

Intelligent Tourist Guiding Service Based on Smart-M3 Platform

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Abstract

The paper proposes an intelligent tourist guiding service based on the Smart-M3 information platform and context management technology. It suggests attractions that are better to attend based on the tourist preferences and current situation in the region. The Smart-M3 platform implements a concept of the smart space providing the information sharing infrastructure in the intelligent tourist guiding service. The smart space is a decentralized infrastructure that allows different devices to share required information between them. The main benefit of the presented approach is to assist tourists in the region using their personal mobile devices. Such mobile devices need only Internet connection and capability to show appropriate information to tourists.

Index Terms: Smart space, Smart-M3, Tourism, Guiding service.

I. INTRODUCTION

Recently, the tourist business has become more and more popular. Tourists travel around the world and visit attractions and other places of interests. The following major issues for a tourist arise when he/she comes to a touristic region:

Information needs:

- Tourist greetings with essential information of the region (e.g., police and ambulance phones, consulate or embassy contact information);
- The main country laws and regulations (e.g. smoking and drinking is prohibited in public areas, regulations for attending churches, taking photos of government building);
- Region specific information (e.g., how to use public transport, left-hand drive or right-hand drive);
- Tourist safety information with description the most popular incidents when a tourist can lose his /her money.

Transportation possibilities:

- Public transport schedule, interactive map, routing;
- Taxi phones;
- Ridesharing possibilities.

Intelligent guides:

- Information about attraction and places of interests;
- Suggestions which attraction is better to attend and how to reach it, based on tourist preferences and current situation in the region.

In this regard an approach is needed, which allows guiding tourists (using their mobile devices), in planning their attractions attending time depending on the context information about the current situation in the region (amount of visitors in attractions, closed attractions, reconstructions, traffic jams in the road and other) and visitor's preferences.

Using his/her mobile device the tourist can easily discover available local services and utilize those, which better suit the current situation and device constraints. Mobile computing has been an active area of research for the past years. All these allow choosing and providing the tourist contextualized and personalized information according to personal needs, rather than having the user searching endlessly for useful information. A mobile device should not be treated as an autonomous environmental device, but as an artifact seamlessly integrated into the environment.

Tourist guiding service is based on the open source Smart-M3 platform [1-3], which provides implementation of the smart space methodology. This platform was first released at the NoTA conference in October 1, 2009 in San Jose. The Smart-M3 is being developed at ARTEMIS JU programme in SOFIA (smart objects for intelligent applications) [4] and in Finnish national DIEM (Device interoperability ecosystem) research projects. At the moment Smart-M3 platform development is implementing by FRUCT members in particular in University of Bologna.

The key idea of this platform is that the formed smart space is device, domain, and vendor independent. Smart-M3 assumes that devices and software entities can publish their embedded information for other devices and software entities through simple, shared information brokers. Information exchange in the smart space is implemented via HTTP using Uniform Resource Identifier (URI) [5]. Ontologies are used to provide for semantic interoperability. The platform has a decentralized architecture and allows seamless integration with other systems, services, and program modules. Modern tendencies of information and communication technologies require development of stable and reliable infrastructures to extract and keep different kinds of information and knowledge from various members of the smart environment. The smart space assumes more than one device that uses common resources and services.

Research efforts in the area of the smart spaces have become very popular recently. Such topics of research as smart home, smart car, etc. are widely discussed on research conferences (e.g., Smart Homes [7], RuSMART [8], FRUCT [9]).

Decentralized smart space in the proposed approach allows mobile device of every tourist acquire up-to-date information from different services (e.g., attraction, region, or worldwide services) and based on it make own decision about the suggestions to the tourist taking into account his/her preferences and current situation in the region.

For tracking of current situation in the region a context management technology has to be used. According to Dey et al. [6], context is defined as any information that can be used to characterize the situation of an entity. An entity should be treated as anything relevant to the interaction between a tourist and information system which extract information from different services and provide it to him/her. Therefore, the notion of context is of fundamental importance to anticipate the design challenges in mobile applications.

The main benefit of the presented in the paper approach is assisting tourists in the region using personal mobile devices based on smart space technology. Such mobile devices should have Wi-Fi connection and possibility to show appropriate information to visitors.

The rest of the paper is structured as follows. Section II presents an overview of mobile tourist guides systems. An approach for tourist guiding service based on ontological knowledge representation is given in Section III. Description of intelligent tourist guiding services general schemes can be found in Section IV. A model for secure information exchange for tourist guiding service presented in Section V. Case study can be found in Section VI. Main results are summarized in Conclusion.

II. RELATED WORK

Smart Travelling [10] is an online travel guide, supports about 30 cities worldwide including the most interesting capitals of European countries and USA. The guide includes a database of restaurants, cafes; hotels, shopping-tips and other places of interests. The mobile application for iPhone is accessible through AppStore. Integration with Google maps allows user to see the current location in the map and helps to navigate to each and every tip in destination cities. Application allows the user to download the content and use guide without Internet connection.

ARTIZT [11], an innovative museum guide system, where a ZigBee [12] protocol is used for determine user's position information. Visitors use tablets to receive personalized information and interact with the rest of the elements in the environment. The system achieves a location precision of less than one meter. The context is used to provide needed at the moment personalized information to the user.

Authors of [13] present a context based design for guiding visitors in museums based on mobile devices. A set of existing systems have been considered compared and classified according to the presented context-based approach.

P. Jeon in [14] proposes a context-aware mobile platform for use of various surrounding local services with minimal user intervention in the forthcoming ubiquitous environment. Context management technology is used for modeling current situation and proposing the user appropriate services.

Authors of [15] describe implementation of a context-aware mobile guide for outdoor as well as indoor locations. It uses GPS to identify user's location in outdoor environments, communicates with other objects in the environment through Bluetooth. The information that is shown in the user interface can be obtained in two different ways: stored on the mobile guide, or queried from the artifacts that are in the direct surroundings of the mobile guide through wireless communication.

The travel guide Triposo [16] is a free mobile guide service available for Apple and Android devices. A user can download the application and appropriate database (which is updated ones each two months) to the mobile device beforehand and use it during the trip without Internet connection. The application supports logging of travelling. It includes databases from the following sources World66, Wikitravel, Wikipedia, Open Street Maps, TouristEye, Dmoz, Chefmoz and Flickr [17]. Each guide contains information on sightseeing, nightlife, restaurants and more.

III. CONTEXT-BASED APPROACH FOR TOURIST GUIDING SERVICE

The approach presented in the paper relies on the ontological knowledge representation. The conceptual model of the proposed ontological approach is based on the earlier developed ideas of knowledge logistics [18]. In this work, the ontology is used to describe knowledge and information in the smart space. It allows providing interoperability between different devices in smart space.

Mobile devices interact with services and get information from resources through the smart space (see Fig. 1). The tourist installs the smart space client to his/her mobile device. When the tourist registers in the service, his/her mobile device creates a profile which contains long-term context information of the tourist. This profile allows specifying and complements tourist requirements and personifying the information and knowledge flow from smart space services to the tourist. The client shares the tourist profile with the smart space, so, that this information could be acquired by other smart space services.

Tourist profile accumulates and stores main tourist information in the smart space. It includes:

- Tourist location (to determine nearest museums);
- Museum reaching time (to organize tourist day schedule);
- Current weather (in case of rain it is better to attend indoor museums then outdoor);
- Tourist role (e.g., business, education, health, adventure, cultural, eco-tourists, leisure, visit friends and relatives, youth, religious, shopping, sport);
- Length of the trip (to provide suggestions about attractions visiting).

For getting external information for different system modules, the following services are used:

- Positioning service (calculates current positions of the tourist, based on raw data provided by visitor mobile device);
- Information acquisition service (provides tourist mobile device with needed information about attractions, e.g., Wikipedia, Wikimapia, Wikitravel, and attractions internal information services);
- Current situation acquisition service (provides information about the current situation in the region, e.g., weather, GIS information, traffic information);
- Routing service (provides suggestions how to reach an attraction or other end points).

The ontology in the smart space is used for the interoperability support of different mobile devices and services. It describes the main terms used for the museum smart space description and relationships between them. Smart space services use the ontology for the information and knowledge exchange.

The tourist context is formed based on the interaction process between the tourist's mobile device and different services through the smart space. The context is the current tourist's requirements and current situation description in terms of the ontology. Tourist's requirements are a list of attractions the tourist would like to attend.

IV. INTELLIGENT TOURIST GUIDING SERVICES

A. *Intelligent tourist guide*

The following scenario for using the intelligent tourist guiding service is considered. A tourist arrives to a region. His/her mobile device shares the tourist's location and his/her preferences with the smart space (see Fig. 2). Tourist guiding service generates the context, which includes attractions related to the tourist's preferences, his/her current location, and the current situation of the region. It connects to different services to extract information about the attractions (working time, closed exhibitions, statistical occupancy of interesting attractions for the next few days) and suggests the tourist preliminary attractions attending plan.

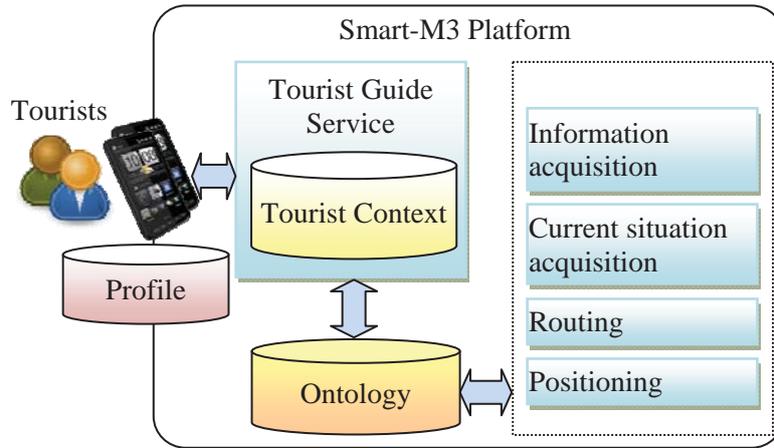


Fig. 1. Ontological approach for tourist guiding service

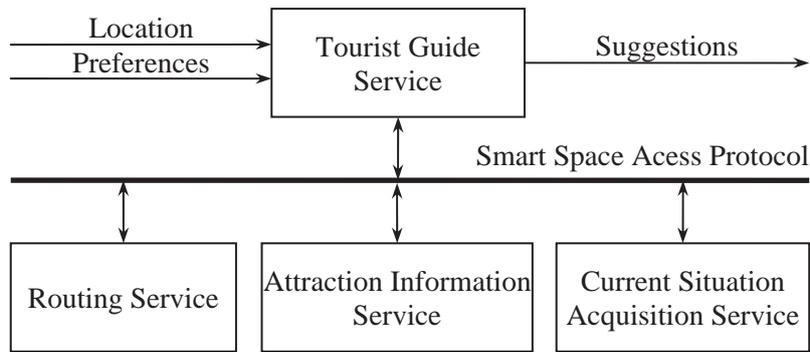


Fig. 2. The general scheme of the tourist guiding service

When the tourist is going to attend the museum (next day), the tourist guiding service updates the context according to the current situation in the region, e.g.: weather (in case of rain it is better to postpone attending outdoor museums), traffic situation on the roads, current museum occupancy, and expected museum occupancy. Based on this information, the corrected museum attending is suggested to the tourist.

B. Routing Service

When the tourist accepts the suggested attraction the tourist guiding service shares the current tourist location, attraction location, and tourists preferences (cost and time constraints, readiness for using public transport and travel with fellow travelers) with the routing service (Fig. 3).

Based on these preferences, public transport schedule, taxis drivers, and ridesharing possibilities the routing service suggests the tourist a set of alternative transportation means.

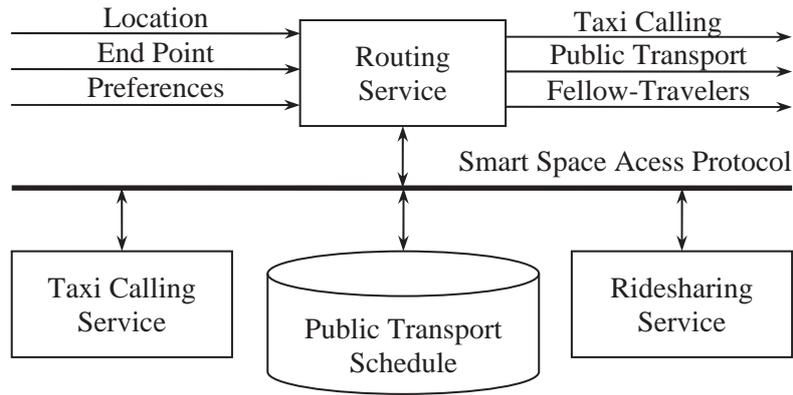


Fig. 3. The general scheme of the routing service

C. Taxi Calling Service

If the tourist chooses the taxi, the routing service shares through the smart space information about tourist location and his/her preferences about vehicle type, smoking or non-smoking driver (see Fig. 4) with taxi calling service. Based on this information the service chooses the nearest taxi and calls it.

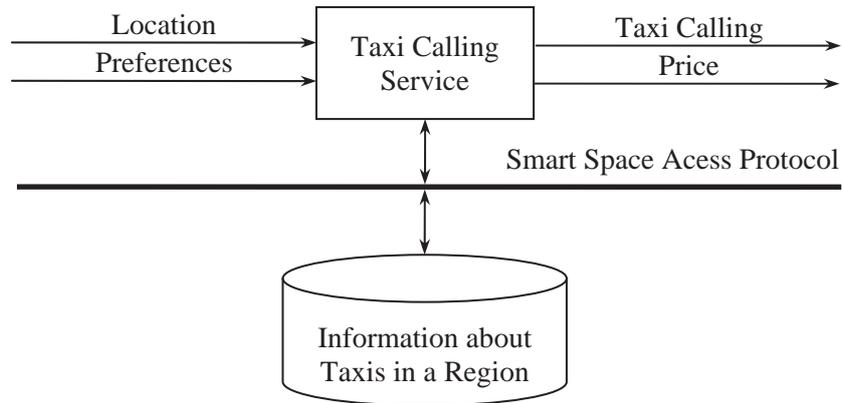


Fig. 4. The general scheme of taxi calling service

D. Ridesharing Service

If the tourist chooses the travelling with fellow travelers, the routing service shares the information about tourist location, attraction location and his/her preferences about maximum waiting time of the fellow traveler, walking distance to the meeting point, vehicle type, gender of the driver, smoking or non-smoking driver, and other specific to ridesharing information with the ridesharing service (see Fig. 5).

The service makes matching of tourists and attraction locations with driver’s paths of the region [19] and proposes the tourists possible fellow travelers. The tourists can brow additional information about proposed drivers and choose one of them for going to the attraction.

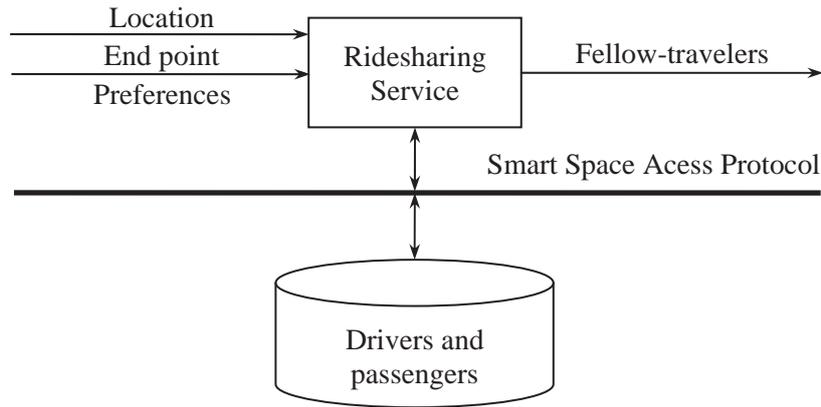


Fig. 5. The general scheme of ridesharing service

E. Attraction Information Service

When the tourist reaches the attraction the guiding service shares through the smart space information about attraction and preferable type of information: textual, audio, and/or video with the attraction information service (see Fig. 6).

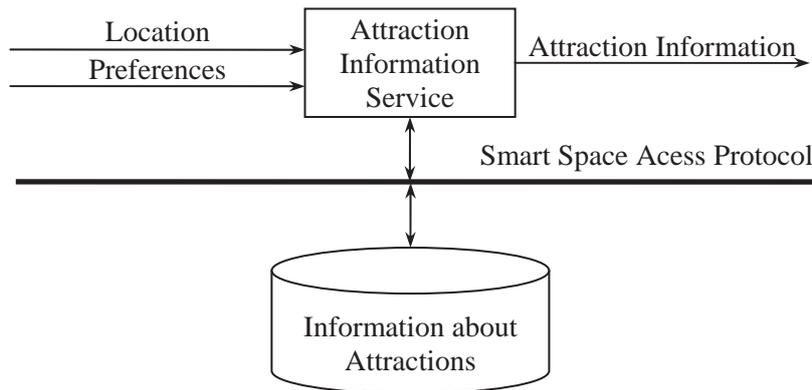


Fig. 6. The general scheme of attraction information service

The attraction information service extracts appropriate information from different sources like: World66, Wikitravel, Wikipedia, Wikimapia, TouristEye, Dmoz, Chefmoz, Flickr, and internal attractions services and shares it with the tourist through smart space.

V. SECURE INFORMATION EXCHANGE IN SMART SPACE

The lack of dynamic security management in smart spaces leads to the situation when services can read and alter information which is not addressed to them. Therefore, a tourist will get bogus information and lose time.

The following scheme for secure access to Smart space resources has been proposed. The participant is identified by the system when registering in the smart space. The unique identifier is generated and saved in the Security Broker. The public and private keys are

generated using the RSA algorithm. A consumer service sends the request to access some private information to the public smart space from service provider and subscribes to the corresponding response about the access granting (Fig. 7):

```
smart_space.insert("consumer_ID", "request", "resource");
smart_space.subscribe("consumer_ID", "access_granted", None);
```

The smart space service provider accepts the request and calls a special Security Broker service for the access permission.

```
smart_spase.insert("service_ID", "request_SB", "user_ID");
smart_spase.insert("service_ID", "resource_type", "type");
```

The security broker reads the consumer service profile and verifies its digital signature using the open key. If the signature is correct, the broker confirms that this consumer is authenticated and applies the rules from the security policies to assign the role to the participant. The assess permission is granted based on the role of the participant and then is sent to the smart space service, which requested it.

```
smart_space.insert("SB", "consumer", "consumer_ID");
smart_space.insert("SB", "access", "granted" or "denied");
```

If the access to the resource is granted, the smart space service provider creates a virtual private space. The information requested by the participant is transferred to this virtual private space. The connection information (space IP, space port and space name) is encrypted via the open participant's key and is sent to the public smart space.

```
smart_space.insert("consumer_ID", "access_granted", "(IP,Port)");
```

If the access was denied, the service sends the corresponding notification to the smart space participant.

```
smart_space.insert("consumer_ID", "access_granted", "Denied");
```

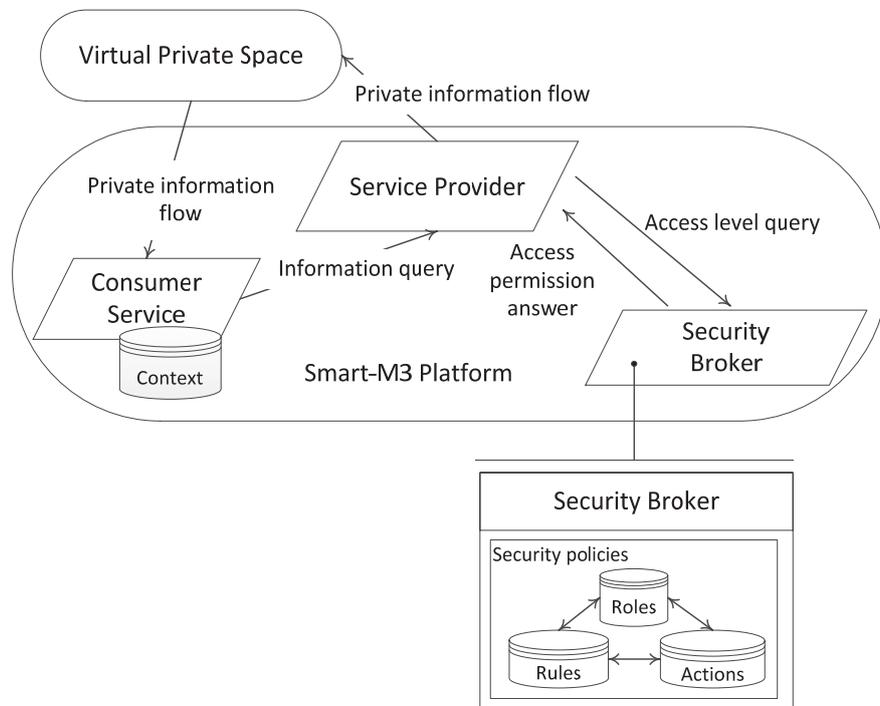


Fig. 7. General scheme for secure access to Smart space resources

The consumer service gets the notification via the subscription. If access is granted the consumer service decodes the encoded data with its private key and creates a connection to the specified virtual private micro smart space. When the requested information is transferred the virtual private micro smart space is destroyed.

VI. PROTOTYPE

Implementation of the proposed approach has been developed based on Smart-M3 information platform [3] using Java KPI library [21]. Mobile clients of ridesharing service have been implemented using Android Java Development Kit [22], the core of the service has been developed using the Python Programming Language [23]. The core service includes intelligent drivers and tourists paths matching which has been tested using the following computer: Intel Pentium 4, 1.6 GHz, RAM: DDR1 512 Mб. For the experiments the algorithm has been run on random datasets as input parameters for the random drivers and passengers (see, Table 1). Each dataset includes coordinates of start and end points of a fellow traveler.

TABLE I
RESULTS OF THE EXPERIMENTS

Drivers	Passengers	Matching time, sec
1	1	0,0135
5	5	0,0316
10	10	0,0641
20	20	0,2248
40	40	1,5462
60	60	2,2416
80	80	3,4725

For providing tourists with possibilities to share messages, photos, and videos with friends during the trip integration with social networks has been studied. For the ridesharing service this integration allows to see a detailed profile of the potential fellow-traveler and the list of his/her friends which helps to estimate driver and decide to accept or decline joint trip. Sometimes, the suggested fellow traveler can be a friend of the friend of the given tourist which might impact his/her decision. For prototyping the Vkontakte social network [24] has been investigated. For the integration the open standard for authorization OAuth 2.0 [25] has been used. It provides possibilities for clients to access server resources on behalf of the resource owner. It also provides a process for end-users to authorize third-party access to their server resources without sharing their username and password, using user-agent redirections.

For extracting and providing tourist attractions information from Wikipedia an appropriate service has been developed using the Android Java Development Kit [22] (Fig. 8). For this purpose it is needed to parse the wikitext description of attraction which can be

obtained through Wikipedia API [26]. Java Wikipedia parser [27] allows parsing and converting to HTML wikitext format pages. For this purpose methods of the class “be.devijver.wikipedia.Parser”, which allow resolving links, footnotes and other templates can be used. Besides, these methods ignore tables, sounds and images without defined output settings. They also allow getting content from the Wikivoyage resource.

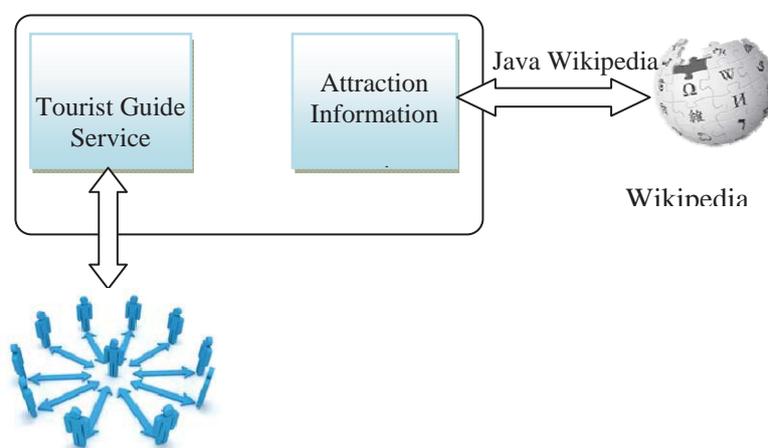


Fig. 8. Using Wikipedia and Vkontakte social network in the tourist guiding service

VII. CONCLUSION

The main difference between the proposed approach and existing services and solutions is that the considered systems use attraction information database (like in [15]) or use own information database which has to be prepared beforehand (like Smart Travelling [10] and Triposo [16]). Some of these services and solutions don't require the Internet connection but sometimes tourists can get outdated information. At the moment, the mobile roaming is very expensive and tourists can't use it during the trip, but governments of different countries plan legislative regulations to reduce roaming prices [20]. This means that in the nearest future the presented approach, which takes into account current situation and acquires information about attractions from different sources, will be in demand.

Experiments show that presented approach and chosen developing infrastructures are applicable for this kind of application.

Future work will be concentrated on development and implementation of routing and attraction information services. Routing service will provide the tourist alternative types of transportation: by public transport, by taxi, or using ridesharing service depending on tourist preferences and current situation in the region. Attraction information service will accumulate information about nearest attractions around tourist location and provide it to the tourist.

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