

# 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 as per CDS Rev. 13

#### 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 via accelerometer & temperature sensor data

## 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 Health Data Packet

As a **Ground Station Operator** I want to **view satellite health data packet** so that I can **validate that satellite is operating nominally**.

### Example:

View satellite health data packet to verify or validate AODS sensor & GPS data is within nominal range and/or corresponds to expected orbit profile

### 2.1: Listen for Satellite Beacon

As a **Ground Station Operator** I want to **Open ground station beacon monitor** so that I can **View satellite health data packet**.

### Example:

Open ground station beacon monitor to listen for satellite health data packet downlink

### Derived From:

- [View Satellite Health Data Packet](#)

## 3: Update Beacon Rate

As a **Ground Station Operator** I want to **Update Beacon Rate** so that I can **Conserve power budget**.

### Example:

Update beacon rate to transmit every 30 minutes to conserve power

## 4: Request Telemetry Data

As a **Ground Station Operator** I want to **Request satellite telemetry data packets** so that I can **Locally verify/validate onboard AODS computations**.

### 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 AODS sensors and GPS data correspond to expected attitude and/or orbit profile based on pre-computed attitude or orbit propagation model

##### Derived From:

- [Request Telemetry Data](#)

#### 4.2: Request Satellite AODS Sensor Data

As a **Ground Station Operator** I want to **request satellite AODS sensor data** so that I can **verify AODS sensor data yields nominal parameters**.

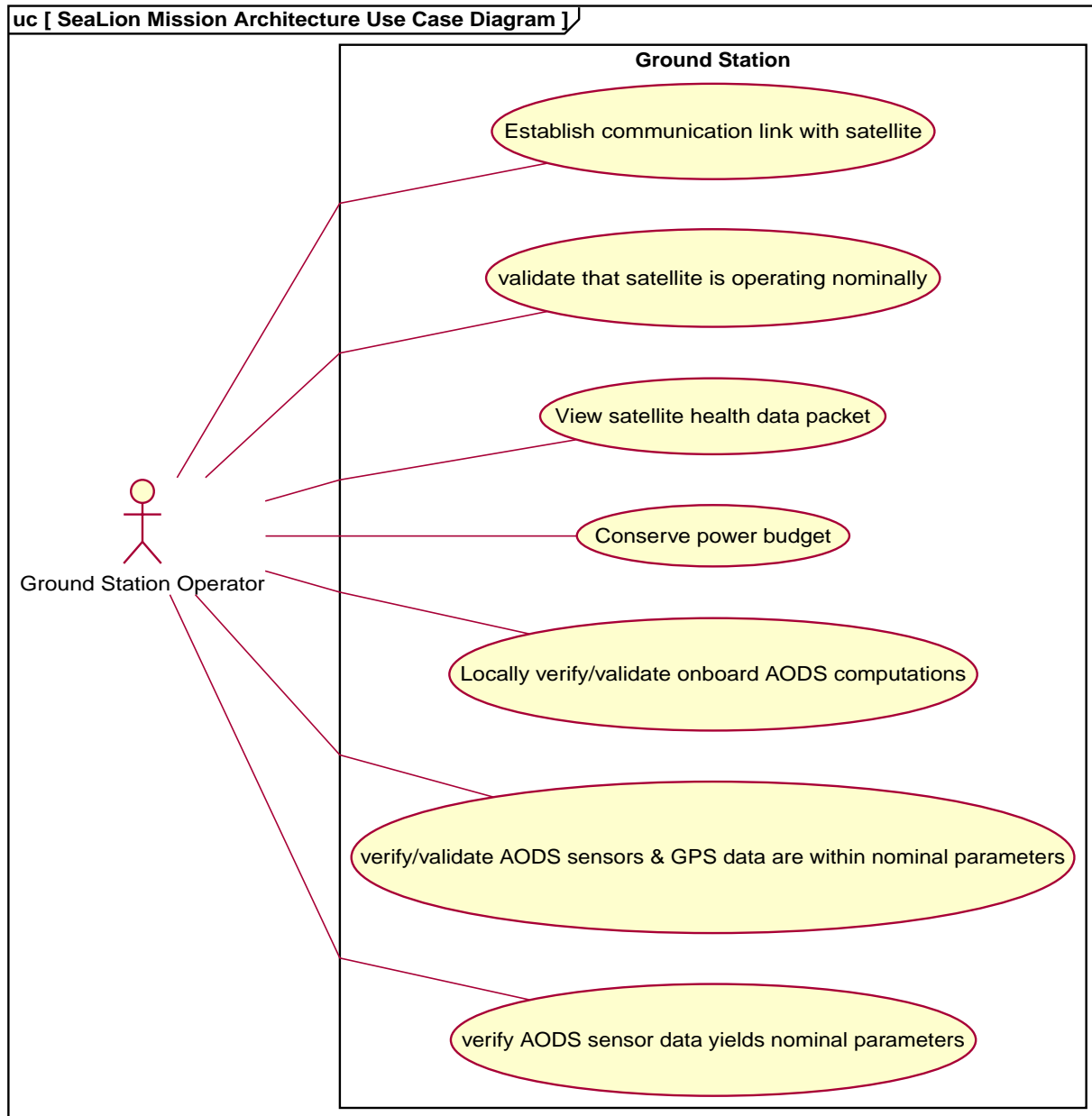
##### Example:

Request satellite AODS sensor data for verifying AODS sensor data corresponds with a known magnetic field, light source, and/or change in orientation w.r.t. satellites body frame of reference

##### Derived From:

- [Request Telemetry Data](#)

#### 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}}
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.  |        |
| mode           | integer                     |           | Integer value indicating current mission mode. 0 = Safe, 1 = mission mode 1, 2 = mission mode 2, 3 = mission mode 3. |        |
| tle_data       | 3-DataStructures/4-TLE.yaml |           | TLE data from orbit propagator at time of beacon.  |        |

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

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

**Satellite AODS IC Data**

**Purpose:** Data structure for satellite AODS initial conditions data packet used for attitude determination and orbit propagation

## Satellite AODS IC 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}}
altitude_data_GPS: {{altitude_data}}
latitude_GPS: {{latitude}}
longitude_GPS: {{longitude}}

```

| 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. |        |
| 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<br>netomete<br>r_x   | float |           | The magnetic field strength with respective to the x-axis in the IMU's reference frame.     |        |
| imu_mag<br>netomete<br>r_y   | float |           | The magnetic field strength with respective to the y-axis in the IMU's reference frame.     |        |
| imu_mag<br>netomete<br>r_z   | float |           | The magnetic field strength with respective to the z-axis in the IMU's reference frame.     |        |
| sun_sen<br>sor_pitch<br>_pos | float |           | Sun sensor measurement with respect to positive pitch angle.                                | • []   |



| Field                | Type   | Item Type | Description  | Source |
|----------------------|--------|-----------|--|--------|
| 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.                         |        |
| 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 AODS IC Data Specification

**Derived From:****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. |        |
| 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<br>netomete<br>r_x   | float |           | The magnetic field strength with respective to the x-axis in the IMU's reference frame.     |        |
| imu_mag<br>netomete<br>r_y   | float |           | The magnetic field strength with respective to the y-axis in the IMU's reference frame.     |        |
| imu_mag<br>netomete<br>r_z   | float |           | The magnetic field strength with respective to the z-axis in the IMU's reference frame.     |        |
| sun_sen<br>sor_pitch<br>_pos | float |           | Sun sensor measurement with respect to positive pitch angle.                                | • []   |
| sun_sen<br>sor_pitch<br>_neg | float |           | Sun sensor measurement with respect to negative pitch angle.                                | • []   |

| Field               | Type   | Item Type | Description   | Source |
|---------------------|--------|-----------|---|--------|
| 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:**

- [Request Satellite AODS Sensor Data](#)

**TLE**

**Purpose:** Data structure for the TLE data

*TLE Template*

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

| Field      | Type                             | Item Type | Description         | Source |
|------------|----------------------------------|-----------|---------------------|--------|
| tle_line_1 | 3-DataStructures/5-TLELine1.yaml |           | Data for TLE line 1 |        |

| Field      | Type                             | Item Type | Description         | Source |
|------------|----------------------------------|-----------|---------------------|--------|
| tle_line_2 | 3-DataStructures/6-TLELine2.yaml |           | 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) |        |
| satellite_number | string |           | Satellite number (Column 03-07)         |        |
| classification   | string |           | Classification of satellite (Column 08) |        |

| Field                      | Type   | Item Type | Description  | Source |
|----------------------------|--------|-----------|--|--------|
| 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](#)

## Finite State Machine

