



Rules and Task Descriptions

Version 1.3, Updated June 15, 2018

Reed Canal Park

Daytona Beach, Florida, USA

June 18 – 24, 2018

www.roboboat.org

RoboBoat 2018 Rules and Task Descriptions

2018 RoboBoat

www.roboboat.org

1 Deadlines and Due Dates

Each team is required to submit all the competition items listed below. Please refer to the team submission instructions on the Team Central page of roboboat.org for more details.

Due Date	Description
February 5, 2018	Early Bird Registration Closes and Early Bird payment due.
April 20, 2018	Registration Closes. Final Registration payment due. *
May 14, 2018	Team Roster with T-shirt size, waiver and release of liability forms, team bio, logo, website, Facebook and Twitter due.
June 4, 2018	Team introductory Videos, Journal Papers and Battery Safety Plan due.
June 11, 2018	Individual student résumés due.
June 18-24, 2018	International RoboBoat Competition

**If payment is not submitted by this day, your team may not be eligible to participate in the competition.*

2 Competition Points of Contact

Please direct your comments and questions to the [RoboBoat Forum](#). Teams are encouraged to participate in the community.

- Technical Director – Felix Pageau: pageau@robonation.org
- Competition Questions: competitions@robonation.org
(questions related to registration, travel, hotel or team deliverables)

3 Competition Venue Overview

The competition is held at the Reed Canal Park's pond; located at 919 Reed Canal Rd, South Daytona, FL 32119. The cruciform-shaped pond measures roughly 700ft by 550ft and water depth ranges from 5ft to 30ft. The pond is generally free from obstacles (seaweed, lily pads, trees, etc.), however, three floating water fountains are located near the center of the pond. The fountains should be treated as a natural obstacle and be avoided at all costs. See satellite image for more details: goo.gl/maps/p28kwaZjtKw.

During the competition, each team is provided with one covered 10ft by 10ft workspace. Electricity (one 15A 110VAC circuit) and Internet (one Ethernet wired connection) are available in the workspace. Although the covered workspace is weather resistant, teams are strongly discouraged from leaving humidity-sensitive electronics or other equipment in their workspace overnight. Additional information about the facilities can be found on the official competition website: roboboat.org.

4 Overall Competition Schedule

The RoboBoat competition is held, rain or shine. The competition's schedule is subject to changes due to inclement weather and safety considerations.

Competition schedule overview:

- June 18: Team arrivals and lodging check-in
- June 19 1000-1100: Orientation meeting at Embry-Riddle Aeronautical University
- June 19 1200-1800: In-water practice time
- June 19 1800-1830: Daily team meeting in TD tent
- June 20 0800-1800: In-water practice time
- June 20 1800-1830: Daily team meeting in TD tent
- June 21 0800-1800: In-water practice time
- June 21 1800-1830: Daily team meeting in TD tent
- June 22 0800-1800: Static judging in the outdoor pavilion at Reed Canal Park
- June 22 0800-1800: In-water practice time
- June 22 1800-1830: Static judging results and qualification time slots selection
- June 23 0800-1800: Qualifications
- June 24 0800-1200: Qualifications overflow/Last Chance Qualifications
- June 24 1200-1230: Qualification results and finals time slots selection
- June 24 1300-1700: Finals
- June 24 1900-2200: Award Ceremony

5 Participation and Eligibility Requirements

There is no requirement for teams to be associated with a school or university to enter the competition, however, 75% of their members must be full time students. Though a minimum number of on-site team members is not prescribed, please consider that at least 3 members are needed for RoboBoat operations. Faculty, industrial and governmental partners may be used.

Only one vehicle per team can be entered in the competition. Each team must designate a student team member as their *team leader*. The team leader is the only person allowed to speak for the team to request vehicle deployment, run start, run end, or vehicle retrieval. The team leader must be conversationally fluent in English to communicate with RoboBoat staff. Teams who don't have members who are fluent in English should contact AUVSI Foundation as soon as possible to plan alternative communication accommodations.

6 Registration Information

6.1 Fees

To participate on-site at the competition, all teams must register via the [official competition website](#) and submit the registration fee. Please ensure that your registration fee is paid by April 20.

7 Significant Changes versus 2017 Rules

RoboBoat is initiating the concept of an introductory competition course. This course is designed to give new teams, or returning teams with new members, an opportunity for basic training in maritime autonomy. Tasks for introductory course are derivations of those in the advanced course and as such autonomy development in the introductory course can be applied to the advanced course.

A separate document on RoboBoat Unmanned Aerial Vehicle (UAV) guidelines is published along with these Final Rules. Teams must read and comply with these guidelines, in addition to all FAA regulations in order to fly a UAV at RoboBoat 2018.

8 Land-Based Team Tasks

In addition to the in-water competition tasks, each team must document their efforts leading up to the competition by writing a paper, building a website, authoring a video, and preparing a presentation. All elements of the competition will be conducted in English.

8.1 Technical Design Report

Each team is required to submit a Technical Design Report (TDR) that describes the design of their vehicle, as well as strategies for their approach to the tasks. TDR should also include the rationale for their design choices. Specific requirements for the journal paper are listed below:

- All technical design reports must use the Technical Design Report available in the Team Central page of roboboat.org and your Team Dropbox.
- 5-page limit (excluding References and Appendices)
- 10-page limit (including References and Appendices)
- Technical Design Reports longer than 10 pages may be subject to penalty.

8.2 Website

Teams must maintain a website documenting their efforts and progress, leading up to the competition. The exact layout and contents of the website are left for the teams to develop; however, the website should include at a minimum the following information:

- Team information (name and team contact information).
- Team member information (name, picture, contact information).
- Media (pictures, video, etc.) taken during development and testing.
- List of sponsors with logo.
- Teams are encouraged to also build an archive of previous vehicle's designs and journal papers on their website. *

**New teams entering RoboBoat, and hobbyists frequently visit team websites for historical and reference information.*

8.3 Team Introduction Video

Each team must submit an introductory video. Please follow the official instructions available in your Team Dropbox.

8.4 Design Presentation

Static Judging is an opportunity for the judges to inspect the vehicle and allow time for them to interview the team members with questions about both the presentation and the vehicle. The presentation should introduce the team, their vehicle, and special features and/or strategies for the competition. Presentations will be conducted at the competition venue. We discourage slide-based (ex: PowerPoint) presentations as outdoor audio-visual equipment will be limited.

Planned Presentation Breakdown:

- 20-minute oral presentation with visual aids (for example: a poster board).
- 5-minute question and answer session.
- 5-minute judges' inspection of the vehicle.

After the design presentation, teams should make themselves available for a team photo, and optional video interview for archival purposes. This video interview will not be judged.

8.5 How to Submit Land-Based Task Materials

Once your team is officially registered for the competition, the team leader will receive an invitation to an individual Dropbox Folder that will be used for the team's submissions. Only the Team Leader and RoboNation staff will have access to this Folder. Each Team Leader is responsible for meeting all deadlines listed in [Section 1](#), Deadlines and Due Dates. Detailed instructions on how to submit your items are included in your Dropbox Folder. These instructions are also posted on roboboat.org.

9 Public Display

The Daytona Beach and Volusia County community is proud to host the 2018 RoboBoat Competition and plans to organize a number of public events during the competition. These events will include organizations interested in STEM (Science, Technology, Engineering, and Mathematics), autonomous systems, and public education. Media are likely to be present. These events will showcase your team and your vehicle; you may wish to have material prepared for public display. RoboBoat judges and industry partners will be on the lookout for specific examples of outstanding public displays amongst the teams entering the competition.

Schools/colleges typically have resources both at the department level and in their recruitment/alumni offices. Material bearing the color/logo of your school (ex: flag, tablecloth, etc.), printed copies of relevant white papers and even recruiting information might be of interest to the public.

10 Competition Rules

The following is a list of minimal requirements for a vehicle to be permitted access to a course. In past competitions, accommodations have been made for non-compliant vehicles. Teams are cautioned that will not be the case in 2018. **Teams that arrive at the competition failing to meet these requirements will not be permitted on the course until they modify their vehicle to meet all the requirements.**

10.1 Vehicle Requirements

- **Autonomy:** Vehicle shall be fully autonomous and shall have all autonomy decisions made onboard the ASV.
- **Buoyancy:** The vehicle shall be positively buoyant and remain buoyant for at least 30 minutes.
- **Communication:** The vehicle cannot send or receive any control information while in autonomous mode. Communication is allowed between the vehicle and subsystems (Unmanned Aerial Vehicle – UAV).
- **Deployable:** The vehicle must have its own 3 or 4-point harness for crane deployment.
- **Energy source:** The vehicle must use only self-contained electrical energy sources. Sailboats are permitted.
- **Kill Switch:** The vehicle must have at least one 1.5-inch diameter red button located on the vehicle that, when actuated, must instantaneously disconnect power from all motors and actuators.
- **e-Kill Switch:** In addition to the physical kill-switch, the vehicle must have at least one remote kill switch that provides the same functionality as mentioned above.
- **Propulsion:** Any propulsion system may be used (thruster, paddle, etc.). All moving parts must have a shroud.
- **Remote-controllable:** The vehicle must be remote-controllable (tele-operated) to be brought back to the dock.
- **Safety:** All sharp, pointy, moving or sensitive parts must be covered and marked.

- **Size:** The vehicle must fit within six feet, by three feet, by three feet "box".
- **Surface:** The vehicle must float or use ground effect of the water. Mostly submerged/flying vehicles are forbidden.
- **Towable:** The vehicle must have a tow harness installed at all times.
- **Weight:** The entire maritime system (including UAV) must be 140 lbs. or less.
- **Payload:** The vehicle must have a place to mount a GoPro (or similar) camera with an unobstructed view from the front of the vehicle.

10.2 Interference

- Interference will result in a run termination.
- Any vehicle entangled in, dragging, pushing or damaging competition elements or the landscape is interfering.
- Any vehicle leaving its assigned course is interfering.

10.3 Judge's Decisions

- Judge's decisions are final.

11 Water-Based Team Tasks

The Reed Canal Park's pond is divided into four courses. Course Alpha, Bravo and Charlie are similarly arranged advanced competition courses. Course Delta is designated the introductory course. An area for testing and practice is located south of course Charlie.

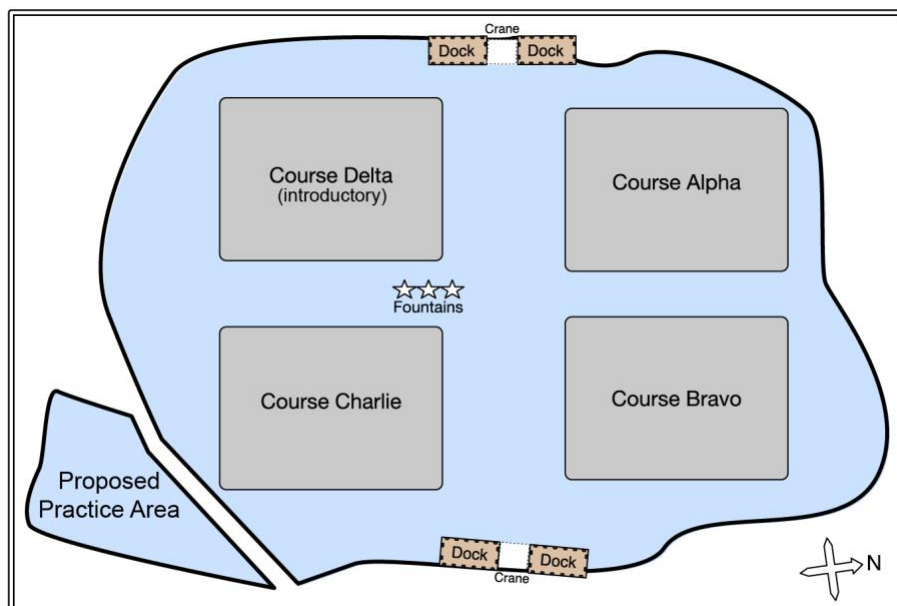


Figure 1: Reed Canal Park Pond Layout

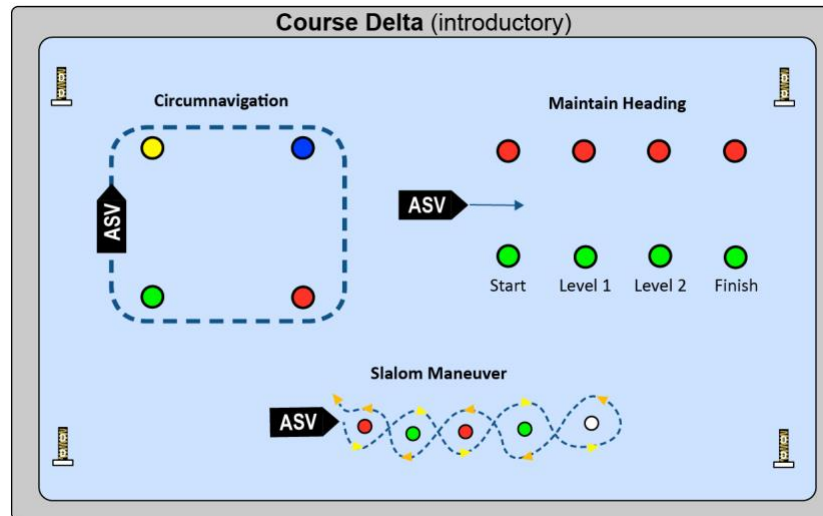


Figure 2: Introductory Course Layout

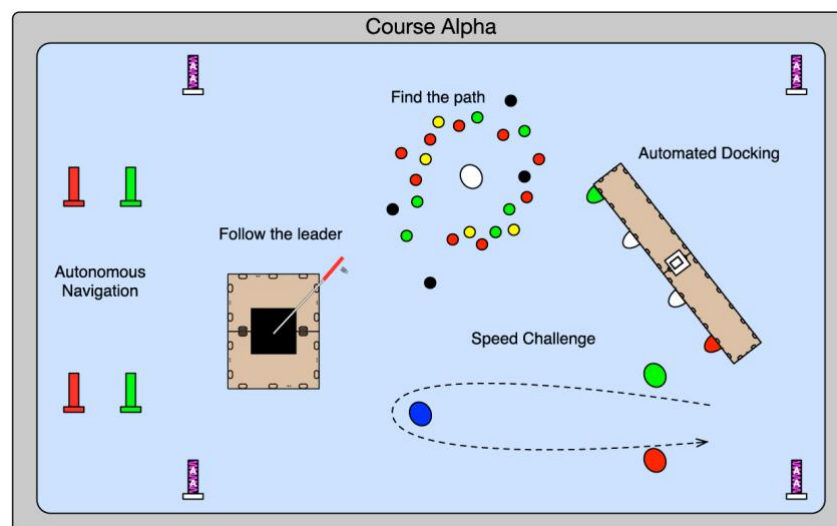


Figure 3: Sample Advanced Course Layout

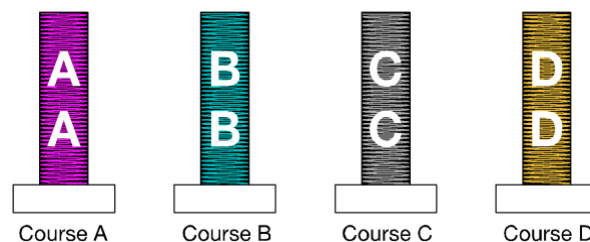


Figure 4: Course Markers

Teams must comply with the requirements set forth in the sections entitled: [Network for communication with the vehicle](#), [Starting/Ending a run](#) and [Heartbeat](#). These requirements are listed below in [Section 14](#), Miscellaneous.

11.1 Weight and Thrust Measurements

Vehicles are weighed during crane deployments (see [Appendix 2: Vehicle deployment](#) for details). The weight used is the stable scale reading. Thrust is measured after the vehicle is deployed in the water either in manual or autonomous mode. The thrust value used is the highest scale reading that is stable for at least two seconds. Vehicles are weighed each time they are deployed. Teams may opt to repeat their thrust measurement at each deployment.

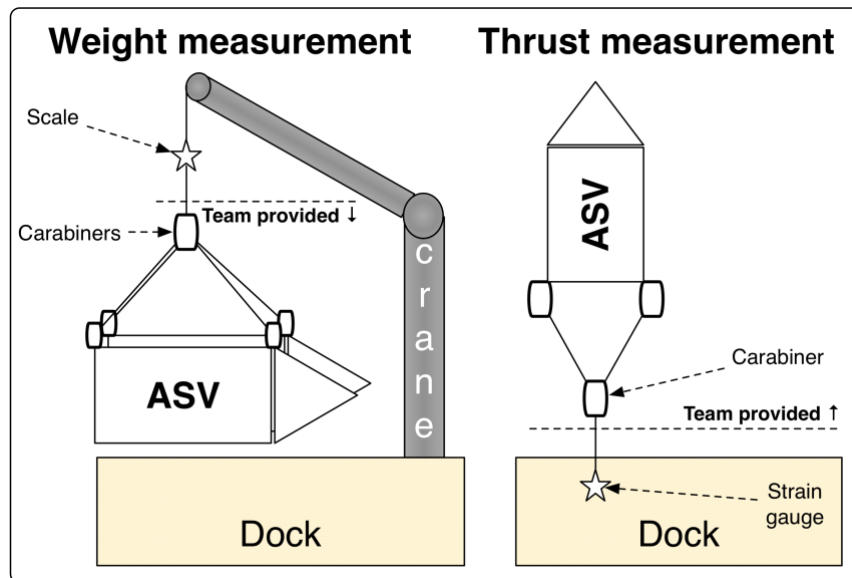


Figure 5: Weight and thrust measurement setup

Task scoresheet:

- **[-399, 149] points:** See for weight entries in scoresheet in [Appendix 3](#).
- **[0, ∞) points:** See for thrust entry in scoresheet in [Appendix 3](#).

Note: all weight and thrust values will be entered as whole numbers.

Ex: A vehicle that weighs 72 lbs. and generates 5 lbs. of thrust gets 83 points. The point breakdown is: 76 (weight score) + 7 (thrust score) from formula in [Appendix 3](#).

12 Introductory Course Tasks

This course is designed to allow new teams, or returning teams with new members, the opportunity to learn about fundamentals of autonomous maritime navigation. Hands-on learning will be encouraged through introduction of the following challenges.

12.1 Circumnavigation

Using their vehicle, teams must collect Global Positioning System (GPS) data at each of the buoys. This portion of the task may be accomplished by tele-operating the vehicle.

After collecting the GPS data points, teams must circumnavigate the buoys in a prescribed sequence. Teams will be notified of the sequence each day. Figure 6 depicts a subset of potential sequences. The buoy used are Polyform A-0 buoys. These sequences are subject to change and could be altered based on the level of task success. This aspect of the task must be accomplished autonomously.

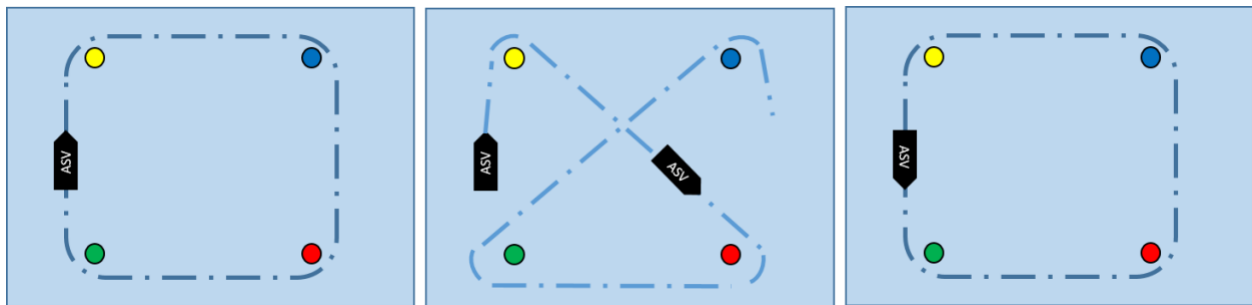


Figure 6: Potential configurations of Circumnavigation

12.2 Maintain Heading

Vehicle shall navigate through a set of buoys, from Start to Finish, using any set of autonomous behaviors to navigate through the gates (vision, path planning, obstacle detection and avoidance, heading hold or a combination of any of these).

Figure 7 is an illustration only and not indicative of the final layout. Buoy color, size and shape, and orientation is subject to change. The buoy used are Polyform A-0 buoys. Distance between a set of buoys could change (for example – wide to narrow, from start to finish).

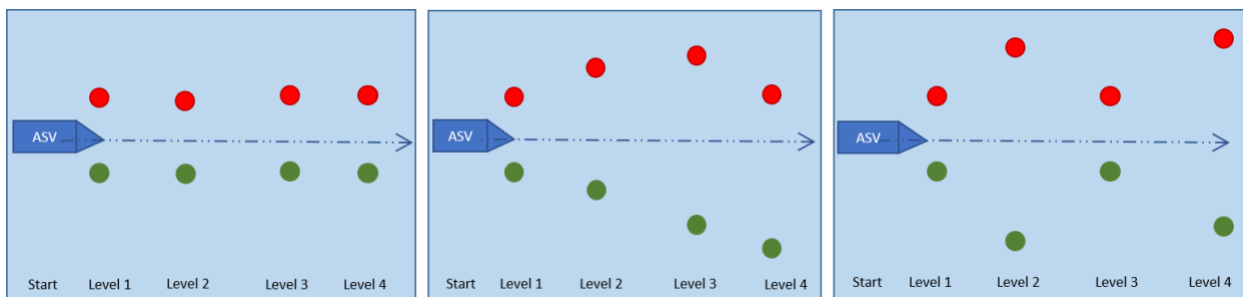


Figure 7: Potential configurations of Maintain Heading

12.3 Slalom Maneuver

Teams must use a combination of sensors and algorithms (vision, object detection and classification, and others) to navigate this challenge. The object of this task is to maneuver between the buoys while avoiding contact with any buoy.

The vehicle must traverse the course, circumnavigate the white can buoy, and return to the start point. Traversing the buoys must be accomplished such that ASV must remain to the Starboard (right) side of the red buoy, and to the Port (left) side of the green buoy.

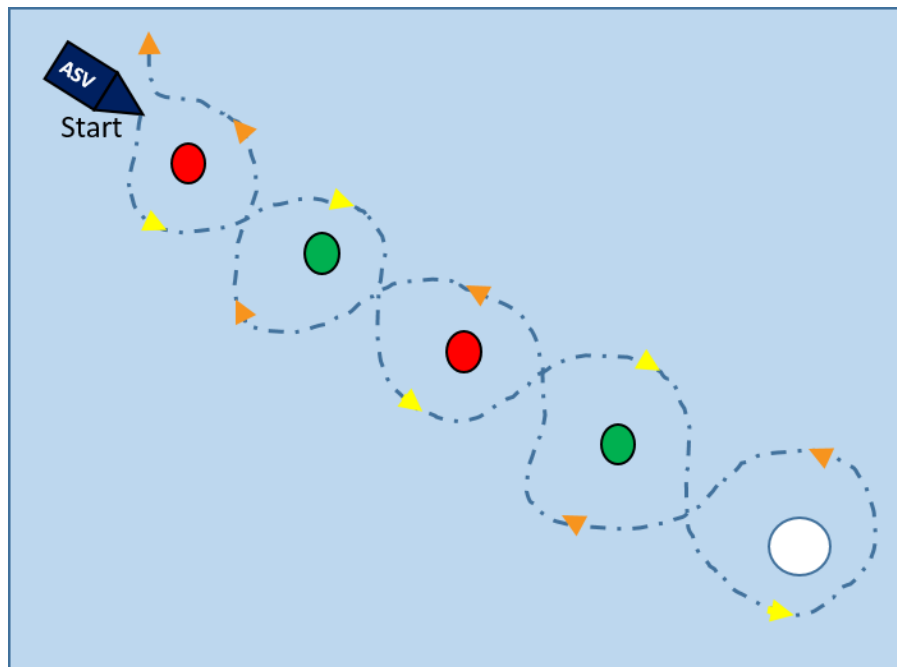


Figure 8: Slalom Maneuver

From the vehicle's perspective, this means it must always pass a red buoy to the vehicle's port side and must always pass a green buoy to the vehicle's starboard side. This is illustrated in Figure 8 above. The can buoy is a Taylor Sur-Mark Marker buoy #46104 while the colored buoys are Polyform A-0 green and red buoys.

13 Autonomous Navigation (mandatory)

The purpose of this mandatory task is to demonstrate basic autonomous control and sensing abilities. This mandatory task is required for all teams operating in the advanced courses.

This water-based task must be completed once per competition day or at the start of new competition phase (ex: finals) before mission tasks are attempted. If the vehicle carries a UAV it must be present during the mandatory water-based tasks but cannot be launched during this task.

The vehicle passes through two sets of gates. Each gate is composed of a pair of red and green Taylor Sur-Mark Marker buoys #950400 & #950410 (49" in tall, 10-18" in diameter) that are moored 6-10 ft. apart. To be successful, the entire vehicle must pass through both sets of the gates in fully autonomous mode, without touching the buoys. The vehicle must start its autonomous navigation a minimum of 6 ft. before the first gate. Successfully passing through both gates is a requirement to attempt any mission task.

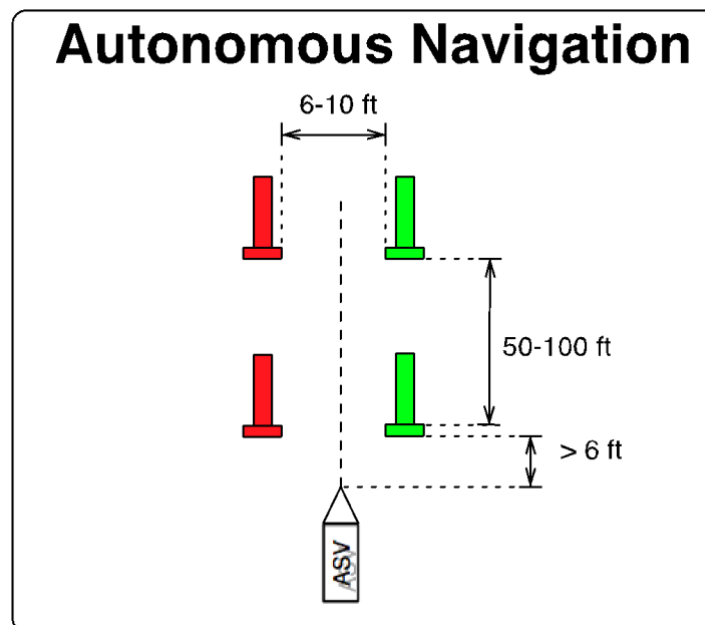


Figure 9: Navigation demonstration overview

Task scoresheet:

- **100 points:** Pass through both sets of gates

Ex: A vehicle that passes through the first set of gates but misses the second one shall not receive any points.

14 Mission Tasks

The purpose of the mission tasks is to demonstrate complex autonomy behavior of the maritime system in different scenarios. Mission tasks may be attempted in any order. A single GPS position, representing the center of the task's 'entrance' will be provided at the competition (in decimal degree format).

14.1 Speed Challenge

The purpose of this task is to demonstrate quality of the path planning and maneuverability of the vehicle.

The vehicle enters through the gate buoys, circles the Mark buoy (counterclockwise or clockwise), and exits through the same gate buoys, as quickly as possible. The vehicle must come to a full stop 3-6 ft from the gate buoys before attempting this challenge. The gate buoys are a set of red and green Polyform A-2 buoys moored 6-10 ft apart. The mark buoy is a blue Polyform A-2 buoy placed 100 to 250 feet from the gate buoys. The speed challenge timing is measured from the time the bow of the vehicle passes through the Gate buoys (entry) to the time the stern of the vehicle passed through the Gate buoys (exit).

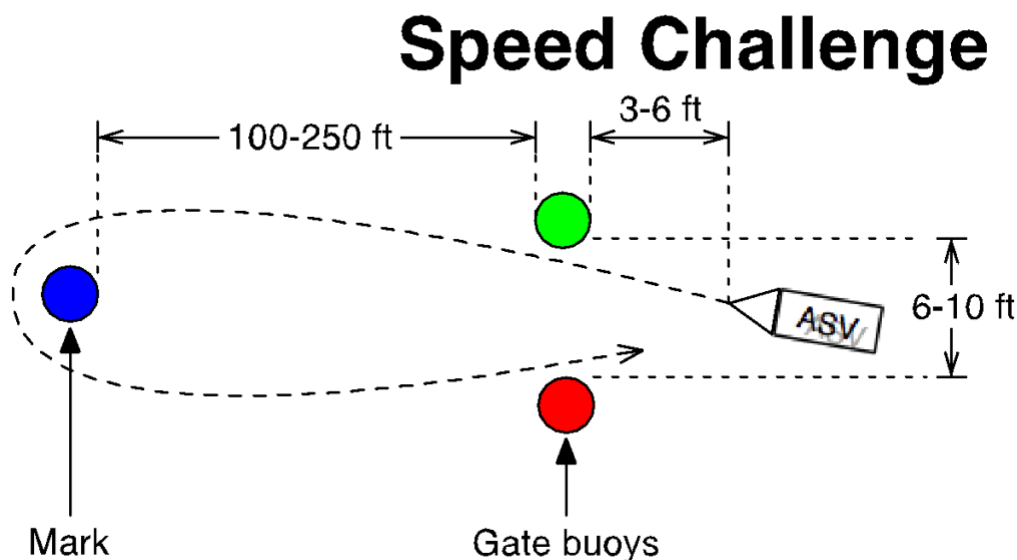


Figure 10: Speed Challenge

Task scoresheet:

- **50 points:** Vehicle enters through the gate buoys without touching them
- **100 points:** Vehicle circles the mark buoy without touching it
- **100 points:** Vehicle exits through the gate buoys without touching them after having circled the mark buoy
- **[0, 250 points]:** 250 points minus the number of seconds (rounded up) used to complete this challenge

- **250 points:** Fastest vehicle per course in a competition phase (qualifications or finals)
- **No timing points if the vehicle hits any buoy**
- **Straddling a buoy counts as a hit**

Ex: A vehicle that enters through the gate buoys, circles the mark buoy, and exits through the gate buoys in 45 seconds gets 455 points (assuming another team completed the challenge in 42s). The point breakdown is: 50 (enter) + 100 (circle) + 100 (exit) + 205 (timing).

14.2 Automated Docking

The purpose of this task is to demonstrate the ability to launch an aerial drone and use information from multiple sensor systems, including off-board sensor system, to make decisions and execute maneuvers based on that information.

The vehicle executes a sequence of docking maneuvers based on which pinger is active and the number displayed on a 7-segment module; located on top of the dock, and behind the middle sign. Each bay is fitted with an acoustic modem.

To execute the first docking maneuver, the vehicle identifies the location of the active pinger and enters the bay corresponding to the active signal. The vehicle then exits the bay and attempts to find the second bay for vehicle docking. To identify the second bay, the vehicle must first launch an unmanned aerial vehicle (UAV). Once airborne, the UAV will inspect the number displayed on a 7-segment display to determine the correct docking bay. The number indicated on the 7-segment display will be the second bay the vehicle (ASV) shall dock in.

The 7-segment display is built in such a way that it is not readable unless a vehicle is directly above it. The active pinger and the number shown on the 7-segment display change at the start of each run.

The aerial vehicle must capture an image of the 7-segment display and transmit the image as described in [Appendix 5: Automated Docking Communication Protocol](#). The specifications for acceptable UAV's are defined in [RoboBoat - Aerial Vehicle Specifications](#).

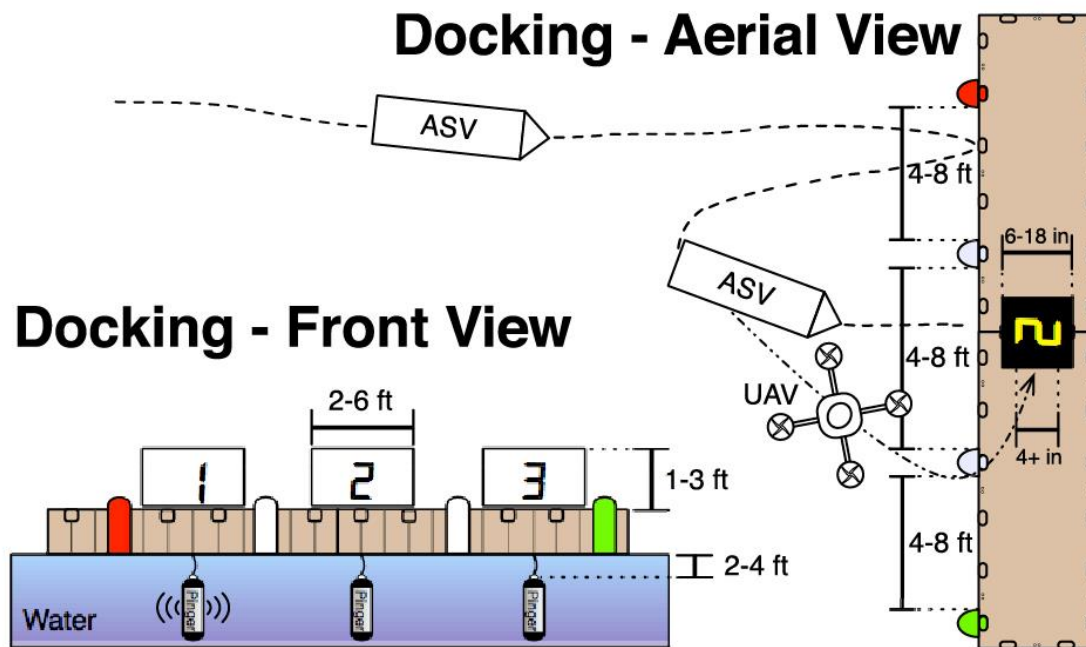


Figure 11: Automated Docking (illustration only)

Task scoresheet:

- **250 points:** Launch UAV from vehicle
- **250 points:** Enter the first bay with the active pinger
- **250 points:** Report image of the 7-segment display
- **250 points:** Enter the second bay as indicated by 7-segment display
- **250 points:** Vehicle recovers UAV in autonomous mode
- **750 points:** Perfect docking sequence (UAV launched & recovered, correct bays) *
- **No points are allocated for straddling two bays**
- **No points are allocated if the vehicle gets entangled in the bay**

* Points for perfect docking sequence are only allocated on the first attempt at the challenge during a run.

Ex: A vehicle launches a UAV, enters the bay #1 (correct), enters the bay #3 (incorrect) gets 500 points. The breakdown is: 250 (launch UAV) + 250 (entered bay with active pinger).

14.3 Find the Path

The purpose of this task is to demonstrate complex path planning in a crowded area.

The vehicle finds an opening in a field of obstacles to reach the can buoy in the middle. Upon reaching the can buoy, the vehicle circles it, and finds an opening (either a different one or the same) to exit the obstacle field. The can buoy is a Taylor Sur-Mark Marker buoy #46104 while the obstacles are Polyform A-0 green, red, yellow and black buoys. As illustrated in Figure 12, there is at least one point in the obstacle field where the two closest buoys are four to six feet apart.

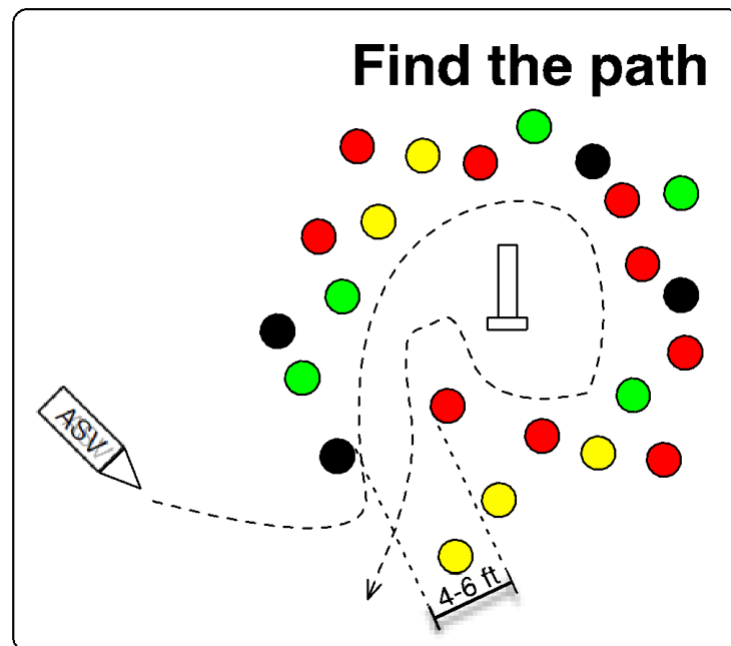


Figure 12: Find the path (illustration only)

Task scoresheet:

- **100 points:** Enter the obstacle course
- **200 points:** Circle the can buoy
- **100 points:** Exit the obstacle course
- **50 points:** Hit three or less obstacles
- **50 points:** Hit two or less obstacles
- **100 points:** Hit one or less obstacles
- **400 points:** Perfect Find the Path execution (enter, circle, exit, no obstacle hit)
- **Straddling a buoy counts as a hit**
- **No points are allocated if the vehicle straddles the can**
- **No points are allocated if the vehicle gets entangled with/stuck on a buoy**

Ex: A vehicle that hit one buoy while entering the obstacle field, circles the can buoy, and fails to exit gets 500 points. The breakdown is: 100 (enter) + 200 (circle) + 50 (3 or less) + 50 (2 or less) + 100 (1 or less).

14.4 Follow the Leader

The purpose of this task is to demonstrate dynamic target identification and precise navigation.

Upon reaching the task, the vehicle requests activation of the carousel, through the competition mission server. Once the carousel is activated, the vehicle must identify a flag, hanging from the moving carousel. Once the flag is located, the vehicle must follow the flag, while circumnavigating the floating platform. The vehicle should make a full 360° rotation around the platform, while maintain a relatively constant distance from the flag. The vehicle should not touch the flag or any part of the task element.

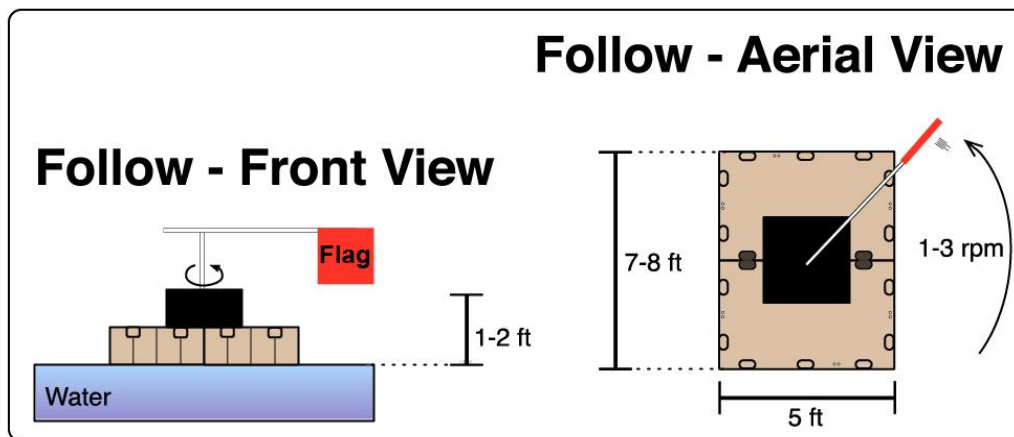


Figure 13: Follow the Leader

Task scoresheet:

- **50 points:** Request carousel start up
- **250 points:** Maneuver near carousel, behind the flag
- **400 points:** Follow flag one complete revolution
- **400 points:** Follow flag second complete revolution
- **400 points:** Follow flag third complete revolution
- **300 possible points (bonus):** Circumnavigate platform while tracking flag. **100 points** per rotation (total of three rotations)
- **500 points:** Perfect Follow the Flag

Ex: A vehicle requests carousel start up, identifies the flag and while actively tracking the flag, completes one revolution; for a total of 800 points. The breakdown is: 50 (communication) + 250 (maneuver behind the flag), 400 (one revolution) + 100 (bonus – active tracking of flag).

14.5 Return to Dock

The purpose of this task is to demonstrate the ability to navigate back to the launch point while avoiding interaction with any obstacles.

After having earned points on mission challenges, the vehicle returns to the dock in autonomous mode. The vehicle avoids all obstacles and challenge equipment (buoys, floating docks, etc.) on its way back. The vehicle then comes to a full stop within six feet of the dock from which the vehicle was launched.

If a vehicle crosses through a different course on its way back, the run will be immediately terminated (refer to 10.2 Interference).

Teams attempting all tasks and returning to dock, before end of their in-water time, will be awarded points for returning to the dock, as well as bonus points for their remaining in-water time. Teams returning to dock without attempting all tasks, will only be awarded points for returning to the dock.

Task scoresheet:

- **500 points:** Making it back to the dock autonomously.
- **T points:** One point per second left on the clock.
- **No points are allocated if the vehicle interacts with any competition elements on its return to the dock.**

Ex: A vehicle returns to the dock with two minutes and 25 seconds left in the time slot gets 645 points. The breakdown is: 500 (dock) + 145 (time left).

15 Miscellaneous

15.1 Network for Communication with the Vehicle

(Please pay particular attention to this section)

Each team shall roll out their own 'network' solution for communication with their vehicle. There is no restriction on the actual communication mechanism (e.g., underwater modems, cellphone, 802.11xx wireless, etc.). Each team must provide a base station that can bridge the communication between their vehicle and a wired RJ-45/cat5 Ethernet network. If you opt for a wireless technology, you must use a public frequency or acquire a license from the FCC.

Side View

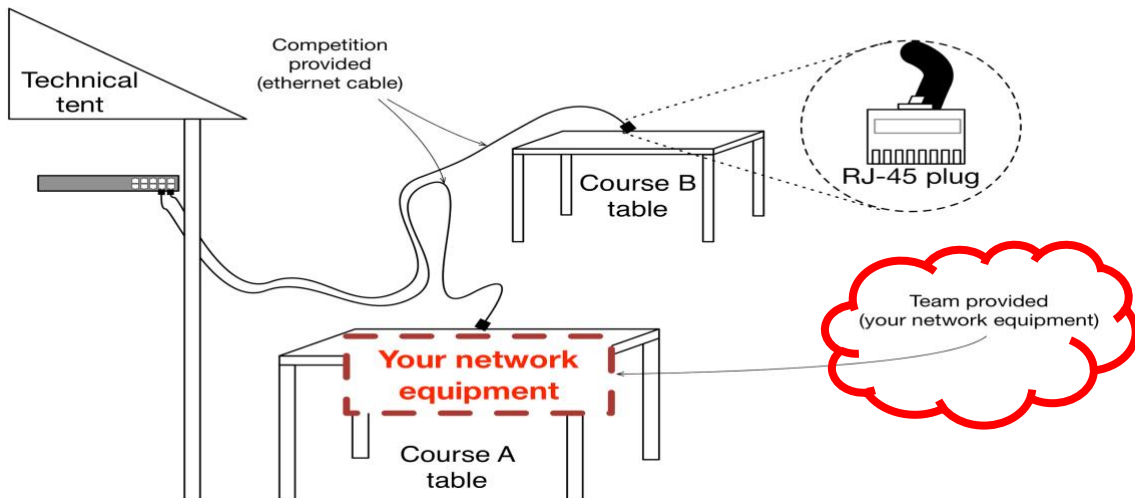


Figure 14: Physical network setup

An Ethernet cable with RJ-45 plug is available on the Course A & Course B tables in front of the technical director tent. These cables are connected to competition network including the mission task server. The router is DHCP enabled and provides IP addresses in the range 192.168.0. [50,250]

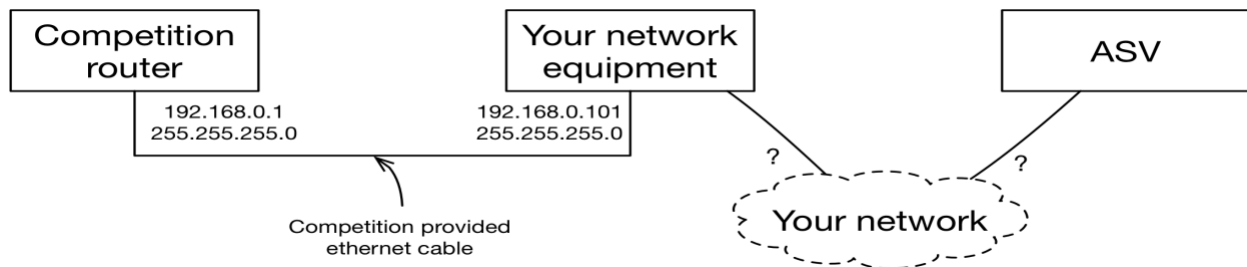


Figure 15: Virtual network connectivity overview

15.2 Mission Web Server

The competition mission task server is available on the competition network. The web service offers HTTP and HTTPS protocols. We strongly suggest that all teams use the HTTPS protocol for added security. The HTTPS endpoint of the service will be using a self-signed certificate. Certain programming languages and technology stacks require special flags or configurations to accept self-signed certificates. **Please make sure that you test your code against a web service using a self-signed certificate.**

15.3 Software Security

A primary goal of the competition is for student to develop skills in systems engineering by accomplishing realistic missions with autonomous vehicle. We have a strict zero tolerance policy for any security attacks (man-in-the-middle, injection, reporting false data as another team, etc.) against the scoring software or the software used by the teams to complete the mission. Any attempt (successful or not) to hack any of the software systems or other team's vehicle will result in disqualification of the team.

15.4 Starting/Ending a Run

The purpose of the run start/end messages is to reset the active competition elements and to notify the judges that a new run is starting.

While at the dock the vehicle may start a run. Any run started while the vehicle is not at the dock will be considered void. A vehicle can end a run anytime. No points will be accrued after a run has been ended or before a run is started.

The run start and end may be requested using the protocol defined in [Appendix 7: Start/End a Run Communication Protocol](#).

15.5 Heartbeat

The purpose of the heartbeat is to validate if the vehicle is functional and to provide insight about what task is being attempted.

The heartbeat can be reported using the protocol defined in [Appendix 6: Heartbeat communication protocol](#).

Each vehicle must emit a heartbeat every one second during the water-based tasks. If a heartbeat has not been received for ten seconds, the vehicle will be considered as out-of-control. It is left to the judge's' discretion whether to stop the run, to tow the vehicle, or to keep going.

There are tasks that will not be scored if there is no heartbeat and no communications.

15.6 Testing Course

In addition to the four courses, a testing-only course may be offered for in-water testing.

15.7 Selection of TIMESLOTS

The TIMESLOT selection rules vary between phases of the competition.

16 Appendices

Appendix 1: Breakdown of a TIMESLOT

TIMESLOTS are the in-water times allocated to a team to demonstrate their vehicle's performance. The TIMESLOT'S duration varies between the practice, qualification and final rounds.

The TIMESLOT'S start time is the time at which the team's vehicle will be deployed in the water. To maximize in-water time for each team, teams should be physically present with their vehicle in a ready state at least fifteen minutes before the start time.

The first five minutes of a TIMESLOT are allocated to dock time. Dock time can be used for weight and thrust measurement, troubleshooting, and preparation for the runs. Any remaining dock time is waived as soon as the vehicle leaves the dock or at the request of the team leader. If the vehicle is still at the dock when the dock time runs out, in-water time will automatically start.

In-water time follows the designated time dock. During in-water time, teams may attempt as many 'runs' as desired. Please note that only points accrued in the last run of a TIMESLOT will be scored (starting a new run waives all points previously accrued in the same TIMESLOT). **The last run of a TIMESLOT will automatically end as soon as one of the following occurs:**

- The in-water time runs out.
- The team leader request that the run be ended.
- The technical director or a judge orders the end of the run. *
- Others, as provided in section 10.2.

**Note: TDs and Judges rarely order the end of a run but they can do so at their discretion including for safety or competition rule violations.*

At the end of a run or TIMESLOT, vehicles must be brought back to the dock on their own power. In case of catastrophic system failure, RoboBoat staff may manually tow back vehicles. The in-water time clock keeps running when vehicles are brought back to the dock.

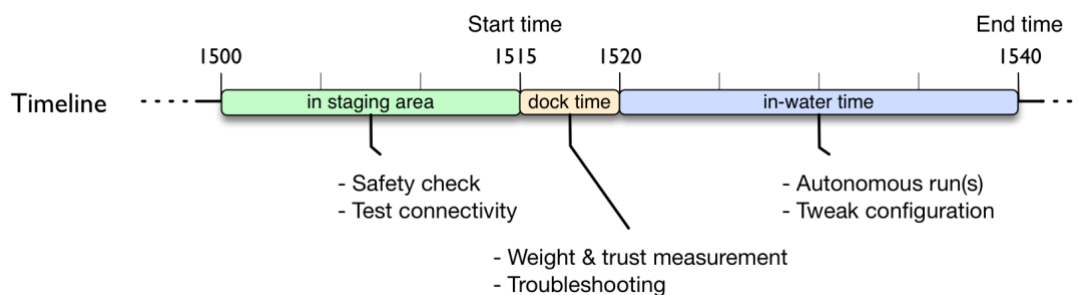


Figure 16: Breakdown of TIMESLOT

Appendix 2: Vehicle Deployment

Vehicles are deployed in the water using a crane and a team-provided 3 or 4-point harness. Each end of the harness must be physically and securely attached to a fixed point on the vehicle (cannot be slung under the vehicle). The best-practice is to incorporate three or four [eyebolts](#) in the main vehicle structure. These eyes bolts, when paired with a set of [spring loaded carabiners](#), will allow for quick harness attachment/removal from the vehicle during recovery/launch. To ensure that the vehicle does not yaw and get damaged during deployment, a single fixed point (could be a separate carabiner) must be provided to attach the harness to the crane. ***(Note: when selecting these lifting components, ensure they are rated to lift more weight than your vehicle).***



Figure 17: Examples of 3 and 4 point lifting harness

To move your vehicle around the competition, teams must provide a trailer for their vehicle. (Suggestions: [garden cart](#), [dump cart](#), etc.). The trailer is manually propelled on site (ie: no motorized cart). In order to be maneuvered on the tight launch pad, the cart's handle must be solid (no rope/chain). The trailer's width must be less than thirty-six inches to fit on the ramp as well as ingress and egress from residential door frame. We strongly recommend trailers with six+ inches rubberized wheels to navigate the gravel, mud and grass terrains on the competition site. ***(Note: Standard residential door frame width is 36" but only 35" is available – accounting for ½ loss on each side).***



Figure 18: Examples of vehicle trailer (cart)

Appendix 3: Weight/Thrust Formulas

Table 1: Weight and thrust scoresheet

Parameters	Points
ASV + UAV weight > 140 lbs.	Disqualified!!!
140 lbs > ASV + weight > 110	-250 - 5*(w - 110)
110 lbs > ASV + weight > 70	2*(110 - w)
ASV weight ≤ 70 lbs	80 + (70 - w)
Dimensions greater than: - three feet of width or - three feet of height - six feet of length	Disqualified!!!
Thrust (t) vs weight (w)	100*(t / w)

Appendix 4: Follow the Leader Communication Protocol

NMEA API definition for the Follow the Leader:

Request: \$SVFOL,<course>,<teamCode>*<checksum>

where <course> either "courseA", "courseB" or "courseC"

and <teamCode> case-sensitive string that must respect the regex: [a-zA-Z]{2,5}

and <checksum> bitwise XOR of ASCII codes of all characters between \$ and *

Response: \$TDFOL, <timestamp>,<status>*<checksum>

where <timestamp> is YYYYMMDDHHMMSS in UTC

and <status> is either "true" or "false"

and <checksum> bitwise XOR of ASCII codes of all characters between \$ and *

Errors:

If an error occurred or the message was malformed, you will get not a response

JSON/HTTP API definition for the Follow the Leader:

Request: HTTP GET on /followLeader/<course>/<teamCode>

where <course> is either "courseA", "courseB", "courseC"

and <teamCode> case-sensitive string that must respect the regex: [a-zA-Z]{2,5}

Response: A JSON structure in the format: {"turning": "<status>"}

where <status> is either "true", "false"

Status code:

200: Everything is okay

400: Your request is malformed

404: Cannot find the course or team

500: The gate assignment service is broken

503: Please retry the request

Headers supported:

Request: the server ignores all HTTP headers

Response: contains the 'Content-Type' and 'Content-Length' headers

Sample NMEA request/response

```
$SVFOL,courseA,AUVSI*44  
$TDFOL,20170306061030,true*46
```

Sample JSON/HTTP request/response:

```
> GET /followLeader/courseA/AUVSI HTTP/1.1  
> Host: 192.168.0.15:8080  
> Accept: */*  
>  
< HTTP/1.1 200 OK  
< Content-Type: application/json  
< Content-Length: 23  
< Server: Jetty(8.0.4.v20111024)  
<  
< {"status":"true"}
```

Appendix 5: Automated Docking Communication Protocol

Note: The image upload message is HTTP only since there is no NMEA support for file upload.

Request: HTTP POST on /docking/image/<course>/<team Code>
where <course> is either "courseA", "courseB" or "courseC"
and <teamCode> case-sensitive string that must respect the regex: [a-zA-Z]{2,5}

Request payload: Multipart with content-type: "multipart/form-data"

Response: A JSON structure in the format: {"id":<imageID>}
where <imageID> is string of characters

Status code:

100: Server is ready to accept multipart chunk
202: Upload successfully completed
400: Your request is malformed
404: Cannot find the course or team
500: The gate assignment service is broken
503: Please retry the request

Headers supported:

Request: You must specify the content-type as 'multipart/form-data'
Response: contains the 'Content-Type' and 'Content-Length' headers

Sample JSON/HTTP request/response:

```
> POST /docking/image/courseA/AUVSI HTTP/1.1
> Content-Type: multipart/form-data; boundary=PqjtwSukItOMmSZ6NSvgT661LL9lXkOHSdnV
> User-Agent: curl/7.38.0
> Host: 127.0.0.1:8080
> Accept: */*
> Content-Length: 7280
> Expect: 100-continue
>
< HTTP/1.1 100 Continue
> --PqjtwSukItOMmSZ6NSvgT661LL9lXkOHSdnV
> Content-Disposition: form-data; name="file"; filename="test.jpg"
> Content-Type: application/octet-stream
>
> c1790bde8f831e7c
> --PqjtwSukItOMmSZ6NSvgT661LL9lXkOHSdnV
>
< HTTP/1.1 202 Accepted
< Date: Thu, 19 Mar 2017 06:05:17 GMT
< Content-Type: application/json
< Transfer-Encoding: chunked
< Content-Length: 45
<
< {"id":"a4aa8224-07f2-4b57-a03a-c8887c2505c7"}
```

Appendix 6: Heartbeat Communication Protocol

NMEA API definition for reporting the heartbeat:

Request: \$SVHRT,<course>,<teamCode>,<timestamp>,<challenge>,<latitude>,<longitude>*<checksum>
where <course> either "courseA", "courseB" or "courseC"
and <teamCode> case-sensitive string that must respect the regex: [a-zA-Z]{2,5}
and <timestamp> is YYYYMMDDHHMMSS in UTC
and <challenge> is "speed", "docking", "path", "follow" or "return"
and <latitude> is a float using the degree decimal format (ex: hddd.dddddd)
and <longitude> is a float using the degree decimal format (ex: hddd.dddddd) and
<checksum> bitwise XOR of ASCII codes of all characters between \$ and *

Response: \$TDHRT, <timestamp>,<status>*<checksum>
where <timestamp> is a repetition of the timestamp you submitted
where <status> is either true, false representing if the run is still active
and <checksum> bitwise XOR of ASCII codes of all characters between \$ and *

Errors:

If an error occurred or the message was malformed, you will get not a response

JSON/HTTP API definition for heartbeat:

Request: HTTP POST on /heartbeat/<course>/<team Code>
where <course> is either "courseA", "courseB" or "courseC"
and <teamCode> case-sensitive string that must respect the regex: [a-zA-Z]{2,5}

Request payload:

```
{"timestamp":<timestamp>,"challenge":<challenge>,"position":  
{"datum":"WGS84","latitude": <latitude>,"longitude": <longitude>}}
```

where <timestamp> is YYYYMMDDHHMMSS in UTC
and <challenge> is "speed", "docking", "path", "follow" or "return"
and <latitude> is a float using the degree decimal format (ex: hddd.dddddd)
and <longitude> is a float using the degree decimal format (ex: hddd.dddddd)

Response: A JSON structure in the format: {"success":<status>}
where <status> is either true, false representing if the run is still active

Status code:

200: Everything is okay
400: Your request is malformed
404: Cannot find the course or team
500: The gate assignment service is broken
503: Please retry the request

Headers supported:

Request: the server ignores all HTTP headers
Response: contains the 'Content-Type' and 'Content-Length' headers

Sample NMEA request/response

```
$SVHRT,courseA,AUVSI,20170306061030,speed,40.689249,-74.044500*0A  
$TDHRT,20170306061030,true*4D
```

Sample JSON/HTTP request/response:

```
> POST /heartbeat/courseA/AUVSI HTTP/1.1
> Host: 192.168.0.15:8080
> Content-Length: 78
> Content-Type: application/json
>
>
{"timestamp":"20170306061030","challenge":"gates","position":{"datum":"WGS84","latitude":40.689249,"longitude":-74.044500}}
>
< HTTP/1.1 200 OK
< Date: Sun, 09 Mar 2017 01:58:26 GMT
< Content-Type: application/json
< Content-Length: 96
< Server: Jetty(8.0.4.v20111024)
<
< {"success":true}
```

Appendix 7: Start/End a Run Communication Protocol

NMEA API definition for starting a run:

Request: \$SVSTR,<course>,<teamCode>*<checksum>

where <course> either "courseA", "courseB" or "courseC"

and <teamCode> case-sensitive string that must respect the regex: [a-zA-Z]{2,5}

and <checksum> bitwise XOR of ASCII codes of all characters between \$ and *

Response: \$TDSTR, <status>*<checksum>

where <status> is either true, false representing if the run has been started

and <checksum> bitwise XOR of ASCII codes of all characters between \$ and *

Errors:

If an error occurred or the message was malformed, you will get not a response

If the status is 'false' consult the Technical Director before restarting the run

JSON/HTTP API definition for starting a run:

Request: HTTP POST on /run/start/<course>/<team Code>

where <course> is either "courseA", "courseB" or "courseC"

and <teamCode> case-sensitive string that must respect the regex: [a-zA-Z]{2,5}

Response: A JSON structure in the format: { "success": <status> }

where <status> is either true, false representing if the run has been started

Status code:

200: Everything is okay

400: Your request is malformed

404: Cannot find the course or team

500: A server error occurred. Consult the Technical Director

503: Please retry the request

Headers supported:

Request: the server ignores all HTTP headers

Response: contains the 'Content-Type' and 'Content-Length' headers

NMEA API definition for ending a run:

Request: \$SVEND,<course>,<teamCode>*<checksum>

where <course> either "courseA", "courseB" or "courseC"

and <teamCode> case-sensitive string that must respect the regex: [a-zA-Z]{2,5}

and <checksum> bitwise XOR of ASCII codes of all characters between \$ and *

Response: \$TDEND, <status>*<checksum>

where <status> is either true, false representing if the run has been started

and <checksum> bitwise XOR of ASCII codes of all characters between \$ and *

Errors:

If an error occurred or the message was malformed, you will get not a response

If the return status is 'false' consult the Technical Director

JSON/HTTP API definition for ending a run:

Request: HTTP POST on /run/end/<course>/<team Code>

where <course> is either "courseA", "courseB" or "courseC"

and <teamCode> case-sensitive string that must respect the regex: [a-zA-Z]{2,5}

Response: A JSON structure in the format: { "success": <status> }

where <status> is either true, false representing if the run has been ended

Status code:

200: Everything is okay

400: Your request is malformed

404: Cannot find the course or team

500: A server error occurred. Consult the Technical Director

503: Please retry the request

Headers supported:

Request: the server ignores all HTTP headers

Response: contains the 'Content-Type' and 'Content-Length' headers

Sample NMEA request/response

\$SVSTR,courseA,AUVSI*54

\$TDSTR,true*7F

\$SVEND,courseA,AUVSI*4E

\$TDEND,true*65

Sample JSON/HTTP request/response:

> POST /run/start/courseA/AUVSI HTTP/1.1

> Host: 192.168.0.15:8080

> Content-Length: 0

> Content-Type: application/json

>

>

< HTTP/1.1 200 OK

< Date: Sun, 17 May 2017 01:58:26 GMT

< Content-Type: application/json

< Content-Length: 16

< Server: Jetty(8.0.4.v20111024)

<

< {"success":true}

> POST /run/end/courseA/AUVSI HTTP/1.1

> Host: 192.168.0.15:8080

> Content-Length: 0

> Content-Type: application/json

>

>

< HTTP/1.1 200 OK

< Date: Sun, 17 May 2017 02:01:24 GMT

< Content-Type: application/json

< Content-Length: 16

< Server: Jetty(8.0.4.v20111024)

<

< {"success":true}