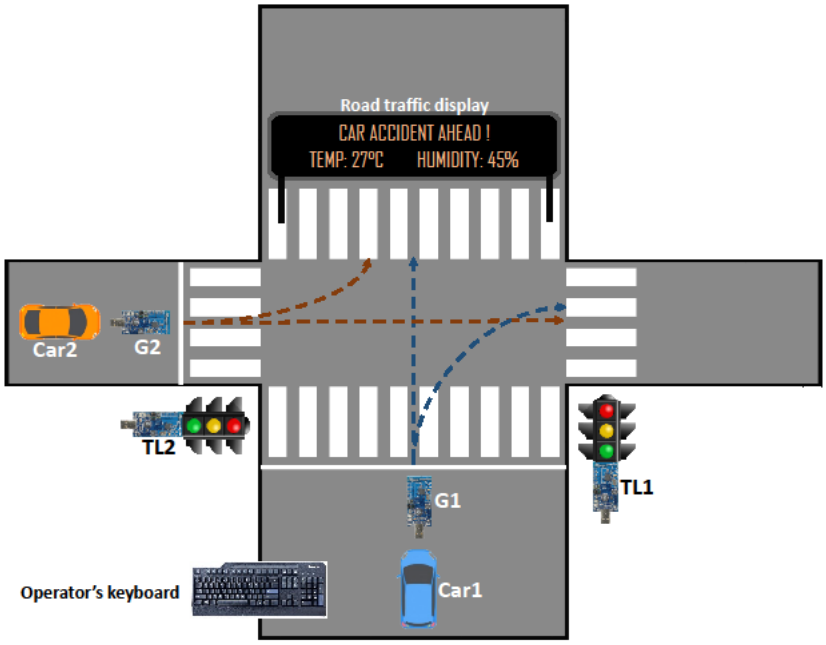
Contiki Project – NES 2017/2018



Consider the **Intelligent Transportation System** (ITS) scenario that is depicted in Figure. There is an **intersection** between two streets. Both of them are one-way. In particular, the vertical one is the **main street**, while the horizontal one is **secondary**. The smart devices in this intersection are the following:

- **G1** is a Tmote Sky placed on the ground in the main street, before the intersection;
- **G2** is a Tmote Sky placed on the ground in the secondary street, before the intersection;
- **TL1** is a Tmote Sky that behaves as a Smart Traffic Light for the vehicles on the main street;
- **TL2** is a Tmote Sky that behaves as a Smart Traffic Light for the vehicles on the secondary street;
- **Road traffic display (RTD)** provides the drivers with information regarding the current temperature, humidity, and eventual emergency warnings. Only G1 writes on the RTD;
- **Keyboard** is placed on the side of the main street and can be used by the road traffic operator to write emergency warnings on the RTD through G1.

All these smart devices need to collaborate with one another in order to perform **three tasks**.

First Task – Road traffic management and scheduling

In the considered scenario, there are two categories of vehicles: **normal vehicles** (cars, trucks, etc…) and **emergency vehicles** (police, firefighters, ambulance, etc…). The ITS system knows when a vehicle reaches the intersection because, when this happens, the **button on either G1 or G2 is pressed**. Every time in which the button is pressed, the mote **waits 0.5 seconds for another button press**. If there is this second press, it means that the vehicle is an emergency vehicle; otherwise (only one button press), the vehicle is a normal vehicle.

That said, road traffic has to be managed such that **the categories of the vehicles have higher priority than the type of the streets** (i.e., main/secondary). More specifically, you need to consider and implement all the following conditions:

- **No vehicles** → the **green and red LEDs** of both TL1 and TL2 **periodically blink** together until at least a vehicle arrives on any of the two streets. In particular, the period of the blinking is **2 seconds** (i.e., both the green LEDs and the red LEDs on both the nodes are repeatedly on for 1 second and off for 1 second);
- **Normal or emergency vehicle on only one of the two streets** → the **green LED** of the traffic light on that street is switched on for **5 seconds**. For the same period of time, the **red LED** of the other traffic light is on;
- **Normal vehicles on both streets** → the vehicle on the main street has a higher priority than that on the secondary street. The behavior is that of the previous point, where the green traffic light is shown to the vehicle with higher priority;
- **Emergency vehicle on the secondary street and normal vehicle on the main street** → the emergency vehicle has a higher priority than the normal one. The behavior is that of the previous point, where the green traffic light is shown to the emergency vehicle;
- **Normal vehicle on the secondary street and emergency vehicle on the main one** → the emergency vehicle has a higher priority than the normal one. The behavior is that of the previous point, where the green traffic light is shown to the emergency vehicle;
- **Emergency vehicles on both streets** → the vehicle on the main street has a higher priority than that on the secondary street. The behavior is that of the previous point, where the green traffic light is shown to the vehicle with higher priority.

Note that, at any instant of time, at the most only one vehicle can be waiting on top of G1 and only one vehicle on top of G2. While a vehicle is crossing the intersection during the 5 seconds, the eventual vehicle that follows

can press the button and wait on top of the mote so that at the end of those 5 seconds the system can make a new traffic management decision depending on the new condition (see the previous six points).

Second Task – Sensing

All the four Tmote sky nodes sense **temperature** and **humidity**. In particular, **G2** is connected to the **electricity supply** and ALWAYS senses both variables every **5 seconds**.

Instead, **TL1** and **TL2** are **battery-powered**, and by default they also sense both variables every **5 seconds**. Though, note that every action performed by TL1 and TL2 consumes their battery. More specifically, consider that the **battery level is 100** at the beginning and is **decremented by 5 at every LEDs toggle and by 10 every time that the mote senses both temperature and humidity. Once the battery level reaches 50, the sensing is performed every 10 seconds; once the battery level reaches 20, the sensing is performed every 20 seconds in order to save energy.** Besides, once the battery of TL1 and/or TL2 is **below 20**, their **blue LEDs** start blinking with a period of **2 seconds** (i.e., 1 second on and 1 second off). **If the user presses the button of TL1 and/or TL2, the battery level of that mote goes back to 100, the blue LED stops blinking, and sensing happens again every 5 seconds.**

All the temperature and humidity measurements are every time sent to G1, which thus behaves as the sink node of the network. **THE PROCEDURE THAT FOLLOWS IS RELATIVE TO TEMPERATURE BUT IS EXACTLY THE SAME FOR HUMIDITY.** Every time in which G1 receives a **new temperature measurement** from any of the other nodes, it **stores it**. **When and only when** it has received a new temperature value from **ALL** the other motes, **then also G1 senses the temperature and calculates the average** temperature among the four values (the three received values and the one that it sensed). Then, G1 **prints out a new message with the format "*Emergency warning*[1] *+ temp + humidity*" on the RTD, as in Figure**, and **deletes all the temperature values** that were previously stored (the **humidity values are kept,** instead). Note that if, while G1 is waiting for all the motes to provide a new temperature value, it receives a new temperature value from a mote that has already sent it, **this new value replaces the old** temperature value of that mote.

[1] The Emergency warning will be clearer with the third task

Third Task – Emergency warning

The **operator** can use the **keyboard** to specify **Emergency warnings**. In particular, the operator has to provide the correct **password** (i.e., NES) in order to complete this task. **If the password is incorrect**, **G1** asks again for it. Once the provided password is correct, the operator can type the Emergency warning. Note that this warning is **displayed only the next time in which a new average temperature or humidity is ready** (see the previous task). A blank string provided by the operator means that there is **no emergency warning** to be displayed. In this case, the message will have the following format "Temp + humidity".

Final remarks

- Each of you should **contact me** when he/she wants to **start** implementing the project. In that case, I will provide you with **four Tmote Sky nodes.** Please, note that **you must discuss the project in the same exam session** (appello d'esame) in which you perform the oral examination with Prof. Anastasi and Marcelloni. This means for example that you cannot discuss the project at the beginning of June and do the rest at the end of July;
- I suggest you to discuss your project around **one week before** the official date of the exam session. Therefore, you should **contact me in advance** in order to arrange the day, time, and place;
- It is **not necessary that you send me your code** before the actual project discussion;
- All the firmwares must **compile** and **respect the specifications** when running (these are the minimum requirements);
- **Apply all the knowledge and concepts** that you have learnt during the lessons. This would increase the overall **quality of the work** (e.g., use both broadcast and runicast, use both default and custom events, etc…);
- During the examination, you will have to show a **deep comprehension** of the topics in general and that the project is **your own work**.