# SPACE HAUC: Open Source Communication Tools

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## What is SPACE HAUC?

The Science Program Around Communications Engineering with High Achieving Undergraduate Cadres (SPACE HAUC) is UMASS Lowell's first CubeSat project, sponsored by NASA! Started in 2016, the project aims to test out new methods of communication on small satellites.

First developed by Cal Poly and Stanford, a CubeSat is a type of space research satellite designed to be produced at a much lower cost than typical satellites, allowing smaller groups to have a hand in space research.

Our project is a multidisciplinary undergraduate project, with over 25 students currently involved, and over 100 alumni.

## What are our goals?

Our main payload and primary mission goal is an X-band phased array radio antenna, which have previously been too large for small satellites. The antenna was developed in house, and should acheive data rates of 50-100 Mb/s, up to 20 times faster than the typical speeds for a CubeSat.

We also hope to create software solutions to bolster future CubeSat projects. The two biggest open source contributions we have made so far are our Command and Data Handling system, OctopOS, and our generalized serial communication protocol.

## OctopOS

OctopOS is our Command and Data Handling (CDH) system. It collects and distributes data to and from individual sensors, algorithms, and processes.

- Utilizes a publisher/subscriber system. Data is published to a "topic", or storage space. Then it is pushed by the topic to any subscribed processes.
- Uses shared memory segments to allow processes access to the data without memory copies.
- Acts as a process/thread manager, ensuring the status of vital flight software.

This system has been made as generic as possible, allowing for adoption and use as a CDH system for any small satellite.

## Serial Communication

We have found that many devices use a type of serial bus communication. Using the termios C++ library, we created generalized code to allow communication with any serial device.

- The flight camera uses hexadecimal character arrays to communicate its commands over an Rx/Tx UART.
- The ground station motor control, manufactured in the 1980's, uses the same method, but over an RS-232 serial connection.
- The backup Ultra-High frequency radios utilize a more complex UART command structure, similar to the camera.

Our generalized code makes it easier for anyone to communicate with a serial communication device.



Link: https://Github.com/SPACE-HAUC
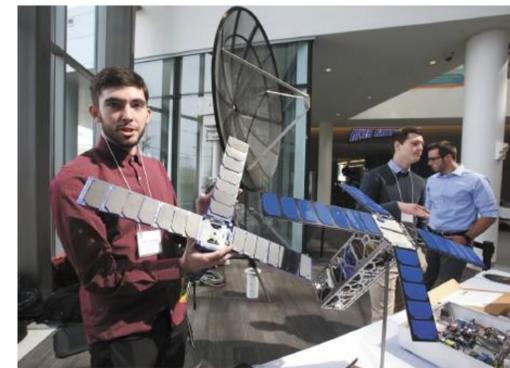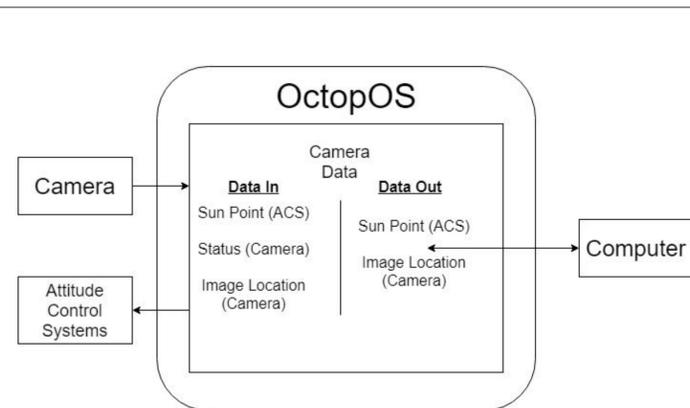
## Conclusions

SPACE HAUC will expand the capabilities of all future CubeSats and other small research satellites. Our X-band phased array antenna shows that high data rates are capable on small satellites. Our open source satellite tools will simplify the development process for future satellites.

The Command and Data Handling system is a highly complex data broker which took almost a year to develop. In its final polished shape, it enables users to communicate between devices and processes by writing a simple driver using the OctopOS libraries.

The generalized serial communication protocol simplifies the coding process for any serial device. While the development time for each new device will vary, with just the hardware datasheet, users can establish contact with any device after just a few tweaks.

## Acknowledgements