STINGRAY Project: Smart Stations as hubs of infomobility services for Smart Cities

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***Abstract*—Railways constitute the backbone of urban mobility and, in a Smart City perspective, stations should provide easy access and seamless interchange among transport and operation modes, booking tickets through different channels, paying with different methods, exploiting online services of different providers. Traditionally, station information systems have been quite closed to the external world; *rebus sic stantibus*, the STINGRAY project aims at renovating the role of the station improving passengers experience by providing the access to real-time trains information and to external mobility services (public or private), optioning between wheels, rails, or ecological means. This paper focuses on the distributed software architecture supporting the interface with heterogeneous external infomobility service providers by means of the definition of a general ontology capturing main characteristics of the mobility domain as well as the adoption of suitable Enterprise Integration Patterns.**

***Index Terms*—Smart City, Smart Station, Infomobility Services, Software Architecture, Web Application**

I. INTRODUCTION

The evolution of the Smart City paradigm, according to a mobility-oriented vision, may help satisfying the escalating demand of transportation requirements for metropolitan and industrial areas, overcoming lack of efficient public utilities, connections and infrastructures. In this perspective, the role of railway station should be empowered also to behave as an hub of public and private Smart Mobility services by exploiting all the potential information provided by available sensors and open data repositories [1], [2].

The STINGRAY (SmarT station INtelliGent RAilwaY) project[1] aims at making the station environment evolve and integrate in the Smart City through a distributed hardware/software architecture based on *Internet of Things*, *Smart Energy*, *Smart Industry*, and *Smart Mobility* pillars.

The overall architecture leverages two main subsystems: *i)* a Station Controller, replicated for each Smart Station, responsible of command and control of remote station entities (e.g., lighting systems, rail heaters) also incorporating energy efficiency measures, and *ii)* an *on-cloud* Service Provider (SP) [3], supplying added-value services for railway technicians and travellers. In turn, the SP subsystem consists of two main components: SRI (Services for Railway Infrastructure) which exposes services about timetables, expected delays, weather conditions as well as implementing energy efficiency policies, and SIM (Services of Information on Mobility) which provides up-to-date information about mobility with an *ad hoc* integration of both external service providers as Enjoy and Mobike, and aggregation platforms as Km4City [4].

This paper focuses on how the *SIM component* enables the dynamic integration with heterogeneous infomobility services, leading, *ipso facto*, the station to become the centre of the Smart City as its aggregation place: in so doing, the station acts as single access point for mobility-related information, relieving travellers from accessing many different third-party platforms, in a time consuming, difficult, and mostly incomplete operation.

II. SIM: SERVICES OF INFORMATION ON MOBILITY

The *SIM component* is responsible for providing functionalities to three user classes: *traveller users*, browsing train timetables, environmental and meteorological data, as well as geolocalised infomobility services; *railway technicians*, managing Smart Station configurations of digital instances; and *account administrators*, managing authorisations.

External infomobility providers tailor their services on different mobility types (e.g., bike, bus, car, scooter) and are accessible through different interfacing modalities: *i)* proprietary Application Programming Interfaces (API) as Web Services [5] consumable over HTTP protocol, *ii)* embeddable HTML views which dinamically pre-load the correct markup for geolocation of mobility points of interest, and *iii)* official third-party mobile applications, often freely distributed over digital marketplaces (e.g., Android Play Store) and referable through external links.

For these reasons, the *SIM component* leverages on the general domain model of Fig. 1 capturing, without losing significant information, the concept of *mobility resource*. The representation of a *mobility resource* strictly depends on the source provider which usually models a mobility vehicle with a specific data abstraction, including different attributes and also adopting an internal meaning of exchanged fields. At the same time, data interpretation about geolocation changes depending on mobility type (e.g., for a bike sharing provider indicates the spatial position of a single bike, while, for a bus service it indicates only one of the bus stops along a specific urban track). As a consequence, there is a need for data adaptation processes, converting the data originating

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[1] STINGRAY is a R&S project funded by Tuscany Region government (Italy) in the POR FESR 2014–2020 program and developed by industrial SME partners and research institutions.

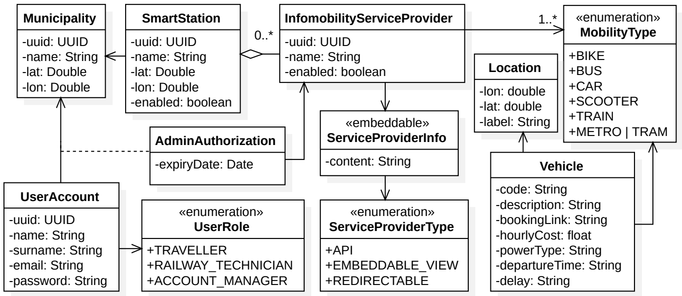

Fig. 1. UML Class Diagram of *SIM component* domain model and DTOs.

from external infomobility sources into a final shared data format: 1 model). in so doing, it was possible to extract the general domain model and to lay the foundations of a final shared data-contract, implemented as the *Vehicle* and the *Location* Data Transfer Objects (DTOs) [6], as shown in Fig. 1. The underlying software architecture of the *SIM component*, depicted in Fig. 2, has been designed on a set of distributed subsystems with different roles and responsibilities, realising a Service Oriented Architecture (SOA), specifically complying to REpresentational State Transfer (REST) principles [7] .

In particular, the *SIM frontend*, consuming services exposed by the *SIM backend*, is responsible of the decoupled presentation layer (see Fig. 3), implementing main use cases available within client devices (e.g., mobile smartphones, tablets). The *SIM backend -implemented in compliance with Java Enterprise Edition main specifications-* realises the business logic required to fulfill use cases through a set of *ad hoc* controllers interfacing with an Object Relational Mapper which guarantees coherence and adherence between the domain logic and the Relational Database Management System schema. Finally, the *SIM gateway* plays the role of intermediary for all requests coming from the *SIM backend* to available *External service providers*, adopting an internal *Router* component and a dynamic *Service registry*. In this way, each request is forwarded to the right *Service provider adapter* exploiting information returned under the shared data contract (i.e., the *Vehicle* and *Location* DTOs).

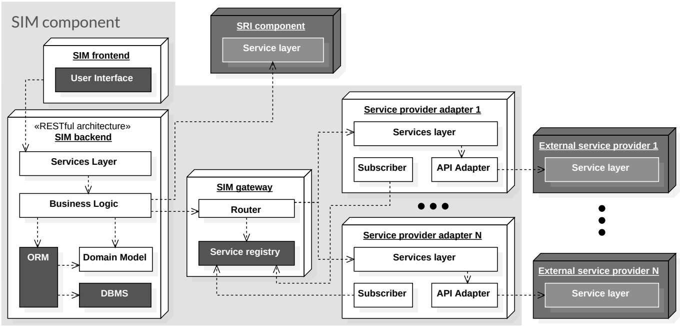

Fig. 2. UML Deployment Diagram of *SIM component* architecture.

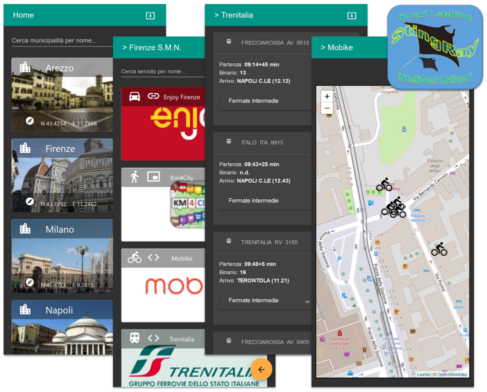

Fig. 3. *SIM component* frontend preview (mobile layout).

III. CONCLUSIONS

The engineering of a universal data contract, able to model relevant mobility information, enables the design and implementation of a secure, flexible, and scalable software architecture (i.e., *SIM component*) with *plug-and-play* capabilities for the runtime integration of new infomobility providers without requiring system rebooting or service disruptions. In so doing, STINGRAY project promotes the concretisation of the *Smart Station in Smart City* paradigm, highlighting the central role of railway stations within an integrated urban context so as: *i)* to innovate management processes of transport infrastructures, enabling real-time monitoring of mobility assets and just-in-time maintenance processes of plants; *ii)* to optimise city energy consumption, significantly reducing waste and inefficiencies, entailing an increase in economic resources thus enabling QoS enhancement; *iii)* and, to create a hub of advanced added-value services, exploiting an ecosystem powered by city and railway information (e.g., combining real-time delays and traffic data with urban weather conditions). The described *SIM component* integrates a set of existing providers exploiting public interfacing modalities. The developed component has been publicly released within the STINGRAY repository[2].

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