RiBBIT

River **B**athymetry **B**ased **I**ntegrated **T**echnology

Manufacturing Status Review

Abdullah Almugairin, Paul Andler, Andy Benham, Daniel Crook, Mikaela Dobbin, Courtney Gilliam, Megan Jones, Jessica Knoblock, Phil Miceli, Sam Razumovskiy

Project Overview → Schedule → Manufacturing → Budget

Project Overview

Mission Motivation

Problem

Rivers are a critical resource to monitor due to contributions to agriculture, urban development, hazard monitoring, and environmental monitoring.

There is a lack of updated and accurate global data for river discharge, especially in hard to access rivers.

A hard to access river is one which presents a physical risk for humans to access on foot.

Existing Solutions

Earth Orbiting Satellites

Boat tagline system with acoustic instrument and velocity tracker

Helicopters towing radar systems

ASTRALite EDGE

Market Gaps

Data Resolution

Safety

Low-Cost

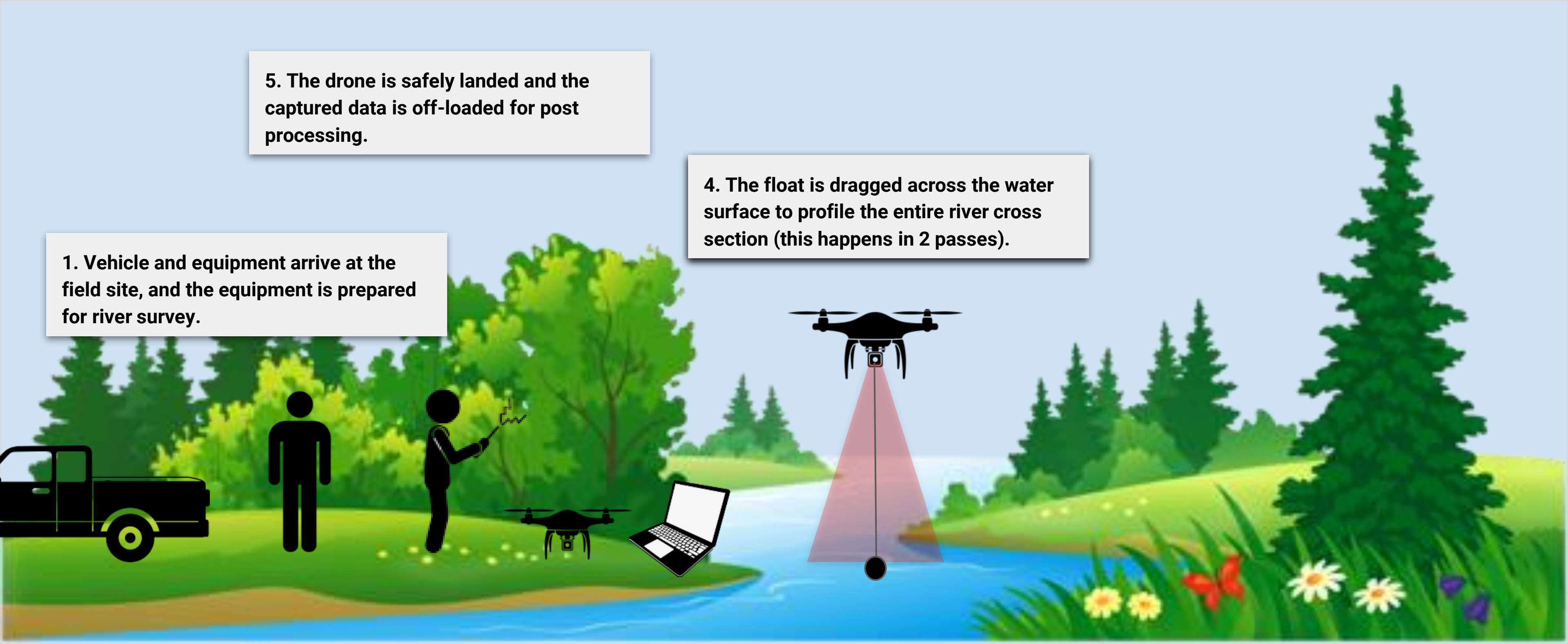
Ease of use

Quick set-up and data collection

Mission Statement

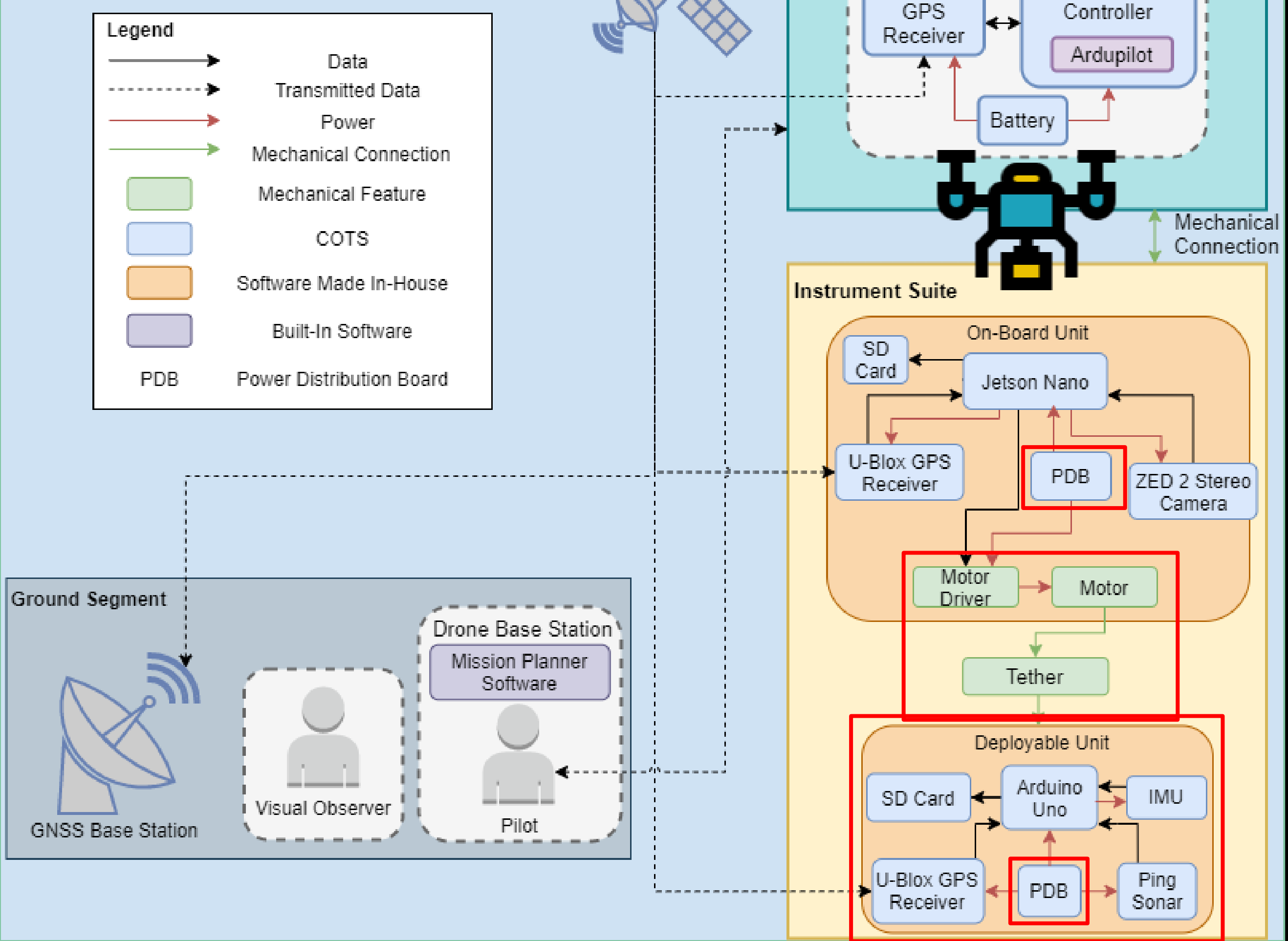
"The long term goal of this project is to design, manufacture, and test a drone-mounted sensor system to gather river depth profile and velocity data in hard-to-access areas for the purpose of monitoring river discharge."

CONOPS



5. The drone is safely landed and the captured data is off-loaded for post processing.
4. The float is dragged across the water surface to profile the entire river cross section (this happens in 2 passes).
1. Vehicle and equipment arrive at the field site, and the equipment is prepared for river survey.

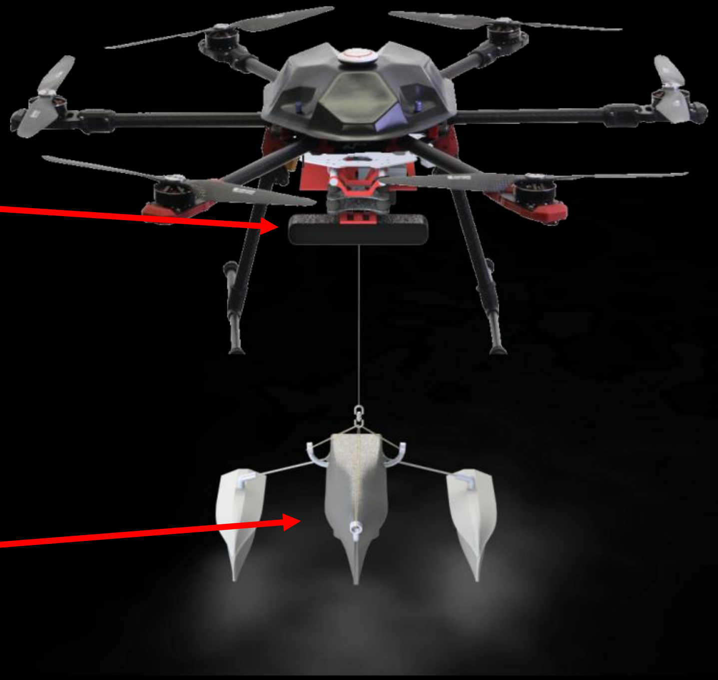
FBD


GNSS Satellites
Legend
Data
Transmitted Data
Power
Mechanical Connection
Mechanical Feature
COTS
Software Made In-House
Built-In Software
PDB
Power Distribution Board
Drone
Built-in Components
GPS Receiver
Pixhawk Flight Controller
Ardupilot
Battery
Mechanical Connection
Instrument Suite
On-Board Unit
SD Card
Jetson Nano
U-Blox GPS Receiver
PDB
ZED 2 Stereo Camera
Motor Driver
Motor
Tether
Deployable Unit
SD Card
Arduino Uno
IMU
U-Blox GPS Receiver
PDB
Ping Sonar
Ground Segment
GNSS Base Station
Visual Observer
Drone Base Station
Mission Planner Software
Pilot

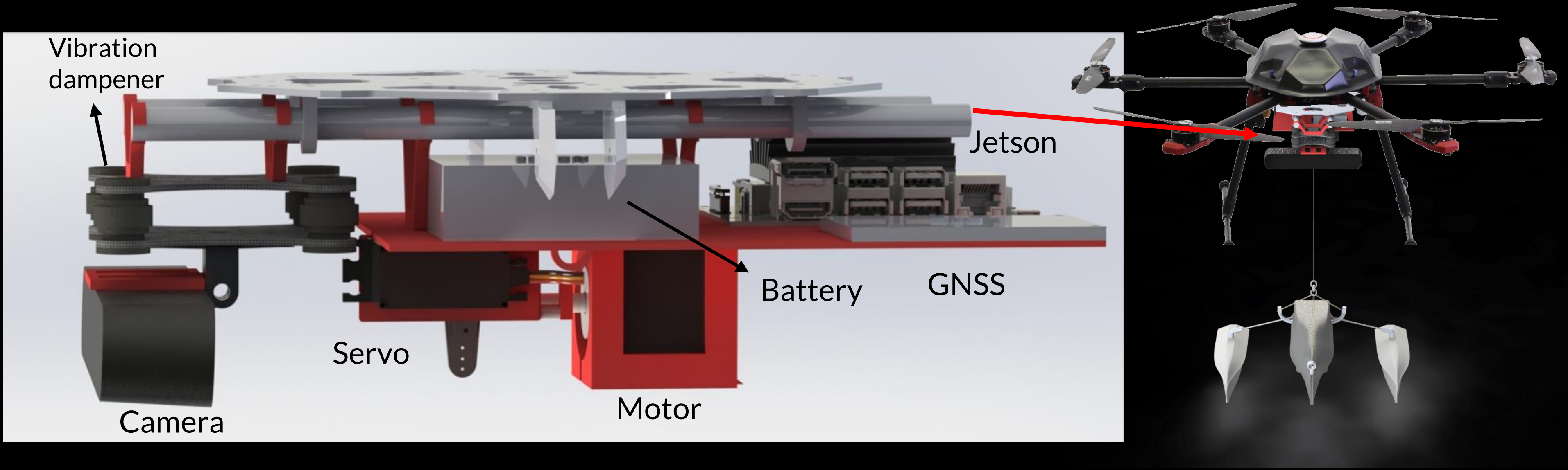
Science Instruments

Zed 2 Stereo Camera

Ping Sonar Echosounder

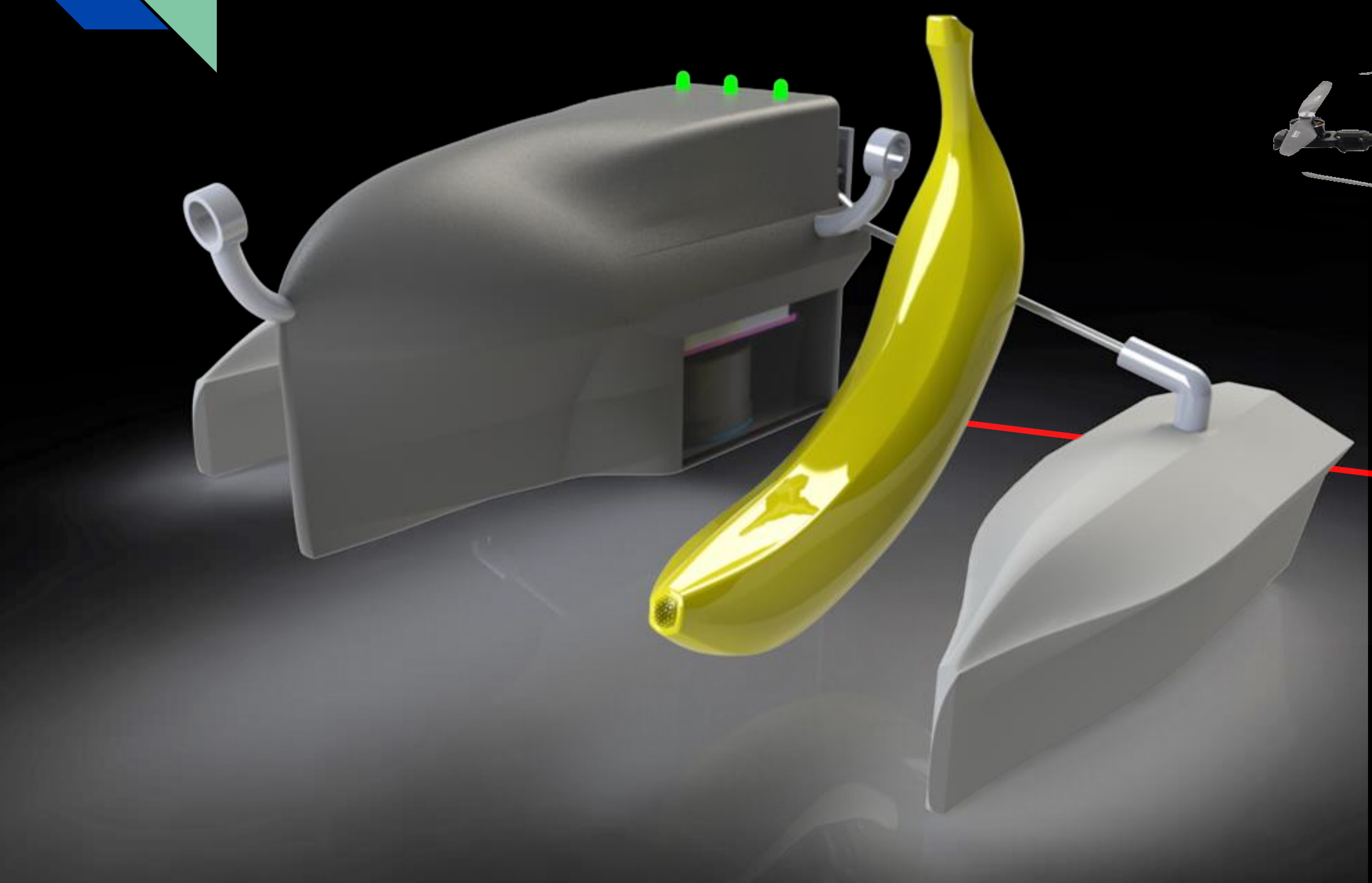


Deployment Mechanism



Sonar Float Design

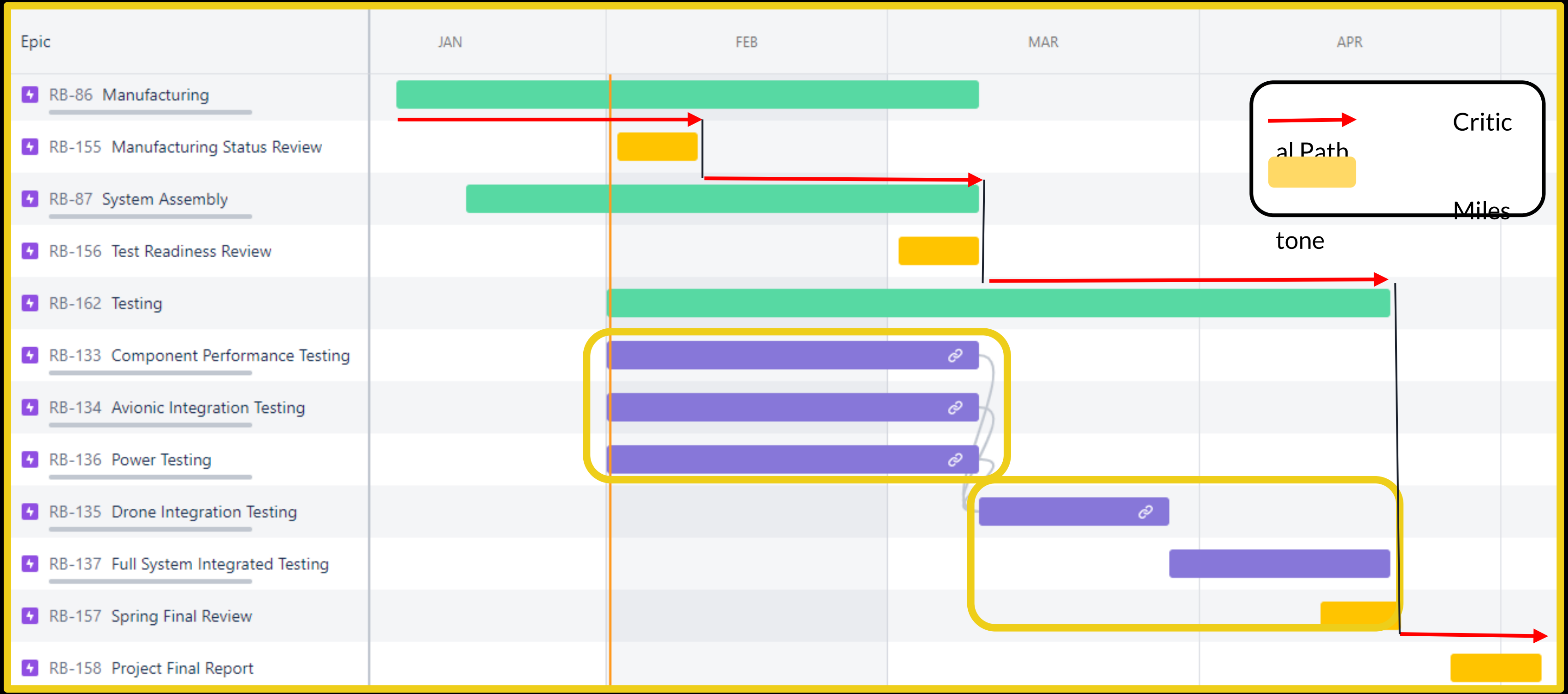
Total est. weight: 894 grams



Note Banana for scale ONLY, not a part of design

Schedule

Gantt Chart



Epic
JAN
FEB
MAR
APR
RB-86 Manufacturing
RB-155 Manufacturing Status Review
RB-87 System Assembly
RB-156 Test Readiness Review
RB-162 Testing
RB-133 Component Performance Testing
RB-134 Avionic Integration Testing
RB-136 Power Testing
RB-135 Drone Integration Testing
RB-137 Full System Integrated Testing
RB-157 Spring Final Review
RB-158 Project Final Report
Critic
al Path
Miles
tone

Testing Schedule

Round 1 - Complete by Early March

Component Testing

- Zed 2 Camera
- Ping Sonar
- UAV + Pixhawk Controller
- Deployment Mechanism/Motor
- Float & Electronics Box

On-Board Unit Interface Testing

- Zed Camera + Jetson
- U-blox receiver + Jetson
- Remote Controller + Pixhawk + Jetson

Deployable Unit Interface Testing

- Ping + Arduino
- IMU + Arduino
- U-blox receiver + Arduino

Round 2 - Complete Mid-April

On-Board Unit Integration

- On-Board Electronics Integration
- On-Board Electronics Fastening to payload housing

Deployable Unit Integration

- Pre-stacked electronics integration
- Stacked electronics integration
- Float + Electronics Box Integration

UAV Integration

Manufacturing

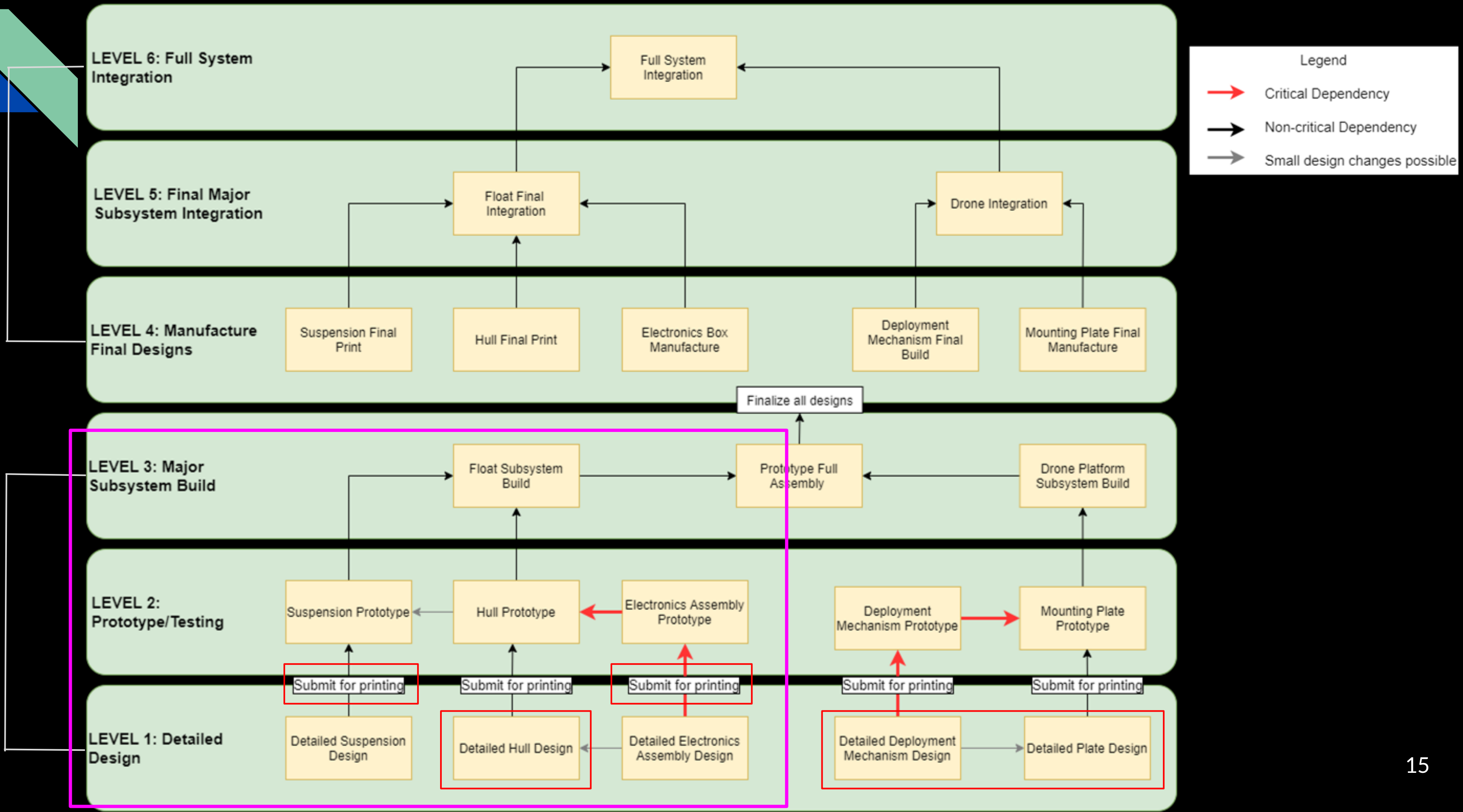
Manufacturing

- Hardware
  - Sonar Deployment Mechanism
  - Payload Housing and Drone Mount
  - Sonar Float & Electronics Housing
  - Off-the-Shelf UAV Assembly
- Avionics
  - Electronics Wiring and Power - On-board and Deployable Unit
- Software
  - Flight Software
  - Data Post-Processing

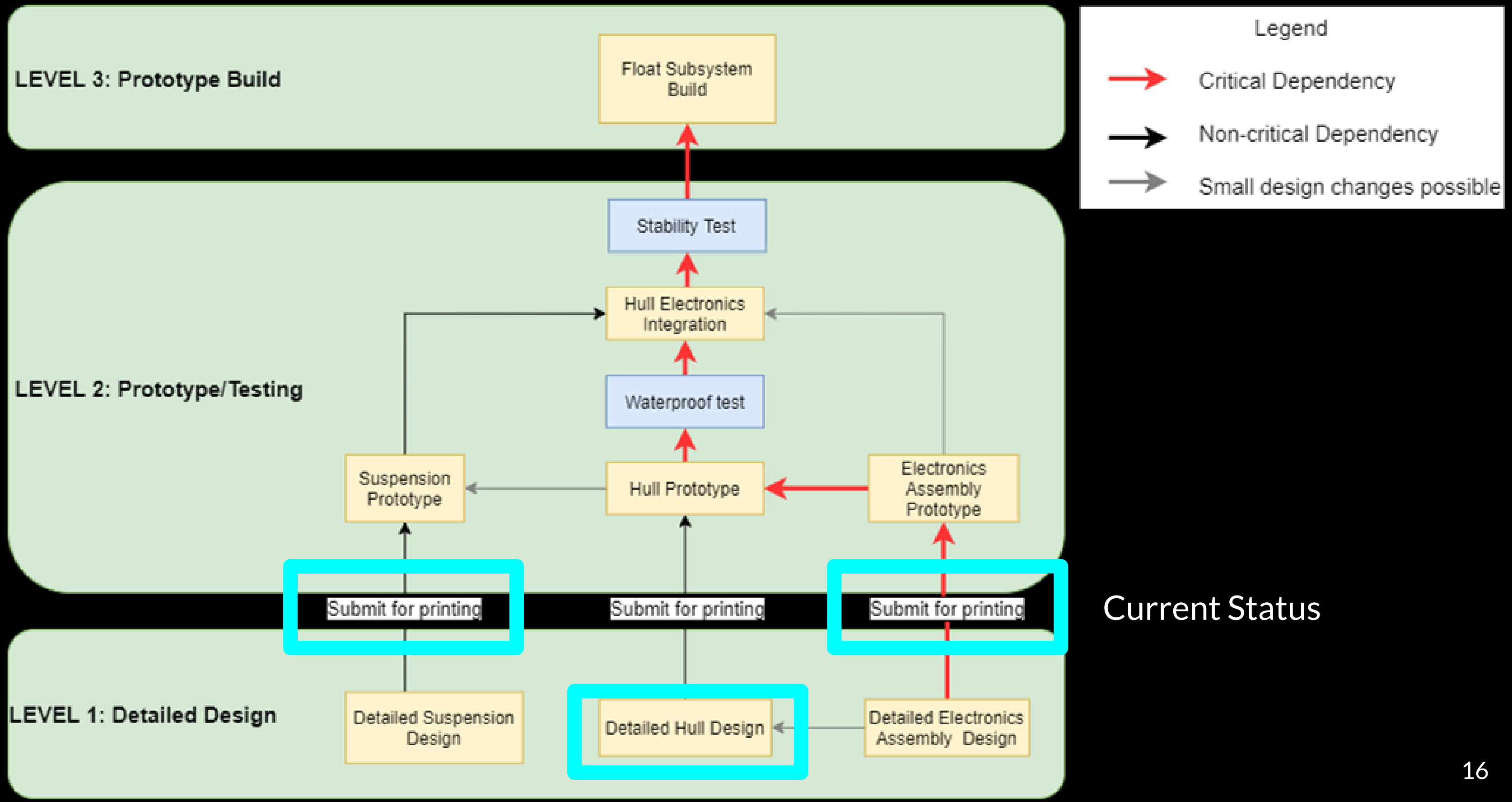
HARDWARE MANUFACTURING FLOW DOWN

Round 2
March

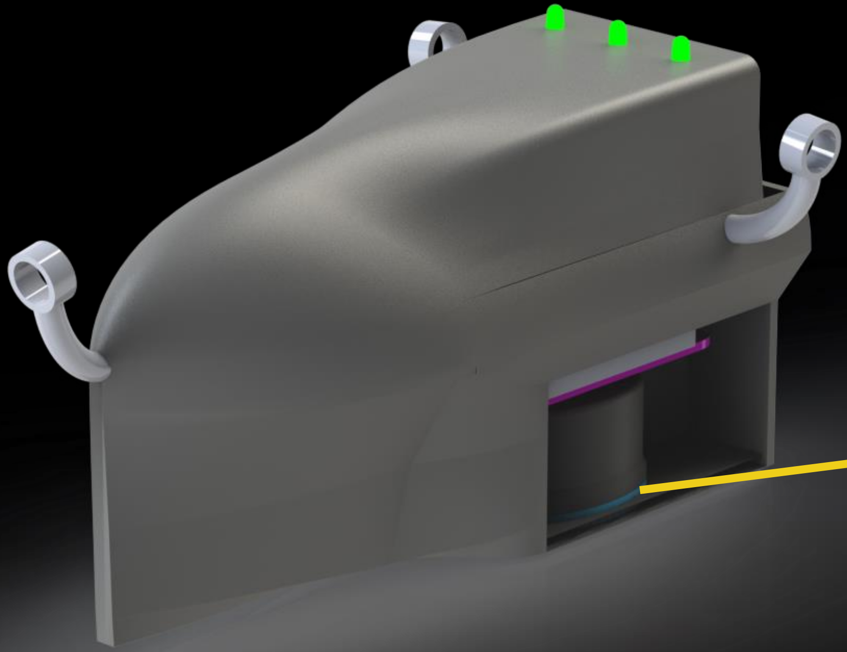
Round 1
End of Feb

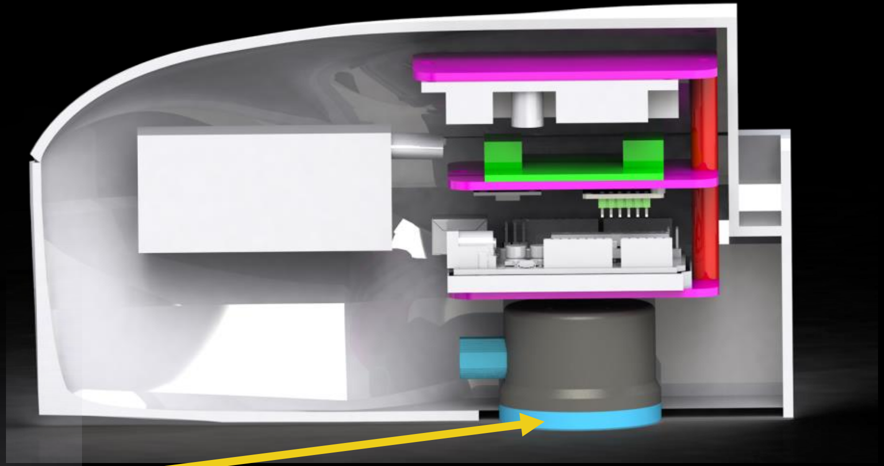


DETAILED FLOAT MANUFACTURING FLOW DOWN



Float Electronics Box Manufacturing



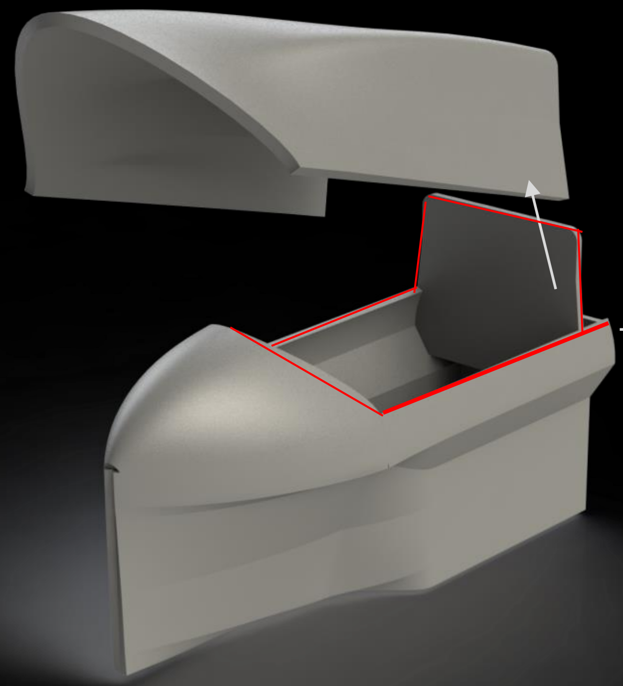


Current focus:

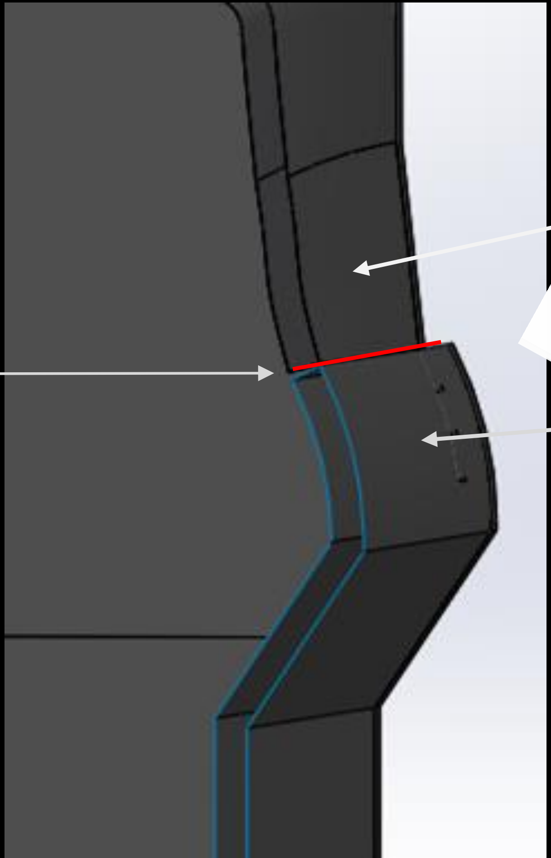
Designing for manufacturability

- ➢ Creating features easy for 3D printers
- ➢ Minimizing post-printing altercations
  - ○ Printing in multiple sections

Float Waterproofing



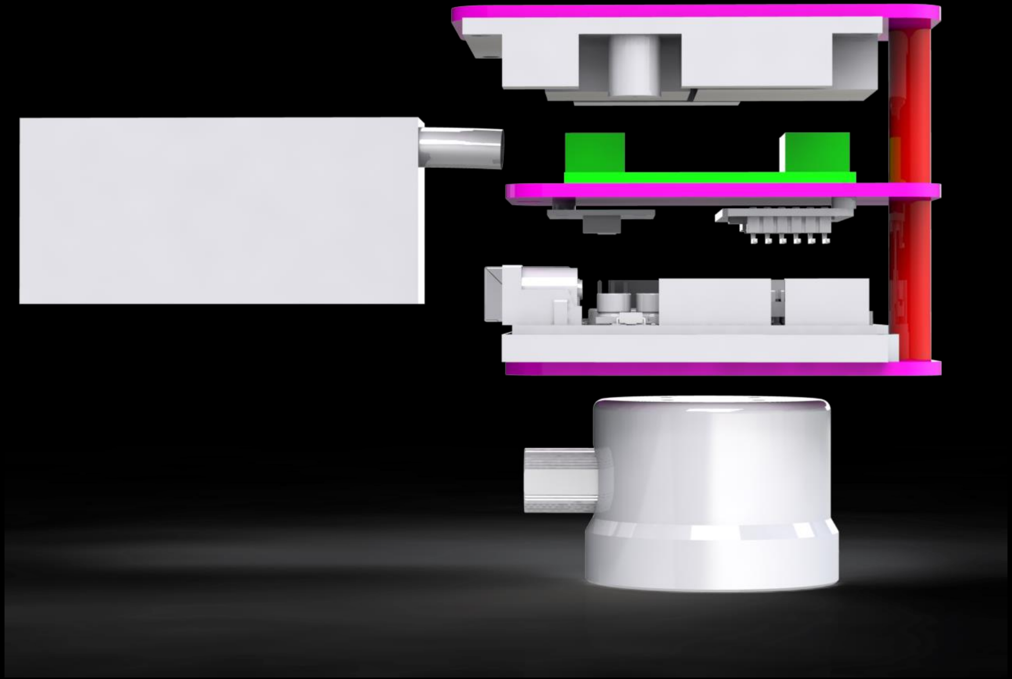
Rubber seal where red lines are



Planning to have 4-5 brackets. Mounting holes are 2.5mm for ref

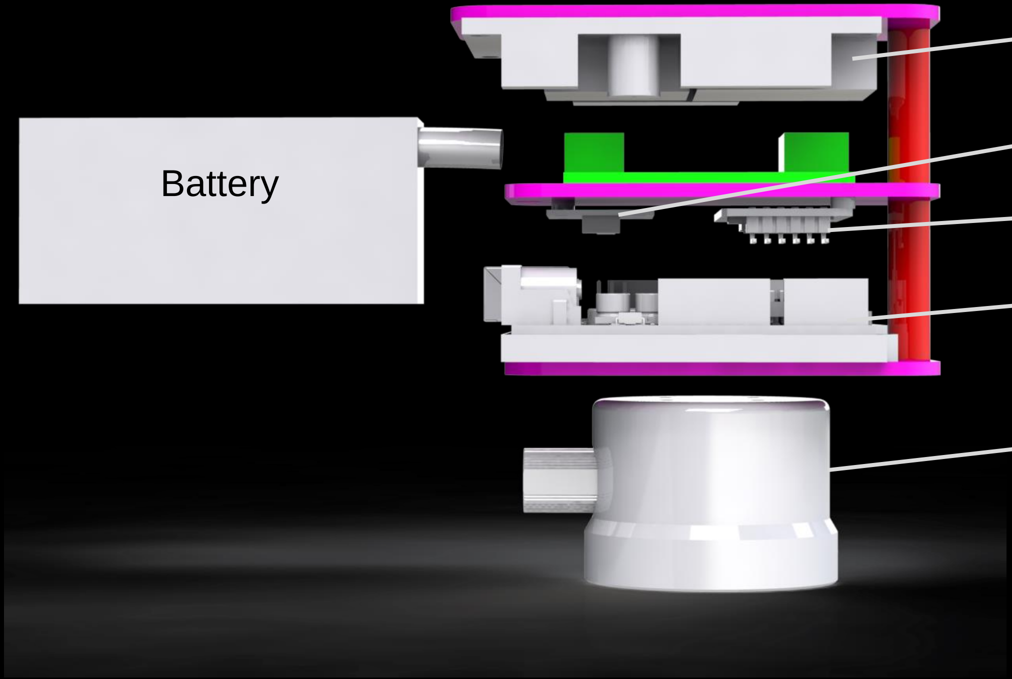
Float Electronics Box Assembly Overview

On Schedule



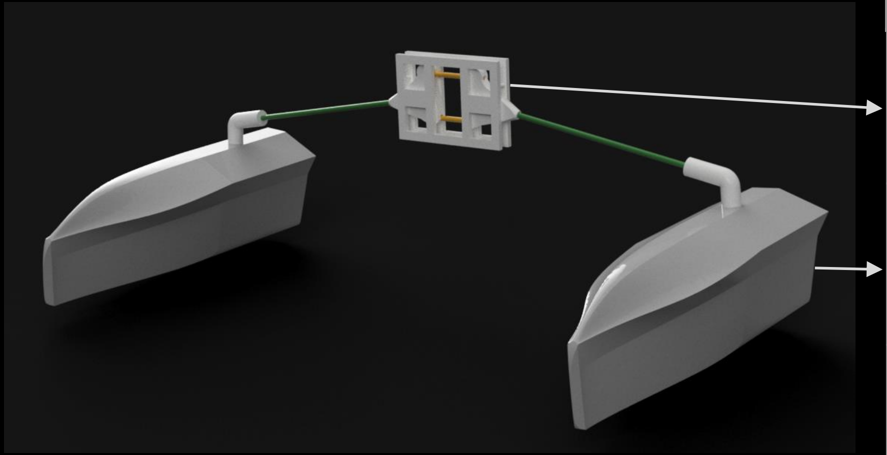
Color	Manufacturing Method	Status
WHITE	COTS	Next Slide
GREEN	Custom PDB	Under design
PINK	Laser cut Acrylic	Design Finished Prototype v1
RED	PLA 3D Printing	Design Finished Prototype v1

COTS Parts Status



Part	Order Status
U-blox, GNSS	In hand, begun testing
IMU	Ordered
SD Card Reader	Ordered
Arduino Uno	In hand, begun testing
Ping Sonar	In hand, begun testing
Battery	In hand

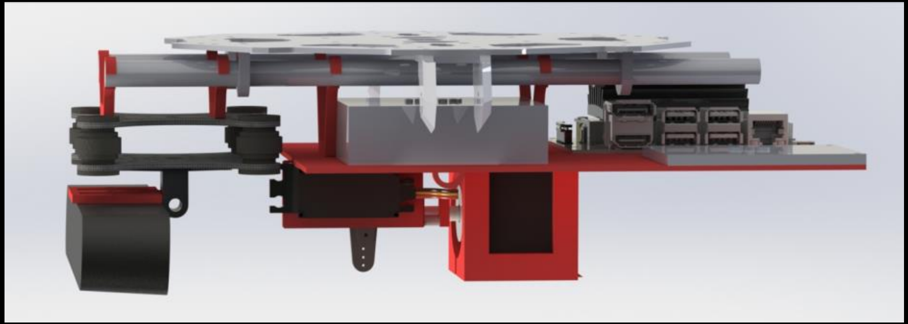
Float Stabilizer Overview



Color	Part	Manufacturing method	Status
WHITE	Suspension Assembly	PLA 3D Printing	Prototype v1 submitted to print
GREY	Stabilizer	PLA 3D Printing	Prototype v1 submitted to print
GREEN	Carbon Fiber Rods	COTS	Specific part chosen
YELLOW	Rubber band	COTS	Specific part chosen

On Schedule

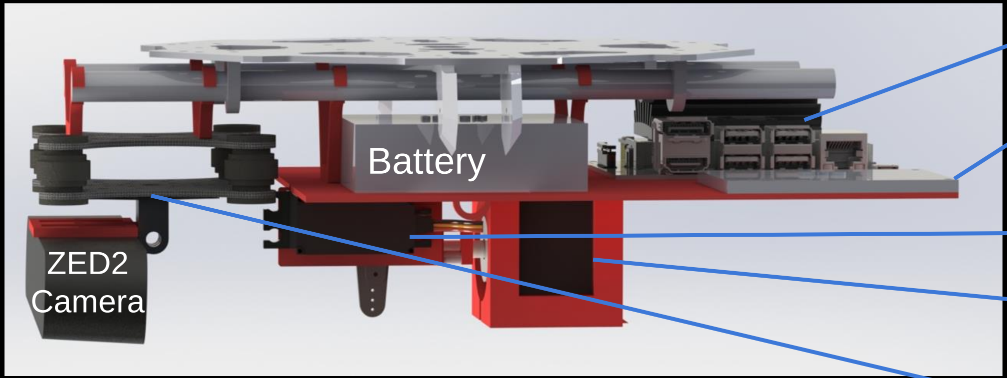
On-Board Payload Housing



Color	Manufacturing Method	Status
WHITE/ BLACK	COTS	Next Slide
RED	PLA 3D Printing	Waiting for drone for exact dimensions

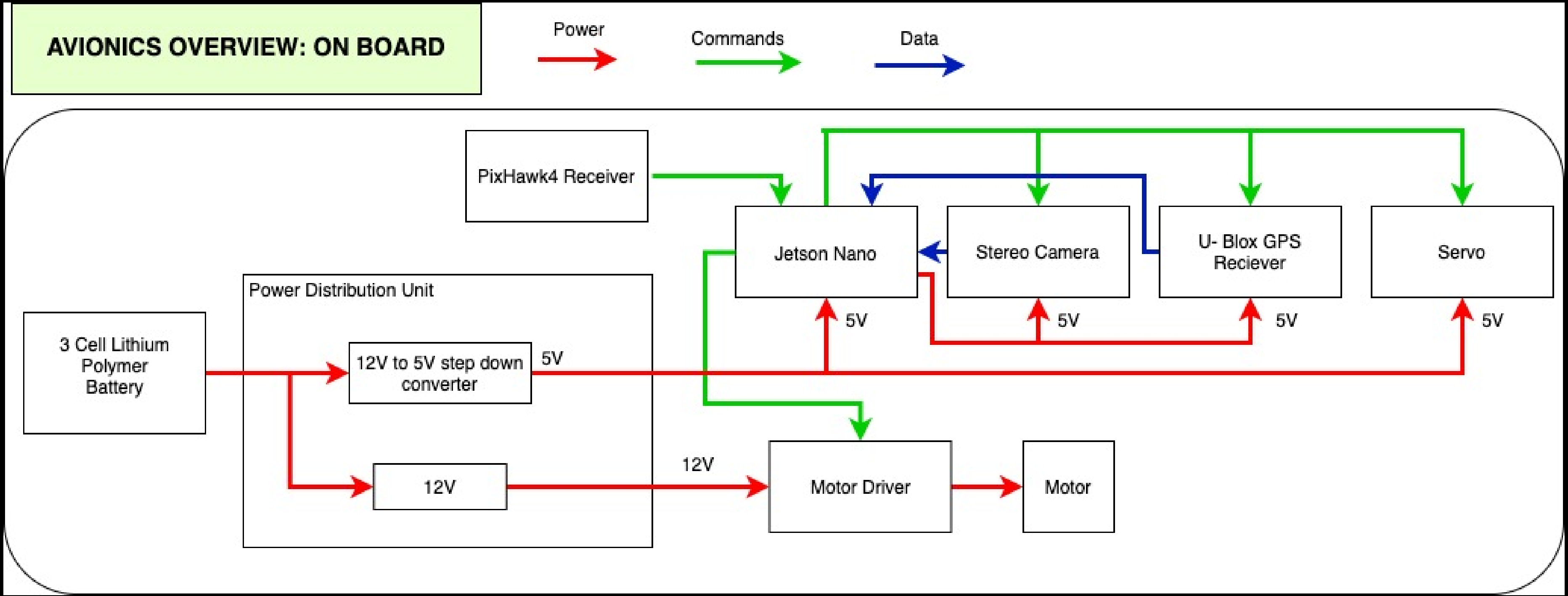
On Schedule

COTS Parts Status

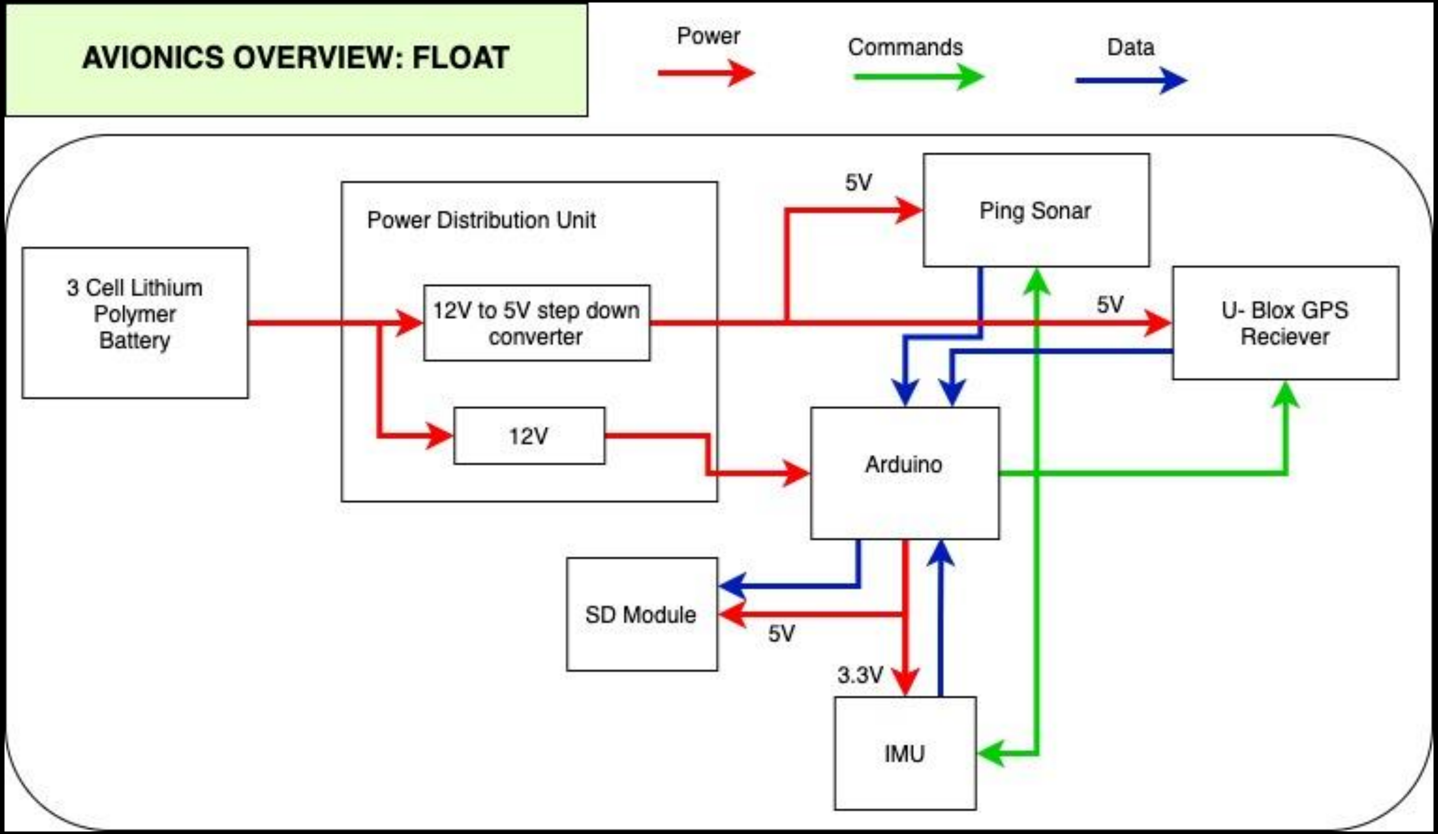


Part	Order Status
Jetson	In Hand
GNSS Receiver	In Hand
Battery	In Hand
Servo	Type chosen
Motor	Under design
Vibration Dampener	In hand
Camera	In Hand

Avionics Overview: On Board Unit



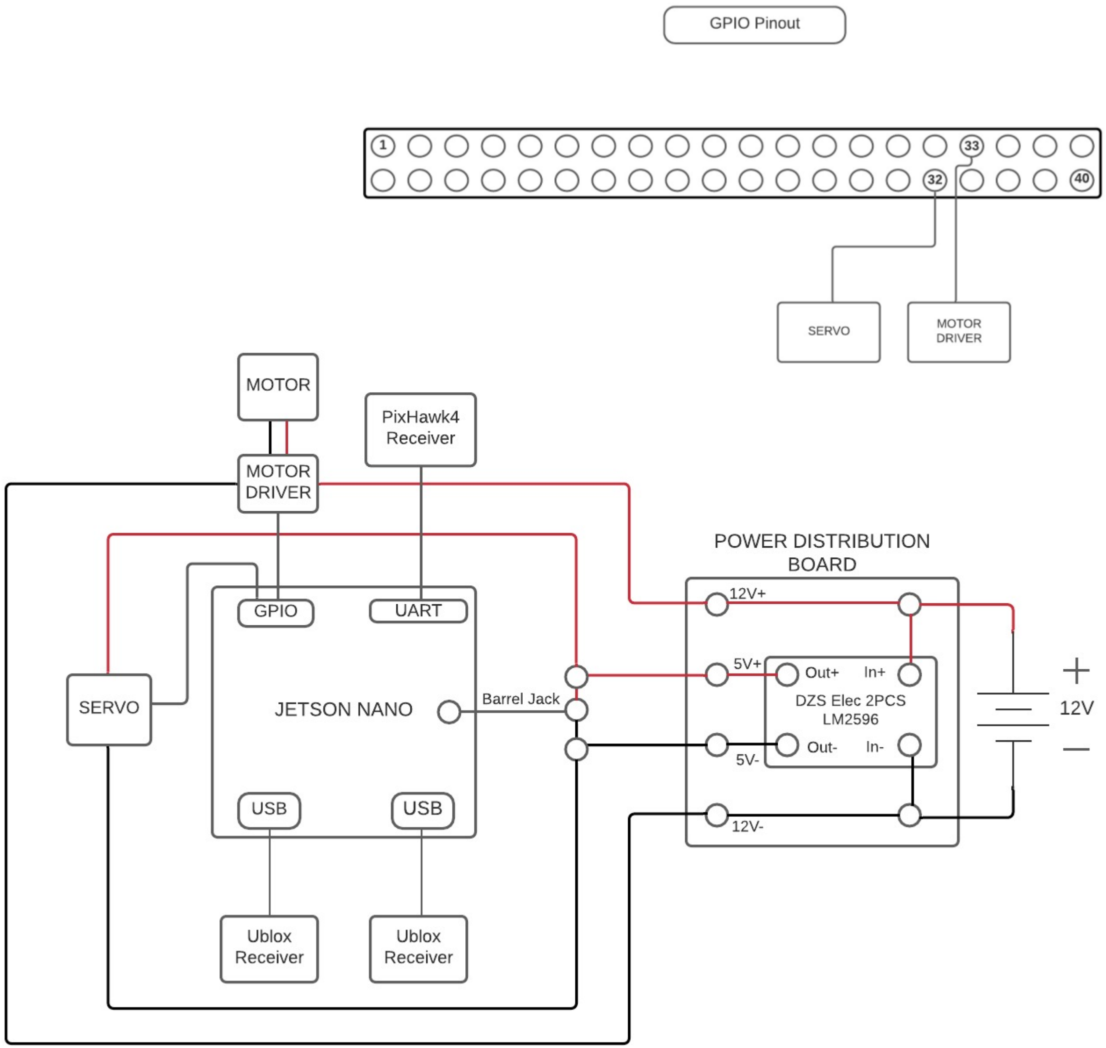
Avionics Overview: Float Unit



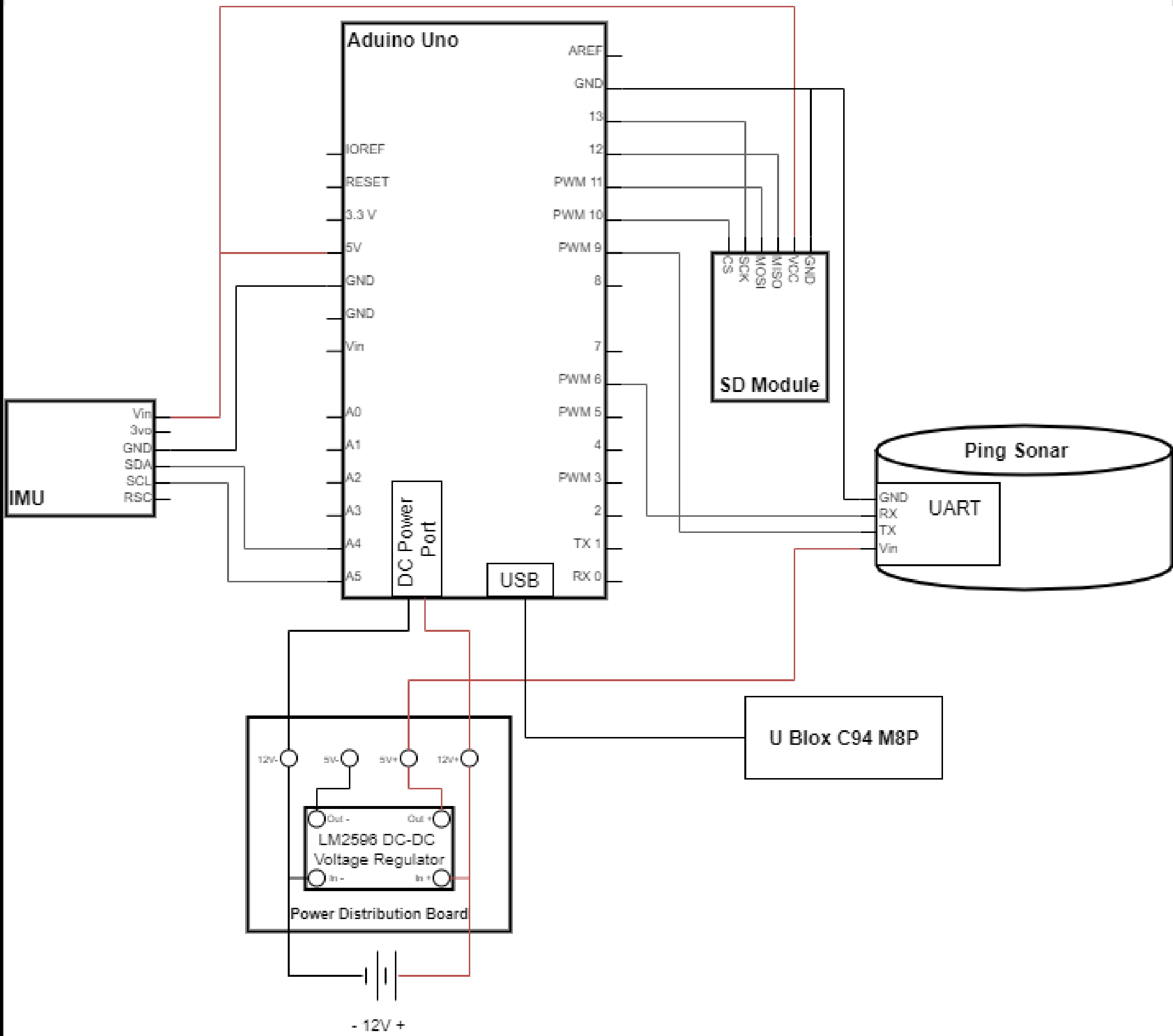
Avionics Overview

Avionics Component	Complexity	Priority	Progress	On Schedule?
Power Distribution Board	Medium	High	Schematic design completed, need to build prototype	Yes (early March)
Motor Implementation with Motor Driver	High	Medium	Waiting on motor selection	Yes (end of February)
Communication with PixHawk Receiver	High	Medium	Have necessary components, studying how receiver works	Yes (mid-March)
SD Module Interfacing	Low	Medium	Part selected and ordered	Yes (end of February)

On Board Wiring Diagram



Float Wiring Diagram

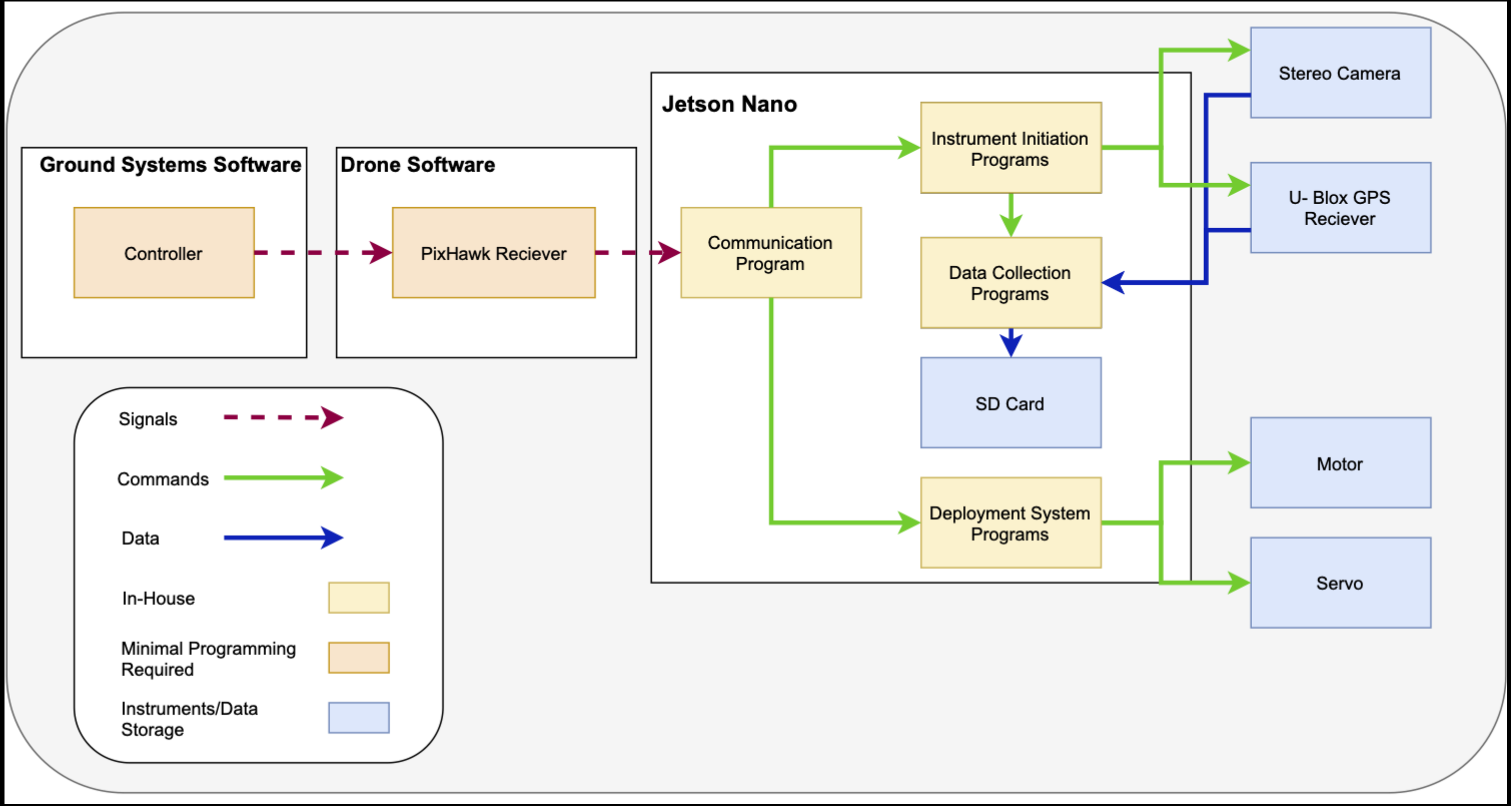


Instrument Suite Wiring

Component	Method/Material	Progress
Zed Camera Integration	Through USB connection	Have identified necessary software and connections to begin testing
Sonar Integration	Serial communication through UART ports on Arduino	
GNSS Receiver Integration	USB connection for both Jetson Nano and Arduino Uno	
Power Distribution Board	Will use M/F jumper wires for Arduino, Barrel Jack for Jetson	Electrical schematic designed

On Schedule

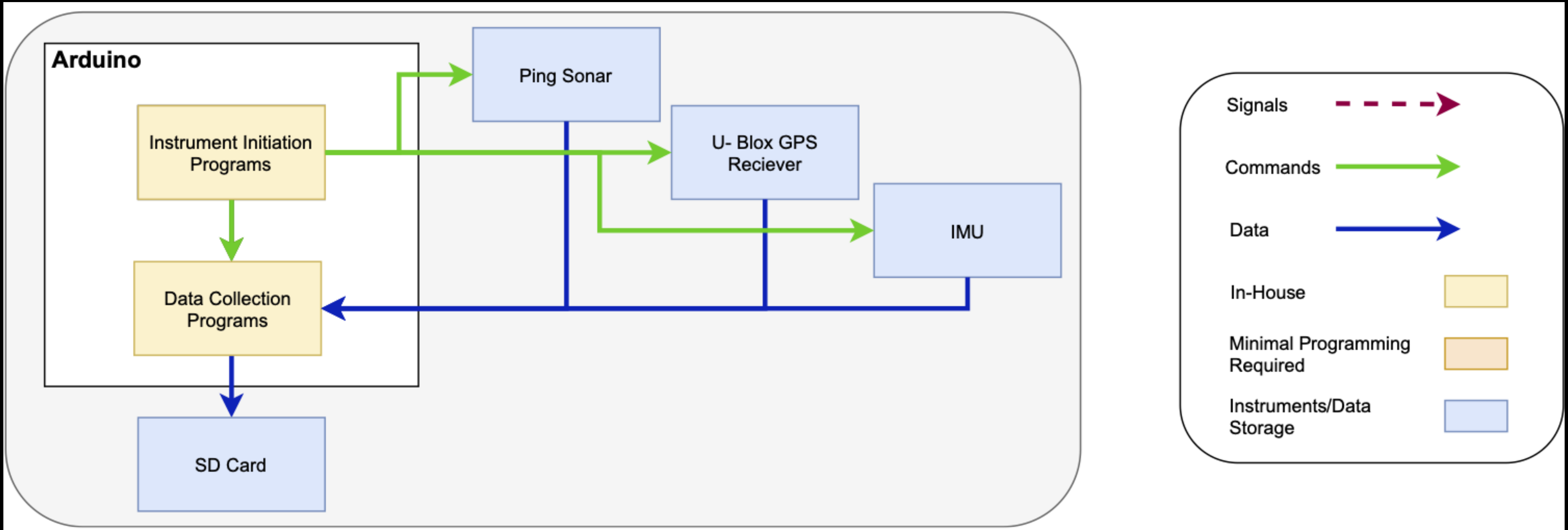
On-Board Flight Software Overview



On-Board Flight Software Overview

Software Component	Complexity	Priority	Progress	On Schedule?
Communication Program	High	High	Researched interfacing Pixhawk with companion computers	On schedule, plan to work with Pixhawk and Jetson interfacing (mid-February)
Instrument Initiation Programs - ZED Camera, GNSS Receiver	Medium	Medium	Researched running programs on Jetson's Linux OS from command line. Completion is dependent on the Communication Program	On schedule, dependent on Communication Program (end of February)
Data Collection Programs	Medium	High	Skeleton code completed for ZED 2 camera and in progress for GPS receiver	On schedule, ready for testing (mid-February)
Deployment System Initiation Programs	Medium	Medium	Same as Instrument Initiation Programs	On schedule, dependent on Communication Program (end of February)

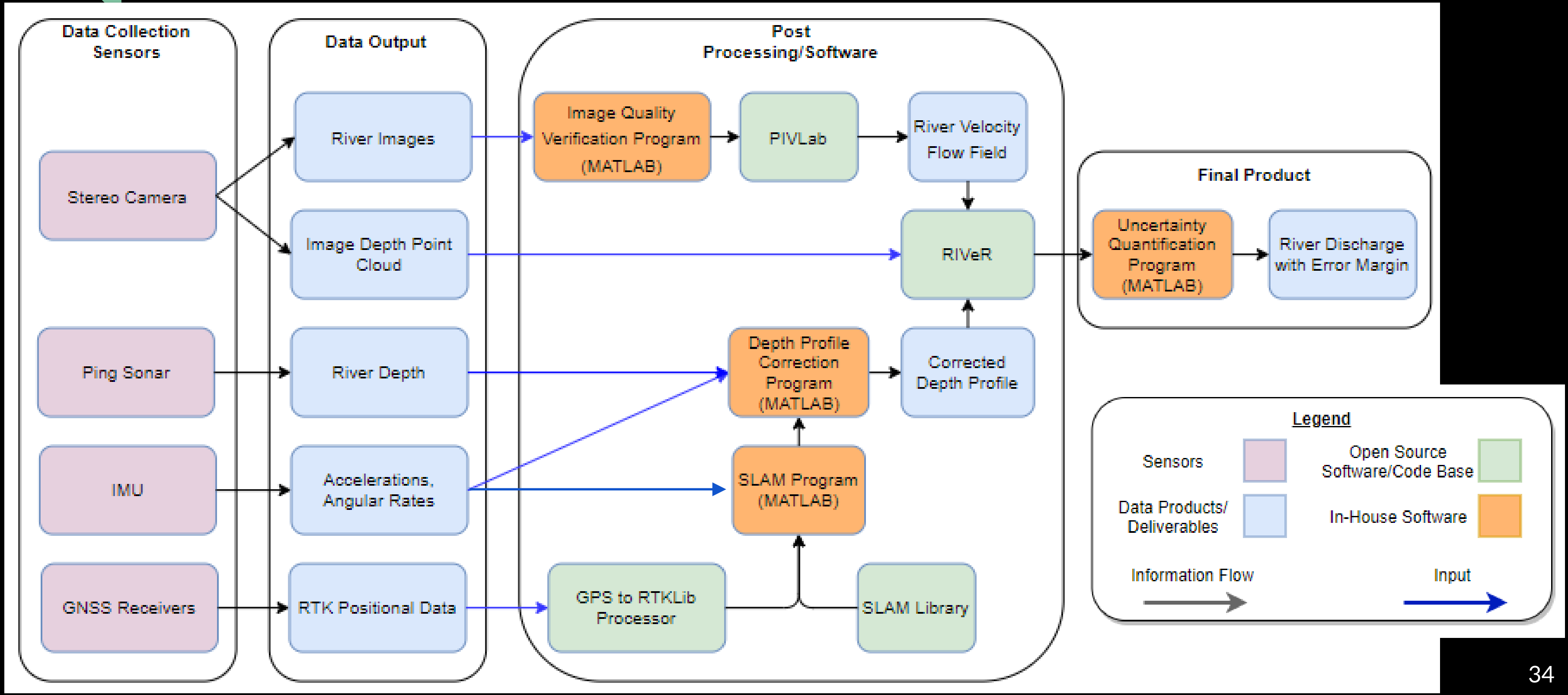
Deployable Unit Flight Software Overview



Deployable Unit Flight Software Overview

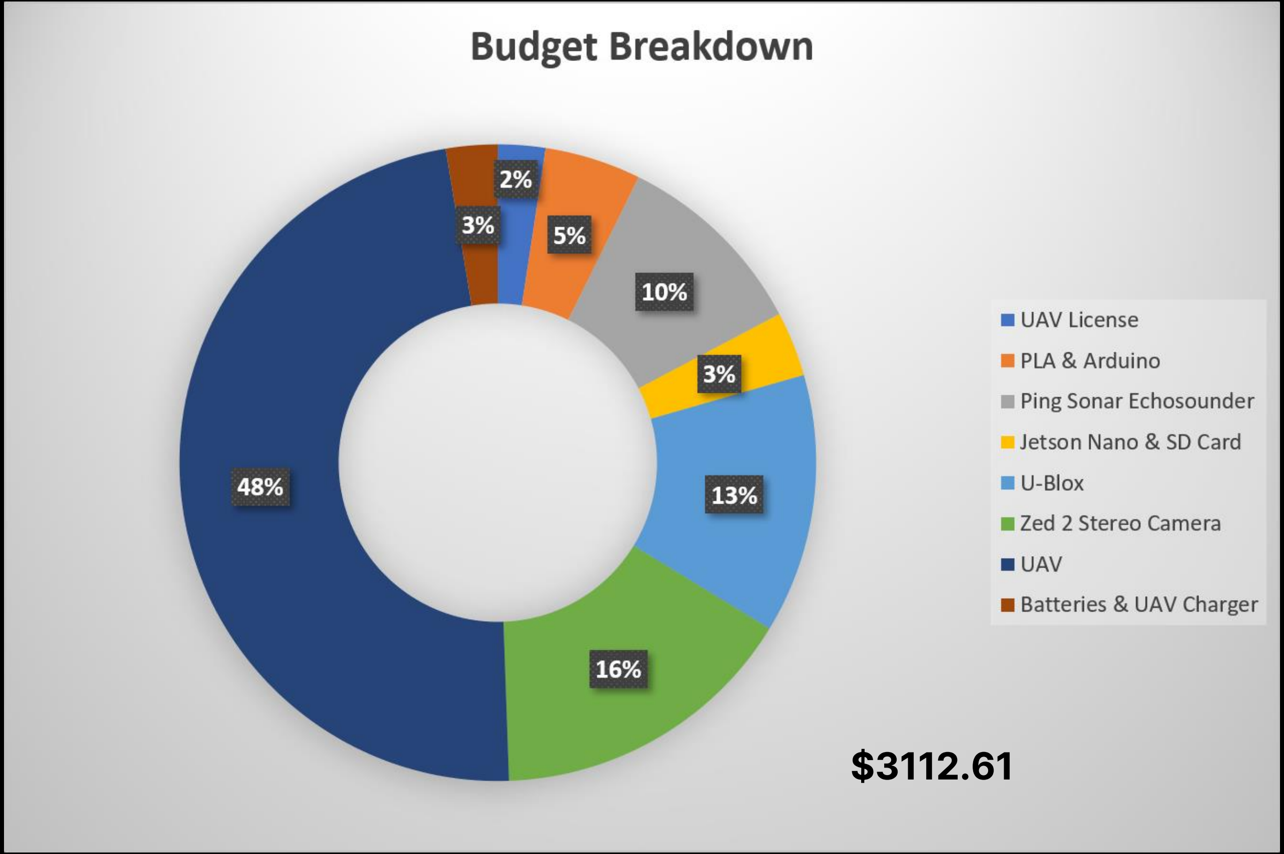
Software Component	Complexity	Priority	Progress	On Schedule?
Instrument Initiation Program - Sonar, GPS Receiver, IMU	Medium	Medium	Data flow between SONAR and arduino established Validity of SONAR data verified	On schedule (end of February)
Data Collection Programs	Medium	High	Have completed preliminary testing with SONAR and Arduino	On schedule (end of February)

Post-Processing Software Overview



Post-Processing Software Overview

Software Component	Complexity	Priority	Progress	On Schedule?
Image Quality Verification Program	Low	High	Particle diameter and particle density code written, need to integrate	On schedule, nearly complete (mid-March to April)
Depth Profile Correction Programs	High	Medium	Model finished, need to complete real testing with data & integrate with SLAM output	On schedule (mid-March to April)
SLAM Program	Medium	High	Skeleton code outline	On schedule (mid-March to April)
Uncertainty Quantification Program	High	Medium	Skeleton code, not started	On schedule, will be developed with testing and integration of individual systems (mid-March to April)

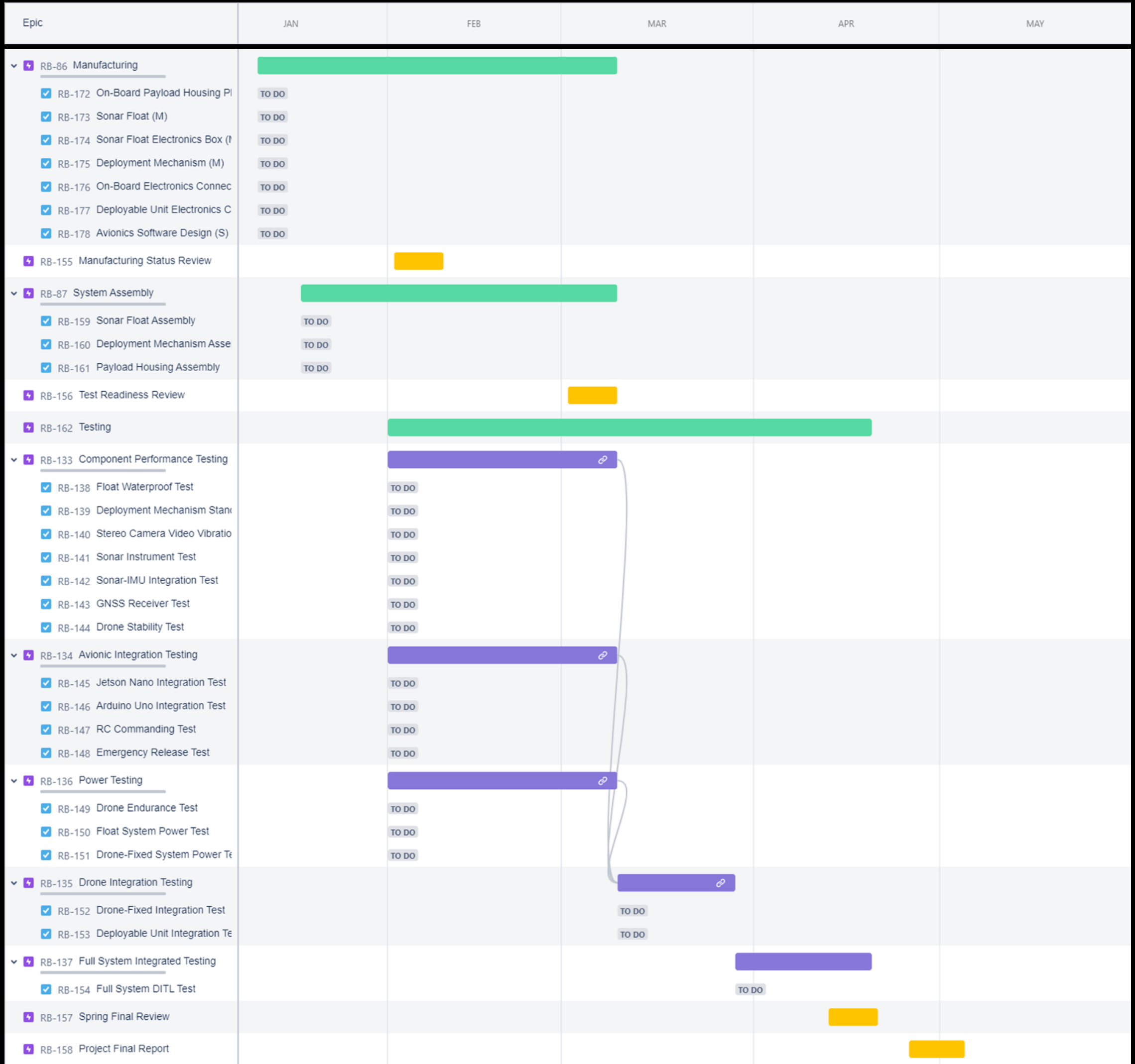


Item	Cost
UAV License	$75
PLA & Arduino	$152.14
Ping Sonar	$310.50
Jetson Nano & SD Card	$102.24
U-Blox	$409.99
Stereo Camera	$489
UAV	$1492.11
Batteries & Charger	$81.63

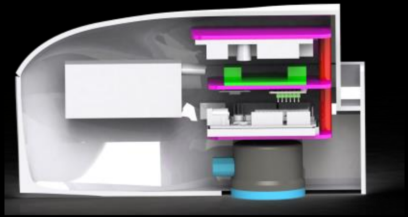
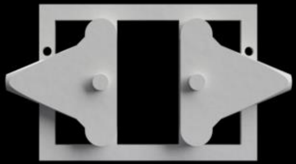
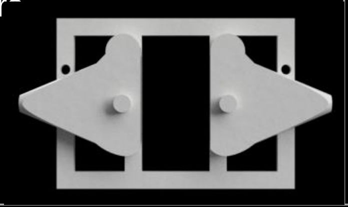
Questions?

Backup Slides

Backup Slides Table of Contents


Epic
JAN
FEB
MAR
APR
MAY
RB-86 Manufacturing
RB-172 On-Board Payload Housing Pl
RB-173 Sonar Float (M)
RB-174 Sonar Float Electronics Box (I
RB-175 Deployment Mechanism (M)
RB-176 On-Board Electronics Connec
RB-177 Deployable Unit Electronics C
RB-178 Avionics Software Design (S)
RB-155 Manufacturing Status Review
RB-87 System Assembly
RB-159 Sonar Float Assembly
RB-160 Deployment Mechanism Asse
RB-161 Payload Housing Assembly
RB-156 Test Readiness Review
RB-162 Testing
RB-133 Component Performance Testing
RB-138 Float Waterproof Test
RB-139 Deployment Mechanism Stan
RB-140 Stereo Camera Video Vibratio
RB-141 Sonar Instrument Test
RB-142 Sonar-IMU Integration Test
RB-143 GNSS Receiver Test
RB-144 Drone Stability Test
RB-134 Avionic Integration Testing
RB-145 Jetson Nano Integration Test
RB-146 Arduino Uno Integration Test
RB-147 RC Commanding Test
RB-148 Emergency Release Test
RB-136 Power Testing
RB-149 Drone Endurance Test
RB-150 Float System Power Test
RB-151 Drone-Fixed System Power Te
RB-135 Drone Integration Testing
RB-152 Drone-Fixed Integration Test
RB-153 Deployable Unit Integration Te
RB-137 Full System Integrated Testing
RB-154 Full System DITL Test
RB-157 Spring Final Review
RB-158 Project Final Report
TO DO

Design Changes Since CDR

Part	Old Design	New Design	Rational
SONAR float	Electronix box sat atop the float 	Box is entire hull body 	- Fewer parts - Lower CG - Better cable management - Less wasted space - Original box was undersized
Stability Mech	Wider plate and longer pivot shoulders 	Shorter plate and shorter pivot shoulder 	- Account to float dimension change - Eliminate shoulder collisions while rotating

Levels Of Success

Drone

	Level 1	**Level 2**	**Level 3**
Drone Command & Control	- Drone is capable of being flown manually the entire course of the flight.	- Drone is capable of being flown manually the entire flight with commands to correct for wind or other disturbances.	- Drone is capable of using autopilot along a pre-programmed flight path.
Drone Performance	- Drone is capable of carrying payload - Drone is capable of flight time of at least 12 minutes carrying payload	- Drone can fly 12 minutes with 5 minutes of additional flight time for travel	- Drone can fly for 25 minutes.

Structural and Instrument

	Level 1	Level 2	Level 3
Depth Sensing	- Instrument system can measure river depths of 0.5m-3m in ideal conditions to an accuracy of <1% of the total depth	- Instrument system can measure river depths of 0.5m-3m in ideal conditions to an accuracy of <0.75% of the total depth. - Instrument can measure river depths to 3-5m in ideal conditions with an accuracy of <1% of the total depth.	- Instrument system can measure river depths to 0.5m-3m in ideal conditions to an accuracy of <0.5% of the total depth. - Instrument can measure river depths to >5m in ideal conditions with an accuracy of <1% of the total depth.
Velocity Measurements	- Instrument system can sufficiently capture surface velocity of 0m/s-4m/s.		
Instrument Positional Measurements	- The instrument system can know its relative horizontal position to an accuracy of +/-3 cm and its vertical position to an accuracy of +/-4 cm using RTK or PPK. - The instrument system will know its angular position to an accuracy of +\- 1 degree.	- Inclusion of GNSS receivers on both the drone and sensor suite.	- Inclusion of ground control points or use of advanced base station localization techniques such as truthing to survey landmarks. - Perform SLAM algorithm to integration receivers and IMU.
Drone Mount	- Instrument suite can be mounted to the selected drone.		

Software and Electronics

	Level 1	Level 2	Level 3
Data Handling	- All data is stored in on-board memory		
Power	- All onboard sensors shall be powered at minimum for the flight duration of 720 seconds	- All onboard sensors shall be powered for 720 seconds with reserve charge	- Drone shall be able to draw upon reserve sensor suite power under necessary conditions
Velocity Data Post Processing	- The river is modeled as a flat plane. - The velocity of the flow is the horizontal component of true velocity.	- The river is modeled as a 3D surface. - The velocity of the flow is the horizontal component of true velocity.	- The river is modeled as a 3D surface. - The velocity of the flow is the true velocity. [See appendix section 7.1 for schematic of flow velocity components].
Data Verification and Validation	- River velocity and depth profile data shall be compared to in-situ measurements to observe system accuracy.	- Depth profile data shall be compared to that collected by AstraLite.	- Ground control points shall be collected and integrated into the depth profile model to ensure the model is accurately georeferenced.

Test Plan

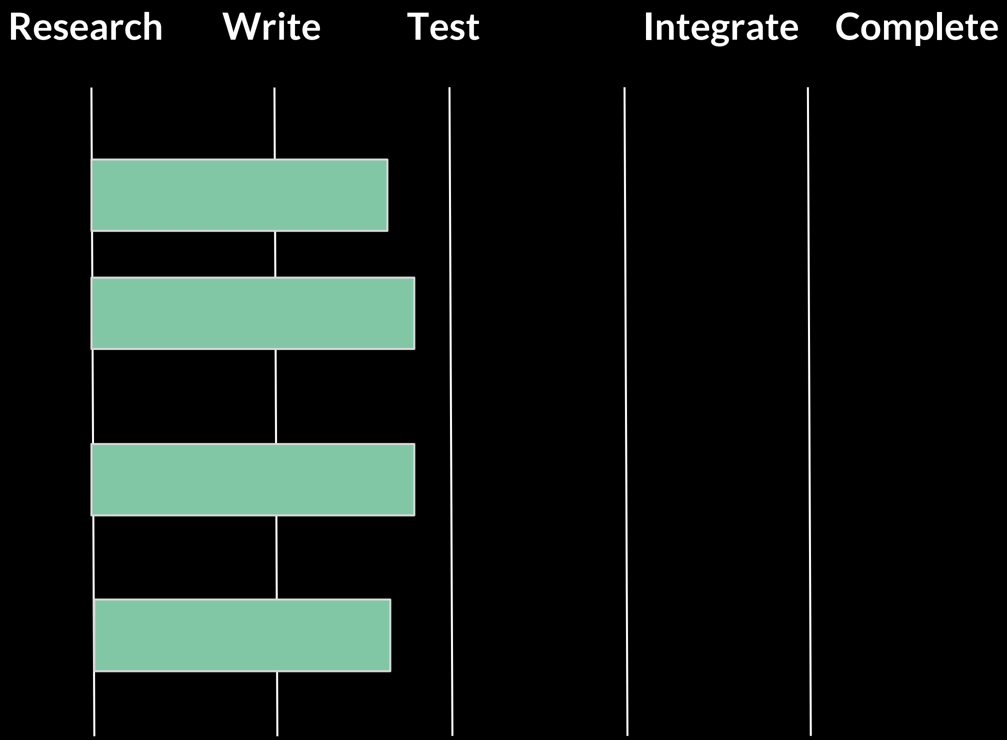
Test	Date	Location	Status	Phase
Velocity Post-Processing Test	11/20/2020	Boulder Creek	Complete	2
Stereo Camera Data Collection	1/1/2021 - 3/1/2021	Boulder Creek	Under design	
Sonar Data Collection	1/1/2021 - 3/1/2021	Boulder Creek	Under design	
Float Stability Test	1/1/2021 - 3/1/2021	Boulder Creek	Under design	
UAV Control & Weight Capacity Test	3/1/2021 - 4/1/2021	CU East Campus	Initial planning stage	2
Deployment Mechanism & Emergency Release Test	3/1/2021 - 4/1/2021	Boulder Creek	Initial planning stage	
Full data software collection test	3/1/2021 - 4/1/2021	CU South Campus	Initial planning stage	
System Integration Testing	3/1/2021 - 4/1/2021	CU South Campus	Initial planning stage	3
Final Demonstration	4/1/2021 - 4/19/2021	Colorado Blue River Confluence	Initial planning stage	

Stereo Camera Data Collection Program

Language: Python

Critical Tasks:

1. Adjust camera controls
2. Record video data
3. Save recorded video to output file on micro SD card in SVO format
4. Collect 3D depth point cloud data



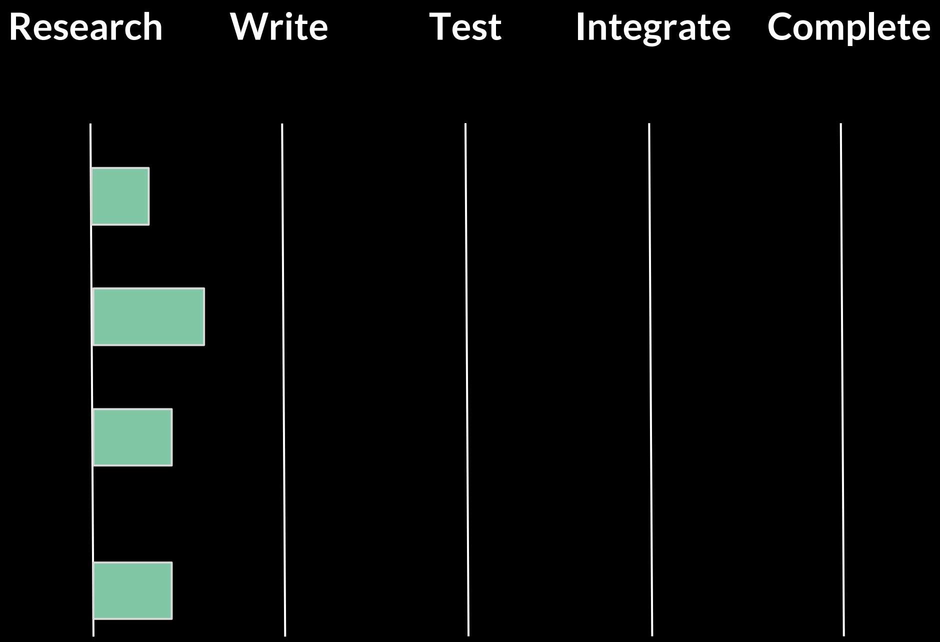
Estimated Date of Completion: 02/28/2021

Pixhawk-Jetson Communication Program

Language: Bash or Python

Critical Tasks:

1. Send a signal from the ground controller
2. Pixhawk receives and processes signal from controller
3. Pixhawk forwards the appropriate command to the Jetson Nano
4. Jetson Nano calls requested initiation program



Largest Uncertainty: What communication between the Pixhawk and Jetson Nano will look like

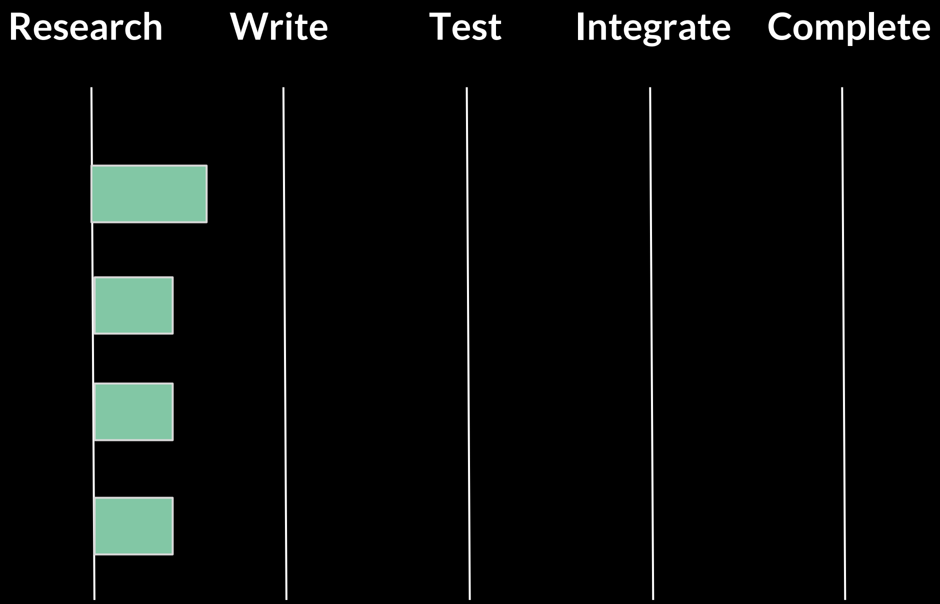
Estimated Date of Completion: 02/28/2021

On-Board Initiation Programs

Language: Bash or Python

Critical Tasks:

1. Respond to commands from Pixhawk controller
2. Initiate ZED camera data collection program
3. Initiate GNSS Receiver data collection program
4. Initiate deployment system functions



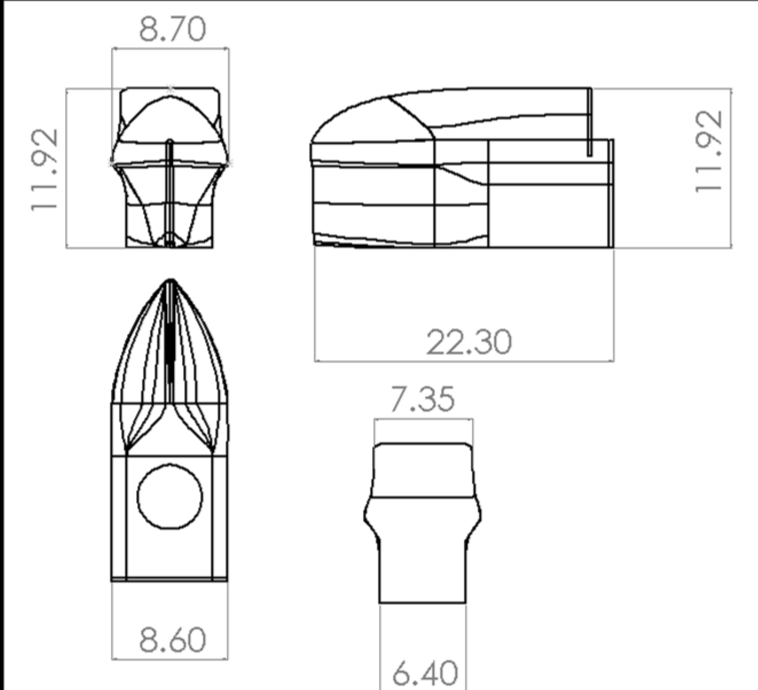
Largest Uncertainty: What communication between the Pixhawk and Jetson Nano will look like

Estimated Date of Completion: 02/28/2021

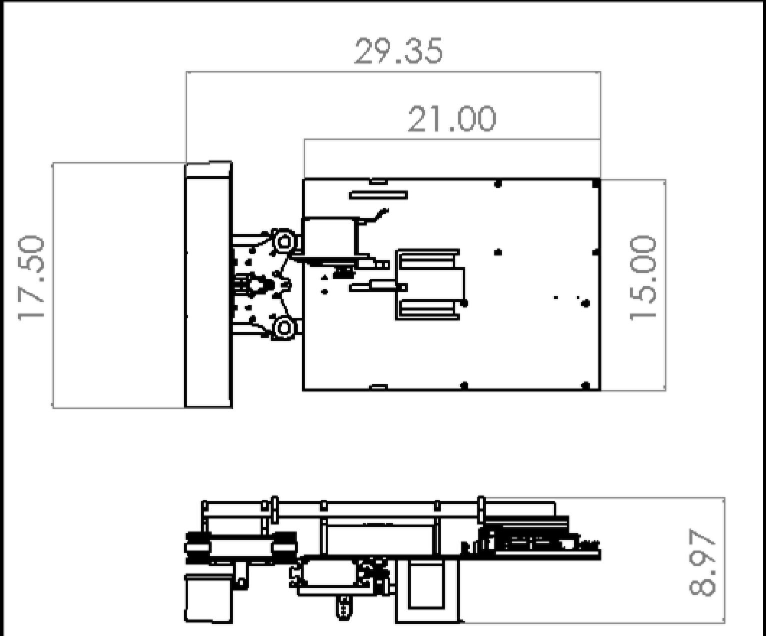
Hardware Overview

System	Remaining Work	Schedule Status
SONAR Float	- Print part - Integrate stability system - Install Electronix box	On-Schedule
Float Stabilizer	- Print individual components - Assemble system - Integrate into float	On-Schedule
Electronics Box	- Laser cut shelves and print standoffs - Install electronics - Integrate into SONAR float	On-Schedule
Deployment Mech	- Further testing is required - Assemble and integrate into mounting plate	Behind Schedule

Updated Dimensions



All units are [cm]



All units are [cm]

Float Weight Budget

Part	Weight [g]
Arduino Uno	25
1000mAh Battery	98
SD Shield	5
Wiring	15
Ping Sonar	135
IMU	3
U-Blox	35
Hull	219
Pontoons	364
TOTAL	**894**

Deployment Mech Options

Continuous Rotation Servo

- Operates on 5 to 6V
- Typically slower than motor
- Simpler integration with Jetson nano

Stepper Motor

- Operates on 12V
- Faster deployment than servo
- Requires motor driver

Data Flow Analysis

On-Board Unit	
Component:	Maximum estimated data required
Jetson Nano	6Gb
ZED 2	64Gb
Ublox Receiver	1Gb
Additional Code:	5Gb
Total:	77Gb

Design solution:
128Gb microSD card on Jetson Nano

Deployable Unit	
Component:	Maximum estimated data required
Ping Sonar	2Gb
Ublox Receiver	2Gb
IMU	2Gb
Total:	6Gb

Design Solution:
Minimum of 8Gb microSD card