AUTONOMIC MULTI-MODAL JOURNEY PLANNERS

Bia Mandžuka
PhD student
Faculty of Transport and Traffic Sciences, University of Zagreb

Abstract

Multi-modal journey planners are very important part of Intelligent Transport Systems (ITS) services. Generally Multi-modal journey planners allow affordable selection of different modes of transportation during one trip, according to the current status of the transport network. Autonomic property may allow some optimization possibilities on the user own preferences and real time information about current transport network status.
Journey planners as innovative services give clear and precise instructions from the current place of user to required destination. Instructions may consist of walking time estimation up to the public transport, the time of his departure from the station, travel time estimation according to the current traffic conditions, the number of stations to the next place where the user needs to transfer at a different mode of travel, etc.
The paper presents some objectives of autonomic approach for these applications. Some development specifications of autonomic multi-modal journey planners are given, also. On this base some guidelines for development of autonomic service-oriented journey planners are proposed.
Keywords: intelligent transport systems, journey planners, multi-modal travelling, autonomic systems.

1. Introduction

Several European documents emphasize the importance of promoting multi-modal journey planners. The framework of the Action Plan for ITS (Intelligent Transportation Systems) is the optimal use of road and traffic data in order to encourage multi-modal travel, which is a key part of the European Commission's strategy for the future of transportation. Action 1.5 in the mentioned plan is related to the promotion of multi-modal journey planners. Besides the Action Plan for ITS the European Commission has completed a study “Towards a European Multi-Modal Journey Planner”. The study aims to support the development of regional and national multi-modal journey planners and connecting existing planners - with the final goal to enabling users to travel "door to door". There is no any reference to using autonomous property of these services.
Multi-modal journey planners are defined through ITS architecture and ISO 14813-1 specification [1] as pre-trip and on-trip route guidance and navigation service within traveller information functional area. Based on collected and processed traffic data multi-modal journey planners enable travel planning for end-users, selection of different modes of transport during one trip, according to current state of transport network and their own needs [2]. Basically, existing route planners include estimated travel times to next stopover (or to the end of travel), travel times to the place of mode transition, additional information about the route, points of interests, etc.
Multi-modal journey planners and guidance are defined as service which integrates pre-trip and on-trip traveller information from different modes of transport. Basically, they answer the question: “How to complete the journey from A (origin) to B (destination) in specified time and with specified modes of transport according to defined conditions?” [2]
As systems that support multi-modal journey planners become too complex to manage or maintain, computer scientists are seeking to embed “autonomic properties” into them. This means giving systems the ability to self-manage, maintain and adapt themselves.

The next characteristics of general autonomic computing systems are [3]:

1. The autonomic computing systems have to know themselves – their components have to present the system's identity. Since the system can exist in many layers, detailed knowledge is necessary of the state of all its components, their capacity, final states, and relations to other systems in order to be controlled.
2. The autonomic computing systems must change their structure under some conditions and be self-configured. This pre-structuring must be automatically realized by dynamical adaptation to the changing environment.
3. The autonomic computing systems have to optimize their work. They have to observe their consisting elements and working flows in order to reach the preliminary put goals.
4. The autonomic computing systems must be able to self-heal themselves from usual or unusual events which can damage some system's elements. They have to find problems or potential problems and discover alternative ways for using resources or for reconstruction of the system in order to keep its normal operation.
5. The autonomic computing systems must be able to protect themselves. They must find, identify and protect against different attacks, in order to maintain the system safety.
6. The autonomic computing system has to know its environment and act according to it. It has to find and generate rules how to interact with the neighbour systems. It has to use the most appropriate resources and if they are not available, to negotiate with other systems so that take them from these systems. It has to change itself and the environment or it has to be able to adapt it.
7. The autonomic computing systems cannot exist in closed environment. They have to act in various environments and apply open standards. They do not perform preliminary done decisions. They have to continuously make decisions.
8. The autonomic computing system has to predict the necessary optimal resources for accomplishing the current tasks. The system has to satisfy the quality of services and arrange the information-technological resources in a manner to 20 decreases the distance between the business and personal goals of the customer and IT instruments.

Multi-modal journey planers are very complex systems with a lot of subsystems (in different modes), components, information sources, services etc. It must be able to self-heal themselves from usual or unusual events (loss of some information, the lack of capacity in a mode etc.). Multi-modal journey planers have to find problems or potential problems and discover alternative ways for using resources or for reconstruction of the system in order to keep its normal operation. As systems become too complex to work or maintain by engineers, computer scientists are seeking to embed "autonomic properties" into them. In short, this means giving systems the ability to self-manage, maintain and adapt themselves.

2. Autonomic multi-modal journey planner concept

Autonomous Route Guidance (ARG) calculates the optimal route on the "navigation computer" in the vehicle using the "on-board" digital maps. Driver entries a travel destination, and then the navigation computer calculates the best route based on the current location of the vehicle (provided by GPS or DGPS receiver) and digital map. Therefore, it is an offline device that has no any data about the current status of traffic. The basic disadvantage of this system is the lack of knowledge of the current traffic situation.
In contrast to the Autonomous Route Guidance, in Centralised Dynamic Route Guidance (CDRG) processing of requests is done in the central computer in Traffic Information Centre (TIC). TIC disposes real-time data about the status of traffic (incidents, congestions, road works etc.). After the request from the vehicle's navigation computer (via communication link, e.g. mobile network) in TIC calculates the optimal route and sent a set of "route instructions" back to vehicle. A digital map in the vehicle is not necessary. The basic disadvantages of this approach are the need for communication link and the communication costs.

Dual Mode Route Guidance (DMRG) is combination of autonomous and centralised route guidance. In the case of good traffic status estimation (night, weekend, etc.) is used autonomous mode; in case of driving in rush hour is used centralised mode [4].
This paper proposes a new approach to the CDRG/DMRG, where exist a communication channel that connects route guidance equipment and TIC (dedicated or broadcast). In this case, "on-board" computer would provide an optimal route, but also would receive some information about "traffic situation within a pre-defined range of a transport network (zone, corridor, etc.). In case of communication disruption, CDRG would be switch to the autonomic mode (aCDRG) using pseudo (near) real-time traffic information. The new approach of route guidance would use the latest saved real-time data (e.g. backwards 15-30 minutes). Based on this pseudo real-time information, it will calculate the optimal route. Of course, this autonomic mode would have a time-limited reliability of data (i.e. approximately 60 minutes). In addition to these pseudo real-time data, it could use and some archived data, such as speed profiles for links of pre-defined range of transport network. The architecture of Autonomic Centralised Dynamic Route Guidance (in USA ITS Architecture notation) is shown in Figure 1.

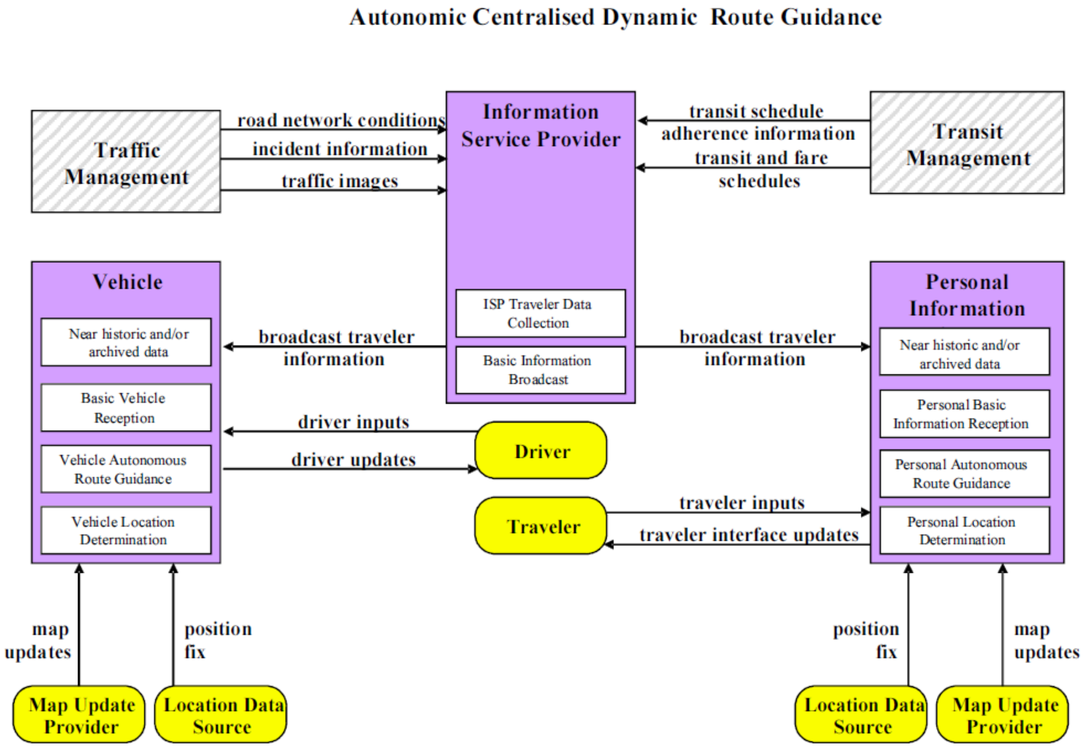

Figure 1. The architecture of Autonomic Centralised Dynamic Route Guidance

It is very important to have the necessary information about the events in all the possible modes that can potentially use in the specified part of the transport network. It is a very demanding task in the real environment.

3. User needs and what/how concept

First phase of development of multi-modal journey planner systems include definition of stakeholders (at the widest range) and their needs. Four main groups of stakeholders can be defined:

1. Want it – users which want the development of the system in order to enable multi-modal door-to-door journey as one unique service (public transport operators, road and maritime transport operators, etc.),

2. Make it – users which can develop services and applications for multi-modal travels (IT operators, service providers, tourist boards, etc.),

3. Use it – end users which will use developed services and applications (tourists, citizens, etc.) and

4. Rule it – local and national services and departments that prepare and issue regulations, standards, recommendations (ministries, government bodies, etc.).

In case of autonomic properties of multi-modal journey planner, very important are "want it" and "use it" stakeholders. Their knowledge about autonomic properties of future systems will be key success factor.

After the definition of stakeholders their specific needs can be defined. In initial phase of system development it is necessary to define the model of user needs which will be the basis for multi-modal journey planning service development. This approach implies WHAT/HOW concept (Figure 2) which means that firstly the satisfactory level of "WHAT will the system do?" among all defined stakeholders should be achieved.

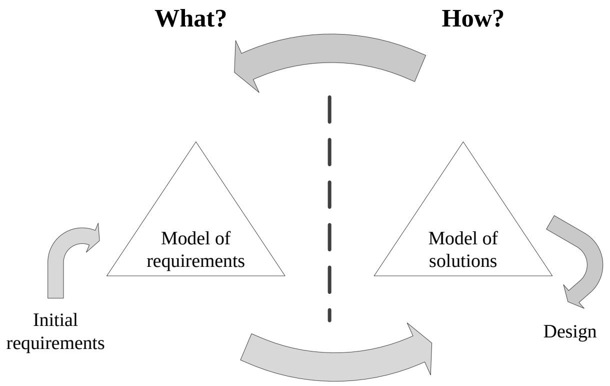

Figure 2 What/How concept of ITS service development [4]

Only after answering the WHAT question, the second phase can begin, which include "HOW will the system work" according to technical, technological and organizational sense. It is scope of "make it" stakeholders.

4. Development of autonomic multi-modal journey planners

General model of autonomic multi-modal route planner service development is presented on Figure 3.

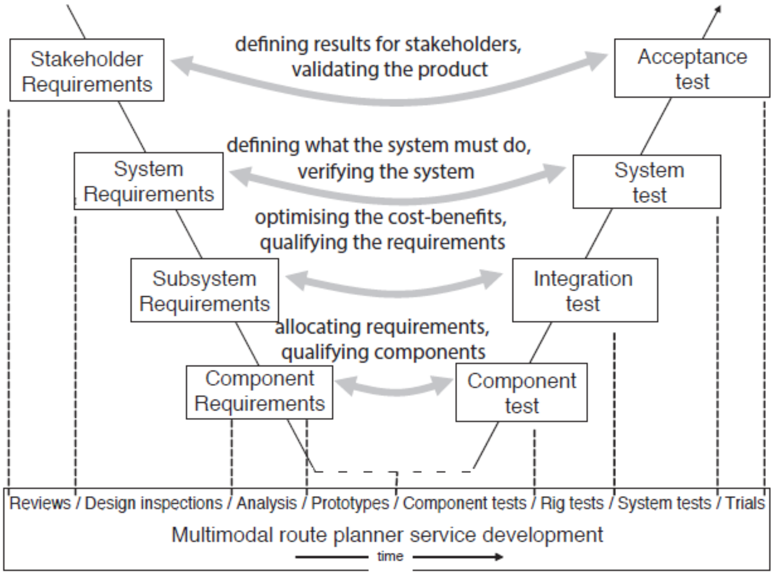

Figure 3 General model of autonomous multimodal journey planner service development

Figure 3 shows the classic V-model – initial approach of previously described methodological process. This approach provides basic principles of development of modern ITS services such as analysis of user requirements at all stages of system life cycle, but also testing of the system according to defined user needs. According to depicted V-model development of multi-modal journey planner service can be observed separately for every level. This methodological procedure allows all stakeholders to follow level of fulfilment of their user requirements, user needs update, etc.

User requirements must be conceived in order to respect features of proposed system which will enable smooth and normal work. The features of the system with which user requirements should not enter into conflict are [5]:

- Secured data flows – sending of information in right time before, or during the journey,
- Adaptability – the ability to alter the system according to user requirements,
- Limitations – rules and regulations that need to be accepted,
- Continuity – the ability to maintain service running in time and space,
- Financial viability – system is built only if it is profitable to end-users,
- Quality of information - information must be as simple as possible and must be designed to provide all the necessary information without additional (unnecessary) additions,
- User-friendly - system must be simple and expedient so that is easier to use.

After the completion of the first stage of service development (definition of user requirements), it is necessary to define autonomic properties of future system and services. Complete information “packed” in service must fulfil user requirements, so it is necessary to extract concise, understandable and important information that needs to be delivered in right time and on right place [6].

5. Conclusion

ITS service Route Guidance (and Navigation) includes the Autonomous Route Guidance, Centralised Dynamic Route Guidance and a combination of the above - Dual Mode Route Guidance. Autonomous Route Guidance has static traffic data and calculating the optimum route based on digital maps, while Centralised Guidance communicate with TIC, which means that the real-time traffic information are available. Dual mode is a combination of these two. The new proposed approach, in case of communication disruption - CDRG would be switch to the autonomic mode (aCDRG) using pseudo (near) real-time traffic information. The new approach of route guidance would use the latest saved real-time data (e.g. backwards 15-30 minutes). Based on this pseudo-real-time information, it will calculate the optimal route.
Lately a lot of R&D activities in traffic management systems have the goal to develop and implement autonomic approaches that have possibilities for adaptation with respect to changeable conditions and with property that efficiently allocates their resources. Existing multi-modal journey planners are without autonomic properties. An identified current deficiency of these systems suggests the necessity for improvements in this area. Possible erroneous solutions can be avoided with the proper approach in their designing through collaboration with a broad set of stakeholders [7].

Literature

1. ISO 14813–1:2007 – Intelligent transport systems – Reference Model Architecture for the ITS sector – Part 1: ITS Service Domains, Service Groups and Services, 2007.

2. Skorput, P.; Mandzuka, B.; Vujic, M.: The Development of Cooperative Multimodal Travel Guide, Proceedings of the 22th Telecommunications Forum - TELFOR, Beograd, 2014

3. Horn, P. Autonomic Computing: IBM's Perspective on the State of Information Technology, IBM, 2001.

4. Bosnjak, I.: Intelligent Transportation Systems 1 (in Croatian), University of Zagreb, Faculty of Transport and Traffic Sciences, Zagreb, 2006.

5. Vujic, M., Skorput, P., Mandzuka, B.: Multimodal route planners in maritime environment, Pomorstvo, 2015. (In the press)

6. Vujic, M., Cavar, I., Bosnjak, I.: Distribution of Travel Information and Driver's Perception, Proceedings of 14th International Symposium on Electronics in Traffic – ISEP 2006, Ljubljana, Slovenia, 2006.

7. Herbert, W., Mili, F., Route Guidance: State of the Art vs. State of the Practice, IEEE Intelligent Vehicles Symposium, Eindhoven University of Technology, Eindhoven, 2008