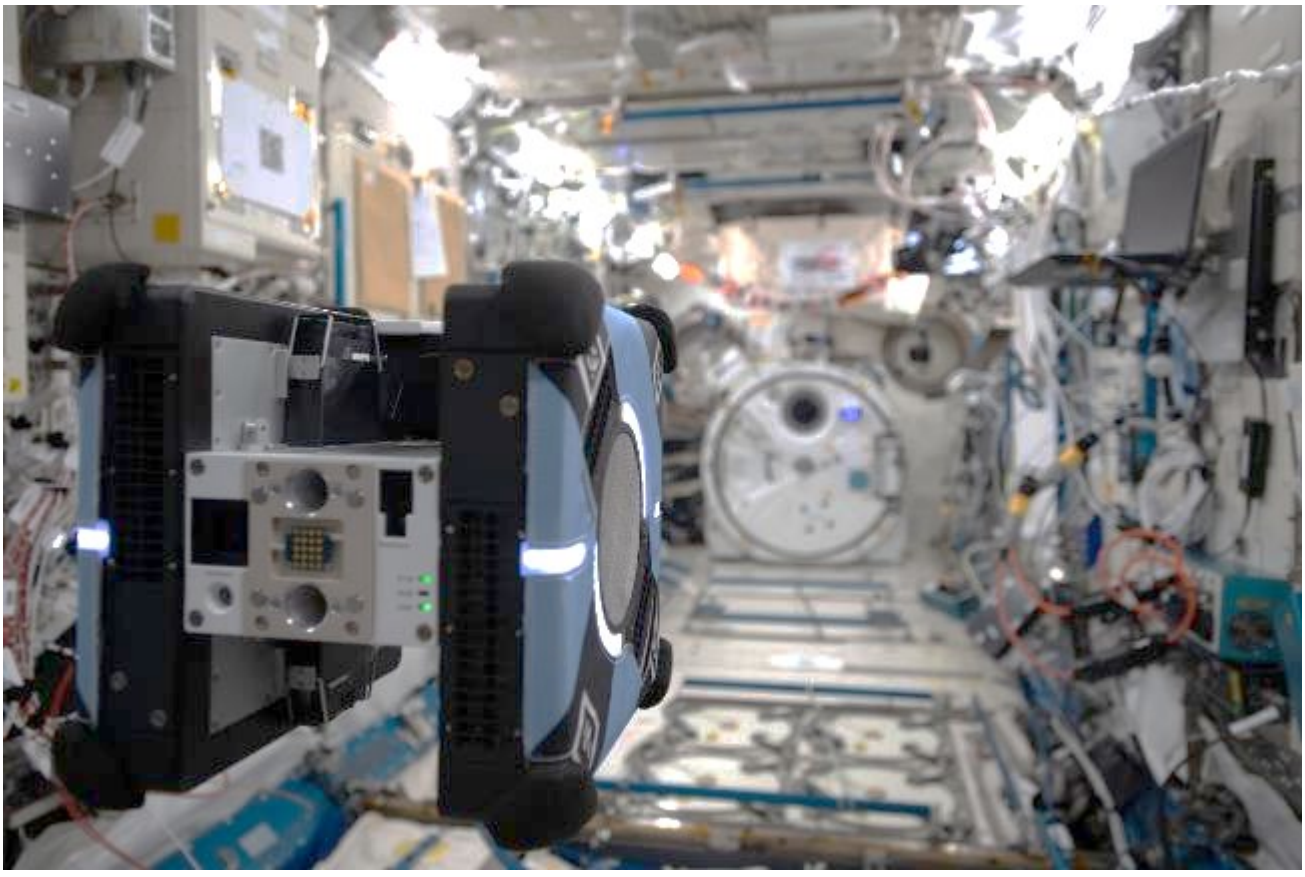
The 6th Kibo Robot Programming Challenge

Rulebook



Version 1.0 (Revision date: April 1, 2025)

Japan Aerospace Exploration Agency (JAXA)

Revision History

Revision history is listed below.

Revision Date	Version	Paragraph	Revision Location
April 1, 2025	1.0	All	-

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1. Introduction

The 6th Kibo Robot Programming Challenge (Kibo-RPC) is here. Create the best program to see if you can win.
A preliminary round will be held in each country/region to select their representatives. Participants compete using programs they have developed beforehand using JAXA's simulation environment. Game rules and scoring are basically the same in each country/region, although some have adopted their own evaluation criteria, so be sure to check your local Kibo-RPC website for details. Information regarding venue and dates will be made available by the point of contact (POC) in each country/region. This Rulebook contains general rules for all participants.
The winning teams from each preliminary round get to compete to be the best in the world in the final round where they will program and operate an Astrobee free-flying robot in the Japanese Experiment Module KIBO, which is part of the International Space Station (ISS).

2. Preliminary Round

2.1. Preliminary Round Period

The preliminary rounds will be held separately in each country/region during the period, so please participate in the preliminary round held in the country/region where you are registered. The preliminary round information for each country/region can be found on the official Kibo-RPC website (https://jaxa.krpc.jp/). For more information, please contact your country/region POC.

Question Acceptance Deadline[*1]: June 19, 2025, 12:00 (JST)

APK Submission Period: May 27-June 19, 2025, 23:59 (JST)

Preliminary Round Period: June 20 to July 6, 2025

[*1] **Any questions submitted after this date will receive a delayed response.**

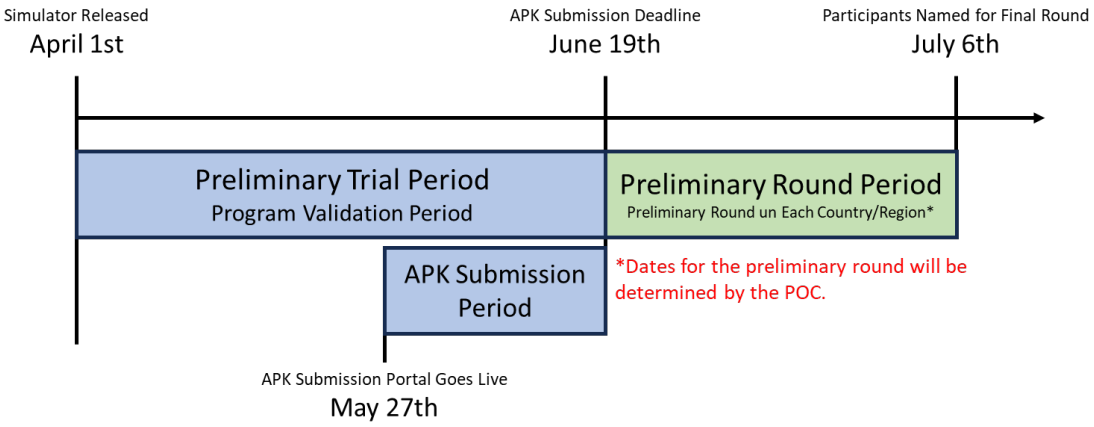


Figure 2.1-1 Preliminary Round Period

2.3. Game Rules

2.3.1. Game Flow

To control NASA's Astrobee in the Preliminary round, please create a program to complete the following game using JAXA's web simulation environment.

Within a time limit, Astrobee will be moved from the starting position (dock station) to a candidate location in Kibo where the treasure is hidden, and all images will be read. Astrobee will then be moved to the astronauts' site, where it will read the images of the treasure and landmarks in the astronauts' possession to provide clues to locate the real treasure. After reading the images, the player moves to the location where the real treasure is hidden, takes a picture of the treasure, flashes the Signal Lights to signal that he/she has found the treasure, and tells the astronaut where the treasure is hidden to complete the mission.

1. Start from the docking station.
2. After starting, Astrobee will patrol several candidate sites aboard Kibo where treasures are hidden.
3. Each team may choose a route through the Oasis Zones*1, where they receive points for passing through, and report what they find at each candidate location for hidden treasures.
4. Once all Astrobee has visited all of the sites, go to the astronaut and read the im-age of the real treasure and its nearby landmark. This will reveal the identity of the real treasure.
5. Go to the real treasure and take a picture.
6. After taking the photo, activate the Signal Lights to inform the astronaut of the treasure's location, and the mission is complete.
7. *1Oasis Zone: Points will be added as long as Astrobee is moving through this area.

*1Oasis Zone... Points will be added as long as Astrobee is moving through this area.

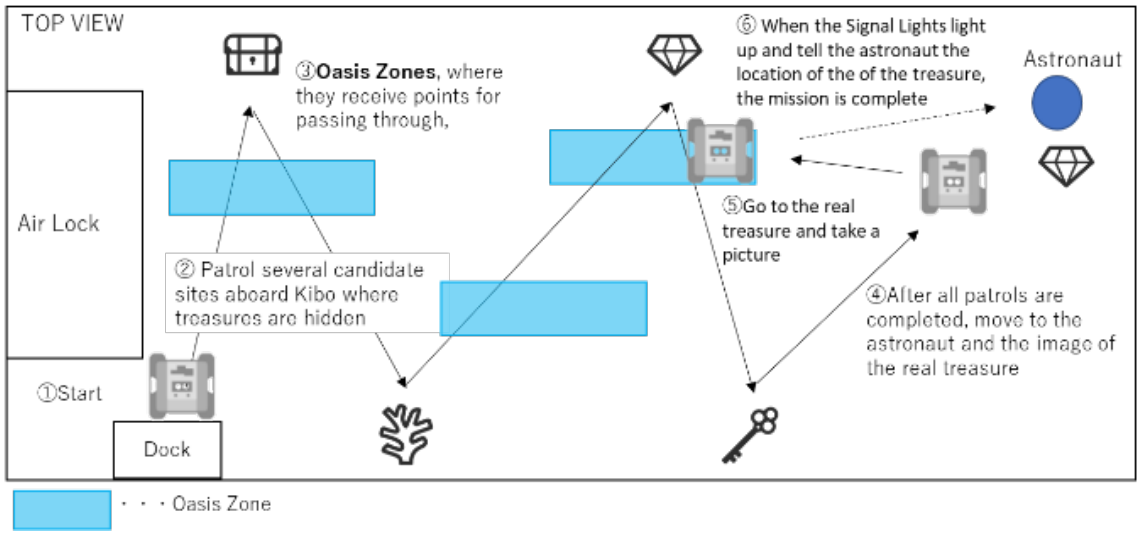


Figure 2.2.1-1 Game Flow

2.3.2. Preconditions

Table 2.2.2-1 Preconditions for Preliminary Round

#	**Content**
1	The starting position is the Dock Station, and the timer starts once Astrobee undocks.
2	There are 11 types of Lost Item images placed in each area. Breakdown: (3 Tresure Items, 8 Landmark Items) Prepare an AR tag on the same plane as the printed surface of Lost Item. The search area for Lost Item (hereinafter referred to as "Area") is limited to four locations. The area is specified as a plane, and one Lost Item is placed somewhere within the Area. Lost Item placement is random.
3	The Target Item is randomly selected from one of the Tresure Items in the game.
4	The following information will be presented to participants in advance. For more information on AR tags and Lost Item, please refer to section 2.2.3. 1. Orientation of the position of the starting point (StartPoint) 2. Report position to an astronaut (RoundingCompletionPoint) 3. Location and size of each area 4. Total number of Areas 5. Types of images to be placed and examples of difficulty levels 6. Location and size of the oasis zones 7. Parameters for a given angle and distance
5	Oasis Zones are set up along the route, where points are added according to the time spent in the zone. This oasis zone is given as a precondition. Please see section 2.2.5 for details. *Depending on the team's strategy, Astrobee does not have to go through the Oasis Zone.

Table 2.2.2-2 Coordinates (StartPoint and RoundingCompletionPoint to the astronaut)

Point	Coordinates			Orientation			
	x	y	z	x	y	z	w
Start	9.815	-9.806	4.293	1	0	0	0
Astronaut	11.143	-6.7607	4.9654	0	0	0.707	0.707

Table 2.2.2-3 Coordinate Information (Area)

		x_min	y_min	z_min	x_max	y_max	z_max
Area*	1	10.42	-10.58	4.82	11.48	-10.58	5.57
	2	10.3	-9.25	3.76203	11.55	-8.5	3.76203
	3	10.3	-8.4	3.76093	11.55	-7.45	3.76093
	4	9.866984	-7.34	4.32	9.866984	-6.365	5.57

***Area is displayed as a plane.**

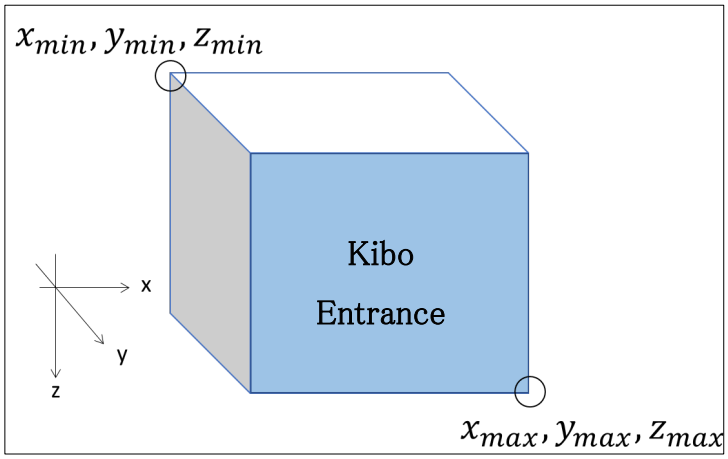
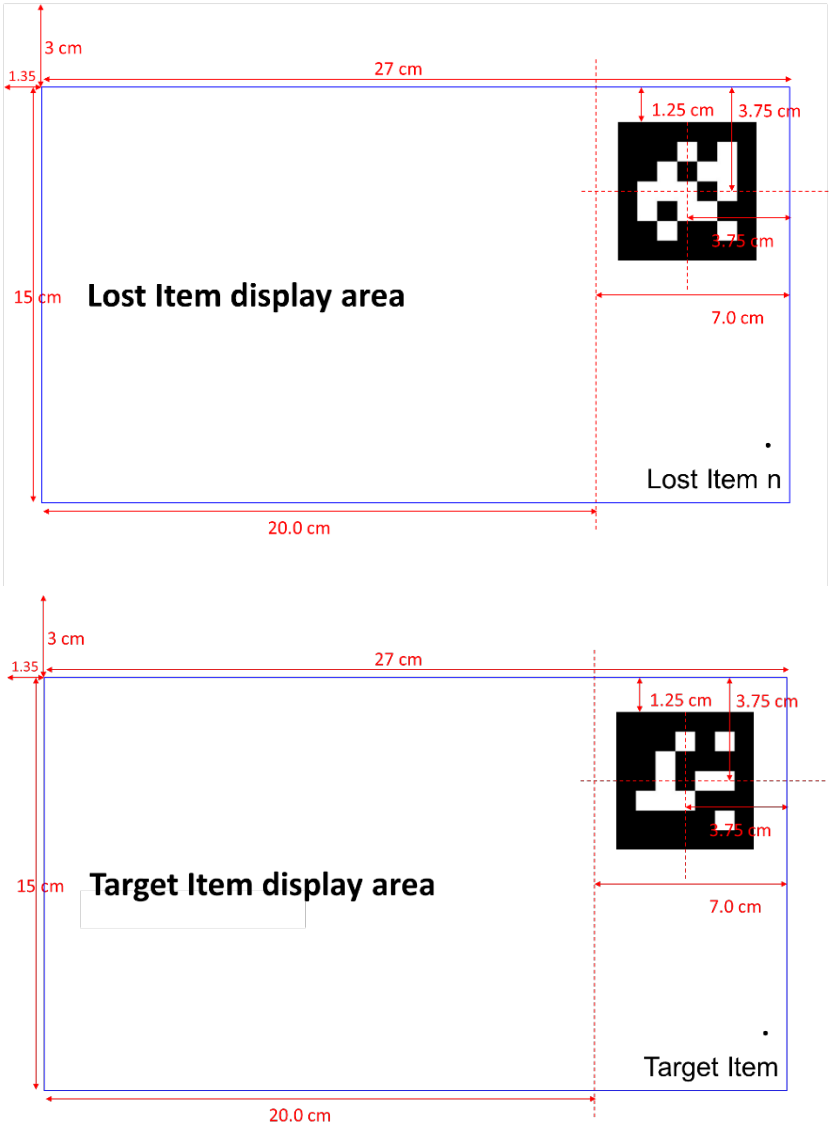


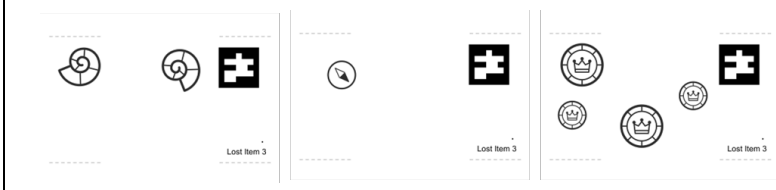
Figure 2.2.2-1 Definition of a Coordinate

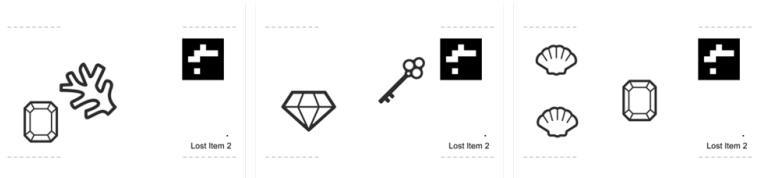
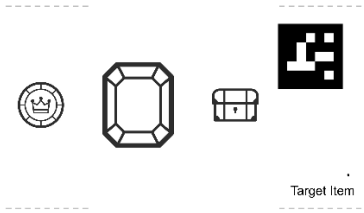
2.3.3. Objects

Table 2.2.3-1 Objects for Preliminary Round

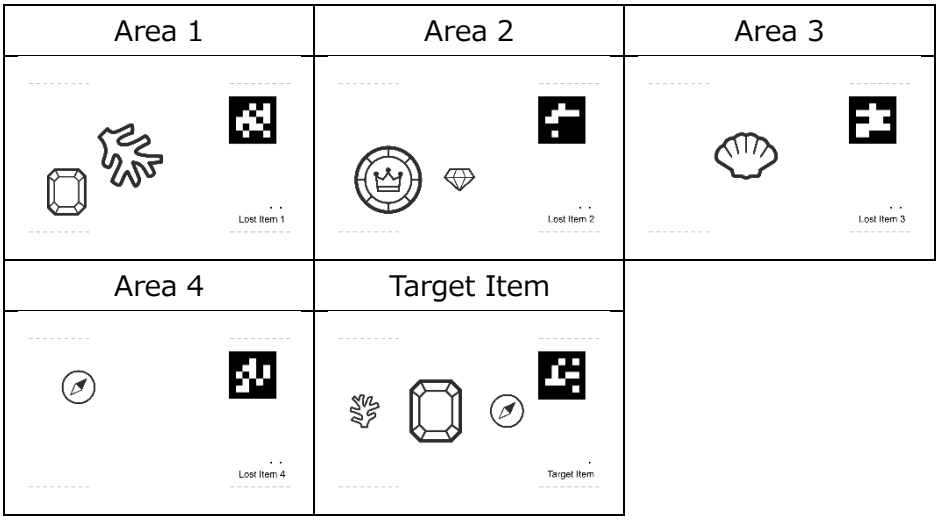
<table>
<tr><th>#</th><th>Object Name</th><th>Process</th></tr>
<tr><td>1</td><td>Lost Item List</td><td>
Tresure Item (3 types)
<table>
<tr><td>crystal</td><td>diamond</td><td>emerald</td></tr>
<tr><td>  </td><td>  </td><td>  </td></tr>
</table>
Landmark Item (8 types)
<table>
<tr><td>coin</td><td>compass</td><td>coral</td></tr>
<tr><td>  </td><td>  </td><td>  </td></tr>
<tr><td>fossil</td><td>key</td><td>letter</td></tr>
<tr><td>  </td><td>  </td><td>  </td></tr>
<tr><td>shell</td><td>Treasure_box</td><td></td></tr>
<tr><td>  </td><td>  </td><td></td></tr>
</table>
*The size of the Lost Item placed in the Area changes depending on the image difficulty level.
</td></tr>
</table>

2	AR Tag Information	AR Tag Information (No size change between Lost Item and Target Item) 

<table>
<tr>
<td>3</td>
<td>List of Lost Item image levels placed in each area
(Landmark Items only)</td>
<td>
<table>
<tr><th>Level</th><th>Image Examples</th></tr>
<tr><td>1</td><td>  </td></tr>
<tr><td>2</td><td>  </td></tr>
<tr><td>3</td><td>  </td></tr>
<tr><td>4</td><td>  </td></tr>
</table>
*Levels are subject to change based on all participants.
</td>
</tr>
</table>

<table>
<tr>
<td>4</td>
<td>List of Lost Item image levels placed in each area
(When Landmark Items and Tresure Items are displayed)</td>
<td>
<table>
<tr><th>Level</th><th>Image Examples</th></tr>
<tr><td>1</td><td>Level 1 image of Lost Items including Tresure Item are not available.</td></tr>
<tr><td>2</td><td>  </td></tr>
<tr><td>3</td><td>  </td></tr>
<tr><td>4</td><td>  </td></tr>
</table>
*Levels are subject to change based on all participants.
</td>
</tr>
<tr>
<td>5</td>
<td>Example of Target Item display</td>
<td> 

*Levels are subject to change based on all participants.
*Target Item displays two types of items: Tresure Item and Landmark Item.</td>
</tr>
</table>

6	Examples of images displayed in each Area and as Target Item	 *The level of Lost Item placed depends on the difficulty level of the simulator. *One Tresure Item and two Landmark Items are placed in the Target Item. One of the Landmark Items is placed with the Tresure Item in the Area, but the other is different.

2.3.4. Mission Completion Report

To complete the mission, you need to create a report using the QR code you scan.

Please see takeTargetItemSnapshot() in chapter 7 of the Programming Manual for the API to use in the Mission Completion Report.

2.3.5. Keep-In-Zone (KIZ) & Oasis Zone

Astrobees may move within Keep-In-Zones (KIZ), which means basically within the walls of Kibo. These are the Astrobee's pre-set boundaries, and if the destination set is outside a KIZ, the command will be rejected. In other words, it is necessary to program the Astrobee to move only within the KIZs.

Oasis Zones are areas within the KIZ where Astrobee will be scored based on the time it spends in that zone. 6th Kibo-RPC will add Oasis Zones, which will require participants to be more strategic in designing Astrobee's travel routes. (Figure 2.2.5-1, 2.2.5-2, 2.2.5-3, Table 2.2.5-1)

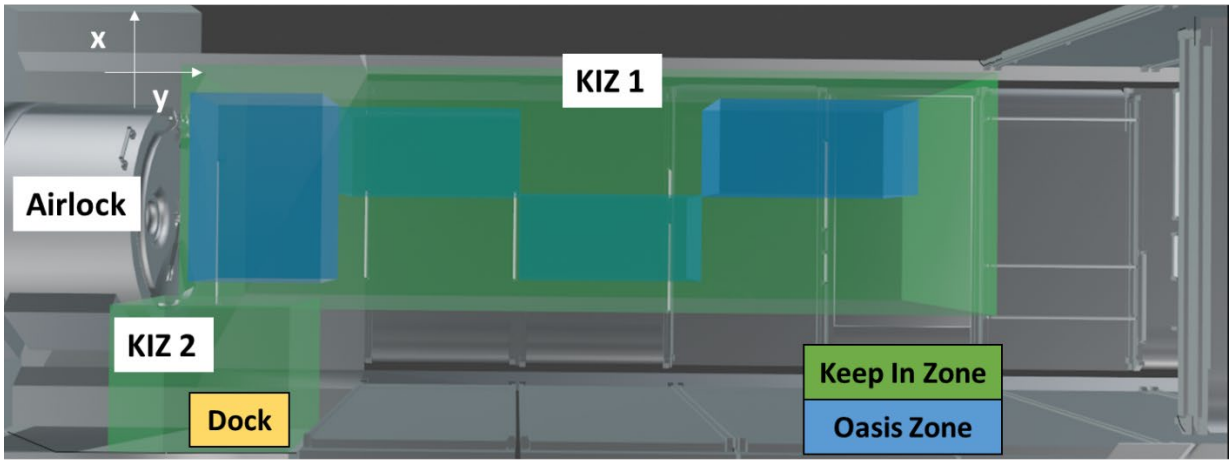


Figure 2.2.5-1 KIZ and Oasis Zone for the Preliminary Round (Top View)

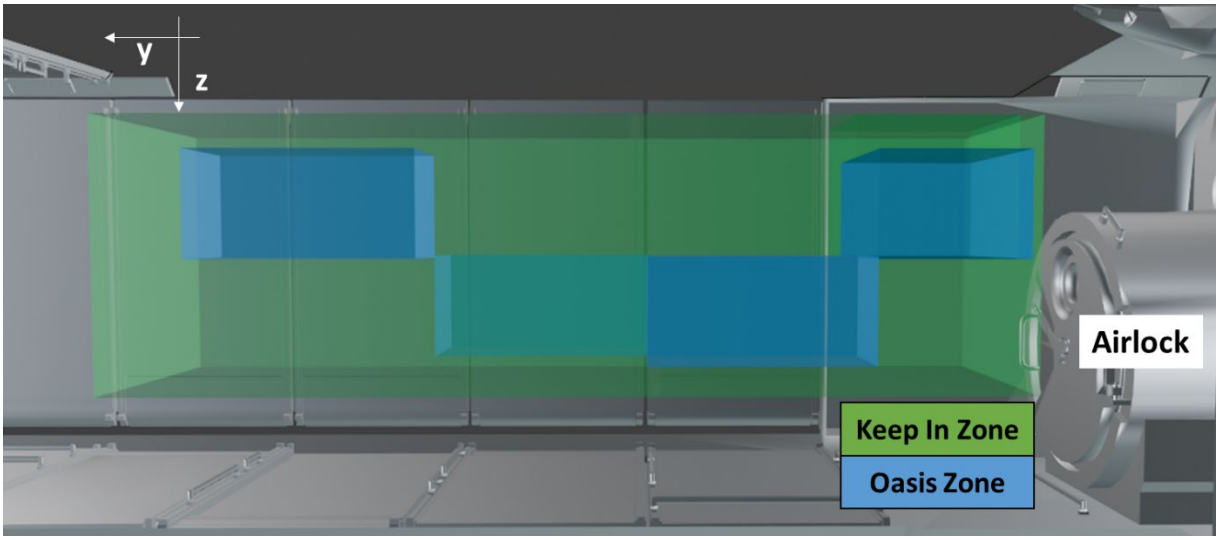


Figure 2.2.5-2 KIZ and Oasis Zone for the Preliminary Round (Side View)

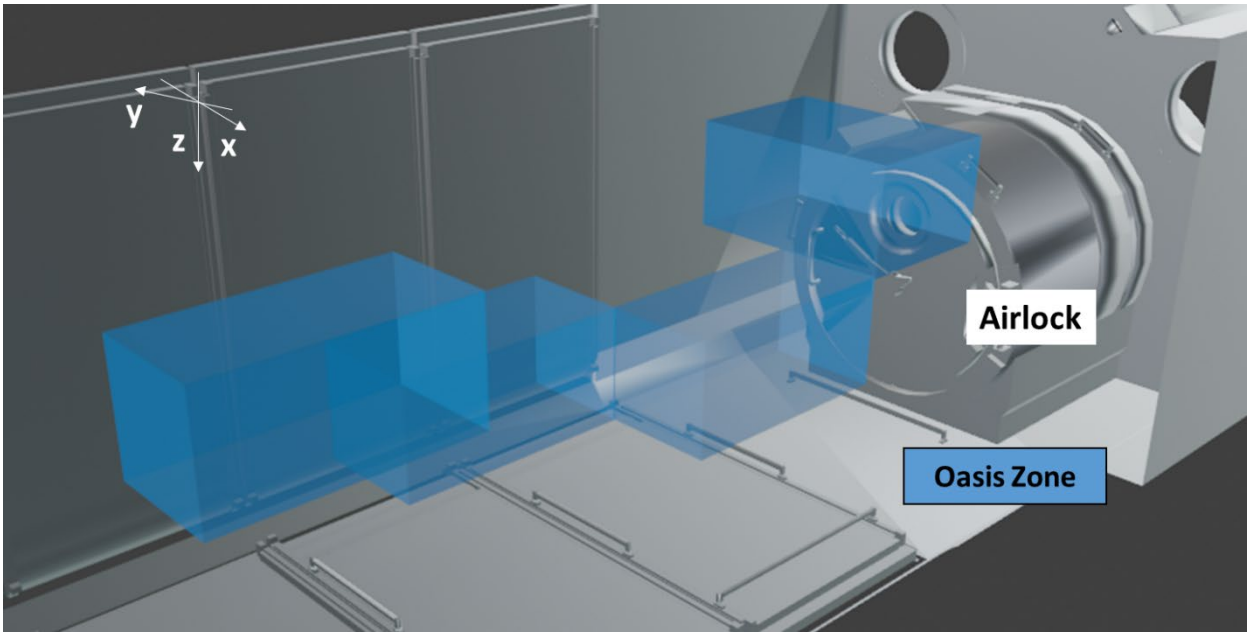


Figure 2.2.5-3 Oasis Zone for the Preliminary Round (Diagonal View)

Table 2.2.5-1 shows the coordinates of KOZ and KIZ. Figure 2.2.5-4 shows the definition of coordinates (x_min, y_min, z_min) and (x_max, y_maxm z_max).

Table 2.2.5-1 Location Coordinates of Obstacles

		x_min	y_min	z_min	x_max	y_max	z_max
オアシスゾーン	オアシスゾーン 1	10.425	-10.2	4.445	11.425	-9.5	4.945
	オアシスゾーン 2	10.925	-9.5	4.945	11.425	-8.45	5.445
	オアシスゾーン 3	10.425	-8.45	4.945	10.975	-7.4	5.445
	オアシスゾーン 4	10.925	-7.4	4.425	11.425	-6.35	4.945
KIZ	KIZ 1	10.3	-10.2	4.32	11.55	-6.0	5.57
	KIZ 2	9.5	-10.5	4.02	10.5	-9.6	4.8

*The origin of the coordinate axis is set outside of Kibo.

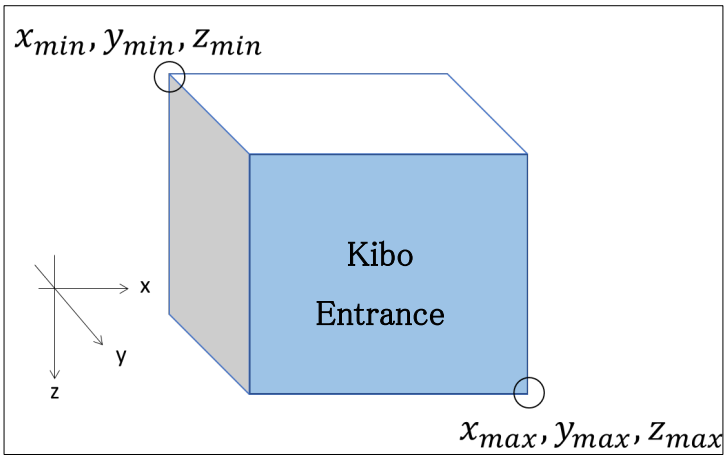


Figure 2.2.5-4 Definition of Coordinates

2.3.6. 10 Automatic Executions per APK

In the preliminary round, each Android Application Package (APK) will be automatically executed 10 times and will include random elements to make it fair for everyone. The image generation patterns, and random elements will be different for every run. Therefore, rankings will be determined using the average value instead.

This allows all participants to compete on the same terms, regardless of whether their results happen to be good or bad. Please see Section 2.3 for details regarding scoring criteria.

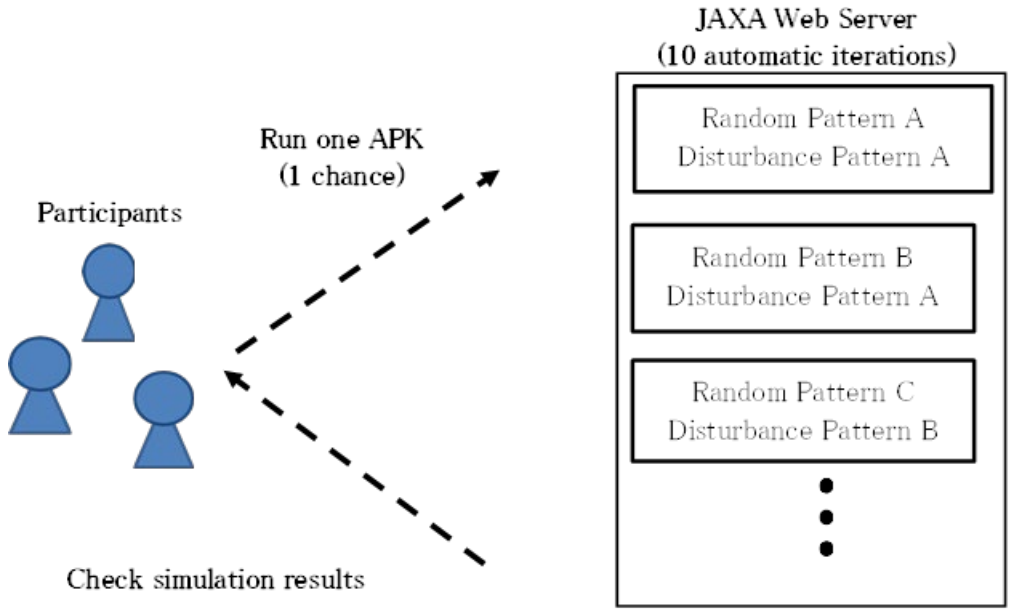


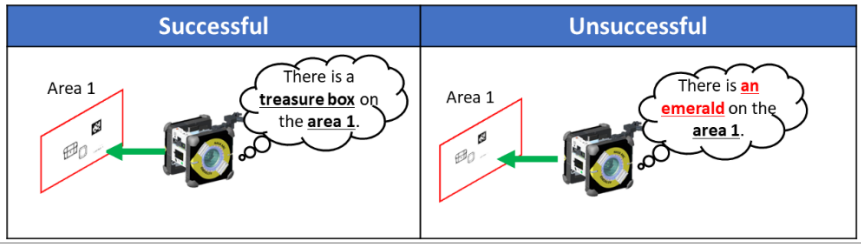
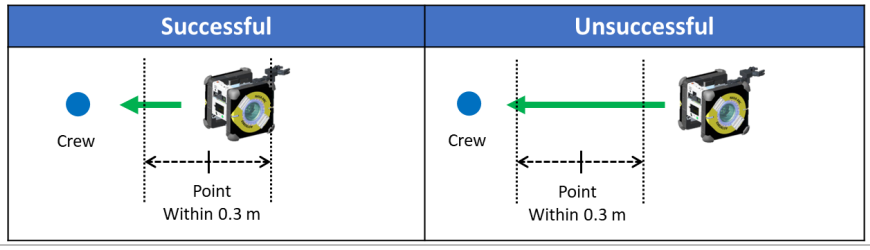
Figure 2.2.6-1 10 Runs

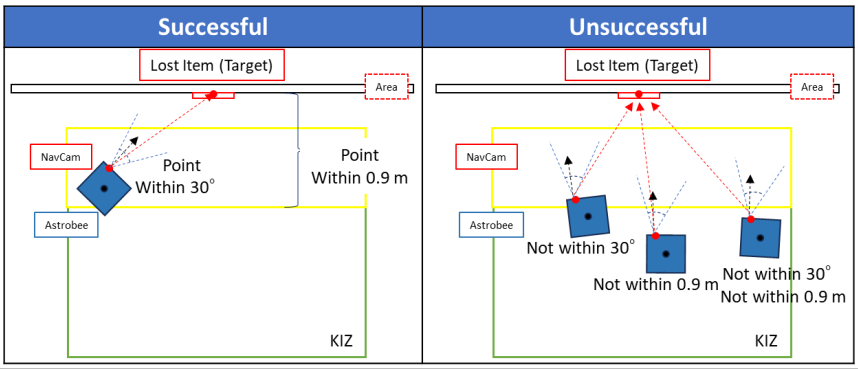
2.4. Scoring

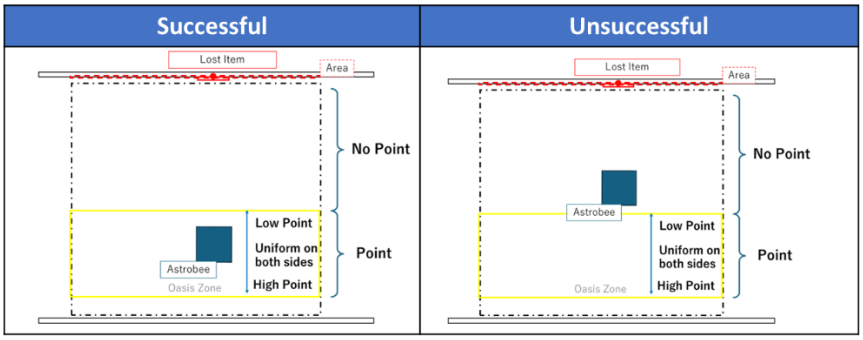
2.4.1. Factors

Your team's score will be calculated based on the following factors

Table 2.3.1-1 Scoring Factors for Preliminary Round

#	**Criteria**	Details
1	Matching of Area and Item	Points will be awarded if the type and number of Lost Items randomly placed in each Area are accurately processed and recognized. Lost Item displays are divided into difficulty levels, with higher levels (more difficult image processing) resulting in higher scores. Please note that Treasure Items may be displayed along with Landmark Items, but no points are awarded for matching a Treasure Item to an Area. 
2	Reporting coordinate of the patrol's completion	Scoring is based on the arrival coordinate when the patrol's completion report is submitted. Points will be awarded if the coordinates reached are within 0.30m from the given coordinates. 

3	Photo Angle and Position of Target Item	Scoring based on the angle of view of the camera and the coordinates when reporting the location of the Target Item. Points will be awarded when both I and II below are satisfied. I. Scores are based on the angle of view of the camera at the time the Target Item is reported. The angle of view is determined based on the acquired NavCam position and orientation of the Target Item, and points will be awarded if the angle of view is within the 30° angle of view. II. Scoring is based on the coordinates at the time the Target Item is reported. Points will be awarded if the coordinates obtained are within 0.9 m of the plane of the area. 
4	Mission Time Remaining	The time limit remaining at the time of reporting the Target Item is converted into points and additional points are awarded. There is a limit to the additional points based on the remaining time. If you complete the mission with a certain amount of time remaining, you will receive a uniform amount of additional points.

5	Astrobee flight path	If the Astrobee's flight path was within the Oasis Zone, it will score points based on the time it spent in that zone, with different points awarded for different locations within a single Oasis Zone. 

***Scores are calculated starting from the center of Astrobee.**

2.5. Participation in the Preliminary Round

2.5.1. How to Participate in the Preliminary Round

Participants must submit APKs for the preliminary round by the submission deadline.

Detailed submission instructions will be announced at a later date.

3. Final Round

3.1. Final Round Schedule

Only representative teams can participate in the final round. Teams may refine their programs from the Preliminary Round for the APK Final Run (on ISS) and submit the APK and source code before the deadline. Please see Section 3.4 for details.

1) Draft source code submission deadline: Late July 2025 (JST)*1)

2) APK Final Run program submission deadline: Late August 2025 (JST)*2)

*1) JAXA will check APK source codes to ensure that they will not have a negative impact on the Astrobee and if necessary ask participants to modify the code.

Please submit only the source code for the pre-check. Submission instructions will be provided at a later date.

Due to the short revision period, please make arrangements in advance.

(Many revisions have occurred in previous years.)

*2) You will be required to **submit both APK and source code when submitting** the final version.

Submission instructions will be provided at a later date, but please refer to section 3.4.

Failure to submit by the deadline may result in not being able to participate in the APK Final Run, so please be sure to submit on time.

3.2. Game Rules

3.2.1. Game Flow

In the Final Round, the Astrobee on the ISS will be required to patrol each area from the starting position within a time limit[*1] and recognize the placement of the Lost Item. Then, the Astrobee moves to the Astronaut and asks for clues to the treasure. Finally, each team will create a program to move to the vicinity of the treasure, photograph it, and then report the results. Basically, the process is the same as in the preliminary round, **but Astrobee's behavior when reporting mission completion is different. There is no change in the program, but in the real environment, Astrobee will run SignalLights according to the API.**

① Start from Dock Station.

② After starting, Astrobee will patrol several candidate sites aboard Kibo where treasures are hidden.

③ Each team may choose a route through the Oasis Zones*1, where they receive points for passing through, and report what they find at each candidate location for hidden treasures.

④ Once all Astrobee has visited all of the sites, go to the astronaut and read the im-age of the real treasure and its nearby landmark. This will reveal the identity of the real treasure.

⑤ Go to the real treasure and take a picture.

⑥ After taking the photo, activate the Signal Lights to inform the astronaut of the treasure's location, and the mission is complete.

[*1]Oasis Zone... Points will be added as long as Astrobee is moving through this area.

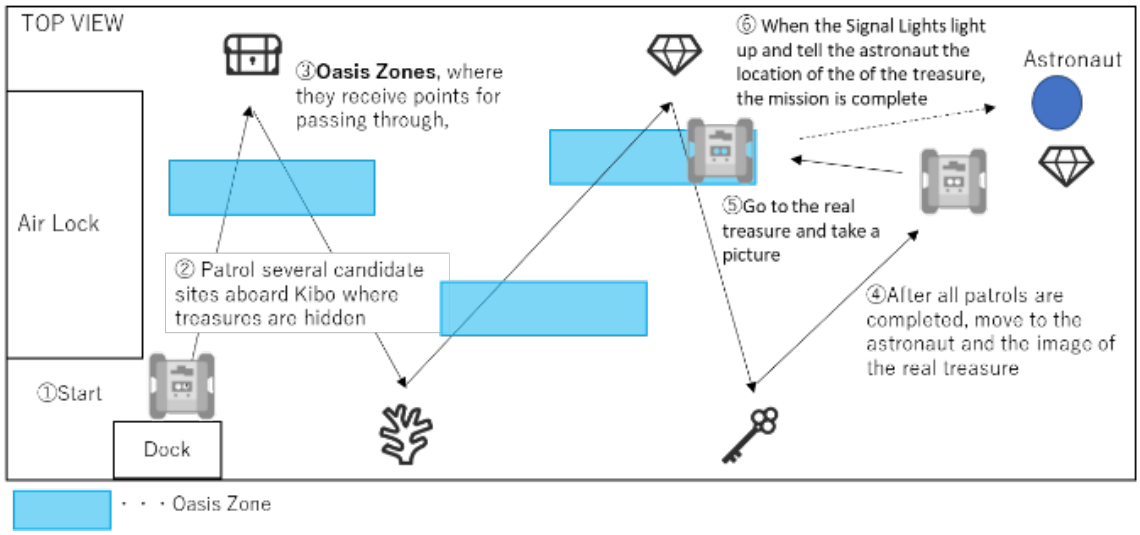


Figure 3.2.1-1 Final Round Game Flow

3.2.2. Preconditions

Table 3.2.2 Preconditions for Final Round

#	Content
1-4	Conditions for start and finish positions, Area, etc. are the same as for the Preliminary round. Please refer to section 2.2.2 for details. *Coordinate information may be revised in the future.
5	Some information on KIZ or Oasis Zone may change from the preliminary round. We will release details as soon as they are finalized.

Creating a program that can perform well in the actual environment on board the ISS is important as the environmental conditions in orbit differ from those of the simulation.

3.2.3. Objects

There will be no major changes from the preliminary round. Details will be released as soon as they are finalized.

3.2.4. Mission Complete Report

There will be no major changes from the preliminary round. Details will be released as soon as they are finalized.

3.2.5. Keep-In-Zone (KIZ) and Oasis Zone

Details will be released as soon as they are finalized.

3.2.6. 1 Run per APK

In the same way as in the preliminary round, teams will submit one APK, but in the final round it will only be run once on the ISS using the Astrobee. It will be impossible to redo or stop once started, so do your best because this will be a one-off chance.

If the Astrobee experiences a problem such as getting stuck, under the rules in Section 3.2.9 you will be given the opportunity for a re-run..

3.2.7. 5 Minute Time Limit

If the time limit is exceeded, the APK will automatically shut down. Please program to complete the mission within the time limit. Even if the time limit is not reached, the game is automatically considered over if the Astrobee gets stuck or loses its self-position. The system may also terminate without waiting for the time limit when it is judged that no further operation can be expected for any reason.

3.2.8. APK Operation on the Day of the Final Round

Participants may not operate their APKs on the day of the final round. Submitted APK will be checked by the JAXA/NASA technical team and preinstalled on the Astrobee. APKs are started with an execution command from ground operators.

3.2.9. Final Round Run Order

In the final round, teams will be divided into three tiers according to the results of the preliminary round and runs will be performed in that order. An example of team tier grouping is shown in Table 3.2.9.

*Please note that changes may be made to the tiers.

＊Tier divisions are subject to change.

Table 3.2.9 Team Divisions

Tier	Preliminary Round Score Results
1st Tier	1st place
	2nd place
	3rd place
	4th place
2nd Tier	5th place
	6th place
	7th place
	8th place
3rd Tier	9th place
	10th place
	11th place
	12th place

If the Astrobee gets stuck due to a problem in orbit, the team will be given another chance to run the mission again before moving on to the next tier as long as there is enough time left in the event. However, if the problem is caused by the APK created by the participant, there will be no rerun. Please note that there is limited time to conduct the competition in orbit, and teams with lower rankings in the preliminary round may not be able to run their mission on the day of the final round. For more information, please refer to Figure 3.2.9.

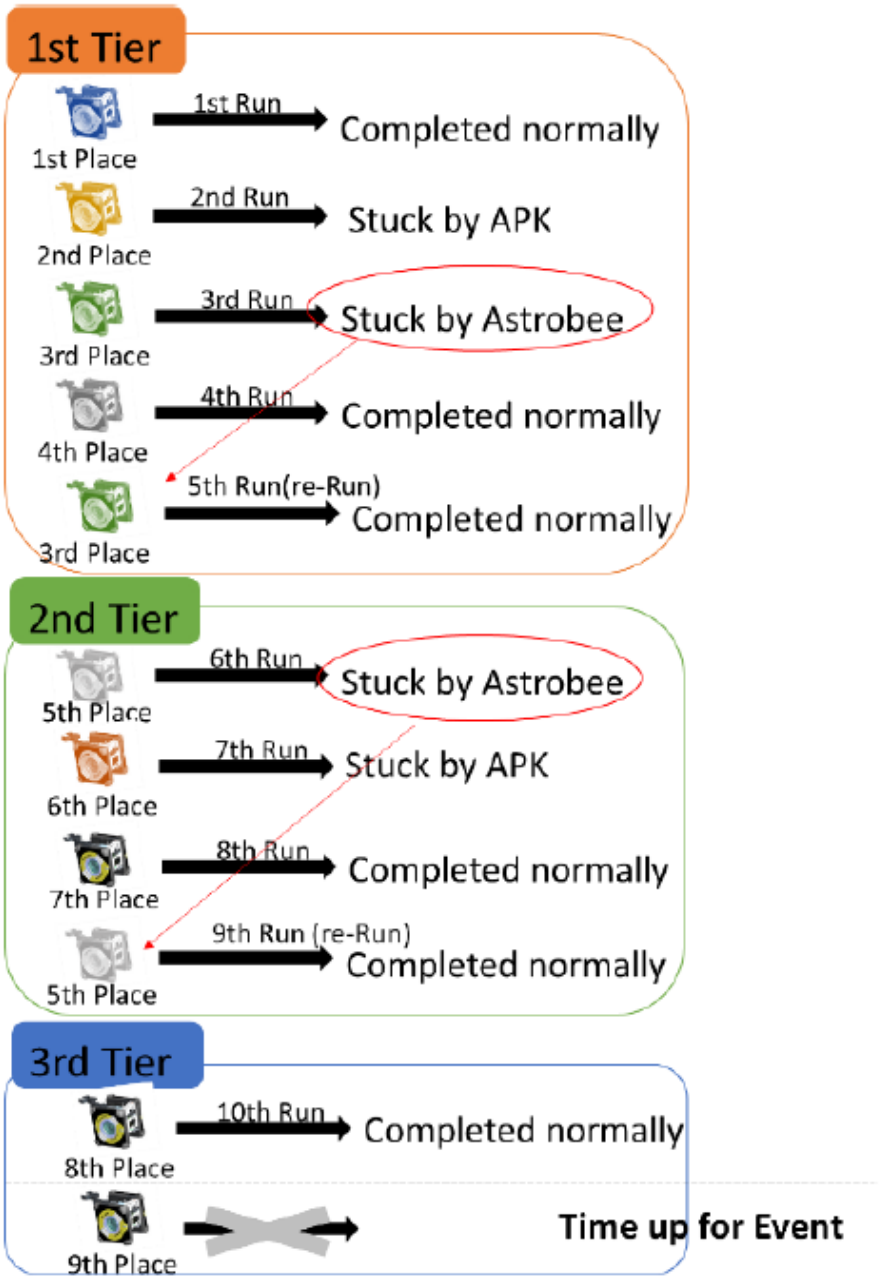


Figure 3.2.9 Example of Team Order for Final Round

3.3. Scoring

3.3.1. Factors

The scoring criteria are the same as in the qualifying round. Please refer to section 2.3.1 for details.

3.3.2. Judging

Only one run is allowed for the in-orbit final. As a result, the team's score will be the result of 1 run, not the average.

3.4. Participating in the Final Round

Participants in the final round must do the following.

(1) Change APK application ID and APK name

You must change the APK application ID and name as shown in Table 4.4 and included your country/region name. When submitting your APK, check that you have made the changes before uploading it to the Web Simulator. The Kibo-RPC Secretariat uses these names to identify the file when installing and executing the APK. Please refer to Section 3.3.3 of the Programming Manual for details on how to set the application ID, etc.

Table 4.4 Various Naming Conventions

Country	Application ID	APK name	APK file name	Short name
Australia	jp.jaxa.iss.kibo.rpc.australia	australia	australia.apk	australia
Bangladesh	jp.jaxa.iss.kibo.rpc.bangladesh	bangladesh	bangladesh.apk	bangladesh
Indonesia	jp.jaxa.iss.kibo.rpc.Indonesia	Indonesia	Indonesia	Indonesia
Japan	jp.jaxa.iss.kibo.rpc.japan	japan	japan.apk	japan
Malaysia	jp.jaxa.iss.kibo.rpc.malaysia	malaysia	malaysia.apk	malaysia
Nepal	jp.jaxa.iss.kibo.rpc.nepal	nepal	nepal.apk	nepal
Philippines	jp.jaxa.iss.kibo.rpc.philippines	philippines	philippines.apk	philippines
Singapore	jp.jaxa.iss.kibo.rpc.singapore	singapore	singapore.apk	singapore
Taiwan	jp.jaxa.iss.kibo.rpc.taiwan	taiwan	taiwan.apk	taiwan
Thailand	jp.jaxa.iss.kibo.rpc.thailand	thailand	thailand.apk	thailand
UNOOSA	jp.jaxa.iss.kibo.rpc.unoosa	unoosa	unoosa.apk	unoosa
USA	jp.jaxa.iss.kibo.rpc.usa	usa	usa.apk	usa
Vietnam	jp.jaxa.iss.kibo.rpc.vietnam	vietnam	Vietnam.apk	vietnam

(2) Send APK and source code

Please refer to section 3.4.1 of this rulebook.

(3) Confirm that everything is completed

Follow the checklist in Table 3.4-2 to confirm that you have completed the items to be performed for the Final Round.

(4) Update the API

Please comply with the instructions of the Secretariat with regard to any API updates.

Table 4.4-2 Checklist

No.	Item	Description	Related Section(s)
1	Application ID	Change the application ID of the APK	Section 3.4 PG Manual Section 3.3.3
2	Rename the APK	Rename APK as per the regulations	Section 3.4 PG Manual Section 3.3.3
3	Rename the APK File	Rename the APK file according to the rules	Section 3.4
4	Change the APK short name	Change the short name of the APK in accordance with the rules	Section 3.4 PG Manual Section 3.3.3
5	MD5	Create the APK's MD5	Section 3.4.1(2)
6	Submission	Submit the APK	Section 3.4.1(1)
		Submit the source code	Section 3.4.1(2)
7	Completion of the Competition	The startmission function is called at the beginning of the program	PG Manual Section 7.1
		After recognizing the Target Item, notifyRecognitionItem is called when moving to the Lost Item that matches the Target Item	PG Manual Section 7.1
		takeTargetItemSnapshot is called	PG Manual Section 7.1
8	Software Safety	Infinite loop with for or while is not implemented	PG Manual Section 5.1
		No danger of infinite loops due to recursion	PG Manual Section 5.1
9	Resource Load	No extra resources in the source code	–

3.4.1. Submit APK and Source Code

You need to submit your program by the deadline for the final round. After submission, JAXA and NASA will review the source code in advance for safety reasons. Therefore, please submit the APK and source code according to the following procedure. **(At the time of the preliminary review, only the source code will be submitted)**

Due to the short time available for code modifications, please keep your schedules clear.

(Many revisions have occurred in previous years.)

Detailed submission instructions will be announced at a later date.

3.5. Organizing the Event

The 6th Kibo-RPC will be held in a similar format as that of the 5rd Kibo-RPC, which is shown in Figure 4.5. JAXA will run the Astrobee and finalists' APKs in advance. Footage of the competition is scheduled to be broadcast live, and finalists will be able to watch footage of their own runs. A final round event, featuring commentary by experts watching the pre-run footage, will be held at a later date. Finalists will be contacted by the Secretariat via email with more details..

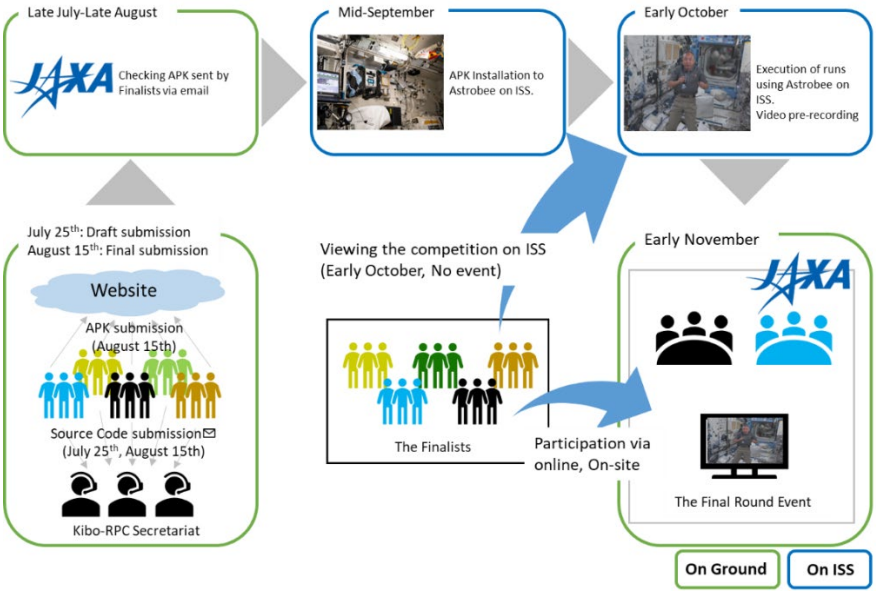


Figure 3.5 Flow up to the day of the event

Appendix 1

This will be the definition of terms used in the 6th Kibo-RPC.

用語	定義
Kibo-RPC	Abbreviation for Kibo Robot Programming Challenge, a programming competition using robots on the ISS.
ISS	Abbreviation for International Space Station.
Kibo	The Japanese Experiment Module developed by JAXA on the ISS. Also known as JEM (Japanese Experiment Module), this is where this game will take place.
Astrobee	Free-flyer robot developed by NASA that will be used in this game.
Area	A plane representing a potential location for a Lost Item, set on an ISS wall or Airlock.
Lost Item	A collective term for the images placed in each Area. Lost Items are categorized into two types: Treasure Items and Landmark Items.
Target Item	In the game, this word represents the real treasure the astronaut is searching for.
Tresure Item	One type of Lost Item, of which there are three different images. In this game, two or more are placed in each Area, but the real treasure the astronaut is searching for will be randomly chosen from these.
Landmark Item	One type of Lost Item, of which there are eight different images. In this game, points are awarded for accurately reporting the type and number of Landmark Items located in each Area to the astronaut.
AR Tag	An AR marker used to identify the location and orientation of an Item.
KIZ	Abbreviation for Keep-In-Zone, the range within which an Astrobee can move.
Oasis Zone	Located within KIZ, points are awarded based on the time spent in this zone. The points earned can vary depending on the specific location within a single Oasis Zone.。
Crew	Used interchangeably with astronaut.