SysML Hands-On Exercises

Exercise 5.3
SysML Parametrics Diagrams

MagicDraw

August 2018

OBJECTIVES

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.

This process is intended to represent parametric analysis for performance analysis and verification for the UAV.

PREPARATION

1. This exercise assumes the student has Cameo System Modeler 19.0 (or MagicDraw with SysML 19.0) and the ParaMagic plug-in for MagicDraw/CSM (ParaMagic 18.0 or later) installed correctly on his or her machine with valid licenses for use.
2. The student should load the Part 5 course materials onto the computer, specifically Exercise 5.3 Starter UAV.mdzip and Exercise 5.3 Final UAV.mdzip.
3. The student should view the video Introduction to SysML Part 5 Exercise 5.3 in its entirety before attempting the exercise.

NOTES AND CAUTIONS

We recommend that the student watch the video demonstration of this exercise in its entirety before beginning their own work. The video includes background and explanatory material that is not repeated in the written instructions.

We also recommend that the student read the material carefully. The most common source of error is confusion between blocks, packages and diagrams, some of which have similar names. When the student is not sure what an element is, either in the browser or in a diagram, select that element and look in the Properties tab for the gray label that identifies the element type. Also, be careful in reading the instructions in realizing when an instruction should be carried out in the browser or in a diagram.

EXERCISE

5.3.1 Start Cameo System Modeler

5.3.2 Open Exercise 5.3 Starter UAV.mdzip

5.3.3 Create an External Analysis Structure

- Right-click on the **UAV Analysis** package in the browser.
- Select Create Diagram → SysML Block Definition Diagram.
- Name the diagram **UAV Analysis BDD**.
- Create two blocks in the diagram: **UAV Loiter Time Analysis**, **UAV Range Analysis**. Use your method of choice.
- Add the following value properties to the **UAV Loiter Time Analysis** block:
  - **maxLoiterTime:Hours**
  - **altitude:Km**
  - **energyLoiter:KJ**
  - **energyTakeoff:KJ**
- Add the following value properties to the **UAV Range Analysis** block:
  - **maxRange:Km**
  - **altitude:Km**
  - **energyTransit:KJ**
  - **energyTakeoff:KJ**
  - **velocity:Km/hr**
- Drag the **UAV** block into the diagram. See *Figure 1*.

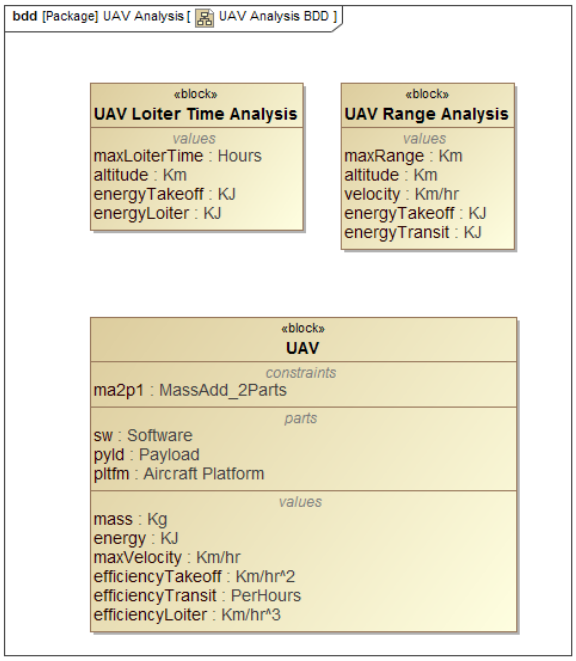

Figure 1 UAV Analysis BDD, Stage 1

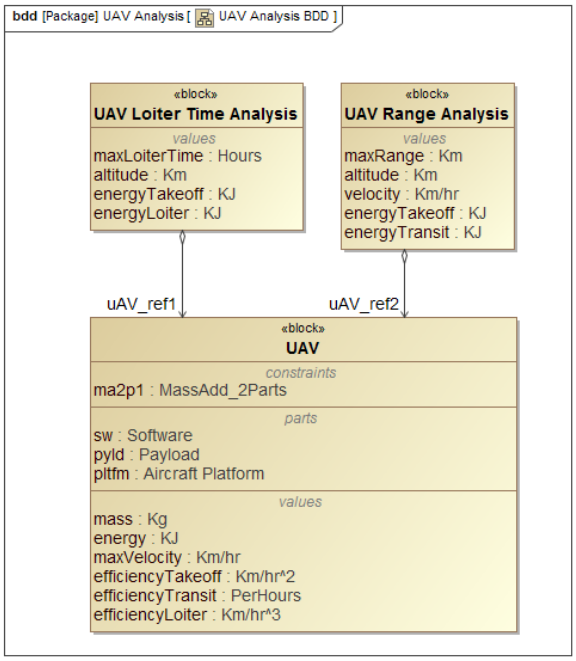

Figure 2 UAV Analysis BDD, Stage 2

- In the Diagram Toolbar, select Directed Aggregation (white diamond arrow). Click on the **UAV Loiter Time Analysis** block and drag the end to the **UAV** block.
- Repeat for the **UAV Range Analysis** block.
- In the containment browser, rename the two reference properties as **uAV_ref1** and **uAV_ref2**.
- The final diagram should appear as in Figure 2.

5.3.4 Create a Parametric Diagram for UAV Loiter Time Analysis

- Right-click the **UAV Loiter Time Analysis** block in the browser. Select Create Diagram → SysML Parametric Diagram.
- Select parts to display as shown in Figure 3. Arrange as shown in Figure 4.
- Name the diagram **UAV Loiter Time Analysis PAR**.
- Drag the constraint blocks **EnergyLoiterTest, EnergyLoiter,** and **Energy Takeoff** from the **UAV Library::Constraints** package into the diagram. Name the constraint properties created as **elt1**, **el1** and **et1**, respectively, and display the constraint parameters.
- Draw binding connectors as shown in Figure 5.
- Validate the model by selecting the **UAV Loiter Time Analysis** block in the browser and clicking the ParaMagic icon at the top menu bar.

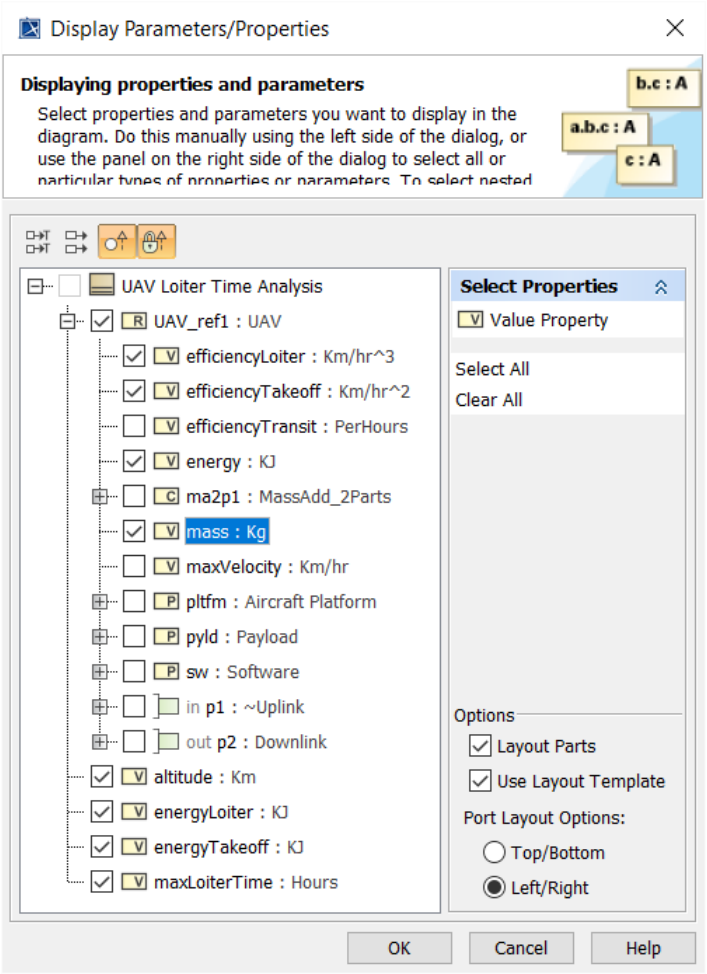

Figure 3 Display parameters/properties for parametric diagram

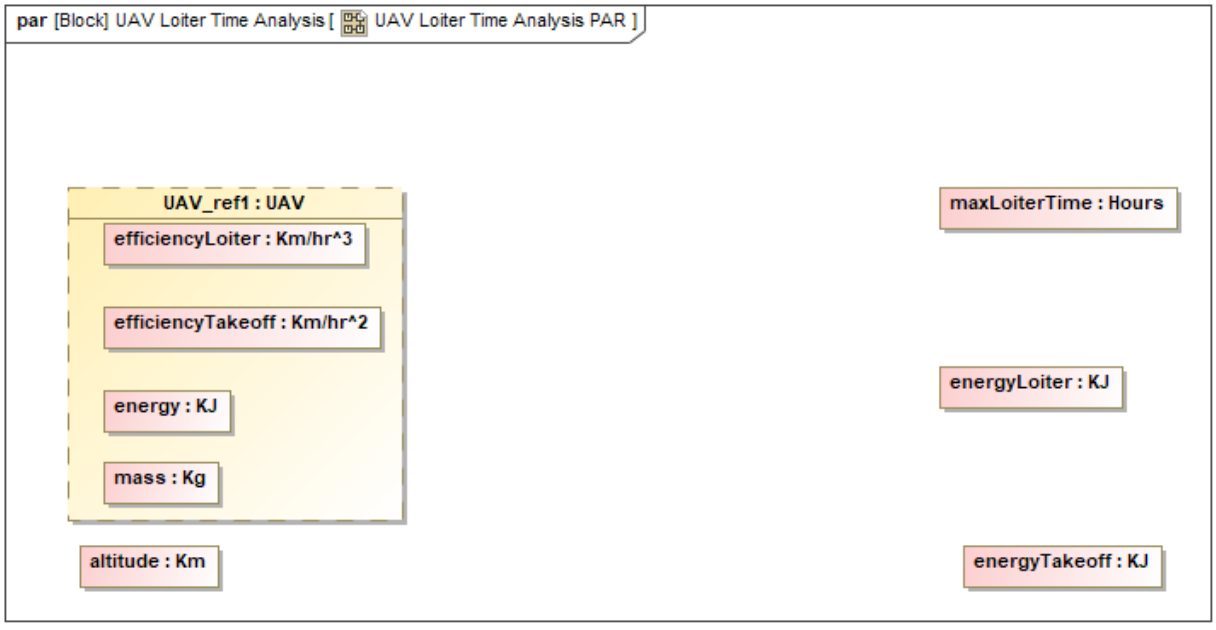

Figure 4 UAV Loiter Time Analysis PAR, stage 1

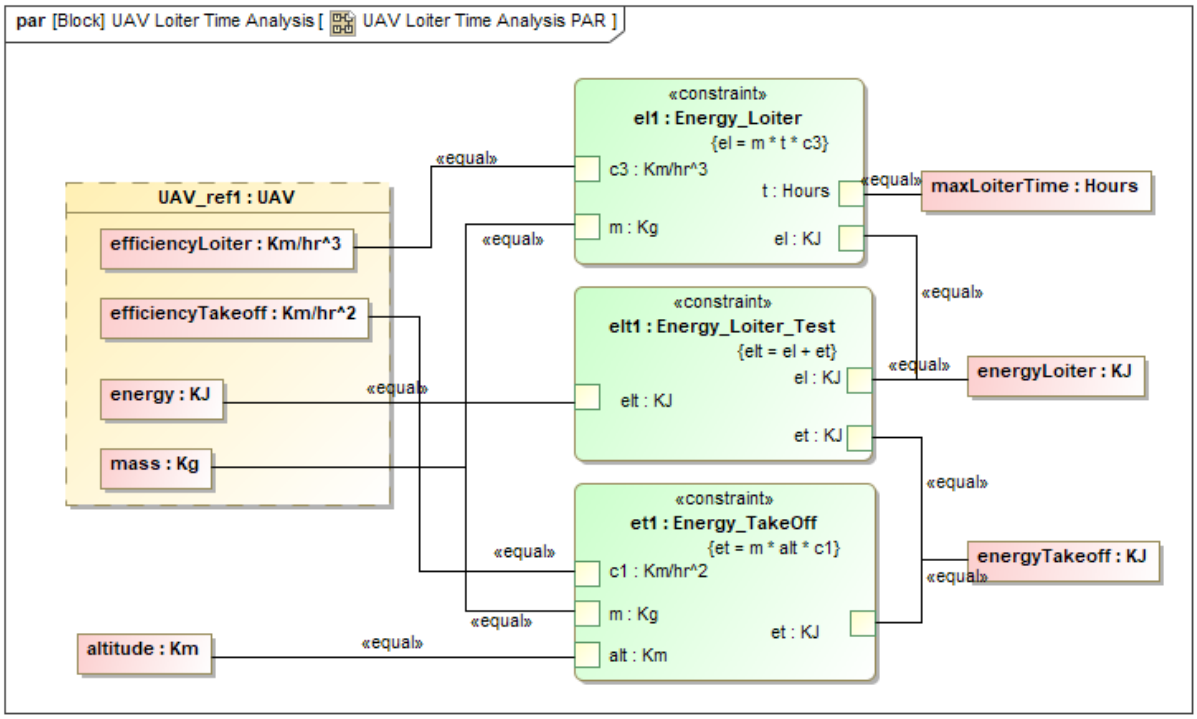

Figure 5 UAV Loiter Time Analysis PAR, stage 2

5.3.5 Create an Instance of the UAV structure

- Right-click the **UAV** block in the browser.
- Select Tools → Create Instance...
- Using the instance creation wizard, create the instance structure in a new package **Instance 5.1** in the **UAV Analysis** package. There is no need to create a diagram.
- In order for ParaMagic to validate the instance model, the instances for the radar and cameras must also be assigned to the slot corresponding to the **pc** part property (the instance creation wizard does not do this initially). Open the specification window for **uav.pyld:Payload**, select Slot in the left column (Figure 6), create a value for pc in the central column, and assign **uav.pyld.tc1**, **uav.pyld.vc1**, and **uav.pyld.r1** to the slot.

5.3.6 Create an Instance of the Loiter Time Analysis block

- Right-click the **Instance 5.1.** package in the browser
- Select Create Element → Instance Specification. Name the new instance **lta5.1**.
- Select **lta5.1** and open its Specification window.
- In the first window, click to the right of Classifier in the table, then click the Edit button.
- In the second window, start typing in UAV Loiter Time Analysis in the search by name field. When the **UAV Loiter Time Analysis** block appears below, double-click it to select it and close the window.

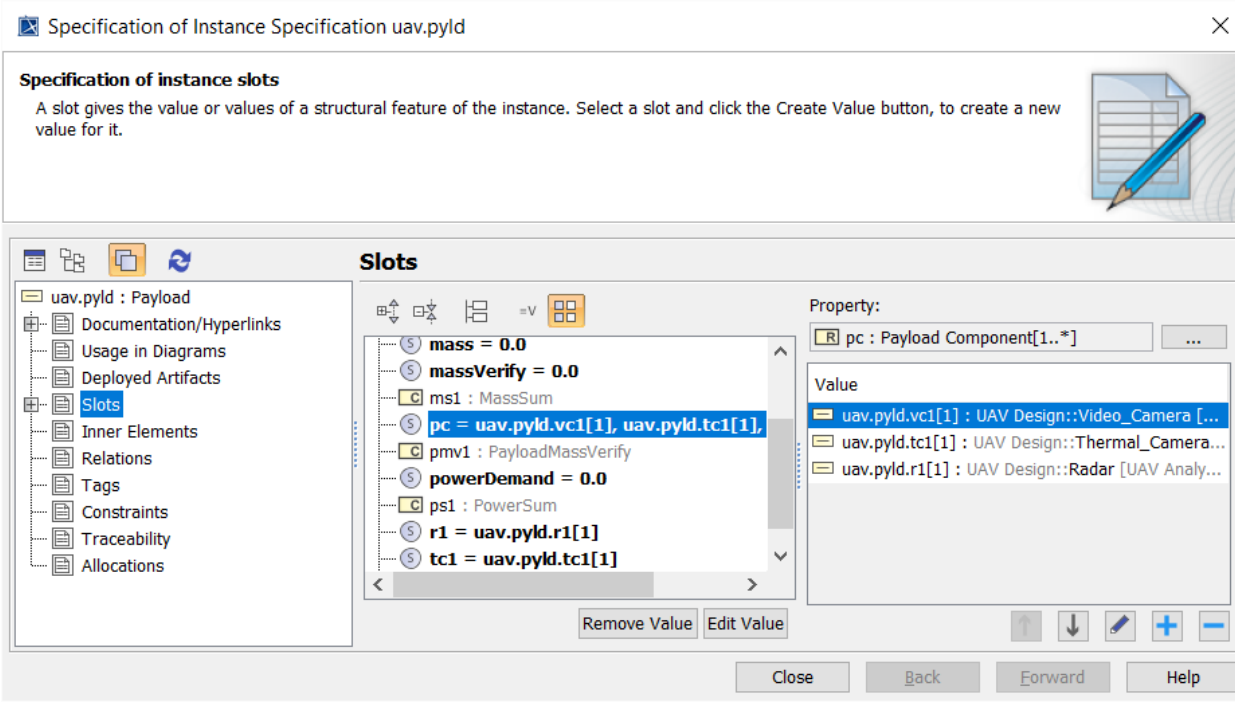

*Figure 6 Assigning camera and radar instances to **pc** slot*

- In the left box of the Specification window, click on Slots (Figure 7).
- In the center box, double-click on **uav_ref1**. Assign **uav:UAV** to fill slot (Figure 8).
- Close the instance Specification window.

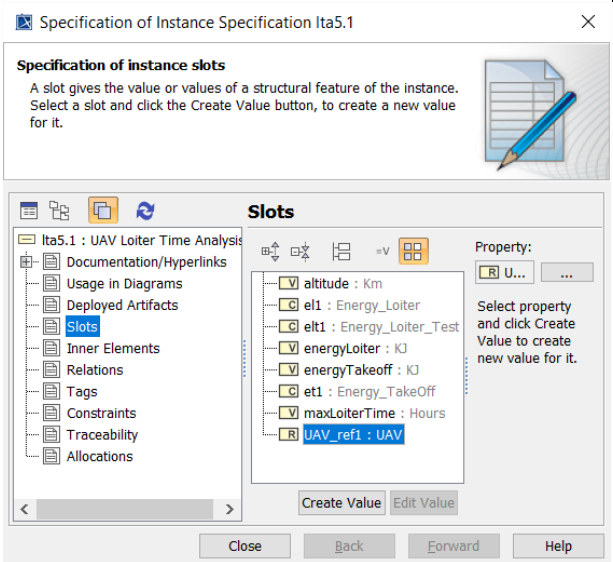

Figure 7 Populating uav_ref1 slot, stage 1

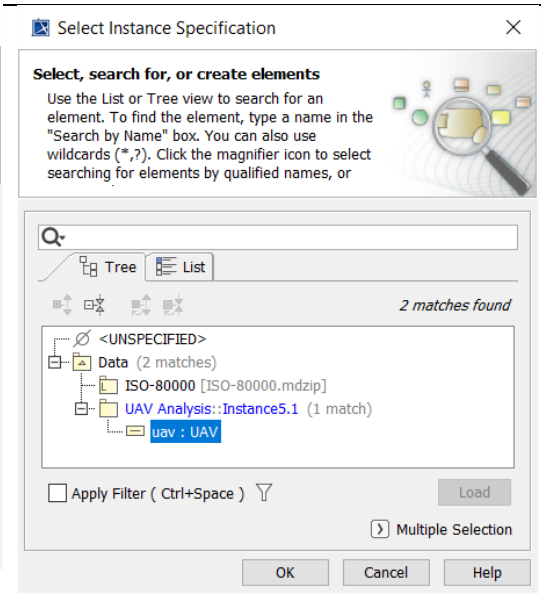

Figure 8 Populating uav_ref1 slot, stage 2

5.3.7 **Assign Values and Causalities to the Instance**

- Select the **lta5.1:UAV Loiter Time Analysis** instance in the browser and click the ParaMagic icon in the Main Toolbar.
- Initialize and reassign causality for all slots as requested.
- Expand the ParaMagic browser until all parameters are shown.
- Enter the causality and values for all parameters as shown in Table 1. Parameters without causalities do no need to be entered at this time.
- Update to SysML and save project to save causalities and values.
- Relaunch ParaMagic browser and click Solve.
- Results appear as in Figure 9.

Parameter	Causality	Value
UAV Loiter Time Analysis.altitude	given	0.50
UAV Loiter Time Analysis.energyLoiter	undefined	
UAV Loiter Time Analysis.energyTakeoff	undefined	
UAV Loiter Time Analysis.maxLoiterTime	target	
uav_ref1.efficiencyLoiter	given	1.0
uav_ref1.efficiencyTakeoff	given	1.0
uav_ref1.energy	given	1000
uav_ref1.mass	undefined	
pltfrm.mass	given	250
pyld.cost	target	
pyld.dataRate	target	
pyld.mass	undefined	
pyld.massVerify	target	
pyld.powerDemand	target	
r1.cost	given	1000
r1.dataRate	given	0.50
r1.mass	given	20.0
r1.powerDemand	given	2.0
tc1.cost	given	1000
tc1.dataRate	given	1.00
tc1.mass	given	20.0
tc1.powerDemand	given	1.0
vc1.cost	given	200
vc1.dataRate	given	2.00
vc1.mass	given	10.0
vc1.powerDemand	given	0.20

Table 1 Causalities and Values for Instance5.1, UAV Loiter Time Analysis

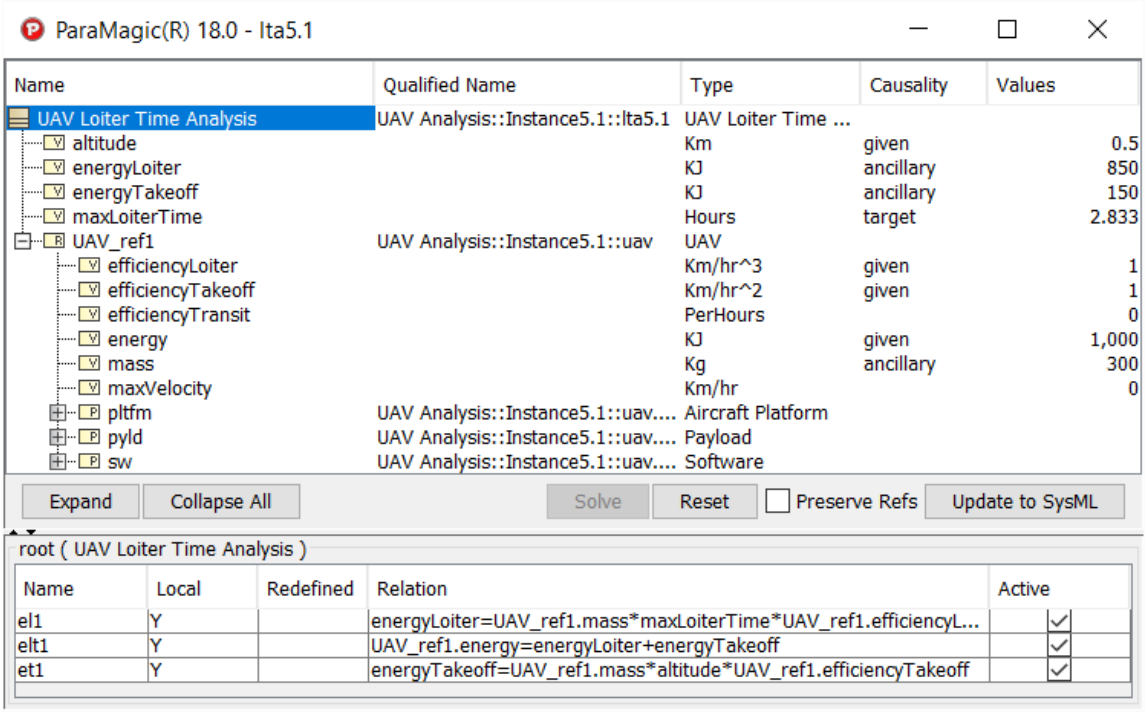

Figure 9 ParaMagic browser, solution, Max Loiter Time

5.3.8 Create and Solve Instance of the UAV Range Analysis block

- Repeat process for UAV Range Analysis. The parametric diagram is shown in Figure 10. Additional parameter values are in Table 2.
- Solve for maximum range. See Figure 11.
- Close and save the project.

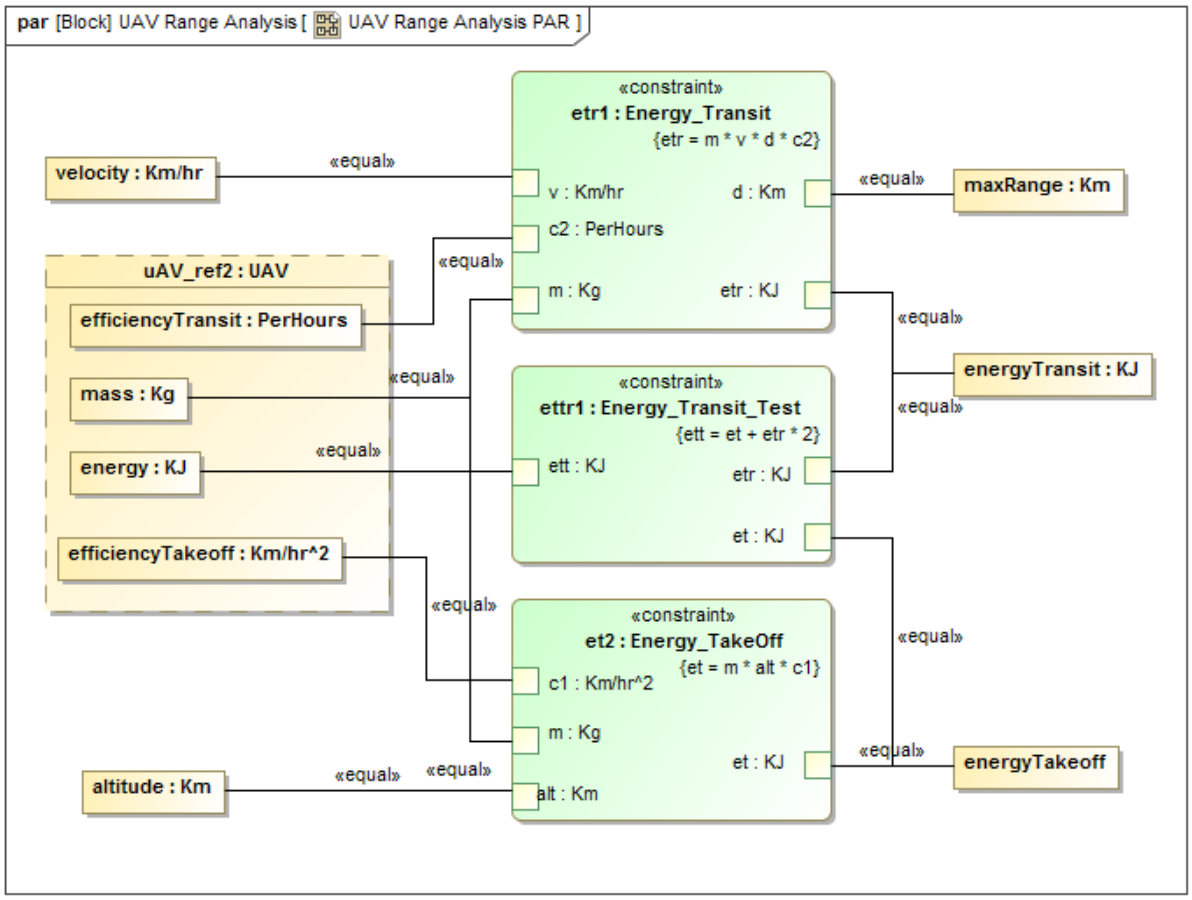

Figure 10 UAV Loiter Time Analysis PAR, stage 2

Parameter	Causality	Value
UAV Range Analysis.altitude	given	0.50
UAV Range Analysis.energyTransit	undefined	
UAV Range Analysis.energyTakeoff	undefined	
UAV Range Analysis.maxRange	target	
UAV Range Analysis.energy	given	1000
UAV Range Analysis.velocity	given	100
uav_ref1.efficiencyTransit	given	0.01

Table 2 Causalities and Values for Instance5.1, UAV Range Analysis

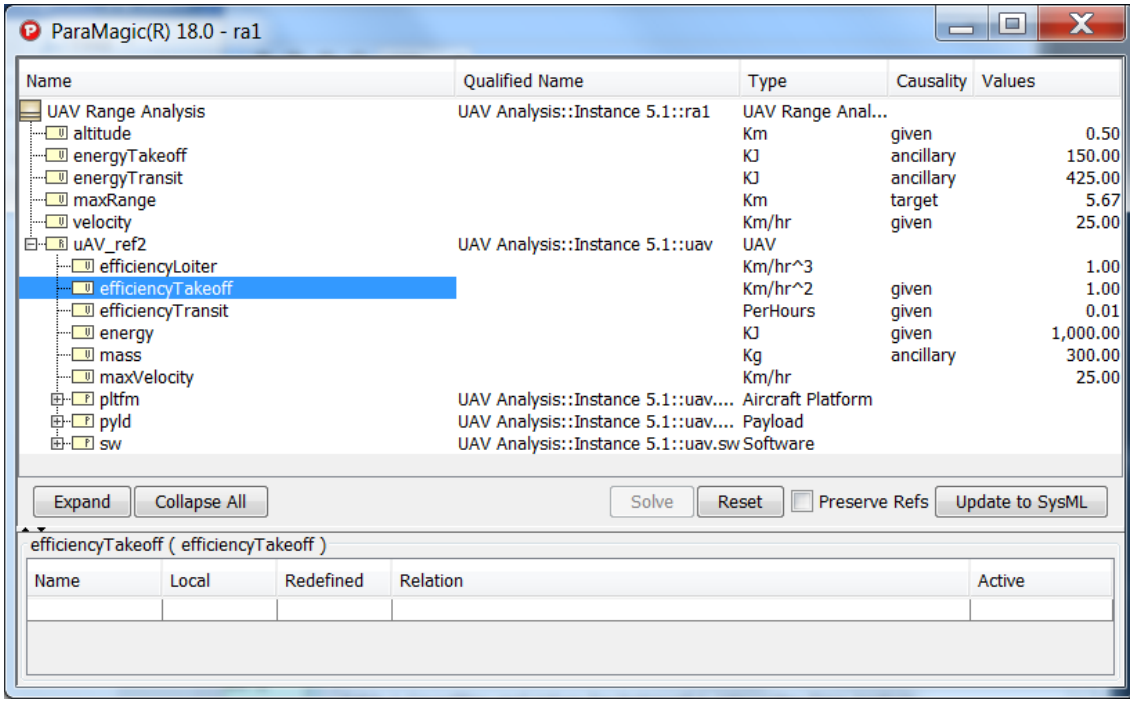

Figure 11 ParaMagic browser, solution, Max Range