SysML Hands-On Exercises

Exercise 4.1
SysML Requirements and Requirements Diagrams

MagicDraw

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OBJECTIVES

The objectives of this exercise are to

- Create a Requirements Table from existing Requirements
- Create a Requirements Diagram
- Create a Requirements hierarchy in the diagram
- Create a second Requirements Diagram
- Add Dependencies between Requirements and other SysML Elements

This process is intended to represent an early step in creating a SysML system model for the UAV system establishing system requirements.

PREPARATION

1. This exercise assumes the student has Cameo System Modeler 19.0 (or MagicDraw 19.0 with SysML plug-in) installed correctly on his or her machine with a valid license for use.
2. The student should load the Part 4 course materials onto the computer, specifically Exercise 4.1 Starter UAV.mdzip and Exercise 4.1 Final UAV.mdzip.
3. The student should view the video Introduction to SysML Part 4 Exercise 4.1 in its entirety before attempting the exercise.
4. By this stage, we also recommend installing the ParaMagic plug-in for MagicDraw (ParaMagic 18.0 or later).

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

4.1.1 Start Cameo System Modeler

4.1.2 Open Exercise 4.1 Starter UAV.mdzip

4.1.3 Create a Requirements Table

- Right-click on the **UAV Requirements** package in the browser.
- Select Create Diagram → Requirement Table
- Name the table **UAV Reqt Table**.
- Expand the **UAV Requirements** package in the browser.
- Select all twelve requirements using shift-left-click.
- Drag the requirements into the empty table.
- The top part of the requirements table should appear as in Figure 1.

#	△ Name	Text
1	R 1 Payload Power Demand	The UAV shall support a payload power demand of up to 1 kW.
2	R 2 Payload Data Rate	The UAV shall support a payload data rate out of up to 8 Mb/s.
3	R 3 Payload Mass	The UAV shall support a payload mass of up to 50 kg.
4	R 4 Autonomous Flight	The UAV shall be able to fly a preprogrammed course without pilot intervention.
5	R 5 Autonomous Return to b	The UAV shall be able to return to base and land without pilot intervention in case of communications failure.
6	R 6 Manual Flight	The UAV shall be able to fly under direct pilot control up to 10 km from the pilot station.

Figure 1 Creating a Requirement Table (partial)

4.1.4 Create a Requirement Diagram

- Right-click on the **UAV Requirements** package in the browser.
- Select Create New Diagram → Requirement Diagram
- Name the diagram **UAV REQ**.
- Select all twelve requirements using shift-left-click in the browser.
- Drag the requirements into the empty diagram.
- The requirement diagram at this stage should appear as in Figure 2.

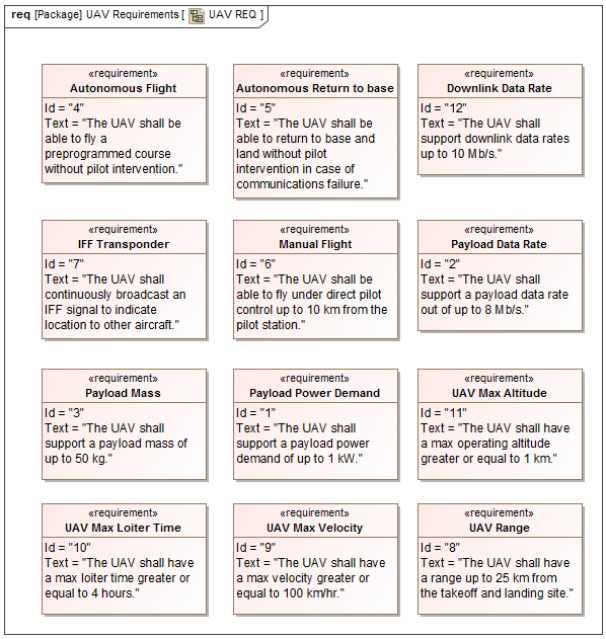

Figure 2 UAV REQ, initial

4.1.5 Create a Requirements Hierarchy

- Right-click on the **UAV Requirements** package in the browser.
- Select Create Element → Requirement
- Name the new requirement **UAV Specification.**
- Repeat these steps for three more requirements: **UAV Payload Spec**, **UAV Functional Spec**, and **UAV Performance Spec**.
- Drag the four new requirements into the **UAV REQ** diagram.
- Arrange the requirements as follows, using the video and Figure 3 as a guide. The exact ordering of the symbols is not important for this exercise.
    - **UAV Specification** is at the top of the diagram.
    - **UAV Payload Spec**, **UAV Functional Spec** and **UAV Performance Spec** are in a row directly below **UAV Specification**
    - Below **UAV Payload Spec**, in a column, are **Payload Mass**, **Payload Power Demand** and **Payload Data Rate**
    - Below **UAV Functional Spec**, in a column, are **Manual Flight**, **Autonomous Flight**, **Autonomous Return to Base** and **IFF Transponder**
    - Below **UAV Performance Spec**, in a column, are **UAV Range**, **UAV Max Velocity**, **UAV Max Loiter Time**, **UAV Max Altitude** and **Downlink Data Rate**
- Select the sticky button at the top of the diagram toolbar. Click the Containment icon on the floating toolbar next to the **UAV Specification**. Use containment relationships as shown in Figure 3 to create a single hierarchy. Press the Escape key and unselect the sticky button when complete.
- Right-click the **UAV Specification** requirement and select Element Numbering.
    - In the Element Numbering window (Figure 4), if needed, click Edit and set the ID for UAV Specification to 1
    - Make sure Numbering Scheme is set to Multi-level

- Click Details button (bottom left) to show Renumber Recursively button
- Click Renumber Recursively, then OK

- Diagram should appear as in Figure 4 (although id numbers may not be identically assigned).

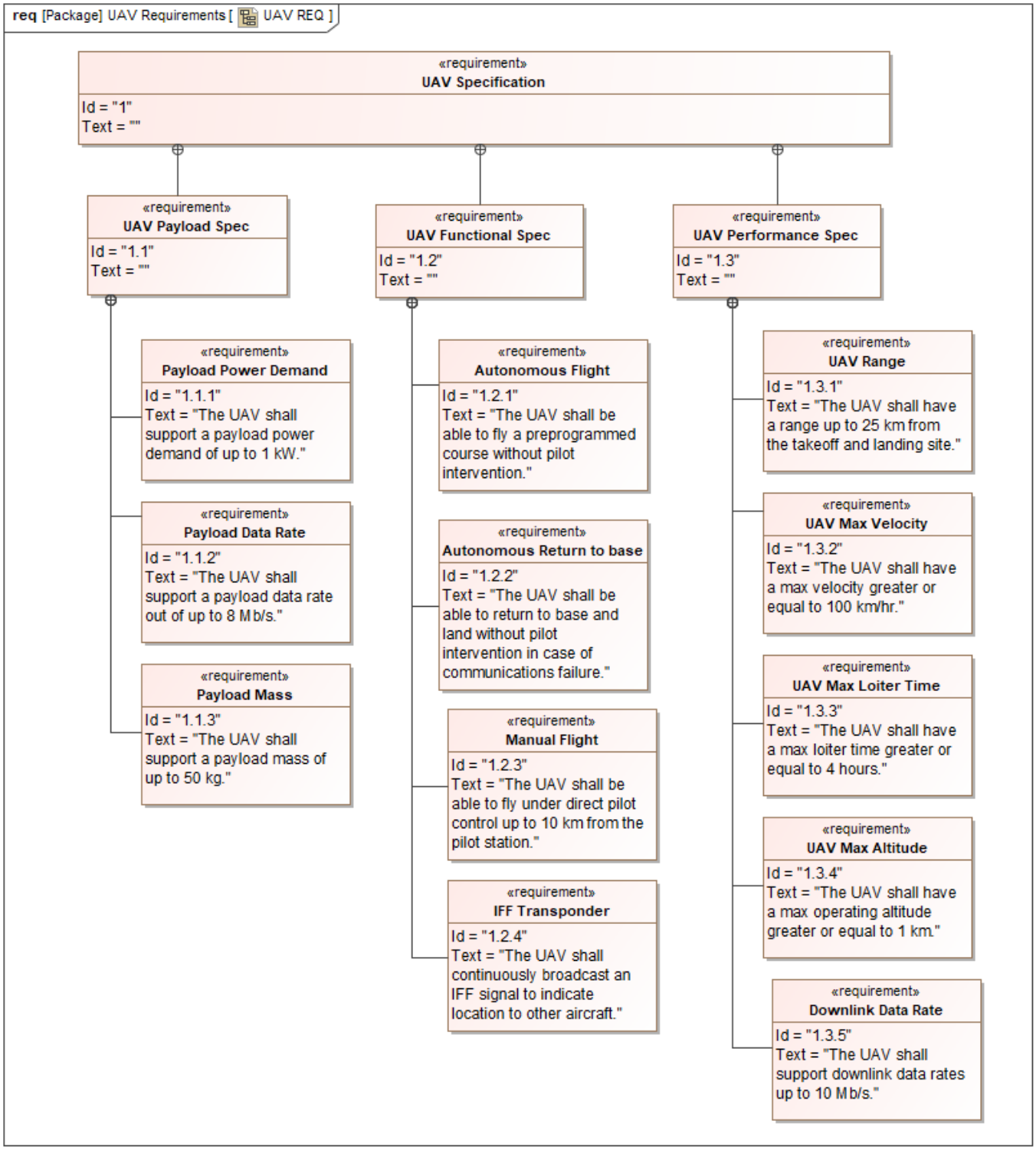

Figure 3 UAV REQ, Final

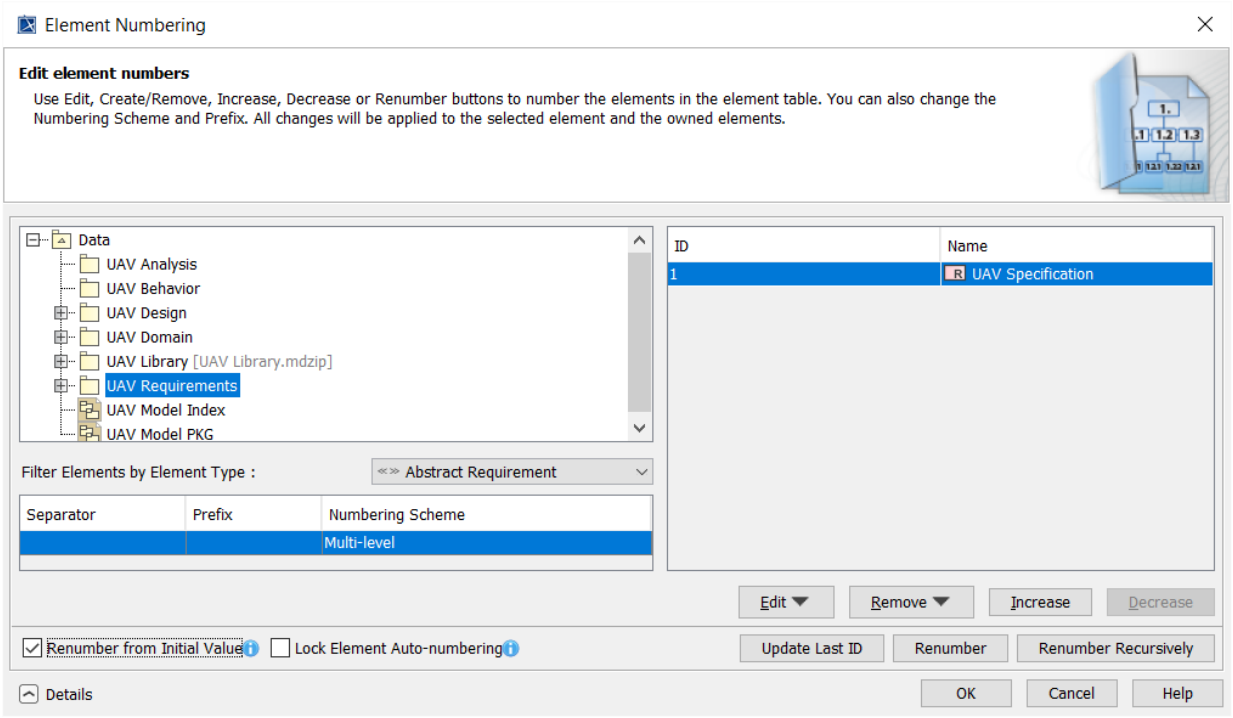

Figure 4 Element Numbering window

4.1.6 Create a Second Requirement Diagram with Dependencies

- Right-click **UAV Requirements** in the Containment Browser and choose Create Diagram → Requirement Diagram.
- Name the diagram **UAV Dependency Example REQ**.
- Drag the following elements from the browser into the diagram.
    - **UAV Payload Spec**, **Payload Power Demand** and **Autonomous Return to Base** from **UAV Requirements** package
    - **FAA Regulations: 3.5.3 Autonomous Return** from **UAV Requirements::Related Elements::FAA Requirements**
    - **Independent Power Supply** from **UAV Requirements::Related Elements::Tech Requirements**
    - **Flight Test Profile B** testcase from **UAV Requirements::Related Elements:: Testcases**
    - **Payload Power Supply** block from **UAV Design** package
    - **Return to Base Autonomously** use case from **UAV Domain::UAV Use Cases**
- To show any existing relationships between any of these elements, click inside the diagram, hit Ctrl-A, right-click on any of the elements and choose Display → Display Paths. Answer Yes to the question.
- Create the following dependencies, using either the floating toolbar or the Requirements Diagram section of the central Diagram Toolbar.

- Derive from **Independent Power Supply** to **Payload Power Demand**
- Satisfy from **Payload Power Supply** to **Independent Power Supply**
- Trace from **Autonomous Return to Base** to **Return to Base Autonomously** use case
- Copy from **Autonomous Return to Base** to **FAA Regulations: 3.5.3 Autonomous Return**
- Verify from **Flight Test Profile B** testcase to **Autonomous Return to Base**

- The final diagram should appear similar to Figure 5, although the layout need not be the same.
- Save and close the project and return to the video lecture.

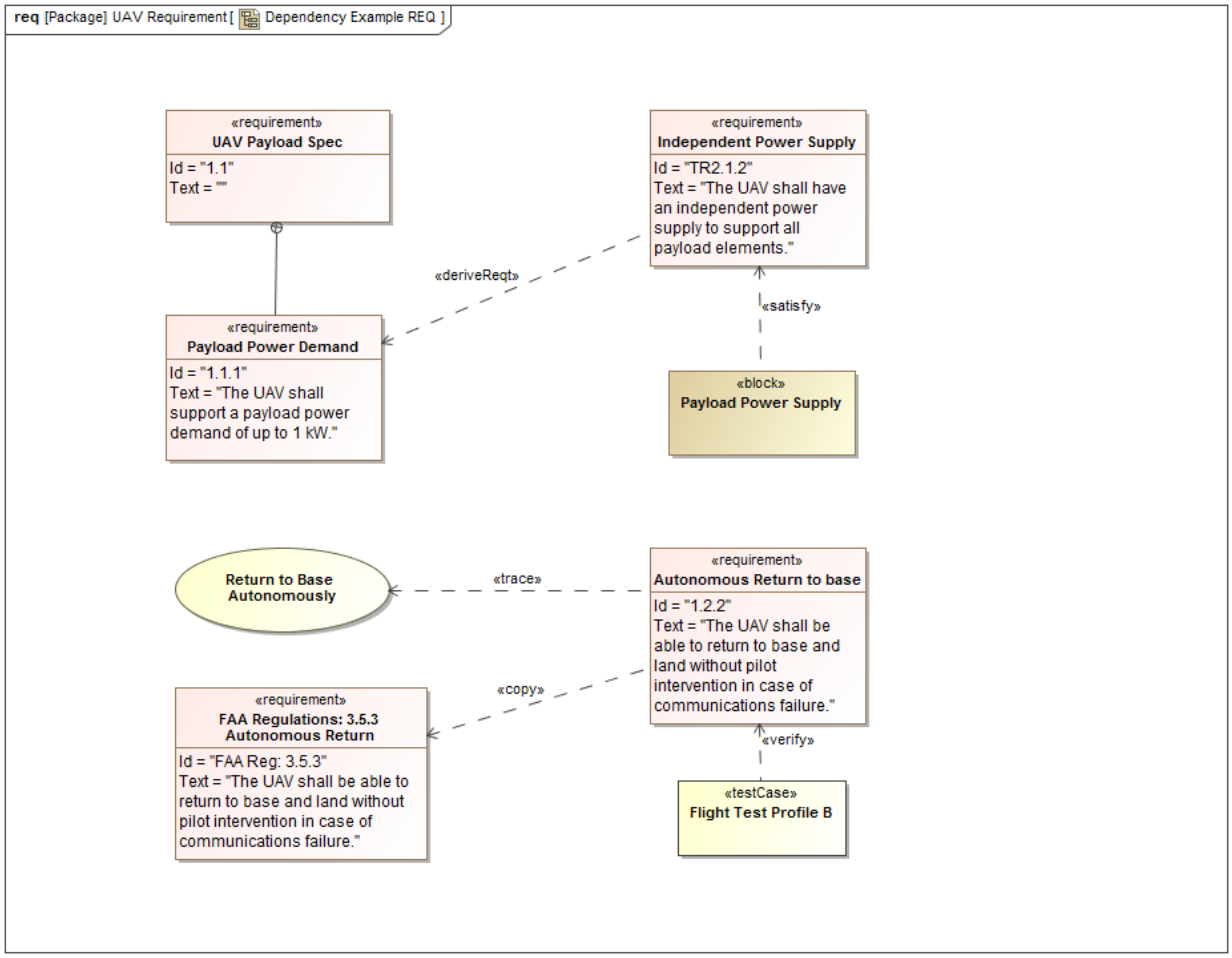

Figure 5 Final Dependency Example REQ diagram