Closing the information gap of multimodal transports

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Contribution abstract

Customer and freight related information is essentially to enable and ensure reliable transport chains. Therefore, real-time information along the transport service is to be made available by the participating companies to enable each service provider to optimise its resources and dispositive control of its processes. This paper deals with the result of the project RRTM-C which tested a closed information chain of an exemplary daily multimodal container shuttle service running in Austria between Vienna to Bludenz. The used information and data were provided by combining the tools that the project partners OeBB (Austrian Federal Railways), Asfinag (Austrian Motorway and Expressway Financing Joint-Stock Company) and shipper company Venz Logistik use for their daily operation. By connecting the main tools of the partners via specialised interfaces a continuous, cross- modal exchange of information including a stable prediction of ETA (Estimated Time of Arrival) of the containers in the terminals was made possible. The system was tested successfully in real transport conditions in June and September 2022. Additionally, an optimisation model of the involved container terminal was implemented to research the effects of different scenarios of different grades of information availability in the container terminal.

RRTM-C was a national cooperative implementation project that that was funded by the Austrian Ministry of Climate Action, Environment, Energy, Mobility, Innovation and Technology (BMK) and the National Railway Infrastructure Funding Agency (SCHIG).

Objectives

The customer information in the case of rules and deviations in the area of freight transport is essentially based on the information relationship between the individual participants along the transport and process chains and the data and information generated and used therein. Therefore, real-time information along the transport chain is to be made available by the participating companies to enable each service provider to optimise its resources and dispositive control of its processes in order to be able to react in time to deviations that occur at short notice. The tools available at the project partners ÖBB, Asfinag and Venz for the ongoing collection of ETA (Estimated Time of Arrival) are to be connected via suitable interfaces so that a continuous, cross-modal exchange of information is made possible. These interfaces also include methods for guaranteeing data sovereignty and data protection to the data brought in. This was designed so openly that in future a scalable and portable

solution can be offered for information transfer and coordination across companies, transport modes and countries. The solution was tested and evaluated on an exemplary transport chain (daily shuttle train from Vienna to Bludenz). This will be an imported step towards improving plannability and reducing empty runs and waiting times in the event of deviations from the original ETA. With the implementation of the project idea, an increase in the attractiveness of long-distance transports by rail can be expected will help to shift long-distance freight transports from road to rail.

Method

The project goal was to set up a connected system to exchange data and information of two infrastructure and the participating logistic company that are managing a daily multimodal container shuttle service in Austria rom Bludenz in Western Austria to Vienna in the East of Austria and then back to Bludenz. The considered transport chain is divided into several parts and transport modes. The first mile from the producer to the terminal Bludenz is carried out as a road transport on a federal road. The main run from Bludenz to terminal Vienna uses rail transport. The last mile from the terminal Vienna to the producer in the Greater Vienna Region has a longer part on the highway and a shorter section on the federal road system.

The unified ITU container number (ITU – intermodal transport unit) serves as the connection point that is represented in all data of the involved transport companies and transport modes. The container number is first used in the data of the logistic company to connect the information of the transported goods and the used transport unit with information of starting and end point as well as starting and delivery time. The project partner Asfinag has developed an information platform for users of the road tolling system in Austria (ETA Monitor©) that offers a service to give ETA information to customers based on their toll data when they fill in the relevant information (number plate of truck, starting and expected end time and starting and destination) in secure input form. The OeBB has implemented an internal data exchange platform (infra:infoHub©) that offers the possibility to connect all relevant data (container number with wagon number and train number as well as current position and ETA in destination railway station. The main idea of the project was to connect these three systems to offer a closed information chain to all involved parties and achieve a better planning situation for multimodal transport.

In a first step all transport processes, exchanged or needed data and all involved companies and stakeholders were documented in a graphic plan and were described in detail. Based on these first findings a system architecture and an implementation plan ware developed. The further work was concentrating on the definition of the interface protocols and connecting step by step the relevant components. Contemporaneous, the legal concept for ensuring the data sovereignty was set-up and all relevant legal aspects were collected and signed between the partners.
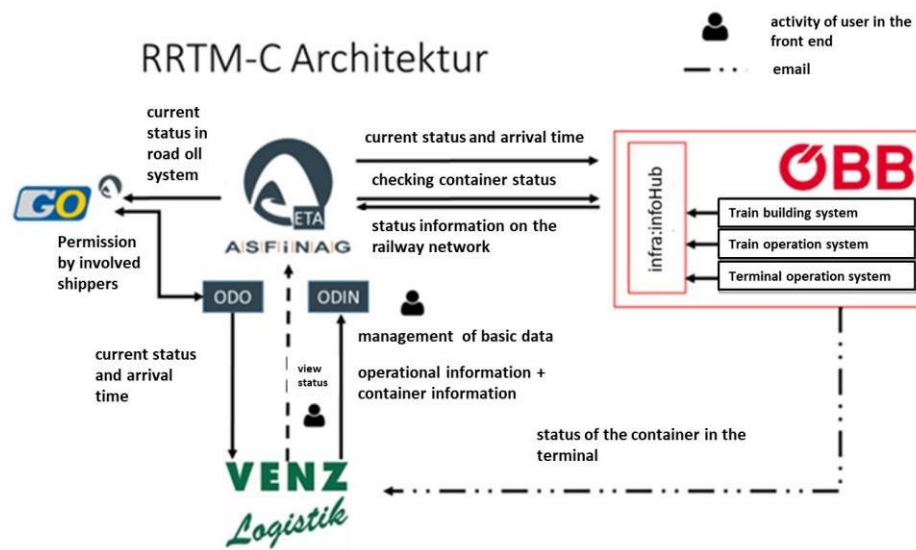
**Figure 1 – system architecture developed in project RRTM-C** (©AIT, Asfinag, OeBB and Venz Logistik)

The testing phase started in June 2022 and showed a highly reliable system for exchanging the relevant data. During this phase it was possible to track mainly all transports along their routes and the multimodal ETA was successfully tested.

Optimization model

As part of the project, an optimisation framework was developed that enables the user to abstractly represent and optimise the logistics processes within a container terminal. The central optimisation algorithm is based on a mathematical representation of the relevant aspects of the terminal as a system of linear equations and inequalities, a so-called Integer Linear Program (ILP).

This makes it possible to create possible scenarios of the effects of different arrival times of the investigated train in the terminal with its internal processes. For the implementation of the investigations, the real data must still be finally assigned to the intended variables. The necessary data sets include, among others:

- Geometry of the terminal (track plans, routes, crane tracks, etc.),
- Manipulation units (cranes, reach stackers, other necessary vehicles, etc.)
- Timetables from the railway operation,
- manipulation times,
- dwell times in the terminal of trains and trucks,
- sub-process durations,
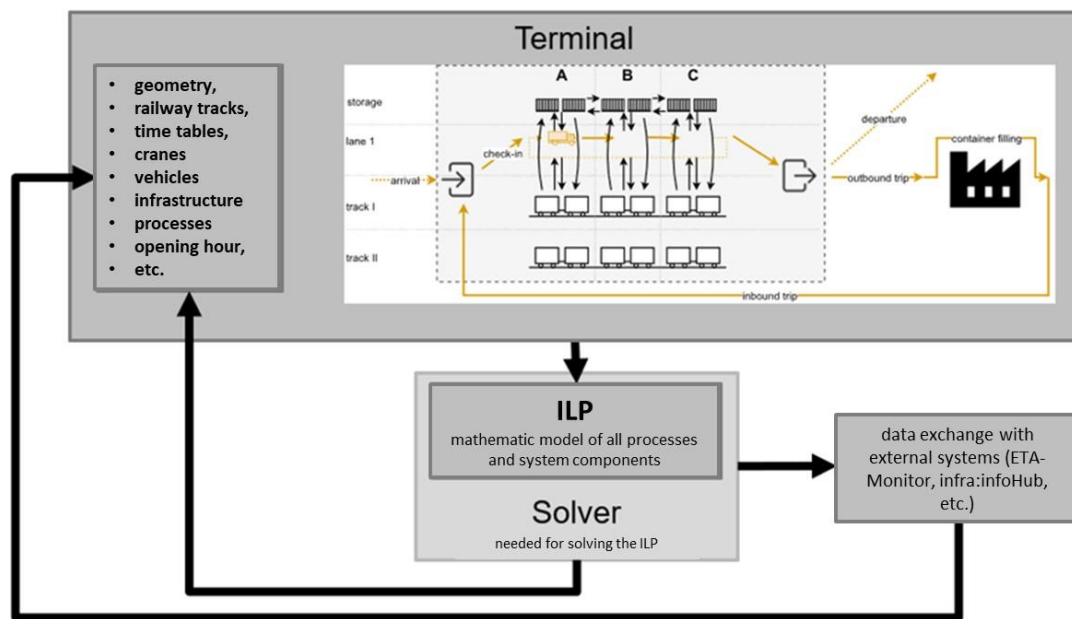
Figure 2 – optimisation model for testing different scenarios (©AIT)

The layout of the terminal is shown in simplified form in the mathematical model. A terminal consists of tracks on which trains can be parked, lanes on which trucks can drive for loading and unloading purposes, and a container storage facility along the tracks. All these components are divided lengthwise into sectors. The representation of the container warehouse is simplified in that the exact location of each container is not considered. Instead, each sector of the warehouse has a certain container capacity, which determines the number of containers that can be stored there at any given time. The loading of containers between trains and trucks always takes place within a sector - a container stored on a train in sector B can therefore only be reloaded onto a truck also parked in sector B. The loading of a container from or into a truck in sector B is also possible. Loading from or into the container depot, on the other hand, is possible between any sectors. The number of simultaneous loading operations is limited according to the available loading infrastructure (such as cranes and reach stackers).

For each train considered in the planning, the exact arrival and departure time as well as its parking position on the tracks of the terminal are known. This also indirectly results in the positions and the arrival and departure times of the containers loaded on the train that are to be unloaded and loaded in the terminal. The time availability of the individual trucks is also known and is taken into account in the planning.

The aim of the optimisation is to carry out all planned logistics operations as cost-effectively as possible within the time windows resulting from arrival and departure times. A possible logistics operation would be, for example, the unloading of an empty container from the train onto a truck parked next to it, the transport of this container to the customer for loading, its return transport to the terminal, the intermediate storage in the container warehouse and the final loading onto the train.

In order to be able to depict the resulting temporal dependencies in the model, the relevant parts of the terminal were modelled in the form of a so-called "time-space network" - a special type of graph in which the temporal component is represented in discretised form as a separate dimension. The physical transport route of a container can be represented in such a network together with the time schedule of the transport as a path in the time-space network.

For this purpose, a node is created in the time-space network for each physical location and each time necessary for this. Each node is always connected by at least one edge to the immediately following node at the same location - which represents a stay at that location. Furthermore, individual nodes

can be connected to the nodes of other locations if a transport between these two locations is possible. The time difference between these nodes corresponds to the duration of the corresponding logistics process - for example, if it takes five minutes to load a container from a truck onto a train, the lane node is connected to the track node five minutes later.

The model describes the transport of containers, trucks and loading infrastructure (such as cranes). The transport of containers must always be synchronised with the transport of the truck transporting them or the crane loading them (see figure 3).
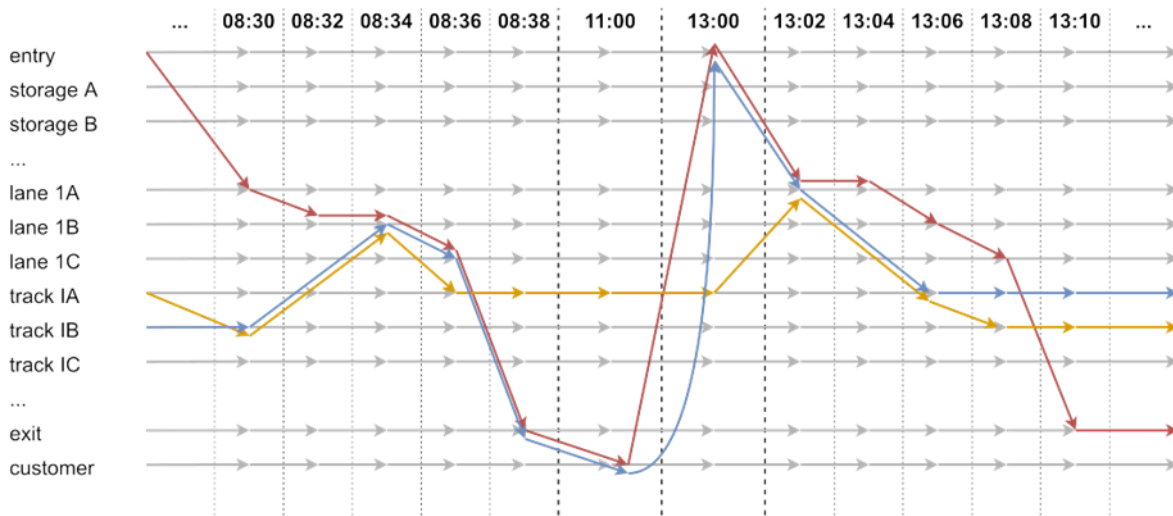
Figure 3 – example of a result from the optimisation model for testing specific scenarios (©AIT)

Results and evaluation

The evaluation and potential assessment are based on the assessment of the ETA Monitor / RRTM-C service management in ASFINAG (product development) and a questionnaire that was prepared during the trial operation. Some findings occurred in the interview and the evaluation.

- The targeted 75% of successful tracking via the system are good, but are considered to be potentially too low, especially with regard to the acceptance by the employees who organise dispatching and other logistical processes.
- The most important date in the application is to see at first glance when the expected arrival time is and whether it is on time or deviation from plan.
- The users of the system should be the dispatchers or, after connection via interface, the drivers directly.
- The application can contribute to the further development of intermodal freight transport by providing tracking and tracing functions without additional effort. In this way, fears can be taken away from potentially interested companies and hurdles can be removed. At the same time, the application is probably not a sufficient reason for deciding in favour of combined transport, time, costs, logistical effort and reliability are certainly more important here.
- For freight companies that successfully introduce the system, considerable time-saving potential is seen in connection with the frequent train delays: about 50%‑100% of the total delays could be saved in working time
- Further development of the application with regard to the display of the secured information that a) the container is on the wagon and b) the wagon is attached to the train (current implementation cannot check this a priori).
- Further development of the application and addition of output interfaces (e.g. for direct connection of driver apps).

Conclusion

In summary, the project was able to show that tracing and tracking could be implemented and put into operation within the framework of the technical possibilities and limits (e.g. tracking in road traffic only on the motorway) and thus a functioning solution with real data could be provided. The innovative content of the solution lies in the exclusive use of infrastructure data or existing/obligatory telematics (tolling data) as well as the linking of traffic information services of the infrastructure partners for tracking and tracing. In particular, no GPS boxes or similar are required, making onboarding easier and faster.

It is one big issue that the roadside part of the transport can be informed of the status of the trains running the container services. With the trustable knowledge regarding to the ETA the trucking companies have now the valid information that the train with the container to be transported to the recipient will arrive at a particular time. Finally, the project enables a stable prediction of ETA on a multimodal transport for the first time. Due to this there is no longer the problem that the trucking companies have to go to the terminal without knowing if their awaited container will arrive and at what time. This information implies no longer empty runs like in the past when n incident happened during the main run on the rail network.

Outlook

Due to the successful implementation and testing of the connection of the systems of the partners ASFINAG and OeBB Infrastruktur a follow-up project is being considered.