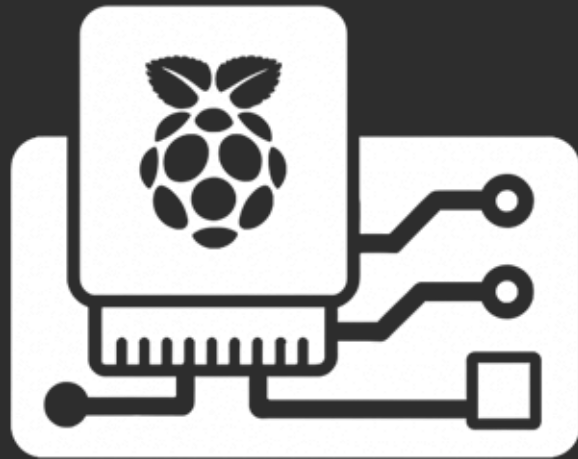


05/28/2026

PI IN THE SKY

Integrated RPi Companion Computer



UC **SANTA BARBARA**
College of Engineering

Meet the Team

Loren Ashfield



Adit Suman



Zach Duckering



David Chang



Vishal Seenivasan



PI IN THE SKY

UC **SANTA BARBARA**
College of Engineering

Problem

- AeroVironment (AV) is currently developing a drone flight controller named Varmint
- Varmint offloads compute intensive processes to a high-cost Nvidia Jetson Orin NX
- How to reduce costs while maintaining the current design?



Our Solution

- Enable Varmint compatibility with cost-effective Raspberry Pi Compute Module 5 (CM5)
- Develop custom carrier (adapter) board to interface the Varmint's native DDR4 SODIMM connector with CM5's custom high-throughput connectors
- Maintain equal functionality while lowering overall costs

Overview

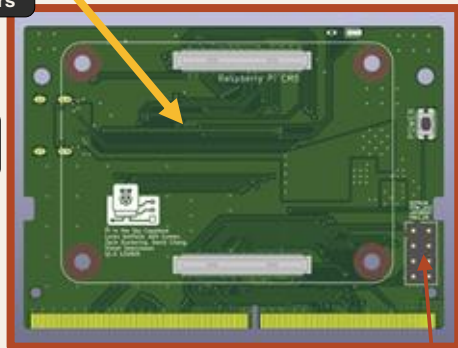


Raspberry Pi Compute Module 5

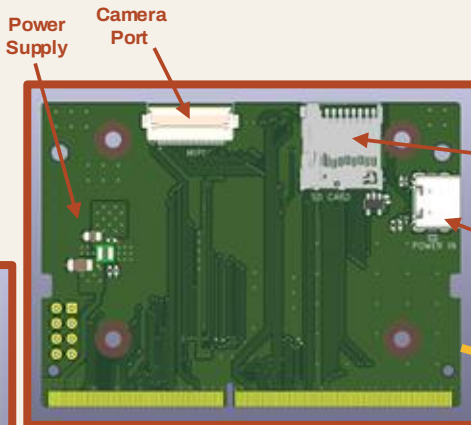
- Autopilot
- Image Processing
- State Estimation
- Data Analysis

Interfaces through dual high-density connectors

Carrier Board FRONT



Power and CM5 Debug



Power Supply

Camera Port

microSD Slot

USB-C and Alternate Power

Carrier Board BACK

Interfaces through DDR4 SODIMM

- USB, HDMI, M.2, GbE
- GPIO, SPI, I2C, UART

Contains HDMI, USB, M.2, and GbE ports for passthrough to CM5



AeroVironment Varmint

- Motor, Gyroscope, Sensor, Radio Interface
- Reports data to CM5

Software:

- CM5 runs **Ubuntu** with **ROS** and **ROSflight software** package
- **Varmint** runs **ROSflight firmware**



PI IN THE SKY

Now Presenting: Loren

UC SANTA BARBARA
College of Engineering

- ✚ Carrier PCB
- ✚ ROSflight
- ✚ Final Design

PCB Layout

Primary functions:

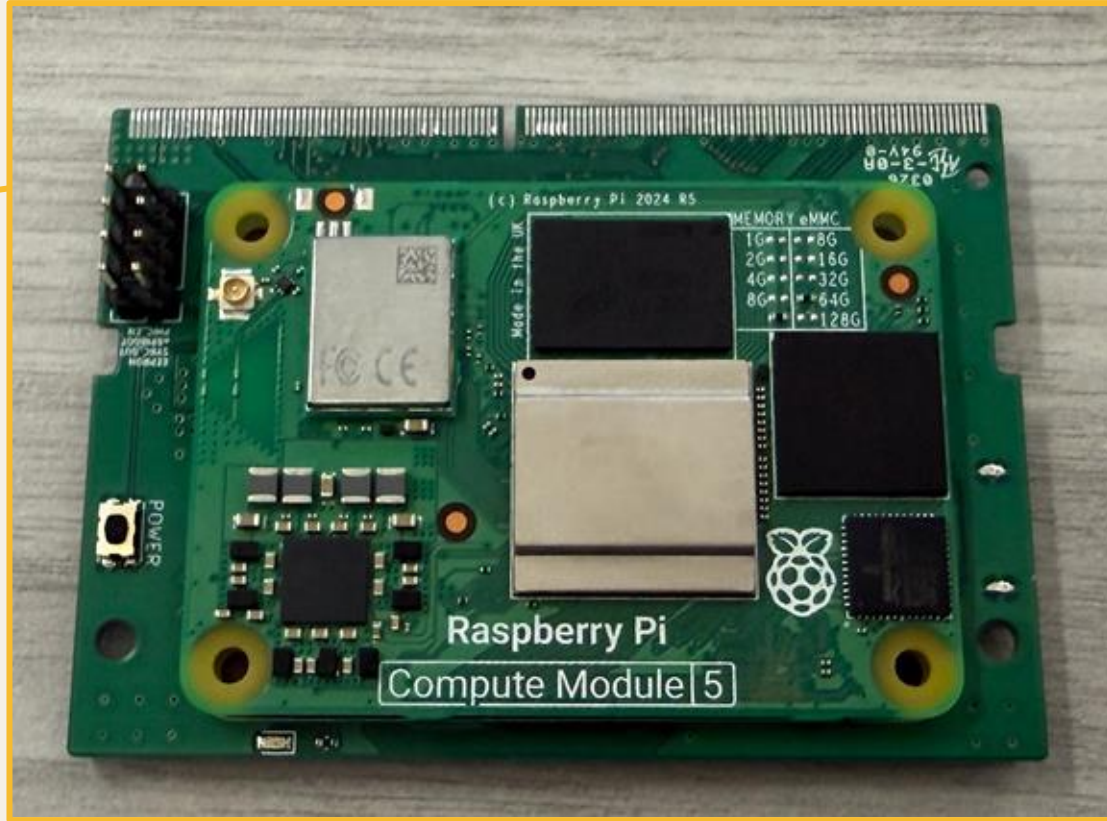
- **Deliver signals** from Varmint to RPi and vice versa (GPIO, SPI, I2C, UART)
- **Provide additional I/O** (microSD, MIPI, USB) for RPi
- **Passthrough I/O** ports on Varmint to RPi (GbE, HDMI, USB, M.2)

Front

RPi interfaces through dual high speed connectors

RPi Power

RPi Debug



PI IN THE SKY

Now Presenting: Loren

UC SANTA BARBARA
College of Engineering

Back

RPi Camera Port

Power Supply

RPi microSD

RPi USB-C and
alternate power



PI IN THE SKY

Now Presenting: Loren

UC SANTA BARBARA
College of Engineering

Carrier PCB



ROSflight

Final Design



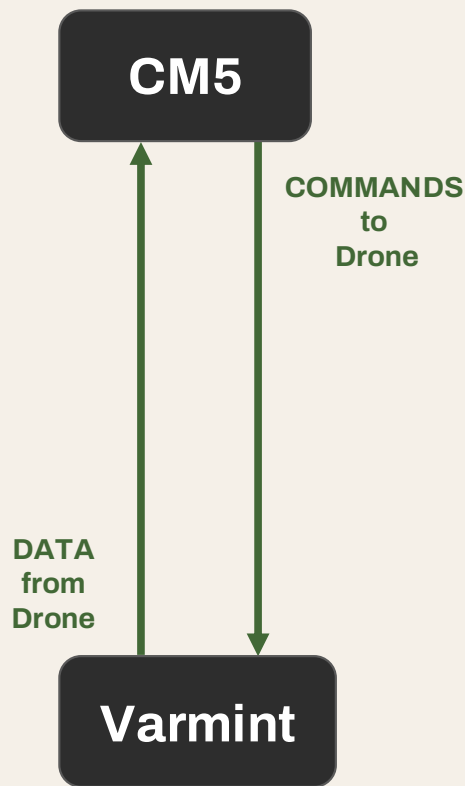
PI IN THE SKY

UC SANTA BARBARA

College of Engineering

✚ ROS/ROSflight Background

- **Robot Operating System (ROS)** - set of software for robotic development
- **ROSflight** - lightweight flight framework built on ROS meant to stream drone data
- **Flight Controller (Varmint)** runs ROSflight firmware and transmits the sensor data to companion computer
- **Companion Computer (CM5)** runs ROSflight software to analyze and dictate the target vehicle's behavior



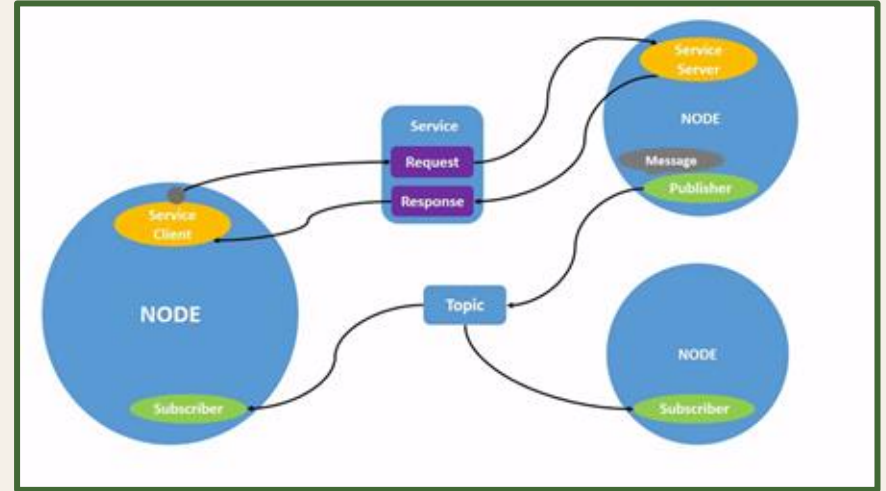
✚ ROS/ROSflight Background

ROS

- Nodes: places in system to send/receive information
- Publisher: sends data through Topics (communication channels)
- Subscriber: listens to Topics to receive data

ROSflight

- Each system component (motors, sensors, flight controller, etc) is a Node
- Communication between the system components are designed as Topics



ROSFlight with the CM5

- **ROS2** runs on the CM5
- The `rosflight_io` node runs on the CM5 and handles communication between it and the Varmint
- CM5 stores important info such as drone parameters, gain values, and the mixer matrix
- The CM5 is also used to communicate with the ground station computer via SSH

```
aditspi5@cm5:~$ ros2 node list
/rosflight_io
aditspi5@cm5:~$ ros2 topic list
/airspeed
/attitude
/attitude/euler
/aux_command
/baro
/battery
/command
/external_attitude
/gnss
/imu/data
/imu/temperature
/magnetometer
/output_raw
/parameter_events
/rosout
/status
/status/params_changed
/status/rosflight_errors
/status/unsaved_params
/version
```



✚ ROSFlight on the Varmint

- **ROSflight *firmware*** is flashed on the Varmint
- Varmint handles interfacing with drone and send data back to CM5
 - Data includes: IMU measurements, state readings, signals from the RC
- Varmint uses mixer matrix (on right) generated by and received from CM5 to set motor voltages

```
[INFO] [1779842297.465803244] [rosflight_io]: Received all parameters
[INFO] [1779842297.466311084] [rosflight_io]: Mixer output channel types: 2 2 2 2 0 0 0 0 0
[INFO] [1779842297.466499976] [rosflight_io]: Primary mixer:
0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0
-5814.79 -5814.79 0 -5814.79 -5814.79 0 0 0 -5814.79
-25303.7 -25303.7 0 25303.7 25303.7 0 0 0 25303.7
25303.7 -25303.7 0 25303.7 -25303.7 0 0 0 -25303.7
267066 -267066 0 -267066 267066 0 0 0 267066
0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0
[INFO] [1779842297.466735646] [rosflight_io]: Secondary mixer:
0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0
-5814.79 -5814.79 0 -5814.79 -5814.79 0 0 0 -5814.79
-25303.7 -25303.7 0 25303.7 25303.7 0 0 0 25303.7
25303.7 -25303.7 0 25303.7 -25303.7 0 0 0 -25303.7
267066 -267066 0 -267066 267066 0 0 0 267066
0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0
[INFO] [1779842298.467927129] [rosflight_io]: ROSflight/firmware version: 2.0
```



✚ ROSflight with RC Connection

- ROSflight can interact with and control external remote controllers (RC)
- **Shown below:** video of paired RC sending real time information to CM5 through ROSflight



Carrier PCB
ROSflight

 Final Design



PI IN THE SKY

UC **SANTA BARBARA**
College of Engineering

✚ Drone Choice - Holybro X500

- Almost-Ready-to-Fly kit
 - Most parts included
- Very customizable
- Popular and mature brand with lots of documentation and mounts
- Similar drone used by ROSflight team



✚ Drone Design - Drone and Components



Varmint Mounted on Drone



Complete System



CM5 mounted on Varmint using Pi in the Sky Carrier Board



Underside of Varmint



PI IN THE SKY

Now Presenting: David

UC SANTA BARBARA
College of Engineering

Demo Video



PI IN THE SKY

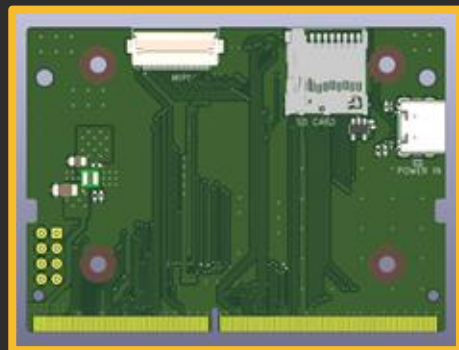
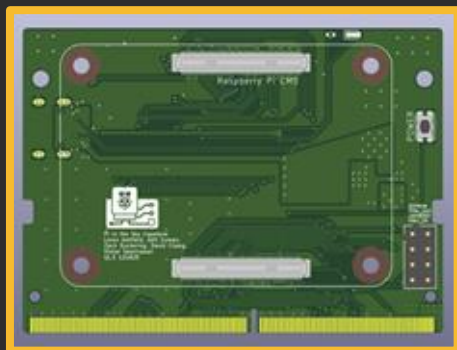
Now Presenting: Vishal

UC SANTA BARBARA
College of Engineering

Acknowledgements

- **Yogananda Isukapalli** - Capstone Instructor
- **Tien Nguyen, Kriteen Shrestha, Lucas Liang** - Teaching Assistants
- **Phil Tokumaru** - AeroVironment Project Advisor
- **Jacob Moore** - ROSflight Advisor
- **AeroVironment Inc** - Sponsor





```
[INFO] [1779842297.465981244] [rosflight_lo]: Received all parameters
[INFO] [1779842297.466311084] [rosflight_lo]: Mixer output channel types: 2 2 2 2 0 0 0 0 0
[INFO] [1779842297.466499976] [rosflight_lo]: Primary mixer:
0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0
-5814.79 -5814.79 0 -5814.79 -5814.79 0 0 0 -5814.79
-25303.7 -25303.7 0 25303.7 25303.7 0 0 0 25303.7
25303.7 -25303.7 0 25303.7 -25303.7 0 0 0 -25303.7
267066 -267066 0 -267066 267066 0 0 0 267066
0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0
[INFO] [1779842297.466735646] [rosflight_lo]: Secondary mixer:
0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0
-5814.79 -5814.79 0 -5814.79 -5814.79 0 0 0 -5814.79
-25303.7 -25303.7 0 25303.7 25303.7 0 0 0 25303.7
25303.7 -25303.7 0 25303.7 -25303.7 0 0 0 -25303.7
267066 -267066 0 -267066 267066 0 0 0 267066
0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0
[INFO] [1779842298.467927129] [rosflight_lo]: ROSflight/firmware version: 2.0
```

