Executive Summary

About SEDS-UChicago

SEDS-UChicago is UChicago's first ever space-focused registered student organization (a 501c3 non-profit). In the past 3 years, we have gone from being a few students launching rockets on the midway, to having several members with rocketry certificates, and hosting events such as SpaceVision 2022, a conference attended by 400+ students and 90 speakers. This event even won us the best event of the year at the annual RSO awards. SEDS-UChicago is now working on an even more ambitious project- UChicago's first ever cubesat.

What is a CubeSat?

A CubeSat is a class of nanosatellites built to a set of standardized specifications. This standardization and miniaturization has led to a massive availability of parts that can be used to design a scientific payload and caused a sharp decrease in costs required to perform space-based experiments. Additionally, NASA's CubeSat Launch Initiative (CLSI) allows university-based organizations even easier access to space by covering launch costs and guiding student organizations through the process of building and launching a satellite, provided the proposal gets selected. We at SEDS-UChicago hope to leverage the lower costs associated with a cubesat, and the infrastructure provided by organizations like NASA, to design a satellite capable of transmitting data to the earth via laser communication.

Why laser communication?

Laser communication provides a few key advantages over classical radio communications:

- **Higher throughput**- Space-to-ground laser communication has the potential to offer much higher speeds. Previous demonstrations have established connections of up to 200 Gbps (NASA TBird). This allows for the transmission of far more data in a single pass over a ground station than current satellites can achieve.
- **Increased security**- Laser communications have higher directionality compared to radio transmission. This means that it is much harder for a potential malicious entity to intercept a signal and eavesdrop on sensitive communication
- **Infrastructure can be used for further missions**- A ground station built for the purposes of receiving a laser signal can very easily be modified for a mission to demonstration space-to-ground quantum key distribution (QKD). QKD is the key for higher security communications compared to anything available in the "classical" realm, and will also form the basis for the quantum internet. Currently, free-space links are also a requirement for long distance quantum communication (as opposed to fiber-optics). Indeed, it is SEDS-UChicago's ultimate goal to demonstrate space-to-ground QKD, which is only realistically possible after first testing "classical" laser communication.

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Strategy and Timeline

SEDS-UChicago is planning on submitting a proposal to NASA CubeSat Launch Initiative (CSLI) by November 17th, 2023. This proposal would be only for the initial "classical" laser communication satellite, which will be a 2U satellite, based on an open-source design produced by Hawaii Space Flight Laboratory. By basing the overarching design on a pre-existing concept and focusing on developing an innovative payload, we at SEDS-UChicago are leveraging our strengths of being at an elite research university. Moreover, by choosing an open-source design, we have far reduced our cost- compared to a commercial solution, we save $25,000 and maintain similar capabilities.

We will spend 2024 constructing and testing our satellite; and expect a launch date no earlier than mid-to-late 2025. After the initial satellite is realized, the focus of SEDS-UChicago would shift to the development of a second satellite capable of Quantum Key Distribution, utilizing much of our existing ground infrastructure, and the technical expertise gained from launching a satellite with a somewhat similar payload. The Quantum Key Distribution satellite would be launched no earlier than 2028 but would be a pioneer in the creation of a quantum internet.

If accepted, CSLI would offer engineering guidance, and also provide for the launch costs of our satellite (a contribution of ~ $50K). However, to be accepted, CSLI needs to see strong financial and technical support from the both the organization's parent university, and if necessary, financial support from external institutions. SEDS-UChicago is currently in the process of establishing connections both within the university and at large companies. Our initial estimate for our project is $25K - $95K for prototyping and testing hardware, $20K for a ground station, and $50K for the satellite itself. While a large amount in absolute terms, this would be one of the cheapest satellites to demonstrate a communications link like ours, and would therefore be an extremely impressive first launch from an undergraduate student organization.