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# SAL-E

# System Architecture

## Cal Poly CubeSat Laboratory

## Revision History

| Rev Date | Engineer(s) | Notes |
|---|---|---|
| 2/16/2024 | Dave Mays | Creation |
| 7/10/24 | John Bellardo | Updated to include OWL |
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## 1.0 Spacecraft

The spacecraft flying aboard the SAL-E mission is a 3U CubeSat. The rail-type 3U CubeSat will have dimensions of 100 mm x 100 mm x 340 mm and a mass of less than 7 kg. The 3U CubeSat will contain a microchip from Cal Poly's Computer Architecture Research Project (CARP) as the primary payload. The secondary payload is a receive-only OWL radio, also developed at Cal Poly, to monitor the 902.3 - 914.9 MHz spectrum.

### 1.1 Flight Software

SAL-E's software stack is composed of the Linux-4-SAM Linux kernel fork from Microchip. The kernel is designed for use on Microchip's embedded Linux cores, such as AT91, which is in use by PolySat's Systemboard version 1.5 within the avionics stack.

### 1.2 Structure

SAL-E's structure is composed entirely of 6061-T6 aluminum. The structure's main purpose is a chassis to secure and restrain the spacecraft's components during all phases of the mission from launch to disposal. The structure also contains a deployment mechanism in the form of a burn wire to deploy the spacecraft's antenna.

### 1.3 Command and Data Handling (C&DH)

The C&DH subsystem consists of an ARM9 processor and provides standard I2C, UART, SPI, USB 2.0 Full Speed, and ISI Interfaces. The C&DH handles commands received from the communication subsystem and allocates each command to its respective service. The C&DH also manages all the data from the spacecraft's on-board sensors by compressing and encoding the data to prepare for transmission.

### 1.4 Communications (COMMS)

The Communication subsystem consists of the spacecraft's antenna and UHF radio daughter board. The spacecraft's COMMS is responsible for transmitting and receiving in the 435-485 MHz radio band. The spacecraft's COMMS transmits health beacons every 9 seconds and transmits ADCS, camera sensor, and CARP Payload data when requested by the Cal Poly ground station.

### 1.5 Electrical Power System (EPS)

The Electrical Power System consists of the avionics stack including the Systemboard version 1.5 and several daughter boards, 24 solar cells, and four Tenergy 18650 Li-Ion batteries. The purpose of the EPS is to regulate, distribute, store, and generate power for the spacecraft. The EPS also includes a camera sensor for capturing images of space and the Earth.

### 1.6 Attitude Determination and Control System (ADCS)

SAL-E's ADCS consists of a passive attitude controller in the form of hysteresis rods and a permanent magnet to dampen the spacecraft's rotational rate in all three principal axes. The ADCS also contains an IMU composed of a 3-axis gyroscope and a 3-axis accelerometer to measure the spacecraft's rotation and acceleration rates.

### 1.7 CARP Payload

The Computer Architecture Research Project (CARP) payload consists of 2 custom integrated circuits (IC) developed by Cal Poly to measure and analyze the effects of radiation in Low Earth Orbit (LEO) on digital systems.

### 1.8 OWL Payload

SAL-E will also include a receive-only radio board, OWL, designed by a team of eletrical engineering students at Cal Poly. This radio will monitor the 902.3 - 914.9 MHz spectrum to help determine suitability for future missions.

## 2.0 Cal Poly Ground Station

The Cal Poly Ground Station consists of an antenna system known as Marconi, a Physical Server, and an Operations Computer. The main purpose of the ground station is to communicate with the spacecraft while the spacecraft is making a ground pass.

### 2.1 Marconi

The Marconi subsystem consists of a dual Yagi antenna, an Low Noise Amplifier, Rotor, Rotor controller, RF switch, Terminal Node Converter, and a Raspberry Pi. The Marconi subsystem functions primarily within the UHF radio band range. The antenna has two connections, a receive and transmission line.

### 2.2 Physical Server

The physical server consists of a SatComm server, past and current mission servers, and a telemetry database that are connected to an Open Mission Control Technology software used to visualize the data on a desktop computer.

### 2.3 Operations Computer

The Operations Computer is a desktop computer in the Cal Poly CubeSat Laboratory used to track and communicate with the satellite. The Operations Computer directly integrates with Marconi's radio to send and receive data.