An Approach for Monitoring and Smart Planning of Urban Solid Waste Management Using Smart-M3 Platform

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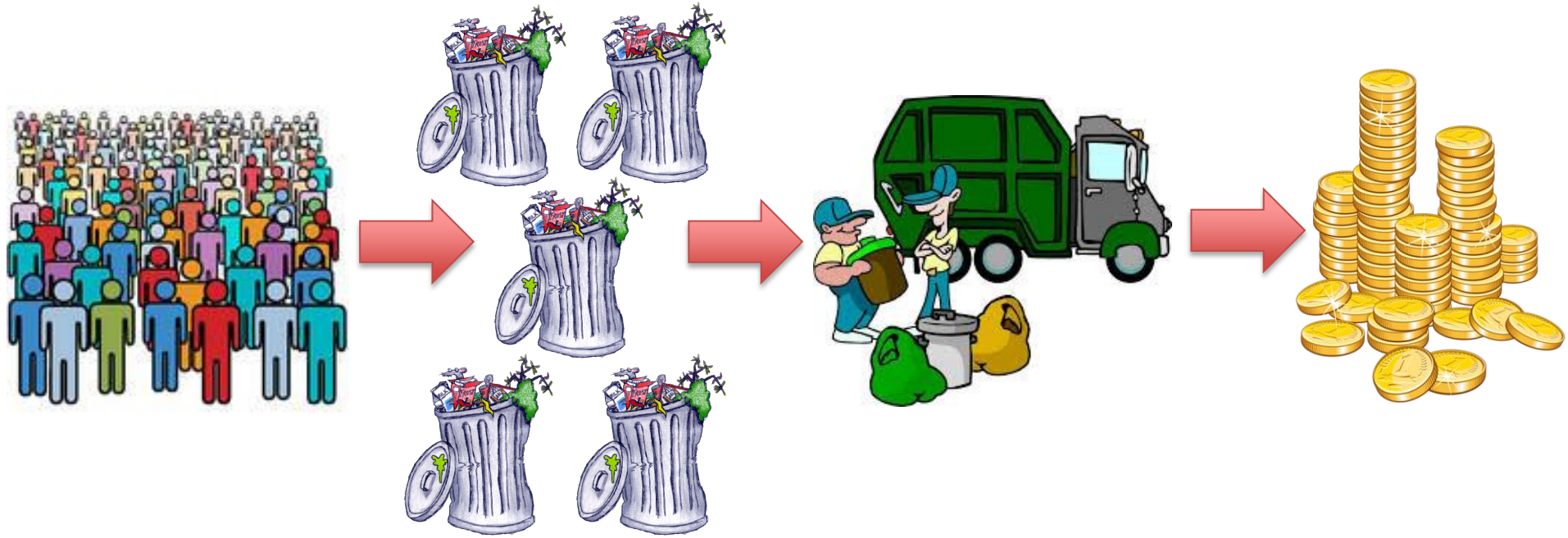
Introduction

Global Issue



Introduction

Characteristics of current waste collection systems:

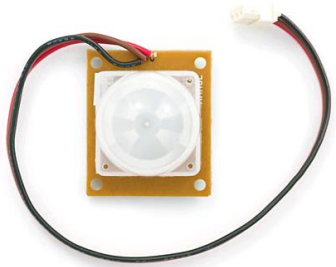
- The number of bins and the number of vehicles are generally **estimated** based on the number of citizens.

  Effects:
  - Or the provision of poor service
  - Or to incur in high costs

- The collection of waste is typically fixed weekly but **without taking into account the actual state** of the level of fullness for each bin.

  Effects:
  - Or the collection of semi-empty bins
  - Or the trash accumulations that cause degrading conditions of hygiene of the city.

Introduction



Spread of low cost devices or objects having long battery life enables <u>monitoring</u> of bins' fullness

What is a SWM?

On-site and in real-time monitoring

Phase 1

+

Data elaboration through decisional algorithms to apply different strategies

Phase 2

=

Smart waste management

What was done?

An approach to smart waste collection is proposed able to **improve** and **optimize** the handling of solid urban waste.

Through: **Monitoring** + **Data Elaboration** & using **Smart-M3 Platform**

Service Providers

Exempt from collecting semi-empty bins.

Goal 1: less costs

Service Customers

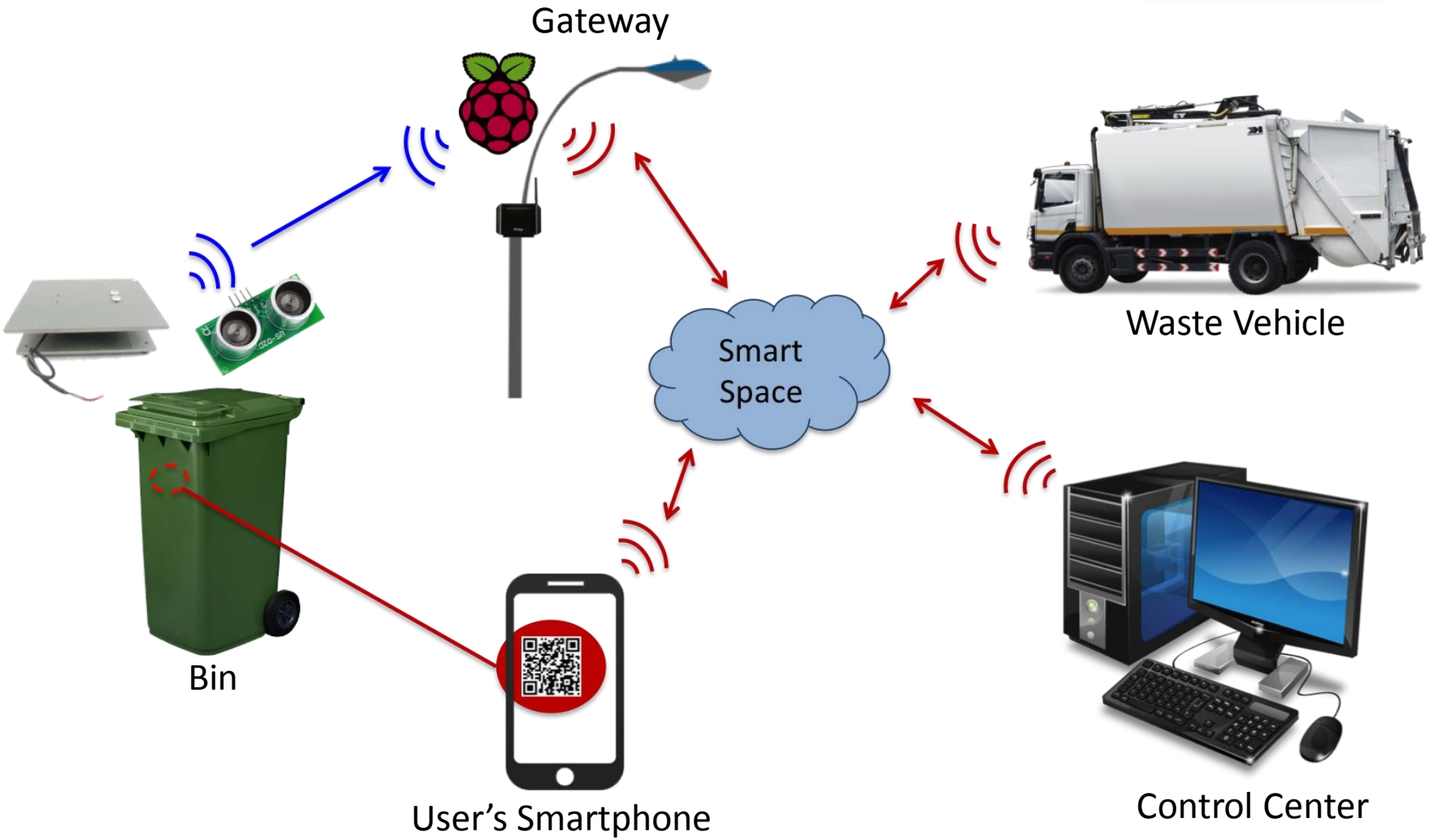
Application for users that provides information about the nearest bins

Goal 2: more services for citizens

Collection of "green points"

Goal 3: Stimulate Recycling

Hardware Architecture



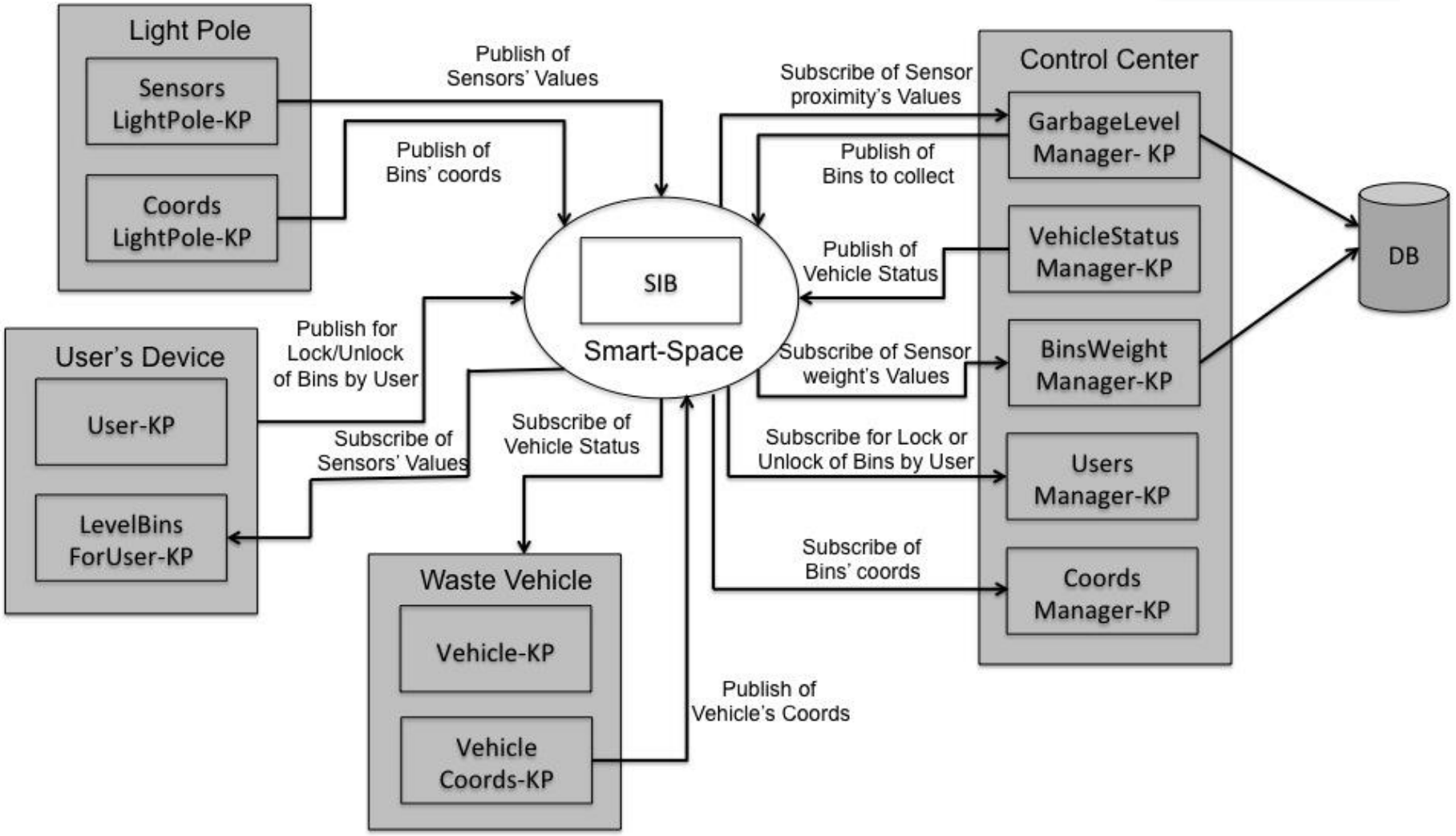
Why Smart-M3 for SWM?

Characteristics of SWM: highly dynamic, fast data production, presence of many users that require this data, heterogeneous devices.

Smart-M3 allows:

- high level of decoupling between producer and consumer of data => unawareness of all participants;
- sharing of knowledge and access to the freshest data on the monitored environment independent of the operating system or manufacturer => through the use of ontology;
- an wide range of APIs and ease of implementation;
- good degree of ease to extend and integrate different applications in similar contexts;

Software Architecture



Software Architecture

1 - Real-time monitoring for intelligent daily planning

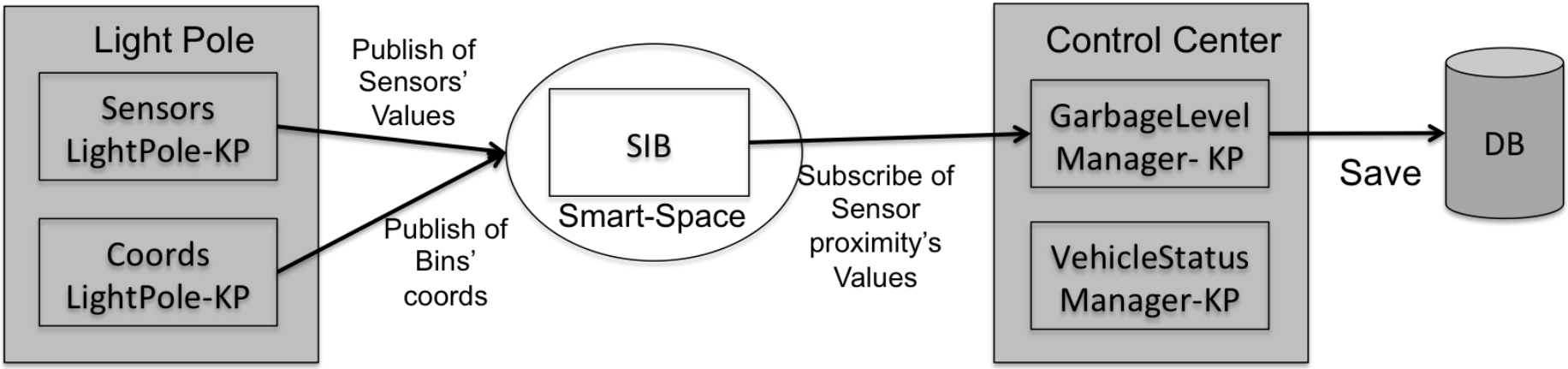
Phase 1
Monitoring

Light Pole:

- SensorsLightPole-KP updates sensor data within the smart space after operations of aggregation.
- CoordsLightPole-KP is responsible for updating the coordinates of the bins.

Control Center:

GarbageLevelManager-KP collects data from the various proximity sensors and save them for offline elaboration and time series analysis.



Software Architecture

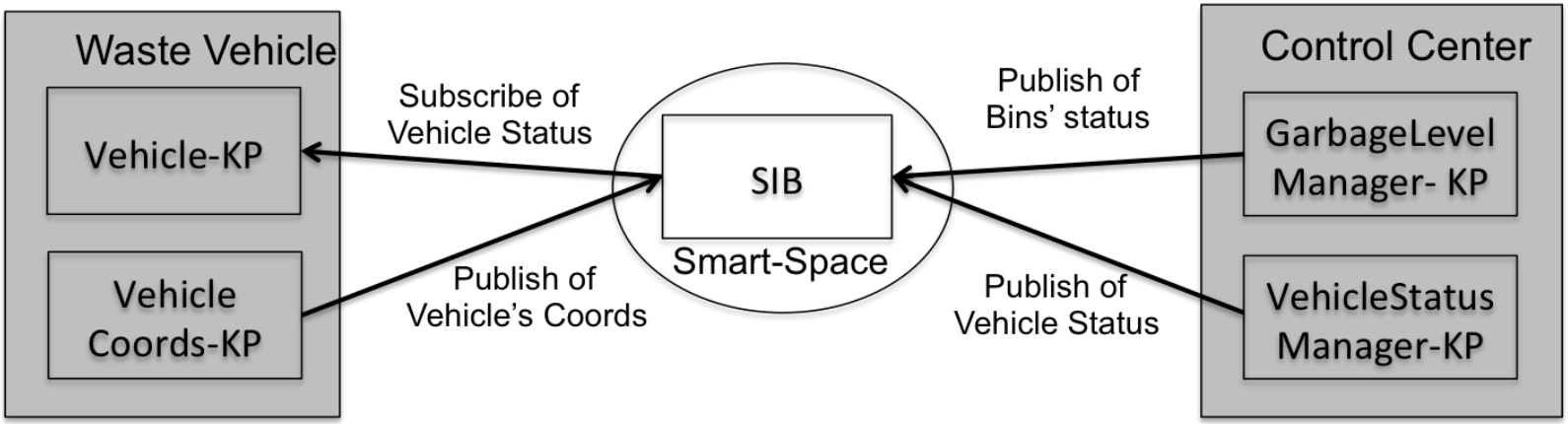
1 - Real-time monitoring for intelligent daily planning

Phase 2
Computation

Control Center:

- GarbageLevelManager-KP sets status bins to: empty, half-empty, half-full or full.
- VehicleStatusManager-KP determines if an area must, may, or doesn't require the collection and set status of vehicles to work or not work.

Waste Vehicle: obtains command to work or not work and updates its coords.



Software Architecture

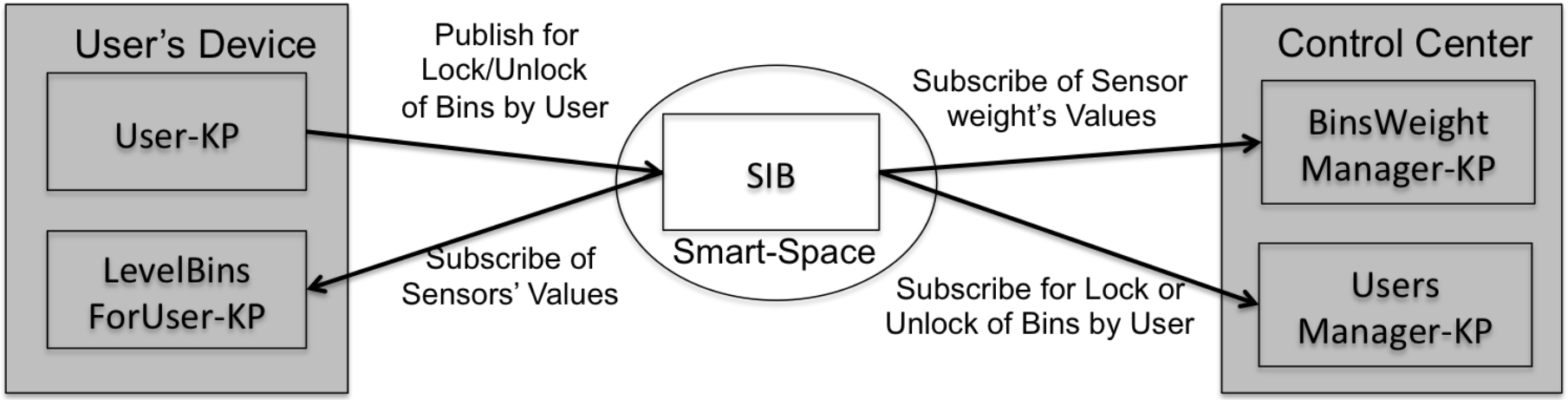
2 - Real-time monitoring and incentives for citizens

User's Device:

- LevelBinsForUser- KP notifies to users about the status of the closest bins to him according to filter options selected.
- User-KP makes an insert-query to add the access token to identify the user.

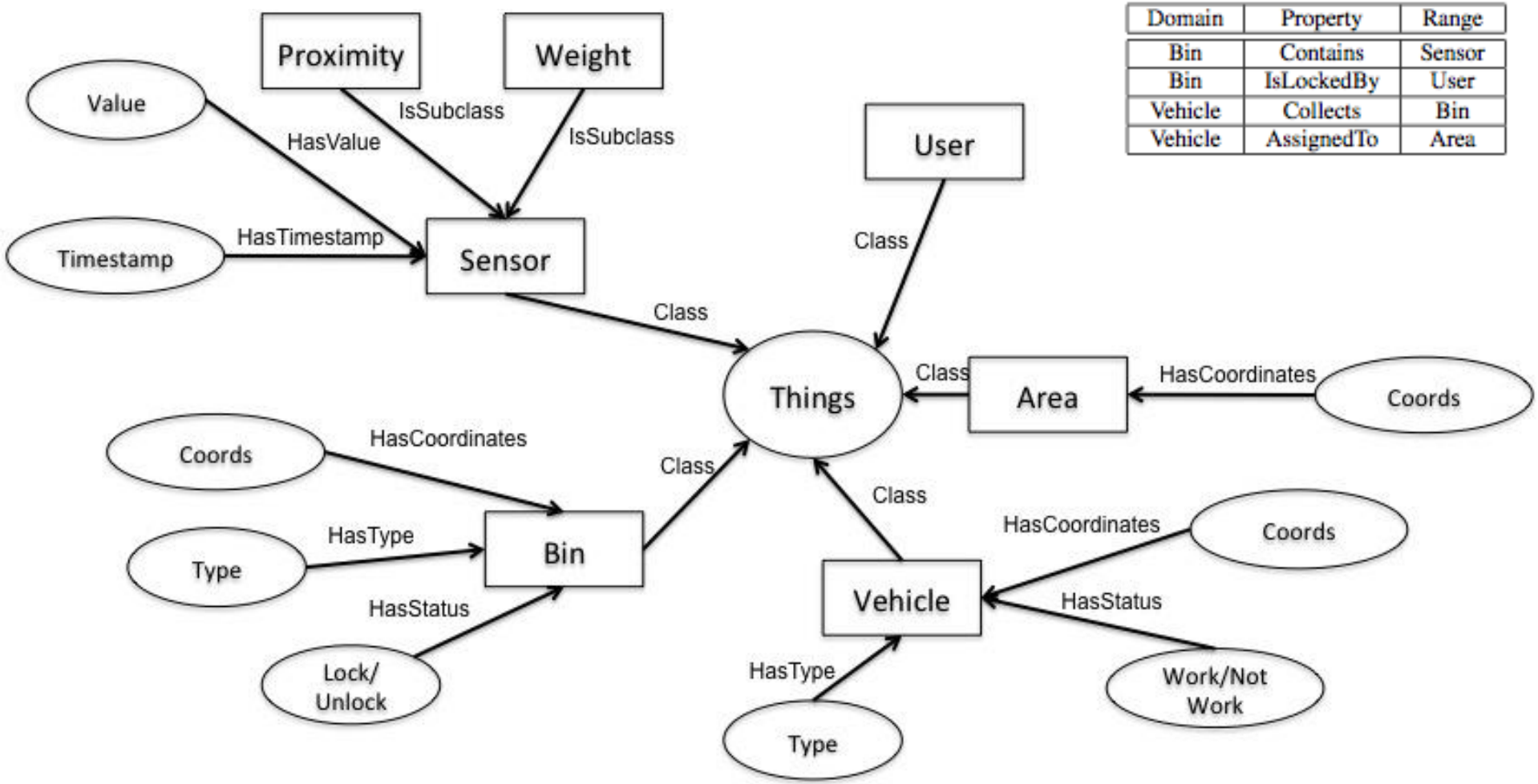
Control Center:

- The UsersManager-KP is notified when a user locks a bin.
- BinsWeightManager-KP measures the amount of trash thrown by the user and converts them in "green points".



Ontology

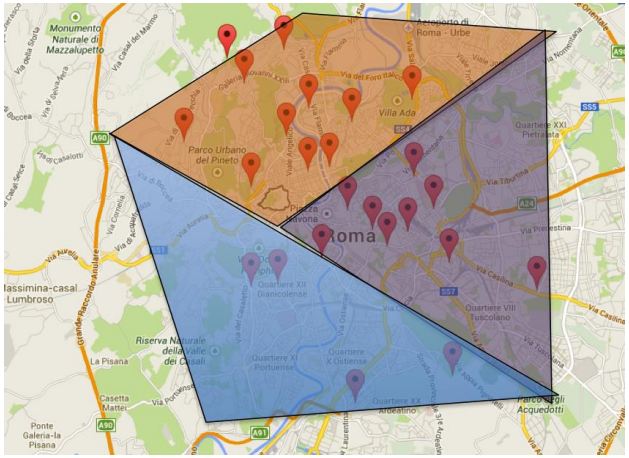
Data Properties:



Object Properties:

Domain	Property	Range
Bin	Contains	Sensor
Bin	IsLockedBy	User
Vehicle	Collects	Bin
Vehicle	AssignedTo	Area

Simulation and Application



Simulation with 3 vehicles.
Bins to collect in 3 different areas of a city.

User Application:
(a) filter search query;
(b) bins empty near the user for different waste types;
(c) bin lock.

(a)

(b)

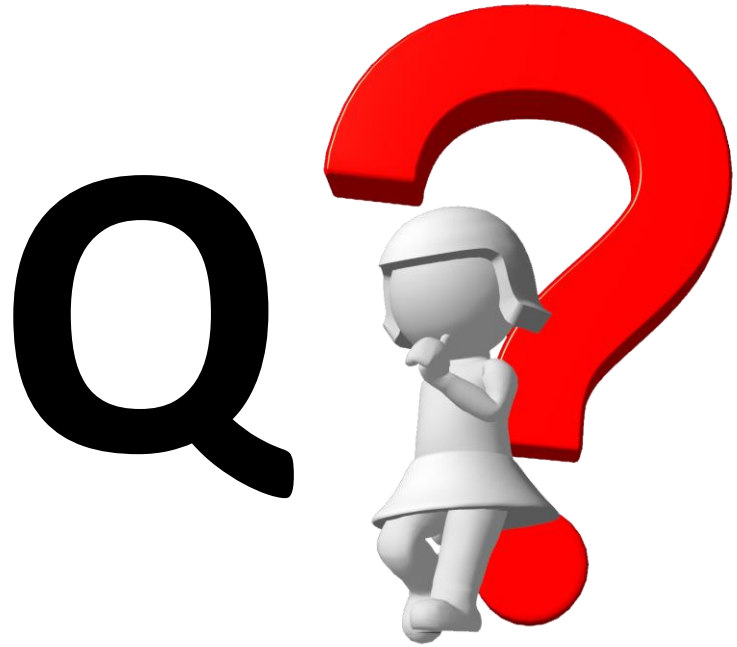
(c)

Future Research & Improvements

There are several future works and improvements:

- Modify the users authentication and atomic lock of bins during the collection of green-point in accordance with Smart-M3's features.
- Implement graphical interfaces for the control center and complete Android applications.
- Extend the system adding other use cases and applications for smart cities (ex. smart traffic monitoring).
- Study of models that offer the best results in terms of decision-making and optimal route for vehicles.

Thanks For Your Attention!



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