

**Team Bravo Request for
Proposal
Saint Louis University**



by

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1. Mission Introduction

Team Bravo is requesting proposals for a mission consisting 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.

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
Collision Avoidance	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.

This mission, as defined, was presented as a part of Boeing’s Advanced Space and Intelligence Systems (AS&IS) search for a university satellite program whose mission goals and designs could best transition to wide-scale use in industry satellite systems.

As a result, vast portions of the proposed mission, if accepted, would be provided by Boeing, so that students at Saint Louis University can focus specifically on making the mission payload perform to its best possible ability. For example, where most satellite programs have to develop and test their own Attitude Determination and Control (ADC) systems, which can involve complex interactions between gyroscopes, reaction wheels, magnetorquers, sun sensors, Earth sensors, star trackers, et cetera, the Saint Louis University team will only have to focus on developing algorithms to orient the spacecraft based on data provided from ADC systems that have been developed and tested by engineers at Boeing. This aid from experienced professionals would add a layer of confidence to the performance of said systems and allows for a greater focus on mission definition and integration.

Subsequently, the proposed mission would take the form of developing a payload around the core bus that would be provided by Boeing. Thus, in order for the mission to be considered acceptable to fly, it must be capable meeting the goals laid out by Boeing integration and performance standards, as defined in Table 1-2.

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Table 1-2. Proposed Payload Integration and Performance Standards

Parameter	Payload Accommodation/Space Vehicle Performance
Design Life	1 to 3 Years
Payload Mass	Up to 1.83 kg (Per 3U)
Payload Power	The Payload power is highly dependent on the vehicle and mission CONOPS parameters, especially mission attitude control. For solar inertial attitudes, nominal Payload power can be 35W operating with a 50% duty cycle. Peak power excursions of up to 70W can be accommodated. For LVLH attitude, continuous 5W (OAP) is nominally available for the Payload. Payload power will be re-evaluated based on selection of the solar array configuration, mission orbit, and vehicle attitude during mission operations
Payload Electrical Power Interfaces	9.7V-12V unregulated, 5V regulated, 3.3V regulated
Payload Size	Up to 1.5U (10cm x 10cm x 15cm)
Pointing Control	0.42 deg
Pointing Knowledge	0.31 deg
Agility	Up to 3.0 deg/sec
Radiation Environment	Rad hard for LEO total dose for 3 years, SEU tolerant
Mass Data Storage	8 GB
Propulsion	Up to 150 m/s with 0.5U reduced payload volume
Launch Environment	CubeSat GEVS standard

2. Mission Overview

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

2.1. Mission Objective

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

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2.2. Mission Success Criteria

The proposed mission shall demonstrate:

1. Stationkeeping within a 10-75 m sphere of a resident space object for at least 5 orbits.
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 to at least 100 meters in a maximum time of 1 orbit.
3. Rendezvous by performing an orbital maneuver that intentionally decreases the final relative displacement between the mission spacecraft and a resident space object to within 50 m for a period of time of at least 5 orbits.

3. 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. As an example of this particular satellite configuration, a 3U sized spacecraft is shown in Figure 3-1 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.

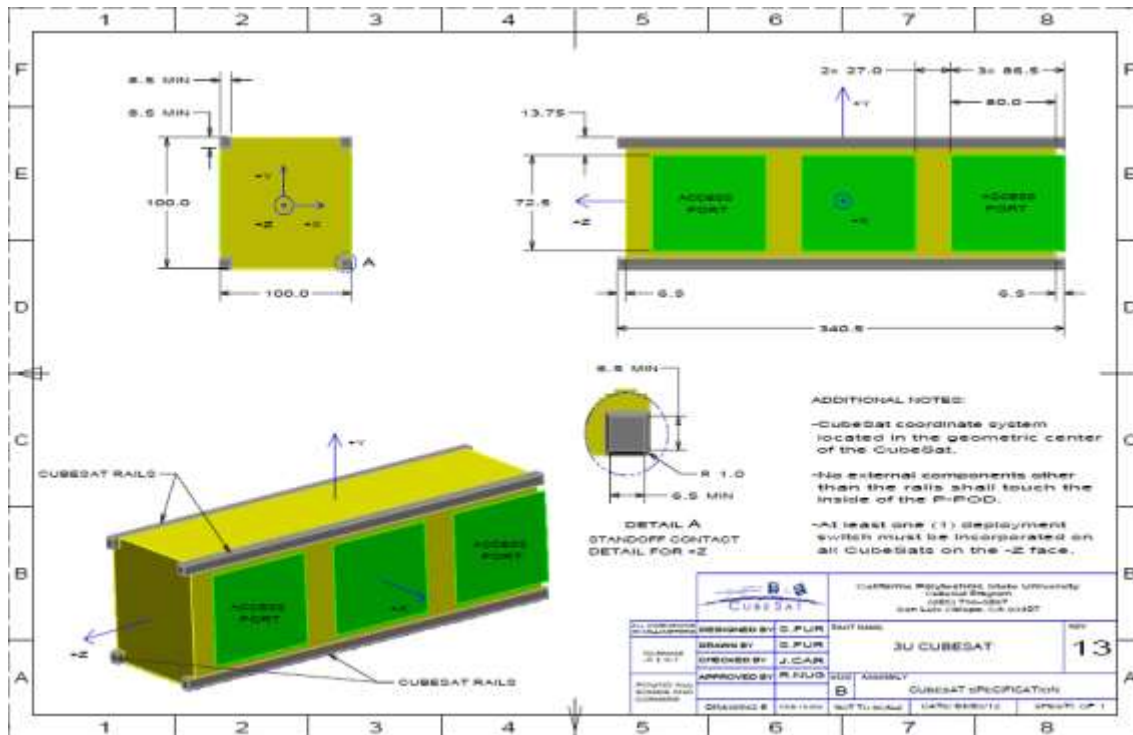


Figure 3-1. Example 3U CubeSat Architecture