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ATLAS: A new way to exploit world-wide mobility services

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ABSTRACT

Despite the extent of the ecosystem of mobility services and the disparate functionalities they offer, organizing journeys by properly exploiting them and enhancing their interoperability is still a complex task. Moreover, the high degree of dynamicity characterizing modern service-based systems requires to make them able to self-adapt at runtime. In this paper, we present ATLAS, a world-wide travel assistant able to provide accurate and context-aware traveling solutions, supporting users for the whole travel duration. ATLAS has been realized by exploiting a tool to engineer *adaptive by design* service-based systems operating in open and dynamic environments.

Code metadata

Current code version	v2
Permanent link to code/repository used for this code version	https://github.com/SoftwareImpacts/SIMPAC-2019-21
Legal Code License	GNU General Public License (GPL)
Code versioning system used	git
Software code languages, tools, and services used	Java, APFL, Telegram
Compilation requirements, operating environments & dependencies	See the README file on the git repository
If available Link to developer documentation/manual	
Support email for questions	martina.desanctis@gssi.it

1. Motivation and overview

The inadequacy of traditional transportation models is proven by the prolification of alternative, social, and travelers' initiatives aiming at a more flexible, customized, and collective way of organizing transport (e.g., carpooling, ride and park sharing services) [1–3]. An attempt rethinking of the way mobility is managed and offered is represented by the Mobility as a Service (MaaS) model [4,5]. MaaS solutions (e.g., MaaS Global[1]) aim at arranging the most suitable transport solution for their customers, thanks to a cost-effective integrated offer of different multimodal means of transportation. MaaS also foresees radical changes in the business landscape, with a new generation of mobility operators emerging as key actors to manage the increased flexibility and dynamism offered by this new concept of mobility.

In this paper we present ATLAS - *personAlized TraveL AssiStant*, a world-wide travel assistant able to provide *accurate*, *personalized* and *context-aware* traveling solutions, supporting users while moving around among different cities/countries, according to their needs. ATLAS represents an implementation of the MaaS concept whose main idea is to "*encourage the use of public transport services, by bringing together multi-modal transportation and allowing the users to choose and facilitating them in their intermodal trips*" [4]. Moreover, in the last decades, the planning and design for sustainable Smart Cities has become relevant both at European and World level. In the mobility domain, government institutions are asking for policies for sustainable and smart mobility and mobility management, whose long-term aim is also that of changing mobility behaviors of users [6]. The idea of realizing ATLAS comes from the need of overcoming the intrinsic limitations of the overall ecosystem of mobility services. Despite the market offers a multitude of independent services and applications, these are highly fragmented and limited. Drawbacks are due to the partial coverage these services offer in terms of the overall journey (e.g., only planning, or only booking for a specific transport mean), the geographic scope (i.e., *local* vs. *global*) and the managed transport mode (i.e., *single* vs. *multiple* mode). For instance, there are world-wide multi-modal journey planners (e.g., *Rome2Rio*[2]) offering world-wide

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[1] http://maas.global.

[2] https://www.rome2rio.com/.

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travel solutions that do not consistently integrate the (local) mobility offer of a city/country (i.e., local bus schedules). To the contrary, many cities have their own local journey planner offering accurate solutions, but specifically focused on the city and its local transport means (e.g., *ViaggiaTrento*[3] for the city of Trento, in Italy). Moreover, differently from multi-modal journey planners, many mobility services deal with just one transport mode (e.g., *CityBikes*,[4] *Flixbus*[5]) without any interaction with the mobility offer of the environments in which they operate. These limitations also imply different levels of data accuracy that each service offers (i.e., *higher* for local services handling few transport mode and *lower* for global services). Lastly, the independent and heterogeneous nature of mobility services does not facilitate any interoperability or service composition to provide better and contextualized travel solutions to the users.

To fill the gaps of the available mobility services, while also profit from their potentialities, we propose a new way for bringing them together, thus facilitating their interoperability and contextualization to the changing users contexts. ATLAS also capitalizes on previous research achievements [7,8] allowing for the exploitation and dynamic combination of services. ATLAS relies on a platform supporting services *modeling*, *interoperability* and *adaptation*. The *modeling activity* leverages on a *design for adaptation* approach for the development, deployment and execution of adaptive service-based systems [7,8]. Each developer can contribute to wrap up available independent services in a *uniform* way [9]. This way, the application is open to continuous extensions. From the execution perspective, an *adaptation engine* implements different adaptation mechanisms, which are performed through the application of advanced techniques for dynamic and incremental *service composition* based on AI planning [10]. On top of this platform ATLAS is presented as a Telegram[6] chat-bot. By using ATLAS the user interacts with and exploits different mobility services and related functionalities to organize and accomplish his/her journey in a completely transparent way. We highlight that ATLAS currently exploits *real-world mobility services* exposed as open APIs, which are wrapped to be effectively part of the application [11]. Users might also access to supporting services, such as managing context changes (i.e., strikes, delays, tickets refund) to adapt and customize their journeys.

2. Impact

In the context of sustainable and smart mobility, ATLAS represents a comprehensive travel assistant aiming at overcoming the intrinsic limitations of the overall ecosystem of mobility services, which typically lead individuals to choose behaviors more environmentally hostile (e.g., use of private cars). Indeed, ATLAS acts as a MaaS [4] application providing real-time mobility information, through the *integration* of as many services as possible, in interoperable inter-modal solutions. This way, it allows us to improve the users perception and usage of urban mobility. In other words, ATLAS represents *a container for mobility services*, both in the local and global settings, that creates an additional value by enhancing services interoperability. In this setting, actors such as Google Transit[7] as well as local transport services become potential beneficiaries, and not competitors, of the overall ecosystem.

In the research scene, ATLAS is an example of application integrating and relying on research results for services modeling [7,8], composition and adaptation [10]. ATLAS has been tested and validated [11] to verify the impact of the automatic adaptation (runtime service selection, composition) on the overall execution of the travel assistant. Evaluation results showed that the automatic adaptation responsiveness is equivalent to that of the mobility services that ATLAS integrates. A comparison between the adaptation time and the services response time demonstrated that the use of automatic adaptation techniques does not degrade the application performance. To the contrary they guarantee the effectiveness and the efficiency of ATLAS.

ATLAS may be considered a starting point for researchers and practitioners inclined to develop new policies for sustainable and smart mobility, to improve the users perceptions of urban mobility, and change their behaviors. Similar applications do exist. We mention, for instance [12] that describes a mobile application about a crowdsensing based public transport information service. Other applications consist in well established MaaS platforms, such as [13,14]. In [15], instead, the authors report about the need of exploiting travelers' preferences for combining mobility services, in order to meet travelers' expectations and properly exploit the available services. However, to the best of our knowledge, ATLAS represents the only attempt combining results coming from the realm of research (i.e., advanced techniques for dynamic and incremental service composition based on AI planning [10]) with new technologies (e.g., Telegram) and intelligent and open services. Furthermore, ATLAS as well as the modeling and adaptive technologies behind it have been used to develop new *collective* mobility solutions in the context of the ALLOW Ensembles European project [16]. Eventually, besides the first publication presenting ATLAS [11], it further enabled other scenarios, i.e., in the Internet of Things domain, leading to subsequent research publications, such as [17,18].

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Appendix. Illustrative examples

A supporting video illustrating the main features and a demonstration of ATLAS can be found at: https://vimeo.com/357367106.

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