

Satellites Around Mars: What Will It Take?

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The colonization of Mars has become a much-talked-about topic, from Elon Musk's stated desire to end his days on the red planet to the Mars One campaign to send astronauts on a one-way journey there. One of the first steps required for successful colonization will be to put communication relay satellites into orbit to support robot landers and ultimately human settlements. Satellites are a well-established technology – but the challenges of getting them to another planet and operating them there will be vast

Project Specifications

Your assignment is to create a satellite communications capability to support exploration, colonization and early development of Mars, including both surface-to-space communications and Mars-to-Earth communications.

Mission Description

Initial exploration of Mars will be conducted robotically to assess environmental conditions, availability of resources and potential colonization sites. Supporting the robotic mission will be a fleet of small satellites in low Mars orbit, which provide a minimum of 6 hours of connectivity per robotic lander or about 25% of the sidereal day. Because smallsats will lack sufficient power for Earth-Mars communication, they will network with a larger satellite in middle or synchronous orbit positioned for a maximum duration of line of site with Earth.

The robotic exploration mission(s) will be followed by the dispatch of habitat units assembled in Earth orbit, flown robotically to Mars orbit and landed on Mars. Once operation of the habits is confirmed, the first human colonists will make the journey from Earth to Mars. By the time human colonists reach the surface, the communications system will need to provide surface-Mars orbit-Earth connectivity for 98% of the sidereal day.

The mission will be developed and funded by multiple nations, which will also contribute terrestrial communications infrastructure to maintain the link with Mars. The mission plan should include testing in Earth orbit before deployment to Mars.

Mission Duration

The robotic phase of the mission will commence with a first Mars landing no later than 10 years from today. The first small human colony will be established within 20 years of today. (If you wish to propose a different duration, specify what it is and provide a rationale.)

Technologies

Your engineering and technology proposal may make use of established technologies or rely on technologies currently in development that may be successfully tested and commercialized between now and the time of the mission(s). If you rely on to-be-proven technologies, indicate so in your submission and briefly explain your knowledge of them.



Your submission should address:

- Engineering and technology requirements for building, launching and flying satellites from the Earth's surface into Mars orbit and operating them there.
- Business analysis of the costs of designing and building the satellites, insuring them, launching them and operating them over a reasonable lifetime.

The submissions will be judged first on the quality, depth and rigor of the work presented and secondly by the breadth of the work in terms of topics covered.

Team Specifications

Teams must be comprised entirely of students at one university. Teams will be limited to one per university, and team candidacy must be submitted to MarsSat@seds.ca. We recommend between 3 and 8 members per team, but we encourage team leadership to include as many interested members as possible. Individual team members must maintain student status at the university naming the team, and may only contribute to one project at a time.

Since this is a student project, SSPI and SEDS Canada expect student team members to do the vast majority of the work. Mentors are assigned to assist teams with overcoming the learning curve, but should not do substantial work on the project, except when necessity dictates (driven by, e.g., proprietary software). All contributing team members should be credited on the team roster, which is submitted with the project.

Timeline for Submissions

Activity	Responsible	Target Date
Project announcement to chapters	SEDS Canada	Sept 18, 2017
Teams form, registration deadline	SEDS Canada	Oct 6
Mentor assignment deadline	SSPI	Oct 16
First online meeting with mentor	Teams	Oct 23
Submit documentation of first meeting	Teams	Nov 3
Reports due to SEDS Canada and SSPI for review	Teams	Feb 23
Completion of judging, announcement of awards	SSPI	March 21
Presentation of awards	SEDS Canada	March 23/26



Submission Details

Teams are expected to thoroughly document their progress through their project:

First Meeting

Team leadership should meet with their assigned mentor and submit brief documentation by the deadlines above. The documentation should include the following:

- Project overview (round-number estimates of basic engineering goals)
- Team roster
- How you will address each bullet point under “Project Specifications” (above), which you expect to be most challenging (and why), and a couple of scope reduction options.
- Brief timeline for project completion
- “Wish List” from SSPI/SEDS Canada

These items should all be discussed among team leadership before the mentor meeting.

Final Submission

The final submission should address each bullet point under “Project Specifications” (above), including brief descriptions where appropriate of why items were not treated in the project as a whole. Your submission should “tell a story,” more or less. The overall submission should be built around a Project Overview document, which should reference documents like:

- Technical Drawings
- Case-studies
- Orbit scenarios
- Launch simulations

Final submission should reference modern scientific literature, much like a research paper. Additionally, the project must include a team roster, preferably with each team member credited with general areas of contribution. Teams are encouraged to assist and seek assistance from one another during that session.

How to Structure the Report

Use the following outline as a template for your report. You need not follow this exact order or include every item, but an effective report will use this outline as a guideline.

1. Introduction
 - a. Description of the mission
 - b. Description of your team’s specific focus, if applicable
2. Satellite constellation
 - a. Requirements and constraints on constellation, including management of interference
 - b. Launch/assembly of initial spacecraft, including launch vehicle requirements and orbital mechanics



- c. Design of final constellation
3. Satellite hardware
 - a. Requirements and constraints
 - b. Assumptions on technology advances
 - c. Power generation systems
 - d. Power transmission systems
 - e. Telemetry, tracking and control systems
 - f. Station-keeping and fuel
4. Production schedule through deployment of full constellation
5. Cost analysis
6. Risk analysis
7. Conclusions

Awards

SSPI is making available up to three cash prizes payable to the top-scoring teams in the competition. The first prize is C\$750, second prize is C\$500 and third prize is \$250.

