SocIoTal: Creating a Citizen-Centric Internet of Things

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***Abstract*—In this paper the vision and the main objectives of the FP7 SocIoTal project are described together with a description of the initial activities and results in relation to the scenario definition. Contrary to the general approach of creating Internet of Things (IoT) services from a business perspective, the project addresses the design of citizen centered IoT solution. For this, it is required to create new IoT solutions from the citizens' point of view and for the immediate benefit of the citizens without necessarily involving city or commercial service providers. In the initial period of the project, it was focused on the definition and analysis of potential scenarios and use cases. A co-creation approach towards definition of user scenarios was adopted resulting in a series of workshops with groups of citizens in two cities: Santander and Novi Sad, discussing the issues they face and how IoT could help and improve the quality of life in their home, building or a neighborhood. The results of the workshops, i.e. the user scenarios, are presented, as well as the requirements involved in using the methodology defined by the IoT-A Architecture Reference Model (ARM). In addition, a survey of existing citizen-centric applications, services and platforms is provided. This survey shows that there is justified motivation for fostering of creation of a privacy-preserving architecture for the citizen-centric Internet of Things, in which several existing platforms can be used as a foundation for attaining this goal.**

I. INTRODUCTION

The growing citizen expectation on Smart Cities is placing increasing pressure on European cities to provide better and more efficient infrastructures and services, ranging from the use of discrete new technology applications such as RFID and the Internet of Things (IoT) [1] to a more holistic conception integrating users and technology that is closely linked to the concept of Living Labs and user-generated services. This fosters an also growing number of initiatives focused on new services development that interconnect citizens and cities infrastructures.

In previous work [2] we have highlighted the challenges that the creation of a privacy-aware framework needs to face for envisioning the social perspective of citizen-centric services based on the IoT paradigm. For this, a taxonomy is provided to define concepts such as *smart object*, *entity*, *partial entities*, *access control capabilities*, and *relations* among different objects cooperating to provide a requested service, trust and reputation of entities.

In this paper a step further is taken by analyzing existing solutions and platforms to provide relevant use cases based on citizens‟ feedback from the City of Santander and the City of Novi Sad.

The final goal is to create a consolidated architecture enabling an increased citizen participation in the Internet of Things (IoT) while lowering the barriers to the creation of novel citizen-centric and citizen-generated services.

The structure of the paper is as follows: in Section II an analysis of existing previous work is given and existing solutions are analyzed. Section III defines the main features of SocIoTal project that fill the gap that previous solutions have identified. Section IV describes the scenarios and use cases selected to identify new requirements that need to be solved from the user-centric perspective of the project. And finally, Section V presents conclusions and the future directions of this work.

II. PREVIOUS WORK

In order to envision the platform that will enable a large scope of supported applications, we have surveyed existing work on this area. Accordingly, this section presents an analysis of existing solutions based on the information collected about the FP7 projects, platforms and commercial/non-commercial applications that provide services for a city or a citizen.

A. Citizen-centric applications and services

The analysis of the application and services was centered on the functionalities offered, the security and trust capabilities and the way the citizens are involved. The following criteria were identified:

(1) Functionalities, related to the different features the services provide but focused on who is providing (producer agent) data and who is demanding the information (consumer agent). This way, we may find several options: *city to citizen* where the city council information system is gathering data from different sources, compiles

and "publishes" it for the final users (citizens, tourists, etc.) to access it; *Citizen to citizen*, a citizen (or a producer user) provides data from its own information sources directly to other citizens (or consumer users), through its own created services or through some kind of platform; *citizen to city*, where the citizen here provides data to the city information system, coming from its sensors, data bases or services; and *combined*, where the service itself takes information from producer citizens and information sources (such the city council or the utilities‟ data services) to provide information to both, the consumer citizen and the city.

(2) Application domain as the scope of applicability of the services analyzed. Current interesting areas for smart cities are sustainability, efficiency and public services improvement what promotes the development of services for citizens on urban transport, touristic information, waste management, environment, energy savings and efficiency, maintenance of urban resources, safety and so on. Citizens (as producers) are fostering instead the Sharing Information services and platforms, which allow users to publish data from their own sources to be shared with other consumer users.

(3) Privacy and Trust management criterion searches for privacy and trust features in the analyzed solutions, as one of the main SocIoTal application areas. This involves (but is not limited to) security, privacy, policies definition, identity management (including identification and authentication), trust and reputation management features.

(4) The Business model analysis aims to the way services are delivered and marketed. Here we can find free access services, premium licenses, pay-per-use models etc. The different business models and related options offered inside SocIoTal will foster the development of new services and involve stakeholders: the more business opportunities, the more actors working.

(5) Proprietary code vs open source issue, related also with the business models, addresses the nature of the solution: is it an open source service that can be modified and adapted by other users or does it consist of a closed service.

Other aspect taken into account during the initial analysis was the level of accessible documentation for each solution, which directly impacts on the level of technical details available for elaboration and comparison. The existing solutions are presented by application domain criterion.

Cities of Barcelona and Santander were making significant effort to bring "smart" into their cities. Barcelona City Council launched "Barcelona CiutatIntelligent" project [3], aiming to define, design and develop a reference model of a network management platform and sensor data and finally validate it in Barcelona, with the ultimate goal of being able to adopt this model to any other city around the world.

SmartSantander project [4] provides a unique in the world city-scale experimental facility for the research and experimentation of architectures, as well as services and applications for a smart city (parking management, participatory sensing, augmented reality, environmental monitoring).

Citizens‟ opinion has been recognized as important in related projects such as UrbanSensing [5], Live+Gov [6] and Nomad [7]; as feedback from the citizen to the municipality and the citizen participation in decision making can have positive impact on the life of the people in the city. Different crowd sourcing and participatory sensing applications [4][5][6][8] already provides the citizens with a tools to point out to authorities about different events and issues in the city. These services are mainly based on a user generated reports, feedbacks or information extracted from user devices, social networks, sensors, etc. Similar to these are Smart Santanders‟ environmental monitoring application and other eco crowd sourcing applications [9][10][11][12].

Transport services [10][13][14] offer different information to the user about traffic: road cameras, nearest bus and metro position and stops over map; rental (e.g. bike rental, car rental); or even motivates citizens to use alternative environmental friendly transport and to compete with other citizens.

Safety applications are ranging from disaster relief [15][16] and alert systems [17]; over health and emergency services [18][19] to citizens auto-protection applications [20].

Majority of the above solutions as graphically presented in Figure 1, does not satisfy many of predefined criteria: functionalities are only provided or consumed by one side; privacy and trust management are not employed; the business model is limited or solution is not "meant to last"; and the most important, there is no open source code that will enable further progress of the service.

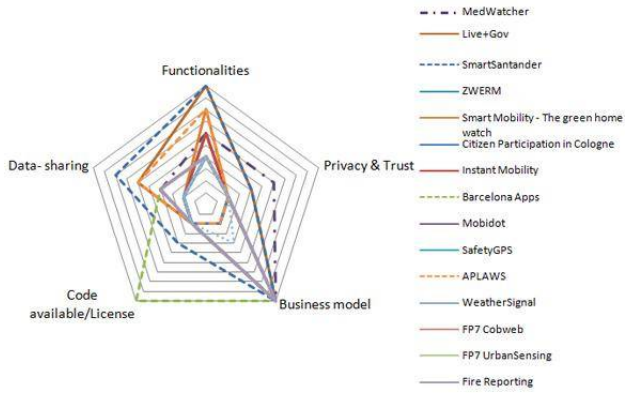

Figure 1. Citizen centric applications and services

B. *Ctizen-centric platforms*

Analysis of the existing platforms will serve as evaluation guidelines for the selection of the platforms, facing the early trials, the pilots and the final SocIoT alarchitecture. The main criterion followed was platform openness and extensibility. As SocIoTal aims firstly to help existing eco-system to grow, thus allowing their vertical scalability, by introducing new concepts in the IoT world and tools to support them, platform openness and extensibility is an important dimension for the evaluation of existing platforms. SocIoTal project will target platforms satisfying the following requirements: (1) Extensibility, thus allowing to add new functionalities

defined as part of the SocIoTal research and innovation efforts; (2) Open source is preferred in order to allow ease of modification, while closed source could be still possible as long as extensible around the closed core and in case the close core should be already very well aligned with SocIoTal requirements and should not prevent other desired but missing features to be realized; (3) Non-commercial license is essential as no available money can be allocated to fund such platform.

There are many existing platforms that to some extent can be utilized for building IoT ecosystem [21][22] [23][24][25][26][27][28][29][30][31][32][33][34][35] [36][37][38][39][40][41][42][43][44][45]; but after selection of the solutions that are open sourced, extendable and in its final phase, we have found that Webinos, Butler, OpenIot, DI.ME, FI-LAB and DeviceHive are the best candidate for further analysis.

BUTLER is an open platform provided under non-commercial license. The modular approach of the BUTLER platform makes it easily extensible, thus would allow straight forwardly enhancing it with SocIoTals‟ security solutions. Its service oriented architecture would allow creation of tools of service composition to enable developers and users applications reusing BUTLER smart objects and services that provide open well documented APIs. The support of various IoT protocols is an advantage for demonstrating SocIoTal solutions on a wide variety of IoT devices. Adding new IoT devices is possible by creating the necessary protocol bridge with a quite small effort.

OpenIoT is focused on building open source solutions, thus research and providing the means for formulating and managing environments comprising IoT resources, which can deliver on-demand utility IoT services such as „sensing as a service‟. Smart city services/applications are a big segment of OpenIoT portfolio and thus this project should be referenced in the SocIoTal. The OpenIoT project has also developed and implemented a Security Architecture [46] for authorizations and trust mechanisms for sensor based readings. The currently implemented method for calculating the reputation score introduces many risks so a more reliable and efficient method would need to be included. Implemented trust mechanisms for event based entities should also be further developed to satisfy the requirements of SocIoTal.

Platform DI.ME supports multiple identities by implementing the concept of different user-defined profile cards, which represent multiple identities of the same individual. The proposed privacy-enhancing technologies by the platform could serve as a useful starting point for SocIoTal view regarding security and privacy requirements about information sharing and the application to the use cases which are being envisioned by SocIoTal. Additionally, the platform can be extended by activating additional connectors and services.

FI-WARE provides a Security Architecture specification to address both the security properties of the FI-WARE platform itself and the applications that will be built on top of it. As such, the Security Architecture will focus on four main modules: Security monitoring; Generic Security Services (Identity Management, Privacy, Data Handling); Context-Based Security and Compliance; and Optional Generic Security Services (Secure Storage Service, Morphus antivirus, DB Anonymiser). Other relevant aspect of FI-LAB/FI-WARE is its Developer Community and Tools (DCT) architecture, designed to offer a multi-functional development, enabling the development and management of the applications and services built on top of FI-LAB.

The DeviceHive platform provides the necessary communication framework and tools for the efficient integration of IoT devices to the cloud server that already comprises of the concept of Data Producer (Device) and Consumer (Client). Therefore, its scope is considered as quite relevant to the SocIoTal concept, which focuses on enabling active citizen integration and participation in the IoT. The richness of APIs would allow extending the client side by building SocIoTal dashboard and customized SocIoTal user environments. Privacy, trust and reputation management schemes should be significantly enhanced: by introducing more sophisticated policies for data access and sharing on the client side building a reputation framework, adding policies to control the data generation from the user side, thus implementing context-based privacy and security mechanisms.

C. *State of the art summary*

After looking into the previous solutions, it can be stated that the privacy, trust and reputation aspects are partially treaded (such is done for OpenIoT, DI.ME and FI-WARE platforms), or is not considered at all. In many of these services, final user that consumes the service is ignorant about the user that provides the service, but there is no layer that secures users‟ stored data and that provides any logic for the trustworthy validation and involved data sharing. In addition, although some of services have very strong utility value, it can be noted that there is a gap that SocioTal can fill in by providing appropriate architecture that will support identified use cases empowered by trust and privacy mechanisms that can be built from scratch or based upon existing framework, i.e. one or several open source platforms.

III. SOCIOTAL FILLING THE GAP

SocioTal have four main target groups of stakeholders: (1) a technical Ecosystem of enablers: Ipv6, RFID, Sensors, QR codes, barcodes, large service providers (telco‟s and data integrators, corporate IT, startups, etc); (2) a policy ecology of local neighborhood groups, city councils, regional incubators, national and EU policy makers; (3) developer communities: Arduino, Raspberry Pi, Internet of Things Meetups (20.000 members globally) 3D Printing etc., accelerated by inexpensive open hardware, software, database storage and data analytics; and (4) citizens that are co-creator of scenarios.
The SocIoTal use cases are verymuch in line with the driving location based aspects that underlay many of smart city applications. As we iterate and refine the use cases with input from our four Stakeholder Groups we believe that „sharing‟ and „facilitating sharing‟ as well as „collaboration‟ will become a main driver for adoption of smart city applications.
Taking into account the analysis made in section 2, it can be concluded that the current trend in citizen centric services, applications and platforms is mainly oriented towards concentrate information from different sources

(provided from citizen, extracted from authorities or specific information systems, etc.) and present it through some kind of web portal or events reporting system, such a Publish/Subscribe service, keeping the citizen aware about the public transport, parking, environment and events, and the corresponding municipality up to date about what‟s going on in the city. In main lines, privacy and trust issues are not addressed enough in current solutions, mainly because these solutions do not involve sensible or personal information from users and are not oriented to a user-to-user interaction, but a user-to-community or a user-to-municipality where identity and privacy are not the main important targets.

Here is where SocIoTal goes a step beyond, focusing on this user-to-user interaction (including user-to-communities as an extension of this one), that will allow the users to offer their devices (or "Things") and information sources, sharing interesting information sets within a well identified community.

This approach will bring new business models, based on the data that can be provided and the services the users can create. But this requires a solution that provides security, trust and reliability to the interactions in this environment. SocIoTal envisions this by defining a set of atomic (and generic) core services that will comprise the basic enablers to further build the use cases and scenarios for trials. These core services are described in the following subsection by using methodology defined by the IoT-A Architecture Reference Model (ARM) [46].

A. Users' group management

This service allows the users to create, configure and manage communities belonging, personal trust circles and user‟s identities in an easy way. A community is a group of people trusted by the user. The user can create a group, be added to a group, add the people they want (all after been authenticated within SocIoTal framework), and select the resources (e.g. access to some sensors owned by the person) they want to share or not. Once created the group, all people from the same community will have access to the resources shared by each person in the community. Also, if the user does not want to continue sharing resources with a member of the group, they can leave the group or they can oust the person from the group, and all the access to the shared resources are revoked

B. Discovering People and Devices

It enables checking user/device‟s location and discovering other users/devices around them. According to IoT-A nomenclature, the physical entity within this service will be the users to be discovered, associated to their smart phones as the devices in charge of sensing the position of its owner. When a device/user detects the presence of another device/user which belongs to the same community/bubble, both devices receive a notification indicating the presence of a community/bubble member and basic data from their profiles. Once this has been received, they can establish a secure communication link to share data, services or chat.

C. Sharing Entities

It supports communications between two users who want to share physical objects. The physical entity here is the object to be shared. First, the object/entity that the producer user wants to share is registered in a resource directory, becoming a virtual entity. The information provided in this registration process will describe the object, according to a specified resource model. The consumer user who wish to access an object checks this resource directory for the available virtual entities (e.g. searching for an object "car" with the desired attribute "route") creating the proper request. The service registers and delivers this request to the producer user, owner of the requested object. Then, a communication link among these users is created to somehow arrange the use of the object.

D. Sharing Information

This service is intended to cover both, an M2M/User-2-User communications to share, send, lookup or visualize information provided by the users or IoT devices. The process will include interaction between a set of remote sensors or a user‟s information source (coming from social networks, cloud storage, etc.) and other users, machines or servers, whether through any platform or a "dedicated" link between the source and the sink. Virtualized physical entities from different nature are monitored by sensors and the raw data that they generate is formatted according to a defined data model to make it homogeneous. Afterwards, authorized users (humans or active digital artefacts) get access to them in order to create new services to other users. In case of physical proximity of consumer and producer devices and no remote consumers exist, a direct communication should be also provided by instantiating the required resources on the consumer device.

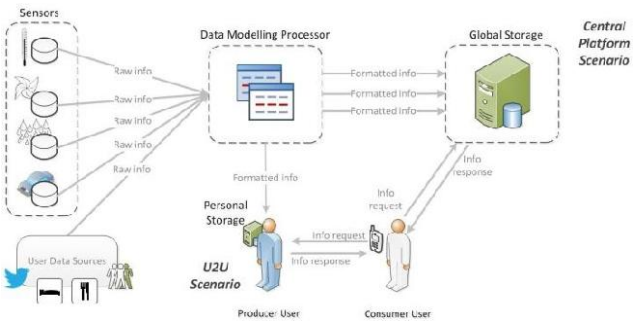

Figure 2. Sharing information service

E. Data Access Control

This service provides an access control to the system components through implementation of all authentication, authorization and accounting (AAA) mechanisms. Access to the virtual entities is provided for the registered users only. Data access is restricted to registered users allowing only those having a digital profile with sufficient privileges to retrieve certain information. Data access control handles several users‟ roles. The user creation and management is one of the key components in the platform. The platform should manage several types of

user accounts as well as the user authentication in the system. Data access control should be performed in such a way to limit the access only inside the trusted group.

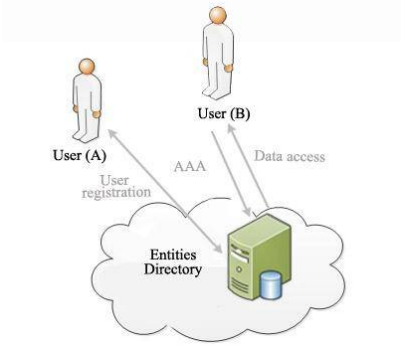

Figure 3. Data Access Control

F. Notification service

This service implements notifying capabilities - notifications. Several types of notifying mechanisms should be implemented such as push notifications, SMS and email. Consumer user can register their preferred notifying mechanisms based on the notification importance level and availability. The same notification could be sent to multiple users (e.g. a notification for the water leaks detection in the apartment could be sent to both the apartment owner and the public water company at the same time. The owner can be notified via SMS whilst the water company can be notified via e-mail). All reported events (virtual entities) are available via the web portal where an access to a more detailed description of the virtual entities is provided only to the authorized person/companies.

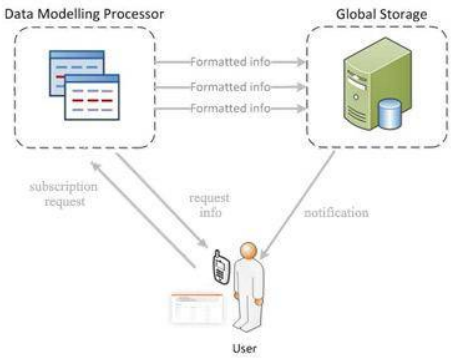

Figure 4. Notification service

G. Reputation service

This service describes the trust and reputation mechanisms that will enable generation of a reputation score for the entity in the global storage; e.g. a reputation score for the sensed phenomenon; a trustworthiness score for a given user trust, etc. A reputation score can be seen either as an indicator that a particular device has provided reliable measurements in the past, or as a measure of how trustworthy is a given user for another. Together with other metrics, as measure of trust, the degree of social interaction among the devices belonging to two users can be also considered.

The reputation score can also be generated automatically by the algorithm based on a certain model. Commonly used reputation models include: (i) an outlier detector model [47][48][49], based on summation and aggregation; (ii) Bayesian framework models [50] which depict the reputation value as a probability distribution, (iii) models based on fuzzy logic, (iv) or even methods based on the social ratings system model [51][52][53][54].

H. Route Calculation

This service provides the user a route to go from one place in the city to another based on information collected from diverse registered sources and the events and incidences uploaded by the users.

A user will introduce the positions of the starting point and the destination, as well as other preferences related to the desired route. A global database server is checked to gather the information that the route calculation algorithms needs. This storage entity can provide information uploaded by the utilities of the city, municipality, public service transport and updated by other users. With this collected data, the service"s route calculation algorithms will process them and provide the most suitable route.

IV. Scenarios and Use Cases

Based on the SocIoTal development objective described in the previous section and the information gathered from the citizens of Novi Sad and Santander, this section presents the different scenarios to be deployed in these two cities that will group the different sets of use cases and core services designed to achieve the project goals.

Information is gathered in Santander by using Santander City Brain platform portal provided by Santander"s City Council and in Novi Sad by organizing the workshops. From the sample of 850 registered user in Santander platform and 120 people attending 9 workshops in Novi Sad, a number of 825 ideas are collected. The security, trust and reliability technical aspects of the provided sample were analyzed to form SocIoTal scenarios and use cases

In the following text are presented some of the scenarios to be deployed in Santander and Novi Sad which group the different sets of use cases and core services designed to achieve the project goals.

A. Scenario Enabling Santander

Over the smart city platform, this scenario creates an applications environment oriented to disabled people (although any user could also benefit from it). The main idea is to create a way for disabled people to point out incidences (e.g. traffic light for pedestrians doesn"t work, open ditch at this street, etc.) over a city map, so the rest of the users can get access to the current status of how "enabled" is the city. The location data of these reported incidences can be used together with other information sources (such as city information, public transport, taxis, etc.) to calculate alternative routes suitable for disabled people, avoiding obstacles from one point of the city to

another. Also, the users can check the locations of disable parking spaces and the number of free available lots.

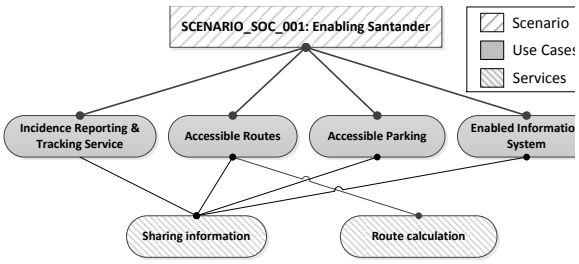

Figure 5. Scenario Enabling Santander

In this line, extra info can be shared in this scenario, like disabled accesses locations, adapted premises, bars, pubs, restaurants, etc. or events related to this collective.

All this shared information will make interesting to create a community made up by disabled people, their family, assistants, caretakers, etc. This means to set up a registering utility and a profile creation and management tool, so every incidence, event or comment uploaded can be assigned to an identified (only by community members) profile.

1) Incidence reporting & tracking

The main functionality of this use case is to register a geo-located event in a specified environment (e.g. a broken bench, a broken handrail, etc.) reported by a user. The user data could contain plain text and/or multimedia files (audio, video, photo). As part of this service, the platform will also offer the capability of tracking the events uploaded (incidence properly registered, status, actions taken, etc.).

2) Accessible Routes

This use case will offer the citizen an accessible route to go from one point to another along the city. This route will avoid barriers of different nature such as not accessible infrastructures, works in the city, blocked access to streets, broken traffic lights, etc. The information will be gathered from different sources such as municipality information, public transport, local authorities, utilities, reporting incident applications, etc.

3) Accessible parking

It has been designed to provide the user information about the location of disabled parking spaces and its availability. To make this information available to the user, the data gathered from the parking sensors installed under the pavement in the disabled parking spaces are modelled and stored so that users will be able to select an area and check how many free available lots are.

4) Enabled Information System

It allows disabled users to have updated information about accessible locations, adapted premises, bars, pubs, restaurants, etc. or events related to this collective. After being authenticated, the user will be able to look for an adapted location around their position or in other place they selected in the city. The information will be provided and updated by the municipality, restaurants/pubs/bars‟ owners or other users. The users of the service will be able to punctuate the locations taking into account different aspects such as the grade of adaptability, the quality of the service/products, etc. Also, leisure events reported through the reporting service could be added in a list or in an information map.

B. Scenario Santander Citizen

Santander Citizen tries to create an environment for users to share their resources/data/sensors. The Santander platform will provide mainly the identity management infrastructure and the security and trust mechanisms whilst users provide information, resources and services.

1) Car pooling

This use case will allow citizens to share car trips. Within the use case, the users will be able to offer their car for giving others a lift or vice versa. The information that citizens should provide would be their starting points and destinations and the date/time. The process would start when people who want to drive their car find other people with the same/similar route. The next step would be to select the partners and to send them an invitation. After that, a meeting is established and when people are arriving to the place the discovery mechanisms are triggered and they can meet in an easy and trust way. A secure communication between each travel partner and the shared car is initiated when the meeting point is reached in order to discover the car. While traveling together, day after day, the same partners get to know each other better and the same their mobile devices. After few trips together, their devices start to share data by using relaxed secure communication mechanism, i.e., music from one of the partner‟s phone can be directly streamed to the car stereo without need to encrypt it, thus saving device battery.

These tasks will elapse within a trust framework, where all users have been authenticated and their profiles have been validated, so the rest of users can trust in the veracity of the main info provided by users of the service.

At the same time, to compensate the owner of the shared car, its private parking lot can be automatically rent during the time it is not used. To this purpose, the parking lot position can be shared with interested citizen when the car is not there. To avoid malicious user to use the system to track presence at home of specific user, the information should be provided only to registered user, traveling by car in the proximity of the parking lot.

2) Sharing sensors – Weather forecast

It will allow users to share information gathered with their own weather sensors. Also, they will be able to create new services using data from that sensors or sensor information sources from other users. To create a uniform framework for this use case, it has to be developed a common data modeling to ensure that all data have homogeneous format and all devices can understand the data received. There can be described different ways of receiving data. First, people can be subscribed to a set of weather sensors and they can receive data from them every so often. Also, they could request the information directly to the global storage in charge of storing all data from sensors. Other way could be that someone creates a service which estimates a weather forecast with data gathered from the sensors, sending more concrete information to other users.

C. Scenario Novi Sad

This scenario creates different domains of applications environment that will enable children and elderly monitoring, watering of the green surfaces, reporting of

different categories of problems in city and buildings; and monitoring of different crowd sourced information from social networks and local TV and news stations.

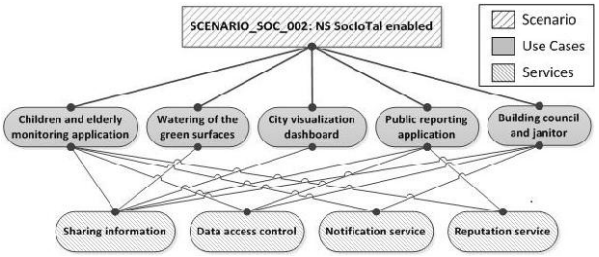

Figure 6. Scenario Novi Sad

1) Guardian - Children and elderly monitoring application

This scenario proposes a system that will enable remote location monitoring of children and elderly and alerting in case of emergency. The user location may be obtained either using GPS coordinates or by checking on control points with NFC and/or QR tag enabled places (schools, playgrounds, bus stations, home, etc.).Several types of users should be supported by the use case. The final user will be able to create groups. Users can subscribe to specific (expected) routes in order to receive notifications if the monitored user deviates from the expected route. Elders/children in emergency situations can use panic button to alert their person of trust. Monitoring of the elderly people is more focused on the user activity detection, thus the appropriate mobile application will upload the observed acceleration data. Subscribed users may be notified if a lack of activity is detected. The mobile application should include a function for the fall detection that is reported to the system. Mobile application can also implement the heart rate (HR) interface. The HR may be estimated either using the mobile device"s camera with the flash placed near the camera objective or by using the cheap ECG device. Additional processing within the mobile application may also provide useful intuitive messages to the end user. Additionally the processing may provide the stress level estimation on the smartphones with or without an additional device.

2) Watering of the green surfaces

The Public City Utility Company (PCUC) may provide a list of green surfaces which are equipped with the soil moisture sensors. Citizens may register for some areas and receive reminders for watering. Using the sensor data PCUC should detect the watering and provide a discount to the worthy citizens" monthly bill.

It is mainly composed by the sharing information service together with data access control for users and service for providing notifications.

3) Building Council and Janitor

The main purpose of the Building Council and Janitor Use Case is reporting the building defects and problems with tenants. Reported issues are sent to the person in charge. Defects can be either detected automatically or reported manually by tenants. Automatic detection of a problem can be illustrated through example of the water leakage detection. In such a case the report is sent automatically either to the public water company if the leakage takes place in the common areas or to the apartment owner if the leakage is detected inside the apartment. Manual reporting is done by tenants for the situations like: lift failure, fuse failure etc. Users register their preferred notification mechanisms based on the notification importance level. The same notification can be sent to multiple users. For example, a notification for the water leakage detection in the flat can be sent to both the flat owner and the public water company at the same time. The flat owner will be notified via SMS whilst the water company will be notified via email to the appropriate person from the company responsible for monitoring alarms and handling emergency situations. Similarly, in case of the lift failure the reporting will be done to the responsible maintenance company. All messages should contain details about reported issues. It is mainly composed by the sharing information service together with data access control for users and service for providing acknowledge for users of trust.

4) Public reporting application

This scenario proposes a reporting application for different categories of problems directly to municipalities. These reports are available to other citizens that can rate published events. The rating mechanism is based on trust and privacy mechanism that will be later developed within this scenario. Reports related to communal issues are directly forwarded to communal department. There are many applications with similar functionalities; the added values from this use case are: privacy and trust, reputation mechanism that will enable efficient collection of relevant information and presentation of collected issues in the application. Users may subscribe for specific types of events or city areas. It is mainly composed by the sharing information service together with data access control for users and service for providing acknowledge for users of trust.

5) City Visualization Dashboard

SmartCity dashboard visualizes a general opinion of the people in a city about upcoming events by data mining and extracting of patterns from online news station, social networks, and other sources. A devoted mobile application enables users to express their current feeling using the mood meter. The final statistics is visualized using the IoT led lamp driven by a very popular ARM based Linux embedded system, the Raspberry Pi. All fields of the lamp are independent and can be controlled individually by visualizing different letters, numbers or even pictures. The lamp is controlled through a SPI interface on the Raspberry Pi. Based on a current mood in the city, the lamp can visualize different types of information such as: a smile or a sad face; a statistics about the city; measurements collected from sensors such as environmental parameters, etc. It is mainly composed by the sharing information service together with data access control for users and service for providing notifications.

V. CONCLUSION

The services and use cases defined in this paper will enable contribute with high value along the following key socio-economic dimensions: increased resource efficiency to build more sustainable and leaner communities; increased public and community accountability; increased safety of vulnerable in the

community; increased social inclusion and awareness of citizens. Among others, SocIoTal will provide an architecture including an intuitive and secured environment inspired by social media tools and focused on empower citizens to easily manage access to IoT devices and information, while allowing IoT enabled citizen centricservices to be created through open community API‟s which will run on the top of an IoT service framework.

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