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Abstract	This report documents the status of the Smart applications in the City, Security and Health scenarios.
Keywords	smart city, smart healthcare, smart security

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EXECUTIVE SUMMARY

SmartSDK delivers a set of applications in the Smart City, Smart Healthcare, and Smart Security domains. Such applications are based on: components (i.e. Generic Enablers and Specific Enablers), data models (i.e. NGSI formalisation of the data exchanged among components) and reference architectures (i.e. the combination of components and data models to support production grade requirements).

This document describes an overview of the objective application, main functionalities, reference to manuals (English and Spanish version), results and trails of the next steps in the following three scenarios:

- monitoring pollution and traffic in cities (Smart city);
- mobile sensing of health parameters (Smart healthcare);
- intelligent video surveillance in parkings and buildings (Smart security);

The architecture of the applications and details on its module can be found in D2.2 "Reference architectures for data-intensive and IoT-based Smart City, Smart Healthcare and Smart Security applications " [5], while D3.1 "SmartSDK Reference Models and Recipes" [6] provides insights on the adopted data models.

The next release of this document (August 2018) will refine the components of the smart scenarios according to the evolution on the project and requirements in the applications.

TABLE OF CONTENTS

ABBREVIATIONS

SDK	Software Development Kit
LwM2M	Lightweight M2M
O3	Ozone
NO2	Nitrogen dioxide
PM10	Particulate matter
SO2	Sulfur Dioxide
CO	Carbon monoxide

1. INTRODUCTION

This document presents the reference material for the applications developed by the SmartSDK project in the Smart City, Smart HealthCare and Smart Security domains. For each application, the objective and background are described, the main functionalities are discussed and the reference manuals, in English and Spanish, are also presented. It is important to point that the trials for those applications are still under planning, so provided details are not yet complete. The next steps for the development and testing of the applications are listed in this document.

The Smart City, Smart Healthcare and Smart Security applications are based on the Generic Enablers by FIWARE, the data models, architecture patterns and specific enablers developed as result of the SmartSDK project.

1.1 Structure of the deliverable

The deliverable is structured as follows:

- Section 2 presents Green Route, a Smart City application focusing in monitoring pollution and traffic congestion for smart cities.
- Section 3 presents Mobility Assessment Test, a Smart HealthCare application for mobile sensing.
- Section 4 presents a Smart Security application for intelligent video surveillance.

1.2 Audience

This deliverable is mainly intended for:

- Developers looking for replicable examples of FIWARE Smart applications.
- Developers interested into adopting FIWARE or contributing to the initiative.

2. SMART CITY APPLICATION

2.1 Introduction

This section presents the Smart City application focusing on monitoring pollution and traffic congestion.

2.1.1 Background

The population living in cities increase every day. In this sense, since this century, half of the population in the world live in urban areas compare with 15% that lived in cities one hundred years ago. The increase in the world's urban population, from two hundred million to almost 3 billion in only one hundred years is a clear indication of a lot of people moving from rural areas to urban centres and also an increase in the number of people born in cities [1].

If we combine these data with the fact that the area that is urban has only grown to the 2.8% of the total land area of Earth it is a clear indication of overpopulation in several cities. Usually, many ecosystems in and around urban areas are more biodiverse than rural monocultures; however, as cities grow in size, they start suffering from increased congestion, higher crime rates and air pollution. Usually cities suffer to manage energy, mobility, environment, services, waste, living places, logistic health, security, etc. The financial and human resources needed to support cities are immense.

In this context, new innovative solutions are need to old problems of cities are needed. We consider that SmartSDK will provide a good solution for some mobility issues in most of the cities in the world.

2.1.2 Objective of the application

The application developed in the Smart City domain (called Green Route) focuses on supporting the citizen mobility in high-polluted cities, like Mexico City, with the aim of improving the life quality of citizens and fostering environmental friendly behaviours by citizens.

The objective of Green Route is to help the final user to determine the best route to follow to reach a destination, taking into account the user profile (such as health conditions), the user preferences (such as transport type), as well as the weather and pollution of the city.

This application will improve the experience of the user to plan a trip according to their own profile conditions and the context data.

2.1.3 Main functionalities of the Green Route

The list of functionalities of the Green Route application for users, transport manager and super users is presented below.

Functionalities for end users:

- **User account management:** In this functionality, we have the options for user management. In the case of a new user, this is the section to indicate their personal data. In the case of health profile, in this moment we have 3 options about the current state of health of the user, good, allergy, where the user can select symptoms of this disease and asthma where the user can select the rate of severity of the disease. In this section, the user can also introduce the basic information of their vehicles.

- **Subscriptions to alerts by groups:** This functionality is the subscriptions to groups, this subscription is needed to receive alerts that are relevant for the group, and for example, the Biker group is related to alerts for traffic jam, accidents, and weather conditions.
- **Alerts management:** This functionality is related to alerts. Currently, the alert module is not integrated with Green Route. However, the alert module allows to user for generating geo-located alerts about asthma attacks, traffic jam, accidents, weather conditions, high level of pollution, or presence of pollen. The alert that can be placed by using the smartphone and the system will take the location of the situation.
- **Plan your trip:** This functionality is related to the selection of the destination to reach, indicating the different alternatives of public transport.

Air quality monitoring: This functionality displays, in a map, the information of air quality units of Mexico City. For instance, the information is related to temperature, relative humidity, O3, NO2, PM10, SO2, and CO.

Functionalities for public transport manager:

- **Public transport management:** This functionality manages the information related to the vehicle assigned as public transport. It is necessary to add data related to total number of passengers, name, fuel type and other information related the vehicle. Besides, a vehicle should be assigned a transport schedule.
- **Transport schedule management:** This functionality is for adding, editing or updating a transport schedule. The manager indicates the route name, and the departure and arrival time for each day. In addition, the manager could indicate if the schedule is activated or not.

Functionalities for super users

- **Group management:** This functionality is only for the super-user and it consists of creating, editing, updating and deleting a group to receive alerts. In this way, an end user can receive real time alerts from weather conditions, pollution, traffic, and so on from other users. In order to receive alerts, the end user should subscribe to one group or groups, according to his preferences.
- **User manager tray:** This functionality is related to the creation of new users by a super user. In this way, the super user can create a public transport manager or end user. In addition, the functionality allows editing, updating or deleting a user.

2.2 User Manuals

User manuals have been created in both English and Spanish to explain the main functionalities of the application. Having the manuals in both languages maximizes the propagation of the application in users in Mexico and Europe. We know that providing manuals in Spanish could boost Mexican users to try with the Green Route application.

- The link for documentation in English is the following:

  http://green-route-manual.readthedocs.io/en/latest/

- The documentation in Spanish is the following:

  http://green-route-manual-version-spanis.readthedocs.io/es/latest/

2.3 Results of the trial

The current vision for the trial is to test Green Route in a Mexican and a European city. We are considering the Mexico and Porto City; concrete plans are yet to be defined.

2.4 Next steps

Following, we present the next functionalities to be implemented in next months:

- Define a collection of recipes based on the open platform Docker.
- A component that is able to record information of the public transportation of Mexico City.
- Integrate the real time location of the public transport vehicles in the maps.
- Display information related to pollen concentrations.
- Integrate traffic and pollution data while calculating an optimal route.
- Perform a single LWM2M connection to multiple entities of the NGSI data model.
- Perform a trial with lab users from INFOTEC and ITESM.

3. SMART HEALTHCARE APPLICATION

3.1 Introduction

This section presents the Smart Healthcare application for mobile sensing.

3.1.1 Background

Population worldwide is aging as a result of improvements in health services and lower fertility rates. It is expected that by 2050, 20% of the population worldwide will be older adults[1]. Functional capacity and independence tends to diminish with age due to limited mobility, loss of strength, or other physical or mental problems. As people age they tend to experience frailty, manifested with health and social challenges; such as decreasing vision, reduced mobility speed, loss of muscle mass, and partial hearing loss. These problems increase the demand for medication, lifestyle counselling, specialized assistance, and care attention. The increase in chronic and age-related diseases calls for a change from our current emphasis on managing disease towards an approach aimed at preventing them[2]; including tools to infer, monitor and change behaviours that might hamper wellbeing.

Advances in mobile and wearable sensing are allowing the inference of activities and behaviours associated with health by facilitating the collection of daily-life data. Several research initiatives in this area are collecting large amounts of data from studies in diverse fields of healthcare and wellbeing, raising the challenge of integrating heterogeneous datasets.

The healthcare initiative of the SmartSDK project aims at developing schemas and software infrastructure to facilitate the harmonisation, curation, and sharing of mobile sensing datasets for healthcare.

3.1.2 Objective of the application

The main purpose of the healthcare application is to expedite the harmonization and sharing of mobile sensing datasets for the healthcare domain. It focuses on mobile devices that collect data from sensors used on physical tests by following clinical protocols to assess the risk of falls.

The generated application has been designed for research purposes, thus, parameters of interest (associated to the risk of falling) are analysed *a-posteriori* and raw sensor data is kept allowing different stakeholders, such as patients and physicians to better understand how patients' activities and behaviours influence a healthier lifestyle.

3.1.3 Main functionalities

The list of functionalities for the healthcare application are presented below:

Mobile application:

- **Registration of patients:** This section allows the users to keep a record of the patients'

[1] Organization WH. Aging. 2011

[2] Dishman E. Inventing wellness systems for aging in place. Computer (Long Beach Calif). 2004 May; 37 (5):34–41.

performance.

- **Collect test data:** This section guides the user to appropriately conduct a physical test.
- **Upload data:** This section enables the user to upload data to FIWARE server for further analysis.

Dashboard:

- **Search of data:** This section facilitates the query of the patient's performed test.
- **Data visualization:** It allows the user to display the results of different tests and assess the performance of a patient.

3.2 User Manuals

User manuals have been created in two languages English and Spanish:

- Documentation in English: http://ma-test-fiware.readthedocs.io/en/latest/
- Documentation in Spanish: http://ma-test-fiware.readthedocs.io/es/latest/

3.3 Results of the trial

MA-Test, is an application developed to be used on smartphones, its primary function is to collect sensor data (i.e., acceleration and gyroscope data) automatically and store the information on the Fiware Cloud for further analysis.

3.3.1 Study design

The smartphone was placed in the participant's lower back as indicated in the user's manual, data is collected while the participant performs three different physical tests, as described below:

The Timed Up and Go (TUG) Test:

A. The participant stands up from a chair.
B. The participant walks along a 6 meters marked line on a regular pace.
C. The participant walks back to the chair at a regular pace.
D. The participant sits down.
E. The evaluator stops the application after the participant has sat down.

The 30-Second Chair Stand Test:

A. The participant seats in the middle of a chair with hands on the opposite shoulder crossed by the wrists, the feet are to be resting on the ground and the participant's back is to be straight.
B. The participant is incorporated into a complete standing position and then returns to sit.
C. The participant must repeat step 3 for 30 seconds as fast as possible.
D. Data collection will stops after 30 seconds.

The 4-Stage Balance Test:

A. There are four progressively more complex positions. Participants should not use any help device (walking stick) and should keep their eyes open.

B. The evaluator should stand next to the participant, hold his arm and provide help to assume the correct position of the feet. When the participant is stable, the evaluator must release him / her, but stay close to keep it in case it loses its balance.
C. The participant maintains the position for 10 seconds.
   The four positions to take into account for the balance test are:

   - **Feet together:** Feet side to side.
   - **Semi-tandem:** The instep of one foot at the height of the big toe of the other foot.
   - **Tandem:** One foot forward of the other, the heel touching the tip of the foot.
   - **Lame paw:** Standing on one foot.

Note that the subjects perform the physical tests in a controlled area in space (i.e., areas with dimensions greater than 10 x 5 meters free of obstacles) where the technical support necessary to develop the tests will be available.

3.3.2 Parameter of interest

The risk of falling is based on the calculation of parameter of interest derived from the previous mechanisms. Thus, in this trial data is calculated after retrieving the data collected during the physical tests.

Parameters obtained in the TUP test:

- Speed of travel.
- Distance between steps.
- Time between steps.

Parameters obtained in the 30-Second Chair Stand test:

- Number of repetitions.
- Time between repetitions.

Parameters obtained in the 4-Stage Balance test:

- Time in position.
- Rolling index.

3.3.3 Methodology

The study was carried out in the facilities the research center CICESE, enabling 3 common areas: (1) waiting area in which entertainment material is provided to participants, (2) obstacle free test area with a minimum dimension of 10 x 5 meters, and (3) a recovery area.

The execution of the physical tests lasted approximately 10 minutes, however, the approximate time that the participants will be involved in the collection of data was approximately 40 minutes, as illustrated in below diagram:

SCHEDULE OF ACTIVITIES	Duration in minutes			
	10	10	10	10
ACTIVIDAD				
Training (pre-tests)	■			
Response to questions and comments by the participant		■		
Reading and signing of consent letter		■		
Rest and recreation (eg, reading magazines)		■		
Execution of physical tests			■	
Rest				■

3.2.4 Participants and inclusion criteria

The target population consisted of adults of any gender and with availability of time. Testing was planned primarily with CICESE staff and students interested in participating.

Participants should meet the following inclusion criteria:

- Do not depend on walking equipment (eg, walker, walking stick).
- Do not have chronic diseases.
- Not having suffered a fall in the older adult stage (i.e., after age 60).

3.2.5 Results

Please, note that this is an ongoing trial conducted from August 28th to 31st, 2017. Final data analysis will be available for the next report. This trial involved the participation of 20 adults (15 men and 5 women. Mean: 27.25 years, Standard Deviation: 4.89 years).

The number of event automatically identified will be compared to the events visually quantified using video recording (as ground-truth element) for each performed test.

3.4 Next steps

Following, we present the next functionalities to be implemented in the next months.

- ➔ Define a collection of recipes based on the open platform Docker.
- ➔ Conduct a trial based of the current application.
- ➔ Extend the capacities of current development towards other health applications such as rehabilitation and robot-assisted interventions for dementia.

4. SMART SECURITY APPLICATION

4.1 Introduction

This section presents the Smart Security application for intelligent video surveillance.

4.1.1 Background

Ensuring society's security and welfare is one of the main concerns of many governments. In an attempt to achieve these goals, global leaders along with the private sector, are reaching out to the state-of-the-art technologies trying to find a solution for their security problems. To be more accurate, in the fields of machine learning and data analysis, mainly because these disciplines are applied to huge amounts of data, which eases their interpretation and allows an expert to make a decision based on the summarized version of the original information. A common way to improve security is the use of video surveillance systems; however, the huge amount of information obtained from hundreds of cameras becomes overwhelming and unmanageable for the security operators. Thus, a system that can analyse this information and reduce the load for the security guards is required.

In an attempt to solve the problem of security in cities and organizations, we propose the Smart Security Application as part of the SmartSDK project, which is based on an automated video surveillance approach that integrates the cloud-computing schema, computer vision algorithms and data management features, as a long-term solution.

4.1.2 Objective of the application

The Smart Security Application has the main objective of providing an efficient and scalable solution for the video surveillance domain. The implemented application has the following capabilities: (i) provide real-time summarized information for the user, indicating relevant events that occur in the area under surveillance; (ii) store the relevant events for future access, facilitating an easy and efficient search for the user. These capabilities include analysis of video from several cameras, including recording when movement is detected, real time detection of people and vehicles from a set of video cameras, generating notifications related to certain events that occur within the monitored area and a friendly graphic user interface that eases the management of the data generated by the system and its interaction with the user. Additionally, the application considers integrating information from other sensors, in particular from smart phones, which can complement the data from the video cameras.

4.1.3 Main functionalities

The main functionalities of the Smart Security Application developed until now are summarized below:

Graphical User Interface:

- **Live video visualization:** The GUI provides the user two ways of displaying real time video. In the first one, "Main tab", most of the cameras are displayed within a small frame while one of them is displayed on a larger one, however, the user can determine which camera is displayed in the main view at any time. In the second mode of visualization, "Multiple tab", every camera is displayed on an equally sized frame.
- **Stored video visualization:** The GUI provides the functionality of playing videos previously

stored by the system. In order to ease the access to a determined video, the GUI provides input controls that enable searching by certain criteria such as camera ID and date/time the video was stored. In the next stage of the project, the access criteria will be extended, incorporating semantic information such as specific type of objects (person, vehicle) and events (crowd formation, people running, etc.)

- **User registration and access:** The system enable the registration of new users. This registration is required to guarantee privacy of the information; to gain access to the system's functionalities an authentication control has been incorporated.

Data management:

- **Alerts and notifications:** The system generates alarms and notifications related to relevant events in the monitored areas.
- **Subscription to events:** The system enables the subscription of users to certain events so they receive a notification whenever these occur.
- **Video Storage:** The system provides the functionality of recording videos whether by user request or by movement detection.

Computer Vision Algorithms:

- **Movement Detection:** The system has the functionality of detecting movement within a monitored area. An example of the usage of this feature is the video storage by movement detection.
- **People Detection:** The system has the functionality of detecting people within a monitored area, whether is an indoor or outdoor scene.
- **Vehicles Detection:** The system has the functionality of detecting a variety of vehicles, such as sedans, trucks, SUV's, for instance.

4.2 User Manuals

User manuals have been created in two languages English and Spanish:

- Documentation in English: http://video-surveillance-application.readthedocs.io/en/latest/
- Documentation in Spanish: http://video-surveillance-application-es.readthedocs.io/es/latest/

4.3 Results of the trial

To develop and evaluate the smart security app, we have implemented a realistic video surveillance prototype that includes four cameras, three outdoor and one indoor, at INAOE's campus. The system also incorporates computers for local processing and an Internet connection to the FIWARE platform at Infotec in Mexico. The final trial will be conducted on a larger video surveillance system at ITESM Campus Estado de México, which incorporates many more cameras and security guards that will be the users of the system.

At the time this document was completed some performance evaluations were realized on the people and vehicles detection tasks. The initial functional evaluation was done using data from two of the cameras in the prototype system at INAOE. In order for the algorithm to detect people or vehicles, a database file must be loaded. Such file contains a set of feature vectors; each of these vectors represents an instance of the class of object the algorithm is intended to detect. Also, in order to successfully detect certain class of objects the database must be built with feature vectors extracted from the camera on which the algorithm will perform the detection task, *i.e.*, in order for our application to detect people in two different cameras two databases had to be built, one for each camera.

For all our tests, we decided to use the F1-measure as a metric [7]. So far, we have evaluated three configurations of the detection algorithm:

- **People detection in an indoor scene:** The first configuration uses a database constituted by 55 feature vectors. This configuration was evaluated upon a dataset of 1,651 instances, from which 630 were people. The F1-measure obtained was 0.817003.
- **People detection in an outdoor scene:** The database used by this configuration is composed by 50 feature vectors. Its evaluation was performed upon a dataset constituted by 771 instances, from which 460 were people. The F1-measure obtained was 0.922756.
- **Vehicles detection with a side view:** The configuration for the detection of vehicles uses a database of 102 feature vectors. This configuration was evaluated upon a dataset of 1,387 instances, from which 575 were vehicles. The F1-measure obtained was 0.93299.

4.4 Next steps

The next functionalities will be implemented in the following months:

- Complete the development of the database to store the relevant events (video clips).
- Integration of face recognition algorithms for people identification capabilities.
- Implementation of vehicle classification.
- Integration of the activity recognition algorithms.
- Extend the capabilities of video search using semantic information.
- Integrate the detection of events using smart phones data.
- Improve the visualization using geographic information systems.

5. CONCLUSIONS

This document presents the status of Smart City, Smart HealthCare and Smart Security applications. Besides, for each application the document includes the link to the reference manual for users in English and Spanish versions with the main functionalities of the software components. The aim of the manuals is to facilitate the dissemination of the applications in real trials both in México and in Europe.

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