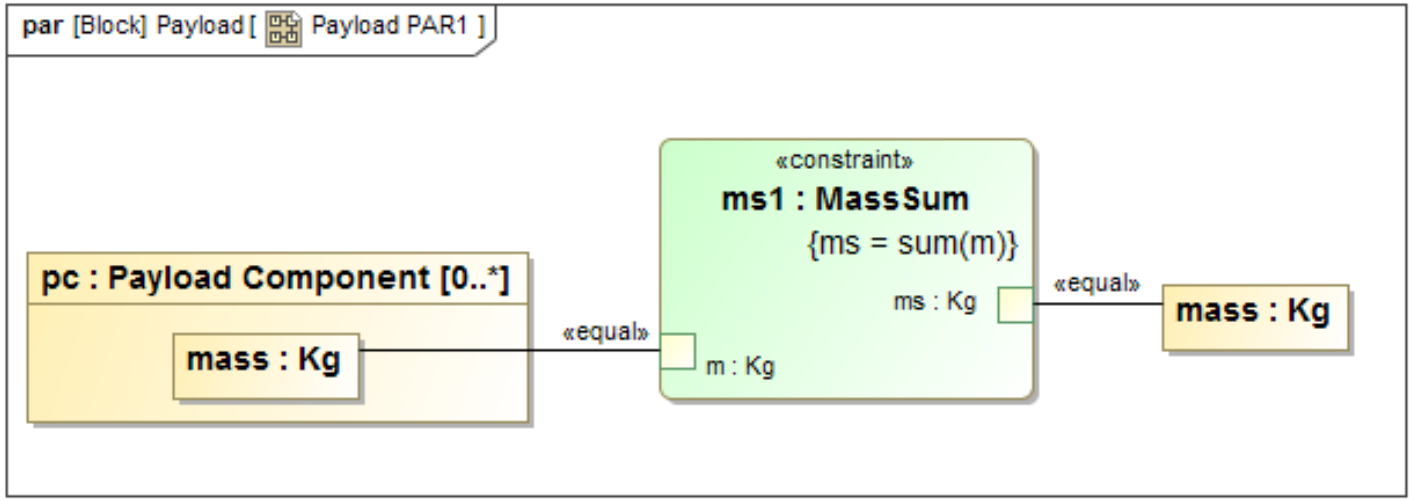
First Exercise



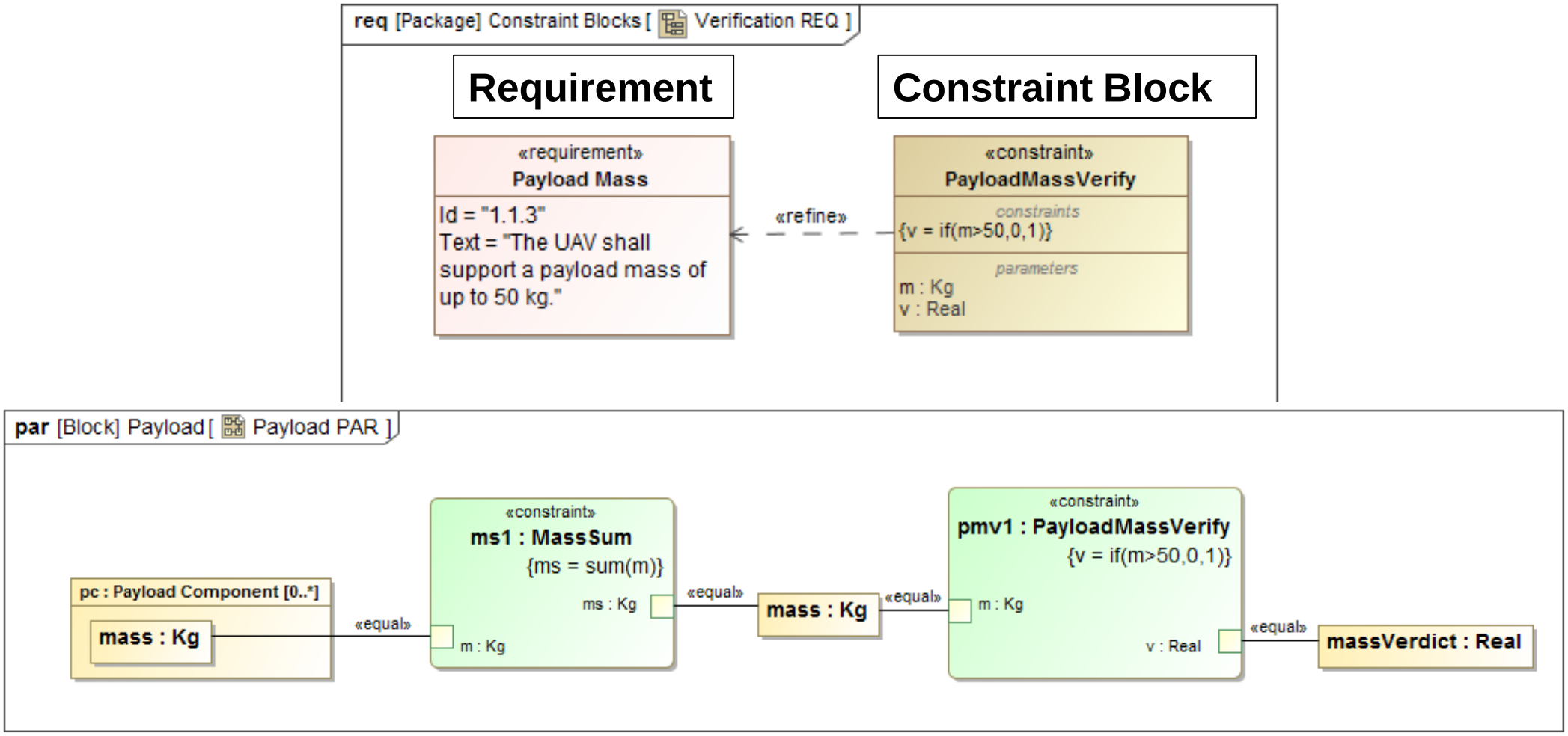


Complex Aggregates





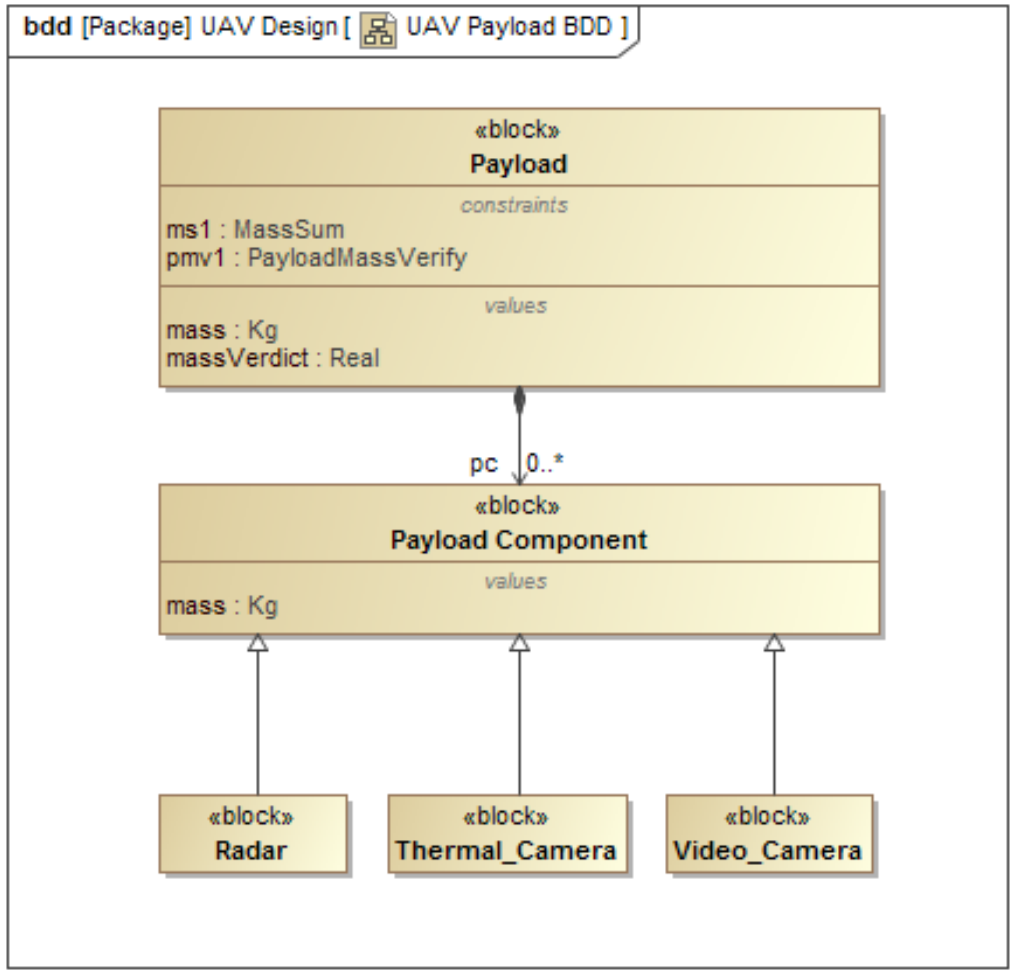
Requirement Verification

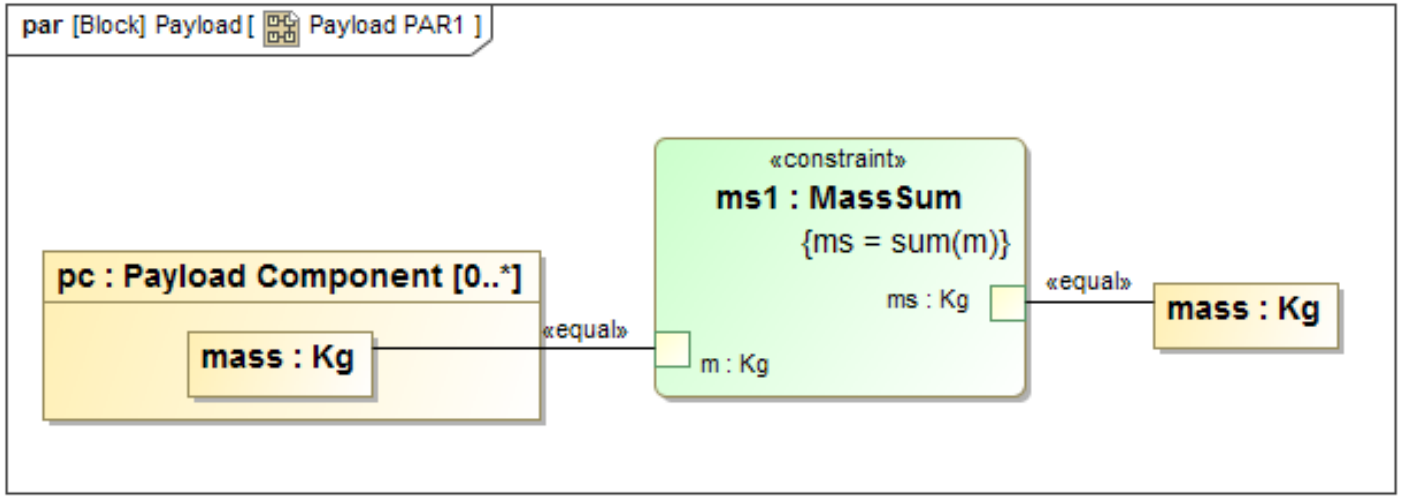


Second Exercise

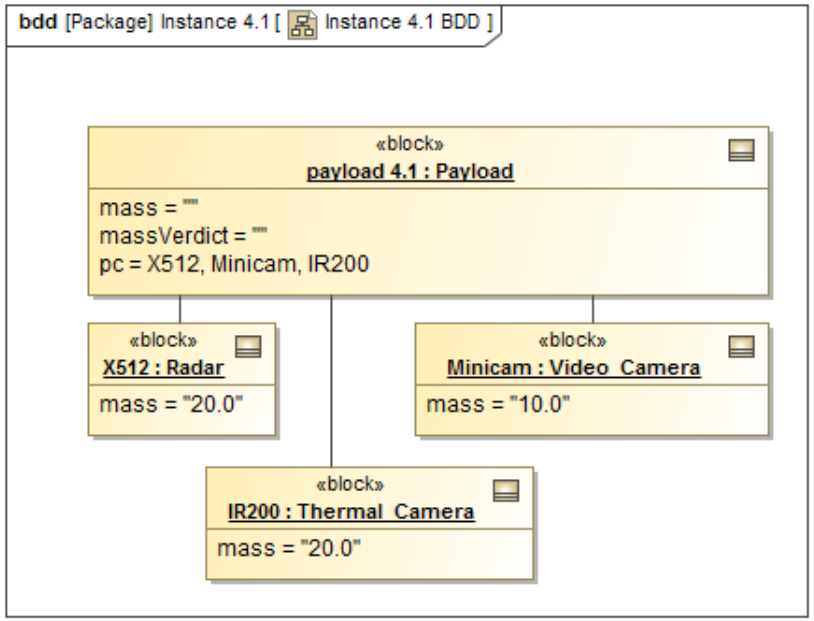
- The objectives of this exercise are to
  - Create a flexible Part Property relationship using Multiplicity and Inheritance
  - Create a Parametric Diagram using Complex Aggregates
  - Create multiple Instances of the Payload assembly
  - Solve these Instances for mass roll-up
  - Use mass roll-up calculation to verify UAV Payload Mass requirement.

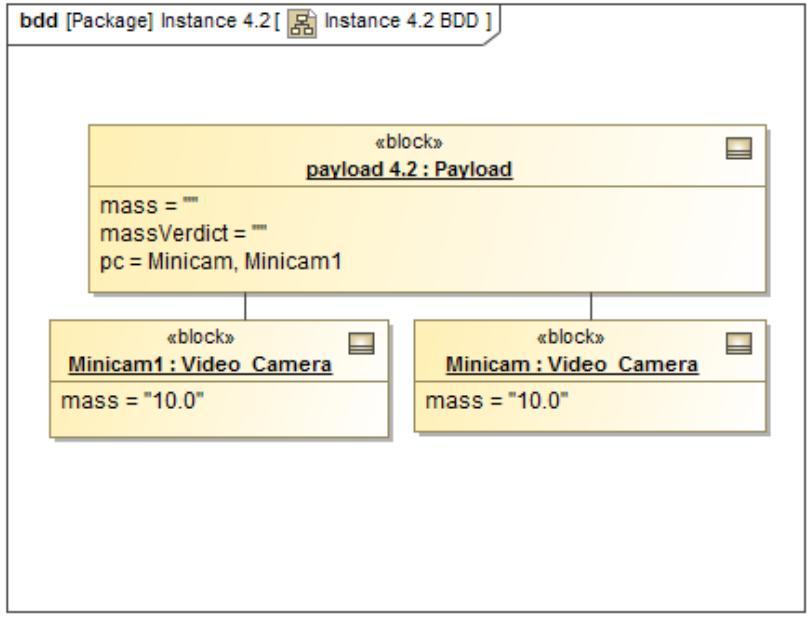
Second Exercise

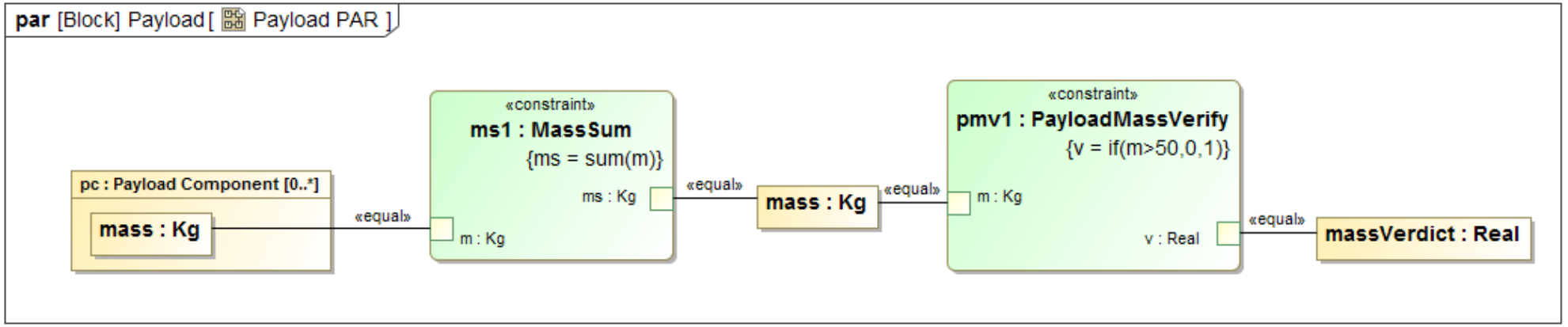




Second Exercise

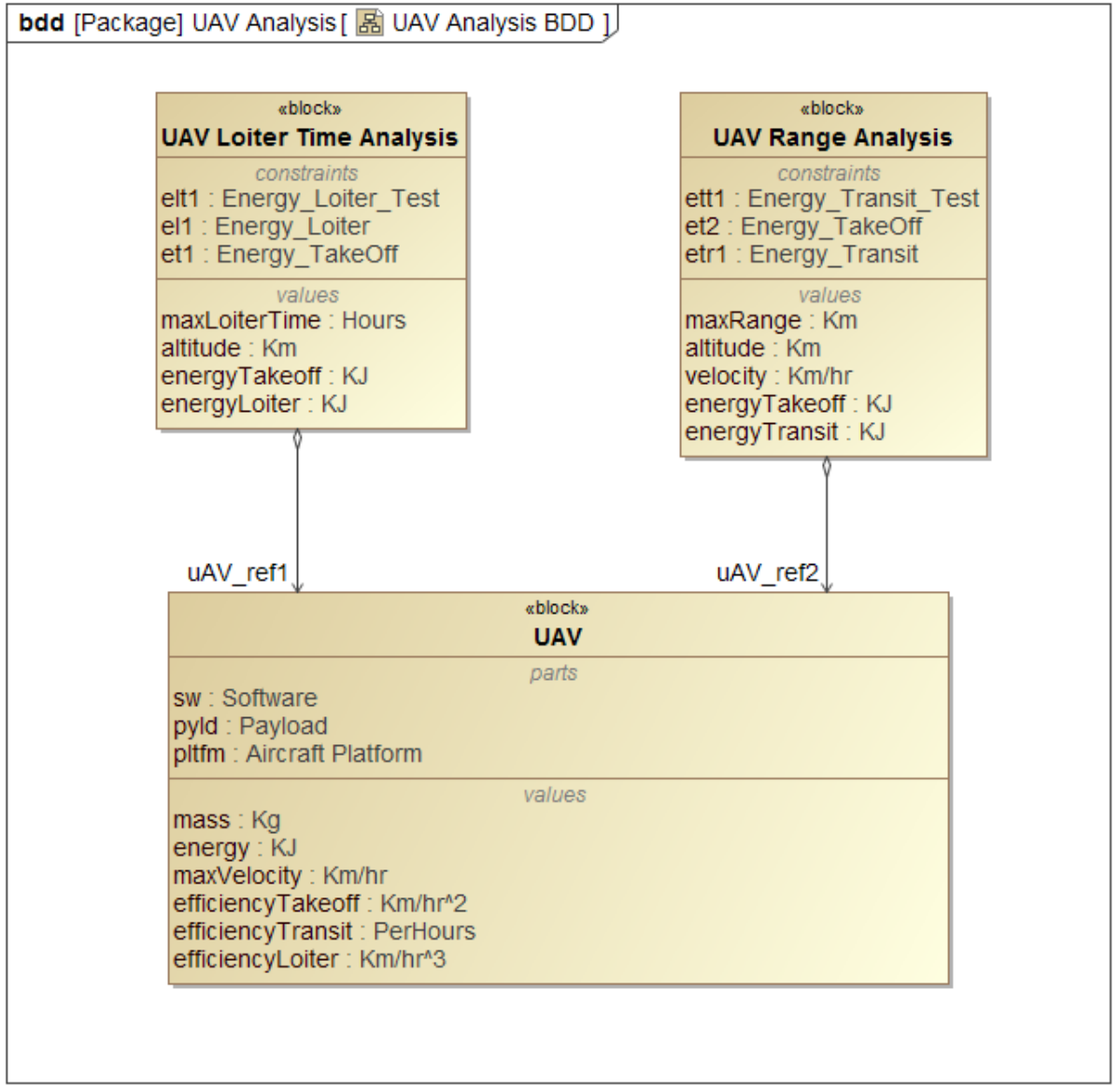






External Analysis Blocks

Reference Properties



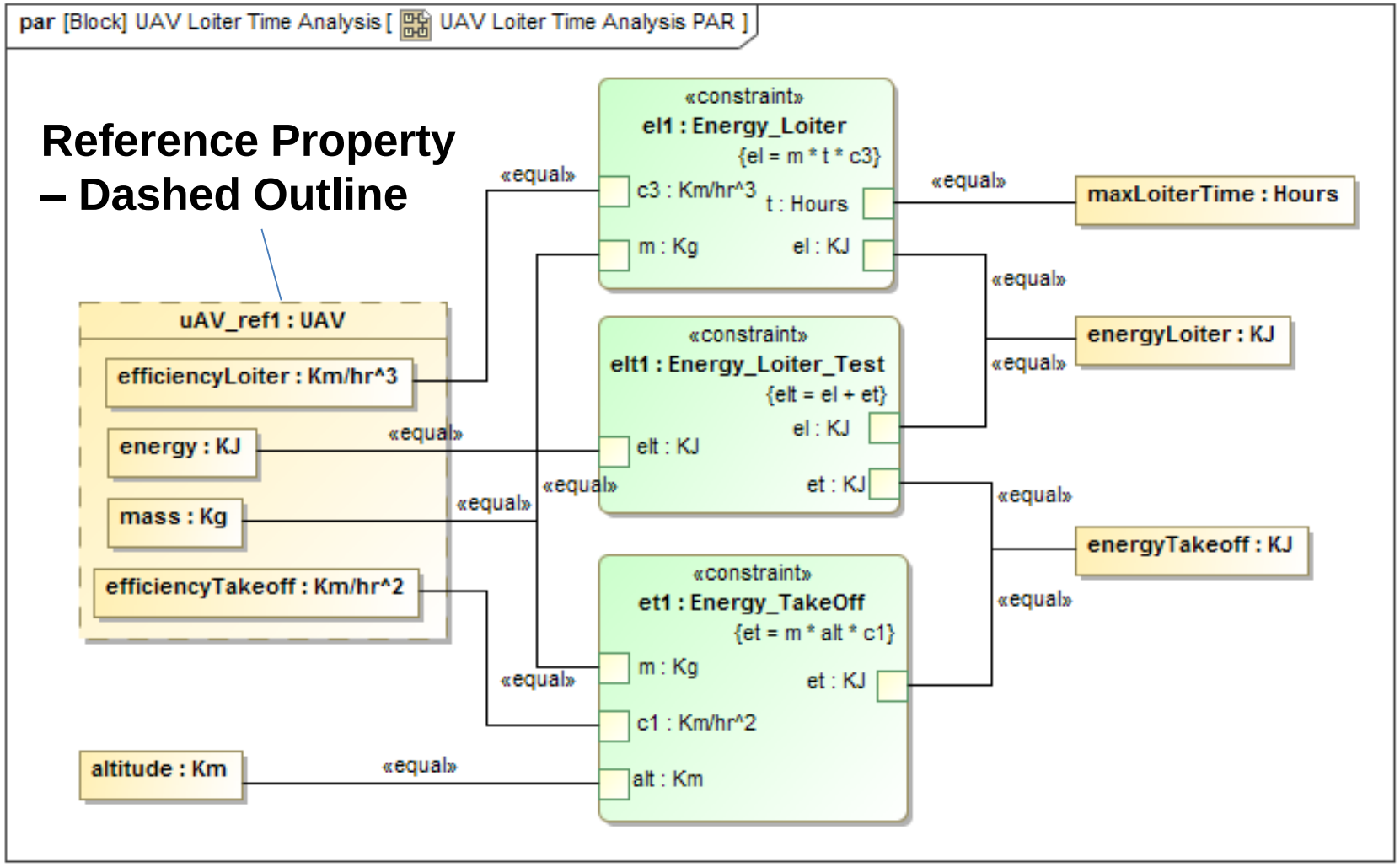
External Analysis Blocks

- Parametric models can be embedded in the structure, or
- Captured in other blocks that reference the structure
- External analysis blocks are also a good place to put value properties that describe the experimental condition, but aren't characteristics of the structural block
- External analysis blocks allow a developer to create an analysis without changing or disturbing the structure blocks

Reference Properties

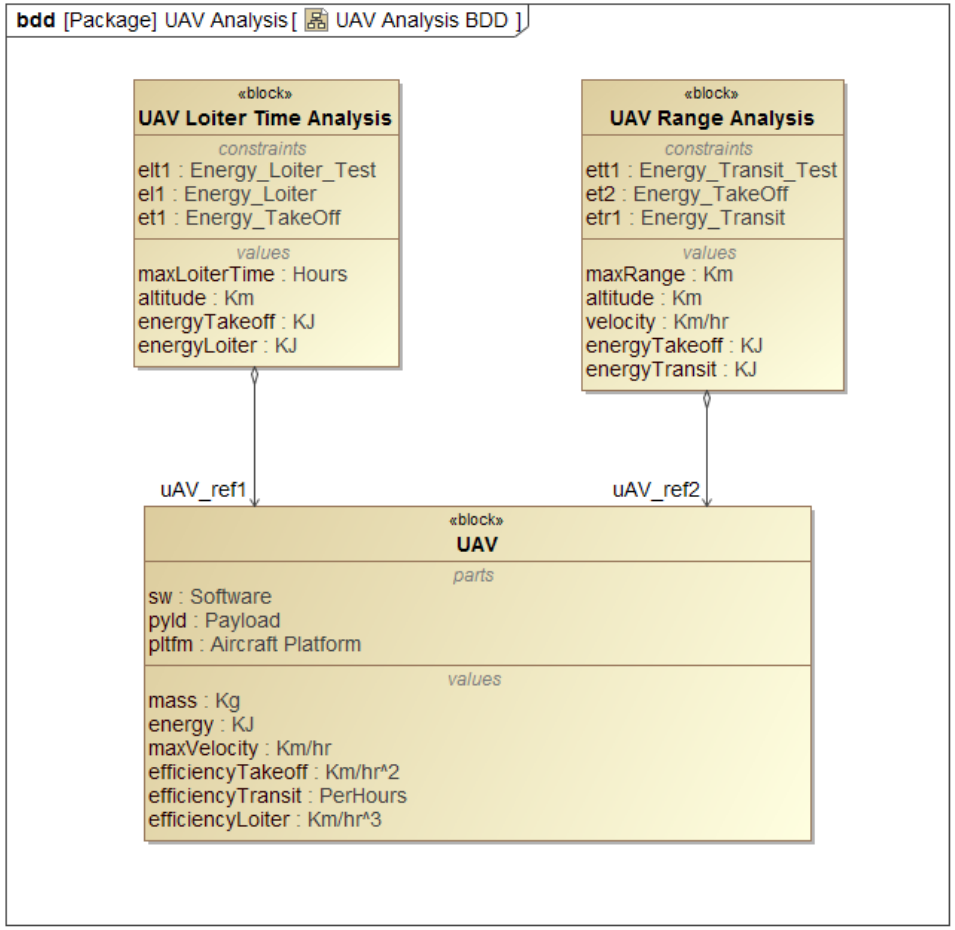
- Reference or Shared Properties allow one Block to reference the values (or other properties), without the implication of ownership
- They are shown with a white diamond arrow (or no diamond), unlike part properties with a black diamond arrow,

Loiter Time Analysis

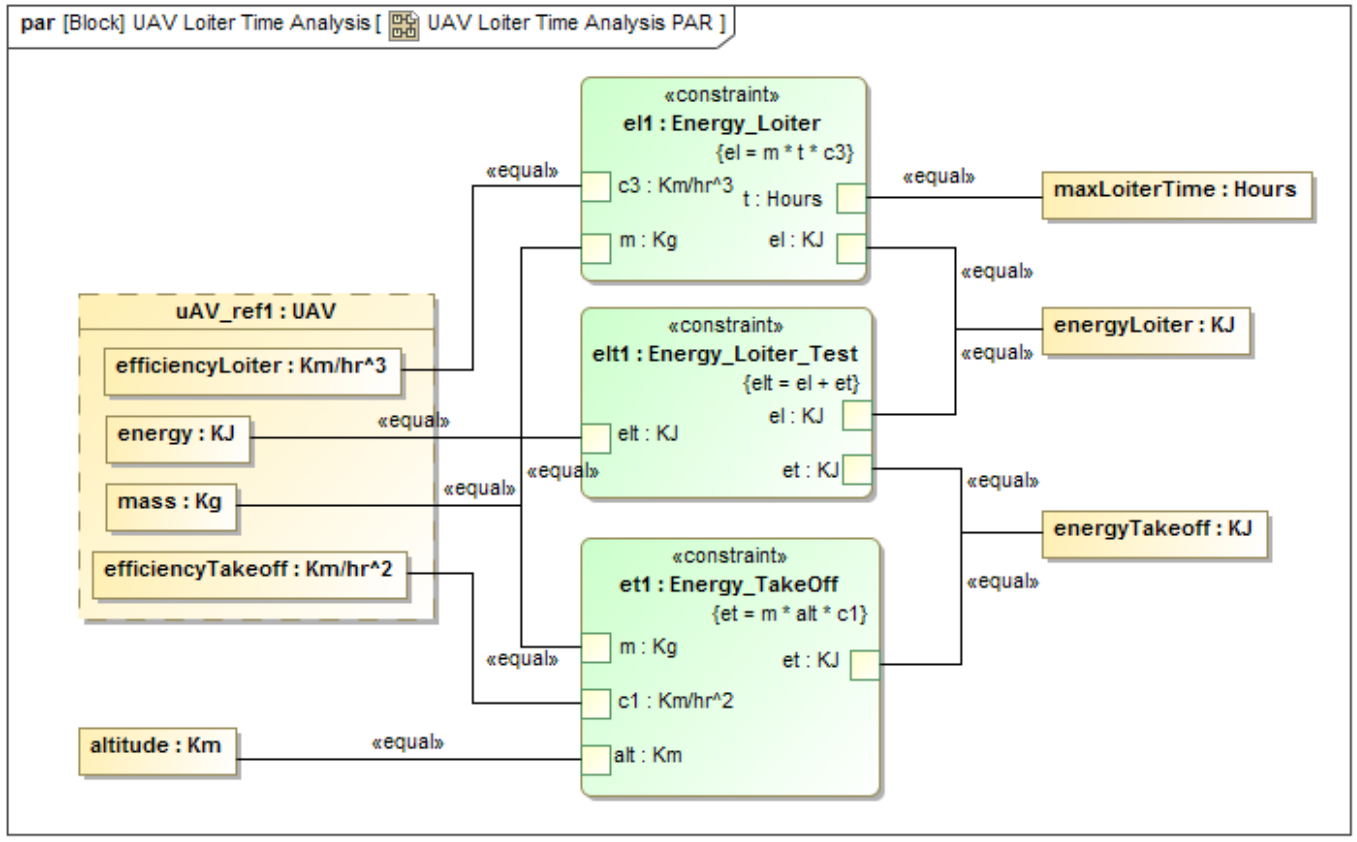


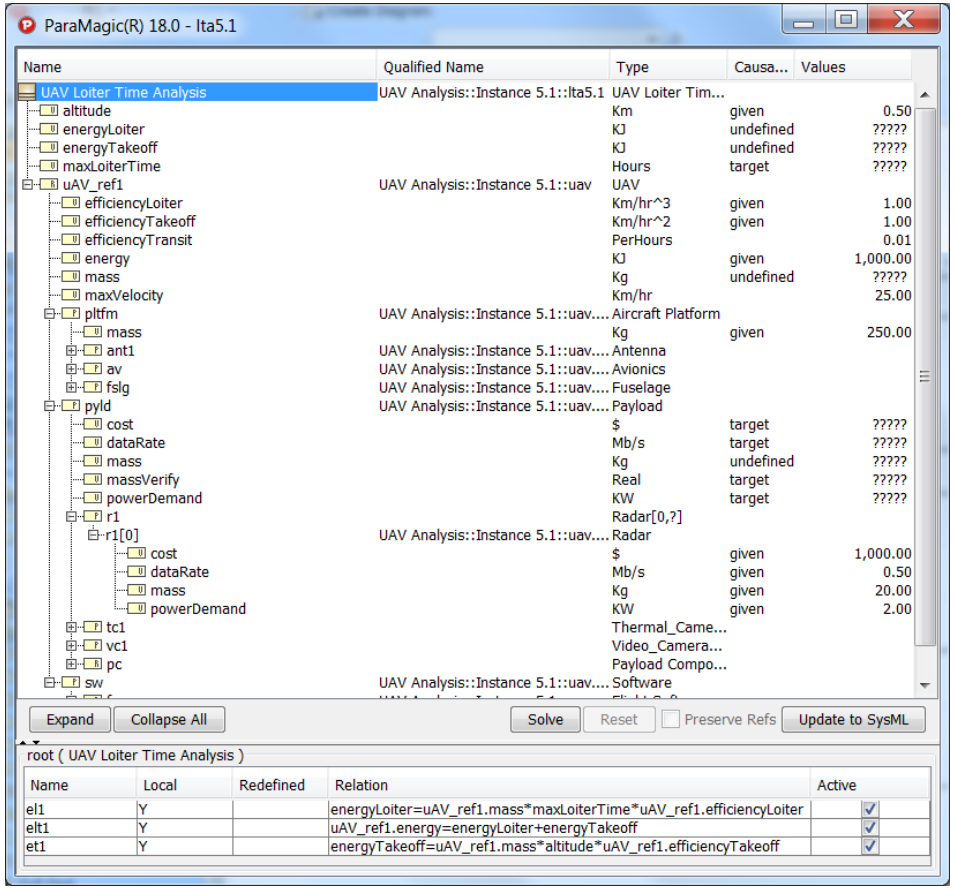
Third Exercise

- The objectives of this exercise are to
  - Create external analysis blocks with parametric models
  - Use reference property relationships to access UAV system values
  - Create an instance involving reference properties
  - Solve this Instances for UAV range and loiter time.



Third Exercise





Recap

- At the end of the hands-on exercises, you should be able to
  - Describe the objectives and approaches to analysis in MBSE
  - Explain the following terms: instance, constraint block, constraint property, binding connector, reference property
  - Create a model instance and display it in a block definition diagram
  - Create a parametric diagram
  - Validate and execute a parametric model

Questions?

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