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FREIGHTWISE

Management Framework for Intelligent
Intermodal Transport

Integrated Project (IP)

Sustainable surface transport - Rebalancing and integrating different transport modes.

D12.4 High Level Formal Model

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Executive Summary

The overall objective of the FREIGHTWISE project is to support the modal shift of cargo flows from road to intermodal transport using road in combination with short sea shipping, inland waterways and rail. This objective will be achieved by means of improved management and facilitation of information access and exchange between large and small, public and private stakeholders across all business sectors and transport modes. FREIGHTWISE aim is also to support the Commission in formulating future legislation and in developing initiatives that can provide a platform on which the industry can develop management solutions thus helping to increase the competitiveness of intermodal transport. Under the heading of the FREIGHTWISE FRAMEWORK - FWF- the project intends to develop generic system architecture for intermodal transport management based on previous European and national efforts.

Task 12.3 High Level Formal Model aims to use the findings from the Review of relevant RTD activities in Task 12.1 and the information from the D12.3 Requirement handbook generated in Task 12.2 in order to provide a blueprint of the FREIGHTWISE Framework. The requirements are formalized in a high level formal model.

The basic output of this task is this deliverable (D12.4 High level Formal Model) which consists of:

- A top-level model. Mapping of the intermodal transport chain transport domains.
- Actors and roles model. Inventory of actors and roles (including a set of functions).
- Functional model. The generic functionality required for intermodal transport chains.

The deliverable will be directly usable for WP13 FREIGHTWISE framework architecture, WP14 Implementation Rules and guidelines and WP15 Intermodal management Services where there will be a shift from the theoretical to the implementable framework

A set of generic business processes that describe the whole freight transport supply chain is established in the top level model:

- Transport planning
- Transport execution and
- Transport completion

Each of these processes has been broken down into a small number of subprocesses. Transport planning subprocesses are:

- Find available transport services and create transport chains
- Select the best alternative chain
- Organise transport

Transport execution subprocesses are:

- Issue transport instructions
- Monitor transport

Transport completion subprocesses are:

- Issue proof of delivery
- Handle claims
- Handle invoices
- Manage transport performance information

The deliverable also makes an introduction to the FREIGHTWISE architecture that will be analysed in detail in WP13.

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List of abbreviations

RTD	Research and Technological Development
ICT	Information Communication Technology
WP	Work-Package

1.Introduction

1.1. *Project Overview*

Intermodal transport is recognised as an important option when seeking to influence modal split towards more sustainable modes such as rail, short sea shipping and inland waterways. However, road transport remains indispensable and incentives and methods must be found which contribute to an optimum modal mix for every type of transport. There are a number of commercial, technical and organisational obstacles to overcome in this process of combining a number of transport services to an efficient transport chain. On a general level, there is too little transport chain thinking. Integrated transport management requires a certain level of business integration, which demands trust, and in consequence often a perspective of longer term co-operation.

Information access is a key element in any competitive intermodal chain which requires some degree of interoperability between the systems of the organisations involved in the chain, but also with authorities who require reporting e.g. customs, coast guard and bodies which provide traffic information. Small and Medium Enterprises (SME) often find the threshold for using advanced Information Technology (IT)-based management tools still too high in term of costs and necessary know-how. Standards are too wide or inadequate for small enterprises and do not support the interaction of all parties involved.

Rapidly changing business and administrative requirements demand a high level of flexibility from the transport industry both in terms of the services offered and the management systems. Software tools and IT-services to support the management are developing, but they do not adequately serve the entire business community.

FREIGHTWISE overall objective is to support the modal shift of cargo flows from road to intermodal transport using road in combination with short sea shipping, inland waterways and rail. It will achieve this objective by means of improved management and facilitation of information access and exchange between large and small, public and private stakeholders across all business sectors and transport modes.

FREIGHTWISE promotes EU-policies encouraging the development of open and interoperable systems, which meet the requirements of cargo owners, transport operators and intermodal freight integrating services. The aim is to support the Commission in formulating future legislation and in developing initiatives that can provide a platform on which the industry can develop management solutions thus helping to increase the competitiveness of intermodal transport.

Under the heading of the FREIGHTWISE FRAMEWORK (FWF) the project intends to develop generic system architecture for intermodal transport management based on previous European and national efforts. But the FWF shall also provide support in the use of management tools and demonstrate some new developments intended to facilitate market transparency and a management framework supporting the organisation of intermodal transport chains.

1.2. *Objective of WP12 and link to other WPs*

WP12 Requirement Generator establishes a formal requirement structure for the FWF architecture by providing a broad and integrated definition of stakeholder requirements that can be mapped onto the emergent FWF, identifying aspects already covered (possibly by several different approaches) and highlighting those aspects that the market demands, but that are not yet or not sufficiently well reflected on the level of reference architecture.

Within D12.1, a thorough review of RTD projects in the field of intermodal transport has been performed, with emphasis on EU projects within the 4th, 5th and 6th Framework programs that developed architectures for ICT systems for intermodal transport. The main findings of these projects have been consolidated and tabulated so that they can be easily accessible to the partners. The objective of this effort was to present an easy to read, understand and reuse synopsis of the state-of-the-art, so that duplication of effort is avoided and the modelling effort within FREIGHTWISE is facilitated. EU policies and regulations about intermodal transport systems architecture have also been considered in D12.1. Standardisation is one prime example where EU policies can catalyze intermodal transport in Europe. D12.1 reviewed extant and planned EU policies on architecture of ICT solutions in intermodal transport.

Additionally, within Task12.2 the situation analysis of WP11 has been taken a step further by moving from desk research to engage the whole range of freight transport stakeholders. The requirements for business settings, harmonization, interoperability and interconnectivity have been gathered and presented in D12.3 Requirement handbook.

Task 12.3 High Level Formal Model aims to use the findings from the Review of relevant RTD activities in Task 12.1 and the information from the D12.3 Requirement handbook generated in Task 12.2 in order to provide a blueprint of the FREIGHTWISE Framework. The requirements are formalized in a high level formal model.

The basic output of this task is the present deliverable D12.4 High level Formal Model which consists of:

- A top-level model. Mapping of the intermodal transport chain transport domains.
- Actors and roles model. Inventory of actors and roles (including a set of functions).
- Functional model. The generic functionality required for intermodal transport chains.

The deliverable will be directly usable for WP13 FREIGHTWISE framework architecture, WP14 Implementation Rules and guidelines and WP15 Intermodal management Services where there will be a shift from the theoretical to the implementable framework.

1.3. *Structure of the deliverable*

In Section 2 there is a description of ARKTRANS' reference model and of the use of roles in ARKTRANS. ARKTRANS is the project that was proposed by deliverable 12.1 Previous RTD projects findings and EU policy as the basis for the development of the FREIGHTWISE framework. Section 3 presents the FREIGHTWISE Top level model. The freight transport is split into generic processes and there is a description of these processes. In Section 4 there are the actors and roles models that are derived from the top level model description. In Section 5, the Functional model describes in a visual way the data flows and the roles' functionality. Finally, Section 6 provides an overview of the FREIGHTWISE framework, as it is being developed, and Section 7 concludes the deliverable.

2. ARKTRANS reference model

2.1. *Building on ARKTRANS*

FREIGHTWISE's aim was not to build a framework from the beginning but to build a framework based on the experience gained from previous projects and the findings that came from them. Deliverable D12.1 *Previous RTD projects findings and EU policy* concluded that the FREIGHTWISE project team should adopt the ARKTRANS project framework as the basis for the FREIGHTWISE architecture framework. ARKTRANS is an architecture framework that focuses on intermodality and does not refer to a specific mode. It describes an open system architecture that enables the interaction with other systems and the integration with new features. In ARKTRANS Roles, Functions and Data flows are described in detail. One special characteristic of ARKTRANS is the fact that it divides the transport domain into five manageable sub-domains and each sub-domain relates to a limited set of roles, defined objectives, and defined responsibilities (Figure 1). An additional advantage of ARKTRANS is the fact that systems based on it have been implemented successfully (D2D). A closer look to the strengths and weaknesses of ARKTRANS, as they came up during the D2D implementation, could provide useful information to FREIGHTWISE. It is clarified that ARKTRANS is not adopted directly, but the key concepts and methodology could be used as a basis for the development of the FREIGHTWISE Framework architecture. This process is described in more detail in D13.2.

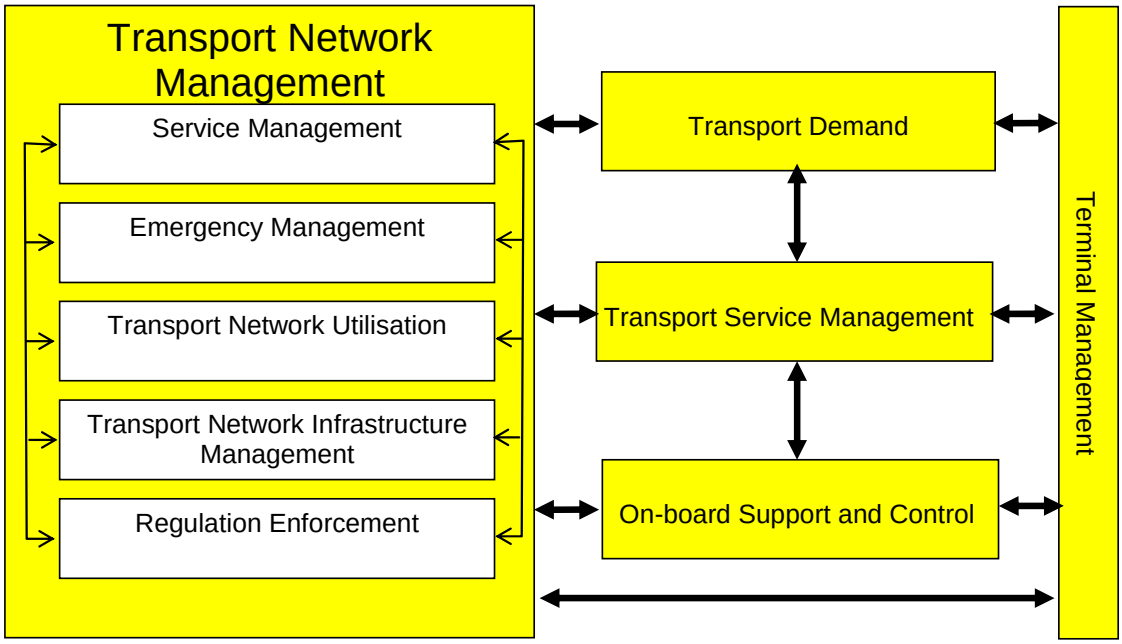

Figure 1. The ARKTRANS Reference Model

2.2. *ARKTRANS Reference Model*

ARKTRANS divides the transport domain into 5 sub-domains. Each sub-domain relates to a set of roles, objectives and responsibilities. The 5 sub-domains are (Figure 2):

- *Transport Demand* – the sub-domain relevant for those in the need for transport. The main role associated with the sub-domain is the Transport User. It supports transport preparation, planning, order initiation and follow-up for freight as well as personnel transport. Functionality needed by both the transport user who wants to travel or to order freight transport and those who are representing the transport user (travel agency, forwarding agent, logistics provider) is provided. Transport chains of variable complexity that may include several transport modes are defined and managed.

- *Transport Service Management* – the sub-domain relevant for those offering transport services. The main purpose is to be able to plan and accomplish transport services based on actual and foreseen demands from the Transport Demand sub-domain, as well as on available infrastructure provided by the Transport Network Management and Terminal Management sub-domains. Routes and timetables are to be planned. A key role in this sub-domain is the Transport Service Provider.

- *On-board support and control* – the sub-domain relevant for those operating vehicles. Crew is one important role here. In the context of FREIGHTWISE, this sub-domain need to be investigated to ensure that vehicle operators are receiving sufficient information for efficient operation and that information about vehicle operations is sent back to the Transport and Handling Management sub-domain to ensure that proper status information is available.

- *Transport Network Management* – the sub-domain related to the transport network infrastructure. This sub-domain addresses those parts of the transport infrastructure that support and control the traffic flow along the transport networks. This sub-domain also takes care of managing any emergencies that need attentions. In relation to FREIGHTWISE the role in this sub-domain of Transport Controller could deal with receiving and processing all mandatory reporting (one example is reporting related to the transport of hazardous cargo).

- *Terminal Management* – the sub-domain related to terminals where goods and passengers enter or leave the transport means, and where cargo and passengers are transferred between transport means. The transport means may represent different transport modes. Terminal operations are planned and carried out, terminal resources are allocated, and so on. For FREIGHTWISE the actual roles and functions from terminal management is merged into Transport Service Management.

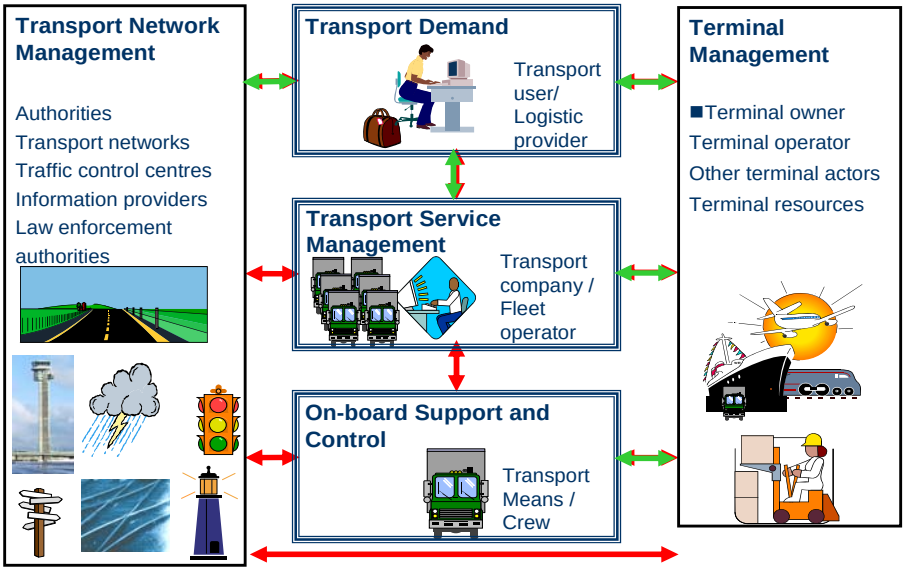

Figure 2. ARKTRANS Sub-domains

2.3. *Roles in ARKTRANS*

The core concept for the roles in ARKTRANS is the “stakeholder”. A stakeholder may be a person, a team, an organization or an institute (which, in general, are region specific) and can be defined by means of one or more *responsibilities* (which are generic and organisation unspecific). The same responsibility can also apply to different types of stakeholders. To end this confusion there is a need to define a unique and consistent set of responsibilities. Using a responsibility as the basic entity we can define roles:

- One responsibility belongs to just one role.
- A role is used as a generic term that implements a particular set of (related) responsibilities.
- Using roles, the responsibilities of stakeholders can be handled in a generic way.
- Stakeholders can fulfil one or more roles.
- Stakeholders with identical responsibilities will implement the same set of roles.

In ARKTRANS, roles are used instead of stakeholder names to arrange for generic specifications:

- A role belongs to just one sub-domain or sub-area in the Reference Model.
- A role represents all stakeholders with the same set of responsibilities. For example the *Transporter* role represents all carriers and describes the carrier responsibilities. Thus, roles make it easier to make references to stakeholders and units in a generic way: It is favourable to use *roles* instead of using the unique labels or names that the stakeholders and units have in the real world. E.g. the role *Transporter* is used in FREIGHTWISE instead of the name of the transport company.
- Stakeholders that implement multiple roles can be handled by focusing on each role separately. A forwarder may for example be a *Transport User Agent* who books transport services on behalf of a Transport User. The same forwarder may also possess the *Transporter* role as the forwarder receives transports bookings from a Transport User that may not know that the forwarder is a forwarder and not the real carrier

ARKTRANS defines about 25 superior roles. In FREIGHTWISE the need to simplify the understanding of the complexity in the freight sector implies that the number of roles in FREIGHTWISE needs to be reduced. This effort is part of D13.2, where the roles in the FREIGHTWISE framework architecture will be finalized. A preliminary list of these roles is provided in Section 4.1 of the present deliverable, while a grouping of these roles is presented in Section 6.2. Furthermore, within D13.2 these roles will be finalized and grouped into a manageable and practical set of superior roles, which will be covered by the FREIGHTWISE framework architecture.

3. Top level model

A set of generic business processes that describe the whole freight transport supply chain is established:

- Transport planning
- Transport execution and
- Transport completion

The generic business processes are divided into sub-processes as seen in Figure 3.

3.1. *Transport Planning*

3.1.1. Transport planning description

A person or a company offering freight transport services publishes the offering services on the Internet.

A consignee or consignor assigns a transport agent or a forwarder to handle a transport. As far as the consignee and consignor are concerned, the transport agent or the forwarder act as the one offering transport services but for the transport operator/carrier the transport agent and forwarder are customers using transport services. The first step for the transport planning will be the investigation about available transport services, their combination into transport chains, the gathering of all the alternatives for the transport and the specification of the transport conditions with those offering the services so that the best alternative can be identified and chosen.

The consignor/consignee (or their representative in organizing their transport) has to define information such as the origin and the final destination of the transport. Additional information about the cargo, such as type of cargo, load unit type (containers, pallets and cartons etc.), volume of the cargo and dates that the transport should be performed, has to be defined as well.

The Forwarding agent searches for all available services meeting the above criteria either directly or combined. Currently, this search has to be made through many different sources, making it tedious, impractical, and susceptible to omissions. After the search completion, a list of one or more services that can be consolidated into chains of transport services bringing cargo from origin to destination is available.

Based on this list of available options, the forwarding agent can have a dialogue with the providers of transport services defining the details of a service and the details of the transport. The forwarding agent can also gather information concerning the alternative routes from other sources. Such information can be weather forecasts, traffic flow and road condition information, Customs fees, legislation governing transports in various countries. This information can be given by a road traffic information centre, the Authorities or a statistics provider. The communication between the forwarding agent and the entities offering the services or the entities offering information can be supported by the FREIGHTWISE Framework. However, it is possible to be done by telephone, fax or e-mail, bypassing the framework.

Top level model

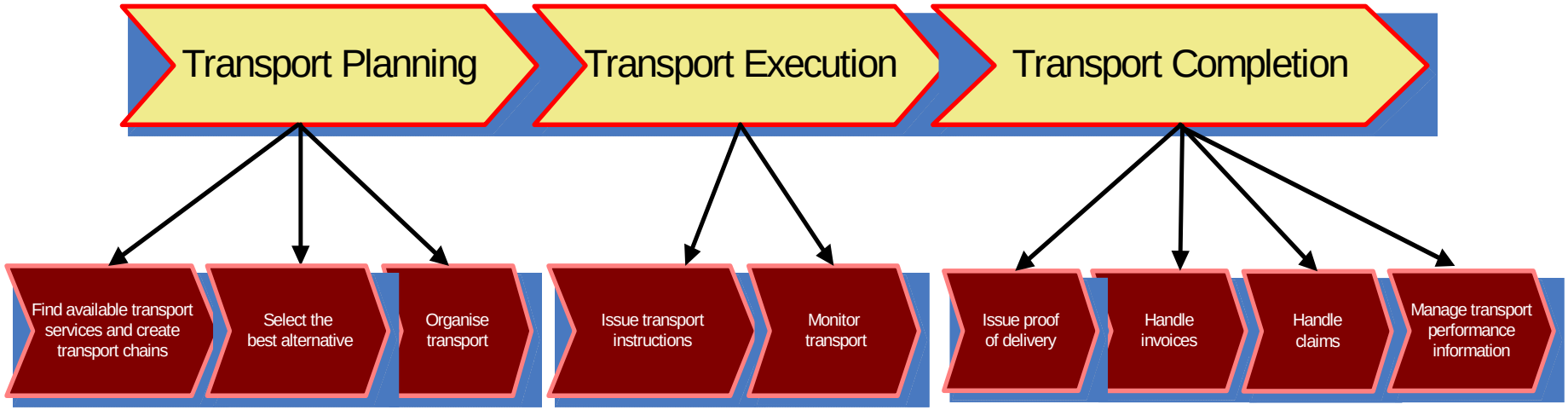

Figure 3. Top level model

After this step and having gathered all the information concerning the alternative transport chains, the best alternative is chosen and the final bookings between the forwarding agent and the service providers take place. The bookings include the contract between the two parties and details about the costs, the management of deviations and the claims that these deviations will entail for the transport provider, the way of exchanging information during and after the transport execution.

3.1.2. Transport planning sub-processes

Upon the previous description the transport planning generic process can be split into the following sub-processes:

- Find available transport services and create transport chains
- Select the best alternative chain, according to consignor preferences (lower cost, time etc)
- Organise transport. Forwarder organises the transport of cargo from source to destination

For a schematic review of Transport Planning see Figures 4-7 (Pages 28-31).

3.2. *Transport execution*

3.2.1. Transport execution description

Following the selection of the best route, the forwarding agent and the service provider(s) continue communicating clearing details of the transport such as providing information about the loading and handling of goods being transferred, especially when the cargo refers to products that need special care (dangerous materials, perishables etc). Documents are exchanged to support the loading and handling of goods. Additional documents are issued to accompany the cargo such as documents needed for the Customs and other authorities. In this exchange of information the consignee and the consignor may have an active role by providing the necessary information or issuing documents.

One result of the negotiation can be the way the forwarding agent will receive information about the status of the transport execution. This depends on the transport that is performed and on the tracking services a service provider offers. The tracking services can vary from a simple notification about the arrival of the cargo at its destination to real-time information about the position and the status of the cargo.

The additional negotiations include discussion about defining deviations, handling deviations and the claims that occur after a deviation.

After all the negotiations have ended and the necessary documents are issued the transport execution begins. During the transport execution and based on the agreements between the involved parties, documents are exchanged regarding the transport status. Additionally a service provider can have a “dialogue” (i.e. exchange of pre-defined sequence of appropriately defined messages) with information providers in order to get information about the transport conditions (traffic, weather, network condition). Based on this information and after agreeing with the forwarding agent the route can be re-planned.

In case a deviation occurs the service provider is informed about it either by his own means, or by the Authorities.

After the estimation of the deviation impact there are four options:

- the service and transport execution continues in the same way; a re-estimation of the service's and transport's route and completion time may take place.
- an alternative route is adopted in case the route condition does not ensure the safety of the transport. The alternative route can be selected with the help of the information providers such as the Authorities, a statistics provider or a road traffic information centre. Re-estimations of service's and transport's completion time are performed.
- a service is cancelled and an alternative route is adopted in case the service cannot be executed. The alternative route can be selected with the help of the information providers such as the Authorities, a statistics provider or a road traffic information centre. Re-estimations of service's and transport's completion time are performed.
- the transport is cancelled in case a severe damage either in the freight or in the means of transport carrying the freight occurred or there is no way continuing the transport.

The FREIGHTWISE Framework can be the backbone of the Transport execution. It can provide the framework through which most of (ideally all) the information concerning the status of the transport could be exchanged.

3.2.2. Transport execution sub-processes

Upon the previous description the transport execution generic process can be split into the following sub-processes:

- Issue transport instructions. Transport Users and Transport Service Providers exchange information to each other throughout the execution of the transport
- Monitor transport. This sub-process is focused on the cargo in such a way that damage and irregular or dangerous situations can be detected and if possible averted

A schematic review of Transport Execution is presented in Figures 8 and 9 (Pages 32-33).

3.3. *Transport completion*

3.3.1. Transport completion description

The transport is completed in two ways. Either the freight is transferred at its destination or due to problems and/or deviations the transport was cancelled.

In the first case, after the freight has arrived in the consignee premises, the service provider issues a proof of delivery document. The service provider prepares and sends an invoice to his customer. In case the transport is completed but deviations occurred there can be claims from the customer's side. A dialogue takes places where the two parties, based on the contract they signed during transport planning, negotiate on the claims. The contribution of Authorities or entities ensuring a fair judgment may be required during these negotiations.

In case the transport was cancelled and there is no chance of repeating it the service provider and his customers negotiate on the claims as described above.

At this phase statistic information regarding the transport can be gathered and send to a Statistics Service Provider or to other entities processing transport data.

3.3.2. Transport completion sub-processes

Upon the previous description the transport completion generic process can be split into the following sub-processes:

- Issue proof of delivery. The transport user receives a proof of delivery message from the transport service provider
- Handle claims. If claims have occurred a claim process between the transport service provider and the transport user will take place
- Handle invoices. The transport service provider is sending an invoice to the transport user containing payment information about the transport
- Manage transport performance information. After the completion of a transport, information about the transport process may be gathered for statistics reasons

For a schematic review of Transport Execution see Figures 9 and 10 (Page 34).

4. Actors and roles model

The actors and roles model presents in a tabular format the roles involved in the freight transport and the processes in which each of these roles is involved.

4.1. *Roles description*

The detailed roles identified in the actors and roles model are:

Consignee: the person to whom the shipment is to be delivered.

Consignor: the person sending a shipment to be delivered whether by land, sea or air.

Forwarding Agent: the person/enterprise responsible for organising the transport on behalf of a consignor or a consignee. Thus, the forwarding agent can act as service provider (for the Consignor and the Consignee) and as a transport user (for other Transport Service Providers) as well.

Transporter: the person/enterprise that performs the transport service (shipping line, truck company, rail freight company).

Transport related service provider: person/enterprise that performs transport related services (warehouse services).

Transport infrastructure provider: Responsible for a transport network infrastructure.

Terminal: a facility where cargo is transhipped between different transport vehicles, for onward transportation. The transhipment may be between ships and land vehicles (trains or trucks) or between land vehicles.

Statistics provider: responsible for providing and collecting statistic information concerning transports. It can be an authority or a private enterprise.

Road traffic information centre: responsible for providing information about traffic conditions (traffic flow, traffic network condition).

Authorities: public authorities, public agencies or officials responsible for the application and enforcement of the laws and regulations (Customs, Police) and for providing helpful information (statistics, weather forecast).

The above list comprises a preliminary description of roles in the transport freight domain, while in subsection 6.2 a first grouping of these roles is attempted. In D13.2 these roles will be finalized and grouped into a manageable and practical set of superior roles in order to be integrated into the FREIGHTWISE Framework architecture.

4.2. *Actors and roles model of each generic process*

As mentioned before, the whole freight transport supply chain is broken into three generic business processes:

- Transport planning
- Transport execution and
- Transport completion

Each of these processes involves different types of actors.

The way that it was adopted for performing the actors and roles model is the following: For each one of the generic processes a table was created that contains the following data: the detailed processes that make up a generic process and the role involved in these processes. In some cases the detailed processes have been grouped to show the correspondence between the generic processes and sub-processes described in the top level model and the detailed processes of the Actors and Roles model.

In this way a first grouping of the roles in the FREIGHTWISE framework was performed. However a more descriptive and organized grouping of roles is taking place in WP13

A cross (+) sign in the junction of a role line and a process column indicates that a role is involved in the specific process.

4.2.1. Transport planning actors and roles model

The transport planning actors and roles model is shown in Table 1. The transport planning generic process is split in the following set of detailed processes.

Publish a service: Make a service available to transport service users. The offered transport services will be published in a Transport Services repository from where it will be available to transport service users.

Assign a transport: A consignee or a consignor assign an agent or a forwarder to carry out a transport, providing him with the necessary information (origin, destination, cargo, dates etc).

Search available services matching the transport needs: The agent or forwarder acting on behalf of the consignee/consignor is searching to find suitable available services for the transport he wants to carry out.

Link the services into transport chains: Having found the suitable services the forwarding agent links the services in order to make up the whole transport chain. It would be interesting to have the FREIGHTWISE Framework provide a mechanism for performing this task.

Request information about a chain: Once the chains are created the forwarding agent can gather information about a chain in order to find out if this chain can cover the transport needs.

Supply information about a service: A service provider gives information about the service that is offered.

Supply information about traffic conditions: Infrastructure information providers provide information about the traffic conditions of a route.

Supply information about the service provider profile: A service provider gives information about his profile. Information about a service provider profile can be gathered from other resources that keep transport data as well.

Supply information about the weather conditions: Infrastructure information providers give weather forecast information.

Supply information about Customs and transport legislation: Information providers provide information about Customs (Customs fees) and laws referring to transports.

Select a set of best alternatives: Given the set of transport chains available and based on the information gathered a set of the best alternatives is chosen.

Make negotiations to find the best alternative: The forwarding agent negotiates with service providers in order to find the best alternative.

Make bookings: Make the necessary bookings for a service.

Process	Publish a service	Assign a transport	Search available services matching the transport needs	Link the services into transport chains	Request information about a chain	Supply information about a service	Supply information about the service provider profile	Supply information about traffic flow and traffic network conditions	Supply information about weather conditions	Supply information about Customs and legislation	Select a set of best alternatives	Make negotiations to find the best alternative	Make bookings
Process group			Search available services and create transport chains		Find a set of best alternative chains							Find the best alternative and make bookings	
Role													
Forwarding Agent	+					+	+			+			
Transporter	+					+	+			+			+
Transport related service provider	+					+	+			+			+
Transport infrastructure provider	+					+	+	+		+			+
Terminal	+					+	+			+			+
Consignee		+											
Consignor		+											
Forwarding Agent		+	+	+	+						+	+	+
Statistics provider						+	+	+					
Road traffic information center								+	+				
Authorities								+	+	+			

Table 1. Transport planning actors and roles model

4.2.2. Transport execution actors and roles model

The transport execution actors and roles model is shown in Table2. The transport execution generic process is split in the following set of detailed processes.

Issue freight handling instructions: The consignor, the consignee or the forwarding agent issue instructions about the freight loading/unloading and handling of the cargo that are given to the Transport Service provider.

Issue the documents that are necessary for the authorities: The consignor, the consignee, the forwarding agent or the service provider issue the documents required by the Authorities (Customs, Environmental Authorities, Police) and that will follow the cargo until its arrival at the destination.

Activate service execution: service provider after having made all the necessary preparations gives the order for the service execution to begin.

Supply information about traffic conditions: Information providers provide information about the traffic conditions of a route.

Supply information about weather conditions Information Providers give weather forecast information.

Supply information about transport status: Service providers provide information about the transport status. Such information can be the position and the condition of the cargo or a deviation that occurred

Detect deviation: A deviation is detected.

Detect and estimate deviation damage: The consignee, the consignor, the forwarding agent, the service provider or the Authorities, detect the damage that this deviation has caused and make an estimation of its impact.

Cancel the service execution: Depending on the deviation that occurred, the service execution is cancelled.

Cancel the transport: Depending on the deviation that occurred, the transport is cancelled

Adopt alternative route: Depending on weather and traffic conditions or on a deviation that occurred, an alternative route is selected.

Re - estimate predictions: After a deviation occurred or an alternative route was selected the service provider re – estimates the time that the service or a transport will be completed.

Process	Issue freight handling instructions	Issue the documents that are necessary for the Authorities	Activate service execution	Supply information about traffic conditions	Supply information about weather conditions	Supply information about transport status	Detect deviation	Detect and estimate deviation damage	Cancel the service execution	Cancel the transport	Adopt alternative route	Re-estimate predictions
Process group	Issue transport instructions			Monitor transport			Manage deviations					
Role												
Forwarding agent		+				+	+	+				
Transporter		+	+			+	+	+	+		+	+
Transport related service provider		+	+			+	+	+	+		+	+
Transport infrastructure provider		+	+	+		+	+	+	+		+	+
Terminal		+	+			+	+	+	+		+	+
Consignee	+	+						+	+	+		
Consignor	+	+						+	+	+		
Forwarding agent	+	+						+	+	+		
Authorities				+								
Statistics provider				+								
Road traffic information center				+	+							
Authorities					+		+	+	+	+		

Table 2. Transport Execution Actors and Roles model

4.2.3. Transport completion actors and roles model

The transport completion actors and roles model is shown in Table3. The transport completion generic process is split in the following set of detailed processes.

Issue proof of delivery: The service provider issues a Proof of Delivery document in order to prove to his customers that the service requested has been completed.

Specify claims on damages: In case a damage or a deviation occurred, the consignor, the consignee or the forwarding agent, taking into consideration the contract signed between the two parties (user and service provider) specify claims on the damages.

Invoice handling: The service provider, taking into account the transport contract prepares and sends the invoice to the customers.

Collect transport statistics: Statistics providers and Authorities request and collect statistics concerning the transport by the involved parties.

Process	Issue proof of delivery	Check for deviations	Specify claims on damages	Invoice handling	Collect transport performance data
Process group		Manage invoices and claims			
Roles					
Forwarding agent	+	+		+	
Transporter	+	+		+	
Transport related service provider	+	+		+	
Transport infrastructure provider	+	+		+	
Terminal	+	+		+	
Consignee		+	+		
Consignor		+	+		
Forwarding agent		+	+		
Authorities					+
Statistics provider					+
Authorities		+			

Table 3. Transport Completion Actors and Roles model

5. Functional model

The functional model describes in a generic format the flow of data and information as well as specific functionality of roles. It uses as input information from the actors and roles model that was presented in the previous section. It demonstrates parts of the generic processes described in the top level. Functional model's steps are presented in the following subsections.

5.1. *Publish a service*

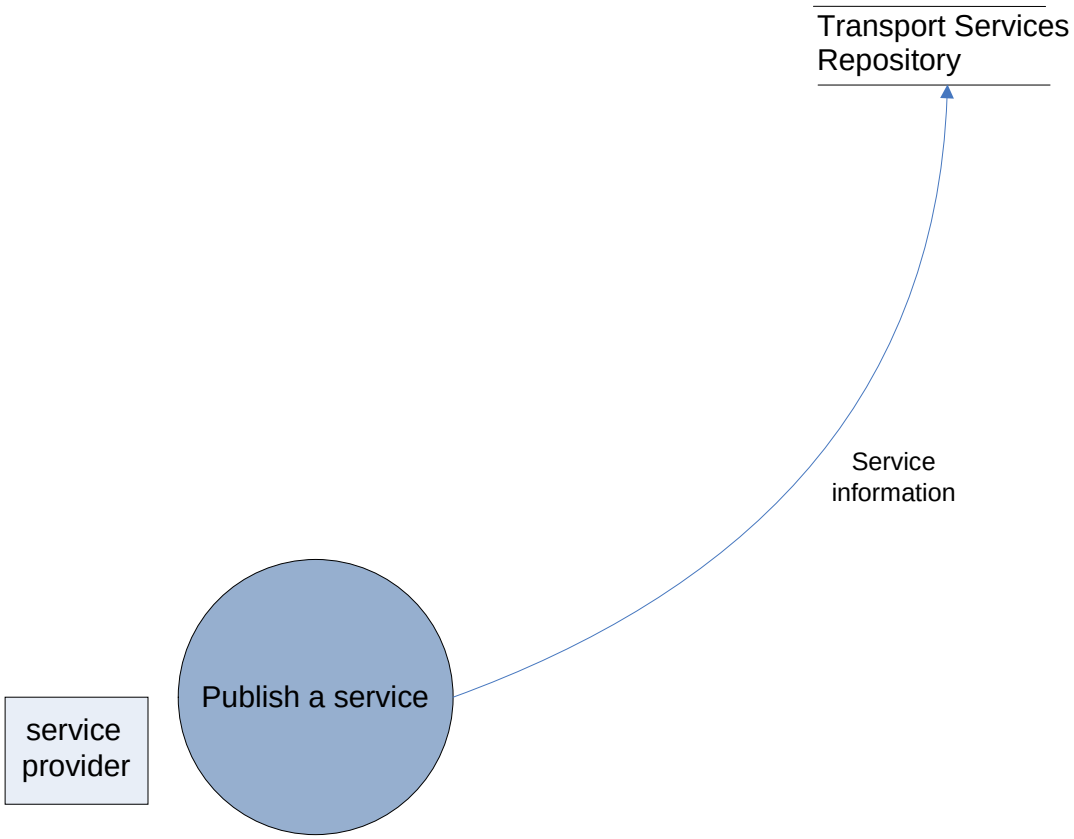

Figure 4. Publish a service

A service provider makes available information about services that he offers. This information can be stored in a Transport Services Repository that will be held and updated by the service provider.

5.2. *Search for available services and create transport chains*

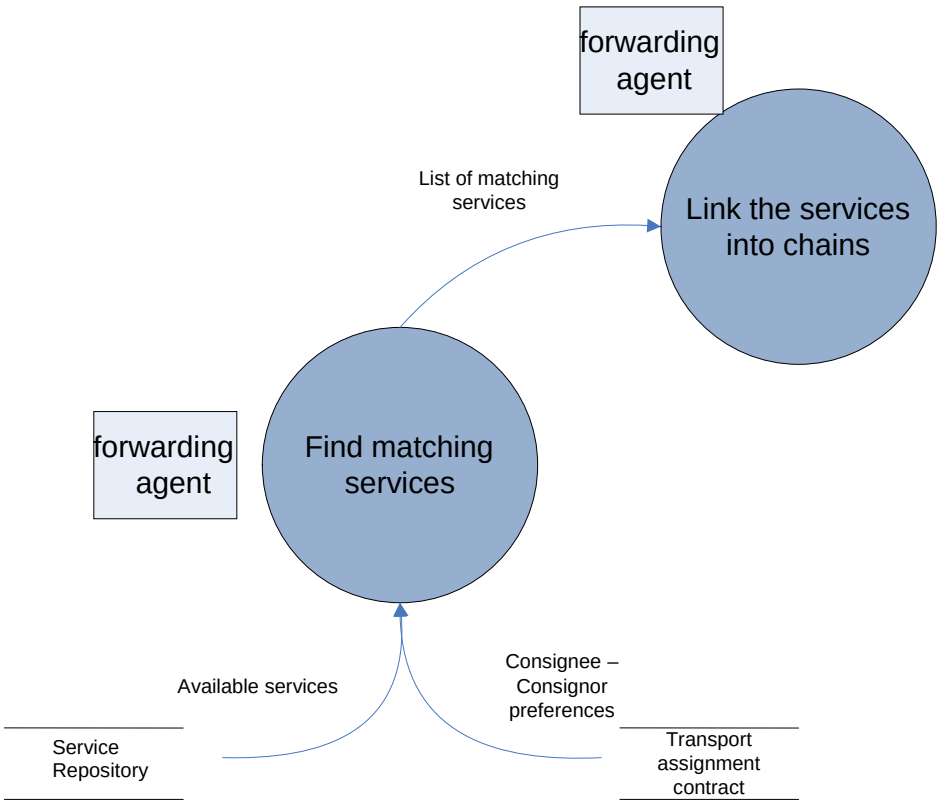

Figure 5. Search for available services and create transport chains

The forwarding agent (acting as a transport user) after collecting the consignee and consignor preferences and by accessing the lists of services provided by the service providers finds services that meet the transport criteria. This list of services is used for creating transport chains.

5.3. *Find the best alternatives*

Having a list of available transport chains the forwarding agent sends a request for information concerning the services of each chain. Requests are send to service providers or information providers, depending on the nature of information the forwarding agent wants to get. The service and information providers send their information to the forwarding agent and the next action is the selection of a set of best alternative chains for the transport.

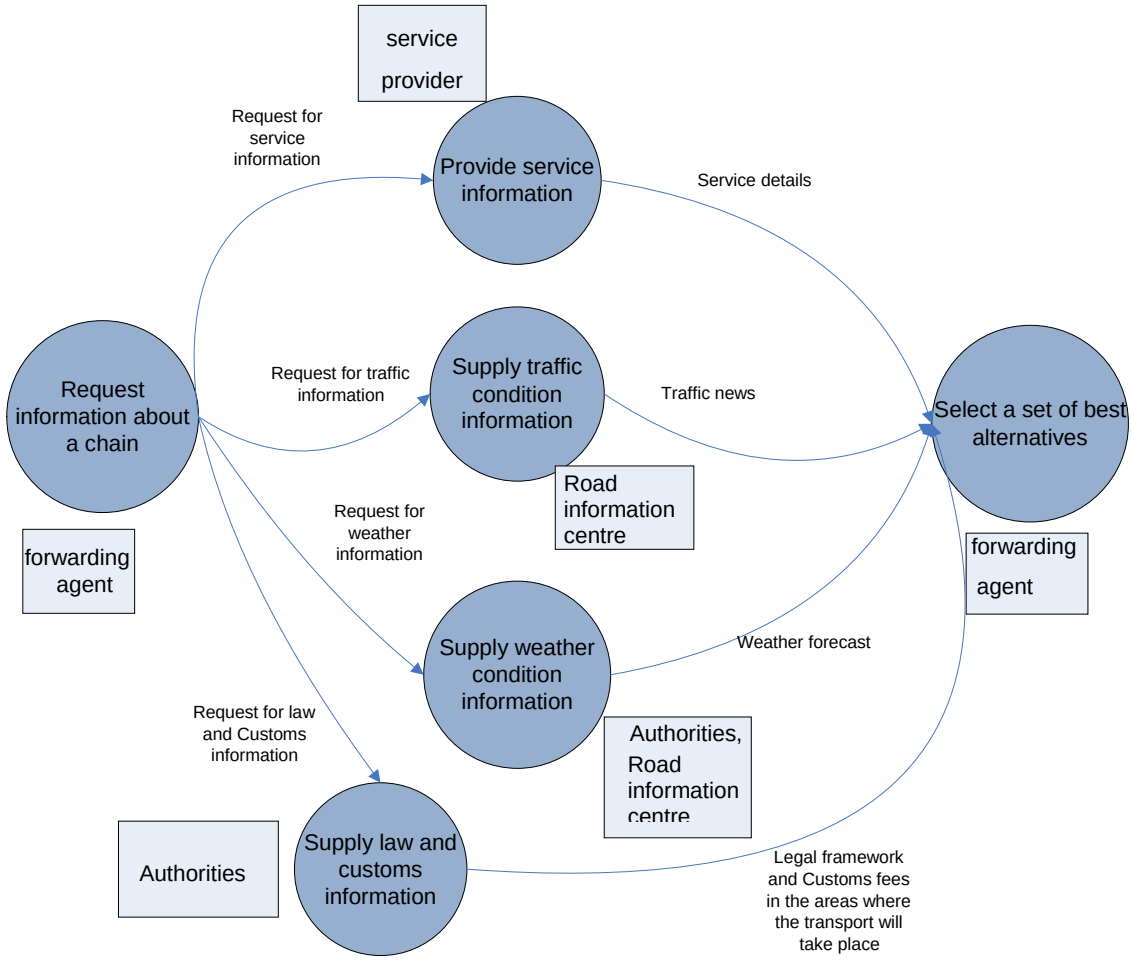

Figure 6. Find the best alternatives

5.4. *Find the best alternative and make bookings*

Having a list of available chains the forwarding agent gets in contact with all the service providers involved in the chains in order to get additional information and the cost of the service (in case it was not defined in the previous steps). The service providers send the forwarding agent the information he requested. Having gathered all the necessary information, the forwarding agent decides on the best alternative and proceeds to the booking. He sends a booking request to the service providers he chose. The service provider either accepts the booking request or rejects it. In case the service provider accepts the booking request he sends a booking confirmation to the forwarding agent who confirms the booking as well. On the other hand, if the forwarding agent receives a booking rejection he selects another chain and proceeds with the booking as described before.

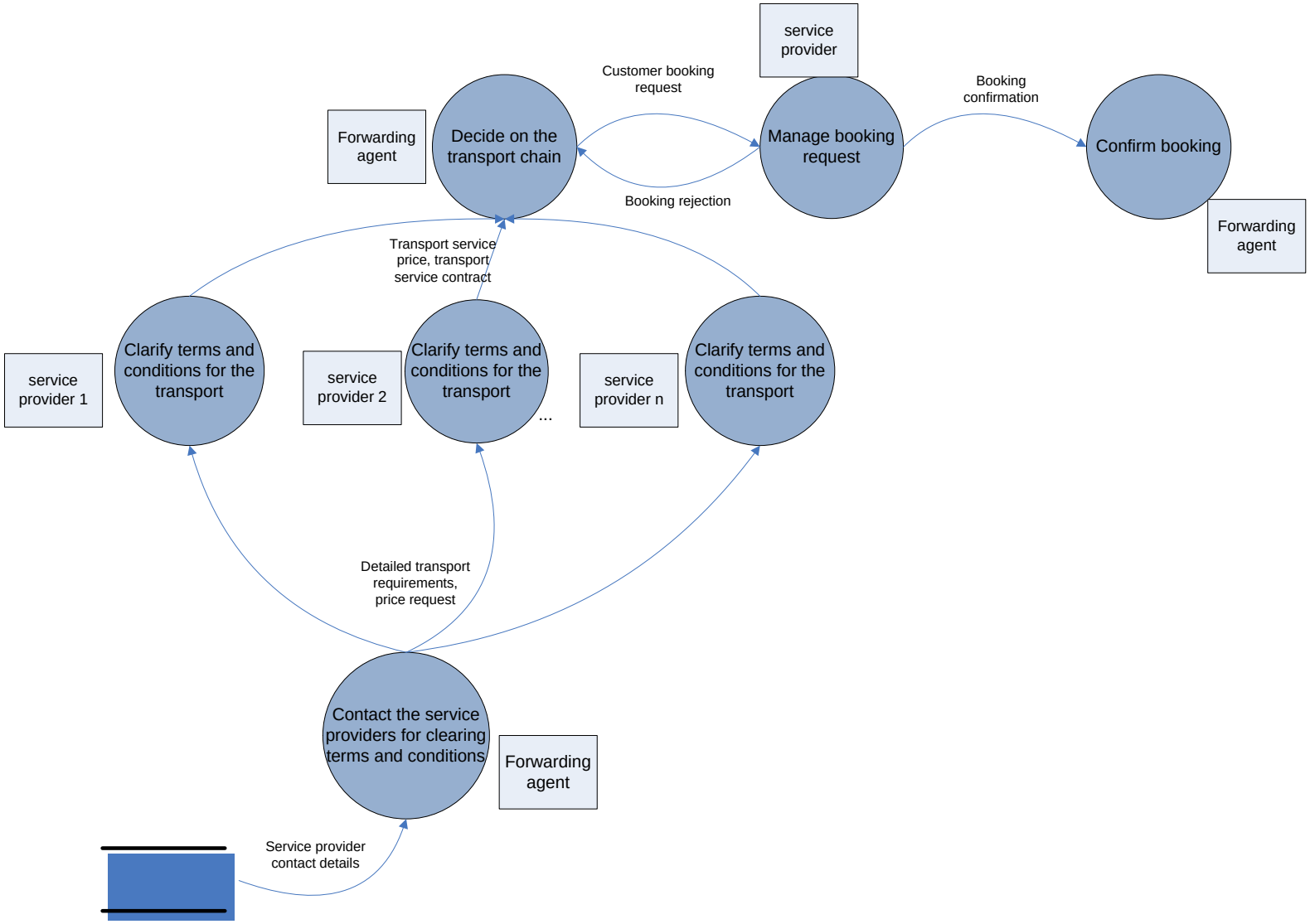

Figure 7. Find the best alternative and make bookings

5.5. *Issue transport instructions and necessary documents*

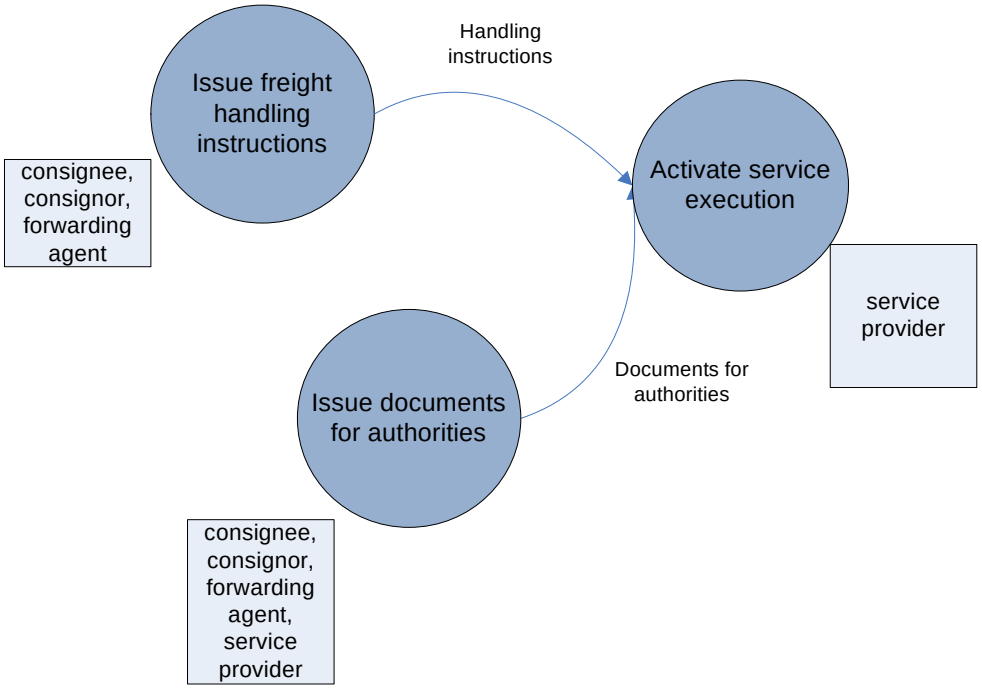

Figure 8. Issue transport instructions and necessary documents

Before the activation of the service the forwarding agent sends handling instructions about the cargo to the service provider. Additionally, the forwarding agent and/or the service provider issues documents that are necessary for the Authorities. Having all these, the service provider starts the service execution.

5.6. *Monitor Transport*

After a service has started the forwarding agent, depending on the agreement he has with the service provider, may request information about the status of the transport (position and condition of the cargo, traffic and weather conditions etc.). The service provider may provide this information on his own depending on the conditions he has to face. The service provider can find the information about where and in what condition the cargo is on his own. Therefore, the only information he may request would be information about weather conditions or information about traffic conditions (if there is too much traffic on a road, if a road is in bad condition or closed etc.) and weather conditions. Having gathered all the necessary information the service provider sends it to the forwarding agent. Depending on the transport status information that he receives from the service provider, decisions are made on going on with the service, finding an alternative route, cancelling the service, cancelling the transport. In case an alternative route is selected, the service provider has to make new estimations about the transport (ETA, cost etc.). In case a deviation occurs, the deviation impact is estimated and there are the same options as before: going on with the service, finding an alternative route, cancelling the service, cancelling the transport.

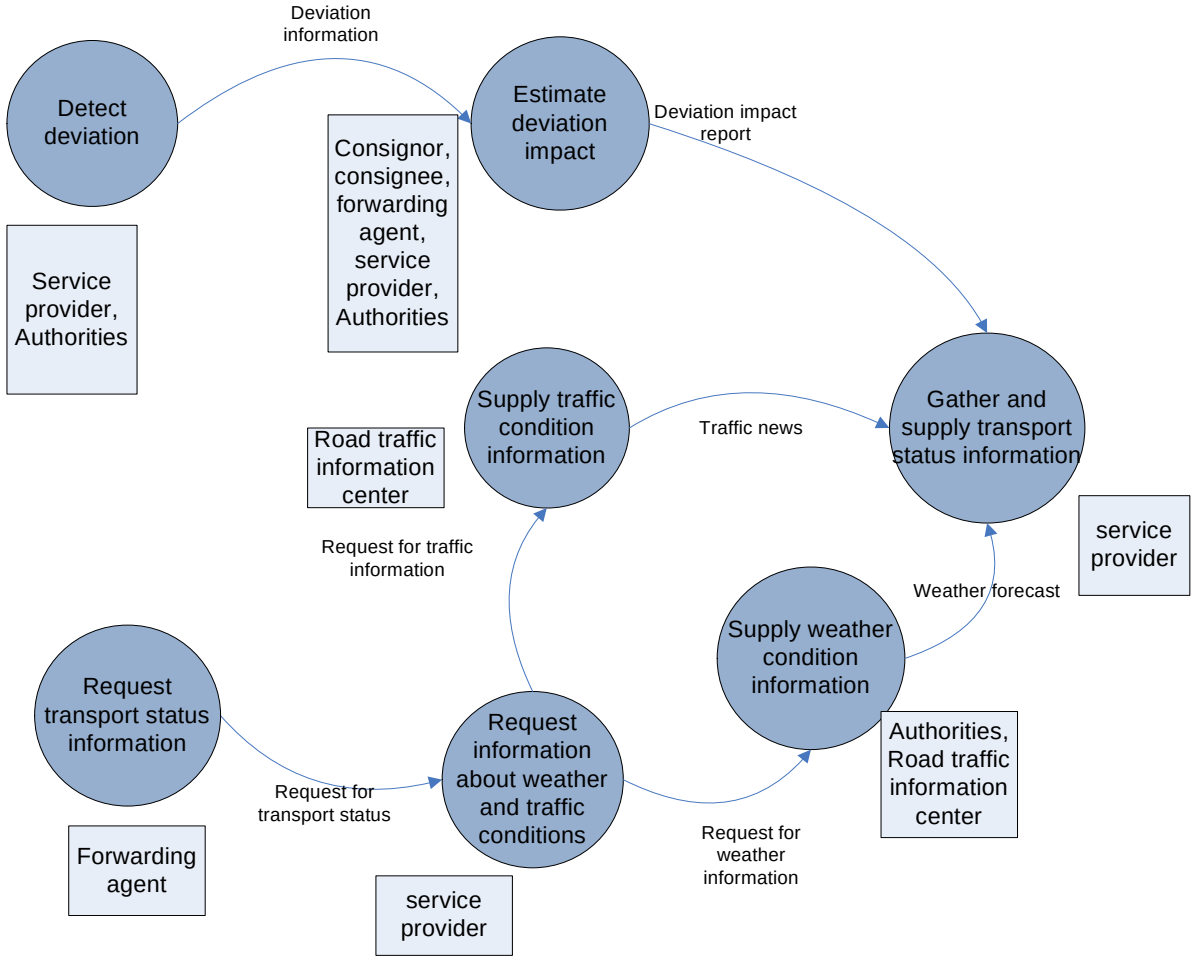

Figure 9. Monitor transport

5.7. *Manage invoices and claims*

After the transport service completion the service provider issues a proof of delivery that is send to his customers. The service provider sends to his customers an invoice about the service payment. By receiving the above documents the consignor, the consignee or the forwarding agent check if there are any contract deviations (for example if the cargo arrived in the desired condition or it is damaged, if it arrived in time etc). In case there are no deviations they proceed to the necessary actions for the payment. Otherwise, they make a list of the deviations that occurred and define their claims. The claims are sent to the service provider and a negotiation starts for defining responsibilities, payments and compensations.

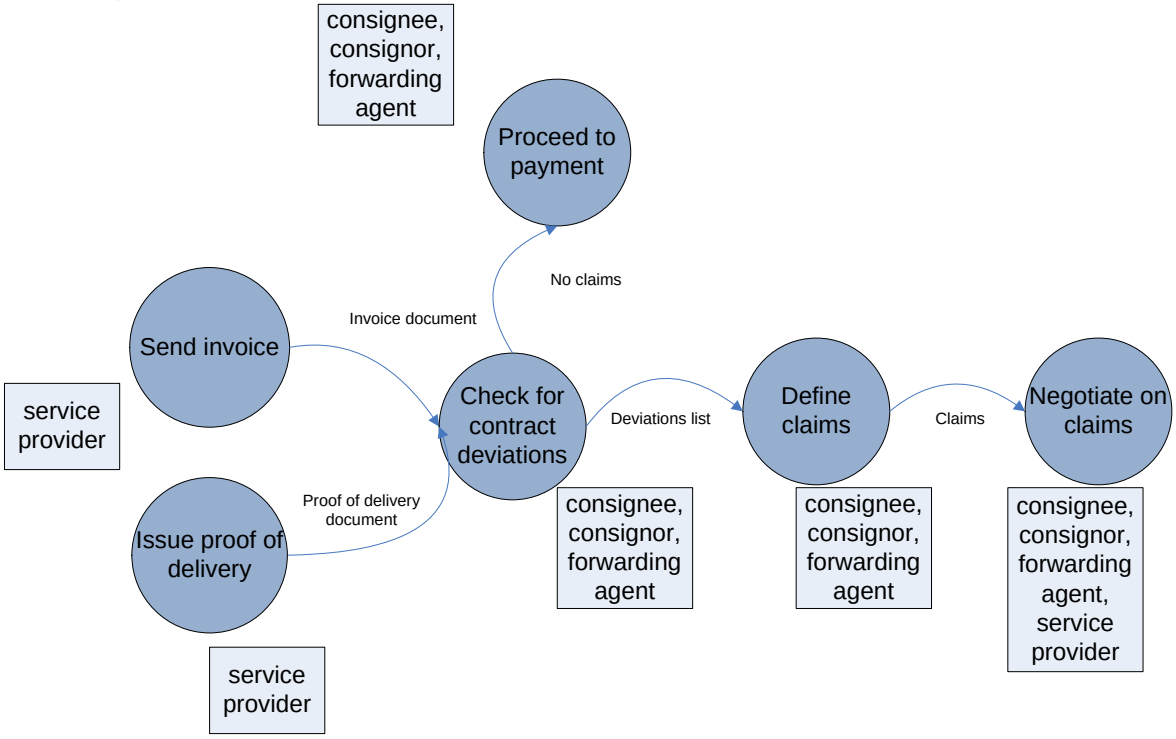

Figure 10. Manage invoices and claims

5.8. *Collect transport data*

After the completion of a transport, a statistics provider or an Authority may request from the parties involved in the transport data used for statistics reasons.

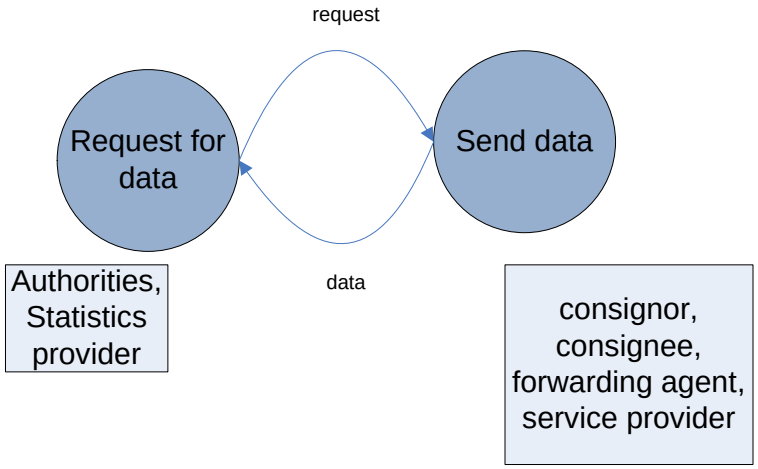

Figure 11. Collect transport data

6. The FREIGHTWISE Framework architecture

This deliverable provides a high-level formal model that can be used as a blueprint for the FREIGHTWISE framework architecture. Based on ARKTRANS' framework architecture, the transport domain was organised into sub-domains (in a reference model) and each sub-domain was decomposed by means of a functional breakdown. The result was a functional hierarchy providing a structure and a terminology for the overall functionality. However, as the overall functionality was decided upon, oriented system specification methodologies were used to specify information, interactions and dependencies.

6.1. *FREIGHTWISE Architecture*

The FREIGHTWISE architecture includes the following components (Figure 12):

- Reference model that defines the overall concepts by dividing the transport domain into sub-domains
- Roles of the stakeholders in the transport domain and objects of relevance are defined
- Functional viewpoint which describes the logical functionality and structure of the sub-domains of the reference model
- Information viewpoint describing the structure, relations and content of information elements as well as the information content that is exchanged between sub-systems
- Process viewpoint describing process scenarios and overall information flows
- Communication viewpoint specifying technical requirements to interfaces, and communication solutions.

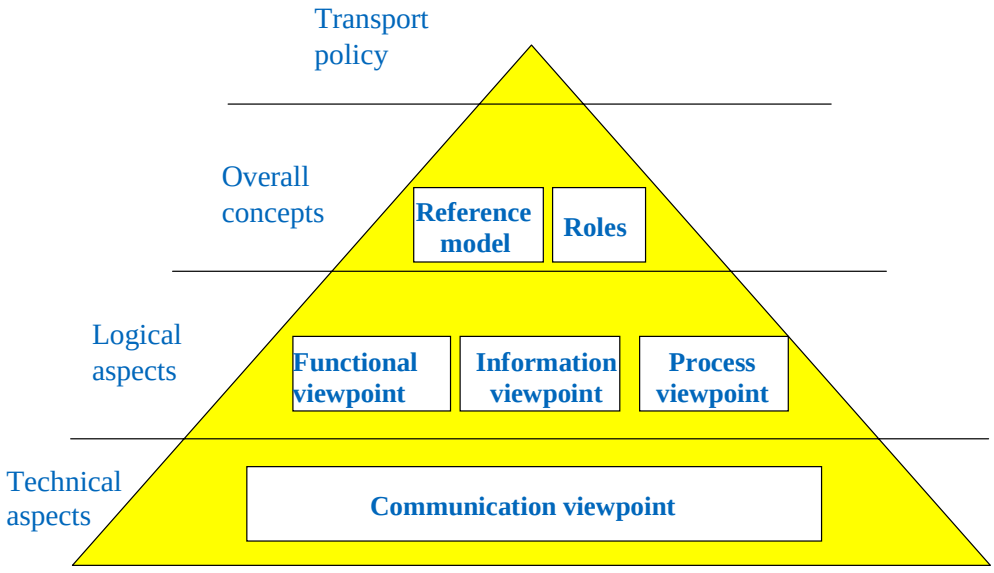

Figure 12. The content of the FREIGHTWISE framework architecture

6.2. *FREIGHTWISE Superior Roles*

From the Actors and Roles Model described in Section 4 it can be observed that we can group the roles that are involved in the Transport domain, as this domain is covered by FREIGHTWISE, in four superior roles; **Transport User**, **Transport Service Provider**, **Traffic Manager** and **Transport Regulator**.

Transport User is the role that is making use of transport services. From the detailed roles described in Section 4, the roles that belong to this category are the consignee, the consignor and the forwarding agent.

Transport Service Provider is the role that provides transport services. This superior role publishes services, organises the transport execution, executes the transport and provides status information concerning the transport. Detailed roles mentioned in Section 4 that belong to this superior role are Forwarding Agent, Transporter, Transport Related Service Provider, Transport Infrastructure Provider and Terminal.

Traffic Manager is the role that provides information concerning the transport network and manages the transport network. Detailed roles of this category are Transport Infrastructure Provider, Road traffic information centre, Statistics Provider and the Authorities.

*The Transport Regulato*r role ensures that all the activities concerning a transport are taking place within a specific regulatory framework. The authorities (the Customs and the Police) are detailed roles of this category.

The above mentioned detailed roles that belong to the superior roles are still generic. During the FREIGHTWISE project and especially within the different Cases probably many other detailed roles, new or further detailed, will appear.

As in ARKTRANS there is no exclusiveness in the participation of a detailed role in a superior role set. There are detailed roles that can belong to more than one superior role. The forwarding agent for example can be Transport Service Provider as far as the services he offers to a consignee are concerned but he is a Transport User since he uses the services offered by a transporter.

6.3. *FREIGHTWISE Reference Model*

The reference model divides the freight transport domain into manageable sub-domains and defines necessary interactions (Figure 13).

The FREIGHTWISE reference model is based on that of ARKTRANS' as it is described in Section 2. Nevertheless, the FREIGHTWISE reference model is focused on intermodal freight transport.

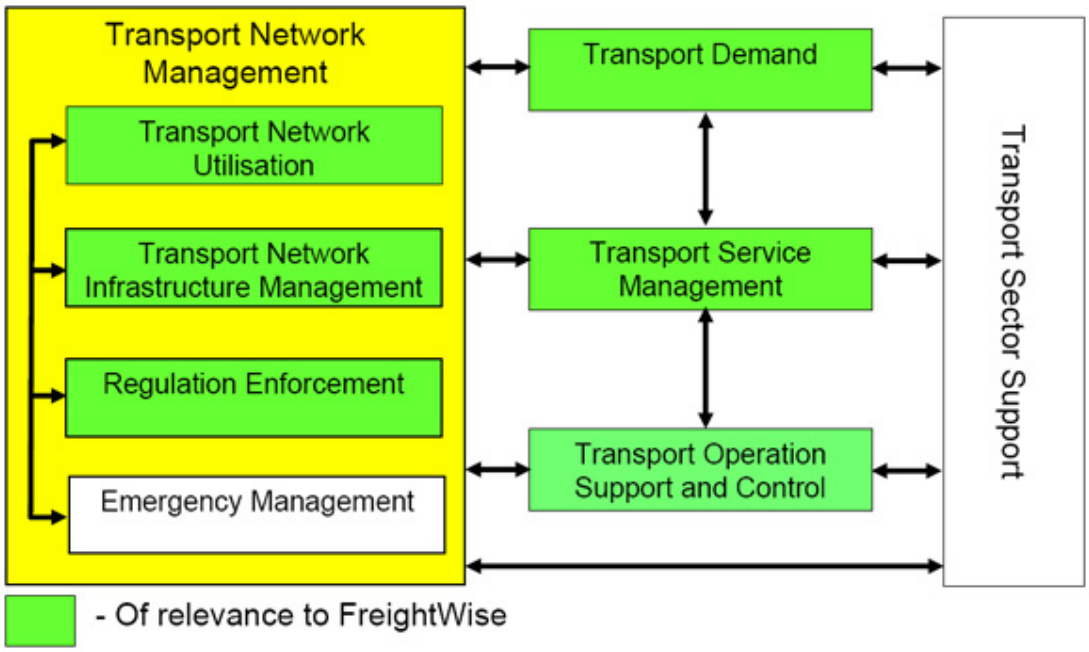

Figure 13. FWF Reference Model

The reference model shows the complete picture of the freight transport sector, but focuses on the sub-domains that are relevant to FREIGHTWISE. The relevance to FREIGHTWISE were derived by D12.3 Requirements Handbook and the analyses that proceeded in Sections 3, 4 and 5 of the current document.

These sub-domains are Transport Demand, Transport Service Management, Transport Operation Support and Control and Transport Network Management. The latter is divided in Transport Network Utilisation, Transport Network Infrastructure Management and Regulation Enforcement. These important sub-domains and sub-processes for FREIGHTWISE are green in the reference model:

- *Transport Demand* is the sub-domain relevant for those in the need for transport. The FREIGHTWISE role associated with this sub-domain is the Transport User.

- *Transport Service Management* is the sub-domain relevant for those offering transport and cargo handling services. Transport Service Provider is the important FREIGHTWISE role for this sub-domain.

- *Transport operation support and control* – This sub-domain refers to the operations taking place during the execution of the transport and mainly to the information concerning the transport operation status. All the superior roles are involved in this sub-domain.

- *Transport Network Infrastructure Management* and Transport Network Utilisation consist the sub-processes where operations concerning the transport network condition and forecast as well as operations concerning traffic control take place. The superior role involved mainly in these processes is the Traffic Manager.

- *Regulation enforcement* refers to the actions taken to ensure that all the rules and regulations are complied with in transport. In relation to FREIGHTWISE the role in this sub-process of the Transport Regulator deals with receiving and processing all mandatory reporting (e.g. reporting related to the transport of hazardous cargo).`

FREIGHTWISE reference model is described in more detail in D13.2.

6.4. *Information Exchange*

The sub-domains displayed in the FREIGHTWISE Reference Model relate to each other, exchange information and provide services to each other. The functionalities in two sub-domains may represent two sides in a business-to-business interaction. E.g. the Transport Demand sub-domain will order transport services, while the other side represented by the Transport Service Management sub-domain will accept and process the orders.

Functionality provided by one sub-domain may also be the basis for functionality in other sub-domains. E.g. tracking information collected by tracking technology on-board the transport means (Transport Operation Support and Control) may support the management and tracking of fleet resources in the Transport Service Management sub-domain. Further on, such tracking information can be passed to the Transport Demand sub domain and provide the Transport User (a consignor, consignee, etc.) with status and tracking information for the cargo on its way towards its destination.

The information exchanged as it is described visually in section 5 Functional Model of the current document can be grouped in a set of information objects, blocks of information containing specific information elements - attributes. The use of information objects can simplify significantly the exchange of information in the transport domain and enforce the standardisation to the communication between the different superior roles of FREIGHTWISE. The information objects, that are identified and will be further elaborated within WP13, are the following:

- A basic information object is the one containing the information concerning a transport service offered by a transport service provider (Figures 4, 5). This object can include all the information that is needed by a transport service user in order to decide whether this service covers his needs or not. Such information can be a description of the service, the geographic area in which the service is available, the service provider, the means of transport involved, the charge for the service and many other details.

- Another information object is the information describing the service agreed by the service provider and the service user (Figure 7). This information object can contain information such as the time the service execution will start, the location that it will take place or the starting and ending points, its duration, general contract terms etc.

- Another information object is the information concerning the status of a transport service exchanged between a service user and a service provider (Figure 9).

- The network and traffic status may be another information object (Figure 9).

- Another information object is the transport operation status that describes the information exchanged between the traffic manager and the transport service provider (Figure 9).

- The hazardous goods authorisation and the taxes and customs declaration could also become information objects. In both objects there must be a description of the transport item – cargo, the item’s owner, its destination and perhaps its use.

- Finally the statistics gathered by the transport service provider and/or the transport user could result in a statistics information object (Figure 11).

A centralised environment acting as an information objects repository would provide many benefits in terms of implementation and efficiency. It would enforce the standardisation of information objects by preventing their abuse and it would provide a user friendly way of using and managing the information objects. Such a repository would not only store the structure and requirements of each information objects but would also guide the users on how to populate an information object and how to use it.

Accordingly, the services offered by the transport service providers can be gathered into a services repository. The two repositories (information objects and services) can be linked in order to provide an integrated environment for the FREIGHTWISE Framework.

7. Conclusion

In this deliverable a High Level formal model to be used as a blueprint for the development of the FREIGHTWISE framework architecture in WP12 was presented. This model relies heavily in information gathered from previous deliverables and especially D12.1 and D12.3.

The High level Formal Model consists of:

- A top-level model.
- Actors and roles model.
- Functional model.

In the top-level model a mapping of the intermodal freight transport domains to generic functions was made. There were three main functions identified: transport planning, transport execution and transport completion.

In the Actors and Roles model a mapping of roles identified in the freight transport chain to functions of the freight transport chain was made. The work done in this deliverable was made in a rather generic and non-restrictive way. Deliverable 13.2 will provide a thorough description of roles in the FREIGHTWISE Framework and the relation between ARKTRANS and FREIGHTWISE roles.

The functional model presented in a generic format the flow of data and information in relation to the functions identified in the previous models. This provides a useful, high-level representation of the key functions of the intermodal transport chain and can be used by subsequent WPs to develop more detailed representations.

The analysis of the previous sections led to a higher level of the FREIGHTWISE Framework Architecture. The FREIGHTWISE superior roles are derived by a grouping of the detailed roles of the High Level Formal Model. The creation of the FREIGHWISE Reference Model is influenced by the ARKTRANS Reference model. However, some sub-domains or sub-processes of ARKTRANS are not relevant to FREIGHTWISE. Additionally there was need for the creation of new sub-domains not existing in ARKTRANS in order to describe FREIGHTWISE processes. Finally the document introduces the notions of information objects, information objects repository and transport services repository for the exchange of information, concepts that will be further detailed within WP13 and 15.