When Smart Comes to Town: A Mobile Platform for Smart District Services

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***Abstract*—In this work, we demonstrate the feasibility and the main functionalities of a low-cost, nomadic platform for Smart District services. The goal of the platform is to enable the extension of Smart City services to smaller cities, to towns and into the countryside, bypassing the natural barriers through the use of services and vectors which are naturally cross-domain, such as public transportation vehicles, and moving people. the platform is based on mobile and opportunistic sensing, on crowdsensing, and on strategies for community engagement and co-creation mediated by a map-based crowdsourcing application. The demo will showcase the main components of the system, as well as a sample set of Smart District services supported by the platform.**

I. Introduction

A Smart City is a complex ecosystem which, through an intensive use of information and communications technologies (ICT), aims at making cities more attractive for citizens and for business, and more sustainable, fostering innovation and entrepreneurship [1]. Medium/small cities, towns and districts with a sparse distribution of population are presently cut out of the Smart City paradigm, despite covering the large majority of the territory of a country. This is due the fact that each small town or district, taken alone, lacks of a critical mass (of needs, of competences, of budget) which justifies infrastructure investments. the issue is exacerbated by administrative fractioning, which makes it hard to coordinate and cooperate, to share data and build joint policies, and to build a common set of services.

These issues which hamper the development of the Smart City paradigm outside of cities have a heavily negative impact on the economy of districts (and of the country as a whole), and on its potential for expansion. In perspective, an increase of the gap between cities and metropolitan areas on one side, and districts on the other, is to be expected, in terms of quality of life, of economic development, of business opportunities.

In this demo we present a first prototype of a low-cost, nomadic platform for Smart District services based on mobile and opportunistic sensing, on crowdsensing, and on strategies for community engagement mediated by a crowdsourcing application. The main idea is to overcome the above mentioned obstacles by exploiting services and vectors which are naturally cross-domain (i.e. which naturally span a large geographic area), such as public transportation vehicles, and commuting people (and their smartphones). The use of mobile sensing, of crowdsensing and crowdsourcing, moreover, allows to spare the CAPEX and OPEX costs of fixed installations and dedicated infrastructure, lowering the economic barriers to deployment and adoption of Smart City services.

Finally, through crowdsourcing and other mechanisms for incentivization to cooperation, community engagement and co-creation, the peculiar social environment of districts is harnessed, putting people and their needs at the center of the Smart District paradigm.

II. System Architecture

The architecture of our platform is described in Figure 1 [2]. It consists of three types of functional elements. The first

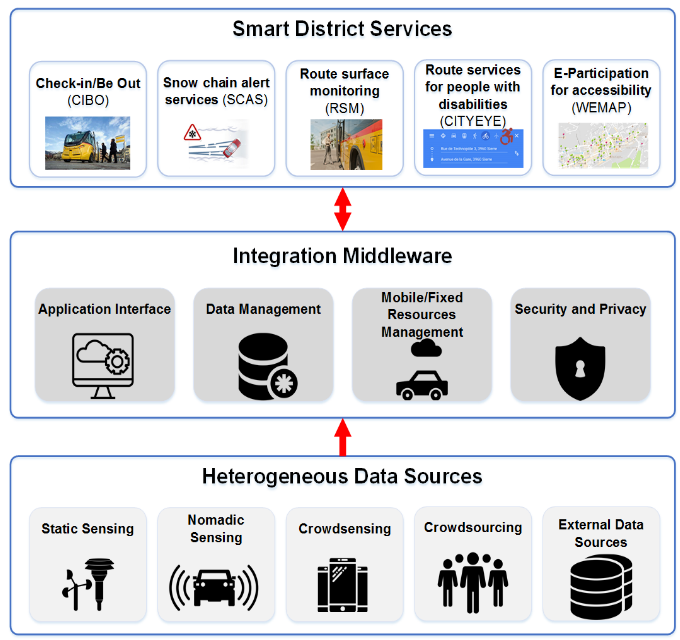

Fig. 1. System architecture and main services supported.

one is represented by data sources, either residing on vehicles (such as the MARWIS road surface monitoring [3]) or static (such as public and private weather stations). Those sources are integrated by data derived through crowdsensing applications, through crowdsourcing (based on the WeMap platform [4]), and from external sources (such as databases of weather data, of records of accidents, traffic conditions).

These data sources are inputs to a middleware, with the function of data aggregation and integration (using semantic approaches), and of data consistency check. This layer is also responsible for the management of the sensing infrastructure, and for protecting privacy. Towards the applications and services which require these data to operate, the integration middleware exposes an application programming interface which allows abstracting from the complexity of the underlying heterogeneous sensing infrastructure, and which enables multiple application to run at the same time on the same platform.

Finally, the third type of components are Smart District applications. The ones we will demonstrate are:

- *Check-in/Be-Out (CIBO)* is an Android application for Smart ticketing, enabling a dynamic, context-aware pricing. It is based on the use of the WiFi onboard of buses for presence detection, ticket checking, trip duration computation, enabling flexible billing based on the actual path travelled, on the time of the day, and so on.
- *Snow chain alert services (SCAS)* is an Android app, based on sensed data about actual road surface conditions and adherence, on weather forecast and on historical data on accidents. It aims at giving a precise indication of where and for how long to put on snow chains, and at indicating the maximum safe speed at any point of a road, with or without snow chains.
- *Route services for people with disabilities (CITYEYE)* is a Web mobile application that generates door-to-door routes automatically to avoid obstacles to wheelchair accessibility. By entering the addresses of departure and destination, CITYEYE calculates and finds a suitable route while taking into account accessibility requirements. For example, if there is an unaccessible road segment between the departure and destination, this application suggests an alternative path.
- *E-Participation for accessibility (WEMAP)* is a Web mobile application that implements a smart city co-creation tool for road accessibility. This application is based on crowdsourcing informations about citys point of interests, which allows user to rate the accessibility of the facilities and, more importantly, to suggest how to improve the accessibility. In this way, issues and possible solutions are discussed and elaborated in a collaborative manner, and exposed to the attention of local authorities.
- *Route Surface monitoring (RSM)* is a web-based service, which provides a near-real-time map of road surface conditions for a whole region, providing indications for drivers on road safety. In addition, it provides road maintenance services with information on where and when intervene in order to remove ice or snow, thus contributing to improved road safety in winter while decreasing maintenance costs through targeted interventions.

III. STRUCTURE OF THE DEMONSTRATION

In this section we describe in detail the system we will demonstrate, and the main elements of the demonstration. The presentation of the main services enabled by our system will be story-based, revolving around the story of a family of tourists with children, which visits a mountainous region which is made ”smart” thanks to our platform.

The demo will start with the family planning a drive through an alpine region to reach a ski resort. Weather is cold and ice is dangerously present along the way. The driver uses the RSM service, alongside a classic route planner, to plan the path and evaluate the risk of any road hazard. Here the demo attendants will be shown the RSM web interface, with a map of an alpine region, with real-time data about road surface condition (Figure 2). The story will then bring the family to try reaching a town on a high altitude. They are on a hurry, as they have to check in in a hotel by a given time, and they cannot put on chains for the whole path, as this will slow down enormously their pace and prevent them from reaching

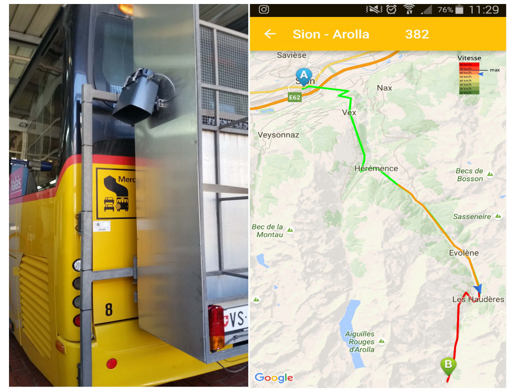

Fig. 2. Road surface sensor installation (left) and RSM interface (right).

Fig. 3. CITYEYE: Itinerary generation for wheelchair and baby stroller accessibility.

the hotel on time. Luckily, the dad has installed the SCAS app which tells him when chains are really needed for his car, where to stop to put on chains, and where to put them off. Thanks to this, the family is able to schedule their trip precisely, avoiding unnecessary delays and reaching their hotel safe and on time.

The day after, the family goes skiing and sledging. That evening, the dad proposes to have dinner in a famous traditional restaurant in the ski resort area. However, he does not know which path was suitable for a family with baby stroller. Thanks to the CITYEYE mobile application (Figure 3), he finds all information about accessibility (e.g. eventual obstacles or difficulties, such as slope, the width of the sidewalk, among others). Finally, the family decides to use the public transportation to go back to the city. Through CIBO, they avoid paying full fare for a short, off-peak night ride.

REFERENCES

[1] A. Cocchia, “Smart and digital city: A systematic literature review,” in *Smart city*. Springer, 2014, pp. 13–43.

[2] A. Dupont, Y. Bocchi, and G. Rizzo, *NOSE: A NOmadic Scalable Ecosystem for Pervasive Sensing, Computing and Communication*. Cham: Springer International Publishing, 2018, pp. 884–893.

[3] W. Bunnell, D. Krohn, J. K. Mathew, M. McNamara, M. Mekker, L. Richardson, and D. M. Bullock, “Evaluation of mobile advanced road weather information sensor (marwis) by lufft for indiana winter road operations,” 2016.

[4] Z. Liu, S. Shabani, N. Glassey Balet, M. Sokhn, and F. Cretton, “How to motivate participation and improve quality of crowdsourcing when building accessibility maps,” in *CCNC 2018 - International Workshop on Accessible Devices and Services*, submitted.