TNO innovation for life

Synchromodality pilot study

Identification of bottlenecks and possibilities for a network

between Rotterdam, Moerdijk and Tilburg

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BRABANT INTERMODAL

BARGE TERMINAL TILBURG BV

RAILPORT BRABANT

EUROPEAN GATEWAY SERVICES

ect Europe Container Terminals

MCT Moerdijk Container Terminals B.V.

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Summary 1/3

In 2011, TNO performed a study 'Roadmap Synchromodaliteit' for the Dutch Ministry of Infrastructure and the Environment. In the work plan for this study, support for a pilot study on topics around Synchromodality was also included. The goal of the synchromodality pilot study is **to research the possibilities of implementing a synchromodal transport system** on the corridor from Rotterdam to Tilburg and identify bottlenecks and challenges and if possible also practical solutions for these bottlenecks.

Synchromodal transport is defined as constantly tuning inside and between good chains, transport chains and infrastructure so that given the aggregated transport demand, and at any moment in time, the best modality can be chosen. Key aspects to synchromodal transport are mode free booking, joint planning and coordination for a network of chains and not for individual chains. This asks for good information infrastructure and flexible operations. The goal is to make optimal use of available capacity on the network.

The transport system in this study can be seen as a **light version of a full synchromodal transport concept**, since it includes a tri-modal network with mode free bookings by shippers, where for each container the best transport lane is selected and where different parties work together in optimizing a transport chain. By working in this manner, they have achieved a stable modal split that is even more desirable than the modal split target of the Maasvlakte for 2033. It is not a full synchromodal transport concept because there is not yet a possibility for real time planning and switching, nor optimization of the whole network capacity.

A **Synchromodality framework** is introduced that divides the key aspects and areas of change when implementing a synchromodal transport system over 5 different topics: Cooperation & Control, Network & Organization design, Infrastructure use, Dynamics and the Role of the shipper.

Summary 2/3

The current cooperation in the transport network can **benefit from improved cooperation and control** by having more formalized cooperation. This formalization and preparation of collaboration is even more crucial when the network grows or more partners are included. The basis for formalizing the collaboration is the **alignment of different business interests**. The number of different interests is as high as the number of involved parties and will be higher when parties play slightly different roles depending on network design and customers. Business interests and their alignment form the basis for negotiating cost and gain sharing models, decision models and creating the required shared situational awareness for control. Development of decision models is easier for daily operations, especially when decisions are taken by one party, than for event management when causes and circumstances vary. The end goal of being in control is to **develop joint, and real-time planning** of containers on a network.

A common vision on the future transport and network demands is necessary to determine requirements for a transport network, capacity and business models. **Strategic locations** for inland terminals and network design options, like hub-spoke systems need to be considered. The way parties cooperate in the network also influences existing business models and ownership of assets. **Ownership of assets** has a large influence on business interests and can stimulate sub-optimization. A modal split can also be stimulated by putting penalties on parties in the network. Currently, these penalties are put on deep-sea terminals but because of their very indirect influence on modality choice the effects of these penalties can only be limited.

Next to business owned infrastructure, government owned infrastructure and permits for using infrastructure (sound permits etc.) influence the capacity and performance of the transport system. Influence of government on the transport system can be substantial and since **interests of municipalities and the government are not always aligned with the interests of businesses**, cooperation is necessary.

Summary 3/3

Switching is defined as having the opportunity to change to the best transport modality at any time to optimize network utilization and fulfill transport demand. A flexible and dynamic transport system is needed to give users the opportunity to benefit from switching. In current systems no formalized processes for switching exist and **inflexibilities** like cut off times, Customs transit declarations, insurance per modality and having container documentation for container groups make switching very difficult. To enable switching, a high level of control is necessary to enable real-time planning and on top of that inflexibilities need to be solved and processes that allow flexibility need to be in place. This asks so much change that the consortium partners think switching is **only possible on mature transport lanes**.

The role of the shipper is important because **mode free booking is a prerequisite** for using a synchromodal transport concept. Experience learns that shippers are mainly interested in receiving reliable service against low costs. To stimulate mode free booking, transporters need to demonstrate the reliability of a synchromodal concept. This can only be done in cooperation with some shippers. **Price incentives can also be used to stimulate synchromodal transport**. Developing a pricing model for synchromodal transport is difficult because the sold product is no longer directly linked to the delivered product.

It was concluded that some aspects are prerequisite (especially mode free booking), while others are topics for the future (switching). But between this, attention is necessary for the execution of transport on a synchromodal network. The consortium partners expect that there is perhaps no real benefit for shippers using synchromodal transport as addition to using a reliable intermodal transport system. The benefits are expected to be with the transport executors who can benefit from better utilization of their infrastructure and transport assets. The synchromodal transport concept promotes flexibility in all ways and **never enforces a single view on the network and cooperations**. For some corridors the current way of working can give sufficient results. This flexibility however puts other challenges on the industry when parties operate on different corridors. Most urgent work needs to be done in the area of cooperation, since more formalized cooperation is at the basis of **being in control together**.

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1 Introduction

In 2011, TNO performed a study 'Roadmap Synchromodaliteit' for the Dutch Ministry of Infrastructure and the Environment. In the work plan for this study, support for a pilot study on topics around Synchromodality was also included. Goal of this pilot study was to identify practical bottlenecks for implementing a Synchromodal transport system, as is envisioned in the 'Roadmap Synchromodaliteit' study, with the help of business parties. In November 2011, contacts with ECT and EGS resulted in the plan to construct this pilot together on the corridor from Rotterdam to Tilburg, via Moerdijk. Terminals in Moerdijk and Tilburg were contacted, as well as the barge operator on the lane between Rotterdam and Moerdijk. Finally, a pilot consortium was formed of European Gateway Services (EGS), Europe Container Terminals (ECT), Barge Terminal Tilburg (BTT), Brabant Intermodal (BIM), Moerdijk Container Terminals (MCT) and Danser, supported by TNO. The pilot study was kicked off on December 14, 2011. The analysis in this study was performed with interviews and workshops with all participants.

The goal of the synchromodality pilot study is **to research the possibilities of implementing a synchromodal transport system** on the corridor from Rotterdam to Tilburg and identify bottlenecks and challenges and if possible also practical solutions for these bottlenecks. One of the central questions in the pilot is whether shippers can be served reliably when they only give deadlines for the availability of their cargo at the warehouse, instead of prescribing the mode of transport. This mode free booking is a prerequisite for implementing synchromodality in practice. By booking mode free, operators are free to choose the modality and switch between modalities if needed. A greater flexibility in the choice of modality can increase the utilization of different modalities and the underlying infrastructure. Because of this, an integral, more efficient transport system can be created for this specific corridor. Other central topics are the design of the network, necessary changes in cooperation and business models and (central) coordination of the transport system.

2 Description of the transport system

Before the implementation of a new transport system can be discussed, the current network needs to be studied and described. The network of the corridor Rotterdam-Moerdijk-Tilburg consists of 5 different routes or transport lanes, all starting in Rotterdam and ending in Tilburg. Different transport modes or combinations of modes are used in every route. All consortium partners are involved in at least one transport lane. This chapter starts with an introduction to the parties involved in the network of this study. A detailed description of the transport system involved in this pilot is given in the second paragraph. An analysis of the performance of the network is given in section 2.3. This analysis uses the data of three shippers that transport containers in this network. Finally, section 2.4 gives an overview of the operational processes that are in place for every lane in the network.

2.1 Involved parties

Since its foundation in 1966, ECT has expanded rapidly, growing into the leading and most advanced container terminal operator in Europe, handling most of the containers in the port of Rotterdam. In 2011 ECT handled 7,5 million TEU. ECT operates the ECT Delta Terminal and the Euromax Terminal Rotterdam, both at Rotterdam's Maasvlakte along the North Sea, and the ECT City Terminal in the Eemhaven/Waalhaven area (near the city centre).

ECT is a member of the Hutchison Port Holdings (HPH) Group. HPH, a subsidiary of the multinational conglomerate Hutchison Whampoa Limited (HWL), is the world's leading port investor, developer and operator with interests in a total of 52 ports, spanning 26 countries throughout Asia, the Middle East, Africa, Europe, the Americas and Australasia.

European Gateway Services (EGS) of ECT, offers its customers an extensive network of inland terminals which function as extended gates of ECT's deep-sea terminals in the seaport. Trains and barges ensure highly frequent connections. EGS offers many additional advantages. For example, it is possible to transport cargo between the deep-sea terminal and extended gate without customs documents. It is not until the hinterland that the customer needs to arrange his customs formalities. Also, numerous onward connections deeper into Europe are available from the inland terminals. Through European Gateway Services, customers can always choose the most efficient and sustainable mode of transport between Rotterdam and the European hinterland.

European Gateway Services is a subsidiary of Europe Container Terminals (ECT) from Rotterdam.

2.1 Involved parties

MCT
Moerdijk Container Terminals B.V.

Moerdijk Container Terminals (MCT) is a joint venture of ECT and Combined Cargo Terminals (CCT) in Moerdijk. It serves as an Extended Gate in the EGS network and as hinterland terminal for the nearby seaports. MCT is a tri-modal container terminal that can handle containers transported by barge, rail and truck, providing a congestion-free and sustainable connection between local ports, the southern parts of the Netherlands, and the European interior.

Danser stands for reliable and completely taken care of container transport across the European inland waterways. From its original set-up in 1982, the Danser Group has grown to be a barge-operator with an extensive and dedicated hinterland-network through which on-time transport is guaranteed from A to Z.

From its headquarter in Sliedrecht, more than 1 million TEU are being scheduled and shipped yearly between the seaports of Rotterdam and Antwerp and the European hinterland.

danser

2.1 Involved parties

BARGE TERMINAL TILBURG BV

RAILPORT BRABANT

Barge Terminal Tilburg (BTT) has daily sailings between Rotterdam and Tilburg. With inland terminals in Tilburg and Eindhoven, BTT is in effect an "Extended Gateway" of Rotterdam sea port. Upon arrival at the terminal in Tilburg, BTT takes care of connective regional distribution, or haulage over (longer) distances by either rail (via Railport Brabant) or road.

Railport Brabant is the rail terminal in Tilburg which links up directly to the Brabant network and as such has connections to Rotterdam and Central, Southern and Eastern Europe. Together with BTT, railport Brabant forms a tri-modal cluster that guarantees maximum flexibility and haulage assurance.

Brabant Intermodal (BIM) is a company jointly founded by Barge Terminal Tilburg and 3 other inland terminal companies in the province of Noord-Brabant. The main goal of Brabant Intermodal is optimizing intermodal transportation in this region by improving the cooperation between the involved inland terminals.

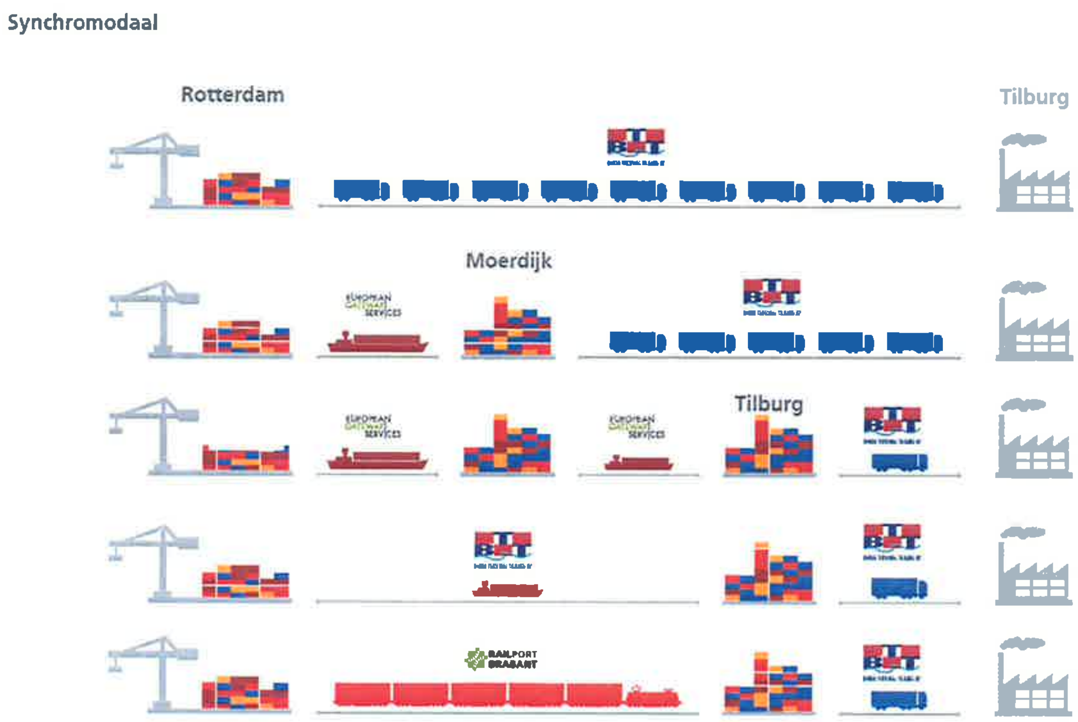
Brabant Intermodal strives for providing shippers with synchromodal transport solutions by using its diverse network to always ensure the container will be transported between seaport and hinterland according to the fastest, cheapest and most efficient route.

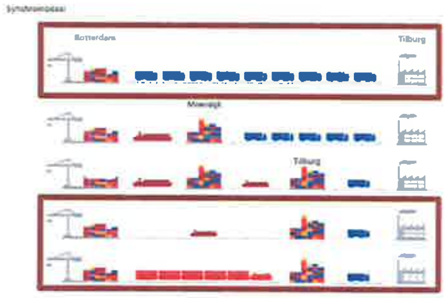
BRABANT INTERMODAL

2.2 Network from Rotterdam to Tilburg

The studied network starts in Rotterdam at the ECT deep-sea terminals, and more specifically the Euromax and Delta terminals. In this study, focus was on transport movements of three shippers. These shippers are customers of BTT. The network ends at their warehouses in Tilburg. Between ECT and the warehouses, two inland terminals are involved. The terminal in Moerdijk (MCT) is a tri-modal terminal with barge, rail and road connections. The terminal in Tilburg (BTT and Railport Brabant, later referred to as only BTT) is a tri-modal terminal with barge, rail and road connections.

The network from Rotterdam to Tilburg consists of 5 routes or lanes:





2.2 Network from Rotterdam to Tilburg – Direct lanes

BTT operates three direct routes to the Tilburg terminal and also arranges for final transport to the shippers. These routes have three transport modalities: road, rail and barge.

For direct trucking, both own assets and contracted assets are used. In trucking, there is a difference between direct trucking and trucking through BTT (these options are combined in the picture). Some trucked containers are delivered directly from the ECT terminal to the customer warehouse, but most trucked containers are first transported to BTT, before being delivered to the customer. This usually occurs when a container is due at the warehouse in the early morning. BTT then picks up the container at ECT the day before the deadline, and stores it at their terminal overnight.

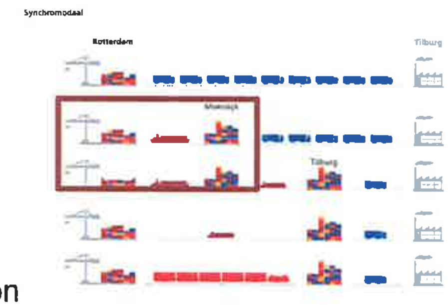
BTT operates own barges between Rotterdam and Tilburg and charters trains from DB Schenker. This leads to the following intermodal capacity between Rotterdam and Tilburg:

Modality	Amount	Capacity	Frequency	Yearly capacity
	1	88 TEU	300 voyages per year	26,400 TEU
	5	32 TEU	7 voyages per barge per week	53,760 TEU

With these assets, BTT has a total intermodal capacity of 80,160 TEU per year.

The BTT office is operational during office hours only.

2.2 Network from Rotterdam to Tilburg – Indirect lanes



Two indirect lanes were identified at the beginning of the pilot. Both lanes include barge transport from Rotterdam to Moerdijk. Transport between Moerdijk and the Tilburg terminal would then be either by a smaller barge or by truck. The barge-barge connection however, was not operational before the end of the pilot study. Therefore, this transport lane is out of scope for the rest of the study.

EGS and MCT jointly charter a barge, operated by Danser for the route from Rotterdam to Moerdijk. This vessel has 6 voyages per week, loads and discharges at different terminals in the Rotterdam port and sails on a fixed schedule, as shown below on the left.

Time	Action
18.00	Arrival Delta Terminal
01.00	Arrival Euromax Terminal
05.00	Ex-Maasvlakte
10.00	Arrival MCT

Modality	Amount	Capacity	Frequency	Yearly capacity
	1	190 TEU	6 voyages per week	59,280 TEU

The vessel used for this transport is a barge combination. The barge combination uses two barges. There is always one barge located at MCT. This ensures fast handling at MCT, as the barge combination can decouple the barge coming from Rotterdam, and directly connect to an already loaded barge at MCT. A stationary barge in Rotterdam is not (yet) available due to regulations in the Port of Rotterdam. The barge combination used at this moment carries 1 barge at the time. In case of high demand the barge combination can consist of two barges, doubling its capacity to 118,560 TEU per year.

Offices of both EGS and MCT are only operational during office hours. Bookings that arrive outside these hours are handled the next day. The Danser office is operational 24 hours a day.

2.3 Transport system in figures – Data collection

In order to gather more insight in the current status of the network, container flow performance was measured on the routes from Rotterdam to Tilburg. For this exercise the container flow data from three high-volume clients in Tilburg was monitored. To calculate total performance for the whole network, data from BTT, ECT and MCT was combined. Data was collected for all containers of these shippers, that were imported through ECT terminals, between September 2011 and December 2011.

Methodology

As the observed clients book their containers at BTT, BTT has the most detailed information about the containers and also the link between clients and transported containers. With the container numbers, ECT and MCT can provide information on the events related to these containers at their terminals. Combining this information leads to an overview of the entire container flow from the moment the container arrives in Rotterdam, to the moment it is delivered to the shipper.

ECT has information on the container handling in the port of Rotterdam. Before containers can be picked up at the deep-sea terminal, multiple administrative processes have to be completed. The container has to be cleared ("released") by both customs as well as the shipping line before inland transporters can pick-up the container. ECT saves the time stamps of these events. ECT also saves the time stamp for the moment the container enters (Gate In, GI) and leaves (Gate Out, GO) the terminal area. The hinterland modality is also known by ECT because they make containers available for these modalities at their premises and are in charge of loading containers to truck, train and barge. In case the container travels through the MCT terminal, MCT can also deliver time stamps for GI and GO. BTT provides information about the booking date and expected delivery date of the containers, the modality used for import, the time the container arrived in Tilburg and the time the container was delivered to the shippers.

2.3 Transport system in figures – Shipper A

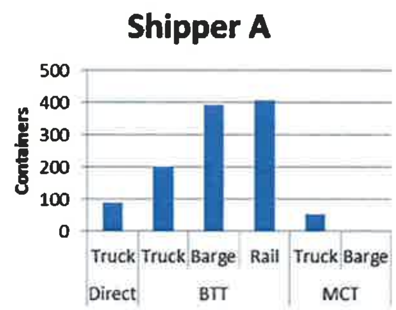
Shipper A

Shipper A has no production facilities in the Netherlands for the goods imported to Tilburg. All products are destined for sale. Most imported goods are high-value electronic devices.

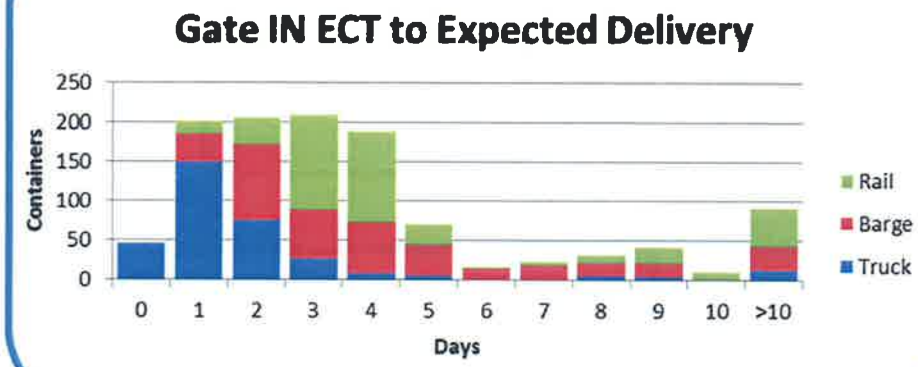
A week before the arrival of the deep-sea vessel, shipper A sends a booking to BTT. Two days before the arrival a more detailed booking is sent. Shipper A and BTT then decide on a warehouse delivery time together, based on availability at BTT. Shipper A has a preference for intermodal transport.

Even though Shipper A has a preference for intermodal transport, 25% of the containers are still trucked. Most containers that are trucked are not directly delivered to the shipper, but first stored at BTT. Most of these containers are picked up in the afternoon and delivered the next day. Barge and rail transport have an almost equal share.

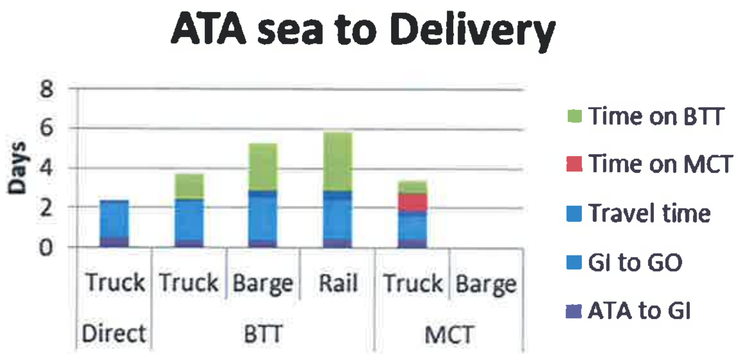
A limited amount of the containers (5%) is transported through MCT. All of these MCT containers were trucked to Tilburg. The barge-barge connection via Moerdijk was not used.



2.3 Transport system in figures – Shipper A



- This graph indicates the time in days between discharge from the deep sea vessel and the date when the shipper requested the containers to be available at their warehouse. Most containers are trucked when the container is expected to arrive at the warehouse within 2 days after GI. There is a peak in rail transport when the container is expected 3 or 4 days after arrival at the deep-sea terminal. Interestingly, some containers that are expected more than 8 days after arrival at the deep-sea terminal are still trucked.



- The ATA sea is the actual arrival time of the deep sea vessel. The graph indicates the time spent on different stages between ATA and Delivery. Regardless of the chosen modality, on average a container from this shipper idles at the deep-sea terminal for 2 days. Containers that were transported through MCT had a shorter dwell time on the deep-sea terminal. The average time on BTT is much higher when containers are transported with rail or barge. This indicates that these containers were less urgent for the shipper than the containers that were trucked.

2.3 Transport system in figures – Shipper B

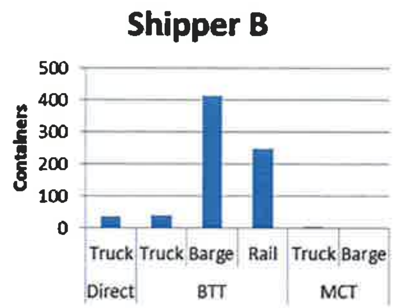
Shipper B

Shipper B has no production facilities in the Netherlands for the goods imported to Tilburg. All products are destined for sale. Shipper B imports high-value electronic devices.

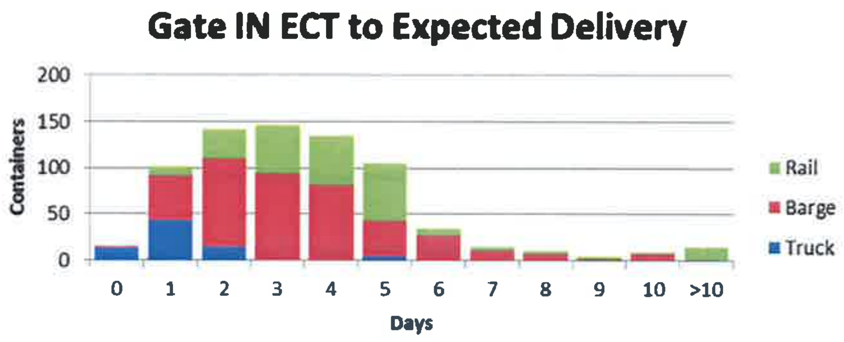
At the beginning of the week Shipper B sends an overview of the arriving containers in the given week. Depending on the arrival date and time of the deep-sea vessel, the shipper asks BTT at what time and date the container will be available in Tilburg. Shipper B has a preference for intermodal transport.

For Shipper B only 10% of the containers were trucked. 56% of the containers were transported by barge, and 33% of the containers were transported by rail. This means that 89% of containers were transported by barge and rail, which is the highest intermodal score of the three shippers.

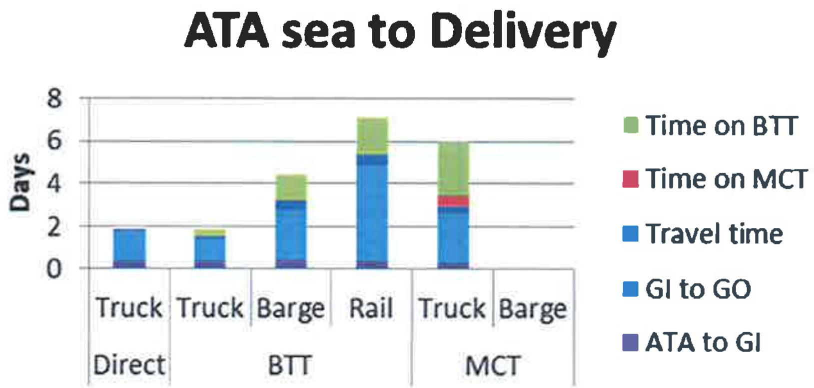
Only 4 containers were transported through MCT between September and December 2011. These 4 containers were trucked from MCT. The barge-barge connection was not used.



2.3 Transport system in figures – Shipper B



- Most containers are trucked when the container is expected to arrive at the warehouse within 2 days after GI, as was also the case for Shipper A. After that, barge transport usually is the modality used for Shipper B's containers. Other than an occasional trucking (at 5 days), there is no trucking other than the trucking of containers that need to arrive at the warehouse within 2 days.



- For Shipper B's containers, the average time spent at the deep-sea terminal greatly differs per chosen modality, but it is clear that containers that are trucked spend less time at the deep-sea terminal. So although Shipper A and B use the same network, the dwell times are different. This can be influenced by customs and commercial release and connections between vessel arrival times and the intermodal schedule. Dwell-times at BTT are short, containers are usually delivered to the warehouse on the day after they arrived at BTT.

2.3 Transport system in figures – Shipper C

Shipper C

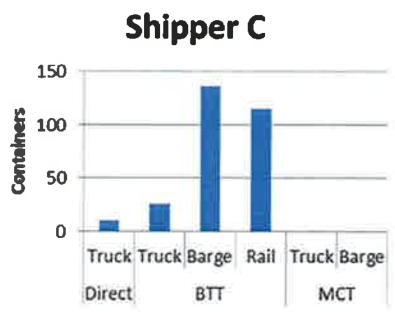
Shipper C has production facilities in The Netherlands. The imported goods are base materials for these facilities.

Two weeks before the arrival of the deep-sea vessel, Shipper C notifies BTT of the arriving containers. One day before arrival of the vessel, the shipper communicates the expected delivery date to BTT.

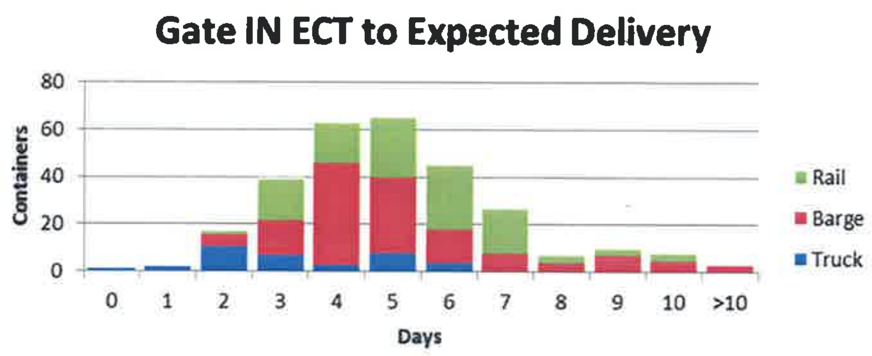
Unlike Shippers A and B, lead times can be longer with containers from Shipper C. Containers are usually expected one week after arrival of the deep-sea vessel. This also means there is enough opportunity for BTT to transport the containers via rail or barge.

Compared to the other shippers, Shipper C imports a lower amount of containers (287 containers in the given period). 47% of these are transported by barge and 40% by rail. Only 13% of containers is transported by truck. The intermodal score is therefor 87%.

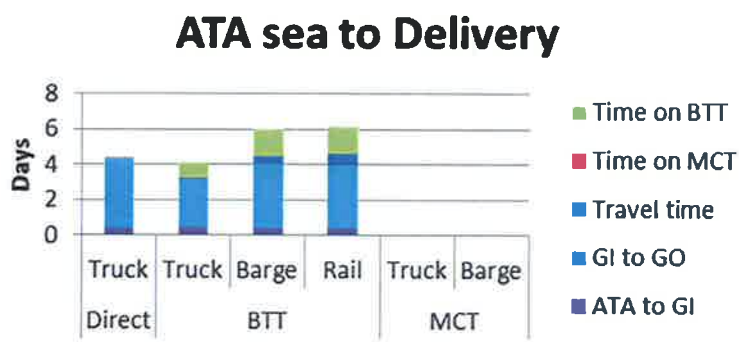
No containers from Shipper C were transported through MCT.



2.3 Transport system in figures – Shipper C



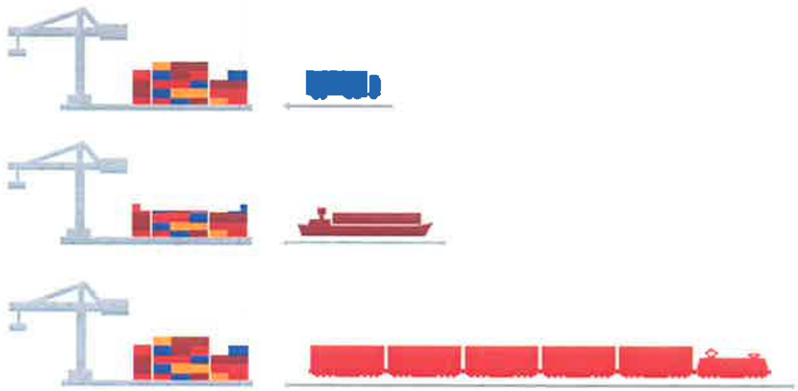
- Compared to the other shippers, Shipper C's containers are expected later and this is also clear from the graph. Hardly any containers are expected within 2 days after arrival at the deep-sea terminal. Interestingly though, some containers are trucked even when they are expected 6 days after arrival at the deep-sea terminal.



- The average dwell time at the deep-sea terminal differs per modality and is relatively high compared to the other shippers. This is because Shipper C does not expect the containers shortly after arrival at the deep-sea terminal, but usually gives BTT a week to deliver the containers. BTT can therefore plan these containers more freely, and if intermodal capacity is not sufficient on a certain day, it is no problem to transport the containers the next day.

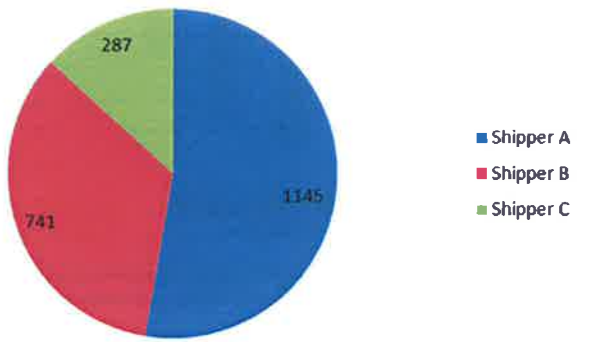
2.3 Transport system in figures - Overall

Below figure indicates the modal split for truck, barge and rail for the Rotterdam port in 2010, the modal split target for the Maasvlakte I and II for 2033 and the modal split results for the network in this pilot study as calculated for the period September to December 2011. The realized modal split on this transport network shows that the 2033 target is realizable and that perhaps road transport can be further reduced by optimizing the use of rail transport. Whether these targets can be achieved on all transport corridors of course depends on circumstances.

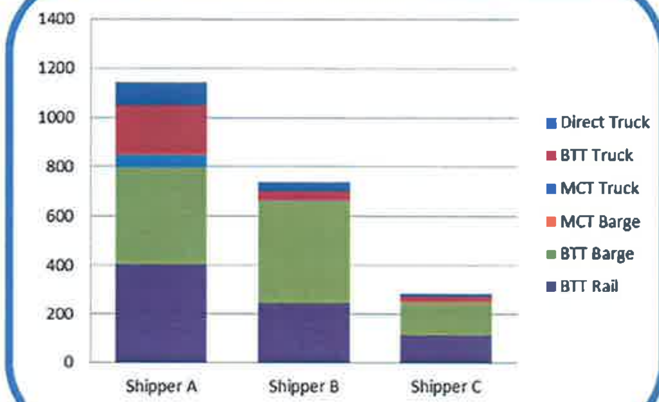


2010	2033 target	Synchro pilot
57%	35%	19%
33%	45%	46%
10%	20%	35%

2.3 Transport system in figures - Overall

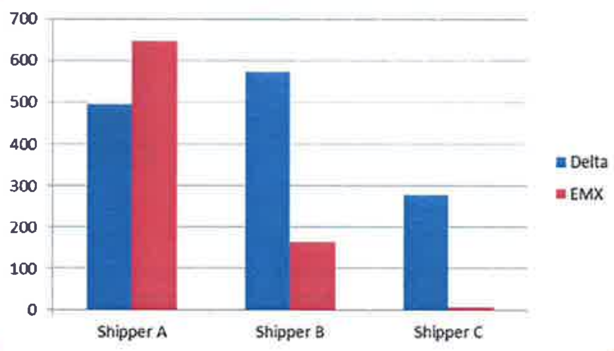


- In the period between September and December 2011 a total of 2,173 containers were transported from Rotterdam to Tilburg for the three shippers. Shipper A is the biggest shipper in this network, with over 50% of the containers.

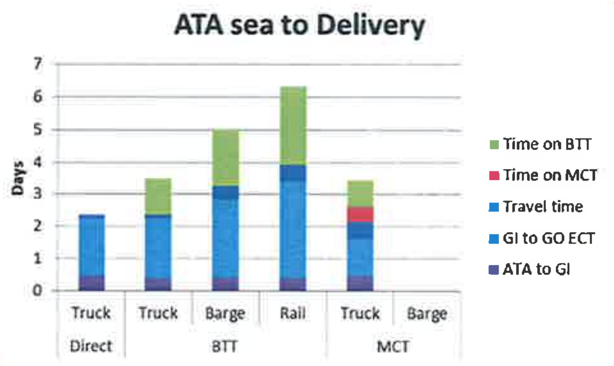


- For each shipper, the split over the different transport lanes was analyzed. For each shipper, most containers are transported by rail or barge, making the average intermodal score 76%. Shipper A has a significantly higher percentage of trucked containers (25%) and because this shipper ships the biggest volume, this decreases the average intermodal score. Based on only Shipper B and C the score could be 88%.

2.3 Transport system in figures - Overall



- Most containers are imported through the ECT Delta terminals. Only Shipper A has imported most of their containers through the Euromax terminal (EMX). The BTT operation with barge and rail is mostly operated from the Delta terminal. So the higher trucking percentage of Shipper A might also be partly related to this.

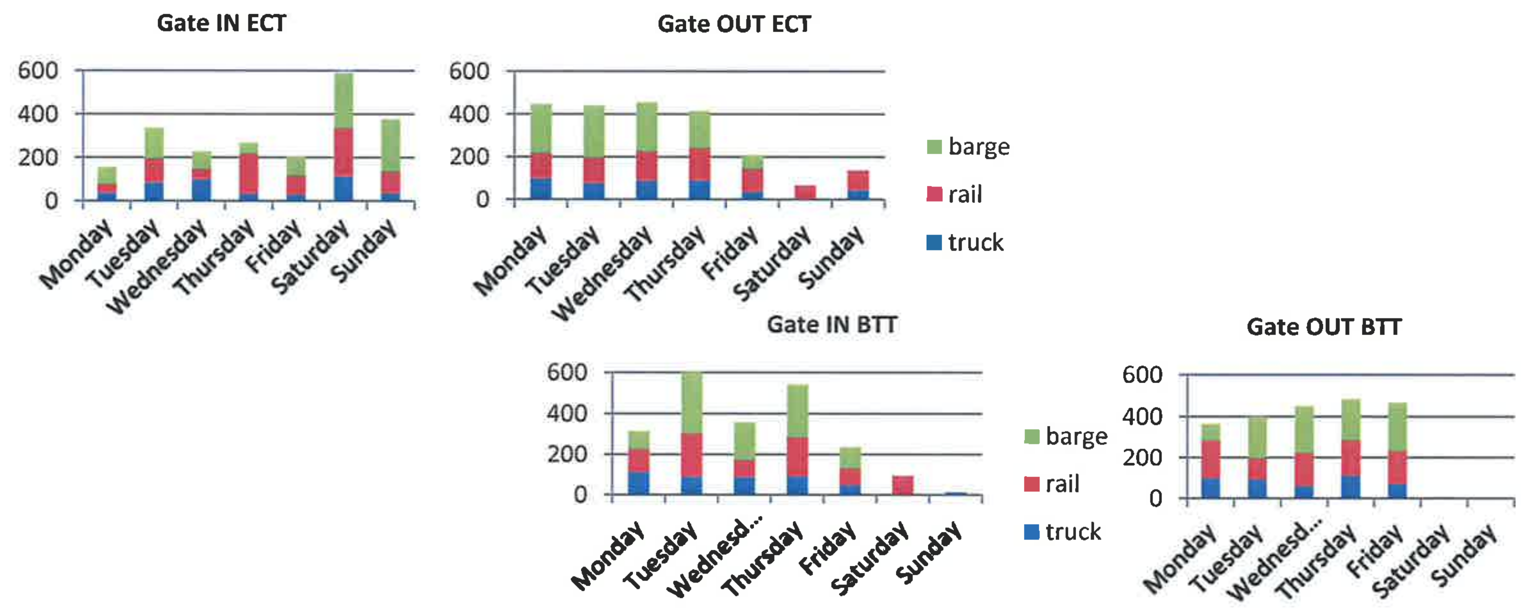


- The time spent on the different transport stages between ATA and delivery for all containers is shown in the table on the left. On average, terminal dwell times differ most between the different transport lanes and therefore cause big differences in total lead time. Benefits can be obtained when trying to push containers to inland terminals as soon as possible after discharge, e.g. by using extended gates. The green blocks indicate storage time on BTT so this can be considered as an indicator for container urgency and less for transport system performance.

2.3 Transport system in figures - Overall

Because the intermodal capacity on the network differs during the week, it is valuable to get some insight in the arrival patterns at both ECT and BTT during the week. Below graphs indicate the days of the week for GI and GO for both of the terminals.

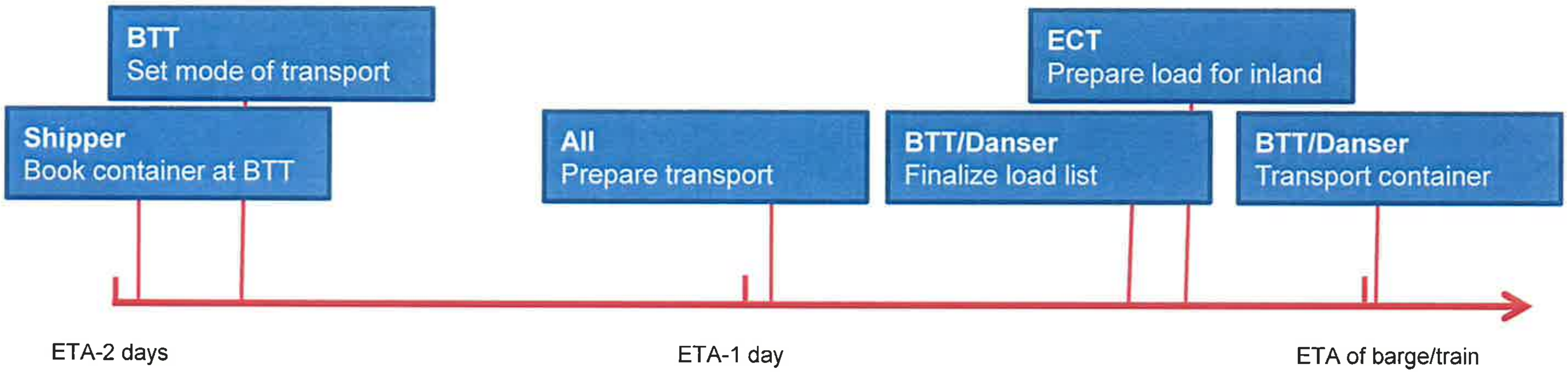
When comparing the day most containers arrive at the deep-sea terminal (Gate IN ECT) to the day the containers arrive at the inland terminal (Gate IN BTT) different patterns occur. At the deep-sea terminal most containers from the three shippers arrived on Saturdays, whilst most containers arrived on Tuesday and Thursday at the inland terminal. The amount of containers that leave the deep-sea terminal from Monday through Thursday is rather uniform. However, these containers do not always arrive at the inland terminal the same day. Many containers that leave the deep-sea terminal on Monday and Wednesday, arrive the next day in Tilburg. This depends on the operating schedule. Whilst more containers leave the deep-sea terminal at the beginning of the week, slightly more containers leave the inland terminal at the end of the week.



2.4 Operations

To provide the reader with a clear overview of the booking and transport preparation process, the whole process was divided over different high-level steps. Below is a timeline, related to the estimated time of arrival (ETA) of a barge or train at the ECT deep sea terminal. The process is different for containers that need to be trucked. The trucking process will be described separately in the last section of this paragraph.

The process of transporting a container starts with the booking of the shipper. The shipper notifies BTT of arriving containers. In cooperation with the shipper, BTT determines the mode of transport, based on the required delivery date set by the shipper and the available capacity of BTT. Depending on the chosen transport lane, the booking needs to be processed by different parties. In case of intermodal transport, a load list for barge or train has to be sent to ECT. ECT will then prepare the container for inland transport by checking release status and stacking the container in dedicated stacking areas if needed.



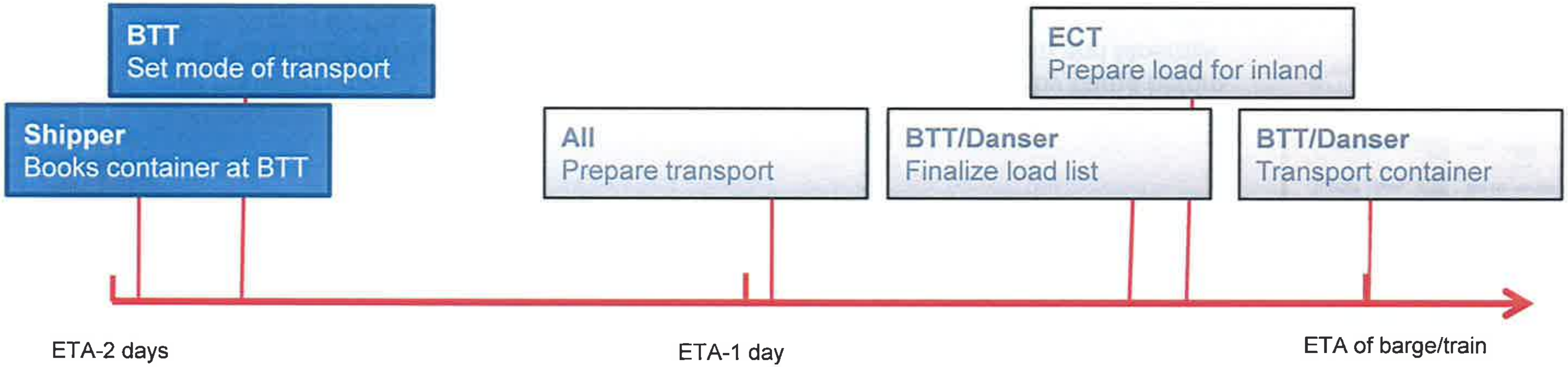
2.4 Operations – Booking and setting mode of transport

Shipper books container at BTT

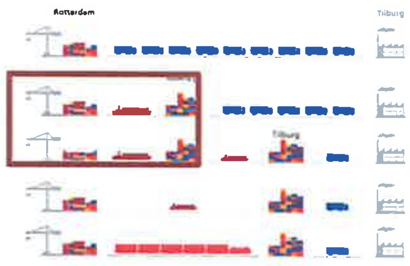
Transport conditions differ per shipper. Containers from Shipper A and C are transported under the carriers responsibility (carrier haulage), whilst Shipper B's containers are transported under the shippers responsibility (merchant haulage). BTT promises availability in Tilburg one day after the deep-sea vessel has left the deep-sea terminal (to cater for enough time for container discharge). All clients consult with BTT about the possible delivery dates. The final delivery information is available at BTT approximately 3-4 days before expected delivery, meaning approximately 2 days before ETA of barge or train in case of intermodal transport. In some cases shippers prescribe the mode of transport to BTT. Shippers only prescribe transport mode if the container is urgent and usually the required transport mode is then truck.

BTT sets mode of transport

When BTT has the final delivery information, BTT will decide which transport lane the container will follow from Rotterdam to Tilburg. BTT will try to optimise the utility rates of their own assets before looking at other options. Use of the MCT transport lanes depends on two aspects: 1) In case of high volumes and insufficient BTT capacity. 2) In case of high volume at the Euromax terminal. The BTT operated train visits the Euromax terminal at most once a week. In case of high volume on the Euromax terminal it may be beneficial for BTT to transport the containers via MCT.



2.4 Operations – Prepare transport

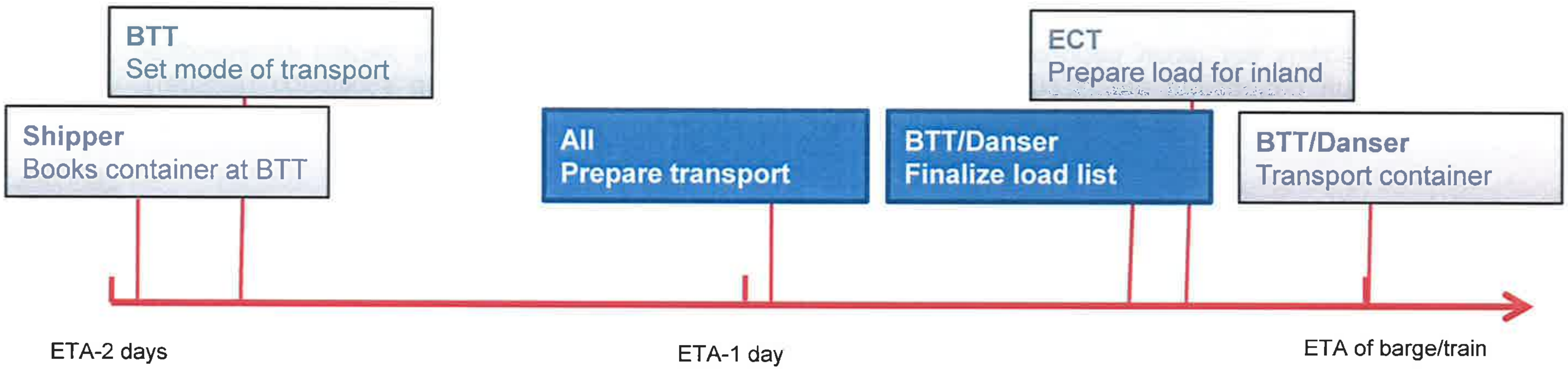


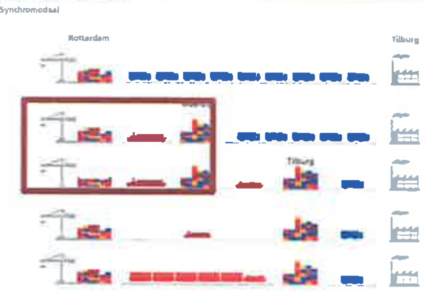
Prepare for barge transport to MCT

In transport lanes 2 and 3, the container is transport from ECT to MCT by barge before it is transported to Tilburg. The Orca barge that sails between Rotterdam and Moerdijk is operated by Danser, contracted to MCT and also operates as part of the EGS network. Communication between all these parties is required. A graphical overview of this communication is provided on the next page.

The Orca sails according to a fixed schedule. One or two days before sailing, a slot needs to be booked at the quay of the deep-sea terminal. This slot request is sent by Danser to the ECT department CAL/CAR, responsible for all barge and rail slots at the ECT terminals. This slot request is only related to the vessel call and not to the individual containers.

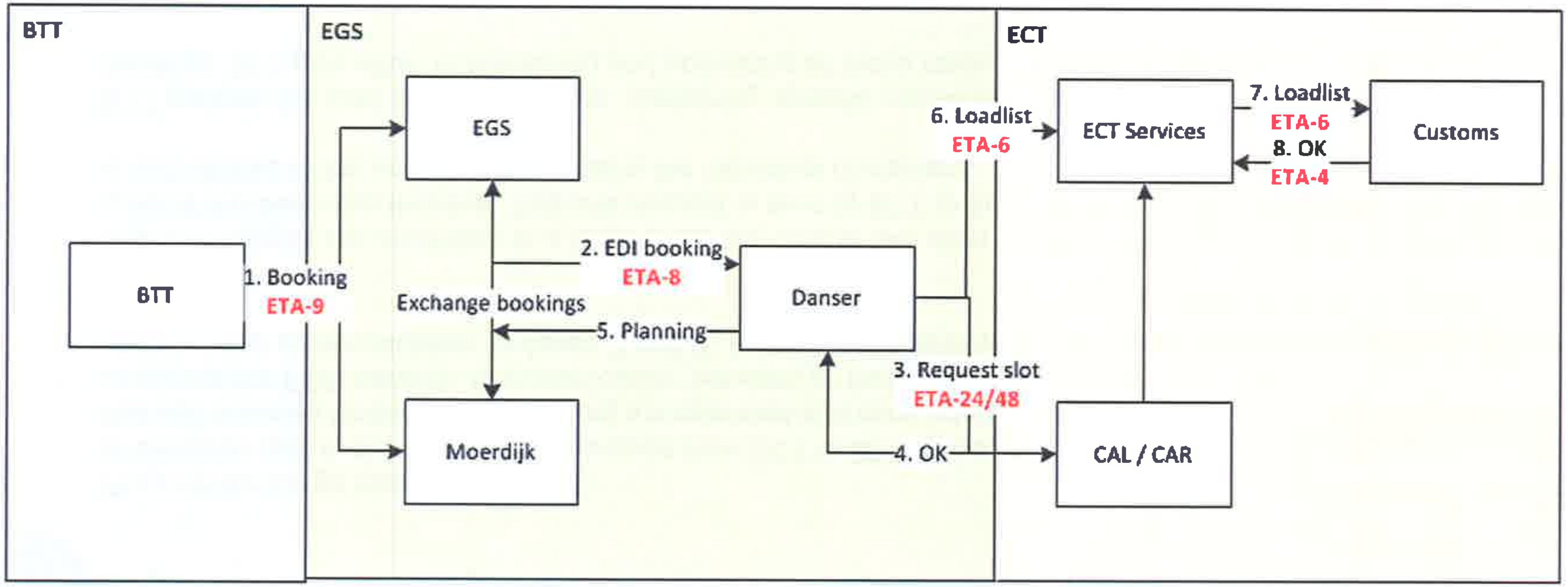
BTT sends a booking for this barge service to either EGS or MCT. EGS and MCT can both receive bookings for this service from their respective customers. The total number of bookings is then forwarded to Danser by MCT. Danser confirms the booking to MCT. Finally, Danser creates the load list for the barge, containing specific containers, and sends this to the ECT department ECT Services. ECT Services is responsible for loading operations for barges and trains. As Danser acts on behalf of EGS, they can deliver the load list 6 hours before barge ETA instead of the normal 8 hour cut-off. But ECT Services expects Danser to safeguard the load list is correct and all containers are available. EGS monitors and coordinates this process for all their network operations.



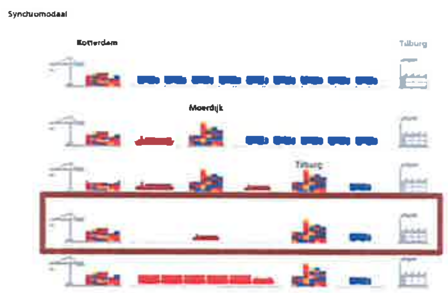


2.4 Operations – Prepare transport for MCT barge

In below figure the communication process for preparing barge transport to MCT is shown. The red text indicates the cut off time in hours before ETA of the barge at the ECT terminal. A cut off time is the last possible time when the information can be provided. The total number of communication partners in this process is 7 and the total cut off time is 9 hours before barge ETA.



2.4 Operations – Prepare transport

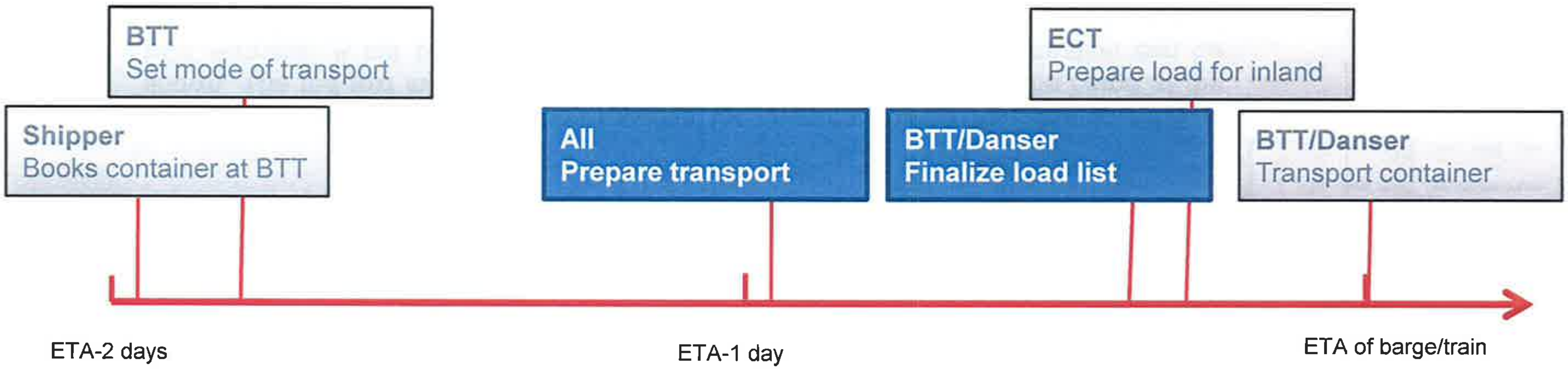


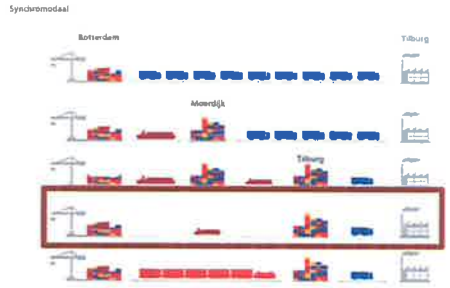
Prepare for barge transport to BTT

In transport lane 4, the container is transport from ECT to BTT by barge. The barges that sail between Rotterdam and Tilburg are operated and contracted by BTT, and are no part of the EGS network. Communication between all these parties is limited compared to communication for lanes 2 and 3. A graphical overview of this communication is provided on the next page.

The BTT barges sail according to a fixed schedule. One or two days before sailing, a slot needs to be booked at the quay of the deep-sea terminal. This slot request is sent by BTT to the ECT department CAL/CAR. This slot request is only related to the vessel call and not to the individual containers.

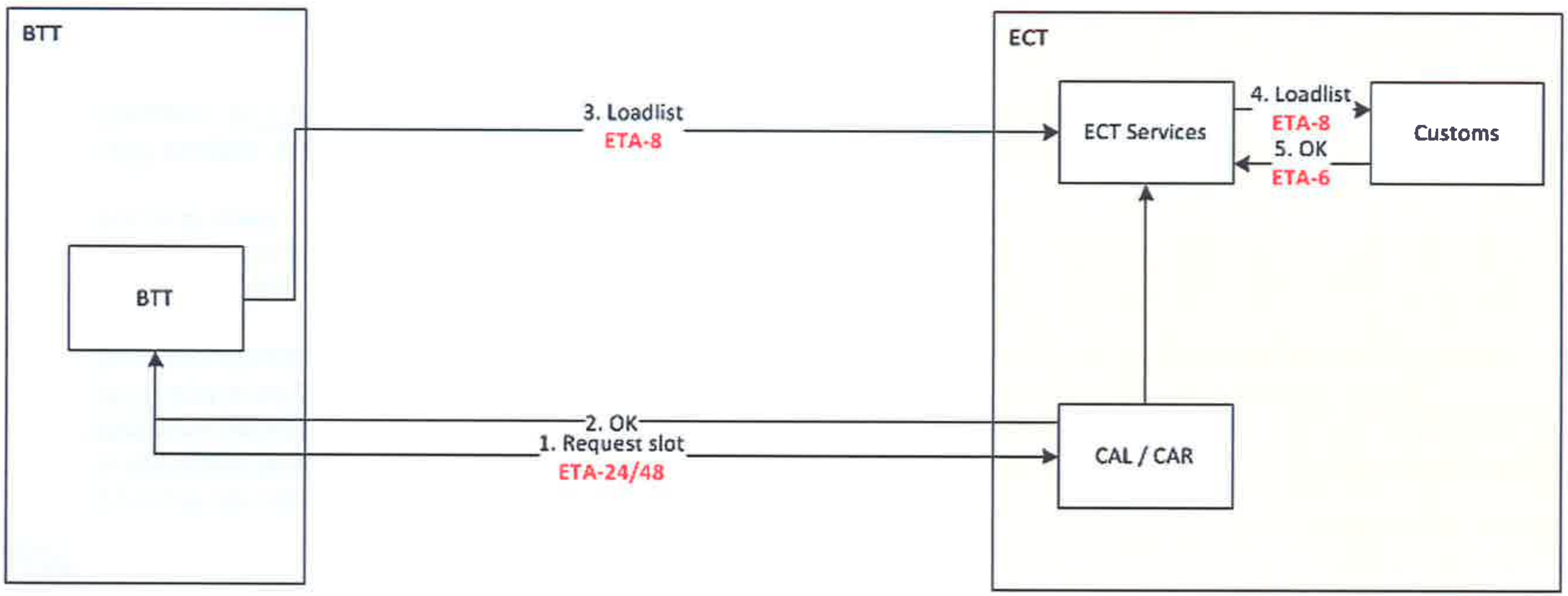
BTT creates the load list for the barge, containing specific containers, and sends this to the ECT department ECT Services. BTT puts effort in monitoring and optimizing all these steps. EGS is not involved in this operation.

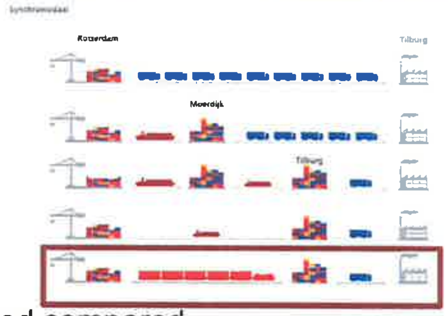




2.4 Operations – Prepare transport for BTT barge

In below figure the communication process for preparing barge transport to BTT is shown. The red text indicates the cut off time in hours before ETA of the barge at the ECT terminal. A cut off time is the last possible time when the information can be provided. The total number of communication partners in this process is 4 and the total cut off time is 8 hours before barge ETA.





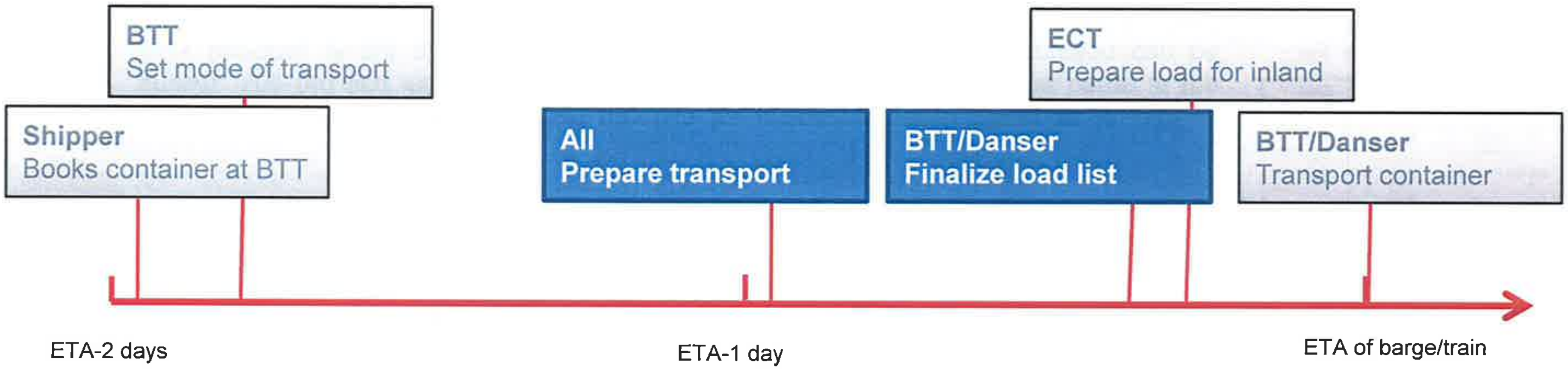
2.4 Operations – Prepare transport

Prepare for rail transport to BTT

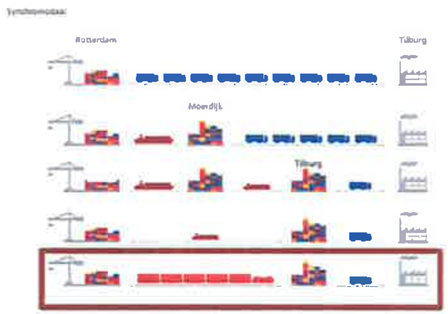
In transport lane 5, the container is transported from ECT to BTT by train. The train that runs between Rotterdam and Tilburg is operated by DB Schenker and contracted by BTT, and is no part of the EGS network. Communication between all these parties is limited compared to communication for lanes 2 and 3. A graphical overview of this communication is provided on the next page.

The BTT train runs according to a fixed schedule. A slot needs to be booked at the rail terminal of the deep-sea terminal. This slot request is sent by BTT to the ECT department CAL/CAR each Thursday for the trains running in the next week. This slot request is not related to the individual containers.

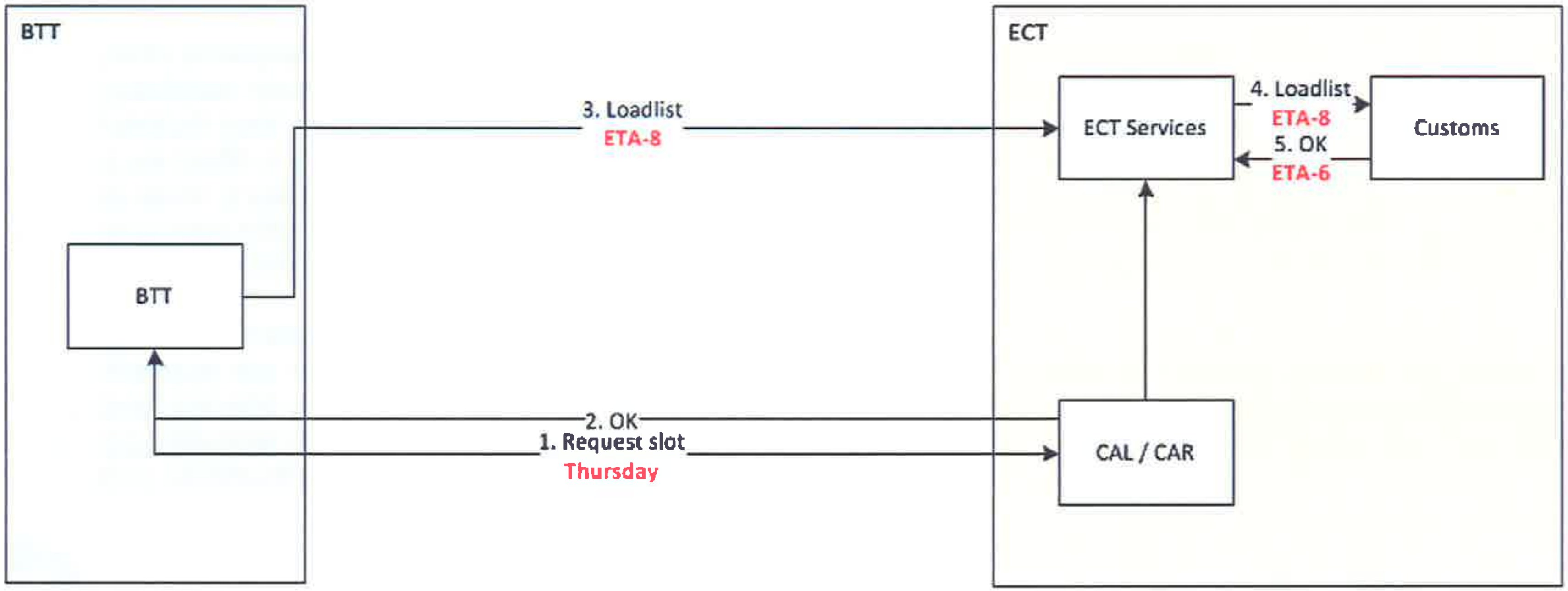
BTT creates the load list for the train, containing specific containers, and sends this to the ECT department ECT Services. BTT puts effort in monitoring and optimizing all these steps. EGS is not involved in this operation.



2.4 Operations – Prepare transport for BTT train



In below figure the communication process for preparing rail transport to BTT is shown. The red text indicates the cut off time in hours before ETA of the train at the ECT terminal. A cut off time is the last possible time when the information can be provided. The total number of communication partners in this process is 4 and the total cut off time is 8 hours before train ETA.

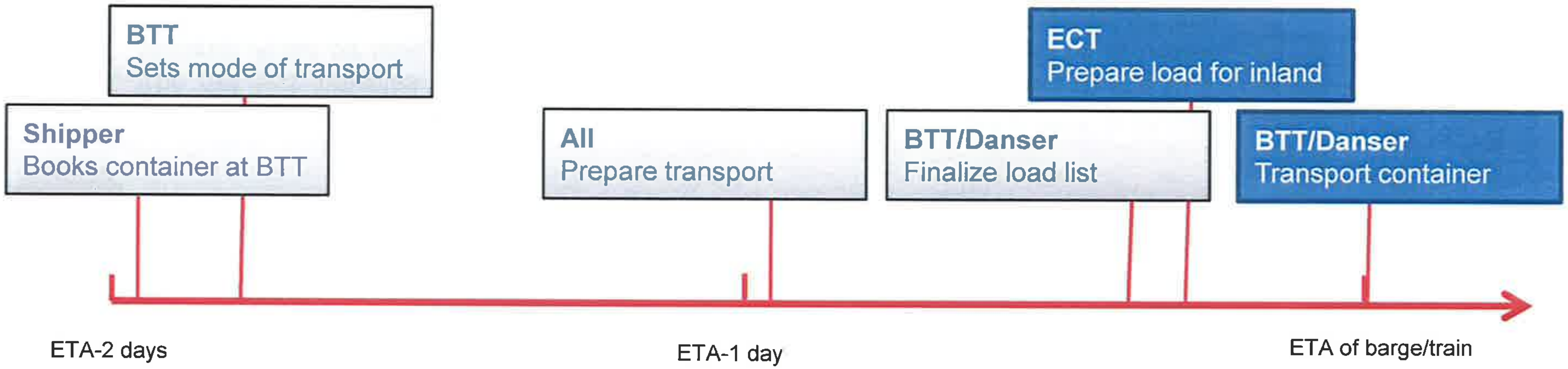


2.4 Operations – Prepare load and transport

ECT prepares load for inland transport
ECT Services checks whether all containers on the load list are released and available for inland transport. After that, the load list is forwarded to Customs. Customs will approve these load lists if all required information is available and correct and when all the containers are released by Customs. Customs asks for two hours to perform this action.

After customs approval the containers can be prepared for loading to barge and train by transporting them to dedicated stacking areas. At the ECT Delta Terminal, barges can be loaded at the deep-sea quay or at the barge terminal. If the barge is loaded at the barge terminal, containers need to be moved there using internal transport. If the barge is loaded at the deep-sea quay, internal transport is not required when the container is in the general stacking area. The rail terminal at the ECT Delta Terminal is located next to the terminal, not on the terminal. Therefore, containers need to be moved to the rail terminal using internal transport. ECT Services asks for 6 hours to perform this activity. EGS monitors this process for all their network operations.

BTT or Danser transport the container
Transport is executed by either Danser or BTT. In case of transporting via Moerdijk, the process for trucking (described on next page) is followed for the leg from Moerdijk to Tilburg.



2.4 Operations – (Direct) trucking

In transport lane 1 (and partly 2), the container is transport from ECT (or MCT) to BTT by truck. Trucks operate on demand and are contracted by BTT. Communication between all these parties is very limited compared to communication for the other lanes. A graphical overview of this communication is provided on the next page.

The process steps for container booking by the shipper and setting the mode of transport are identical to what was described earlier in this document. When the container will be transport by truck, BTT creates the load list for the truck, which only consists of one 40ft container or two 20ft containers, and sends this to ECT Services via the Portbase road planner. ECT Services checks the availability and commercial release for this container. EGS is not involved in this operation.

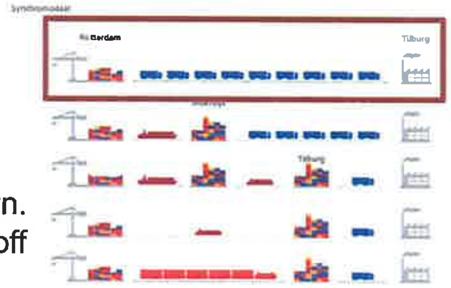
Upon truck arrival at the ECT terminal, the truck driver is asked to identify himself and indicate the container that he wants to collect. ECT Services checks whether the truck driver has the necessary security codes to collect the container (line release pin number) and if correct, the container can be collected in the stack. Containers can be loaded on trucks directly from the ECT stack, so no preparation for loading is necessary by ECT. Before the truck can depart, Customs checks whether the container is released. Queues at the gate of ECT as well as congestion on the roads to and from the Maasvlakte can cause delays in truck transport.

Shipper
Books container at BTT

BTT
Sets mode of transport

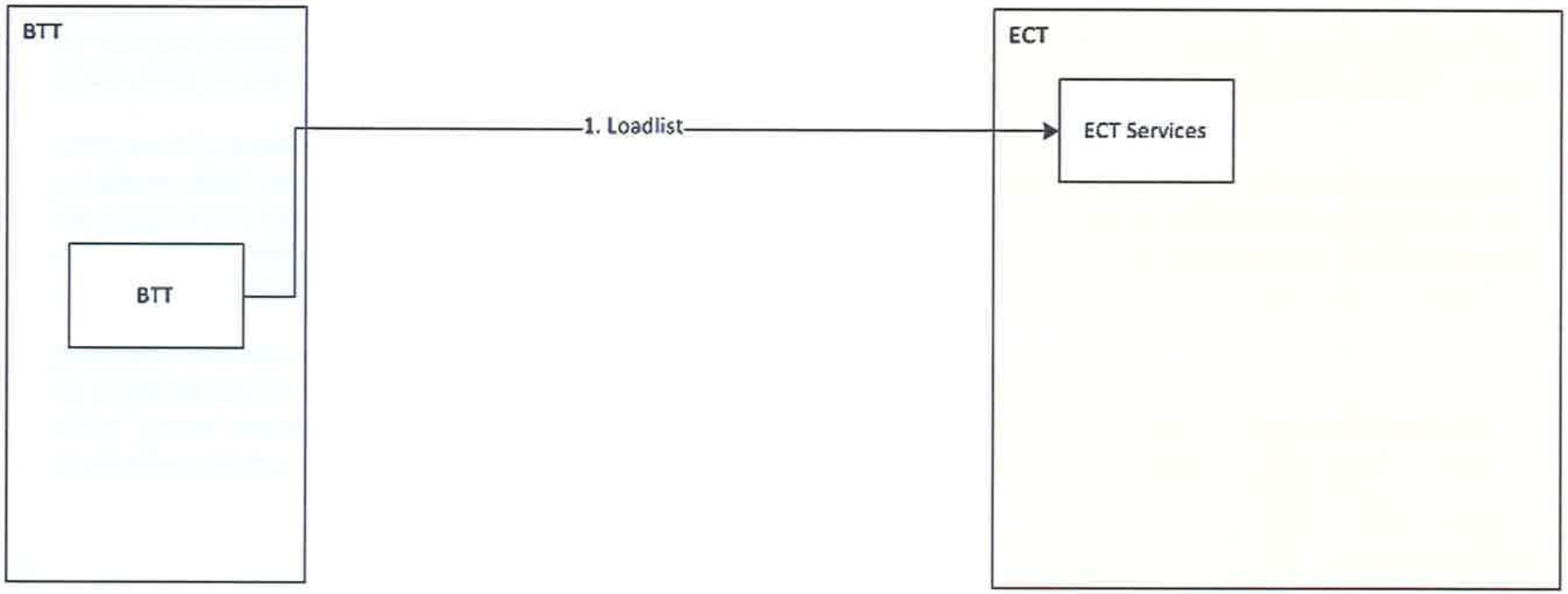
BTT
Finalize load list

BTT
Transport container



2.4 Operations – Prepare transport for trucking

In below figure the communication process for preparing truck transport to BTT is shown. The total number of communication partners in this process is 2 and there is no cut-off time.



3 Synchromodality Framework

This synchromodality study researches the possibility of synchromodal handling of containers on a corridor from Rotterdam to Tilburg. The synchromodality framework introduced in this chapter divides the synchromodal concept in 5 areas that each need specific consideration and work when implementing a synchromodal transport system. These areas are used to structure the work done during the study and to structure the remaining part of this document. This chapter will first define synchromodal transport, also related to intermodal and multimodal transport. After that the framework will be introduced. The topics of the framework will be described in more detail in the next chapters.

3.1 Synchromodality

The definition that is used for synchromodal transport in the course of this study is as follows:

Synchromodal transport: Constantly tuning inside and between good chains, transport chains and infrastructure so that given the aggregated transport demand, and at any moment in time, the best modality can be chosen. Key aspects to synchromodal transport are mode free booking, joint planning and coordination for a network of chains and not for individual chains. This asks for good information infrastructure and flexible operations. The goal is to make optimal use of available capacity on the network.

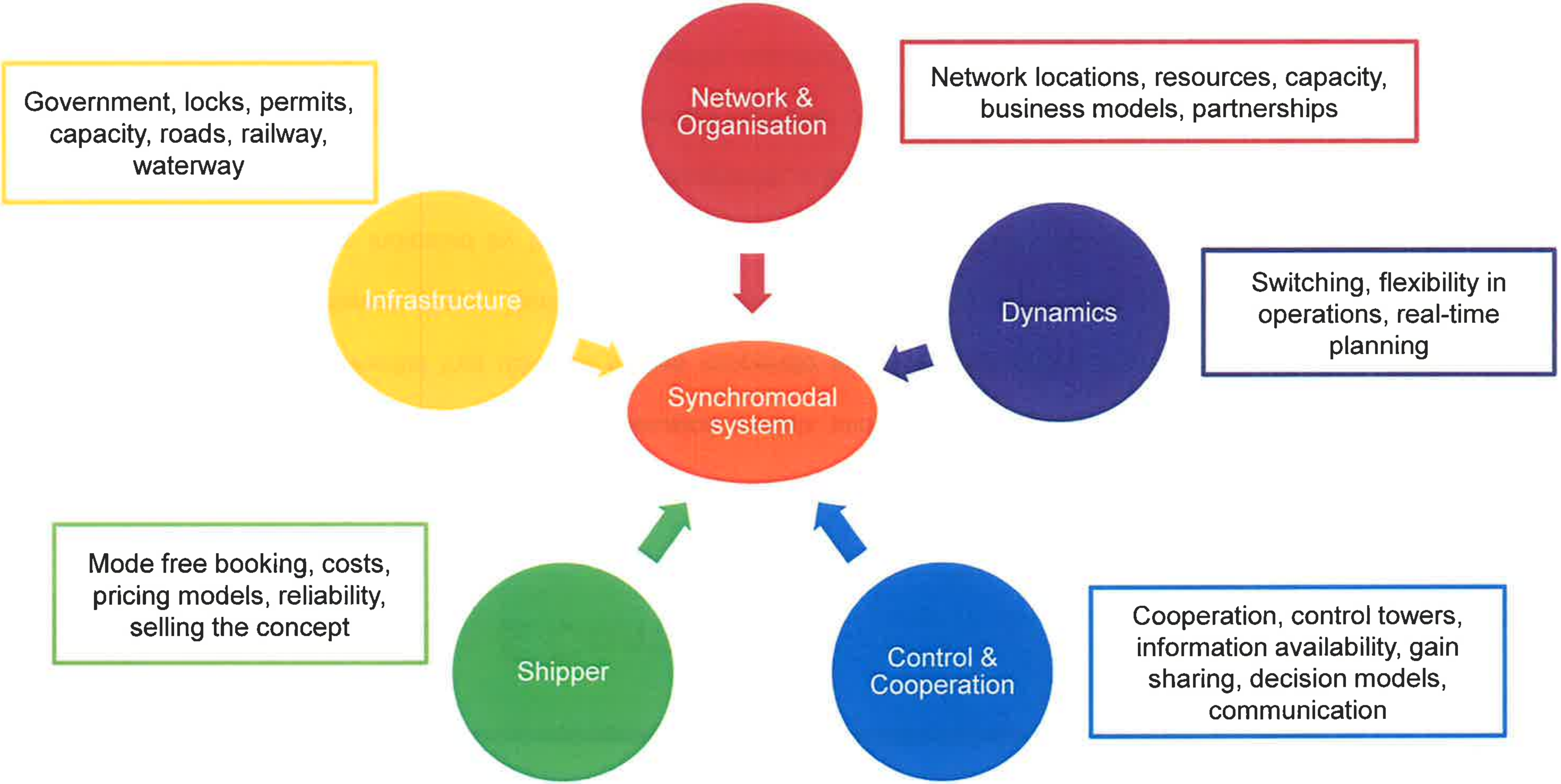
Synchromodal transport is related to the more well-known concepts of intermodal, multimodal and co-modal transport. In **multimodal** transport, more than one modality is used while transporting the container from A to B. **Intermodal** transport is a more specified form of transport where the cargo is carried in standardized equipment, such as a maritime container. Sometimes it is also referred to as being multimodal transport that involves rail or barge. The concept of **co-modal** transport is the use of unimodal and multimodal transport chains next to each other to make optimal use of available capacity and resources from a perspective of one single customer or coordinator.

For the network in this pilot, it can be concluded that there is one unimodal transport lane (direct trucking) and four lanes with multimodal transport. Because maritime containers are used, the multimodal chains can also be called intermodal lanes. Because BTT, for every container, chooses between those lanes and coordinates the transport over these multiple possibilities, co-modal transport also holds for the network as a whole.

Synchromodal transport adds to the definition of co-modal transport in the sense that synchromodal transport should not be made available by one party for one customer (or a group of customers) but that the capacity is supplied by a lot of providers simultaneously and that switching between these options is also possible. This directly results in more necessary cooperation and coordination and increased need for network visibility.

3.2 Synchromodality Framework

The Synchromodality Framework divides the concept of synchromodality and the efforts related to its implementation in five different areas. Keywords of the different areas can be found in the picture below. In the next chapters, every aspect is discussed in more detail.



4 Cooperation & Control

In this chapter the focus is on 'Cooperation and Control', so the keywords are cooperation, control towers, information availability, gain sharing, decision models and communication. In a synchromodal transport system it is essential that different parties cooperate and this cooperation takes place within transport chains and between chains. During the pilot study, the topic of cooperation came across several times and at the end was indicated by the involved partners as most important when implementing a successful synchromodal concept. Formalizing the cooperation, e.g. with rules for gain sharing and decision making, becomes essential when the number of parties increases or the effect of the cooperation on individual profit levels increases. The paragraphs in this section describe the work done during the pilot study and the list of topics is not meant to be exhaustive.

1. OSIST model for control towers
2. Design for a cooperation
3. Business interests
4. Decision making
5. Creating situational awareness
6. Providing visibility with a dashboard
7. Planning synchromodal transport together

4.1 OSIST model for control towers

When implementing control rooms for example for coordination of railway infrastructure and operations, TNO has developed a model, called the OSIST model, for the design of control rooms. This model can also be used as a starting point for a framework to design control towers for a synchromodal transport system.

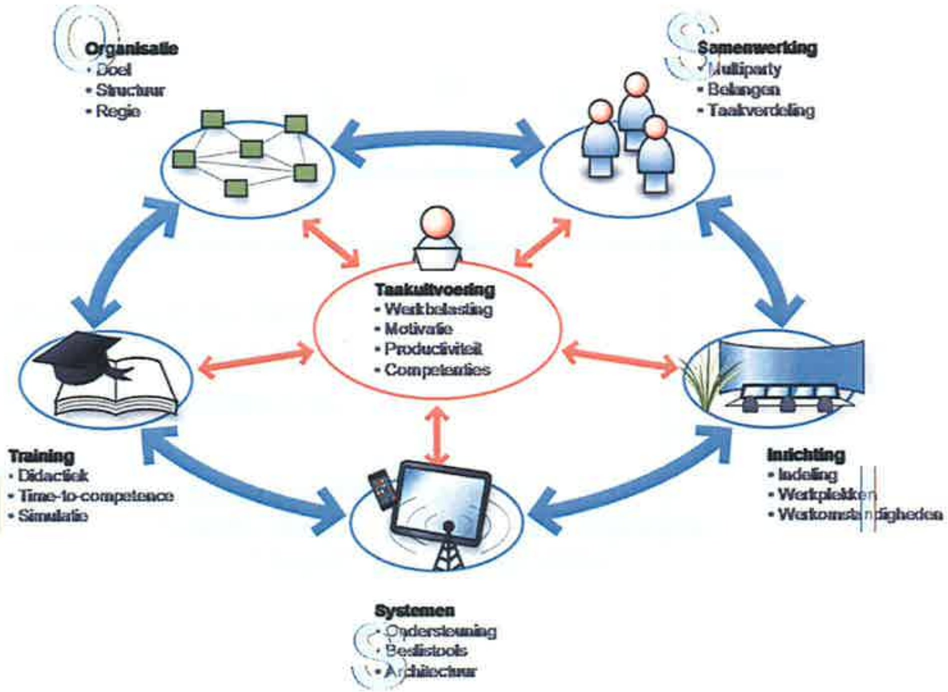
A **control tower**, in the field of logistics, can be described as a (virtual) location from where coordination of and between chains can take place on a daily basis.

The model is helpful in the sense that when designing a control room and its functionality, the collaboration needs to be formalized. The framework therefore also gives some guidance when starting up a collaboration with the final goal of implementing joint planning and control.

The model consists of 5 parts:

O: Organization
S: Collaboration
I: Facilities
S: Systems
T: Training

The central topic is that of Execution, where the control operators perform their job.



4.1 OSIST model for control towers

Organization

This is the control tower organization, that can constitute of representatives of different businesses. Within *organization* the common mission and goals are defined. The control tower is used to reach these goals. The mission and goals therefore influence the design of the control tower concept to a large extent.

To complete this step it is necessary to:

- Formulate a common mission and goal
- Define roles for different parties

The work in a control tower concept is usually not performed by one operator and/or one business party but in a *collaboration*. Representatives of different organizations work together in one team. Processes and procedures are necessary to guide this collaboration and the execution.

To complete this step it is necessary to:

- Define tasks for different parties and operators
- Have insight in different interests
- Develop a Gain/Cost sharing model
- Create processes and decision rules

Collaboration

4.1 OSIST model for control towers

Facilities

The *facilities* and environment of the control tower need to fit the requirements from the tasks and the collaboration. These requirements determine the room design and working conditions. By creating a new control room location communication, trust, team dynamics and support for the new organization is improved.

To complete this step it is necessary to:

- Have insight in tasks and operators
- Have insight in processes and necessary communications (with control room parties and externals)

The operators need tailored support to perform their tasks and that helps in communication and also supports collaboration. To communicate effectively it is essential to create a shared situational awareness. Tools have to support the operator in taking the right decisions according to the set decision rules.

To complete this step it is necessary to:

- Have visibility systems (shared situational awareness)
- Have decision support tools
- Have communication equipment to communicate internally and externally

Systems

4.1 OSIST model for control towers

Training

The operator needs training to know how to perform the tasks and how to use the systems and facilities to maximum benefit. Having the right level of training helps to optimize task execution and employee satisfaction and productivity.

To complete this step it is necessary to:

- Train operators e.g. using simulations
- Have good task descriptions

Most important is that the operators can perform their tasks effectively, efficiently and safely. All OSIST factors should be addressed carefully to achieve this. The operators should have the right level of organizational awareness so they can act correctly in a dynamic multiplayer control tower environment. In a control tower multiple operators from the different organizations work together.

To complete this step it is necessary to:

- Have good task descriptions
- Have insight in necessary competences for operators
- Train according to competences and tasks

Task execution

4.2 Design for a cooperation

The OSIST model starts with formalizing the organisation of the control tower by formulating a common goal and mission. During the discussions in the study it became clear that for the consortium members that work together in a transport network, this step was never formally taken. In the transport industry, it is quite normal to start cooperation from a practical and pragmatic point of view. This means that the collaboration is started based on a gentleman agreement and with a handshake. It was agreed by the consortium parties that this can work very well in certain situations when implementing small changes because bottlenecks can be identified and solved during the first weeks and months. When implementing more complex changes or extensive collaborations, this approach is less ideal.

When going from the current transport network to a synchromodal transport system where cooperation is a key element, it was agreed that **the collaboration needs a formal starting point and a preparation phase**. First element in this preparation should be the identification and sharing of the business interests of all members in the collaboration. Having insight in these interest is the first step in aligning interests and operations. Understanding each other's businesses also helps in creating a decision model to stream line joint activities and control.

One of the important topics that was identified in the study was that, during the preparation phase of the collaboration, the **development of a gain and cost sharing model** needs to take place. By using joint planning, using each others assets and perhaps even hand over the control over assigning bookings to capacity to a central (neutral) party, the profit and loss results of individual companies are immediately affected. Gain and cost sharing models need to be developed for a synchromodal transport system and cooperation members have to agree on a model before transport execution in the collaboration can start.

4.3 Business interests

Individual businesses are primarily interested in the profitability of their business. Directly related to that they are interested in different costs and service levels. Depending on their role in the transport chain, different parties in the corridor from Rotterdam to Tilburg are interested in different levels of the transport system. Three levels were identified.

Container level	Interest in the whereabouts and service quality of a (single) container
Equipment level	Interest in the whereabouts, service quality and profitability of an equipment
Fleet level	Interest in the utilization of a set of vessels or other transport resources

The picture on the next page summarizes the interests of the parties involved in the study.

From the discussions it became clear that **difficulties arise when these interests are very diverse and also very different for each situation**. For BTT for example, the interests are very similar to the interests of EGS in their role of intermodal, co-modal operator in the direct connections to Tilburg. Their interests are very different when they have subcontracted MCT and Danser to perform certain activities in the network. The interests of EGS are described for the MCT case only but these will be different when another network destination is considered. This is because EGS knows different levels of involvement in inland terminals and the resources used in transport. Different contracts can exist with different customers, meaning that interests can also differ when a different customer is involved.

Formalizing collaboration in a network, resulting in a common goal and more standardized cooperation with tasks and decision models, will be extremely difficult when the business interests that can be seen as a starting point cannot be, to a certain extend, fixed and standardized.

4.3 Business interests on three levels

BTT (for direct lanes)
Service: On time equipment arrival and container delivery
Cost: Barge/train/truck utility rates, demurrage, detention, volume, cost price, terminal efficiency

BTT (for MCT lanes)
Service: On time container delivery
Cost: Truck utility rates, demurrage, detention

EGS (in MCT lanes)
Service: On time container & vessel arrival, reliability, connection with ECT
Costs: Volume on the EGS network

MCT
Service: On time vessel arrival and truck departure
Cost: Barge utility rate, cost price and volume, terminal efficiency (related to reliability of schedule)

Danser
Service: Customer satisfaction (MCT), compliance with vessel schedule
Cost: Volume and cost price (to assure future business)

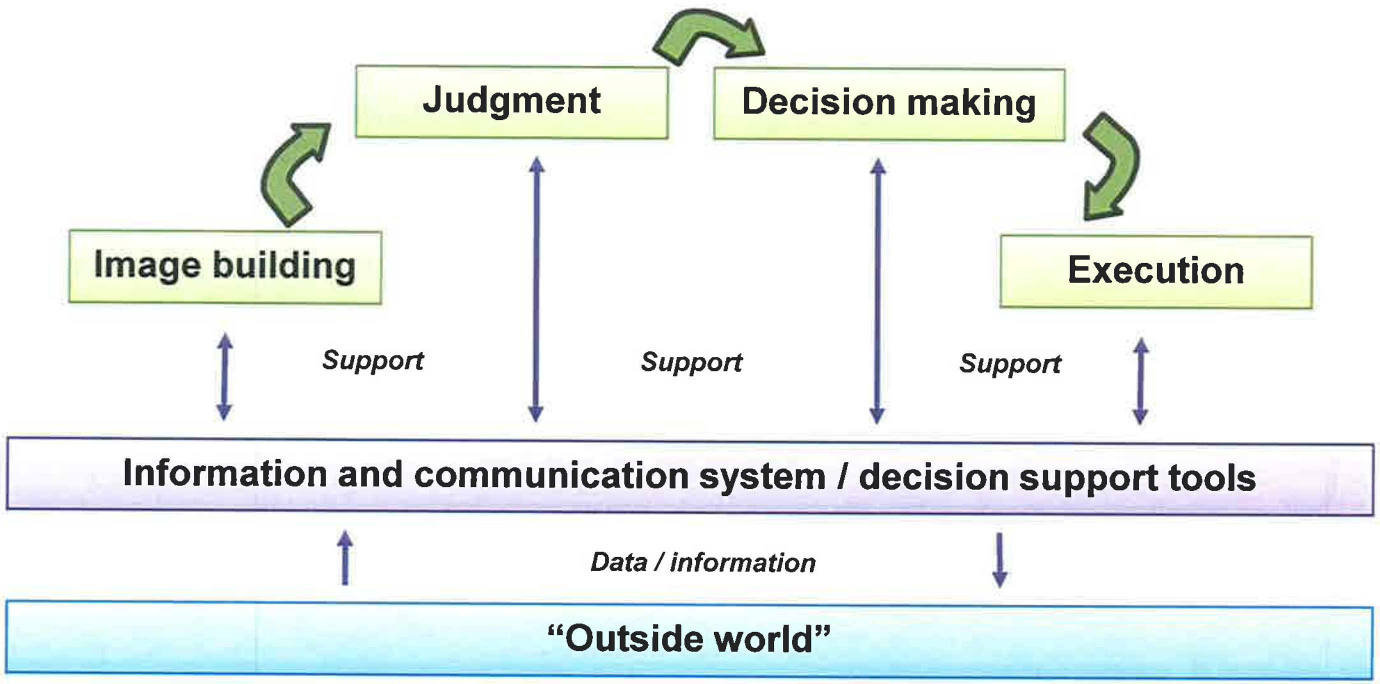
ECT
Service: On time vessel/ train departure
Cost: terminal efficiency

Container → Equipment → Fleet

4.4 Decision making – Process Control Framework

One of the important goals of implementing a control tower is being in control. This being in control results from the availability of information and the ability to take decisions that can change the further chain of events and thus prevent issues. Decision making is a key activity in a control tower, but the steps that surround the actual decision making are worth noting.

The below Process Control Framework (TNO) shows the process steps that belong to 'being in control'. It involves gathering information from the outside world, judging the situation and this finally leads to making a decision. After the decision is made, the desired execution steps need to be communicated efficiently and effectively.



4.4 Decision making – Decision rules

Decisions are taken as part of the general process but are also taken as part of event management. Decision that need to be taken in the general process are usually formalized in handbooks and operational procedures. The day-to-day operations are planned and executed by people who take these decisions on a daily basis and they know how to optimize transport according to these procedures. **Decisions taken as part of event management are more difficult to formalize** since the number of possible events and causes is usually big and how to handle the event in the most effective and efficient way depends greatly on the circumstances.

Taking decisions becomes easier when decision rules are defined. These **decision rules** can help in taking the right decision at the right moment. To give an example of how decisions can be structured in a decision tree an example is shown on the next slide. This example shows the decision tree for the process step ‘Set transport mode’ which is performed by BTT.

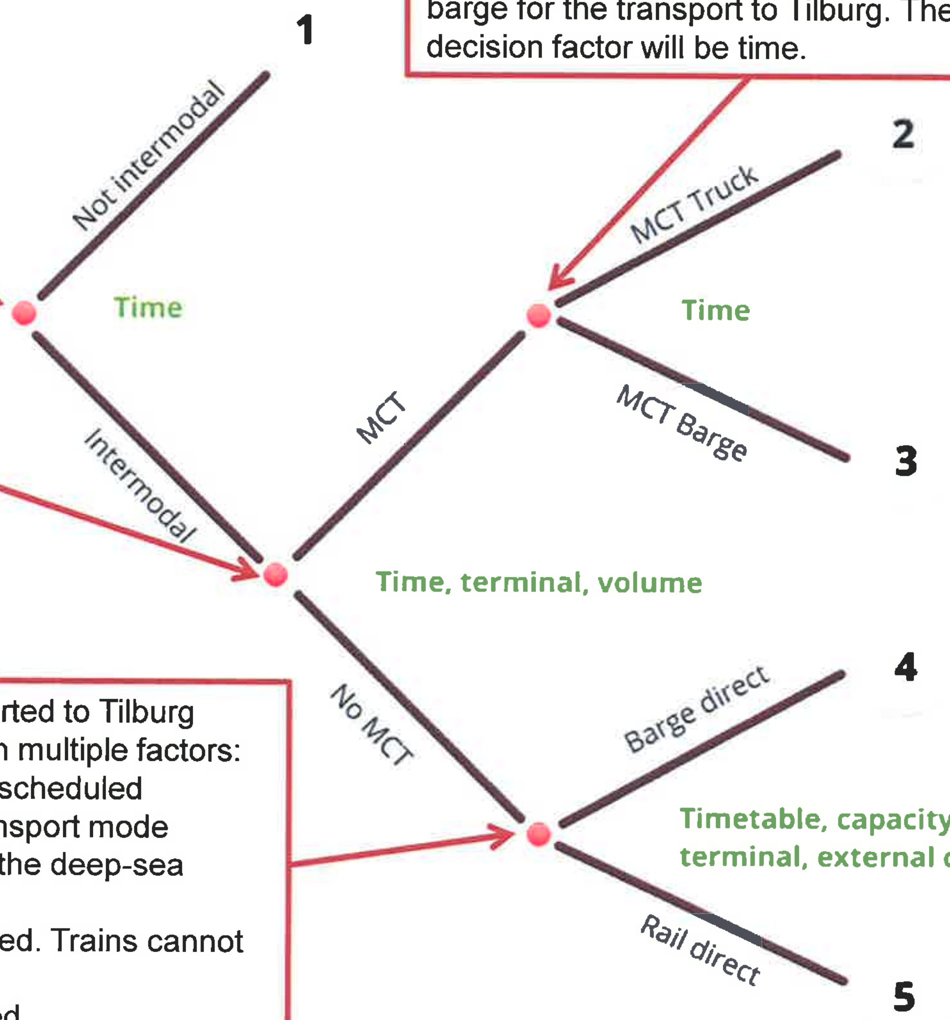
Creating decision rules for event management in synchromodal transport is possible but is even more complex than a decision tree for an individual company since now the interests of all involved partners need to be included. The first step is clearly to create the overview of business interests and from there start identifying possible events that can be handled in a standardized way.

2.4 Operations – Decision factors in general process

Time is the most important decision factor when deciding between truck or intermodal. Trucking is necessary when a container is urgently needed at the warehouse.

When containers are transported through MCT, they can be picked up either by truck or barge for the transport to Tilburg. The main decision factor will be time.

This decision to choose between BTT intermodal services or transport via MCT, depends again on time, but also on the amount of containers and the deep-sea terminal where they are located. The utilization rates of BTT resources are an important factor.



With BTT resources, the container can be transported to Tilburg using either rail or barge. The decision is based on multiple factors:

- Timetable: At what times are barges and trains scheduled
- Capacity: Are there slots available on either transport mode
- Time: At what time is the container available at the deep-sea terminal and is delivery expected
- Terminal: At what terminal is the container located. Trains cannot reach all terminals.
- External causes: Is any of the modalities blocked

4.5 Creating situational awareness

The first step towards decision making and being in control is to build the image of the situation (as shown in the Process Control Framework). In the OSIST framework this image is called **Situational awareness**. This image needs to support the rest of the process and therefore the requirements for this image directly follow from the decision rules and the job description of the control tower operators. Indirectly, these requirements follow from the organization's mission and goals and the business interests.

In a synchromodal concept, the requirements for situational awareness are such, that it can be called **Shared situational awareness**, because not only one party needs to control its own processes, but every party involved in the synchromodal transport system should be able to use the same image to base decisions on. Creating a shared situational awareness is more complex because it also asks for understanding the underlying business interests of all parties involved. Next to this, the IT requirements to realize this shared image are also more difficult because it asks for information sharing on a near real-time basis with multiple parties.

For creating shared situational awareness on the corridor between Rotterdam and Moerdijk, the following information levels and data elements were identified to support event management:

Container level	Container importance (e.g. related to customer segmentation, urgency), latest availability in Moerdijk, next transport, priority load/discharge, cause of delay, (estimated) delay
Vessel level	# of planned containers, # of delayed containers, ATA (R'dam), cause of delay, (estimated) delay, ETA (Moerdijk)
ECT operations	Cause of delay, (estimated) delay, reliability of delay estimation
MCT operations	(Planned) capacity (especially labor), cause of delay, (estimated) delay, reliability of delay estimation

4.5 Providing visibility with a dashboard

For a control tower to function efficiently and effectively, visibility is needed to provide (shared) situational awareness and to analyse the performance of the transport system. Visibility can be provided by using a dashboard where the user can for example see the chain on a high level and zoom into specific parts of the chain when needed. Event management can also be support by advanced dashboard by using message flags and milestones.

In order to create a basic Synchromodal dashboard for the Rotterdam-Tilburg corridor, the whole process was described with **different stages and resulting milestones**. To measure performance of the system and to be able to define message flags, it is important to define links between milestones. These relations between milestones are called **Key Performance Indicators (KPI)**. When used for individual containers, these KPIs can be used for event management. When calculated for a period of time, the KPIs give the performance of the transport system. For example the difference between the time stamp of container unloading from a deep-sea vessel (milestone: Gate In ECT) and the time stamp of a container leaving the terminal for inland transport (milestone: Gate Out ECT) can give an indication on the performance of the deep-sea terminal.

On the following pages, the container milestones and KPIs that were identified in this pilot study are described.

4.5 Milestone description for Rotterdam-Tilburg

The container milestones that were identified for the 5 transport lanes between Rotterdam and Tilburg can be split into four categories, depending on the location where the milestone time stamp is generated. The milestones are listed and defined below. A graphical overview of these milestones is given on the following page. The list of milestones can be further expanded with for example vessel milestones.

ECT Milestones

ATA sea	Actual Time of Arrival of deep-sea vessel
GI ECT	Time stamp of unloading (Gate IN) from deep-sea vessel
ComRel	Time stamp of container release by shipping line (commercial release)
CusRel	Time stamp of container release by customs
GO ECT Truck	Time stamp of terminal leaving (Gate OUT) by truck
GO ECT Train	Time stamp of loading on train (Gate OUT)
GO ECT Barge	Time stamp of loading on barge (Gate OUT)

MCT Milestones

GI MCT	Time stamp of unloading (Gate IN) from barge at MCT
GO MCT Truck	Time stamp of terminal leaving (Gate OUT) by truck
GO MCT Barge	Time stamp of loading on barge (Gate OUT)

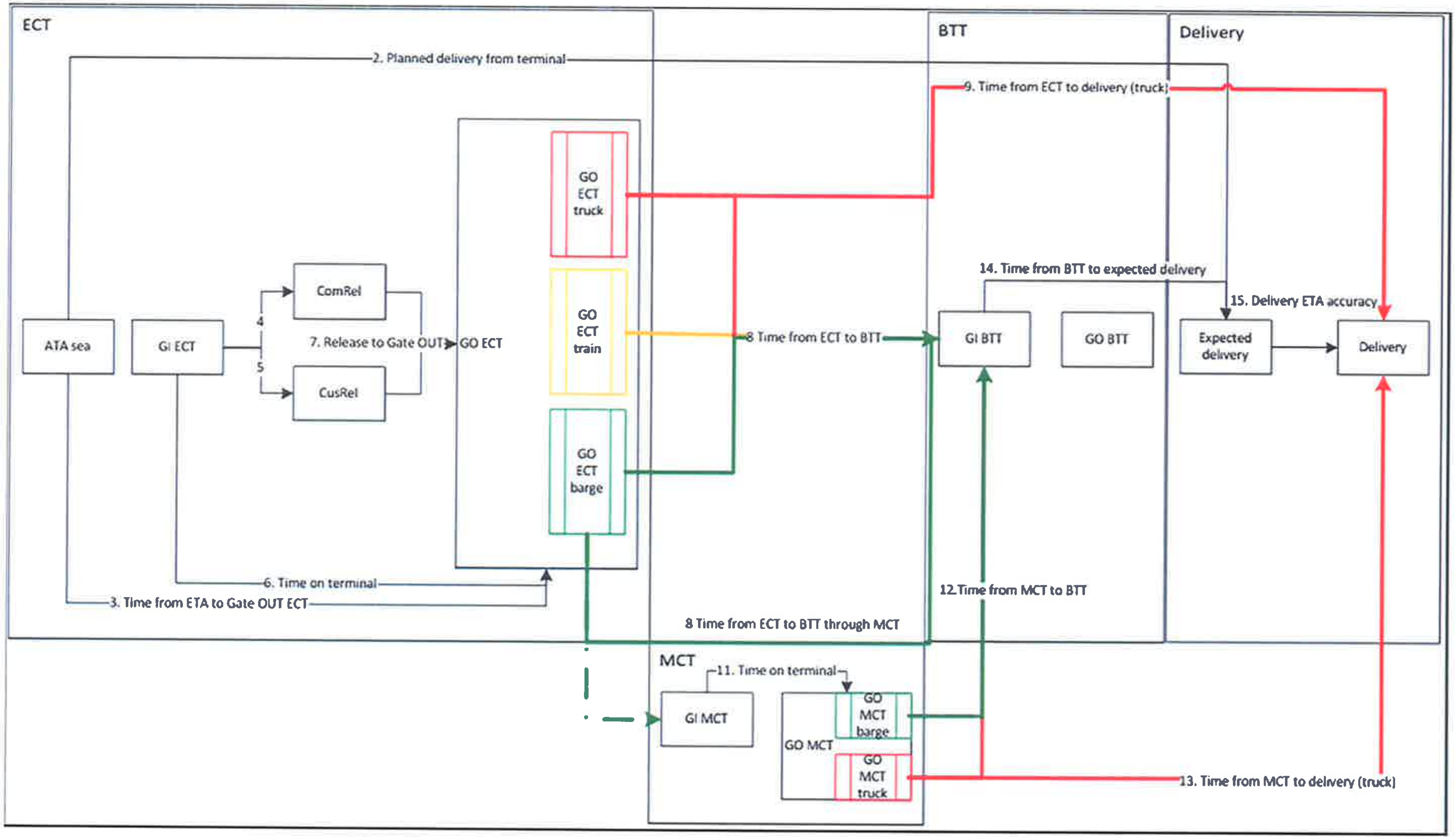
BTT Milestones

GI BTT	Actual arrival time of barge or train at BTT
GO BTT	Time stamp of terminal leaving (Gate OUT)

Delivery Milestones

Expected delivery	Time at which shipper initially expected container
Delivery	Actual time of final delivery

4.5 Milestone overview for Rotterdam-Tilburg



4.5 KPIs for Rotterdam-Tilburg

Where relevant, KPIs were defined between sets of two milestones. The KPIs that were identified for the corridor between Rotterdam and Tilburg, and that were thought relevant by the partners can be divided into four categories: ECT KPIs, MCT KPIs, Transport KPIs and Delivery KPIs. The KPIs are presented in the table at the bottom of this page.

Using these KPIs, a dashboard was created for the network from Rotterdam to Tilburg. KPIs were calculated by combining historical data from ECT, MCT and BTT. Because the dashboard was build using historical data, it is not usable for a control tower function. It was therefore designed to be used by BTT for transport performance evaluation per customer and for use in customer meetings. The graphs shown in chapter two of this document are part of the results of this exercise.

Category	KPI	Milestone 1	Milestone 2
ECT	Time on ECT terminal	GI ECT	GO ECT
	Time to commercial release	GI ECT	ComRel
	Time to customs release	GI ECT	CusRel
	Time to release	GI ECT	Last release (ComRel or CusRel)
	Release to Gate OUT ECT	Last release (ComRel or CusRel)	GO ECT
MCT	Time on MCT terminal	GI MCT	GO MCT
Transport	Time from ECT to BTT	GO ECT	GI BTT
Delivery	Planned delivery from terminal	GI ECT	Expected delivery
	Time from BTT to expected delivery	GI BTT	Expected delivery
	Delivery ETA accuracy	Expected delivery	Delivery

4.6 Planning synchromodal transport together

One of the core aspects of the synchromodal transport concept is that transport is planned as a joint effort by different parties, making optimal use of the capacity of the whole network (both infrastructure and resources). **Planning systems** for planning transport are available on the software market, but most software products work from a single business perspective and not from a network perspective. For implementing synchromodal transport, new software products need to be developed.

Planning software needs to be **fed with information** in order to work properly and to provide the user with good support in daily operations. This information is operational data (booking data, network capacity data, etc.) and also decision rules for the transport selection process, such as the rules belonging to the decision tree in paragraph 2.4. So for successful implementation not only IT development work is necessary but also formalization of collaboration in a network as described earlier.

Some additional requirements for a synchromodal planning tool were discussed in the course of the project. A synchromodal planning tool should ideally also **include cost structures** and provide insight in the most interesting transport options based on costs. So insight in cost structures and calculations is necessary to find the best possible fit between different trade lane configurations and customer transport demand.

When using a more advanced planning system, it should also be possible to go **from a pull based system to a push based system**. In a pull system, the booking party is in control and pulls the containers from the deep-sea terminal to a hinterland location. In a push system, containers are pushed from the deep-sea terminal to an inland terminal as soon as possible after container discharge from the ocean vessel. This however requires collaboration, information on container destination before discharge and new ways of working, controlling and joint planning. Most benefits of a push system are with deep-sea terminals because they benefit from reduced terminal dwell time. A push system does not need to exist on all corridors because pulling containers can also be very efficient when there is good cooperation and an efficient network between deep-sea terminal and inland operators.

5 Network & Organization design

In this chapter the focus is on 'Network and Organization design', and it is about the transport network from a business perspective (so no government owned infrastructure and permits) and the organizational models of the parties operating this network. In a synchromodal system, one of the key aspects is working from a network perspective and not necessarily from a point-to-point connection. This does not mean that point-to-point connections cannot be sufficient for certain corridors. The keywords are (inland) terminals, transport connections, resources, business models, partnerships and flexibility. During the pilot study, this topic was discussed several times because it provides the basis of the transport system and is the foundation of a synchromodal transport concept. After cooperation and control, this topic was indicated by the involved partners as second most important. The paragraphs in this section describe the work done during the pilot study and the list of topics is not meant to be exhaustive.

1. Strategic locations and Hub & Spoke
2. Asset ownership and sharing
3. Business models and partnerships
4. Stimulating a modal shift

5.1 Strategic locations and Hub & Spoke

Looking at a future with more container volume between Rotterdam and the hinterland, the question arises how the network capacity, and especially the inland terminal capacity and distribution of terminals across the hinterland can deal with these flows and offer the required capacity and flexibility. In the last years, the number of smaller inland terminals has increased significantly. When more capacity of inland terminals is required this means that capacity of these terminals needs to be increased or only a selected number of terminals needs this increased capacity, creating a so-called hub and spoke network.

According to the participants it is likely that having **hubs on strategic locations** will become more and more important in container transport. The urgency of having a hub and spoke network also depends greatly on how the terminals in Rotterdam will develop. If the deep-sea terminals can still reliably and cost efficiently serve an increasing number of small barges in the future, there is no real need for a hub-spoke system. However, if reliability and efficiency for handling small volume barges drops, and barge waiting times increase, such a system is likely to become the most cost-efficient alternative.

When implementing a hub-spoke system, **costs will determine the density of the inland terminal network** and the number of transport connections to each of these terminals. Bundling of volumes will be necessary on the connections between a deep-sea terminal and an inland hub. According to the group it will also be likely that bundling is necessary between different deep-sea terminals and an inland hub. A hub close to Rotterdam, e.g. Moerdijk, will then fulfil this function.

The whole consortium thinks that it is likely that hubs will evolve on strategic locations. However, the future on container transport and volumes is too insecure to make more detailed remarks on these locations. A joint vision on the future developments is also necessary to align the development and incentives of different parties involved in Dutch hinterland logistics. These volume developments will also have a large impact on the design and necessary functions of inland and deep-sea terminals.

5.2 Asset ownership and sharing

When multiple parties collaborate in a network and have the common goal to optimize the capacity utilization on this network, it becomes important to **formalize the ownership, use and sharing of transport assets**, such as barges, train (capacity) and trucks. In the current Dutch situation, a lot of different types of logistics service providers exist and a lot of these companies own a small or large amount of transport assets. When looking at financial results of individual companies in this network, the cost-price and efficiency of these assets have a significant effect. The goal of these individual companies is therefore to optimize the use of their own assets, meaning overall **sub-optimization**, and it is very likely that this goal comes before a collaboration's goal.

Project consortium members know from experience that businesses are usually very reluctant to let other parties in control of their assets. A concept of joint control over individual company's assets can only be implemented in small steps. For example when working towards a combined planning in a network, the first step is not just to plan together, but give each other insight in each other's planning first. A more dramatic structuring of cooperation is perhaps that asset ownership and transport bookings are divided over different organizations, which work together in optimizing the cost efficiency of assets and cost price of transport. Parties will then only collaborate where they are **complementary and not competitive**.

Another problem with sharing or redistributing asset ownership is that the development of container transport for the coming years are very insecure and there is no common vision in the business community. A good starting point for this discussion can be to get insight in each other's business interests and vision.

The reader should note that the synchromodal transport concept promotes flexibility in all ways and **never enforces a single view on asset ownerships and cooperation**. For some corridors the current way of working can give sufficient results and the earlier mentioned sub-optimization is not an issue. This flexibility however puts other challenges on the industry when parties operate on different corridors.

5.3 Business models and partnerships

When parties cooperate in transport corridors or networks where they are only complementary, and never competitive, this means that the **diversification of logistics providers** that exists in today's business community will in time change dramatically. It also means that the different **roles** that are necessary in a synchromodal transport concept need to be present on all transport lanes. It also means that individual businesses could never develop a synchromodal transport system on a corridor without starting one and perhaps even more partnerships.

For a party that wants to operate on a network with for example different inland destinations, it means that a **large amount of partnerships** with a lot of different parties is necessary. Because companies are never completely identical and roles will never be entirely fixed, it means that this kind of company will be likely to play slightly different roles in each transport lane. In the earlier paragraphs on collaboration it was already concluded that it is difficult to align interests of different businesses and that it will be increasingly difficult to align an individual company which plays different roles with other businesses in different transport lanes or for different customer requirements. This means that managing all these different partnerships can become more of a burden than an opportunity.

5.4 Stimulating a modal shift

One of the goals of implementing a synchromodal transport system is to stimulate a modal shift from road transport to rail and water transport. This goal is directly related to the goal of optimizing network utilization because the Dutch road network is increasingly congested while the capacity on especially waterways is not entirely used. A reduction in CO2 pollution is also possible when realizing this modal shift.

One of the identified challenges of stimulating a modal shift in the existing transport system is that at this moment the **penalties for using road transport are put on the wrong network party**. At this moment the penalties of using road transport from the Maasvlakte or developing Maasvlakte 2, are put on the deep-sea terminal. However, Dutch deep-sea terminals have a sea-side cost model, meaning that costs of container handling, which vary depending on inland modality, are always charged to the terminal's customer, being the ocean carrier. In the Dutch situation, 80% of inland carriage is merchant haulage. The penalties that terminals charge to ocean carriers will only very indirectly reach the party that decides on the inland modality. To make the use of penalties effective, the deep-sea terminals should change to a land-side cost model, meaning a huge organizational and operational change or the penalties should be put on the party deciding on inland modality.

The project consortium also thinks that to stimulate the use of intermodal transport, and realize a modal shift, not every deep-sea terminal should implement its own synchromodal solution for inland transport, but that deep-sea terminals, for example all terminals on the Maasvlakte, should bundle their volumes and cooperate. This is also in line with paragraph 5.1.

6 Infrastructure use

One of the goals of implementing a synchromodal transport system is making better use of available infrastructure capacity. In this chapter especially the role of the government is important. For infrastructure, there can be a distinction between business owned infrastructure (e.g. terminals, as discussed in chapter 5) and the infrastructure network as developed and managed by government and without direct influence of businesses, like inland waterways, road network and locks. The capacity of this **government owned network** and having the information about the availability of this network is an important prerequisite for successful implementation.

Government also **influences the use of business owned infrastructure by permits** (sounds, pollution) for example influencing the opening hours of terminals. The government decisions related to these permits directly influence the transport network and its use, so therefore also the capacity.

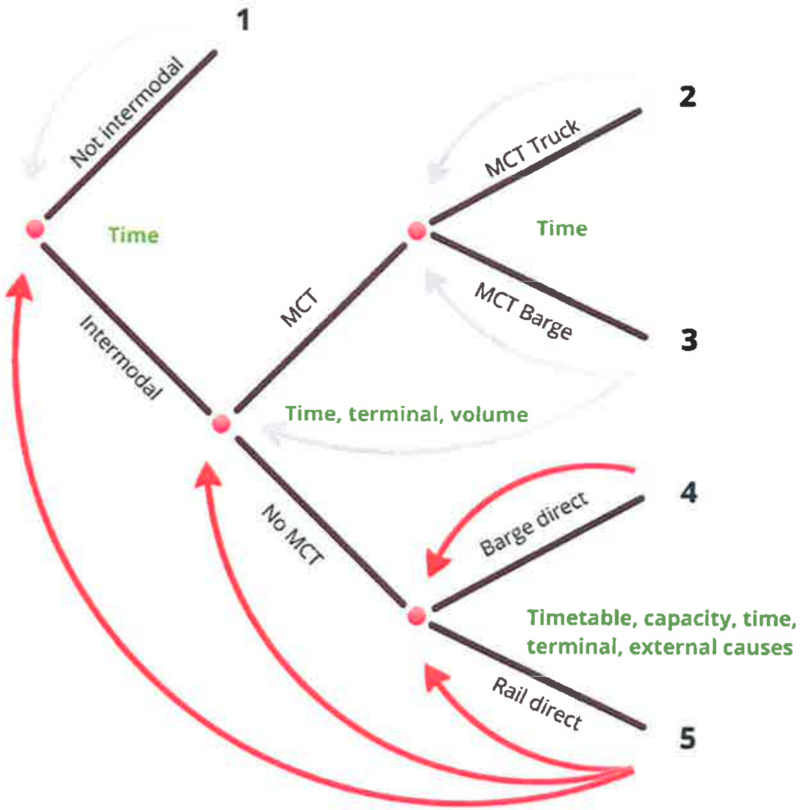
Better use of infrastructure essentially means how the current infrastructure network can be used more efficiently. One of the issues expected by the project consortium is that current limitations to network use are only going to change if enough volume is transported. For example opening hours of locks will be extended once enough volume is reached to make lock operation cost efficient. But flexibility in opening hours is first needed to demonstrate the concept and show its reliability to shippers. **Interests of municipalities and the government are not always aligned with the interests of the corporations**, so cooperation is necessary. According to project partners, at the moment there are no big bottlenecks, but when creating a synchromodal, and more flexible system, the infrastructure restrictions will become more and more a bottleneck.

The topic of infrastructure use and effects on the transport system was not much discussed during the pilot study. The content on this topic is therefore limited to this page.

7 Dynamics

In this chapter the focus is on ‘Dynamics’, describing current aspects of the transport system that make the system less flexible and some possibilities to increase flexibility. This chapter is directly related to the synchromodal concept of switching between modalities. The keywords of this chapter are administrative processes, switching and flexibility in transport execution. Real-time planning is a key word in this topic but was not really discussed during the study. The project parties decided this to be a less important topic for transport systems that have not yet solved a lot of the other bottlenecks that were found for implementing a synchromodal transport system. But this can be an important topic for mature transport lanes. The chapter will start with a definition of switching and some background on the estimated (un)importance. The paragraphs in this section describe the work done during the pilot study and the list of topics is not meant to be exhaustive.

7.1 Switching



One of the key aspects of the synchromodal transport concept is real-time switching between modalities. **Switching** is defined as having the opportunity to change to the best transport modality at any time to optimize network utilization and fulfil transport demand. This might especially be interesting in case of sudden urgent container availability (demanded by the customer) or in case of calamities.

The project consortium estimates that the amount of containers that could benefit from real-time switching is not larger than 5%. But this 5% probably consists of urgent containers that are now trucked. Having an intermodal system in place that can provide intermodal transport for these urgent containers might be difficult and probably only feasible for intermodal systems that are mature.

In the current system there are no formalized processes in place for switching. Different modalities have different cut-off times and communication lines, so switching between modalities, as is indicated by the red arrows in the decision tree, is not always possible. When switching is necessary this requires multiple parties to take actions related to resource and operations planning and execution.

7.2 Inflexibilities – Cut off times

Cut off times exist in current processes because the different involved organizations want to safeguard a certain amount of time to perform their tasks. By doing this they also build in a certain amount of flexibility in execution so that operations can be slightly delayed without affecting service levels. For example, ECT asks for 6 hours to prepare for internal transport before barge arrival, but they never need a full 6 hours for transport. But when the terminal is very busy, it might take 6 hours to organize the transport and actually execute all the necessary work.

As was described in paragraph 2.4, cut-off times **differ per modality and used transport lane**. The mentioned cut off times are however the theoretical cut-off times. In practice, these cut-off times can be larger depending on office hours and transport schedules. For example when the barge to Moerdijk loads containers at the Euromax Terminal (EMX), the barge is scheduled to arrive at the deep-sea terminal at 1.00h. The load list needs to be delivered 6 hours before ETA, which would be 19.00h on the previous day. However, as EGS only operates on office hours, data is delivered to customs at 17.00h, 8 hours before ETA. As Danser uses two hours to process bookings and EGS one hour, the cut-off time for BTT is in practice 11 hours.

Cut-off times **impose inflexibilities** to the transport system and make switching nearly impossible when strictly followed. But although the cut-off times are relatively high, they are not considered to be the main issue that cause containers to be trucked when urgent. The project partners think that when more detailed information is available on the expected availability of the container at the deep-sea terminal, planning of intermodal transport can be improved for more urgent containers as well. This will then result in an even lower number of containers that can benefit from switching.

To use switching in case of calamities, formalized but flexible processes are necessary that describe new ways of working.

7.3 Inflexibilities – Documentation

An inflexibility that arises when a synchromodal system needs to be implemented is the necessary documentation that needs to accompany the container to the hinterland. Three different problems were identified, related to customs, insurance and containers travelling as a group.

Before the container is allowed to travel to the hinterland, Customs needs to approve of the documentation and load lists. The modality with which the container is destined to travel inland needs to be mentioned on the T1 form. This **transit declaration** form is usually submitted to Customs by the party responsible for organizing inland transport (on behalf of the shipper). When the modality is switched after submitting T1, it needs to be changed on the T1 form as well. There is no formal process in place to make this change and the process to arrange this is now cumbersome.

Insurance companies usually have insurance rates depending on the inland modality. When the container needs to be switched near real-time, this means that it might be difficult to change the insurance as well. Real-time switching means that is will be necessary to have an insurance rate that allows for switching (flat rates or insurance change after transport execution). BTT made special arrangements with insurance parties. Other parties who want to implement a synchromodal solution should be aware of the legal/insurance consequences, and make similar arrangements.

Having a flexible synchromodal system means that containers that travel as a group are sometimes separated and put on different modalities or transport resources. However, when transporting a set of containers, the administrative process is more limited when **one document set** for these containers mentions the group, so there is no document set per container. While the administrative process benefits from this, the operational process is hindered since the container group cannot be split.

7.4 Introducing flexibility

Introducing flexibility in the current transport system means that potentially **all processes, both administrative and operational are subject to change**. It can therefore be expected that flexibility will be introduced gradually. Sometimes however collaboration will be necessary because processes of different parties need to change at the same time in order to achieve the desired effect.

ECT and EGS are already working on *Dynamics* in the transport system. Examples are the postponement of the customs release to their extended gates (inland terminals) for containers transported by EGS. ECT is now working on postponing the commercial release to their extended gates as well. This means that transport to the hinterland is less hindered by these releases and that in time containers can be pushed to the inland terminals. The consortium noted that dynamics are becoming more and more important, as with the new ISO 28002 certification, transport companies must guarantee a resilient transport flow. This requires the availability of multiple modalities, and easy switching between them.

The ultimate goal of a creating a flexible transport system is that **real-time planning** is possible. With real-time planning across a network, the synchromodal objective will be within reach. The number of bottlenecks that need to be solved before real-time planning can be implemented is such, that during the project the topic of real-time planning was not discussed.

8 Role of the shipper

In this chapter the focus is on the 'Role of the shipper', who is the end customer of the transport system. The keywords of this chapter are mode free booking, selling points, pricing and profitability. All parties do acknowledge that the goal of synchromodal transport is to serve the shippers, and, in order for a synchromodal system to work, the shipper must allow such a system by making mode free bookings. But compared to a high quality intermodal transport system, there is perhaps no real benefit for shippers in synchromodal transport as addition to intermodal transport. Therefore, although mode free booking is a prerequisite, the project parties decided this to be a topic of less importance. The paragraphs in this section describe the work done during the pilot study and the list of topics is not meant to be exhaustive.

1. Mode free booking
2. Pricing for a synchromodal solution

8.1 Mode free booking

Mode free booking is a key aspect and a prerequisite for synchromodal transport since it means that the logistics service provider is free to choose the inland transport mode and as such optimize the network utilization. Shippers book container transport by indicating the container and the required availability at their premises. According to the consortium partners this means that shippers should give transporters the opportunity to implement a synchromodal transport system and proof the reliability of this system to them. The system is however more easily sold to shippers when the reliability can be guaranteed and proven, meaning that this is a gradual and perhaps joint process.

Shippers can benefit from **green, cheap and reliable** transport, offered by a synchromodal transport system. But to some extent this is also what they expect from the current transport system. The consortium therefor thinks that although there are benefits for the shippers, **most benefits of a synchromodal transport system are with the parties offering transport capacity** in the network, since increased network utilization usually means lower cost price. More emphasis on these benefits is necessary to tempt transport companies to remove the existing bottlenecks and implement a synchromodal system.

The consortium partners indicated that although shippers can benefit from this system, it might also put some more **emphasis on the quality of shippers' internal processes**. For example, BTT demands that shippers sends their bookings in time, else it is not possible to meet their demanded modal split. The quality of this booking information needs to be high.

8.2 Pricing for a synchromodal solution

Product pricing influences the demand for the product and therefore insight in **customer demand and price elasticity** is necessary to make the synchromodal transport product a success. It is important to know which factors customers use to estimate the reasonability of the price. Estimating this reasonability is more difficult for a synchromodal product because there is no direct link between the price and the transport execution because the modality is not yet determined, so the exact product is not yet known. It will also be important to know how customers respond to changes in pricing and whether they think special conditions make the product more attractive.

BTT uses a single rate for intermodal transport, so no difference is made between barge and rail. This is identified as crucial for synchromodal transport, because otherwise shippers will always choose the lowest-cost solution, whilst that may not be the best way of transport at that moment.

From a logistics service provider perspective it is important to know the cost components related to the price of the synchromodal product. In a synchromodal transport system these **prices are no longer directly linked to the sold transport product** but to a mix of possible transport products. Estimating the realized modal split is therefore also important in setting the right price. In order to guarantee profitability of the transport product for the logistics service provider, it is important to know the influence of the pricing model on the business model.

9 Conclusions 1/2

The transport system in this study can be seen as a light version of a full synchromodal transport concept, since it includes a tri-modal network with mode free bookings by shippers, where for each container the best transport lane is selected and where different parties work together in optimizing a transport chain. By working in this manner, they have achieved a stable modal split that is even more desirable than the modal split target of the Maasvlakte for 2033. It is not a full synchromodal transport concept because there is not yet a possibility for real time planning and switching, nor optimization of the whole network capacity.

Looking at the different topics of the Synchromodality framework, it can be concluded that **some are prerequisite** (especially mode free booking), **while others are topics for the future** (switching). But between this, **attention is necessary for the organization and execution of transport on a synchromodal network**. Shippers might be willing to book mode free as long as the reliability of transport is guaranteed. Transport needs to be executed cost-efficient for the transport operators. The consortium partners expect that there is perhaps no real benefit for shippers using synchromodal transport as addition to using a reliable intermodal transport system. The benefits are expected to be with the transport executors who also need to invest in the network and cooperations because they can benefit from better utilization of their infrastructure and transport assets. Of course, financial benefits can (partly) be transferred to shippers but the extent to which this is done needs to be seen.

The synchromodal transport concept goes beyond what is demonstrated on the network between Rotterdam and Tilburg but based on the first results, it is interesting to research where the current system can be improved and better approach a full synchromodal concept. **Most urgent work needs to be done in the area of cooperation**, since more formalized cooperation is at the basis of being in control together. This cooperation and all its aspects need to be in place before joint and real-time planning can be used to full extent.

9 Conclusions 2/2

The cooperation will also influence the existing business models and partnerships in the logistics sector and have impact on asset ownership and network design. A more **common strategic view on future logistics** is necessary to support design and development of this network and required cooperation. Also, more fundamental research is necessary to investigate business models, gain sharing principles and ways to align sometimes conflicting business interests in these models.

The synchromodal transport concept promotes flexibility in all ways and **never enforces a single view on the network and cooperations**. For some corridors the current way of working or an intermediate version can give sufficient results. This flexibility however puts other challenges on the industry when parties operate on different corridors. It makes it also very difficult to study the concept in a more generic way.

On a certain corridor, the topic of synchromodal transport needs to be studied as a whole because a lot of the different aspects influence each other and realization of a network means that different changes need to be made to different parties and to different parts of the transport system. However, sometimes independent study objects can be found, e.g. effective price models for synchromodal transport. Because the end goal of synchromodal transport, optimizing the use of available network capacity, is to some extent obstructed by difficulties related to cooperation, it **can be interesting to study the topic with simulations** as well. This can help develop insight in the benefits of the concept, the business case for the different parties in a transport chain and also give input to the research on business models etc.

A lot of work needs to be done before full synchromodal transport systems can be implemented. Vision and guidance is necessary to support future implementation of this full system with the necessary research activities and to make sure funding is used for work that will directly provide new insights and support future full implementations or smaller light version implementations. This task clearly lies with the synchromodal steering group of the 'Strategisch Platform Logistiek'.

8 Recommendations for further research

A lot of research is still needed to be able to implement a full synchromodal transport system in the Netherlands. A short overview of recommendations for further research is given on this page. This list is not meant to be exhaustive and needs to be combined with long list of business incentives necessary to overcome practical hurdles.

- Feasibility of a synchromodal system for a export and a combination of export and import containers
- Feasibility of and impact on the transport system after further fragmentation due to Maasvlakte 2
- Transporting empty containers in a synchromodal system
- Alignment of conflicting business interests in cooperations
- Suitable business models in a synchromodal transport concept
- Gain and cost sharing models for synchromodality
- Decision models for synchromodal networks (both daily operations and event management)
- Pricing for mode free bookings and impacts on business models
- Business case for different parties involved in synchromodal transport
- Flexibility in transport systems (maximum flexibility and support by advanced planning)

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