



# STEM IOT/Robotics Competition 2018

Date: 23/24 October 2018

Venue: Microsoft, North Ryde

Organiser: Nexgen Codecamp Pty Ltd

# STEM IoT Project Rules

## Project Description:

Nexgen Codecamp, in co-operation with Microsoft, is inviting high schools located in Sydney to participate in an IoT (Internet of Things) STEM competition (October '18) by assigning teams consisting of Year 9-11 students and assisting them in creating IoT robots, which will be assessed during the event.

## Project Venue & Date:

Microsoft Offices - Ryde on 23/24 October 2018

## Scenario Summary

*Can you build a robot to save a life?*

*An environmental disaster has occurred. There is a risk that contamination could spread to populated areas within the next 48 hours. The area concerned has been cordoned off and secured. It is now imperative that autonomous vehicles are sent in to help assess the immediate damage and risk to the general population, animal and plant life. To do this as much data as possible must be collected, reported and displayed from the disaster site.*

## 1. RULES & REQUIREMENTS

**Teams must build** a robot equipped with certain basic functionality:

Further build rules in Section 3.

- Remote control the robot using WiFi OR bluetooth with a controller such as a laptop, bluetooth keyboard, X-Box controller or mobile phone/tablet
- The ability to connect with the designated Microsoft Azure Cloud service on the internal WiFi
- The ability to push & pull messages from designated channels on the Azure Cloud service.
- Use both a camera and distance (ultrasonic) sensor
- The ability to take various sensor readings. For example:
  - Temperature/Humidity
  - Potential harmful gases
  - Light/visibility
- The ability to detect an infrared LED signal (simulating a person to be rescued).
- The ability to run remote controlled and autonomous mode
- The ability to navigate accurately to precise locations eg. an 'X' on the ground.

*Optionally the robot may be given the following functionality:*

- The ability to send pictures and/or video of the surrounding area via email OR to a location/machine on the WiFi (simulating the internet), a dropbox location, an SMS to a given phone OR your team dashboard.
- The ability to communicate over some social networking tool such as Facebook, Twitter etc

**Teams must build** a data visualisation interface (dashboard) to receive messages from the designated cloud service, originating from their robot. The recommended technology is Microsoft Power BI, however if teams have a strong preference for their own web-based solution, this is also acceptable..

6 teams will be given a number of challenge scenarios with a time limit within which ALL challenges must be completed. Each team will take their turn to accomplish the challenges. Robots will be controlled remotely with line of sight to the robot (the driver will be able to see their robot directly).. Bonus points will be awarded at the discretion of the judges for decisiveness, initiative, ingenuity & effectiveness. Each of the 6 teams will have 2 runs at the course. The second run will contain changes from the first run. Robots may need modification between runs. The best 2 teams will battle it out in a final challenge. The winning team will be the team judged to have completed the final tasks most effectively. The judges decision is final.

## 2. CHALLENGES AND SCORING POINTS

Points will be awarded for completion of the basic requirements detailed above. Further points will be given for completing the following challenges:

### Challenges

#### 2.1 Navigate the city within the allotted time **[20 pts] - Required**

Penalties will be given for coming in overtime and for any obstacles/buildings that are hit.

#### 2.2 Take & report sensor readings in key locations and optionally position & speed **[5 pts/ sensor reading]**

Your sensor readings will be published via Microsoft's Azure Cloud to be displayed on a dashboard. Your vehicle may be equipped to take the following sensor readings:

- Light (visible/IR)
- Humidity
- Temperature
- Soil (extra credit for this one)
- Distance
- Vehicle telemetry

Your dashboard should update the sensor readings in real-time in an intuitive and legible way . We would suggest that you display readings in a graphical way if possible. You could make use of Microsoft Power BI or a web interface for the dashboard.

#### 2.3. Build Presentation **[10 pts]**

This is where you get to tell us about your vehicle and your team journey (This is why it is very important to document the build journey in the months before the event). We will be looking at/for:

- How you built it including why you made particular decisions
- Any demonstrations/videos that help explain this journey
- What issues did you have and how did you solve them as a team?
- General team participation and dynamics ie. How did each member participate?
- Feel free to include design diagrams, ideas that didn't materialise (We want to know how you have gone about the whole process)

- You will have 15 minutes to present.

## 2.5. Publish pictures and/or video footage of the City [5 pts]

You should try and ensure that you have a working camera on board your vehicle. Everyone likes pictures because they always tell a story and gets the imagination working. Live video would be the ultimate, but pictures will be fine. You should try and integrate them into your dashboard or you could even publish them to a social media stream.

## 2.6. Publish relevant information to social media [3 pts]

As mentioned above, you may want to publish appropriate data to social media. It is often the way during such a terrible event that Facebook and Twitter are the first to hear about it as opposed to the news channels. You could for example send a message to a running (python/nodejs) program that re-sends the data in a post to a public network, or you can send it directly if you like.

## The Final Challenge

In the final challenge (TBA at a later date), the best 2 robots will take on the City once again with a modified goal. Details of the final challenge will be published on Day 1 of the 2 day event.

## 3. Build Rules

1. The chassis used must be the one supplied by Nexgen, the Devastator Tank Mobile Platform
2. You may upgrade the chassis with your own 3D-Printed parts, however we do not provide any *official* advice regarding 3D-Printed upgrades
3. The size of your robot must not exceed : (L x W x H): 250 x 250 x 240 mm
4. The vehicle should be capable of completing all of the mandatory challenges detailed in this document.
5. The vehicle should be capable of connecting to the local WiFi network.
6. The vehicle should have an autonomous mode (for obstacle avoidance) and a manual mode.
7. The vehicle may use one or more micro-controllers, Raspberry Pi's or something similar as the 'brains' of the vehicle.
8. Some credit will be given for aesthetics, however this is not of crucial importance.
9. You may use any language to program your vehicle eg. Arduino 'C', Python, Java, C#, NodeJS..etc.
10. The visual interface must represent a monitoring dashboard, measuring aspects of the vehicle's movements such as speed and position in real time plus any relevant sensor readings. **There are no particular compulsory aspects here**, however teams are encouraged to present as much data as they can in a visually attractive and meaningful way.
11. You may use any software to build your dashboard. Microsoft's Power BI is preferred unless you are building your own webpage.
12. The communications hub will be Microsoft Azure, therefore any testing of your platform should use our test framework.
13. Progress of your vehicle build must be recorded in your team diary and updates should be pushed/communicated to Nexgen approximately every 2 weeks.

## Data Format, Protocol and Dashboard

The data format for any data being sent over the cloud should be JSON (Javascript Object Notation).

The protocol used for all communications with the hub will be MQTT. You can also use MQTT over Websockets.

The Dashboard is purely a monitoring device i.e. a display of your vehicle's activity. The dashboard should be visual, attractive and easy to read. It may display some or all of the following (this is not an exhaustive list however):

1. Vehicle speed
2. Vehicle position
3. Vehicle health (battery life)
4. Sensor readings
5. Communications with the hub
6. Communications with the outside world
7. Pictures captured from the site.
8. Video captured from the site.

## Cloud Infrastructure

Cloud infrastructure will be provided by Microsoft and will be based on a Microsoft Azure Hub. There will be several endpoints for vehicles to publish & receive messages. The hub should be a simple & standard configuration. Access to the hub will be facilitated through a local WiFi access point.

## Publish/Subscribe Channels

Channels will be setup for vehicles to communicate with their team base and the outside world.

## Team Composition

Teams should be comprised of no less than 4 and no more than 6 team member. The team should be mixed with at least 2 boys and at least 2 girls. All team members should be made up of Year 9-11 students in 2018. A Nexgen mentor will be allocated to each team.

## Team Onboarding

Each school is allowed to field one team. There will be a maximum of 6 teams in 2018. Kickoff presentations to each team will take place early August. After that, kits will be sent out in a couple of drops. In the first drop teams will be given the chassis and computing platforms. The second drop will contain sensors and cameras and will be between 1 and 2 weeks after the first drop.

Each team will be given the competition kit. This will include:

1. Robot chassis
2. A specified 'kit' of components optionally including an Arduino, RaspberryPi, Romeo BLE Arduino compatible board, resistors, jumper wire, LEDs, switches
3. A set of sensors

#### 4. A Raspberry Pi camera module

Each team is expected to make their robot 'their own' - in other words we don't really want to see 6 identical black tanks on competition day. To that end, you are encouraged to 'decorate' your robot and build 3D printed attachments/cases.

The Nexgen website will be gradually populated with guides & tutorials but teams are encouraged **NOT** to rely on this. There is a wealth of material out there on YouTube, Instructables and many other excellent information sources. Good research technique is an expected part of the project as teams will learn more this way. Nexgen tutorials, articles & videos are intended to be a guide but are most definitely not meant to be a ready made solution.

### Team Checkpoints

Teams are required to keep diary, cataloguing their progress of the design, build, code and test phases with photos, video, written and diagrammatic content. This could be via a Blog, a Word document or anything in between. As it is required to present your robot at the event, this exercise will prove to be very useful.

### Team Mentor Assignment

Teams will be assigned a mentor who will work with them on a regular basis to build their robot. The role of the mentor is to consult and advise, make recommendations and help when the team is stuck. The team itself should make any decisions that need to be made.

Teams that require consulting days can book them as needed up to a total of 6 hours face to face. Teams will request the particular training or advice that they require and Nexgen will allocate consultants on a needs basis in the lead up time to the competition.

Email support is also available. Please discuss this with your mentor.

[END]