FInest – **F**uture **In**ternet **e**nabled optimi**s**ation of **t**ransport and logistics networks

D7.1

Requirements analysis and selection of technology baseline for transport planning component

Project Acronym	FInest	
Project Title	Future Internet enabled optimisation of transport and logistics networks	
Project Number	285598	
Workpackage	#WP7 Transport Planning and Re-planning	
Lead Beneficiary	MARINTEK	
Editor(s)	Kay Endre Fjørtoft	MARINTEK
Contributors(s)	Marianne Hagaseth	MARINTEK
	Lone Ramstad	MARINTEK
	Åsmund Tjora	MARINTEK
	Cyril Alias	UDE
	Michael Stollberg	SAP
	Metin Turkey	Koc University
Reviewer	Yagil Engel	IBM
Reviewer	Metin Turkey	Koc University
Dissemination Level	PU	

The research leading to these results has received funding from the European Community's Seventh Framework Programme [FP7/2007-2013] under grant agreement no. 285598

Contractual Delivery Date	30-09-2011
Actual Delivery Date	30-09-2011
Version	2

The research leading to these results has received funding from the European Community's Seventh Framework Programme [FP7/2007-2013] under grant agreement no. 285598

Abstract

This document gives the initial analysis of the requirements to the Transport Planning Module (TPM). The purpose of the TPM is to create an overall, operational transport execution plan for a multimodal transport chain handling goods by utilizing highly relevant and recent information at planning time. By doing this, other FInest modules will be able to support third party transport provider systems with updated status information during execution of their transport plans. The transport execution plan contains a description of both transported items and transport services being used during the transport. Several transport execution plans are assembled to form the plan for a complete door-to-door transport chain.

V2 of the document has been updated with a technical state-of-the-art analysis (Chapter 7) and some more details on TPM (Section 6.2.3).

Disclaimer

Document History

Version	Date	Comments
V0.1	01-07-2011	Initial document structure
V0.2	19-08-2011	Draft document structure
V0.3	08-09-2011	Update after project meeting in Istanbul
V0.9	15-09-2011	Draft version for internal review
V1.0	20-09-2011	Draft version for internal review
V1	30-09-2011	Final version
V2	30-12-2011	Revised version

Table of Contents

List of Figures

Acronyms

Acronym	Explanation
AIS	Automatic Identification System
BCM	Business Collaboration Module
Co-modality	Use of different modes on their own and in combination in the aim to obtain "an optimal and sustainable utilization of resources". Source: EU
ECM	E-Contracting Module
EPM	Event Processing Module
GE	Generic Enablers
HazMat	Hazardous Materials i.e. Dangerous goods
IaaS	Internet as a Service
Inter-modality	Transport that involves more than one mode of transport
IoT	Internet of Things
LSC	Logistic Service Client
LSP	Logistic Service Provider
NTS	Network and Traffic Status
PaaS	Platform as a Service
PCS	Port Community System
PPL	PrimeLife Policy Language
PTO	People Technology Organisation
RUP	Rational Unified Process
SLA	Service Level Agreement
SSN	SafeSeaNet: EMSA system to support the requirements of Directive 2002/59/ EC establishing a Community vessel traffic monitoring and information system. The system is accessible to the National administrations of all the Member States of the European Community and of the European Free Trade
SSO	Single-Sign-On
TEP	Transport Execution Plan
TES	Transport Execution Status
TIS	Transport Item Status
TNM	Transportation Network Manager
TOS	Transport Operation Status
TP	Transport Plans
TPM	Transport Planning Module
TR	Transport Regulator
Transparency	To visualise the transport i.e. by offering real-time tracking features
TSD	Transport Service Description

USDL	Unified Service Description language
VM	Virtual Machine
WADL	Web Application Description language
WSDL	Web Service Definition language

1 Introduction

1.1 WP7 – Planning and Replanning

A planning process for the transport of goods will result in a transport plan that describes the goods' journey through the entire transport chain. Such a planning process must obtain information about the cargo to be transported, selection of logistic service providers that will play a role in the transport, as well as schedules and requirements for the different transport modes such that the plan is consistent and easy to monitor during the transport execution process. The Transport Planning Module (TPM) will develop requirements for the planning services that are needed, where the input is the transport demand from a logistic client, and the output is a transport plan.

1.2 Description of Task 7.1

According to the Description of Work, the two main objectives of Task 7.1 "Planning and replanning" are to document the current replanning processes of the stakeholders and to develop the user requirements for the Transport Planning Module. Process mapping is performed by the research partners as a combination of a literature search and domain study. The domain partners will expose their existing business processes, which will be generalized and used as an input to the requirement process.

User requirements will be developed in close collaboration with the domain partners in an iterative process, where the research partners facilitate and document the results. The method used will be aligned with the technical development process selected by the consortium's architecture team. This task has tight interdependencies with the business requirements identified in WP1 and the design and architecture of the overall technical solution elaborated in WP3.

1.3 Deliverable D7.1 Introduction

This deliverable is the first deliverable in FInest WP7 – Transport planning and replanning. It gives the initial description of the Transport Planning Module (TPM), including requirements analysis and a technological baseline for the module. Some basic requirements that should be mentioned regarding a planning and replanning module are:

- It should support inter-modality and co-modality;
- It should be future oriented where use of Future Internet is mandatory;
- It should be stable, modular, and easy to refine;
- It should support visibility/transparency in the transport chain;

- It should be independent of technology;
- It should be more automatic than today's existing solutions (i.e. use of sensors and statuses in a planning exercise); and
- It should be easy to integrate with existing systems and standards (legacy systems, etc).

The Planning and Replanning module's success is dependent on fulfilling the real needs expressed by the stakeholders and users as well as securing the overall objectives set by the project. In addition, current business processes and state of the art technology must be taken into account.

1.4 Structure of Deliverable

This deliverable is structured as follows:

- Chapters 2 and 3 contain background descriptions for the planning/replanning domain.
- Chapter 4 summarizes requirements for planning given by the Use Cases.
- Chapter 6 describes the structure of the TPM.
- Chapter 5 contains initial technical requirements for the TPM
- Chapter 7 contains a state of the art analysis of relevant tools in the supply chain management domain.
- Chapter 8 gives a reference to new generic enablers that may be needed by the TPM.

2 Planning and Replanning in Transport and Logistics

This chapter describes different aspects of planning and identifies the most relevant issues regarding the TPM.

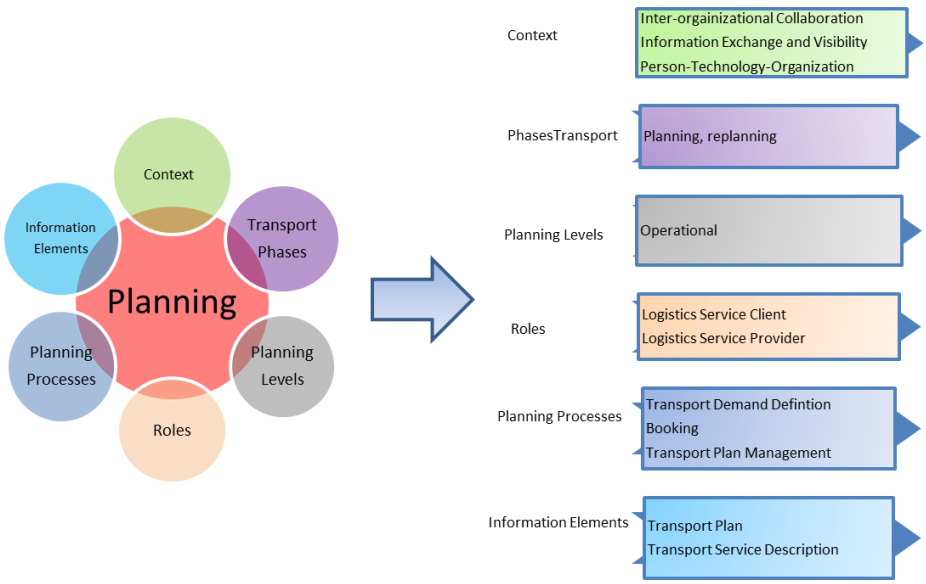

Figure 1 Aspects of Planning and the most relevant issues regarding the TPM

The structure of the planning/replanning description in this chapter is as follows (as shown in Ffigure 1) :

- **Context**: Section 2.1 describes the context of transport planning and replanning. Most relevant here is the need for inter-organizational collaboration and information exchange during planning and re-planning and also the PTO (Person-Technology-Organization) perspective (Figure 2). Section 2.7 contains descriptions of research projects that are relevant for planning in transport.
- **Transport Phases:** Section 2.2 describes the four phases of transportation: Marketing and Sales, Planning, Execution, and Completion. For the TPM, the planning phase is the most relevant. However, the interaction between planning and the other transport phases must also be taken into consideration.
- **Planning Levels**: Section 2.3 describes three levels of planning: tactical, strategic and operational (Figure 4). For the TPM the focus is on operational planning.
- **Roles**: Section 2.4 describes relevant transport roles. For the TPM Logistic Service Client is the most important role since the task of the TPM is to fulfil the transport demand. However, the other roles are important in that they are indirectly needed to complete the transport plan composition.
- **Planning Processes:** Section 2.5 gives an overview of processes in the planning phase. Some of the key processes for the TPM to support are Transport Demand Definition, Booking and Transport Plan Management.
- **Information Elements**: Section 2.6 describes information elements that may be useful for the TPM. The most relevant are TSD – Transport Service Description – to be used in the interaction between the TPM and the ECM to exchange information on available transport services, and TEP – Transport Execution Plan – to be used in the interaction between the TPM and the BCM to exchange information on the transport plan. Section

2.7.2 points to standardization bodies that are relevant for FInest. The TPM builds on existing standards e.g., the use of the concept Transport Execution Plan.

2.1 Context of Transport Planning and Replanning

Efficient and effective transport planning and replanning is about making sure that relevant information is available at the right time that supports logistic chain operations in all phases such as, marketing, planning, execution, and completion of a transport operation. Planning consists of handling resource utilization and information requirements, and is tightly related to resource status, availability, configurability and the possibility to negotiate more efficient use of equipment and better cargo stowage. The ability to acquire, or "wrap-in," this information in the planning domain is essential. Today this is mainly done through inter-organizational collaboration, but the FInest Planning and replanning module will make real-time information about resource statuses available across actors/organizational boundaries, which constitute a significant potential to improve the planning processes and to optimize the transport operation.

The replanning process is a typical deviation management operation in most organizations, which indicates that a large element of flexibility in process execution is required to be able to tackle different contingent situations. Real-time information and transparency are key elements in such processes and can be enhanced through use of Future Internet technology.

Transport planning and replanning as a discipline focuses on two main goals. The first goal is the transport of goods from origin to destination according to the transport user's requirements, such as required pickup and delivery times, costs, quantity of goods to be transported, load unit type(s) to be used, all this in accordance with any regulatory requirements, such as HazMat restrictions, cargo declarations, etc. The second goal of transport planning and replanning is sustainability. Sustainability in this case has an economic focus. It refers to making sure that the transport provider (responsible for the transport) maximises the profit, not from each individual transport assignment, but as a whole for the chain. This latter point is vital. A logistic service provider might accept a transport assignment from a transport user even though the specific transport assignment is not very profitable per se. Sustainability is secured by making sure that the sum of all transport assignments contributes to maximum profit[1].

The processes to achieve these goals are highly interactive and to a large extent inter-organisational. It is therefore necessary that an approach to achieve these goals is not pursued solely through technical means. One needs to address these goals through a balanced approach involving people, technology and organisations (PTO). The PTO perspective is multi-

[1] Environmental sustainability should not be disregarded but this is more an incentive in the sense that transport planning and replanning will only entail environmental sustainability as a goal either because it will reduce costs (e.g. by limiting emission fees), because it supports the transport provider's public image or because it is required by the transport user (through the transport user's requirements).

dimensional in a transport operation as it involves several organisations with their individual objectives and business processes (Figure 2).

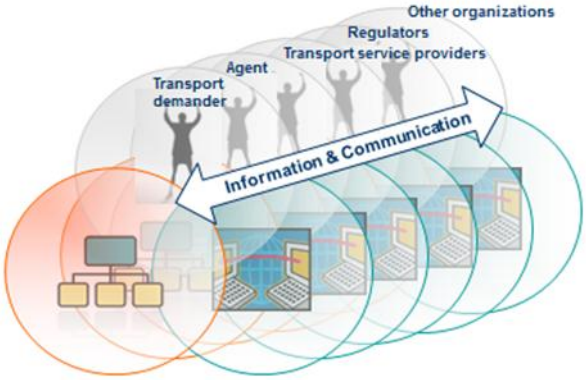

Figure 2 People, Organisation and Technology

The fact that transport operations involve several organisations complicates handling of information exchange throughout each phase of transportation (marketing and sale, planning, execution, completion, see Section 2.2). Future Internet technologies will enable the necessary advanced and secure information exchange between these entities, and will also influence the business processes used to achieve the goals mentioned previously.

2.2 Transport Phases

The planning and replanning module must consider all elements that are typically part of a door-to-door transport chain planning process. The FInest project has defined four phases in freight transport that are generic; marketing and sales, planning, execution, and completion where the alignment of information between the phases is central.

Figure 3 Four main phases in freight transport

Examples of the types of information within each phase are as follows (a list of relevant information elements are summarized in Appendix B):

- **Marketing and sale** of services
  - Service category and type (truck services, terminal services, sea services, etc)

  - Operation areas (location or district that the service should cover)
  - Environmental profile of the service
  - Service capacities such as weight restrictions, dangerous goods limitations, availability
  - Price information regarding the transport services
- **Planning** of a transport chain
  - Selection and negotiation of transport services to be included
  - Quotation, pre-booking and booking of services
  - Contracting with the service providers and with the customs
  - Reservation of place on the transport mean(s) or load units to be used
  - Definition of transport items (goods to be transported)
  - Split and joint booking activities
  - Stuffing and stripping activities
  - Transport chain composition
- **Execution**
  - Monitoring of progress and status reporting
  - Status information and deviation reporting
  - Deviation management
  - Information reporting to authorities
- **Completion**
  - Proof of delivery
  - Invoicing
  - Claims and deviation management
  - Contract performance evaluation

Information generated in each of the phases is critical regarding planning and replanning activities. The challenge is how to obtain the information listed here and to make sure that this information is reliable and up to date, available when needed and available to all relevant stakeholders while at the same time minimizing the costs of obtaining and using the information properly. Some of this information will also be regarded as business critical and not readily shared.

2.3 Planning Levels

Different types/levels of planning can be used in different phases such as the tactical, strategic or operational planning of a transport.

Figure 4 shows how the different levels of planning (tactical, strategic, operational) relate to the transport phases (Figure 3).

- **Strategic transport planning** is the long term planning of transport activities in line with the overall organisation's strategy. It consists of network design, investments in assets and resources, strategic partnerships with suppliers and customers, and the development of specific communication channels between partners.
- **Tactical transport planning** is the determination and scheduling of the short-term activities required to fulfil the objectives of the strategic plan. It consists of sourcing contracts, resource allocations, routes and schedule plans, as well as performance and customer relationship mangement.

- **Operational transport planning** is the management of daily transport operations. It consists of responding to customer demands, coordinating transport services and engaging necessary resources, and following up on transport services in real time.

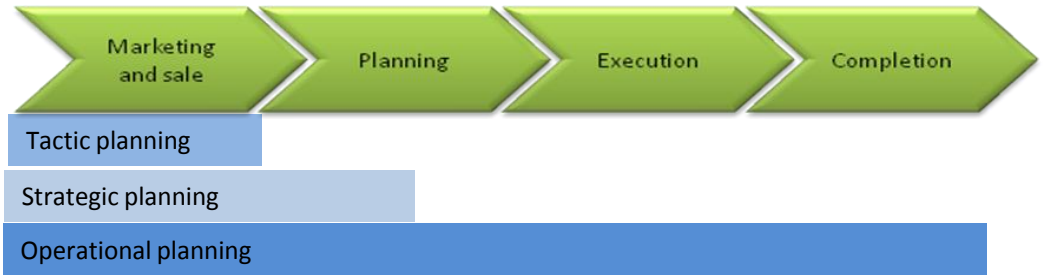

Figure 4 - Different levels of planning related to the transport phases

Related to these planning levels are the different types of execution alternatives. One alternative could be scheduled transports where the transport service executes in a regular manner at predefined times, another alternative would be spot transports where the transport approach is decided based on the immediate requirements of a Logistic Service Client.

The primary focus within the FInest project will be the operational plan using scheduled transports, but spot market transports may be used when replanning activities occur.

2.4 Roles in Transport

In FreightWise [1] and eFreight[2] a set of roles relevant for transport activities were defined to develop a clear picture of involved stakeholders, and to ease the description of transport processes and related information components. These roles where added to the EU's common framework [11] on transport and will be used in FInest as well.

The roles derived from the Freightwise and e-Freight projects are:

1. **Logistic Service Client (LSC)**
   - The Logistic Service Client is the role representing anyone that searches for logistics services; books logistics services and follows up on the execution of logistics services. The Logistic Service Client also provides the Logistic Service Provider with instructions and detailed information about the logistics units and cargo to be included in the logistics services.
   - A typical LSC actor could be a Cargo Owner.
   - This role is highly relevant for the TPM since it provides the transport demand.
2. **Logistic Service Provider (LSP)**
   - The Logistic Service Provider is the role that plans, markets and executes logistics services. The requirements for the services are collected from the Logistic Service Client. The Logistic Service Provider communicates with the Transportation Network Manager and the Transport Regulator during planning and execution of the logistics services. The Logistic Service Provider has the

responsibility of providing the Logistic Service Client with status information during the execution of the transport services.
    - A typical LSP could be a Shipping or Trucking company, a Forwarder, or a Stevedore.
    - This role is directly relevant for the E-contracting module (ECM) since this module is used in the marketing of transport services.
    - For the TPM, the ECM will provide the voice of the Logistic Service Provider, since the ECM will specify the contractual requirements for the transport services.
3. **Transport Regulator (TR)**
    - The Transport Regulator is the role that receives all mandatory reporting (and checks if reporting has been carried out) in order to ensure that all transport services are completed according to existing rules and regulations. The Transport Regulator has the responsibility to do the necessary clearance of the goods.
    - A typical TR could be Customs or the Coast Guard.
    - This role is directly relevant for the Event Processing Module (EPM) since transport regulators may receive events from the EPM.
    - For the TPM, this role is relevant through the definition of triggers related to transport execution plans. For instance, triggers may be defined in a transport execution plan saying when to report to an authority and what to report.
4. **Transportation Network Manager (TNM)**
    - The Transportation Network Manager is the role that extracts all information available regarding the infrastructure (static or dynamic) related to planning and executing transport and makes this information available to the Logistic Service Provider.
    - A typical TNM could be a Traffic Centre, or Metrological Provider Centers.
    - This role is directly relevant for the Event Processing Module (EPM) since actors playing this role will feed the EPM with events.

In the TPM, the users representing transport demand and legacy systems play the **Logistic Service Client** role (see left part of Figure 16). The Logistic Service Provider role is fulfilled by information from the ECM since this module is used to support the marketing and sale of services and also contract handling. Both the Logistic Service Provider role and Logistic Service Client role will query the BCM for status information on the execution of the transport activity.

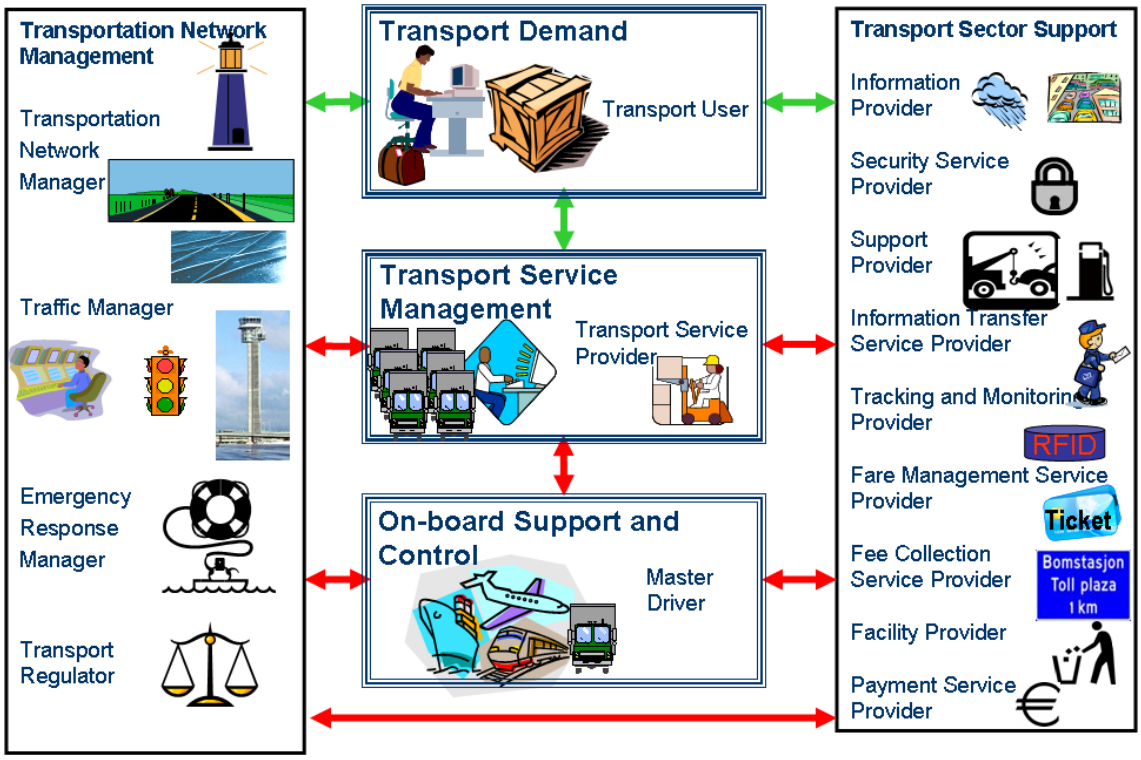

Figure 5 ARKTRANS Reference Model [13]

Figure 5 shows how these four roles relate to the ARKTRANS reference model [13]. The transport user role in ARKTRANS is similar to FInest Logistics Service Client, while Transport Service Provider is similar to FInest Logistics Service Provider. The ARKTRANS model has been used as the basis in several projects including FreightWise [1] and eFreight [2].

2.5 Planning Processes

The interaction process between the different roles is a complex process where agreements, processes, as well as information standards are critical to a successful outcome. Figure 6 describes the Process Viewpoint where interactions between the roles are explained. This is taken from eFreight[2], which has described three transport phases: Planning, Execution and Completion. In eFreight, the Marketing and Sale phase is integrated in the planning phase.

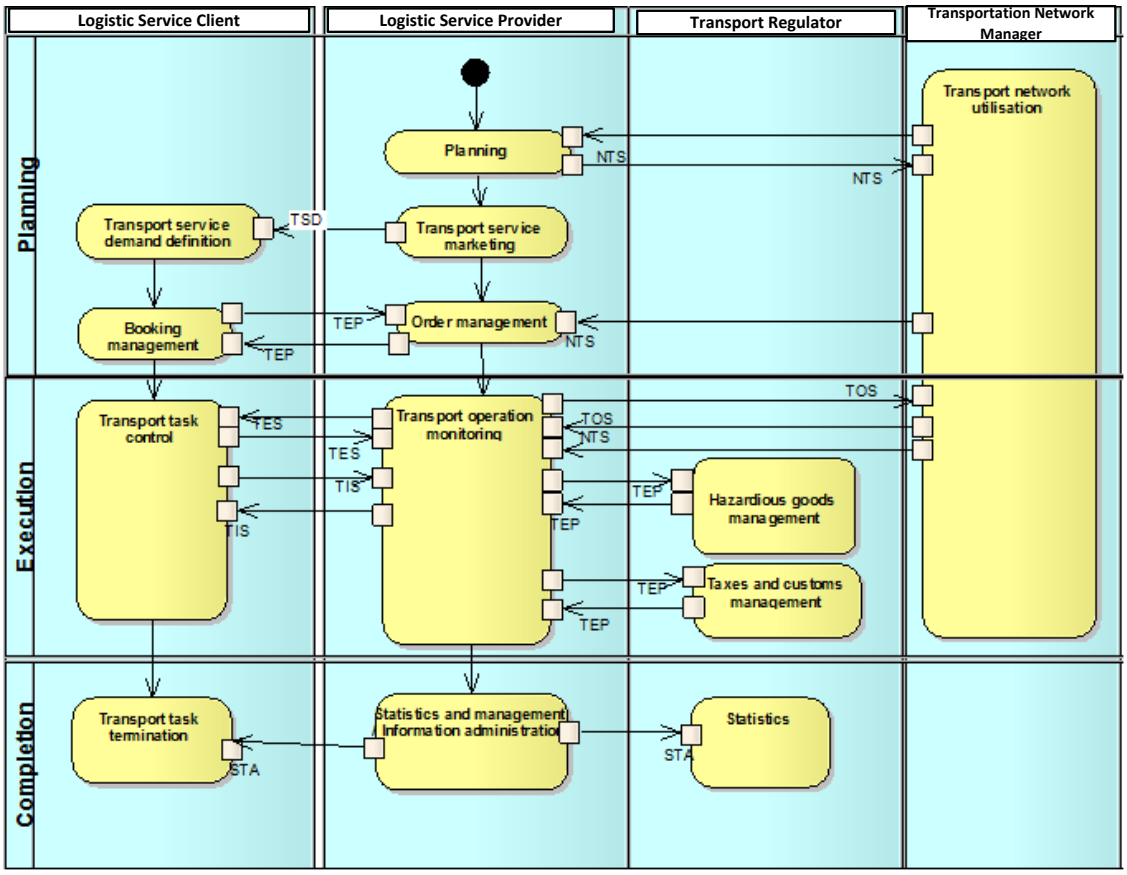

Figure 6 - Process diagram

The process viewpoint describes the overall processes that take place during the main phases in transport activity: Planning (including marketing and sale), Execution and Completion. The process viewpoint is depicted by means of activity diagrams, and shows the four roles involved, the functions to be performed by each of the roles, as well as the exchange of information (by means of information packages) between the roles.

Figure 7 gives a more detailed view of the processes needed to be performed during the planning phase. For each branch shown there exists the need to exchange information, or to execute a service that can help with the specific process.

Figure 7 – Transport planning processes

Planning can be done from different perspectives, and there are different requirements for services that can assist in a planning operation. The FInest project will utilize the planning services shown in Figure 8 following.

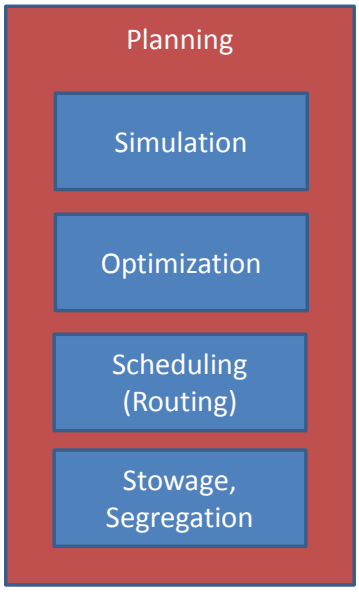

Figure 8 - Planning activities

Figure 8 shows four activities of the planning process that are considered to be relevant in FInest. These activities are described as follows:

1. *Simulation* in transport planning consists of calculations based on models for a transport service description. A simulation series usually includes stochastic variables and events that bring in uncertainty aspects to the model (e.g., weather or traffic situations for freight transport). In the TPM this results in proposing several transport service descriptions (TSDs) for a transport demand to account for the uncertainties.
2. *Optimization* refers to methods that are used to find the best transport services within given constraints and a given weighting function. In order to find the optimal plan in reasonable time, good algorithms and considerable computing power is necessary. In order to generate a useful set of transport service descriptions, some simple optimization needs to be built into the TPM, but it is not envisioned that the Transport Planning Module will have a very powerful optimizer. The Transport Planning Module should, however, be able to interface with external transport optimizing tools. In the TPM, optimization results in selecting a set of transport services to be used to fulfill the transport demand. The TPM may use external optimization tools to support this selection.
3. *Scheduling and routing* are methods for finding a good schedule (e.g., the terminals that should be visited and the order of visits) and a good route (the best way of getting from one terminal to the next). The focus here is in the planning of transport equipment activities.
4. *Stowage and segregation* refers to the actual placement of cargo on the cargo carriers with requirements that certain cargo items should be segregated (typically when hazardous materials are transported). The focus here is on the planning of the efficient loading and operation of transport equipment.

The objectives in FInest are not to develop all relevant support applications for transport planning, but rather the development of a system to compose a Transport Execution Plan that covers the entire transport chain from door-to-door. For the TPM, simulation and optimization, as required for operational execution activities, is directly relevant and will be handled by the Transport Planning Engine (Figure 16). Scheduling and Routing is indirectly relevant for the TPM since the TPM will not focus on the planning of transport equipment activities. However, the planning and replanning done by the TPM will give valuable input to this type of planning by creating and maintaining transport execution plans. Third party systems dealing with the planning of transport equipment activities (proprietary vehicle routing systems, etc.) will receive statuses on the transport execution plan's execution from the BCM. For similar reasons, the TPM will not address stowage and segregation activities, which will be managed through equipment operator systems.

2.6 Information Elements

The activity diagram in Figure 6 shows the requirements for information exchange between the roles. The individual information elements are grouped in information packages as follows [1]:

TSD – Transport Service Description

This is the information that any Logistic Service Provider needs to communicate to Logistic Service Clients (potential clients) such that they may use the information about the service provided when the transport demand has been established. This is an attempt to define a standard way of describing transport services such that they will be "searchable" and such that individual services may be automatically connected in transport (supply) chains. A TSD is relevant when describing the interaction between the TPM and the ECM (Figure 16).

TEP – Transport Execution Plan

This contains all the information needed for a Logistic Service Client and a Logistic Service Provider related to the execution of a transport service. A Transport Execution Plan can be developed through several steps, or it can be created in a single step. How the TEP is developed depends on the agreements already in place between the Logistic Service Client and the Logistic Service Provider and the complexity of the service to be executed. The execution of a service can start when the Transport Execution Plan is marked "Ready for Execution". A Transport Execution Plan is identified by a unique identifier, valid for the relationship between a given Logistic Service Client and a given Logistic Service Provider.

In many cases a TEP will be needed to come up with a travel plan for the Goods Items that are transported, and not only the transport services that are involved. The Goods Item Itinerary (GII) provides this capability and the planned, estimated, and actual times for departure and arrival for each service, or segment is included. This means that information in the GII may later be used to trace the exact movement of goods through a supply chain.

A Transport Execution Plan (TEP) is relevant when describing the interaction between the TPM and the BCM, and also as a basis for storing information for the transport plan (Figure 16).

TES - Transport Execution Status

The Transport Execution Status information package gives the status of a Transport Plan. Further investigation is required to see how this message can be used in the communication between the TPM and the BCM.

NTS - Network and Traffic Status

Network and Traffic Status is the status message published by a Traffic Manager. It is information about the condition of network infrastructure (such as an icy road), about traffic conditions, traffic incidents and weather information. Further investigation is required to determine how this message can be used in the communication between the TPM and the BCM.

TOS - Transport Operation Status

Transport Operation Status (TOS) is a status report given by a Traffic Manager to a Logistic Service Provider. The Logistic Service Provider requests the Traffic Manager to provide status information on a transport vehicle, using the vehicle identification number. The Traffic Manager then provides status information to the Logistic Service Provider. Further investigation is required to determine how this message can be used in the communication between the TPM and the BCM.

TIS – Transport Item Status

Transport Item Status (TIS) provides the status on the level of the individual items being transported, which means it provides information on whether a transport item has arrived at a location, as well as the condition of the transport item. Further investigation is required to determine how this message can be used in the communication between the TPM and the BCM.

The Marketing and Sale Phase[2] starts when the Logistic Service Provider carries out the operational planning for its services and then informs the market about the services offered (i.e., publishes the services available to Logistic Service Clients). Logistics Service Clients use this information to select potential LSPs for their transport operations. The TPM is used in this phase to generate the information (Transport Plans) upon which quotations are based and LSP selection is made. In the simplest cases the Transport Plan will be exchanged once or twice, while in more complex cases it will be exchanged many times through a set of steps in a defined process. The process of establishing a Transport Plan also includes the exchange of instructions, like handling instructions for the goods, as well as detailed information about the contractual terms and conditions between a Logistic Service Client and a Logistic Service Provider. It is also likely that a Logistic Service Provider requests and receives information about the infrastructure from a Traffic Manager so that this information can be used during the Marketing and Sale Phase.

The Planning Phase begins when a contract has actually been awarded. A TEP is developed for the goods that the LSC offers for transport. Information concerning infrastructures are obtained from Traffic Managers along the various alternative routes to ensure that the most current information on the route is available for the planning system. The Planning Phase ends when the Transport Plan is marked “Ready for Execution.”

The Execution Phase begins when the Transport Plan is marked “Ready for Execution”, and ends when the Transport Execution Status is marked with “Completed” or “Cancelled”. In this phase the status of the Transport Plan and the goods or load units to be transported are

[2] Note that in this section the FInest four phase approach to goods movements is used, not the three phase approach developed in the eFreight project and depicted in Figure 6.

exchanged. Handoffs between service providers are monitored as are sevice levels and performance indicators.

The Completion Phase begins when the TES is marked as “Completed” or “Cancelled.” During the Completion Phase “proof of delivery” documents or information is collected, damaged goods processes executed if required, invoicing and collections activities and freight auditing activities performed. The Completion Phase ends when all “after delivery” activities have been completed to the satisfaction of all parties to the original TEP.

2.7 Relevant Projects and Standardization Bodies

2.7.1 Identified Relevant Projects

There have been many projects during the past few years that have focused on the logistics transport domain. Some of them have developed relevant information for FInest, others are interesting, but not as relevant for the Finest project. The following table contains identified projects that are relevant for FInest and points to the relevance of the work to that which is being performed in FInest.

Projects/Concept/Standard

Projects	Identified planning and replanning activities of importance for WP7
eCoMove	The eCoMove project[3] targets three main causes for avoidable energy use by road transport, i.e. inefficient route choice, inefficient driving performance, and inefficient traffic management and control. The route planning and fleet management parts of the project may be of interest to the transport planning work in FInest.
eFreight	The eFreight project may be considered a continuation of FREIGHTWISE and will provide an eFreight platform supporting the design, development, deployment and maintenance of eFreight Solutions which will be validated in business cases and pilots involving representatives from all relevant stakeholders in surface transport including large and small businesses and authorities. eFreight deals with Framework, Single transport Document and Single Window. The Framework that is developed in eFreight will be of importance for the FInest project, as well as standards and new transport documents.
GOODROUTE	GOOD ROUTE [4] aims to develop a cooperative system for dangerous goods vehicles routing, monitoring, re-routing (in case of need), enforcement and driver support, based upon dynamic, real-time date, in order to minimize the Societal Risks related to their movements, whereas still generating the most cost efficient solution for all actors involved in

Projects	Identified planning and replanning activities of importance for WP7
	their logistic chain. The routing module is of interest for the FInest work.
PLANTCockpit	PLANTCockpit is an FP7 project aimed at visibility and optimization of manufacturing logistic processes. Research results of the PLANTCockpit project might provide production supervisors, foremen, and line managers with the required visibility to make well-informed decisions to optimize plant processes. This includes the holistic visibility of the plan, the current status, deviations, exceptions, and bottlenecks. PLANTCockpit will suggest a model for integrating heterogeneous shop floor management systems including ERP, MES, SCADA, condition-based maintenance, energy management, and other special-purpose systems.
SMARTFREIGHT	The SMARTFREIGHT project wants to make urban freight transport more efficient, environmentally friendly and safe by answering to challenges related to traffic management, freight distribution management, and a better coordination between the two. The main aim of SMARTFREIGHT is therefore to specify, implement and evaluate Information and Communication Technology (ICT) solutions that integrate urban traffic management systems with the management of freight and logistics in urban areas. The actual transport operations carried out by the freight distribution vehicles will be controlled and supported by means of wireless communication infrastructure and on-board and on-cargo equipment. Wireless communication solutions will be of importance for FInest. This can also be used in a dynamic planning setting.
SUPERGREEN	An EU project entitled “Supporting EU’s Freight Transport Logistics Action Plan on Green Corridors Issues” (abbreviated name “SuperGreen”). It is a 3-year project started in 2011, and is a Coordinated Action supported by the European Commission (DG-TREN) in the context of the 7th Framework Program. The purpose of the project is to promote the development of European freight logistics in an environmentally friendly manner. Environmental factors play an increasing role in all transport modes, and holistic approaches are needed to identify ‘win-win’ solutions. For FInest the planning elements in green corridors will be relevant. Questions of relevance will be; how to plan a green corridor, what emission parameters is available, and how this can be done in an intermodal aspect.
Freightwise	FREIGHTWISE [1] was an EU funded project under the 6th Framework Program (6th FP) for research and development that was completed in April 2010. FREIGHTWISE built on (and contributed to) ARKTRANS, developing a simple, standard framework for information exchange in co-modal transport that may be implemented at a very low cost. • Standard Information Objects related to transport planning and replanning

Projects	Identified planning and replanning activities of importance for WP7
	• Generic set of roles related to transport planning and replanning (ARKTRANS) • A Framework for intermodal goods transport Freightwise and eFreight gives important information to the domain studies, as well as can be used to identify requirements to Future Internet.
DynKo	The aim of the project „Dynamic Consolidation“ (DynKo) – *funded by BMBF/EffizienzCluster LogistikRuhr, Germany* – is the provision of logistic concepts for the introduction of flexible (dynamic) connections in rail freight traffic – especially for the connection from Duisburg, Germany, to Moscow, Russia. More precisely, DynKo aims at the provision of a logistic concept that enables the organization of parallel running trains with dynamic consolidation. This concept has to consider a multiplicity of problems, such as various technical and legal general preconditions and requirements. Some of the relevant objectives from the DynKo project are • Flexible route planning according to volume of cargo and desired destinations (including difficult issues like different track gauges and customs clearance) • Dynamic planning of block train consolidation (origin, sequence, destination) Dynamic replanning in case of delays and unscheduled events (countermeasures) is of relevance for FInest.
OrGoLo	The project "Organizational Innovations with Good Governance in Logistics Networks" (OrGoLo) – *funded by BMBF/EffizienzCluster LogistikRuhr, Germany* – aims to add the novel dimension of so-called "supply chain governance" to the conventional supply chain management that is otherwise mostly affected by purely economic and transport-related aspects. This governance perspective claims to enable a responsible design of international supply chains with special consideration of company external requirements and stakeholder interests (following a common view of all participants of the network. This design should be effective and efficient not only from an ecological but also from a „good governance“ point of view. The project have come up with some objectives such as: • Planning for the alignment with a global optimum of a logistics problem (“supply chain governance”) instead of local optimization (e.g. only from an economic point of view) • Planning based on adaptive knowledge management tools using case-based reasoning and on the knowledge saved on a web 2.0 collaboration platform offering various assistance systems • Planning and configuration of international supply chains considering the special requirements of SMEs and the respective national features (re. politics, legislation, economics and society)

Projects	Identified planning and replanning activities of importance for WP7
	Planning of supply chains and the collaboration platform are of relevance for FInest.
SCP	The objective of the project "Logistics-as-a-Service: Supply Chain Planning" (SCP) – *funded by BMBF/EffizienzCluster LogistikRuhr, Germany* – is the development of new methods and tools for the support of planning tasks in logistics in order to attain a quicker and better control of the entire supply chain. For that purpose, universally applicable solution components are to be developed for the operative planning in supply chains and to be made available in a solution kit called 'plug & plan suite'. Being configurable services, these components can be combined with merely minor adaptation efforts to a customized Logistics Assistance System (LAS) for supply chain planning purposes. • Support of logistics planning and decision-making in a highly dynamic, international environment by means of a Logistics Assistance System, which lead to a higher demand for (constant/regular) replanning • Development of new planning methods, concepts and tools considering new market developments and novel technologies (plug & plan suite) • Approach of decentralized and conjoint planning for attaining optimal processes throughout the supply chain network New planning methods emphasising the whole supply chain and use of new technology is of relevance for FInest and the planning module.
ARKTRANS[12]	ARKTRANS is a joint effort by Norwegian transport authorities (the Public Road Administration, the Norwegian State Railways, the National Rail Administration, Avinor, and the Norwegian Costal Administration, and representatives for transport users and providers of transport services). ARKTRANS addresses the coordination and harmonisation of services for multiple transport modes as well as services for freight and public transport. ARKTRANS is used in developing the Use Case Methodology in the FInest project and constitute a framework describing the domain, including all relevant roles in transport operations.

There are different models related to specification of transport planning for different transport segments (train, road, sea, intermodal, oil transport, wood transport, container transport, air transport, passenger transport etc). Some domains or transport segments are using domain specific tools for transportation planning, while others are focusing more on the intermodal side. Some tools are tailored for public and regulator needs while others are focusing more on commercial activities.

The projects and concepts presented above represent "state of the art" in research within transport and logistics. Development and design of the planning and replanning module will

build on these projects where it is of relevance for the module. The strategy is to use and combine existing knowledge in a new way in the design of the module.

2.7.2 Identified Relevant Standardization Bodies and Concepts

In Appendix A some relevant international standardization bodies and concepts are listed. Some of them are highly relevant for the FInest project, others are interesting, but not directly relevant to the project

3 Overview of Transport Execution Plan

This chapter gives more details on transport execution plans. Section 3.1 describes several sources of information that should be taken into account when composing a transport execution plan. Section 3.2 describes how transport execution plans relate to service descriptions, how several transport execution plans are composed to form a transport chain plan, and describes the visibility of transport execution plans throughout the hierarchy of Logistic Service Clients and Providers.

3.1 Transport Execution Plan Purpose

The state of the art in transport planning focuses on the seamless provision of information on the state of a shipment to any stakeholder requiring such information. One of the potential weaknesses in the state of the art approach is that by providing transparency in supply chain operations “levels the playing field” and this levelling may actually inhibit the acceptance by certain players of new technologies. Therefore, the Finest project is seeking to maintain the business models of the stakeholders while enhancing the effectiveness and efficiency of how they operate their business through the provision of virtual collaborative arenas for conducting parts of the planning and replanning activities.

Future Internet technology provides opportunities for integrating and distributing information in a wider context, through increased use of sensor data and enhancing the information content and contextual alignment of this data. Enhanced content from sensors requires intelligent agents that are able to adapt to context. However, one of the most promising features of the Future Internet is its ability to integrate people more directly into the information enhancement process. This approach to directly injecting people into the process is being pursued through virtual collaboration arenas and through the creation of virtual business process flows that cross corporate boundaries. This approach requires creation of standardised service definitions, similar to web services but extending into business processes.

Creation of virtual trading areas where resources can be traded efficiently is one of the main features of the Future Internet that is being pursued. These areas require a secure trading place, and possibly standardised rules for trading, not unlike those developed for stock trading

robots, but more complex as the level of constraints for contract closure is more complex. This functionality will also require human intervention and, therefore, the availability of distributed services for operators is essential. Distributed services, like smartphone apps in the world of mobile telephony, is mandatory to avoid relying on the installation of system components at every end-user location.

The FInest approach will be to demonstrate services that allow transport and logistics operators to make existing processes more efficient and to open up new ways of performing business in the future. One of the modules needed to reach such an ambitious goals is a planning and replanning module that covers required functionality for the stakeholders involved in a transport chain.

To develop a good and efficient transport execution plan one can not only satisfy in-house needs. The plan should also consider inputs that are coming from other stakeholders in a planning step. Three other primary "stakeholders" are identified as:

Traffic and infrastructure management stakeholders: These sources of information provide relevant information from traffic management networks and traffic information systems. Some of these sources of information will be public domain players such as the road authorities, but some will also be private service providers (weather information, AIS-network, etc).

Transport management service stakeholders: These include all commercial and market players that can be, or are, included in a transport chain. Examples of such stakeholders are shippers, forwarders, operators and maybe agents.

Regulatory/administrational stakeholders: These stakeholders provide information on regulated activities such as customs information (clearance), border crossings, hazardous cargo, as well as safety and security issues.

To have a good and reliable plan, an interaction between these sources of information must be in place. This is not the case of today [6]:

- Business integration in transport planning and execution is not fully achieved (especially within intermodal transport)
- There is little intermodal transport chain thinking, the normality is from a modal perspective
- Infrastructure information is not available (or limited)
- Business process thinking is not yet commonplace
- Standards are missing or are developed from a sector perspective that do not cover intermodal aspects
- Electronic interaction with administrative bodies is still at a limited level

Any state-of-the-art planning and execution service should be designed to include many stakeholders and domain areas. From the work performed in the Freightwise project, four different roles have been identified that should be considered (Section 2.3). Each role can be played by different actors. However, one actor could also play several roles, i.e., it is normal

that a logistic service provider (e.g., a trucking company) offers a solution to a logistic service client (e.g., a cargo owner) and then the logistic service provider changes its role to a logistic service client when it buys services from other logistic service providers to fulfil its obligations to the logistic service client.

In order to make sure relevant requirements from the users of the planning module are completely identified, there will be several iterations of requirements gathering from the transport industry partners in the FInest consortium as well as from external providers.

3.2 Transport Execution Plan Composition

The main purpose of the TPM is to handle transport demands by proposing several possible transport execution plans, and to support the selection of the best plan based on some optimization criteria. Through this, the TPM will support simplification of planning, execution, and following up on Transport Execution Plans between a Logistic Service Client and a Logistic Service Provider.

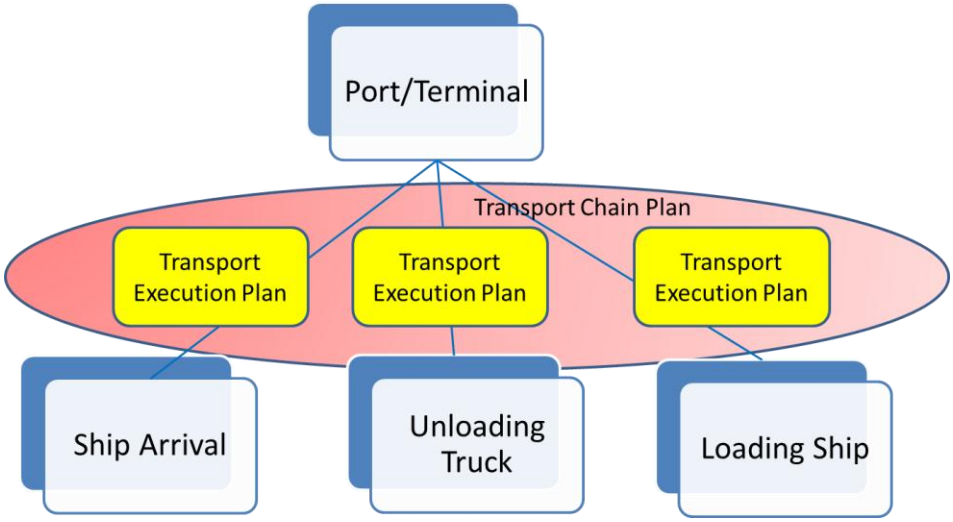

Figure 9 Transport Execution Plan (TEP) and Transport Chain Plan (TCP) Example

Figure 9 shows how three transport plans are collected to form a transport chain plan. In this example, a port offers a 'Port Call' service containing Ship Arrival (berth allocation, etc), Unloading truck (unloading of goods) and Loading Ship. The port has a transport execution plan with each of the three service providers in the port.

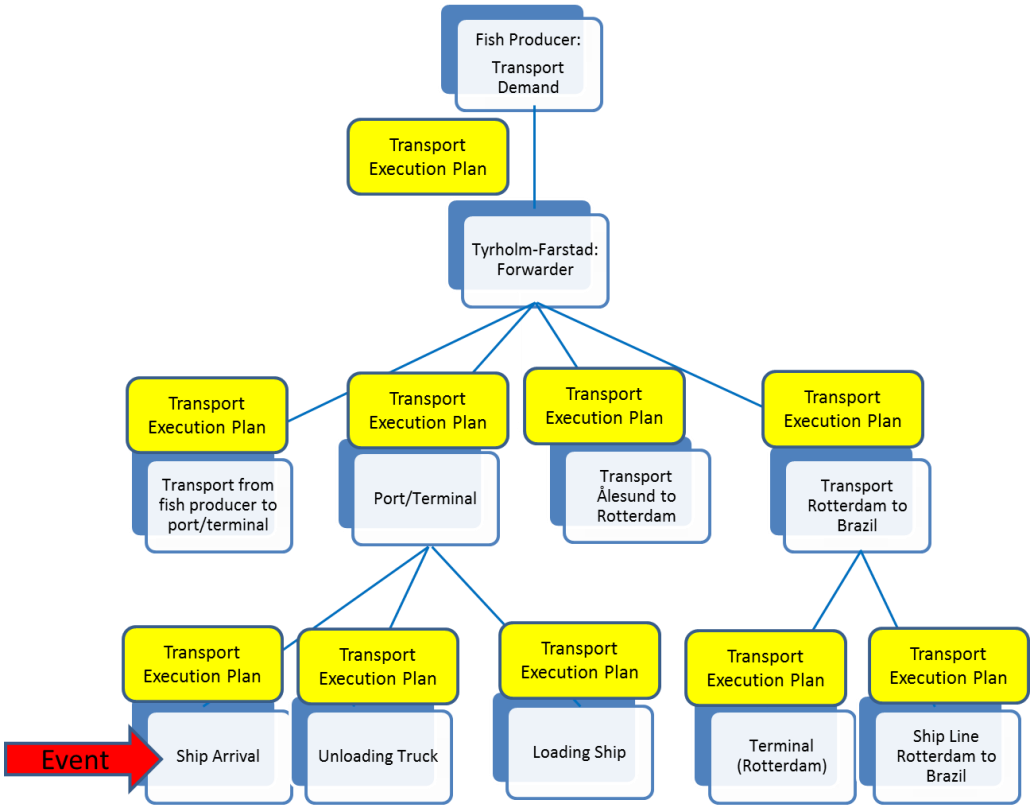

Figure 10 Transport Plans and related Event

Figure 10 shows how the transport execution plans can be viewed as being a hierarchy with respect to events. When an event occurs and a trigger is activated, this may not only affect one transport execution plan, but several others in the hierarchy. For instance, a late ship arrival will affect the transport execution plan that is set up between the port and the responsible quay. However, it may also affect the transport execution plan regulating the unloading and loading of the ship. Sometimes replanning can be done with no further propagation of changes. In other cases, the event will propagate up and down again in the hierarchy. In this example, it may affect the transport execution plan related to the port call in Rotterdam if the ship is not able to reach its time slot.

The Logistic Service Client's main role is to define the transport demands and to request services needed to execute the transport from door-to-door while using a chain management tool to organise the different steps. The development of a complete chain management tool is not a part of the FInest project. Rather, the project is focused on identifying the requirements for a planning and re-planning module that will play an important role in collecting and distributing transport plan information in an efficient and transparent manner.

In some cases the Logistic Service Client is buying services from, e.g., a Freight Forwarder that might organise parts of the transport chain. If the Freight Forwarder is building up their service based on multiple outsourced services, they are then changing their role to the role of a Logistic Service Client for those services they are putting together from other Logistic Service

Providers, and the role of a Logistic Service Provider when they are talking to their customer, the Logistic Service Client (Figure 6).

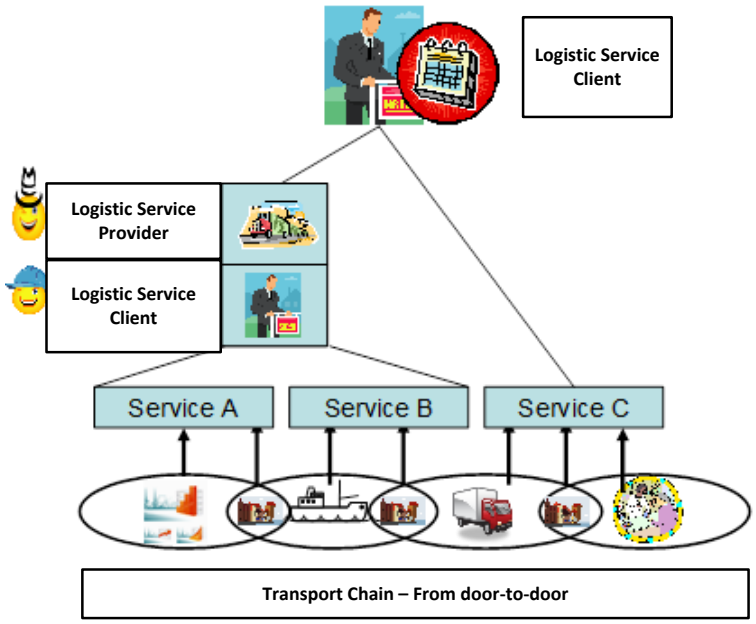

Figure 11 - The Transport chain

The transport planning module will create a transport execution plan (TEP) for each of the services A, B and C. To be able to hide details of the contracts and the transport, the top level Logistic Service Client will only know of transport execution plan C, in addition to the transport chain description composed of the services A and B. The top level Logistic Service Client will not know details of transport execution plan A and B.

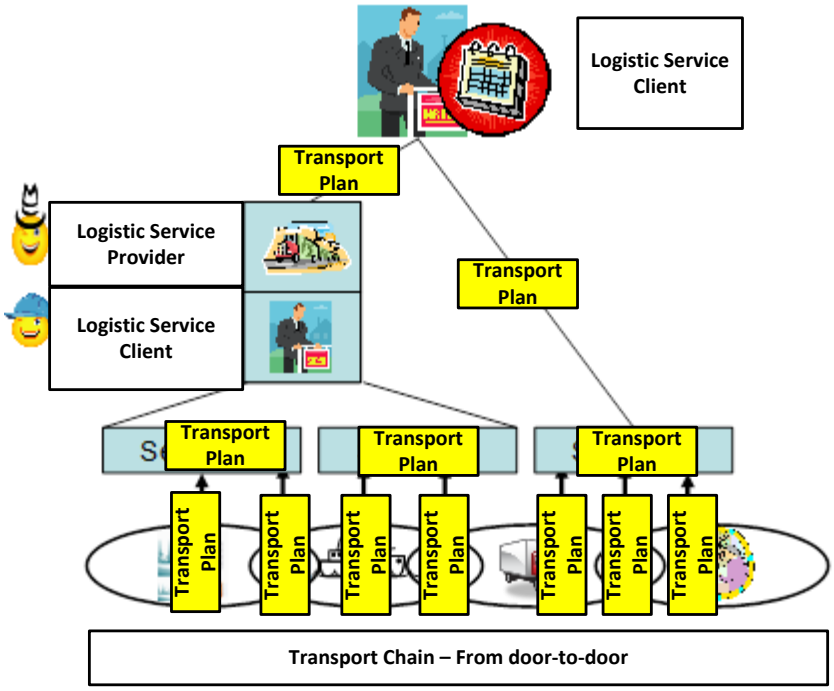

Figure 12 - Multiple Transport execution plans in a total supply chain[3]

Figure 12 expresses the typical hierarchical structure of a supply chain. A TEP refers to one contract between a Logistic Service Client and a Logistic Service Provider; the TEP can be composed of multiple lower-level TEPs, and so on. The individual TEPs are, therefore, composed in a hierarchical manner to a complete transport chain description.

4 Planning/Replanning Requirements from Case Studies

4.1 Transport Planning in the Use Cases

Work Package 2 in the FInest project is concerned with mapping and specifying the three use cases for the FInest project: Sea transport of fish, Air transport of equipment, and Transport of consumer goods, Figure 13, Figure 14 and Figure 15.

[3] Transport Plan in the figure is the same as Transport Execution Plan.

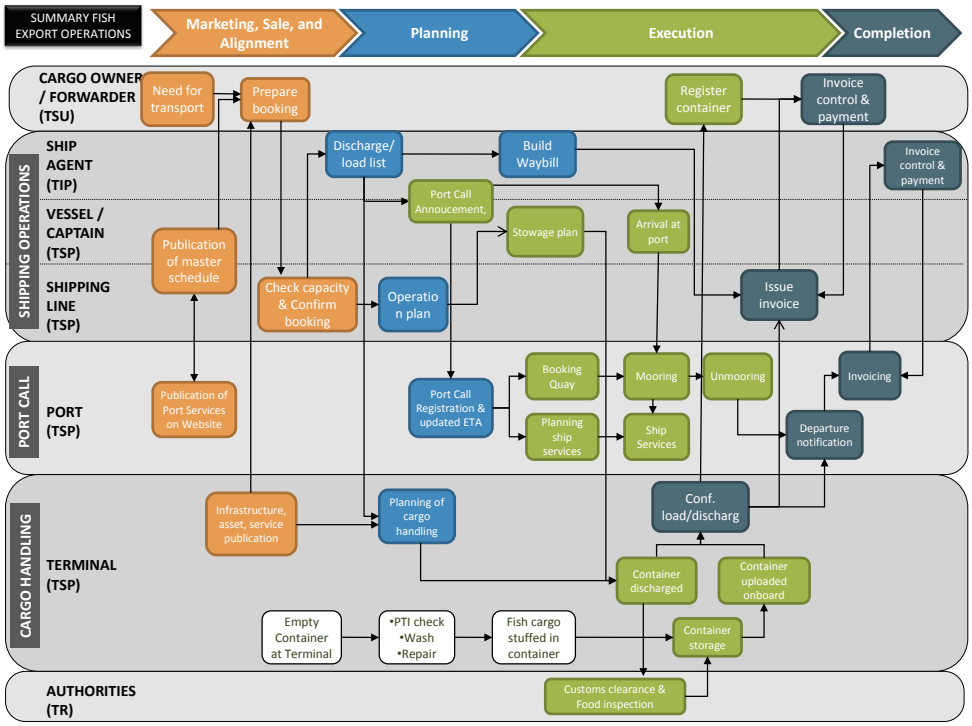

Figure 13 – Example of as-is processes within the fish case

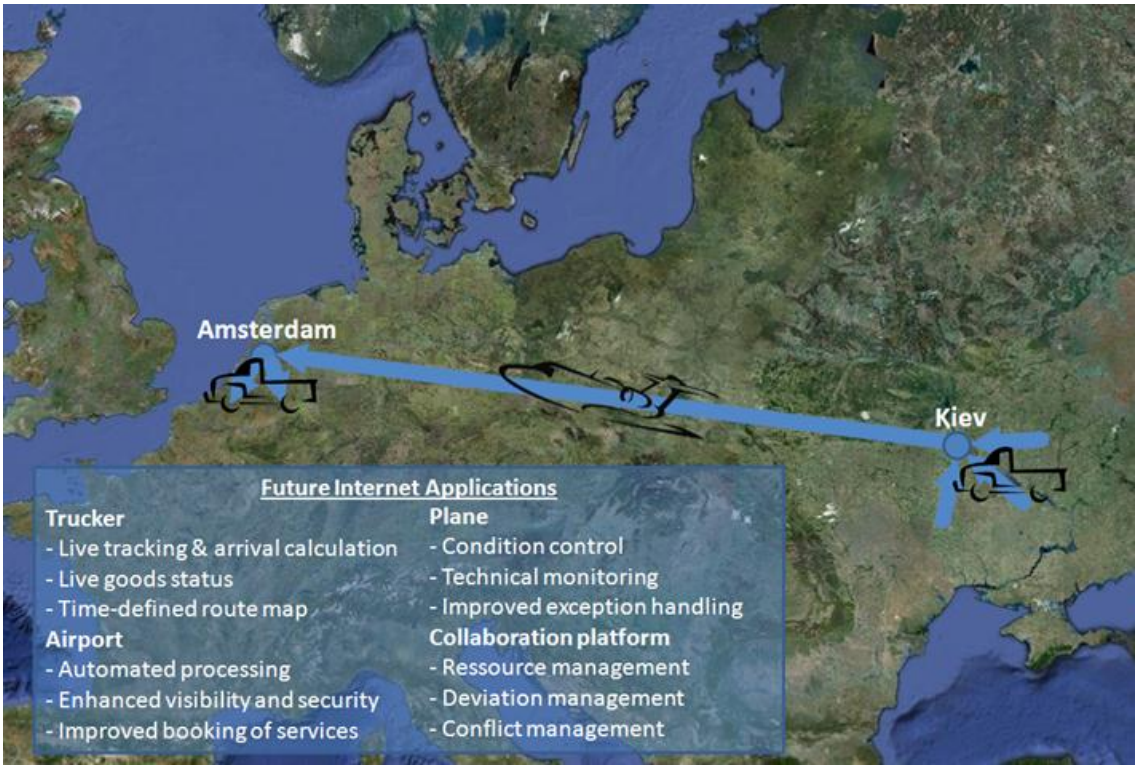

Figure 14 – Example of as-is processes within the air transport case

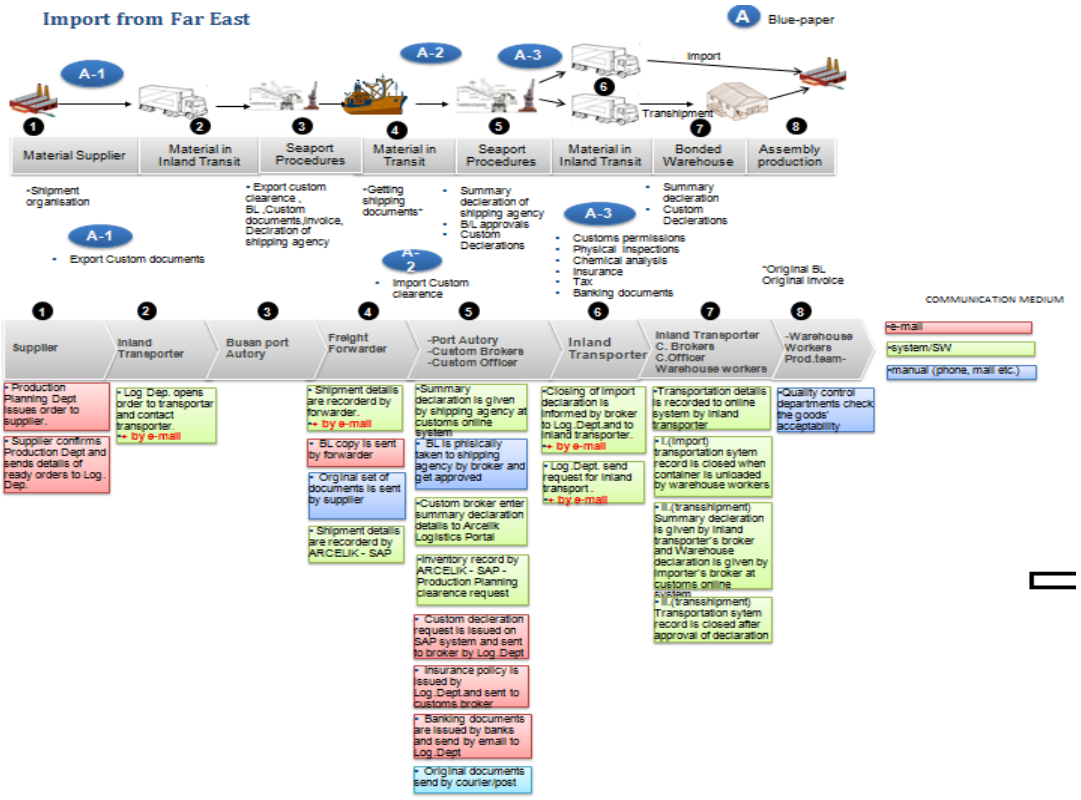

Figure 15 - Example of as-is processes within the consumer goods case

The aims of this mapping process have been to identify requirements to be covered by Future Internet. The three use cases are from the fish industry (mainly maritime transport including terminal handling), the air cargo sector where transport of equipment has been the focus, and the final use case where transport of consumer goods is covered. For all three use cases the team has identified business processes as well as information exchange between involved stakeholders. From these identified activities the team will generate requirements for enablers that are important in a planning and replanning service.

The second deliverable from the use case work [7], written concurrently with this deliverable, presents a high-level mapping of the use cases, showing the as-is situation of the processes necessary for transport in the three use cases, as seen from the viewpoint of the FInest consortium's industry partners. The high-level descriptions also contain descriptions of relevant challenges in today's processes, as well as some envisioned uses of Future Internet technologies.

While the current results from the use case studies bring little concrete results to the technical work (the next deliverable in the use case work will bring in a more detailed view with more concrete examples on the envisioned use of new technology) the use cases stress the need for good planning and replanning tools and improved visibility of transport services, demands and status of transport execution plans. There are also other interesting points that should be noted and that will be useful for the transport planning work.

4.2 Visibility of Transport Services and Demands

Several of the use case partners publish, or wish to publish, their relevant services on their web pages. While some of the partners still are doing the web site updating manually, the studies show that an automatic link between the partners' own systems and the web sites are planned or wished for, so one can expect that an automatic publishing and updating of transport services based on plans made in the companies' internal systems will come fairly soon for most of the partners.

Seen from the transport users, a better overview of transport availability and capacity from different transport providers is considered important and is an expected outcome of the project. Properties of different transport alternatives, like schedules, price, and carbon footprint are considered important parts of this information.

For the service providers, the expected transport demand is a useful parameter for planning, and improved visibility and predictability of transport demand is wished for, especially in the sea transport scenario.

For the Transport Planning Module, the visibility of transport services and demands is important in order to make good transport execution plans. While information on transport services are published on each companies' web site, one can envision this information also being published in a standardized format for easy machine reading so that the planning module can use it when generating plans.

4.3 Visibility of Transport Execution Plan Status

Some of the studies point out deviations and challenges that arise due to the export or import clearance of the transported goods. Late clearance may result in late cancellations, which is a problem for the transport service provider. The clearance status and possible problems with clearance is not visible to all relevant stakeholders.

While the Transport Planning Module is not directly addressing challenges with export or import clearance, the studies point out that this is an issue that may result in deviations from the original plans and thus generate a need for replanning.

The lack of real-time tracking information is also an issue that has been pointed out. Again, this is not directly linked to the planning module, but it may give an early warning that a deviation will occur. An early warning of a deviation may give more flexibility when replanning.

4.4 Booking Process

If the planning module also performs the booking necessary for the execution of the plan, the use case scenarios showing the booking process is of interest. The studies show that today's booking processes often are e-mail and phone-based, thus a full automation of the booking process would require changes in the systems involved. If booking is part of the planning module it should be designed so that automated booking systems are supported, but it must also have support for a "manual" booking process when automated booking systems are not available from the service provider.

4.5 Summary of Use Case Requirements

This section gives a summary of most of the requirements for planning and replanning from the use cases as described in [7] and how they are handled by the TPM.

Requirements from Use Cases	TPM Relation
Centralized and improved exchange of information: right information, right time, easy access, higher coordination among all involved actors.	TPM may use standard information elements for instance for Transport Execution Plan and Transport Service Description. TPM may support collaboration during transport execution plan composition and optimization, especially related to replanning. TPM may define a Transport Chain Plan to achieve higher coordination between actors in a transport chain. Included in this is also increased automatization of information and documents (legal documents etc) exchange. The FInest project must also ensure secure transfer of information and documents.
A system adapted to current systems in place	TPM may support interfaces to third party systems. This includes integration with other data systems to reduce manual inputs. The 'Back End' component as described in WP3 [10] is the component that will facilitate the integration of external systems.
Online Booking	TPM may support transport service bookings during transport execution plan composition.
Improved predictability of market demand (Statistics, forecasts, market portal)	TPM can use information on stored Transport execution plans to aggregate statistics on actual market demands. This is not included in this phase of TPM development but will be considered in the next phase.
More automatization of information registration (reduced manual work)	TPM may lead to reduced manual work for instance by connecting the transport execution plan to a transport service booking system. The booking system will automatically give an overview of the resource situation relevant for a certain transport execution plan execution.
Resource and capacity overview and management (resource hub; one virtual meeting place for all actors)	TPM may provide interface to transport service booking system and integrate this in the planning/replanning process.
Increase transparency and enable flexibility (Networking/pooling could be a valuable	TPM may use the Transport Chain Plan to

strategy)	increase transparency during transport execution. An example is that an event that affects a transport execution plan early in the transport chain may affect later transport execution plans, and that these effects are described by meta information related to the transport execution plan and transport chain plan.
Facilitate Port Call and more flexible use of slot-time (need more coordination)	A overall goal for TPM is to improve planning and replanning and through this facilitate Port Call handling.
Improved handling of deviations; Better monitoring and immediate treatment of information (e.g PTI check)	TPM may relate a transport execution plan to events coming from BCM. Also, TPM composes a transport chain plan from a set of transport execution plans that will be used to describe the effects of an event on the whole transport chain.
Real-time tracking of container and vessels around the world.	Relevant for other modules than TPM.
Event-driven monitoring and tracking of logistic processes	TPM receives events from BCM and use this to track the logistic processes. Events are linked to triggers that may result in both handling of deviations but also in reporting (ad-hoc or periodically).
Collaboration manager (A standardized communication interface between all participants)	TPM may support collaboration during creation and management of transport execution plans, and also during optimization.
Pervasive RFID structures	This is relevant for the event processing module.
Real-time Tracking and Tracing	This is directly relevant for the event processing module.
Clear responsibilities	TPM supports clear responsibilities by defining user groups with certain access rights regarding functionality and information elements.
Need to access the right information	TPM may use FIware modules to ensure authentication and authorization of data access.
Re-planning of the routes when deviations from the plans	TPM may give information to Logistic Service Providers about possible events and how they may affect each transport execution plan contained in a transport chain plan.

A unique reference number which can be used to trace the materials/products and data associated with them through all the phases of the transport.	TPM must offer a unique and well-known identification of a transport execution plan.
Visibility on environmental carbon footprint and reduction of carbon emissions	TPM may handle environmental aspects by being able to define optimization criteria to be used when selecting the best transport execution plan.
Foresee possible bottlenecks & problems to take action on-time	TPM can be used to foresee possible bottlenecks and problems by offering statistical data on transport execution plans, for instance by giving data on which transport execution plans have been frequently replanned. This is not part of TPM in this phase, however, it may be considered in the next phase.

5 Initial Requirements Analysis for TPM

This chapter provides the initial analysis of requirements for the TPM. These requirements are summarized for each of the TPM components; the Interface Manager, Transport Planning Storage, and the Transport Planning Engine.

5.1 Initial Functional Requirements for the Interface Manager

The initial functional requirements for the Interface Manager are summarized as follows:

Id	Name	Description
R101	Definition of user groups	Support definition of user groups with the following associated information: • end users and systems, • access rights, • services, and • data artifacts. This requirement emerged from the use case work.
R102	Forward requests	Forward requests from users and systems to Transport Planning Storage and Transport Planning Engine

Id	Name	Description
R103	Interface to Business Collaboration Module, BCM	Send new transport execution plans to BCM and receive triggers to do replanning back from BCM.
R104	Interface to E-Contracting Module, ECM	Receive contract information from E-Contracting module and send contract information requests to this module.
R105	Provide acknowledgement	Provide proper response back to users and systems saying that their request will be handled by the TPM (acknowledgement for the request). Provide response to the other FInest modules saying that the request will be handled by the TPM module.
R106	Information validation	Check integrity and consistency of information given by end users
R107	Interface to Storage	Manage storing and retrieval of information from the storage

Note that authentication (identification of end users and systems) and authorization (definition of allowed operations for each user and system) can be performed by a GE in the Future Internet platform.

5.2 Initial Functional Requirements for Transport Planning Storage

The central requirement for the Transport Planning Storage is to handle information relevant to planning and replanning of the transport. It is important that the structure of this information is described according to a **common, conceptual object model** that all end users and systems must relate to. Each of the end users has their own external view of the object model that may be a subset of the conceptual object model. Internally, the Transport Planning Storage represents the conceptual object model as an internal object model, dependent of the object storing technology that is used.

The initial functional requirements for the Transport Planning Storage are summarized as follows:

Id	Name	Description
R201	Persistent and consistent object storage	Persistent and consistent storage of data related to the planning and replanning processes including standard read and write operations.

R202	Store transport execution plans	Store transport execution plans. A transport execution plan handles information related to a transport service participating in a transport chain.
R203	Store meta information on transport execution plans	This is event data and trigger values that have to be set on each transport execution plan. This information is used by BCM when sending notifications and handling events related to the transport execution plans.
R204	Store information on transport services	Store information on transport services: both the structure and the actual data. This is needed for transport booking purposes.
R205	Store information on transport chains	Information about a transport chain is stored in the form of a set of transport execution plans for each transport service included in the transport chain. Events and trigger data are not associated with the transport chain.
R206	Logging	Maintain log of data for the whole object storage to foster use of historical data.
R207	Transparent access to data in different data storages	The transport planning storage should provide secure access to data found at different concrete storage facilities.

5.3 Initial Functional Requirements for Transport Planning Engine

The Transport Planning Engine covers the following subtasks:

- Transport Plan Composition
- Service Search
- Simulation
- Optimization
- Meta data management
- Service booking management
- Transport Chain Composition

The central requirement for the *TPM Engine* is to handle the planning and replanning of transport processes (Transport Chain Composition).

Id	Name	Description
R301	Create a Transport Execution Plan	Create a transport service description that covers the usage of a transport service. This may include:

Id	Name	Description
		• Handle a transport need from an end user or legacy system • Search for possible contracts • Search for possible services • Select services • Handle transport service bookings for this transport service Based on a set of TSDs, a set of TEPs are created. Meta data are added to the transport execution plan. Meta data, TEPS and TSDs are stored in Transport Planning Storage and TEPs are sent to BCM. During planning and replanning, some collaboration between actors may be needed. Also, graphical presentation of the processes related to transport execution plan execution, would be useful to support this collaboration.
R302	Compose a transport chain plan from existing transport execution plans	The Transport Planning Engine must be able to compose a transport chain plan based on a set of transport execution plans and based on the description of/requirements to a certain transport chain.
R303	Manage Transport Execution Plan Updates	Manage updates related to a transport execution plan: • Handle incoming events on an existing transport execution plan • Handle status information and other information related to an existing transport execution plan • Handle changes in contract information related to an existing transport execution plan • Handle changes in contracts • Changes of transport items related to the transport execution plan • Handle changes in related Transport Chain Plans
R304	Service search	The Planning Engine must search for available services based on cooperation with the E-Contracting module. This is based on requirements from the use cases to improve the overview of available resources.
R305	Simulation	Find a set of possible transport execution plans based on optimization parameters (time, cost, environment),

Id	Name	Description
		available services, possible service bookings, and contracts that will fulfil the transport demand.
R306	Optimization	Select a set of TSDs based on optimization parameters or input from user. External optimization tools may be useful to complete this task. During optimization, especially related to replanning, some collaboration between actors may be needed.
R307	Meta data management	Add events and trigger values to transport execution plans that will be used by BCM. BCM needs this information to know when to send status information and replanning events to TPM. Further, meta information is needed to fulfill the requirement from the use cases on improving information exchange since this will facilitate the propagation of deviation information to all Logistic Service Providers engaged in a Transport Chain.
R308	Service Booking	Handle booking of transport services to be used in the transport execution plan. Online booking facilities were one requirement set up by the use cases to be able to improve the overview of available capacity and also improve predictability of market demands.

6 Conceptual Technical Architecture for TPM

6.1 Overview

This section gives an overview of the initial conceptual architecture of the Transport Planning Module (TPM). It describes the components of the module, their purpose and interactions. Subsequent sections will consider each component in more detail.

As stated in Section 2, transport planning and replanning has two main goals:

1) Transportation of goods from origin to destination according to the transport user's requirements, and

2) Sustainability, meaning to maximize profit for logistic service providers.

The TPM focuses directly on the first of these goals by providing transport execution plans for door-to-door transportation of goods. These transport execution plans are sent to the Business Collaboration Module (BCM) for execution. However, indirectly, the TPM supports sustainability for logistic service providers by ensuring that logistic users can book transport services through the TPM interface. To fulfill the transport demand, the TPM sends requests for published transport services to the e-contracting module (ECM) meaning that logistic service providers may increase their profit by offering more of their services to logistic users. The TPM handles transport demands from Logistic Service Clients and is the connecting link towards services offered by Logistic Service Providers.

The purpose of the TPM is to create an overall, operational transport execution plan for a multimodal transport chain handling goods by utilizing highly relevant and recent information at planning time. By doing this, other FInest modules will be able to support third party transport provider systems with updated status information during execution of their transport execution plans.

The transport execution plan contains a description of both transported items and transport services being used during the transport. Several transport execution plans are assembled to form the plan for a complete door-to-door transport chain. To be able to set up a transport execution plan, the following functionality must be available:

- Possibility to search for transport services to be used (provided by the e-contracting module).
    - A central requirement from the use cases is the possibility to publish their transport services on the Internet.
- Possibility to compose the transport chain based on input for:
    - Available transport services (based on contracts when they exists, and based on services not included in contracts)
    - Simulation: Presentation of several possible transport execution plans to the end user to fulfill the transport demand.
    - Optimization requirements (time, cost, environment)
- Add meta data to be used during transport execution plan execution:
    - Possibility to add triggers on each transportation service in the transport execution plan that may lead to replanning.
    - Add a list of triggers that will lead to status reporting (status that are just information, but not lead to any replanning). The notification is done in the business collaboration module, however, the actual events to be handled for each transport execution plan is set up in TPM.
- Support booking handling of the transportation services in the selected transport execution plan.

From this, replanning can be described as follows:

- Based on events related to an existing, ongoing transport execution plan, the values of the event may lead to replanning. This means that the transport execution plan must be revisited from the current time to the end of the transportation to set up a new transport execution plan.

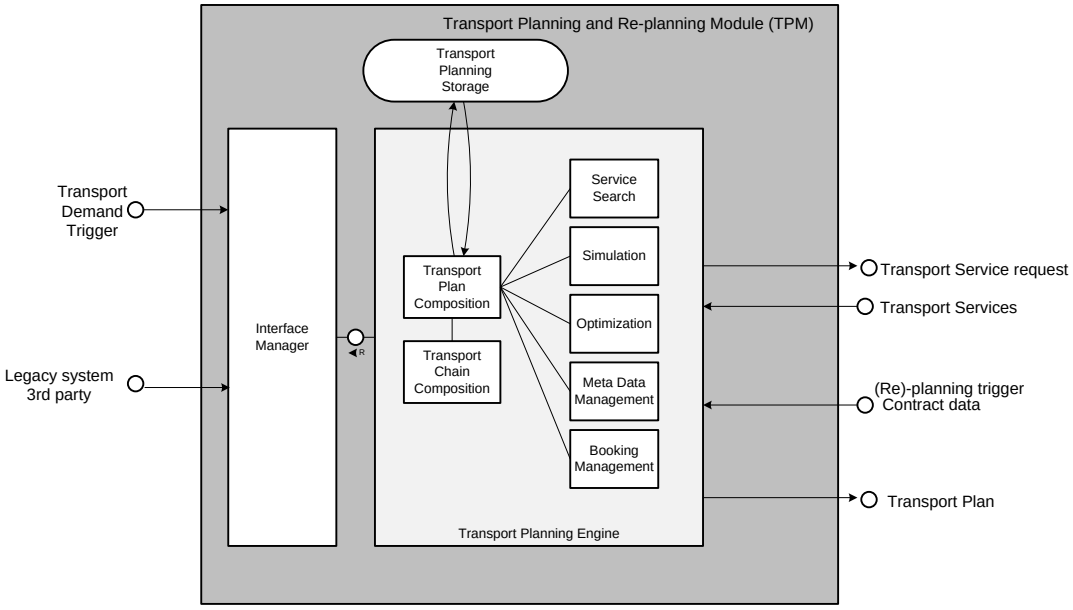

Figure 16 TPM Components

Figure 16 shows an overview of the three components included in the TPM (Interface Manager, Transport Planning Storage, Transport Planning Engine) and how they relate to triggers and input/output data that are described below:

- Interface Manager: Component to handle the interface between the planning components and the users, see Section 6.2.1 for more description of this component.
- Transport Planning Storage: Object storage needed by the TPM to store transport execution plans, meta data on transport execution plans, etc., see Section 6.2.2 for more description of this component.
- Transport Planning Engine, see Section 6.2.3 for more description of this component. This component contains the following sub-components:
    - Transport Plan Composition
    - Transport Chain Composition
    - Service Search
    - Simulation
    - Optimization
    - Meta Data Management
    - Booking Management
- Other FInest modules with an interface to the TPM: the BCM (Business Collaboration Module) and the ECM (E-Contracting Module). They are shown in the figure by having

information exchange with the TPM: Transport execution plans are sent to the BCM, and replanning events are received from the BCM. Contract data is received from the ECM, and transport service requests are sent to the ECM.

- Transport Demand trigger: This includes both back end systems (third party transport provider systems) and end users accessing the planning module through a front-end. The planning process in the TPM starts with an end user or third party system presenting their transport demand to the TPM.
- Legacy system/Third party system: Some legacy systems, for instance for scheduling, transport service bookings, or optimization, may be useful for the TPM, and thus be handled by the interface manager through the backend module described in WP3 [10]. The backend module is also responsible for information mapping between existing third party systems and FInest modules.

This lead to some overall requirements from the TPM to other FInest modules:

- ECM: Transport services and contracts should be described to cover all information needs for the TPM.
- BCM: The BCM must prepare information about the transport execution to the transport provider systems that participate in the transport execution plan. The TPM sets up the structure of the meta information to be related to each transport execution plan. However, it should be the task of the BCM to notify third party transport service provider systems about the status of a transport execution plan (in addition to sending events to the TPM).

The planning activities Simulation and Optimization from Figure 8 are found as sub-components in Figure 16 (to the extent that they are implemented by the TPM). The Scheduling and Stowage/Segregation activities from Figure 8 are not directly covered by the TPM. However, the meta data on transport execution plans set up by the TPM are used by the BCM to support these two planning activities. Further, the transport execution plans generated by the TPM can be used by third party systems to fulfill scheduling activities since, for instance, updates on individual transport execution plans can be used as input to (re)scheduling and (re)routing of transport means.

6.2 Description of TPM Components

6.2.1 Interface Manager

The *Interface Manager's* main task is to ensure the integrity of the stored data and the non-disclosure of confidential information. It controls the information flow between the TPM, user interfaces and (legacy) third party systems. For this, it has to check whether information output is consumed only by authorized users or systems. However, this is done through the functionality of the backend module as described in WP3 [10].

The *Interface Manager* handles the secure management of the end-to-end networks between all users of the TPM, authorization of users, and the Quality of Service regarding the

information received outside the TPM. For this it validates the whole information exchange between user interfaces and external legacy systems.

6.2.2 Transport Planning Storage

The purpose of the *Transport Planning Storage* is to provide persistent storage of objects needed by the Transport Planning Module. The main objects are transport execution plans and meta data related to the transport execution plan, that is, information about events and trigger values related to a transport execution plan. In addition, the object storage service must handle a set of transport execution plans that are put together to form the plan for a whole transport chain. The collection of transport execution plans is also needed to be able to describe how an event affects all transport execution plans related to a transport chain, not only a single transport execution plan.

The *Transport Planning Storage* transforms all information delivered by the *Interface Manager* into its internal representation model.

The *Transport Planning Storage* is the central data store of the TPM. It persistently stores transport execution plans and related information on event handling and trigger values for each plan. The storage is intended to be distributed. This means that it consists not only of one monolithic database but each provider of the TPM can define their own data store. Further, the TPM will need access to several data sources, for instance vessel information databases and information on transport service bookings. It is assumed that the different data stores are connected via secure interfaces, which allows a controlled access to information found at different concrete storage facilities. In addition to this, it is envisioned that the *Transport Planning Storage* is working in a cloud-based manner and therewith hides the concrete storage technology from potential clients. Clients simply send storage and load requests and the underlying logic delegates these to the corresponding data store. The cloud-based logic of the *Transport Planning Storage* organizes the addressing of concrete data bases in order to achieve a persistent storage of all data.

6.2.3 Transport Planning Engine

The Transport Planning Engine consists of the following sub-components:

- Transport Plan Composition
- Transport Chain Composition
- Service Search
- Simulation
- Optimization
- Meta Data Management
- Booking Management

The Transport Execution Plan Composition sub-component is the main part of the planning engine where a transport execution plan is generated based on transport demand, searches for transport services, simulation, optimization, meta data management and booking of services.

- Service Search: Ask the ECM for contracts and services that match the transport need. If a contract that matches the transport need exists, this contract will be used when finding relevant transport execution plans. If a contract does not exist, the ECM will return possible transport services to choose among.
- Simulation: Propose a set of possible transport service descriptions (TSDs) that will fulfil the transport demand. This is based on existing contracts and published services received from the ECM. Also, the booking management sub-component can be used to present more details on the availability of the transport services.
- Optimization: Based on some defined optimization parameters, the best TSDs for the transport demand are found. It may be relevant to use some third party optimization module to achieve this. Also, selection of the actual transport service descriptions can be left to the end user. In this case, graphical presentation of the transport planning process would be useful, especially for replanning.
- Meta Data Management: Add triggers to the selected transport service descriptions to describe what to do with the various events. These are triggers for replanning, but also triggers for other actions (forward status information, etc). This meta data must be stored and related to each transport execution plan. This is an important part of the TPM since it is used by the BCM to notify third party transport provider systems about the status of the transportation. The transport providers involved in the transport chain can use this information in their own systems to do early planning and replanning. This means that not only deviations from the plan, but also general statuses should be made available by the BCM.
- TEPs are created from the TSDs and the related meta data.

The Transport Chain Composition sub-component is used to assemble a plan for the whole transport chain based on a set of transport execution plans for the transport services used in the transport chain. This is used by the BCM to keep track of TEPs belonging together for a certain transport demand.

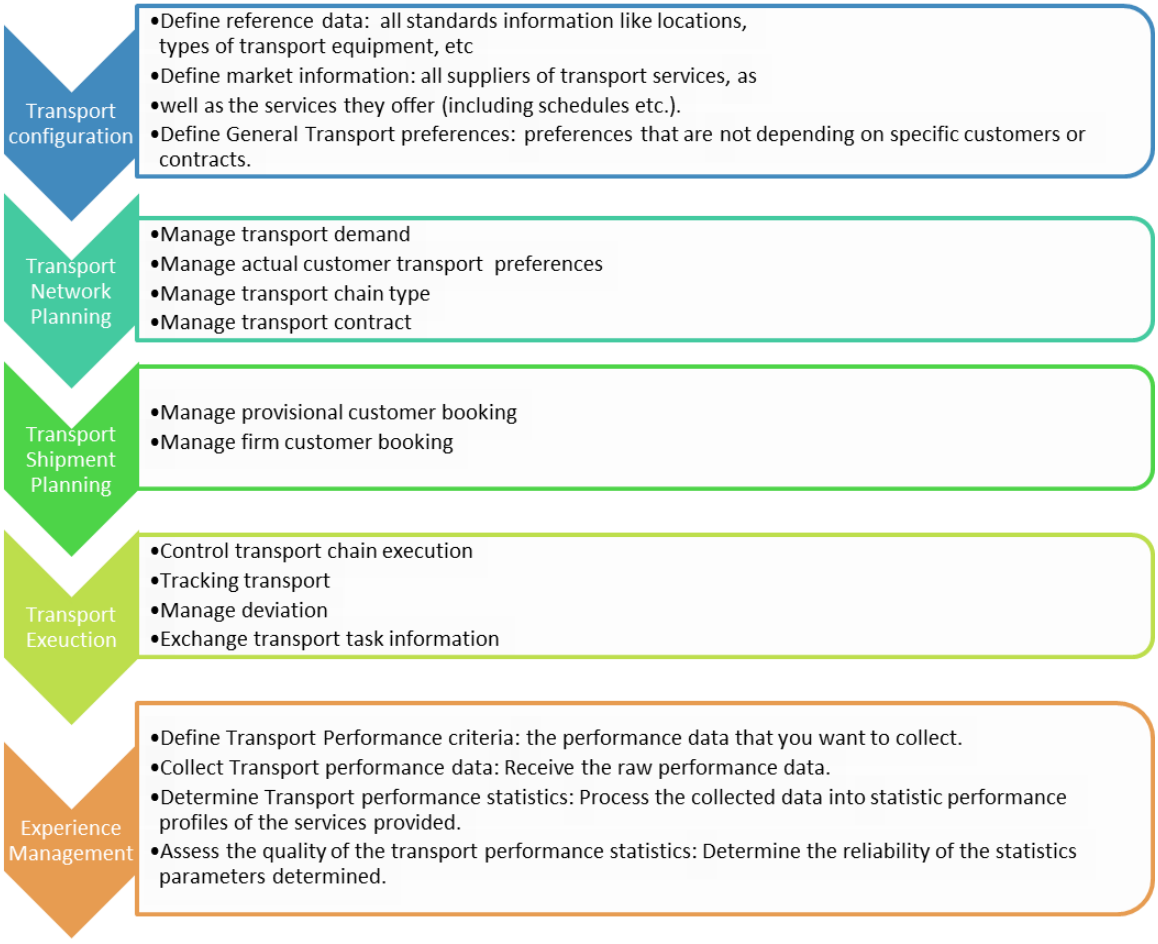

Figure 17 D2D [21] transport chain management reference model

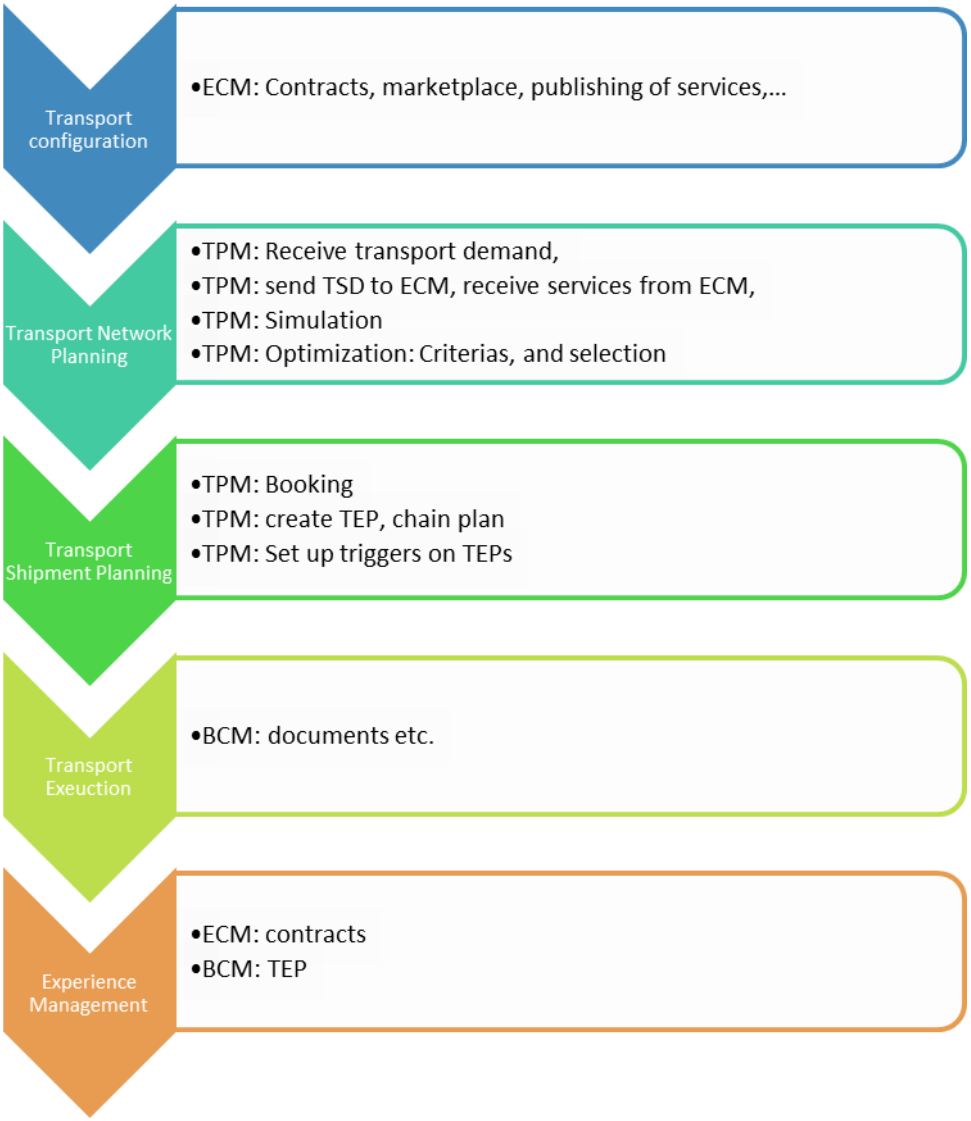

Figure 18 TPM described according to D2D

Figure 17 describes the main parts in the D2D [21] transport chain management reference model, and Figure 18 relates this to the TPM. According to this, the TPM supports the Transport Network Planning phase and Transport Shipment planning phase. In the following, only Transport Network Planning and Transport Shipment Planning are covered, since this is relevant for the TPM. Transport Configuration, Transport Execution, and Experience management are related to the other FInest modules.

The Transport network planning phase for TPM will contain the following:

1) Manage Transport Demand, done in relation with the service search part of the TPM:
    a. Receive Request for quote: Receive a request from a customer to provide transport services for a specific contract period. This is part of the ECM.
    b. Define transport demand: Define the amount of goods expected to be transported between which locations in which period.
    c. Consolidate or split transport demand forecast(s): Optionally merge different forecasted flows that will be treated as one from now, i.e. which will be served by

a single network. This is not the focus in the TPM, since the TPM is not a complete SCM system, but rather focuses on supporting collaboration between actors and systems in the supply chain by making information related to the TEP and TSD available to all actors in the chain. We suppose that handling consolidation and split of transport demand forecasts will take place in third party systems interacting with the TPM.

2) Manage Actual Customer Transport Preferences: Define preferences that are specific for a certain customer. These preferences can be used during the service search part of the TPM when asking the ECM for possible contracts and services to be selected. Examples of preferences are requirements for environmental details, actual transport modes to be selected, or actual service providers to chose among. This information is part of the TSD as described in Section 2.

3) Manage Transport Service Descriptions (TSDs), Transport Execution Plan (TEP) and related meta data:

    a. Collect TSD information: Based on information given in the transport demand, the TPM must put together a set of TSDs. If relevant contracts are found, these must also be used in the selection of TSDs.

        i. Possible structure of the set of TSDs: all locations within the network, and the modalities of the legs; covering a possible network of alternative routes.

        ii. Assign alternative service providers: Assign which alternative service providers can be used for each leg in the transport type structure, based on selected contracts, if existing.

        iii. Define service provider capacities to be sourced: Define the capacity of the services that you want to source from each of the alternative service providers indicated.

    b. Ask the ECM for possible contracts based on transport demand

    c. If any contracts are found, use these to ask the ECM for services that are covered by the selected contracts. If no contracts are found, do the selection of services based on (predefined) customer preferences.

    d. Simulate shipment planning: Simulate the efficiency of the set of TSDs, depending on the statistical profile of the demand forecast as well as statistical performance profiles of the used transport services. This includes the Simulation task of the TPM.

    e. Specify document exchange(s): Specify which documents have to be exchanged at what moment in the chain. For the TPM, this is done by using the facilities provided by the backend module of the FInest platform described in WP3 [10] to integrate external, existing systems which are dealing with the creation and management of various transport documents. Information requirements about or from these documents are sent to the BCM and this information is further fetched by the BCM from the FInest backend module.

    f. Specify required alert(s): Specify which alerts have to be exchanged at which point in the chain. For the TPM, this is done by specifying meta data (trigger information

and event handling) and by sending this request to the BCM. The BCM will then fetch the correct information from the EPM.

g. Specify tracking parameters: Specify which sources of tracking information are available in the chain and how they have to be used. For the TPM, this may be handled by the EPM.

h. Selection of actual set of TSDs can be done manually by the end user, or by applying an optimization tool. Note that the set of TSDs to optimize on has been reduced by already performing a selection of contracts and services from the ECM.

The Transport Shipment planning phase for TPM will contain the following:

1) Manage Provisional Customer Bookings

   a. Specify customer booking: Specify the booking information in the TPM based on the transport services selected.

   b. Consolidate customer bookings: Combine separate bookings in one consolidated booking, i.e., they will be handled technically as a single shipment. For the TPM, this means that several third party booking systems may participate in the handling of one transport demand. To fulfill a transport demand, bookings in several third party systems may be needed.

   c. Send customer booking confirmation: Confirm to your customer that the shipment can (or cannot) be dealt with under the restrictions of the contract and the amount of shipments already handled. For the TPM, integration with third party booking systems are handled by the backend module in the FInest platform [10], including information mappings. What the TPM does is to facilitate the integration of third party booking systems with the transport chain including trigger information.

2) Manage Firm Customer Bookings

   a. Specify customer booking: Specify the booking information.

   b. Manage service provider booking

   c. Consolidate customer booking: Combine separate bookings in one consolidated booking, i.e. they will be handled technically as a single shipment.

   d. Send customer booking confirmation: Confirm to the customer that the shipment can (or cannot) be dealt with under the restrictions of the contract and the amount of shipments already handled and that (in the case of a firm confirmation) the LSP accepts full responsibility for the execution of the shipment.

At last, when all information is present and bookings are confirmed, the TPM can set up the TEPs, relate the various TEPs to each other, and send the result to the BCM for execution.

In addition to this, the TPM executes an optimization task that consists of proposing the optimal set of services (TSDs) based on contracts and services received from the ECM as an answer to a certain transport demand. This means that optimization is done on a set of TSDs that has already been reduced in size by setting up requirements to the selection of contracts and services from the ECM.

7 Technical State-of-the-Art Analysis

This chapter describes a selection of existing tools used in the transport and logistics domain and their relevance to the Transport Planning Module. One source for finding existing ICT solutions to transportation is The Logistics for LIFE knowledge base [22], which is an EU administered knowledge base for presenting best practice solutions to increase the efficiency and sustainability of freight transport by using ICT. The portal presents best practices both regarding ICT, functional areas (strategy, planning, operation, and supporting systems), and policy indicators. In addition, a comprehensive list of software vendors can be found in [73].

Note that cloud computing platforms are not covered here since this is part of the Future Internet platform environment.

This survey is based on the available information on the websites of the software vendors.

7.1 Transport Planning and Schedule Optimization Software

In transport planning and scheduling, a variety of software may be used to model different transport plans and schedules to find the optimal alternative considering an objective function. Objective functions in transport plan and schedule optimization involve minimization of a cost function while satisfying all time and capacity constraints. Due to the discrete and continuous nature of transportation planning and scheduling problems, a mixed-integer optimization software is usually employed. There are two dominant approaches to obtain solutions to these problems:

1. Exact Methods: These methods are based on branch-and-bound enumeration that may be combined with advanced features such as cutting planes. One of the most successful software applications to apply these methods is the IBM ILOG/CPLEX Solver which is tested for many different problems [64]. Other software packages include XPRESS Optimization Suite [65] and Gurobi [66]. The nice feature of the software packages in this category is their ability to characterize optimal solutions. Guaranteed optimal solutions can be found for most of the problems; however when the optimal solution cannot be found in a reasonable computing time, upper and lower bounds on the optimal solution is reported. These software packages can be interfaced with other software, databases and ERP systems via C++, C#, and Java programs.
2. Heuristic Methods: These methods mainly aim to find feasible solutions first, and then try to converge to an optimal solution. A variety of procedures such as genetic algorithms, tabu search, and simulated annealing have been developed. The optimization models depend on the type of the procedure that is applied; therefore there is an added complexity to using these approaches, a set of parameters must be customized for the

specific problem under study prior to optimization. Since the algorithms depend on the problem structure and specific data related to the particular instance of the problem, it is very hard to develop a software package to solve general mixed-integer programming problems.

There are several well-known software packages that aim to provide a platform for transport planning and scheduling. These software packages use one of the optimization approaches listed above.

JDA Transportation Manager (formerly Manugistics)[43,44,67]

JDA Transportation Manager is a software application for logistics and supply chain management. This software can be used to forecast the demand, operational efficiency, inventory control, internal and external collaboration and many other areas within the transportation and supply chain. The JDA Transportation Manager includes several components such as fleet management, transportation modeller and transportation planner. The system is also available as a SaaS; therefore, the system can be used independent from the operating system platform through web objects.

IBM ILOG Transportation Analyst [68]

IBM ILOG Transportation Analyst is a route planning software for vehicle routing and shipment planning to optimize utilization of transportation assets. It is mainly based on the optimization capabilities of IBM ILOG/CPLEX software to find optimal solutions. It is available for Windows operating system.

SAP APO Transportation Management [69]

The SAP APO Transportation Management system includes two main components: Supply network Planning and Vehicle Scheduling.

Supply Network Planning is used for long-term to medium-term planning. A major advantage of this component is the Sourcing function, which allows you to specify at which location the product is procured and how it is to be procured. Sourcing is optimized using functions such as deployment and the transport load builder (TLB). Bucket capacities, which show the most detailed level for day planning, are used for product planning in Supply Network Planning.

Vehicle Scheduling (VS) is a component for short-term planning. You can define planning horizons for both Supply Network Planning and VS. These horizons are dependent upon each other and must be planned separately. In Vehicle Scheduling, the resources and transportation processes are maintained in detail to allow for very exact planning. When the orders from Supply Network Planning are converted to VS orders, the following occurs:

- The orders are put in a certain order.

- The exact move time is determined.
- Information and operations still required are added (data and operations that are not required for Supply Network Planning but are necessary for Vehicle Scheduling, such as loading activities).

Oracle Transportation Management [70]

Oracle Transportation Management is mainly targeted to deliver robust transportation planning and execution capabilities to shippers and third party logistics providers. It integrates and streamlines transportation planning, execution, freight payment, and business process automation on a single application across all modes of transportation, from full truckload to complex multi-leg air, ocean, and rail shipments.

Besides these global leaders in software for transport planning and scheduling, there are many other software products that aim to deliver niche services. Two of them are:

Whitestein Technologies: Living Systems [71]

Living Systems Adaptive Transportation Networks software is a comprehensive solution for the dynamic optimization and dispatching of Full and Less Than Truck Load (FTL and LTL) operations. The software delivers real-time visibility and dispatching decision support for distributed transportation networks.

MJC^2 [72]

MJC^2 software optimizes vehicle routes and driver schedules on a real-time or forward planning basis. It is also possible to use the real time dispatcher system to schedule and re-schedule vehicle movements in real-time, receiving information such as GPS location and transport order status to automatically update the transport schedule and re-issue it to drivers and managers, continuously optimizing the operation as the day evolves.

Logit D2D [13] offers management systems for intermodal supply chains in transport & logistics. Core features are services promotion, network/flow (tactical) planning, shipment (operational) planning, booking management, documentation & compliance, and visibility

KN Login [54] is the Kuehne+Nagel Internet based system for user interaction and information view on the complete supply chain management solutions. The system gives 'clear access to all important data relating to a freight shipment, automated process monitoring and powerful tools for data integration, statistics and reporting'. The system consists of several modules that can be combined, allowing it to be easily adapted to the individual needs of a specific customer. **KN Login Shipment** gives instant location of shipments within the transport cycle by searching online using different search criteria, including your own references, matching physical flows with real-time information on the status of shipments and across multiple carriers and modes, and receipt and posting of commercial and transportation documents

against the relevant shipments, enabling efficient processes for clearance and security procedures in advance of shipment arrival. **KN Login Monitoring** gives 'proactive event management, exception monitoring and alerts, enabling effective management of your supply chain'. **KN Login Booking** supports submission of booking requests and revisions through a template-driven online tool and enables the shipper to request equipment, advise a pick-up address and cargo-readiness date, enter reference information and submit shipping instructions. **KN Login Order** provides visibility and interaction with Kuehne + Nagel's Order Management Solution (OMS) controlling procurement and supply chain processes.

Cargo2000 [58] is an IATA lead industry project to create logistics standards for air cargo industry to simplify processes and hence to improve efficiency, customer services and reduce costs. In phase three of Cargo2000, focus is on control of information flow, freight flow, and documentation, achieving a paperless environment (IATA e-Freight), unique piece level scanning using RFID, cycle control framework, and security scanning. A supplier can be Cargo2000 compliant or not. A **route map** is created when the booking is accepted and describes the path the freight shipment follows including flight bookings as well as the checkpoints/timestamps required in the various Phases. This is used to verify progress of the freight movement continually and to determine whether service commitments are kept. This is similar to what is needed in TPM: TPM must also be able to set up triggers on events to be handled during execution of a TEP, similar to checkpoints on a route map in Cargo2000.

Table **1** gives a list of other selected SCM and transport planning software tools relevant for the TPM.

Supply Chain Design and Optimization: The table lists a variety of supply chain network design and optimization tools. Typical functionality of these tools are modeling, design and optimization of supply chain networks and the placement, selection and configuration of facilities like warehouses and plants, as well as inventory level optimization. Typically they can be integrated with, or exchange data with, ERP tools, office applications and existing databases. Seen from the TPM's viewpoint, most of these tools provide services that on a strategic level are similar. They are primarily meant for setting up strategic plans (and sometimes also tactical plans), which is somewhat out of scope for the TPM that focuses on operational planning. The TPM must, however, be able to use the supply chain data provided by such tools, and the optimizing tools or libraries used by the tools might also be of use for optimizing the plans for transport execution.

System	Main Functionality	Relevance for TPM	Interfacing/Technical Requirements
Logit D2D [13]	Supply chain visibility, transport collaboration and planning	Several similar features as planned for the FInest TPM.	Exchange of XML messages with other systems

System	Main Functionality	Relevance for TPM	Interfacing/Technical Requirements
Seaberth [19,20,37]	Berth scheduling and simulation	Advanced system for berth scheduling allow a higher level of automation of planning and replanning in ports	
Resource Hub (under development) [46]	Port and terminal resource management, service composition, planning and booking.	Services offered through the Resource Hub may be a part of the transport plan. System will keep track of resource availability, which will be useful for replanning scenarios.	All external services of the Resource Hub will be available as web services
Opti-Net [38]	Supply Chain modeling and optimization	The TPM shall be able to read supply chain data and interface with a variety of optimizers.	Automated linkage with ERP systems Flexible import file formats incl. Excel Upload of clients' data on the website to replicate
PRODISI SCO/CEP [39]	SCO: Supply Chain optimization for distribution networks of industry and trade CEP: Optimization of transportation networks of small goods carriers and express / parcel services.	The TPM shall be able to read supply chain data and interface with a variety of optimizers.	
SAILS/ISCO [40]	Supply Chain analysis and optimization	The TPM shall be able to read supply chain data and interface with a variety of optimizers.	Interoperability with MS Office
Infor SCM Network Design [41]	Supply Chain network modeling and optimization.	The TPM shall be able to read supply chain data and interface with a variety of optimizers.	
Supply Chain Guru[42]	Supply Chain design and optimization.	The TPM shall be able to read supply chain data and interface with a variety of optimizers.	Integration with SAP ERP
NDO Planner [45]	Supply Chain network design and optimization.	The TPM shall be able to read supply chain data and interface with a variety of optimizers.	
ProfitPoint Network Design	Supply Chain network design and optimization.	The TPM shall be able to read supply chain data	Integration with most common ERP and SCM

System	Main Functionality	Relevance for TPM	Interfacing/Technical Requirements
[47]		and interface with a variety of optimizers.	sources. Input Data and output data can be read and written to MS Excel, MS Access or SQL Server
Voyager Network Design [63]	Supply Chain network design and optimization.	The TPM shall be able to read supply chain data and interface with a variety of optimizers.	
planLM [48]	Supply Chain planning and analysis.	The TPM shall be able to read supply chain data and interface with a variety of optimizers.	Interoperability with common ERP sources, Microsoft office, and ODBC-compliant databases
NETWORK [49]	Supply Chain analysis.	The TPM shall be able to read supply chain data and interface with a variety of optimizers.	
LOPTIS [50]	Logistics Optimization System.	The TPM shall be able to read supply chain data and interface with a variety of optimizers. The producer (Ketron Managment Science) also seem to provide several stand-alone optimizer products/libraries that may be of interest.	
4flow Vista [51]	Logistic Optimization system.	The TPM shall be able to read supply chain data and interface with a variety of optimizers.	Open interface, XML, EDI, CSV
CAST [52]	Supply Chain modeling, network design and optimization.	The TPM shall be able to read supply chain data and interface with a variety of optimizers.	Results can be exported as Excel, Access, or CSV
TRAXON CDMP [53]	Cargo Monitoring for airlines	Events from monitoring may trigger replanning, state of transport may affect the replanning process	

System	Main Functionality	Relevance for TPM	Interfacing/Technical Requirements
KN Login [54]	Shipment location and monitoring, document handling, booking	Events from monitoring may trigger replanning, state of transport may affect the replanning process	EDI
ediEnterprise /CargoWise[55]	Modular set of supply chain solutions	Subsystems from the set can provide events and statuses that affect plans and replanning	
Cargonaut [56]	Cargo community system at Schiphol	The TPM should be able to communicate and exchange data with a variety of cargo community systems	
CHAMP Cargosystems [57]	Provider of air cargo systems	The TPM should be able to communicate and exchange data with a variety of cargo systems	
Primary [62]	Supply Chain in order to support tactical and strategic decision making		

Table 1 Some Supply Chain Management Tools

7.2 Fleet Management Systems

This section gives a summary of some fleet management systems and their relevance to the TPM.

TurboRouter [15] is an optimization software used as a decision support tool for fleet management. Key elements of TurboRouter include database for vessels, ports, cargoes etc., automatic calculation of port-to-port distances, vessel position reports and automatic update of Estimated Time of Arrival, sophisticated optimization routines for fleet scheduling, schedule visualization, and schedule calculator for manual planning. It generates routing plans for a set of available ships based upon information from the underlying data, the existing plan and input from the user. TurboRouter also includes a topology module to calculate distances and travel times between ports. A scheduling plan for ships consists of a set of sailing plans, one for each ship. Each sailing plan consists of a sequence of port stays. Details about times, quantities and orders served are part of the port stay. The main attributes of a port stay are the harbour the stay is in, the order serviced, arrival and departure time, and the quantity loaded/unloaded. There are three different objectives to evaluate the quality of a plan: *Net income* calculates the total profit of the plan, i.e. income from serviced orders minus all sailing and port costs. *Net*

daily calculates the net income divided by the total number of days the fleet is utilized, and *Capacity utilization* calculates the average utilization of the ship capacity. The topology is the part of the model that calculates aspects of sailing such as distance, sailing time and canal cost. For each pair of geographic locations the topology can calculate travel distance, and based on the distance it can find sailing time and sailing cost for a specific ship. The topology of the transportation network is configured by a superuser, and the resulting optimal routes can be exported as excel files.

Danaos Enterprise [59] is based on modules linked with key performance indicators (KPIs). The KPI's are used as a part of a measurement system and determine the quality of the processes and to what degree objectives are being achieved. Danaos claim to be "the only maritime software provider that offers a complete range of modules that cover all the areas of the daily operation of a shipping company". Danaos Enterprise contains modules designed to support investment decision that are considering marine accounting, budgeting, payments and freight collection. There are also a module that provides a decision making tools for vessels' operations with optimum passage speed calculation and a voyage estimation module, including a large port distance database that gives the opportunity to create what-if scenarios.

IMOS6 [60] is a modular system that can be used by commercial maritime organizations to create complete solutions. It helps the decision making process by providing the user with "what's next" and "what if" scenarios. Modules provided are chartering, operations, financial, planning, trading, demurrage, pooling, data center and data services. The planning module provides a "unified interface that integrates visual and quantitative analysis and allows executives, managers, charterers, operators and schedulers to test, analyze and modify assumptions about existing or proposed contracts, voyages, vessels and fleets".

Ocean Scheduling Software [61] "makes decisions based on actual events and data to reduce idle days, increase cargo carried and make the most cost effective use of the fleet at all times". The software claims to add value to ocean fleet planning by minimizing errors in scheduling in a high cost market, allowing complex interrelated schedules to be managed, dealing with the high frequency of changes due to unforeseen events, capturing the benefits of human decision into the scheduling process, producing schedules rapidly, and providing clear visibility of changes, options and decisions that can be shared across teams and suppliers.

7.3 Simulation Software

This survey of simulation software is done based on a survey conducted in [23] and on information available on the website of the software vendors.

In transportation planning, simulation software may be used to model different transport execution plans, and to compare them in order to find the best one. Given a set of transport execution plans, simulations models may uncover the expected performance, any weaknesses or bottlenecks, and any high risk factors in each of the plans. Thus the user may get a better

understanding of the transport execution plan, and make a more informed decision on which plan performs better according to their criteria.

ExtendSim Suite is a software suite delivered by Imagine That Inc. Its functionality includes simulation of continuous and discrete event, as well as discrete rate processes. It offers a large set of "building blocks" to model the processes, and also allow the user to program their own blocks, using the modL programming language. The software supports internal data storage both with a built in relational database, and reading/writing to text-files. ExtendSim is integrated with COM/ActiveX and ODBC. It is directly integrated with Excel, Stat::Fit, and JMP software, and allows you to source data directly from Access databases. ExtendSim may be used to control external applications, and have the other applications use ExtendSim models as a module using COM/OLE.

ExtendSim offers a wide range of visualization aids. "Block icons convey the structure and behavior of the model at a glance. In ExtendSim, both the flow of items and the flow of values are graphically represented. This unique mapping of visual meanings into their equivalent icons promotes quick understanding of a model to anyone viewing it." It also allows visualization of the simulation using a 3D visualization package, and the option of customizing a dashboard in order to present model output in a concise manner. ExtendSim supports both Microsoft Windows and Apple OS X platforms.

Arena Enterprise Suite is a simulation software suite developed by Rockwell Automation. It is a discrete event simulation software tool that can model "any process you can describe". Like ExtendSim they offer an intuitive flowchart view, with drag-and-drop functionality to build simulation models. They offer customization of templates and the ability to build your own entities using VBA programming language. Arena may communicate with external programs using either VBA or C/C++ programming languages, and also allows for external software to control ARENA through this programming interface.

Arena offers real-time 3D animation of the processes, as well as extensive reporting functionality through Crystal Reports. They also provide fully customizable dash-boards to give the user a detailed overview of the simulation results using graphs, charts and KPIs. Arena is available on all newer Microsoft Windows platforms.

7.3.1 Other Simulation software

A selection of other simulation software is presented below. Their selection is based on the relevance of their primary markets as stated in the survey conducted in [23]. Additional information has also been added concerning the available options for integrating each software with external programs in order to easier see how suitable they are to integrate into the TPM.

Software	Vendor	Interface to external programs

Software	Vendor	Interface to external programs
Capacity planning simulator	ProModel Corporation	Microsoft Excel
Enterprise Dynamics Logistics	INCONTROL Simulation Solutions	Any using ActiveX
Flexsim	Flexsim software products, Inc.	Any software that can execute commands such ass a DLL or other programmed software.
Micro Saint Sharp	Alion Science and Technology	Built-in console application, SharpTalk360
Oracle Crystal Ball Suite	Oracle Americas Inc.	Microsoft Excel
ProModel Optimization Suite	ProModel Corporation	Excel, Access, C++, C#, VB.Net, VBA
SAS Simulation Studio	SAS	
ShowFlow	Webb Systems Limited	
Simcad Pro	CreateASoft Inc.	Any Windows based application
Simio Scheduling / Risk Analysis	Simio LLC	Any .NET language (C#, C++, Visual Basic)
SIMPROCESS	CACI	Any software that can make web service calls or execute batch or shell files
SIMUL8 Professional	SIMUL8 Corporation	Any program with a COM interface, eg Excel, Visual Studio etc
SLIM	MJC2	Several integration options available

Table 2 Some Simulation Tools

7.4 Cooperation Tools

Collaboration tools are most relevant for replanning since this will involve a great deal of human interactions, especially related to checking existing contracts and service level

agreements. It may also be relevant when negotiating new contracts and also during a booking process containing several stages. Table 3 lists some collaboration tools and their main functionalities. Based on provided functionality, it seems that these tools are quite similar. However, regarding the TPM's need to support replanning, tools that are strong on graphical presentations should be selected since an important part of the collaboration will be to show the current execution stage of the transport.

Software	Description
Acrobat/Adobe Connect[32]	Enterprise web conferencing solution for online meetings, eLearning, and webinars: Screen sharing, mission-critical collaboration, online training, webinar attendance, audio conference integration.
Campfire[33]	Internet based group chat tool to set up password protected chat rooms for teams providing sharing of text, files, and program code. It includes voice conference, history of past chats, and uploading of pictures.
GoToMeeting[34]	Web conference tool for online meetings with up to 15 people to share any application in real time. This includes video conferencing and audio conferencing via computer or telephone from either Mac, PC, iPad or iPhone. The web site is SSL encrypted, end-to-end 128-bit AES encrypted, and password protected.
Microsoft LiveMeeting[35]	Subscription-based web conferencing service including software that is installed on client PCs, and uses a central server for all clients to connect to. Includes rich media presentations (Windows Media and Flash), live webcam video, multi-party two-way audio via computer, and file transfere. Java applet available on Windows, Linux, Solaris, MacOS.
Skype[36]	Voice and video calls and chats over internet, group video calls, file sending, SMS sending, instant messaging, conference calls.

Table 3 Some Collaboration Tools

7.5 Port Community Systems (PCS) and Terminal Systems

For the TPM the resource planning part of port community systems and terminal systems are most relevant. Resource planning is relevant in all tasks mentioned in Transport Network Planning and Transport Shipment Planning in Figure 18. The transport demand is fulfilled by a set of services which in turn will relate to booking of resources handled in the PCS or terminal system.

SoftShip [27] contains two modules, one for shipping line operations (LINE), and one for agent operations and customer services (ALFA). Softship is used by NCL as described in WP2. LINE handles the day-to-day processes required for management of a liner shipping operation including the carriage of dangerous goods. The interface is EDI compliant.

Greenwave [28] is used by Tyrholm-Farstad as a terminal operator (WP2) to control container movement: transaction registration (discharge, gate-out, gate-in, load, stripping, stuffing,

maintenance and repair), reporting, generation of basic invoice data, and maintenance of booking information from liner companies. The system is internet based and has an EDI interface to other systems.

PortIT [29] is a system used for logistics handling in ports and multi modal terminals. It is internet based, and contains modules for Offer and Contract, OneStopBooking, ResourcePlanning, Vessel Call, Sea Forwarding, Liner Shipping, Rail, Warehousing, Container Terminal, Bulk Cargo, General Cargo, Track&Trace, and Invocing. Vessel Call is the main module which is integrated with vessel arrivals and departures(times and bookings, cargo, reporting and generation of basic invoice data.

PortWin [30] is the PCS currently used by most Norwegian ports, PortWin used to be a closed system with limited possibilities for interaction with other systems. However, with the introduction of **PortTools** this has changed. For instance, PortTools WIE is an internet based tool for sharing of vessel and port arrival information between several actors (shipping line, agent, terminal and port to fulfil requirements given in the ISPS code. The relation from PCSs such as PortTools is that they can subscribe to parts of the information given in relevant TEPs and the associated meta data to be able to update their internal transport documents and information. PortTools has XML and EDI interfaces, including messages for arrivals, goods and passengers.

Another important PCS is **PortInfoLink** [31] used in Rotterdam and several other Dutch ports.

7.6 Other Information Sources

PCSs and terminal systems will be important subscribers to information possibly handled by FInest, for instance on AIS information or port arrival information from Safe Sea Net. This section describes some information sources that are relevant for TPM and which can be used to create added value services for cooperative transport planning.

Automatic Identification System (AIS) is a system used by ships and Vessel Traffic Services (VTS) principally for identifying and locating vessels. AIS provides a means for ships to electronically exchange ship data including identification, position, course, and speed [24]. Ship's speed and maneuvering status are used to ensure the appropriate levels of positional accuracy for ship tracking. The AIS messages are grouped into static, dynamic and voyage related and are valid for different time periods and are updated at different rates.

SafeSeaNet (SSN) [25] is a system to support the requirements of Directive 2002/59/ EC establishing a Community vessel traffic monitoring and information system and contains information related to ship arrivals and some information on dangerous goods. The system is accessible to the National administrations of all the Member States of the European Community and of the European Free Trade. Every country has to dedicate an internal authority as a National Competent Authority that will be the official connection between the

country and the central SSN system that is under the responsibility of the European Maritime Safety Agency, EMSA.

ShipLog [26] is an AIS based system which uses the dynamic position information from AIS to give a graphical view on both port arrivals and ship movements and also to present real time position information of a fleet on a map. The system includes automatic notification on SMS or email of specific events related to user defined areas in a map. The application is internet based via a java interface and with xml message formats for data exchange.

8 Generic Enablers

The FI WARE platform [9] includes several generic enablers (GE) that will be useful when implementing the TPM. In addition to this, two GEs have been identified that are not found in FI WARE, and these two are added as a request to FI WARE for inclusion, see details on http://www.finest-ppp.eu/index.php/project-results/generic-enablers. More details on generic enablers are found in [10].

9 Conclusion and Next Steps

This document gives an overview of the FInest planning/replanning module the TPM and how it interacts with other FInest modules. The conclusion is that the TPM will focus on operational planning of door-to-door transportation of goods to fulfil transport demands from Logistic Service Clients. The TPM needs close cooperation with other FInest modules to fulfil requirements from Logistics Service Providers.

The next step in this work package will be to do conceptual design and technical specification of the TPM. Further, the TPM must be aligned with FI WARE specifications and generic enablers. Some of the ideas will be tested out in a prototypical implementation of the TPM. Lastly, an implementation plan for a full scale TPM will be given.

References

1. Freightwise project website. http://freightwise.info/
2. e-Freight project website. http://www.efreightproject.eu/
3. eCoMove project website. http://www.ecomove-project.eu/
4. GOOD ROUTE project website. http://www.goodroute-eu.org/
5. Gelovã, E. (editor), *FREIGHTWISE D13.4 Recommendations for Standardisation*
6. *Freightwise – managment Framework for intelligent intermodal transport. Description of Work,* Contract no 020188, 2006
7. Rialland, A. (editor) (2011), *FInest D2.2 – High Level Specification of Use Case*
8. Franklin, R. et.al (2011), *Future Internet Technology for the Future of Transport and Logistics*
9. FI-WARE High-level Description (Product Vision), FI-WARE-11-08-1
10. Metzger, A. & Stollberg, M. (editors) (2011), *FInest D3.1- Technological Requirements and State-of-the-art Analysis*
11. EU document (2011), *One Common Framework for Information and Communication Systems in Transport and Logistics*
12. Natvig, M.K. et.al (2009), *ARKTRANS The multimodal ITS framework architecture*, Version 6: SINTEF Report No. A12001
13. http://www.logit-systems.com/
14. http://www.whitestein.com/living-systems-adaptive-transportation-networks-ls-atn
15. K. Fagerholt and H. Lindstad (2007) TurboRouter: An interactive optimisation-based decision support system for ship routing and scheduling. Maritime Economics and Logistics 9, 214-233.
16. http://www-01.ibm.com/software/integration/optimization/cplex-optimization-studio/
17. http://www-01.ibm.com/software/integration/visualization/jviews/enterprise/
18. http://www-01.ibm.com/software/integration/business-rule-management/jrules-family/
19. http://www.portstrategy.com/features101/port-operations/port-services/vessel-tracking-management-systems/simulation_and_scheduling_tools_a_must_for_busy_ports
20. http://www.portstrategy.com/features101/port-operations/planning-and-design/tos-vs-pos/seeing_the_process_through
21. D2D: http://cordis.europa.eu/newsearch/index.cfm?page=docview&collection=EN_PROJ&reference=87076&position=1&Highlights=DEMONSTR,INTEGR,MANAG,COMMUN,SYSTEM,DOORTODOOR,DOOR,DOOR,INTERMOD,FREIGHT,TRANSPORT,OPER,CORDI&prevPage=resultList&similarity_id=2728143
22. http://www.logistics-knowledgebase.com/
23. Swain, J. J., 2011, Software Survey: Simulation — Back to the future, ORMS-Today 38(5)

24. Automatic Identification System [cited 2008 July 2nd] (http://en.wikipedia.org/wiki/Automatic_Identification_System)
25. Safe Sea Net: http://www.emsa.europa.eu/operations/maritime-surveillance/safeseanet.html
26. http://www.oddstol.no/shiplog
27. http://www.softship.com/
28. https://www.greenwave.no/gwi/
29. http://www.inport.com/Home.aspx
30. http://www.seamless.no/index.php?expand=47&show=47&topmenu_2=8
31. http://www.portbase.com/en/Portbase.aspx
32. http://www.adobe.com/products/acrobatconnect/
33. http://www.campfirenow.com/
34. http://www.gotomeeting.com
35. Http://office.microsoft.com/en-us/livemeeting/
36. http://www.skype.com/
37. http://www.cirruslogistics.com/index.asp?page=seaberth_sub
38. http://www.technologix.ca/software/opti-net/
39. http://www.prologos.de/English/Prodisi.htm
40. http://www.insight-mss.com/_products/_sails/
41. http://www.infor.com/solutions/scm/strategicnetworkdesign/
42. http://www.llamasoft.com/
43. http://www.jda.com/solutions/solution_library/supply_chain_strategist.cfm
44. http://www.jda.com/solutions/network-design-optimization-overview/
45. http://www.riverlogic.com/solutions/ndo-planner/
46. Hagaseth, Baltzersen, Tjora: Maritime Information Centre: Technical Solutions and Systems Architecture, report in the MIS project.
47. http://www.profitpt.com/software/network-design/
48. http://www8.solvoyo.com/webfront/planlm.html
49. http://SupplychainAssoc.com/NETWORK.htm
50. http://www.ketronms.com/loptis.shtml
51. http://www.4flow.de/en/logistics-consulting/4flow-vista.html
52. http://www.barloworldscs.com/home/solutions/cast-supply-chain-modelling.aspx
53. http://www2.traxon.com/home.html
54. http://www.kn-portal.com/about_us/kn_login_solutions/
55. http://www.cargowise.com/enterprise.html
56. http://www.cargonaut.nl/index.php?uk_home

57. http://www.cargoserv.com/
58. http://www.iata.org/whatwedo/cargo/cargo2000/Pages/index.aspx
59. http://web2.danaos.gr/danaos/MaritimeEnterpriseSoftwareSolutions.aspx
60. http://www.veson.com/
61. http://www.magenta-technology.ru/docs/factsheets/ocean_scheduler_software.pdf
62. http://www.primary.gr/pages/solutions_eng.html
63. http://www.logility.com/solutions/transportation-and-logistics-optimization/network-design-software
64. http://www-01.ibm.com/software/websphere/ilog/#
65. http://www.fico.com/en/Products/DMTools/Pages/FICO-Xpress-Optimization-Suite.aspx
66. http://www.gurobi.com/
67. http://www.jda.com/solutions/transportation-manager/
68. http://www-01.ibm.com/software/integration/sca/transportation-analyst/
69. http://www.sap.com/industries/transportationandlogistics/index.epx
70. http://www.oracle.com/us/products/applications/ebusiness/scm/018756.htm
71. http://www.whitestein.com/living-systems-adaptive-transportation-networks-ls-atn
72. http://www.mjc2.com/transport_logistics_management.htm
73. http://www.orms-today.org/surveys/Vehicle_Routing/vendor.html

Appendix

A. Concepts and standards - summary matrix

As a summary of the listed concepts and standards we have grouped them in a matrix (from [5]).

Groups	Family	Body	Description	Process viewpoint	Information viewpoint	Functional viewpoint	Communication viewpoint	FInest relations
Trade World	United Nations	UNECE	The United Nations Economic Commission for Europe (UNECE) is one of the five regional commissions of the United Nations. It is the forum of 56 countries of western, central and eastern Europe, central Asia and North America. The develop the tools for easier economic cooperation, where transport and trade are among its topics.	X	X			For processes, location etc.
		UNCEFACT		X	X			For processes

Groups	Family	Body	Description	Process viewpoint	Information viewpoint	Functional viewpoint	Communication viewpoint	FInest relations
		EDIFACT	See UNECE below, too. EDIFACT is an acronym for EDI For Administration, Commerce and transport. It coordinates international standardization for Europe in regard of a set of syntax rules, data elements, segments and codes, and messages. EDIFACT brings the Proprietary Standards of the U.S. and Europe together to form a single international EDI standard. See also UNECE.	X	X			For processes
Trade World		ICSO	The International Container Security Organisation is dedicated to increasing the security and efficiency of international commerce by creating and implementing standards for container security devices and systems.	X			X	For physical security, communication
Trade World		INCO-TERMS	International Commercial Terms standard is developed, maintained and promoted by ICC Commission on Commercial Law and Practice (CLP). Incoterms make international trade easier and are the most commonly used in	X	X			For legislation, documents

Groups	Family	Body	Description	Process viewpoint	Information viewpoint	Functional viewpoint	Communication viewpoint	FInest relations
			international contracts.					
Trade World		GS1		X	X		X	EAN for processes, location and communication
Trade World		SCC	Supply-Chain Council (SCC) is a global non-profit consortium supporting companies in making their improvements in supply chain processes efficient. SCC has established the world's most widely accepted framework SCOR® (Supply-Chain Operations Reference-model), for evaluating and comparing supply chain activities and linked operations.	X				SCOR for evaluation and benchmarking of supply chains
Trade World		SNIA	The Storage Networking Industry Association develops standards for storage hardware and software. One of the results is SMI-S, the Storage Management Interface Specification. SNIA ratified SMI-S 1.0 in 2003 and it was approved as an ANSI standard in 2004 and is				X	For storing and managing information

Groups	Family	Body	Description	Process viewpoint	Information viewpoint	Functional viewpoint	Communication viewpoint	FInest relations
			expected as ISO standard.					
Technical Europe	CEN	TC278 WG13	European Comitee for Standardization supports the aims and policy of the European Union and European Economic Area by preparing voluntary technical standards promoting free trade, safety of both workers and consumers, interoperability of networks, environmental protection, exploitation of research and development activities, and also public procurement.	X	X	X	X	For ITS Architecture (FWF overall concept)
Technical World		IATA	The International Air Transport Association is a global trade organisation. IATA has developed the commercial standards that built a global industry.	X	X	X		For location, processes, functionalities (AMADEUS concept)
Technical Europe		ICTSB	The ICTSB (ICT Standards Board) is an initiative in the area of ICT of the following three European standards organizations – CEN, CENELEC and ETSI.	X				For co-operation on ICT among various standardisation bodies (CEN CENELEC, ETSI)

Groups	Family	Body	Description	Process viewpoint	Information viewpoint	Functional viewpoint	Communication viewpoint	FInest relations
Technical Europe		CENELEC	The European Committee for Electrotechnical Standardisation (Comite Europeen de Normalisation Electrotechnique) has developed activities in the ICT field and has set up an ICT Unit. This Unit works in close collaboration with CEN and ETSI.				X	For electrotechnical tasks
Technical World	ISO	TC204 WG1	The International Organization for Standardization (ISO) is a worldwide federation of national standards bodies from some 140 countries, one from each country. ISO represents a special position between the public and private sectors. Its members are part of the governmental structures and other members work in the private sector. From this reason, ISO is able to offer solutions that meet the requirements of business and the broader needs of society as well.					For ITS Architecture (FWF overall concept)

Groups	Family	Body	Description	Process viewpoint	Information viewpoint	Functional viewpoint	Communication viewpoint	FInest relations
		TC204 WG7					X	Fleet Management for co-operation COLUMBUS, based on UBL
Technical World		OASIS	Organization for the Advancement of Structured Information Standards. Has established a joint committee with UNCEFACT to migrate EDIFACT to XML.	X	X		X	UBL for schemas (COLUMBUS concept)
Technical World		i2	i2 solutions serve to customers when using industry best practices based on knowledge and experience in following areas: integrating data, processes, and systems belonging to suppliers, customers, distributors, carriers, partners, and contract manufacturers.	X			X	For integration, information security
Technical World		OGC	Open Geospatial Consortium has created the GML language, XML based, for geographic		X		X	GML for geographic information and location

Groups	Family	Body	Description	Process viewpoint	Information viewpoint	Functional viewpoint	Communication viewpoint	FInest relations
			systems.					
Technical Europe	European Comission	ETSI	The European Telecommunication Standards Institute is a non-profit organization for production of the telecommunications standards that will be used throughout Europe and beyond.				X	For ICT
Technical World		IEEE	The IEEE name was originally an acronym for the Institute of Electrical and Electronics Engineers, Inc. Today, the organization's scope has expanded. The IEEE is a leading developer of international standards of telecommunications, information technologies and power generation products and services.				X	For electrotechnical and communication tasks
Technical World		IEC	The International Electrotechnical Commission is the international standards and conformity assessment body for all fields of				X	For electrotechnology and assessment

Groups	Family	Body	Description	Process viewpoint	Information viewpoint	Functional viewpoint	Communication viewpoint	FInest relations
			electrotechnology.					
Technical World	United Nations	ITU	International Telecommunication Union ITU is the global telecommunication organization as a United Nations agency for ICT that focuses on work for both governments and the private sector. Its role is in the main three areas: radiocommunication, standardisation and development.				X	For communications
Technical World		OMA	OMA is the leading industry forum for developing market driven, interoperable mobile service enablers.				X	For communications (WAP, location, multimedia messaging etc.)
Technical World		WSSN	World Standards Services Network (WSSN) is a network of publicly accessible World Wide Web servers of standards organizations around the world.				X	For web services

B. Messages related to transport

The table in this appendix describes typical messages that are used in the performance of a transport. It is divided into three phases; the planning, the execution and the completion phase. The goals in many projects such as the e-Freight is to come up with one single transport document that can replace all listed messages in the table. For the planning module it is of importance to see the process not only from a planning perspective but as a whole that supports the execution of a transport.

Phase	Message type	Existing
Planning	Demand	Load tender, Load tender response, Load available
	Quotation	Request for quotation, request for quotation response, Load tender response
	Booking	Provisional provider booking request, provisional provider booking confirmation, provisional customer booking request, provisional customer booking confirmation, firm customer booking request, firm provider booking request, firm provider booking confirmation, firm customer booking confirmation
	Invoice	Invoice
Execution	Status Report	Transport chain advice, transport chain order, transport chain status report, proof of delivery from consignee, provider status reports (transport service status report, transport service deviation report, proof of delivery from consignee, proof of delivery to consignee, transport means position, transport means arrival notification, transport means arrival report, transport means departure notification report, transport means departure report, transport means damage report, load unit position, loaded goods report, unloaded goods report, tally report, damage inspection report, stuffing report, stripping report, stock report, gate in report, gate-out report, damage certification report, claims report, shipment status), customer status reports (transport chain status report to customer, transport chain deviation report, damage inspection report, claim report)
	Advice report	Transport advice, loading advice, unloading advice, release advice, service advice, stuffing advice, stripping advice, final release approval, load available, delivery message, goods receipt
	Order reports	Transport order, loading order, unloading order, storage order, release order, service order, stuffing order, stripping order, call off
	Deviation	Delayed production, reduced production, transport arriving early, delayed loading and departure, incomplete loading, delayed arrival and unloading, incomplete unloading, early loading and departure, delayed progress, too fast progress, deviation in quantity, deviation on goods quality, shipment status
	Customs / Authority	Customs declaration, customs clearance, dangerous goods notification, bill of lading rail bill, truck bill, customer /cargo specific document
Completion	Status	Proof of delivery
	Invoice	Invoice to customer, payment to transport service providers
	Claims	Claims to transport service providers