CS3560.03 Group Project #1

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Stakeholders of our system:

a. Private space-related companies or space-related government agencies
   i. **External, Executive:** They fund, regulate, and oversee space missions but do not directly operate the system.
b. Mission controllers, flight directors, simulation supervisors, ground control operators, astronauts (essentially all the employees involved in carrying out spacecraft missions)
   i. **Internal, Operational:** These users directly interact with the system for real-time mission tracking, decision-making, and spacecraft operations.
c. Space program administrators
   i. **Internal, Executive:** They oversee space missions and manage policies but are not involved in real-time operations.
d. Scientists/researchers receiving data from spacecraft missions
   i. **External:** They analyze mission data for scientific purposes but do not operate the system themselves.
e. Engineers building mission-related technologies
   i. **External:** They use mission reports to improve spacecraft technology but are not system operators.
f. Media/general public/space enthusiasts
   i. **External:** They receive mission updates and reports but do not interact with the system.

System Vision Document: *Spacecraft Mission Monitoring System (SMMS)*

Problem Description

At any one time, a space program (like NASA) may have dozens or even hundreds of ongoing missions. Each mission requires a precise tracking of its spacecraft's maneuvers, fuel levels, status, and much more. Currently, most of these missions are monitored separately across different systems. Any misstep in tracking a mission can result in catastrophic failure which at the minimum will be very expensive, and if the mission has a crew, it could be deadly. Without a unified mission monitoring system, a misstep or mistake is only a matter of time. This is because each mission's data is fragmented, which increases the risk of inconsistencies, delays in decision-making, or critical oversights. To address this challenge, we will create a centralized **Spacecraft Mission Monitoring System (SMMS)**. A centralized monitoring system enables real-time synchronization of the data of different missions and allows for better coordination, situational awareness, and results. The system will track all ongoing spacecraft missions, including their location, scheduled and executed maneuvers, remaining fuel levels, and critical system alerts, while also logging mission status updates, detecting potential risks, generating regular reports, and running mission simulations with corresponding reports.

System Capabilities

The new system should be capable of: (1) Managing multiple spacecraft missions simultaneously. (2) Entering and storing information about a new spacecraft mission upon launch. (3) Logging and storing details about maneuvers performed by the mission's spacecraft in real-time. (4) Scheduling a future or immediate maneuver for a mission's spacecraft, storing and sending maneuver details. (5) Updating and tracking fuel levels based on executed maneuvers. (6) Updating a mission's status to 'Terminated' when the mission is officially ended and logging mission details and archiving its data for future reference. (7) Detecting critical issues such as low fuel, failed maneuvers, etc. and sending alerts accordingly. (8) Allowing the simulation of a spacecraft mission's progression up to a specified date and generating a report of results. (9) Generating a mission report every 24 hours for each mission, summarizing key data.

Business Benefits

It is anticipated that the deployment of this new system will provide the following business benefits to companies: (1) Provides a unified/organized view of all active missions, allowing for more informed decisions. (2) Supports simulation-based testing, allowing for predictive analysis before making costly mistakes. (3) Handles various mission types, from satellites to crewed spacecrafts. (4) Avoids costly mission failures by detecting potential issues. (5) Helps optimize fuel usage and maneuver efficiency, reducing unnecessary fuel spending. (6) Reduces the need for excessive manual monitoring, improving workforce efficiency. (7) Standardizes mission data storage—making it easier to review past missions, analyze performance, and make better strategies for future missions. (8) Enhances coordination/communication between mission controllers, flight directors, spacecraft crews, and external systems—reducing communication delays. (9) Enhances the company's technological capabilities, making them more competitive.

Spacecraft Mission Monitoring System

Event	Event Type	Resulting Use Case	Actor(s)
Mission controller enters new mission details following spacecraft launch.	External	Enter Mission Information	**Mission Controller**
The spacecraft's computer system or its crew transmits their maneuver's data to our system.	External	Log Executed Maneuver	**Spacecraft's Computer System** **Spacecraft's Crew**
The flight director or mission controller schedules a future maneuver.	External	Log Scheduled Maneuver	**Flight Director** **Mission Controller**
The flight director or mission controller schedules an immediate maneuver.	External	Log Immediate Maneuver	**Flight Director** **Mission Controller**
The flight director, mission controller, spacecraft's computer system, or the spacecraft's crew initiates mission termination.	External	Terminate Mission	**Flight Director** **Mission Controller** **Spacecraft's Computer System** **Spacecraft's Crew**
The simulation supervisor initiates a mission simulation.	External	Initiate Simulation	**Simulation Supervisor**
The system's timer detects a critical mission issue (such as low fuel, a failed maneuver, etc.).	State/Internal	Alert Spacecraft's Computer System	**System's Timer**
Every 24 hours from the moment a spacecraft mission is launched, the system's timer triggers the generation of a mission report.	Temporal	Generate Mission Report	**System's Timer**

Note: A "maneuver" in spacecraft missions is basically an intentional/calculated change in a spacecraft's trajectory/orbital path, achieved by firing its propulsion systems. In the context of our system, maneuvers are typically scheduled by mission controllers or flight directors to achieve mission objectives (course corrections, docking, etc.). In our system, maneuvers are logged with details such as fuel cost, execution time, resulting changes in spacecraft location, etc. The actual execution of the maneuver is handled by an external system (not in the scope of our system).

Spacecraft Mission Monitoring System

Use Case	**Use Case Description** (actor, act done, system response)
Enter Mission Information	The **mission controller** enters new mission details following a spacecraft's launch. The system then creates a mission record, storing key information such as the mission name, spacecraft name, initial fuel levels, current location, launch time, mission objectives, and other relevant data.
Log Executed Maneuver	A **spacecraft's computer system** or the **spacecraft's crew** for a specific mission transmits their maneuver's data to our system. The system then logs that data about the executed maneuver and updates the spacecraft's fuel levels, location, and other parameters accordingly.
Log Scheduled Maneuver	The **flight director** or **mission controller** schedules a future maneuver for the spacecraft of a specific mission. The system assigns the maneuver to the appropriate spacecraft mission and logs the maneuver's details (including fuel cost, whether it results in a change of location, and other relevant parameters) and the scheduled execution time; and it sends a notification of these details to the external execution system responsible for carrying out the maneuver (as execution of the maneuver itself is beyond our system's scope).
Log Immediate Maneuver	The **flight director** or **mission controller** schedules an immediate maneuver for a specific spacecraft mission. The system assigns the maneuver to the appropriate spacecraft mission and logs the maneuver's details (including fuel cost, whether it results in a change of location, and other relevant parameters) and it sends a notification to the external execution system to immediately carry out the maneuver (as execution of the maneuver itself is beyond our system's scope).
Terminate Mission	The **flight director**, **mission controller**, **spacecraft's computer system**, or the **spacecraft's crew** initiates mission termination. The system updates the mission status to 'Terminated' (ensuring it is no longer tracked as part of an active mission) and archives all relevant mission data for record-keeping.
Initiate Simulation	The **simulation supervisor** initiates a simulation for a specific mission to evaluate its behavior up to a specified date. The system runs a test scenario, simulating mission progression by executing all pre-scheduled maneuvers and fuel consumption calculations up to the specified date. The system logs and analyzes the simulated mission data, including fuel levels, trajectory changes, and potential problems. Upon completion, the system then generates a simulation report summarizing the mission's simulated performance and any possible problems.
Alert Spacecraft's	The **system's timer** detects a critical issue for a specific mission, such as low fuel or a failed maneuver. The system then logs the detected issue and its severity, and sends an

Computer System	immediate alert to the respective spacecraft's computer system.
Generate Mission Report	Every 24 hours from the moment a spacecraft mission is launched, the **system's timer** gets triggered. The system then compiles and analyzes the mission's data, including spacecraft status, executed maneuvers, fuel levels, and any detected issues; and it generates a mission report, summarizing all these things.