SUPAERO Satellite Space Mission Project

UML Diagrams Report

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Introduction

This report details the Use-Case, Sequence and Class diagrams which are prepared in order to model the Satellite Space Mission. The diagrams are constructed taking into some reasonable assumptions that simplify the model in order to simulate the most relevant and critical functions to be carried out by the satellite during the mission.

The report also lists the assumptions taken for the purpose of constructing the diagrams.

The system models two main parts of the mission. The first part requires the satellite to take good quality pictures of the ISAE-SUPAERO campus and send them to the ground station for quality inspections. The second part focusses on the rocket launch where functions like fuel monitoring, engines release sequences and trajectory control are implemented through command sequences given by the ground station.

Assumptions Taken

1. It is assumed that the satellite is entirely powered by the solar panels without any power storage. Transmission is thus only possible when the panels are on.
2. We assume that the orbit chosen for the satellite passes over the ISAE-SUPAERO campus and there is no requirement for Attitude Control and Orbital Adjustment to capture the image of the campus.
3. For the sake of simplicity, we have taken 1 set of coordinates to represent the location of the campus: 43.5655° N, 1.4740° E.
4. We assume that there is enough power to send a power “OFF” message even if the solar panels are off.
5. The rocket engine separation is assumed to be implemented in two stages. The fuel mass distribution between both engines is represented by a ratio attribute.

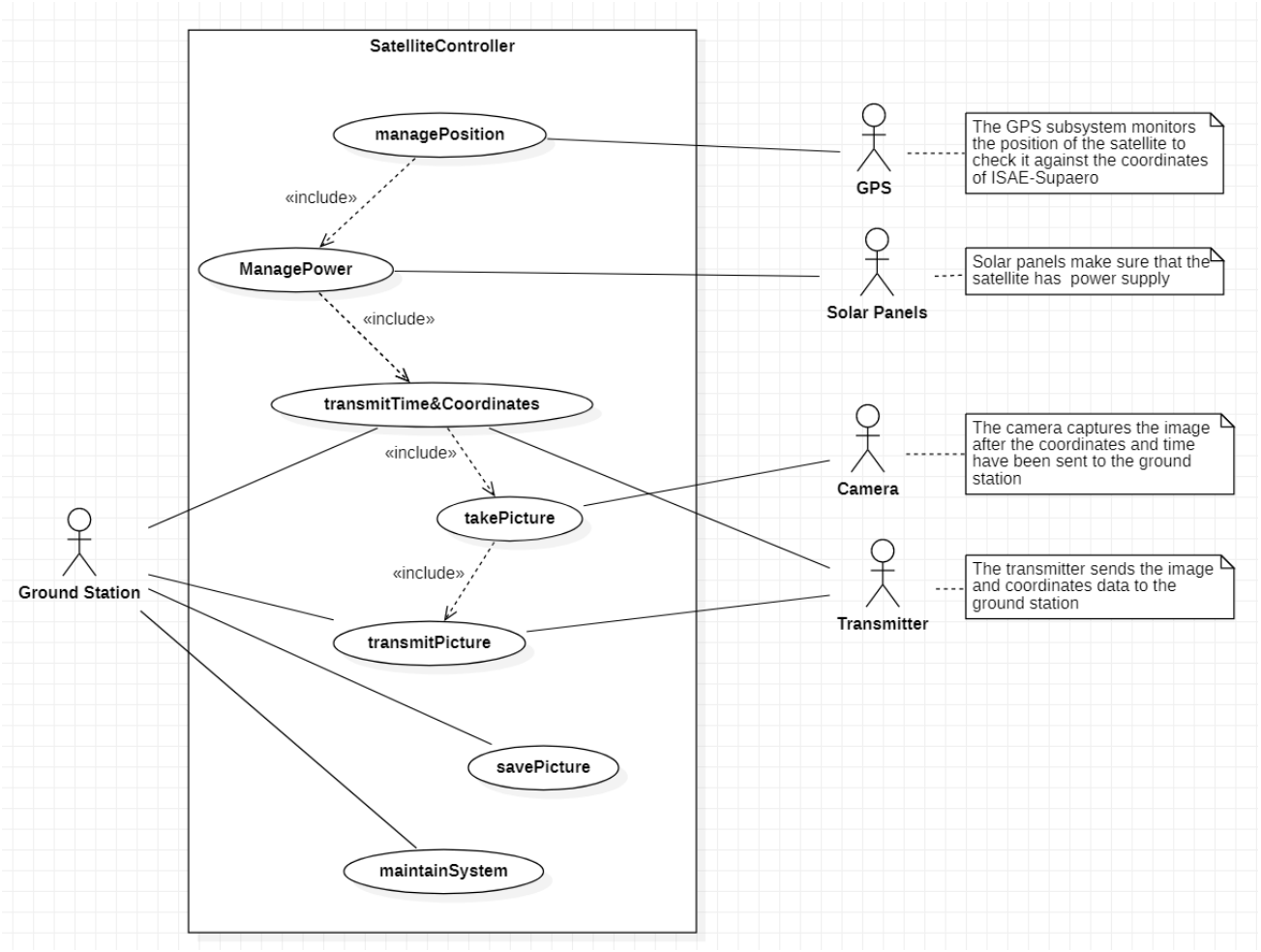
Associations and Functions of Sub-Systems

The ground station class, which normally sends commands, does not have to be connected to the GPS, clock and camera subsystems, since these subsystems work autonomously to carry out the mission of taking pictures of ISAE-SUPAERO. The ground station is only associated to the transmitter to receive the data sent by the satellite.

The GPS monitors the location of the satellite and initiates the image capture procedure as soon as the satellite passes over the ISAE-SUPAERO campus. The image is captured by the camera and sent to the transmitter. Then, the transmitter sends this image data along with the coordinates and the timestamp to the ground station, which performs quality checks and saves the image if the quality of the image is acceptable.

The ground station is associated with the rocket to send commands for the rocket launch. This association is used to monitor, fuel ratio levels, altitude adjustments and successful engine releases.

Use-Case Diagram



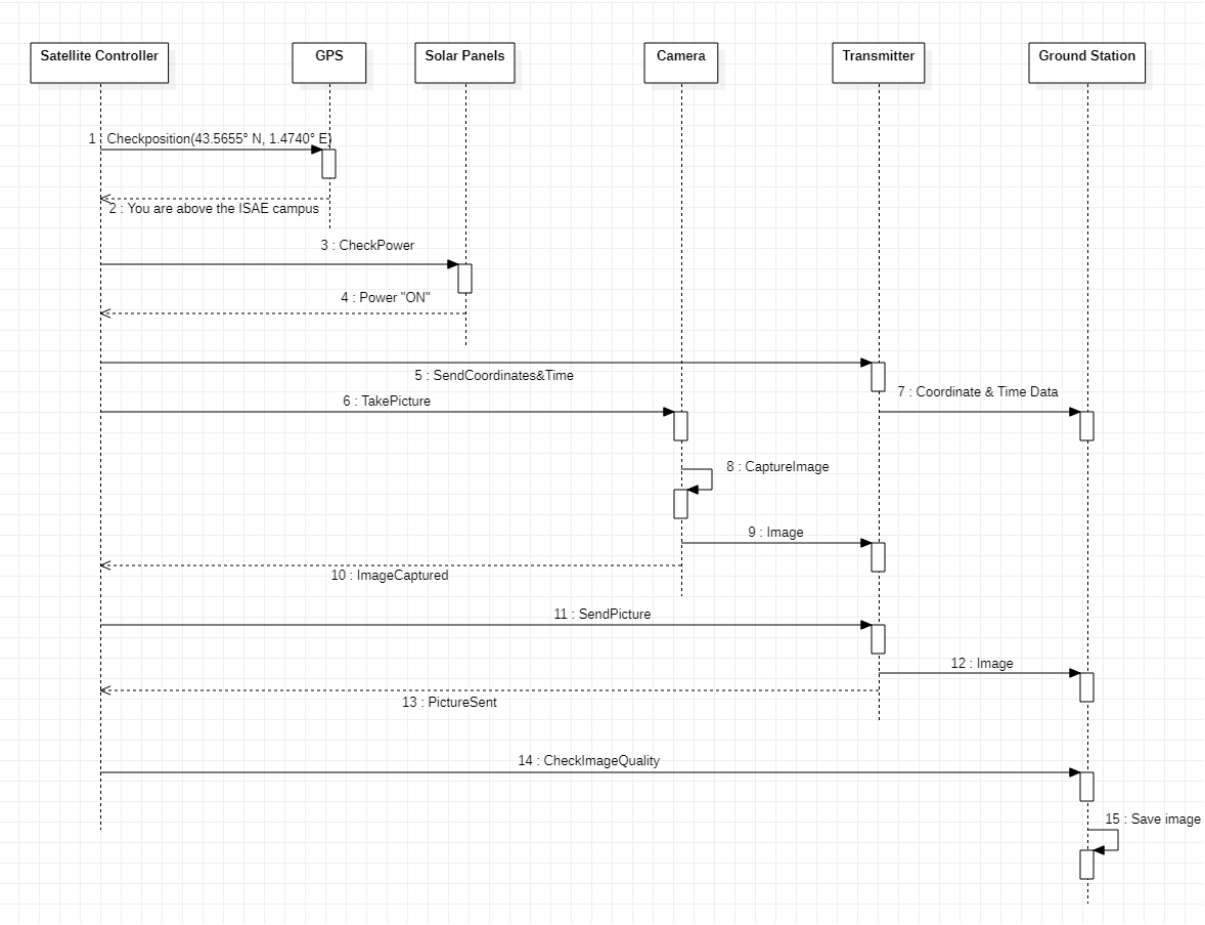
The actors for this UCD are all the subsystems that send/receive data and the ground control. The use case depicted here is for the first part of the specification, which is the image capture procedure.

The process is initiated when the SatelliteController confirms with the GPS that the satellite is above ISAE. Then it checks for available power, and transmits the current location and time coordinates. Next, it directs the camera to capture the image and this image is transmitted by the transmitter subsystem.

The connectors between the actions are <<include>> to indicate that each of the actions is necessary, and follow each other as consequent steps in the procedure.

The UCD also includes the ground station functions of checking the image quality and saving the image. An auxiliary function of system maintenance is added which is carried out by the ground station.

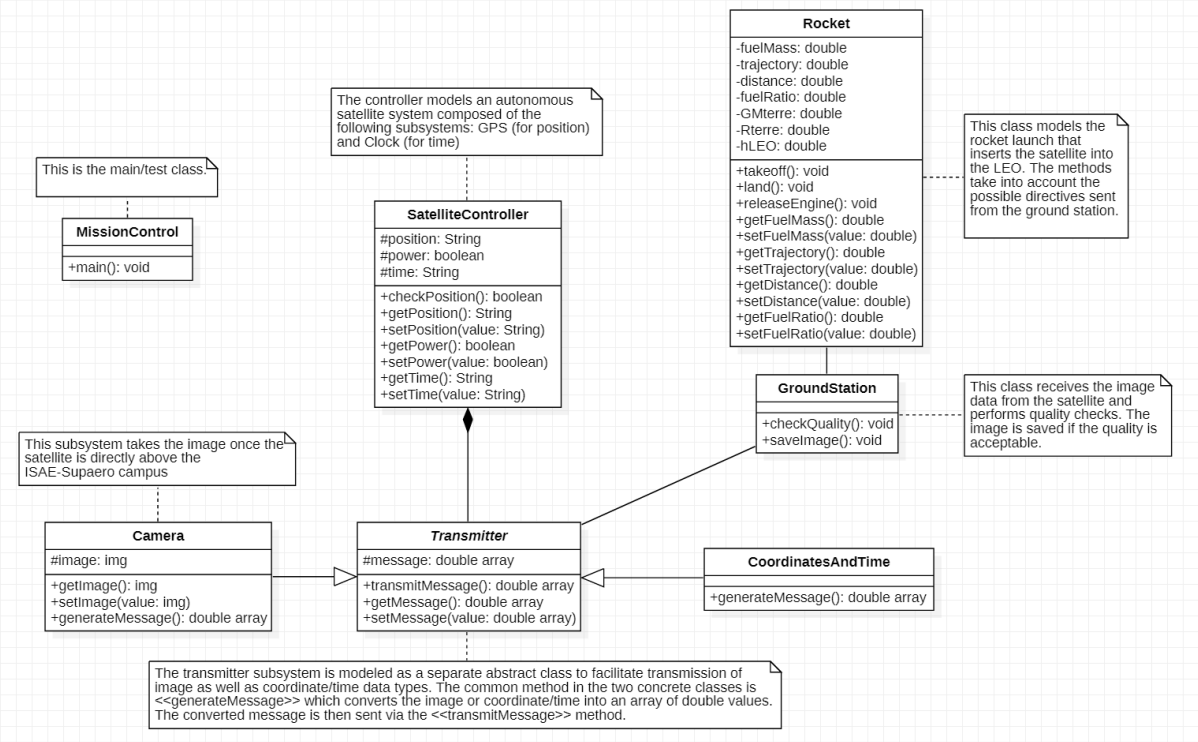
Sequence Diagram



The sequence diagram shows the messages that pass between the actors described in the UCD during the image capture procedure. The messages are structured as queries, replies, and data transmissions.

This sequence follows the condition of power ON, and in the case of power OFF it is assumed that the image capture does not take place. Thus, there is no need for a sequence diagram for the power OFF case and it is assumed that the satellite is not operational until power is ON again.

Class Diagram



The **"SatelliteController" class** takes care of all the autonomous functions of the satellite platform like power management, position management and clock funtions.

An abstract class is used here to model the **Transmitter**, which can either send image data or time/coordinate data. Concrete classes of **"Camera" and "CoordinatesAndTime"** are implemented to process image data and coordinate data separately. The common method "generateMessage" returns an array of double values which can then be transmitted by the transmitter. The transmitter is a component of the satellite which is vital to its function, so a composition relation is used here.

This follows usual satellite transmitter technology, where images and coordinates are converted to RGB values or bits before transmission.

To account for the extended second part of the specification, the **"Rocket"** class is added which will be used for the satellite launch. The rocket contains the "trajectory" attribute to calculate the path through the release rate equation defines in the specification document. For this computation, it uses the attributes corresponding to distance from Earth, GM value, radius of earth and LEO altitude.

Engine release functions are also supported by the rocket, where the engine is split into 2 stages. The "fuelRatio" attribute is defined as,

$$\boldsymbol{fuelRatio} = \frac{\boldsymbol{fuel\ mass\ in\ Stage1}}{\boldsymbol{fuel\ mass\ in\ Stage2}}$$

This ratio is used to determine when each engine stage will be released. Additionally, take-ff and landing functions are supported.