

Small Sats – The Next Generation

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Small satellites are at an inflection point in their journey from educational and hobbyist projects to commercial success. Earth observation has been the first commercial success for companies including Planet Labs, Digital Globe and Skybox. The next opportunity is for communications services from LEO, whether it is maritime and asset tracking (Spire) or Internet (OneWeb and others). But nearly every aspect of small satellite technology for communications remains unproven as of today. Given the small physical size of the platforms, it is unclear how they can be powered, how their flight can be controlled, how signals will be handed off between satellites and how they will deliver the power to close the communications link with small antennas on the ground. For university projects, it is enough to get a smallsat into orbit and have it perform its experimental function; for a communications business, the bar is considerably higher.

Project Specifications

Your assignment is to develop a design for a small communications satellite capable of delivering 50 Mbps of data connectivity from LEO to small antennas on the ground without exceeding a weight limit of 150 kilograms, while handing off communications traffic to other satellites as they pass over the user, and maintaining their orbital station. In addition to issues of manufacture, launch and technology, consider the challenges of avoiding radio frequency interference with satellites in GEO orbit and of safely de-orbiting the spacecraft at the end of its useful life. Your submission should address as many of the following topics as possible:

- Engineering design and technology requirements for the spacecraft
- Assumptions about technology advances that will be available within a reasonable time to improve the cost and performance of components, manufacturing, launch and communications
- Design of a constellation of spacecraft, including a minimum configuration to inaugurate service and the final constellation to provide global connectivity
- Cost estimates to develop the first set of spacecraft and place them into orbit, and an estimate of costs for the total constellation assuming cost-efficiencies from mass production and launch
- Discussion of regulatory issues regarding landing rights and interference with GEO spacecraft
- Time-frames for development, achievement of a minimum configuration and completion of the constellation

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 through that university's UKSEDS branch. We recommend between 3 and 10 members per team, but we encourage team leadership to include as many interested branch 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 UKSEDS 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.

Sources

The following offer a starting point for research:

- [One year after kickoff, OneWeb says its 700-satellite constellation is on schedule](#), SpaceNews
- [OneWeb submits application for space-based Internet](#), Spaceflight Insider
- [Boeing proposes big satellite constellations in V- and C-bands](#), SpaceNews
- [NASA Small Satellites to Demonstrate Swarm Communications and Autonomy](#), NASA
- [Surrey Satellite & BridgeSat to Develop Satellite Laser Communications](#), Surrey

Timeline for Submissions

Discussions with UKSEDS leadership have yielded the following schedule for the project.

Activity	Responsible	Target Date
Project announcement to branches	UKSEDS	20 September
Teams form, registration deadline	UKSEDS	21 October
Mentor assignment deadline	SSPI	28 October
First online meeting with mentor	Teams	11 November
Submit documentation of first meeting	Teams	15 November
Reports due to UKSEDS and SSPI for review	Teams	16 June 2017
Completion of judging, announcement of awards	SSPI	20 October 2017
Presentation of awards	UKSEDS	?? March 2018

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/UKSEDS

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 three cash prizes payable to the top-scoring teams in the competition. The first prize is £500, second prize is £350 and third prize is £200. SSPI will also conduct video interviews with the winning teams and promote them and their project to its global membership of 5,000 satellite professionals in more than 40 nations.

