DATA INTERFACE MODEL FOR PASSENGER-CENTRIC INTERMODAL TRAFFIC MANAGEMENT

Olaf Milbredt and Florian Rudolph, German Aerospace Center (DLR)
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Introduction

In the beginning of transportation, efforts were made to build infrastructure in order to establish connections. These efforts were driven by visions such as the coast-to-coast railway track in Canada 150 years ago. Nowadays, the challenges have changed. Besides sustaining newly built infrastructure and coping with congestions, the demand for people-centric planning and passenger-centric services may rise. Whereas in Europe, where respecting passengers' needs and opinions may become an increasing competitive factor for choosing infrastructure such as airports or competing transport modes such as high-speed trains, the distances in Canada are too big for the transportation market to provide such opportunities. Nonetheless, mobile devices may also generate demand for passenger-centric services.

The issue of involving inhabitants in the planning of huge transportation infrastructure have been addressed by the Strategic Plan *Transportation 2030* (see Transport Canada, 2016). The goals are similar to European research agendas for transportation. Reliability, safety and security, and environmental sustainability should mark the corner points of future transportation. Meeting society's needs marks another goal of Europe's transportation research, similar to the requirements of Transportation 2030 for the provision of services to businesses and the Canadian middle class (see e.g. High Level Group on Aviation Research, 2011).

Meeting the needs of passengers can be better achieved by employing a passenger-centric view. Since passengers may encounter many modes of transportation during travel, adopting the passenger-centric view leads in a natural way to intermodality. Very few people are able to reach the airport on foot, so at least one different transportation mode will be part of the transportation chain. Here, intermodal traffic management on a passenger-centric basis comes naturally into play.

Why should effort be wasted on intermodal traffic management? Each transportation mode has its own sophisticated management system, so any change would be difficult. Increasing use of mobile internet and its broad availability implies a win-win situation for both, passengers and transportation stakeholders. From the passengers' point of view, timely provided relevant information is one of the most demanded services (cf. Garcia et al., 2012). Systems providing such information are called Passenger Information Systems (PISs). Mobile devices make it possible for stakeholders to satisfy this need. To provide the best possible information and estimates about remaining times, data concerning the passenger's trip are required. These data are the gain from the stakeholder's point of view.

The passenger's data can be used to adjust or trigger management decisions. Intermodal traffic management is only possible, if the affected stakeholders exchange information about their operations. Naturally, this information is seen as a company secret. Exact knowledge of information and respective interfaces required for a PIS may lower the inhibition threshold of stakeholders to share information.

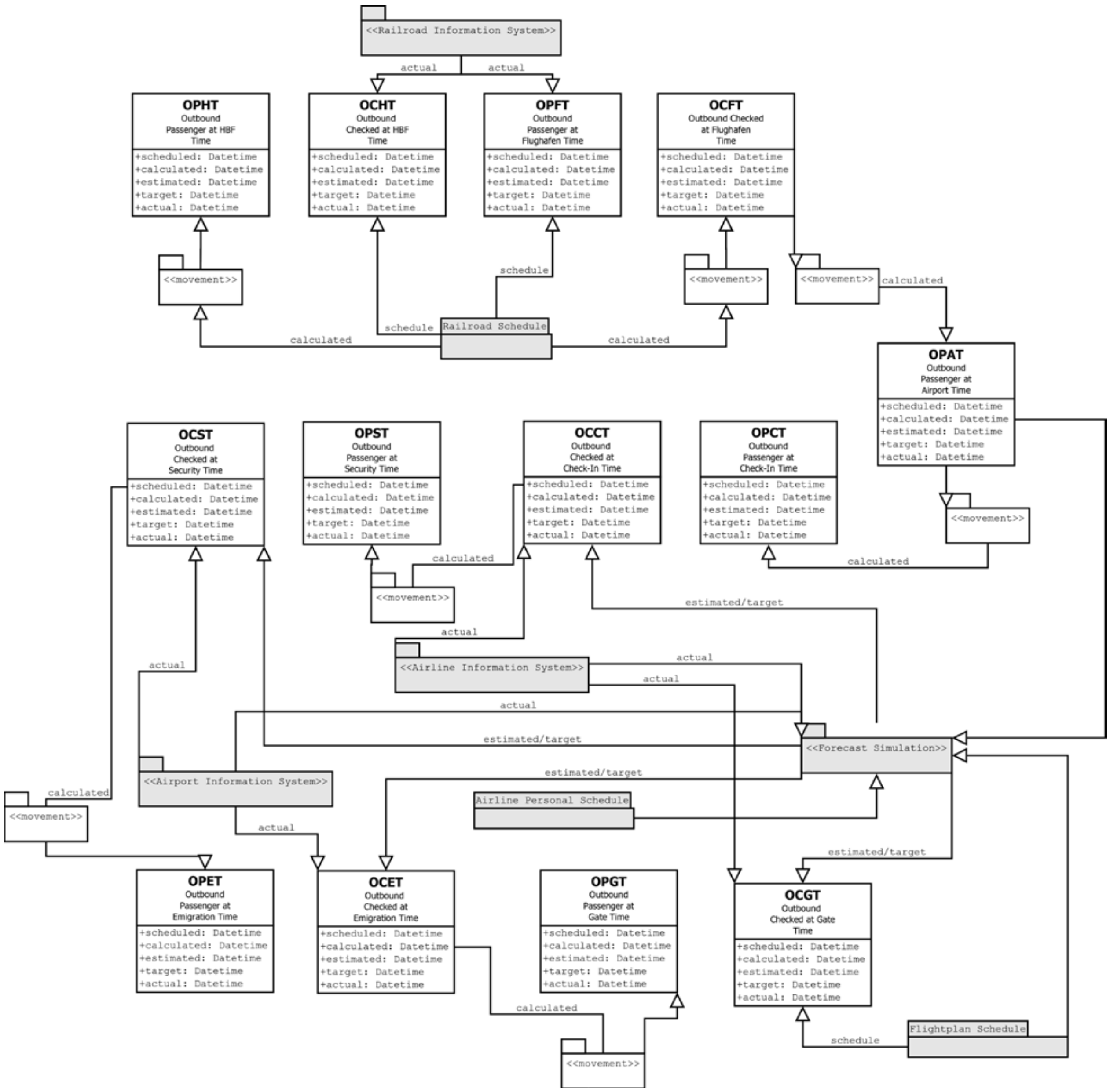

Figure 1: Data scheme and data interfaces for the journey's milestones.

In this paper, we describe the data model and the interface model necessary to implement a PIS on a mobile device. The features of our system comprise real-time and personalized information about departure times of urban transport and air transport, estimated time to complete the next milestone of the journey, such as check-in or security check, and estimated spare time for visiting the retail area. Especially for stakeholders such as airports, passengers waiting in the retail area instead of waiting at the gate are beneficial.

Data model and interface model are described by using standard methods in computer science, so that the description is independent of the implementation itself. Furthermore, it is transferable to other situations where a PIS is to be installed, such as big events, urban emergency, or evacuation scenarios. The generic nature of the model makes it possible to transfer the findings to other combinations of stakeholders who want to cooperate and share information.

Data Model

The data model underlying the "Passenger Information System" accesses a central database. For each user, nodes within his travel chain are thereby filed as milestones with differing characteristics. These characteristics follow the SCETA model and range from planned times derived from the flight schedules (scheduled), through calculated times, which take into account the current traffic situation (calculated), as well as expected times (estimated), which incorporate the first confirmations of the passenger's preceding nodes, up to the target times (target), which define, within their characteristics, the specific point in time which is to be effectively achieved. And finally, the actual measured timestamp (actual), which then lies in the past.

The quality of these timestamps transcends the predefined hierarchy, which means that "calculated" values possess a higher accuracy than the "scheduled" values. The same applies to "estimated" versus "calculated", "target" versus "estimated" and "actual" versus "target". Solely the most accurate milestone value is thereby always offered to the Passenger Information System.

As can be seen in the data schema, the times from widely differing sources are stored in the system. "Scheduled" times are based on static plans (flight plans, timetables and also personnel deployment plans). "Calculated" times are composed of preceding, actual updates of these plans as well as the inclusion of transit times and the new times for the milestones derived therefrom. A route network is thereby defined on the basis of the layout of the considered flight plan and the transit times for the passenger trajectory are calculated therefrom.

"Estimated" times are based, amongst other things, on an event-based forecast simulation in order to determine waiting times at the respective service points based on the current recorded situation. The simulation, in turn, uses the "scheduled" and "actual" times as actually recorded values from the differing information systems for a more detailed situation overview, in order to derive therefrom the future conditions. Whilst the simulation uses the layout of the airport to take into account the transit times, an interaction between the individual agents is not implemented. It thereby runs constantly in a continuous loop with the most accurate available times and calculates the waiting times for the entire specific day ("Day of Operations"). The times are thereby filed in a 5-minute grid for this day.

"Target" times use, amongst other things, "actual" times from the preceding milestones of the passenger trajectory and provide a value which is as accurate as possible and which should not differ from the value actually measured later. "Actual" times ultimately mark the recorded value as timestamps, which are combined from the differing information systems and are therefore independent of both preceding times and differing characteristics.

A prototypical application with the applied milestones is presented by Milbredt, Rudolph, and Grunewald, 2016.

Conclusions

Meeting the needs of passengers will increasingly become a competitive factor for each stakeholder of the air transportation system. To achieve this goal, a passenger-centric view needs to be employed. Since passengers may encounter many modes of transportation during travel, adopting the passenger-centric view leads in a natural way to intermodality. Timely provision of relevant information is one of the most demanded services. Exact knowledge of information and respective interfaces required may lower the inhibition threshold of stakeholders to share information.

In this paper, we describe the data model and the interface model necessary to implement a Passenger Information System on a mobile device. The features of our system comprise real-time and personalized information about departure times of urban transport and air transport, estimated time to complete the next step, such as check-in or security check, and estimated spare time for visiting the retail area.

Data model and interface model are described by using standard methods in computer science, so that the description is independent of the implementation itself. Furthermore, it is transferable to other situations where a Passenger Information System is to be installed.

In future work, we will implement a Passenger Information System on the basis of the data interface model described. We will evaluate the performance of the data interface model described with respect to reliability and throughput. We will answer the question of whether the model is appropriate for real-world applications. A further step would be the dissemination of the — hopefully positive — results of the evaluation among stakeholders in order to propose an information system which is independent of the data's owner.

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