SeaLion Mission Architecture

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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) inorbit

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.

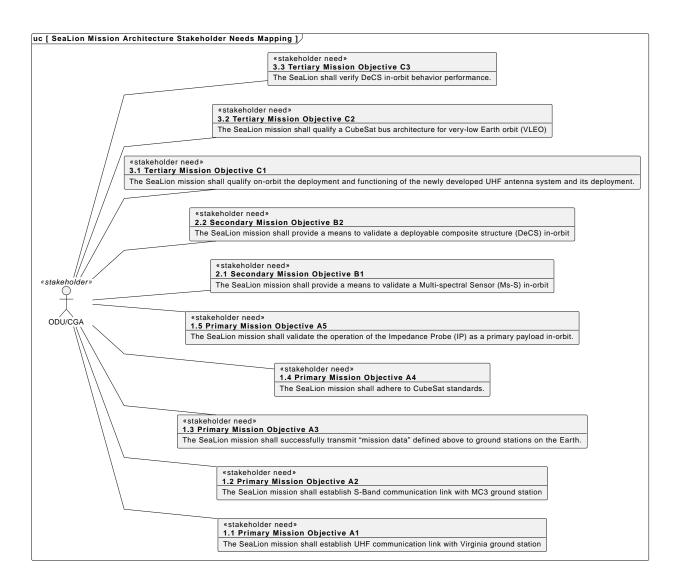
3.2: Tertiary Mission Objective C2

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

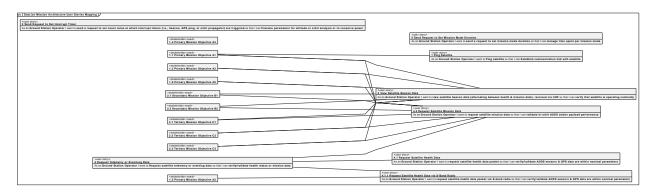
5: Send Request to Set Mission Mode Duration

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**.

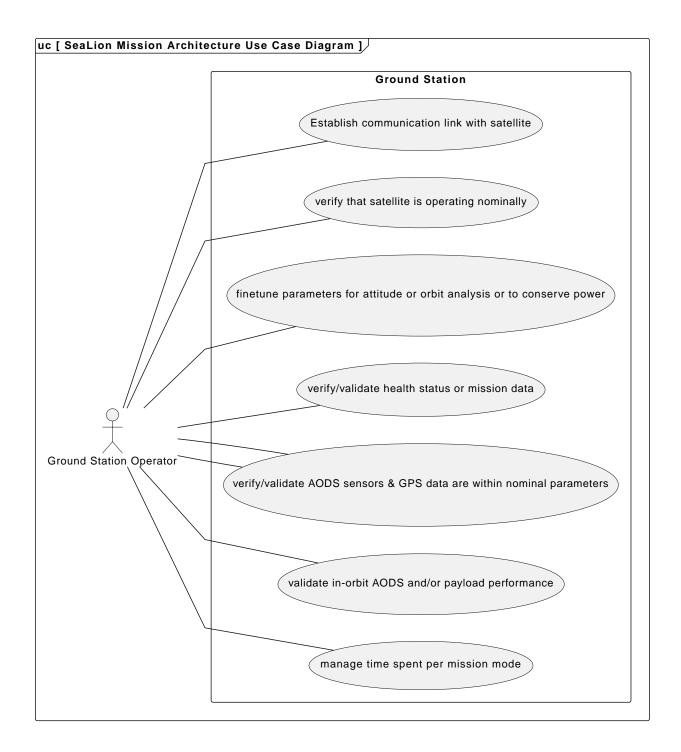
Example:

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	Туре	Item Type	Description	Source
call_sign	string		Identifying call sign for the Sealion mission.	
battery_h ealth	float		Percent value indicating the remaining charge of the batteries.	
temperat ure_batte ry	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 propogator 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}}
lattitude_GPS: {{lattitude}}
longitude_GPS: {{longitude}}
```

Field	Туре	Item Type	Description	Source
time_sta mp	string		Time stamp when GPS data was acquired.	
altitude_ data_GP S	float		The altitude data of the satellite from GPS.	
lattitude_ GPS	float		Lattitude 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 propogation

Satellite AODS Sensor Data Template

```
imu_gyro_x: {{imu_gyro_x}}
imu_gyro_y: {{imu_gyro_z}}
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	Туре	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	Туре	Item Type	Description	Source
imu_gyro _z	float		The angular rate of the body with to respective to the z-axis in the IMU's reference frame.	
imu_mag netomete r_x	float		The magnetic field strength with respective to the x-axis in the IMU's reference frame.	
imu_mag netomete r_y	float		The magnetic field strength with respective to the y-axis in the IMU's reference frame.	
imu_mag netomete r_z	float		The magnetic field strength with respective to the z-axis in the IMU's reference frame.	
sun_sen sor_pitch _pos	float		Sun sensor measurement with respect to positive pitch angle.	• []
sun_sen sor_pitch _neg	float		Sun sensor measurement with respect to negative pitch angle.	• []
sun_sen sor_yaw _pos	float		Sun sensor measurement with respect to positive yaw angle.	• []
sun_sen sor_yaw _neg	float		Sun sensor measurement with respect to negative yaw angle.	• []
sun_sen sor_roll_ pos	float		Sun sensor measurement with respect to positive roll angle.	• []
sun_sen sor_roll_ neg	float		Sun sensor measurement with respect to negative roll angle.	• []
time_sta mp	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

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TLE Template

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

Field	Туре	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	Туре	Item Type	Description	Source
line_num ber	string		Line number of element data (Column 01)	

Field	Туре	Item Type	Description	Source
satellite_ number	string		Satellite number (Column 03-07)	
classifica tion	string		Classification of satellite (Column 08)	
internatio nal_desi gnator_1	string		International designator 1 (last two digits of launch year) (Column 10-11)	
internatio nal_desi gnator_2	string		International designator 2 (launch number of the year) (Column 12-14)	
internatio nal_desi gnator_3	string		International designator 3 (piece of the launch) (Column 15-17)	
epoch_y ear	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)	
checksu m	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	Туре	Item Type	Description	Source
line_num ber	string		Line number of element data (Column 01)	
satellite_ number	string		Satellite number (Column 03-07)	
inclinatio n	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_an omaly	string		Mean anomaly (degrees) (Column 44-51)	
mean_m otion	string		Mean motion (revs per day) (Column 53-63)	
rev_epoc h	string		Revolution number at epoch (revs) (Column 64-68)	
checksu m	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}}
```

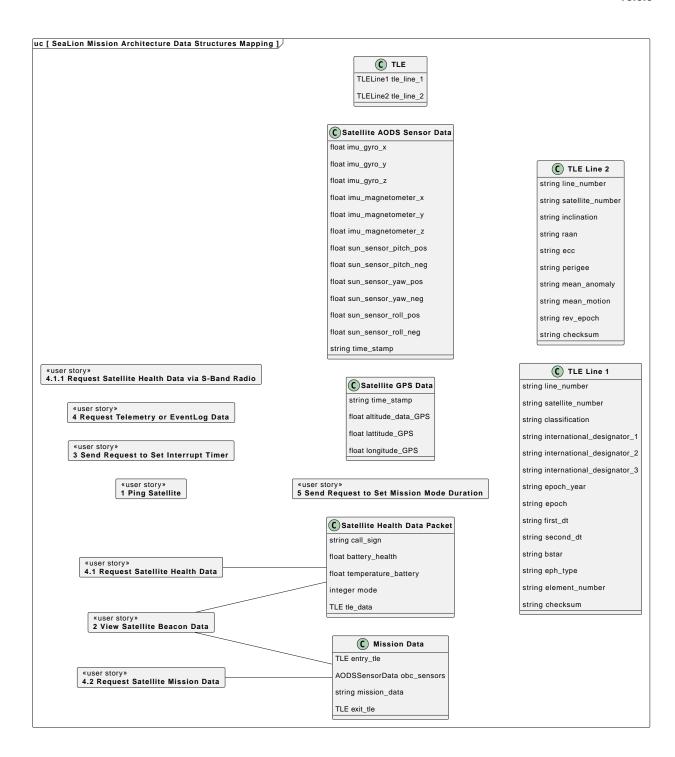
Field	Туре	Item Type	Description	Source
entry_tle	TLE		TLE at time of beginning of mission mode	
obc_sen sors	AODSSe nsorData		AODS Sensor data	
mission_ data	string		Data recorded during mission mode	
exit_tle	TLE		TLE at time of end of mission mode	

Table 7. Mission Data Specification

Derived From:

- View Satellite Beacon Data
- Request Satellite Mission Data

Data Structures Mapping



Finite State Machine

