

# SeaLion Mission Architecture

## Table of Contents

Stakeholder Needs .....	2
1.1: Primary Mission Objective A1 .....	2
1.2: Primary Mission Objective A2 .....	2
1.3: Primary Mission Objective A3 .....	2
1.4: Primary Mission Objective A4 .....	2
1.5: Primary Mission Objective A5 .....	2
2.1: Secondary Mission Objective B1 .....	2
2.2: Secondary Mission Objective B2 .....	3
3.1: Tertiary Mission Objective C1 .....	3
3.2: Tertiary Mission Objective C2 .....	3
3.3: Tertiary Mission Objective C3 .....	3
Stakeholder Needs Mapping .....	3
User Stories .....	4
1: Ping Satellite .....	4
2: View Satellite Beacon Data .....	5
3: Send Request to Set Interrupt Timer .....	5
4: Request Telemetry or EventLog Data .....	5
4.1: Request Satellite Health Data .....	6
4.1.1: Request Satellite Health Data via S-Band Radio .....	6
4.2: Request Satellite Mission Data .....	6
5: Send Request to Set Mission Mode Duration .....	7
User Stories Mapping .....	7
User stories as Use Case Diagram .....	7
Data Structures .....	8
Satellite Health Data Packet .....	8
Satellite GPS Data .....	9
Satellite AODS Sensor Data .....	10
TLE .....	11
TLE Line 1 .....	12
TLE Line 2 .....	13
Mission Data .....	15
Data Structures Mapping .....	15
Finite State Machine .....	16

## Stakeholder Needs

The SeaLion Mission Architecture is guided by a series of stakeholder needs, listed below.

### 1.1: Primary Mission Objective A1

The SeaLion mission shall establish UHF communication link with Virginia ground station

### 1.2: Primary Mission Objective A2

The SeaLion mission shall establish S-Band communication link with MC3 ground station

### 1.3: Primary Mission Objective A3

The SeaLion mission shall successfully transmit “mission data” defined above to ground stations on the Earth.

### 1.4: Primary Mission Objective A4

The SeaLion mission shall adhere to CubeSat standards.

#### Reference:

- [CubeSat Design Specification Rev. 13](#)

### 1.5: Primary Mission Objective A5

The SeaLion mission shall validate the operation of the Impedance Probe (IP) as a primary payload in-orbit.

### 2.1: Secondary Mission Objective B1

The SeaLion mission shall provide a means to validate a Multi-spectral Sensor (Ms-S) in-orbit

## 2.2: Secondary Mission Objective B2

The SeaLion mission shall provide a means to validate a deployable composite structure (DeCS) in-orbit

## 3.1: Tertiary Mission Objective C1

The SeaLion mission shall qualify on-orbit the deployment and functioning of the newly developed UHF antenna system and its deployment.

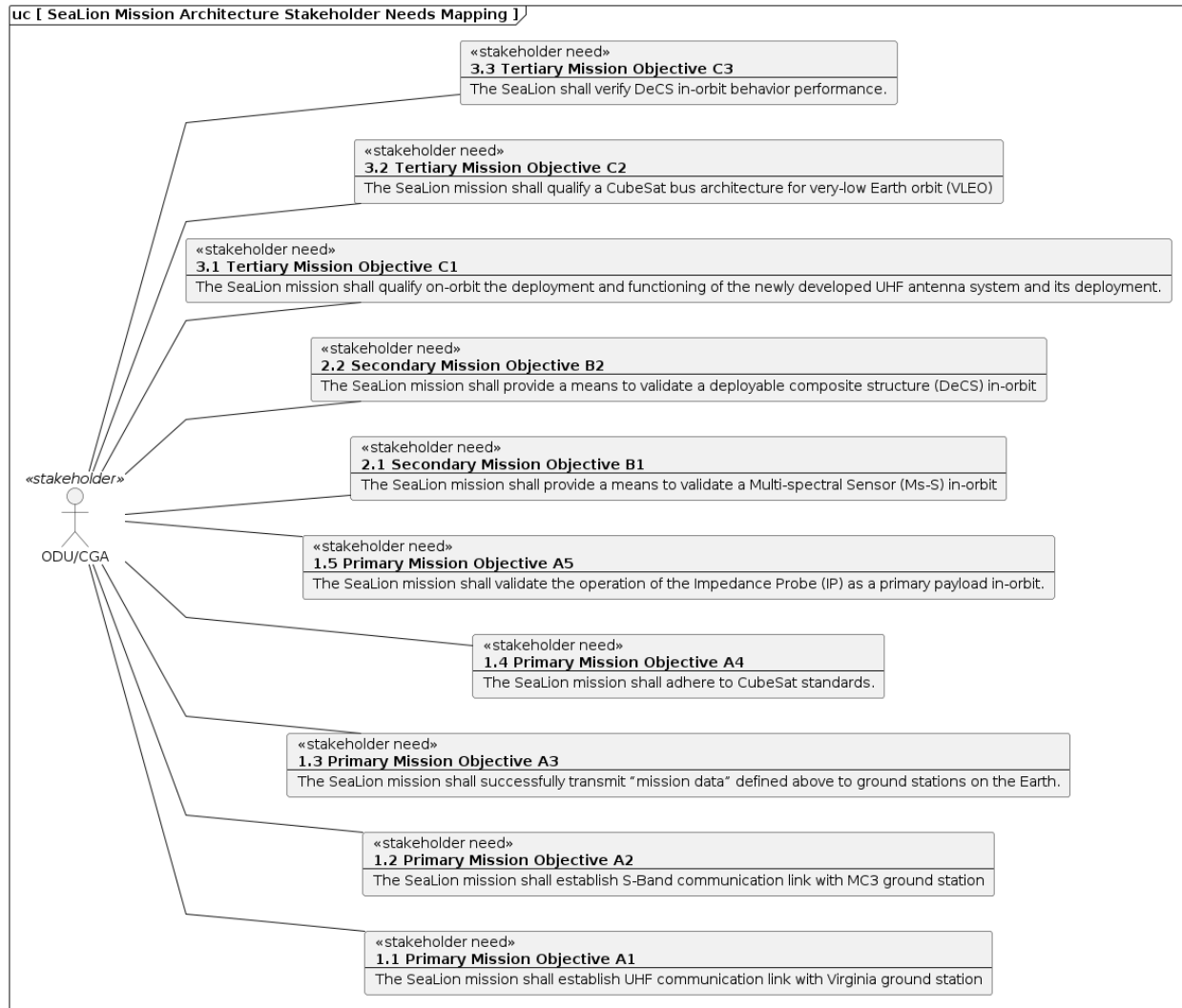
## 3.2: Tertiary Mission Objective C2

The SeaLion mission shall qualify a CubeSat bus architecture for very-low Earth orbit (VLEO)

## 3.3: Tertiary Mission Objective C3

The SeaLion shall verify DeCS in-orbit behavior performance.

## Stakeholder Needs Mapping



## User Stories

The SeaLion Mission Architecture's stakeholder needs are then used to identify a series of user stories which then lead to design decisions captured in data structure and activity definitions.

### 1: Ping Satellite

As a **Ground Station Operator** I want to **Ping satellite** so that I can **Establish communication link with satellite**.

#### Example:

Ping the satellite in order to establish UHF communication link with Virginia ground station

**Derived From:**

- [Primary Mission Objective A1](#)

**2: View Satellite Beacon Data**

As a **Ground Station Operator** I want to **view satellite beacon data (alternating between health & mission data), received via UHF** so that I can **verify that satellite is operating nominally**.

**Example:**

View satellite beacon data (health or mission data) to verify that TLE's correspond with expected orbit profile and/or to validate that a mission mode was successful

**Derived From:**

- [Primary Mission Objective A1](#)
- [Primary Mission Objective A3](#)
- [Primary Mission Objective A5](#)
- [Secondary Mission Objective B1](#)
- [Secondary Mission Objective B2](#)
- [Tertiary Mission Objective C1](#)
- [Tertiary Mission Objective C2](#)
- [Tertiary Mission Objective C3](#)

**3: Send Request to Set Interrupt Timer**

As a **Ground Station Operator** I want to **send a request to set count value at which interrupt timers (i.e., beacon, GPS ping, or orbit propagator) are triggered** so that I can **finetune parameters for attitude or orbit analysis or to conserve power**.

**Example:**

Update beacon rate to transmit every 30 minutes to conserve power

**4: Request Telemetry or EventLog Data**

As a **Ground Station Operator** I want to **Request satellite telemetry or eventlog data** so that I can **verify/validate health status or mission data**.

**Example:**

Request satellite telemetry packets for local verification/validation of onboard AODS computations

**4.1: Request Satellite Health Data**

As a **Ground Station Operator** I want to **request satellite health data packet** so that I can **verify/validate AODS sensors & GPS data are within nominal parameters**.

**Example:**

Request satellite health data packet to verify or validate TLE data corresponding to expected orbit profile based on pre-computed orbit propagation model

**Derived From:**

- [Request Telemetry or EventLog Data](#)

**4.1.1: Request Satellite Health Data via S-Band Radio**

As a **Ground Station Operator** I want to **request satellite health data packet via S-band radio** so that I can **verify/validate AODS sensors & GPS data are within nominal parameters**.

**Example:**

Request satellite health data packet via S-band radio to verify or validate TLE data corresponding to expected orbit profile based on pre-computed orbit propagation model

**Derived From:**

- [Request Telemetry or EventLog Data](#)
- [Primary Mission Objective A2](#)

**4.2: Request Satellite Mission Data**

As a **Ground Station Operator** I want to **request satellite mission data** so that I can **validate in-orbit AODS and/or payload performance**.

**Example:**

Request satellite mission data to verify that TLE's & AODS sensor data correspond with expected orbit profile and/or validate that a mission mode was successful

**Derived From:**

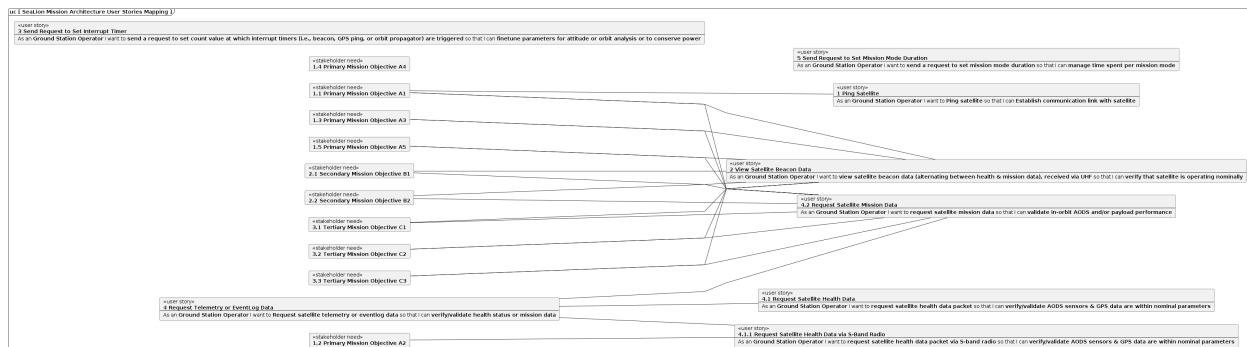
- Request Telemetry or EventLog Data
- Primary Mission Objective A1
- Primary Mission Objective A3
- Primary Mission Objective A5
- Secondary Mission Objective B1
- Secondary Mission Objective B2
- Tertiary Mission Objective C1
- Tertiary Mission Objective C2
- Tertiary Mission Objective C3

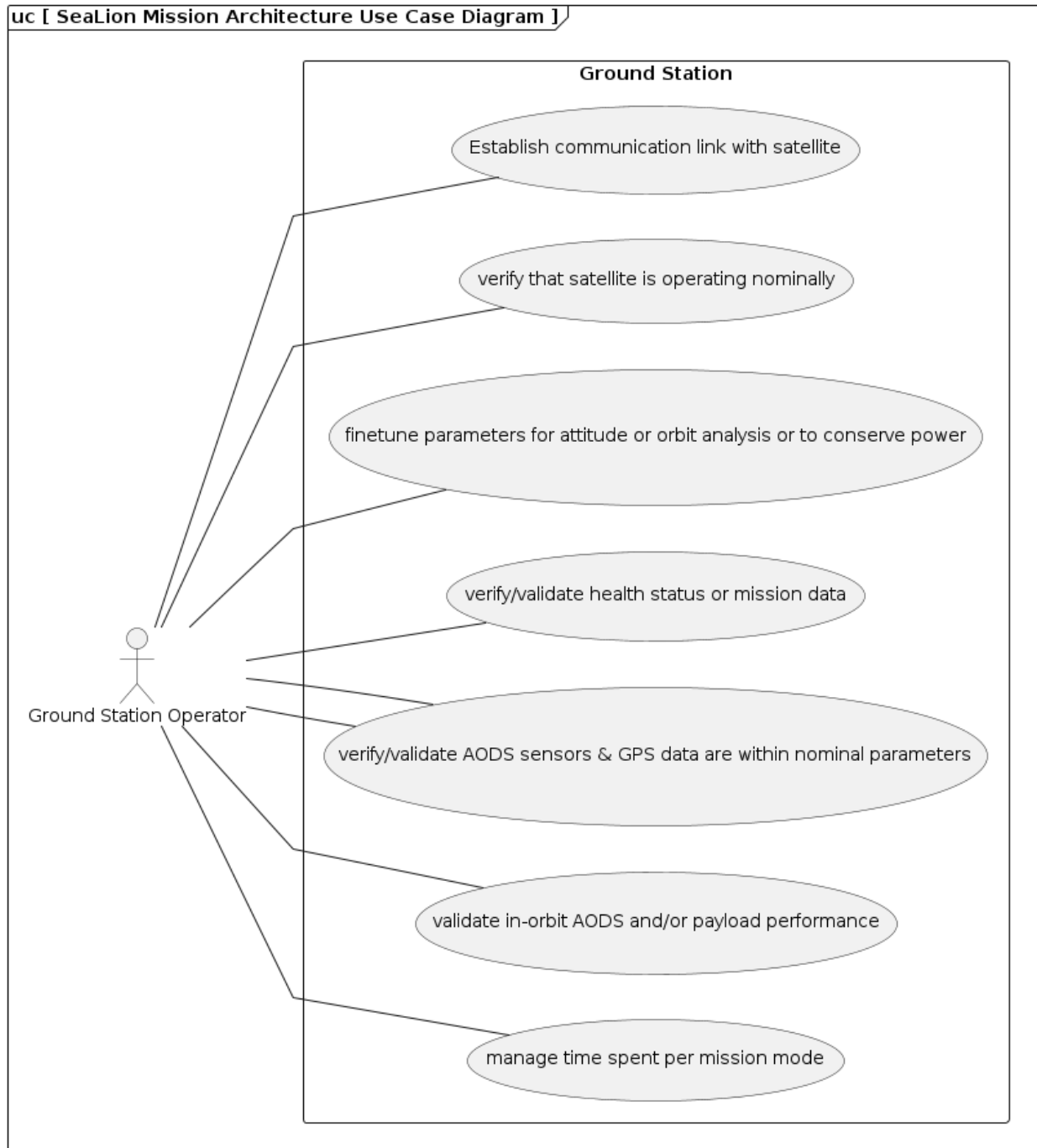
**5: Send Request to Set Mission Mode Duration**

As a **Ground Station Operator** I want to **send a request to set mission mode duration** so that I can **manage time spent per mission mode**.

**Example:**

send a request to set Mission Mode 1 duration to 25 minutes

**User Stories Mapping****User stories as Use Case Diagram**



## Data Structures

This section covers each data structure type in the **SeaLion Mission Architecture**.

### Satellite Health Data Packet

**Purpose:** Data structure for satellite health data packet used for beacon telemetry



*Satellite Health Data Packet Template*

```

call_sign: {{call_sign}}
battery_health: {{battery_health}}
temperature_battery: {{temperature_battery}}
mode: {{mode}}
tle_data: {{tle_data}}

```

Field	Type	Item Type	Description	Source
call_sign	string		Identifying call sign for the Sealion mission.	
battery_health	float		Percent value indicating the remaining charge of the batteries.	
temperature_battery	float		The temperature of the battery. Units in Kelvin.	
mode	integer		Integer value indicating current mission mode. 0 = Safe, 1 = mission mode 1, 2 = mission mode 2, 3 = mission mode 3.	
tle_data	TLE		TLE data from orbit propagator at time of beacon.	

*Table 1. Satellite Health Data Packet Specification***Derived From:**

- [View Satellite Beacon Data](#)
- [Request Satellite Health Data](#)

**Satellite GPS Data**

**Purpose:** Data structure for GPS data used for orbit propagation

*Satellite GPS Data Template*

```

time_stamp: {{time_stamp}}
altitude_data_GPS: {{altitude_data}}
latitude_GPS: {{latitude}}
longitude_GPS: {{longitude}}

```

Field	Type	Item Type	Description	Source
time_stamp	string		Time stamp when GPS data was acquired.	
altitude_data_GPS	float		The altitude data of the satellite from GPS.	
latitude_GPS	float		Latitude coordinate of the satellite from GPS.	
longitude_GPS	float		Longitude coordinate of the satellite from GPS.	

Table 2. Satellite GPS Data Specification

### Satellite AODS Sensor Data

**Purpose:** Data structure for satellite AODS sensor data used for attitude determination or incremental orbit propagation

Satellite AODS Sensor Data Template

```
imu_gyro_x: {{imu_gyro_x}}
imu_gyro_y: {{imu_gyro_y}}
imu_gyro_z: {{imu_gyro_z}}
imu_magnetometer_x: {{imu_magnetometer_x}}
imu_magnetometer_y: {{imu_magnetometer_y}}
imu_magnetometer_z: {{imu_magnetometer_z}}
sun_sensor_pitch_pos: {{sun_sensor_pitch_pos}}
sun_sensor_pitch_neg: {{sun_sensor_pitch_neg}}
sun_sensor_yaw_pos: {{sun_sensor_yaw_pos}}
sun_sensor_yaw_neg: {{sun_sensor_yaw_neg}}
sun_sensor_roll_pos: {{sun_sensor_roll_pos}}
sun_sensor_roll_neg: {{sun_sensor_roll_neg}}
time_stamp: {{time_stamp}}
```

Field	Type	Item Type	Description	Source
imu_gyro_x	float		The angular rate of the body with to respective to the x-axis in the IMU's reference frame.	
imu_gyro_y	float		The angular rate of the body with to respective to the y-axis in the IMU's reference frame.	

Field	Type	Item Type	Description	Source
imu_gyro_z	float		The angular rate of the body with respect to the z-axis in the IMU's reference frame.	
imu_mag_netomete_r_x	float		The magnetic field strength with respect to the x-axis in the IMU's reference frame.	
imu_mag_netomete_r_y	float		The magnetic field strength with respect to the y-axis in the IMU's reference frame.	
imu_mag_netomete_r_z	float		The magnetic field strength with respect to the z-axis in the IMU's reference frame.	
sun_sensor_pitch_pos	float		Sun sensor measurement with respect to positive pitch angle.	• []
sun_sensor_pitch_neg	float		Sun sensor measurement with respect to negative pitch angle.	• []
sun_sensor_yaw_pos	float		Sun sensor measurement with respect to positive yaw angle.	• []
sun_sensor_yaw_neg	float		Sun sensor measurement with respect to negative yaw angle.	• []
sun_sensor_roll_pos	float		Sun sensor measurement with respect to positive roll angle.	• []
sun_sensor_roll_neg	float		Sun sensor measurement with respect to negative roll angle.	• []
time_stamp	string		Time stamp of the last transmission.	

Table 3. Satellite AODS Sensor Data Specification

**Derived From:****TLE**

**Purpose:** Data structure for the TLE data computed from GPS data or orbit propagator

*TLE Template*

```
tle_line_1: {{tle_line_1}}
tle_line_2: {{tle_line_2}}
```

Field	Type	Item Type	Description	Source
tle_line_1	TLELine 1		Data for TLE line 1	
tle_line_2	TLELine 2		Data for TLE line 2	

*Table 4. TLE Specification***Derived From:**

- [Two-Line Element Data](#)

**TLE Line 1**

**Purpose:** Data structure for the first line of the TLE data

*TLE Line 1 Template*

```
line_number: {{line_number}}
satellite_number: {{satellite_number}}
classification: {{classification}}
international_designator_1: {{international_designator_1}}
international_designator_2: {{international_designator_2}}
international_designator_3: {{international_designator_3}}
epoch_year: {{epoch_year}}
epoch: {{epoch}}
first_dt: {{first_dt}}
second_dt: {{second_dt}}
bstar: {{bstar}}
eph_type: {{eph_type}}
element_number: {{element_number}}
checksum: {{checksum}}
```

Field	Type	Item Type	Description	Source
line_number	string		Line number of element data (Column 01)	

Field	Type	Item Type	Description	Source
satellite_number	string		Satellite number (Column 03-07)	
classification	string		Classification of satellite (Column 08)	
international_designator_1	string		International designator 1 (last two digits of launch year) (Column 10-11)	
international_designator_2	string		International designator 2 (launch number of the year) (Column 12-14)	
international_designator_3	string		International designator 3 (piece of the launch) (Column 15-17)	
epoch_year	string		Epoch year (last two digits of year) (Column 19-20)	
epoch	string		Epoch (day of the year and fractional portion of the day) (Column 21-32)	
first_dt	string		First time derivative of the mean motion (Column 34-43)	
second_dt	string		Second time derivative of the mean motion (leading decimal point assumed) (Column 45-52)	
bstar	string		BSTAR drag term (leading decimal point assumed) (Column 54-61)	
eph_type	string		Ephemeris type (Column 63)	
element_number	string		Element number (Column 65-68)	
checksum	string		Checksum (modulo 10) (letters, blanks, periods, plus signs = 0; minus signs = 1) (Column 69)	

Table 5. TLE Line 1 Specification

**Derived From:**

- [Two-Line Element Data](#)

**TLE Line 2**

**Purpose:** Data structure for the second line of the TLE data

*TLE Line 2 Template*

```

line_number: {{line_number}}
satellite_number: {{satellite_number}}
inclination: {{inclination}}
raan: {{raan}}
ecc: {{ecc}}
perigee: {{perigee}}
mean_anomaly: {{mean_anomaly}}
mean_motion: {{mean_motion}}
rev_epoch: {{rev_epoch}}
checksum: {{checksum}}

```

Field	Type	Item Type	Description	Source
line_number	string		Line number of element data (Column 01)	
satellite_number	string		Satellite number (Column 03-07)	
inclination	string		Inclination (degrees) (Column 09-16)	
raan	string		Right ascension of the ascending node (degrees) (Column 18-25)	
ecc	string		Eccentricity (leading decimal point assumed) (Column 27-33)	
perigee	string		Argument of perigee (degrees) (Column 35-42)	
mean_anomaly	string		Mean anomaly (degrees) (Column 44-51)	
mean_motion	string		Mean motion (revs per day) (Column 53-63)	
rev_epoch	string		Revolution number at epoch (revs) (Column 64-68)	
checksum	string		Checksum (modulo 10) (letters, blanks, periods, plus signs = 0; minus signs = 1) (Column 69)	

*Table 6. TLE Line 2 Specification***Derived From:**

- [Two-Line Element Data](#)

## Mission Data

**Purpose:** Defines EVR (event) elements to be recorded to the eventLog during a mission mode

### *Mission Data Template*

```
entry_tle: {{entry_tle}}
obc_sensors: {{obc_sensors}}
mission_data: {{mission_data}}
exit_tle: {{exit_tle}}
```

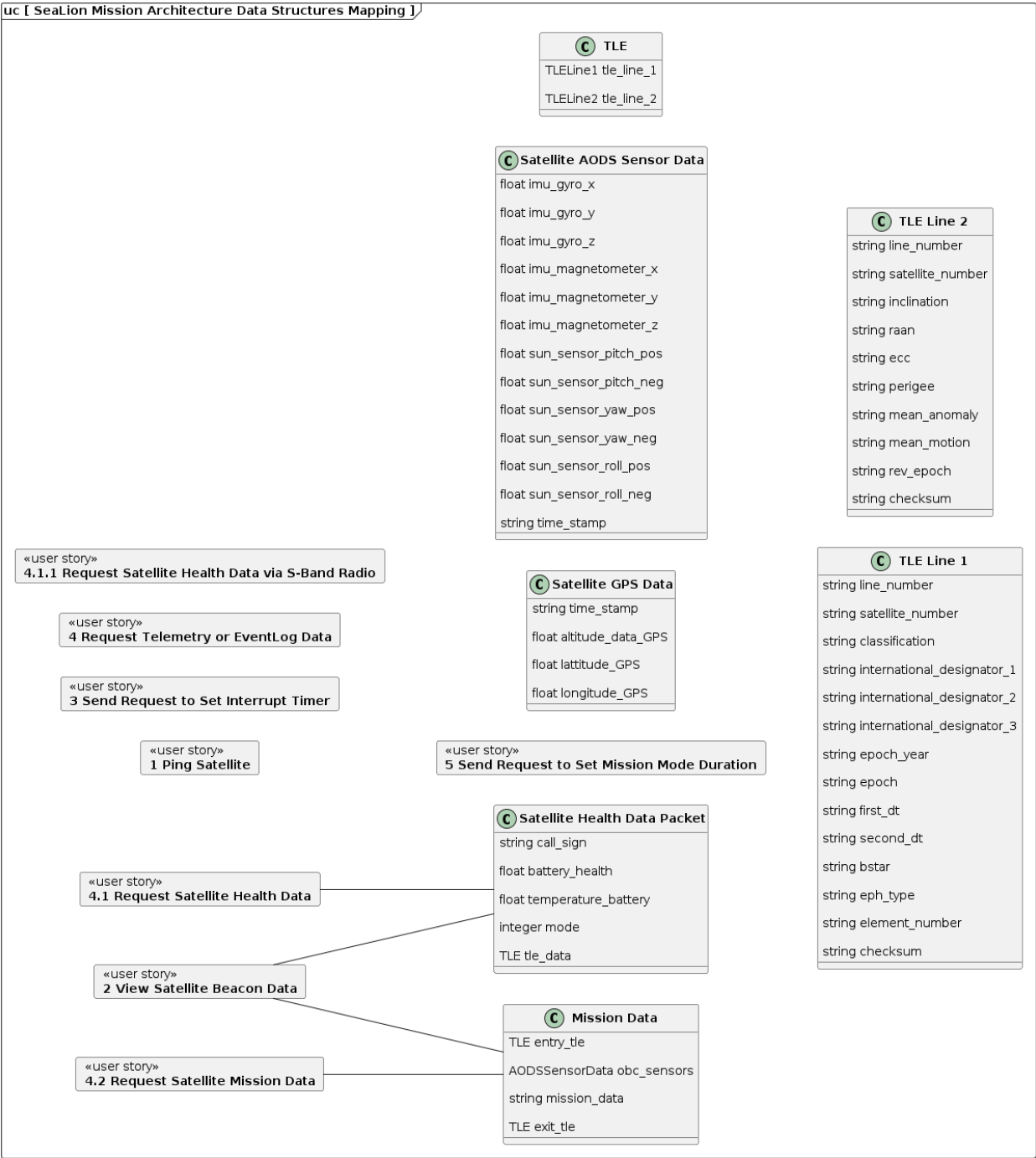
Field	Type	Item Type	Description	Source
entry_tle	TLE		TLE at time of beginning of mission mode	
obc_sensors	AODSSensorData		AODS Sensor data	
mission_data	string		Data recorded during mission mode	
exit_tle	TLE		TLE at time of end of mission mode	

*Table 7. Mission Data Specification*

### Derived From:

- [View Satellite Beacon Data](#)
- [Request Satellite Mission Data](#)

## Data Structures Mapping



Finite State Machine



