RTF - Using ferry real time information to optimise intermodal transport chains in the Baltic Sea Region

WP 3.4

Monitoring parallel development activities with relevance for ferry real time data generation

Annual ferry real time generation trend report No. 1

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prepared by

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Interreg Baltic Sea Region

EUROPEAN UNION

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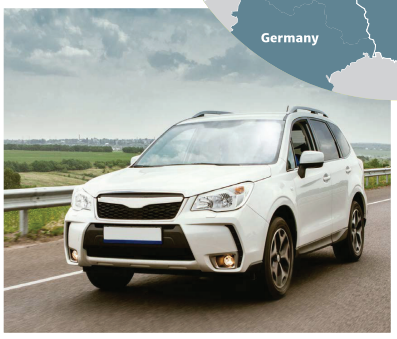

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List of abbreviations

AIS	Automatic Identification System
CEF	Connecting Europe Facility
CORDIS	Community Research and Development Information Service
ETA	Estimated Time of Arrival
IT	Information Technology
Ro-Ro	Roll on Roll off
RTF	Real Time Ferry
R & D	Research and Development
TMS	Transport Management System
TRIMIS	Transport Research and Innovation Monitoring and Information System

Abstract

In the framework of the RTF project, it is aimed for the development of an RTF platform. This platform will provide real time information from the ferries for the example of the Baltic Sea region. Therefore, the generation of real time information is an important part of the project. To support the implementers of the data generation tools, continuous monitoring of developments in the field of real time data generation is required, which will be documented in annual ferry real time data generation trend reports. Therefore, scientific papers, research projects and IT-solutions developed by companies are reviewed and summarised in the following. Moreover, pros and cons are discussed.

1 Introduction

1.1 Introduction and scope of the project

Real time information from ferries in the Baltic Sea region is hardly available and currently the information exchange is executed by conventional information transfer (e.g. phone and email). This is a restriction for logistics service providers e.g. to establish just-in-time concepts, and also reduces the planning ability of passengers. The scope of this project is mirrored in the collaborative development and installation of a real time data management system (data hub/platform) for the ferry traffic in the Baltic Sea Region, which provides ferry real time information from ferries to the different stakeholders in the public transport and to the stakeholders along the maritime supply chain.
This system will enable the improvement of related processes for the logistics companies, for the ports, for the public authorities and for the passengers at land and on board of the ferries.
Therefore, a data generation tool will be developed. This toolset generates and provides real time data to the RTF platform. This annual report supports the implementer of data generation toolset by finding new data generation methods or confirming the used methodologies.
Twelve ferry real time demo lines will be implemented and tested under real world conditions (see Figure 1).

Figure 1: Collaborating ferry lines in the Baltic Sea Region

1.2 Monitoring parallel development activities with relevance for ferry real time data generation

The field of real time traffic information and digitalisation of logistics and port processes is very dynamic at the moment. One of the issues, which a lot of different initiatives and actors are dealing with, is the data generation. As a consequence, it could be possible that new methods for generating real time data could be found during the lifespan of the RTF project.
For noticing and taking advantage of these new methods, it is important to continuously monitor and track the developments in the area of generation of real

time information and data. Whenever new solutions are found that add value to the project, they have to be investigated and analysed. Through continuous reviewing of relevant scientific papers and journals, scanning of research projects and monitoring of developed/implemented IT-solutions by companies, this report presents a comprehensive review of parallel developments in the area of real time data generation.
Therefore, different sectors such as public transport (includes bus, train, public ferries and tram), logistics (road, rail, air and sea) and other relevant areas were considered to get an overview about the methods to generate real time information. The findings with relevance to the generation of real time data are presented in this report. Applicable solutions are assessed by collecting and comparing the pros and cons.
This summary could help the implementers of the real time data generation tools through new real time data generation approaches or could confirm the currently applied methods.

1.3 Structure of the annual ferry real time generation trend report

The annual ferry real time generation trend report is divided into the following sections:
The methodology to monitor parallel developments to generate real time information is explained in section 2. This section is followed by the review of the scientific papers in section 3. The reviewed research projects are presented in section 4. Section 5 shows the review of IT-solutions developed by companies. A conclusion is given in section 6.

2 Methodology

The methodology consists of the following steps (see Figure 2):

1. Scope of analysis
2. Identification of publications
3. Selection and evaluation

In the first step, scientific data bases, R&D Information Services and search engines and in a later stage company IT-solutions are selected.
The second step includes defining appropriate keywords related to the field of real time data generation and setting different search criteria such as the period of analysis. The period of analysis is limited to the last six years 2014-2019). This is followed by the search for papers and research projects. In this report, articles in peer-reviewed journals and conference proceedings which are related to real time data generation are considered. The third step is represented by filtering search results based on title and abstract followed by reviewing and analysing them. After full-text reading, the classification takes place and the results are integrated into the annual report. Finally, the related IT-solutions developed/implemented by companies are scanned and discussed.

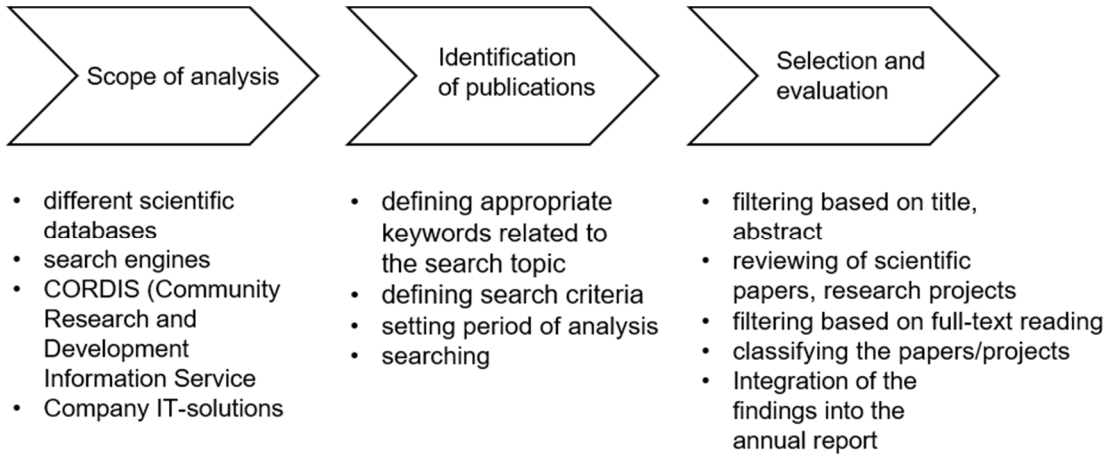

Figure 2: The steps of the methodology

A limitation was the accessibility of the papers. The chosen databases are not accessible for every institution. This means, that there will be an exchange between the project partners, as they may have different access to different databases. As a result, a variety of databases are used for the annual ferry real time generation trend report. To limit the error quote, topic-related papers were considered to get the crucial information. [Konovalenko 19]

2.1 Databases and Search Engines

The considered scientific databases of journals and papers are listed in theTable 1. The used scientific databases were Science Direct, Emerald Insight, Taylor & Francis and IEEE Explore.
For the second part of this report, the review of projects, CORDIS (Community Research and Development Information Service) was used. It gathers all information about EU-financed projects in one database. It is created by the European Union. These findings will be complemented by the search results,

which were found by “Interreg” and “TRIMIS” (Transport Research and Innovation Monitoring and Information System). Both databases also include projects funded by the European Union, but focus on different topics.
For the monitoring of IT-solutions a different approach was applied. Therefore, instead of using scientific databases, general search engines (e.g. Google) were used. Additionally, IT-solutions presented at conferences and exhibitions were included.

Used Scientific Databases
Science Direct
Emerald Insight
Taylor & Francis
IEEE Xplore
Other possibilities
Scopus
Web of Science

Table 1: Different science databases for the review of scientific papers

2.2 Keywords

The determination of the topics and keywords is significant for the execution of the research process. To increase the benefits for the stakeholders, it is important to keep track of the latest developments in the field of real time data generation. The keywords were selected as part of the brainstorming process of the research group members. At the beginning, generic keywords were used for the search process.

The following keywords have been defined:

- Arrival Time
- Calculation Arrival Time
- Vessel Arrival Time
- Estimated Vessel Arrival Time
- Real Time Information Arrival
- Transport Real Time Information
- Multimodal Transport Freight Monitoring
- Real Time Multimodal Freight Transport
- Real time data generation
- Data generation tools

2.3 Selection and evaluation

The entire selection of the results has been divided into a preselection part, an extended search part and finally a part about the selection and integration of the selected results.
Using the previously defined keywords and databases / search engines, a large amount of results was compiled. To make an appropriate selection, the process was divided into two rounds. In the first round, papers, projects and IT-solutions were evaluated by their titles and abstracts / short summaries in relation to RTF.

Therefore, the first results found were briefly read and rejected if they were not relevant for the project. A paper was relevant if it met the following criteria:

- Main topic is the transport of goods and / or passengers
- It is about real time data and its generation

The second round includes reviewing and filtering the results of the preselection based on full-text reading. Finally, the results are analysed, classified, summarised and integrated into the report.

3 Review of scientific papers

The following section presents the review of scientific papers. The reviewed papers are divided into different areas. The Table 2 gives an overview of the reviewed papers.

Public transport	
Public transportation (bus) - ETA	
[Fan 14]	A real-time bus arrival prediction method based on energy-efficient cell-tower positioning
Sea transport (Vessel)	
Transportation (vessel) - ETA	
[Mohd Salleh 17]	Predicting a Containership's Arrival Punctuality in Liner Operations by Using a Fuzzy Rule-Based Bayesian Network (FRBBN)
[Pani 14]	A data mining approach to forecast late arrivals in a transhipment container terminal
[Alessandrini 18]	Estimated Time of Arrival using Historical Vessel Tracking Data
Transportation (vessel) – Berth scheduling/simulation/routing	
[Bellsolà Olba 18]	State-of-the-art of port simulation models for risk and capacity assessment based on the vessel navigational behaviour through the nautical infrastructure
Road Transport, logistics and other topics	
Intermodal ETA	
[Elbert 14]	Information flow along the maritime transport chain - a simulation-based approach to determine impacts of estimated time of arrival messages on the capacity utilization
Real-Time Information systems – Real time information acquisition	
[Lai 18]	Real-time rescheduling and disruption management for public transit
[Horbury 99]	Guidelines for specifying automatic vehicle location and real-time passenger information systems using current best practice
[Zappia 14]	SITMar project: An integrated platform for goods monitoring in multimodal transport
[Harris 15]	ICT in multimodal transport and technological trends: Unleashing potential for the future

Table 2: Overview of the reviewed papers

3.1 Papers concerning public transport

The paper "A real-time bus arrival prediction method based on energy-efficient cell-tower positioning" by the author Fan considers the estimated time of arrival of busses with the help of the localisation via cell-tower. The used technology is called "cell of origin" (COO). Figure 3 shows a graphic of the cell stations and their spheres. Whenever the cell phone leaves a sphere of a cell tower, it connects to another cell tower. Advantages of this method are the lower energy consumption and that no additional devices are needed. The presented prediction model divides the travel time into two segments: the driving time and the bus stop time. The driving time is calculated by the historical data and the actual driving time. The bus stop time is calculated by the collected real time data of the previous busses. Together, these two data correct the variations, e.g. caused by rush hours. [Fan 14]

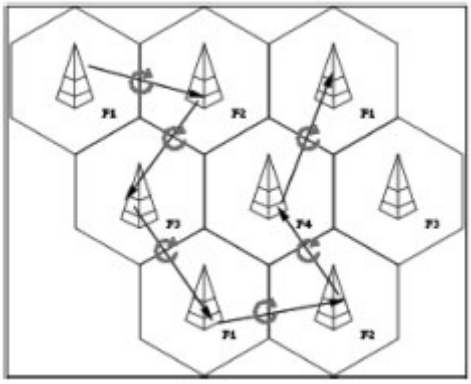

Figure 3: Connections and links between different cell towers along the bus route [Fan 14, p. 718]

Suitability check for RTF:
The idea considered in this paper shows many advantages like the low energy consumption. But in contrast there a several disadvantages for the ferry business. One of the main issues is the lack of cell-towers. The presented method can probably not be used for the ferry traffic, because there may not be enough cell-tower at sea. This issue must be further analysed. The author of this paper mentioned that the model would be more accurate, if there were more cell-towers nearby. The density of cell-towers is in urban areas is higher than in rural regions (including off-shore areas).

3.2 Papers concerning sea transport

The objective of the paper “Predicting a Containership’s Arrival Punctuality in Liner Operations by Using a Fuzzy Rule-based Bayesian Network (FRBBN)” by Mohd Salleh is based on the statistics that the reliability of container ships is around 73% (statistic by Drewry Shipping Consults). A FRBBN is a combination of a fuzzy rule-based approach and a Bayesian Network. The Figure 4 illustrates the procedure. A test of this method evaluates three significant criteria that most affect the punctuality of the arrival (departure from previous port, condition of the berth and machine failure). These factors should be considered highly by the operators. [Mohd Salleh 17]

Suitability check for RTF:
Criteria that most affect the punctuality have been reviewed and ranked in this paper. These criteria can be used for the ferries, which are the main transport vehicles of the project. Different delays have been categorized in this paper. A short delay is up to 12 hours, a delay is up to 24 hours and a strong delay is up to 36 hours. This is difficult to compare with the Baltic ferries because their total travel time is beyond these delays.

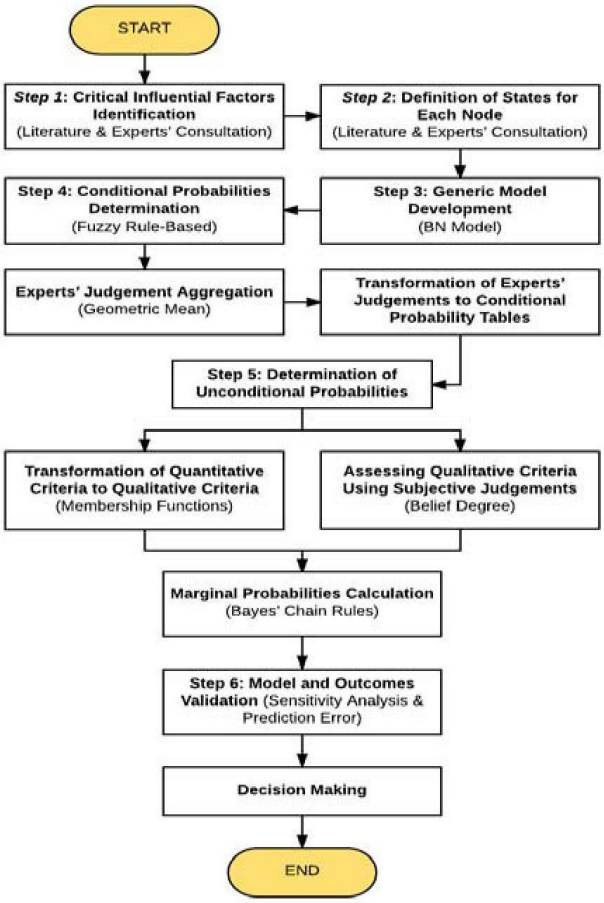

Figure 4: The procedure for analyzing and predicting the arrival punctuality [Mohd Salleh 17, p. 97]

Pani et al. have published the article “A data mining approach to forecast late arrivals in a transshipment container terminal” in the journal “Transport”. In this paper a tool to predict the arrival times of vessels is described. Over a period of 6 months, data from Cagliari’s transshipment container terminal was collected and analysed.

Variables that affect late or early arrivals are:

1. ETA at pilot point
2. actual time of arrival
3. gross tonnage
4. vessel type
5. shipping line
6. length
7. sailing direction
8. capacity
9. previous port
10. service
11. average speed

The Classification and regression Trees (CART) are used to classify new data. Predictor variables are: Length ETA DAY, ETA Shift, Vector Type and Sailing. The response variable is Delay. The arrival time estimation model time has a mean error in the delay prediction of 1 hour and 30 min. [Pani 14]

Suitability check for RTF:
Because of the ETA prediction, the model and the approach could be relevant for the RTF Project and also applicable. The issues could be the data mining process

that is very long and the mean error on delay prediction. A delay of 1 hour and 30 minutes could be too long for the ferry transport.

Alessandrini presents in his scientific paper “Estimated Time of Arrival using Historical Vessel Tracking Data“ an algorithm for estimating the time of arrival of vessels in Mediterranean ports. Initially, the routes were determined on the basis of the LRIT-data (Long-Range identification and tracking) of the ships. These routes are used by different vessels to reach their destination. The ETA is calculated from the transmitted AIS-data of each ship (location and speed). The algorithm is validated in this paper and compared with other calculation approaches. The Figure 5 shows the algorithm mentioned. The Dijkstra Algorithm is also included for the determination of the shortest path for the initial solution. [Alessandrini 18]

Algorithm 1 Path Finding & ETA Estimation

Require: Port $\mathbf{x}_p$, $\{MMSI_i\}_{i=1}^N$, $\{\mathbf{S}_i\}_{i=1}^N$, $\mathbf{R}_t$, $\mathbf{R}_d$, $\mathbf{R}_l$, w_t, w_d, w_l

// Rasters to graphs conversion:
$\mathbf{G}_t \leftarrow \text{transition}(\mathbf{R}_t, mean)$
$\mathbf{G}_d \leftarrow \text{transition}(\mathbf{R}_d, mean)$
$\mathbf{G}_l \leftarrow \text{transition}(\mathbf{R}_l, mean)$
// Graphs geocorrection:
$\mathbf{T}_t \leftarrow \text{geocorrection}(\mathbf{R}_t)$
$\mathbf{T}_d \leftarrow \text{geocorrection}(\mathbf{R}_d)$
$\mathbf{T}_l \leftarrow \text{geocorrection}(\mathbf{R}_l)$
// Weighted geocorrected graph:
$\mathbf{G} = w_t\mathbf{T}_t + w_d\mathbf{T}_d + w_l\mathbf{T}_l$
for $i = 1$ to N **do**
  // Extraction of newest state variables from track i
  $[\mathbf{x}_{i,S}, time_{i,S}] \leftarrow last\_obs(\mathbf{S}_i)$
  // Optimum path between last observation and port
  $[\mathbf{P}_i, \hat{D}_i] \leftarrow Dijkstra(\mathbf{G}, \mathbf{x}_{i,S}, \mathbf{x}_p)$
  // Speed profile for vessel i
  $sog_i \leftarrow speed\_profile(\mathbf{S}_i)$
  // Speed expected value from Gaussian fitting on speed profile
  $[\hat{v}_i, \sigma_{v,i}] \leftarrow gauss\_fitting(sog_i)$
  // ETA estimation
  $\hat{T}_{A,i} = time_{i,S} + \frac{\hat{D}_i}{\hat{v}_i}$
end for
// Return the list of times of arrival
return $\{\hat{T}_{A,i}\}_{i=1}^N$, $\{\hat{D}_i\}_{i=1}^N$

Figure 5: The algorithm to estimate the arrival time of a shipping route [Alessandrini 18, p. 3]

Suitability check for RTF:
The presented algorithm could be applicable in a limited version for the RTF-project. It is possible to implement this algorithm in a different system, because all the necessary data is available. Just the LRIT-data must be subscribed and is not freely available. However, the pathfinding for ferries can also be done in other ways without the use of LRIT. Furthermore, in this paper vessels are considered, which are normally used for longer distances and for the freight transport, whereas ferries are used for shorter distances. Ferries also transport passengers and freight. RTF is using historical data for the prognosis of real time data as well. The historical data generation algorithm presented in this paper could be modified and adapted to the RTF project.

In the scientific paper “State-of-the-art of port simulation models for risk a capacity assessment based on the vessel navigational behavior through the nautical

infrastructure" the simulation of ports is investigated. The Figure 6 shows the schematically process of vessels in ports which is simulated. The reviewed and evaluated simulation models were not commercial. The evaluation criteria of the models can be divided in two categories: nautical layout assessment (details of the criteria that can be modelled; criteria: nautical infrastructure, anchorage, berth, terminal operations, assistance to tugs and pilots, traffic rules) and navigational behavior assessment (modelling of navigational criteria and similarity with reality; criteria: vessel arrival process, fleet composition, vessel navigation, course choice, choice of sailing speed, calibration). [Bellsolà Olba 18]

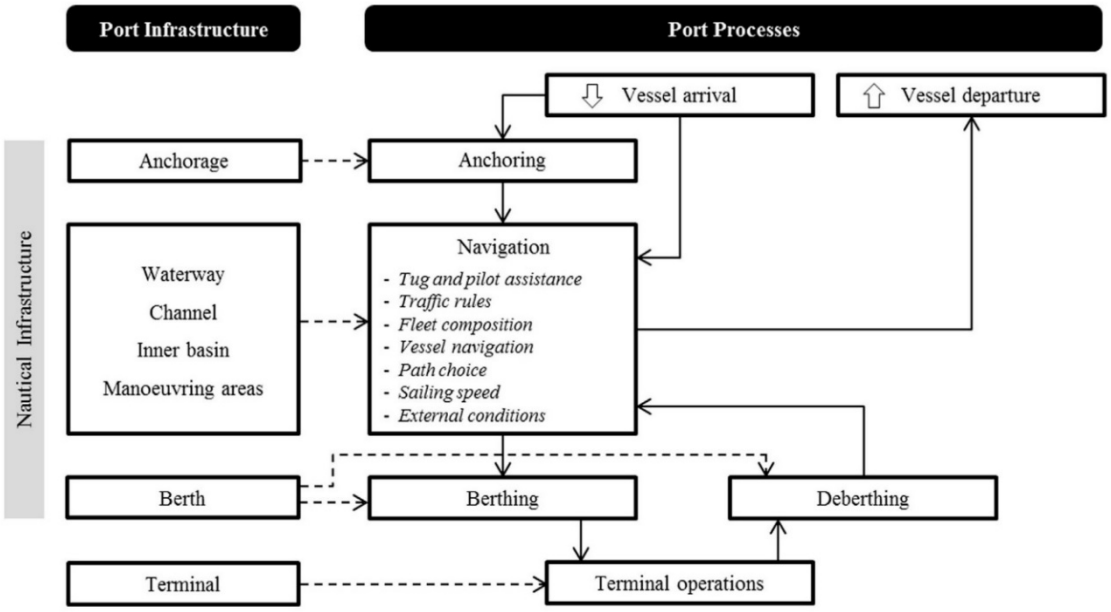

Figure 6: Processes in a port classified in the different nautical infrastructure [Bellsolà Olba 18, p. 337]

Suitability check for RTF:
Port simulation could be important for the future port planning. This simulation considers the process of vessels entrance in the port area. In case of the RTF project, an extensive port simulation as described in the paper is not necessary. One possibility to look at the simulation in the project is to use a simulation model that focuses on the simulation of all the processes of a port, including cargo handling.

3.3 Papers concerning logistics

In the paper "Information flow along the maritime transport chain - a simulation-based approach to determine impacts of estimated time of arrival messages on the capacity utilization" in 2014, Elbert presents a simulation approach that covers the processes between vessel and hinterland rail road traffic. The effect of calculating the ETA of containers is examined using the example of the port of Hamburg. The containerized ETA deals with the problem that the transport of the container is regulated from the terminal to the hinterland. If the container is late, the space is not used. Also presented is a literature review on the simulation of container terminals, which is assigned to the category "System Dynamic Modelling". The simulation software "AnyLogic 6.9.0" was used because this software is able to fulfil all requirements and to collect the data from the different

operators of the transport chain. The simulation proves that the information about the transport chain is valuable. The Figure 7 shows an example of the container transport by rail to the hinterland. [Elbert 14]

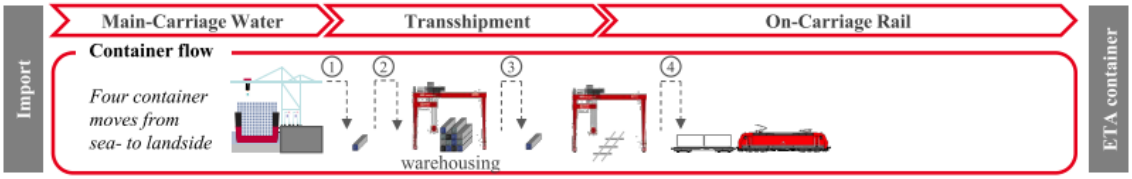

Figure 7: Transport chain of the container between the port and the hinterland [Elbert 14, p. 1795]

Suitability check for RTF:
The RTF project considers the transport and information flow between the different operators of the transport chain. An intermodal transport chain between vessels and trains is presented by Elbert. In addition, a simulation approach of the ferry processes for the various ports can be carried out. This paper highlights the significance of the ETA-information and how it could be used.

The scientific paper “Real-time rescheduling and disruption management for public transit” by the author Lai presents the creation of a decision support system which includes historical and real time data. The focus was on real time scheduling and optimization of routes and frequencies taking into accounts delays. The real time data is e.g. position data measured by RFID location sensors. With the help of a simulation different mathematical models were examined and tested. [Lai 18]

Suitability check for RTF:
The proposed decision support system could be relevant for the project. A decision support system could help to decide which ferry to choose if a transport vehicle is late. A system that looks at all transport vehicles in the Baltic Sea region is questionable because of the high effort.

In the paper “Guidelines for specifying automatic vehicle location and real-time passenger Information systems using current best practice” by Horbury advantages and disadvantages of automatic vehicle location technologies (AVL) and real time passenger information systems have been analysed and guidelines based on the analyses are presented. Following AVL-technologies were considered: dead reckoning (measurement of the travelled distance by counting the number of wheel revolutions), beacon and tag (intelligent beacon), beacon and radio (intelligent bus), radio triangulation and satellites (e.g. GPS). [Horbury 99]

Suitability check for RTF:
The paper was published in 1999, so the findings could be too old and other technologies were established. Nonetheless, the paper could be solid fundament to investigate general tips and hints for an AVL or a real time passenger information system. But it should be compared to papers which were published later and deal with a similar issue.

The paper “SITMar project: An integrated platform for goods monitoring in multimodal transport” was written by Zappia in 2014. It concerns an Italian project, which was conducted in the maritime freight and transport sector. The objective is the development of a system that can monitor a multimodal transport chain, including sea and land transport links. RFID-Tags and sensor networks are used to capture and transmit the crucial information. The integrated sensor measures environmental changes and discrete events. Exceeding a threshold triggers an alarm, that informs the operators. The system is based on a platform of NEGENTIS, a software provider. The Figure 8 shows the system consisting of different subsystems to operate the monitoring function. The subsystems are mentioned as follow: SITMar Land Center, SITMar on Board Center, Enhanced Traffic Services Platform, SITMar Compliant Container and the Nodal Framework. The communication between the subsystems is visualised with the flashes. The indicated website www.sitmar.net is not available anymore. [Zappia 14]

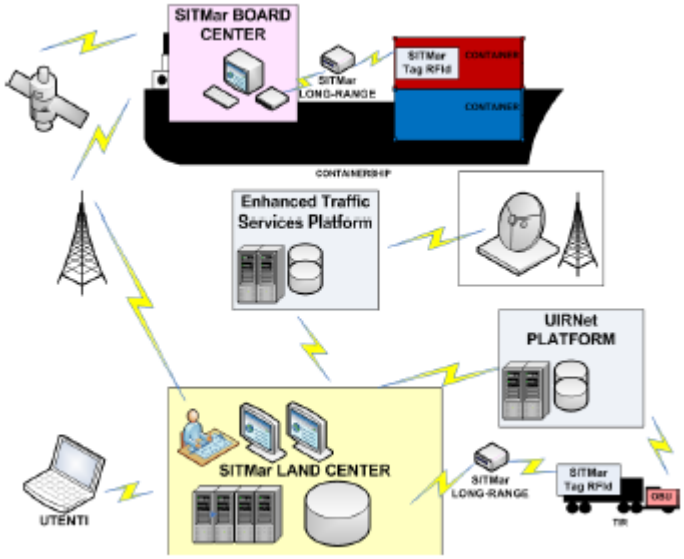

Figure 8: System Architecture of the presented project SITMar [Zappia 14, p. 2]

Suitability check for RTF:
The reviewed system considers a multimodal transport chain that includes the maritime transport, as the RTF project also takes into account. The communication and the transfer of information between the different transport vehicles are important for the planning process of the different stakeholders of the multimodal transport chain. The example of monitoring environmental changes is not a priority of the RTF project. The SITMar project also concentrates on the transport of freight and goods. The demands of passengers are not considered.

The paper by Harris presents the potential reasons for a slow adoption and assess the uptake of recent information and communication technologies (ICTs) advances for multimodal freight transport, barriers inhibiting quick take-up of ICT applications in multimodal transport and ways help to overcome these barriers as well as analysis of four key new ICT development trends and evaluating their possible impact in minimize such obstacles for deployment. [Harris 15]

Suitability check for RTF:
The considered idea shows many advantages that could be considered as example of using the latest information and communication technologies in the RTF project, eliminating the problems that arise during the creation of the idea of the project and its later functioning.

4 Review of research projects

The second component of this annual ferry real time generation trend report is the review of research projects. The projects were chosen and evaluated by the main issue “transport”. The Table 3 Table 3shows an overview of analysed research projects. Following databases are used to find the RTF-related research projects:

CORDIS (commission database of EU-funded research and innovation projects)

- TRIMIS (transport research and Innovation Monitoring and Information System project database)
- Interreg project database
- Using general search engines to find research projects

				Mode of transport					Kind of transport		
Projects	**Project abbreviation**	**Programm/Financed**	**Multi-modal**	**Maritime**	**Road**	**Railway**	**Inland waterway**	**Aviation**	**passenger**	**freight**	**Security**
Strengthening Combined Transport in Baltic Sea Region	Combine	Interreg Baltic Sea Region	x	x	x	x	x	x		x	
Bus Real-time Information – Business Case Research		TRIMIS - National (Great Britain)			x				x		
Intermodal Transport Real-time Information Platform	INTRATRIP	TRIMIS – European (4th RTD Framework Program)	x		x	x		x		x	
Navigational System for Efficient Maritime Transport	NAVTRONIC	TRIMIS – European (7th RTD Framework Program)		x					x	x	
River Service for Improving the Integration Waterway transport into Intermodal Chains	RISING	TRIMIS – European (7th RTF Framework Programme)	x		x	x	x			x	
Collaborative Information Services for Container Management	COMCIS	TRIMIS – European (7th RTD Framework Programme)	x	x	x	x				x	
Enhanced real time services for an optimized multimodal mobility rlying on cooperative networks and open data	TIMON	TRIMIS – European (2020 Horizon)	x						x	x	
Vessel Traffic Monitoring and Information System	VTMIS	TRIMIS – National (Croatia)		x					x	x	x
STM Validation Project		Trimis - European		x						x	
Real time Technologies for Maritime Security	MaFo	TRIMIS – National (Germany)		x					x	x	x
Electronic exchange of Estimated Time of Arrival information	ELETA	CEF Transport	x							x	

Table 3: Overview of found research projects

4.1 Logistics related projects

ELETA - Electronic exchange of estimated time of arrival information

The project “Electronic exchange of estimated time of arrival information (ELETA)” is partly funded by the Connecting Europe Facility. The website of the project indicates a period from September 2017 to August 2019. The title addition “Sharing of train tracking & estimated time of arrival information” describes the objectives of the project in a concise form. The project is part of the Connecting Europe Facility (CEF) funding program in the field of transport. [ELETA 18]

The means of transport considered in the project is the rail. Real time information will be provided to the different operators along the transport chain. This will improve intermodal transport and competitiveness compared to the road transport. An example of train time information is the estimated time of arrival, which is important to the stakeholders. This information will be shared through a Train Information System (TIS). Figure 9 shows the future situation after the implementation of ELETA and the relations between the operators. The ETA will be shared between the operators and leads to an improved planning and transport process. The estimated time of arrival, which is transmitted, is shown in the figure by red, two-sided arrows. The ETA will be calculated using machine learning algorithms. [ELETA 16]

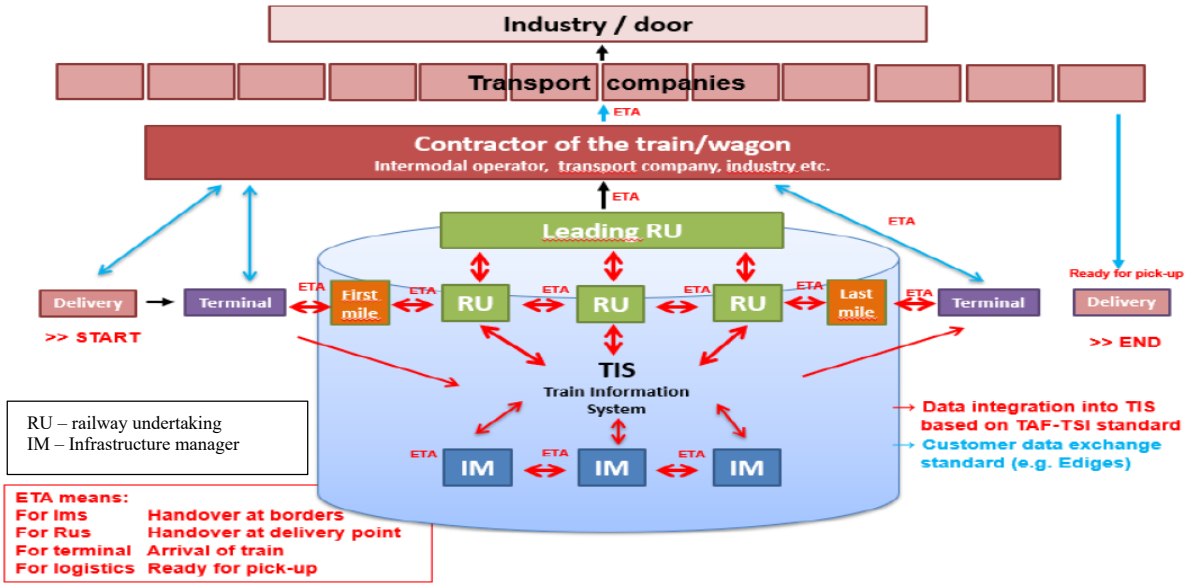

Figure 9: The future situation after the execution of ELETA [ELETA 16, p. 10]

Suitability check for RTF:
The project focuses on one component of an intermodal transport chain, the rail transport. ELETA’s objective is the exchange of crucial transport information for the different operators along the intermodal transport chain, which is similar to the RTF project. The difference is the considered transport vehicle (ELETA – train, RTF – ferry). This may be an issue for the application of the system architecture. However, due to the similarities mentioned, it is possible to consider the results of ELETA in the implementation of RTF. The infrastructure and architecture of the system and the data formats can be applicable for RTF.

TIMON – Enhanced real time services for an optimized multimodal mobility relying on cooperative networks and open data

Database/program: TRIMIS – European (2020 Horizon)

The project “TIMON” provides an open web-based platform that provides real time data to participants of the transport and was completed from June 2015 to December 2018. The mode of transport is the transport by road. Open data sources are used to transmit real time data and made available for a web platform and a mobile application. [TIMON 15]

The project “TIMON” implemented different kind of services in the system e.g. Alerting services (Collison alert, Emergency Vehicle and Road Hazard) and Planning services (Vehicle Density Awareness, Dynamic Route re-planning, Multimodal Route Planning System and Enhanced real-time traffic information). [Benkic 18, S. 7] In addition, artificial intelligence is used in the form of algorithms for multimodal planning. [Benkic 18]

Suitability check for RTF:

TIMON is a relevant project because they offer a multimodal transport management service. A similar service will be developed during the RTF-project. TIMON is focusing on the multimodal transport for trucks, there is no information if the ferry transport or the ETA generation is also considered. The web application is on the official project website available (https://timon-project.eu).

4.2 Public transport related projects

Bus Real-time Information - Business Case Research

Database/program: TRIMIS – National (United Kingdom)

The duration of this project was from July 2002 to September 2003. It was conducted in the United Kingdom and the impact of real time information on public transport was considered. [UG423I 19]

Proving the advantages and impacts of a bus Real Time Passenger Information system, a literature review was created. The different findings, papers and reports were assigned to the relevant effects. Examples of impacts include savings in travel times, improved regularity and reliability of the service. [Basford 03]

Suitability check for RTF:

This project has some limitations for the adaptation to the RTF-Project. First of all, the focal transport mode is the passenger transport. Another limitation is the type of transport vehicle. The RTF-project focuses on intermodal transport, integrating different transport vehicles (in particular the ferries) and not just the bus.

5 Review of IT-solutions developed by companies

The importance of IT-solutions in the transport sector is increasing over the last couple of years. Furthermore, software and systems are a crucial component for optimising the transport and planning processes. A central point of the RTF project is the determination, calculation and transmitting of the estimated time of arrival of ferries. The objective of this part of the report is to search for related IT-solutions which are offered and provided by different companies. At the end, a suitability check for the RTF project will be conducted and an overview of the solutions found will be given.
To identify IT-solutions developed by companies search engines were used (see also website www.predictiveanalyticstoday.com). [NN 19]

The following overview shows some IT-companies:

- BNS-Software
- ETAtransIT
- Inform software
- Kratzer Automation
- LogistIQo
- Paris
- PTV Group
- Sauer Software
- Synfioo
- Transpereon
- Software AG
- Manhattan Associates
- Allotrac
- Jda
- OneNetwork
- Trimble
- Mercury Gate
- Oracle
- Eyefreight
- Cerasis
- Descartes
- AscendTMS
- Transplace
- BlueJay
- Alpega
- TMC
- 3GTMS
- TransCAD
- Paragon
- Kuebix
- Real-ETA
- leogistics

6 Conclusions

In the report No. 1, a general overview of real time data generators in different transport and logistics sectors is given. For the development of a data generation tool, it is important to keep track of the IT-solutions developed and the algorithms and methods used. Therefore, various scientific papers and research projects have been examined so far.

6.1 Evaluation of the results

In order to evaluate the results, it is important to consider all findings and how they may affect the data generation in the RTF project. Therefore, a suitability check was carried out for each finding. An overview of the suitability of each finding is given in Table 4. This table compares the pros and cons of each scientific paper and research project to give an overview of the findings.

Papers	Pros	cons
[Fan 14]	This method requires low cost technical equipment and reduces the energy consumption, because of the usage of mobile data signals.	There are not enough cell towers at sea to provide a constant signal.
[Mohd Salleh 17]	Consideration of criteria that most affects the punctuality of container ships has been evaluated in the paper.	Considering 12 hours' delay as short delays as a short delay, because of the long travel times of container ships. An average ferry cross over takes less than 12 hours.
[Pani 14]	Presentation of a detailed ETA prediction model for vessels.	Complex and time-consuming data collection method, considered delays of 1,5 hours.
[Alessandrini 18]	Presentation of an algorithm for historical data and real time data to calculate the ETA of cargo vessels.	Developed for cargo vessels. They have higher travel times than ferries.
[Bellsolà Olba 18]	Describes a port simulation model that considers the port entrance of the vessels and all related processes in the port. It includes all berthing and anchorage processes. Supports the ETA calculation and generation by showing off the port processes.	The simulation is primarily planned for the risk and capacity management of vessels in the port.
[Elbert 14]	The significance of ETA calculation for an intermodal transport chain is highlighted.	Simulation is based on rail and road transport, ferries are not included.
[Lai 18]	Decision system based on real time and historical data to optimise the transport in case of delays.	Designed for the public bus transport, real time data is generated by RFID tags.
[Horbury 99]	Solid foundation about passenger information systems.	Paper from 1999, a few information may be outdated.
[Zappia 14]	Real time monitoring of goods and their environmental changes in a real time information system.	No generation of ETA.
Projects	**Pros**	**cons**
ELETA	During the project a real time information system that shares the ETA of trains with all stakeholders will be developed.	The project is just focused on the train transport.
TIMON	A real time information system will be developed for trucks. Shares data about alerting and planning services.	It does not consider the ferry transport and the ETA generation.
Bus Real Time Information	In this project a real time passenger information system was developed that shares real time data like ETA of the buses with passengers.	This system is developed for passengers and buses only.

Table 4: Overview of the findings

6.2 Outlook for the future

The methodology will be refined in the next report. Further scientific papers, research projects and IT-solutions developed by companies will be reviewed and the results will be included in the upcoming report.

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