Using wireless communications for car access in historical zones

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Presentation outline

- Motivation
- State of the art and project objectives
- Implementation of the solution
- Achievements, challenges and future work

Motivation

Why is mobility in historical zones a problem?

- Rapid growth of tourism in some cities
- Narrow and irregular shape streets

Source: https://www.theguardian.com/environment/2017/jul/12/auto-industry-fights-back-at-plan-to-cut-cars-greenhouse-gas-emissions

➢ **Large flow of cars and pedestrians**
  - Less safety
  - Air pollution
  - Noise
  - Difficulties in emergency situations

➢ **Challenge from FL Gaspar, a leading company in Portugal in this field**

Source: https://www.responsibletravel.com/copy/overtourism-in-venice

Motivation

Cities management tends to limit the traffic to:

- Residents
- Taxis and other private transports
- Ambulances and medical vehicles
- Fire combat vehicles
- Cleaning vehicles
- Police
- Merchants
- Providers of services to establishments located in historical zone

Source: https://www.responsibletravel.com/copy/overtourism-in-venice

State of the art

Manual bollards

Problems:

- Key replications
- Personnel costs

Source: FUN 3.1 – Control of Limited Traffic Zone in the Historical Centre, Armando Ribeiro, Augusto Vieira, Lívia Silva, 2013

State of the art

Systems with retractable bollard

Lisbon, Portugal

Source: http://www.flgaspar.pt/sistemas-de-gestao-de-trafego/portefolio-de-produtos/controlo-de-acessos-a-zonas-pedonais

Funchal (Madeira), Portugal

Source: FUN 3.1 – Control of Limited Traffic Zone in the Historical Centre, Armando Ribeiro, Augusto Vieira, Lívia Silva, 2013

State of the art

Systems without retractable bollard

- Connected to local authorities

Rome, Italy

Source: https://blog.rome-accommodation.net/driving-in-rome-limited-traffic-zones-ztl-hours-and-information

Florence, Italy

Source: https://www.visitflorence.com/tourist-info/driving-in-florence-ztl-zone.html

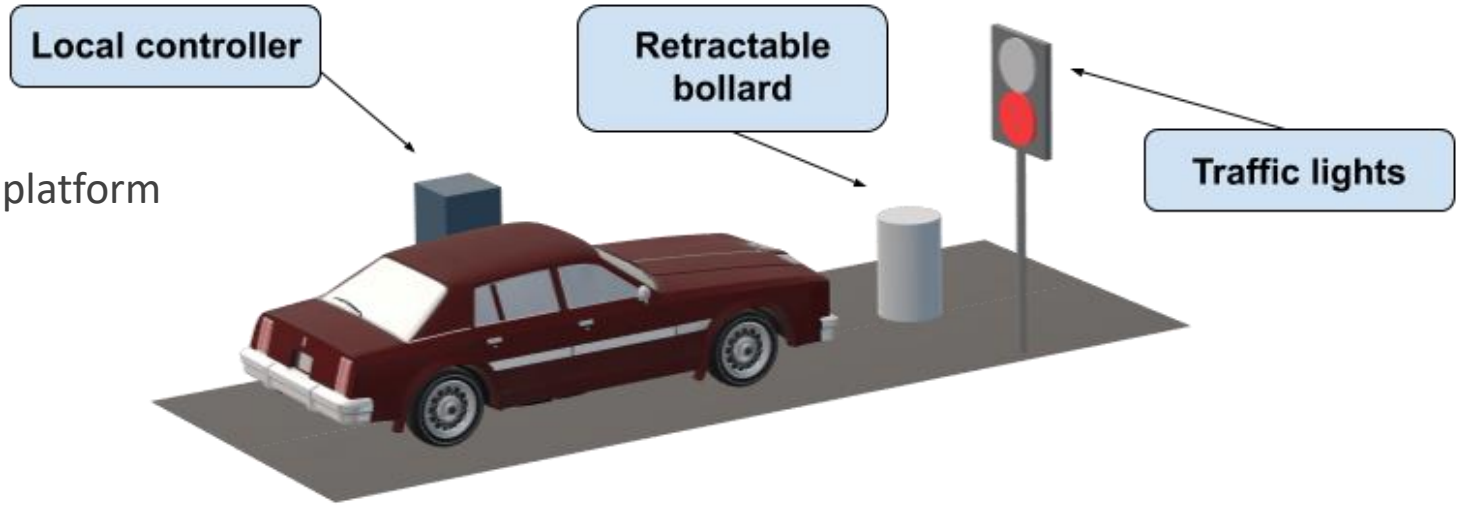
Project objectives

- **Implementation of a car access control system based on wireless technologies**
  - **Collection of all relevant data**
  - **Development of safety modes for emergency situations**
    - Earthquakes, Fires, …
  - **Evaluation of the suitability of the LoRa in this type of applications**

Access control system architecture

❑ Local controller

- Performs user authentication
- Actuates the retractable bollard
- Keeps permanent connection with central platform



❑ Retractable bollard

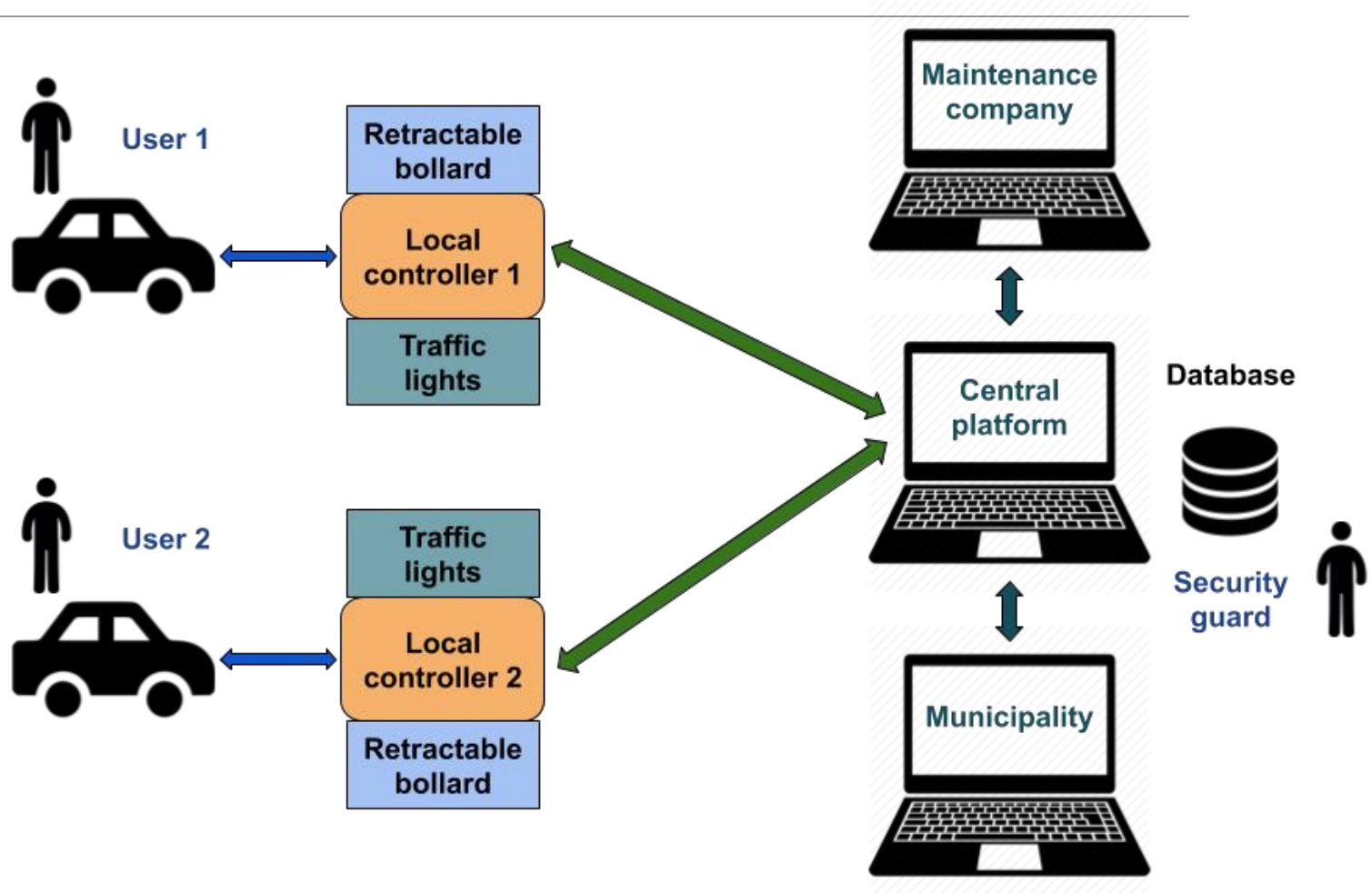
- Blocks unauthorized vehicles

❑ Traffic lights

- If the user is included in the whitelist, the bollard goes down and a green light turns on. In all other cases, the bollard remains high and the traffic signal shows a red light

Access control system architecture

- Municipality can manage the white list of users and get all the system information at any time
- A security guard can be called to give access to unauthorized vehicles or drivers in special situations

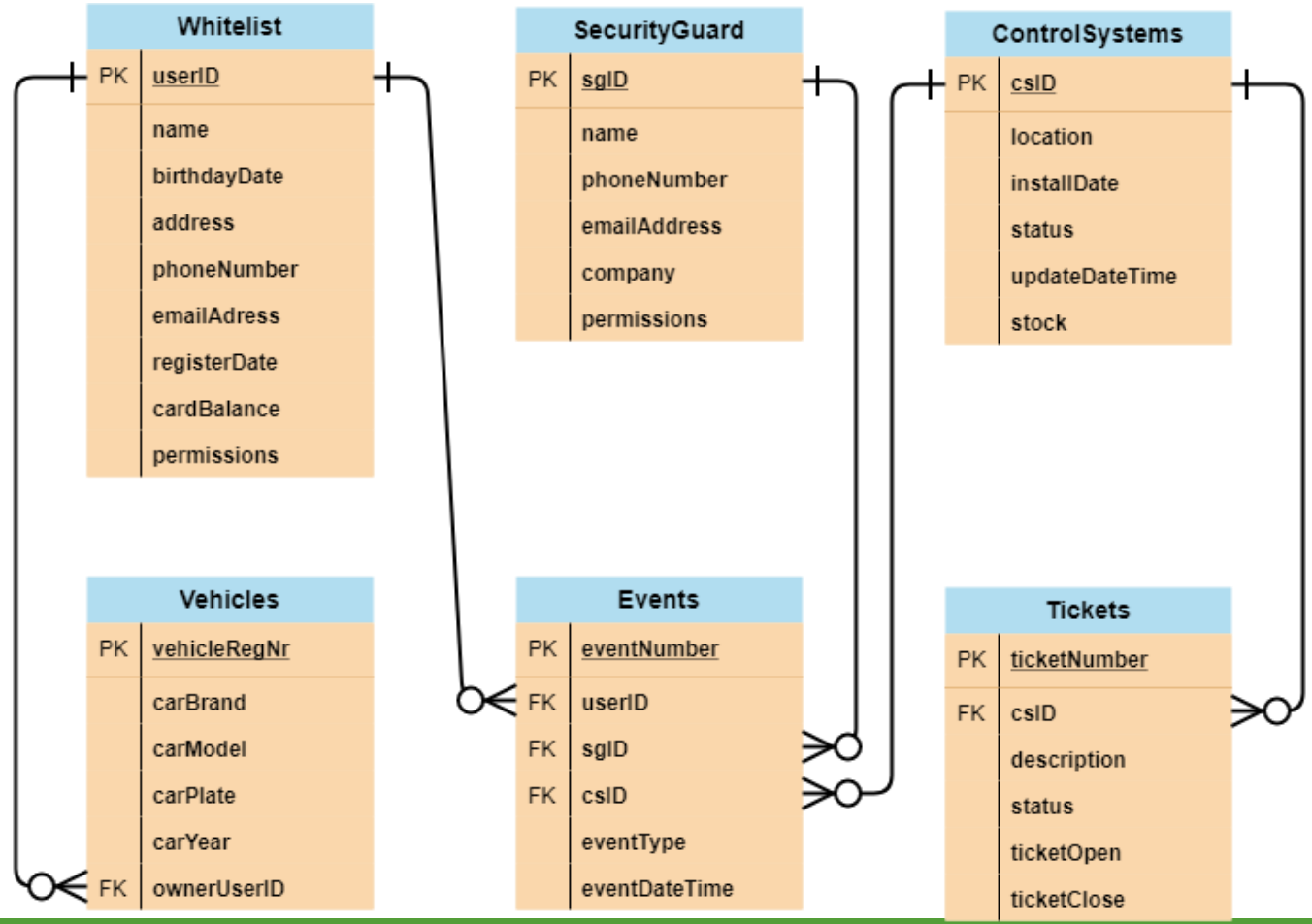


Advantages of the proposed solution

- **Wireless communications simplifies the installation of access control points**
  - Scalable network
  - Can be easily applied in other systems with similar requirements
- **Reduced communications costs with LoRa based network**
- **Smartphone as an access token with Bluetooth Low Energy**
- **All important data is collected and stored in a database**

Implementation of the solution

- **Database tables**
  - **Whitelist**
  - **Local controllers**
    - Stock provides information to the manufactory about the number of local controllers that are ready for installation and those that need maintenance
  - **Vehicles (For future use)**



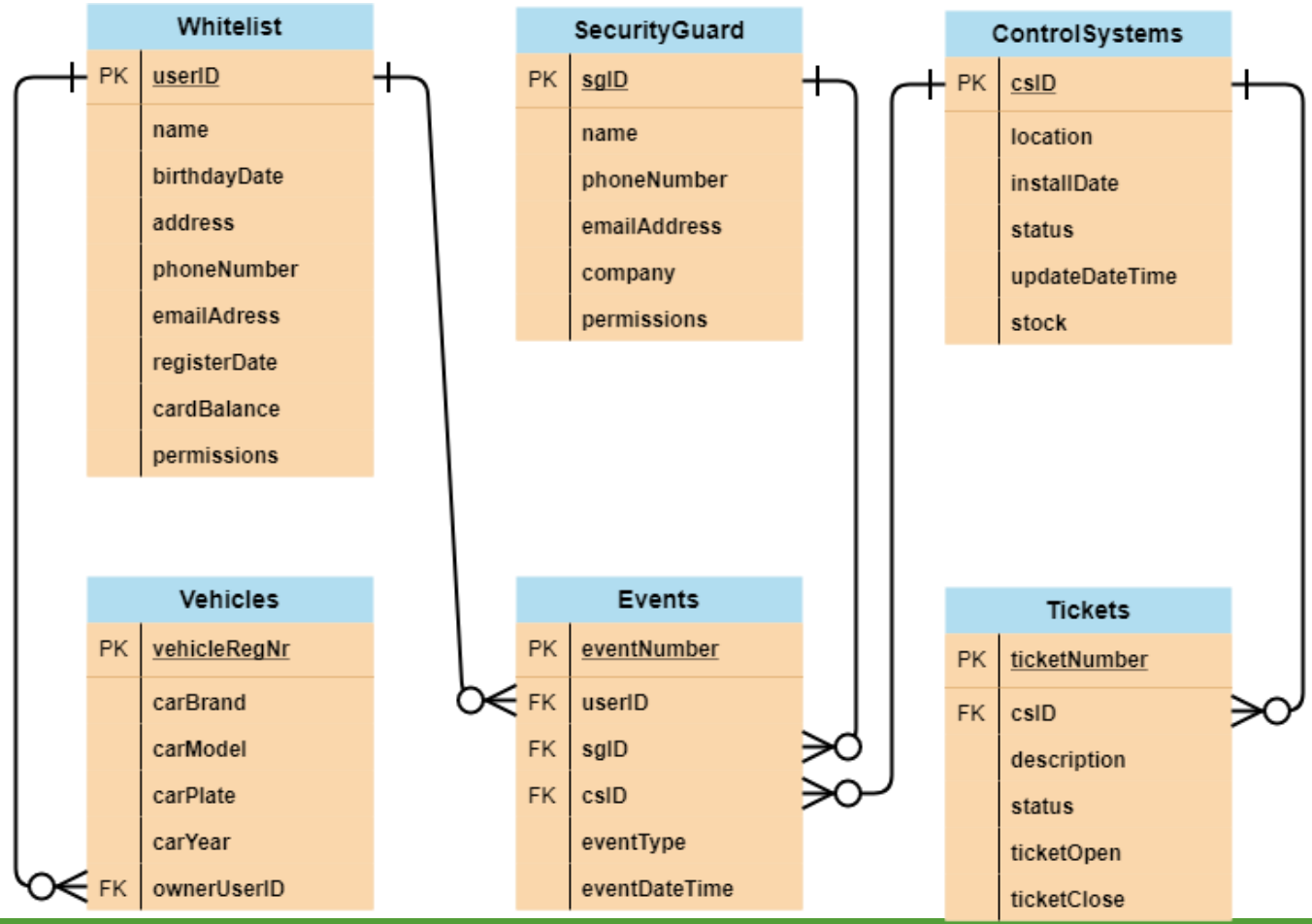
Implementation of the solution

Database tables

- **Security guard**
- **Events (Entrance/Exit)**

  Let us know:

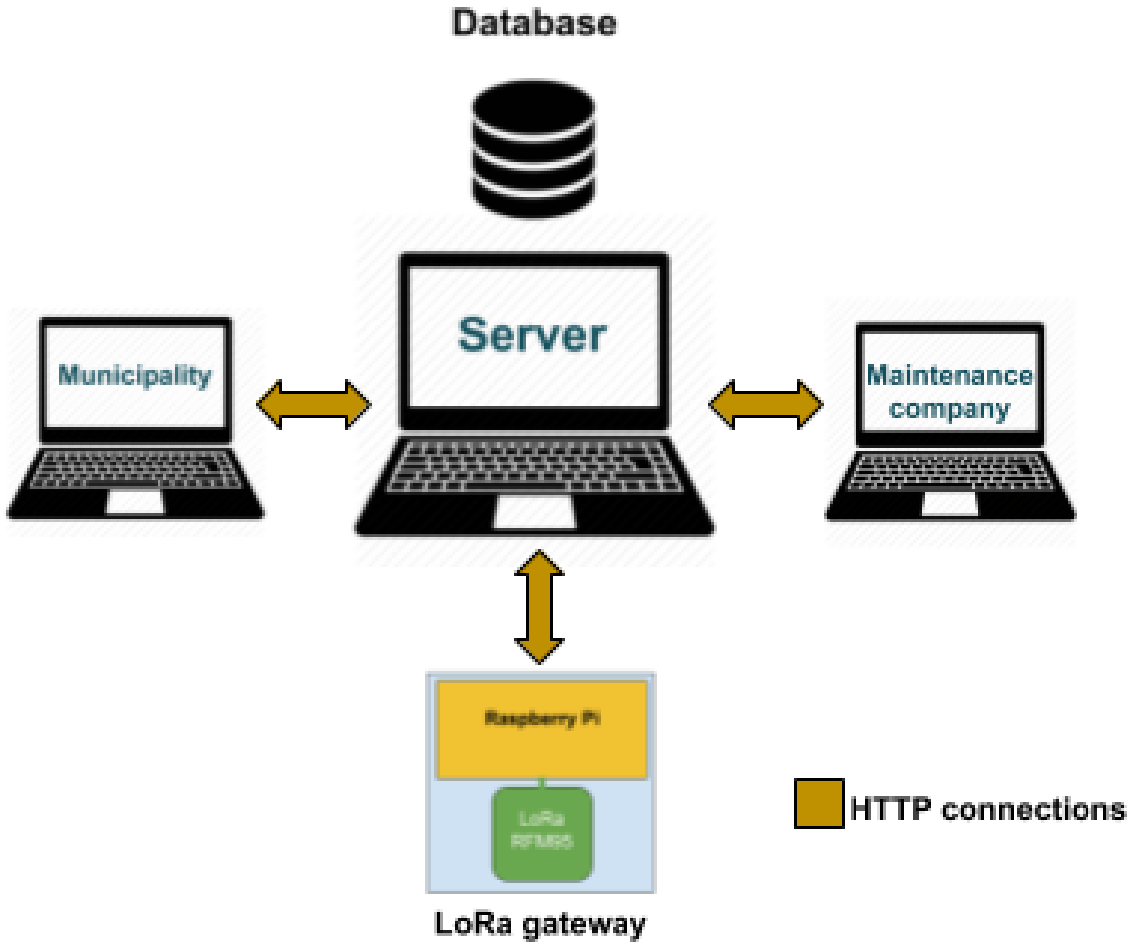
  - Time spent inside limited traffic zone
  - An estimative of available parking spaces
- **Tickets**
  - Enables support companies to provide quick solutions for reported problems



Implementation of the solution

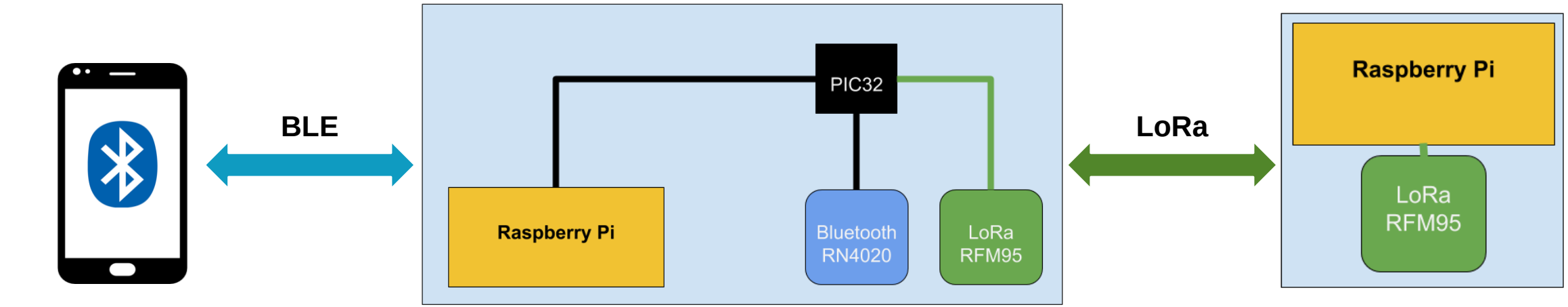
Server with REST API

- Municipality, maintenance company and LoRa gateway use **GET**, **POST**, **PUT** and **DELETE** methods in order to manage database information through dedicated HTTP clients



Implementation of the solution

- Protocol developed on top of LoRa physical layer acknowledges messages to ensure successful transmissions
- Local controller periodically sends an update message containing status information



Achievements

- **User authentication with smartphone through Bluetooth Low Energy**
- **Reduced communications costs with a private LoRa based network**
- **Proprietary message protocol between local controllers and gateway**
- **A database that stores all the relevant information**
  - a log of every unexpected authorization is registered to prevent abuse

Challenges

- **Latency and limited duty-cycle of LoRa**

Alternatives**:**

  - Decentralized architecture with multiple databases?
  - Licensed spectrum wireless technology with guaranteed quality of service?

- **Authentication with smartphone**
  - Out of battery, theft, …

- **The need of a security guard may permit illegal entrances**
  - but a log of the authorizations can identify guards that are permissive

- **Share of user information, access tokens and relevant information about the system**
  - Identity thefts, hacking

Future work

- **Range and robustness tests**
- **Security improvements**
- **Addition of multi-factor and multi-technology authentication**
  - Video camera, RFID
- **Development of the interface to actuate the bollard**
- **Application of dedicated message protocol for emergency situations**

Thank you for your attention

Questions?

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