# **SustainCity: smart urban mobility for a greener future**

* 1. **The problem**

Two urgent global concerns are environmental sustainability and climate change; because of air pollution and greenhouse gas emissions, transportation—especially urban commuting— contributes to worsening those issues.

* 1. **The Goal**

We want to dynamically modify the duration of traffic lights on the main roads in the city depending on the directions from where we observe the main traffic movements. For instance, if, at a certain point in time, we observe that the traffic flow on a certain road A is significantly higher than in the crossing roads, then we may decide to extend, for instance, for one hour, the duration of green lights on A (and, consequently, extend the duration of red lights in the crossing roads).   
We want to analyze the daily traffic patterns and identify possible optimizations in terms of one-way roads, traffic lights configuration, and public transport schedule.   
We want to collect information about the planning of events attracting large crowds (e.g., important sport events, concerts, fairs) and define event-specific configurations for traffic lights, roads and public transport schedules.

* 1. **Stakeholders**

Drivers: for reduced waiting times stuck in the traffic

Citizen: for air pollution, public transport

Urban Traffic manager: for optimization of city viability

Events planner: for a better management of events attracting large crowds

**2 Requirement Analysis**

**2.1.1 Human Actors**

Drivers: benefit from the SustainCity system

Citizen: benefit from the SustainCity system

Urban Area manager: monitors type2 and type3 actions

**2.1.2 Non-Human Actors**

Traffic Lights: get its state set from the ET system for a determined time period

Sensor Infrastructure: send sensor information to the ET system via data bus

Public Transport Microservice: sends public transport schedules to the ET system via function calls

News Channel: transmits city events information to the ET system

* 1. **Use Cases**
     1. **Scenarios**

**Traffic light duration adjustment**

1. During peak traffic hour, cars take more than the necessary to cross a particular intersection coming from a busy road, while the crossing road are less used.
2. The system sensor measures this data and publish them on the data bus.
3. SustainCity retrieves the data from the data bas and stores them into a database.
4. SustainCity compares the data with the previous one.
5. If a misbehaviour is detected, then SustainCity compute the new routines time for the traffic light which has to be modified.
6. SustainCity connects to the traffic light system interface.
7. SustainCity provides to the traffic light system the serial numbers of the traffic lights which must modify the routine with the amount of time interval to be changed.
8. SustainCity writes into a log file the modifications done.

**Traffic Zone Optimization**

1. The Urban Area Manger asks to SustainCity to verify if the traffic light system is optimized in a certain zone.
2. SustainCity analyses the zone given to find information about the services active in the area (such as schools, important streets, stadiums…)
3. SustainCity retrieve from the database the time needed to cross all the intersection in the provided zone.
4. SustainCity analyses the data retrieved and tries to minimize the medium amount of time taken to cross an intersection into the zone.
5. SustainCity performs the getScheduleByStreet and the getScheduleByLine offered by the microservice to get all the bus lines that has a stop into the area to optimize.
6. After the information arrived, SustainCity tries to reschedule the timetable of the bus lines in such a way to minimize the traffic. (i.e if in the zone there’s a school, then the system could anticipate the timetable of the stops near that to avoid the students to arrive late or could suggest increasing the number of buses in the area).
7. SustainCity presents to the UAM the recommendations and waits till the UAM decide to accept or to reject the recommendation and store the decision.
8. SustainCity writes into a log file the recommendations approved and the one rejected for yearly reporting.

**Event-specific configurations**

1. News channel publishes information about upcoming event with the expected attendance.
2. SustainCity receives the event information via integration with news channel.
3. SustainCity automatically categorizes the event by the attendance.
4. SustainCity analyzes historical traffic patterns from similar events.
5. SustainCity retrieves public transport schedules via microservice using getScheduleByStreet operations.
6. SustainCity generates event-specific configuration recommendations for traffic lights and roads.
7. SustainCity notifies Urban Area Manager about new event-specific configuration.
8. UAM reviews the configuration and decides to accept or to reject.
9. If accepted SustainCity schedules the configuration changes for event day.
10. SustainCity store the changes suggested and the decisions made by the UAM.
11. SustainCity logs the action for yearly reporting.

**System monitors traffic during special event**

1. SustainCity detect the presence of a special event happening today.
2. Traffic sensors detect traffic flow.
3. Traffic sensors publish data to message bus.
4. SustainCity receives sensor data from message bus.
5. SustainCity retrieve the data in the area near the event.
6. SustainCity implements temporary traffic light timing changes if needed.
7. SustainCity logs all adjustments and their effectiveness
8. SustainCity updates event-specific configuration data based on observations for future similar events

**Citizen views public traffic reports**

1. Citizen accesses SustainCity public portal.
2. SustainCity presents options for viewing reports.
3. Citizen selects the preferred option
   1. Citizen selects "Daily Traffic Reports" and choose the date and time.
      1. SustainCity retrieves daily report data from database service
      2. SustainCity displays report showing:
         1. Average traffic flow on main roads
         2. Visualization of peak congestion periods
         3. List of actions taken automatically
         4. Traffic prediction for tomorrow
   2. Citizen selects "Yearly Reports" option
      1. SustainCity displays yearly report options
      2. Citizen selects "Type 2 and 3 Actions"
      3. SustainCity retrieves yearly report data from database service
      4. SustainCity displays comprehensive report showing:
         1. Suggested Type 2 and 3 actions that were accepted
         2. Suggested Type 2 and 3 actions that were rejected
         3. Resultant traffic improvement metrics
4. Citizen can navigate back to the main reports page using a dedicated "Back" button
   1. **Domain assumption**
5. The sensor infrastructure works correctly and with low latency 24/7
6. The traffic lights are not faulty and get their state set correctly in time from the ET system
7. Drivers behave accordingly to the traffic light state
8. No car can obstruct the passage in the crossing no matter the reason
9. Events planners always report to the news channel up to date events in the city
10. The public Transport Microservice always returns the right timetable given a line or the name of a street
    1. **Requirements**