Unmanned Aerial Systems Flight and Payload Challenge Submission

Business Contact:

Damon Henry, CEO

www.flyasylon.com

757.695.0088

damon@flyasylon.com

Abstract

Drones are poised to (and have already begun in many ways) make tremendous impacts in various industries including public safety, but until the back-end infrastructure is automated and the steep learning curves associated with operating a UAS are reduced, drones will never reach their full potential impact in the marketplace. Asylon was founded in 2015 by three MIT aerospace engineers as an answer to that challenge, automating the back-end infrastructure of the UAS industry: power, payload, and data.

Our first product, DroneHome (http://www.flyasylon.com/product/), is an automated battery swap station. When a drone's battery gets low, DroneHome can land the drone, swap the depleted battery with a freshly charged one, and relaunch the drone to resume its mission. All without a pilot or ground crew. DroneHome extends the mission capabilities of a given UAS by allowing it to operate 24/7 without intervention from a human operator while simultaneously reducing learning curves associated with the mission, by automating all battery charging, data downloading, and payload transmission. The station is connected to the cloud, allowing an operator to see both mission data and payload telemetry in real time from any location.

DroneHome is paired with the Asylon custom UAS, a platform capable of autonomous and manual flight, live telemetry and video link to operators on the ground, and extended remote operations via its exchangeable battery packs, which can be automatically exchanged by the DroneHome system. Using a DroneHome system in an emergency scenario would mean that an operator would not be needed to support the UAS on the ground (e.g. battery exchange, data upload) freeing up valuable resources. It is not too much of a stretch to imagine the ability to provide 24/7 coverage and/or uptime of cell connectivity, comms, or video using only two UAS platforms in tandem with the DroneHome system. Asylon's UAS platform does not currently meet the challenge requirements but can be leveraged as a starting point for the Asylon submission that meets many of the Pass/Fail requirements and can be modified to satisfy the flight time requirements of the proposed challenge. By using this prior work as a starting point, schedule and cost risks are mitigated from the beginning.

Our unique approach to the UAS market, by focusing on the back-end first, has given us the ability to focus on automating and extending mission life to support operators on the ground. We believe that this unique position in the UAS market combined with our team's strong background in aerospace, discussed in later sections of this submission, will allow us to successfully achieve the proposed challenge at each phase. Second, this submission will align strategically with the long-term goals of supporting first responders' communication technology by leveraging not just a UAS platform, but a commercialized, fully-integrated UAS solution.

The Target Flight Times for the Challenge are as follows:

Payload	Time	Power Source
10 lbs	42 mins	LiPo Battery
15 lbs	34 mins	LiPo Battery
20 lbs	26 mins	LiPo Battery
Total Target Score:	**300**	

Project Description

Vision

The goal of this challenge is to design, build, and test a UAS platform that is optimized for the payload criteria listed. The UAS platform must also satisfy additional requirements such as (but not limited to), a kill switch, live telemetry, RF compliance, and use of COTS components to satisfy cost restrictions.

Based on the following scoring requirements, with a minimum of 270 points required to be eligible for grand prizes in the challenge,

Payload	Time	Multiplication Factor
10 lbs.	1 point per minute	1
15 lbs.	1 point per minute	3
20 lbs.	1 point per minute	6

Asylon has proposed the following flight time goals of their UAS platform.

Payload	Time	Power Source
10 lbs	42mins	LiPo Battery
15 lbs	34 mins	LiPo Battery
20 lbs	26 mins	LiPo Battery
Total Target Score:	**300**	

The Asylon team members have considerable experience with SWAP (Size, Weight, and Power) requirements on Class I UAS platforms both internally with their current UAS platform and in prior experience, including at Boeing Defense. As such, this knowledge and the relevant tools and/or software platforms will baseline Asylon's current UAS platform and modify the baseline UAS to be optimized for the challenge. This allows us to work from a base vehicle that can satisfy a majority of the Pass/Fail requirements, thus vastly risk mitigating the challenge goals, and also be a running start towards a long term strategic alignment with a fully integrated solution that can be commercialized and provided to public safety operators.

Metrics

The key metrics have been split into two categories: Payload Scoring and Pass/Fail. Each is detailed below with the proposed strategy to design, validate, and risk mitigate any efforts to increase the probability of success in meeting the challenge goals.

Payload Scoring

The payload scoring portion is related to the physical performance of the aircraft during flight. The design, build, and validation portion of these metrics are detailed below:

Baseline Design

Asylon currently utilizes a custom built UAS platform for their automated missions in the commercial drone industry. The platform is a quadrotor with a max takeoff weight (MTOW) of approx. 22lbs. The

UAS is built around the PixHawk open-source autopilot, allowing for a variety of inflight features including but not limited to, autonomous way point navigation, payload control, live telemetry/video downlink, manual override, precision landing, and battery swapping on the Asylon DroneHome system.

The Asylon UAS does not currently meet the payload requirements of the proposed challenge goals but can serve as a starting point to risk mitigate a variety of obstacles. The UAS payload and flight times can be flown, recorded, and compared to calculated numbers, to both provide a starting point and validate the accuracy of anticipated flight time models, such as eCalc, that will be used to size the final Challenge's UAS platform. Working from the original design, we then plan to modify and integrate new motors, batteries, structure, and control software as necessary to optimize for the challenge.

Design and Build Process

Asylon will utilize their existing CAD software, CATIA, and other software resources such as eCalc, an online UAS estimator tool, to design the modifications necessary to meet the challenge requirements.

The Asylon office includes a small machine shop with base tools, equipment, and 3D printers. This will be used for the primary fabrication of the vehicle. Asylon will use existing relationships with outside manufacturing houses for any additional CNC and composite work that may be outside the office's capabilities, to guarantee that the UAS platform can satisfy the design criteria.

Flight Validation

A tiered approach will be used with any flight testing to guarantee the safety of employees and any potential third parties. This process will be used with any pass/fail validations (where applicable) and with each payload weight.

- ***Bench/Static Testing***

  Any Pass/Fail and payload components will be tested statically on the UAS platform, in an unpowered state initially. This will validate form and fit of any components. This testing may also include loaded testing with weights to simulate flight loads on any components that will be attached to the airframe (payload and power).

- ***1st Flight***

  The first flight will be performed indoors (the Asylon office has an indoor flight space with 20' ceiling) with the aircraft tethered to the ground. This will allow for a baseline, controlled flight test to validate flight systems such as the control loops, kill switch, and telemetry communication.

- ***Outdoor Flight Testing***

  Once the UAS has been validated indoors, outdoor testing will be performed. Asylon has a fenced-in outdoor testing area that can be utilized for the challenge. All flights will be conducted by one of Asylon's certified drone pilots and within the rules of Part 107.

Once each payload has been tested, a mock-up of the competition space will be constructed and the flight times with each payload will be compared to the baseline vehicle and the flight time targets shown above to validate the requirement of 270 minimum points.

Pass/Fail:

The following are the high-level requirements that the UAS platform must meet to be eligible for competition. **Note: Some lower level sub-requirements not detailed in this chart.*

Pass/ Fail Requirement Must:	**Design Considerations**	**Validation Process**	**Risk**	**Risk Assessment Rationale and/or Mitigation**
Not be completely unaltered COTS drone	Use Asylon UAS platform as baseline unit	Pass/Fail		N/A
Auto and Manual Flight Capable	Use COTS Pixhawk autopilot for flight controls (allows for manual, auto, and override flight)	1. Validate control loops with stable manual flight 2. Validate basic autonomous flight characteristics with "Loiter" and "Pos Hold" modes 3. Validate fully autonomous flight with pre-programmed waypoint mission 4. Validate manual override during auto-flight by using TX to regain control of UAS and manually land		Asylon team has 10+ years of experience w/ Pixhawk platform and autonomous UAS flight.
VTOL Capable	Use Asylon UAS platform as baseline unit	Pass/Fail		N/A
No Tethers (Free Flying)	Use Asylon UAS platform as baseline unit	Asylon UAS does not required tethers to fly (Electric Battery Power Anticipated)		N/A
Include Interchangeable Payload Adapter	Build in Payload Rail onto UAS platform	1. Validation of mounting pattern to payload adapter mounting pattern 2. Validation of "mock-up" of payload during flight		- If allowable in budget, outsource payload adapter rails to outside manufacturer for higher precision of hole pattern to guarantee usability. - Asylon has existing relationships with outside CNC vendors and manufacturers
Include Flight Termination System	Design and build an independently operated switch via a secondary companion computer with wireless communication	1. Validate "Kill Switch" during tethered ground test to verify independent system and fail-safe operation 2. Validate "Kill Switch" during low altitude, manual flight		- Include a COTS parachute to prevent substantial damage during the validation process
Energy Source Must be Safely Integrated	Utilize Asylon Battery Packs, which include a mechanical locking mechanism	1. During static test, load battery into UAS and load with weight to verify lock restrains battery up to the flight threshold		- Asylon integrated battery packs have a mechanical lock (no Velcro). 100+ hours of flights with these packs to date.
Fit within 6x4x3 container	During design phase, an initial envelope volume	1. A mock-up of the required volume will be built in house and the drone will be		N/A

	will be created in CAD to constrain the design environment.	placed inside, fully assembled.		
Weigh under 55lbs (MTOW)	A detailed BOM and weight roll-up will be completed weekly to maintain design criteria.	Pass/Fail		The baseline UAS platform will be weighed prior to design of NIST challenge UAS. This will provide an accurate airframe weight roll-up to be used in the design process
Continuous radio Comms	Utilize COTS telemetry/video radios to establish communication and frequency requirements	1. Ground test of telemetry radios with operator's computer 2. Ground test of range of telemetry radios with operator's computer to verify it meets range requirements of the competition space 3. Validation during flight of telemetry radio with computer and verify range requirements with a "mock-up" outdoors of the competition space.		Asylon had experience with multiple COTS telemetry and video radios that satisfy the requirements of the competition
BOM must be < $20,000	Utilize COTS components where possible, with limited custom machinings/parts to reduce cost	Pass/Fail		1. Weekly roll-up of BOM throughout competition 2. Utilize BOM of baseline UAS platform (detailed below)
FAA Part 107 Certified Operator	Use FAA Part 107 Certified Operator	Pass/Fail		Asylon employs two (2) FAA Part 107 Certified Drone Pilots

Competitive Advantage

The end goal of the Payload challenge is to provide an innovative UAS solution that will keep the UAS airborne as much as possible to support first responders' communication technology on the ground. Asylon's approach to the challenge, by leveraging their existing technology which automates the back-end processes associated with power, payload, and data, will not only lead to a UAS platform that can meet the payload and flight time requirements of the first responders, but also lead to a UAS platform capable of 24/7 flights and remote operations by leveraging the capabilities of the DroneHome system.

Key Members

The cofounders of Asylon have held a variety of roles in the aerospace industry including foreman of jet engine assembly lines at GE, ISR and UAV programs at Boeing Defense Systems, and missile defense simulation and control at the Applied Physics Lab at John Hopkins. Combined they have over 25 years of relevant experience related specifically to the UAS industry. The cofounders have built over 15 drone platforms in the past eight years, including several custom designed platforms. The team's background in the aerospace industry gives them a strong understanding of the quality and safety standards required by commercial, federal, and military customers.

In this challenge, Asylon will also be leveraging the experience and knowledge of Intelligent Drone Systems (IDS), an advanced systems company specializing in the designing and deployment of Security Robotics and AI powered situational awareness sensors. The IDS team is comprised of SME's with over 40 years of experience with specific focus on unmanned systems as it pertains to military, law enforcement/public safety and enterprise physical security use cases. Recent accolades include:

- Participation in FAA's project pathfinder testing at Denver International Airport;
- Selection as the only service deployment team for team FL as part of the new DOT initiative *Integration Pilot Program* to test new and innovative technology outside of the scope of the current regulatory frame work.

IDS's knowledge of drone operations and deployment, in combination with Asylon's experience mentioned above in UAS design and robotics, will help to guarantee that the end product of the challenge will both meet the technical requirements set forth and represent the usability needs of the first responders in the operational environment.

The founding teams resumes and LinkedIn profiles can be found below.

Asylon:
Damon Henry – CEO – https://www.linkedin.com/in/damonchenry/

Adam Mohamed – CTO – https://www.linkedin.com/in/adamohamed/

Brent McLaughlin – COO – https://www.linkedin.com/in/brent-mclaughlin/

IDS:

Michael Quiroga – CEO - https://www.linkedin.com/in/michael-quiroga-b2675112/

Resumes: https://drive.google.com/open?id=1PLHJPBpAlTUcCDsmzoeIJ-JFMGzobXW1