Critical Design Review Presentation

Prepared By

Unmanned Aerial Systems Solutions

for the

Alaska Center for Unmanned Aerial Systems Integration

November 9, 2015

Overview

The Critical Design Review has been prepared by the EE 656 class at UAF for ACUASI. This presentation will cover what the class has done in preparation for the arrival of the components that have been ordered for both the Stalker and the S900. This preparation consisted of final selection of the components, calculations supporting the choice of components, potential failure modes of the subsystems and placement/integration of the components into the Stalker and S900. Due to time constraints, not all of this information can be presented during this presentation. Additional information can be provided upon request. The focus will be primarily on where each subsystem will be located in each respective system and what has/will be done to integrate all systems safely.

Each subsystem will be covered briefly with accompanying figures where required. The idea will be to give an overview of each subsystem followed by it's location and integration designs in both the Stalker and S900. After the subsystems are covered, a final drawing of the Stalker and S900 will be presented to wrap up the subsystem section. Upcoming and completed tasks will be covered afterwards with tentative schedules. A brief cost analysis will follow that summarizes costs for each system. Detailed lists can be found within this document. The presentations will be wrapped up with a summary of what testing is planned when all the components arrive.

Cost Analysis

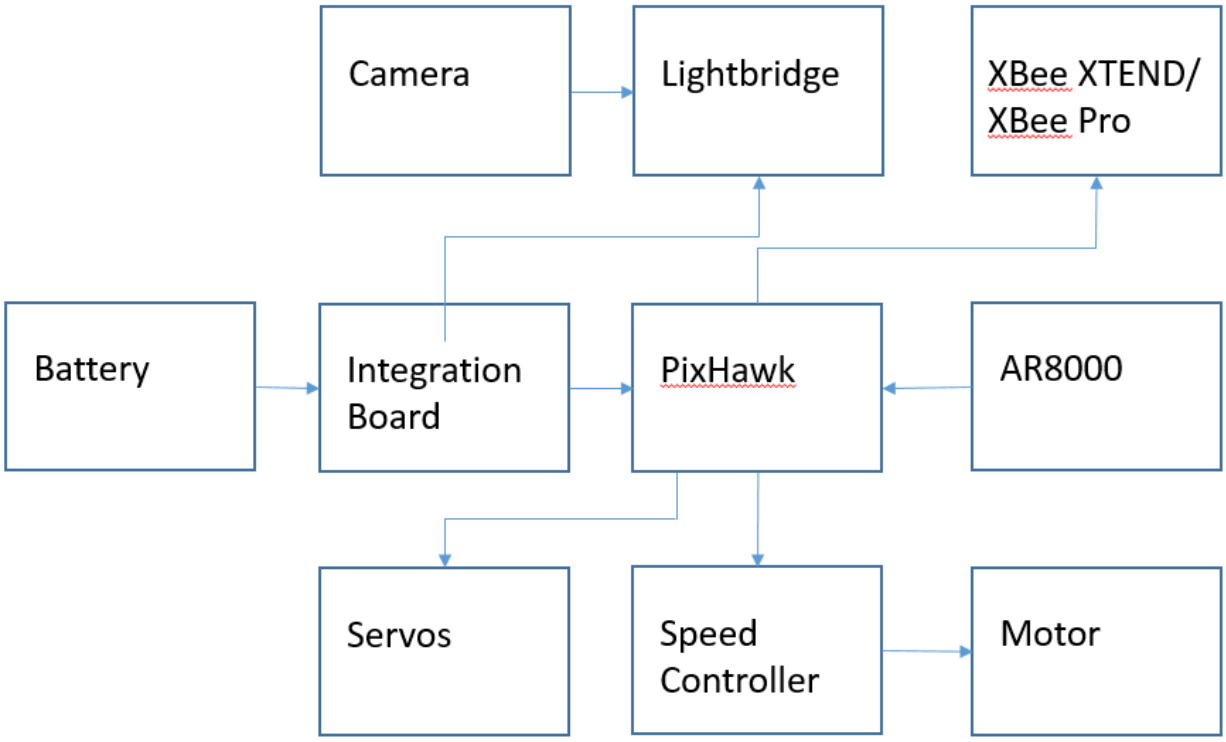
Stalker Cost analysis

PixHawk Kit	1	$ 539.00
Carbon Fiber Propellers	6	$ 41.40
Xbee XTEND	2	$ 358.00
Xbee Dipole Antenna	2	$ 42.00
Lightbridge 1.0	1	$ 999.00
Spektrum DX8 RC w/ AR8000 RX	1	$ 399.99
4S 20000 mAh Battery	2	$ 339.80
4S 16000 mAh Battery	2	$ 259.80
Integration Board + Components	EST	$ 150.00
Payload Mounting Plate	EST	$ 150.00
	Total:	**$ 3,278.99**

S900 Cost Analysis

Item	Quantity	Total Price
PixHawk Kit	1	$ 539.00
Carbon Fiber Propellers	12	$ 214.80
Xbee Pro-XSC	2	$ 84.00
Xbee Dipole Antenna	2	$ 42.00
Lightbridge 1.0	1	$ 999.00
Spektrum DX8 RC w/ AR8000 RX	1	$ 399.99
6S 20000 mAh Battery	2	$ 439.80
6S 16000 mAh Battery	2	$ 357.80
Misc. Wires and Connectors		$ 200.00
Nylon Dome		$ 250.00
Integration Board + Components		$ 150.00
Payload Mounting Plate		$ 150.00
	Total:	**$ 3,826.39**

Functional Diagram of Control and Information Signals



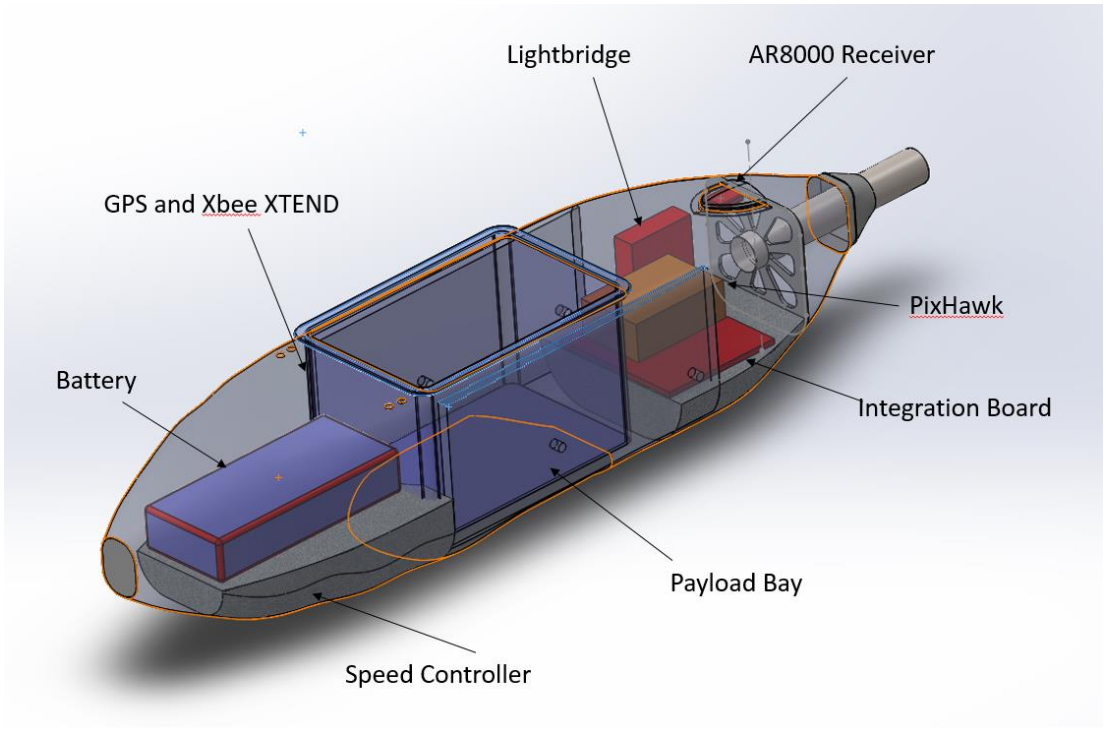


Figure 1: 3-D CAD Model of Stalker Showing Components in Their Place

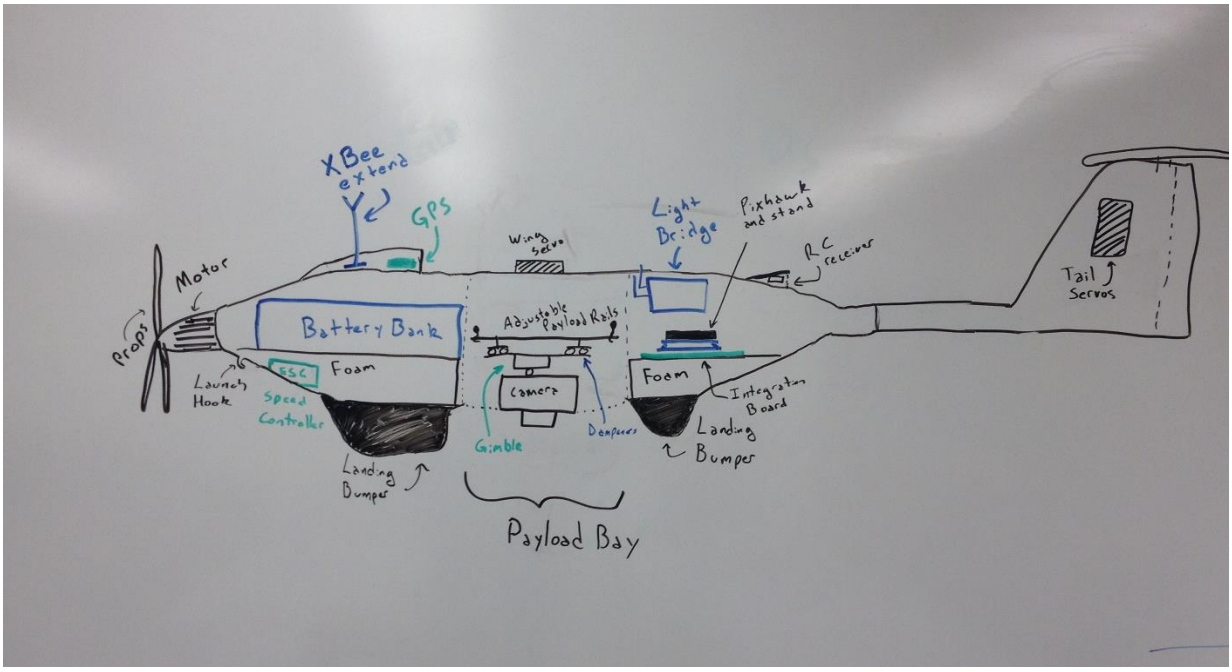


Figure 2: Sketch of Locations of Each Component in the Stalker

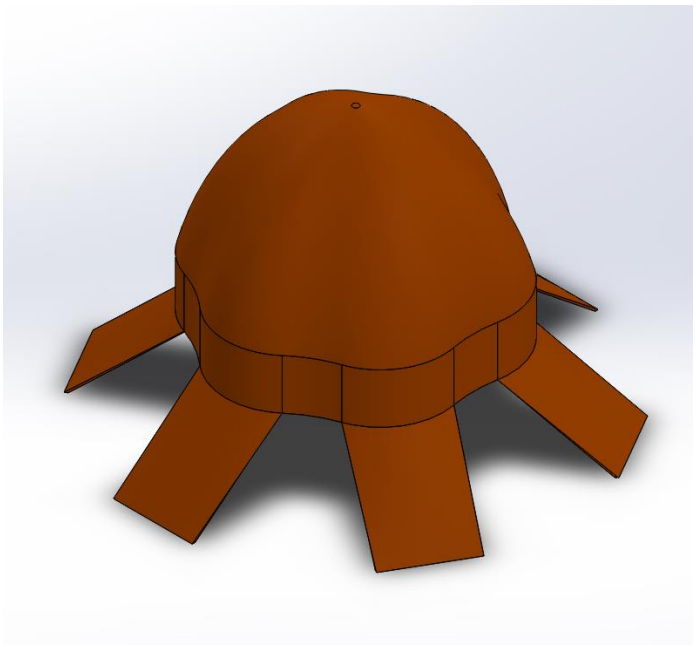


Figure 3: 3-D CAD Model of the S900 Dome Design

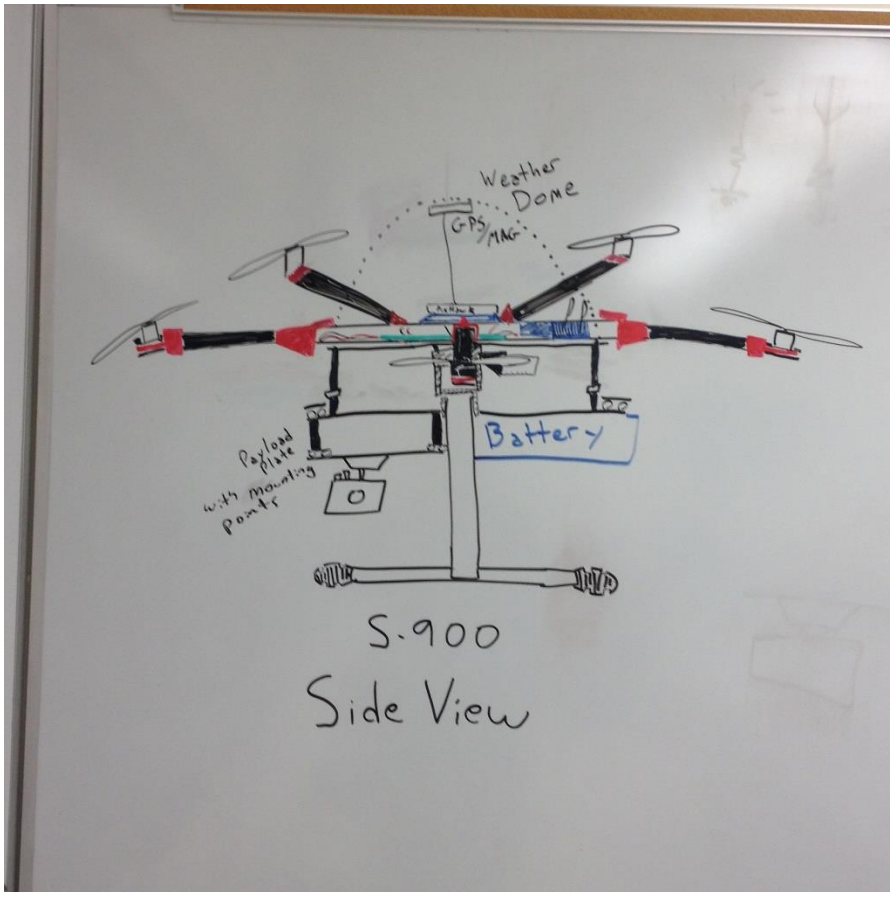


Figure 4: S900 Side View of Component Placement

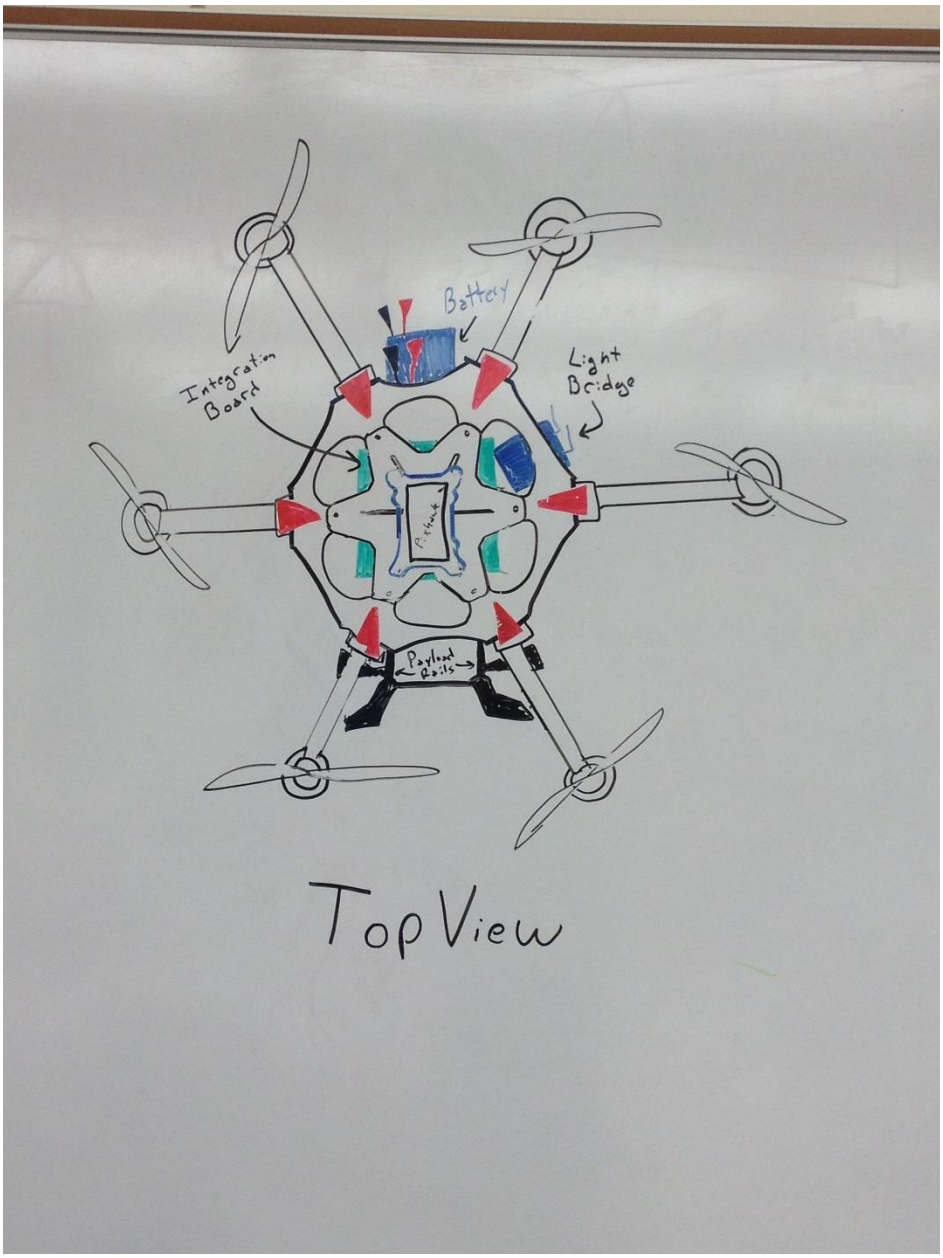


Figure 5: Top View of S900 Component Placement

Critical Design Review

S900 and Stalker Revamp

Brandon Burgett and Bharath Veeravalli

Unmanned Aerial Systems Solutions

November 9, 2015

Agenda

- Design Overview
- Project Schedule and Progress
- Cost Summary
- Prototype Demo
- Operational/Field Testing

Top Level Description

Each platform contains multiple subsystems:

- Payload/Airframe
- Power
- Propulsion
- Communications/Control
- Ground Station

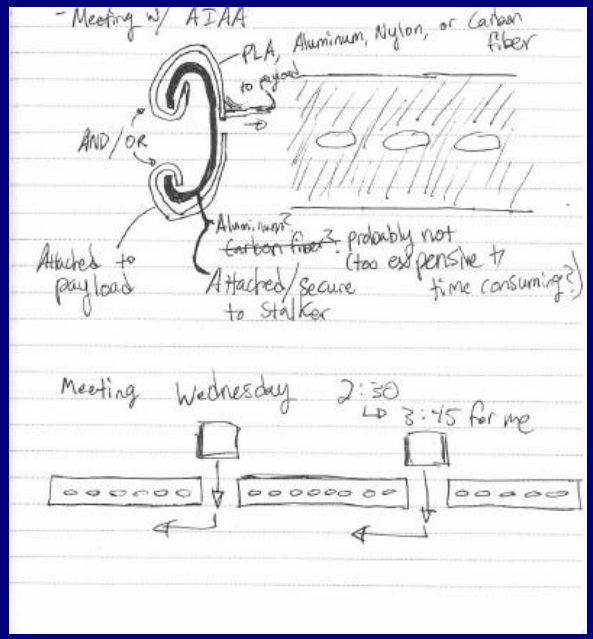
Airframe Condition

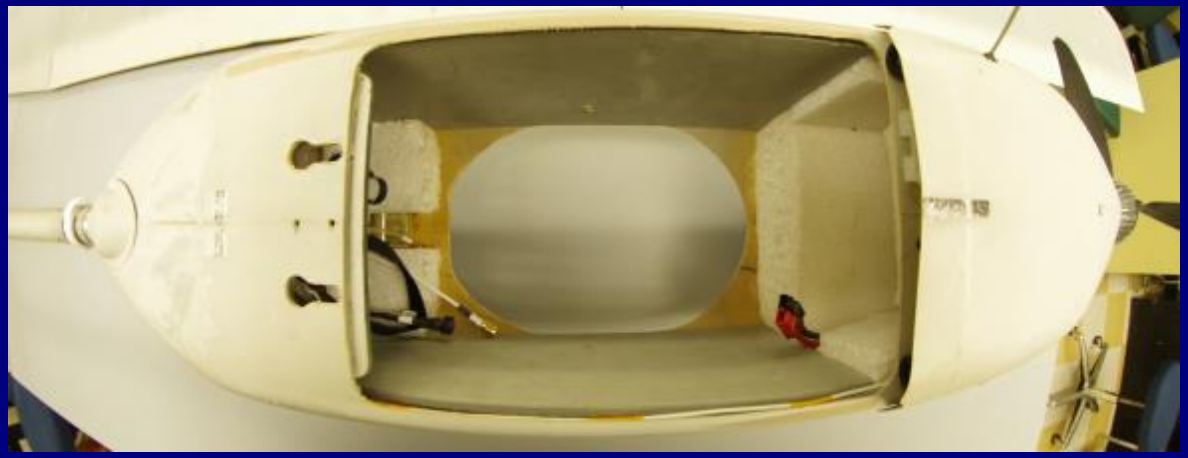
- 3-D Print Plate to Attach Board
- Stalker Body
- Servo Motors Tested and Verified to Function

Payload Attachments

- Generic Payload Rail for Standard Mounting
- Make a Plate for Payloads
  - Specific Design is Still Under Development

Payload Attachments





Battery Selection

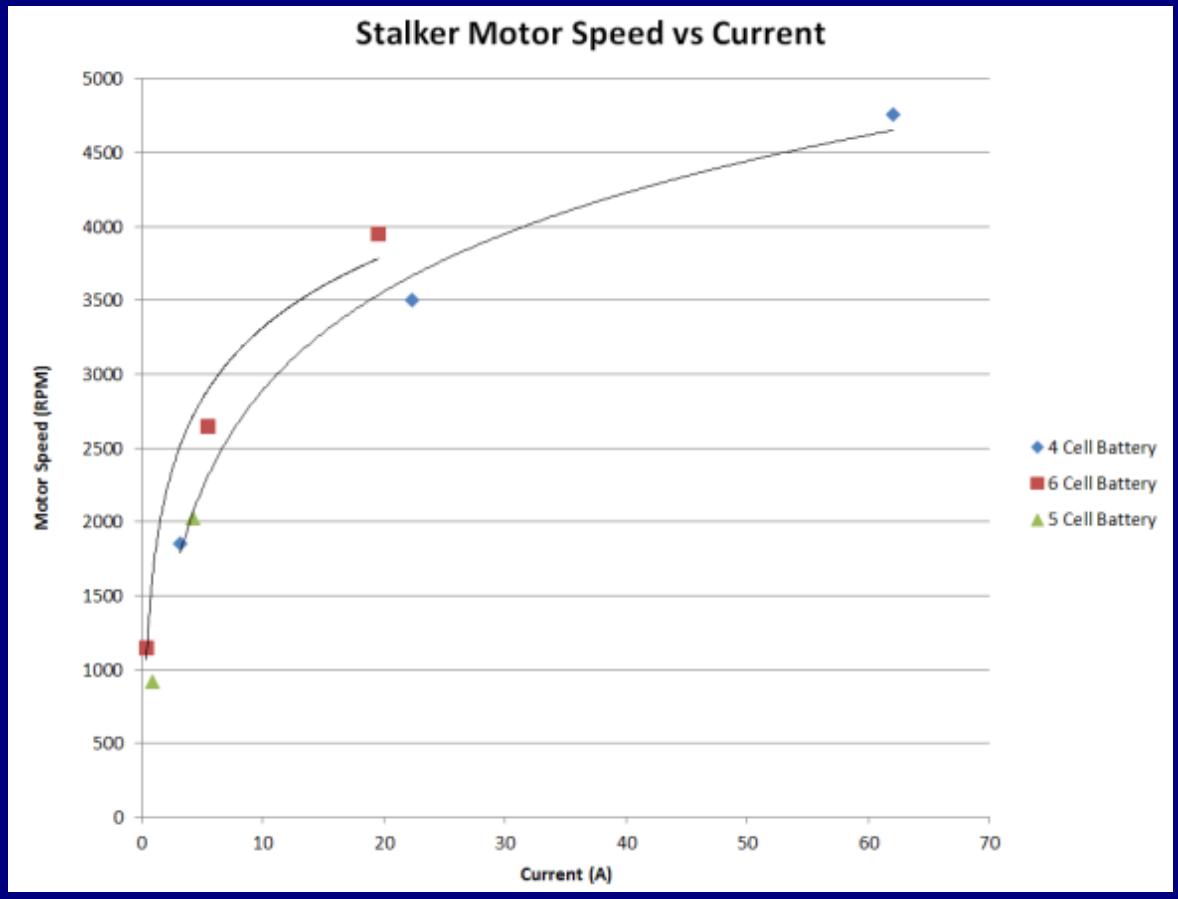
- Turnigy Multistar Batteries
- Chosen for Proven UAS Track Record
- Best Battery Found

Operational Characteristics and Flight Time

- Battery
  - 4-Cell Battery
  - Max Current: 200A
  - Charging Cycles: 300 to 500
  - Energy Storage: 20 Ah
- Using One Battery We Have:
  - Projected Flight Time of 50 minutes (30% power)

Motor Specifications

Tested Motor to Generate Current vs. RPM Plot

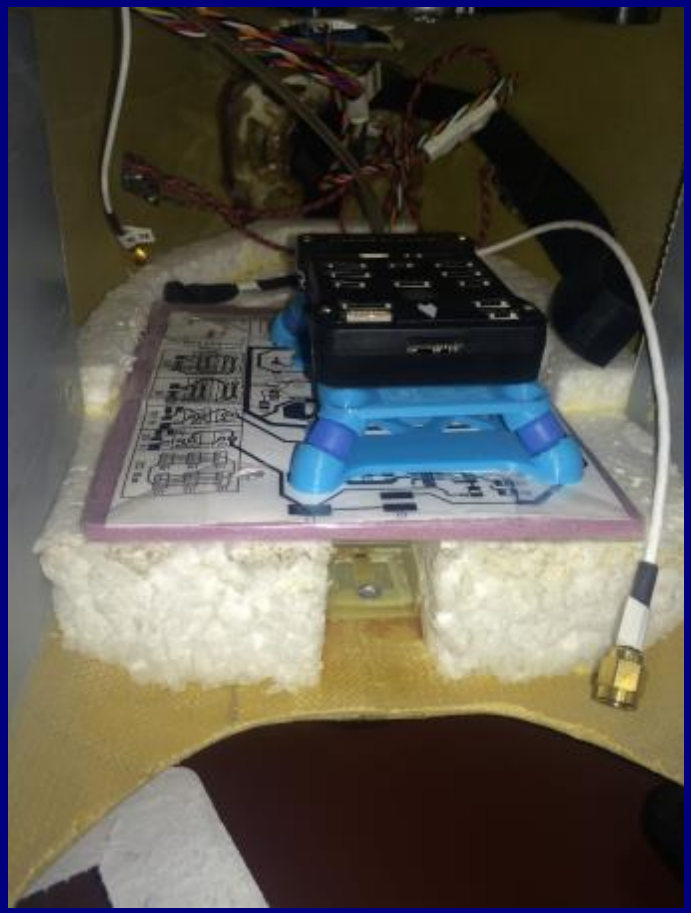


Propulsion System

- Carbon Fiber Propellers
- Speed Controller:Turnigy AE-100A Brushless ESC
- Motor: Proprietary, Potential Replacement Found

Autopilot

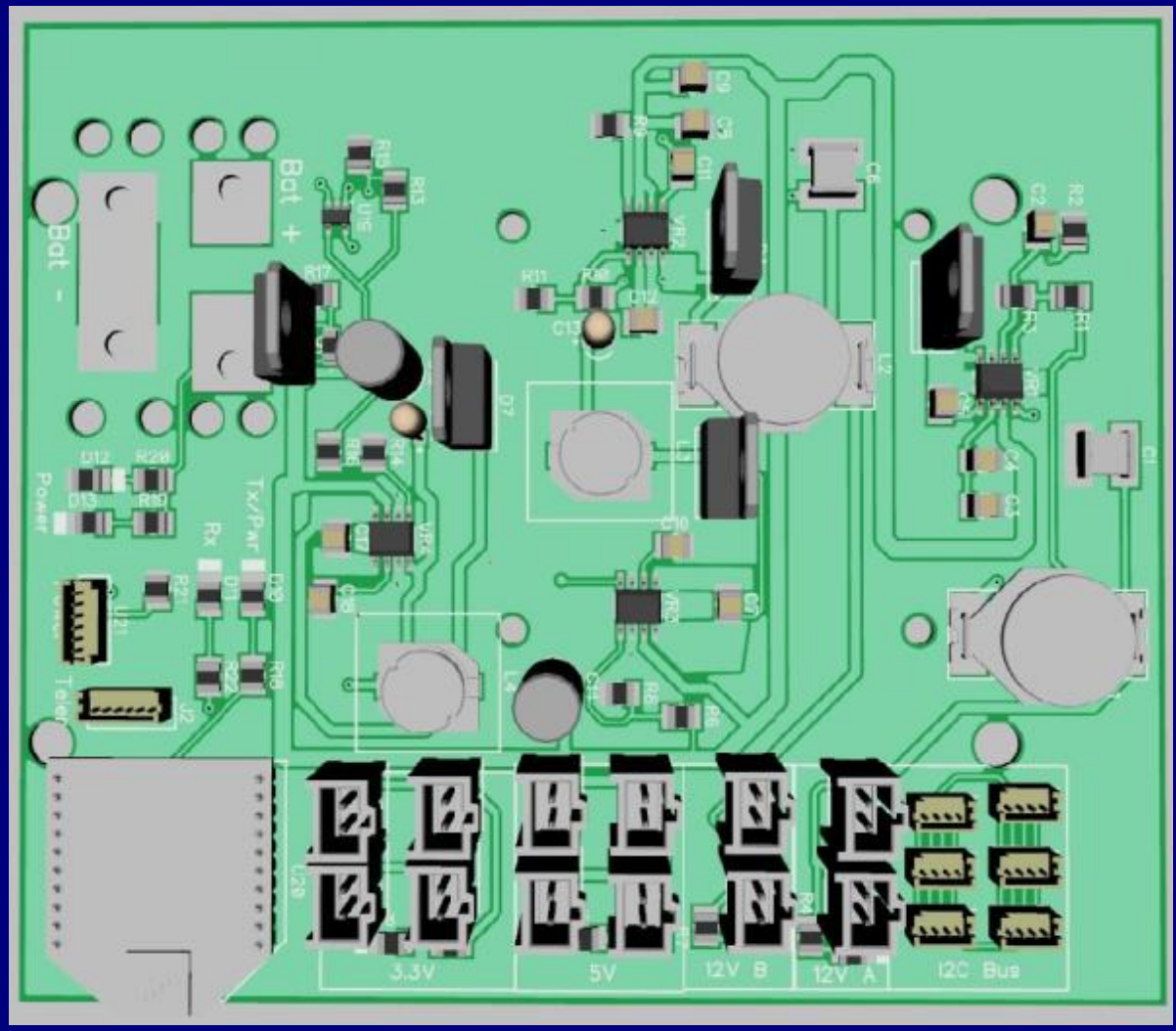
- PixHawk will Rest on/by Integration Board
- Vibration Dampener Designed for it
- Brains of the Stalker



Controller and Antenna

- Spectrum DX8 talks to AR8000 for controlling Stalker
- Improvement Possible with Upgrade to Yagi Antenna

Integration Board



Video Link

- Lightbridge will be permanent feature on the Stalker
- Multiple Options for Antenna Placement

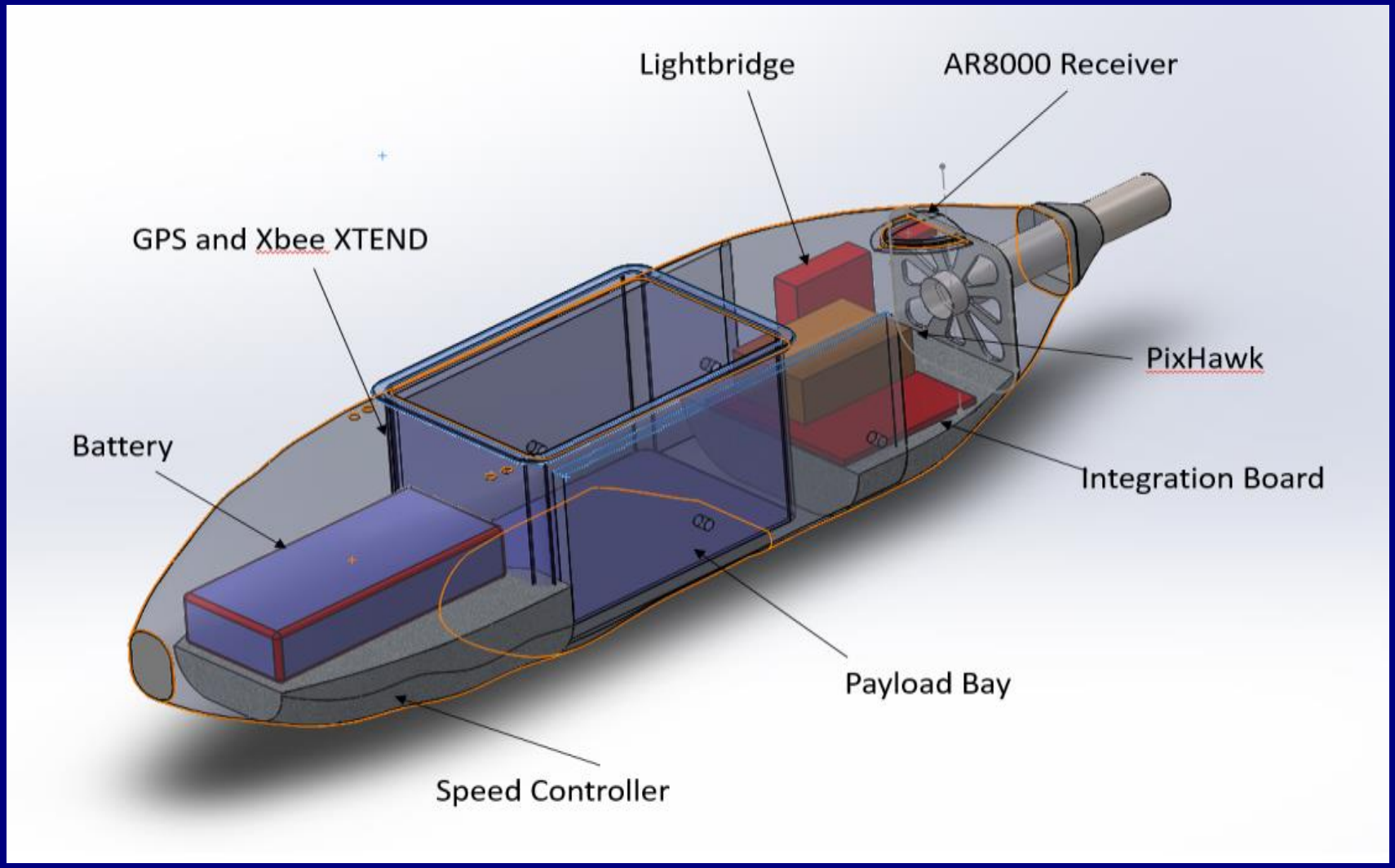
Ground Station Components and Setup

- Entire Ground Station will Fit into Single Case
- Panasonic Toughbook 54

Weight Budget

Component	Weight
Aircraft Weight	6.4 kg
AR8000 - RC RX	9.4 grams
Lightbridge (no antenna)	71 grams
Estimated Antennas	50 grams
XBee XTEND	< 70 grams
PixHawk	38 grams
GPS	16.8 grams
Battery (16 Ah)	1.29 kg
XBee Dipole Antenna	20 grams
Payload Weight	2 kg
Total Weight:	9.97 kg
Maximum Takeoff Weight	10.2 kg

Physical Assembly



Upcoming Milestones

16-Nov: FMEA and EAP

2-Dec: Test Readiness Review

9-Dec: Performance Acceptance Demonstration

11-Dec: User's Manual

Completed Tasks

Parts Order: PO's Submitted and Parts Inbound

Integration Board: Design Finalized, to be Sent for Manufacturing

Motor and Servos: Tested and Verified to Function

Placement and Connections: Identified Locations for Each Component Placement

Assembly Work Schedule

18-Nov: Motor Integration

19-Nov: Board Integration

20-Nov: Battery Integration

21-Nov: Communication System Integration

22-Nov: Payload System Integration

Summary of Expenditures

- Stalker Components.....$3278.99
- Panasonic Toughbook 54...$1300 - $2000
- Integration Board Cost.....$150

Component Testing

- Propulsion Testing: Amperes vs. RPM
- Ground Station Testing: Does everything fit/work?
- Communication System Testing: Verify all work when on at same time
- Payload System: Subject Rail System to Shake Test
- Power System Testing: Test Under Full Load for Fail Safe Point Determination (When to come home)
- Integrate and Fly!

Questions?

Unmanned Aerial Systems Solutions

Thank You

Critical Design Review

Project Copter & Wings

Brandon Burgett and Bharath Veeravalli

Unmanned Aerial Systems Solutions

November 8, 2015

Agenda

- Design Overview
- Project Schedule and Progress
- Cost Summary
- Prototype Demo
- Testing

Introduction

Project Copter

- Hexacopter build using DJI S900 Airframe
- Custom Covering for weather resistance
- Maximum Takeoff Weight: 8.2 kg

Flight Time	Payload
20 min	1.5 kg
30 min	1 kg

Airframe [1]

Top Level Description

S900 platform subsystems:

- Propulsion
- Power
- Payload
- Communications/Control
- Ground Station

Propulsion

- Replacement Propellers
  - Foldable
  - Size: 15 in diameter x 5.2 in Pitch
  - Material: Carbon Fiber
  - Weight: 35g
  - Better Temperature Variations

CW [3]

CCW [4]

Battery Selection

Specs:

- Maximum Capacity: 16000 mAh
- Configuration: 6 Cell/22.2 V
- Maximum Current(A): 160
- UAV Flight time: 24 min
- Weight: 1920 g

Charge Time: 60 min
Charge Cycles: 300 to 500
Battery Flight Hours: 120h – 200h

Battery [6]

Safety

- 3D Print Battery Case
- Insulation: Torch Guard Flame Blankets
- Charging System for the Battery not to overcharge

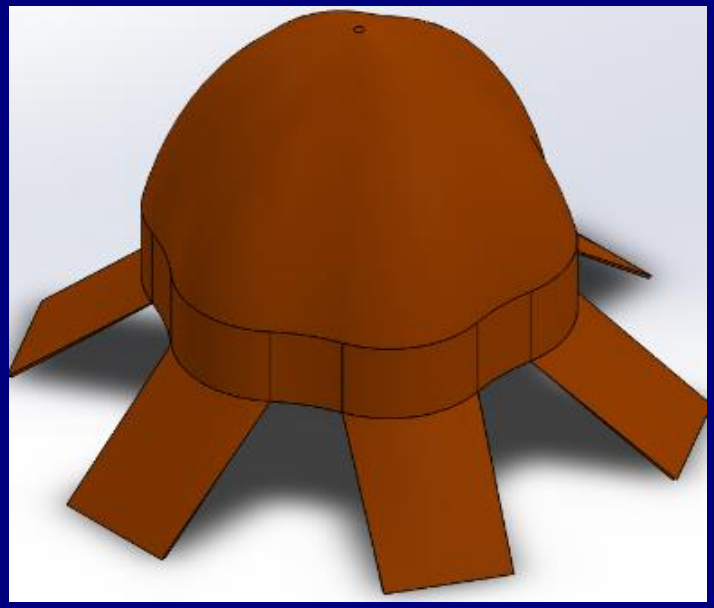
Example of 3D Printed Battery Case [7]

Weight Budget

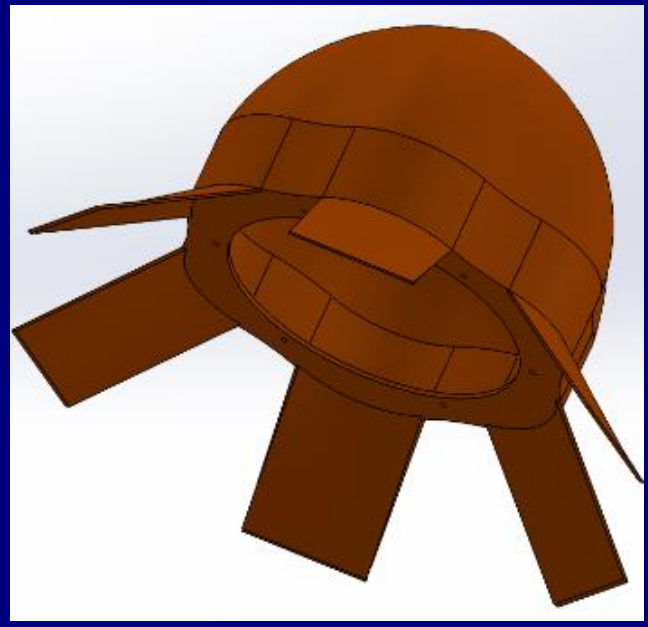
Component	Weight (grams)
S900	3300
AR8000 - RC RX	9.4
Lightbridge (w/o antenna)	71
Estimated Antennas	50
XBEE PRO-XSC	20
Pixhawk	38
GPS	16.8
Batteries (16000 mAh)	1920
X Bee Dipole Antenna	20
Payload	2000
Total Weight	7445.2
Maximum Takeoff Weight	8200

Dome Design

- 3-D Print Design
- Printer Filament: Nylon
- Good Tensile Strength (70 MPa)
- Material Density (1.14 g/cc)



Top View

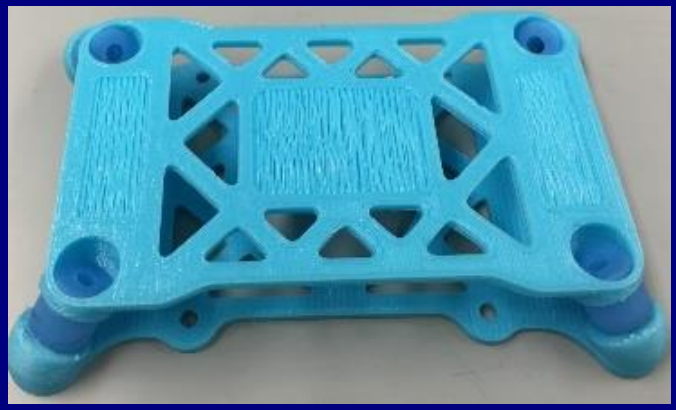


Side View

Autopilot

- Pixhawk will be connected to an integration board.
- 3D Printed anti-vibration platform

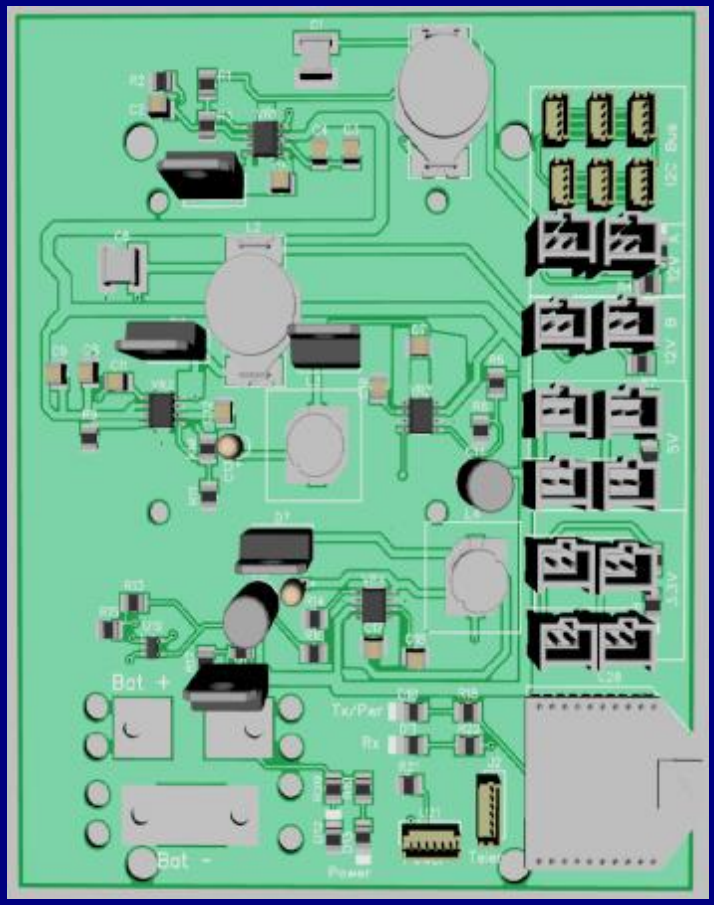
Pixhawk Labeled [8]



Vibration Dampener for Pixhawk

Integration Board

- Telemetry (X BEE Pro XSC)
- Voltage Regulators(3.3,5,12v)
- I2C Splitter
- Power Module



3D Model of Integration Board PCB Design

Controller

- Spectrum DX-8 RC Controller is used for the manual control of S900
- Mainly used for take off and landing the Hexcopter

Spectrum DX-8 & Receiver [9]

AR8000 RC Rx

Payload Data Link

- Light Bridge is used as the datalink for the camera payloads
- Using the antenna extensions the antenna are to be mounted on the landing gear.
- Antennae are pointed towards the ground to maintain good data link (90 degrees to the landing gear)

Lightbridge Antenna [10]

Light Bridge [11]

Python Scripting

- Script Driven Missions
- Mission Planner allows us to run scripts for common mission parameters

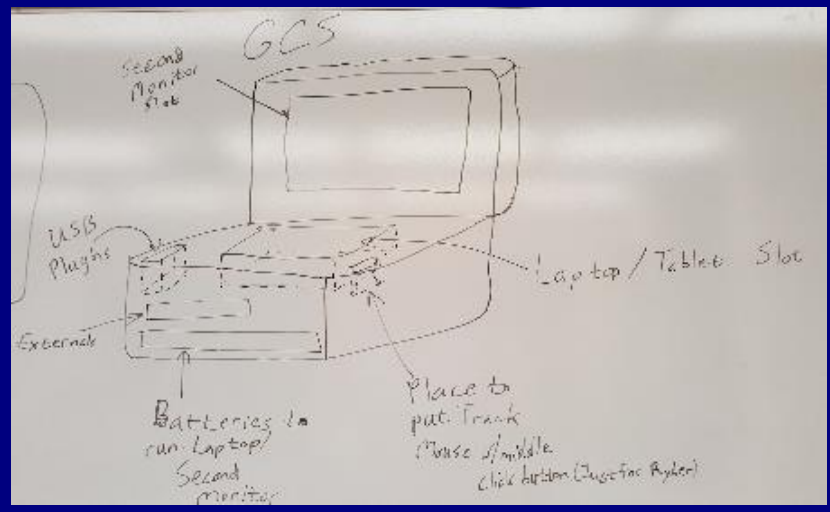
Sample Script Command

- Script.ChangeMode(name)
- The command lets us set the autopilot modes like Return to launch (RTL)

Ground Control Station

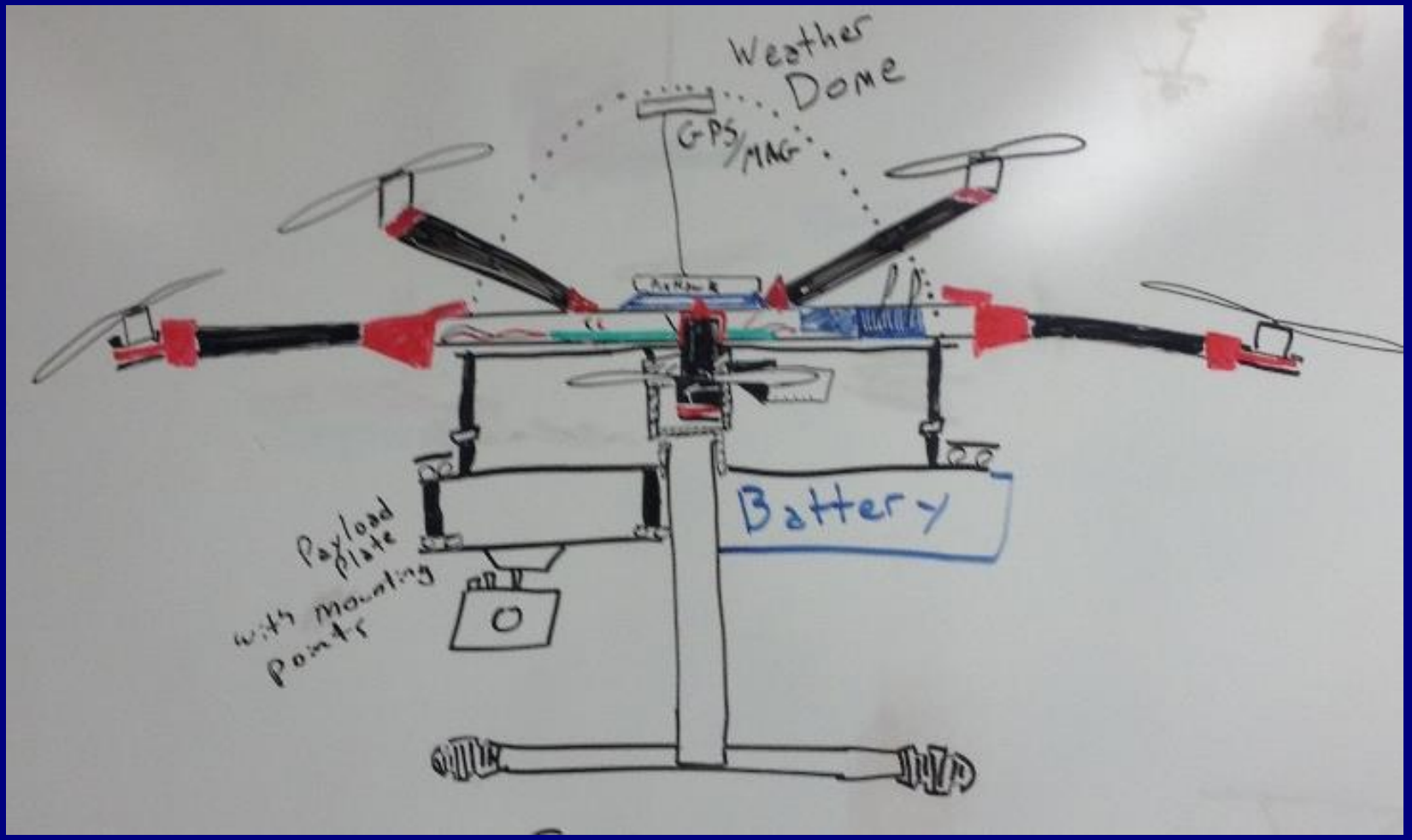
- All the components of a ground control station including batteries will be maintained in a single box

GCS Setup



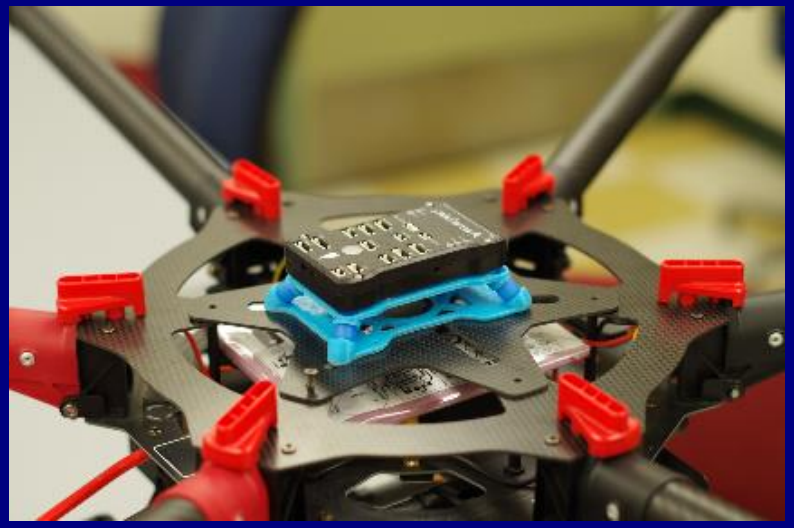
Box Setup

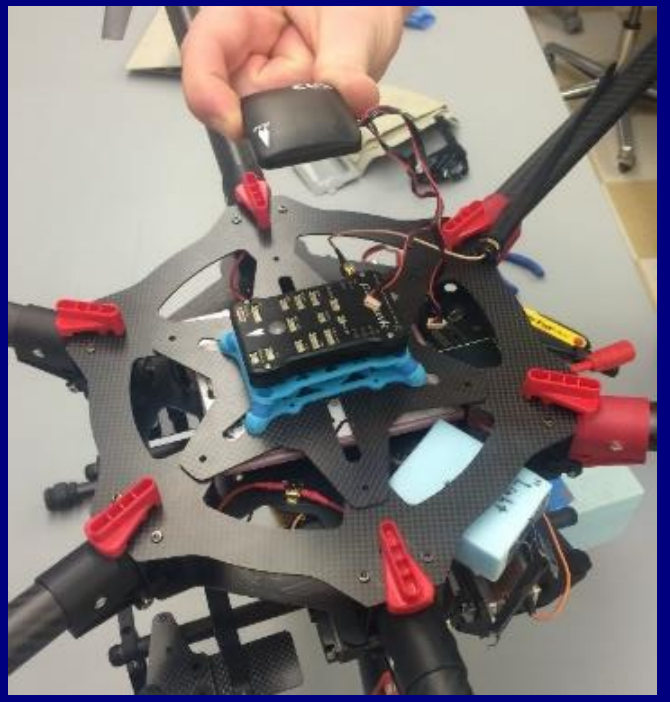
Sketches



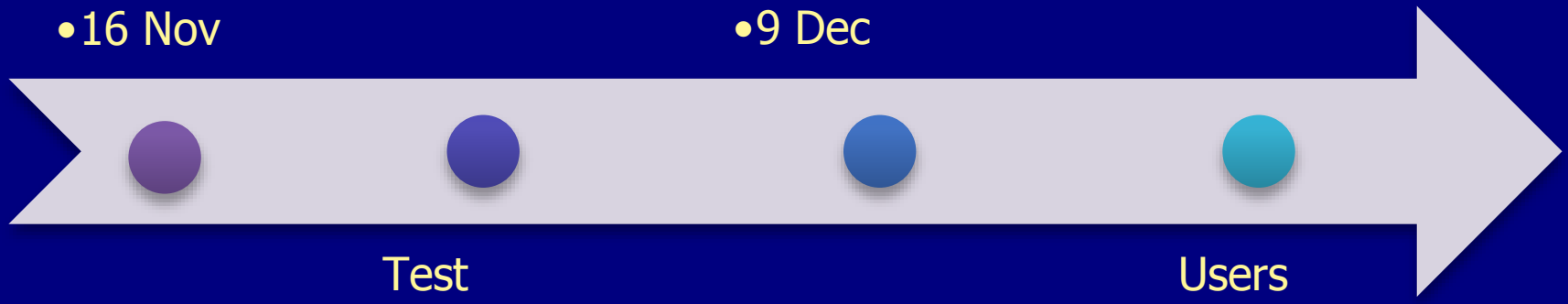
Side View

Assembly





Upcoming Milestones



FMEA and EAP
- 16 Nov

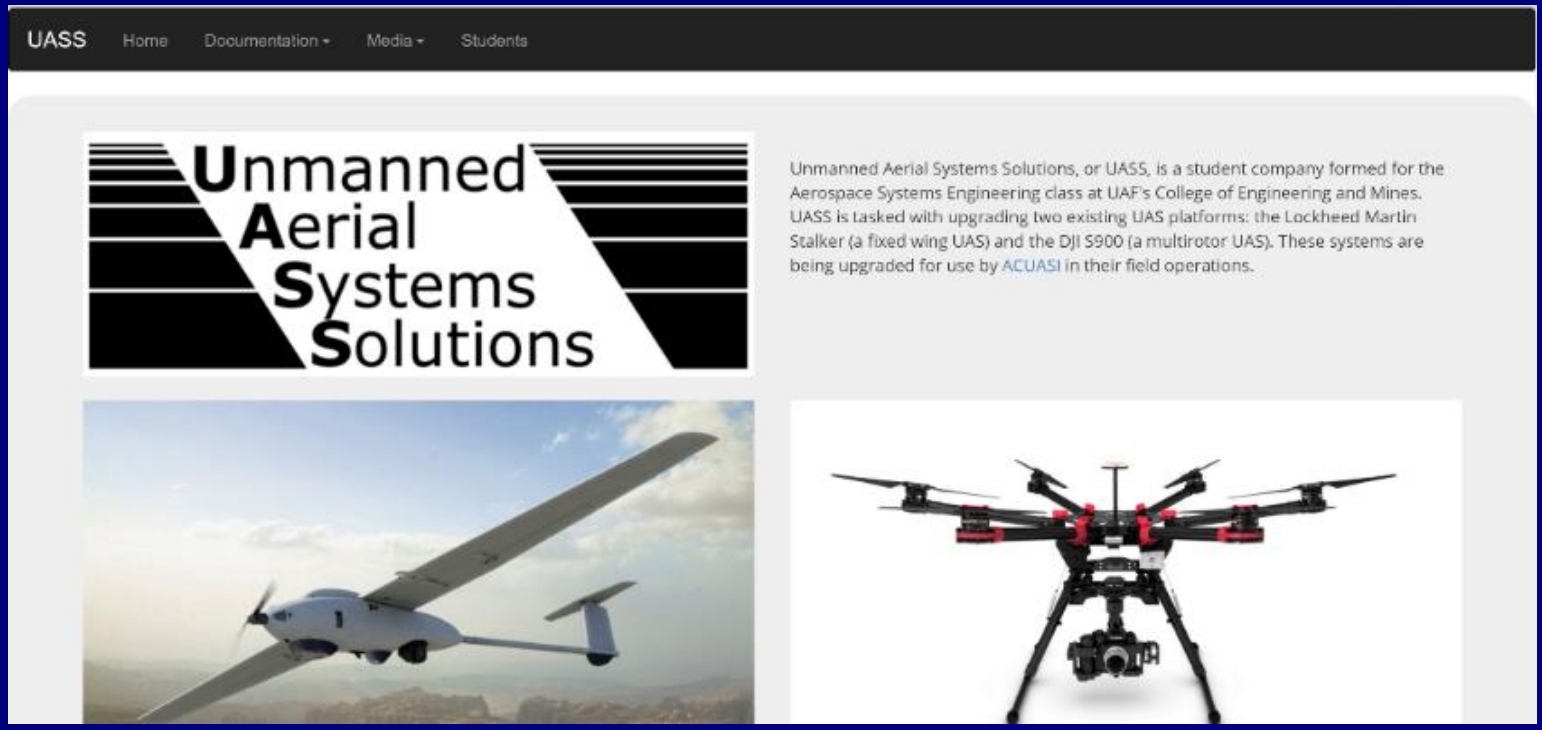
Test Readiness Review
- 2 Dec

Performance Acceptance Demonstration
- 9 Dec

Users Manual
- 11 Dec

Website

Link: http://uass.uaf.edu/



Summary of Expenditures

Rough Estimate : $3829.39
Panasonic Tough Book: $1449.00
Total Cost: $5278.39

Component Testing

Propulsion

- Current vs RPM

Power Testing

- Battery Working Temperature

Payload Testing

- Dome Good enough? Weather Coverings?

Communication Testing

- Working of all communication systems

Ground Station Testing

- Does everything works and fits in one case?

Final Product Testing

- Make sure all the parts are fitted properly
- Check all the subsystems and make sure the systems are fully functional
- Shake down test for S900 can be done at Ice Rink
- Fly!

Flying Experience

Team UASS

Questions?

Thank You