Defend the Republic - DRAFT
Spring 2022 Date TBD

Host Facility: Indiana University

POC for Participation: Samantha Lawrence, NSWC Crane, Samantha.lawrence@navy.mil

Event Sponsor: Dr. Michael Qin, Office of Naval Research, Code 34

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1. Introduction

The Defend the Republic test event serves as a force-on-force event whereas two teams of mostly autonomous lighter than air (LTA) vehicles attempt to capture and score within each other's set of goals. This event seeks to focus the researchers in supporting multi-agent swarming, communication, and payload designs. LTA vehicles stay afloat for longer periods of time, making swarming algorithm and sensor research easier and safer to test. The use of helium forces participants to optimize to only the most basic sensor and control systems required to complete their goal.

2. Participation

The following list includes slated participants for the Spring 2022 competition. There is no entry fee; however, teams will need to find alternative funding for supplies, time, and travel. If interested in participating, please reach out to Samantha Lawrence (Samantha.Lawrence@navy.mil). It is also encouraged for prospective teams to reach out to existing teams to learn about the competition, the technologies they have tried thus far, and have discussions on the best paths forward.

- George Mason University (GMU): Cameron Nowzari, (cnowzari@gmu.edu)
- University of California Los Angeles (UCLA): Ankur Mehta (mehtank@ucla.edu)
- Pennsylvania State University Applied Research Lab (PSU/ARL): Mike Yukish (may106@arl.psu.edu), Mike Zugger (mez115@arl.psu.edu)
- Navy Research Lab (NRL): Dan Lofaro (daniel.lofaro@nrl.navy.mil)
- University of Florida (UFl): Matt Hale (matthewhale@ufl.edu)
- Baylor University: Scott Koziol (Scott_Koziol@baylor.edu)
- Indiana University (IU): Martin Swany (swany@indiana.edu), Adam Baker (barkerap@iu.edu)

Non-confirmed participants

- Virginia Tech: Ehren Hill (ehren@vt.edu), Tom Krauss (mailto:tkrauss@vt.edu)
- University of Ohio, Miami: Dave Hartup (hartupd@miamioh.edu), Colleen Bush (bushc4@miamioh.edu)

3. Visitors

Visitors interested in funding teams, fielding teams, or simply curious are welcome. All visitors must reach out to Samantha Lawrence (Samantha.Lawrence@navy.mil). Visitors who fail to pre-register may be turned away at the door. Visitors are also subject to dress code requirements.

4. Dress code

All participants and visitors on the floor are encouraged to wear only the colors white, gray, khaki, or black. The wearing of red, blue, yellow, orange, or green will NOT be permitted due to the autonomous nature and sensing of the LTA vehicles.

5. Game Play Regulations

5.1. Game balls

5.1.1. Five or more game balls will be in the playing field at any given time.

5.1.2. Game balls consist of the following:
https://www.amazon.com/dp/B07X242MTL

- They will be weighted to approximately neutrally buoyant. Note: They will not be perfect, thus adding to the challenge. If they fall back down, we will adjust their weight and knock them upwards. If they get stuck on the ceiling, we will put another balloon in the air.

5.2. Goals

5.2.1. Each team will defend their Life, Liberty, & Property, or three hoops mounted from the ceiling in each end zone.

5.2.2. Hoops will consist of one circle, square, and triangle in each end zone. These will be made with ½" plywood and coated with retro-reflective tape. One end of goals will be orange. The other end will be yellow. The tapes used will be as follows:
https://www.walmart.com/ip/Oralite-Reflexite-V98-Microprismatic-Conspicuity-Tape-2-in-x-15-ft-Fluorescent-Orange/101885580
https://www.amazon.com/Oralite-Microprismatic-Retroreflective-Conspicuity-Tape/dp/B0041PCG2A

5.2.2.1. Goal tags – None (photos of them are from previous events).

5.2.2.2. Circle - Cut out of plywood, 36.5" inside diameter, 4" wide frame.

5.2.2.3. Square – Cut out of plywood, 38" inside diameter, 4" wide frame.

5.2.2.4. Equilateral Triangle – Cut out of plywood, positioned point down, inside leg length 55", 4" wide frame.

5.3. Scoring

5.3.1. A goal is made via pushing a game ball through any opponent goal in either direction (1 point awarded for each goal scored).

5.3.2. Teams may not push a green ball through one of their goals (Own goal = -1 point).

5.3.3. Once scored, the LTA vehicle shall come down for the game ball removal / release, and can return to game play from the center of the field. Alternatively, the LTA vehicle may release the game ball and travel to the middle of the field to 'reset' prior to continuing game play.

5.4. Team Vehicles / Fielded Equipment

5.4.1. For all vehicles, negative buoyancy may not exceed 100 grams.

5.4.2. A LTA vehicle may not be considered within game play if it is tethered, resting on the ground, or resting on the ceiling.

5.4.3. Each team must have a red fleet and blue fleet (or a way to swap colors).

5.4.4. Each vehicle must be at least 70% red or blue. The opponent's color must not appear on the balloon.

5.4.5. Sensory tools / equipment may be placed on walls or hoops by the blimps at the start of game play.

5.4.6. Any placed equipment shall be removed between games by the team that placed them. Any equipment placed on goals must be removed at the end of each half.

5.4.7. No active adhesives are permitted for game play.

5.4.8. No purposefully destructive attack methods are permitted. Bumping into one another is not considered destructive. If a LTA vehicle is 'propped,' the team which lost an asset is permitted to select two assets of the other team's to hold until the end of the game.

5.4.9. No one LTA vehicle can contain more than 50 cubic feet of helium.

5.4.10. There are no shape restrictions.

5.4.11. All effects leaving one's tent (RF, light, sound, etc.) may only interact with one's own LTA vehicle. Signals meant to inhibit the other team's LTA vehicles may not originate from a source other than an item mounted on a LTA vehicle or one placed by a LTA vehicle during that game.

5.4.12. Due to the infancy stage of the autonomy, no signals meant to disrupt the opponent's LTA vehicles may be used during the 30 second periods where direct interaction is permitted.

5.5. Helium Supply

5.5.1. Each team will be provided quantity 2 tanks of 220 cubic feet of industry quality helium. Please note, this is different than helium one would obtain from a party store.

5.5.2. The provided helium is determined to be for 200 cubic feet of helium per each fleet with a 10% buffer for mistakes, leaks, popped balloons, etc. throughout the week.

5.5.3. There will be a minimum of 2 helium tanks on standby in case it is needed due to a catastrophic accident (e.g. a team leaves their regulator open and they lose all their helium). In this case, the team will receive a new tank to continue playing.

5.6. Qualification

5.6.1. All teams must complete a qualification round prior to being permitted to play. The qualification round requires that each team score a goal in unopposed game play in a maximum of a 30 minute period.

5.6.2. If a team fails to qualify on day 1, they may try again in the morning of day 2, etc. until the end of the week.
5.6.3. Once a team qualifies, they will be permitted to play their scheduled games for that day and the rest of the week.

5.7. Game Start

5.7.1. Coin toss for sides.
5.7.2. Team members can toss their LTA vehicles once the referee confirms start of game play and starts the clock.
5.7.3. LTA vehicles must be launched from the center of the field. The operators may select others to launch the LTA vehicles for them.

5.8. Operation

5.8.1. Game play will consist of two 30 minute halves with a 20 minute half-time.
5.8.2. Each team may have only 1 operator.
5.8.3. During game play, the operator will only be permitted to directly control their fleet during the first 30 second interval within every 5 minute increment.
5.8.4. The 30 second 'hands on' period will occur at the same time for both teams.
5.8.5. Operators may have visual line of sight of their assets during game play.
5.8.6. Each team may have one 'runner' who may use a referee balloon to retrieve stuck or dead LTA vehicles.
5.8.7. If a LTA vehicle must be retrieved by a runner, it may be returned to the team for repairs and returned to the game the next 'hands on' period. Upon return, it must be launched from the center of the field.
5.8.8. Batteries may be swapped, but this will be restricted in future events.
5.8.9. There are no offside calls.
5.8.10. The official will announce manual & autonomous time periods.

5.9. Overtime

5.9.1. If both teams are tied at the end of the last 30 minute half, the game will continue into sudden death overtime.

5.10. Referee Balloon

5.10.1. The referee shall provide two referee balloon assemblies (large balloon on a string) for teams to pull lost balloons off the ceiling.
5.10.2. Equipment not retrievable (due to pit locations, etc) will be retrieved once it comes down due to loss of helium. This may take a week or more. IU personnel will dispose of it at that point or if desired, a team can prepay for a shipping label and have the equipment shipped back to them.

5.11. Championship Round

5.11.1. Teams will be ranked by most games won. Tie-breaker is head to head competition. Second tie-breaker is goal differential.

5.11.2. Top two teams will compete Friday morning.

6. Location

Indiana University MESH
(Defined on Google Maps as “Center for Exploration of Energy and Matter (CEEM))
2401 N Milo B Sampson Ln,
Bloomington, IN 47408

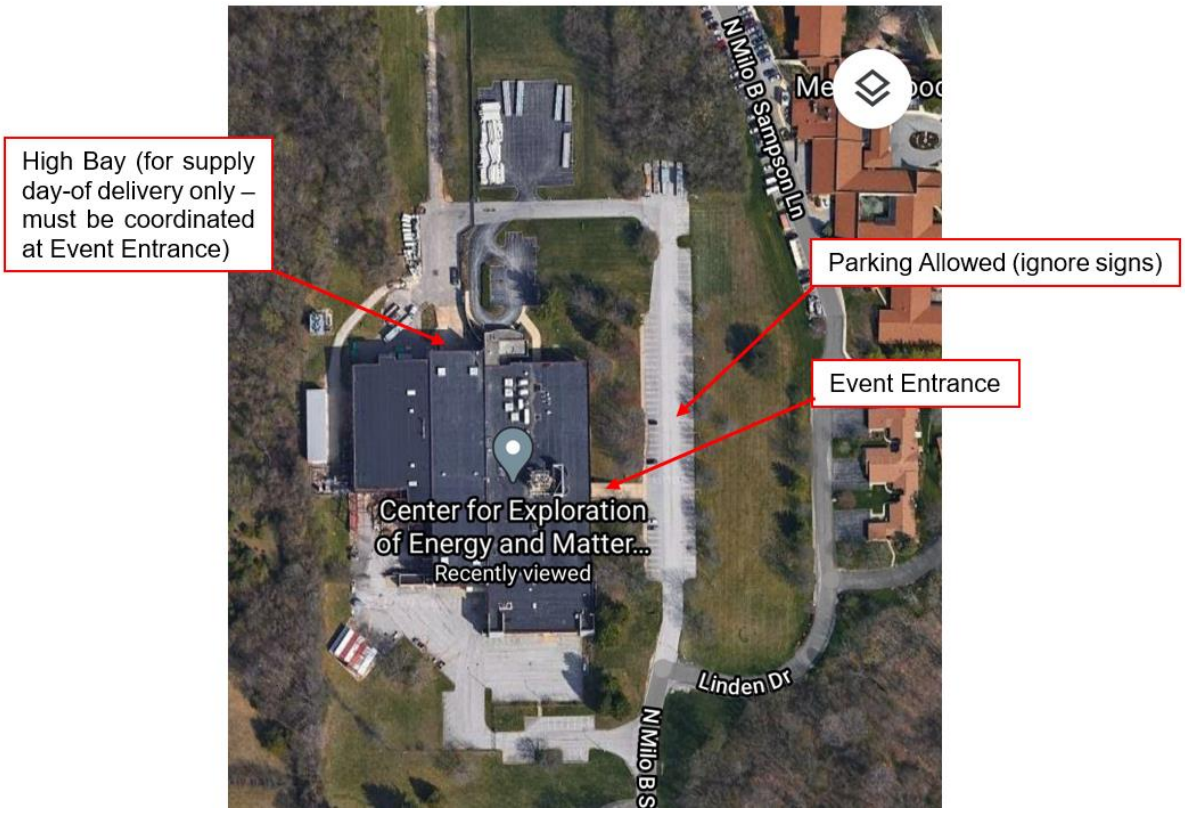

Figure 1: Google Maps view of IU MESH. Parking, event entrance, & supply drop-off areas identified.

7. IU MESH High Bay - Field Set-Up

There is airflow at various points that will affect flight, which are roughly defined in Figure 2 by the blue arrows. Draft direction, strength, and overall flow varies throughout the day and week based upon temperature and humidity differentials from the facility to outside. Team work stations will be along the walls of the high bay area. The large door in the far, north side of the photo should be used to bring in all supplies and tools once coordinated with the personnel at the Event Entrance, identified in Figure 1. Figure 3 provides a top view of the MESH facility with approximate goal locations. Notice, the goals are not mounted in line with each other. Figure 3 provides a top view of the MESH facility with approximate goal locations. Notice, the goals are not mounted in line with each other.

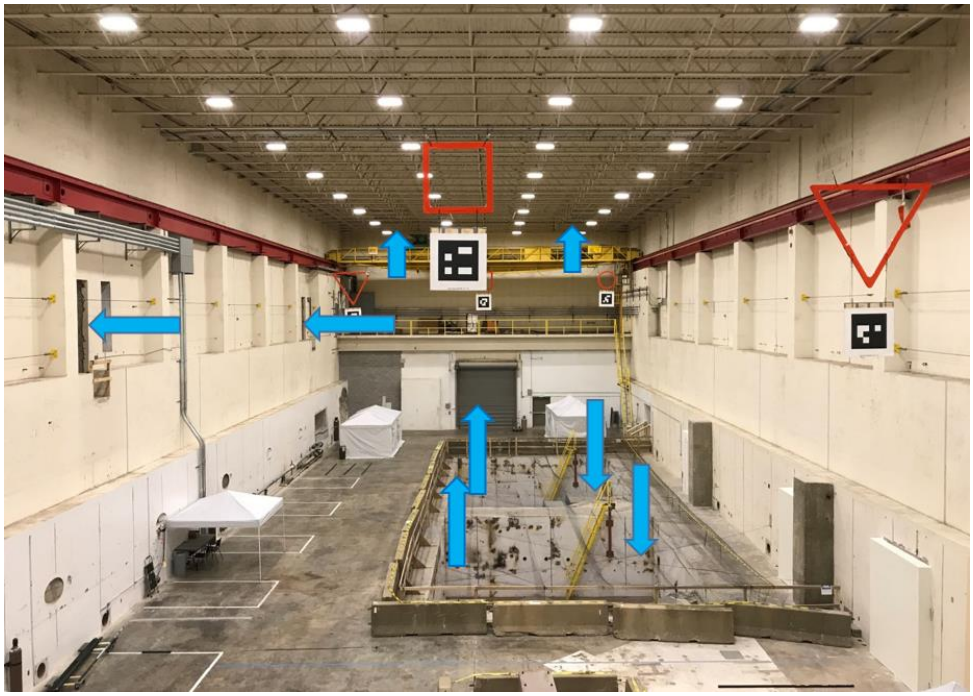

Figure 2: Playing field with draft directions roughly defined. (Note, goals have changed)

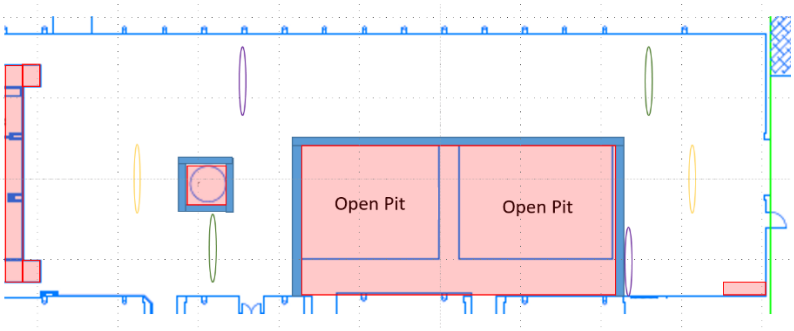

Figure 3: MESH top view with approximate goal locations

Figure 4 shows the goal set-up from the November 2021 competition. The relative location of the goals will remain the same, including the colors. The orange goals are located on the north side of the building. The yellow goals are located on the south side of the building. The April Tags will NOT be mounted on the goals.

Figure 4: Nov 2021 Goal Set-Up (Note: No goal tags no longer used.)

8. Supplies

8.1. Shipping Items

Shipped items are recommended to have a planned arrival date by the Thursday prior to the start of the event to ensure readiness. All items shipped shall have a tracking number; once a tracking number is received, please provide it to Scott (sdhein@indiana.edu) and Samantha (Samantha.lawrence@navy.mil) via e-mail. A short description of what was shipped (box x size or black pelican case, etc.) is appreciated. Items shipped early will be stored in the high bay of the MESH until the event. Ship material directly to Scott Hein using the following address:

LTA
Attention – Scott Hein
2401 N. Milo B. Sampson Ln
Bloomington, IN 47408

8.2. Router

Teams are responsible to bring their own router if they require LAN for any operations or communicating with their LTAs.

8.3. Tools

Some tools are available on-site, but it is recommended teams bring their own tools. If specific needs are expected, please reach out to the event coordinator to see if they will be available on-site.

9. Facility Safety Rules

9.1. Only authorized personnel from IU will have access to the upper / lower levels of the high bay.

9.2. IU building/Facilities personnel will attempt to retrieve any items that get stuck as soon as possible and return the respective owner. Participants should ensure that they have adequate spare parts as the recovery effort may not be completed until the conclusion of the activities.

9.3. Personnel shall not sit on the concrete barriers.

9.4. Personnel shall not use the ship's ladders located in the high bay.

9.5. Personnel shall follow all posted signage for restricted areas.

9.6. Helium gas cylinders will be secured to walls or other suitable object when in use.

9.7. Helium gas cylinders will be secured in a limited access exterior compressed gas storage area when not in use.

9.8. Each team will be provided a 10x10 canopy/tent over the team work area in the completion arena to mitigate hazards from airborne hazards.