1 Name of Use Case

Name of the Use Case	**IoT platform for Smart Traffic Lights**
Version No.	v1.0
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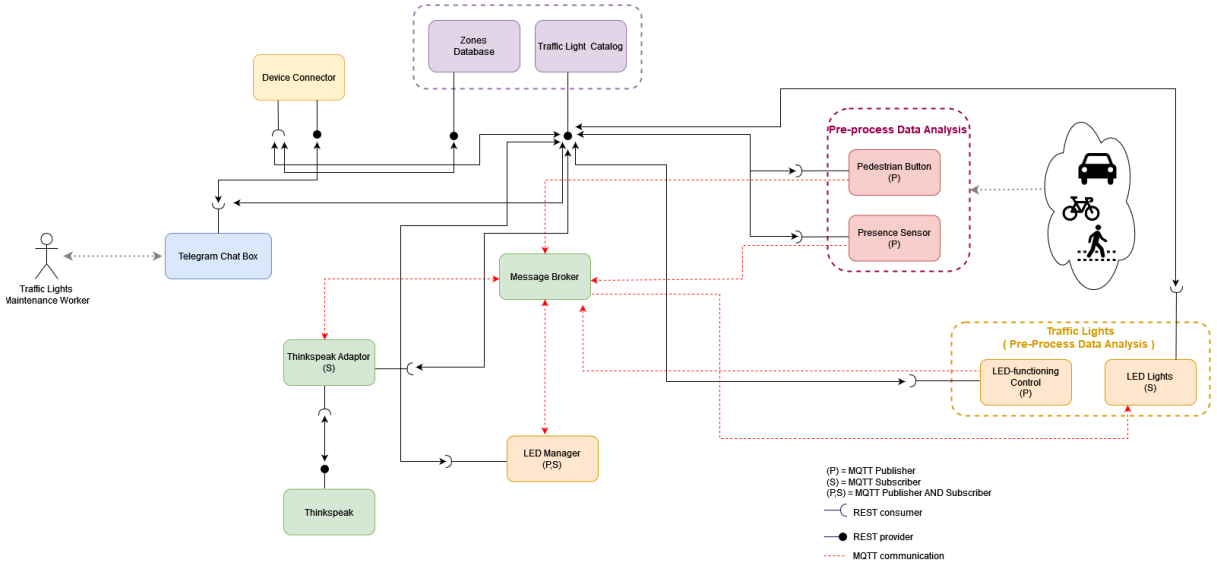
2 Scope and Objectives of Function

Scope and Objectives of Use Case	
Scope	The service provides smart traffic light control at crossroads.
Objective(s)	Increase safety of road users, decrease energy consumption and enhance traffic light management and monitoring
Domain(s)	Smart traffic light control, Sustainable use of traffic lights, Traffic Light Maintenance
Stakeholder(s)	Road users, Road maintenance companies
Short description	The IoT platform will aim to make traffic more efficient and less energy consuming to benefit the stakeholders. The integration of IoT-compliant sensors, able to monitor the presence of both cars and pedestrians, will make it possible to create a platform which will control the traffic lights in a tailored way, informing every traffic light in a specific zone when a car is detected. It will perform several over-time computations, such as counting detected cars or pedestrians, delivering an extended overview of the system usage. It will provide a cohesive platform that is scalable across a broad road network. Different components will make use of REST and MQTT protocols to communicate. The end user (traffic light maintenance workers) will be provided with a list of information regarding all the traffic lights for the selected area, with particular attention to the malfunctioning ones. In this way, maintenance of the traffic lights will be managed in a sensitively more efficient way.

3 Diagram of Use Case



4 Complete description of the system

To ensure the flexibility and scalability of the proposed IoT platform, it will be developed following the microservice approach. The two main communication protocols are: 1) the publish/subscribe-based protocol (MQTT) and 2) REST web services based on the request/response approach. The components are discussed below:

- The **Message broker** ensures asynchronous communication between components, based on the publish/subscribe paradigm (MQTT).
- The **Zones Database** is a database that contains a list of malfunctioning traffic lights. It is written in JSON format and every worker will be able to access the data in it (throughout the Telegram Bot). The database will be exposed through a REST web service.
- The **Traffic Light Catalog** will act as a service,device and resource catalog. It will contain all the information about end-points (MQTT topics and REST web services), a complete list of registered devices, a list of users, and a list of zones, with all the details which are necessary to ensure a correct communication between all the components. The data are stored in JSON format and exposed through a REST web service.
- The **Device connector for RPi** integrates into the platform Raspberry Pi boards. It provides REST web services, to enable the Telegram Bot service to work properly. As already explained previously,.
- The **Pedestrian Button** and the **Presence Sensor** are the two sensors for car-pedestrian presence detection, which allow the system to be aware of the presence of cars and pedestrians willing to cross the roads. They act as MQTT publishers. In the platform Raspberry is equipped with a presence sensor, a button, temperature sensors and a set of LEDs (simulating the behavior of a normal traffic

light). Even if they are going to be mounted on a Raspberry board, however, for scalability purposes, they could be implemented as stand-alone components, each one capable of managing its own MQTT functions.

- The **LED functioning control** is a temperature sensor, capable of periodically measuring the temperature near to the LEDs. It acts as a MQTT publisher to send the data for post-process data analysis: in order to enable the update of Zones Database, which stores for each zone data useful for maintenance.
- The **LED manager** is the unit that will manage the LEDs behavior among all the traffic lights of a specific zone (a few blocks, a neighborhood). It will subscribe to the Traffic Light Catalog using REST and will act as a MQTT publisher and subscriber, in order to receive real-time data from the message broker (such as the presence of car/pedestrian) and publish appropriate commands for LEDs to obey.
- The **LED lights** will be the platform actuators, receiving commands from the LED manager and turning ON/OFF the Traffic Lights. As already explained previously, they will be mounted on a Raspberry board, but in hypothetical future implementations they could be integrated as stand-alone smart components.
- The **ThingSpeak Adaptor** is a MQTT subscriber that receives measurements and uploads them on ThingSpeak through REST web services.
- **ThingSpeak** is a software that provides REST web services. It is an open-data platform for the IoT that can be used to store, process and visualize data. It will allow to display some computations performed by the system over time, such as total counts of detections (cars or pedestrians)
- The **Telegram Chat Box** is a service implemented for user-awareness purposes, i.e. Traffic-Lights-maintenance workers. It provides an interactive interface directly accessible by the end-users to instantly get information about the status of the platform and all the malfunctioning devices, such as LEDs, Presence Sensors, Pedestrian Buttons, LED-functioning sensors. It requests data from the Zone Database using REST web services.

5 Desired Hardware components (only among those we can provide)

Device Name	Quantity	Needed for…