

HMDS2027

MULTI-DOMAIN ROBOTICS CHALLENGE

HMDS 2027 · TOKYO, JAPAN

Three Robots. One Team. One Mission.

THE CHALLENGE

Build a coordinated robotic system that gathers information, transfers it correctly and completes linked missions across air, ground and water.

CORE PRINCIPLE

The best integrated system wins.

Mission completion, correct information transfer and demonstrated autonomy matter more than raw speed.

THREE PROGRESSIVE STAGES

STAGE 1 · CATEGORY 1

Single Domain

UAV, UGV and USV compete individually in compact navigation challenges.

STAGE 2 · CATEGORIES 2-3

Cooperative

Air + Ground and Air + Water connect UAV reconnaissance to a second vehicle.

STAGE 3 · CATEGORY 4

Grand Final

UAV, UGV and USV execute one continuous tri-domain mission with dependent handovers.

University teams

max 8 members

Teleoperation to full autonomy

International participation

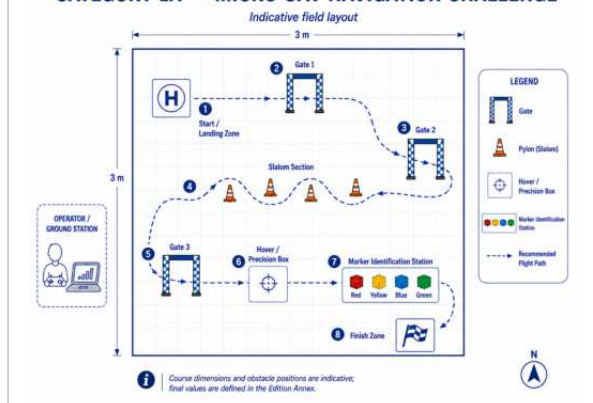
Designed for progressive participation. Teams may begin with a single vehicle, then advance to cooperative categories as their perception, communications and autonomy capabilities mature.

CATEGORY 1

Three entry challenges. One route toward integration.

Each drawing below is an illustrative course concept. Exact field geometry and scoring details are defined in the Rulebook and Edition Annex.

CATEGORY 1A — MICRO UAV NAVIGATION CHALLENGE



CATEGORY 1A

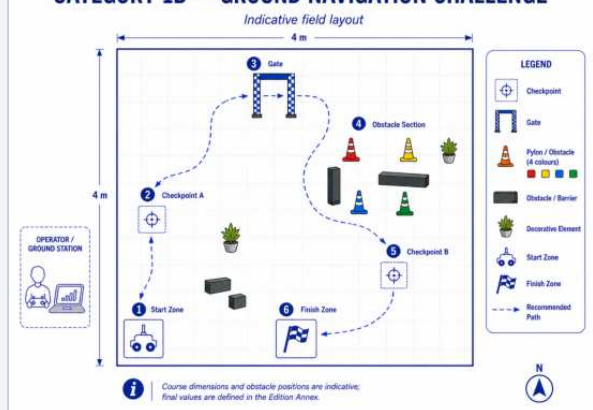
Micro UAV Navigation Challenge

Navigate a compact aerial course while maintaining stable, controlled flight. An illustrative task may combine gates, slalom elements, a precision zone and visual-marker identification.

Direct visual control, video-assisted control and autonomous operation are permitted according to the declared autonomy level. FPV is not required.

UAV: < 100 g, ≤ 150 mm motor-to-motor (diagonal), propeller guard

CATEGORY 1B — GROUND NAVIGATION CHALLENGE



CATEGORY 1B

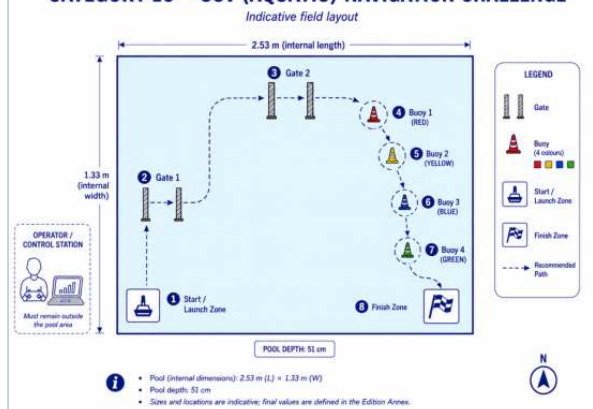
Ground Navigation Challenge

Drive from the Start Zone through a defined sequence of course elements. The illustrative layout includes checkpoints, a gate, obstacles and a colour-coded pylon section.

The route must be followed in the numbered order with the correct given colour sequence.

Start configuration: 300 x 300 x 300 mm maximum

CATEGORY 1C — USV (AQUATIC) NAVIGATION CHALLENGE



CATEGORY 1C

USV Navigation Challenge

Navigate through the designated gates, round four buoys completely and cross the finish line. The buoy order may be assigned at random and communicated before each run.

Sizes and locations shown in the drawing are indicative. The official field geometry, valid rounding direction and sequence procedure are defined in the Edition Annex.

Start configuration: 200 x 200 x 200 mm maximum

These are visual summaries, not field drawings. Teams must design against the official Rulebook, Edition Annex, inspection checklist and published Q&A.

One aerial observation. Two cooperative missions.

The UAV determines mission data, the declaration is locked, and the second vehicle must act on that information.

CATEGORY 2

Air + Ground Challenge

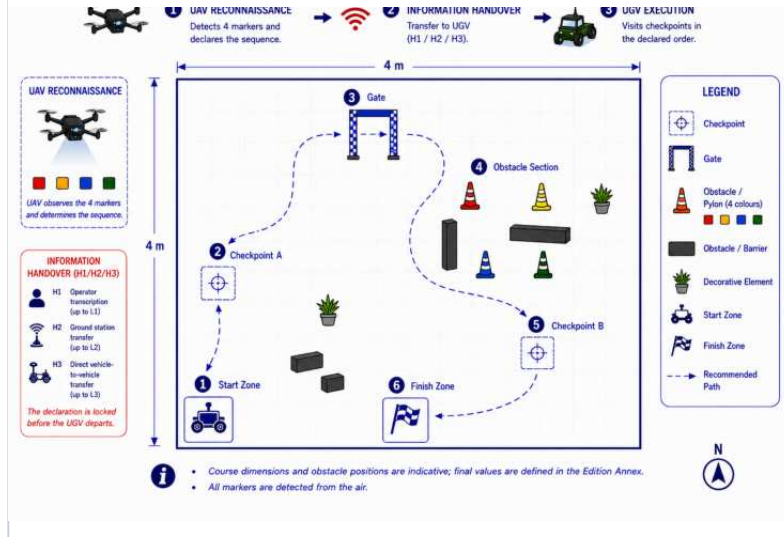
UAV reconnaissance establishes the mission sequence. After Handover, the UGV completes the declared ground route.

The challenge is correct information transfer and coordinated execution.

UAV → Handover → UGV

CATEGORY 2 — AIR + GROUND CHALLENGE

UAV identifies mission data; UGV completes the declared route.



CATEGORY 3

Air + Water Challenge

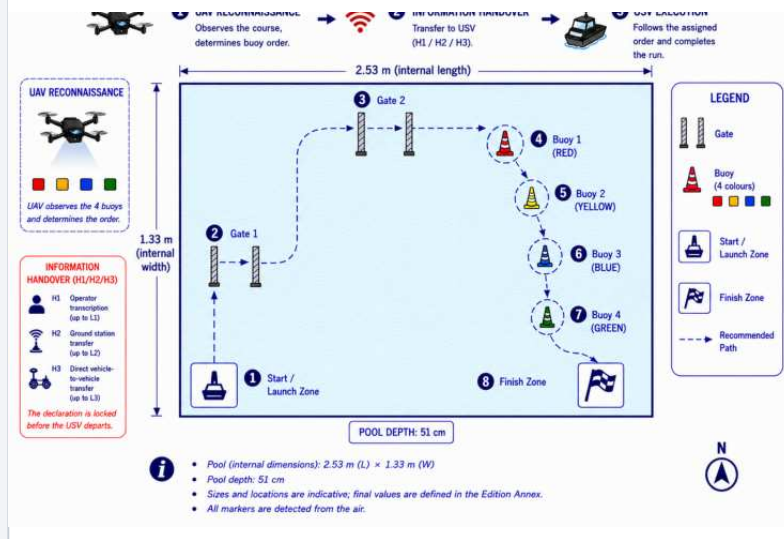
UAV reconnaissance determines the assigned buoy order. After Handover, the USV completes the declared aquatic route.

The challenge is correct information transfer and coordinated execution.

UAV → Handover → USV

CATEGORY 3 — AIR + WATER CHALLENGE

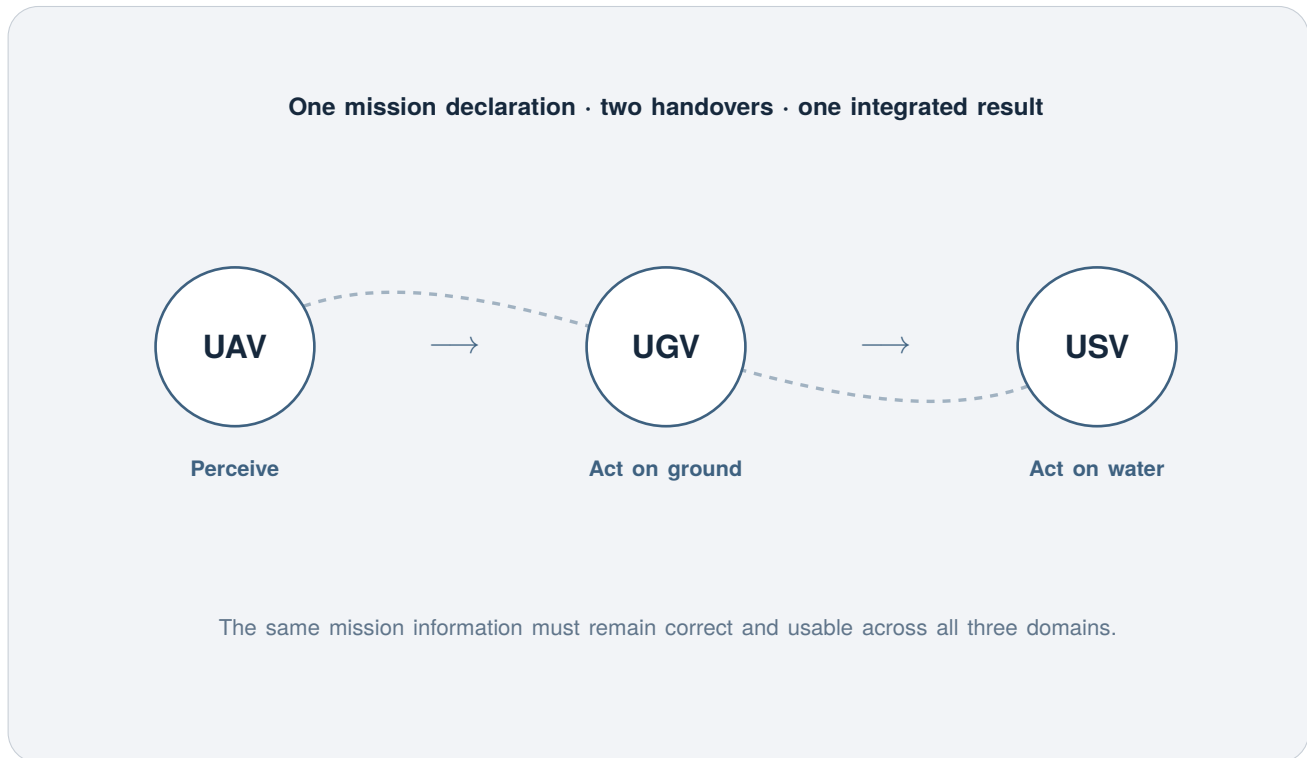
UAV identifies mission data; USV completes the declared route.



Handover is the differentiator. Mission information must be preserved and used by the receiving vehicle. Higher demonstrated autonomy is rewarded.

Grand Final. One integrated tri-domain mission.

The Grand Final combines the Category 2 ground course and Category 3 aquatic course. The challenge is to preserve and act on mission information across the complete UAV–UGV–USV chain.



WHAT THE GRAND FINAL EVALUATES

PERCEPTION

Correct acquisition and declaration of mission information.

INFORMATION TRANSFER

Reliable Handover through the team's declared H1, H2 or H3 method.

COORDINATED EXECUTION

Correct ground and aquatic execution as one continuous system mission.

Exact field geometry and binding procedures remain those defined in the Rulebook and Edition Annex.

Build safely. Declare autonomy. Score the integrated system.

This page collects the requirements that apply across the competition. Mission visuals are summarized on the preceding pages; the Rulebook and Edition Annex remain authoritative.

SCORING

CATEGORIES 2–4

**(Task Points × Autonomy Multiplier)
+ Time Bonus - Penalties**

Highest score wins. Category 1 uses elapsed time plus penalties; the lowest score wins.

L0

1.00

L1

1.15

L2

1.30

L3

1.50

COMPETITION STRUCTURE

CATEGORY 1 Single Domain

Individual UAV, UGV and USV navigation challenges establish baseline vehicle capability.

CAT. 2–3 Cooperative

Air + Ground and Air + Water add information transfer and system-level autonomy.

CAT. 4 Grand Final

One continuous tri-domain mission evaluates integration across all three vehicles.

Official details live in the Rulebook.

Field dimensions, sequence procedures, inspection criteria and binding clarifications are defined in the Edition Annex and published Q&A.

BUILD AND OPERATION

Platform	Start envelope	Essential condition
UAV	150 mm diagonal under 100 g	Battery and payload included; full propeller protection required.
UGV	300 x 300 x 300 mm	Battery, antennas, wheels, sensors and deployment mechanisms included.
USV	200 x 200 x 200 mm	Battery, antennas, hull elements, sensors and deployment mechanisms included.

Deployable UGV and USV designs are allowed.

They may unfold or expand only after the Start Signal. Every component must remain attached throughout the run.

AUTONOMY LEVELS

L0 Teleoperation

Operator commands all actions.

L1 Partial autonomy

One or more segments run automatically.

L2 Supervised autonomy

Full mission automatic; operator may only abort.

L3 Full autonomy

No operator input after the Start Signal.

PARTICIPATION

- ✓ **max 8 members** from one institution; one team Captain.
- ✓ Faculty Advisor.
- ✓ Commercial components allowed; unmodified commercial platforms prohibited.
- ✓ A Technical Design Report is required per team.

Safety first: main power disconnect, secured battery, abort function and appropriate failsafe are mandatory. No battery replacement is permitted during a run.