



Bosch Future Mobility Challenge 2020

Competition Regulations

Robert Bosch SRL Romania

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1 Overview

1.1 Introduction

This document presents the regulations of the *Bosch Future Mobility Challenge* (hereafter “BFMC”) event.

BFMC participants should use the competition’s web page (www.boschfuturemobility.com), especially the **Forum** for obtaining information regarding technical and organizational aspects of the event. The **web page**, along with the **Forum** will be the main communication channels with the organizers. In case of additional questions, **e-mails** can be sent to the organizers at the following e-mail address: ideabox@ro.bosch.com.

2 Prerequisites for Attending

2.1 Team structure

Every team must be composed of:

- a **team leader**, enrolled at a technical university as Bachelor or Master student;
- a **mentor**, a teaching/research staff-member of a university, including Ph.D. student;
- a **maximum of four** team members, all enrolled university students (Bachelor or Master).

The role of the mentor is to guide the team, offer support in creating the time-plan, monitor progress in order to ensure that milestones are reached with the desired level of content and quality.

The maximum allowed number of team members, including the team leader and excluding the mentor, is **five**, the minimum allowed is **two** members.

After submitting the registration, the team structure can be modified with only one of the following changes:

- adding a new team member;
- changing a team member with a new one;
- excluding a team member;

These modifications will be accessible for the team leader on the event’s web page after the selection step, it could require adding extra information and uploading new documents for the modifications. Any modification could be accepted or declined by the organizing team, based on the same criteria as the initial selection process.

2.2 The Registration Process

Registration requests have to be submitted through the Registration Form available on the event’s web page: www.boschfuturemobility.com. Each participating team has to fill in the required information and the team leader has to upload the documents required in the registration form.

2.3 *The Selection Process*

After receiving all registration requests a first screening will take place and the selected teams will be individually contacted and planned for a face-to-face or Skype interview.

After conducting all interviews, the selected teams will receive a 1:10 model vehicle platform during the kick-off meeting or via courier for the teams outside Cluj-Napoca.

Selection criteria will be, but not limited to:

- Motivation and goal of each team;
- Link between the competition topic and ongoing University projects (e.g. diploma projects);
- Proven interest and experience in similar contests;
- Recommendation from University professors.

The teams that won one of the first three prizes during the previous editions are admitted to the contest without interview, if they register for the current edition.

2.4 *Prizes for the BFMC 2020*

The winner of the first three places will be rewarded with an amount of **4500 Euro**, **3000 Euro**, and **1500 Euro**, respectively.

2.5 *Period of Registration*

Registration for the competition will open on 1st October 2019 and will end on 31st of October 2019.

3 **Vehicle Requirements and Limitations**

The same model vehicle, provided by Bosch, must be used for all events. Adding stickers, using any other messages, slogans or names/logos of other companies to the vehicles, wearing or using equipment representing other companies (e.g. clothing, flags, banners, etc.) during the competition is not allowed. If this rule is not respected, the team will not be allowed to compete.

3.1 *Development Know-How*

The basic concepts of the vehicles must be conceptualized and implemented by the students themselves. The students are encouraged to do research and/or discuss their problems with professional engineers or suppliers, however direct development work should not be accepted from the latter ones. Ready-made solutions may never be included in the vehicle. This particularly concerns the usage of predesigned algorithms which may be part of a hardware platform, which serve the purpose of providing a fully functional system for perception, behaviour generation or control for automated vehicles or robots. The final decision on acceptable components is taken by the organizing committee. The teams are encouraged to contact the organizing committee in case of doubts or questions about a particular component. In case of violating these guidelines or intentional fraud, the organizers have the right to exclude the respective team from the competition.

3.2 **Safety Regulations**

During the competition, safety instructions issued by the committee members are to be followed. Ignorance of notes or guidelines can be punished by excluding the respective team from the training sessions or the competition. Each individual shall take care at all times so that neither other participants are injured, nor other vehicles are damaged due to careless behaviour. As far as the sensor setup is concerned, the following requirements and restrictions arise: all components within the vehicles must adhere to established guidelines for safe public usage. Particularly the usage of active sensors can be limited by this rule. The teams must make sure that no third parties are subject to possible injury due to installation or handling of the sensors. In case of questions concerning particular sensors, the admission must be discussed with the organizers prior to the beginning of the training sessions. Violations of these regulations lead to the immediate exclusion from the competition.

3.3 **Modification of the Vehicle**

Every team that received a model vehicle from Robert Bosch is allowed to modify it (e.g. by installing additional sensors) while still complying with the standards mentioned as follows. **Lane following sensors are not allowed and laser sensors are permitted only up to class 2 devices.** Class 2 lasers emit only visible radiation not exceeding 1mW power. Accidentally looking into the beam does not create damage to the eye even when using optical instruments.

3.4 **Data Transmission**

No data or signals must be transferred from the vehicle to the outside world during the dynamic events, except for those signals necessary for GPS navigation and intelligent traffic lights.

4 **GPS system**

A video camera based “GPS like” localization system will be installed in order to provide geo-spatial positioning. It allows each model vehicle to determine their location and rotation in relation to the track as a reference system. Geo-spatial positioning will be provided with a frequency of 1 second.

5 **Progress Reports**

Teams participating at the *BFMC* must agree to send one page **monthly technical reports** and a **video** (deadlines communicated through the web page) showing their progress to Bosch representatives. The quality of these reports will be scored and added to the final score with an emphasis on visible improvements (i.e. top marks are given to teams that reach an efficient organisational process, not necessarily having one from the beginning).

6 **Technical Progress and Pitch**

During the static event, the teams must present and defend their concepts in front of a jury. Each team is awarded an individual grade for each key aspect of the presentation.

These consist of the overall concept behind their vehicle, and considerations regarding automated driving, lane detection and lateral control, traffic signs recognition, parking, and/or obstacles/intersections. The judges are experts from the industry and from academia. The maximum achievable number of points is described in subsection 7.1.3. All presentations must be digitally available (in .ppt, .pptx or .pdf format) and sent to the organizers **no later than the day** before the qualification session.

6.1 *Agenda*

There is maximum 10 minutes for the presentation of the team's concept that will continue with a panel discussion with the jury of about 5 minutes.

The discussions are followed by the dynamic events, where the jury will score the performance of the automated driving algorithms developed by each team.

7 **Track Challenge**

During the dynamic events, the actual performance of the automated model vehicles will be evaluated in **two different challenges**: a technical one and one where speed is taken into account. Both events contain the same elements (static car on the road, free parking spots, three crosswalks, one crossed by a pedestrian, ramp, traffic lights, and traffic signs).

7.1 *Main objective*

The vehicle shall automatically cover the distance to a destination point, passing through requested checkpoints, and return to the start taking into account real life traffic rules. The vehicle drives in the right lane without crossing the markings, avoids collision with obstacles, and executes parking manoeuvres.

7.1.1 **Scenario**

The scenario consists of a road with two parallel lanes, one in each direction. The road has straight sections, turns, designated parking spaces, ramp, and intersections. The lanes are marked by different types of lane markings. All markings are white and approximately 20 mm wide, if not specified differently.

Driving on the right side of the road, the vehicle shall pass through all specified checkpoints and shall find a suitable parking spot and manoeuvre into it, without touching obstacles. Real life traffic rules have to be obeyed. The vehicle has to respect traffic light colours, has to take into account the meaning of traffic signs, and has to avoid obstacles, such as stopped cars and pedestrians at crosswalks.

7.1.1.1 **Lane width**

Each lane has a width of 350 mm, measured from the inside of the respective markings.

7.1.1.2 **Lane markings**

Both lanes may be separated by a dashed or continuous central line.

7.1.1.3 Parallel Parking Spots

The parking spots measure 850 mm or 1300 mm in length and 300 mm in width and are placed next to the right lane. They are signalled by the corresponding traffic sign.

7.1.1.4 Traffic Signs

Traffic signs can be present at the roadside. They are located on the right hand side of the lane. These can be: **STOP**, **parking place**, **crosswalk**, and **priority road**.

7.1.1.5 Traffic lights

Traffic lights will be placed at the start point and in one intersection.

7.1.1.6 Crosswalks

Crosswalks will be placed on the road. They will be marked with road markings and the corresponding traffic sign. It is possible that a pedestrian crosses the road when the car reaches the crosswalk.

7.1.1.7 Obstacles

At least one stationary car, similar to the ones provided to the participants will be placed on the road. A pedestrian will cross a crosswalk during the trials.

7.1.1.8 Intersections

Intersections may be displayed with stop lines to opposing entries. A stop line may be complemented by a traffic sign (STOP or priority road). If a stop sign is located in the car's own lane, the vehicle must stop for at least 3 seconds.

7.1.2 The Course of the Event

7.1.2.1 Start

At the beginning of the event, the vehicle must be ready to start and it must be placed in front of the start traffic light. The attempt is started when the traffic light shows the colour green. The order of the teams will be announced by the organizers.

7.1.2.2 Attempts

The attempt may be cancelled by the team representative within 30 seconds. Cancelling an attempt results automatically in a 10% penalty from the obtained score. A maximum of two attempts is allowed for each challenge (technical and speed).

7.1.3 Scoring

Each concept and its realization will be evaluated by the organizing team during development and by the jury during the competition. The members of the jury will be announced on the web page of the challenge.

The maximum amount of points per event is distributed as follows:

Technical Progress and Pitch:

S1: Evaluation during development stage (reports)	100 Points
S2: Overall concept presentation in front of the competition jury	100 Points

S3: Technical approaches	100 Points
Track Challenge:	
D1: Technical challenge	400 Points
D2: Speed challenge	400 Points
Maximum Score: 1100 Points	

7.1.3.1 Penalties during Dynamic Events

Technical challenge

- 5% of the maximum event points
 - Crossing the road (markings) and/or parking space limits while driving (for each case)
 - Collision with obstacles (for each case, e.g. car on the road)
 - Sign detection failure (e.g. road signs, traffic light)
- 10% of the maximum event points
 - Cancelled attempt
 - Non-smoothness movement
- 20% of the maximum event points
 - Not giving priority to the pedestrian

Speed challenge

The car should perform the same actions as in the previous event, with the goal to finish at the shortest time. In case a car does not perform all actions flawlessly, the penalties percentage indicated above will be applied to the teams overall time (e.g. 1.4 min. measured time with 35% penalties results in 1.89 min. final time). The points received at the end of the speed challenge will be marked according to the position reached based on the teams' time after applying the penalties, and presented in the below table:

Team order	Points
1	400
2	288
3	240
4	192
5	160
6	128
7	96
8	64
9	32
10	16

8 Competition Schedule

8.1 *Training and Elimination Rounds*

A physical test track will be available at Bosch Engineering Center Cluj (ECC). The teams will be allowed to send maximum **two members** to participate at the training and eliminatory rounds at Bosch ECC. The **training and elimination rounds will take place in March-April 2020**, within a period of two weeks (exact date to be announced via the web page and Forum). More information regarding the venue and planning will be posted on the web page and on the Forum.

For the elimination round, the car must perform the following actions:

- Lane keeping;
- Intersection crossing;
- Sign detection.

The three actions have to be fulfilled in one autonomous run, each team having two attempts for the run. Failure to successfully complete one of the aforementioned actions results in the team's disqualification.

BFMC organizers will ask that the model vehicle is returned, if one was provided, in case the team does not pass this test.

8.2 *Qualifying Rounds*

The qualifying rounds will follow the same rules as the final event. The fulfilment of the requirements will be checked by the jury members (may differ from the finals' jury) during the qualifying rounds on the two days (Friday and Saturday) before the final event. The organizers will ask to return the provided model car, in case the team does not qualify for the final event. The ten best teams, based on the scoring obtained in the qualifying round, will be invited to compete at the final challenge and they can keep the model vehicle after the participation at the event.

8.3 *Competition*

8.3.1 Preparations

30 minutes before the start of the competition, the teams must be present at their stands.

8.3.2 Order of Events

The technical and speed challenges will take place in a given order. One attempt can be cancelled according to the regulations. The jury will decide when a new trial will take place in case an immediate trial is not possible.