RoboBoat
Final Rules and Task Descriptions

Version 1.1, Updated 22 June 2017

www.roboboat.org

June 20-25, 2017

Reed Canal Park, Daytona Beach, FL

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 www.roboboat.org for more details.

Competition item's due dates:

February 15	Early Bird Registration Closes and Early Bird payment due*
May 1	DEADLINE EXTENDED - Regular Registration closes
May 1	Final Registration payment due*
May 5	Team Roster with T-shirt size, waiver and release of liability forms, team bio, logo, website, Facebook and Twitter
May 15	Team Introductory Videos, Journal Papers and Battery Safety Plan
June 16	Individual student resumes
June 20-25	10th International RoboBoat Competition

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

Competition Points of Contact

Technical questions: RoboBoat Forum <http://robonation.org/forums/roboboat>

Technical director: Felix Pageau <pageau@auvsifoundation.org>

Competition questions (registration, travel, hotel or team deliverables):
competitions@AUVSIFoundation.org

Competition Overview

The competition is held at the Reed Canal Park's pond. The cruciform-shaped pond measures roughly 700ft by 550ft. The highly variable water depth ranges from 5ft to 30ft. The pond is generally free from obstacles (seaweed, lily pads, trees, etc.) but three floating water fountains are in the center of the pond. The fountain should be treated as a natural obstacle and be avoided at all costs. See satellite image for more details: https://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 at night. Additional information about the facilities can be found on the official competition website: http://www.roboboat.org

Overall Competition Schedule

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

Competition schedule overview:

- June 20 1000-1100: Orientation meeting at Embry-Riddle Aeronautical University
- June 20 1200-1800: 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: In-water practice time.
- June 22 1800-1830: Daily team meeting in TD tent.
- June 23 0800-1800: Static judging in the outdoor pavilion at Reed Canal Park.
- June 23 0800-1800: In-water practice time.
- June 23 1800-1830: Announcement of static judging results and qualification time slots selection.
- June 24 0800-1800: Qualifications.
- June 25 0800-1200: Qualifications overflow/Last Chance Qualifications.
- June 25 1200-1230: Announcement of qualifications results and finals time slots selection.
- June 25 1300-1700: Finals.
- June 25 1900-2200: Award Ceremony.

Participation and Eligibility Requirements

Teams do not have to be associated with a school or university but 75% of their members must be full-time students to enter the competition. Faculty, industrial and governmental partners are recommended but are not required.

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 accommodations.

Registration Information

Fees

All teams must register via the official competition website, and submit the registration fee in order to participate on-site at the competition. Please ensure that your registration fee is paid by date listed in the Deadlines and Due Dates section above to secure entry in the competition.

Required Submissions

All teams must submit the following items by the deadlines indicated in the Deadlines and Due Dates section above to secure their entry in the competition:

- Registration Fee
- Team Registration Roster. Please only include team members that will be on-site at the competition
- Waiver and Release of Liability Forms
- Individual Student Resumes

See the Team Central page on www.roboboat.org for more details.

Mobile App Submissions

- Facebook and Twitter accounts (If applicable)
- Team Bio and Logo

Significant Changes versus 2016 rules

The competition has moved from Virginia Beach, VA to Daytona Beach, FL. Expect significant facilities, equipment and amenities changes compared to the 2008-2016 competitions.

A significant public and corporate presence expected at the 2017 competition and a section about Public display has been added to these Final Rules.

A separate document on RoboBoat drone guidelines is published along with these Final Rules. You must read and comply with these guidelines in addition to all FAA regulations in order to be allowed to fly your drone at RoboBoat 2017.

Two new challenges replace the old 'speed gate' challenge. The mandatory Autonomous Navigation challenge proves that the vehicle entering the course has basic autonomous control.

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 Land-Based Tasks will be conducted, written, and presented in English.

Technical Journal Paper

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

- All journal papers must use the *Journal Paper Instructions & Template for the RoboBoat Competition* available in the Team Central page of www.roboboat.org.
- Journal papers longer than 10 pages will be disqualified.

- References and appendices are included in the 10 pages limit.

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 for the first time and hobbyists frequently go to the websites for historical information to get up to speed.*

Team Introduction Video

Each team must submit an introductory video. Please follow the official instructions available at:
http://www.robonation.org/sites/default/files/pictures/Team%20Video%20Submission%20Rules%202016.pdf

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.
- 5-minute question and answer session.
- 5-minute judges' inspection of the vehicle.
- 20-minute team interviews (if video crew chooses to do an interview).

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 account that will be used for the team's submissions. Only the team leader and AUVSI Foundation staff have access to this account. Each team leader is responsible for meeting all deadlines listed in the section Deadlines and Due Dates above. Detailed instructions on how to submit your items are included in your dropbox account. These instructions are also be posted on the competition website.

Public display

The Daytona Beach and Volusia county community is proud to host the 2017 RoboBoat competition and they plan to organize a number of public events during the competition for the media, companies interested in STEM (science, technology, engineering, math) and the local public. The showcase of these events will be your vehicle and the materials you have 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.

Water-Based Team Tasks

The Reed Canal Park's pond is divided in four courses. Course Alpha, Bravo and Charlie are identical competition courses. Course Delta is reserved for testing autonomous navigation. Courses A & B are served by the east docks while courses C & D use the west docks.

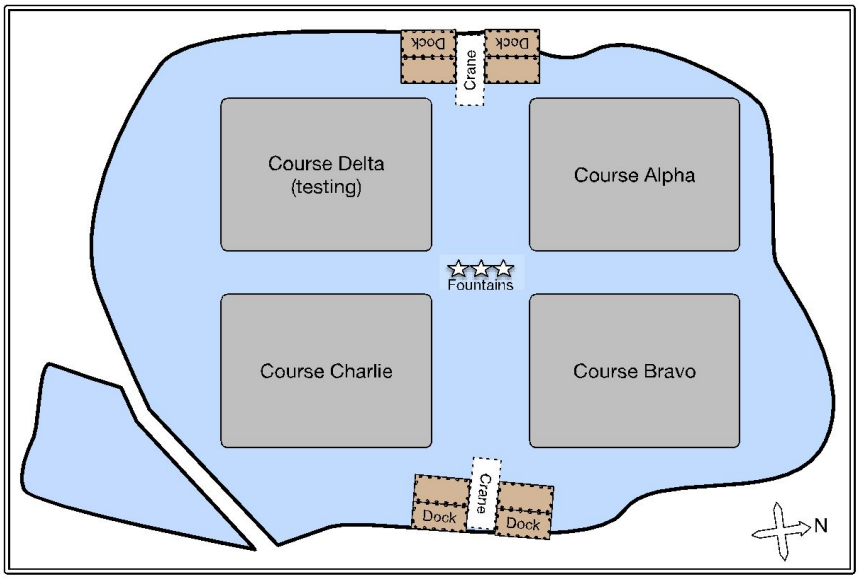

Figure 1. Reed Canal Park's pond layout

The three competition courses use a similar course layout (may be horizontally flipped) as shown in the Course layout diagram below. The course's corners are marked with colored can buoys.

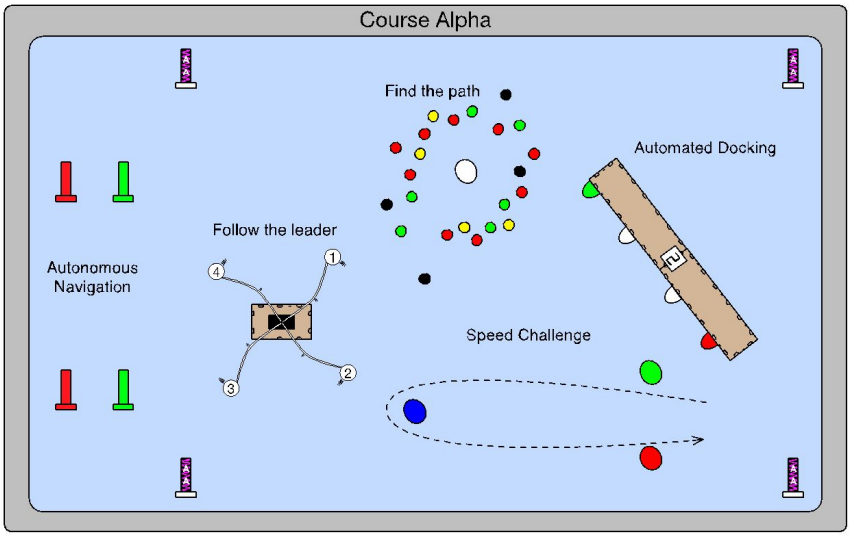

Figure 2. Course layout

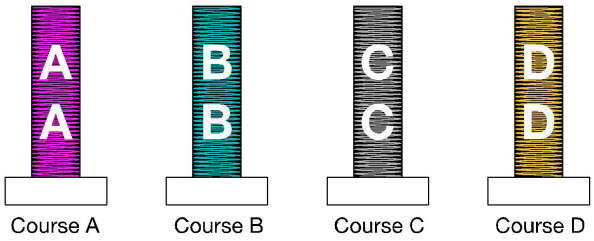

Figure 3. Course markers

In order to accrue points in the water-based tasks listed below, teams must also comply with the Network for communication with the vehicle, Starting/Ending a run and Heartbeat requirements listed in the Miscellaneous section of this document.

Mandatory water-based tasks

The purpose of the mandatory water-based tasks is to demonstrate the quality of each vehicle's engineering. All mandatory water-based tasks 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 and it cannot be launched during these tasks.

Weight and thrust measurement

The purpose of this task is to demonstrate the propulsion ability of the vehicle compared to its weight.

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.

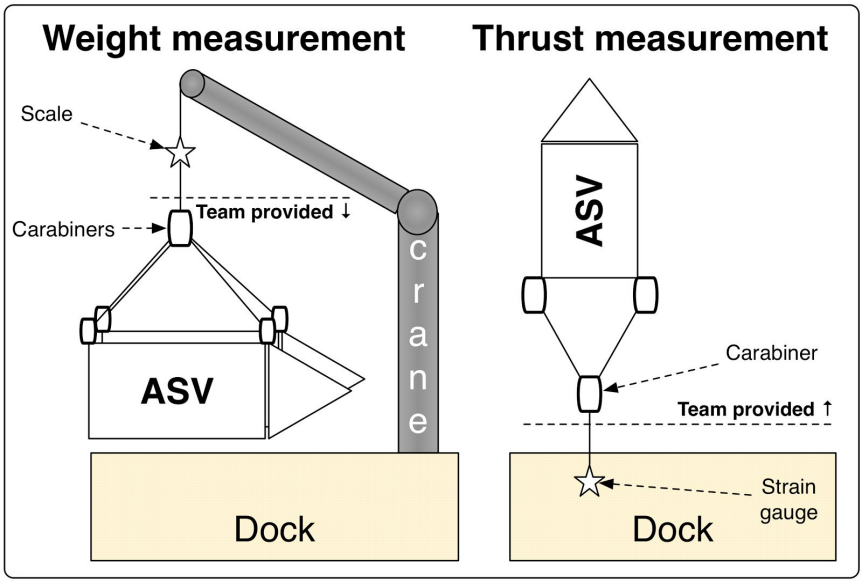

Figure 4. Weight and thrust measurement setup.

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: A half-up rounding is applied to the weight and thrust values prior to scoring.

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.

Autonomous Navigation

The purpose of this task is to demonstrate basic autonomous control and sensing abilities.

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 six to ten feet 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 six feet before the first gate. Successfully passing through both gates is a requirement to attempt any mission task.

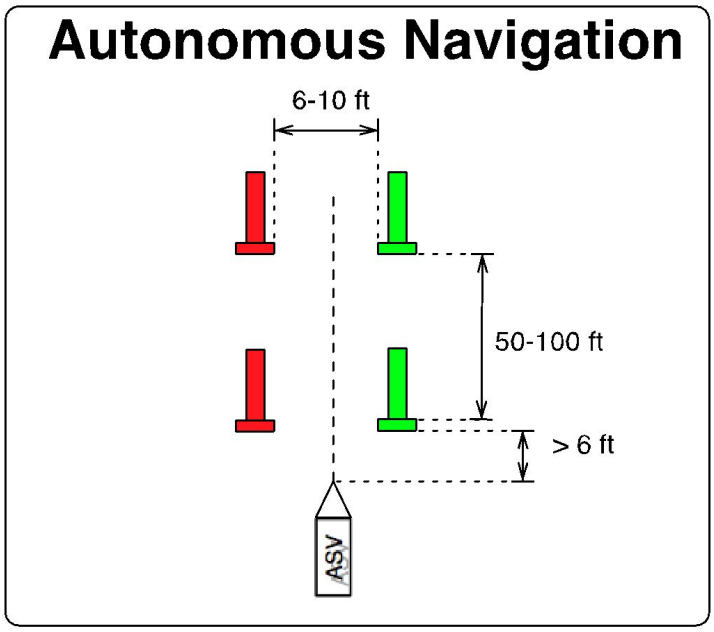

Figure 5. Navigation demonstration overview.

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 gets 0 points.

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).

Speed Challenge

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

The vehicle enters through the gate buoys, circles the mark buoy counterclockwise, and exits through the same gate buoys as quickly as possible. The vehicle must come to a full stop three to six feet from the gate buoys before attempting this challenge. The gate buoys are a set of red and green Polyform A-2 buoys moored six to ten feet 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).

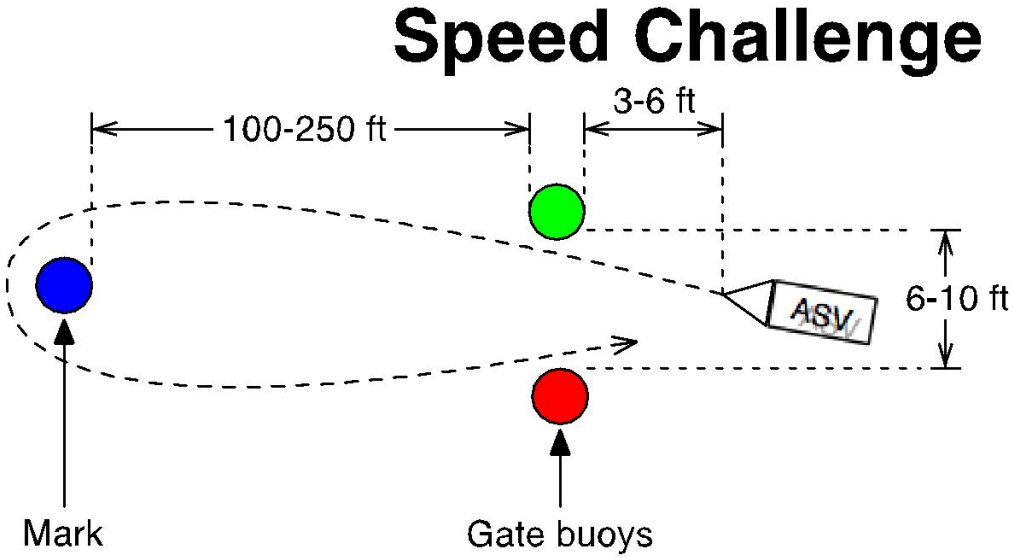

Figure 6. Obstacle avoidance overview.

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).

Automated Docking

The purpose of this task is to demonstrate the ability to launch an aerial drone and combine information from multiple sensor systems to make a decision in autonomous mode.

The vehicle executes a sequence of docking maneuvers based on which pinger is active and the number displayed on a 7-segment module on top of the dock. To find the first bay to enter the vehicle identifies which pinger is active and enters that bay. To find the second bay to enter the vehicle launches an unmanned aerial vehicle (UAV) that will identify the number displayed on a 7-segment display placed behind the middle sign. The number shown on the 7-segment display matches the number of the signs facing the maritime vehicle.

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 each run.

The protocol defined in Appendix 5: Automated Docking Challenge communication protocol is used to report the character shown and to transmit the picture taken. The specifications for acceptable UAV vehicles are defined in RoboBoat - Aerial Vehicle Specifications.

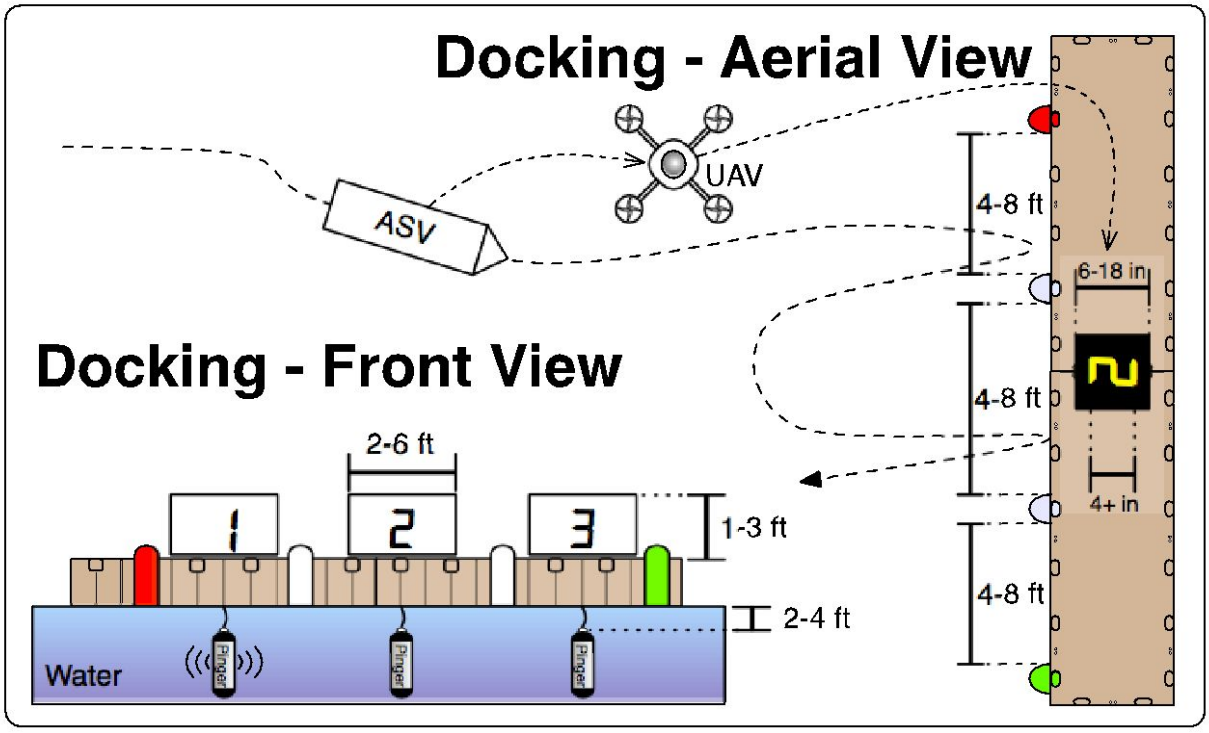

Figure 7. Automated Docking overview.

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).

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 find 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. In at least one point in the obstacle field, the two closest buoys are four to six feet apart.

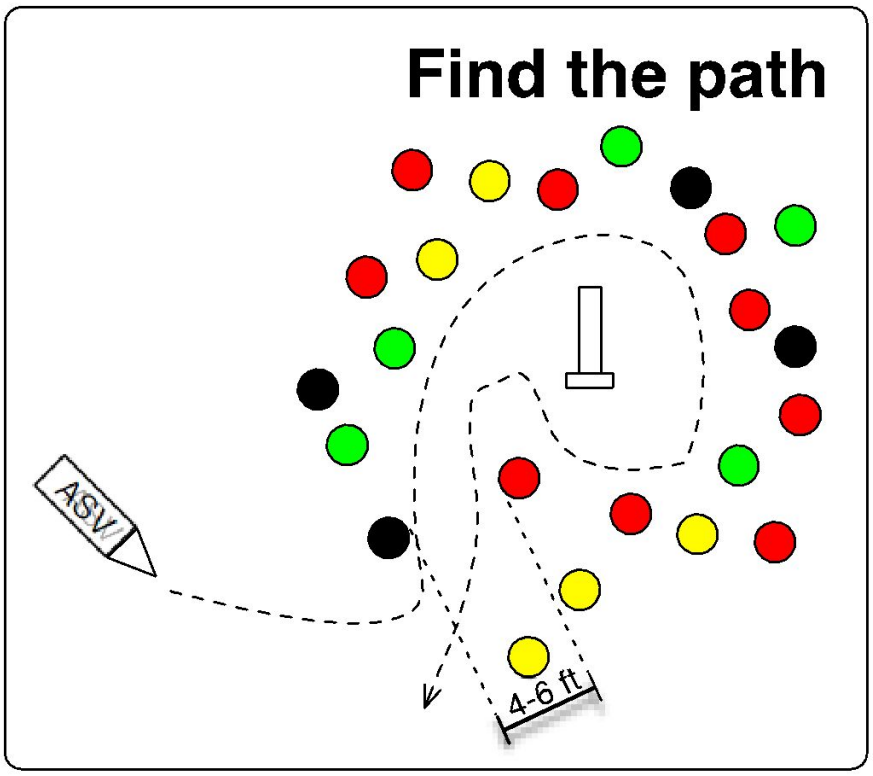

Figure 8. Interop Challenge overview

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)

Follow the Leader

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

The vehicle enters the carousel of numbered items and circles the floating platform at least once. Upon reaching this obstacle, the vehicle request the carousel code (ex: '12') to identify in between which items the vehicle must enter. The difficult part is not just to identify where the numbered items are but to enter the carousel and stay in between two items (ex: between the '1' and the '2') for a full rotation of the carousel.

The correct carousel location changes each run and must be requested using the protocol defined in Appendix 4: Follow the Leader communication protocol.

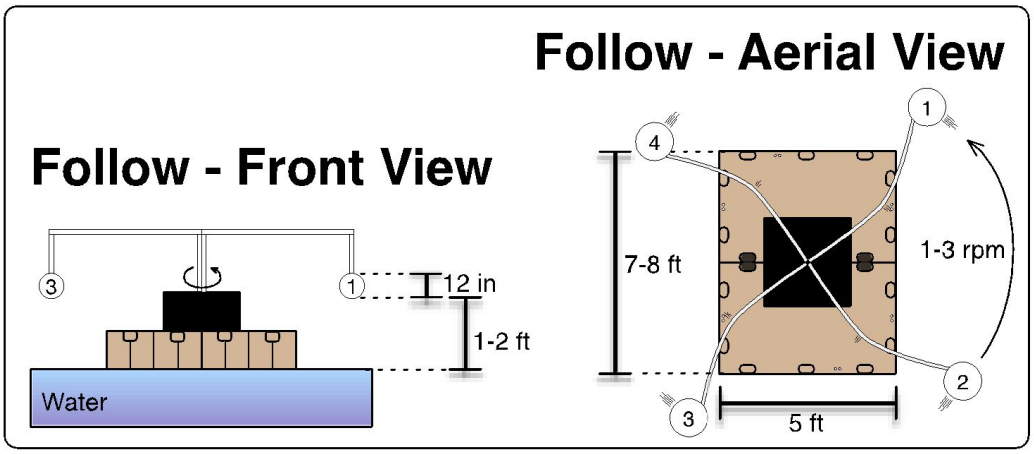

Figure 9. Follow the Leader overview

Task scoresheet:

- **50 points:** Enter carousel between two flags (first one entered).
- **50 points:** Hit one or less flag.
- **150 points:** Enter carousel between the correct flags on first attempt.
- **250 points:** Circle the floating platform while between two flags for a complete rotation.
- **500 points:** Perfect Follow the Leader (enter correct flags, circle, no hit).
- **No points are allocated if more than one flag is hit.**
- **No points are allocated if the vehicle get entangled/stuck in a flag**

Ex: A vehicle that correctly enters between flag 1 and 2, hits flag #1, and circle the floating platform gets 500 pts. The breakdown is: 50 (enter) + 50 (hit 1) + 150 (enter correct) + 250 (circle).

Return to dock

The purpose of this task is to demonstrate the ability to navigate back to the launch point without interacting with any obstacles.

After having earned points on all 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 used to launch the vehicle.

If a vehicle crosses through a different course on its way back, the run will be immediately terminated.

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).

Competition Rules

- Vehicle Requirements
  - **Autonomy**: the vehicle must be fully autonomous and all decisions must be taken onboard the ASV.
  - **Buoyancy**: the vehicle must 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 such as an AUV.
  - **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 1.5in diameter red button located on the vehicle that, when actuated, must 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.
  - **Payload**: the vehicle must have a place to mount a GoPro (or similar) camera.
  - **Payload location**: it must have an unobstructed view from the front of the vehicle.
  - **Propulsion**: any propulsion system is fine (thruster, paddle, etc.), but moving parts must have a shroud.
  - **Remote-controllable**: the vehicle must be remote-controllable 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 a 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.
  - **Waterproof**: the vehicle must be rain/splash resistant.
  - **Weight**: the entire maritime system (including UAV) must be 140 lbs. or less.
- Interference
  - Any vehicle entangled in, dragging, pushing or damaging competition elements or the landscape is interfering.
  - Any vehicle leaving its assigned course is interfering.
  - Interference will result in a run termination or disqualification, at the judge's discretion.
- Judge’s decisions
  - Judge’s decisions are final.
  - Judges may provide an explanation for their decisions if they believe it is necessary.

Competition Logistics

Scoring

Land-Based Scoring

Subjective Measures	Max. Points
Utility of team website	50
Technical merit (from journal paper)	50
Written style (from journal paper)	50
Technical accomplishment (from static judging)	75
Craftsmanship (from static judging)	75
Team uniform (from static judging)	10
Video quality (from introduction video)	25
Discretionary static points (awarded after static judging)	40
Total	**375**

Table 1. Land-based scoresheet

Water-Based Scoring

Task	Performance Measures	Max Points
Weight measurement	Weight	149
Trust measurement	Generate F pounds of thrust (in lbs)	∞
Autonomous Navigation	Pass through the starting gate	100
Speed Challenge	Enter through gates	50
	Circle mark counterclockwise	100
	Exit through gates	100
	Navigate time	250
	Fastest vehicle	250
Automated Docking	Launch UAV	250
	Enter correct first bay	250
	Report image of 7 segment	250
	Enter correct second bay	250
	Recover UAV in autonomous mode	250
	Perfect docking sequence	750
Find the Path	Enter the obstacle course	100
	Circle the can buoy	200
	Exit obstacle course	100
	Hit 3 or less buoys	50
	Hit 2 or less buoys	50
	Hit 1 or less buoys	100
	Perfect Find the Path	400

Follow the Leader	Enter carousel between two flags	50
	Hit one or less flags	50
	Enter carousel between correct flags (on 1st attempt)	150
	Circle the floating platform while between two flags	250
	Perfect Follow the Leader	500
Return to dock	Return to dock	500
	T seconds left on the clock	T

Table 2. Water-based scoresheet

MISCELLANEOUS

Network for communication with the vehicle

The purpose of having each team provide their own network is to encourage creative solution creation.

Each team has to 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 your 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.

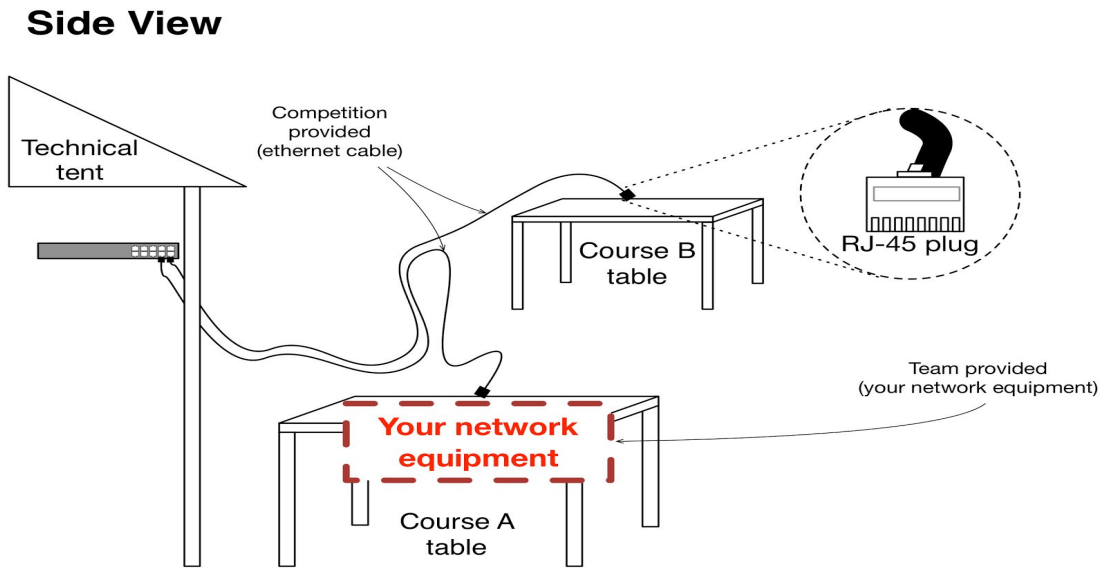

Figure 10. Physical network setup overview

An Ethernet cable with RJ-45 plugs 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 has DHCP enabled and provides IP addresses in the range 192.168.0.[50,250]

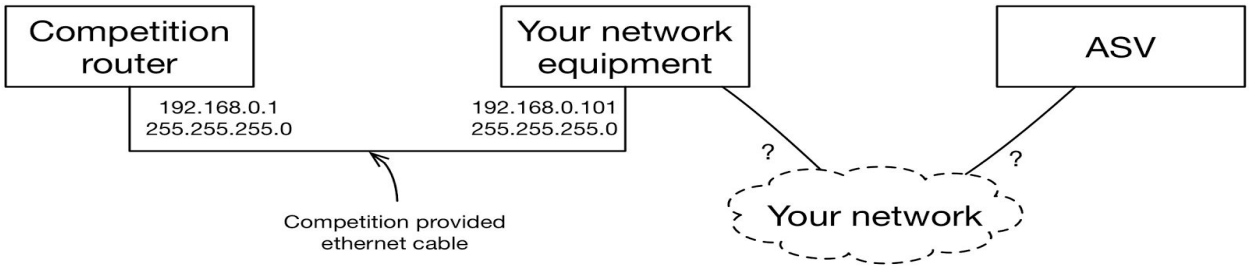

Figure 11. Virtual network connectivity overview

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.

Software security

The 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.

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 can 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 be requested using the protocol defined in Appendix 7: Start/End a run communication protocol.

Heartbeat

The purpose of the heartbeat is to validate the vehicle is still functional and to provide insight about what task it is attempting.

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.

The heartbeat can be reported using the protocol defined in Appendix 6: Heartbeat communication protocol.

Course Delta (Testing)

In addition to the three competition circuits (courses Alpha, Bravo & Charlie), a testing-only Course Delta is offered for in-water testing. Below are the rules of the Course Delta area:

- All Course Delta (testing) rules are subject to changes without notice.
- Content: Only Navigation Challenge equipment.
- First-come, first-served: There are no reservations. Bring your vehicle when you are ready.
- Deployment/run time: At the discretion of the RoboBoat staff in charge of the area.

- Number of vehicles: At the discretion of the RoboBoat staff in charge of the course.
- Towing: Priority is given to team on Course Alpha, Beta & Charlie but towing is available.

Note: Obstacles deployed in the Course Delta (testing) area are backups/replacement parts. Obstacles may be pulled out of the Course Delta (testing) at anytime for replacement on the competition courses.

Selection of timeslots

The timeslot selection rules vary between phases of the competition.

During practice days, teams sign up on a first-come, first-served basis. Teams can only signup for a new timeslot after the end of the previous one. If no one signed up for a timeslot, the team currently in the water on that course may choose to remain in the water until another team signs up. Selection of the first timeslot for the first competition day happens at the end of the orientation meeting.

For qualifications, teams select their timeslots based on their static judging ranking. Qualifications are held on courses Alpha, Bravo and/or Charlie.

For finals, teams select their timeslot based on their qualification results (if they qualified). Finals is held on a single custom course (referred to as ‘finals’).

Ties are resolved with a sudden-death round of in-water performance or a coin toss, at judge's discretion.

APPENDICES

Appendix 1: Breakdown of a timeslot

Timeslots are the in-water time 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 timeslot's 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. 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.

Following dock time is variable amount of in-water time (typically twenty minutes but check with the technical director). During in-water time, teams can attempt as many 'runs' as desired. Please note that only points accrued in the last run of a timeslot count (ie: 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 ASV leaves the course area.
- The ASV become entangled in or damages competition obstacles.
- The technical director or a judge orders the end of the run.*

**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 bought back to the dock.

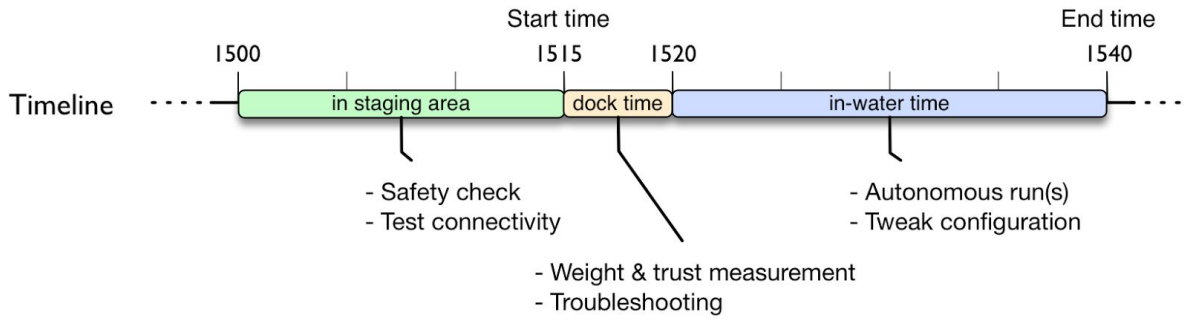

Figure 12. Timeline of a timeslot

Appendix 2: Vehicle deployment

Vehicles are deployed in the water using a crane and a team-provided 3- or 4-points harness. Each end of the harness must be physically 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. To ensure that the vehicle does not yaw and get damaged during deployment, single fixed loop must be provided to attach the harness to the crane. To allow quick harness attachment to or removal from the vehicle, many teams are using spring-loaded carabiners.

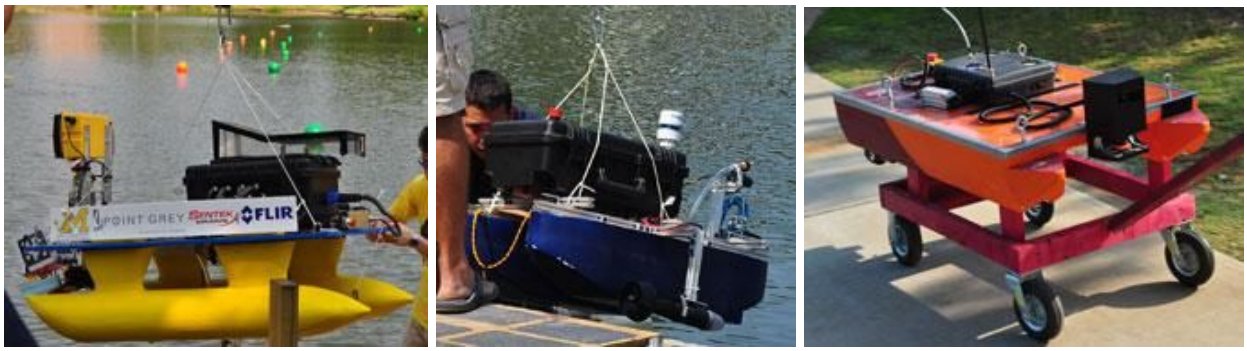

Figure 13. Examples of vehicle design with fixed 4-points harness

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 forty inches or less to fit on the ramp. We strongly recommend trailers with six+ inches rubberized wheels to navigate the gravel, mud and grass terrains on the competition site.

Figure 14. Examples of vehicle trailer with a fixed handle

Appendix 3: Weight/thrust formulas

	Points
ASV 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)*

Table 3. Weight and thrust scoresheet

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: $TDFOL, <timestamp>,<code>*<checksum>
where <timestamp> is YYYYMMDDHHMMSS in UTC
and <code> is either "12", "23" or "34" or "41"
and <checksum> bitwise XOR of ASCII codes of all characters between *$* 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: {"code":"<code>"}
where <code> is either "12", "23", "34" or "41"

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,20170306061030,23*51
```

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)
<
< {"code":"23"}
```

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/mixed"

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/mixed'
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}
```