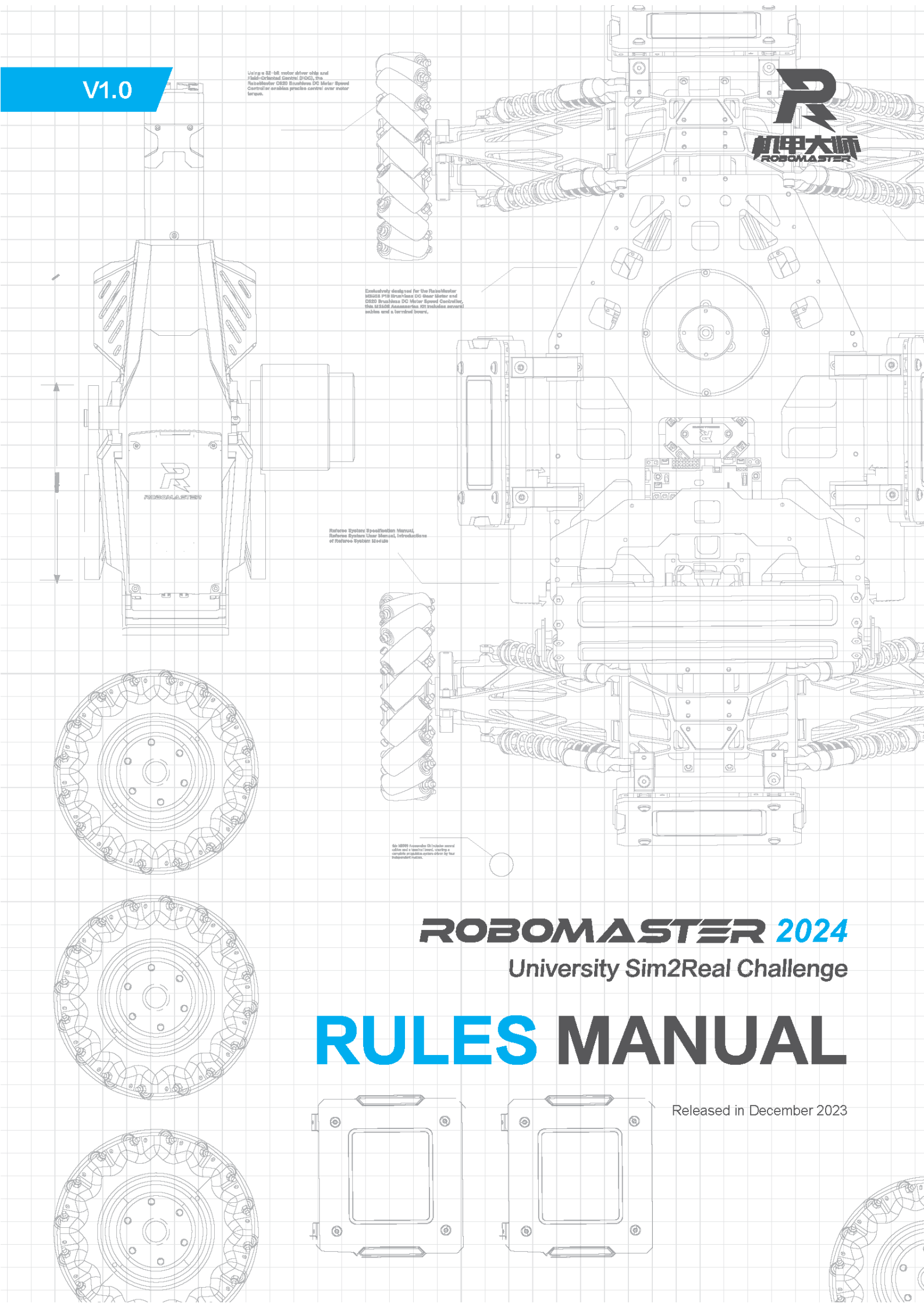
V1.0



ROBOMASTER 2024

University Sim2Real Challenge

RULES MANUAL

Released in December 2023

Statement

The Organizing Committee encourages and advocates for technological innovation, and open-source technology, and respects the intellectual property of participating teams. All rights related to the intellectual property developed during the competition are owned by the individual teams. The committee will not be involved in the handling of intellectual property disputes within teams. The participating teams must properly handle all aspects of intellectual property rights among internal school members, company members, and other members of the team.

While using the supporting materials provided by the committee, teams should respect the owners of all intellectual property. Teams are also prohibited from engaging in any behavior that violates intellectual property rights, including but not limited to reverse engineering, replication, or translation.

With regard to any behavior that may infringe upon the intellectual property rights relating to educational materials provided for the competition by the committee or co-organizers, the intellectual property rights owners are entitled to hold the infringing parties responsible in accordance with the law.

Release Notes

Date	Version	Changes
November 6, 2023	V1.0	First release

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1. Introduction

The RoboMaster University Sim2Real Challenge ("RMUS") at its core allows participants to win points by rearranging minerals using fully automated RoboMaster EPs that have been modified officially. The match lasts for five minutes with a sim2real-based format, where robots rearrange minerals based on the information shown on the exchange tags to earn points. Participants will be ranked according to their total points won. The objective of the challenge is to assess how well a program completed on a simulation platform can be operated in real application environments. Teams are required to develop and debug their algorithms in a simulator and submit their codes by the specified deadline. The office staff will deploy corresponding codes in physical robots of the same models to rearrange minerals. This challenge does not require teams to build physical robots, allowing participants to focus entirely on algorithm design.

Figure 1-1 RoboMaster EP

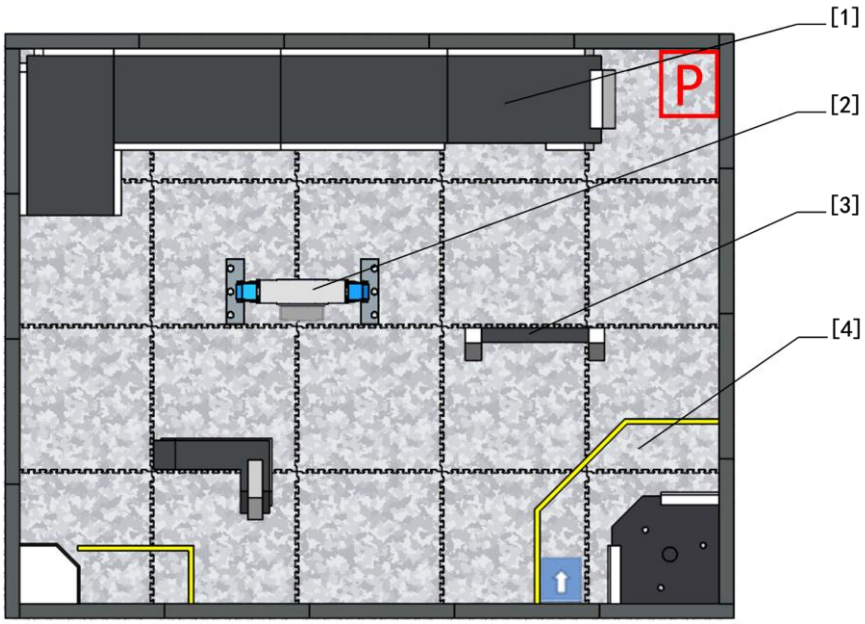
2. Competition Area

The error margin for the dimensions of all Competition Areas and Components described in the document is ±5%. The unit for the size parameters on the site drawings is mm.

2.1 Overview

The competition area is a 4*5m rectangle consisting of infrastructures such as Starting Zone, Exchange Station, Mineral Zones, Obstacle Block, and Road, as shown below.

The labels for Mineral Zones below only indicate their general areas and do not represent their specific locations on-site.



[1]	Road	[2]	Exchange Station	[3]	Obstacle Block	[4]	Starting Zone

Figure 2-1 Site modules

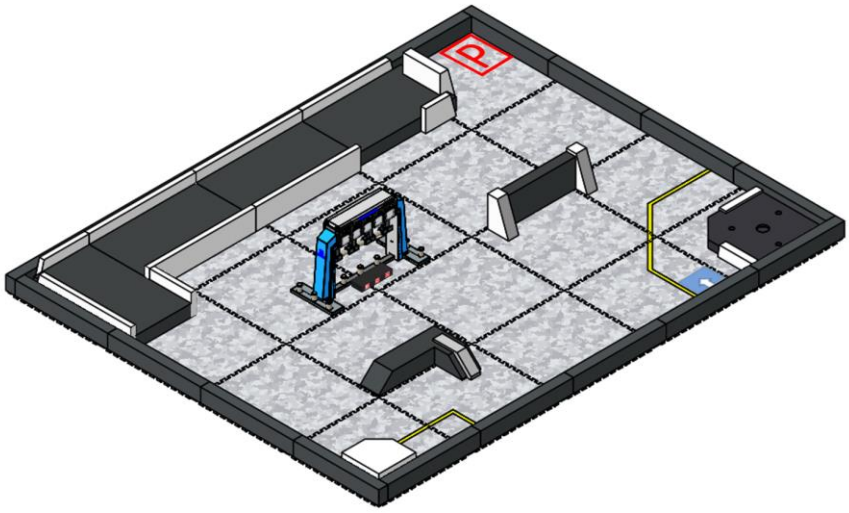


Figure 2-2 Site axonometric view

The floor is covered by 20mm-thick EVA mats. The Road and other modules on the site are also made of EVA.

Figure 2-3 EVA mat

2.2 Starting and Stopping Areas

The Launch Zone is the area where the robot is placed before the official start of the match. Prior to the start of the match, the robot is placed into the blue box in the base area. The robot gripper orientation is aligned with the arrow.

The Parking Zone is the area where the robot stops when the competitor finishes the match. Before the end of the match, the robot must be parked in the red box area (45*50cm area in the red box, 10cm width of the red line) through the competitor's site navigation, and the projection of the robot completely in the parking area is judged as a successful parking.

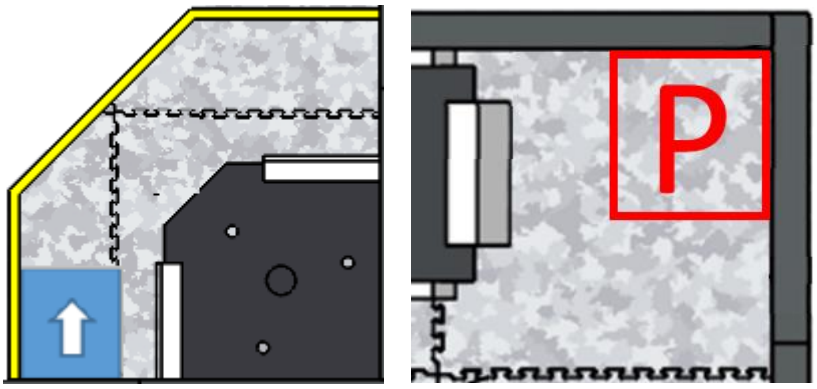
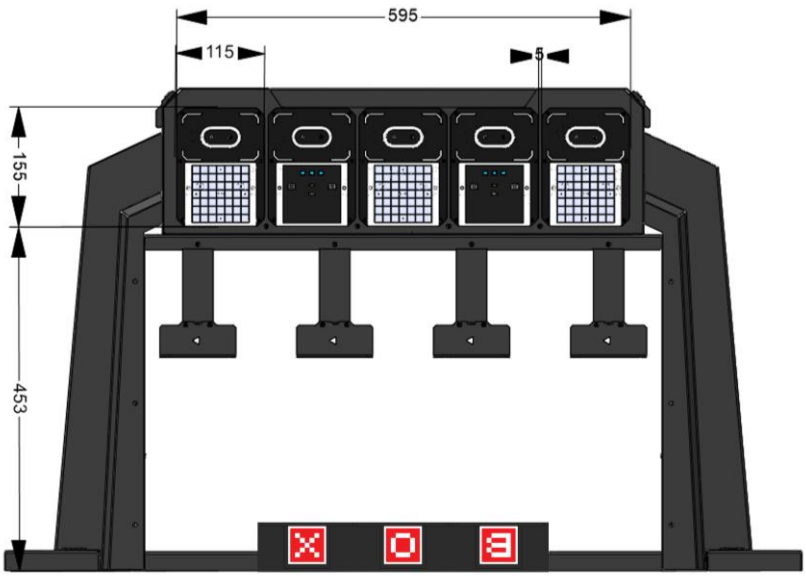


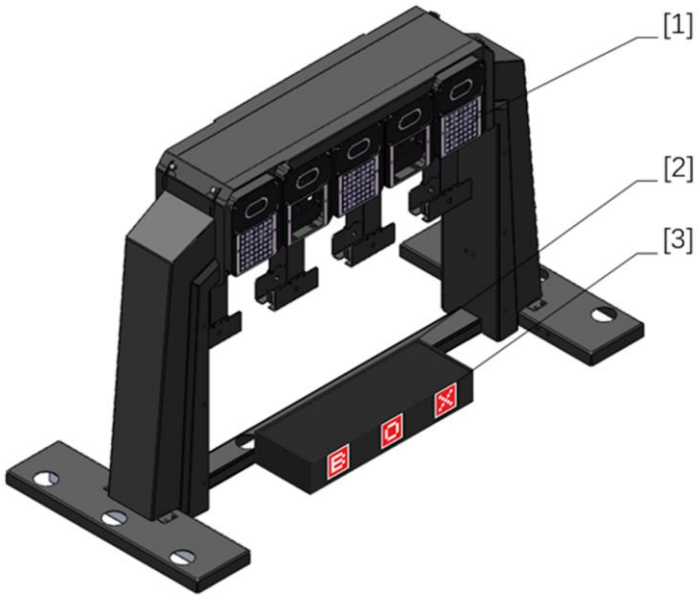
Figure 2-4Starting and Stopping Areas

2.3 Exchange Station

An Exchange Station is made up of three exchange markers and a receptacle.

The three markers are above the receptacle, which has three slots each corresponding to a marker above. A localization marker can be found on the front of each slot to facilitate localization by robots.





[1]	Exchange marker	[2]	Receptacle	[3]	Localization marker

Figure 2-5 Exchange Station

The dimensions of the receptacle are as shown below (in mm):

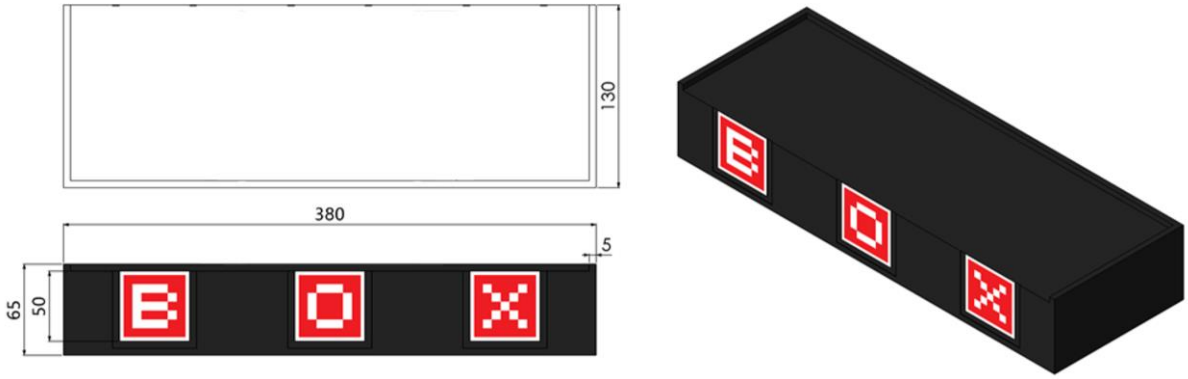


Figure 2-6 Receptacle dimensions

2.4 Mineral Zones

Three fixed-point mining areas are set up in the site, and the centre point of each area is at the same distance from the redemption platform, as shown in the blue area (40*40cm square) in Figure 2-7 below.

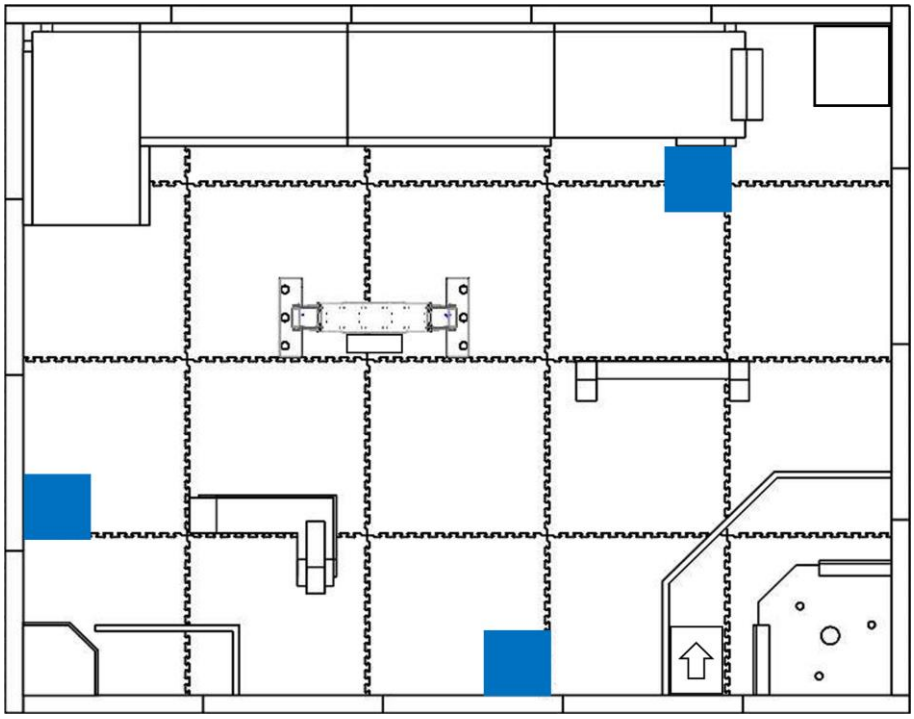


Figure 2-7 Mineral Zones

2.5 Minerals

The ore is a cube with 50mm-long sides, weighs around 98g, and is manufactured of ABS. Each ore's surface has the same digital identification label, the backdrop color is a 45 mm red square digital label, and the value range of each ore's digital identification label is between 1 and 6.

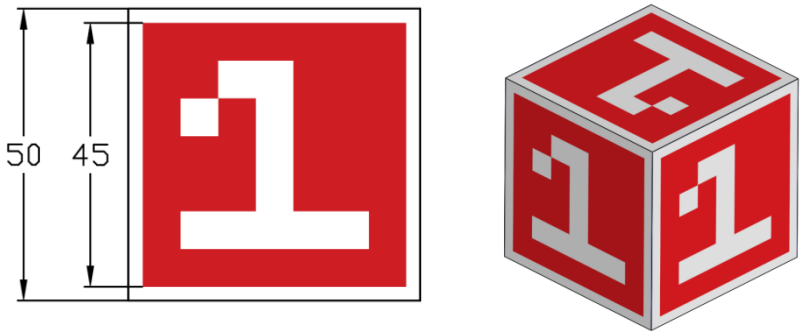


Figure 2-8 Mineral

3. Simulation Technology Architecture

3.1 Simulation Platform

The simulation platform used for the challenge is AI Habitat 2.0. The platform is mainly comprised of two components: Habitat Sim and Habitat Lab. Habitat Sim is a high-performance physics-enabled 3D simulator, while Habitat Lab is a modular library for end-to-end training tasks.

3.2 Data Interface

The standard communication interface used in the challenge is ROS, which bridges the AI Habitat platform with existing robotics resources via ROS-X-Habitat. The committee will provide a standardized sensor data sampling interface and an actuator control interface for the robots, so teams only need to focus on the development of their robotic algorithms. For more details on the sensor data and other parameters provided by the robots, please refer to the officially released “Tutorial” file.

3.3 Platform Architecture

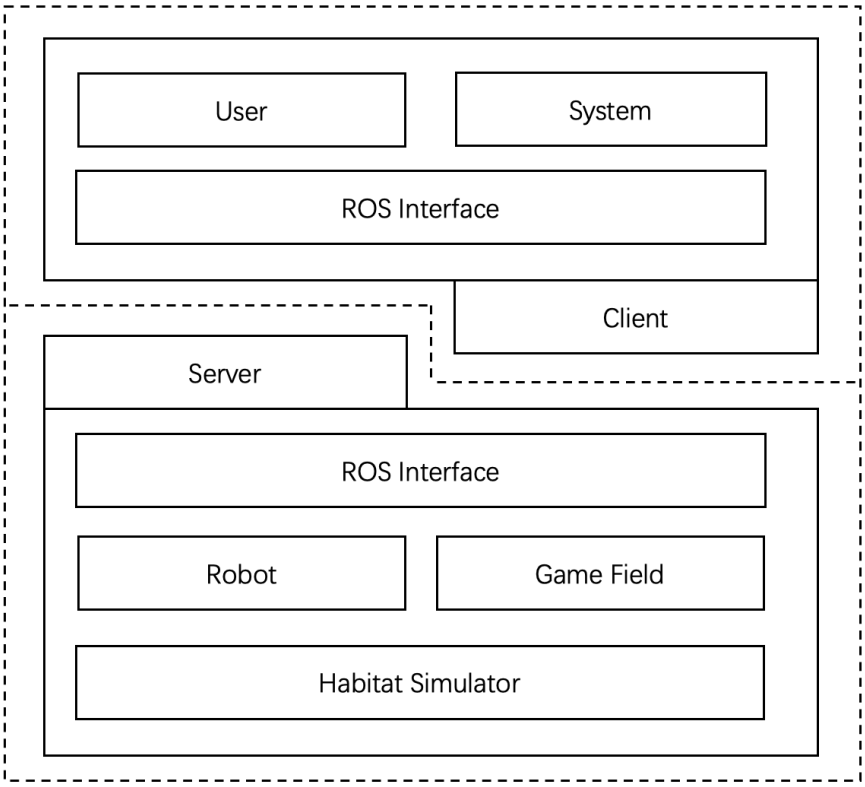


Figure 3-1 Platform architecture

The simulation architecture consists of two components: the Server and the Client.

The Server is a Docker image for the Habitat preconfigured by the committee. In a simulated environment, the Server will provide robot models and the competition site to the team. The Game Field Module includes the Competition Area, Exchange Station, Minerals, and other equipment. The Robot Module consists of the sensor data sampling interface and the actuator control interface. For specific descriptions of the interface, please refer to the officially released “Tutorial” file.

The Client is a Docker image simulating the hardware resource of the main controller of the RoboMaster EP robot and serves as an independently packaged Docker image for the challenge mission. Teams can call the interface provided by the Server image and develop algorithms for the challenge mission in the Client image. The User Module consists of the Demo program provided by the committee and the functional modules required to be developed by the teams. The System Module consists of the monitoring and logging systems for all challenge missions and the communication functions for the referee system. The System Module has a higher process priority than the User Module.

4. Competition Mechanism

Each game is limited to 5 minutes. At the start of a round, 6 ores will be placed randomly in the three ore zones on the playing field (at least 1 ore will be randomly placed in each mine zone), then all teams will use this randomized distribution of ores for that round. After the robot departs from the starting area, it shall automatically obtain the ores from the ore zones and follow the redemption label's prompts to place the corresponding ores on the correct redemption platform. After completing the base three ore placement, it may stack the remaining ores on top of the base three ores, which will earn it bonus points. A robot's projection that is completely within the parking zone is judged to be successfully parked, and 6 points will be deducted from the overall score if it is not successfully parked. The match ends when the robot completes parking or the match time runs out.

Participating robots may only carry 1 ore at a time, otherwise it will be considered cheating and the authority match will be terminated immediately.

If the referee requests termination in advance or if the team members request termination on their own, the team's current challenge opportunity will end and one challenge opportunity will be consumed, with no results for the authorities.

4.1 Ore Distribution Adjustment Rules

Distribution of ores in mining areas:

The initial location of the 6 ores is randomly distributed across the three mining areas within the site (there will be at least 1 ore in each mining area), with each ore spaced no less than 100 mm apart within the mining area, with no stacking placed on top of each other.

4.2 Exchange Markers Mechanism

At the start of the game the redemption tab will display 3 random non-repeating numbers from 1-6. The number displayed on the redemption tag remains constant during the match. The robot follows the numbers displayed on the redemption tags and places the ores containing numerical identification tags onto the correct redemption platforms in order to obtain the corresponding base score. Stacking the remaining ores on top of the base three ores redeemed will earn bonus points.

1. Base points: three serial number ores in the final order of the same score, the order of the wrong placement of ores do not score (base points of 10 points for one ore, three ores in total 30 points). For the first layer (constructed by the base ores), any ores other than indicated in the redemption labels placed here are not scored. The referee system will automatically record the time of the three base ores when the first time they are placed on the redemption platform.

2. Bonus Points: Bonus points will be awarded for stacking the remaining ores on top of the redeemed base three ores (no bonus points will be awarded for incomplete base three ore placement). For the second layer and above, one individual ore score is: 2*(the number of layers in which it is placed - 1), with a maximum of four layers.

4.3 Rules on Exchanges

The following conditions must both be met in order to successfully redeem the ore:

1. Place the ores containing the corresponding numerical identification tags on the corresponding platform in accordance with the information displayed on the electronic redemption tag (the order must be exactly consistent with that displayed on the electronic tag);
2. Any one of the 3 base ores is in full contact with the top of the exchange platform (ores other than the 3 ores displaying the serial number will not be scored if they are in contact with the top of the exchange platform);
3. The conditions for determining the number of layers of two or more layers of ore: if the ore touches the first layer of ore without touching the redemption platform, it is determined to be the second layer of ore; if the ore touches the second layer of ore without touching the first layer of ore, it is determined to be the third layer of ore; if the ore touches the third layer of ore without touching the second layer of ore, it is determined to be the fourth layer of ore.

If a base ore is moved multiple times, the time of the first completed placement on the redemption platform is timed for that base ore.

The following are samples of several redemption statuses (the redemption stations are displayed in serial numbers 1-2-3 from left to right):

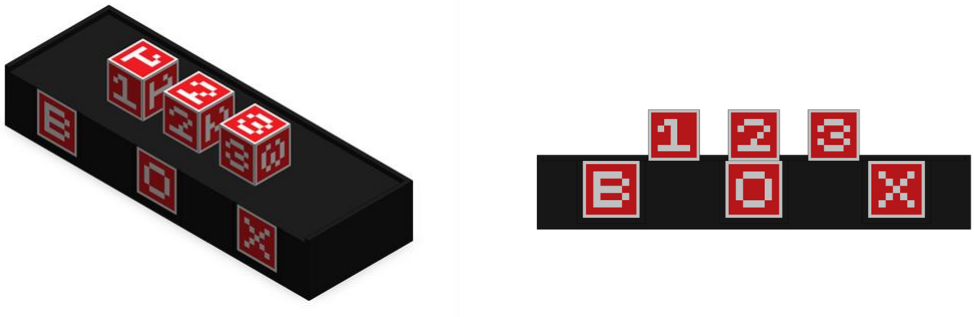


Figure 4-1 Exchange successful

(Score 30)

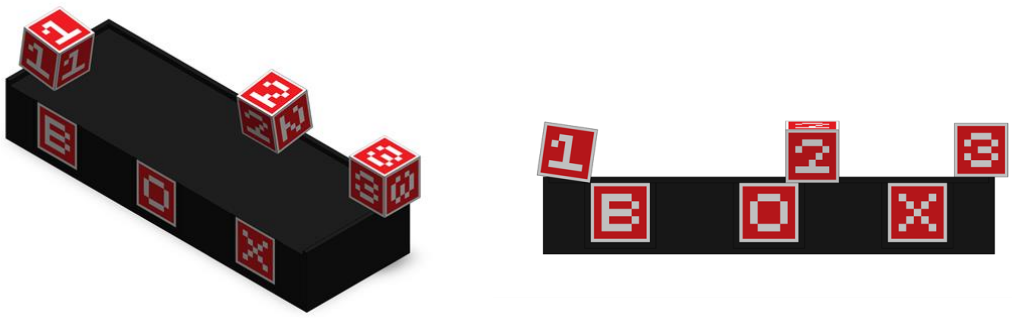


Figure 4-2 Exchange failed

(Score 0 if no ore is fully placed on top of the platform.

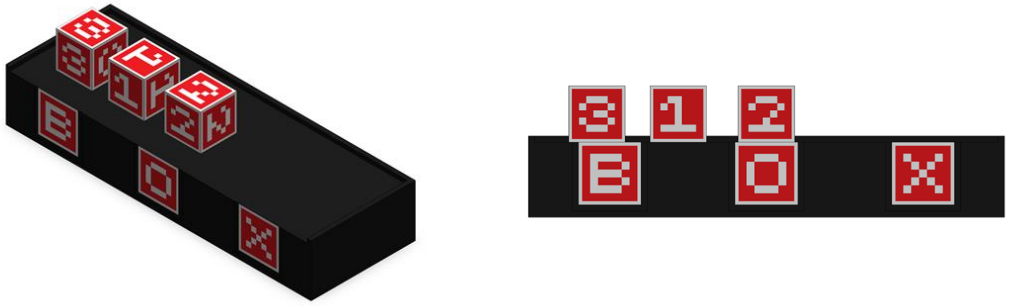


Figure 4-3 Exchange failed

(No ore serial numbers are in the correct order, scoring 0 points.)

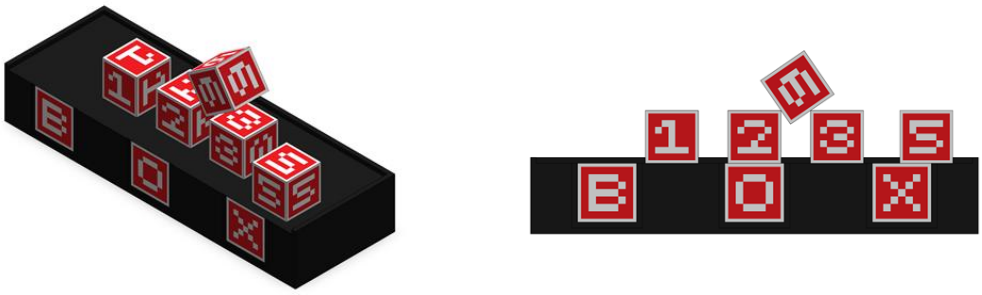


Figure 4-4 Exception

(The basic three ores meet the exchange success with 30 points scored, No. 6 ore for the second layer with 2 points scored, and No. 5 ore did not meet the first layer rule with 0 points scored. The case leads to a score of 32.)

4.4 Scoring

Priority will be given to the winner with the most points for successfully redeemed ores. In the event of a tie in the score of successfully exchanged ores, the winner will be the one who takes the shortest time to park the car.

Parking time: the parking time (to the nearest 0.1s) to park the robot in the parking area after redeeming the ore in the authority match.

Ranked according to the following rules:

R1: The tournament is ranked by taking the highest score of the three rounds;

R2: In the event of a tie for the highest score, the next highest score in the three rounds will be compared, and so on;

R3: If the scores are the same in all three rounds, there will be a rematch. The results of the rematch will only be used to differentiate the ranking of the teams with the same score, and will not be involved in the overall ranking.

Table 4-1 Ranking Example

ranking	competing teams	highest score			Next highest score			Lowest Score		
		Redeeming Ore Count	Ore Score	Parking time	Redeeming Ore Count	Ore Score	Parking time	Redeeming Ore Count	Ore Score	Parking time
1	S	6	42	239.4	6	42	246.8	6	42	249.9
2	E	6	42	254.5	6	42	263.1	6	42	232.1
3	X	6	42	254.5	6	42	272.8	5	36	254.1
4	Y	5	36	209.2	5	34	265.5	3	30	201.8
5	A	3	30	263.4	2	20	232.4	2	20	254.9
6	I	1	10	227.3	1	10	269.4	0	0	300

5. Competition Process

The challenge is made up of four stages: Simulation Stage, Sim2Real stage, and Real-Robot Final Stage.

5.1 Simulator Stage

The simulator debugging phase starts from 31 December 2023 and ends on 28 February 2024. In this phase, the main task of the participating teams is to develop algorithms in the simulator environment and complete the ore search redemption task, which mainly includes the following parts:

1. Download the Habitat environment Docker image and the competition task Docker image through the designated window of the organizing committee;
2. Configure the local environment by referring to the official Tutorial document, run the Demo routine, get the sensor data of the robot, and control the robot to move and grasp;
3. Complete the development of the ore search and exchange task according to the competition rules, and submit the code to the same designated window;
4. 28 February 2024, the organizing committee will determine the list of entrants to the next stage of the competition through technical evaluation.

5.2 Sim2Real Stage

The Sim2Real debugging phase starts on 4 March 2024 and ends on 4 May. The main task of the successful teams in this phase is to adjust and optimize their algorithms with test data from the real site. The main operation process is as follows:

1. The participating teams submit their codes to the designated submission window of the Organizing Committee;
2. The organizing committee will deploy the code submitted by the participating teams to the EP robot to run and execute the match tasks under the real venue;
3. During the test, the feedback data and match video of the EP robot will be released by the organizing committee on the designated platform to each team for the participating teams to download;
4. The participating teams will optimize their algorithms based on the feedback data and match videos.

During this phase, the participating teams will repeat the above 4 processes, continuously adjust and optimize the algorithm and apply for field tests.

The weekly field tests are subject to certain time limits, which will be announced on the official submission page, so teams are encouraged to plan their time wisely. The last code submission date is 4 May 2024 for participating teams.

5.3 Real-Robot Final Stage

The official tournament will be held in Yokohama, Japan at local time (TBD). The official tournament process is:

1. The committee sets the participating sequence of teams based on the dates of their last submitted codes, and deploys their codes on officially modified RoboMaster EP robots.

2. The codes of each team will be deployed on-site, after which the competition is finished. The committee will announce the results on the designated platform, where teams can view their final scores from the match.
3. The committee will release the feedback data from the Referee System and robots as well as the match video on the designated platform for teams to download.
4. Each team may compare their final scores with the feedback data and match video released by the organizer, to verify their match results.

Table 5-1 Competition Flow

Item	Description
Setup period	Competition area reset
Code download	Launch team's code
Referee system initialization	Countdown initialization
Start of match	The calculation of points by the System
Match conclusion	Generating scores and confirming match results

6. Season Schedule

Table 6-1 Season Schedule

Date	Activities	Notes
December 31, 2023	Official Registration Open	Robotic Sim2Real Challenge Official Website
January 31, 2024	Registration Close	Robotic Sim2Real Challenge Official Website
December 31, 2023 – February 28, 2024	Simulation Stage	Teams submit codes on the official website
March 4, **2024**	Simulation Stage Result Notification	Based on the ranking of simulator test 1. Qualified teams shortlisted 2. Double-confirming competition details

Date	Activities	Notes
March 4, 2024 – May 4, 2024	Sim2Real Stage	Committee deploys each teams' submitted codes in physical environment, and provide feedback data as well as video respectively
May 6 – May 10, 2024	Real-Robot Final Stage	Each team is allowed to submit the codes only for once
ICRA 2024 Date: (to be confirmed)	Formal Match	Participating teams are not required to arrive on-site

The time of the official tournament is the time standard of the place where the tournament is held, and the other times are the UTC+8 (i.e. Beijing Time) standard.

7. Participation

Participants will form a team based on the teams and the participants, and complete the registration process through the Sim2real official website, the registration interface.

7.1 Participating Teams

1. Every team member is allowed to join only one team in a competition season.
2. Each team must have a minimum of one and a maximum of five members. Each member's roles and responsibilities must be detailed in the application form.
3. Every team must have one registered team leader, who will be responsible for managing the team's progress in the competition, liaising with the committee, and submitting competition reports, among other tasks.

7.2 Team Member

Table 7-1 Team Member' roles and responsibilities

Roles	Role Instructions	No. of Persons	Status	Responsibilities
Supervisor	● The main person in charge of the team, responsible for the	0-1	Faculty members of the team's college or university who are qualified for	● Responsible for the safety of team members and property, as well as instructing and

Roles	Role Instructions	No. of Persons	Status	Responsibilities
	formation and management of the team ● Responsible for communicating and liaising with the committee. ● Must not be an official team member.		teaching and scientific research during the period of October 2023 to June 2024	managing the use of the team's funds ● Instructs the team in developing their project plan and solving R&D issues, and helps the team complete the challenge successfully ● During the challenge, the supervisor must actively cooperate with the committee and ensure the team leader reports to the committee regularly on the team's progress and other matters
Regular members	● Including the team leader and general team members. ● Must not be a supervisor.	1-5	With proof of full-time student identity up to September 2024	

Table 7-2 Roles and responsibilities of regular members

Roles	Role Instructions	No. of Persons	Responsibilities
Team Leader	● Core team member, the team's technical and tactical leader ● The main liaison with the committee	1	● Responsible for the division of labor, overall planning and tactical arrangement and adjustment ● Attends the Team leaders Meeting, represents the team in confirming match results and participates in appeal processes and any subsequent hearings

Roles	Role Instructions	No. of Persons	Responsibilities
			● Responsible for passing on the team's expertise and the team's future development after the challenge
Team Member	● Including the team leader and general team members. ● Must not be a supervisor.	1-5	

7.3 Other Requirements

R1. Any team participating in different competitions must use the same team name. A team's name must be in the format of "XXX Team", where "XXX" shall be the team's self-chosen name. The total length of the self-chosen name should not exceed 16 English letters or 8 Chinese characters. The self-chosen name must not include the school name or its abbreviation in Chinese/English, the word "team", "squad" and other equivalent terms in Chinese/English, or other special symbols such as "*/-+". The team name must reflect the positive and pioneering spirit of the team and comply with relevant state laws and regulations. If the committee determines that a team's name does not align with the spirit of the competition, it has the right to require the team to change its name.

R2. Each team must represent a university/college and meet the requirements for the roles, number and identity of members stated in "7.2 - Team Member". If a team fails to meet the requirements, it may be disqualified from the competition.

R3. Each university/college is allowed to have more than one team participating in the competition. However, only the team with the highest score from each university/college in the simulator stage will advance to the next stage.

8. Awards

Table 8-1 Awards Setup

Prize	Ranking	Quantity	Awards
First Prize	First Place	1	● Achievement Certificates (for each member) ● $2,000 pre-tax

Prize	Ranking	Quantity	Awards
	Second Place	1	● Achievement Certificates (for each member) ● $1,000 pre-tax
	Third Place	1	● Achievement Certificates (for each member) ● $500 pre-tax
Second Prize	Fourth to eighth places	5	Achievement Certificates (for each member)
Third Prize	Sim2Real debugging phase	Several	Achievement Certificates (for each member)

9. Appeals

9.1 Appeal Materials

How to appeal: Save the edited video (contents of which to be prepared by the team) and the text files containing the appeal materials in a folder (its total size not exceeding 100MB), and send it to the arbitration staff.

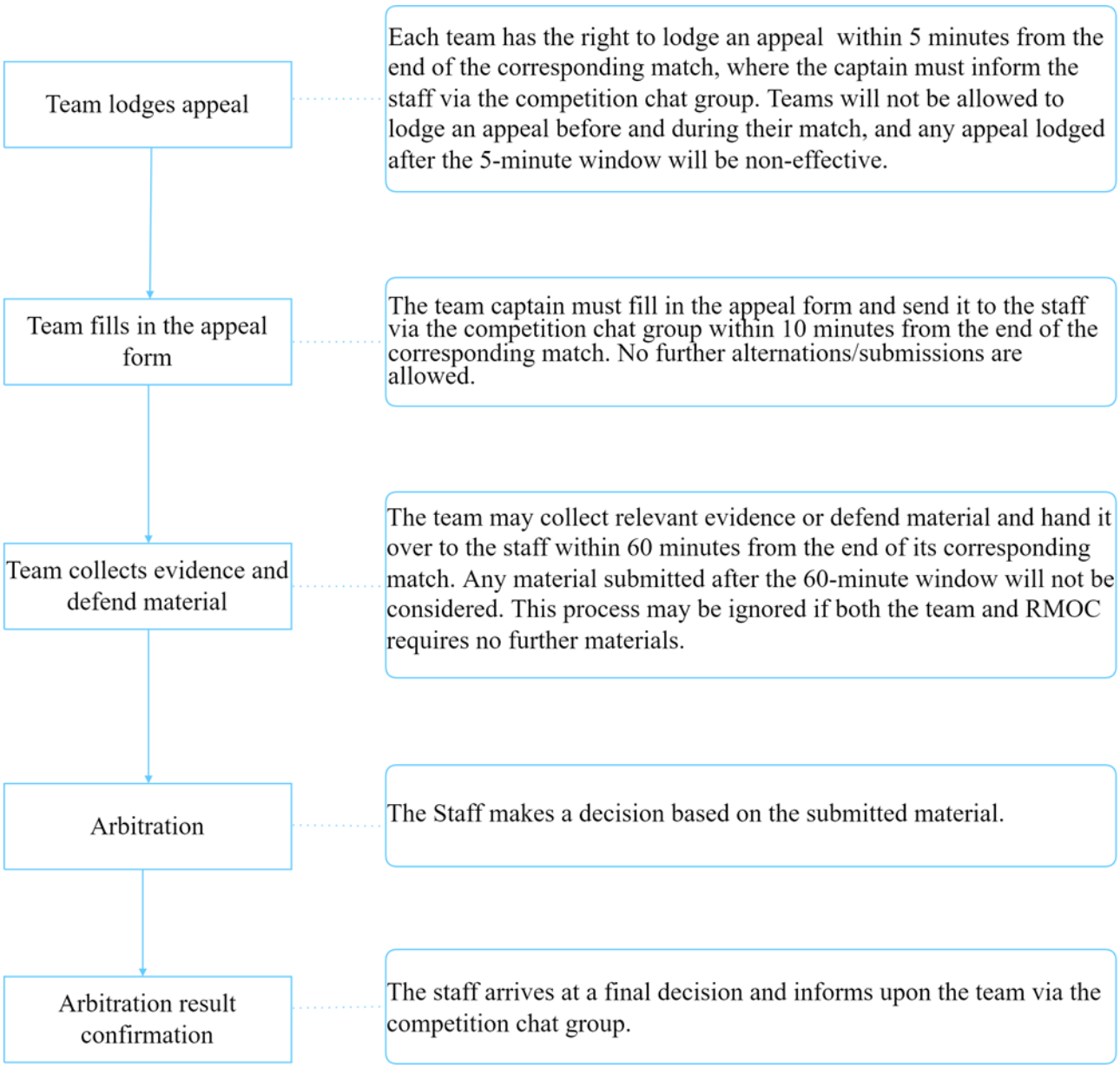
Material format: No video may exceed one minute in length. The name of the video must indicate the specific match, the round of the match and the time it was taken (rounded to minutes). The videos should be compatible with the latest version of Windows Media Player; the photos must be in JPG format; and the text documents must be in PDF format and not exceed 1,000 characters in length.

Naming of materials: The file name of each video and photo must be within 30 characters.

Text requirements: One text file can only correspond to one video or a photo, which must be indicated in the text. Only the violations reflected in the corresponding materials need to be addressed in the text files.

9.2 Appeal Process

Teams lodging an appeal must follow the procedure below:



9.3 Appeal Decision

The arbitration decisions that can be made include: Maintaining the original match results or ordering a rematch. Teams may not appeal against the decision made by the Arbitration Commission.

If a rematch is required by an arbitration decision, the committee will inform the teams of the time of the rematch when announcing the decision. If the team refuses the rematch, the appeal is deemed failed and the original match results are maintained.

10. Q&A

After the start of the competition season, the committee will set up an official chat group in which it will conduct online Q&A sessions and upload frequently asked questions in the competition onto the group's "Q&A Files".