

ProtecSys System

System requirements

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1. INTRODUCTION

1.1. Subject

The context of the study concerns the automation of a radioactive waste flow within a nuclear waste reprocessing center. For this study, conducted in a similar framework to that of the RobAFIS™ 2018 contest, the aim is to create a prototype in a mock-up environment.

The purpose of this document is to establish the set of system requirements to be met by the ProtecSys System in response to the needs expressed in the stakeholder needs definition document.

1.2. Reference documents

- Stakeholder needs: ProtecSys – Stakeholder needs V1-2.pdf.

1.3. Terminology

In this document, the system studied is referred to as either the "ProtecSys System" or "ProtecSys".

In the same way, the robotic sub-system is indifferently named "Robot" or "Mobile Robot". The personnel integrated into the system are identified as part of the ProtecSys team of students participating in the contest.

2. SYSTEM PERIMETER ANALYSIS

As a first step, the context of the system must be reviewed based on the one identified by the project owner. In particular the life cycle stages and the stakeholders involved should be amended if necessary.

2.1. Definition of the purpose and main mission

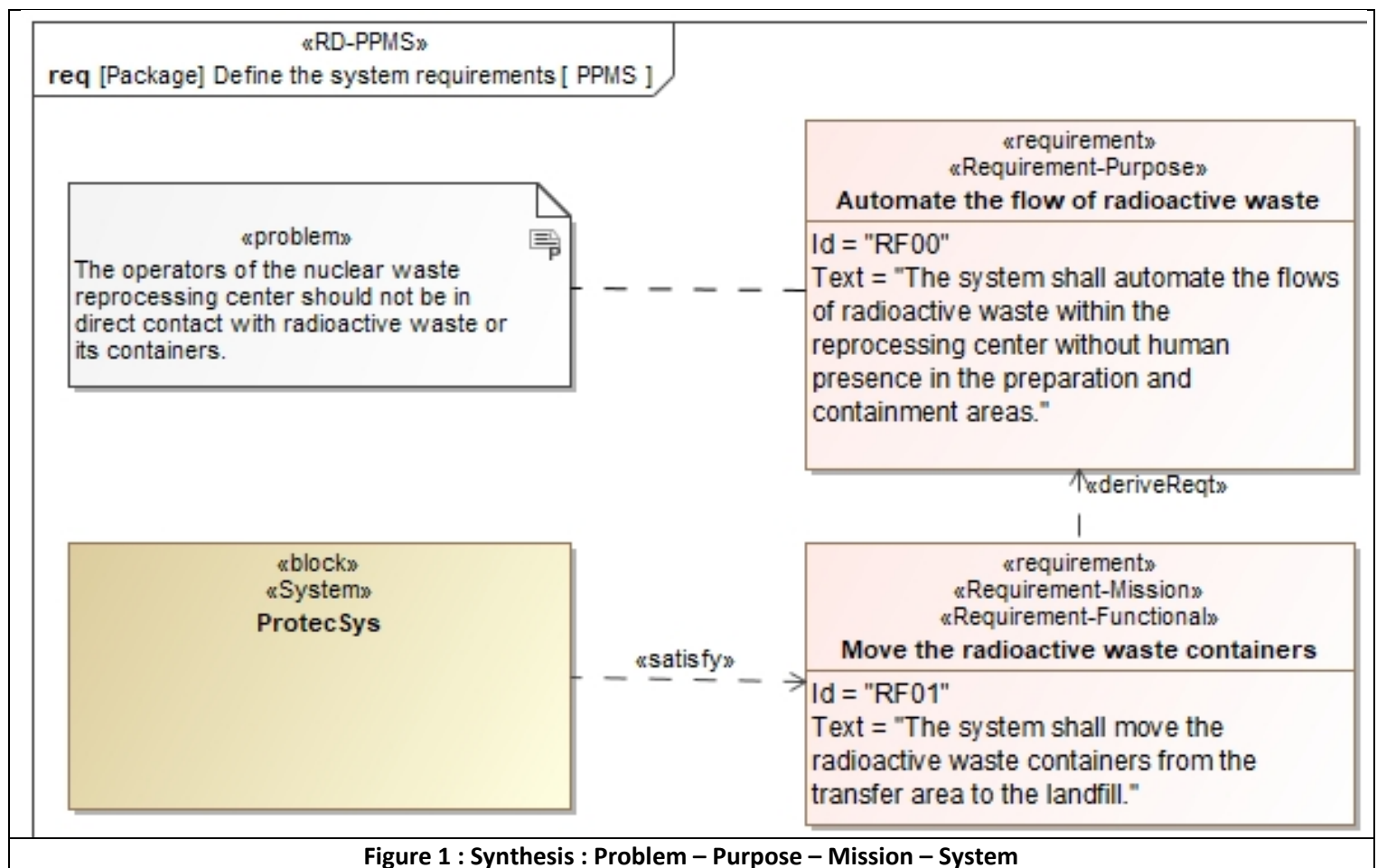


Figure 1 : Synthesis : Problem – Purpose – Mission – System

2.2. Life cycle

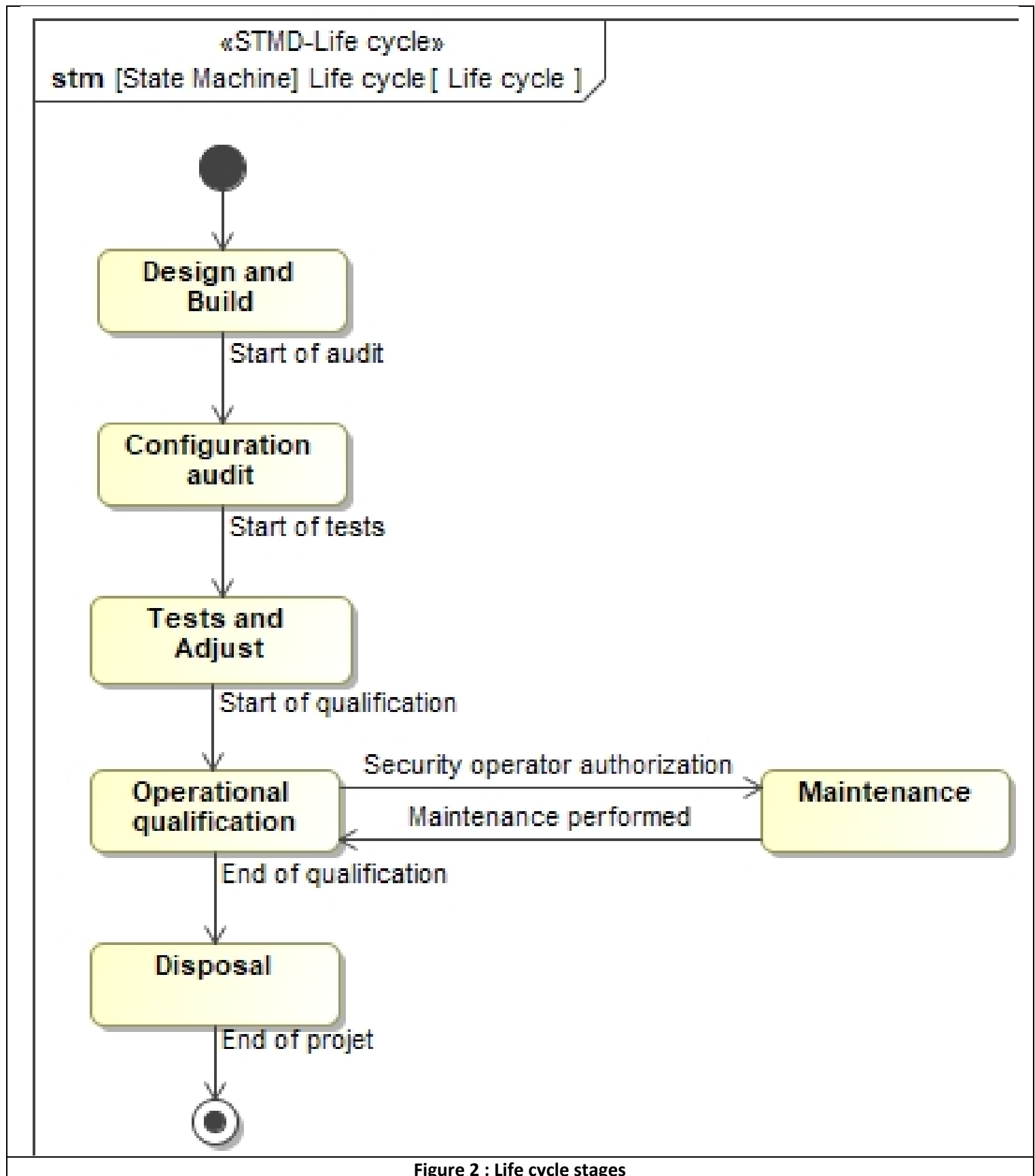
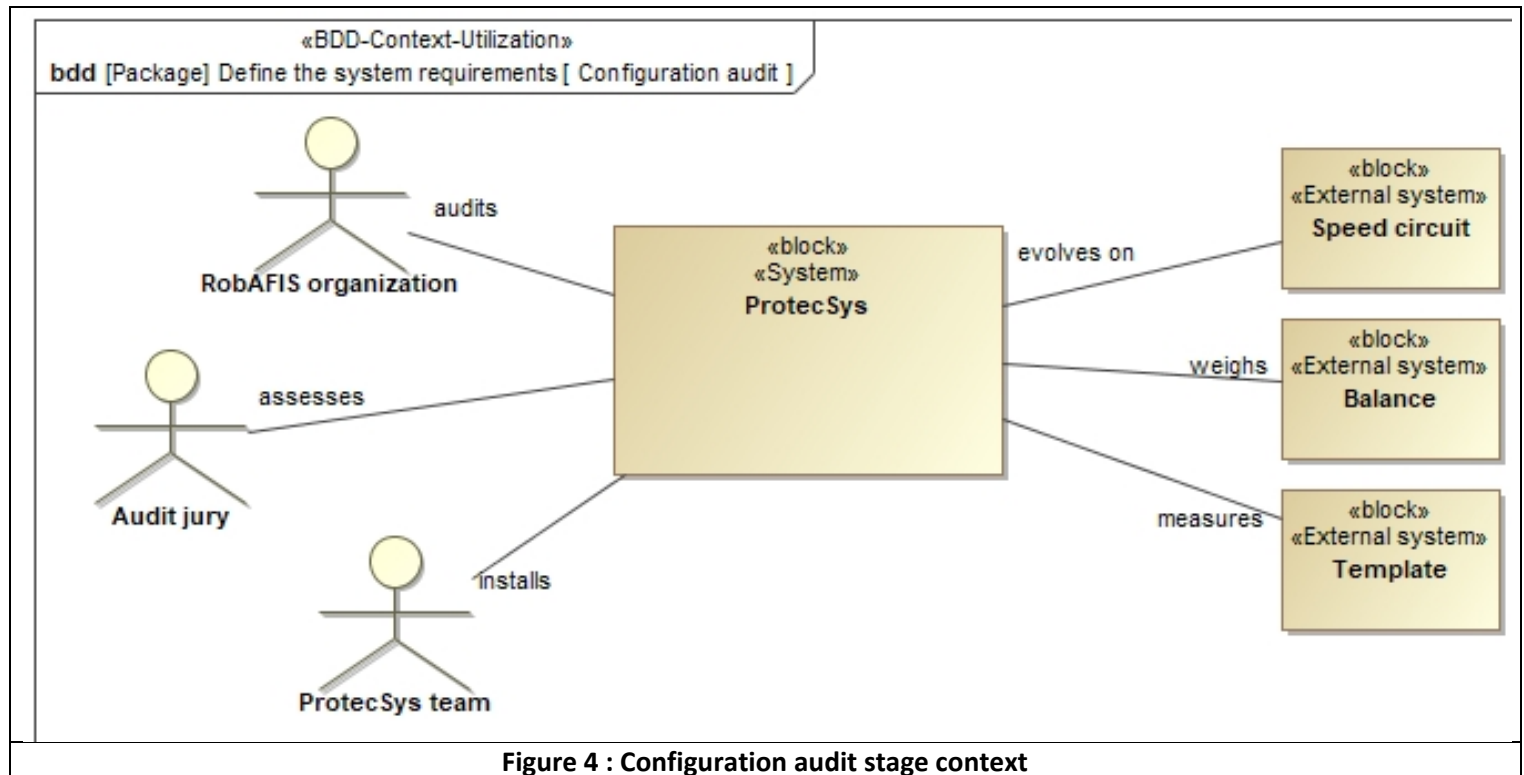
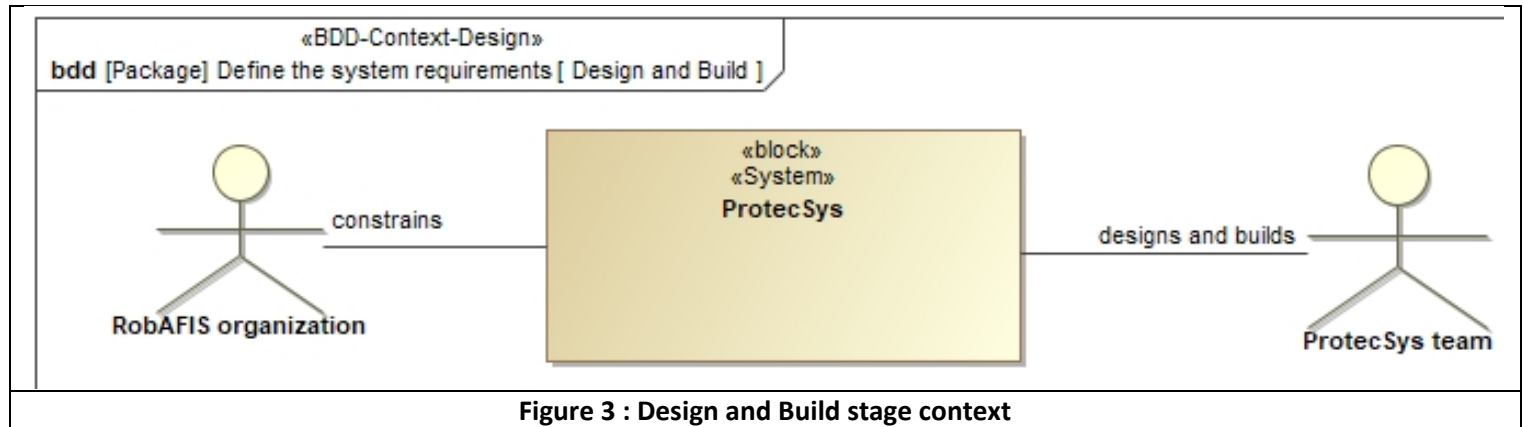
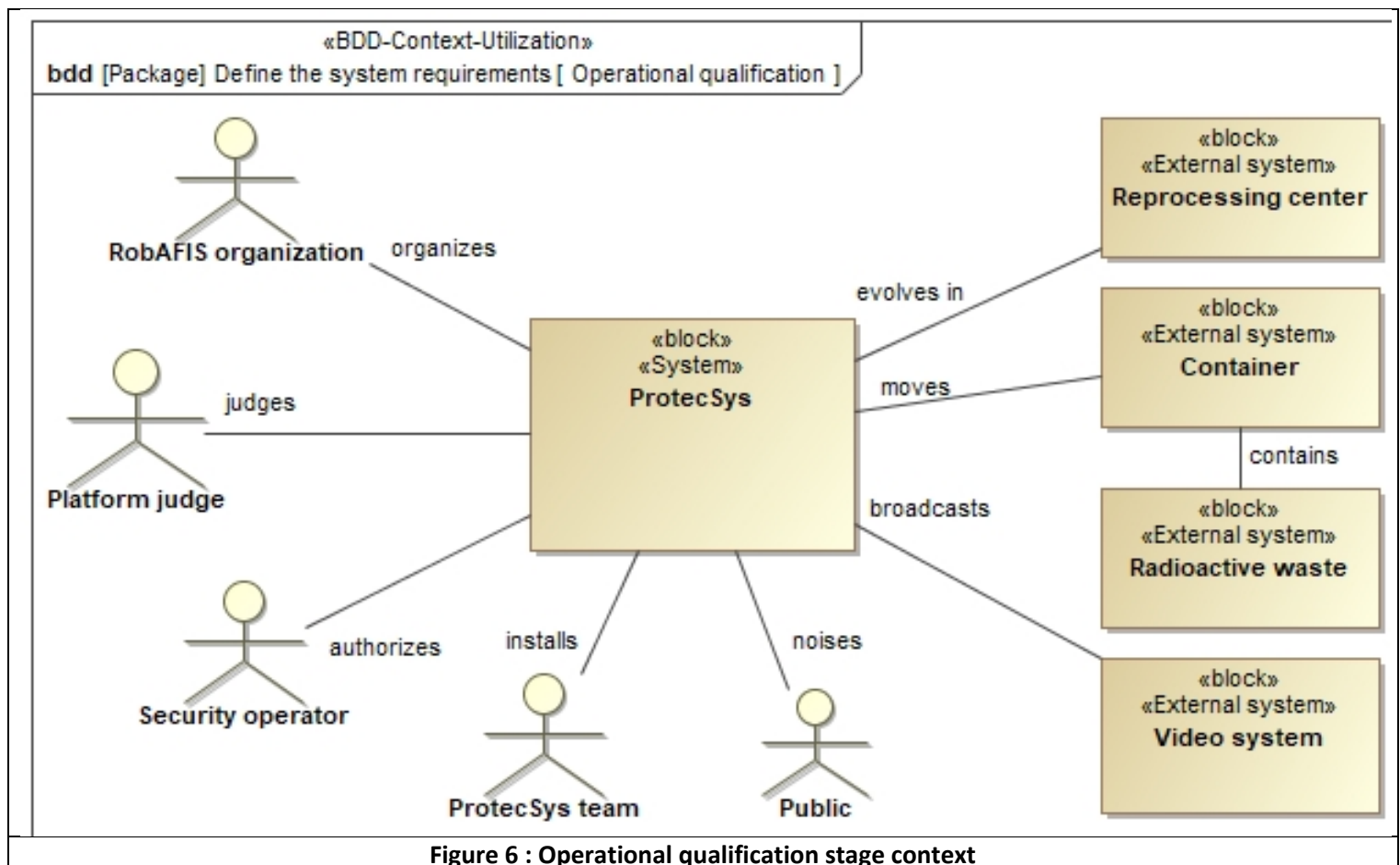
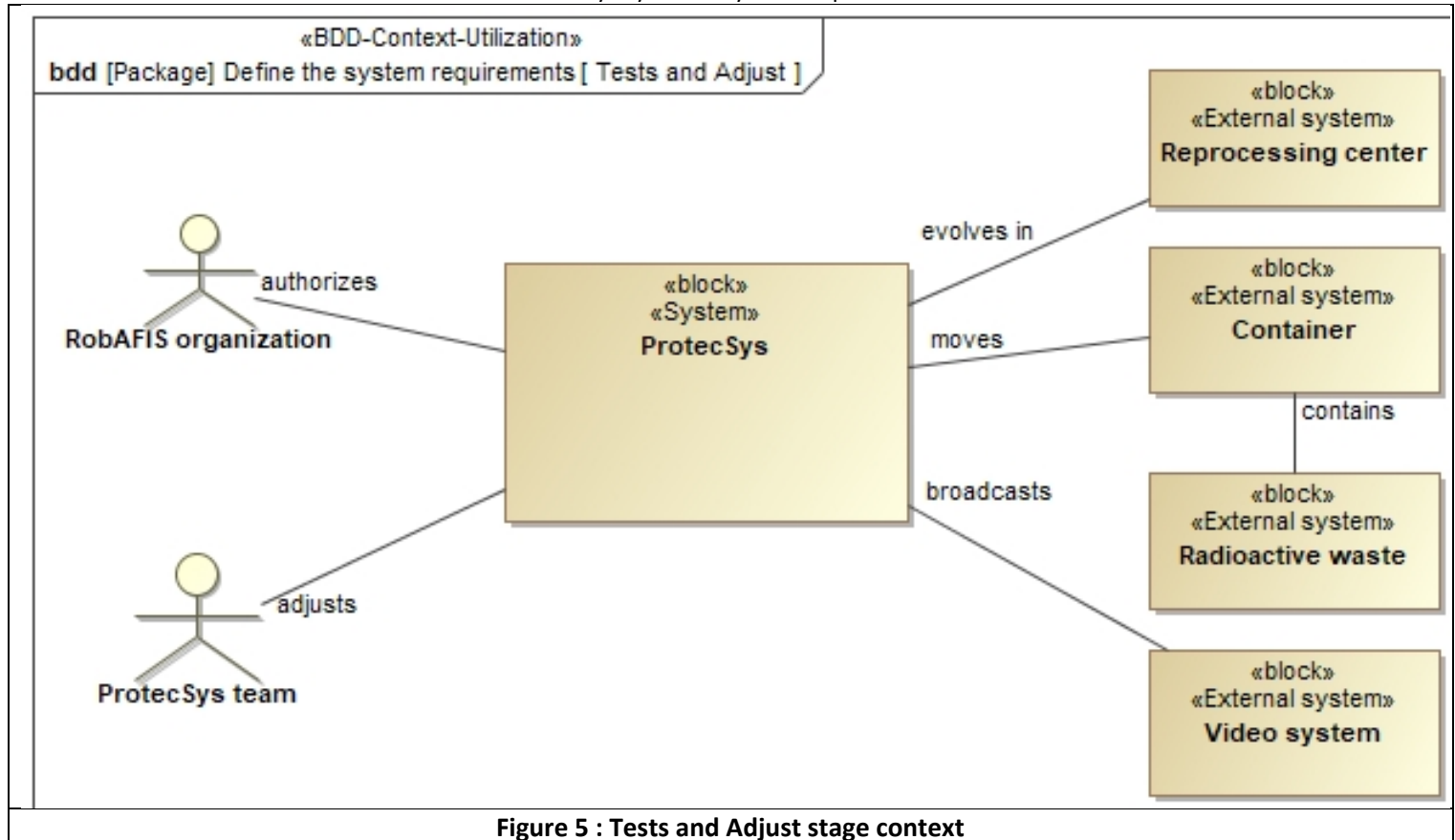
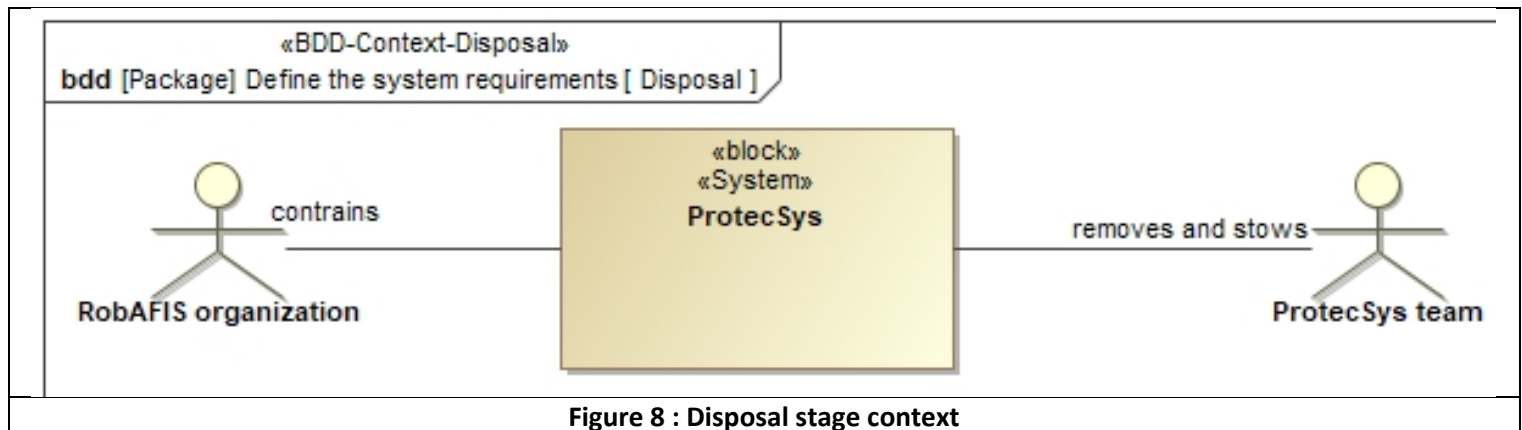
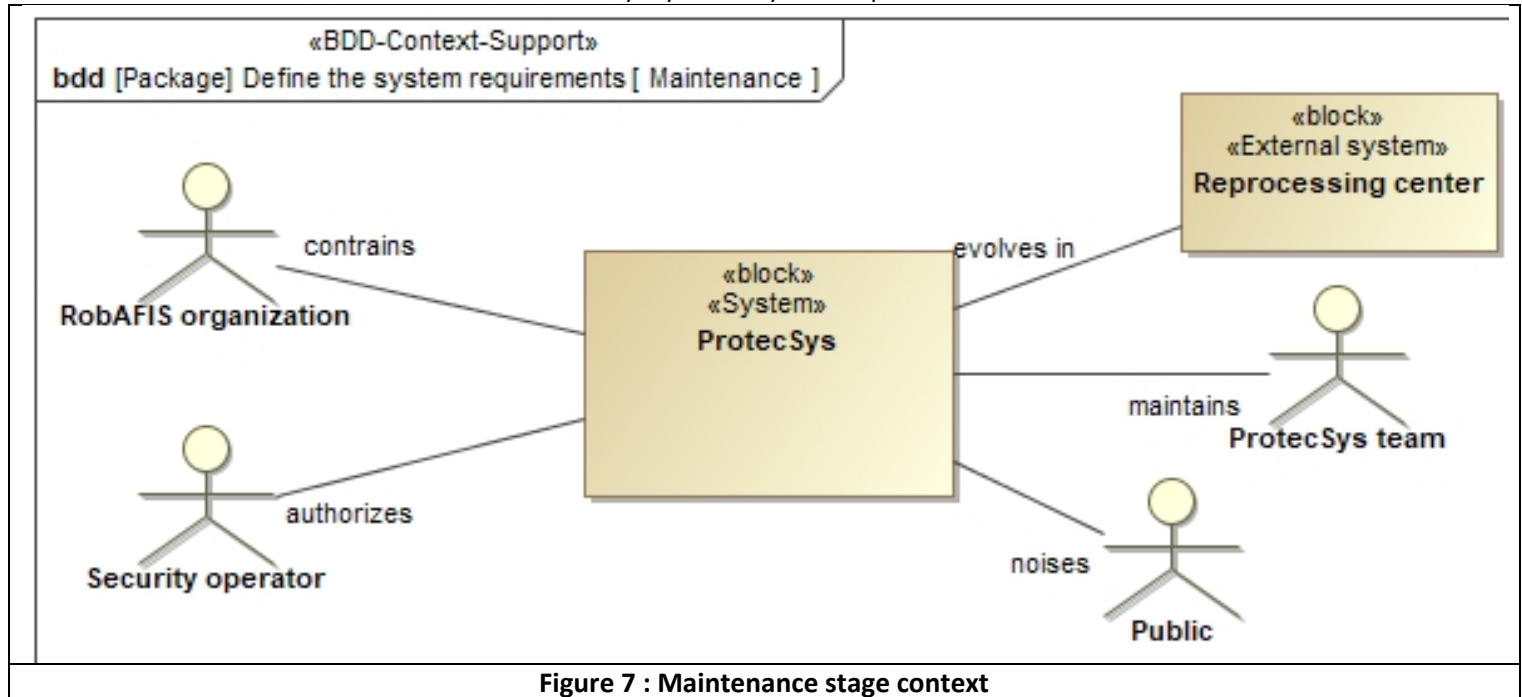


Figure 2 : Life cycle stages

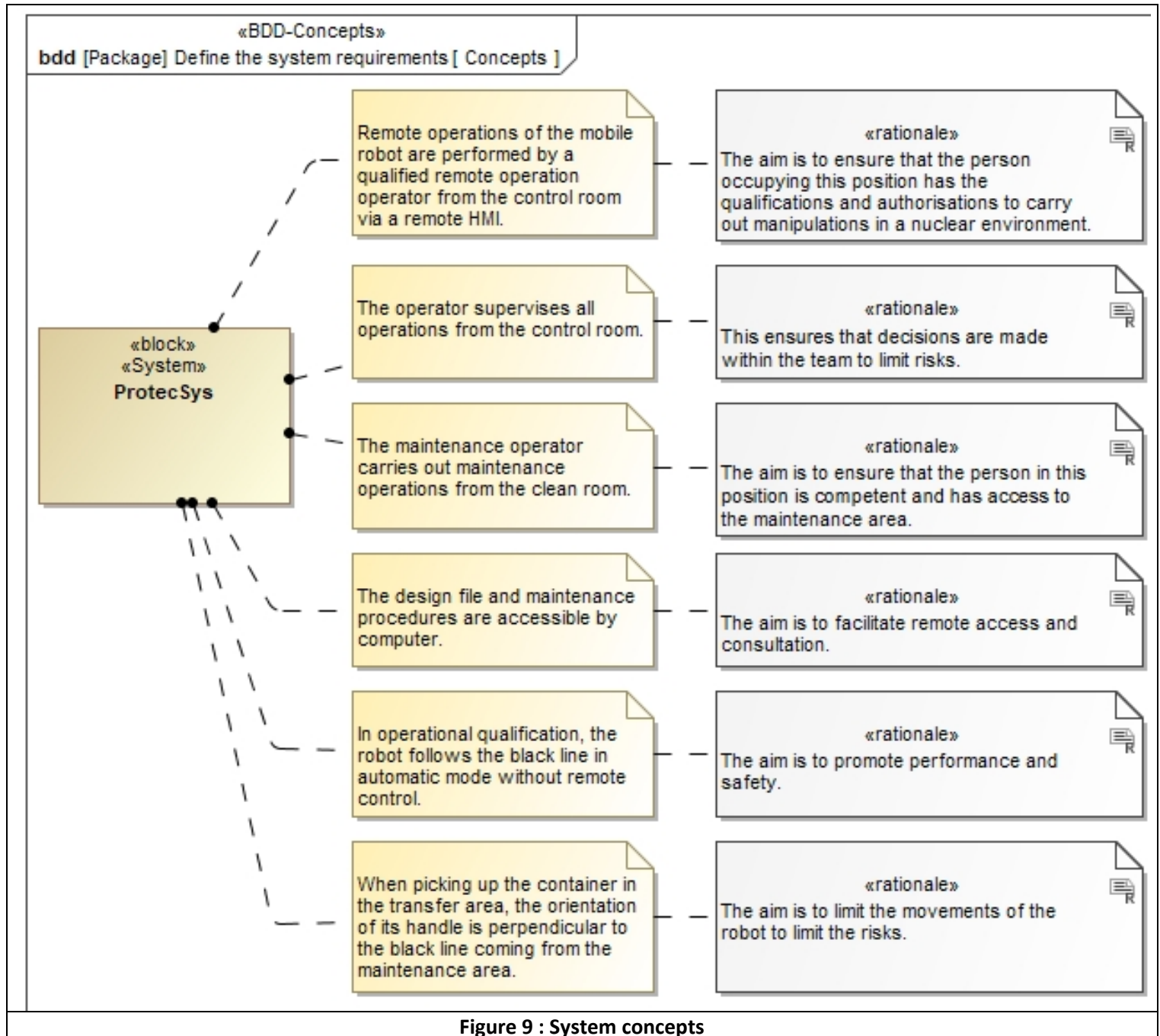
2.3. Stakeholders involved







3. DEFINITION OF THE SYSTEM CONCEPTS



4. SYSTEM'S USE

4.1. Initial architecture

The constraints expressed by the project owner impose a first architecture of the system.

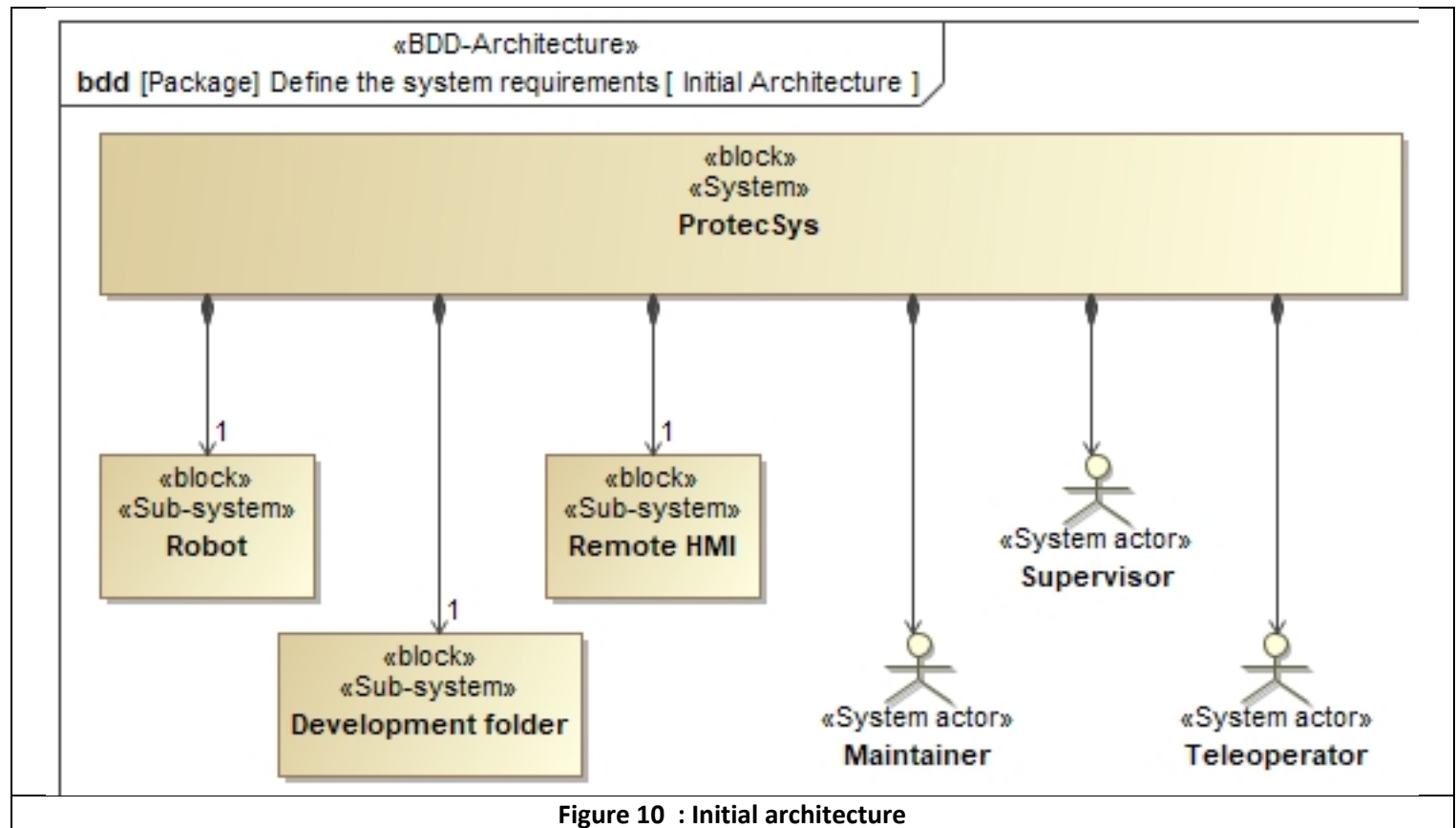
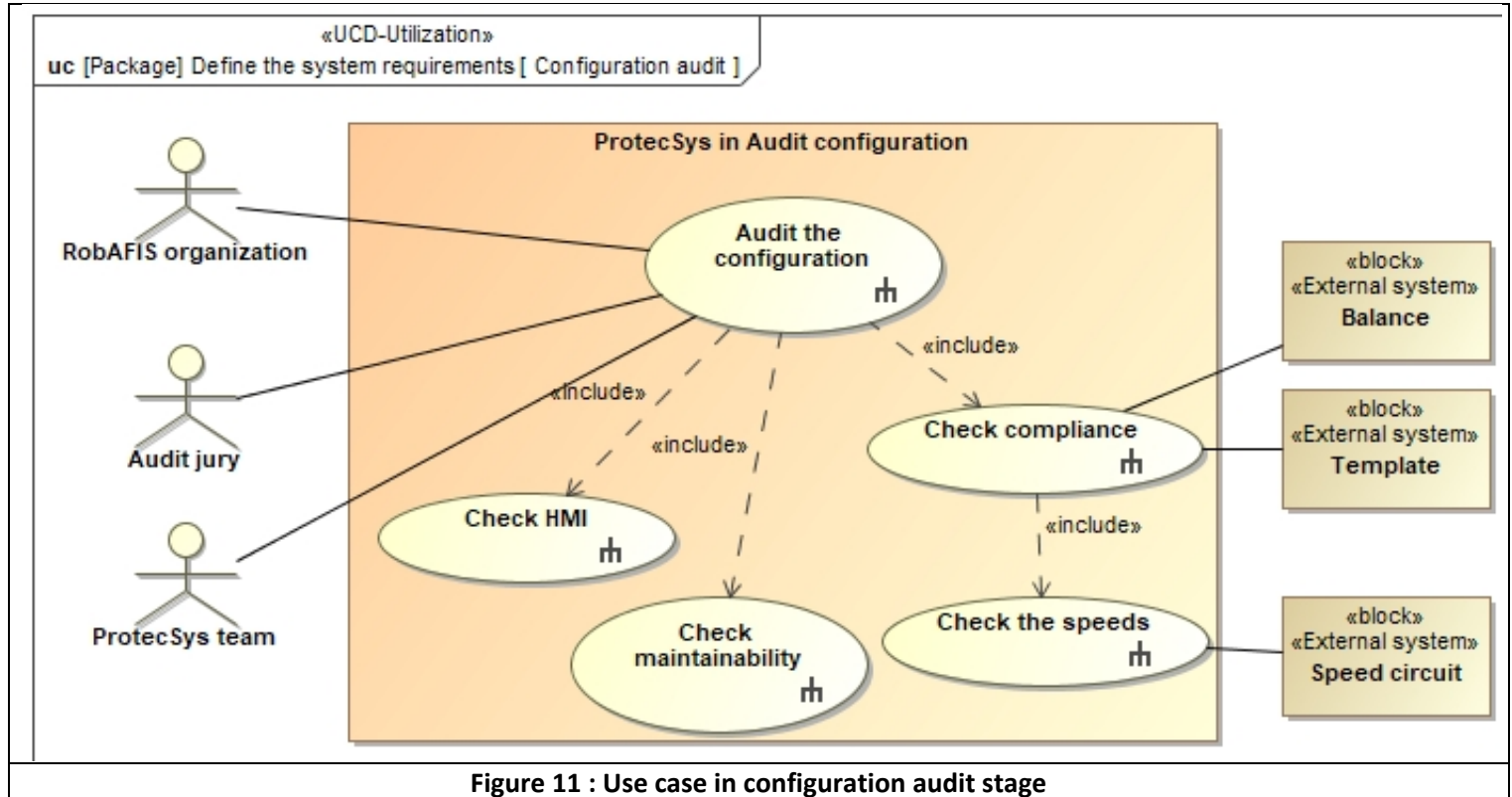


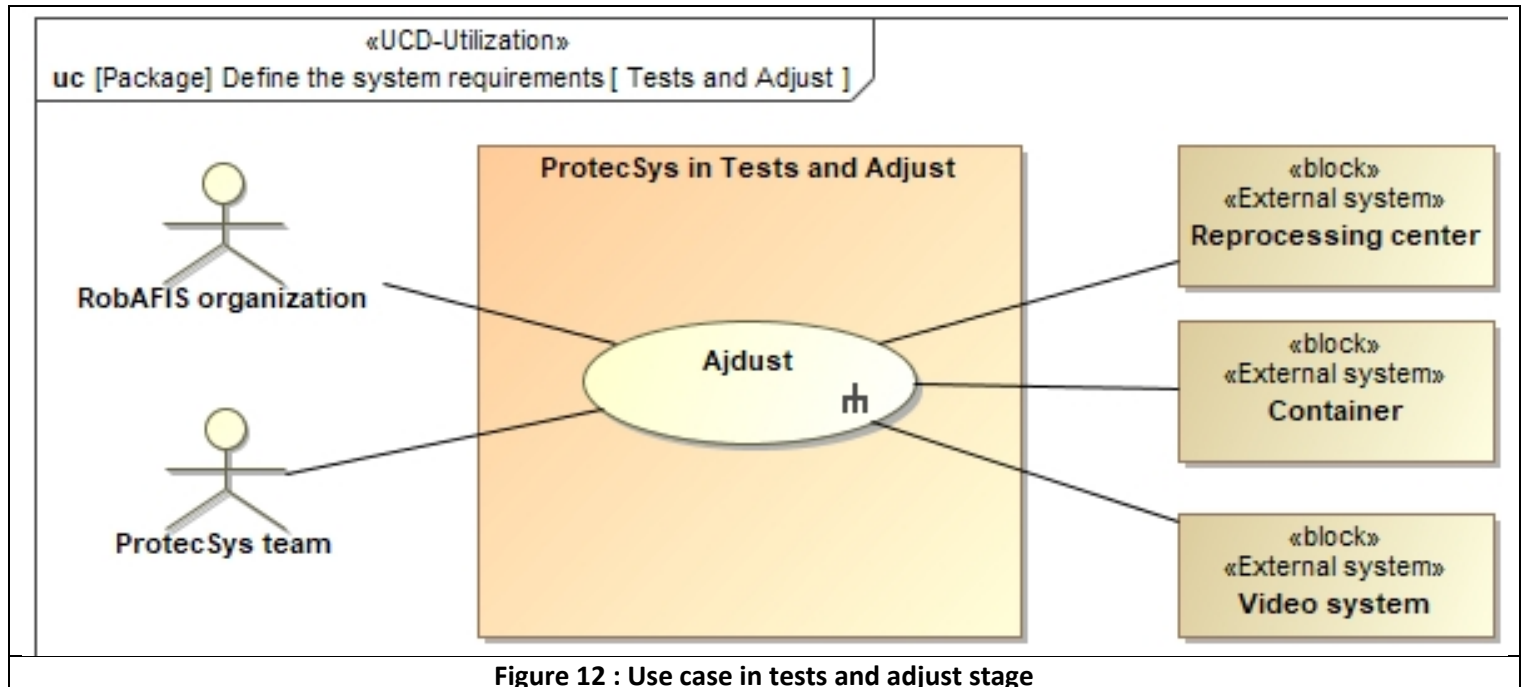
Figure 10 : Initial architecture

Here, the design and disposal phases do not give rise to use of the system. While the operational qualification and maintenance phases have been grouped together because of their common temporality.

4.2. Configuration audit stage



4.3. Tests and adjust stage



4.4. Operational qualification and maintenance stages

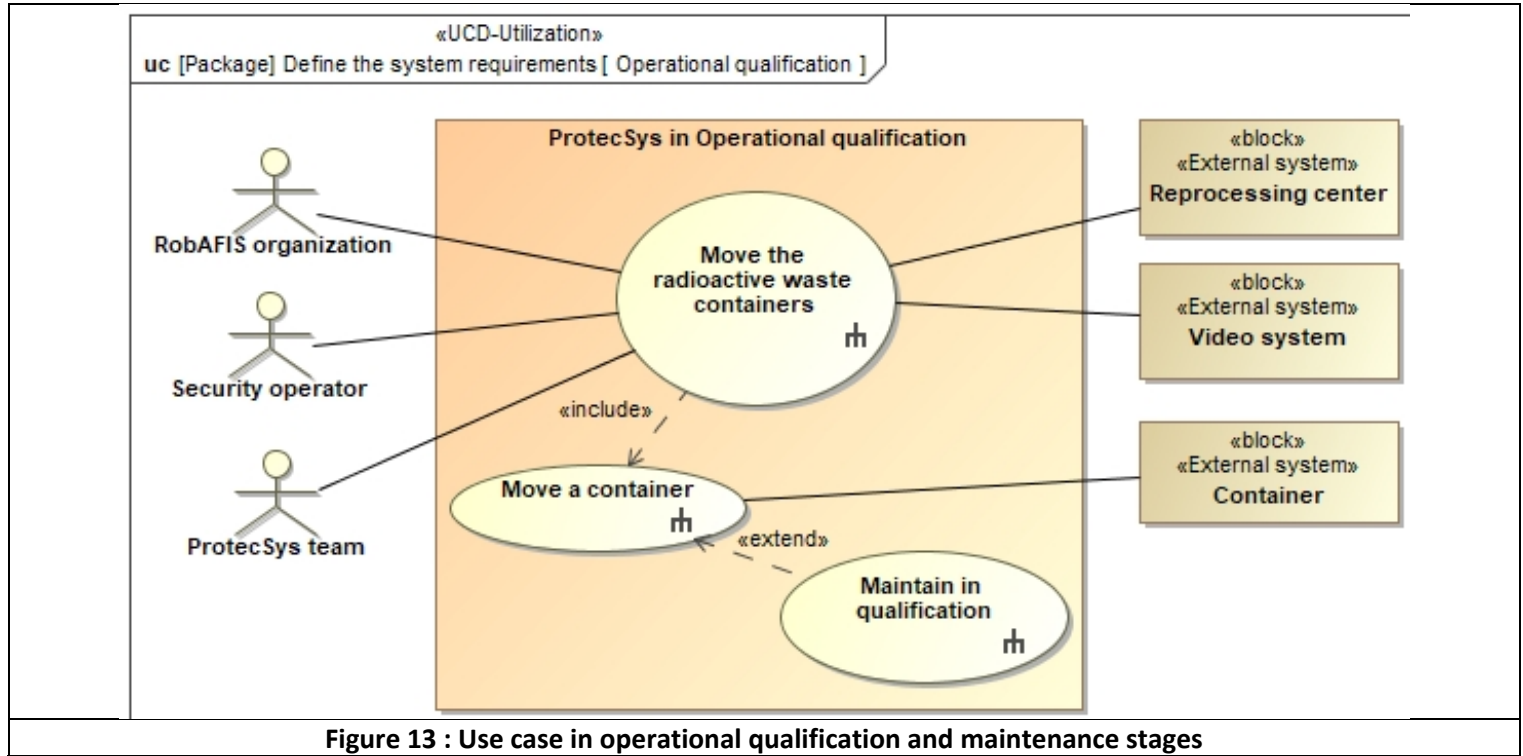
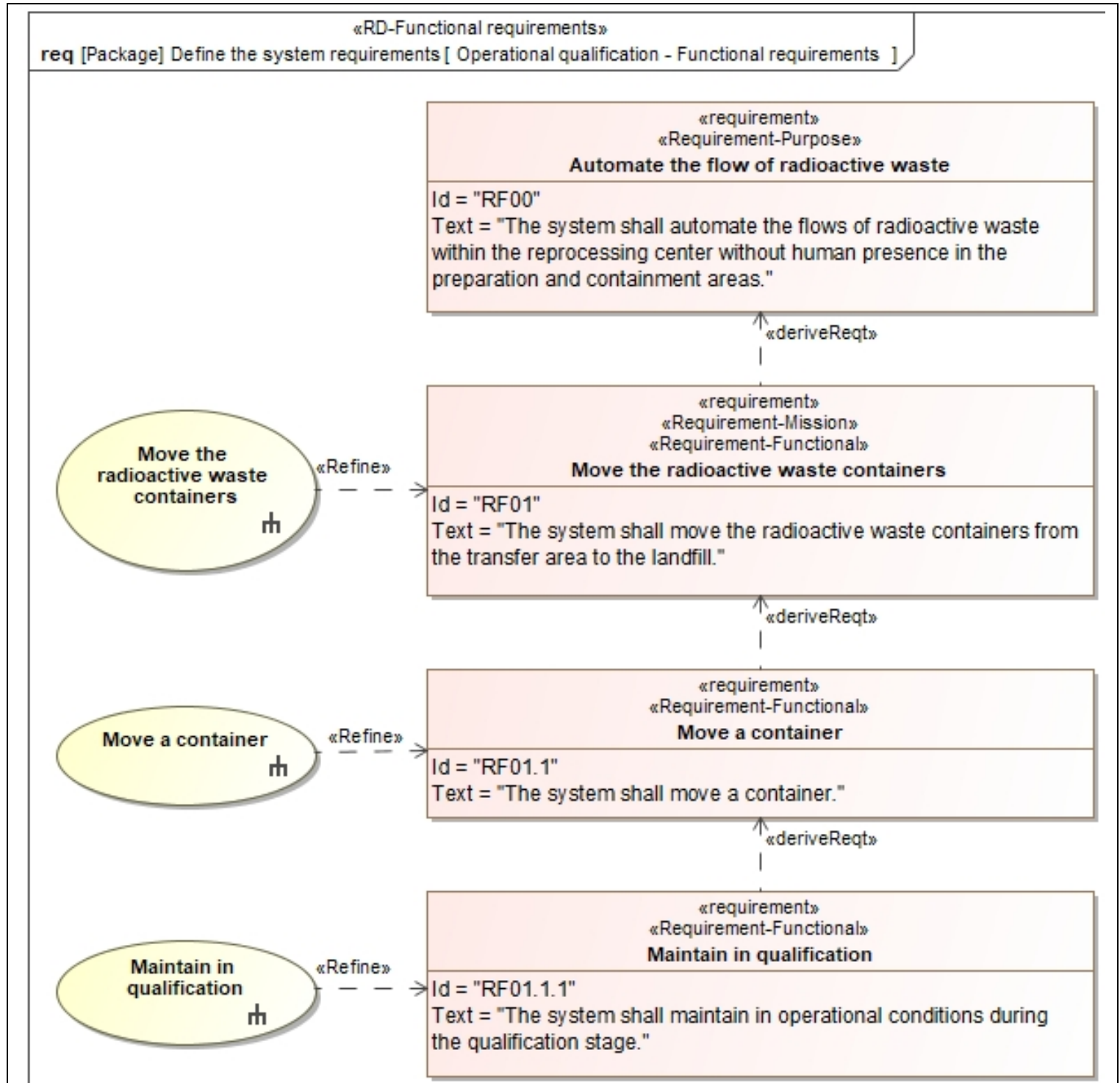
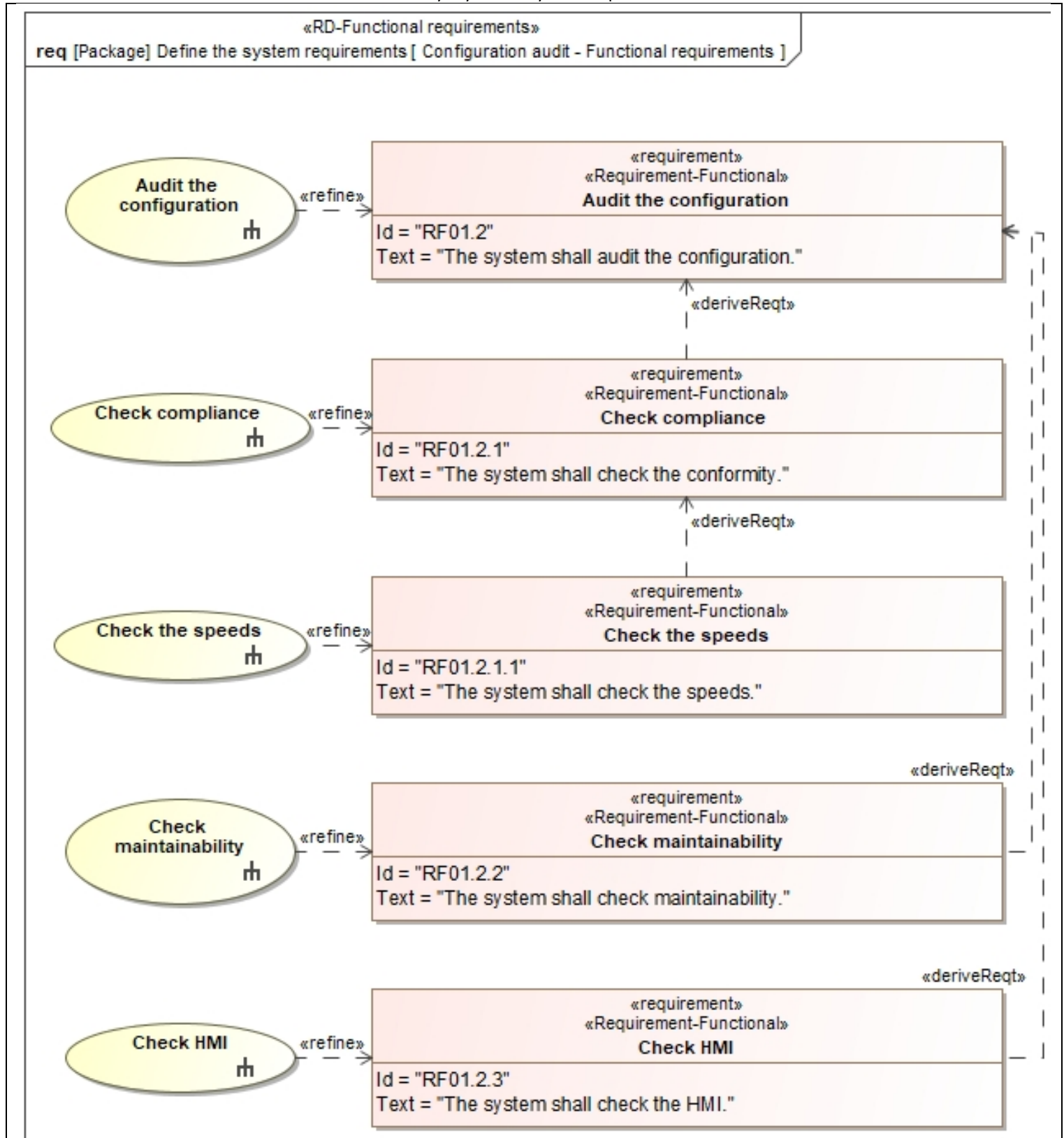


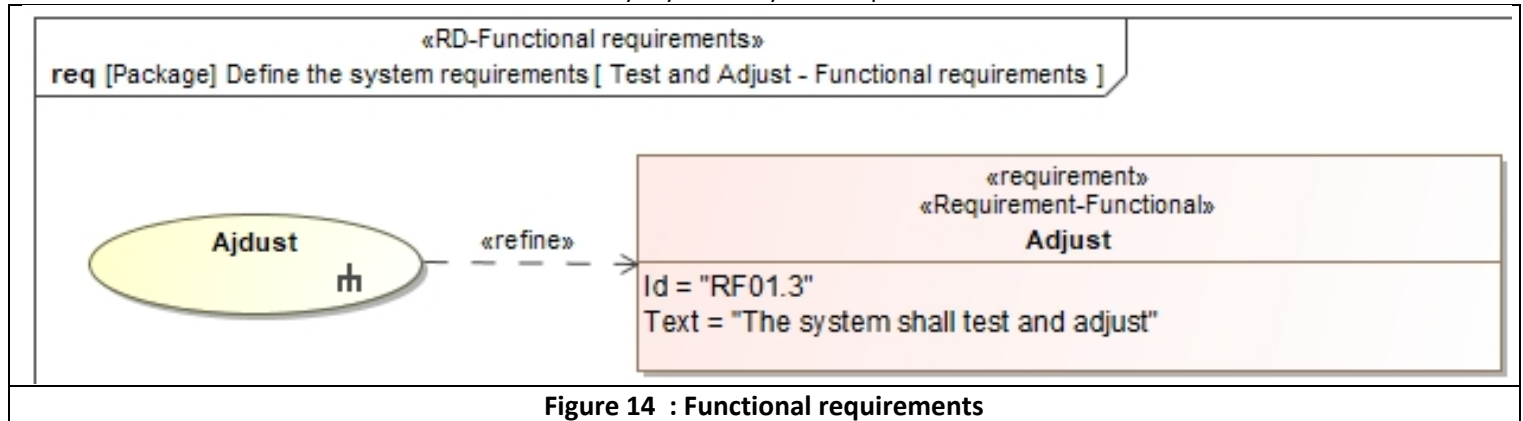
Figure 13 : Use case in operational qualification and maintenance stages

5. SYSTEM REQUIREMENTS

5.1. Functional requirements







Identifiant	Nom de l'exigence	Description
RF00	Automate the flow of radioactive waste	The system shall automate the flows of radioactive waste within the reprocessing center without human presence in the preparation and containment areas.

stm [State Machine] System states [System states]

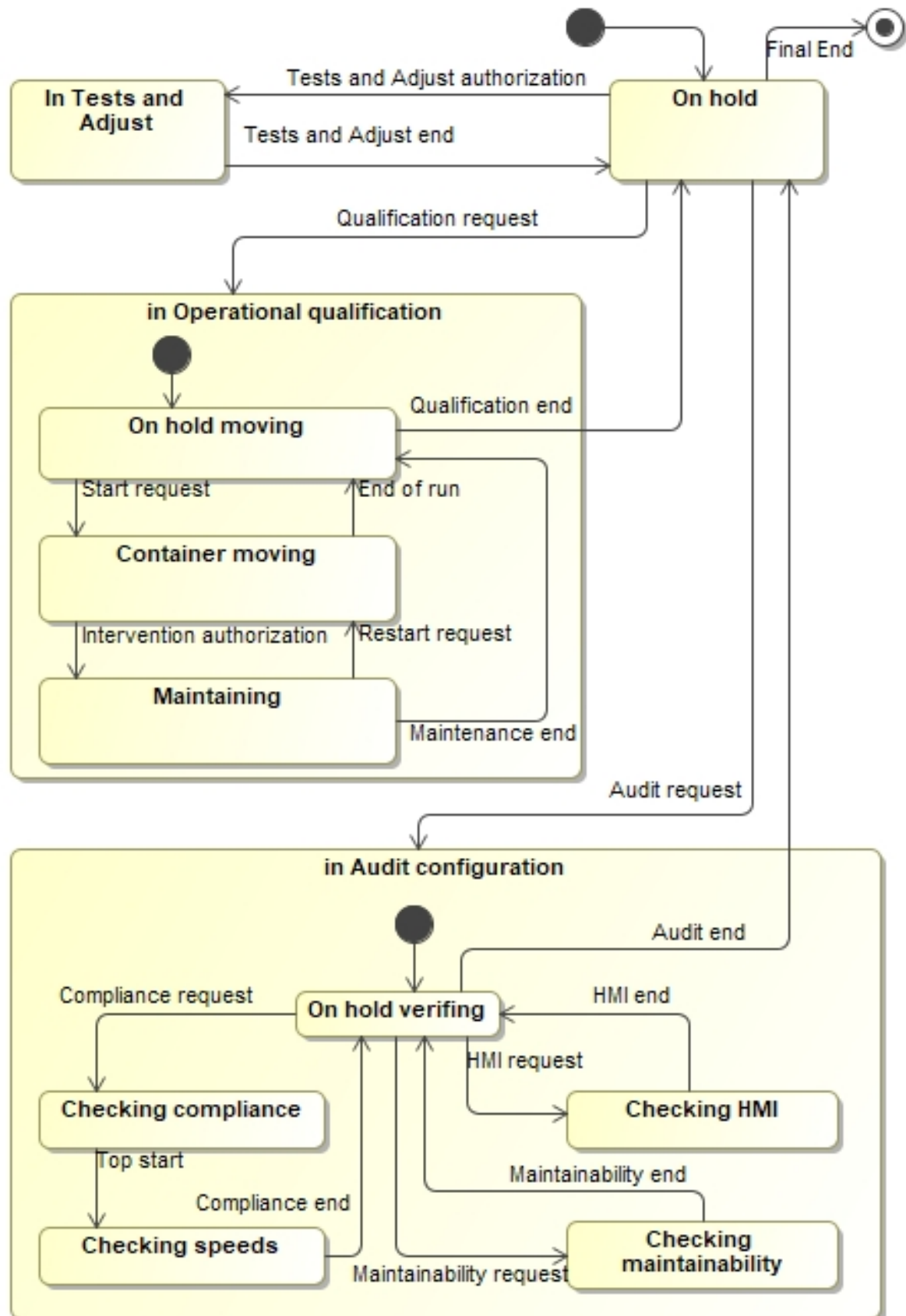


Figure 15 : States of the system

5.1.1. Operational qualification and maintenance stages

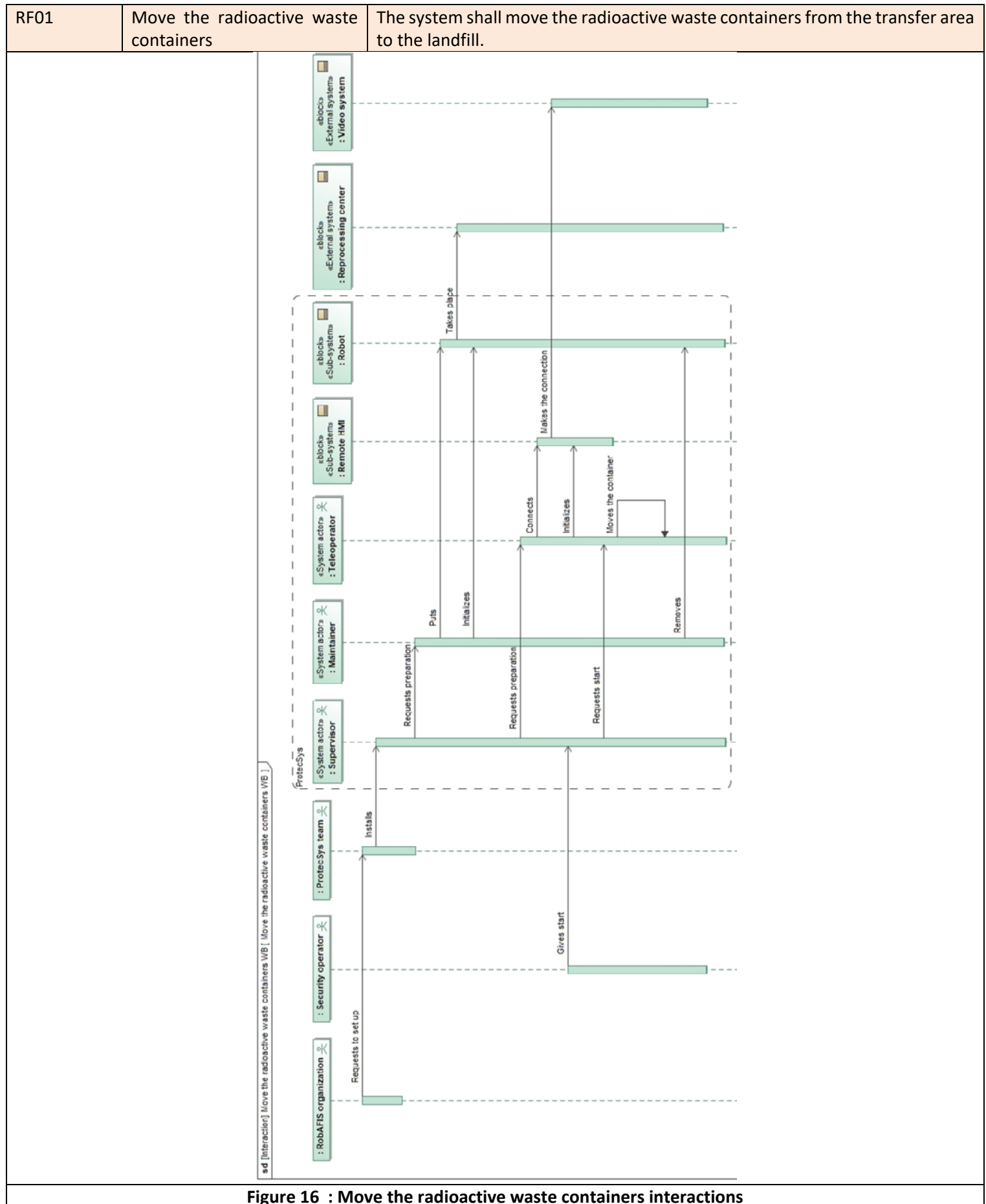
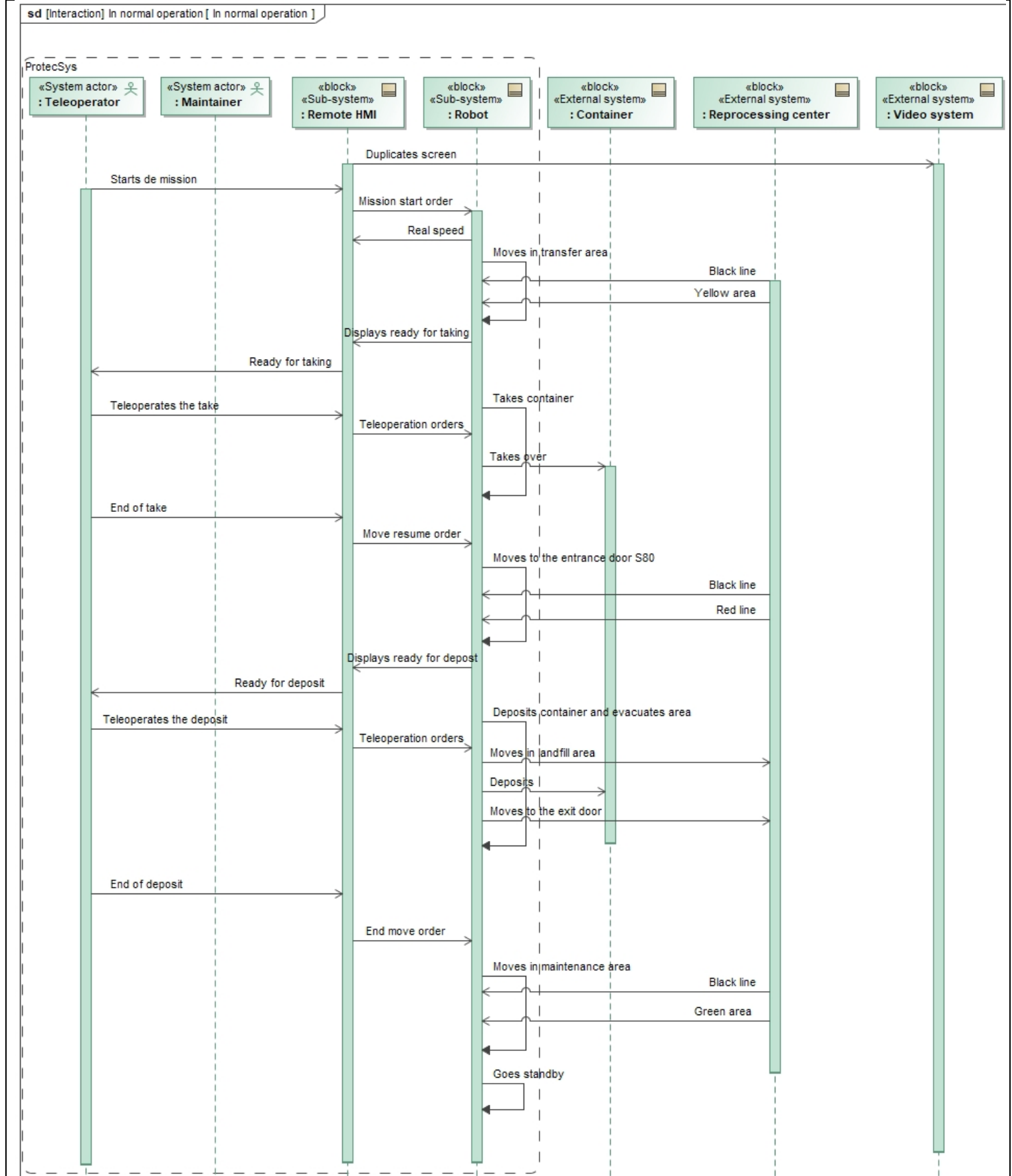
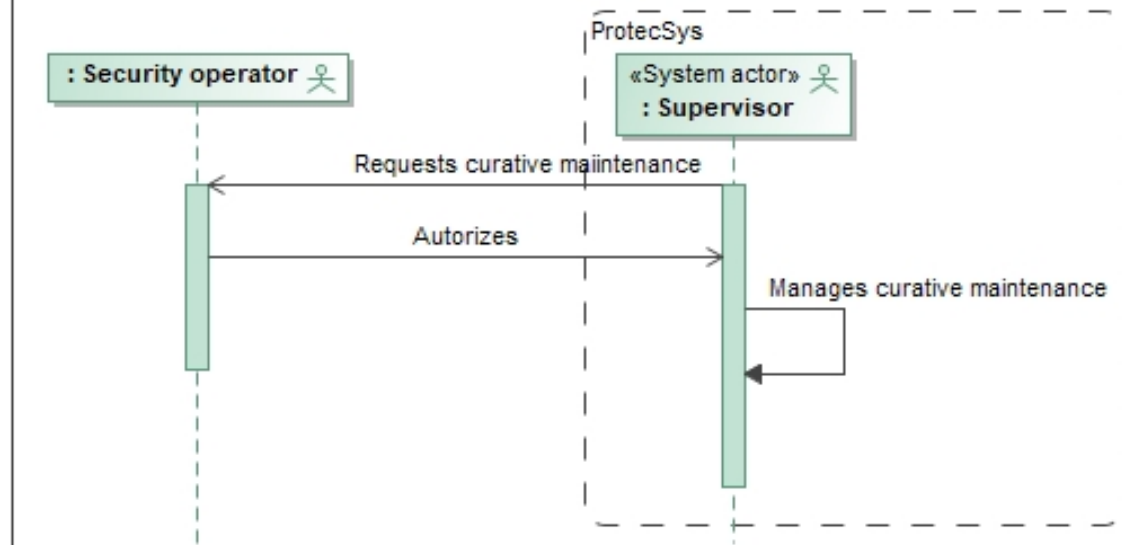


Figure 16 : Move the radioactive waste containers interactions

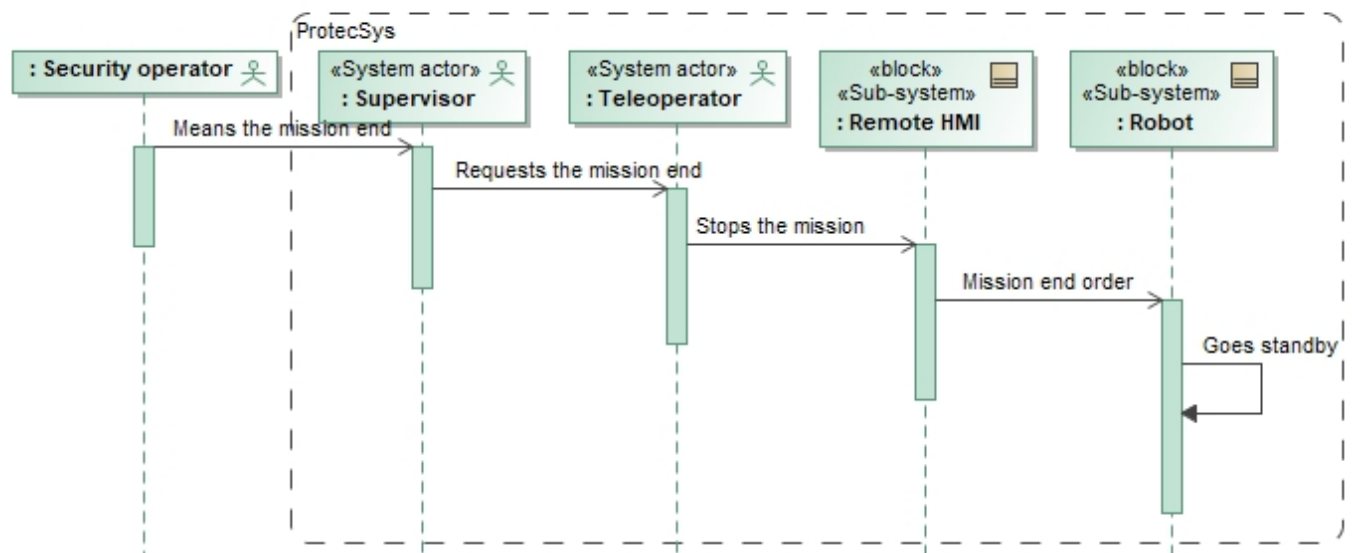
RF01.1 Move a container The system shall move a container.



sd [Interaction] In case of failure [In case of failure]



sd [Interaction] In case of exceeding the authorized time or a negative number points [In case of exceeding the authorized time or a negative number points]



sd [Interaction] Upon returning to the maintenance zone or after stopping the mission [Upon returning to the maintenance zone or after stopping the mission]

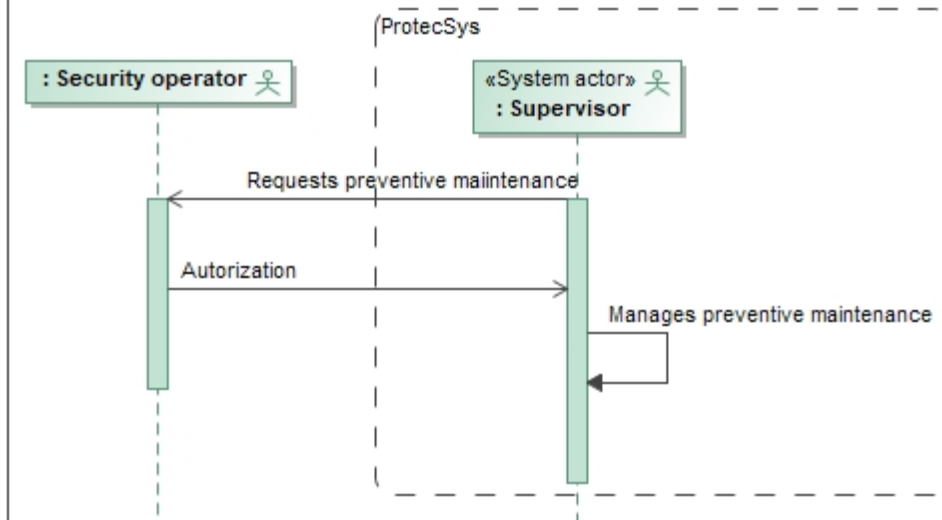


Figure 17 : Move a container interactions

RF01.1.1	Maintain in qualification	The system shall maintain in operational conditions during the qualification stage.
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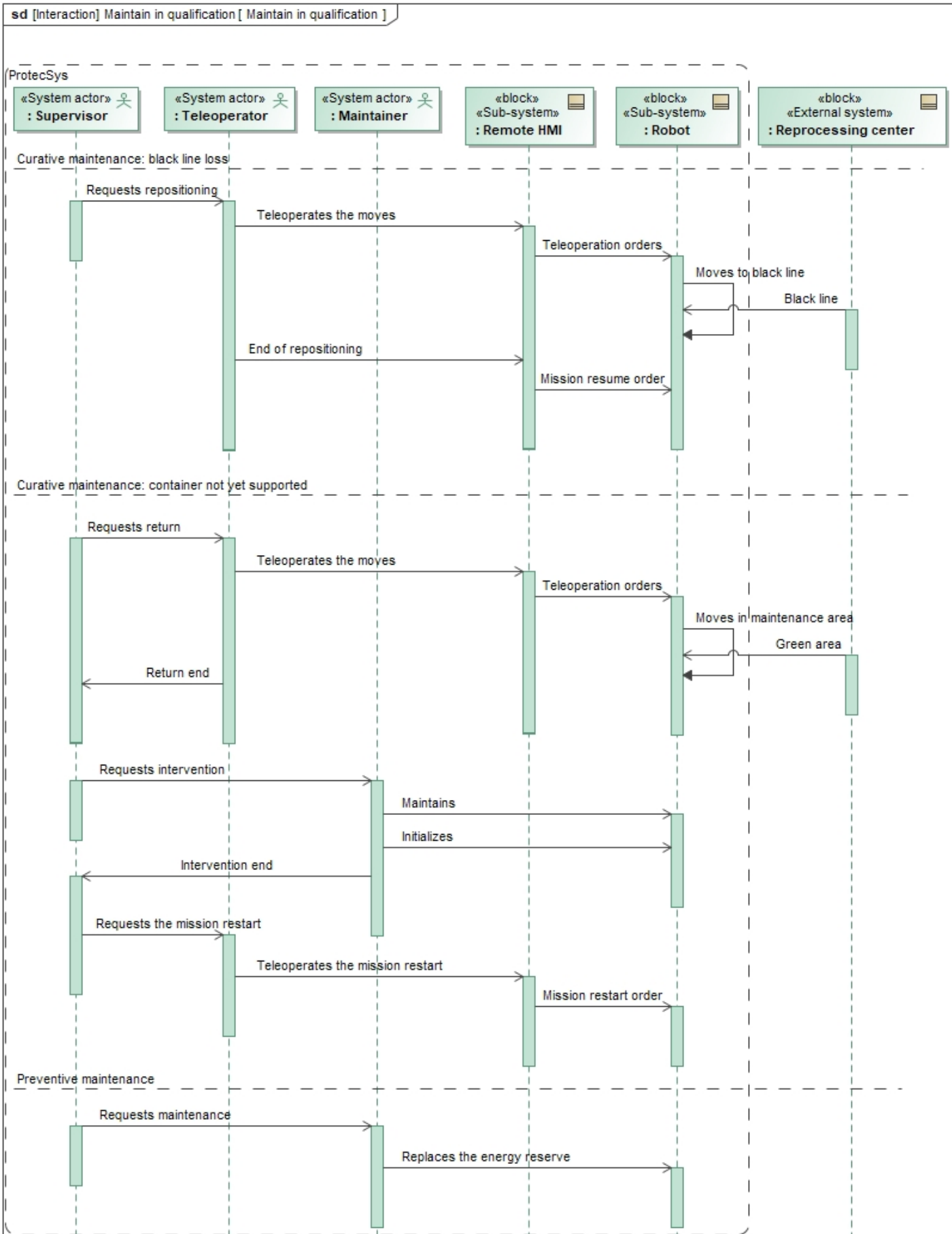
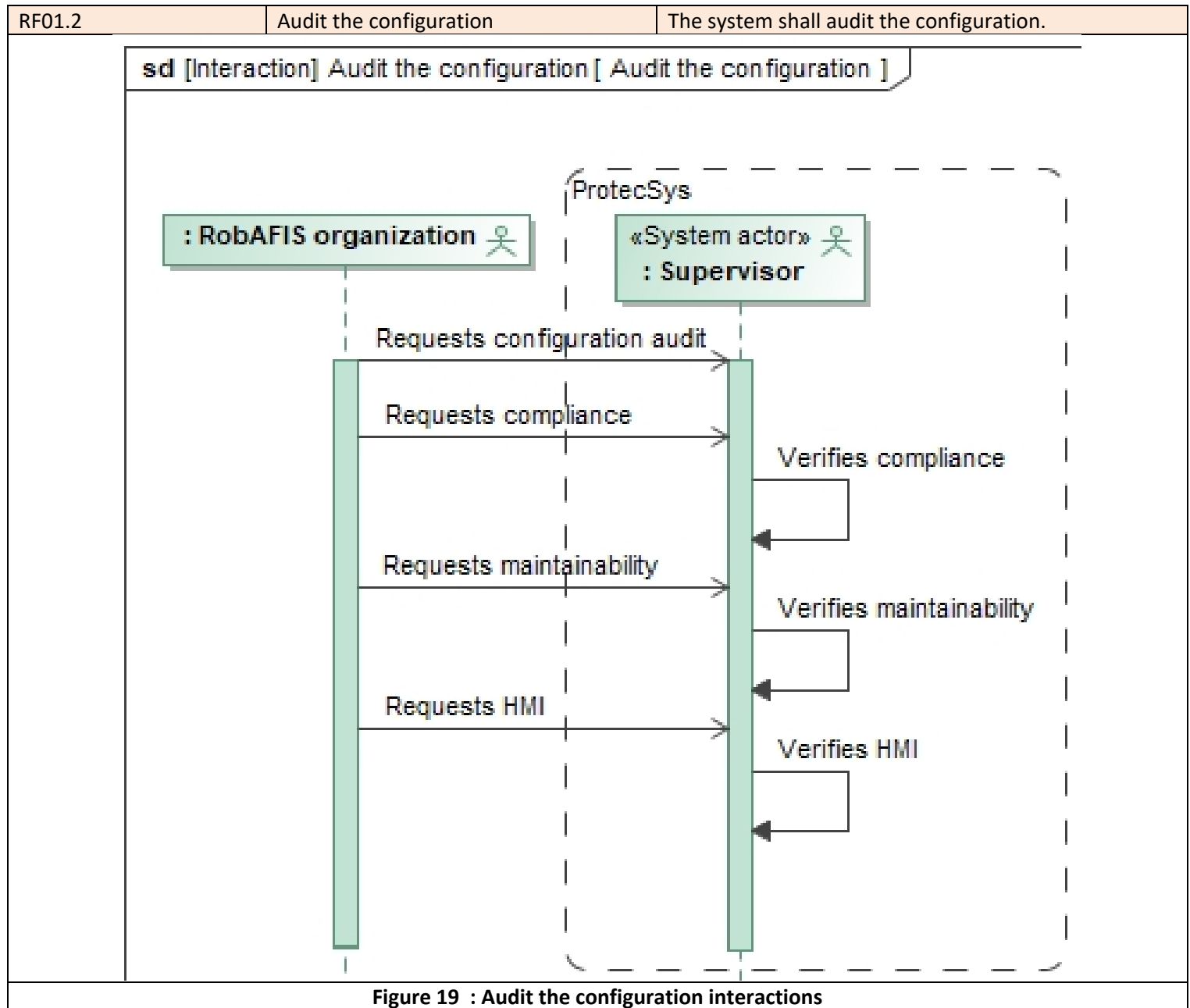


Figure 18 : Maintain in qualification interactions

5.1.2. Configuration audit stage



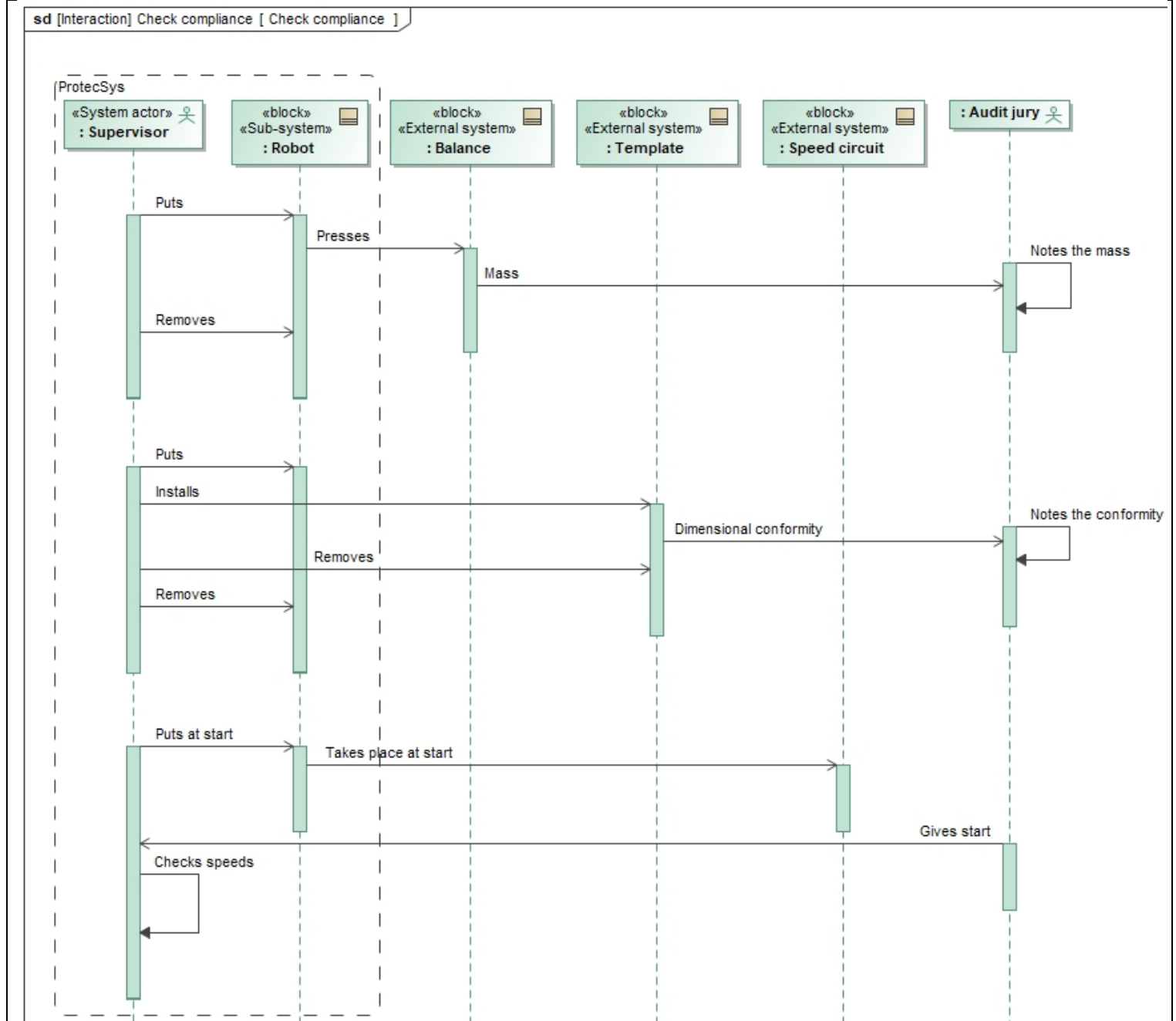


Figure 20 : Check compliance interactions

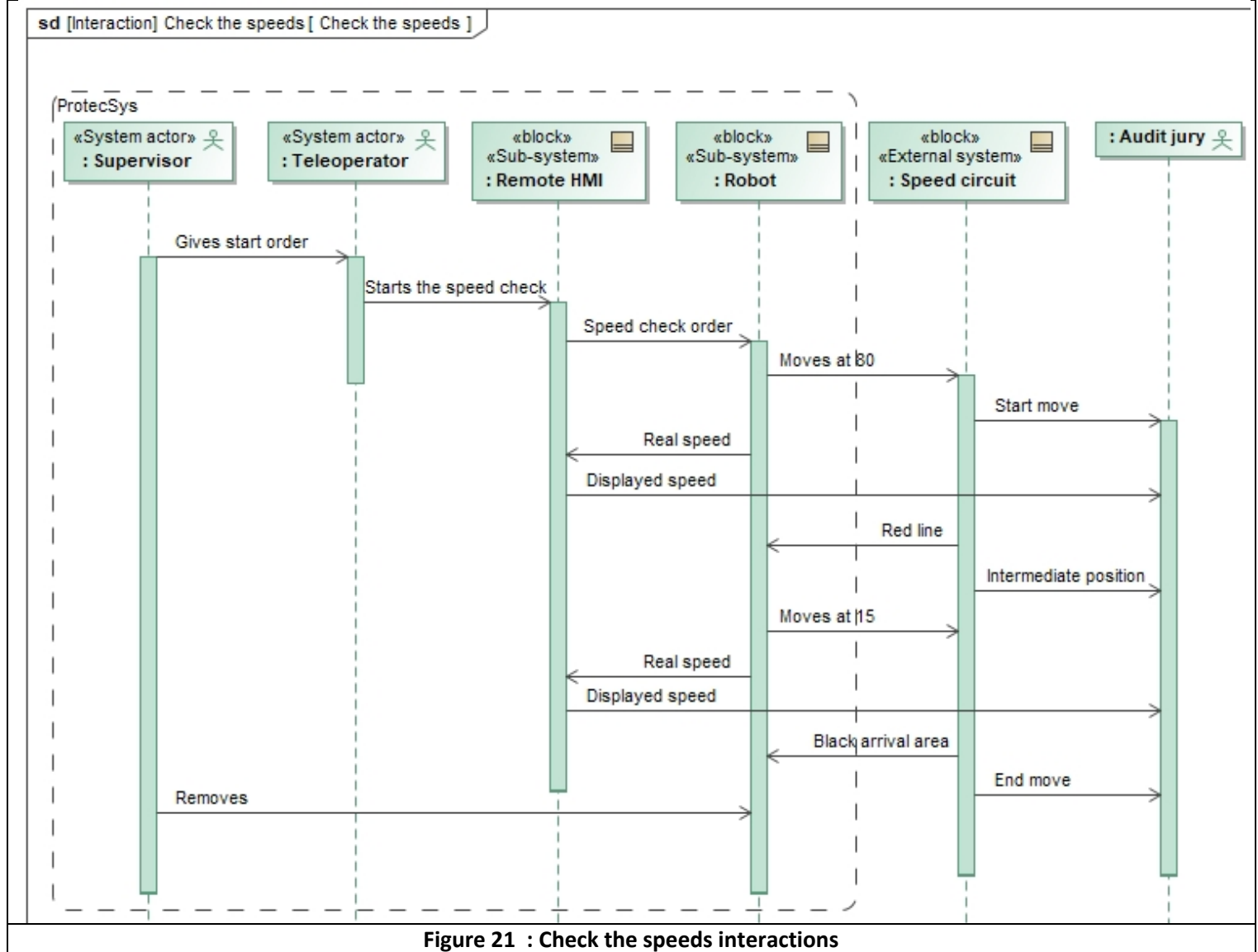
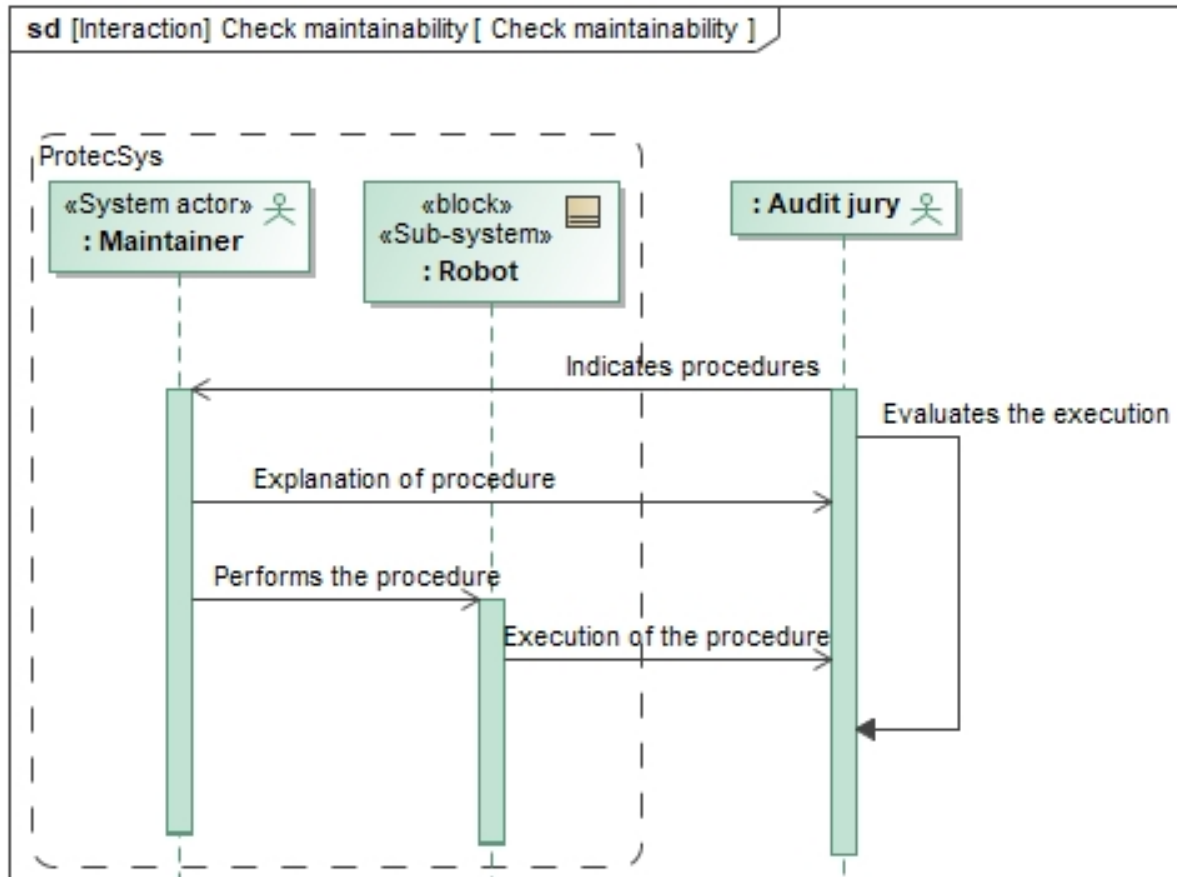


Figure 21 : Check the speeds interactions

RF01.2.2

Check maintainability

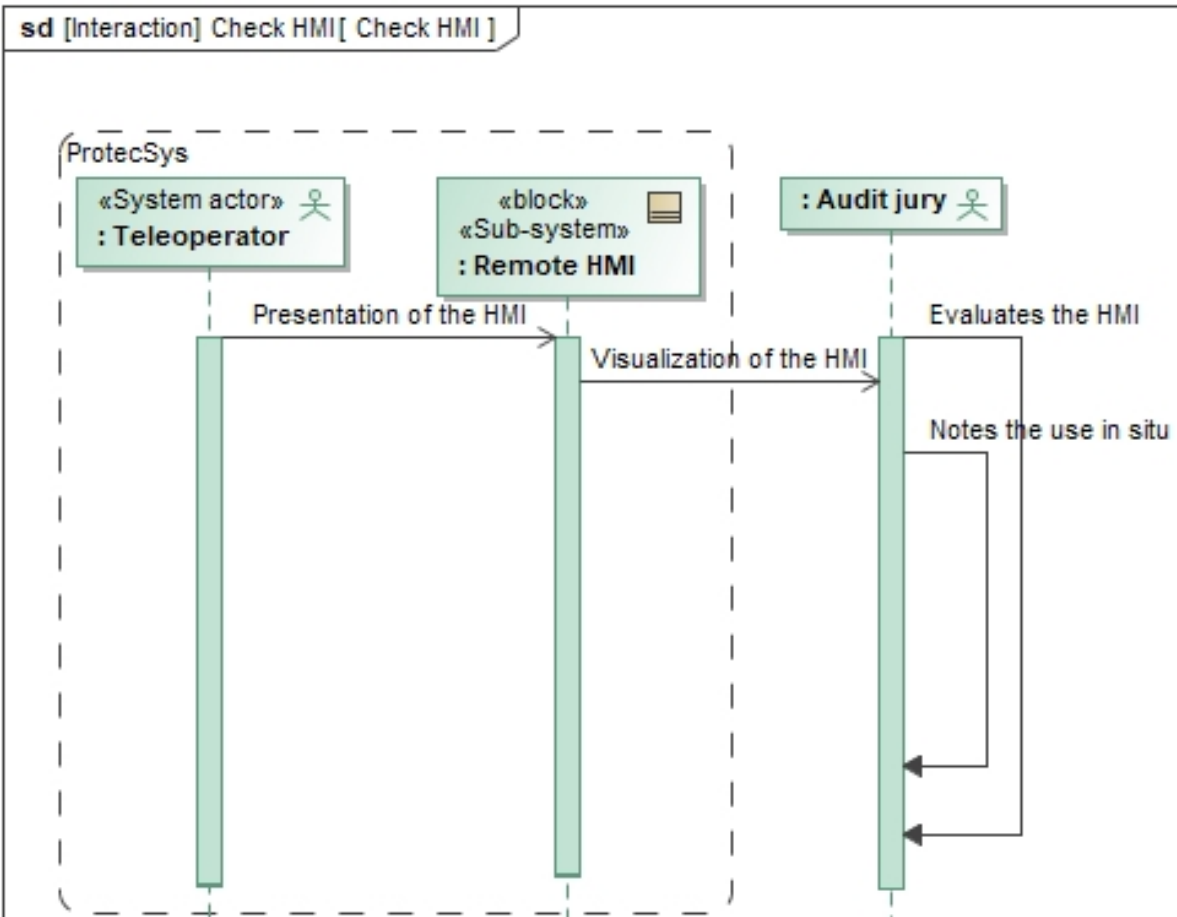
The system shall check maintainability.


Figure 22 : Check maintainability interactions

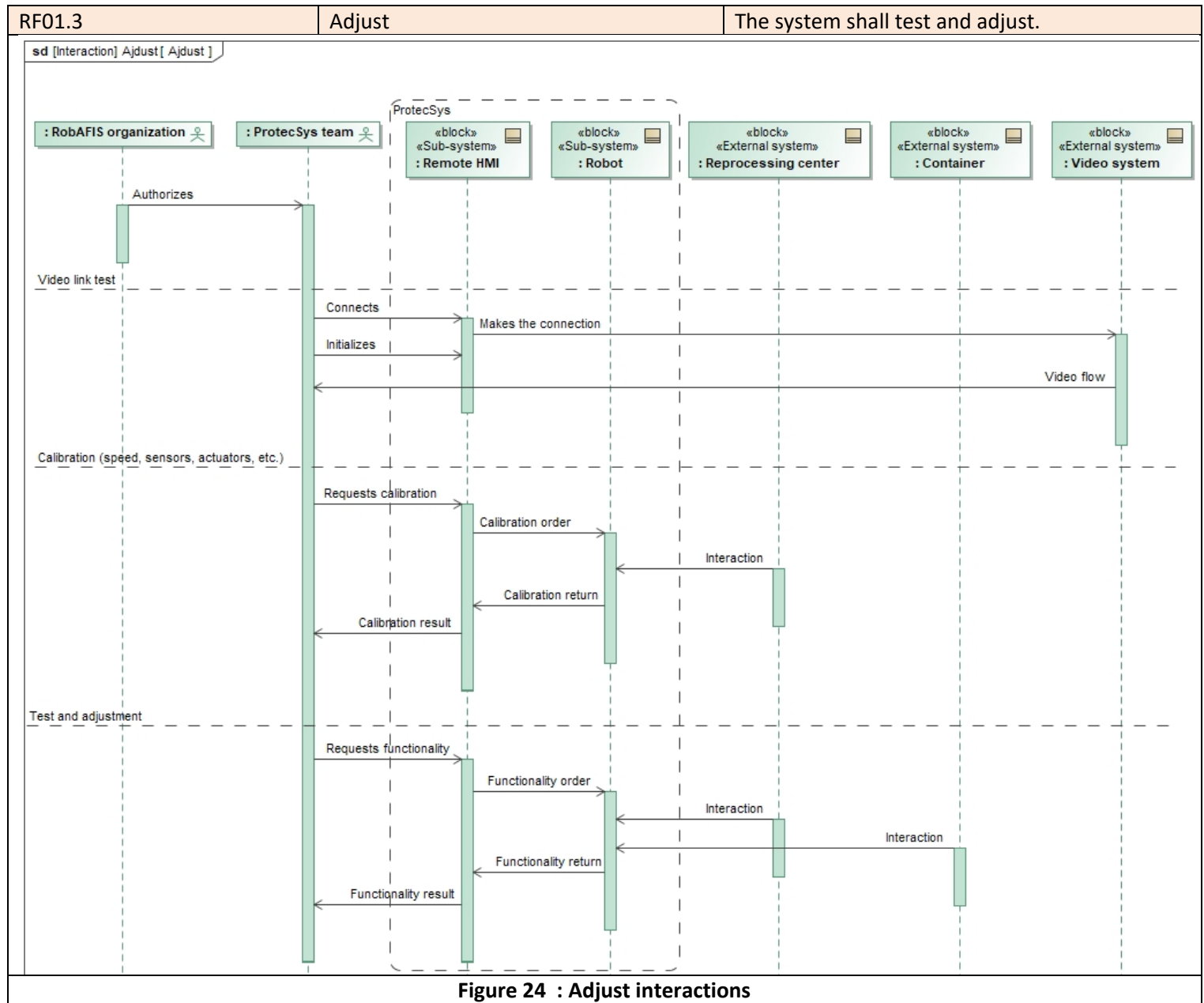
RF01.2.3

Check HMI

The system shall check the HMI.


Figure 23 : Check HMI interactions

5.1.3. Tests and Adjust stage



5.2. Performance requirements

Identifiant	Nom de l'exigence	Description
RP01	Do not exceed 480 s	The system shall not exceed 480s for move the container (+16 points in qualification).
RP01.1	Do not exceed 420s for bonus	The system shall not exceed 420s to move the container with bonus (+4 points in qualification).

5.3. Interface requirements

Identifiant	Nom de l'exigence	Description
RI01	Have a video output	The system shall have a video output in VGA or DVI or HDMI format that allows for the projection of HMIs to the audience in the control room.
RI02	Use the lifting handle of the	The system shall use the lifting handle of the container.

	container	
RI03	Communicate with the RobAFIS organization via the ProtecSys operators	The system shall communicate with the RobAFIS organization and its representatives (Security operator, Audit jury, etc.) via the ProtecSys operators.
RI04	Communicate via Bluetooth	The system shall communicate via Bluetooth between the HMI and the Robot.

5.4. Operational requirements

Identifiant	Nom de l'exigence	Description
RO01	Move a container 3 times in 4 hours	The system shall move a container 3 times over a period of 4 hours without any maintenance other than that allowed in qualification.
RO02	Perform remote operations from the control room	The system shall perform remote operations/remote guidance from the control room.
RO03	Perform remote control in risky situations	The system shall perform remote control of the mobile robot in high-risk situations: taking / depositing the container, moving in the containment area.
RO04	Carry the container vertically	The system shall carry the container vertically and without contact with the ground (-1 point in qualification).
RO05	Follow the black line in automatic mode	The system shall, in operational qualification, follow the black line in automatic mode without remote guidance.

5.5. Constraint requirements

Identifiant	Nom de l'exigence	Description
RC01	Operate within the reprocessing center	The system shall operate within the reprocessing center as defined in appendix 1.
RC01.1	Avoid entering the Prohibited Areas to the Robot	The system shall avoid entering the Prohibited Areas to the Robot in the preparation area (-4 points in qualification).
RC01.2	Avoid any contact with vertical walls	The system shall avoid any contact with vertical walls: outer edge, separation of preparation and containment areas (-1 point in qualification).
RC01.3	Operate under normal climatic conditions	The system shall operate under normal climatic conditions in the reprocessing center: ambient temperature between 10 °C and 32 °C, atmospheric pressure between 1000 and 1030 mb and humidity between 40 and 75 %.
RC01.4	Operate under normal lighting conditions	The system shall operate under normal lighting conditions: homogeneous lighting, except for shadows produced by objects present in the preparation and containment areas, and light intensity in these areas between 100 and 300 Lumen/m2.
RC02	Use the specific container	The system shall use the specific container as defined in Appendice 2.
RC02.1	Avoid any shock of the container	The system shall avoid any shock of the container (-2 points in qualification).
RC02.2	Take over the container with its handle perpendicular	The system shall take over the container in the transfer area with its handle orientation perpendicular to the black line coming from the maintenance area.
RC03	Use a mobile robot	The system shall use a mobile robot.
RC03.1	Do not exceed 1200 g	The system shall use a mobile robot, in working order, of a mass not exceeding 1200 g.
RC03.2	Do not exceed 300 mm	The system shall use a mobile robot, in working order, of a length not exceeding 300 mm.
RC04	Comply with the speed limits for the mobile robot movements	The system shall comply with the speed limits for the mobile robot movements allowed in risk areas.
RC04.1	Do not exceed the speed of 80	The system shall not exceed the speed of 80mm/s in the preparation area (-2 points in qualification).

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RC04.2	Do not exceed the speed of 15	The system shall not exceed the speed of 15mm/s in the containment area (-4 points in qualification).
RC05	Retransmit the HMIs	The system shall retransmit the HMIs on the video output for the audience.
RC05.1	Display the actual robot speed	For qualification and auditing purposes, the system shall permanently display the actual robot speed on the active HMI in green if the limitation is met and in red if not.
RC06	Operate on the speed circuit	During the speed verification audit, the system shall operate on the speed circuit as defined in Appendix 3.
RC07	Be testable and maintainable	The system shall be testable and maintainable.
RC07.1	Have three maintenance procedures	The system shall have three maintenance procedures concerning the following points: change of the on-board energy reserve, change of an actuator, change of a sensor.
RC07.1.1	Provide maintenance procedures in electronic form	The system shall provide maintenance procedures in electronic form.
RC08	Include a development folder	The system shall include a development file as defined in the standard document available at www.robafis.fr .
RC08.1	Provide development folder in electronic form	The system shall provide development folder in electronic form.
RC09	Take into consideration the contest rules	The system shall take into consideration the RobAFIS contest rules available at www.robafis.fr .
RC10	Integrate a maximum of 3 operators	The system shall integrate a maximum of 3 operators from the ProtecSys team: 1 maintenance operator residing in the clean room to intervene in the maintenance area and 1 to 2 remote operation operators in the control room.
RC10.1	Involve only authorized personnel	The system shall involve only authorized personnel such as CASES forklift operators, Nuclear Authorization “Savoir Commun du Nucléaire », etc.
RC10.2	Teleoperate with a teleoperation operator	The system shall teleoperate with a teleoperation operator from the control room.
RC10.3	Maintain with a maintenance operator	The system shall maintain with a maintenance operator from the white room to work in the maintenance area.
RC10.4	Supervise with a supervising operator	The system shall supervise with a supervising operator all operations from the control room.
RC11	Consist of a support frame and components	For the robot, the system shall consist of a support frame and components mounted on/in this frame.
RC11.1	Use a support frame with a low ecological footprint	For the robot, the system shall use a support frame made of a material with a low ecological footprint, reused or recycled.
RC11.2	Use the Makeblock kits components	The system shall, for the robot, use the Makeblock kits components provided by the RobAFIS organization without any addition or modification: Robot Kit Ultimate 2.0-10-in-1 (https://store.makeblock.com/buy/ultimate-2-0-10-in-1-robot-kit) and Robot Kit Electronic Add-on Pack for Starter (https://store.makeblock.com/electronic-add-on-pack-for-starter-robot-kit).

6 SYSTEM REQUIREMENTS VALIDATION

Updated by JYB on 20/01/2020	Verified by XY on 22/01/2020	Validated by JC on 25/01/2020
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