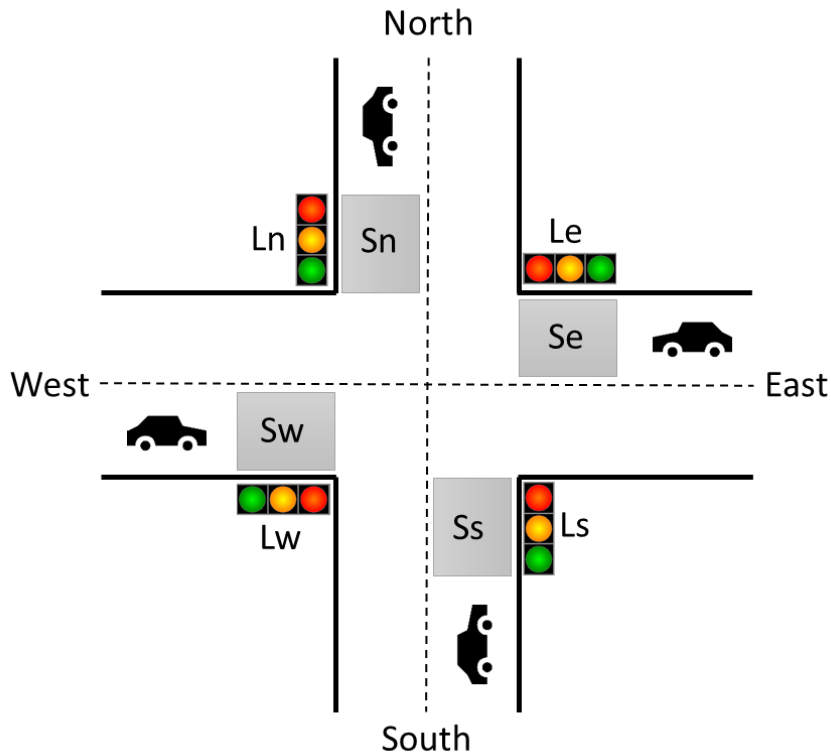# Assignment: Traffic Control

Goal is to model the embedded software controller that coordinates the traffic at a two-roads intersection.

Structure

A two-road intersection is equipped with four traffic lights (Ls, Le, Ln and Lw) and four vehicle detection sensors (Ss, Se, Sn and Sw).
A traffic light can be set on:

1. Green – cars facing the green light can proceed
2. Red – cars facing the red light must wait
3. Orange – cars facing the orange light should prepare to stop.

A sensor can detect whether a car has arrived at the intersection. A sensor can be activate or non-active.

There is also an Intersection Controller (IC) that coordinates the traffic lights and communicates with the sensors. Thus, the IC can change the color of the traffic lights and can change the mode of the sensor. An IC has two modes of operation: *regular* and *non-regular*. (Think for instance on regular mode during the day and non-regular mode during the night).

Furthermore there is a Traffic Control Center (TCC) that controls and communicates with multiple IC's. The TCC can change the operation mode of the IC.
(*) The TCC can also process traffic data that it receives from the IC's.

The "TrafficLight" and "Sensor" capsules, including the protocols of the ports, have already been provided in the template project and are ready for use. *They should NOT be modified!* The rest of the model is up to you.

Behavior

The behavior of the entire Traffic Control System, that you have to model, has to comply with the following requirements:

1. Every IC is initially in the regular mode

2. No accidents must happen. This means that at any moment only one road (i.e. North/South road or West/East road) can have its traffic lights set to Green.

3. Both traffic lights on the same road are synchronized, i.e. they always both have the same color and switch colors at the same time.

4. When the color of at least one of the traffic lights is about to be changed, then before the change takes place all traffic lights must stay Red for 2 seconds.
   For instance, if Ls and Ln are Green and they are going to be changed to Red, and Lw and Le are Red and they are going to be changed to Green, then first Ls and Ln are changed to Red, thus for a while all four lights are Red, and only then Lw and Le are changed to Green.

5. In the regular mode the following must hold:
   a. The Sensors are in active mode.
   b. Initially all lights are set to Red
   c. The Red lights stays on as long as no car has been detected.
   d. If a car has been detected the corresponding traffic light must be eventually turned to Green.
   e. Switching from Red to Green goes directly.
   f. Switching from Green to Red goes via 1 second of Yellow.
   g. (*) The Green light stays on as long as cars are detected but it cannot stay on for longer than 60sec (otherwise the system might experience the so-called "starvation problem").

6. In the non-regular mode all traffic lights are Flashing Orange and the Sensor is in non-active mode.

7. Changing from the regular mode to non-regular mode works as it follows:

    a. first, all Green traffic lights are changed to Red (via Orange);

    b. then all lights are set to Flashing Orange and the Sensor is set to non-active.

8. Changing from the non-regular mode to the regular mode works as it follows:

    a. first, all lights are changed from Flashing Orange to Red

    b. then, the Sensor is set to active mode;

9. (*) The IC should keep track and store information about the amount of traffic at the intersection. And provide it to the TCC whenever requested.

The Trafficlight protocol contains the following messages:
- *red*: to set the light to Red
- *green*: to set the light to Green
- *orange*: to set the light to Orange
- *flash_orange*: set the light to Flashing Orange

The Sensor protocol contains the following messages:
- *activate*: the sensor is activated, i.e. starts detecting cars
- *deactivate*: the sensor is deactivated, i.e. stops detection
- *detected*: to signal that a car has been detected by the sensor

The Control protocol must at least contain the following messages:
- *turn_to_regular*: set the IC into the regular mode
- *turn_to_nonregular*: set the IC into the non-regular regulation mode

Note: The IntersectionControl protocol can be extended according to your own design.

Preparations

A template project is available for your convenience. Import the file "TrafficControl.zip" in your workspace and open the model in the model explorer. This is a template project and your assignment is to finish the model as explained earlier in this document.
Note: The basic assignment is to implement the requirements that are not labeled by a (*). The extended version of the assignment is to implement the all requirements.