Virtual Tourist Hub for Infomobility
Service-Oriented Architecture and Major Components

Alexander Smirnov, Alexey Kashevnik, Nikolay Teslya and Nikolay Shilov
SPIIRAS, 39, 14 Line, St. Petersburg, Russia

Keywords: Tourist, Infomobility, Virtual Hub, Service-Oriented Architecture.

Abstract: Individual travellers are usually restricted in time but wish to see as many attractions as possible. The proposed approach assumes developing a system for ad hoc generation of travel plans as well as helping tourists to plan their attraction attending time and excursions depending on the context information about the current situation in the museums. The major idea of the virtual tourist hub is to arrange transportation based on the available schedules and capabilities of transportation and attraction providers, current and foreseen availability and occupancy of the available transportation means and attraction services so that all information flows are hidden “under the hood” the end-user (travelers), and only the final trip schedule is seen. The trip schedule is generated based on the context of the current situation and user preferences. The tourist logistics system members and elements are represented by sets of services provided by them. This makes it possible to replace the configuration of the logistics system with that of distributed services.

1 INTRODUCTION

Recently, the individual tourism has become more and more popular. People travel around the world and visit museums and other places of interests. They are usually restricted in time but wish to see as many attractions as possible.

Personal travel via cars, buses and trains is usually (and reasonably) done within the radius of 450-500 kilometers. The distance between St. Petersburg, Russia and Helsinki, Finland together with nearby cities (Imatra, Lappeenranta, Kotka, Vyborg) falls into this radius. Taking into account available airports in Helsinki, Lappeenranta, and St. Petersburg as well as ferries in Helsinki, Kotka, and St. Petersburg, this region constitutes a universal hub for travelling all around the world (Figure 1).

In order for this hub to function, an efficient transportation system within the region has to be formed. However, today the travelling in the region is complicated due to a number of reasons, e.g., unpredictable situation at border crossing, unknown traffic condition on the roads, isolation of train, bus, and airplane schedules. The proposed approach is aimed at support of dynamic configuration of virtual multimodal logistics networks based on user requirements and preferences. The main idea is to develop models and methods that would enable ad-hoc configuration of resources for multimodal logistics. They are planned to be based on dynamic optimization of the route and transportation means as well as to take into account user preferences together with unexpected and unexpressed needs (on the basis of the profiling technology).

The proposed approach assumes developing a system for ad hoc generation of travel plans for the region (the South of Finland and St. Petersburg region) taking into account the current situation on the roads and border crossings, fuel management aspects, travel time and distance. The increase of travelling will be a significant step towards development of the integrated economic zone in the region.

This approach is a step to "infomobility" infrastructure, i.e. towards operation and service provision schemes whereby the use and distribution of dynamic and selected multi-modal information to the users, both pre-trip and, more importantly, on-trip, play a fundamental role in attaining higher traffic and transport efficiency as well as higher quality levels in travel experience by the users (Ambrosino et al., 2010).

The other side of the approach is aimed at helping tourists to plan their attraction attending time and excursions depending on the context information about the current situation in the

Smirnov A., Kashevnik A., Teslya N. and Shilov N..
Virtual Tourist Hub for Infomobility - Service-Oriented Architecture and Major Components.
DOI: 10.5220/0004447304590466
In *Proceedings of the 15th International Conference on Enterprise Information Systems* (ICEIS-2013), pages 459-466
ISBN: 978-989-8565-59-4

Figure 1: The South of Finland and St. Petersburg region.

museums (amount of visitors around exhibits, closed exhibits, reconstructions and other) and tourists' preferences, using their mobile devices.

The idea of virtual hub has already been mentioned in the literature (though it could have a different name, e.g., "e-Hub" in (Chang et al., 2003), but it is still devoted very little attention in the research community. For example, Working Group on Logistics and Sweeney (Working Group on Logistics, 2012); (Sweeney, 2002) consider the virtual logistic hub from organizational and political points of view.

Generally, virtual tourist hub represents a virtual collaboration space for two types of members: (i) transportation providers (who actually moves the passengers), (ii) attraction service providers, (iii) other service providers (who provide additional services, e.g., sea port, border crossing authorities, etc.). These providers can potentially collaborate in order to increase the efficiency of the logistic network (solid lines in Figure 2), however, it is not usually the case.

The major idea of the virtual tourist hub is to arrange transportation based on the available schedules and capabilities of transportation and attraction providers, current and foreseen availability and occupancy of the available transportation means and attraction services ("dash-dot" lines in Figure 2). In this case, even though the schedules and actions of different members are not coordinated, the virtual tourist hub will be able to find the most feasible schedule depending on the current situation and its likely future development. For the end-user (travelers), all this is hidden "under the hood", and only the final trip schedule is seen (solid lines in Figure 2).

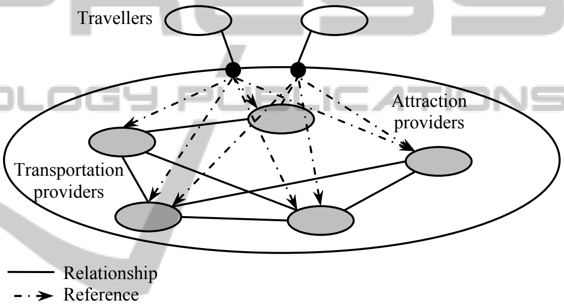

Figure 2: Generic scheme of the virtual logistic hub.

The major scientific challenges of the presented research include context-aware information management, multimodal ad-hoc logistic network configuration, and human-centric cyber-physical system design.

The paper is structured as follows. Section 2 represents related work in the area of tourist support. The reference model of the virtual tourist hub for infomobility is proposed in section 3. The approach is described in section 4. The case study based on the developed approach is given in section 5. Major results are discussed in the conclusion.

2 RELATED WORK IN THE AREA OF TOURIST SUPPORT

There is a large amount of research works and projects related to assisting tourists in attending various attractions (mainly, museum) and providing information about exhibitions. The most typical of them are presented below.

Google Art Project (Proctor, 2011) is a tool from Google that lets people to visit world's most important museums of art, via a virtual tour. The Art Project is available for more than a thousand works of art.

The overall objective of the SMARTMUSEUM project (Kuusik et al., 2009) is to develop a platform for innovative services enhancing on-site personalized access to digital cultural heritage through adaptive and privacy preserving user profiling.

The main research activity of HIPS project (Bianchi and Zancanaro, 1999) is for developing of an approach for navigating artistic physical spaces (i.e., museums, art exhibitions). The system is meant to provide the user with personalized information about the relevant artworks nearby. The information is mainly in the form of audio in order to let the user enjoy the artworks rather than interacting with the tool.

Bohnert et al. (Bohnert et al., 2008) describe a system for providing a tourist with a challenge of selecting the interesting exhibits to view within the available time. It includes the recommendation and personalization process, i.e., the prediction of the visitor's interests and locations in a museum on the basis of observed behavior.

Kuflik et al. (Kuflik et al., 2010) describe an approach for supporting users in their ongoing museum experience, by modeling the visitors, "remembering" their history and recommending a plan for future visits. This approach identifies some of the technical challenges for such personalization, in terms of the user modeling, ontologies, infrastructure and generation of personalized content.

Project CRUMPET (Schmidt-Belz et al., 2003) has realized a personalized, location-aware tourism service, implemented as a multi-agent system with a concept of service mediation and interaction facilitation. It has had two main objectives: to implement and trial tourism-related value-added services for nomadic users across mobile and fixed networks, and to evaluate agent technology in terms of user-acceptability, performance and best-practice as a suitable approach for fast creation of robust, scalable, seamlessly accessible nomadic services.

The main difference of the proposed approach from the existing services and solutions is that the considered systems use attraction information database or own information database, which has to be prepared beforehand. This means that sometimes tourists can get superseded information. These systems don't take into account information about the current situation in the museums and in the region, and they are oriented to assist user only in one museum whereas the proposed approach allows monitoring the current situation in several museums, its usage for tourist assistance, and context-driven update the travel plan "on-the-fly". Also, the approach presented in the paper allows using tourist's mobile device to assist him/her. It is not needed to provide special equipment for museums.

3 REFERENCE MODEL OF THE VIRTUAL TOURIST HUB

The reference model of the proposed approach is based on the above described components and shown in Figure 3. The context-aware trip planning service is in the center of the model. It collaborates with transportation planning services to find appropriate transportation means and schedules, and attraction visit planning services to co-ordinate transportation and attraction attendance schedules. These services, in turn, use transport information services and attraction information services correspondingly to acquire information about schedules, availabilities, occupancies, and prices of the related resources. The latter services can also be used by the tourist to decide preferable means of transportation and attractions.

The tourist profile (Figure 4) accumulates and stores main tourist information in the intelligent environment. It includes context information and long-term tourist information. The context information includes:

- Tourist location (to determine nearest attractions);
- Current time in the tourist region (to prepare attractions visiting plan);
- Current weather (in case of rain it is better to attend indoor museums then outdoor);
- Traffic situation (for transportation means suggestion).

The long-term tourist information includes tourist role and his/her preferences. The role determines a template for suggesting the tourist attractions visiting plan (e.g., business, education, health, adventure, cultural, eco-tourists, leisure, visit friends and relatives, youth, religious, shopping, sport). Preferences include the following:

- Trip length (to provide suggestions about attractions visiting);

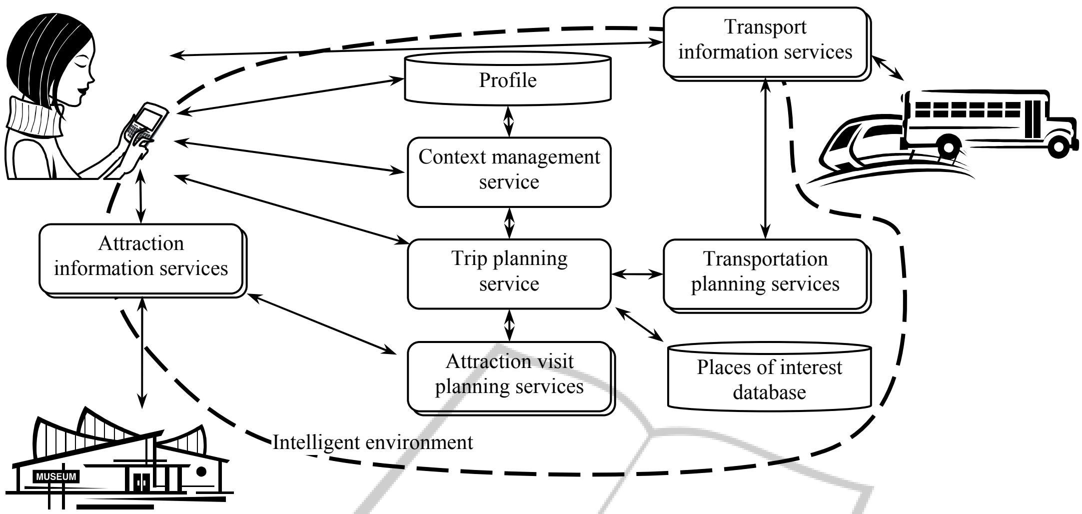

Figure 3: Virtual tourist hub for infomobility: the reference model.

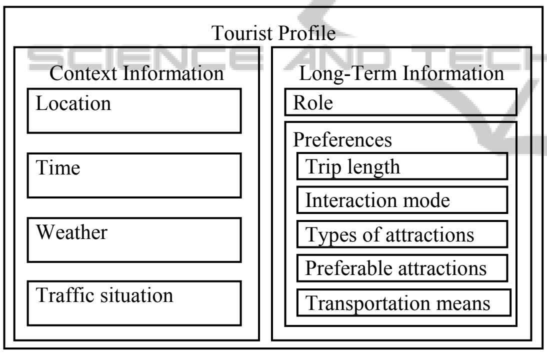

Figure 4: Tourist profile.

- Interaction mode with the mobile device (e.g. textual, audio, and video);
- Types of attractions, which are interesting for the tourist (e.g. Renaissance painting, sculpture of XIX century);
- Preferable attractions (a list of interesting and “must see” attractions);
- Transportations means (the tourist’s preferences related to the types of vehicles for changing location, e.g. taxi, ridesharing, public transport).

The trip schedule is generated based on the context of the current situation provided by the context management service. It can provide such information as weather, special events, etc. The services constitute a so called “intelligent environment”, which is accessed by the tourist through his/her computer (when at home) or smartphone (when in the trip). The tourist’s preferences are stored in his/her profile and also taken into account during trip planning.

4 APPROACH

The main idea of the approach (Figure 5) is to represent the logistics & attraction service providers by sets of services provided by them. This makes it possible to replace the configuration of the tourist logistics system with that of distributed services. For the purpose of semantic interoperability, the services are represented by Web-services using the common notation described by a common ontology. A detailed overview of the approach can be found in (Smirnov et al., 2012). The agreement between the resources and the ontology is expressed through alignment of the descriptions of the services modelling the resource functionalities and the ontology. As a result of the alignment operation the services get provided with semantics. The operation of the alignment is supported by a tool that identifies semantically similar words in the Web-service descriptions and the ontology. In the proposed approach the formalism of Object-Oriented Constraint Networks (OOCN) is used (its detailed description can be found in (Smirnov et al., 2010) for knowledge representation in the ontology.

Depending on the problem considered, the relevant part of the ontology is selected forming an abstract context. The abstract context is an ontology-based model embedding the specification of problems to be solved. It is created by core services incorporated in the environment. When the abstract context is filled with values from the sources, an operational context (formalized description of the current situation) is built. The operational context is

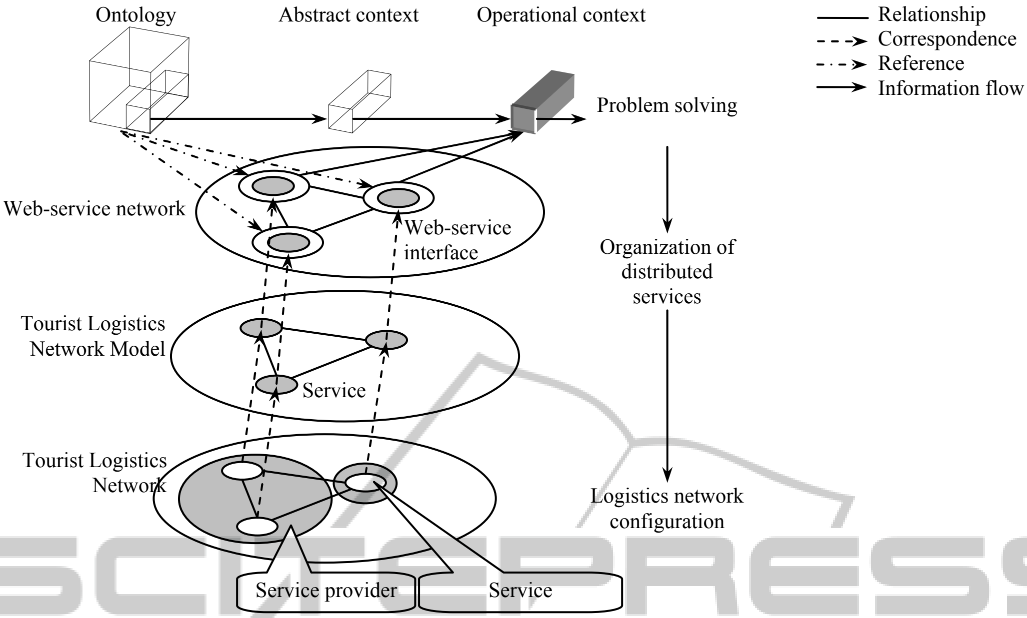

Figure 5: Generic scheme of the approach.

an instantiated abstract context and the real-time picture of the current situation. Producing the operational context is one of the purposes of resource configuration. Since the resources are represented by sets of services, the configuration of the resources is replaced with that between the appropriate services. Besides the operational context producing, the services are purposed to solve problems specified in the abstract context and to get the resources to take part in the trip plan. Due to the usage of the OOCN formalism the operational context represents the constraint satisfaction problem that is used during organisation of services for a particular task.

It can be guessed that for each particular situation there can be a large amount of feasible solutions for the users to choose from (e.g., the fastest transportation, the least amount of transfers, sightseeing routes, etc.). As a result, the paper proposes to build such a system as a group recommendation system that learns user preferences and recommends solutions, which better meet those preferences.

The overall scenario of the tourist hub usage is shown in Figure 6. Before the trip the tourist configures the preliminary plan consisting of the list of attractions the he/she would prefer to visit, and gets information about specifics of the country/region of the trip.

During the trip the tourists gets updates of the actual trip plan and movement directions. If there is no appropriate public transport available, the corresponding service can call for a taxi.

After the trip the tourist can leave his/her feedback and comments regarding the trip in social networks.

5 CASE STUDY

The prototype of the virtual tourist hub has been implemented based on the proposed approach. Maemo 5 OS-based devices (Nokia N900) and Python language are used for implementation.

An open source software platform (Smart-M3) (Honkola et al., 2010) that aims at providing a Semantic Web information sharing infrastructure between software entities and devices is used for system implementation. In this platform the ontology is represented via RDF triples (more than 1000 triples). Communication between software entities is developed via Smart Space Access Protocol (SSAP) (Honkola et al., 2010).

Different entities of the system are interacting with each other through the smart environment using the ontology. Each device has a part of this ontology and after connecting to smart environment it shares a part of the own ontology with the smart environment.

The system has been partly implemented in the Museum of Karl May Gymnasium History (Gymnasium of Karl May, 2012) located in St. Petersburg Institute for Informatics and Automation

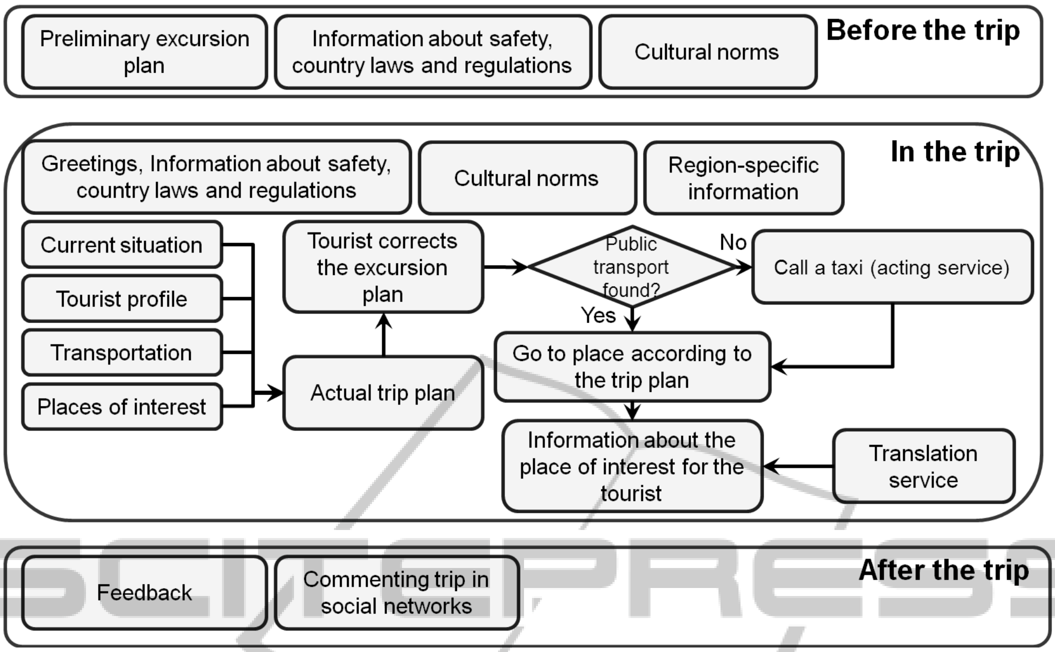

Figure 6: Tourist hub usage scenario.

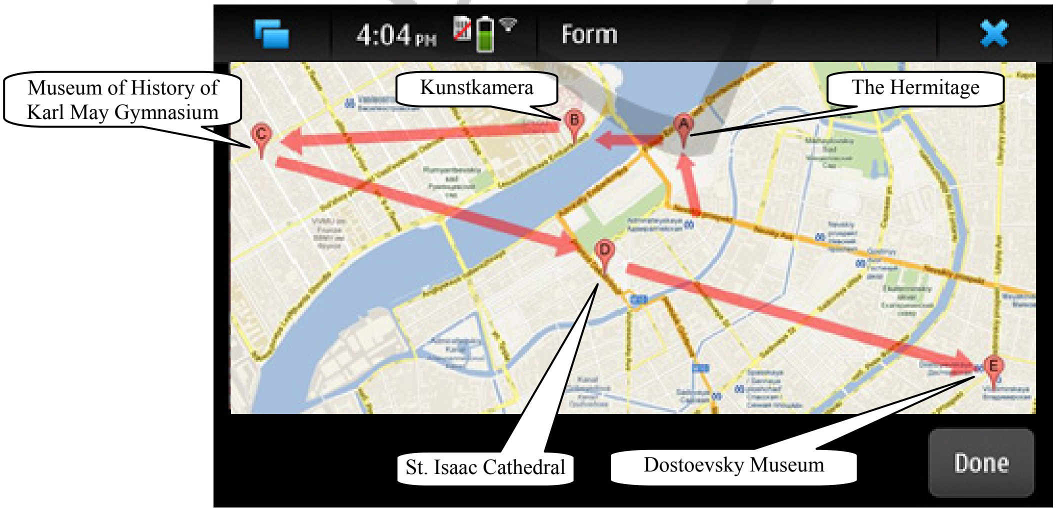

Figure 7: A smaple of museum attending plan in a visitor mobile device in the center of St. Petersburg.

Russian Academy of Science building.

The tourist downloads software for getting intelligent tourist support. Installation of this software takes few minutes depending on operating system of mobile device (at the moment only Maemo 5 OS is supported). When the tourist runs the system for the first time the profile has to be completed. This procedure takes not more than 10 minutes. The visitor can fill the profile or can use a default profile. In case of default profile the system can not propose preferred exhibitions to the visitor.

Response time of the Internet services depends on the Internet connection speed in the museum, number of people connected to the network, and workload of the services. Average response time should not exceed one second.

A museum attending plan is presented in Figure 7. It consists of five museums: the Hermitage, Kunstkamera, the Museum of Karl May Gymnasium History, St. Isaac Cathedral, Dostoevsky museum.

6 CONCLUSIONS AND FUTURE WORK

The paper presents an approach to development of service-based system for virtual tourist hub. Virtual tourist hub performs ad-hoc transportation scheduling based on the available schedules, current and foreseen availability and occupancy of the transportation means and services even though they do not cooperate with each other. It also helps tourists to plan their attraction attending time and excursions depending on the context information about the current situation in the museums (amount of visitors around exhibits, closed exhibits, reconstructions and other) and tourists' preferences, using their mobile devices. User profiles allow keeping important information about the visitor and using it in the smart environment.

The future work is aimed at implementation of the proposed system as well as adding features of group recommending systems. Generation of feasible trip plans taking account explicit and tacit preferences requires strong IT-based support of decision making so that the preferences from multiple users (accumulated in the system and/or obtained from social networks) could be taken into account (McCarthy et al., 2006); (Wang et al., 2012); (Zhang et al., 2012). Group recommending systems are aimed to solve this problem. Recommendation / recommending / recommender systems have been widely used in the Internet for suggesting products, activities, etc. for a single user considering his/her interests and tastes (Garcia et al., 2009), in various business applications (e.g., Hornung et al., 2009; Zhena et al., 2009) as well as in product development (e.g., Moon et al., 2009, Chen et al., 2010).

The preference revealing can be interpreted as identification of *patterns of the solution selection* (decision) by a user from a generated set of solutions. The ability to automatically identify patterns of the solution selection allows to sort the set of solutions, so that the most relevant (to user needs) solutions would be in the top of the list of solutions presented to the user.

Currently, three major tasks of identification of user preferences can be selected:

1. Identification of *user preferences based on solutions generated for the same context*. In this case, the problem structure is always the same, however its parameters may differ.
2. Identification of user *preferences based on solutions generated for similar contexts*. This task is more complex then the first one since structures of the problem are partially different.
3. Identification of *user preferences in terms of optimization parameters*. This task tries to identify if a user tends to select solutions with minimal or maximal values of certain parameters (e.g., time minimization) or their aggregation.

Based on the identified user groups, the user preferences can be revealed as common preferences of the users from the same group.

ACKNOWLEDGEMENTS

Some parts of the research were carried out under projects funded by grants # 13-01-00286-a, # 13-07-00271-a, # 12-07-00298-a, # 13-07-00336-a, of the Russian Foundation for Basic Research, project # 213 of the research program "Intelligent information technologies, mathematical modeling, system analysis and automation" of the Russian Academy of Sciences; and project 2.2 of the Nano- & Information Technologies Branch of the Russian Academy of Sciences.

REFERENCES

Ambrosino, G, Nelson, J D, Bastogi, B, Viti, A, Romazzotti, D and Ercoli, E., 2010. The role and perspectives of the large-scale Flexible Transport Agency in the management of public transport in urban areas. In Ambrosino, G, Boero, M, Nelson, JD and Romanazzo, M (Eds), *Infomobility Systems and Sustainable Transport Services*. Rome: ENEA, 156-165.

Bianchi, A. and Zancanaro, M., 1999. Tracking Users' Movements in an Artistic Physical Space. In *Proc. of the i3 Annual Conference: Community of the Future*. pp. 103-106.

Bohnert, F., Zukerman, I., Berkovsky, S., Baldwin, T. and Sonenberg, L., 2008. Using Interest and Transition Models to Predict Visitor Locations in Museums. In *AI Communications*. Vol. 21, issue 2-3, pp. 195-202.

Chang, E., Dillon, T., Gardner, W., Talevski, A., Rajugan R. and Kapnoullas, T., 2003 A Virtual Logistics Network and an E-hub as a Competitive Approach for Small to Medium Size Companies. *Web and Communication Technologies and Internet-Related Social Issues – HIS 2003*, *Lecture Notes in Computer Science*. Vol. 2713, pp. 167-168.

Chen, Y.-J., Chen, Y.-M. and Wu, M.-S., 2010. An expert recommendation system for product empirical knowledge consultation. In *ICCSIT2010: The 3rd IEEE International Conference on Computer Science and Information Technology*, IEEE, pp. 23-27.

Garcia, I., Sebastia, L., Onaindia, E. and Guzman, C.,

2009. Group Recommender System for Tourist Activities. In *EC-Web 2009: Proceedings of E-Commerce and Web Technologies, The 10th International Conference (2009)*, Springer, LNCS 5692, pp. 26-37.

Gymnasium of Karl May History Museum web page: http://www.spiiras.nw.ru/modules.php?name=Content &pa=shshowpa&pid=8 (In Russian). Retrieved: June, 2012.

Honkola, J., Laine, H., Brown, R. and Tyrkko, O., 2010. Smart-M3 information sharing platform. In *The 1st Int'l Workshop on Semantic Interoperability for Smart Spaces (SISS 2010)*. Electronic proceedings.

Hornung, T., Koschmider, A. and Oberweis, A., 2012. A Recommender System for Business Process Models. In *WITS'09: Proceedings of the 17th Annual Workshop on Information Technologies & Systems, 2009*. Electronic resource. http://ssrn.com/abstract =1328244. Retrieved: February, 2012.

Kuflik, T., Kay, J. and Kummerfeld, B., 2010. Lifelong Personalized Museum Experiences. In *Proc. Pervasive User Modeling and Personalization (PUMP'10)*, pp. 9-16.

Kuusik, A., Roche, S. and Weis, F., 2009. SMARTMUSEUM: Cultural Content Recommendation System for Mobile Users In *ICCIT2009 (IEEE/ACM) Int Conference on Computer Sciences and Convergence Information Technology*. Electronic proceedings.

McCarthy, K., Salamo, M., Coyole, L., McGinty, L., Smyth, B. and Nixon, P., 2006. Group Recommender Systems: A Critiquing Based Approach. In *IUI '06: Proceedings of the 11th international conference on Intelligent user interfaces*. pp. 267-269.

Moon, S. K., Simpson, T. W. and Kumara, S. R. T., 2009. An agent-based recommender system for developing customized families of products. In *Journal of Intelligent Manufacturing*, Springer. Vol. 20, no. 6, pp. 649-659.

Proctor, N., 2011. The Google Art Project: a new generation of museums on the web? In *The Museum Journal*. Vol. 54, Issue 2, pp. 215-221.

Schmidt-Belz, B., Zipf, A., Laamanen, H. and Poslad, S., 2003. Location-based Mobile Tourist Services: First User Experiences. In *International Conference for Information and Communication Technologies in Tourism*, pp. 115-123.

Smirnov, A., Levashova, T., Shilov, N. and Kashevnik, A., 2010. Knowledge sharing in flexible supply networks: a context-based approach. In *Control & Cybernetics*. Systems Research Institute of the Polish Academy of Sciences. Special issue on "Performance Evaluation Models of Manufacturing Systems" (Zbigniew A. Banaszak and Oleg Zaikin, eds.). Vol. 39, no. 1, pp. 177–196.

Smirnov, A., Levashova, T., Shilov, N., 2012. Configuration of ad hoc multimodal logistic networks: approach and technological framework. In: International Journal of Mass Customisation, Inderscience Enterprises Ltd. Vol. 4, nos. 3/4, pp. 208-219.

Sweeney, E., 2002. Supply Chain Management in Ireland: the Future. *Logistics Solutions*, the Journal of the National Institute for Transport and Logistics. Vol. 5, No. 3, pp. 14-16.

Wang Y., Chan, S. C.-F. and Ngai, G., 2012. Applicability of Demographic Recommender System to Tourist Attractions: A Case Study on TripAdvisor. In *Proceedings of 2012 IEEE/WIC/ACM International Conferences on Web Intelligence and Intelligent Agent Technology*. IEEE, pp.97-101.

Working Group on Logistics, "Developing Singapore into a Global Integrated Logistic Hub," Report, 2002. http://app.mti.gov.sg/data/pages/507/doc/ERC_SVS_LOG_MainReport.pdf. Retrieved: February, 2012.

Zhang, S., Zhang, R., Liu,X. and Sun H., 2012. A Personalized Trust-Aware Model for Travelogue Discovering. In *Proceedings of 2012 IEEE/WIC/ACM International Conferences on Web Intelligence and Intelligent Agent Technology*. IEEE, pp.112-116.

Zhena, L., Huangb, G. Q. and Jiang, Z., 2009. Recommender system based on workflow. In *Decision Support Systems*, Elsevier. Vol. 48, no. 1, pp. 237-245.