Middle Size Robot League

Roadmap for Rules and Regulations

Version 1.0

MSL Technical Committee 2025

June 29, 2025

Outset

The goal of RoboCup is to beat the human world champion in 2050 using humanoid robots. Each league focuses on specific developments to get closer to this common goal. Therefore, MSL should focus on its unique strengths: human-scale matches with robots that have all sensors onboard, collaborating to make optimal strategic decisions.

This roadmap provides a framework for future developments of the MSL league. It allows for bigger development efforts to be scheduled such that they are attainable to all teams. The Technical Committee will update this document occasionally in collaboration with the league, as new research directions become applicable to MSL.

Constraints

Keeping the goals of the MSL in mind, we formulate some additional constraints and guidelines when defining this roadmap.

1. Changes should progress the league and promote broad research, allowing researchers to choose their own research directions.
2. Roadmap items may force developments on teams, but only if this is in the interest of making league development possible.
3. All changes for one year together should reflect a workload that can reasonably be expected from all teams. Different types of changes (e.g., hardware and software) should, if possible, have a balanced workload each year.
4. Forced hardware changes should be planned such that teams can plan to gradually incorporate it with normal hardware upgrades and maintenance.
5. Whenever possible, the primary focus of changes should be getting better at playing attractive football. Until the MSL can play an attractive, evenly matched game against humans, changes should not be adding constraints to align the robot capabilities to those of humans, i.e., until that time, robots may use their unique abilities (e.g., wheels, WiFi) to compete. Constraints should only be added for cases where safety for humans and fairness between teams is at risk.

Document structure

Table 1 contains an overview of the planned changes, with references to the details for each proposed change. The following pages provide details on each of the proposed changes.

Questions

While the Technical Committee aims to describe changes in as much detail as possible in this roadmap, the actual implementation will be performed by the Technical Committee of the given year. This may mean that small discrepancies may occur between the proposal and the actual implementation. The Technical Committee will work to keep any discrepancies as small as possible.

When proposals are unclear or inconsistent, make sure to contact the Technical Committee (rc-msl-tc@lists.robocup.org). They will be able to provide clarifications, and, if necessary, update the roadmap and/or rules.

Table 1: References to the details for the proposed changes for the following years. A - indicates no planned changes, a ? indicates that no choice for a change has been made yet.

Year	Arbitrary ball	Robot design	Larger field	Field surface	Light conditions	Playing with humans	Playing against humans	Play time	More players	Goal construction
2025	I	-	-*	-	VIII	-†	-	-	-	-
2026	II	IV	-	-	IX	-	XII	XIV	-	-
2027	-	V	-	VII	X‡	-	XIII	-	XV	XVI
2028	III	-	-	-		-	-	?	-	-
2029	-	VI	-	?§	XI	-	?	?	?	XVII
2030	-	?	-	?	-	-	?	?	?	-

*No changes planned due to difficulties in organizing larger fields at RoboCup.
†No changes planned as the goal of RoboCup is to win *against* humans, not to play *with* humans.
‡Depending on the possibilities of the LOC, implementation may be in 2027 or 2028.
§Depending on the league feedback in 2027 and 2028, future plans will be made.

Arbitrary ball

The arbitrary (non-yellow) ball challenge has been hosted several times as a Technical Challenge. Due to the lack of success of any team, it was abandoned. However, with the recent advancement in machine learning object detection, detecting an arbitrary ball should now be feasible for most teams.

The goal is to work short term to a system similar to that of the Humanoid league, where the ball is decided randomly right before the start of the match.

I Arbitrary balls available for testing

Proposed Year 2025

Required League Actions Arrange balls (OC/LOC)

Change Type None

I.a Considerations

To give teams some time to develop their algorithms and test their setups for when new balls are added, 2025 should not yet force changes.

I.b Proposed Changes

Have several arbitrary balls (in the MSL size) available for teams to test with. This allows teams to test (1) the pipeline to add new ball designs, (2) a detection that can handle multiple arbitrary balls, (3) the detection performance on a full-sized field.

II Arbitrary balls used with some flexibility

Proposed Year 2026

Required League Actions Update rules (TC), New pre-match procedures (TC/OC/referee), Provide ball photos (TC)

Change Type Software (Object Detection)

II.a Considerations

Assuming this roadmap is published before RoboCup 2025, teams have had a full year to prepare for this change. While we expect all teams to be able to implement an arbitrary ball detection, it may be possible that not all procedures are completely in order. This rule change should not prevent teams to play because teams cannot detect the ball at all, therefore we plan to use relaxed constraints for RoboCup 2026.

II.b Proposed Changes

Teams will play with a random ball selected out of a set of five balls available at the tournament. This ball will be selected 10-20 minutes before the match starts, such that teams can configure their software accordingly. Moreover, pictures of the balls will be available before the tournament

to allow teams to prepare. Both teams may (but are not obligated to) veto one ball that will not be used for the next match.

III Full arbitrary ball

Proposed Year 2028

Required League Actions Update rules (TC)

Change Type Software (Object Detection)

III.a Considerations

By RoboCup 2027, teams will have had 2 full years to prepare. We expect teams to be able to have completed their software and procedures to be ready for full arbitrary ball.

III.b Proposed Changes

Teams will see the set balls at the tournament, not before. The referee will select a random ball directly before kickoff. Teams will have no time to alter their software or configuration based on the selection.

Robot Design

Given the developments in off-the-shelf robotic hardware, we want to give teams the opportunity to invest in these, and focus more on software developments rather than spending all their time creating stable hardware.

IV Allow New Goalkeeper Designs

Proposed Year 2026

Required League Actions Update rules (TC)

Change Type Hardware (Platforms), Software (Object detection)

IV.a Considerations

We believe that the MSL can attract more teams and increase its overall level with existing teams when hardware developments are not a prerequisite for the league. However, allowing teams to use more diverse hardware, forces other teams to develop systems to detect these robots.

The hardware changes need to balance (1) more flexibility, (2) not allowing workarounds/abuse, (3) fair matches, and (4) safety.

Currently, teams can rely on a black bottom part of all robots. This may be impossible for some off-the-shelf robots, so robot detection may need to be redesigned by opponent teams.

IV.b Proposed Changes

Only alternative hardware may be used in (1) test matches, (2) ambition challenge, (3) as a goalkeeper, and (4) when the opponent explicitly allows it.

Hardware The following constraints will be in place for all robots, being backwards compatible with existing MSL robots:

1. The bounding box of the robot in its most voluminous state can take up at most 0.2 m^3.
2. The bounding box of a robot in its least voluminous state must be at least 0.036 m^3.
3. The ratio between the smallest and largest dimension of the bounding box can be at most 1:3.
4. Above a height of 0.6 m, except for the goalkeeper, all robots must fit in a cylinder with a diameter of 25 cm. This can be measured with the robot in its "neutral" form.
5. The goalkeeper may add one extension to its bounding box in any direction of at most 0.005 m^3. This extension may be used for 1 second, after which it cannot be used for 4 seconds.
6. Robots need to be matte and be primarily colored one color, possibly complemented with black. The colors of the field and the lines should be avoided.
7. A safety border of 3 cm (at the time of writing) is still required. The exact definition for new robot designs is to be determined.

The hardware must be robust enough to handle occasional bumps by other robots, as commonly seen in MSL. Rules about taking out broken robots still apply.

Software All teams using a non-traditional robot are mandated to supply a robust (good precision and recall) open source algorithm to detect their robot ready to be reused by other teams, including documentation and all details required to run the algorithm. When (labeled) video or photo material was used to build the detection algorithm, all data must be made available. This material must be published least 2 months before the tournament, after which no changes to the look of the robot are allowed.

V Allow New Designs for All Robots

Proposed Year 2027

Required League Actions Update rules (TC), Robot verification (TC)

Change Type Hardware (Platforms), Software (Object detection)

V.a Considerations

After having been able to test with other robot designs in 2026, we believe the MSL is ready to handle other robot designs.

V.b Proposed Changes

All robots, at all games, can use the new design rules. See Sec. IV, now applicable to all robots.

Teams are still reminded that all robots must be able to handle occasional bumps. Moreover, the "broken robot" rules still apply.

Teams are also still required to provide a robust detection algorithm of their non-traditional robot(s) at least 2 months before the tournament.

VI Require Training Data for New Robot Designs

Given the developments in off-the-shelf robotic hardware, we want to give teams the opportunity to invest in these, and focus more on software developments instead.

Proposed Year 2029

Required League Actions Update rules (TC)

Change Type Software (Object detection)

VI.a Considerations

After having been able to test with other robot designs for up to three years, we believe teams must be able to have their object detection pipeline to detect other robot designs.

VI.b Proposed Changes

All teams using a non-traditional robot are mandated to supply video and photo material of the robot in action at least 2 months before the tournament. After this deadline, no changes to the look of the robot are allowed.

Field Surface

The carpet used in MSL is not representative of a real-world scenario of playing against humans. To test how well omni-wheels handle artificial turf (as used in the SPL and Humanoid League), we want to replace the carpet on the test field with short artificial turf. The goal is to keep using artificial turf on the test field after RoboCup 2027, possibly expanding to the main field.

VII Artificial Turf as Test Field

Proposed Year 2027

Required League Actions Arrange different field type (OC/LOC)

Change Type Hardware (Driving Systems)

VII.a Considerations

Moving towards more advanced driving systems that are able to play on other are required for the future of the league and RoboCup's goal. Since most driving systems are not designed for artificial turf, we think it is reasonable to slowly introduce changes and get feedback from the league at every step.

VII.b Proposed Changes

The (half) test field will be constructed out of short artificial turf. The artificial turf should have a length between 2 and 5 mm, and the exact specifications should be communicated well in advance to the teams.

Lighting

The MSL rules do not specify any requirements on the lighting of the field. However, in recent years, we have seen the LOC making adjustments because some teams could not handle certain lighting conditions. We feel the need to make MSL robust in many lighting situations, similar to the SPL outdoor field.

VIII Lighting Requirements Reminder

Proposed Year 2025

Required League Actions Send reminder (TC)

Change Type N/A

VIII.a Considerations

The rulebook does not prescribe any lighting requirements. Because teams are used to uniform brightly lit fields at tournaments, most vision algorithms will not be prepared to handle more complex lighting scenarios. Teams should work towards more resilient algorithms. Because of the lighting quality during the last few years, were very constant, we cannot expect all teams to immediately handle more complex situations.

VIII.b Proposed Changes

Notify teams that no lighting requirements are prescribed in the rules, which means that teams should be able to handle any scenario.

IX Encourage variable lighting solutions in Challenges

Proposed Year 2026

Required League Actions Update rules (TC)

Change Type N/A

IX.a Considerations

Before it is feasible for all teams to achieve being able to play in varying lighting situations, we need some solutions that have been shown to work on MSL robots. The Technical Challenge and Scientific Challenge are great places to share these accomplishments with other teams.

IX.b Proposed Changes

Encourage, by awarding additional points, solutions presented in the technical and scientific challenges that enable robots to handle a wide variety of lighting conditions.

X Ask LOC for temporary challenging lighting conditions

Proposed Year 2027 or 2028

Required League Actions LOC requests (OC)

Change Type Possibly Software (Vision)

X.a Considerations

We believe all teams should already be able to build vision systems capable of handling varying lighting conditions. However, we acknowledge that collecting sufficient varying training data may be challenging. Therefore, we propose to not immediately play the entire tournament in challenging lighting conditions.

X.b Proposed Changes

Ask the LOC to provide a (temporary) lighting condition that is challenging (e.g., inconsistent over the entire field, shadows, glare). We will be able to collect data and test approaches during these temporary conditions. The conditions should still reflect a situation that can be expected in human soccer.

XI Search for Challenging Lighting

Proposed Year 2029 or 2030

Required League Actions LOC requests (OC)

Change Type

XI.a Considerations

After one or two years (Sec. X) of testing more difficult lighting conditions, we believe teams should be able to handle arbitrary lighting conditions.

XI.b Proposed Changes

Place no restrictions on the LOC for the placement of the MSL fields. Moreover, the LOC should be encouraged to place the MSL field such that some type(s) of lighting challenges are created. The conditions should still reflect a situation that can be expected in human soccer. To avoid creating difficult floorplan situations for the LOC, given the size of the MSL field, the difficult lighting situation will not be a requirement from MSL.

Human Opponent

Only the winner of the MSL competition every year gets to play against a human team. While the MSL is the only league that can do this, all other teams are unable to get this experience.

XII Play One Match Against Humans

Proposed Year 2026

Required League Actions Update rules (TC), Arrange safety equipment (OC/LOC), Safety verification (TC/human team)

Change Type Hardware/Software (Human Safety)

XII.a Considerations

We want to give teams experience in playing against humans, as well as encourage them to work on solutions to improve in the future. We believe playing one mandatory match achieves these goals.

XII.b Proposed Changes

Each team must play one match against an all-human opponent. Teams that are incapable of playing, either technically or due to lack of safety, will be appropriately penalized in the competition. This ensures that all teams put in reasonable effort to do well in this test match. The actual outcome of the match (i.e., the score) is irrelevant for the competition. The best team(s) will be awarded with a certificate. To make matches interesting and fair, the TC may make some modifications (e.g., limit the number of humans, not allow a human goalkeeper, reduce play time).

The human team must wear sufficient safety gear to withstand impact of a robot. While the robots must be judged on their safety before the match, occasional accidents could still be possible.

XIII Play One Round Robin Against Humans

Proposed Year 2027

Required League Actions Update rules (TC), Arrange safety equipment (OC/LOC), Safety verification (TC)

Change Type Hardware/Software (Human Safety)

XIII.a Considerations

After having gained some experience in the previous RoboCup when playing against humans, we expect all teams to be able to operate safely around humans. Of course, we expect teams to have played more test matches against their own human team members.

XIII.b Proposed Changes

The first round robin is played against human players. Which team supplies the human players and which team uses their robots is determined at random, whilst making sure that each team plays against humans half of their matches.

The score of the matches should be used to rank teams for subsequent round robins. Moreover, the following steps should be taken to achieve the final ranking:

1. Rank teams on how many matches they have not played due to safety concerns. Playing fewer matches ranks lower.
2. For teams ranked equally, they are ranked on not playing matches due to technical problems (unrelated to safety). Playing fewer matches ranks lower.
3. For teams ranked equally, they are ranked according to the normal rules (i.e., CR 3.4).

The human team must wear sufficient safety gear to withstand impact of a robot. While the robots must be judged on their safety before the match, occasional accidents could still be possible.

Play Time

In a normal soccer match, the ball is approximately 60% of the time in play (https://www.soccermetrics.net/team-performance/effective-time-in-football), with short matches still being close to 50%. For matches in MSL, some matches have a much lower effective play time.

XIV Monitor Effective Play Time

Proposed Year 2026

Required League Actions Update RefBox (anyone), Record outcomes (OC)

Change Type N/A

XIV.a Considerations

While switching to effective play time in MSL seems like an easy solution to achieve matches of similar intensities, it does not actually resolve the problem. This switch may cause long delays, creating problems in planning. Moreover, it does not resolve the root problem, being the long downtime for matches, reducing the audience engagement.

XIV.b Proposed Changes

Record the effective play time (including time spent during various RefBox commands), teams, and referees. Based on these outcomes, the TC can plan changes that reduce downtime and make matches more attractive.

More Players

Given transport and hardware costs of robots in MSL, it is currently impossible to play with larger team sizes. Therefore, we only see the option of playing with larger teams consisting of robots of multiple teams. This has the added benefit of simplifying the transfer of new developments between teams.

XV Encourage Multi-Team Developments in Challenges

Proposed Year 2027 and 2028

Required League Actions Update rules (TC)

Change Type N/A

XV.a Considerations

While we have already seen an example of a single team consisting of robots from Falcons and Robot Sports, however further developments have not been made in MSL. Therefore, we believe that we need more proof that joining a mixed team is attainable for all teams, as well as that the protocol leads to a competitive match.

XV.b Proposed Changes

Encourage, by awarding additional points, solutions presented in the technical and scientific challenges that enable multi-team matches. When challenges have shown that joining a mixed team is feasible for every team and leads to competitive matches, the Technical Committee will update the roadmap to urge, and later mandate, participation.

Goal Design

The current goal design is a remnant of past MSL robots. Robots needed a solid back to localize on the field. Localization and goalkeeper detection should be possible without these custom goals.

XVI Remove Back and Side Boards

Proposed Year 2027

Required League Actions Write new build instructions (TC/OC)

Change Type Software (Goalkeeper localization), Software (Goalkeeper detection)

XVI.a Considerations

Right now, there is a 30-40 cm high border at the back and sides of the goal. This is not present in normal soccer, and should not be necessary to play anymore. While this should be a small change for most teams, we propose to switch to FIFA goals in two steps.

XVI.b Proposed Changes

Remove the boards at the bottom of the goal, and extend the mesh down to the floor. The goal should still be stably mounted on four legs, where the front two legs are at least 125 mm wide.

XVII Use FIFA style goals

The current goal design is a remnant of past MSL robots. Robots needed a solid back to localize on the field. Localization and goalkeeper detection should be possible without these custom goals.

Proposed Year 2028

Required League Actions Write new build instructions (TC/OC)

Change Type Software (Goalkeeper localization), Software (Goalkeeper detection)

XVII.a Considerations

After removing the back and side boards, it should be straightforward for teams to move to FIFA style goals. The main consideration is sturdiness of the goal, as an MSL goal cannot be dug into the ground.

XVII.b Proposed Changes

A goal consists of two uprights and a crossbar. The width of these bars is reduced to be representative of normal soccer. While there may be back posts to support the net, the net may also hang down without back posts. The net must be far enough back to not interfere with the goalkeeper.

While the FIFA rules allow multiple shapes of goalposts, MSL will switch to round goalposts for safety.