
HMDS 2027

MULTI-DOMAIN ROBOTICS CHALLENGE

COMPETITION RULEBOOK

Version 2.3

“Three Robots. One Team. One Mission.”

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Revision history

Version	Date	Summary
1.0	—	Initial concept rulebook
2.0	2026-07	Restructured to international format; added definitions, run procedure, scoring model, inspection, protests, conduct and international participation provisions
2.1	2026-08-02	Clarified document control, qualification, start-envelope measurements, deployable mechanisms, autonomy, Handover verification, phase abandonment, battery changes, scoring and inspection
2.2	2026-08-08	Limited teams to 3–5 students; established the commercial-components / no-unchanged-commercial-platform policy; renamed Category 1A; clarified optional UAV video, Category 1 mission elements, randomized aquatic routing, platform eligibility and inspection
2.3	2026-08-10	Renamed the event Multi-Domain Robotics Challenge; increased team size to a maximum of eight students; updated UGV/USV start envelopes and Japan course dimensions; removed obsolete maze/parking language; clarified Grand Final information flow, Handover, autonomy, cooperative gate requirements, tie-breaking and battery charging; corrected drafting and LaTeX inconsistencies

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PART A

General Provisions

Article 1. Nature and Scope

- 1.1 The HMDS Multi-Domain Robotics Challenge (hereafter “the Challenge”) is an academic technology competition addressing the design, integration and operation of cooperative robotic systems across three navigation domains: **air, ground and water**.
- 1.2 The Challenge is held as an official activity of the HMDS 2027 conference and may be staged in more than one **Edition** during the competition year. Editions are hosted in **Mexico** and **Japan**. Each Edition applies this Rulebook in full; Edition-specific annexes govern venue, schedule, field construction tolerances and local administrative requirements.
- 1.3 Results obtained in either Edition are recognised under the same title structure. Cross-Edition rankings, if published, are advisory only.
- 1.4 In this Rulebook, **shall** and **must** indicate mandatory requirements; **may** indicates permission; **should** indicates a recommendation; and **will** describes an action or commitment of the organization.
- 1.5 Edition Annexes may add venue-specific dimensions, schedules and local administrative or legal requirements. An Edition Annex may not alter the core mission, scoring model or eligibility requirements unless the Rulebook expressly authorises that variation. In the event of conflict, this Rulebook prevails.

Article 2. Objectives

The Challenge exists to promote applied research, technological innovation, intelligent robotic systems, multidisciplinary integration, collaborative work, engineering talent development, and university–industry technology transfer, with emphasis on solutions capable of operating across heterogeneous environments through cooperation between multiple autonomous or teleoperated platforms.

Article 3. Competition Philosophy

- 3.1 The Challenge progresses from **independent single-domain missions** to cooperative missions involving two or three platforms. Category 1 evaluates individual vehicle capability. Categories 2 and 3 introduce information dependency between the UAV and a receiving ground or surface vehicle. Category 4 integrates the UAV, UGV and USV within one continuous mission.
- 3.2 In cooperative categories, the UAV obtains mission-critical information that determines the route or sequence executed by the receiving vehicle or vehicles. The emphasis is therefore on the complete **perception–decision–information-transfer–action chain**.
- 3.3 The Challenge does not reward the fastest robot, the best drone, the best ground vehicle, or the best-funded team in isolation. **It rewards the best integrated system**. The cooperative scoring model in Part F prioritises mission achievement, correct information transfer and demonstrated autonomy over raw speed.
- 3.4 The Challenge evaluates **engineering development and systems integration rather**

than the acquisition of complete commercial robotic solutions. Teams may use commercial components and subsystems, but each competition vehicle shall demonstrate meaningful engineering contribution by the registered student team.

Article 4. Official Language and Precedence

- 4.1** The official language of the Challenge is **English**. All rulings, protests, briefings and official communications are issued in English.
- 4.2** Translations may be published for convenience. In the event of any discrepancy, **the English text prevails**.
- 4.3** Field officials in each Edition will include at least one member fluent in the local language. Teams may address officials in Spanish (Mexico Edition) or Japanese (Japan Edition); rulings will be recorded in English.

Article 5. Rule Interpretation and Amendment

- 5.1** The **Technical Committee** is the sole authority for interpreting this Rulebook.
- 5.2** A public **Question and Answer (Q&A) process** operates from publication until the rule freeze date. Questions are submitted in writing to the official address. Answers are published to all registered teams simultaneously and become binding interpretations with the same authority as the Rulebook itself.
- 5.3** After the rule freeze date, no substantive rule change is made except where required for safety or legal compliance. Such changes are notified to all teams in writing and take effect immediately.
- 5.4** Any situation not foreseen by this Rulebook is resolved by the Technical Committee in accordance with the philosophy stated in Article 3.

Article 6. Governing Bodies

Body	Responsibility
Organizing Committee	Overall event delivery, venue, schedule, registration, awards
Technical Committee	Rule interpretation, field design, technical inspection, rulings on protests
Head Referee	Authority over all runs; assigns field officials; final authority during a run
Field Officials (Marshals)	Run supervision, penalty observation, safety enforcement
Frequency Coordinator	Allocation and control of all radio emissions at the venue
Safety Officer	Authority to halt any activity presenting risk

The Head Referee's decisions during a run are final and are not subject to protest on matters of fact. Matters of rule interpretation may be protested under Article 34.

Article 7. Definitions

Term	Definition
UAV	Unmanned Aerial Vehicle
UGV	Unmanned Ground Vehicle
USV	Unmanned Surface Vehicle
Vehicle	Any single robotic platform entered by a team
System	The complete set of vehicles and ground equipment entered by a team in a given category
Commercial Component or Subsystem	A commercially available part or functional module intended to be integrated into a larger system, including motors, ESCs, flight controllers, sensors, cameras, radios, batteries, actuators and similar hardware
Commercial Platform	A commercially available complete or substantially complete UAV, UGV or USV capable of operating as a robotic vehicle without material team redesign
Donor Platform	A Commercial Platform used as the starting hardware for a team-developed competition vehicle
Meaningful Engineering Contribution	Substantial team work that changes or develops the vehicle's mechanical, electrical, sensing, control, communications or system architecture beyond cosmetic changes, accessory installation or parameter adjustment alone
Run	One scored attempt at a mission by one team
Heat	A scheduled block in which one or more teams execute runs
Attempt	A run that has started, whether or not it is completed
Phase	A mandatory mission segment assigned to one vehicle or domain
Start Signal	The official command that starts Course Time and authorises vehicle motion and deployment
Course Time	Elapsed time from Start Signal to Mission End, excluding officially granted holds
Run Time Limit	Maximum permitted Course Time for a mission
Mission End	The moment the final scoring condition of a mission is satisfied, the Team Captain retires the run, or the Run Time Limit expires, whichever occurs first
DNF	Did Not Finish — an attempt started but not completed within the Run Time Limit
DNS	Did Not Start — a team did not begin a scheduled run within the permitted staging and setup time
Start Configuration	The complete configuration in which a UGV or USV is presented for measurement and positioned at the Start Signal, before any deployment or expansion
Operational Configuration	Any configuration assumed after the Start Signal through deployment, unfolding or extension of parts that remain attached to the vehicle
Start Zone	The marked area in which a vehicle is positioned before its mission phase begins
Handover	The transfer and official recording of UAV-derived mission-critical information to the receiving ground or surface vehicle or vehicles
Mission Data Form	The official paper or approved electronic record of information derived by the UAV and locked before the applicable receiving phase begins (MDF)
Operator	The team member commanding or supervising a vehicle during a run
Abort Command	A safety-only command that stops or makes safe one or more vehicles without supplying mission guidance
Safety Link	A declared link used only to issue an Abort Command or Kill Switch command
Control Link	A declared link used to command vehicle motion or mission actions
Mission Link	A declared link used to transfer mission data between components of the System
Pit	The team's assigned working area
Field of Play	The bounded competition area, including safety margins
Kill Switch	A control that immediately removes propulsive power from a vehicle
Autonomy Level	The classification defined in Article 24

PART B

Teams and Participation

Article 8. Team Composition and Eligibility

- 8.1** Each team shall consist of **no more than eight students** enrolled at the registering institution at undergraduate or postgraduate level at the time of registration.
- 8.2** One of the registered students shall be designated in writing as the **Team Captain** and serves as the sole official point of contact with event officials.
- 8.3** A team may designate **one Faculty Advisor**. The Faculty Advisor is not counted toward the eight-student limit and may provide academic and safety guidance, but is not a competition operator.
- 8.4** During official competition activities, including technical inspection, staging, pits and scored runs, only the registered student team members may perform hands-on modification, repair, programming, setup, operation or handling of the competition vehicles. Faculty Advisors and other accompanying persons may advise verbally but may not function as additional technical team members.
- 8.5** An institution may register more than one team. A student may be registered with only one team, and vehicles may not be shared between teams.
- 8.6** Teams are strongly encouraged to draw members from different engineering disciplines. Multidisciplinary composition may be considered for special recognition.
- 8.7** A student who satisfies the eligibility requirement at registration remains eligible for that Edition if graduation occurs between registration and the event.

Article 9. Registration

- 9.1** Registration is completed online and requires: team roster, institutional endorsement, category declarations, preliminary technical specification of each vehicle, identification of any Commercial Platform used as a Donor Platform, identification of major commercial subsystems, and acceptance of the liability terms of Article 12.
- 9.2** Indicative deadlines, confirmed in the Edition annex:

Milestone	Deadline
Registration opens	[CONFIRM]
Team registration closes	[CONFIRM]
Technical Design Report due	[CONFIRM] rec. 6 weeks before event
Roster and equipment declaration lock	[CONFIRM] rec. 3 weeks before event
Rule freeze	[CONFIRM]

- 9.3** A **Technical Design Report (TDR)** of no more than 10 pages is required for cooperative categories. The TDR documents the system architecture, the Handover mechanism, the autonomy level claimed, the safety design, the origin of major commercial hardware, and the engineering contribution made by the team to each competition vehicle. Failure to submit the TDR precludes participation in Categories 2, 3 and 4.

Article 10. Team Responsibilities and Engineering Contribution

- 10.1** Each team is solely responsible for the mechanical design, electronic design, programming, integration, transport, operation, maintenance and safety of its vehicles. The organization provides no technical assistance, components, tools, spare parts or modifications during the event.
- 10.2 Commercial components and subsystems are permitted.** Teams may use commercial motors, ESCs, flight controllers, computers, sensors, cameras, LiDAR, GPS receivers, radios, batteries, actuators, mechanical elements and similar hardware without penalty, provided all equipment is declared where required.
- 10.3 Complete commercial solutions are not competition entries.** A Commercial Platform may not be entered in its original or essentially unchanged configuration, even when it otherwise satisfies the dimensional, mass and safety requirements of this Rulebook.
- 10.4** A Commercial Platform may be used as a **Donor Platform** only when it has been substantially modified, reconfigured or integrated by the registered student team in a manner that demonstrates Meaningful Engineering Contribution to the competition vehicle.
- 10.5** The modification is not required to improve the Donor Platform's performance. Eligibility is based on demonstrated engineering involvement, not on whether the team's changes make the vehicle faster, lighter, more capable or more competitive than the original product.
- 10.6** Evidence of Meaningful Engineering Contribution may include mechanical or structural redesign and manufacture; relocation and reintegration of components; propulsion or power-system integration; sensor or perception-hardware integration; electronics or communications architecture; substantial low-level control-system development; or other system-level engineering that materially changes how the vehicle is constructed or integrated.
- 10.7** Cosmetic changes, colour or cover changes, replacement of non-functional parts, attachment of minor accessories, parameter tuning alone, or installation of software on an otherwise essentially unchanged Commercial Platform do not, by themselves, satisfy Article 10.4.
- 10.8** Teams using a Donor Platform shall identify the original platform and summarize their modifications at registration. Where a TDR is required, the same information shall be documented there. Officials may request reasonable evidence of the team's development work during technical inspection.
- 10.9** A team uncertain whether a proposed Donor Platform modification is eligible may request a written determination from the Technical Committee before the rule freeze date. A determination remains valid only while the submitted configuration is materially representative of the vehicle presented at the event.
- 10.10** The **Technical Committee has final authority** to determine whether a vehicle satisfies the engineering-contribution requirement. Deliberate misrepresentation of a vehicle's commercial origin or of work performed by the team is a conduct violation under Article 11.

Article 11. Code of Conduct

- 11.1** Participants shall conduct themselves with professionalism, respect and integrity toward other teams, officials, volunteers and venue staff.
- 11.2** The following are prohibited and may result in penalty, disqualification or removal from the venue: harassment or discrimination of any kind; intentional interference with another team's equipment or radio links; misrepresentation of a vehicle's autonomy level; unauthorised entry to the Field of Play; falsification of registration or inspection information; and disregard of

instructions from officials.

- 11.3** Work presented as team-developed must be that of the registered team. Commercial components and eligible Donor Platforms are permitted only under Article 10 and shall be declared as required. Passing off externally developed hardware, software or system integration as original team work is a conduct violation.

Article 12. Liability, Insurance and Media

- 12.1** Each team participates at its own risk. Each participant shall sign a liability waiver in the form provided by the Organizing Committee before receiving venue accreditation.
- 12.2** Teams are responsible for insurance covering their members and equipment. Institutions from outside the host country should verify that their institutional coverage extends to international travel and equipment.
- 12.3** The organization is not liable for loss of or damage to team equipment.
- 12.4** By participating, teams grant the organization the right to record, photograph and publish images of participants, vehicles and runs for documentation, academic and promotional purposes. Teams retain all intellectual property in their designs.

Article 13. International Participation

- 13.1** The organization will issue **invitation letters** for visa purposes upon written request following confirmed registration.
- 13.2** Teams travelling internationally are responsible for customs clearance of their equipment. The organization will provide, on request, a supporting letter describing the temporary import of competition equipment. Teams are advised to inventory all equipment with serial numbers and declared values in advance.
- 13.3** Teams are responsible for verifying that all equipment they intend to bring may lawfully be imported into and operated within the host country of the Edition in which they compete. See Articles 22 and 23.
- 13.4** Each Edition annex lists local suppliers, workshop facilities and consumables available on site.

PART C

Event Structure

Article 14. Categories

The Challenge comprises four official categories, arranged progressively by level of inter-platform integration.

Category 1 — Single Domain Challenge

Single-platform entry. Subcategories: **1A** Micro UAV Navigation Challenge (UAV) · **1B** Ground Navigation Challenge (UGV) · **1C** Aquatic USV Navigation Challenge (USV). *Purpose:* evaluate individual platform capability in navigation, control and precision without any cross-platform

dependency.

Category 2 — Air–Ground Cooperative Challenge

UAV + UGV. The UAV performs aerial reconnaissance and generates the mission information required for the UGV to complete the ground course.

Category 3 — Air–Water Cooperative Challenge

UAV + USV. The UAV identifies mission information from the air; the USV executes the aquatic course using the locked information.

Category 4 — Multi-Domain Grand Final

UAV + UGV + USV. The UAV performs the reconnaissance phase and establishes the mission data used by the UGV and USV. The ground and aquatic missions are then executed sequentially within the same run. Both receiving vehicles act on information derived from the UAV phase; the UGV is not required to generate the USV route.

Article 15. Event Programme

The Edition Annex publishes the exact dates and session times. The standard three-day competition progression is:

Competition Day 1 — Single Domain Challenge. Team check-in · technical inspection and safety verification · captains’ meeting · Category 1 competition.

Awards: UAV Champion, UGV Champion, USV Champion.

Competition Day 2 — Cooperative Challenges. Category 2 (Air–Ground Cooperative Challenge) and Category 3 (Air–Water Cooperative Challenge).

Awards: Air–Ground Champion, Air–Water Champion. Grand Final qualifiers announced.

Competition Day 3 — Multi-Domain Grand Final. Category 4 Grand Final and competition awards.

Article 16. Qualification and Advancement

- 16.1** Eligibility for Category 4 requires: (a) at least one valid scored attempt in Category 2; (b) at least one valid scored attempt in Category 3; and (c) successful technical inspection of the UAV, UGV and USV.
- 16.2** The **Qualification Score** is the sum of the team’s best official Category 2 score and best official Category 3 score. The maximum Qualification Score is 1200 points. A DNS in either category makes the team ineligible for Category 4.
- 16.3** Teams are ranked by Qualification Score. Qualification ties are resolved by: (a) higher combined Task Points before autonomy multipliers; (b) fewer combined penalty points; (c) higher lowest Autonomy Level demonstrated across the two runs; and (d) the tie-breaking procedure of Article 32, applied where relevant.
- 16.4** The number of qualifying teams is published in the Edition Annex and shall not be fewer than four where at least four eligible teams are available.
- 16.5** If fewer eligible teams are available than the published number, all eligible teams advance.

A team that has not met the eligibility conditions of 16.1 may not be admitted merely to fill the field.

Article 17. Run Procedure

- 17.1 Call and staging.** Teams are called to the staging area at the time published in the run schedule. A team not present within **3 minutes** of being called is recorded DNS for that run.
- 17.2 Setup window.** The team has **5 minutes** from entering the Field of Play to position vehicles, verify links and declare readiness. Each UGV and USV shall be positioned in its Start Configuration. Officials may verify the applicable start envelope before readiness is accepted. Time not used is not carried over.
- 17.3 Start Signal.** The Head Referee or delegate gives the Start Signal. Course Time begins at the Start Signal. Vehicle motion, unfolding, extension and other deployment are prohibited before the Start Signal.
- 17.4 Attempts.** Each team is entitled to **two attempts** per mission in Category 1 and **one attempt** per mission in Categories 2, 3 and 4, subject to schedule. In Category 1 the better attempt is scored.
- 17.5 Run Time Limits:**

Mission	Limit
Category 1 (each subcategory)	5 minutes
Category 2 — Air–Ground	10 minutes
Category 3 — Air–Water	10 minutes
Category 4 — Grand Final	15 minutes

- 17.6 Official hold.** The Head Referee may pause a run for safety, field fault or official error. Held time is not counted. A run is not paused for team-caused faults.
- 17.7 Retirement.** A Captain may retire from a run at any time by declaring “retire” to the field official. Points accrued to that moment are retained; the run is recorded DNF.
- 17.8 Field contact.** No team member may touch a vehicle inside the Field of Play during a run except when directed by a field official. Unauthorised contact ends the run.
- 17.9 Restart.** A restart is granted only for organizational error or field fault. Restarts are not granted for vehicle failure, battery depletion, or link loss caused by team equipment.
- 17.10 Phase abandonment and disabled vehicles.** The Team Captain may declare a phase abandoned. The vehicle shall be stopped and made safe. At the Head Referee’s direction, field officials may remove a disabled vehicle where it obstructs the remaining mission. Course Time continues during team-caused recovery or removal; an official hold is granted only where the obstruction or delay was caused by the organization or field.

PART D

Robotic Platforms

Article 18. General Requirements (All Vehicles)

18.1 Every vehicle shall have:

- an accessible, clearly marked **main power disconnect**;
- a **Kill Switch** or Abort Command that removes propulsive power on command and places the vehicle in a safe state on loss of any motion-critical Control Link;
- a **failsafe** that stops all propulsion within **1 second** of loss of a motion-critical Control Link, unless the vehicle is operating at L2 or L3 without such a link, in which case the declared Safety Link shall remain capable of issuing an Abort Command;
- a permanent **team identifier and vehicle designation** visible on the exterior;
- mechanically secured energy storage;
- no exposed sharp edges, no unguarded rotating elements accessible during handling, and no components liable to detach in normal operation.

18.2 Vehicles shall not deposit, discharge, spray or release any substance onto the field or into the water.

18.3 Vehicles shall not physically damage, obstruct, capture or interfere with field elements or other teams' vehicles.

18.4 The dimensional and mass requirements below apply at technical inspection. The UAV is measured ready to run. The UGV and USV are measured in Start Configuration.

Vehicle	Maximum dimensions	Maximum mass	Measurement condition
UAV (micro)	150 mm motor-to-motor diagonal	under 100 g	Ready to run, including battery, guards, antennas, sensors and payload; complete propeller protection mandatory
UGV	300 × 300 × 300 mm	Edition Annex	Start Configuration, including battery, antennas, sensors, guards, wheels, payload and all deployment mechanisms
USV	200 × 200 × 200 mm	Edition Annex	Start Configuration, including battery, antennas, sensors, guards, hull elements, payload and all deployment mechanisms

18.5 Start-envelope test.

The UGV shall fit completely inside a rigid measurement volume with internal dimensions of 300 × 300 × 300 mm. The USV shall fit completely inside a rigid measurement volume with internal dimensions of 200 × 200 × 200 mm. The test is performed without compression, force, removal of parts or manual restraint. Antennas are included within the applicable envelope. An antenna may be folded or secured only where that arrangement is the declared Start Configuration used at the Start Signal; it may not be manually compressed against the measurement fixture merely to pass inspection.

18.6 Included equipment.

All batteries, antennas, sensors, guards, payloads, communication devices and mission equipment required for the run shall be installed during measurement. Equipment may not be added after inspection except an approved replacement of an identical declared component.

18.7 Deployment after start.

A UGV or USV may unfold, extend or otherwise expand beyond the start envelope after the Start Signal. Every deployed component shall remain mechanically attached to the vehicle. A vehicle may not discard packaging, restraints, supports or other parts, and expansion does not permit the vehicle to move or damage field elements.

- 18.8 Pre-run compliance.** The UGV and USV shall be in Start Configuration at the Start Signal. If a vehicle cannot satisfy its applicable envelope before expiry of the Setup Window, the run is recorded DNS. Deployment before the Start Signal is a false start; the vehicle shall be reset within the remaining Setup Window.
- 18.9** Compliance is determined by the official measurement equipment. No design tolerance is added to the stated limits. The resolution and verification method of the official instruments are published in the Technical Inspection Checklist.
- 18.10** The UAV mass and size limits are internal conditions of entry and do not imply exemption from any aviation, radio, venue or transport requirement.

Article 19. Aerial Vehicle (UAV)

- 19.1 Function.** Perform aerial reconnaissance of the competition area and obtain visual information not accessible from ground level, by identifying markers distributed on the field.
- 19.2 Configuration.** Multirotor (tricopter, quadcopter, hexacopter or equivalent) sized for indoor or controlled-space flight.
- 19.3 Required.** Rechargeable battery power; a rigid guard or duct protecting the complete perimeter of every propeller; emergency stop or Abort Command procedure; and visible arming state indication. The guard or duct shall remain installed for inspection, practice and every scored run. In cooperative categories, the UAV shall carry sensing capable of obtaining the official marker information required by the mission.
- 19.4 Video and control method.** FPV is not mandatory. A UAV may be flown by direct visual control, video-assisted control, partial autonomy, supervised autonomy or full autonomy, consistent with the declared Autonomy Level. A real-time video link is optional unless an Edition Annex explicitly requires one for a specific Category 1 task.
- 19.5 Specific objectives (cooperative categories).** Take off · stabilise · traverse the aerial zone · detect visual markers · determine colour and value · establish the sequence · complete the Handover · land in the designated zone.
- 19.6 Recommended capabilities.** Machine vision, image processing, autonomous navigation, position estimation, flight control.

Article 20. Ground Vehicle (UGV)

- 20.1 Function.** In Category 1B, execute an independent ground navigation mission. In cooperative Categories 2 and 4, execute the ground mission using the information obtained and locked during the UAV reconnaissance phase.
- 20.2 Configuration.** Differential, Ackermann, omnidirectional or equivalent drive, stable on flat surfaces.
- 20.3 Required.** Rechargeable battery power; emergency stop; compliance with the Start Configuration envelope of Article 18; and dimensions in Operational Configuration compatible with safe use of the course.
- 20.4 Specific objectives (cooperative categories).** Depart from the Start Zone · complete the required gate and obstacle elements · visit the required checkpoints or colour-coded mission stations in the locked order · reach the Finish Zone.

Article 21. Surface Vehicle (USV)

- 21.1 Function.** In Category 1C, complete an independent aquatic navigation mission. In cooperative Categories 3 and 4, execute the aquatic route using the information obtained and locked during the UAV reconnaissance phase.
- 21.2 Configuration.** Stable hull; electric propulsion; steering by rudder, differential thrust or equivalent.
- 21.3 Required.** Rechargeable battery power; emergency stop; compliance with the Start Configuration envelope of Article 18; construction that prevents leakage of lubricants, fuels or other contaminants into the water; and positive buoyancy in Start Configuration and throughout the run.
- 21.4 Specific objectives.** Pass the required gates · locate the buoys · round each required buoy completely in the assigned order · cross the finish line.

Article 22. Radio Communications

- 22.1** All radio equipment used at the venue shall comply with the applicable national and institutional regulations governing radiocommunication equipment certification, permitted frequency bands and transmission power in the host country of the Edition. **Each team is solely responsible for verifying and demonstrating compliance for its own equipment.** Equipment that cannot be shown to comply will not be admitted to the Field of Play.
- 22.2** Teams competing outside their home country are advised that permitted bands, certification marks and licensing requirements for control links and video transmission differ substantially between countries, and that equipment lawful in one jurisdiction may be unlawful in another. Verification well before travel is essential.
- 22.3** The **Frequency Coordinator** administers all radio emissions at the venue. The following operational rules apply in all Editions:
- All transmitting equipment shall be declared at technical inspection, including control link, video link, telemetry and any inter-vehicle data link, with band, channel range and output power.
 - Radio configurations are **assigned or approved per heat** by the Frequency Coordinator. Fixed-channel video, telemetry and Wi-Fi systems shall use the assigned channel. Frequency-hopping systems, including Bluetooth and BLE, shall use the configuration declared and approved at inspection. Teams may not alter an assigned or approved configuration without authorisation.
 - Video transmitters shall remain **powered off** except when the team is called to the Field of Play and the field official authorises activation. Transmitting from the pits is prohibited.
 - Where a channel-control token system is used, a team may transmit on the controlled channel only while holding the corresponding token.
 - Mission links are permitted.** Short-range wireless links forming part of a vehicle's mission system — including Wi-Fi in any mode, Bluetooth and BLE, ESP-NOW, and proprietary 2.4 GHz protocols — are permitted, provided they are declared under 22.3(a), use the channel or radio configuration assigned or approved by the Frequency Coordinator, use no external amplifier or undeclared high-gain antenna, and are operated only during authorised setup, practice or run periods.
 - Identification.** Every mission link device shall be identifiable by an SSID, Bluetooth

device name or equivalent beginning with the team's assigned identifier. Hidden SSIDs and randomised device names are not permitted.

- g) **Closed system.** A mission link may connect only devices declared by the team as part of its System. Any link to a device outside the declared System — including personal telephones, undeclared computers, or any device situated outside the operator station — is prohibited. If such a link is used to obtain or relay mission information, Article 26.2 also applies.
 - h) **General connectivity is prohibited.** Personal hotspots, mobile tethering and access points that do not form part of a declared mission system may not be operated within the venue.
 - i) **Failsafe.** Loss of a mission link shall not result in uncontrolled vehicle motion. The failsafe requirement of Article 18.1 applies to every link on which vehicle motion depends.
 - j) First violation of this Article results in a warning; a second violation results in disqualification from the heat; a third results in disqualification from the category.
- 22.4** The organization does not guarantee an interference-free environment. Teams are expected to design robust links and failsafe behaviour. Where a mission link and a control link would share the 2.4 GHz band, teams are advised to select low-duty-cycle protocols, or hardware operating in a different band, in preference to full access-point operation.

Article 23. Energy Storage and Battery Safety

- 23.1** Energy storage systems shall comply with the applicable national and institutional regulations and standards governing battery safety, and — for teams travelling by air — with the applicable international air transport provisions for lithium batteries. **Each team is solely responsible for verifying these requirements in advance.** Teams are strongly advised to confirm carriage limits with their airline before travel; the organization cannot supply replacement batteries.
- 23.2** The following operational rules apply at the venue in all Editions:
- a) **Declaration.** All battery packs shall be declared at registration and presented at technical inspection with legible labelling stating chemistry, nominal voltage, cell count, capacity and discharge rating where specified by the manufacturer.
 - b) **Condition.** Packs showing swelling, puncture, damaged wrapping, exposed cells, damaged connectors or evidence of thermal events are rejected. Rejection is not appealable.
 - c) **Construction.** Commercially manufactured packs are permitted by default. Team-assembled packs are permitted only with documented cell specifications, appropriate protection for the chemistry and configuration, and prior Technical Committee approval.
 - d) **Storage and transport.** Batteries not installed in a vehicle shall be kept in a fire-resistant bag or metal container at all times.
 - e) **Charging.** Charging is permitted only in the designated charging area, on a non-combustible surface, with a team member in continuous attendance. Unattended and overnight charging is prohibited. Balance charging is mandatory for multi-cell packs where the battery chemistry and pack design require balancing.
 - f) **Fire response.** Each charging station is equipped with appropriate fire-response means. Any thermal event shall be reported to the Safety Officer immediately.
 - g) **Mounting.** Batteries shall be mechanically retained. Adhesive or hook-and-loop

attachment alone is not sufficient on aerial vehicles.

- h) **Battery changes** are permitted only between runs, in the pits, using declared packs marked with the team's assigned identifier. A battery may not be changed after the Start Signal or between phases of a cooperative run. An unauthorised battery change results in disqualification from the run.

Article 24. Modes of Operation and Autonomy Levels

- 24.1** The Challenge admits the following operating modes. The level claimed shall be declared before each run and is verified by field officials during the run.

Level	Designation	Description
L0	Teleoperation	All actions commanded by an operator via FPV or direct visual control
L1	Partial Autonomy	One or more mission segments executed automatically; operator intervenes at will
L2	Supervised Autonomy	Full mission executed automatically; operator may intervene only to abort
L3	Full Autonomy	Complete mission with no operator input after the Start Signal, including Handover

- 24.2** For a cooperative run, the applied Autonomy Level is the **lowest level demonstrated by any mission-critical part of the chain**, including aerial perception, Handover, ground or surface navigation, and mission termination. A team may declare different intended levels for individual phases, but the scoring multiplier is based on the resulting system-level classification.
- 24.3** At L2 and L3, any operator input other than an Abort Command constitutes a **level violation**: the run is rescored at the highest level actually demonstrated, and a penalty is applied under Article 31. Use of an Abort Command or Kill Switch for safety does not by itself reduce the Autonomy Level, but the affected phase may remain incomplete.
- 24.4** Misdeclaration of autonomy level or concealment of operator input is a conduct violation under Article 11.2.
- 24.5** Autonomy is rewarded through the scoring multiplier of Article 29 and through special recognition under Article 37.

PART E

Mission Specifications

Article 25. Field of Play

- 25.1** Field dimensions and construction tolerances are published in the Edition Annex not later than the rule freeze date, together with dimensioned drawings and a photographic reference. Current indicative Japan Edition footprints are:

Element	Specification
UAV arena	Approximately 3×3 m; enclosure and clear-height requirements published in the Edition Annex
UGV arena	Approximately 4×4 m
Water basin	Internal dimensions approximately 2.53×1.33 m; depth approximately 0.51 m
Marker station cubes	300 mm cube, one per station, colours red, yellow, blue, green
Visual markers	200 mm fiducial (ArUco / AprilTag / QR, dictionary published in the Annex), mounted on the upper face of each cube
Checkpoint / mission zones	Geometry and tolerance published in the Edition Annex [CONFIRM]
Finish Zone	Geometry and completion condition published in the Edition Annex [CONFIRM]
Buoys	Colour-coded and moored; final diameter and reference geometry published in the Edition Annex [CONFIRM]
Lighting	Indoor artificial lighting; illuminance range published in the Edition Annex

25.2 Field elements may not be modified, moved or marked by teams. Contact with a field element that displaces it is penalised under Article 31.

25.3 The Technical Committee may adjust field element positions between heats. Positions are fixed within a heat.

25.4 Marker values used in cooperative categories are randomised between runs and are not disclosed in advance. Category 1C route sequences are randomised and provided to the team immediately before the applicable run in accordance with Article 27.

25.5 Any brochure, website graphic or conceptual field illustration is **indicative only**. The Edition Annex and normative Field Drawings govern dimensions, tolerances, route definitions and scoring boundaries.

Article 26. Handover Rules

26.1 The **Handover** is the defining element of the cooperative categories and is governed strictly.

26.2 Screening. Markers are mounted on the upper face of the station cubes and are not readable from the operator position. The operator station is positioned so that no team member has direct line of sight to the marker faces. Any attempt to obtain marker information other than through the UAV system — including by a team member entering or observing the field from an unauthorised position, or by a spectator relaying information — is a conduct violation resulting in disqualification from the run.

26.3 Permitted Handover methods:

Method	Description	Max level
H1 Declared transcription	An operator reads mission information supplied by the UAV system through an approved human-readable output (for example video or a ground-station display) and records it on the Mission Data Form	L1
H2 Ground-station transfer	Mission information is processed and transferred through the team's ground station to the receiving vehicle without manual transcription or editing of the mission data; an approved display or electronic MDF records the transfer	L2
H3 Direct vehicle-to-vehicle	Mission information passes from the UAV system to the receiving vehicle without human intervention; an approved electronic MDF or status interface makes the locked declaration visible to officials	L3

- 26.4 Declaration record.** The declaration may be recorded on the paper MDF or through an electronic interface approved during technical inspection. For H2 and H3, the record shall contain at least the team identifier, run identifier, detected colour–value mapping, locked sequence or sequences, timestamp, transfer method and sending and receiving device or devices. The Technical Committee may publish a standard log format in Annex D.
- 26.5 Declaration lock.** Mission information required by a receiving vehicle shall be locked before that vehicle departs its Start Zone. Once locked, it may not be amended. In Category 4, the ground and aquatic mission data may be recorded in the same MDF or approved electronic record following Phase I. The field official confirms the record; this confirmation does not certify that the declaration is correct.
- 26.6** A receiving phase started without the required recorded declaration scores zero for that phase. Where an H2 or H3 method cannot be verified from the approved record, the Handover is rescored at the highest method that can be verified.
- 26.7** An incorrect declaration does not stop the run. A receiving vehicle may execute the locked sequence, and scoring is applied under Article 30. Teams are thereby scored on the correctness of the complete perception–decision–information–transfer–action chain, not merely on driving skill.

Article 27. Category 1 — Single Domain Missions

- 27.1** Category 1 missions are **independent single-platform challenges**. No second platform, UAV-derived mission data or Handover is required.
- 27.2 1A — Micro UAV Navigation Challenge.** The UAV completes a compact navigation course that may combine precision take-off and landing, gate passage, slalom or obstacle navigation, controlled manoeuvring and visual-marker tasks. Direct visual control, video-assisted control and autonomous operation are all permitted subject to Article 24. FPV equipment is not a condition of entry unless explicitly required by the Edition Annex.
- 27.3 1B — Ground Navigation Challenge.** The UGV follows a defined ground course that may include checkpoints, a navigation gate, an obstacle or barrier section, route-following segments and colour-coded mission elements. Any run-specific route or colour order is supplied directly by the officials; it does not depend on another competition vehicle. Precision parking is not a mandatory Category 1B element.
- 27.4 1C — Aquatic USV Navigation Challenge.** The course contains **four buoys** together with the required navigation gates. Immediately before each run, the Head Referee provides the team with the run-specific route instructions and ordered buoy sequence. The USV shall pass each required gate in the specified direction, round each designated buoy completely in the announced order, and cross the finish line. The announced sequence is fixed for that run.
- 27.5** For Category 1C, a buoy is completed only when the USV travels completely around it in the required direction as defined by the Edition Annex field drawing. Merely touching, passing beside or partially circling a buoy does not constitute completion.
- 27.6** The exact task combination, route geometry, obstacle arrangement, dimensions, starting positions and tolerances for all Category 1 subcategories are published in the applicable Edition Annex. Any brochure, website graphic or conceptual course illustration is **indicative only**; sizes and locations shown in such illustrations are not normative unless repeated in the Edition Annex or Field Drawings.
- 27.7** Category 1 is scored under Article 29.

Article 28. Categories 2, 3 and 4 — Cooperative Missions

Cooperative missions consist of consecutive execution phases. All receiving ground and aquatic mission data are derived from the UAV reconnaissance phase and locked under Article 26. In Category 4 the UGV phase is completed before the USV phase, but the USV route is not generated by the UGV.

Phase I — Aerial Reconnaissance (all cooperative categories)

Objective: obtain mission-critical information by aerial observation.

Four stations are distributed on the field, each identified by a coloured cube (red, yellow, blue, green). Each cube carries a visual marker on its upper face encoding a numeric value. The UAV shall detect the markers from the air and determine the correspondence between colour and value. The values define the locked mission order used by the applicable receiving vehicle or vehicles.

Illustrative example only — marker values are randomised between runs.

Colour	Example value
Red	3
Yellow	1
Blue	4
Green	2

Example resulting order: Yellow → Green → Red → Blue

Phase completion: the phase concludes when the required Handover record has been locked under Article 26 and the UAV has landed completely within the designated landing zone. A UAV that has not landed within the zone at Mission End forfeits the landing score. The subsequent execution phase may begin only after Phase I has been completed or formally abandoned under Article 17.

Phase II — Ground Navigation (Categories 2 and 4)

The UGV departs from the Start Zone and shall:

1. complete the required gate and obstacle elements defined in the Edition Annex;
2. visit the four required colour-coded checkpoints or mission stations in the order locked under Article 26;
3. remain within each scoring zone for a **dwell of not less than 1 second**, with the vehicle fully inside the zone and stationary where the Field Drawings define a dwell zone;
4. reach the Finish Zone.

Success conditions: all required course elements completed; locked order followed; Finish Zone reached.

Checkpoint validity: where a dwell zone is used, a checkpoint counts as visited when the vehicle's entire ground-contact footprint lies within the zone, the vehicle is stationary, and the dwell condition is satisfied. Dwell timing begins only after all movement has ceased. A checkpoint touched or entered only partially is not valid. Each checkpoint may score once. A checkpoint visited out of the locked order is not scored at that time and is penalised as an incorrect checkpoint; it may be visited again when it becomes the next required checkpoint.

Phase III — Surface Navigation (Categories 3 and 4)

The USV departs from the Start Zone using the aquatic sequence locked from Phase I. The USV shall:

1. pass each required navigation gate in the direction specified by the Field Drawings;
2. locate the four colour-coded buoys;
3. round each required buoy **completely** in the locked order and in the direction specified by the Field Drawings. A valid rounding requires the complete hull to pass the published entry and exit reference lines while the buoy remains on the required side;
4. cross the finish line.

The Edition Annex defines gate directions, buoy entry and exit reference lines, tolerances and the finish condition unambiguously.

Category 4 — Sequencing

In the Grand Final, Phases I, II and III execute consecutively within a single Run Time Limit. Phase II may begin only after Phase I is completed or formally abandoned. Phase III may begin only after Phase II is completed or formally abandoned. Both Phase II and Phase III use mission information derived from Phase I; Phase III does not require mission information generated by the UGV.

A phase that fails does not automatically terminate the run. The Team Captain may declare the phase abandoned under Article 17, after which the team may proceed to the following phase and forfeits all unearned points from the abandoned phase. A disabled vehicle may be removed only at the direction of the Head Referee.

PART F

Scoring

Article 29. Scoring Model

29.1 Category 1 (Single Domain) is scored on time:

$$\text{Score} = \text{Course Time} + \text{Penalties}$$

The **lowest** score wins. A DNF is assigned the Run Time Limit plus 60s plus accrued penalties, and ranks below any completed run.

29.2 Categories 2, 3 and 4 (Cooperative) are scored on mission achievement:

$$\text{Score} = (\text{Task Points} \times \text{Autonomy Multiplier}) + \text{Time Bonus} - \text{Penalties}$$

The **highest** score wins.

29.3 Autonomy Multiplier:

Level	Multiplier
L0 — Teleoperation	1.00
L1 — Partial Autonomy	1.15
L2 — Supervised Autonomy	1.30
L3 — Full Autonomy	1.50

The multiplier applies to Task Points only. In cooperative categories, the level applied is the system-level Autonomy Level determined under Article 24, based on the lowest mission-critical level actually demonstrated and verified by field officials.

- 29.4 Time Bonus** = 0.5 points per second of Run Time Limit remaining at Mission End, awarded only if the mission is completed. Maximum 150 points. A DNF earns no Time Bonus.
- 29.5** The scoring structure is designed to implement Article 3 by prioritising mission achievement, verified information transfer and autonomy while retaining a limited reward for faster completion.

Article 30. Task Points

Category 4 — Multi-Domain Grand Final (1000 points):

Phase	Task	Points
I	Take-off and stable flight established	30
I	Each marker correctly detected and decoded (4×40)	160
I	Complete sequence correctly declared	60
I	UAV landed completely within landing zone	50
II	Each checkpoint / mission station completed in correct order with any required valid dwell (4×60)	240
II	UGV reaches Finish Zone	110
III	Each buoy correctly rounded in correct order (4×70)	280
III	Finish line crossed	70
Total		1000

Category 2 — Air–Ground (600 points): Phase I as above (300) + Phase II as above (300, scaled: 4×50 checkpoints / mission stations, 100 Finish Zone).

Category 3 — Air–Water (600 points): Phase I as above (300) + Phase III as above (300, scaled: 4×60 buoys, 60 finish).

Scoring against truth. Marker detection and sequence declaration are scored against the true field configuration held by the Head Referee. Where the locked declaration is correct, checkpoint and buoy execution is scored against that sequence. Where the locked declaration is incorrect, correctly following that locked sequence earns 50% of the corresponding execution points and forfeits the declaration-correctness points. Incorrect-checkpoint and incorrect-buoy penalties apply only when the vehicle deviates from the locked sequence; following an incorrect locked sequence is not penalised a second time for the same information error.

Required gates and obstacle elements are course-compliance elements. Their omission or incorrect traversal is penalised under Article 31; they do not add Task Points unless the Edition Annex expressly assigns an additional scoring element.

Article 31. Penalties

Infraction	Category 1	Categories 2–4
Incorrect checkpoint	+15 s	−40 pts
Omitted checkpoint	+30 s	−80 pts
Buoy incorrectly rounded	+20 s	−50 pts
Omitted buoy	+30 s	−80 pts
Gate omitted or passed incorrectly	+15 s	−40 pts
Collision with field element or obstacle	+10 s	−25 pts
Displacement of a field element	+15 s	−40 pts
Departure from the Field of Play	+15 s	−40 pts
Unauthorised vehicle contact by team member	Run ends	Run ends
Autonomy level violation (Art. 24.3)	—	−100 pts and rescoring
Late declaration / undeclared phase start	—	Phase scores zero
Radio violation (Art. 22.3j)	Warning / heat DQ	Warning / heat DQ
Unauthorised battery change	Disqualification	Disqualification

Penalties are cumulative unless this Rulebook expressly provides an alternative scoring treatment. The same physical act or information error shall not receive two penalties under different descriptions. A score may not fall below zero in Categories 2–4. In Category 1, checkpoint penalties apply only to 1B; buoy penalties apply only to 1C; and gate penalties apply only to subcategories in which a gate is a required course element.

Article 32. Tie-Breaking

Category 1. A tie within a single-domain subcategory is resolved by:

1. fewer penalty seconds;
2. shorter unpenalised Course Time;
3. where both teams have a second valid attempt, the better score from that remaining attempt;
4. decision of the Technical Committee if the tie remains unresolved and no additional run can reasonably be scheduled.

Categories 2–4. A tie in a cooperative category is resolved by:

1. higher Task Points before application of the Autonomy Multiplier;
2. higher verified system-level Autonomy Level;
3. fewer penalty points;
4. shorter total Course Time;
5. higher Phase I Task Points;
6. decision of the Technical Committee if the tie remains unresolved.

The decision of the Technical Committee under the final tie-break step is final.

PART G

Operations

Article 33. Technical Inspection

- 33.1** All vehicles shall pass a mandatory technical inspection before competing. Vehicles that do not pass may not compete.
- 33.2** Inspection verifies: dimensions; mass; Start Configuration where applicable; electrical safety; batteries and their documentation; emergency stop, Safety Link and failsafe function; declared radio equipment; structural integrity; mandatory UAV propeller protection; deployment mechanisms; positive buoyancy of the USV; basic function; and, where applicable, the Donor Platform declaration and vehicle eligibility requirements of Article 10.
- 33.3 Dimensional demonstration.** The UGV shall be placed inside the official $300 \times 300 \times 300$ mm measurement volume and the USV inside the official $200 \times 200 \times 200$ mm measurement volume, each in Start Configuration. The team may then demonstrate deployment to Operational Configuration. Officials may repeat the applicable start-envelope check before any run.
- 33.4 Failsafe demonstration is mandatory.** The team shall demonstrate, on request, that loss of a motion-critical Control Link stops propulsion within 1 second, or, for an L2/L3 vehicle without a continuous Control Link, that the declared Safety Link can issue an Abort Command that produces the safe state.
- 33.5** A vehicle that fails inspection may be re-presented once within the inspection window. Vehicles substantially modified after passing inspection, including changes to dimensions, deployment mechanisms, propulsion, batteries, radio equipment or safety functions, shall be re-inspected before their next run.
- 33.6** If officials determine that a vehicle appears to be an original or essentially unchanged Commercial Platform, or that the declared engineering contribution is materially inconsistent with the vehicle presented, the matter is referred to the Technical Committee for an eligibility ruling under Article 10. The vehicle may not compete until that ruling is issued.
- 33.7** Inspection approval confirms only compliance at the time inspected. The team remains responsible for maintaining compliance throughout the event.
- 33.8** Inspection stickers shall remain visible on each vehicle throughout the event.

Article 34. Protests and Appeals

- 34.1** A protest may be lodged only by the Team Captain, in writing, in English, within **15 minutes** of the publication of the result concerned.
- 34.2** Protests may address rule interpretation or procedural error. **Matters of fact determined by officials during a run are not protestable.**
- 34.3** The Technical Committee rules on protests before the next scheduled heat where practicable. Rulings are published and are final.
- 34.4** Frivolous or repeated protests may be treated as a conduct matter under Article 11.

Article 35. Safety

- 35.1** The event operates under industrial safety principles. The Safety Officer may halt any activity or vehicle presenting risk, at any time, without prior warning.
- 35.2** The technical safety requirements of Articles 18, 19, 21 and 23 remain in force during inspection, practice and competition. Teams shall also maintain the posted safety distances during flight operations, keep the water basin free from electrical leakage and contamination,

and operate deployable mechanisms only when the surrounding area is clear.

35.3 Eye protection is required within designated areas as posted.

35.4 Teams shall report any incident, injury, fire or near-miss to the Safety Officer immediately.

Article 36. Disqualification

Grounds for disqualification include: modifying the Field of Play; interfering with another team; using undeclared or prohibited communications; changing a battery after the Start Signal; adding undeclared equipment after inspection; entering an original or essentially unchanged Commercial Platform contrary to Article 10; materially misrepresenting the origin of a vehicle or the team's engineering contribution; endangering event safety; misdeclaring autonomy level; obtaining marker information outside the Handover chain; and failing to follow the instructions of officials.

Article 37. Awards

Award	Basis
UAV Champion	Category 1A winner
UGV Champion	Category 1B winner
USV Champion	Category 1C winner
Air-Ground Champion	Category 2 winner
Air-Water Champion	Category 3 winner
Grand Final Champion	Category 4 winner
Second and Third Place Overall	Category 4
Autonomy Award	Highest autonomy level successfully demonstrated
Systems Integration Award	Best-documented and best-executed integration architecture, judged from the TDR and observed performance
Engineering Design Award	Design quality independent of competitive result
Multidisciplinary Team Award	Breadth of disciplinary composition and evidence of genuine cross-disciplinary work

PART H

Educational Framework and Vision

Article 38. Educational Objectives

The Challenge is designed as a platform for developing talent in advanced robotics, integrating knowledge of mobile robotics, artificial intelligence, computer vision, embedded systems, automatic control, mechatronics, electronics, digital manufacturing, multi-agent systems, ROS 2, IoT, wireless communications, naval engineering and aerospace engineering.

Article 39. Vision

The HMDS Multi-Domain Robotics Challenge seeks to establish itself as a leading international university competition in cooperative robotics, advancing technologies applicable to search and rescue, infrastructure inspection, environmental monitoring, precision agriculture, intelligent logistics and exploration of complex environments.

The mission framework is a systems-integration challenge in which perception, planning, informa-

tion transfer and coordination between platforms matter as much as the individual performance of each robot. This reflects current directions in distributed robotic systems and prepares students for problems of high technological complexity, while strengthening the link between academia, industry and research centres.

ANNEXES

Supporting Documents

Document	Purpose and content
Annex A — Edition Annex (Mexico)	Venue, field drawings and tolerances, schedule, local suppliers, administrative requirements, confirmed mass and energy limits, official measurement instruments and radio requirements
Annex B — Edition Annex (Japan)	Equivalent Edition-specific information for the Japan event
Annex C — Technical Inspection Checklist	Official inspection criteria and self-verification checklist published in advance
Annex D — Mission Data Form (MDF)	Official paper form and electronic record specification for Handover declarations
Annex E — Registration and Declaration Forms	Roster, vehicle-development and Donor Platform declaration, battery declaration, radio equipment declaration and liability waiver
Annex F — Field Drawings	Normative dimensions of field elements, checkpoint and Finish Zone boundaries, buoy entry and exit reference lines, gate directions, rounding directions and marker specifications
Annex G — Published Q&A	Binding interpretations issued under Article 5.2

Items marked [CONFIRM] require Technical Committee decision before publication.