COS 214 Project

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- Date Issued: **17 October 2021**
- Date Due: **23 November 2021** at **8:00am**
- Submission Procedure: **Upload via ClickUP**
- Submission Format: **archive (zip or tar.gz)**

1 Introduction

Elon Musk contacted your team to design a system to help them simulate SpaceX and Starlink in order for them to better plan and optimise their launches. SpaceX currently have 2 rockets that they are using, the Falcon 9 and the Falcon Heavy. They also have 2 spacecraft that they use to send cargo and humans to the International Space Station, the Crew Dragon and the Dragon. Each launch has different payloads and different requirements so the aim is to optimise the cost of each launch by choosing the best rocket configuration for the job. Starlink is aiming to provide fast internet to everyone around the world by having a large constellation of satellites orbiting around the planet. The Starlink satellites are launched in clusters of up to 60 satellites at a time on a Falcon 9 rocket.

1.1 Objectives

In this project you will:

- identify the requirements for optimising the launches of the rockets,
- translate the requirements into a design using design patterns,
- highlight aspects of the design that are important in the implementation of the design using UML,
- implement the design in C++ by separating the concerns and providing the class definitions and implementations is separate .h and .cpp files, and
- compile a design document that is to be used to understand the design and implementation of the project.

1.2 Outcomes

When you have completed this project you will:

- have designed and modelled a system and experienced integrating design patterns,
- be able to say with conviction that you have completed a relatively large project,
- have experience of working in a relatively large design and development team, and
- be ready for COS301 next year.

2 Constraints

1. You must complete this project in teams of 5 to 7.
2. At least 10 design patterns must be included in the design and the implementation thereof.
3. UML diagrams showing the design and aspects of the system that need additional explanation.

3 Time line

1. 19 October 2021 - Teams of 5 to 7 registration to be completed. One member of the team should be assigned as team lead.
2. 2 November 2021 - Submit initial design.
3. 2 and 3 November 2021 - Meet with team manager and discuss initial design.
4. 9 and 10 November 2021- Meet with team manager
5. 16 and 17 November 2021 - Meet with team manager
6. 23 November 2021 - Submission of project on ClickUP.
7. 23 and 24 November 2021 - Project demos.

4 Project Description

4.1 The Falcon Rockets

Building an orbital class rocket is an engineering marvel. Throughout a launch there are so many things that could go wrong and with the cost being in the 10s of millions of Dollars if not in the 100s of millions of Dollars, it's crucial that everything is tested and retested in order to reduce the chance of a failure. Before each launch the rocket is tested by having a "static fire" test where they fire up the engines to test if everything is working. In order to save money SpaceX lands the first stage on a drone ship in the middle of the ocean, so that it can be refurbished and then reused.

The Falcon 9 has 2 stages. The first stage has a single Falcon 9 core with 9 Merlin engines to get the second stage and the payload almost in orbit. The second stage has a single Vacuum Merlin Engine to provide the last kick to get the payload in the desired orbit.

The Falcon Heavy also has 2 stages but the first stage has three Falcon 9 cores with a total of 27 Merlin engines to get to the second stage and the payload almost in orbit. The second stage has a single Vacuum Merlin Engine to provide the last kick to get the payload in the desired orbit.

4.2 The Dragon Spacecraft

There are 2 different variants of the Dragon Spacecraft. The Crew Dragon is used to send and safely return Humans and Cargo to the International Space Station and the Dragon Spacecraft which only sends cargo to the International Space Station.

4.3 Starlink Satellites

The Starlink satellites are launched to Low Earth Orbit in clusters of up to 60 satellites on a Falcon 9 rocket. Once in orbit they slowly spread out equally in their orbit to cover a large area. The satellites communicate with each other with the use of lasers and then with users on the ground through radio signals.

4.4 Launch Simulator

Provide an interface to setup simulations. It should be possible to run a simulation in test mode while building the simulation and then run the simulation as if it were a real launch. Test mode simulations can be interrupted, tweaked and then allowed to continue. Simulations of an actual launch are setup and run. Actual launch simulations can also be stored and run in batches.

5 Tasks

Task 1: Design ..... (20 marks)

1.1 Identify the functional requirements.

1.2 Design the processes using Activity diagrams.

1.3 Decide on the patterns to address the functionality defined by the functional requirements and processes.

1.4 Design the classes for each of the identified patterns taking their interrelationships into account.

1.5 Draw a class diagram of your system.

1.6 Draw Sequence and communication diagrams showing the message passing between objects.

1.7 Design state diagrams showing how an object (which could also be a composite) changes state.

1.8 Provide at least two object diagrams showing the state of the objects active in the simulation just before launch and then again when docked at the International Space Station.

Task 2: Implementation ..... (50 marks)

Implement and test the code for each class and grouping of design pattern participants before integrating the classes of the design patterns into the project.

Task 3: Report ..... (30 marks)

A report stating how you applied the design patterns to address the functionality required by the system. This report should include UML diagrams to augment the explanation. This Task goes hand-in-hand with the Design task. Much of the design must be reported on in this task.

6 Submission Instructions

Each team is required to create a Git repository to manage the project. Manage your Git repository with GitHub. Make sure that in the documentation, a link to your GitHub is provided. The following must be available in your repository.

- Your system, this includes all your source files (that is `.h` and `.cpp`) and your Makefile.
- Any data files you may have created and are needed to run your program.
- A readme (`readme.txt`) explaining how to compile and run the program and the placement of any data files you may have created.
- A PDF version of your latest report in a folder named `Report`. The report must be written in Google Docs and a link to the Google Docs version of the report included in the PDF version of the document.

Make a snapshot of your Git repository and submit it as an archive to the ClickUP submission slot before the deadline.

- Place all your system files in a folder called `System`. Running your make file in the `System` folder should compile and link your system correctly.
- Place your data files, if any, in a `Data` folder.
- Make sure your `readme` is included in the root directory of your archive.
- A PDF version of your report in a folder named `Report`.

Failure to upload the project to ClickUP will result in the team receiving 0. It is the duty of the team lead to upload the file.

You will be required to demonstrate your system during the week of 22 November 2021.


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