



HACETTEPE UNIVERSITY
Computer Engineering Department
BBM233 Logic Design Laboratory
Fall 2019

PROJECT (Individual Work)

Deadline for report submission:
Friday, 10.01.2020 at 22:00 for all sections.

BACKGROUND

As technology advanced, and concerns about humanity's future on Earth increased, arguments favoring space colonization gained momentum. Both private and public Space agencies and organizations made serious commitments to researching the viability of long-term colonization efforts, and to taking steps toward a permanent human presence on Mars, which is considered as the next giant leap for humankind.



After a long period of research and development, the human race is finally ready to launch its first batch of Mars settlers in 2020. Since colonization requires the establishment of permanent habitats that have the potential for self-expansion and self-sustenance, the astronaut selection program was very rigorous. Nevertheless, due to your extreme competence and skillfulness in digital logic design, you, the students of Hacettepe Computer Engineering Department, were unanimously selected to head to Mars as the Primary Logic Design Team in charge of all computer hardware and electronics projects that will be implemented on Mars.

Your first mission is to design and implement a Martian Underground Road Intersection Control System which will ensure safe and efficient transport of people and vehicles around our first settlement on Mars. A road network will be built underground due to the safety reasons; primarily for protection against radiation, reduced air pressure and inhospitable atmosphere.

PROJECT SPECIFICATIONS

You will design a Martian Underground Road Intersection Controller and implement it in Verilog.

System Specifications:

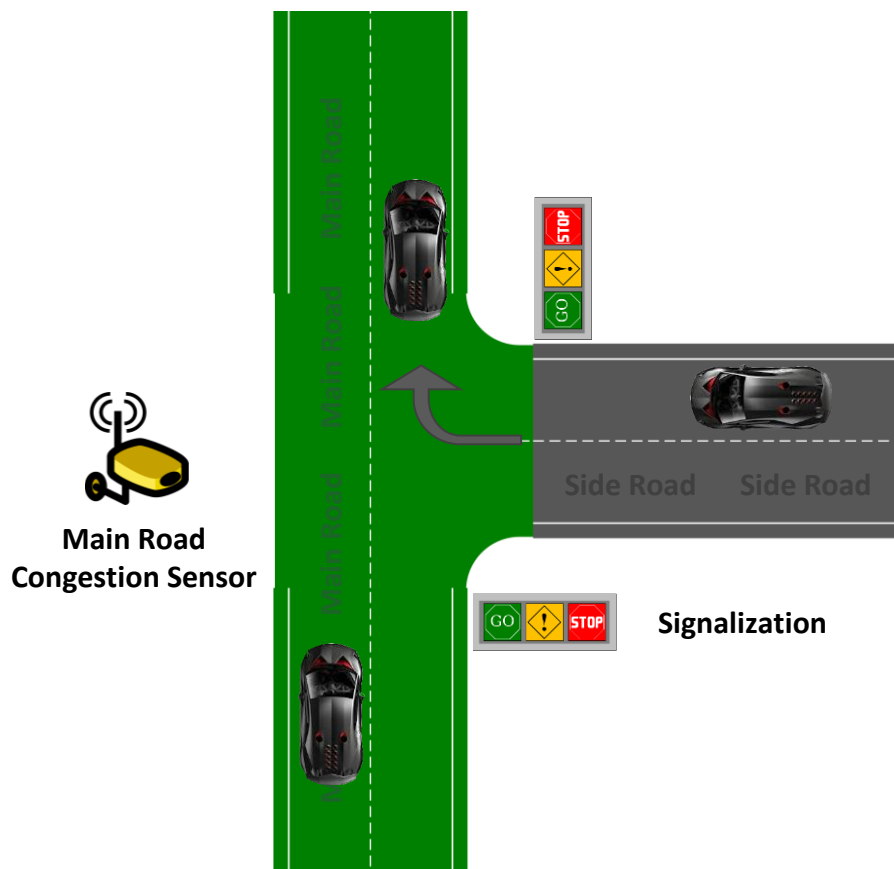
The first Martian underground road network will consist of two types of roads:

- **Main Roads** (green roads whose traffic gets high priority), and
- **Side Roads** (grey roads with lower priority traffic).

An intersection of a main road with a side road will therefore need to be controlled carefully with appropriate signalization. The tasks of the Martian Underground Road Intersection Controller will be the following:

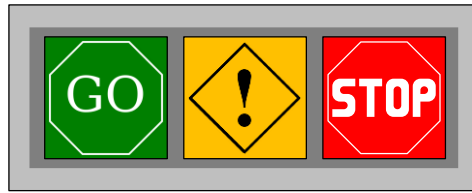
- Ensure efficient and safe flow of vehicles in all directions,
- Take the road priorities into consideration, so that the main roads get higher throughput,
- Monitor and handle possible traffic congestion of the main roads.

An intersection will look as follows:



The main road will have congestion sensors which will monitor the traffic flow and signal the controller in case of a traffic jam.

State Specifications for Signalization



Road Signalization on any road can be in one of the following states:

State	Signalization	Meaning
GO		Vehicles are free to drive forward.
GO-ATTENTION		Get ready to stop in less than 3 seconds.
STOP		All vehicles must stop.
STOP-ATTENTION		Get ready to start driving forward in less than 3 seconds.

At an intersection, there will be two signalization signboards, one for the main road, and another for the side road. The controller must control both signboards at the same time.

Signalization Rules:

- While one road is in the GO state, the other road can only be in the STOP state.
- After the GO state, a road must go through the GO-ATTENTION state before switching to the STOP state.
- Similarly, after the STOP state, a road must go through STOP-ATTENTION state before switching to the GO state.
- While one road is in the GO-ATTENTION state, the other road can only be in the STOP-ATTENTION state.

Timing Specifications for Signalization

Case 1 – No Congestion: The main road signalization stays in GO state for **exactly 20 seconds**. The side road signalization stays in GO state for **exactly 10 seconds**. GO-ATTENTION and STOP-ATTENTION states last for **3 seconds** on all roads.

Case 2 – Congestion is Detected: The main road signalization stays in GO state for **at least 40 seconds and until the congestion sensor stops detecting traffic jam**. The side road signalization stays in GO state for **at most 10 seconds, but may be interrupted earlier in case congestion on the main road is detected**. GO-ATTENTION and STOP-ATTENTION states last for **3 seconds** on all roads.

Testing and Report Notes:

You must test your implementation for all possible situations (congestion, no congestion, prolonged congestion, etc.). Failing to test for any case will result in grade reduction (even if your solution is completely correct).

Write a detailed and well-organized report about your design and implementation stating all the steps you took. Clearly explain the states and state transitions of your system. You may choose any design approach you like.

Report Submission:

The deadline for submission is Friday, 10.01.2020 at 22:00 for all sections. Zip your files (not .rar, only .zip files are supported by the system) and submit your work through <https://submit.cs.hacettepe.edu.tr/index.php> with the following file hierarchy:

- <studentID>.zip
 - controller.v
 - controller_tb.v
 - report.pdf

Important notes:

- All work must be done individually. Each student must submit their own solution. You may discuss the problem with other students, but don't share your codes with anyone as we will perform the plagiarism check.
- Clearly state your name and student ID on the first page of your report.