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Disclaimer

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Smart-Rail consortium
Document information

Additional author(s) and contributing partners

<table>
<thead>
<tr>
<th>Name</th>
<th>Organisation</th>
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<tbody>
<tr>
<td>Joshua van Buuren</td>
<td>Panteia</td>
</tr>
<tr>
<td>Konstantina Laparidou</td>
<td>Panteia</td>
</tr>
<tr>
<td>Susana Val</td>
<td>ZLC</td>
</tr>
<tr>
<td>Milos Milenkovic</td>
<td>ZLC</td>
</tr>
<tr>
<td>Jarco Grapendaal</td>
<td>Seacon</td>
</tr>
<tr>
<td>Joris Tenhagen</td>
<td>Seacon</td>
</tr>
<tr>
<td>David Krásenský</td>
<td>Abirail</td>
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<td>Maria Rodrigues</td>
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<tr>
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<td>Paul Tilanus</td>
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Executive summary

In order to facilitate modal shift from road to rail, as set out in the European Commission’s White Paper on Transport, the rail freight sector faces the challenge of providing the capacity for affordable and attractive services. The complexity of the European rail sector hampers the development of such services. Smart-Rail intends to define, implement and monitor new shipper-oriented rail freight concepts improving the competitive position of the rail sector through a Living Lab approach.

This Work Package aims to improve the quality of rail services by reducing round-trip times, better rail capacity use, improving reliability and reducing transport costs. To this end, the existing logistic Control Tower IT-tool, which at present does not cover rail transport, will be extended with a rail freight service add-on: Control Tower Rail (CT-Rail). This will be carried out through a Continuous Improvement Track. The objective is to expand the use of CT-Rail from one corridor – Bettembourg-Le Boulou – to potential others.

This Work Package proceeds with setting the scope of the Continuous Improvement Track, including the main functions of CT-Rail and corridor selection. Next, an overview is given of existing issues hampering the competitiveness of rail and of measures to improve its position already taken in Europe. Finally, the CT-Rail architecture is derived.

Challenges for the competitiveness of the rail sector, as derived from Work Package 2.1 and stakeholder consultation, primarily concern reliability, costs and visibility. As to the first, a striking similarity with the results from Work Package 8.1 is that reliability of (ad hoc) train paths is found to be of great concern. Existing measures are present in European projects such as CREAM, BRAVO, FLAVIA and described in this deliverable. The Control Tower concept should provide for: data sharing platform, common semantics, and a governance model for data sharing.

The CT-Rail will be based on (re)use of existing systems and interfaces between systems that control different parts and levels in the supply chain. The core solution interfaces are being developed in Work Package 5 and they will be adapted for this CIT and described in detail in D7.3.

The common semantics that are needed pertain to timing (ETA, ETD), real times (arrival and departure), train location, speed and velocity, and train composition. Finally, the governance model for data sharing should stipulate clearly which data will be shared and under which circumstances in this Continuous Improvement Track.
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# Definitions & Abbreviations

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<td>CIT</td>
<td>Continuous Improvement Track</td>
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<td>CT-Rail</td>
<td>Control Tower Rail</td>
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<tr>
<td>ETA</td>
<td>Estimated time of arrival</td>
</tr>
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<td>ETD</td>
<td>Estimated time of departure</td>
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<tr>
<td>GSM</td>
<td>Global Positioning System</td>
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<tr>
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<td>Global System for Mobile communications</td>
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<td>Infrastructure managers</td>
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<td>IT</td>
<td>Information Technology</td>
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<td>LSP</td>
<td>Logistic Service Provider</td>
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<td>RU</td>
<td>Railways undertaking</td>
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<td>SCT</td>
<td>Synchro-modal Control Tower</td>
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<tr>
<td>TCO</td>
<td>Total cost of ownership</td>
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1 Introduction

1.1 Background Smart-Rail

The current European rail freight market is a complex system involving a great number of different public and private stakeholders, such as infrastructure managers, rail operators, terminal operators and freight forwarders who jointly manage the operation of running trains from A to B. This complexity in the rail sector hampers the development of efficient and competitive rail freight services. Smart-Rail intends to contribute to the European policy targets by defining, implementing and monitoring new shipper-oriented rail freight concepts improving the competitive position of the rail sector. In addition, the SMART-RAIL project is aligned to the objectives of SHIFT²RAIL and its results will be used, further, in this programme.

To achieve the necessary modal shift from road to rail the rail sector faces an unprecedented challenge of providing the capacity for affordable and attractive services required to enable this modal shift. The objectives of Smart-Rail are:

- to contribute to a mental shift of the rail sector toward a client oriented and supply chain focus;
- to develop working business models for cooperation of different stakeholders;
- to develop a methodology and architecture for exchange of data/information required for the optimisation process, between stakeholders, making use of existing initiatives where available (for instance the European Corridor Management and national logistical information centres);
- to establish three Continuous Improvement Tracks (CITs) that each focus on different aspects and markets and implement the developed tools, methodologies and concepts. The purpose of the Continuous Improvement Tracks is to test and improve the innovative measures in a real life situation. Specific and more dedicated business models, information systems and new rail services will be tested.

Within this Work Package (WP) the objective is to improve the quality of rail services (reduce round-trip times, better rail capacity use, improve reliability and reduce transport costs) in the total supply chain from shippers point of view on a specific European corridor. Furthermore, the objective is to transfer, in a later stage, the solution to other European corridors. In this regard, an add-on for rail freight transport will be added to the currently existing logistic Control Tower. This add-on will be developed and implemented, by means of the Continuous Improvement Track approach. This CIT will use the Seacon Control Tower as starting point for the improvement cycles. Chapter 2 introduces Seacon’s existing Control Tower.

A total of seven tasks were predefined to structure the work in this Work Package:

---

1 SHIFT²RAIL is a rail joint technology initiative focussed on turning research and innovation (R&I) actions to market-driven solutions and accelerating the integration of new and advanced technologies into innovative rail product solutions (http://www.shift2rail.org/).
1. Problem analysis, link with other studies and design of control tower concept;
2. Potential impact of the control tower concept and involvement of participants;
3. Information exchange required for the control tower concept;
4. Alignment of the value case of involved stakeholders;
5. Implementation of the control tower concept and design of monitoring approach;
6. Monitoring and adjustment of the control tower concept;
7. Conclusions and recommendations.

In this task, the aim is to set the scene for this Continuous Improvement Track. Task 7.1, will form the basis for further research on technical and operation measures for implementing an operational Control Tower for rail freight transport. The project team will determine the most relevant challenges to be tackled and propose different measures. In addition, a link will be made to Task 7.2, 7.3 and 7.4 to ensure that all necessary steps will be taken. Final implementation will then take place in Task 7.5.

In this deliverable the analysis done under task 7.1 will be further elaborated and described. Therefore this deliverable may serve interested Logistic Service Providers in their search for applicable solutions and measures to tackle common rail freight. The proposed solution is to implement a rail add-on to an exciting control tower.

Central focus in this task are the challenges that are complementary to implementation of the control tower concept for rail freight transport. In this deliverable the perspective of a Logistic Service Provider is leading. Where possible RUs or IMs were consulted.

The scope of this Continuous Improvement Track will be described in Chapter 2, wherein background information will be made available. A basic description of purpose of a typical Control Tower will be given, followed by information regarding the existing Control Tower.

Chapter 3 will then go into more details on the challenges that exist in rail freight transport. A reference will be made to previous work, done under WP2. However, this time Continuous Improvement Track cases are provided to illuminate in what context these problems come forward.

In close deliberation, the project partners identified different measures to be taken to make the implementation of the Control Tower a success. Chapter 4 will provide an overview with measures that were discussed under different European projects, followed by ideas that came up with during the discussions in Zoetermeer and Den Haag.

A brief description of different measures can be found in chapter 5.
2 Scope of the Continuous Improvement Track

2.1 Concept and base case

2.1.1 Seacon

Seacon Logistics has strategically chosen their warehousing locations throughout Europe, e.g. Venlo, Duisburg, Bremen and Melzo. Seacon’s Headquarters are located in the area of Venlo, which is tri-modal accessible (Road, Rail and Waterways). With its Headquarters in Venlo, many opportunities arise regarding intermodal transport. However, in order to utilise these opportunities in an efficient- and effective way (cost wise, time wise and environmental friendly), IT support is a prerequisite. Therefore, Seacon Logistics started to develop a Control Tower IT tool to manage transport flows between origin and destination.

2.1.2 Existing Control Tower

The current control tower at Seacon Logistics is founded to support the shippers demand for additional transport services.

Traditionally, shippers asked an LSP (logistic service provider) or transport company to transport goods from A to B, requesting for specific conditions (e.g. temperature controlled transport or within a specific time frame). The demand was often based on the shippers’ requirements and resulted in many inefficiencies. In addition, shippers today require more additional services, like real-time tracking and tracing (depends on the type of commodity) and a continue flow of information in case of (un)planned disruptions in the network.

Since many years, a trend is noticeable. Shippers no longer want to focus on the transportation leg of the process, but rather on the manufacturing side (as this is their core business). In order to reduce costs and to focus on their core business, today’s shippers are more and more often outsourcing transport to dedicated third party logistic companies (also LSPs).

In this regard, two types of contracts can be distinguished:

1) Single leg contracts;
2) Multiple legs contracts.

Single leg contracts which are typically booked between two points, e.g. shipper’s manufacturing side to the container terminal or to the distribution centres.

The multiple leg contracts however, are typically used for multimodal transport. Under the condition of one single contract, different transportations are executed, e.g. from the Shipper’s manufacturing side to the container terminal by road, from the terminal to the terminal by rail and from the terminals to the distribution centre by road.

![Figure 1 – Simplified illustration of single leg contracts and multiple leg contracts](image)

However, at this stage the Control Tower is limited to road transport (with a small extension to Inland Waterway Transport). The application of the control tower is for the
single leg contracts, whereas multiple legs contracts may be cut in smaller legs by the system. The current Control Tower covers the following functional areas:

- Arranging transport from A to B as full service;
- Claim management
- Financial reporting
- (Re)planning transport;
- Administration on transport;
- Billing of transport orders;
- Contract management with LSP’s;
- Evaluation of the used LSP’s, KPI steered;
- Monitoring execution (End-to-end visibility);
  - Trucking visibility;
  - Client visibility;
  - Long-haul invisibility.
- Disruption notification to the end client;

2.1.3 Integration with rail freight transport

Integration of the currently existing Control Tower with other transport modes is essential for seizing the opportunities in intermodal transport. This project focusses on the objective to improve the quality of rail freight services as part of the total supply chain.

In this regard, the project team will develop an extension of the current Control Tower IT tool, by means of a specific rail freight service add-on. For this add-on, it was indicated that the data availability for rail transport – compared to road transport – is poor. In order to improve the quality of rail freight services, multiple stakeholder collaboration is necessary.

With full collaboration among the stakeholders, smart interfaces between multiple stakeholders’ data sources to increase quality of today’s rail freight service. The end-product of this Continuous Improvement Track will be a blueprint/guidance for creating interfaces between different sources as input for a “rail freight decision tool” and should be integrated with other planning/decision making tools for other transport modes. The “rail freight decision tool” – as it is aimed for in this Continuous Improvement Track – will support today’s supply chain planners in their daily planning processes, with real time information.

2.2 Control Tower

In this WP the objective is to improve the quality of rail freight services as part of the total supply chain. By means of a Continuous Improvement Track approach, SEACON’s current Control Tower will be expanded by a rail add-on and the expansion is continuously improved, by developing, implementing, testing and evaluating innovative applications for the (Rail) Control Tower.

The Control Tower is a mean to achieve supply chain visibility. Supply chain visibility enables the potential of using (real time) information on three levels of management control [1]:

- Operational (short-term);
- Tactical (mid-term);
- Strategic (long-term).

Although supply chain visibility is considered to be an important objective to be fulfilled by the Control Tower, it should also be considered that not every leg of the supply chain might be of similar interest for improving the quality of rail freight services. The COFRET project analysed a total of ten supply chain cases, none of the test case companies had a full and clear overview of the entire supply chain from the origin to its
final destination. It is therefore that a clear distinction – in Smart-Rail – should be made between supply chain processes/legs that are nice-to-have and need-to-have.

To clarify what a control tower is the following definition is identified:

"A Control Tower is an information sharing platform to support today’s planners in supply chain optimisation and the fulfilment of the shippers’ requirements for supply chain visibility"

To support this, a control tower consists of supportive IT that is used to support day-to-day business in:

1. Decision making tool based on demand and supply:
   a. The choice of transportation mode;
   b. Optimisation of one or more transport mode(s);
   c. Optimisation of the transport routes;
   d. Load unit sequence planning;

2. Ex ante - forecasting tool:
   a. Predict expected Estimated Time of Arrival;
   b. Forecast different relevant factors, e.g. costs, lead time and flexibility;

3. Event management tool:
   a. Alternative route planning in case of disruptions on the network;
   b. Inform proactive on the changes customers on new route.

4. Ex post evaluation tool (reporting):
   a. KPI monitoring;
   b. Evaluation of the costs and time spend;
   c. Evaluation of on time delivery.

---

2 The COFRET project objective is to recommend further steps towards harmonization of the carbon footprint calculation, using the EN16258 standard. For this, a holistic approach was used to identify total carbon footprint in the supply chain.
2.3 Business Model

2.3.1 The spot market, dedicated slots and dedicated train

Within the logistics regarding train transport three main types of services are being used by LSP's. The types of services being used are:

- Spot market
- Dedicated slots
- Dedicated train

These three types are used for different reasons and have their own pitfalls and benefits. The spot market is highly suitable for ad hoc shipments. This is because these types of requests by a client are unregularly - differing from the normal order arrival process - and therefore these types of requests are not plannable upfront. Spare capacity of existing trains can be sold to a LSP that needs ad-hoc a piece of capacity on the train. The payment structure for one load only increases by marginal costs. The financial risk is minimized, however there is always a chance that there is no spare capacity left, so the operational risk is high.

For small volume streams, often a version of dedicated slots is highly effective. It is expected that in a certain time period for sure there is a volume of x number of freight, but the volume is by far not enough to use a dedicated train. So a certain amount capacity is reserved on a train which you have to pay if you use the slots or not. The train leaves every time period and has the reserved capacity available for the LSP that reserved the slots. Free slots can be used for reselling to another LSP, for example to supply capacity for the spot market.

If you have volume streams that are large enough, an LSP can choose for a dedicated train. The train is paid for and it is the responsibility of the dedicated train "owner" to fill the train. Therefore financial risk fully lies with the train "owner", but the server knows for sure that you will have capacity for transport.

2.3.2 Ad hoc and fixed train path

Another important aspect is how the train path(s) are being used and managed. We are discussing them briefly to assess the differences between them and how they affect a rail service. We will not go into detail since train path allocation is something that is arranged by the RU and the IM. The type of path allocation is highly affecting the following indicators:

- Lead time of the train service
- Reliability of the service

Since the route of a train running on ad-hoc path request is highly uncertain, the predictability of such a train type is low. Due to the low predictability, lead times are also highly uncertain. The uncertainty is something that has to be tackled by the RU and the IM. These indicators are logically omitted from here on forward, since in this LL we can only marginal steer on them.

2.3.3 Friction on the span of control path type allocation continuum

Before going further into detail on the span of control dimension, a better understanding on the working matters of the rail industry from an LSP perspective is introduced. As an LSP, the dimensions span of control and type of train path should be considered when selecting rail as a transportation option with regards to the LSP specific organizational indicators. The type of train path(s) and the span of control are highly affecting the working matters and their indicators.
In this LL we will focus at first on the span of control dimension, however some relationships should be clear.

To give a statement on what is desirable and what is not, see Table 1.

**Table 1 Statement on what is desirable or not in paths and span of control.**

<table>
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<th></th>
<th>Spot market</th>
<th>Dedicated slots</th>
<th>Dedicated train</th>
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<td>Ad Hoc path</td>
<td>-</td>
<td>Undesirable</td>
<td>Undesirable</td>
</tr>
<tr>
<td>Prefixed path</td>
<td>-</td>
<td>Desirable</td>
<td>Desirable</td>
</tr>
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As seen in the table, we are not making a statement on the single slot dimension. This is due to the fact that mostly when an LSP uses the spot market (single slot booking) this is...
in an incidental request. Most likely the same slot will not be booked again in the near future.

### 2.3.4 Span of control

The span of control and its pro’s and con’s are already briefly discussed, in this section we try to make them more concrete.

#### Table 2 The span of control and its pro’s and con’s: indicators.

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<th>Indicator</th>
<th>Definition</th>
<th>Answer range</th>
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<tr>
<td>I.1</td>
<td>Control</td>
<td>How much control does an LSP have over the train service</td>
<td>[No, limited, full]</td>
</tr>
<tr>
<td>I.2</td>
<td>Volume</td>
<td>What is the type of volume passing</td>
<td>[single piece, batch, bulk]</td>
</tr>
<tr>
<td>I.3</td>
<td>Monitor</td>
<td>How should you monitor your used rail service</td>
<td>[cargo or train level]</td>
</tr>
<tr>
<td>I.4</td>
<td>Visibility</td>
<td>Is the cargo flow visible?</td>
<td>[invisible, sometimes visible, visible]</td>
</tr>
<tr>
<td>I.5</td>
<td>Cost structure</td>
<td>What type of cost structure is involved</td>
<td>[variable or fixed]</td>
</tr>
<tr>
<td>I.6</td>
<td>Flexibility (train service)</td>
<td>Can you use different moments in time and do they occur often?</td>
<td>[Inflexible, flexible]</td>
</tr>
<tr>
<td>I.7</td>
<td>Flexibility (load handling)</td>
<td>Is there flexibility for load handling</td>
<td>[Inflexible, flexible]</td>
</tr>
<tr>
<td>I.8</td>
<td>Price per unit</td>
<td>Relative price level</td>
<td>[low, medium, high]</td>
</tr>
<tr>
<td>I.9</td>
<td>Operational risk</td>
<td>The risk of your process</td>
<td>[low, medium, high]</td>
</tr>
<tr>
<td>I.10</td>
<td>Financial risk</td>
<td>On disturbance; what is the financial risk</td>
<td>[low, medium, high]</td>
</tr>
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From the stated indicators of span of control we want to give a detailed explanation, starting with the two types of flexibility (I.6 and I.7). The flexibility of the train service is the capability to re-route cargo fast among different trains. While the flexibility among cargo is the capability if the cargo is not on the right place at the right time to replace it with another freight unit.

Another set of indicators (I.9 and I.10) also need in depth explanation. If a dedicated train is operated, in most cases the operator has to pay a fixed amount for running the train between terminal A and terminal B. In literature, it is stated that a train needs 90% wagon utilisation per direction to be profitable. So if a dedicated train is operated, the operator has to have an overall utilisation of the wagons of at least 90%. Falling below the 90% threshold implies an unprofitable train is running. These problems do not occur when booking on the spot market or running your operation with dedicated slots. The operational risk is rather high on the spot market, this is due to the fact LSPs have to find a suitable place, while on a dedicated train you have a wider range of options to delay a less important transport to make room for a more important transport resulting in less operational risk.

The overall stated indicators and their characteristics per train type are shown in Table 3.
Table 3 Indicators and their characteristics per train type.

<table>
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<th>#</th>
<th>Characteristics</th>
<th>Spot market</th>
<th>Dedicated slot</th>
<th>Dedicated train</th>
</tr>
</thead>
<tbody>
<tr>
<td>I.1</td>
<td>Control</td>
<td>None</td>
<td>Limited</td>
<td>Full</td>
</tr>
<tr>
<td>I.2</td>
<td>Volume</td>
<td>single piece flow</td>
<td>Small batch</td>
<td>Bulk</td>
</tr>
<tr>
<td>I.3</td>
<td>Monitor</td>
<td>Cargo/Train</td>
<td>Train</td>
<td>Train</td>
</tr>
<tr>
<td>I.4</td>
<td>Visibility</td>
<td>None</td>
<td>None</td>
<td>Yes, but via workaround</td>
</tr>
<tr>
<td>I.5</td>
<td>Cost structure</td>
<td>Variable</td>
<td>Variable</td>
<td>Fixed</td>
</tr>
<tr>
<td>I.6</td>
<td>Flexibility (train service)</td>
<td>High</td>
<td>Medium</td>
<td>Low</td>
</tr>
<tr>
<td>I.7</td>
<td>Flexibility (load handling)</td>
<td>Low</td>
<td>Medium</td>
<td>High</td>
</tr>
<tr>
<td>I.8</td>
<td>Price per unit</td>
<td>High</td>
<td>Medium</td>
<td>Low</td>
</tr>
<tr>
<td>I.9</td>
<td>Operational risk</td>
<td>High</td>
<td>Medium</td>
<td>Low</td>
</tr>
<tr>
<td>I.10</td>
<td>Financial risk</td>
<td>Low</td>
<td>Medium</td>
<td>High</td>
</tr>
</tbody>
</table>
2.4 Corridor selection

For this Continuous Improvement Track Seacon selected the long distance corridor U.K. – Poland at first. The reason behind this choice was the fact that Seacon organised the corridor completely as an own dedicated block train. However due to macro developments on this corridor such as immigrants and a decrease of volume, Seacon had to stop this service in the first year of this Continuous Improvement Track.

Four alternative corridors have been selected by Seacon, i.e.:

- U.K. – Milano
- Bettembourg – Le Boulou
- Rotterdam – Milano
- Rotterdam – Budapest

These were selected due to the substantial volume Seacon already has or has quick access to. Bettembourg – Le Boulou is the corridor with a high amount of traffic from Seacon and has a frequent connection of three roundtrips per day. It is the corridor where Seacon has good connections with the trucking and railway undertakings which is also an advantage for the research.

The biggest amount of volume which Seacon ships on the Bettembourg – Le Boulou corridor comes from the Ruhr area in Germany and the southern part of the Netherlands. The destinations are for 90% in the Barcelona and Valencia area of Spain. Only around 10% is delivered in the southern part of France. The loads from Le Boulou to Bettembourg follow a similar pattern.

Seacon orchestrates the transport from the loading addresses by truck to the rail terminal, the rail transport from terminal to terminal and the road transport to the unloading location. These facts make this corridor a very promising choice for Continuous Improvement Track 2.

Figure 3 – Overview of the considered corridors for Continuous Improvement Track 2.
3 Problem Analysis (challenges)

3.1 Problems identified

Deliverable 2.1 – Problem analysis has looked into the rail services framework through desk research and expert knowledge (market intelligence). The latter was important as it provided an integrated view from various stakeholders and was not constrained by specific sectors. Desk research on the other hand was used to see what could be reused from previous executed rail freight projects.

In this regard, different indicated problems of the rail sector for freight services were classified according to their impact on the Smart-Rail objectives. Most problems identified affect reliability, flexibility and costs, three very important elements from a client perspective.

There were four main types of problems identified in this study:

- **Operational**, related to interoperability, network capacity and resource utilisation as well as reliability in transfer times (punctuality). This set of issues affects mainly the flexibility (last minute switching so as to get the order on time) and costs (total shipment costs) aspects;
- **Financial**, related to all types of door-to-door costs (network, equipment, services), integrated transportation and information exchange issues. This set affects reliability (delayed freight due to—for instance—coordination issues or flexibility issues), flexibility and the costs of services;
- **Interaction with users/customers** involving information transparency and delivery delays. This set affects all elements: reliability, flexibility, lead time (reduction of waiting times along the routes), visibility (real-time information on the status of the order) and costs;
- **Interaction between stakeholders** addressing standardisation of data and transferability issues, again affecting all elements of Smart-Rail with the exception of lead time.

The following table summarises the problems extracted from D2.1 directly related to the Control Tower concept and Supply Chain Visibility. It briefly describes the problem and links the aspects associated with the problem. In addition a short case practice is provided to indicate the problem in the context of this Continuous Improvement Track.
Table 4 Selection of the Deliverable 2.1 identified “operational” problems.

<table>
<thead>
<tr>
<th>Problems descriptions and short descriptions</th>
<th>Case Practice</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Operational</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Network Capacity</strong></td>
<td></td>
</tr>
<tr>
<td>Increasing the utilisation of capacity throughout networks ensuring higher availability of slots for further traffic. A better understanding of the available capacity leads to improved slot allocation/ a better view of the effects construction works/ interruptions have.</td>
<td>Especially for ad hoc train planning, it is experienced by LSPs that the international time tables do not allow for supply chain optimisation. This is often the case due to shortage in network capacity. In Europe only a few dedicated freight tracks are available, in all other parts the track is also used for passenger transport. The capacity of dense networks, like in the Netherlands and Germany, is often fully utilised, which means that ad hoc trains are only possible after peak-hours and for example during the nights. In combination with the often unavailability of the resources (e.g. rolling stock and personal), the expectations from the LSP cannot be fulfilled, resulting in modal shift to other, more suitable, transport modes (e.g. road transport). Another example is that of the last-mile transport, whereas it is often unknown what the capacity is on the terminal or marshalling. It was experienced by SEACON that this last mile transport sometimes led to delay of 4-7 hours.</td>
</tr>
<tr>
<td><strong>Flexibility</strong></td>
<td></td>
</tr>
<tr>
<td>Various factors contribute to poor flexibility: insufficient resources (including rolling stock &amp; personnel), poor scheduling, poor cooperation among the stakeholders, and also poor business policy and insufficient readiness to meet the customer’s needs and expectations.</td>
<td>As this Continuous Improvement Track focusses mainly on the Shipper/LSP perspective the lack of flexibility is indicated as one of the major problems. However, it is not something that can be influenced very easily the LSP. E.g. the planning of resources is taken care of by the RU (Railway Undertaking), while train path planning is limited to interaction between RUs and IMs (Infrastructure Managers). This limitation makes this problem even more relevant for this Continuous Improvement Track, as the LSP or Shipper is the decisive factor, due that fact that they are either the consignee or consignor.</td>
</tr>
<tr>
<td><strong>Reliability</strong></td>
<td></td>
</tr>
<tr>
<td>Reliability is the ability of a system or component to perform its required functions under stated conditions for a specified period of time. In the rail sector this is often translated to punctuality. Due to network, processes or vehicle disturbances, delays might occur undermining the reliability of the rail transportation.</td>
<td>The reliability of the supply chain system relies on the reliability of each link in the chain. This refers to both logistic warehouse processes and transport processes. Rail transport is now often considered less reliable than road transport. Therefore only goods that meet the prerequisites for rail transport are transported by this transport mode. Most Fast Moving Consumer Goods (FMCG) are transported by ISO-containers, SWAP bodies or trailer. Transporting these types of goods by rail mode requires reliable transport services.</td>
</tr>
</tbody>
</table>
Table 5 Selection of the Deliverable 2.1 identified “financial” problems.

<table>
<thead>
<tr>
<th>Problems and short descriptions</th>
<th>Case Practice</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Financial</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Transport Costs</strong></td>
<td></td>
</tr>
<tr>
<td>All types of costs (fixed and variable) for door-to-door transportation of goods. High rail transport costs depend on various factors (high maintenance, operational costs, higher transport times, lower load factors etc.).</td>
<td>Although Rail Freight Transport is in general considered to be low costs, practices show – especially for intermodal transport – that the overall transport costs can be high if the conditions are not perfect. Interviews have shown that approximately 40% of the cost of intermodal transport is a result of pre- and end haulage of the transport units. On the other hand, the transport costs are depended on the load factor of the trains. Additional rail freight infra costs can change and vary per country. The unpredictability or uncleanness can result in lower trust at shippers in this transport mode</td>
</tr>
</tbody>
</table>
| **Communication & collaboration** | The lack of communication & collaboration in the intermodal transport business causes additional unnecessary costs for intermodal operators and end-customers. E.g. bullwhip costs in the supply chain due to events in one of the previous single legs. Sophisticated IT-systems and governance models may be the solution for the lack of communication but will lead to high costs for developing such systems.
  
The lack of coordination and interaction between the actors in the supply and distribution chain for synergistic collaboration leading to problems such as inventory excess or lack of product availability. Another important aspect for this issue is the lack of trust, a sort of “mental problem” stemming from the sharp competition on the market. |
| **Information Exchange**         | Information exchange between different actors is a very sensible topic and usually a very difficult procedure, as agreements are not always easy to make. The lack of information exchange in the intermodal transport business causes additional unnecessary costs for intermodal operators and end-customers. E.g., waiting costs, administration cost of re-planned transport. A governance model between the actors where they agree what to share, will contribute to facilitate the information. |
| **Visibility**                  | The lack of visibility is a result of the lack of information sharing and lack of communication along the intermodal chain. As mentioned, Sophisticated IT-systems and governance models may be the solution to tackle these problems. |

The information exchange between supply chain actors should be accompanied by enhanced security measures to ensure reliability in the chain and actor’s confidence in it. The information shared in vehicles, cargo and inspection results should lead to trade facilitation, streamlining authorizations from the customs and some degree of predictability in the processes.
Table 6 Selection of the Deliverable 2.1 identified “interaction with customers” problems.

<table>
<thead>
<tr>
<th>Problems and short descriptions</th>
<th>Case Practice</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Interaction with Customers</strong></td>
<td></td>
</tr>
<tr>
<td>Data Sharing</td>
<td></td>
</tr>
<tr>
<td>Developing systems for managing data through harmonisation process in terms of structure, gathering and interpretation. Generally all the necessary data should be available to all the stakeholders involved in the transport (or in the specific leg); however, often this conflicts with the contractual and general legal issues of the data ownership, data access and data sharing. New rules and methodologies should be therefore adopted in this field.</td>
<td>Today, data sharing and information exchange is still a hot topic in logistics. To improve supply chain visibility and reliability, data sharing is a necessity. However, this is still only done on a small/limited scale. To improve end-to-end supply chain visibility, different actors should share data to come up with smart solutions. In this Continuous Improvement Track case, basic information on the train location is only shared due to contractual agreements. This is however limited information and should be enlarged to other information fields as well, including indirect stakeholders.</td>
</tr>
<tr>
<td>Door-to-Door delivery delays</td>
<td></td>
</tr>
<tr>
<td>Delays in the delivery leading to deviations in the time planning / schedules and decreasing reliability and increasing requirement in inventory levels, costs and waiting time.</td>
<td>Low reliability rates make that door-to-door deliveries are often delayed. These delays are however not always communicated with the (end) customers. As contractual agreements on delays may result in penalties, different stakeholders prefer to know such information as soon as possible, to prevent unnecessary costs, e.g. waiting time. Therefore it is important to have a clear measurement of delays.</td>
</tr>
<tr>
<td>Track and Trace</td>
<td></td>
</tr>
<tr>
<td>Poor tracking of the cargo leads to significant problems. The transport times may be prolonged in an undesirable way, the train or wagon may be misled etc. This way not only inefficiency and higher costs result, but also, due to lower reliability and lack of visibility, the customer may perceive the service as unreliable and he or she may abandon it in the end.</td>
<td>Today’s rail freight customers require full end-to-end supply chain visibility. This means that at each point in time, one should be able to see the conditions of the goods and the exact location. In some cases this is also required by the insurance company, especially for high value consumer goods. In general, market parties – like Seacon – experience that the existing wagon fleet does not meet this technological requirements, as most rail wagons are not compatible for this technology.</td>
</tr>
</tbody>
</table>
Table 7 Selection of the Deliverable 2.1 identified “interaction between stakeholders” problems.

<table>
<thead>
<tr>
<th>Problems and short descriptions</th>
<th>Case Practice</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Interactions between stakeholders</strong></td>
<td></td>
</tr>
<tr>
<td>Standardisation of data</td>
<td></td>
</tr>
<tr>
<td><em>Exchanging data encounters serious problems pertinent to different data formats, their scopes, ranges etc. (data syntax), not mentioning their meaning, involved process area, and level of data detail (data semantics).</em></td>
<td>To arrange a train on a long distance corridor crossing multiple, a wide variety of stakeholders in different countries is included. This includes communication with country specific RUs as well as country specific IMs in different countries. It may be that one stakeholder may have different meaning and conditions of the term “train path”. This makes communication among different stakeholders in the rail freight sector difficult. The same occurs for data sharing, standardisation of the meaning of typical data is necessary to be able to communicate among each other.</td>
</tr>
<tr>
<td>Transferability</td>
<td></td>
</tr>
<tr>
<td><em>Development of strategies, methodologies, procedures and systems for a better movement and management of goods in any phase of the supply chain that could be transferable to other phases of the same Supply Chain or different Supply Chains.</em></td>
<td>In this Continuous Improvement Track the aim is to implement the Control Tower concept on the corridor selected. After succeeding it will then be transferred to another corridor. However it is not said that this transformation from one corridor to another is easy. It involves new stakeholders, which may have different understanding of the problems. On the other hand, a best practice case may accelerate this process.</td>
</tr>
</tbody>
</table>

Based on this theoretical analysis the possibilities for improvements are clear, however, with so many stakeholders involved from various backgrounds the development and implementation of these improvements could prove challenging.

### 3.2 Synthesis of the stakeholder consultation

In addition, Continuous Improvement Track stakeholders were consulted to identify gaps in the identified problems. A synthesis of the consultation can be found below:

- From the LSPs’ point of view, the main issue is that the rail freight business - in general - is not able to fulfil the requirements on the visibility aspect. Whereas road transport, and to some extent Inland Waterway Transport, are able to provide real-time information. It can be said that the rail transport mode is lacking behind in terms of visibility, compared to other transport modes. Even if information is provided by the rail sector, the information is unstructured, too late or inaccurate and can therefore not be used as input for decision making tools.
- In addition, problems were identified in terms of disruptions on the network. Whereas road transport can easily deviate from the planned route, this is impossible in rail case due to the more “physical” restrictions but also the fact that rerouting is costly and requires ordering a new train path. In general Seacon experiences a reactive approach from the rail freight industry instead of a – desired – proactive approach.
- Another problem, pointed out in the consultation, is that different actors are responsible for different parts of the supply chain. This results in a wide variety in
definitions used in the rail freight business. Also the level of satisfaction is different per actor, e.g. a Railway Undertaking may consider arriving as planned at the terminal to be reliable, while a LSP might be more interested if its container is unloaded according to plan. Seacon identified that especially the first and last mile operations cause volatility on the total lead-time.

- Inefficiency often results also from lack of communication between the terminals and the shunting operators at the first and last mile rail operations. By these operations, narrow coordination between the IM, RU and the terminal (LSP, logistic operator, terminal operator), who has the end responsibility for allowing the train to enter or leave the facilities. The terminal operator should therefore communicate with the IM (or with the station facility manager, if different) and get the information on the trains or trainsets on the parking tracks, or give requirements on preferred parking, shunting and handover between the operator and the station. Upon insufficient communication, the parking tracks are not used optimally (in the sense of track lengths and other parameters) and unnecessary delays can result.

3.3 Conclusions

The majority of all identified problems are related to the five main issues of Smart-Rail: reliability, lead-time, costs, flexibility and visibility. The overview in combination with the case practice shows that most problems can be limited to these five main issues, with a strong focus on visibility, costs and reliability.

3.3.1 Reliability

Another problem in international supply chains, especially in those that include rail freight transport, experience characterized lack of reliability. This is often the result of disturbances on the network. Disturbances that have an impact on reliability can have several causes:

- Infrastructure failures, such as malfunctioning switches, broken catenary, failing signals, power failures and non-working automatic barriers.
- Malfunctioning rolling stock, including engine break-downs, leaks in the hydraulic system, problems with splitting and combining train sets, and so on. Also older, used rolling stock, used by some operators as a way to save costs, tends to be less reliable. Especially in the case of a poor maintenance this may pose a serious problem.
- External factors, such as accidents and bad weather conditions (vis major).
- Organizational and planning issues: cross border delays, delays at terminals.

Disturbances on one train can cause a cascading effect (or secondary delay), and can spread throughout the train services (both in terms of geographical space and in terms of time):

- For the involved rail service: A small delay on one part of the journey could lead to missing certain time slots, causing a bigger delay.
- On the network: due to limited capacity on the rail network, time slots are limited. Disturbances on one train can therefore cascade through the network, and have effects on both freight and passenger rail transport. This results often from track
• For Stock circulation: In case of short layover time between trips, delays on one service can cause delays on other scheduled trains (especially in lack of sufficient buffer times, reserve times, or spare resources on the operator’s side).

In addition, shippers and LSPs require a reliable service as a late or unexpected arrival of freight can cause additional costs within the logistics process. Additionally extra stocks are required if the transport process is unreliable, to ensure continuation of the production or sales process.

3.3.2 Costs

In intermodal transport costs are a crucial to compete with other modes, like road. Especially since intermodal transport consists of multiple legs as stated in chapter 2. Due to this combination of legs, every single leg influences the other legs. Therefore events in one leg can have a bullwhip effect on the total costs. These effects can be large, for instance when a train is too late and the last mile delivery by road is already planned and a slot for unloading at warehouses is booked, multiple additional costs occur, e.g. re-planning of transport, no-show penalties, costs for new unloading team at warehouse and different administration costs for rework. Beside these operational costs the suppliers in intermodal market also face increases for e.g. electricity, infra costs etc. These costs vary per country on the different corridors in scope, these costs increase notifications depending on negotiations between RU’s and IM’s, amongst others. Therefore it is often for customers like LSPs and shippers unclear how costs are build up, when price levels are set and therefore more difficult to budget or to assure a good cost/quality service for the market.

3.3.3 Visibility

In the Supply Chain there are many problems that do not allow the client to get his order according to its specifications, in the required time, in the required quantities and perfect conditions. Problems arise because along the supply chain processes different actors are not appropriately coordinated, often there is excess of inventory or no product available, "inbound" processes have a high degree of variability, among others.

The above are causes or symptoms of poor visibility in the supply chain and/or communication of the different actors in the supply chain and distribution.

The visibility is related to the ability of organizations to share valuable information for decision-making to improve their performance. Visibility is a broader concept than traceability. The visibility in the supply chain is the scope and depth of the knowledge that any agent has about the various aspects and data related to the management of products.

Visibility in the supply chain must provide an overview of the global network that allows easy access to data so they can safely check what is happening at every moment and in every phase of the supply chain. Whether it would be necessary to know the positions of the inventory in warehouses or the status of consignments in transit, the visibility of the supply chain should be allowed to show this information in real time (orders, inventory or shipments). The thing is primarily to share visibility data between business and government, in a synergistic collaboration.

The solution of supply chain visibility problems involves the construction of interfaces and visualization tools, in an open and accessible architecture. A methodology and an IT system serving both issues satisfying industry and authorities at the same time.

The Supply Chain Visibility is particularly important in the intermodal door to door container trade and it is crucial in the aim of improving the cooperation of railway across the whole supply chain considering all transport modes.
4 Measures

4.1 Measures identified

This section provides an overview on existing measures, identified in previous works. The basis for this overview is distracted from D2.1. It was chosen to scope the shown projects and measures according to their potential with the Control Tower.

In the past, different projects related to rail freight transport were performed by a wide variety of market parties. For the implementation of the Control Tower, a quick scan is performed to identify potential measures that can easily be taken up from previous projects.

4.1.1 European policy development projects

Nine core network corridors are identified in the annex to the CEF Regulation. Each of the nine core network corridors includes a list of projects pre-identified for possible EU funding during the period 2014 – 2020. In addition the program was there to bring together public and private resources and concentrate EU support from the CEF, particularly to:

- Remove bottlenecks;
- Build missing cross-border connections and;
- Promote modal integration and interoperability.

Moreover, they also aim at:

- Integrating (as ongoing modal measure, these corridors shall be integrated into the multi-modal TEN-T) rail freight corridors;
- Promoting clean fuel and other innovative transport solutions;
- Advancing telematics applications for efficient infrastructure use;
- Integrating urban areas into the TEN-T;
- Enhancing safety.

Such infrastructural investments might enable better utilisation of rail capacity in the long-run. However, in the short-run, the works might influence the current rail track operations and capacity.

Some of the problems concern the regulatory framework. There are three main challenges on rail freight corridors considering this issue:

- Strengthening cooperation between Infrastructure Managers on key aspects such as allocation of paths, deployment of interoperable systems and infrastructure development;
- Finding the right balance between freight and passenger traffic along the Rail Freight Corridors, giving adequate capacity for freight in line with market needs and ensuring that common punctuality targets for freight trains are met;
- Promoting intermodality between rail and other transport modes by integrating terminals into the corridor management process.

The Corridor Regulation addresses two major functions in developing the rail freight corridors in terms of infrastructure capacity and performance. The corresponding TAF TSI functions are those concerning the Railway Undertakings (RU)-Infrastructure Managers (IM) communications that will establish the necessary information flow necessary to operate the corridors. Not all the TAF TSI functions are necessary for such implementation.

Specifically, the Corridor Regulation concentrates on the two following functions: Path Allocation and Traffic Management.

The Corridor approach must be further analysed by the Corridor Managers to arrive at a comprehensive implementation plan by corridor. There are 9 RFCs (Regulation
913/2010) defined within the European railway network, gradually deployed and each having its own corridor manager, coordinating the so-called Corridor Paths bringing faster, more seamless and more reliable train paths through the whole Europe (in comparison to applying in each member state or by each IM separately). These “corridor paths” are so-called Pre-Arranged Paths (PAPs).

For each of the nine Rail Freight Corridors (RFCs), a rail market study has been carried out. The purpose of these studies is to gain insight in the current situation of the corridors, as well as providing a short and long term forecast. The long term forecast is based on existing models and multiple interviews with stakeholders in the corresponding Member States.

4.1.2 European Framework projects

CREAM project

The CREAM project – executed under the sixth Framework Programme for Research and Technological Development – consists of the following elements:

- Analysis of the market requirements for typical supply chains along the entire corridor – or parts of it – and derive a coherent set of templates on innovative rail freight services appropriate to tap the full potential of modal shift towards rail;
- Definition of advanced business models for setting up integrated, road competitive rail freight service offers, thereby considering EU plans of establishing a single European Railway Area and incorporating the experiences of new entrant railways and other transport mode operators on cooperation in international rail freight transport;
- Development of a coherent quality management system (QMS) and implementation of the necessary structural and organisational measures to ensure the monitoring of the most important quality criteria such as punctuality and reliability and the identification of necessary process improvements;
- Outline corridor-specific train operation concepts able to absorb and bundle sufficient quantities of cargoes and to exploit the given resources in the most (cost) efficient way;
- Implementation of interoperability and improved border crossing procedures – thereby making use of multi-system locomotives (MSL) and joint border crossing operating centres wherever appropriate;
- Setting-up of integrated telematics solutions taking up the expanded infrastructure managers’ information systems and supplementing them on corridor sections – mostly in Southeast Europe – by satellite-based (GPS) tracking and tracing systems;
- Analysis of particular markets of temperature controlled cargo logistics and transport of semi-trailers in order to provide technical-operational concepts that allow facilitating the modal shift of the still road-dominated transport to intermodal road-rail transport.

3 http://www.cream-project.eu/home/index.php
BRAVO project

The following activities were developed under the BRAVO project:

1. Development of a coherent Brenner corridor management scheme which shall meet the requirements as a sustainable system – maintained beyond the project period - and an open system enabling the access of new entrants;
2. Development of an improved train path availability and allocation process;
3. Development of an interoperable rail traction scheme involving the employment of multi-current locomotives;
4. Development of an EDP-supported corridor quality management system (QMS) including quality agreements;
5. Development of an advanced customer information system (CIS) generating an “estimated time of availability (ETA)” information in the event of delays based on the development of a real-time train location system;
6. Elaboration of a time-schedule (short-, medium- and long-term perspectives) for extending intermodal transport services, e.g. to Southern Italy and Greece;
7. Development of a self-sustained intermodal technology to capture the growing market of conventional road-only semi-trailers for intermodal transport;

FLAVIA project

The FLAVIA project improves the intermodal transport along the corridor Central/Southeast Europe, using a logistics-oriented approach. Objectives were facilitating the transport of goods, improving prospects of access to markets, economic development and growth and reducing existing disparities of regions.

The project focused on intermodal transport but was also open for multimodal approaches. However the efficient use of inter- and multimodal transport depends not only on network conditions. Market players have sometimes mental barriers which to overcome is very important. Consequently FLAVIA aimed on establishing national pro-rail alliances and a terminal alliance to promote and develop future inter-/multimodal transport.

Improving logistic channels among the involved regions will contribute to the integration of markets of the enlarged European Union. To overcome existing bottlenecks and gaps in the intermodal infrastructure FLAVIA analysed options to reduce organisational and administrative obstacles of integrated logistic chains. Concrete action plans for the removal of bottlenecks were elaborated and new intermodal concepts (rail, inland waterway, terminal development) developed with the help of pre-feasibility studies.

After promoting the concept of a pro-rail alliance during the project the establishment of three pro-rail alliances was accomplished. According to the already existing model in Germany, new alliances were set up in Poland, Austria and Romania. In all three countries memorandum of understandings were signed by profit and non-profit organisations. The alliances will communicate the needs of the railway sector towards the policy decision makers and the public.

In addition to this, over the course of the project the idea of a terminal alliance was discussed and an initial group with terminal representatives from Germany, Hungary and Romania was formed. The terminal alliance shall be used as a platform in order to implement common actions and interests like staff educating, marketing or business development.

Within FLAVIA numerous pre-feasibility studies have been finalised, dealing with the topics terminal development, railway services, green logistics and inland waterway

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4 http://www.bravo-project.com/home/index.shtml
5 www.flavia-online.eu
transport. Furthermore, the partnership released in total eight best practice brochures "From truck to train". In addition an IT routing tool has been further developed. It enables the user to route intermodal transports through Europe. Together with the intermodal wiki both tools shall help to raise the awareness for intermodal transports. The wiki provides a knowledge base for intermodal transport topics.

4.1.3 Best Practices

Considering best practices identified in D2.1, below there is a summary of the recommendations and best practices derived from Work package 2.

**Multimodal transport** is related also to flexibility, lead time, reliability and visibility. Optimal performance of multimodal transport can lead to better agility and flexibility in supply chain processes, short lead times, increase of loading rates, reduction of costs, better efficiency and productivity, trade facilitation and good management services. Together with this concept, synchro-modality is the optimally flexible and sustainable deployment of different modes of transport in a network under the direction of a logistics service provider, so that the customer (shipper or forwarder) is offered an integrated solution for his (inland) transport. In order to create a synchro-modal system, solutions have to be created in three main subjects:

- **Hardware**: Physical infrastructure, multimodal hubs, etc.
- **Software**: data exchange, data analytics, business models, and
- **Org-ware**: Mental shift, business modelling and value case solutions.

**Supply chain visibility.** These solutions, when based on the improvement of customer visibility, allow the organisation to share valuable information for decision-making to improve their performance. The visibility in the supply chain is defined as the scope and depth of the knowledge that any agent has on the various aspects and data related to the management of products. It should provide an overview of the global network that allows easy access to data so they can safely check what is happening at every moment and in every phase of the supply chain. This involves a **synergistic collaboration** among companies and also public administrations. The solution of supply chain visibility involves the construction of interfaces and visualisation tools, in an open and accessible architecture. An effective supply chain visibility solution optimises inbound and outbound supply processes by providing near real time visibility of orders, shipments and in-transit inventory across the global trading partner networks. Finally a good supply chain solution can address the complexity of different networks based on three key visibility factors that are essential to provide users with consistent, reliable and timely information: product visibility, process visibility and profit visibility. This solution increases the safety and reliability through the supply chain and flexibility. Some of the effects related to the visibility can lead to security risks and other threats of the supply chain.

**Real-time/on-time information.** Linked to the concept of improved customer visibility is the real-time information exchange. Coordination of actions between companies is crucial to minimise total costs while offering good service to the end customer. There is a need for the organisations and for the different activities (procurement, production and distribution) to be aligned as well as coordinated and synchronised since changes in one part of the supply chain are likely to affect the performance of other processes. This complexity in supply chain logistic processes creates the need for efficient decision making through a fluent information exchange between actors, not only within the railway sector, but also in the whole supply chain, using information exchange tools in real-time. Intelligent transport systems, information exchange platforms or any ICT system that allows this need of direct and continuous communication would be the solutions that provide efficiency and high performance in any chain. The exchange of information between actors, transport modes and administrations, also enables the modal shift of cargo flows from road to intermodal transport (i.e. railway). This intermodal transport would be based on interoperable information management systems. Regarding the legal issues associated to this solution related with sharing information that disrupts the efficient flow of information, industry and administration should ensure
the proper security measures to guarantee reliability in the supply chain and actor’s confidence on it.

The **optimisation of railway capacity** consists on the improvement of the usage of rail capacity through increased coordination and cooperation in the supply chain. A wide variety of measures can be considered, including:

- Rerouting freight flows over different routes depending on available capacity, characteristics of the goods (dangerous goods) and environmental restrictions;
- Maximum utilization of available equipment (high loading rates of trains and maximum train length);
- Coordination of maintenance and priority freight/passenger in periods with limited capacity;
- Maximisation of the use of available capacity in the rail network; for instance by introducing penalties for not using reserved train paths;
- Efficient and flexible use of all available capacity (infrastructure and equipment) along the corridor by applying smart and introducing an international control tower;
- Impose increased flexibility in the pricing of train paths.

### 4.2 Synthesis of the stakeholder consultation

In addition to the identified measures in previous work, Continuous Improvement Track stakeholders were consulted to identify what possible measures are best fitting, based on their market intelligence. To facilitate the discussion, different Work Package meetings were organised in:

- Frankfurt;
- Zoetermeer and
- Venlo.

The measures will be implemented at SEACON, therefore the focus of the discussions was on deciding what can possibly be achieved within the given timeframe and the available resources (time and money). Also, taking into consideration what is already available in the rail market and the theoretical framework of a “Control Tower” and the identified problems.

It was discussed that the main focus therefore should be on achieving a reliable and visible train service on the corridors in scope. In order to achieve such objective, same underlying problems will have to be tackled by the consortium. Please see the table below for identified problems and corresponding solutions:
### Table 8 Challenges and corresponding solutions

<table>
<thead>
<tr>
<th>Challenges</th>
<th>Solution</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lack of data sharing</td>
<td>Data sharing platform (CT) will be developed to enable safe and easy data sharing.</td>
</tr>
<tr>
<td></td>
<td><strong>Control Tower Architecture (1)</strong></td>
</tr>
<tr>
<td>Different definitions are used by different</td>
<td>One common language regarding the definitions, clearly communicated with all actors.</td>
</tr>
<tr>
<td>actors for an arbitrary semantic.</td>
<td><strong>Common semantics (1.1)</strong></td>
</tr>
<tr>
<td>Unwillingness for information exchange</td>
<td>Governance model will be applied to facilitate communication and to share data among the actors.</td>
</tr>
<tr>
<td></td>
<td><strong>Governance model (1.2)</strong></td>
</tr>
<tr>
<td>Different requirements for train paths leading</td>
<td>Multi-stakeholder involvement in train path planning to find best solution for all partners: LSP, RU &amp; IM.</td>
</tr>
<tr>
<td>to sub-optimal planning</td>
<td><strong>Train path availability (1.3)</strong></td>
</tr>
</tbody>
</table>

**Data sharing platform (CT) to enable safe and easy data sharing.**

The overarching proposed solution is to develop a data sharing platform (Control Tower), to enable safe and easy data sharing. As already identified, LSPs preferably act in a proactive manner, where the available information only allows for acting reactive. Therefore the information flow between the different actors needs to be enabled, in a safe and easy way, to allow for data sharing. Typically, a LSP prefers to receive the information as soon as possible, to act upon accordingly, e.g. inform clients and re-plan the consecutive activities.

**One common language, clearly communicated with all actors**

During Smart-Rail meetings and partner experience, it is known that different definitions are used by different actors for an arbitrary semantic. As a result of different definitions, at first it needs to be stated what is exactly meant by: e.g. ETA of the train. A RU might use the point to arrive once it enters the last mile, while other partners might use the ETA as indicator of entering the terminal. The project team will have to come up with suitable semantics to facilitate reliable information sharing.

**Governance model: communicating and data sharing among the stakeholders.**

Previous projects demonstrated that the exchange of data as a sustainable solution can only be achieved when a clear and balanced governance model is in place. The balance of the governance model relies on the type of data in combination with the role of each stakeholder in this. Therefore, clear rules should be defined under which circumstances data can be shared.

**Multi-stakeholder involvement in train path planning**

An available train path with appropriate parameters (either with right the demanded one, or with those sufficiently close to them) is a necessary prerequisite for realizing the railway leg within the transport chain. Basically the train path may be requested only by the authorized RU, and may be responded (i.e. "solved") only by the IM. This may result in inconvenient train paths (based on LSP or Shippers demand).
5 Design measures for the CIT Implementation

The objective of this chapter is to have a first draft of the design of the measures. Complementary to this, it should give insight in what is currently available and what is still missing. This chapter will then analyse if all that is missing will be tackled/dealt with by Task 7.2, 7.3 and 7.4. If the designated tasks do not cover all topics yet, necessary steps can still be taken by the project team.

In this Continuous Improvement Track, the effect will be monitored of the information sharing among different stakeholders in the rail freight business. The aim is to show the impact of providing information on real time basis and the ability to make rail freight a better product by:

- **Increasing the predictability.** This will result in better management of expectations which in turn results in increased reliability;
- **Increasing the visibility.** This is a result of increased accuracy of the cargo to track;
- **Maintaining the existing lead time.** It’s a myth that an increased informational flow will lead to a reduced lead time, however the agreed lead time is honoured more often and moreover the lead time to agree with the end client can be given with decreased volatility. The lead time will become more stable as a result of increased predictability;
- **Reducing the total cost of ownership (TCO).** The TCO of the LSP’s service will be reduced by minimising mistakes and re-plan actions. Decreased TCO makes it possible for the LSP to decrease the cost per transport unit; and offer a more competitive price on rail;
- **Sharing information real time.** Being informed more often enables the LSP to get a better grip on their processes and work in progress. It allows the LSP to approach the current state of the execution close to the reality, enabling flexibility on transhipment points\(^6\).

5.1 The IT approach:

To facilitate the operations of an LSP (logistic service provider) within the railway leg, i.e. to facilitate the information flows between a LSP and the railway stakeholders (most notably the operators or railway undertakings – RUs), an information exchange tool is suggested, called the “CT-Rail” (Control Tower – Rail).

The concept of its usage and meaning in the WP7, i.e. by the logistic operator or LSP, is suggested in Chapter 2 of this document. Generally the aim of CT-Rail is, through a proper data exchange among the involved stakeholders, to improve visibility in the logistic chain, providing the information necessary for both planning and operative control of the rail services.

5.1.1 General architecture of the CT-Rail

The basic understanding of the CT-Rail and its role in the logistic chain is depicted in the following chart. The CT architecture represents the unified data exchange environment and data interfaces or user interfaces, as designed in a comprehensive and versatile way in WP5.

---

\(^6\) Cargo terminals and country crossings
The communication and data exchange follows a simple “pipeline”, defining at the same the technological interfaces, physical interfaces (cargo handover), information/data interfaces, and contractual interfaces:

**LSP - IO – RU – IM**

where:

- **LSP** is the *logistic service provider* (operator), organising the transport in the whole logistic chain, not only within the railway leg; it is the service provider for the end customer, and the customer for the RU.
- **IO** is the *Intermodal operator* is the operator of transports cargo over different modalities of which the goods are transported by the help of standardized loading units. In this role they are one of the suppliers of the Logistics Service Provider.
- **RU** is the *railway undertaking* (operator), a licensed body allowed to operate trains on the public railway infrastructure, based on the defined general, licensing, contractual, technical and other rules; it is the subject responsible for the train, it is the service provider for the LSP (providing the transport in the railway leg), and a “customer” or user of the public railway infrastructure managed by the IM.
- **IM** is the railway *infrastructure manager*, whose role is to provide a fair, non-discriminatory access to the railway infrastructure for any licensed/authorised RU, and as the Allocation Body, to allocate “time slots” or train paths with assigned timetable as demanded by the RUs.

### 5.1.2 Data requirements on CT-Rail

Generally speaking, the following data were identified as necessary for implementation the Control tower concept:

- Pre-trip information - data and information for planning the train service (in cooperation with the RU), covered often by so-called “reference files”;
- Train path availability for ad hoc planning – in its narrow sense, the train path is available only for the authorised RU; however, for planning purposes, the planning is done in cooperation between RU and LSP;
- Real Time Information – most notably the Train Position; multiple primary information sources are used (e.g. independent ones as GPS units, RFID tags; primary data from the traffic control processes of the IM; fleet management systems of the RU), as described in WP6/D6.1 in more detail;
- Location of the wagons, Track & Trace of individual wagons can be used for prioritisation for loading and unloading trains (e.g. weight, high value products, client request);
- Estimated time of arrival (ETA), estimated time of departure (ETD) – the key data items for the operative planning.
5.1.3 Communication between the CT (LSP) and the RU

As mentioned, the LSP is the “customer” of the RU in the relationship, the RU-LSP-RU is the train service provider. Basically the LSP demands a train service with certain parameters (including also the price), and after departure it supervises the transport.

Therefore the communication needs from the CT (LSP and IO) to the RU include:

- Pre-trip demand information – demanded train parameters (type of cargo, train estimated/projected train weight and length, special handling);
- Cargo information including train composition upon cargo handover;
- Any operative changes in the demanded services.

The communication needs from the RU to the CT (LSP) include:

- Train location;
- Service availability (lead RU);
- ETD (from terminal);
- ETA (at the terminal of arrival);
- Track & Trace (train and wagon position, in relation to locomotive).

5.1.4 Communication between an IM and a RU

As far as planning and controlling the train traffic is concerned, the licensed RU is the only possible authorised partner for the IM, and it is responsible for the train as a whole during its whole lifecycle, from the Path Request, through the pre-trip information (Train Preparation) and trip information (Train Position), to the reporting and access fee charging.

What information is provided by the IM to the RU:

- **Network Statement** – the most basic document (provided generally as PDF), defining the general conditions on accessing the railway infrastructure;
- **Reference Files** – data files containing the keystone information on the railway network (among others), according to the TSI TAF standards, occasionally in other formats;
- **Infrastructure Restriction Notification Database** – defines both planned and unplanned closures (as maintenance works), disruptions, temporary speed limits etc., necessary for proper planning of the train traffic;
- **Path Request** – request for a timetable “slot” or Train Path; involves a rather convoluted communication dialogue described by TSI TAF;
- **Path Study** – a preliminary, non-binding request (“what may be requested, what is feasible to offer from the IM”);
- **Train Composition, Train Ready** – a sort of “complementary” information to the train from its RU (information on vehicles and dangerous goods; Train Ready is a signal saying basically “I am ready to go”).

5.2 Control Tower Architecture

For interacting between the Control Tower (as described in Chapter 2) and the railway leg, the “CT-Rail” solution (Control Tower – Rail) is suggested by the Smart-Rail project. It represents a consolidated data exchange environment, and is designed in a comprehensive way in WP5. It shows simplified schemes and architecture of the relations between different actors. It also shows that the core solution realized in WP5 fits with the realization and roll out in this Continuous Improvement Track in WP7.
The rail CT system will not be a one single new system that controls everything by one stakeholder. The rail CT will be developed based on (re)use of current systems and new interfaces between the different systems that control different levels and parts of the supply chain. By choosing this set up the feasibility of the solution to realize and roll it out in practice increases.

Figure 4 Relationship between different actors, WP5 and WP7

The diagram depicted above suggests the general architecture of the CT-Rail, with focus on the communication and data exchange with all the involved stakeholders:

- LSP – the “data consumer” from this point of view controls the transport as a whole;
- RU – the railway undertaking responsible for the railway leg or its part;
- IM – an infrastructure manager on which the RUs are operating;
- RailData – the international body covering the “national” Cargo RUs, here presenting a specific data source.

The necessary communication interfaces of the CT-Rail are shown in the architecture as realised in WP5 in the figure below. WS means a web service as the preferred way of communication (Request/Response).
Figure 5 Simplified representation of the Control Tower Architecture

The UML diagram suggests methods for communicating between the RU and CT-Rail (i.e. mostly for providing data from the RU for the partners), with the following meaning:

- **SetReferenceFiles**: updates the given reference files in CT-Rail on behalf of the RU;
- **SetTrains**: updates the identified train on behalf of the RU, this way a train may be introduced, modified, or cancelled;
- **SetTrainLocation**: updates the confirmed position of a train in the railway “spacetime” (time position and geographical location);
- **SetTrainComposition**: updates the train composition, upon each change and as requested by TAF TSI;
- **SetTrainETA**: updates the ETA parameter of a train (Estimated time of arrival);
- **SetTrainETD**: updates the ETD parameter of a train (Estimated time of departure);
- **GetKPI**: gets a set of defined KPIs for a given calendar month.
The UML diagram suggests methods for communicating between the LSP and CT-Rail (i.e. mostly for requesting the data by the LSP), with the following meaning:

- **GetReferenceFiles**: requests a reference files in CT-Rail (typically the railway network or other general tables as defined by TAF TSI);
- **GetTrains**: requests a list of trains available for the LSP;
- **GetTrainLocation**: requests the confirmed position of a train in the railway "space-time" (time position and geographical location);
- **GetTrainComposition**: requests the train composition;
- **GetTrainETA**: requests the ETA parameter of a train (Estimated time of arrival);
- **GetTrainETD**: requests the ETD parameter of a train (Estimated time of departure);
- **GetRA**: requests the RA parameter of a train (Real arrival)
- **GetRD**: requests the RD parameter of a train (Real departure);
- **GetKPI**: requests a set of defined KPIs for a given calendar month

All the suggested methods are to be further analysed and elaborated in detail within T7.3, including their parameters and data types, including their allowed usage, and prioritisation of the need to haves and nice to haves.

The necessary authentication and authorization to use the data services is out of the scope of this document; it is elaborated in more detail in WP5/T5.2.

### 5.3 Semantics (ETA/ETD/TRAIN LOCATION/COMPOSITION)

During Smart-Rail meetings and partner experience, it is known that different definitions are used by different actors for an arbitrary semantic. As a result of different definitions, at first it needs to be stated what is exactly meant by, e.g. ETA of the train. A RU might use the point to arrive once it enters the last mile, while other partners might use the ETA as indicator of entering the terminal. To come up with suitable semantics for this
Continuous Improvement Track, in this section the focus lays on the definition of semantics, so in a later stadium of the project the synchronisation of semantics is covered.

For LSPs that want to have more information on rail services, as in the architecture, the semantics are split in forecast semantics and operational semantics. An LSP needs accurate and reliable forecast semantics to align the supply chain and to manage expectations to the end client. The operational semantics are needed to monitor the progress and to intervene in case of disruptions. By intervene re-planning and/or proactively informing the end client is meant.

**Timing ETA, ETD, real arrival time and real departure time**

As in the stated example, different definitions of ETAs are used within the rail sector. When a train enters the shunting yard or parking track or is waiting to enter one of those two, this is insignificant to the whole process of planning the supply chain from an end client point of view. It is important to have a stable/reliable timing on when the first transport unit “touches the terminal grounds”. Within the project SMARTRAIL multiple actors are involved, so it is recognized that other actors might want to use some different ETA semantics. Therefore different ETA’s are defined on which the ETA of the first transport unit touches the ground is important for a SC director. Logically the same reasoning is applied to ETD, resulting in the following semantics on time (short term forecast):

- $\text{ETA}_{\text{terminal}}$ = The expected moment the train enters the terminal for unloading operation;
- $\text{ETA}_{\text{shunting yard}}$ = The expected moment the train enters the shunting yard;
- $\text{ETA}_{\text{parking track}}$ = The expected moment the train enters the parking track;
- $\text{ETD}_{\text{terminal}}$ = The expected moment the train departs the terminal (after loading operations);
- $\text{ETD}_{\text{shunting yard}}$ = The expected moment that the train departs the shunting yard (after loading operations);
- $\text{ETD}_{\text{parking track}}$ = The expected moment that the train departs the parking track (after loading operations).

As LSP, you are interested in the moment that the transport units touch the ground, and the moment your cargo is leaving the shunting yard for its long haul journey. The absolute difference between those two is the time you have to arrange/rearrange your end-haulage. The total transit/lead time for rail is the moment the container is loaded on the train to the moment the same container is unloaded.

Besides the operational forecast, another interesting information source is the tactical forecast such as time tables per leg and departure frequency per A-B connection.

**Operational:**

- $\text{RA}_{\text{terminal}}$ = Real moment the train enters the terminal for unloading operation
- $\text{RA}_{\text{shunting yard}}$ = Real moment the train enters the shunting yard
- $\text{RA}_{\text{parking track}}$ = Real moment the train enters the parking track
- $\text{RD}_{\text{terminal}}$ = Real moment the train departs the terminal (after loading operations)
- $\text{RD}_{\text{shunting yard}}$ = Real moment that the train departs the shunting yard (after loading operations)
- $\text{RD}_{\text{parking track}}$ = Real moment that the train departs the parking track (after loading operations)

Out of these semantics, we can obtain waiting times for all parts. If it normally takes 10 minutes to enter the shunting yard and park the train, then the waiting time would be $\text{RA}_{\text{parking track}} - \text{RA}_{\text{shunting yard}} \sim 10 \text{ min}$. However the suggested 10 minutes are unfounded and therefore we use the term service time from shunting yard entrance to parking
track(s_{\text{shunting yard}}.parking track). Time studies must be performed per terminal to know the real service time. If literature studies have a proper assumption, that would also be founded enough. It is possible to specify everything now, however this document is not about what we can do with the information but what information is needed in this Continuous Improvement Track.

**Train location speed and velocity**

In essence, train location speed and velocity can be used by LSPs to determine the ETA of the train to the entrance of the shunting yard. As stated in the section above, a LSP cannot work with the ETA. In cases where the RU manages the ETA and ETD properly, these semantics are not as essential. However the train location is always a necessity to have. It is besides for monitoring, an additional service to the end client.

**Train composition**

The main reason the train composition is part of semantics, is that in cases of trains that are not fully owned by one LSP, the composition of the train effects the unloading order of transport units, which on turn is directly affecting the pickup time of a road partner. For alignment of the supply chain it is unnecessary to know everything on the composition of the train, but to know what unloading order your cargo is needed. This includes changes during the journey where the locomotive switches from back and front. In cases of a full owned train the LSP setups the loading scheme for the train and therefore the order of cargo handling. In addition, the loading scheme and composition gives the client on train assurance that the loading units are really loaded on the train if the train departs.

### 5.4 Governance model

Previous projects demonstrated that the exchange of data as a sustainable solution can only be achieved when a clear and balanced governance model is in place. The balance of the governance model relies on the type of data in combination with the role of each stakeholder in this. Therefore, clear rules should be defined under which circumstances data can be shared.

To start off, an analysis of the stakeholders and the interaction between these stakeholders is required. Next steps are to identify each stakeholder’s requirements. This chapter will give a brief overview of the stakeholders and the four steps, related to information sharing in the complete supply chain.

**Stakeholders involved**

The problem analysis illustrates the necessity for an increase and improvement of the interaction between stakeholders, including the customers. However to improve the communication among the different stakeholders a proven governance model is required. Directly involved stakeholders can be distinguished into two types of stakeholders:

1) Stakeholders within the rail sector;
2) Stakeholders in the supply chain.
The following table presents the stakeholders within the rail sector:

**Table 9 Stakeholders within the rail sector**

<table>
<thead>
<tr>
<th>Stakeholder</th>
<th>Role</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Rail operators</strong></td>
<td>They should provide all information about train schedules (planning, status, capacity) in order to have a real time overview (origin and destinations, planning).</td>
</tr>
<tr>
<td><strong>Rail terminal operators</strong></td>
<td>Responsible for an efficient management of railway terminals. In order to organize an optimal multimodal transportation it is necessary to have information about the current capacity of all nodes over the network in order to eliminate possible congestions.</td>
</tr>
<tr>
<td><strong>Infrastructure managers (IM)</strong></td>
<td>Represent rail infrastructure providers which have effective control and management of the rail infrastructure of a railway. IM should provide all necessary information about the state of rail infrastructure and possible bottlenecks due to unplanned disruptions.</td>
</tr>
<tr>
<td><strong>Shippers</strong></td>
<td>The main interest of shippers/manufacturers is obtaining reliable rail transport against a competitive price. The shippers/manufacturers are the end customers of rail freight transport, and they generate demand for transportation. The main interest of the shippers is that their cargo is transported when necessary from and to specified locations according to an agreed schedule with minimum damages and losses and at minimum cost. Control tower concept enables to shippers the optimization of modal choice to potentially gain the best service and capacity at the best price to fulfill shipper’s supply chain performance.</td>
</tr>
</tbody>
</table>
The following table presents the stakeholders in the supply chain:

Table 10 Stakeholders in the supply chain

<table>
<thead>
<tr>
<th>Stakeholder</th>
<th>Role</th>
</tr>
</thead>
<tbody>
<tr>
<td>Logistic service providers</td>
<td>They represent transport service providers who arrange full load, door-to-door transportation by selecting and combining without prejudice the most sustainable and efficient mode(s) of transportation. Real time information on planning, capacity and status of the network from transport operators through a control tower will enable the logistic service provider to make real time decisions on which modality is the best suitable for transport.</td>
</tr>
<tr>
<td>Intermodal operator</td>
<td>Besides the Logistics Service provider in most of the intermodal supply chains an intermodal operator is a stakeholder. Its role is often limited in organizing and selling slots for loading units e.g. containers on a train. In this role they are one of the suppliers of the Logistics Service Provider</td>
</tr>
<tr>
<td>Port authority</td>
<td>Ports represent key links in intermodal chain because they provide a seamless transfer between various transport modes (ship, rail, freight). In an efficient synchromodal solution there is a need for having available timely and accurate information about everyday port traffic and its performances.</td>
</tr>
</tbody>
</table>

Data requirements

In modern transport chains, the goods are moving together with information and the aspect of synchronization of all operations during transport, since the planning of a chain is relevant from the organizational point of view and the economic point of view of the entire transport chain. In this perspective, big operators are developing their own infrastructure and services, while small and medium companies are going to have a big gap in terms of their capability to be involved with many different “legacy” software infrastructures with a negative impact in terms of costs and time, as they have to use different systems for different customers since system interoperability has not reached a sufficient maturity.

Since intermodal transport is more data-intensive than conventional transport, the role of information communication technologies (ICT) is of crucial importance. The use of ICT is key to efficient and customer oriented transport services. Open and flexible information and decision support systems are changing the way transport is organized and managed and will enhance present and create future market opportunities.

Therefore, there is a need for a solution that will provide an efficient way for the “grouping” together of data and information, that describes a transportation chain (modal or intermodal), and for disseminating it to all interested users of the system. Data about the status of the transport chain may come from different sources and in different formats.
Figure 7 Smart-Rail “Core Solution” of CT-Rail as will be developed under Work Package 5.

Even the simplest chain which consists of two modes of transport, requires the interaction and exchange of information between eight different “agents” or “parties” which are by definition “sources of information” – receipt or transmittal. In this simplest case one can identify: a consignor and consignee, the pick-up and delivery road carriers, the two intermodal terminals and the party performing the non-road transport. Also, there is the forwarder role of organizing the transport. The number of organizations involved can be less, of course when one organization performs more than one role. However, the points of information transfer--reception or modification--and use can be many and differing in degree of information technology advancement.

Figure 8 Roles in a typical intermodal chain (Source: E. Durr, G.A. Giannopoulos, 2003. SITS: a system for uniform intermodal freight transport)

Also the data and sources of initial information most notably for the location and status of the cargo along its route are many and vary in nature. It is therefore by no means a small task to combine cargo or vehicle status messages received from different sources, and often in various formats, to one common format. It is quite common for a user to consult several companies and service providers in order to find out where his cargo is. Even if the trace is successful, it is still difficult to interpret the information and decide whether there is reason for concern or not. Such an interpretation needs, apart from status messages, also information about what should happen, as compared to what was originally planned.

Capability to harmonize all this information and the way it is presented to the final user is an essential step in devising common platforms for transport data and services provision.
which may be made available to a large number of users. When such information is available, parties in the chain can use it to facilitate planning and allocate future capacity (CEN, 1998).

There are (generally speaking) four stages that can be distinguished in the whole chain of information provision (according to the International Journal of Transport Management 1 175–186):

**Data collection.** This stage is the one in which the various data elements are collected regarding the specific transport. In other words it provides the content of the data transfer and transmission that accompanies a certain transport. The ways and means of collecting these data are many and vary from the various Tracking and Tracing equipment (Global Positioning System (GPS), or Global System for Mobile communications (GSM), or satellite based, etc.), to electronic tags, or more “manual” types of data entry into the computer, etc.

**Data processing.** Information provision means that the (raw) data that have been collected via the different means and methods are analyzed and otherwise processed in order to give meaningful information. This is the Information Provision stage, i.e. the stage in which “information” is generated from raw data.

**Information dissemination.** In this stage the information that is generated is ‘made available’ or otherwise disseminated to the many ‘actors’ involved in the transport chain as well as the end-users. This is done through an appropriate service provider and thus it can also be termed the service provision stage.

**Information use.** In this last stage, the produced and disseminated information is now used by the end-users for their various front office applications or simply for information.

### 5.5 Train path availability

An available train path with appropriate parameters (either with right the demanded one, or with those sufficiently close to them) is a necessary prerequisite for realizing the railway leg within the transport chain. Basically the train path may be requested only by the authorized RU, and may be responded to (i.e. "solved") only by the IM.

The **preparation of the annual timetable**, i.e. long-term planning, has become a lower significance in the freight transport, as a major part of the business is mid-term or short-term based. More important are therefore so-called **ad hoc paths**, i.e. paths and path requests applied on a short notice.

A rather convoluted communication dialogue is involved between the RU and IM, involving especially:

- **Path Request** – a structured request which includes an identification of the train path, the requested departure and destination point, and detailed parameters of both the train and the path requested;
- **Path Detail** – a response of the IM answering to the RU with the train path, i.e. with its detailed timetable;
- **Path Not Available** – a message given by the IM when the path requested by the RU is not available;
- **Path Confirmed** – a message sent by the RU to confirm the path, the path cancellation or other process steps;
- **Path Details Refused** – a message sent by the RU when not accepting the Path Details form the IM.

This process and communication dialogue makes no difference between varying path designations, as the annual train path (long-term), ad hoc path, or diversion path (in case of any major disruptions when the traffic must be diverted).
The purpose of a train path is anyway to satisfy the demand of a RU for running a train service, responded by the IM. The parties involved in the path request process are therefore the RU and the IM; the process of creating a train path follows the general process rules set by RNE (RailNetEurope).

However, in the context of the Smart-Rail project, the whole logistic chain of the three parties described above (see 5.1.1) is to be considered:

**LSP – IO – RU – IM**

The LSP or the IO is the “contracting party” for the train path, it must be also involved in the train path negotiation and preparation processes. These processes are to be based on a close cooperation, matching and fine-tuning the needs or requirements of the market (i.e. those of the LSP) with the technical options of the RU (e.g. the engines power, resources capacity, available licences, cooperation partners) and with the general capacities of the IM (i.e. infrastructure parameters, axle loads, clearance, available geographical routes, congested lines, operational capacity limitations etc.).

The RU is the key actor here, because it merges the capacities of:
- General knowledge of the infrastructure and that of the services which are feasible to be offered (including the availability of shunting facilities, parking facilities etc.);
- Negotiating and requesting the paths by the IM, defining the technical and operational path parameters;
- Assessing the reliability of the path – which cannot generally be guaranteed, however it can be assessed from experiences;
- Providing the available resources for the transport (either its own ones, or hired/leased on both long-term and short-term basis), i.e. the rolling stock, the personnel, and optionally others;
- Negotiating and providing the resulting service to the LSP.

Also when taking measures upon a major disruption (addressed in more detail in WP8/LL3), similar close cooperation has to take place, as there might be changes in the train path (either delay, or a diversion route or re-scheduling the slot), in the train service parameters, or in its very nature.

This close cooperation between the involved parties is not reflected in any real, formally defined communication dialogue; however, it contributes significantly to improving the availability, flexibility and reliability of the service, which are goals of the Smart-Rail project.
Annex A – Functions of current Control Tower (Road)

**Arranging transport from A to B as full service:** The end client sends a transport request to the LSP, the LSP arranges the transport form A to B. This involves alignment of the actors in the SC and makes sure all resources are at the right place at the right time, f.e. customs and all paperwork regards customs.

**Monitoring execution (End-to-end visibility):** The end client requests during the transport how their cargo is progressing to align its internal activities. For these types of clients it is essential to know where the cargo is now, so they can give estimates on arrival day and time. Currently the CT is dealing with Trucking visibility, Client visibility and Long-haul invisibility.

**Disruption notification to the end client:** If an activity in the SC is causing delays in transport, a bullwhip effect can take place on missing a transport mode on a transition point, therefore it is essential to proactive supply information on disruptions to the end client so it can anticipate on disruptions. Locally, disruption notification is a function that is correlated with the monitoring.

**(Re)planning transport:** As an LSP you notice a disruption occurring, it is often the case your transport is delayed as explained in the section on disruption notification. Since your cargo is at a transition point after an executed transport leg and just missed its next modality, given the time dimension, it might be beneficial to re plan your transport to another modality or another actor in the SC. Currently this is not happening as often as we would like to see due to lacking and accurate information.

**Administration on transport:** Everything with regards to papers is prepared and information is collected by the LSP and distributed to the right actors in the supply chain

**Claim management:** Damaged goods can be a result of transporting goods. Damages can occur due to different events in the SC, however we often see this is a result of handling goods on transition points. All damages are aggregated for the end client, damage reports are processed and handled on behalf of the end client.

**Financial reporting:** Costs related to the logistics performed for the end client are aggregated and forwarded to the end client. So the end client only has to approve the “Aggregated bill”, resulting in more time for the end client to focus on its core business.

**Billing of transport orders:** As a CT you buy transport capacity by partners that are approved by the end client. The purchasing of capacity involves payment to the supplier of transport capacity. The billing and controlling of the process is part of the full service provided by the CT.

**Contract management with LSP’s:** As stated in the above point, partners have to be approved by the end client. As CT, the partners are selected based on tenders and business experience with these partners. The whole process of selecting and auditing supplies is done by the CT.

**Evaluation of the used LSP’s, KPI steered:** Monitoring of performance on the execution phase for road transport. F.e. scoring per subcontractor the pickup and delivery performance. On bad performance, a CT can recommend omitting an LSP in the tender phase, however the final decision lies with the end client.
Annex B – Work flows operational planning end-to-end