Team Bravo Request for Proposal

Saint Louis University



by

Jennifer Babb

Bryant Gaume

Tyler Olson

Tom Moline

Nate Richard

Copper Operational

Test Plan

# Mission Introduction

The team Bravo mission consists of a CubeSat-Class satellite system that is capable of demonstrating three key proximity operations relative to a resident space object: stationkeeping, “escape” maneuvers, and rendezvous. Table 1-1 lists the definition of each of these proximity operation terms, while the Appendix discusses in detail general terms associated with any CubeSat mission.

The entirety of this proposed mission shall be executed through the use of a 6U satellite architecture. Thus, in order to achieve mission success, both the satellite conducting each proximity operation discussed in the previous paragraph and the resident space object it is conducting said operations relative to must be contained within only 6U’s of space.

**Table 1-1. Key Proximity Operations Definitions**

|  |  |
| --- | --- |
| **Proximity Operation Terms** | **Definition** |
| Stationkeeping | Maintaining a set relative displacement between two space objects for a period of several orbits |
| “Escape” Maneuver | Performing an orbital maneuver that increases the relative displacement between two space objects, as to avoid on-orbit collisions and potential orbital debris creation. |
| Rendezvous | Performing an orbital maneuver that decreases the relative displacement between two space objects within a set distance for a period of several orbits. |
| Resident Space Object | Any satellite or space debris residing in an orbit around the Earth. |

Along with performing each of the above proximity operations, the proposed mission has several other limits on its successful implementation, as listed in Table 1-2 below.

|  |  |
| --- | --- |
| **Mission Constraint** | **Definition** |
| Lifetime | The amount of time required to successfully execute each of the proposed mission’s goals. |
| Orbit Range | The range of orbits over which the mission can be accomplished/placed in. |
| Mass | Performing an orbital maneuver that decreases the relative displacement between two space objects within a set distance for a period of several orbits. |

* **Mission Lifetime:** the range of orbits over which the mission can take place and still allow for the completion of all mission requirements, as described in the mission summary section.

Assuming a mission lifetime of at least 6 months, the minimum orbit at which the mission can be placed and still be able to complete said mission objectives is 300 km, which is easily reachable with launch providers that have taken missions such as this to low earth orbit in the past.

Along with this lower orbit bound, an upper orbit bound of 900 km can be set, since very few, if any, launch providers have transported past CubeSat missions beyond this point.

Finally, a maximum mission mass of 8 kg can be set, as defined by doubling the mass dictated by the standard 3U CubeSat design specification, as described in *CubeSat Design Specification, Rev 13, California Polytechnic State University CubeSat Program*.

The mission constraints discussed in the previous paragraphs are summarized in Table 1-2 below:

**Table 1-2. Proposed Mission Constraints**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Mass** | **Cube Size** | **Desired Orbit** | | **Acceptable Orbit Range** | **Desired Mission Life** |
| 8 kg | 6U | Altitude | 400 km | 300-900 km  40⁰-100⁰ | 6 Months |
| Inclination | 40⁰ |

# Mission Overview

With the constraints discussed in the previous section in mind, the objective and success criteria of the proposed mission are defined as follows:

## Mission Objective

**The proposed mission shall demonstrate proximity operations and rendezvous within a 6U spacecraft architecture.**

## Mission Success Criteria

**The proposed mission shall demonstrate:**

1. Stationkeeping within a 10-100 m sphere of a resident space object.
2. An “Escape” Maneuver by performing an orbital maneuver that intentionally increases the final relative displacement between the mission spacecraft and a resident space object.
3. Rendezvous by performing an orbital maneuver that intentionally decreases the final relative displacement between the mission spacecraft and a resident space object.

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# Appendix

It is important to establish the meanings of various terms that are associated with any given CubeSat mission, such as the one proposed in this document. Firstly, 1U, or one standard unit, is defined as a cube of a uniform edge length of 10 cm. A CubeSat-Class satellite (aka a “nanosatellite”) is a satellite whose dimensions derive from 1 or more of these standard units. An example of a 3U sized spacecraft is shown in Figure 1-1 below. The reason for creating such satellites is twofold: it greatly reduces the time and monetary investment associated with developing custom satellite shapes and structures, while also allowing the development of standard satellite deployers for integration into any rocket configuration, thus allowing greater access to launch opportunities for university missions. Currently, the largest volume CubeSat deployer is the NLAS (Nanosatellite Launch Adapter System) deployer, which has space for a 6U satellite configuration.



**Figure 3-1. Example 3U CubeSat Architecture**