Rail Baltica

Rail Baltica Project

Piggyback Transportation Services and Related Areas

Pre-Feasibility Study

Final version V2

Co-financed by the European Union
Connecting Europe Facility

The sole responsibility of this publication lies with the author.
The European Union is not responsible for any use that may be made of the information contained therein.

Rail Baltica

Table of Contents

Rationale 3

Assignment Order identification 3

Brief description of the assignment 3

Documents considered for this assignment 3

List of abbreviations 5

Definitions 6

WP 1: Global Environment 11

WP 1.1 - Identification of similar services worldwide and possible best practices 11

WP 1.2 - Description of possible services 27

WP 2: Preliminary analysis 58

WP 2.1 - Preliminary Market Analysis 58

WP 2.2 - Preliminary Systems and Methods Analysis 71

WP 2.3 - Preliminary identification of potential “value added services” 75

WP 3: Recommendations for Rail Baltica 78

WP 3.1 - Analysis of potential market size 78

WP 3.2 - Assessment of Feasibility of Piggybacking intermodal facility solutions 116

WP 3.4 - High-level Considerations for piggybacking solutions 121

WP 3.5 - Use of policy tools for the promotion of modal shift 125

WP 3.6 - Requirements for an optimal / viable freight service 131

Rationale

Assignment Order identification

Consultancy Services: CEF[1] Agreement No INEA/CEF/TRAN/M2014/1045990o – A34. (13th of March 2018)

Framework contract agreement for the provision of the expert services No 8/2017-120-6/4 dated November 24, 2017.

Assignment order n° NO 8/2017-120-6/6

Name of the expert to implement Assignment Order: Alain GAUDRY

Assignment order is covered in the following Field of expertise: Railway Business Development

Brief description of the assignment

The purpose of this pre-feasibility study is to evaluate the essential features and requirements for the integration of intermodal "piggyback" freight traffic with the Rail Baltica Global Project. The intermodal terminals to be considered are: Muuga, Salaspils, Palemonas.

The study will also address related areas such as the regional and wider market, scope and opportunities for freight traffic, intermodal service offerings, and environment aspects and sustainability.

Documents considered for this assignment

The following documents have been provided by RB and have been considered by the Consultant:

- Design Guidelines for Rail Baltica railway, General requirements (38 pages); Final Report (75 pages), performed by SYSTRA, 2018;
- Operational Plan for Rail Baltica railway, 2019 (about 30 related pages);
- Peer Review of Operational Plan, 2018 (about 15 related pages);
- Transport of Over-Gauge Goods Feasibility Study, 2018 (about 30 related pages);
- For documents and supporting information, Service Provider can refer to public information on Rail Baltica documentation library (http://www.railbaltica.org/about-rail-baltica/documentation/); specifically:
    - Cost-Benefit Analysis, 2017, EN;

[1] Grant Agreement under the Connecting Europe Facility (CEF) -Transport Sector Agreement No INEA/CEF/TRAN/M2014/1045990

- AECOM Rail Baltica Final Report, 2011, EN;

In addition, external Studies and Reports should be used, including but not limited to studies such as:

- Capacity For Rail (C4R) project's "Catalogue Rail Freight System of the Future", "Upgrading of infrastructure in order to meet new operation and market demands", etc.
- AlpInnoCT "Database and Comparative Analysis of CT and Transshipment Technologies for CT";
- "Developing Larger Loading Gauges in Europe", Hans E. Boysen, 2016;
- "Why Short-haul Intermodal Rail Services Succeed", research report No. 139, Department of Infrastructure and Regional Development, Australian Government (2016);
- "2018 Report on Combined Transport in Europe", UIC (prepared by BSL Transportation Consultants);
- "Gathering Additional Data on EU Combined Transport", Final Report, European Commission (2018) [ISBN 978-92-79-76992-4].

List of abbreviations

Abbreviations	Meaning
ACT	Accompanied combined Transport
CT	Combined Transport
ILU	Intermodal Loading Unit
IM	Infrastructure Manager
ITU	Intermodal Transport Unit
IWW	Inland Waterway
MTO	Multimodal Transport Operator
RO-RO	Roll-On-Roll-Off
TEU	Twenty-foot Equivalent (container) Unit
RoLa	RoLa from the German "Rollende Landstrasse"
RU	Railway Undertaking
SSS	Short Sea Shipping
ToR	Terms of Reference of the Assignment Order
TSI	Technical Specification of Interoperability
UCT	Unaccompanied Combined Transport
UIC	Union International des Chemins de Fer
WP	Work Package

Table 1. List of abbreviations

Definitions

Piggyback transportation is an intermodal transportation method that placing a delivery vehicle in another carrier.

As clarified in the ToR, for avoidance of doubt, for the purposes of this pre-feasibility study "Piggyback transportation" refers to the transportation of goods where one transportation unit is carried on the back of something else. It is a specialised form of intermodal transport and combined transport.

For the purposes of this study**, piggybacking is defined as transportation of road transport units on the back of railway rolling stock**. It can be added that in this context, the term "piggyback" does not refer to combined transport in general but specifically to the transport by rail of road semi-trailers.

It therefore excluded the transport of exchangeable container or interchangeable unit which can also be transported by trucks on road (container, swap-body called also **Loading Unit**).

It was observed, as first remark, that the terminology used by common users, can lead to various understandings as, for instance, to use indifferently "inter-modal and multi-modal transport" wording.

To solve this issue, the following UN / ECE definitions are provided[2] (Source UN/ECE). When cited in this report, the following expressions of wordings means:

Wording	Definition
Accompanied Combined Transport (ACT)	Transport of a complete road vehicle, accompanied by the driver, using another mode of transport (for example ferry or train)
Articulated vehicle	A tractor unit coupled to a semi-trailer
Basket wagon	A rail wagon with a demountable subframe, fitted with devices for vertical handling, to allow the loading and unloading of semi-trailers or road vehicles
Bi-modal semi-trailer	A road semi-trailer that can be converted into a rail wagon by the addition of rail bogies
Combined transport	Intermodal transport where the major part of the European journey is by rail, inland waterways or sea and any initial and/or final legs carried out by road are

[2] http://rusregister-com.1gb.ru/doc/combinedtransportationterminology.pdf

Wording	Definition
	as short as possible. Combined transport in EU[3] is ***Combined transport** means the transport of goods* ▪ *between member states where the lorry, trailer, semi-trailer, with or without tractor unit, swap body or container of 20 feet or more uses the road on the initial or final leg of the journey and, on the other leg, rail or inland waterway or maritime services where this section exceeds 100 km as the crow flies and make the initial or final road transport leg of the journey;* ▪ *between the point where the goods are loaded and the nearest suitable rail loading station for the initial leg, and between the nearest suitable rail unloading station and the point where the goods are unloaded for the final leg, or* ▪ *within a radius not exceeding 150 km as the crow flies from the inland waterway port or seaport of loading or unloading.*
Consignment	Freight sent under a single contract of carriage
Container	Generic term for a box to carry freight, strong enough for repeated use, usually stackable and fitted with devices for transfer between modes
Forwarding agent / freight forwarder	Intermediary who arranges for the carriage of goods and/or associated services on behalf of a shipper
Intermodal Loading Unit	The most important ILUs in European intermodal transport market are swap-bodies, maritime containers, domestic containers, and semi-trailers.
Intermodal transport	The movement of goods in one and the same loading unit or road vehicle, which uses successively two or more modes of transport without handling the goods themselves in changing modes
ITU or Intermodal transport Unit	Containers, swap bodies and semi-trailers suitable for intermodal transport
Land container	Container complying with International Railway Union (UIC) specifications, for use in rail-road combined transport
Lift-On-Lift-Off	Loading and unloading of intermodal transport units (ITU) using lifting equipment
Loading unit	Container or swap body
Loading tracks	Track on which ITUs are trans-shipped

[3] https://uic.org/IMG/pdf/2018_report_on_combined_transport_in_europe.pdf

Wording	Definition
Logistic	The process of designing and managing the supply chain in the wider sense
Logistic centre	Geographical grouping of independent companies and bodies which are dealing with freight transport (for example, freight forwarders, shippers, transport operators, customs) and with accompanying services (for example, storage, maintenance and repair), including at least a terminal
Lorry	A lorry is a self-contained unit, with space for cargo and cab all attached together
Low floor wagon	A rail wagon with a low loading platform built to carry ITUs
Multimodal transport	Carriage of goods by two or more modes of transport
Multimodal transport operator (MTO)	Any person who concludes a multimodal transport contract and assumes the whole responsibility for the performance thereof as a carrier or a transport operator
Pallet	A raised platform, normally made of wood, facilitating the handling of goods. Pallets are of standard dimensions. The most used in Europe are 1000 mm x 1200 mm (ISO) and 800 mm x 1200 mm (CEN)
Pocket wagon	A rail wagon with a recessed pocket to accept the axle/wheel assembly of a semitrailer
Rail loading gauge	The profile through which a rail vehicle and its loads (wagons - ITUs) must pass, taking into account tunnels and track-side obstacles
Road-rail transport (RRT)	Combined transport by rail and road
Road train	A tractor unit coupled to a trailer
RoLa	RoLa from the German "Rollende Landstrasse" is a form of combined transport involving the conveying of road trucks by rail.
Rolling-road	Transport of complete road vehicles, using roll-on roll-off techniques, on trains comprising low-floor wagons throughout

Wording	Definition
Rolling-road wagon	A rail wagon with low floor throughout which, when coupled together, form a rolling-road
Roll-On-Roll-Off (Ro-Ro)	Loading and unloading of a road vehicle, a wagon or an ITU on or off a ship on its own wheels or wheels attached to it for that purpose. In the case of rolling road, only road vehicles are driven on and off a train
Semi-trailer	A non-powered vehicle for the carriage of goods, intended to be coupled to a tractor unit in such a way that a substantial part of its weight and of its load is borne by the tractor unit. Semi-trailers may have to be specially adapted for use in combined transport
Shipper / Consignor / Sender	A person or company who puts goods in the care of others (forwarding agent/freight forwarder, carrier/transport operator) to be delivered to a consignee
Spine wagon	A rail wagon with a central chassis designed to carry a semi-trailer
Swap body	A freight carrying unit optimised to road vehicle dimensions and fitted with handling devices for transfer between modes, usually road/rail. Originally, such units were not capable of being stacked when full or top-lifted. But many units can now be stacked and top-lifted and the main feature distinguishing them from containers is that they are optimised to vehicle dimensions. Such units would need a UIC approval to be used on rail. Some swap bodies are equipped with folding legs on which the unit stands when not on the vehicle
Terminal	A place equipped for the trans-shipment and storage of ITUs
TEU	Twenty-foot Equivalent Unit. A standard unit based on an ISO container of 20 feet length (6.10 m), used as a statistical measure of traffic flows or capacities
Trailer	A non-powered vehicle for the carriage of goods, intended to be coupled to a tractor unit, excluding semi-trailers
Transport operator	The person responsible for the carriage of goods, either directly or using a third party
Transshipment	Moving ITUs from one means of transport to another

Wording	Definition
Truck	A truck is a colloquial term for a heavy goods vehicle, it's originally an American term. So, a truck is a tractor unit with trailer or semi- trailer as well as a lorry
Unaccompanied Combined Transport (UCT)	Transport of a road vehicle or an intermodal transport unit (ITU), not accompanied by the driver, using another mode of transport (for example a ferry or a train)
Unit Load	Palletised load or prepacked unit with a footprint conforming to pallet dimensions and suitable for loading into an ITU

Table 2. Definitions

According to the ToR, for the purpose of this pre-feasibility study, types of "road transport units" to be considered are Road trailers or semi-trailers transported in a train.

WP 1: Global Environment

WP 1.1 - Identification of similar services worldwide and possible best practices

Overview of what is proposed Worldwide:

In general, for the purpose of this pre-feasibility study, similar services intermodal worldwide presented are classified by main types as follows according to definitions presented in the previous table.

Worldwide examples selected are analysed regarding the main technical solutions implemented and market segment.

The following Worldwide examples are summarizing the technical solution features / market segments presented in detail in chapters thereafter. Four "generic" solutions well proven and developed have been identified:

- RoLa;
- UCT;
- Eurotunnel;
- Modalohr;

Some solutions are covered by a patent as Modalohr but it has been observed some variant of this solution using more and less the concept of "articulated" pocket wagons and currently under development and are available as an alternative (Cargospeed, Megaswing). These solutions are shown as "Wagon-based" in tables below.

	RoLa	UCT	Eurotunnel	Wagon-based
Market segment / operation				
Truck (tractor unit + semi - trailer or lorry)	**X**		**X**	**X**[4]
Truck accompanied by driver	**X**		**X**	**X**
Truck unaccompanied by driver		**X**		
Conventional semi-trailer	**X**		**X**	**X**
Strengthened semi-trailer	**X**	**X**	**X**	**X**
Unaccompanied semi-trailers (without tractor unit in the same train)		**X**		**X**[5]
Range of journey distance	300 km	800 km	50 km	From 500 to 800km
Maximum Height of vehicle (Corner height)	4,0 m	3,96m	4,5 m	4,0 m

[4] Only for Modalohr wagon 1st generation and in this case, they are accompanied
[5] For 2nd and 3rd generation wagons

	RoLa	UCT	Eurotunnel	Wagon-based
Number of vehicles transported by trains	20	36 road consignment	32	40
Net load capacity of trains	400 tonnes	750 tonnes	1400 tonnes max	1100 tonnes max
Rolling stock solution				
Conventional flat wagon height floor about 1100mm, normal wheel diameter			**X**	
Low floor flat wagon, floor height about 330 mm, small wheel diameter	**X**			
Pocket wagon, lowest floor part about 330 mm, normal wheel diameter		**X**		
Other solution (basket wagon, bi-modal solutions, articulated wagon)				**X**
Infrastructure				
Loading platform	**X**		**X**	**X**[6]
Crane or handling device		**X**		

Table 3. **Worldwide examples**

Loading issue of craneable or non-craneable semi-trailers

One of the key issues identified and pointed out in FERRMED studies[7] to be solved and explaining also the different wagons solution developed is the fact that all semi-trailer are not craneable vehicles and only specially equipped craneable semi-trailers can be handled. Today less than 5% of the European semi-trailer fleet has this equipment and have been designed for.

[6] restricted number of suppliers
[7] FERRMED_WagonStudy_FINAL_May_2010

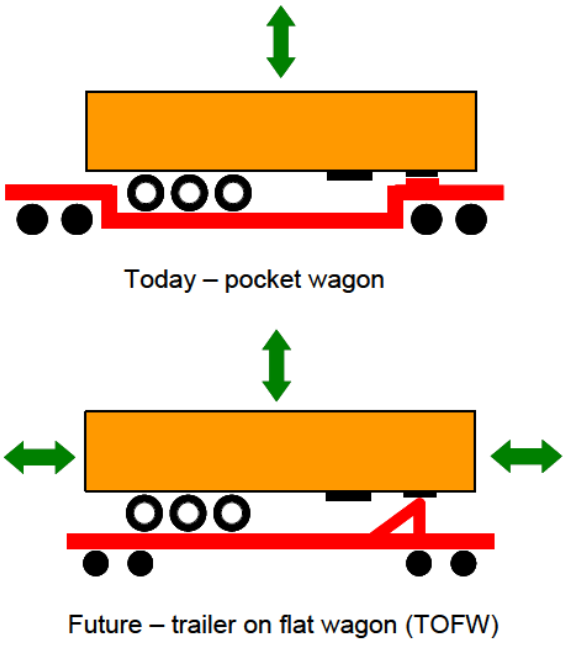


Illustration 1. Concept for future wagon developed by FERRMED wagon (FERRMED study)

Craning of non-craneable semi-trailers onto railway pocket wagons has so far been impossible: the trailers must be specially designed as a craneable semi-trailer. However, these kind of trailers have disadvantages such as higher investment costs, less loading capacity (weight).

The NiKRASA system makes it possible to easily transfer non-craneable semi-trailers from road to rail within the existing standards and infrastructure using a supporting lifting platform. It should be noted that there is anecdotal evidence of damage to both rail and road vehicles, however.

Illustration 2. Lifting non-craneable semi-trailer using a supporting platform (source NiKRASA system)

RoLa (accompanied transport of trucks on low floor wagons):

The "rolling Highway" or RoLa from the German "Rollende Landstrasse" which allows trucks without the necessary fittings for unaccompanied transport to be loaded onto special rail wagons at the terminal. Drivers travel in a specific coach in the same train. Trains are loaded horizontally only and trucks are accessing one after one onto the train on its own via a ramp located at the extremity of the train.

Illustration 3. RoLa loading ramp.

RoLa concept is implement by different operators in the EU: RALpin (Switzerland, HUPAC (Switzerland), Rail Cargo Operator – Austria, Kombiverkehr (Germany).

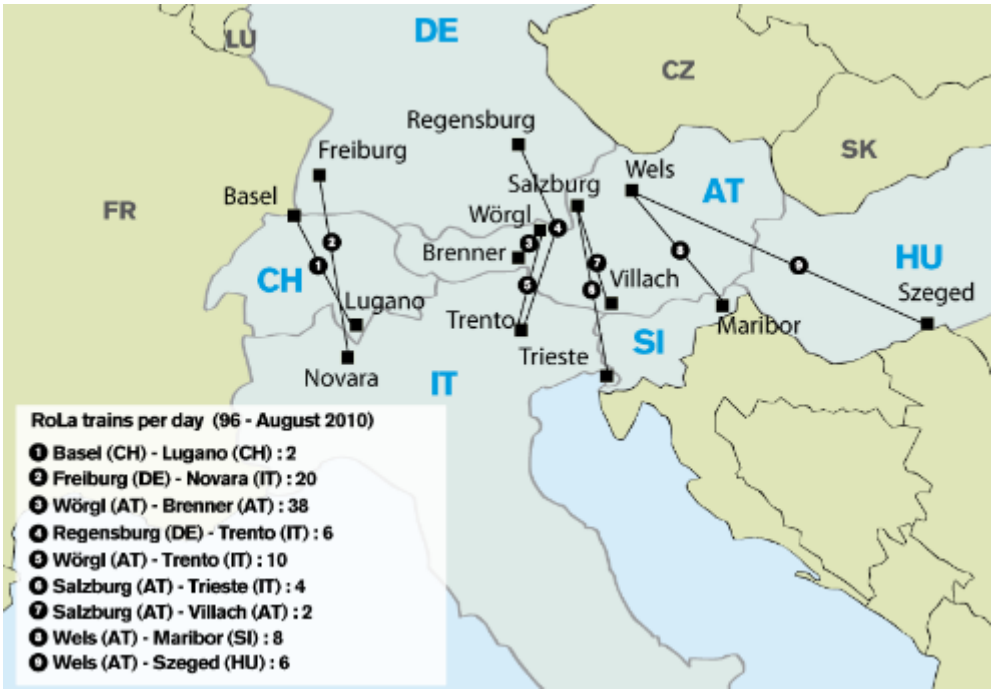


Illustration 4. RoLa solutions implemented in EU.

In the early 1970s a European wagon manufacturer created a revolutionary new freight wagon for combined road-rail transport: the "rolling motorway" wagon. The principle was similar to that of combined road-rail transport in the USA: each wagon had a loading surface that was low and completely flat so that the entire loading area of the rake of wagons could be driven on. The first truck drives up an end-loading ramp at the rear of the train and continue over the coupled wagons until it had reached the head of the train, where it would be maintained in place. In the meantime, the next truck boards the train, followed by the others, until the entire train is laden. A normal European rolling motorway train can carry 20 to 27 trucks and can be loaded in under 30 minutes.

Illustration 5. Rail-road solution "RoLa" (source RoLa).

Driver disembarks and travel in a specific passenger coaches included in the same train. The truck is therefore "accompanied" and semi-trailers are not uncoupled from the tractor unit.

Illustration 6. Low floor flat wagon (source RALpin).

Only specific flat loading platforms are required (at the same level of wagon loading height) with a small ramp. Installations includes also wide parking area where trucks are waiting for boarding (about 2 trains capacity).

Illustration 7. Loading area (Freiburg).

One of the weakness of this solution , recognized since the beginning is the fact that low floor wagons are required to fit with the infrastructure loading gauge and are equipped with small diameter wheels having to a very fast wear because they are turning faster than conventional wheels. The Switzerland example handles around 7000 wheelsets a year. Other aspects which adversely affect the RoLa system include significantly higher acquisition and maintenance costs for the required special wagons.

Net weight of trains is about 400 tons for an average journey is about 300 km.

Switzerland focus, RALpin RoLa service provider:

- The Rolling Highway transports more than 100,000 trucks every year, thus making an important contribution to shifting traffic from road to rail;
- The Freiburg – Novara relation takes 10 hours to complete the 414 km trip. It offers space for up to 22 trucks and each week provides 60 services in each direction. The Basel – Lugano relation is 260 km in length and takes 5 hours to complete. It offers space for up to 26 trucks and each week provides 5 services in each direction;
- Each week, 60 trains are loaded and unloaded so much at the terminal in Freiburg;
- More than 1,000 trucks arrive every week at in Freiburg and more than 1000 trucks leave;
- Each year, more than 1700 million tons of goods pass at the terminal in Freiburg;
- Transformed terminal allows up to increase the number of parking bays for trucks to cater for 2 fully laden rolling highway trains each carrying 22 to 25 trucks. ;
- In total, some six providers of service with fifty employees are on hand to ensure the exploitation of the RoLa. They are involved in the recording process, technical control, loading, security, cleaning and supply of cars of support and maintenance.

UCT by HUPAC (unaccompanied combined transport of Semi-trailers on pocket wagons):

HUPAC is developed on the concept of unaccompanied combined transport (UCT). UCT and the Rolling Highway (RoLa) differ greatly in terms of transportation method. In UCT only the loading units (loading units – containers, semi-trailers or swap bodies) are loaded onto the train, while the driver and the tractor unit remain at the terminal.

Consequently, the net load capacity of UCT is higher than RoLa. An average UCT trains moves up 36 road consignments and RoLa train transports approx. 20 trucks. This results in higher production costs per transported unit for UCT. It can be considered that that on average for a 40 tons semi-trailer coupled to a tractor unit, the tractor unit represents about 8 tons (20 %) which is carried out in excess. Added to this is the inefficient use of scarce rail line capacities.

Net weight of trains is about 750 tons.

The average transportation distance in UCT is considerably longer compared to RoLa (800 km versus 300 km on average). Semi-trailers are loaded using gantry cranes (the entire structure of the crane including gantry is wheeled on rails) and loaded on specific “pocket wagons”.

Illustration 8. Loading of semi-trailer on pocket wagons.

Illustration 9. Conventional pocket wagon for semi-trailer

Of the combined transports through the Swiss Alps approximately 850,000 road consignments are currently attributable to UCT and 100,000 to RoLa. The transportation policy of HUPAC focuses on UCT. RoLa, on the other hand, plays an important supporting role, because it also accommodates transports which lack the special equipment that is required for UCT (loading crane, low floor wagons, loading platforms).

The solution CargoBeamer is quite similar as the HUPAC one but using horizontal loading, and semi-trailer not needing to be strengthened ones are loaded on bowls and specific wagons. CargoBeamer is still under the approval, development and no real transport network is existing[8].

[8] https://www.cargobeamer.eu/7m-from-the-EU-for-the-CargoBeamer-rail-motorway-terminal-in-Calais-852891.html

Eurotunnel (Transport of trucks on conventional flat wagon):

Conventional flat wagons mean wagons having a height floor of about 1100 to 1200mm, usually full-length body, equipped with wheel-axles or bogies suitable for the standard load and dimensions of trucks (lorries or tractor unit with semi-trailers).

The rolling fleet consists of 18 truck Shuttles, 745m long, each shuttle capable of carrying up to 32 trucks and travelling at a speed of 140km/h. A complete truck shuttle comprises of two locomotives, a Club Car with approximately 56 seats for drivers, 3 loading / unloading wagons and 32 carrier wagons. Each train crosses the Channel in only 35 minutes, at 140 km / hour (please also refer to the detailed description of the loading system in this document).

Lorry carrier wagons are conventional ones in terms of size, floor height but specific constraints for the circulation in the tunnel have been considered in terms of safety, fire protection, etc. First wagon type (years 1994) were quite sophisticated but have been replaced / completed by more basic design fleet. Specific "loader wagons" are required.

Illustration 10. Eurotunnel, "lorry carrier wagons", second generation

In 2017, Eurotunnel has strengthened its rail freight fleet by investing 40 million Euros in the acquisition of three new 'third generation' freight shuttles. Built by WBN Waggonbau Niesky (WBN), each one of the 800 m-long shuttles comprise 32 carrier wagons and three loaders.

The maximum size and weight of truck that Eurotunnel can carry are[9]:

[9] https://www.freightlink.co.uk/knowledge/articles/eurotunnel-update-vehicle-height-important-information

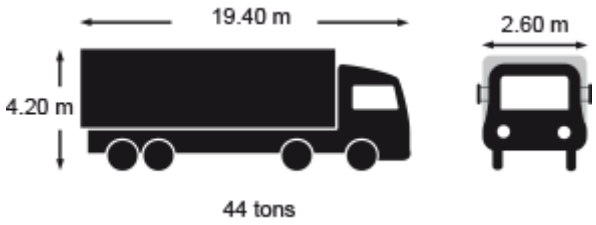


Illustration 11. Eurotunnel, truck size

Illustration 12. Eurotunnel, truck on conventional flat wagons

As for RoLa solution, loading of trucks requires specific loading platform at the same level as wagon floor. But compared to RoLa, some "loader wagons" are provided along the shuttle train offering several accesses to the train by the side (not only by the end as for RoLa). It allows shorter time for loading / unloading operation. Last modern shuttle trains for trucks are composed by 32 carriers wagons, 3 loader wagons allowing loading and unloading in under 25 minutes.

Illustration 13. Eurotunnel, loading truck by the wagon side

Eurotunnel variant in Russia:

In addition, in Russia[10] quite similar system as Eurotunnel solution has been developed.

Technical standards for the piggyback transport of lorries, trailers and cars by rail, including the adoption of a standard floor height of 1 100 mm above the rail head were approved in year 2016.

The regulations follow trials on the Moscow – Novosibirsk – Yekaterinburg route in November 2016 using Type 13-9961 flat wagons.

It includes also the development of a four-axle 23·5 tonne axle-load piggyback wagon and loading platforms, with orders for around 1 300 wagons envisaged. Operators have launched regular piggyback services from autumn 2018 and traffic was predicted to reach 10 000 to 12 000 wagons per month in 2019-20.

It also allows transporting non-craneable trailers without additional handling technology.

It should be remembered that the loading gauge in Russia is more comfortable than the European ones (4 850 mm for a 2 600 mm truck width).

[10] https://www.railwaygazette.com/news/traction-rolling-stock/single-view/view/russia-adopts-piggyback-wagon-standards.html

Illustration 14. Russia, lorry on a flat wagon, floor height 1100 mm.

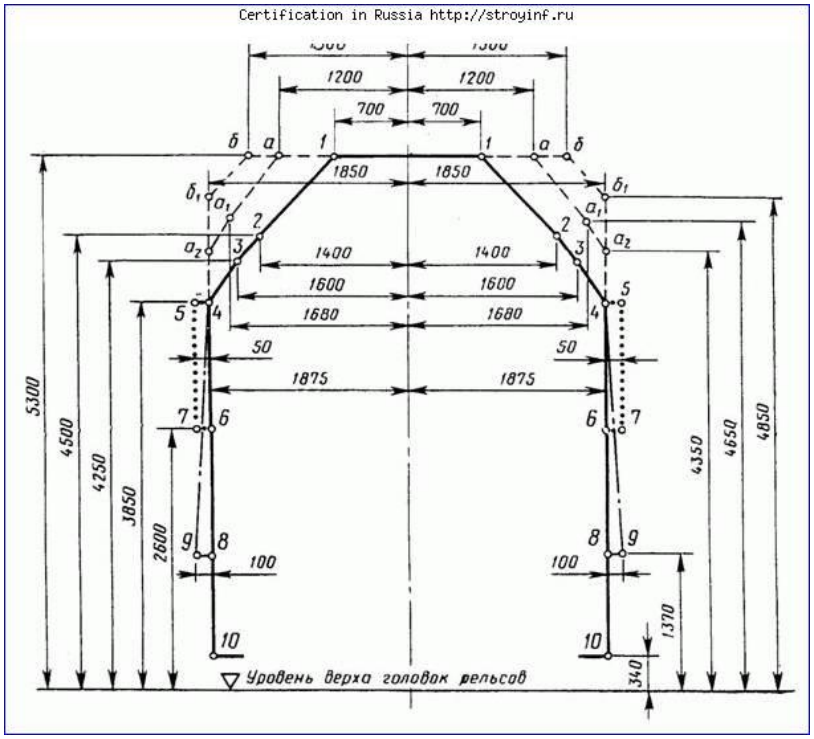


Illustration 15. Russia, Loading gauge.

The "Russian" solution is identical as Eurotunnel one using classical flat wagons for the transport of trucks with semi-trailer. It means same concepts / processes could potentially be used in the Baltics for both 1435 & 1520 railways. In other words, *drivers and customer companies would not have to have different processes or training*. That would seem to be a significant factor in favour of this approach for RB.

Lohr or Modalohr railway system solution:

The Lohr Railway System or Modalohr System uses special piggyback wagons, to carry standard road semi-trailers on the European rail network.

Recently, new generation design of the Modalohr railway wagon has been lowered and articulated and as a result allows for fast and safe transfer of semi-trailers. This technology has made it possible to transfer more than a million trucks from road to rail in the past 15 years, namely on the four rail motorways currently in service; the "Alpine" between Chambéry and Turin (175 km) and the "Lorry-Rail" between Luxembourg and Perpignan (1050 km), "VIIA Britanica" between Calais and Le Boulou (1400 km) and that from Sète to Paris (815 km) and Zeebruge (1150 km). It can be assessed at this date that the service is mostly focussed on French needs:

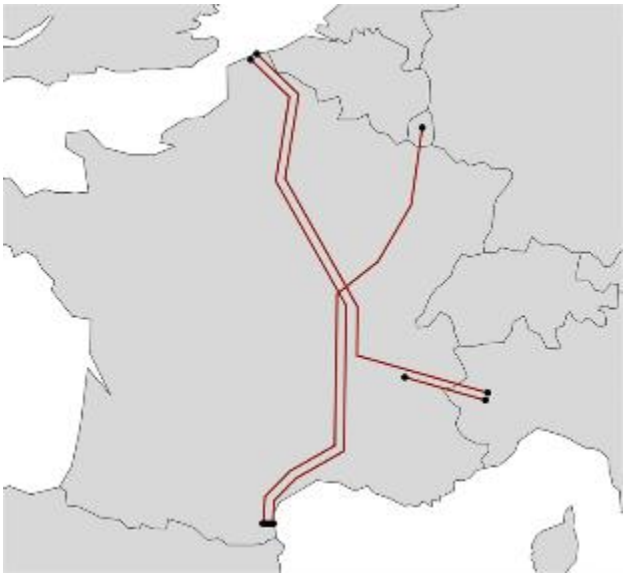


Illustration 16. Modalohr services in France.

Main advantages of Modalohr railway system are:

- All standard semitrailers up to a height of 4.0 can be transported without problem;
- Allows transporting non-craneable trailers without additional handling technology.
- Relatively fast loading and unloading of a complete train in the Modalohr terminal;
- Robust, tried and tested wagon system;

- Same-level loading; the tractor units can drive forwards onto the wagon for loading;

Main disadvantages of Modalohr railway system are:

- Only limited development (mainly in France);
- Low flexibility, as only regular block train services between Modalohr terminals are possible, so all terminals to be served would need Modalohr equipment;
- High levels of investment in wagons (and as noted Modalohr terminals are required at all locations to be served);
- Complex and costly technology for the positioning and swinging out of the wagons, which has to be built into the tracks of the Modalohr terminal;
- Size of terminal is affected by the required separation of tracks
- Modalohr system is only provided by Modalohr company (monopolist position).

"Flexiwaggon" technology solution:

Using the same principle of moving parts on the wagon as the Modalohr system, the "Flexiwaggon" technology uses Flexiwaggon rail-rack which is added to a train. It is a flexible and environmentally friendly roll-on/roll-off solution. Whole trucks, buses or other vehicles can be loaded and unloaded individually via terminals that are part of the Flexiwaggon system. The wagon is rotatable to both sides. Loading and unloading of the Flexiwaggon is done by the drivers who drive their vehicle onto the wagon via ramps on the front and rear end. Drivers are traveling separately in a wagon or sleeping car.

The type of transhipment technology is horizontal and the loading unit is ACT, as the entire truck is transported, including the driver. The Flexiwaggon is under development by the Company Flexiwaggon AB in Östersund, Sweden. A Swedish-Swiss consortium has been formed to realize the project for the Gotthard tunnel, Switzerland. Flexiwaggon is offering a solution to annually transport 1 200 000 trucks swiftly through the Gotthard tunnel but has not been implemented yet, even in Sweden.[11].

The Flexiwaggon allows transporting non-craneable trailers without additional handling technology. Investment cost is about 330 000 € per wagon.

[11] https://www.flexiwaggon.se/about-flexiwaggon/

Illustration 17. Flexiwaggon technology.

Megaswing solution:

Using the same moving wagon principles as the Flexxiwaggon system, the "Megaswing" technolology has been developed by the Swedish company Kockums.

The overall development of the Kockums Megaswing is already considered to be advanced. The first prototype of its predecessor was presented at IVA exhibition in 1988 in Hamburg by the Finnish Transtech, which is now part of Kockums. The 6-axled Megaswing DUO has already been put into commercial service between Malmö and Eskilstuna in Sweden.

The Megaswing system allows transporting non-craneable trailers without additional handling technology.

Compared to Modalohr, Megaswing is innovative in that the wagon separates easily into the sections. For the loading and unloading process, one employee is needed to operate the hydraulics and to monitor the transshipment process. Megaswing`s only requirement is a flat trackside area. The loading process of a full train can be finished within 30 minutes.

For the Megaswing system all technical components are included into the wagon, so no additional terminal infrastructure is needed except a truck-drivable trackside along an existing rail track. It is easy to operate within existing intermodal terminals and it allows horizontal and vertical handling.

Illustration 18. Megaswing solution technology.

Other systems (for information):

Several other solutions have been identified by the Consultant but cannot yet be considered to be "universal" or "Europe field proven". According to the ToR, the Consultant shall focus mainly on "*Identification of similar services worldwide and possible best practices from the point of view of Service Providers field of expertise*" and it could be understood that current unachieved development or prototypes are therefore excluded as "roadrailer", "Cargo-Speed", Railrunner.

Illustration 19. Roadrailer concept.

WP 1.2 - Description of possible services

Overview of typical infrastructure design issues

- **Regulatory / standard issues / Main lobbying stakeholder**

UIC 596-6:

Combined Transport with loading units, or road vehicles on railway wagons, exceeds the G1 UIC loading gauge (it ideally requires the larger GC gauge), hence railway lines must be codified to determine the accurate gauge for CT.

Alongside the codification regime for railway lines, a system of codification of loading units and wagons has been established to enable a smooth flow of CT train. UIC Leaflet 596-6 sets out the prescriptions for this system regarding ITUs, carrier wagons and lines.

UIC 571-4:

Suitable wagons with specific fittings capable of being operated in international traffic for the transport of semi-trailer (pocket wagons) must comply with the prescriptions of UIC Leaflet 571-4.

Line and rolling stock codifications:

The coding of lines on the European network is drawn from the map published by the UIRR Interunit Technical Committee. Technical Commission of the INTERUNIT edits each year a codification map of the railway lines for swap bodies and semi-trailers.

Combined transport gauges are rectangular loading gauges for standard intermodal load units on wagons, as defined by UIC codes 571-4 (UIC, 2011) and 596-6 (UIC, 2006). The standards are based on a floor height of 33 cm from the Top of Rail (ATOR) of a standard pocket wagon, thus code P, and a 3-digit code indicating the maximum height of 2.60 m wide load units. Code "P450" represents a semi-trailer, 260 cm wide by 450 cm high and suitable for loading onto a pocket wagon and requiring a railway intermodal gauge of 2.60 m × 4.83 m (static dimensions). Similarly, code "C" represents containers and swap bodies with the corresponding top corner positions when loaded onto a standard container wagon with container mounts at 117.5 cm above top of rail

Combined Transport Directive (92/106) is the main directive related to combined transport. Semi-trailers, when used as intermodal loading units in unaccompanied combined transport, may be positioned using trucks combinations with a gross weight up to 44 tons.

The European technical specifications for interoperability (TSI) relating to the 'infrastructure' subsystem of the rail system in the European Union, by requiring loading gauge GC (3.15 m × 4.65 m, chamfered) or larger on new Core or other TEN-T lines, implicitly also require intermodal gauge P/C 432 (2.60 m × 4.65 m) or higher.

UIRR. International Union for Road-rail combined transport. Despite not being a regulatory body, UIRR recommendations shall be considered. Created in 1970, the International Union for Road-Rail Combined Transport (UIRR) is the industry association for the sector of Combined Transport in Brussels. Its members are Combined

Transport Operators and Combined Transport Terminals. UIRR actively promotes Combined Transport, primarily towards European decision-makers and facilitates the enhancement of the sector, while also supporting the daily functioning of this ecologically and economically sustainable mode of long(er) distance freight transport.

The players within Continental Combined Transport are predominantly grouped together within the UIRR organization and dispose over their own regulations due to that organization.

- **Infrastructure loading gauge issues:**

The loading gauge is one of the essential criteria which must be taken into consideration when road vehicles or their loading units use rail in the framework of CT.

A loading gauge (called also "gabarit") defines the maximum height and width for railway vehicles and their loads to ensure that they can pass safely through tunnels, under bridges and keep clear of track-side structures.

Limited loading gauges are a major barrier for providing competitive CT rail/road services especially in western and southern Europe. This particularly refers to the continental business and the transport of semi-trailers, which are overwhelmingly employed for cross-border and inland goods transports. While the clear majority of standard general cargo semi-trailers, excluding purpose-built types, feature an external height of 4m the rail infrastructure in the respective countries just allow heights from about 3.52m to 3.85m.

Indeed, CT involves specific gauges and is therefore only viable on previously measured sections. It is possible to exceed the gauge, depending on the type of loading unit used; the upper limit for the height and width of the loading units is specified in the "rail gauge". This is restricted on some lines because of tunnels, bridges and catenaries, and in some cases even by the roofs of railway stations. Main principle is the following:

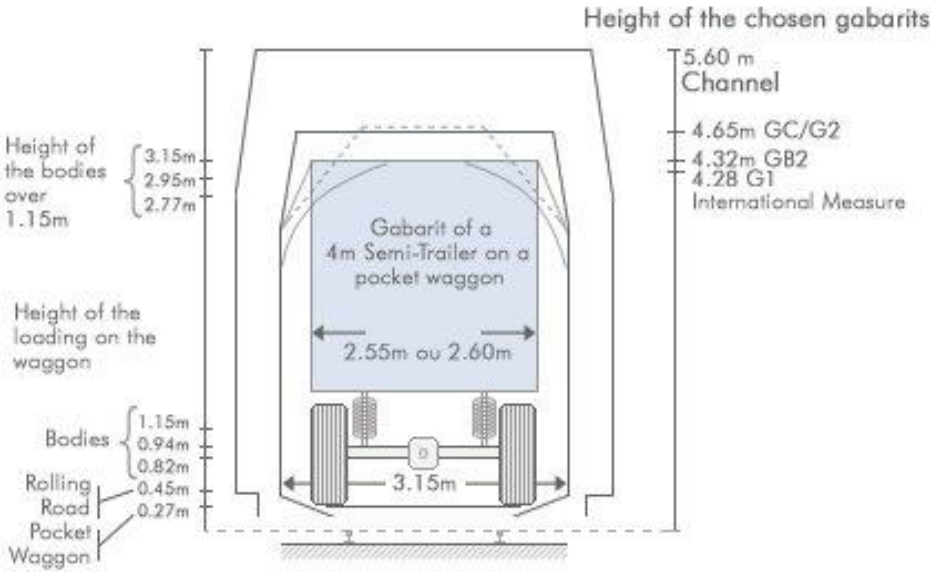


Illustration 20. Main principle of loading gauge suitable for the transport of trucks or semi-trailers (pocket wagon).

The European technical specifications for interoperability (TSI), by requiring loading gauge GC (3.15 m × 4.65 m, chamfered) or larger on new Core or other TEN-T lines, implicitly also require intermodal gauge P/C 432 (2.60 m × 4.65 m) or higher.

The main use of the 2.60 m wide intermodal gauge is to carry standard intermodal load units, whose dimensions are limited by international standards and national highway regulations.

The maximum permissible height of trucks in Europe ranges from 4.0 m to 'not defined' (ITF, 2012). As example, Sweden, France, the UK and Ireland permit trucks of 4.50 m height or taller, and Finland permits 4.20 m.

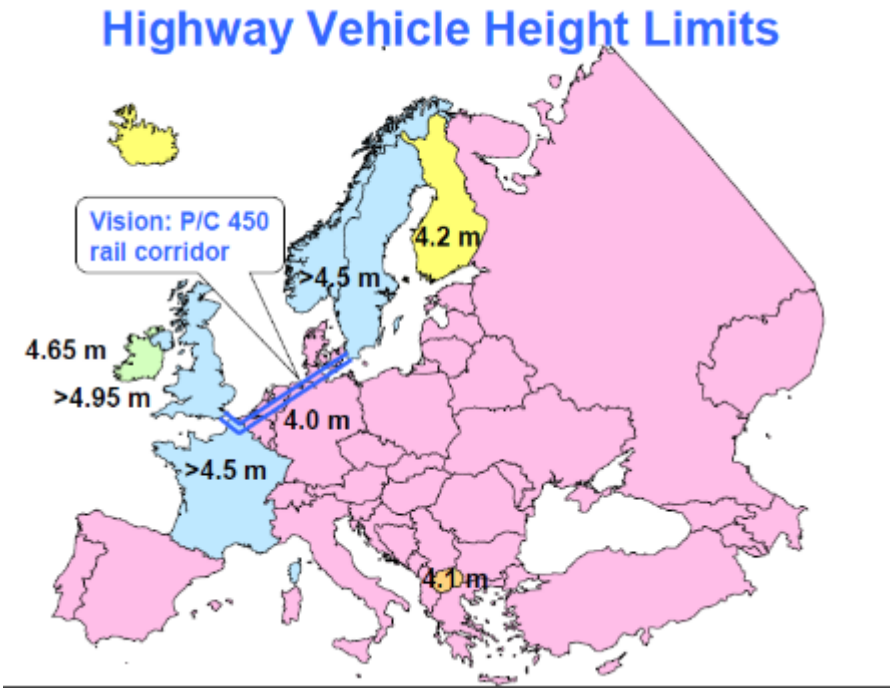
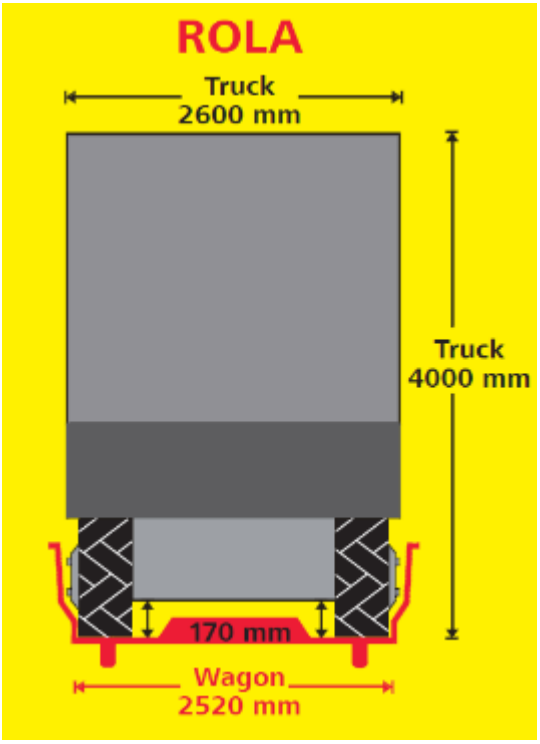


Illustration 21. Authorized height of trucks in EU[12].

Currently RoLa solution using low floor wagons accepts trucks having the following maximum dimensions:

[12] https://www.math-stockholm.se/polopoly_fs/1.347071.1550154728!/Menu/general/column-content/attachment/Hans%20Boysen.pdf



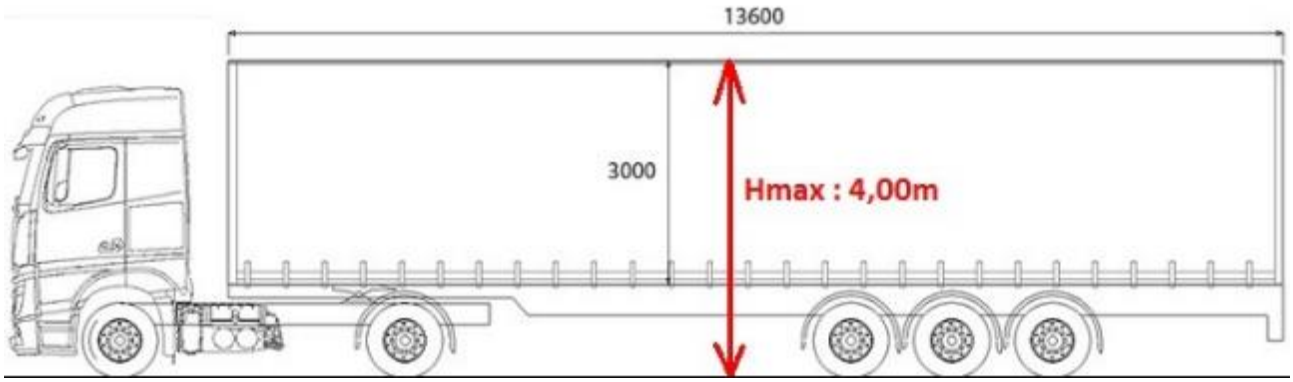


Illustration 22. RoLa, typical vehicle dimensions accepted on low floor wagons[13]

To be compared with Eurotunnel using conventional flat wagon:

[13] https://RoLa.railcargo.com/en/service/downloads

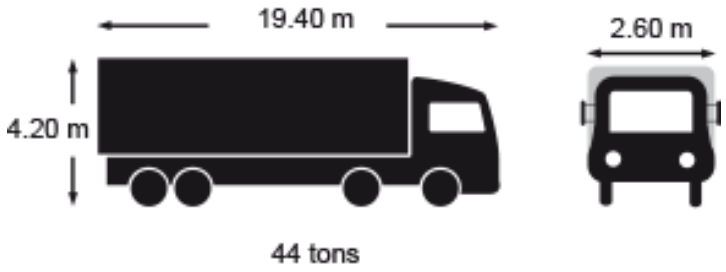


Illustration 23. Eurotunnel, typical vehicle dimension accepted on conventional flat wagons

Loading gauge, especially for the available height is an important factor regarding the combination maximum vehicle height / floor height and constraints (pocket – flat) of wagons.

The following figures shows currently differences between the main intermodal loading gauges in different countries of EU:

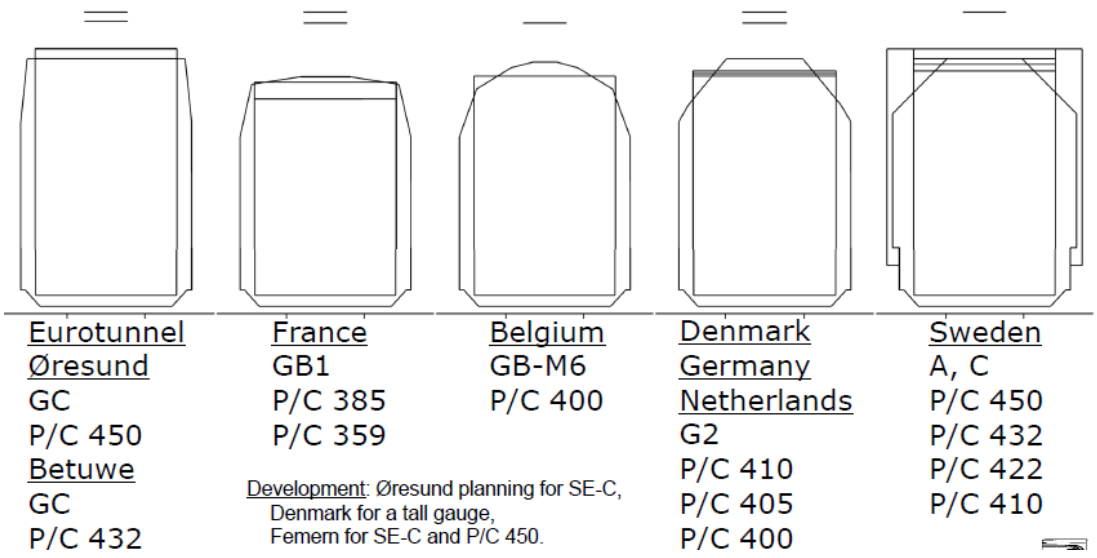


Illustration 24. Loading gauge and intermodal gauge in some EU countries[14]

Eurotunnel with its specific comfortable loading gauge and Sweden are fitting with P/C 450 intermodal gauge requirements. Recommended in[15] C4R report "requirements toward the freight system of 2030-2050", for semi-trailer transportation, it is very important to have a high but not so wide loading gauge. **The loading gauge P/C 450 (4,83x2,60m) is ideal** because it makes it possible to transport both 4,5 m high semi-trailers on pocket wagons and 4,0 m high semi-trailers or trucks low floor wagons.

[14] Railway Group Center for research and education in Railway technology Railway Group Potential of improved infrastructure standards on cross-border
[15] http://www.capacity4rail.eu/IMG/pdf/c4r-d2.1.2_requirements_toward_the_freight_system_of_2030-2050_final_.pdf

The loading gauge "efficiency" is significant: +17 % larger unit volume capacity with intermodal gauge P/C 450 compared to P/C 400.

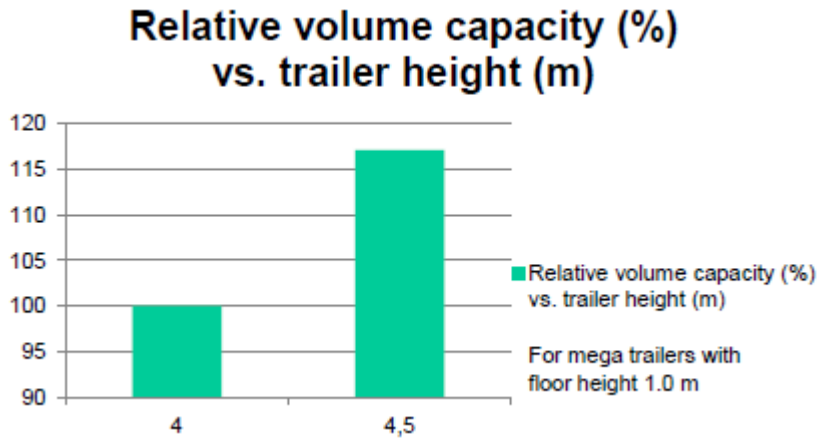


Illustration 25. Loading gauge efficiency in volume between P/C 400 and P/C 450[16]

Therefore, for intermodal transport, the total possible height from ATOR available (with squared corners gauge) is one of the most important criteria.

Eurotunnel is offering the highest clearance available (5,75m). It explains the reason why conventional flat wagon with a floor of about 1 100mm are used combined with truck having a height of 4,2m for a total available height of 5,3m. Eurotunnel loading gauge is accepting all reference profile gauges including GC and GB+ gauge.

- **Net load capacity issues:**

The net load capacity of RoLa trains is lower than that of UCT. An average RoLa train transports approx. 20 trucks, while a UCT train moves up to 36 road consignments. The net weight per train is about 400 tonnes for RoLa and 750 tonnes for UCT.

Taking into consideration the maximum length of RB sidings of 1 050 meters (useful length maximum 1 000 meters) and also the maximum load of semi-trailer with tractor unit (44 tons, 36 tons for the semi-trailer and 8 tons for the tractor unit), typical train composition will be:

CT solution	Wagon type	Wagons length, between couplers (m)	Wagon net load capacity (tons) (1)	Wagon empty weight (tons)	Gross load of wagons (tons)	Number of wagons	Train length including 1 locomotive 19m (m)	Maximum train net load (tons)	Train gross load (tons)
RoLa (2)	Saadkms	19,17	44	18,5	62,5	51	996,67	2 244	3 188
UCT	Sdgnss	20	36	22	58	49	999	1 764	2 842
Modalohr 3rd generation (unit of 2 wagons coupled together)	UIC 3	34,8	77,3	42,7	120	28	993,4	2 164	3 360
Eurotunnel 3rd generation (2)	WBN Waggonbau Niesky GmbH – Loader (3 per train)	25,2		53	53	3	993 (including 3 loaders empty)	1 936	3 594
		20	44	34	78	44			

Table 4. **Typical CT train composition for RB (Source Consultant)**

(*) By "net load", it is considered the truck or semi carrier load (not the load of the goods inside the truck or semi-trailer).

For RoLa and Eurotunnel, it shall be added the weight and length (26 meters) of the passenger coach (42 tons)

- **Train composition and coupler capacity issues:**

Please refer to appendix for coupler issues

- **Wagon issues:**

It is identified above that wagon solutions are interdependent with the maximum height of the trucks accepted in the country and the loading gauge of the railway network.

Pocket wagons:

Typically for pocket wagons (UCT solution of HUPAC, Lift-On-Lift-Off, unaccompanied combined transport of semi-trailers on low floor pocket wagons), the lowest wagon floor high where semi-trailer wheels are positioned is between 270 to 330 mm. These wagons are quite well proven and used commonly for the transport of semi-trailers. They are equipped with standard wheel diameters.

Wagon pocket height ATOR	Wagon type, examples	Max. semitrailer height within P/C 450
0.330 m	UIC 571-4	4.500 m
0.310 m	Sdgms	4.520 m
0.270 m	Sdggmrs, Sdggmrss, Sdgmns	4.560 m

Table 5. **Combined transport loading gauge height in some EU countries**

Illustration 26. Pocket wagon (source UIRR)

But because semi-trailers are loaded and unloaded with a gantry crane, the wagon is from "pocket type" with normal wheel diameter solving the issue of fast wheel wear observed with RoLa solution. Nevertheless it is observed that semi-trailer vehicles shall be designed to be "craneable" and this can be a significant cost factor for hauliers

A classical pocket wagon costs about 90 000 € with a maintenance cost of about 8 cent/km per wagon.

RoLa wagons:

Typically for RoLa wagons (Roll-On-Roll-Off solution, accompanied combined transport of truck on low floor flat wagons), the wagon floor height is between 316mm to 410mm. These wagons are quite well proven but used only for the need of RoLa solution. They are equipped with small wheel diameters turning fast and requiring heavy maintenance. Wagon are equipped with 4 or 5 axle-wheelsets per bogie. Very specific solutions and development have been required to solve the regular use of small wheel regarding the wheel profile, lubrification in curve, braking, turnouts compatibility, etc.

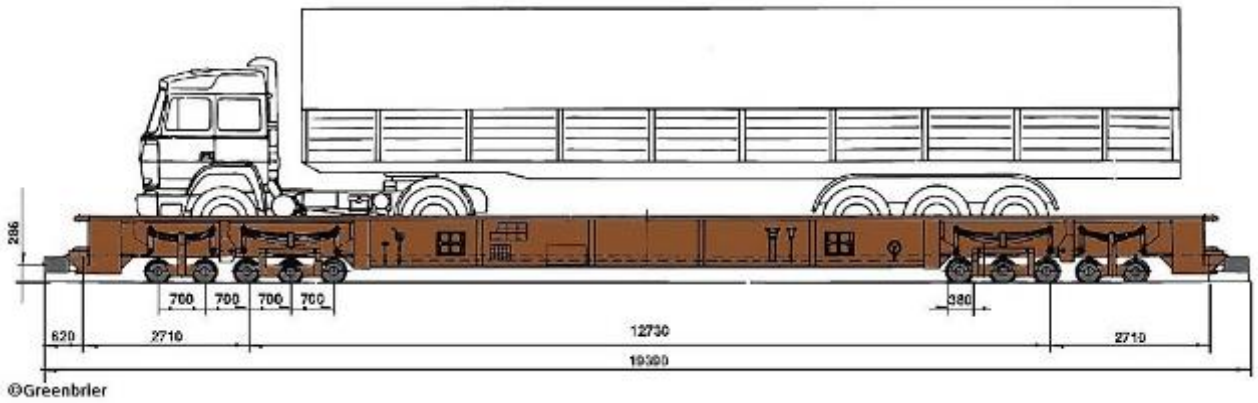


Illustration 27. Wagon for RoLa Saadkkms model (10 axle wheelsets)

Illustration 28. Wagon for RoLa loaded

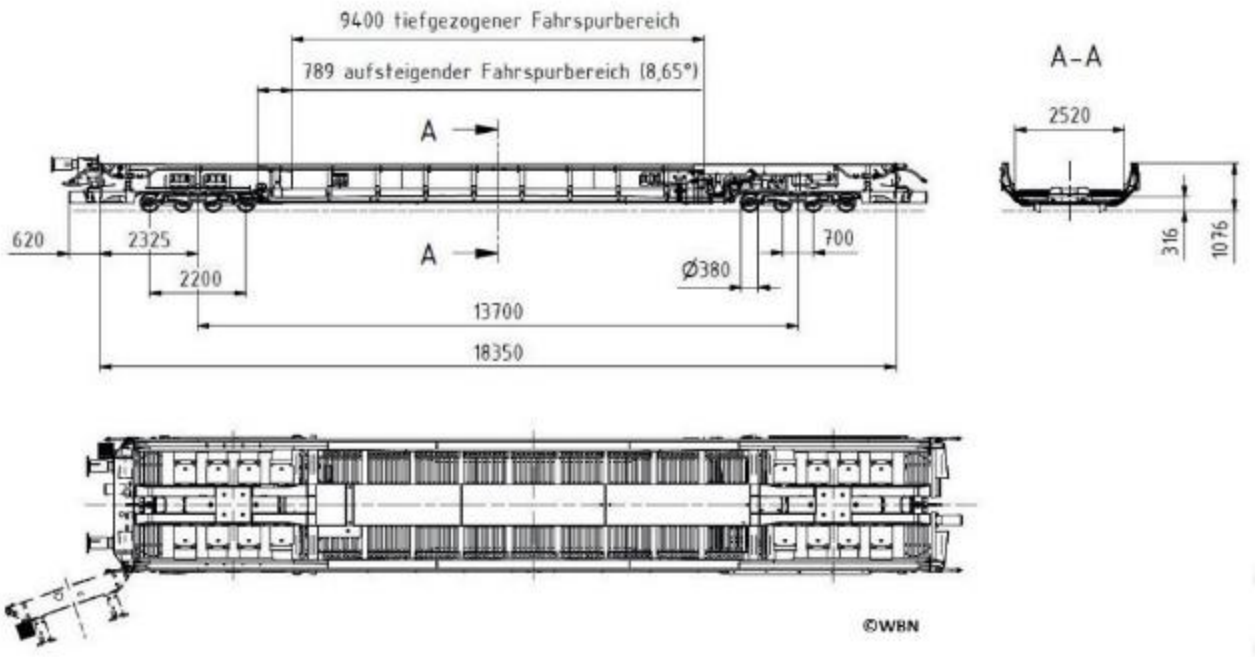


Illustration 29. Wagon for RoLa main dimensions

A RoLa-Wagon costs about 180 000 €. Maintenance costs of RoLa-Wagons are around 15 cent/km per wagon)[17].

Modalohr wagons:

The articulated Modalohr wagon is 32·5m long and weighs 35·7 ton when empty. Riding on a Y33 bogie at each end and a shared Y25 in the middle, it has two swing-tray sections each accommodating a trailer up to 13·7m long or two tractor units. With a floor height of 150mm above the top of the rail, the wagon is able to carry trailers up to 4m high and 2·60m wide or around 90% of existing truck running in Europe (same limitation in Baltic countries). The wagons themselves carry no powered actuators to move the swing-trays, which are unlocked at the terminal and positioned between pairs of fixed ramps for loading and unloading. A complete cycle of unloading and loading can be completed within 30min according to the manufacturer.

The Modalohr UIC wagon (3rd generation) makes it possible to transport standard 4.0 m high semi-trailers on the main European lines with a minimum gauge of UIC GB1 without any modification to the existing infrastructure.

Specific features of the Modalohr wagon:

- Extra low floor: 10 to 20 cm from the rail;
- Standard bogies and wheels;
- Double articulated wagons with 2 pockets on 3 bogies.

[17] https://www.alpine-space.eu/projects/alpinnoct/outputs/deliverable-d.t1.2.1.pdf

Illustration 30. Modalohr wagon with extra low floor.

A Modalohr wagon costs about 400 000 € and maintenance costs are high, about 50 cent/km per wagon[18] approximatively, but it shall be considered that each wagon is in fact a unit of 2 wagons permanently coupled.

- **Loading / unloading issues:**

Loading aspects of trucks and more over for semi-trailers is a key issue.

Lift-On-Lift-Off:

Lift-On-Lift Off concept is implemented in what is generally called "transshipment terminals".

"Transshipment terminals are the 'passenger stations of freight', the locations where cargo arriving in intermodal loading units is loaded onto freight wagons so as to travel in a freight train over the longer part of its journey. Adequate terminal density and the availability of sufficient capacities at these terminals are crucial from the perspective of growing Combined Transport." [UIRR[19]]

"Lift-on lift-off" activities require load semi-trailer units with reinforcements. Few semi-trailers are reinforced (from 5 to 10 % of European semi-trailer stocks) and is therefore impairing the market segment. Loading and unloading of semi-trailers are achieved using gantry cranes or specific forklift devices.

Different systems are proposed regarding the Lift-On-Lift-Off solution, more and less complex as "the ISU Innovativer Sattelauflieger", the "NiKRASA", aiming in most of case to solve the issue of reinforced body for semi-trailers.

[18] Modalohr source
[19] http://www.uirr.com/en/media-centre/annual-reports/annual-reports/mediacentre/1188-uirr-annual-report-2018-19.html

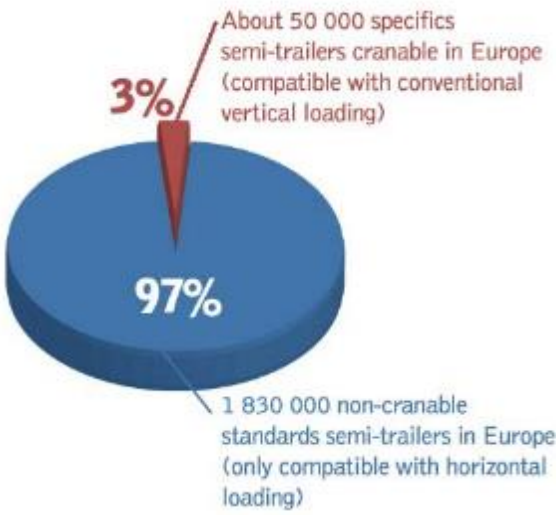


Illustration 31. % of reinforced semi-trailer cranable

Illustration 32. Loading a semi-trailer using a reachstacker device

When a loading platform using gantry cranes is used required, significant place is required. As example, consider the terminal Busto Arsizio-Gallarate for HUPAC to load semi-trailer on pocket wagons:

Busto Arsizio-Gallarate is the central hub of the Shuttle network. Dozens of trains connect the terminal to a wide range of destinations in Switzerland, the Netherlands, Germany, Belgium, Denmark and Sweden. The facility also serves as a gateway platform for continued travel within the Italian network.

- Area 240,000 square metres;
- Transshipment sidings 11 x 540 to 760 m;
- Gantry cranes 12;

- Capacity 30 train pairs per day.

An alternative solution is also to use reachstacker device. A reachstacker is a mobile crane that is the most widely used CT technology on terminals to unload, reload, pile up or move containers. With an empty weight of approx. 100t it can move loads up to 50t.

Horizontal loading (CargoBeamer):

CargoBeamer is a logistics service provider for rail, which is building and marketing a Europe-wide network for the transport of non-craneable semi-trailers in Unaccompanied Combined Transport. In 1998 the CargoBeamer concept was developed and in 2013 the CargoBeamer AG in Bautzen was founded with production starting that same year. The CargoBeamer is in operation on the relation Domodossola (IT) to Cologne (DE). This new wagon system handles semi-trailers, containers and swap bodies in a linear, horizontal loading and unloading zone. Similar to a "classical" container terminal the train needs a long range of rail track. The semi-trailers are loaded in bowls or "pallets" which are shifted beside the wagon for unloading and loading. The bowls are autonomous from the train. This allows loading and unloading autonomously from the presence of the train in the terminal. One train can carry up to 36 trailers and load/unload 72 of them simultaneously.

Illustration 33. Horizontal loading using CargoBeamer solution

Illustration 34. CargoBeamer "pallet"

A Cargobeamer wagon costs 360 000 € for 2 parking spaces, a wagon base costs 40 000 € with 2 pallets per wagon (each 20 000 €). Terminal investment for one transshipment unit is 67 000 €.

Roll-on-roll-Off:

To avoid gantry cranes and to attract any type of semi-trailer (reinforced or not), the Roll-On-roll-Off solution has been implemented typically for the RoLa, Modalohr and Eurotunnel solutions.

In most of cases, the truck (tractor unit + semi-trailer) is loaded as a full unit (RoLa, Eurotunnel). In few case (Modalohr), the semi-trailer is uncoupled from the tractor unit which is loaded or not loaded on the same train.

In principle only if trucks are loaded on the lateral side, long platforms are required along the trains at the same level as the wagon floor (Eurotunnel and Russia). RoLa system required loading access ramp at the train end only, Modalohr system is based on small loading / unloading fixed ramps for each articulated wagon and Megaswing system is based on loading / unloading at floor level.

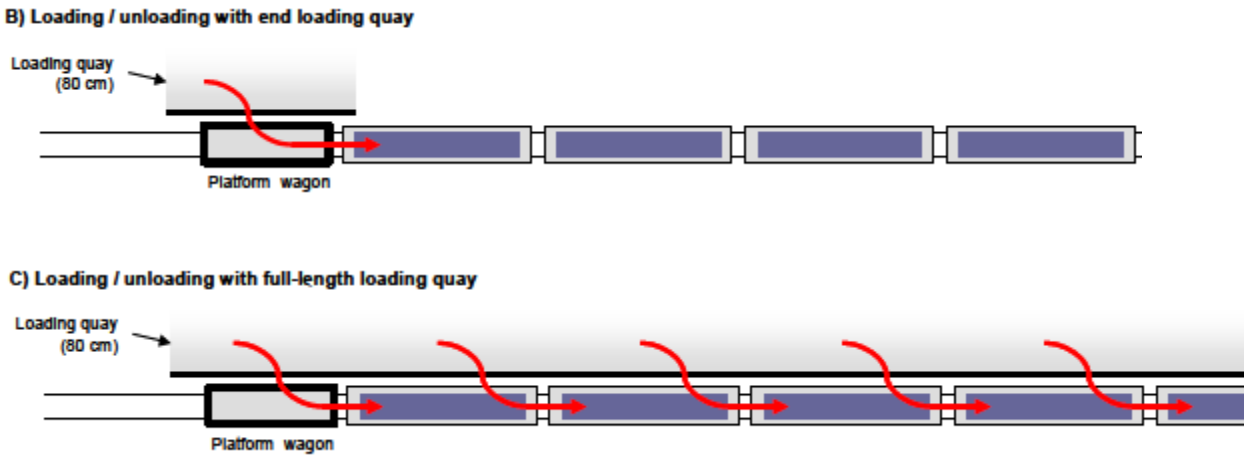


Illustration 35. Loading and unloading concepts

For RoLa solution, the loading ramp requires an area of approx. 80 m2 for one transhipment unit and costs approx. 100 000 €. It needs at least 700 m of a straight railway track for loading and unloading. For Modalohr, investment costs for a terminal is 6,7 million Euro and requires more space in the terminal.

Modalohr railway system:

Despite to be considered as being a Roll-Off-Roll-On system, the Modalohr loading platform is very complex with on-ground equipment. The principle is to "open the pocket of the wagon".

Illustration 36. Loading on-ground equipment of Modalohr railway system (Source Modalohr Railway system)

The "Cargospeed" system is quite similar in principle to the Modalohr system using pistons underground for the wagon pocket orientation. It has been developed by BLG Consult, Warbreck Engineering and Newrail in years 2004 - 2006. The type of transhipment technology is horizontal

This system has only been developed at "prototype" stage and never been implemented. Costs are not available.

Specialy designed wagon

T-shaped hydraulic mechanism

Movable platform

Illustration 37. Cargospeed concept

- Accompanied - Unaccompanied issues:

There are in CT World some discussions existing aiming to promote either the RoLa concept with accompanied vehicle or the UCT (HUPAC) with unaccompanied semi-trailers.

Main issue is to solve the "last mile" issue. It can be considered as typical for Combined Transport the following processes including or not port(s) in the transport chain.

For combined transport limited to trucks (tractor vehicle + semi-trailer) or semi-trailers only, the following first scheme is predominant:

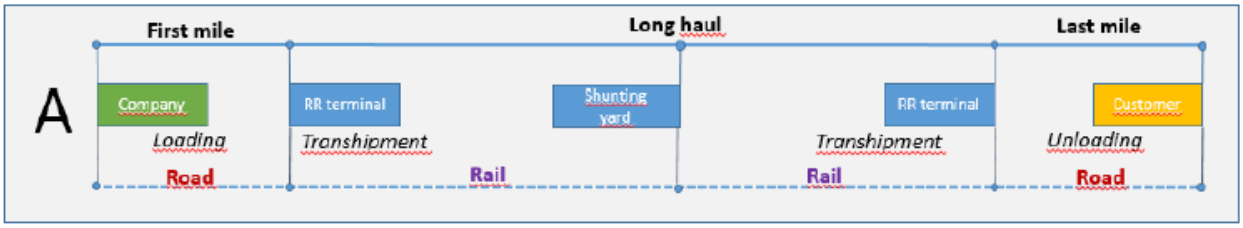
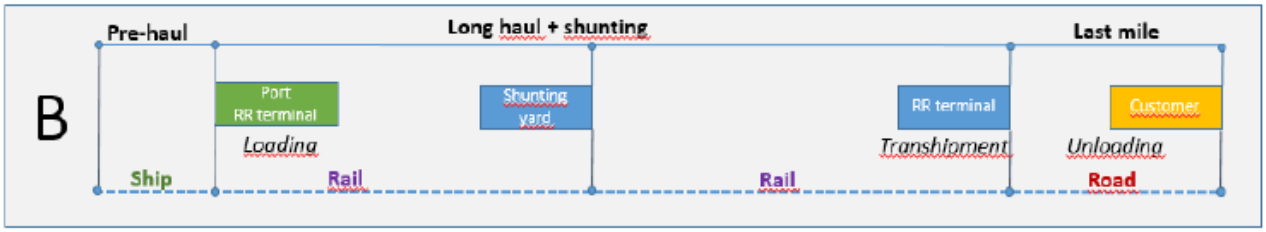


Illustration 38. Last mile continental combined transport issue (Source Modalohr Railway system)[20]

For combined transport including maritime (mainly containers and swap-bodies), main differences are to have the port(s) part of this chain.



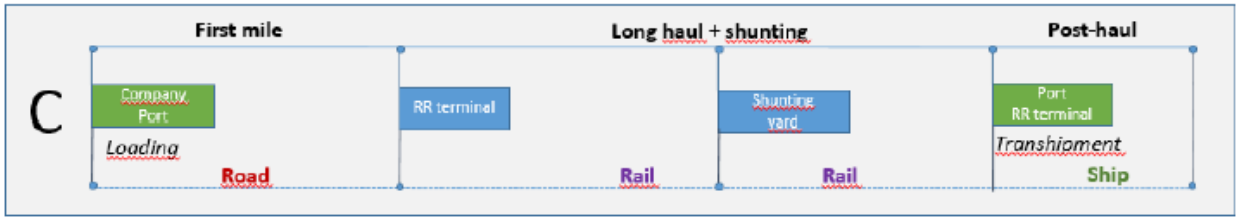


Illustration 39. First or Last mile continental combined transport issue including port(s)

Accompanied vehicle, meaning that the driver and tractor unit are also transporter to destination it can be assessed that existing ratio of payload to gross weight is impaired (the unit tractor has a weight) and also the tractor unit

[20] https://www.alpine-space.eu/projects/alpinnoct/outputs/deliverable-d.t1.2.1.pdf

cannot be used elsewhere for the duration of the transport. In addition, the passenger coach for drivers shall be considered as an empty weight.

On another hand, it is solving the issue of organizing a full transport chain including handling the semi-trailer by 2 different road freight operator each one providing tractor unit at rail terminals.

It could explain also the range of journey distances which are different between RoLa and UCT solution (respectively: 300 and 800 km). The time required for the transportation of semi-trailer on long distance makes more economically more attractive not to have driver and a tractor unit out of work.

The 871 km average non-road distance covered by an intermodal consignment mostly unaccompanied carried by a UIRR members in 2017 has been reduced by 30 kilometres to 841 km in year 2018, which is an important reflection of the encouraging trend that Combined Transport is becoming the choice of shippers over shorter distances too.

Efficiency rate:

If it is considered the typical train composition of RB (1050 m maximum), some "rate of efficiency" can be calculated between the net load (considering that trucks or semi-trailer fully load is the net load) and gross load of the train.

CT solution	Maximum train net load (tons)	Train gross load (tons)	% between net load and gross load
RoLa (*)	2 244	3 230	69,48%
UCT	1 764	2 842	62,07%
Modalohr 3rd generation (unit of 2 wagons coupled together)	2 164	3 360	64,42%
Eurotunnel 3rd generation (*)	1 936	3 636	53,25%

Table 6. **Efficiency rate Net load / gross load (Source Consultant)**

(*) including the load of passenger coach 42 tons.

In general, the lowest efficiency rate is observed for Eurotunnel, mainly due to the 3 loader wagons and coach to be considered to be dead weight, including the weight of tractor unit. RoLa is showing interesting figure (light empty weight of wagons without any loader wagons). UCT is also impaired by the empty weight of pocket wagons.

- **Road vehicle issues:**

In conjunction with the revision of Directive 96/53/EC90, stakeholders have submitted several proposals for increasing the permitted weights and/or dimensions of road vehicles operating Intra-EU services. The most far-reaching proposal is to raise the maximum length to about 25.25m and the gross weight to 60 tonnes. There is no project to increase the height higher than 4,5 m considering the significant impact of existing road infrastructure (bridges). According to the outcome of consultations among policy-makers and stakeholders in the freight industry

this proposal is very unlikely to be adopted. This may also be due to the findings of studies that forecasted a major shift of tonnage from CT rail/road back to road.

Among the other policy options, two are particularly sensitive to the competitive position of Intra-EU CT: an increase of the maximum permitted vehicle length to 25.25m but retaining the 40 tonnes limit; and raising the maximum vehicle gross weight to 44 tonnes without a change of length.

RB's infrastructure design issues and compatibility with existing solutions

- **Loading Gauge:**

Main parameters taken into account is the line classification of RB which shall and will be designed in accordance with Commission Regulation (EU) No 1299/2014 of 18 November 2014.

In the Design Guidelines, passenger trains are P2 (GB reference Profile) and freight trains are F1 (GC reference Profile) categories.

By implementing loading gauge GC (3.15 m × 4.65 m, chamfered), RB implicitly is implementing intermodal gauge P/C 432. The intermodal gauge targeted by RB is not specified in the Design Guidelines documents at time of writing.

Up to a height of 3220 mm, the reference profile of the GA, GB and GC gauges is Identical. GC maximum height of the static gauge is 4 650mm.

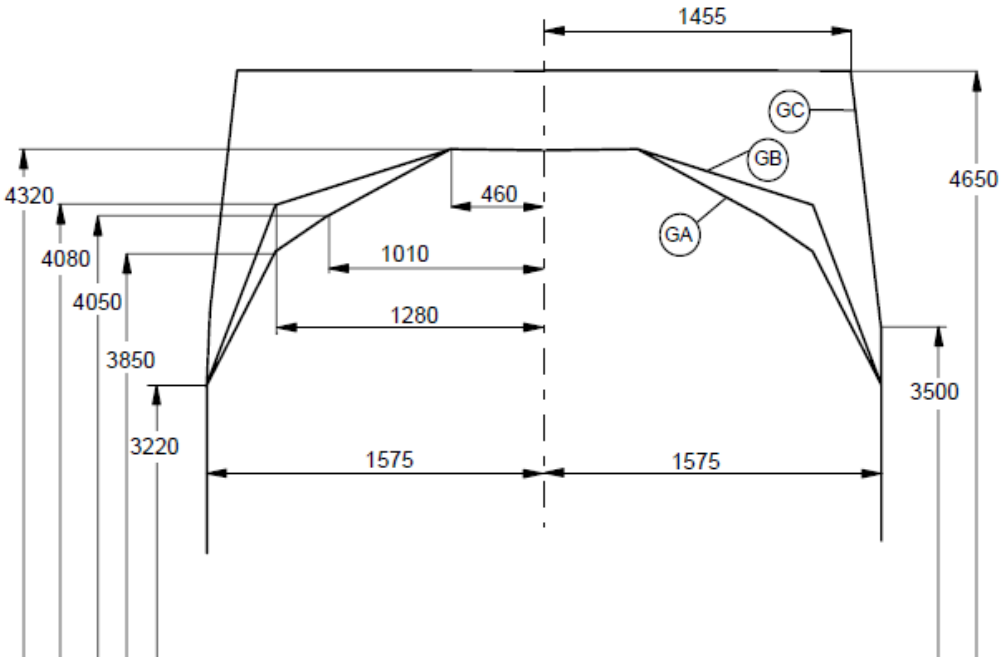


Illustration 40. Static gauge Reference profile for GA, GB and GC (source UIC)

It is first pointed out that there is no issue regarding the compatibility of truck width (2 600 mm) with the regular width of the GC gauge (3 150mm).

UIRR is pushing for the establishment at least of **uniform loading gauge (P400 or UIC GC),** as well as homogeneous train length (750m) and axle weight (22,5t). Concretely, regarding the height, the truck or semi-trailer loaded on the wagon should not have a static height exceeding 4,0 m (P400).

In the current RB case, with GC gauge, the intermodal gauge P/C 432 of RB is slightly more comfortable in height (32mm). In all neighboring countries of RB except Finland, height of truck is limited to 4,0m and in this case most of the Worldwide solutions are currently compatible with RB design:

Compatibility of existing solution with RB GC loading gauge			
Existing solution	**Solution description**	**Pro's**	**Con's**
RoLa solution	Roll-On-Roll-Off solution, based on truck transport (tractor unit + semi-trailers on flat low floor wagons with small wheel diameter. Accompanied transport	All semi-trailers are accepted, no need to have strengthened body. Market is huge Well proven solution Infrastructure for loading / unloading is simple and not requiring lot of space (loading ramp at the end of train)	Limited to 4.0 m high vehicles Usually short range of journeys (300 km maxi) Specific low-floor flat wagons with small wheel diameter turning fast, maintenance cost regarding wheel wear.
UTC solution (HUPAC)	Lift-On-Lift- Off solution for the transport of semi-trailer on pocket wagons with low floors but with standard wheel diameter. Unaccompanied transport	Journey distance up to 800 km limited Well proven solution No problem with wheels Conventional pocket wagons for the purpose of semi-trailer transport.	Limited to 4.0 m high vehicles Semi-trailers shall have strengthened structure, market is limited Loading device like gantry cranes are required. Loading platforms need significant space.
Eurotunnel solution	Roll-On-Roll-Off solution, based on truck transport (tractor unit + semi-trailers on flat standard floor wagons with standard wheel diameter. Accompanied transport	Not compatible without adaptations, as exceeds GC gauge limits in height (5 500mm)	

Compatibility of existing solution with RB GC loading gauge			
Existing solution	**Solution description**	**Pro's**	**Con's**
Modalohr solution	Roll-On-Roll-Off solution, based on semi-trailer transport on specific very low floor pocket wagons (open pocket system). with standard wheel diameter. Unaccompanied transport	All semi-trailers are accepted, no need to have strengthened body. Market is huge. Could be compatible to fit with 4,5m high vehicles (floor of wagon 100mm + 4500mm for the vehicle = 4600mm) Journey distance limit not defined, supposed to be in the range of 800km	Complex on ground solution for loading, complex wagons. Investment costs are significant. Terminals are "locked in" to single specific technology provider.

Table 7. Compatibility of existing solution with RB GC loading gauge

Swedish gauge SEc considerations:

RB is currently considering the possibility to implement the Swedish gauge SEc (Please refer to the study "Transport of Over-gauge goods). For combined transport the fact to have higher gauge with squared corner is an important issue.

In Sweden, a very generous static gauge reference profile called "SEc" is already being introduced in most of the network, which is 3.600 x 4.830 (width x height in static). The reference profile SEc is an extended profile that is being implemented on new lines only. This profile may only be shipped currently as an exceptional-transports at certain lines in Sweden at the moment.

European GA, GB, GC static gauge reference profiles fits into the Swedish profile SEc. The height of the static gauge reference profiles in Continental Europe is up to 4.65 m above top of rail for gauge GC and 4.83 m for the Swedish static gauge reference profile SEc.

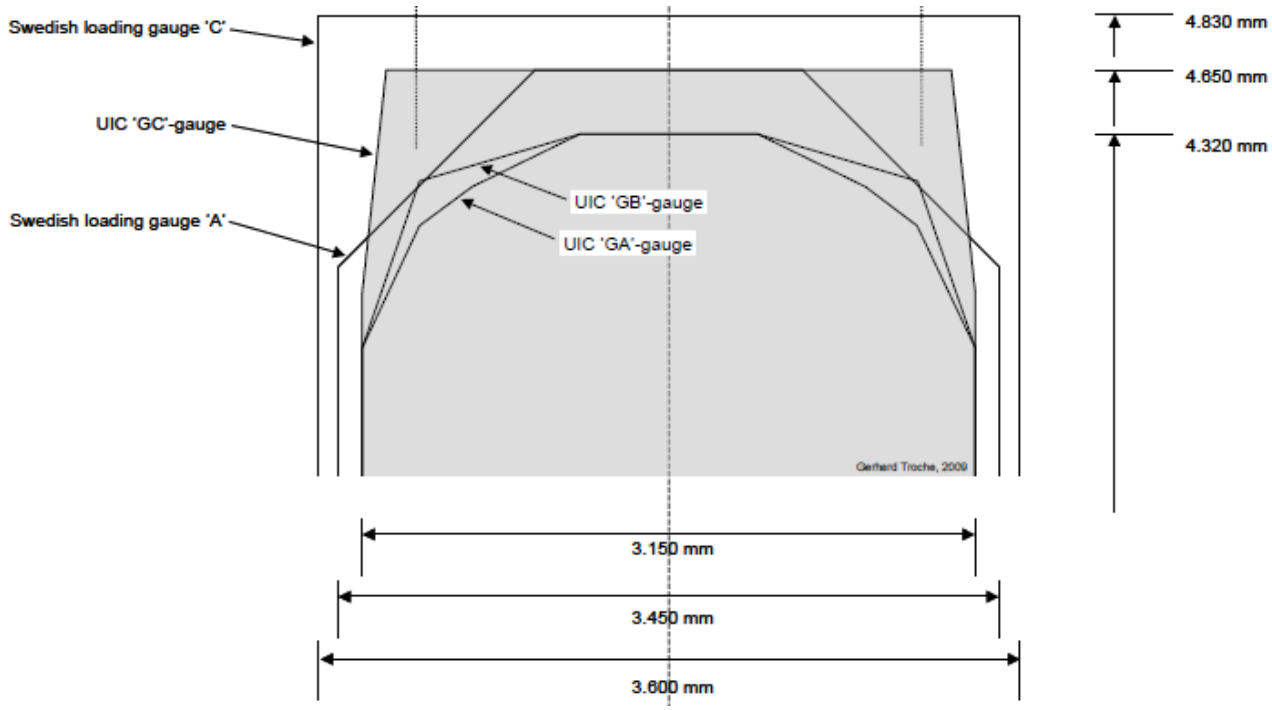


Illustration 41. Static gauge reference profile SEc.

Recommended in[21] C4R report "requirements toward the freight system of 2030-2050", for semi-trailer transportation, it is very important to have a high but not so wide loading gauge. **The loading gauge P/C 450 (4,83x2,60m) is ideal** because it makes it possible to transport 4,5 m high semi-trailers on pocket wagons.

If this SEc gauge is implemented by RB main transport principles for 4.m and 4,5 high vehicles would be the following:

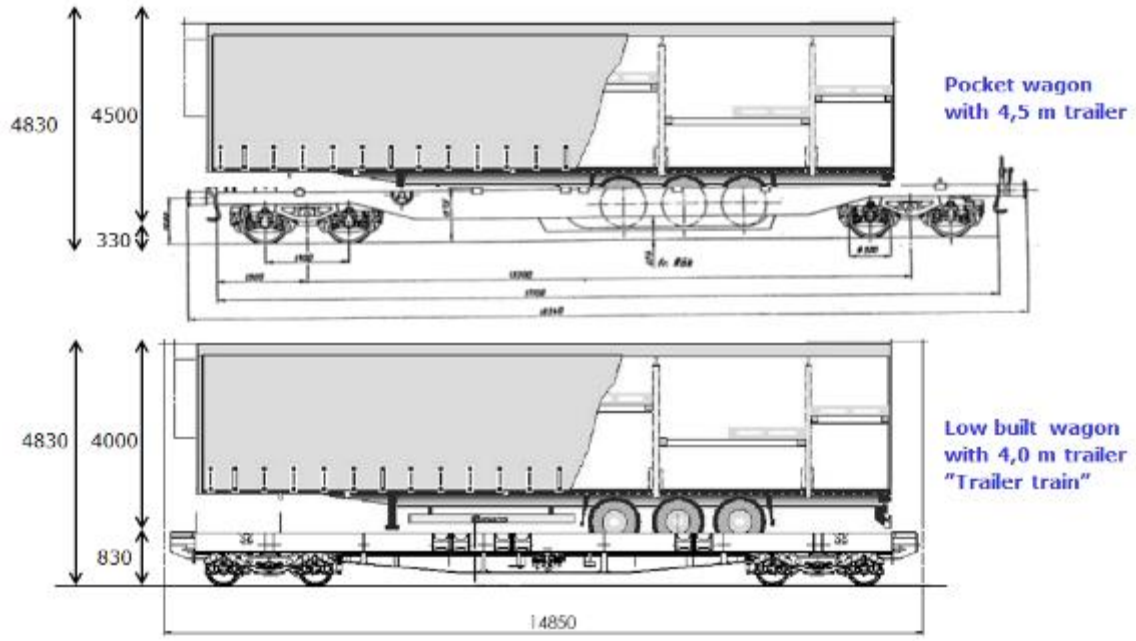


Illustration 42. SEc gauge (4830mm), vehicle heights and wagons

[21] http://www.capacity4rail.eu/IMG/pdf/c4r-d2.1.2_requirements_toward_the_freight_system_of_2030-2050_final_.pdf

Typically, it could solve also the issue of Lift-On-Lift-Off solution requiring crane and strengthened semi-trailer and only Roll-On-Roll-Off solution will be required. By the way, this system will accommodate any type of semi-trailer (craneable or not craneable). It will also involve limited infrastructure investments, simplified design with classical flat wagons, no specific and complex loading and unloading devices (rotating, articulated), maintenance and operation cost reduced.

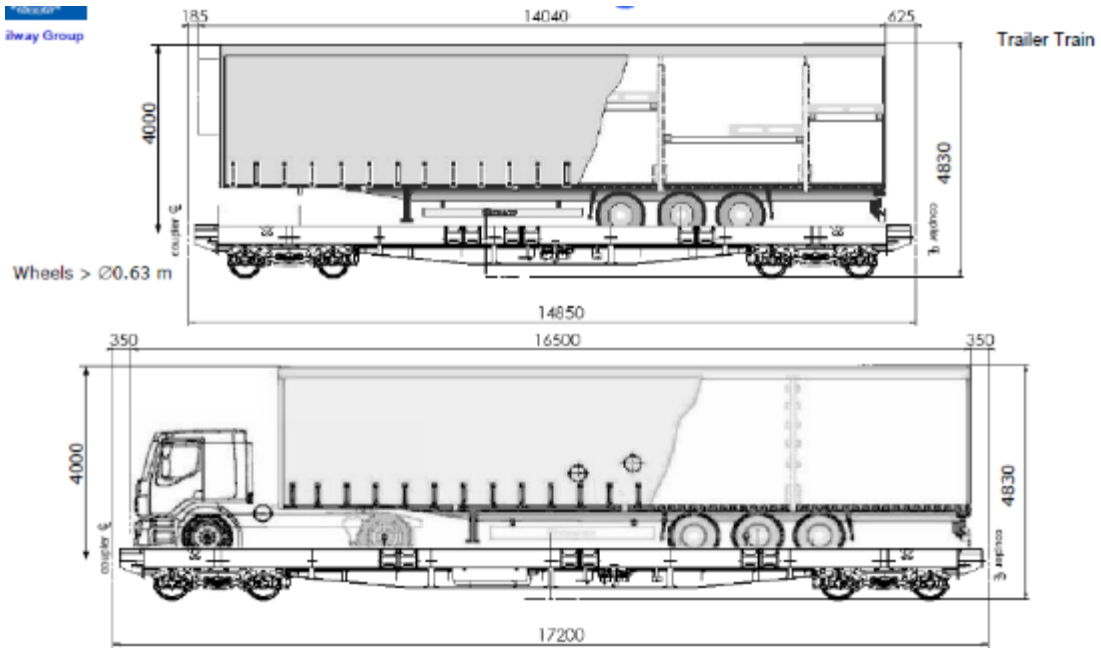


Illustration 43. Roll-on Roll-off Wagons for vehicles 4.0m high using the SEc gauge P 450 [22]

- if the semi-trailer is 4,5m high, the floor of the wagon (pocket one) shall be at about 330mm in the lowest part where the vehicle wheels are located with conventional wheel diameter. Semi-trailer shall be loaded by lift-on lift-off on pocket wagons with crane
- if the vehicle (lorry, motor unit + semi-trailer) is only 4,0m high, the floor of the wagon (flat one) shall be about 830mm which can be called "semi-low floor" lower than conventional height which is about 1 100mm) but using standard wheel diameter. The vehicle can be loaded by roll-on roll-off on the wagon. By avoiding lifting by crane, this would vastly increase the number of existing semi-trailers that can be handled in railway intermodal service, since the majority of the existing semi-trailers in Europe lack the reinforcements that are necessary to be lifted by crane. If the SEc gauge is implemented by RB, the following solutions will be compatible with RB gauge.

[22] Source https://www.slideshare.net/hansboysen/session-34-hans-boysen

Compatibility with RB using SEc gauge			
Existing solution	**Solution description**	**Pro's**	**Con's**
RoLa solution	Roll-On-Roll-Off solution, based on truck transport (tractor unit + semi-trailers on flat low floor wagons with small wheel diameter. Accompanied transport. Suitable for any type of semi-trailers (craneable and non-craneable).	Accepting either 4,0m or 4,5 vehicles All semi-trailers are accepted, no need to have strengthened body. Market is huge. Well proven solution Infrastructure for loading / unloading is simple and not requiring lot of space (loading ramp at the end of train)	Usually short range of journeys (300 km maxi) Specific low-floor flat wagons with small wheel diameter turning fast, maintenance cost regarding wheel wear.
RoLa solution improved	Roll-On-Roll-Off solution, based on truck transport (tractor unit + semi-trailers on flat **semi-low floor wagons with standard wheel diameter.** Accompanied transport. Suitable for any type of semi-trailers (craneable and non-craneable).	Recommended in[23] C4R report "requirements toward the freight system of 2030-2050", for semi-trailer transportation, it is very important to have a high but not so wide loading gauge. **The loading gauge P/C 450 (4,83x2,60m)** (offered by the SEc gauge) **is ideal** because it makes it possible to transport both 4,5 m high semi-trailers on pocket wagons and 4,0 m high semi-trailers or trucks	Accepting 4,0m trucks only Need the development of semi-low floor flat wagon (800mm) Usually short range of journeys (300 km maxi) *This solution requires some development but is a variant of existing solutions (and using existing technologies)*

[23] http://www.capacity4rail.eu/IMG/pdf/c4r-d2.1.2_requirements_toward_the_freight_system_of_2030-2050_final_.pdf

Compatibility with RB using SEc gauge			
Existing solution	**Solution description**	**Pro's**	**Con's**
		All semi-trailers are accepted, no need to have strengthened body. Market is huge. Infrastructure for loading / unloading is simple and not requiring lot of space (loading ramp at the end of train). Standard semi-low floor wagon with standard wheel diameter.	
UTC solution (HUPAC)	Lift-On-Lift- Off solution for the transport of semi-trailer on pocket wagons with low floors but with standard wheel diameter. Unaccompanied transport. Suitable for craneable semi-trailers (or using specific device for non-craneable ones)..	Journey distance up to 800 km limited Well proven solution No problem with the wear of wheels Conventional pocket wagons for the purpose of semi-trailer transport.	Accepting either 4,0m or 4,5 vehicles Semi-trailers shall have strengthened structure, market is limited Loading device like gantry cranes are required. Loading platforms need significant space.
Eurotunnel solution	Roll-On-Roll-Off solution, based on truck transport (tractor unit + semi-trailers on flat standard floor wagons with standard wheel diameter. Accompanied transport. Suitable for any type of semi-trailers (craneable and non-craneable.	Not applicable *without adaption*, exceeding SEc gauge limits in height (5 500mm height of the truck loaded on the flat wagon, the loading gauge is 5 750 mm height). However with adaptation a similar solution to that described as "RoLa Improved" should be possible, with reduced loading times (at the cost of the 'loading' vehicles).	
Modalohr solution	Roll-On-Roll-Off solution, based on semi-trailer transport on specific very low floor pocket wagons (open pocket system). with standard	All semi-trailers are accepted, no need to have strengthened body.	The SEc gauge does not provide any plus values compared to GC gauge

Compatibility with RB using SEc gauge			
Existing solution	**Solution description**	**Pro's**	**Con's**
	wheel diameter. Unaccompanied transport. Suitable for any type of semi-trailers (craneable and non-craneable).	Could be compatible to fit with 4,5m high vehicles (floor of wagon 100mm + 4500mm for the vehicle = 4600mm) Journey distance limit not defined, supposed to be in the range of 800km	Complex on ground solution for loading, complex wagons. Investment costs are significant. Limited number of vendors, monopolist position of Modalohr.

Table 8. Compatibility of existing solution with SEc loading gauge

- Conclusions:

Dispositions of the design Guidelines of RB are compliant with the current requirements regarding the transport of trucks and semi-trailers (GC gauge, P432). Some well proven solutions can be implemented similar as RoLa and UCT or, eventually Modalohr. Vehicle with the height of 4.0m (truck composed by motor unit and semi-trailer) can be transported.

Nevertheless, main recommendations at EU level is progressively to implement P450 height. Using the extended Swedish gauge profile SEc, will allow not only the transport of higher vehicle up to 4,5 with the existing solution but also to implement a simplified or improved RoLa solution using semi-low floor wagons (830mm) more standardized not facing the same problems as the very low floor wagon (310 to 410mm) with small wheels currently in used. The wagon floor height should be semi-low in the range of 830 mm. The wagon floor is flat to allow Roll-On-Roll-Off solution. Another solution could be simply to have a "GC extended gauge" as in fact SEc extended in width is not providing any benefit for the transport of trucks but this solution lead to create a "new and specific" loading gauge for RB which is against any EU interoperability and TSI objectives.

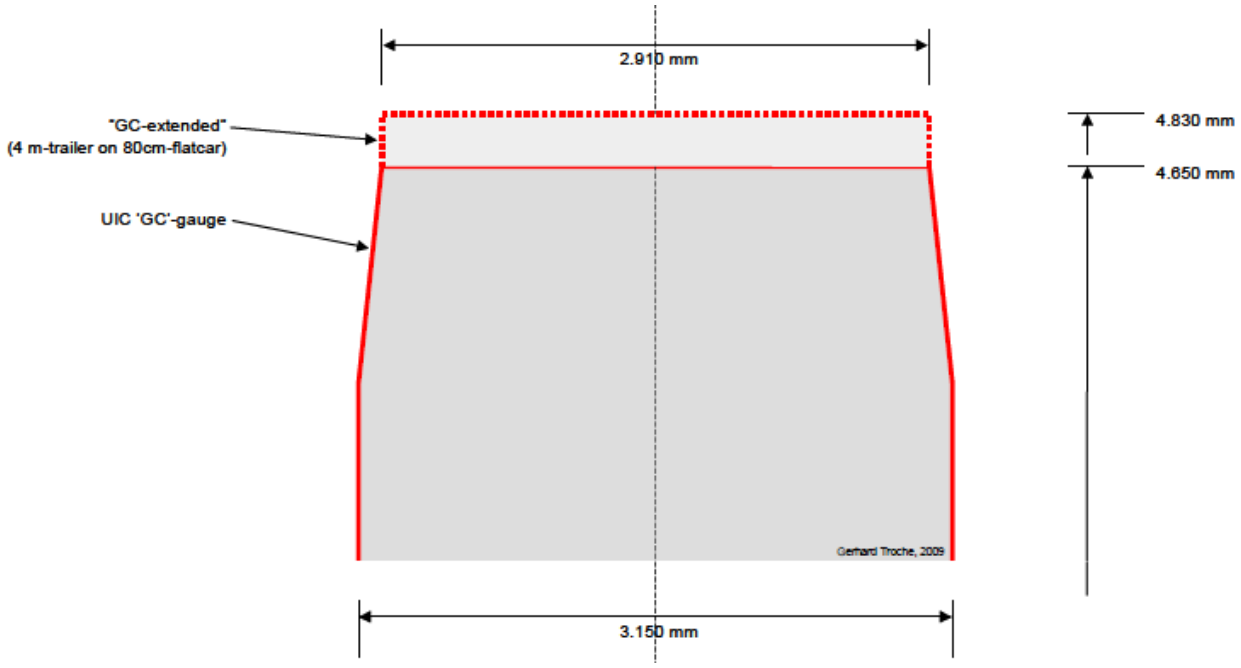


Illustration 44. GC extended gauge

The SEc loading gauge will also provide additional benefits as underlined in the FERRMED report, with more high and squared corner freight wagons:

Illustration 45. Prototype wagon showing SEc /standard sizes (Source FERRMED report)

Note: The prototype covered wagon shown is utilizing the same loading gauge as the SECU trains. Note the yellow line indicating the cross-section of a standard freight wagon.

- **Semi-low floor new wagon issues:**

Currently it has not been identified existing semi-low floor flat wagon for the purpose of truck transport. Main characteristic of the semi-low floor wagon has been recently developed with the support of "FERRMED" association.

FERRMED is a multi-sectoral association that was founded by the private sector in 2004 in order to improve rail freight transportation and to boost the industrial competitiveness in Europe. FERRMED drew up a list of priorities, including the implementation of common technical railway standards, the so-called "FERRMED standards" all over the European Union.

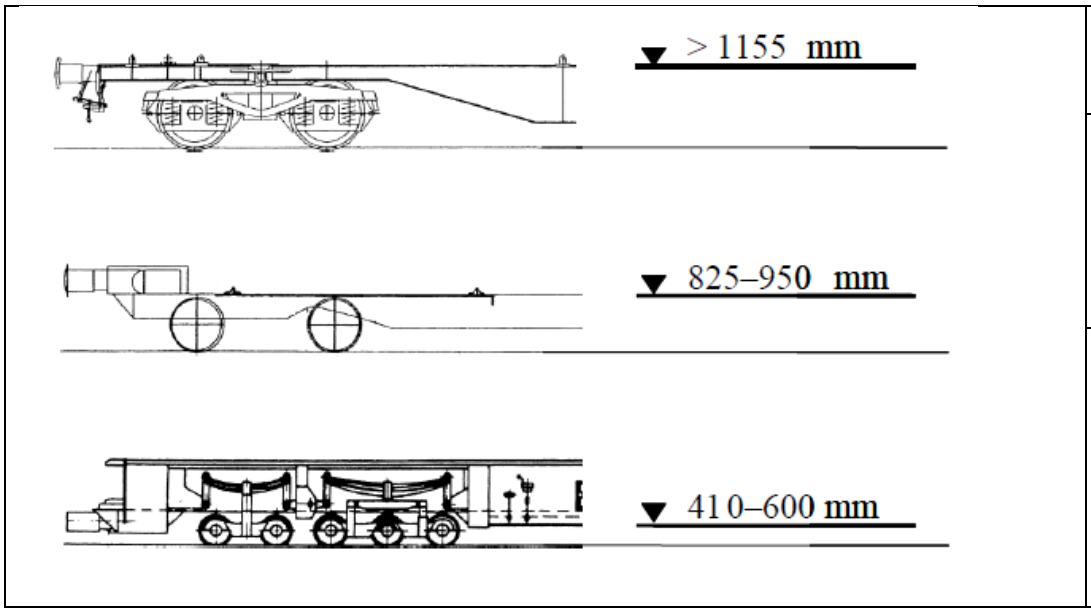


Illustration 46. Flat wagon floor height[24]

Floor heights of different existing wagon designs. As can be seen that a two-axle bogie design is possible down to a floor height of 800mm, while a lower floor height – as on existing RoLa wagons – requires considerably more complex (and expensive) running gears.

The wagon floor height is, as mentioned earlier, 800mm and kept over the whole loading length. The wheel diameter is 700 mm. Main characteristics of this wagon should be:

Denomination	TOFW – Trailer on Flat Wagon
Type of goods	Semi-trailers, containers, swap-bodies; with superstructures: light-density volume goods
Length over couplers	15,35 m
Loading length	14,7 m
Distance between bogie centers	11,0 m
Floor height	800 mm
Tare weight	17 t (17,7 t with standard coupler end beam)
Minimum curve radius	150 m in train formation, 75 m as single wagon
Max. axle-load	15,5 t (at 120 km/h)
Maximum load-weight	44,5 t (43,8 t with standard coupler end beam)

Table 9. Main characteristics of semi-low floor wagon (Source FERRMED)

[24] FERRMED_WagonStudy_FINAL_May_2010

WP 2: Preliminary analysis

WP 2.1 - Preliminary Market Analysis

This chapter aims to provide preliminary Market Analysis and feasibility of intermodal / piggyback services including commercial potential within the region and beyond.

Analysis of existing data sources:

It shall be pointed-out first that the available source of information are not focusing only on **road transport units on the back of railway rolling stock** solutions (as limited by the ToR) but on Combined Transport in general including also Loading Unit (containers and swap-bodies).

It is also observed from the literature sources that different units are considered for the traffic assessment:

- Volume of TEU (20-foot container equivalent unit);
- Volume in tons (even expressed in Ton-km);
- Number of vehicles;
- Number of transshipments;

Which can lead to different and confusing figures. Nevertheless, data collection has been made possible using as relevant source EU publication and previous studies.

- **"Gathering Additional Data on EU Combined Transport", Final Report, European Commission (2018) [ISBN 978-92-79-76992-4].**

This study presents a detailed analysis of combined transport (CT) operations in the European Union (EU) and provides quantitative and qualitative evidence of the current status of the European CT sector in year 2018. Only few information is available and interesting for the preliminary Market analysis. It gives nevertheless some indications but not focusing only on CT but in general including also container and swap bodies.

Rail-road operators by Countries:

An interested fact is the number of rail-Road operators by Countries.

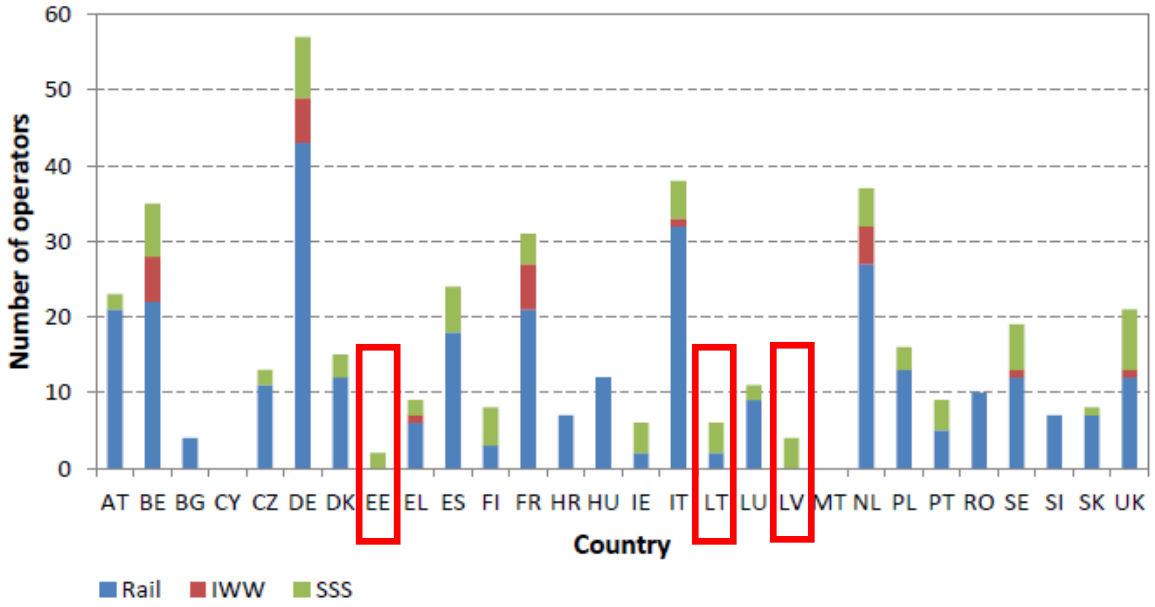


Illustration 47. Rail-Road operators by Countries

Note: IWW = Inland Water Way – SSS = Short Sea Shipping

Baltic countries are in the lowest range of rail-road number in the EU. Latvia does not have yet any rail-road operator.

It can therefore be assessed that the practices of rail-road transshipments in Baltic Countries is at this stage only "Embryonic".

Cost of transshipment:

It should be remembered that transshipments cost in the following figures are not limited trucks and semi-trailers but CT in general, so including also containers and Swap-bodies.

Indicator	Rail/road
Average number of transhipments per one transport operation	2.2
Average transhipment cost (€)	51
Range of cost per transhipment (€)	(18-200)
Estimated annual number of transhipments (million)	17.72

Table 10. Cost of transshipment (Rail-road) in the EU

In a more detailed way for each Baltic Countries:

EE-Estonia	Number of transhipments in MS (1000 TS/year)	12
	Number of transhipments by shippers of MS (1000 TS/year)	6
	Average Cost (Euro/TS)	18
	Cost range (Euro/TS, min-max)	18
LT-Lithuania	Number of transhipments in MS (1000 TS/year)	22
	Number of transhipments by shippers of MS (1000 TS/year)	19
	Average Cost (Euro/TS)	18
	Cost range (Euro/TS, min-max)	18
LV-Latvia	Number of transhipments in MS (1000 TS/year)	24
	Number of transhipments by shippers of MS (1000 TS/year)	21
	Average Cost (Euro/TS)	18
	Cost range (Euro/TS, min-max)	18

Table 11. **Rail-road Transshipment in Baltic countries (Rail-road)**

Average price is low compared to EU average price (51€) and quite similar in all Baltic Countries. The number of rail-road transshipments, between 12 to 24 thousand per year are the lowest observed in EU. For information it can be easily ten times more for some Countries and reaching more than 5 million for Germany.

Intermodality can only be competitive if the costs of all modes of transport reflect the totality of resources used when operating them – including the charging for the use of state-owned transport infrastructure and the external costs related to their operations.

The price of transport is most easily influenced through the applied charging schemes, tax and toll levels – all of which are outputs of political decisions.

Accordingly, the mix of charges, tolls and taxes levied on the four modes of land transport in the European Union shows a one-sided picture: while public subsidies to trucks by road amount to 5 cents per ton-km, trains receive only 3.5 cents.

The 1.5 cent 'advantage' enjoyed by road haulage over its modal competition translates to an annual subsidy of €30 billion (=2 000 billion t-km x €0.015). Expressed in truck kilometre prices this amounts **up to a 40 cent / vehicle km advantage,** which can be as much as 40% of the price. This explains the overuse of trucks in European logistics chains, while also reflects the lagging profitability of non-road modes of goods transport.

Member States were in the process last year of revising their track access charge regimes in reflection of EU law adopted in 2012. This has meant that in some countries, like Sweden or The Netherlands, the previously applied charging principles will have to be adjusted, resulting in continuous track access charge increases over the coming years. Other Member States are planning to introduce 'market segmentation' when determining mark-ups that may affect freight operators. Since track access charges are a significant portion of the fee payable for rail freight traction, the overall costs of rail freight are bound to increase in several Member States.

Break even distance of combined transport:

Regarding the cost of organizing a new CT services in the EU:

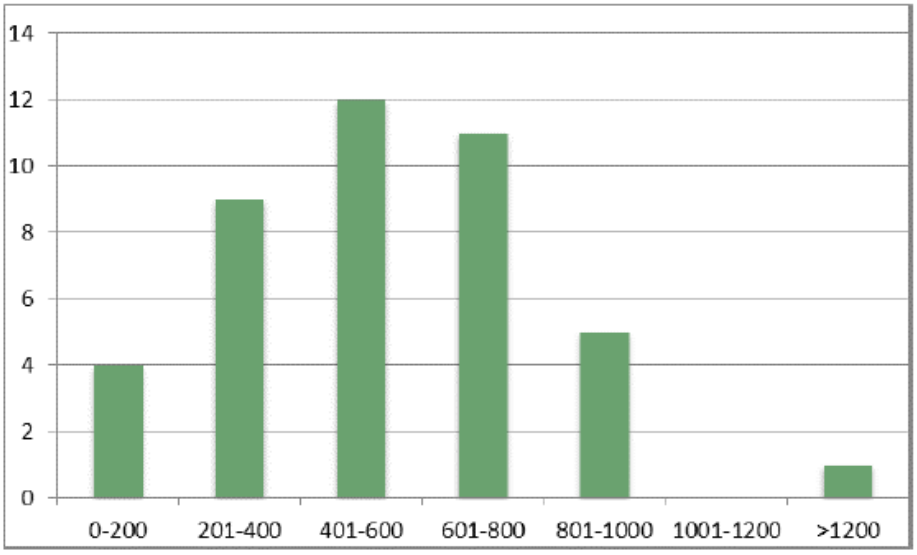


Illustration 48. Break-even distance of CT transport in the EU (Without subsidies from Public sector)

In the EU, the highest break-even distance (without any Public sector subsidies) is between 200 to 800 km (average 595 km). If the total length of 870 km[25], RB is considered, it is not included in the most attractive break-even distances but for intermediate or shorter CT trips with Poland, Muuga – Elk, Salaspils – Elk, Vaidotai – Elk and Palemonas – Elk, etc., could be considered and classified in the highest range of break-even distances.

It is pointed out that in this study that it is estimated that the effect of the public sector support reduces the average break-even distance by 70 - 90 km or about 13-14% of the break-even distance without any support.

- **Analysis of the EU combined transport document (2017)**

This study provides a comprehensive insight into the current economic and legal state of combined transport (CT) operations in the European Union (EU) including all CT sectors and combinations. It establishes an extensive statistical database on CT operations in the reference year 2011 and time series data for recent years. The study also displays the economics of the CT industry with respect to business models, cost structures and socio-economic

[25] 870km is not the only distance to be considered, it is the total length of RB infrastructure in the Baltics, including Kaunas – Vilnius branch.

benefits. The report further investigates trends and forces of change impacting on the evolution of CT sectors and delivers a forecast of CT volumes[26].

Main important information:

- Due to road congestion and the development of maritime containerised transport, intermodal transport has developed dramatically in the past decades, becoming the fastest growing freight transport segment in Europe. Volumes transported by rail-road combined transport have consistently increased since 2005, with the exception of 2009, market by the economic crisis. Total combined rail-road traffic in Europe is expected to increase further in the coming years;
- Based on the market analysis conducted by this study, it is estimated that around 50% of the total CT volume can be attributed to ISO containers and to "continental" types of load units, i.e. swap bodies, domestic containers, semi-trailers, trailers and lorries;
- Regarding the share of sea-port of CT and how it is handled hinterland no reliable figures are available regarding modal split share and hinterland distance. However, it is assumed that the average share of rail is relatively low, below 10%;
- Accompanied CT volumes are recorded by the number of road vehicles carried. A conversion factor of 2.33 TEU per lorry has been calculated from an analysis of traffic volumes of several service providers;
- In the EU, new prospects exist for catching a larger share of the EU semi-trailer market for CT operations on three main trans-European corridors. These measures seek to boost the unaccompanied transportation of craneable and non-craneable) semi-trailers on the respective corridors. Altogether, the rail infrastructure investments are expected to stimulate CT rail/road services.

CT sector	Likeli-hood	Direction and magnitude of impact						
		Negative impact			0	Positive impact		
		-3	-2	-1		+1	+2	+3
Rail/road	High							X
Inland waterway/road	High					X		
Short sea/road	High					X	X	

Table 12. Infrastructure development, impact on CT

- **Analysis of report on combined transport in Europe (2018) UIRR and UIRR European Road-rail combined transport 2018-2019**

Freight / modal share:

[26] https://publications.europa.eu/en/publication-detail/-/publication/675724ad-969f-11e7-b92d-01aa75ed71a1

In general, since 2005, intermodal transport is regularly growing despite that in general, freight volumes are stable or going down.

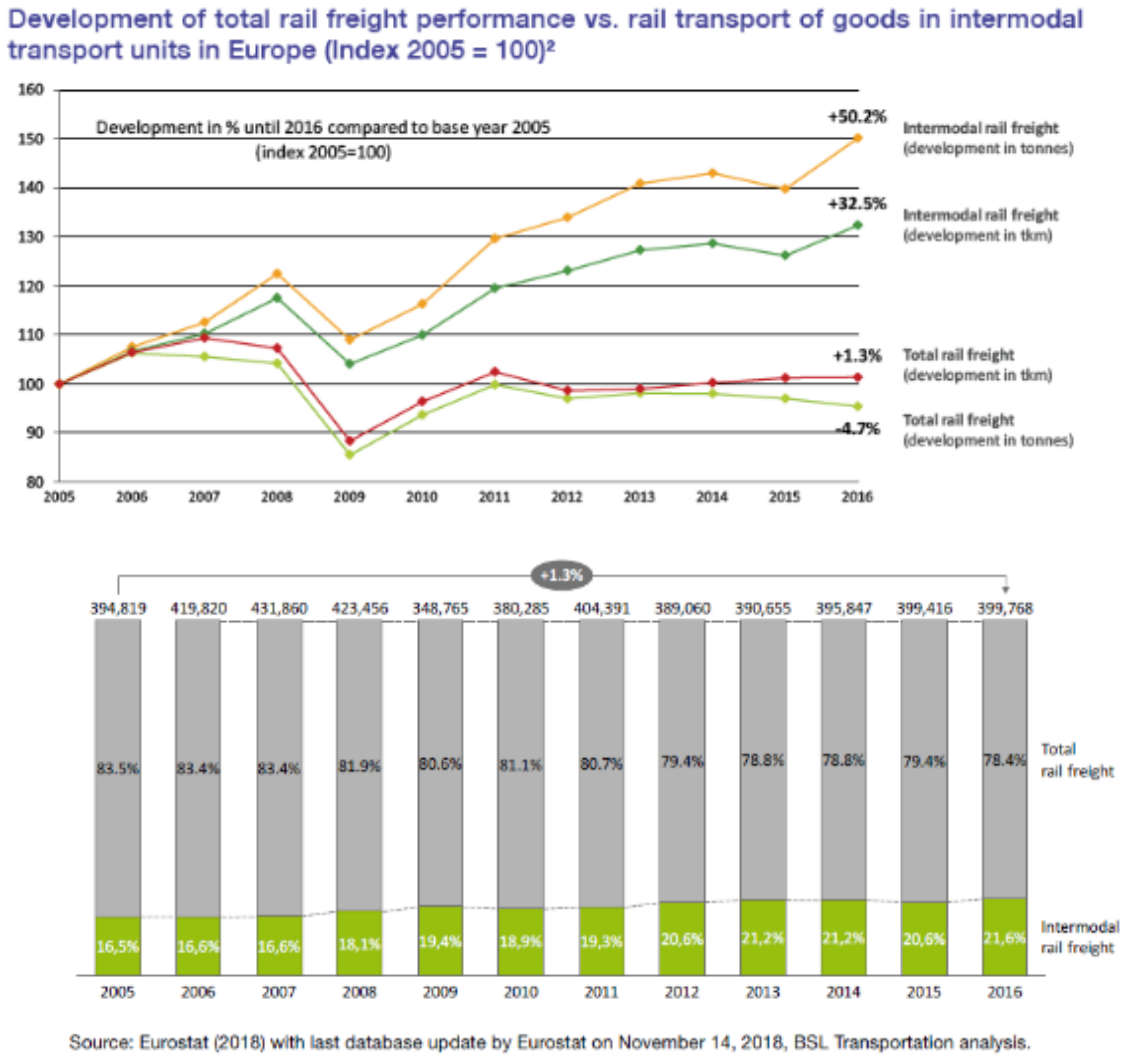


Illustration 49. Railway freight and intermodal transport (year 2018, source Eurostat) 27,

[27] https://uic.org/IMG/pdf/2018_report_on_combined_transport_in_europe.pdf

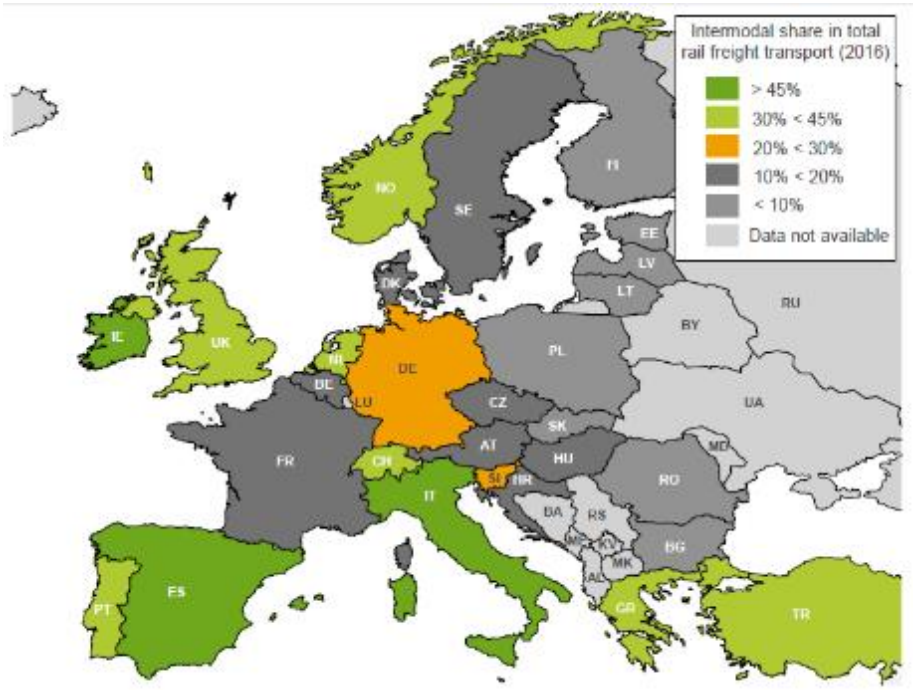
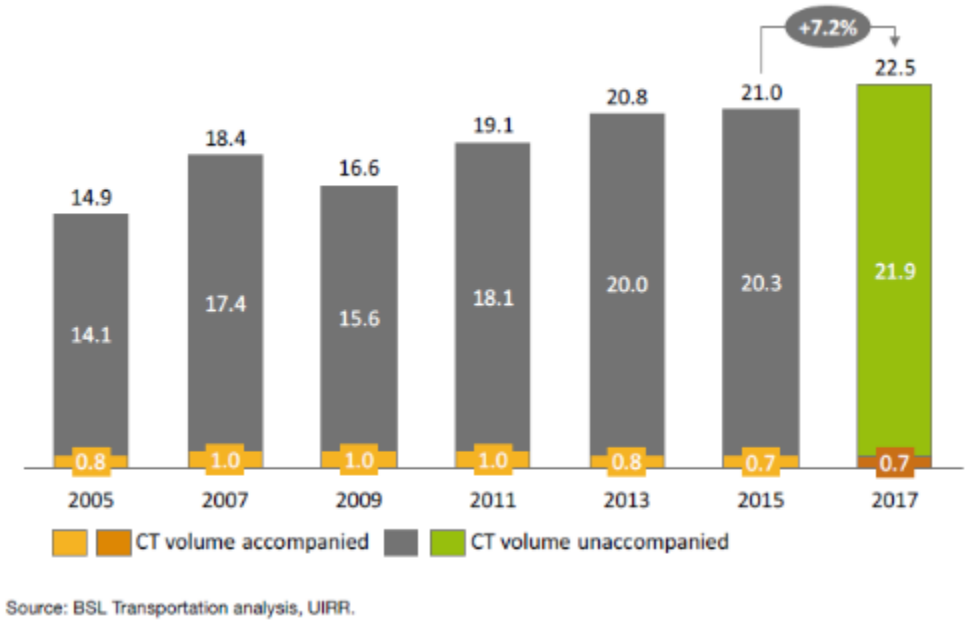


Illustration 50. Intermodal share rail freight transport (year 2018, source Eurostat) 28,

The share of intermodal rail freight transport is variable. Some Countries as Spain, Italia, Ireland are far above some other countries as France, Sweden. Baltic Countries are in the lowest intermodal share.

In general CT volumes (in TEU or equivalent TEU) are increasing. That encompasses unaccompanied CT (container, swap-bodies, semi-trailers) and accompanied CT (tractor unit + semi-trailer and lorries).

[28] https://uic.org/IMG/pdf/2018_report_on_combined_transport_in_europe.pdf



Source: BSL Transportation analysis, UIRR.

Illustration 51. CT volumes year 2005 – 2017

The past year 2018 was concluded with a decisive +4.97% growth in terms of number of consignments forwarded by UIRR member Combined Transport Operators. This growth, however, only reflected a +0.78% expansion in terms of tonne-kilometres as the average consignment covered a shorter distance by rail than a year before. This result comprises **robust development of unaccompanied Combined Transport** – domestic +4.3%, border-crossing +5.3% - coupled with a 7.4% **decline in the transport of complete trucks** also known as Rolling Motorway or Accompanied Combined Transport.

Accompanied CT (tractor unit + semi-trailer or semi-trailers):

Accompanied volumes have a very low share of about 3% compared to the total of CT volume which is including also containers and swap-bodies. It should be remembered that accompanied CT volumes are recorded by the number of road vehicles carried. A conversion factor of 2.33 TEU per lorry is usually considered from an analysis of traffic volumes of several service providers.

Accompanied CT (trucks) are "niche" market representing an equivalent of 0,67million TEU with a decline of 10% compared with year 2016. It gives the figure of about 288 000 trucks transported. It can be considered in addition 1,637 million of trucks handled by Eurotunnel (which is not considered by the EU as CT, considering the short trip length).

In terms of tons accompanied CT are about to 11,5 million in year 2017.

Source: BSL Transportation analysis, UIRR.

Development of total CT volumes 2005 to 2017 [in million tonnes]

Segment	2005	2007	2009	2011	2013	2015	2017
CT volume unaccompanied	145.5	181.5	164.6	191.8	203.0	218.0	241.8
CT volume accompanied	10.2	13.6	15.1	14.9	10.8	13.0	11.5
Total	**155.7**	**195.1**	**179.7**	**206.7**	**213.8**	**231.0**	**253.4**

Source: BSL Transportation analysis, UIRR.

Table 13. **Intermodal share rail freight transport29**

Trade relations and volumes of accompanied CT in 2017 [based on number of shipments/ trucks]

Source: BSL Transportation analysis, UIRR.

Illustration 52. Accompanied CT volumes (Shipment of trucks)[30]

Unaccompanied CT (limited to semi-trailers):

Some figures are also provided in general for unaccompanied CT but showing the share for semi-trailers. It is made a distinction between the domestic market (means internal to the same Country) and international market (crossing border).

[29] http://www.uirr.com/en/media-centre/annual-reports/annual-reports/mediacentre/1188-uirr-annual-report-2018-19.html
[30] http://www.uirr.com/en/media-centre/annual-reports/annual-reports/mediacentre/1188-uirr-annual-report-2018-19.html

Figure 12: Development of domestic and international unaccompanied CT 2005 to 2017 [in million tonnes]

Source: BSL Transportation analysis, UIRR.

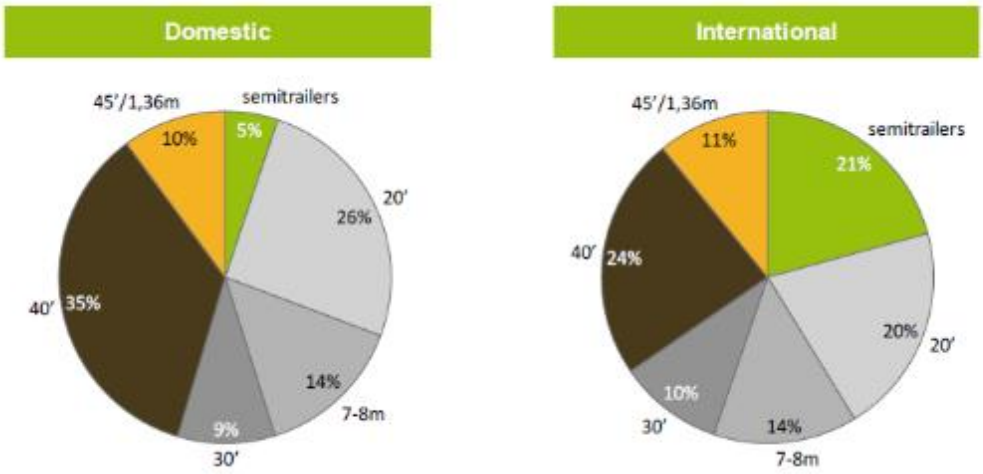


Illustration 53. Domestic and International accompanied CT units (million tons)[31]

Note: Maritime means that the CT unit has for origin or destination a port, continental means from / to inland destinations. It is observed that the share of semi-trailers is more important in case of international traffic crossing border(s).

[31] http://www.uirr.com/en/media-centre/annual-reports/annual-reports/mediacentre/1188-uirr-annual-report-2018-19.html

Using the above figures, it can be identified the volume in tons transported by semi-trailers using rail-road transport in year 2017:

CT Class	Volume in million tons	% carried by semi-trailer	Volume carried by semi-trailers in million tons
Domestic	130,1	5,00%	6,505
International	111,7	21,00%	23,457
		Total year 2017:	29,962

Table 14. Semi-trailer volumes in tons (year 2017)

So, the share between accompanied trucks (tractor unit + semi-trailer or lorries) and unaccompanied semi-trailer is the following:

CT Class	Volume in million tons	%
Truck	11,50	27,97%
Semi-trailer	29,62	72,03%
Total	41,12	100%

Table 15. Share between trucks and semi-trailers volumes in tons (year 2017)

Unaccompanied semi-trailers have the highest share (72%) compared to accompanied trucks. These calculations are in line with other tables provided regarding number of consignments:

	Cross-border			Domestic			Total		
	2017	2018	2018/2017	2017	2018	2018/2017	2017	2018	2018/2017
Number of consignments	2,801,377	2,954,366	5.27%	1,284,079	1,339,265	4.30%	4,085,455	4,288,344	4.97%
containers	2,266,447	2,384,153	5.19%	1,055,726	1,117,836	5.88%	3,322,172	3,501,988	5.41%
(craneable) semi-trailers	372,826	410,952	10.23%	73,453	81,755	11.30%	446,279	492,707	10.40%
complete trucks (RoLa)	162,104	153,975	-5.01%	154,900	139,674	-9.83%	317,004	293,649	-7.37%
Average distance	1,062	1,020	-4.00%	413	406	-1.54%	871	841	-3.37%
Billion tkm	64.69	65.11	0.63%	10.50	10.67	1.70%	75.12	75.71	0.78%
Number of TEU	5,602,753	5,908,731	5.27%	2,568,157	2,678,529	4.30%	8,170,910	8,576,688	4.97%

Table 16. Number of consignments

COMBINED TRANSPORT	2012 [1]	2013 [2]	2014 [3]	2015 [3]	2016 [4]	2017 [5]	2018	% 18/17
Number of consignments	2,529,264	2,645,950	2,819,606	2,876,585	3,014,344	4,085,455	4,288,344	4.97%
swap bodies and container	2,067,488	2,134,004	2,302,831	2,348,762	2,409,070	3,322,172	3,501,988	5.41%
(craneable) semi-trailers	333,597	375,432	362,654	382,250	470,535	446,279	492,707	10.40%
complete trucks (RoLa)	128,179*	136,514	154,121	145,573	134,739	317,004	293,649	-7.37%
Total billion tkm	39.08	40.74	52.17	54.98	58.32	75.12	75.71	0.78%
< 300 km	3%	2%	2%	1%	1%	1%	2%	↑
300 km - 600 km	12%	21%	17%	14%	12%	11%	13%	↑
600 km - 900 km	47%	39%	36%	36%	34%	31%	32%	↑
> 900 km	38%	38%	45%	49%	53%	57%	54%	↓

Table 17. **Number of consignments and length of trips**

Price factor analysis

The price of transport is most easily influenced through the applied charging schemes, tax and toll levels – all of which are outputs of political decisions. Economists have been studying the effect of these decisions on transport modes and markets for several decades now, providing feedback to help the political decision-making process.

Typical prices:

Beförderungspreis Richtung Brenner – Wörgl: (gültig ab 01.01.2019, bis auf Widerruf, längstens jedoch bis 31.12.2019, vorbehaltlich gleicher Tarif- u. Wettbewerbslage)

Einzelpreis je Richtung / Fahrt inklusive 1 bis 2 Fahrer	LKW ≤ 20.000 kg € 100,–	LKW ≤ 30.000 kg € 110,–	LKW ≤ 40.500 kg € 136,–	LKW ≤ 42.000kg € 192,–	LKW ≤ 44.000kg € 226,–

Zug	Annahmeschluss	Bereitstellung	Verkehrstage	Stornofrist
52330	00.25 Uhr	03.00 Uhr	Mo - Sa	14.00 Uhr Vortag

Table 18. **Typical price (HUPAC)**

For a trip of 92km, 2h 30mn.

National legislation:

Volume of rail-road traffic observed and prices are mainly influenced by Public sector which can contributes with incentive to either increase the price of road transport, to impose strict rules of circulation, load, taxes.

The national legislation in most Member States of the European Union provides for restrictions on road transport, which plays a significant role.

Typical example, Austria:

in 1999, 217.500 complete trucks had crossed the Austria by the RoLa. The figures later showed an evolution in five phases: rapid growth (+ 75%) from 1999 to 2002, **a steep fall until 2005 (-58%),** growth from 2005 to 2010 (+ 181%), again a fall until 2012 (-38%) and a phase of stagnation since then. This evolution "sawtooth" can be explained largely by measures of policy transport (limitation of transit through Austria until 2003 by the transit contract ("ecopoints"), the introduction of a new toll system Electronics in 2004 and the sectoral ban on circulation between 2008 and 2011).

Some example of restrictions in EU countries:

- AUSTRIA Prohibited traffic of freight vehicles with a trailer, if the gross weight of the vehicle or the trailer exceeds 3.5 tons, also freight vehicles and trucks with semi-trailers of gross weight exceeding 7.5 tons: • on Saturdays from 3:00 p.m. to 12 midnight • on Sundays and public holidays – from 12 midnight to 10:00 p.m. In the period from June 1 to August 31, on Saturdays from 8:00 a.m. to 3:00 p.m. – prohibition of transport on the routes busiest on week-end for vehicles of gross weight exceeding 7.5 tons;
- ITALY Prohibitions for freight transport: from 08:00 a.m. to 10:00 p.m. on Sundays from January to April and from October to December • from 07:00 a.m. to 12:00 midnight on Sundays and national holidays from May to September;
- GERMANY Prohibition of traffic of freight transport on the entire network of roads from 12:00 midnight to 10:00 p.m. on Saturdays, Sundays and national holidays. There are some restrictions on transportation at night-time on selected sections of highways that are marked with specific road signs; Combined rail/road transportation carries out transportation from a port to the closest railway loading point, or from a railway unloading point to the consignee at a distance not exceeding 200 km; Transportation of fresh milk, dairy products, fresh meat and its products, fresh and live fish and its products, fruit and vegetables; Unfilled road vehicles;
- SWITZERLAND Prohibition of traffic on the entire territory of the country on Sundays and national holidays from 12:00 midnight to 12:00 midnight At night-time the prohibition on traffic is imposed from 10:00 p.m. to 05:00 a.m.

WP 2.2 - Preliminary Systems and Methods Analysis

General

This chapters aims to define the main outlines regarding Rail-road system and method to be implemented for the development of rail-road services on RB. Despite that container and Swap-bodies are excluded from this study, all constraints, organization, parameters having currently a negative impact on EU CT shall be taken into account by RB to set up the most efficient solution.

Matrix of preliminary system and method analysis

The following matrix summarizes the preliminary system and method analysis:

Current weaknesses in the EU	RB preliminary system and method approach
Lack of operational service quality. The lack of performance and productivity are due to a combination of several factors (train operating companies often fail to deploy locomotives and/or drivers on time, poor infrastructure, the operational rules for the network and to train operations, etc.);	It is more than likely that RB, during the next stages of RB development will focus also on organizational, institutional and contractual aspects between the different Stakeholders (IM, RU, etc.). At this stage, it can only be recommended to have design criteria not limiting the efficiency of rail operators whatever they are for passengers of for freight transport, including Companies providing transshipment services. It is important that no steps are taken at this stage which will result in long-term dependency on any single solution or supplier, or which require significantly higher capital costs or larger terminal areas.
Interoperability deficits of rail infrastructure. The constraints especially refer to train weight, axle weight, train length, and loading gauge. A further barrier is the patchwork of energy and signaling systems in the EU requiring a change of locomotives at borders;	Main purpose of RB is to be "interoperable" with EU railway networks using the same track gauge, signaling system. Design Guidelines has been developed on the basis of TSI and EN Standards.
Insufficient train path capacity for CT trains. The prioritization of passenger services reduces the available train path capacity for CT services and generally penalizes them in terms of scheduling and reliability	Same comments as for the lack of operation service quality.
Non-harmonized terms and conditions for rail access. The general terms and conditions of rail infrastructure managers are generally not	For the best outcomes, RB must have harmonized terms and conditions for rail access. Main recommendation is nevertheless is to consider in a wider view rail-access conditions with neighboring Countries as Poland.

Current weaknesses in the EU	RB preliminary system and method approach
harmonized, leading to service disruptions and extra costs for train and CT operators	
Lack of service level guarantees. The rail industry has largely failed to establish a system of effective service guarantees between infrastructure managers, railway undertakings and in turn with CT service providers	Same comments as for the lack of operation services
Costly last mile. Disproportionately high last-mile costs arise if terminals are located off the main line.	Location of Rail-road terminal should be identified not only from the railway side view but taking into account main road corridors, port accesses, etc. It can also be considered that the multiplication of actors leads also to an increase of costs in general (Railway operators, transshipment service Company, road operators in particular for unaccompanied semi-trailers).
Constraints on loading gauges. In addition to other infrastructure-related bottlenecks, limited loading gauges also constrain the market coverage for CT service providers. 4m high semi-trailers, the standard piece of equipment for Intra-Member States and Intra-EU freight traffic, cannot be carried on the larger part of national rail networks in southern and western Member State	As explain in WP1.2 the loading gauge currently GC one will allow 4m high vehicle using well proven existing solutions (RoLa, UCT, etc). The Swedish SEc gauge could also allow either the increase of vehicle size to 4,5m (using existing solutions) or allow the transport of 4m high vehicles with simplified RoLa solution, improve options, such as increasing the vehicle size, specific high volume wagons, over-gauge good transports, etc.
Insufficient ICT capabilities. The CT rail/road sector in the EU lacks an "open data" ICT platform for exchanging booking, operational and tracking and tracing data between relevant companies involved in the CT supply chain. "Open data" means that the system has standardized interfaces and is not determined or controlled by a single actor	It could be considered that it is a general problem outside from RB field of influence but for the processes to be efficient systems should be set-up not only from the RB perspective but in keeping with general requirements from operators, customers and other stakeholders. This is best done during project delivery to ensure smooth transition with

Current weaknesses in the EU	RB preliminary system and method approach
	operational capabilities demonstrated to maximize opportunities and to attract potential customers. While many issues are rolling stock specific, there are enough common requirements to enable these to be taken into account (for example, train/vehicle tracking, consist, connectivity for condition monitoring, etc.).
Lack of open-access terminals. Market entry barriers are high in some countries as state-of-the art and/or open access terminals are missing.	The key factors in successful terminal operation are the functional layout of the facility with its tracks, cranes, road and parking lanes, together with efficient procedures supported by IT Rail-road terminals, size, features are strongly dependent with the solution implemented (Ro-Ro or Lo-Lo). It has a global impact on the land required, investments, market segment (accompanied or unaccompanied). Terminals are generally own and built by railway operators (or RU) specialized in intermodal Transport owning also the Wagon fleet and even locomotives. It is observed in some cases that the same terminal, despite to be owned by only one management company, this company can rent services for handling, storage to different railway operators. One of the main issues to be solved by RB is therefore to solve the issue to prepare attractive conditions for terminal location for CT operators not using the same technical solutions and not having the same requirements in terms of land required, size.

Table 19. **Matrix of preliminary system and method analysis**

WP 2.3 - Preliminary identification of potential "value added services"

Combined transport chain added value

Typical combined transport chain shall be considered in order to identify the possible "value added services". From the point of view of "railway segments" the following figure shows the principle

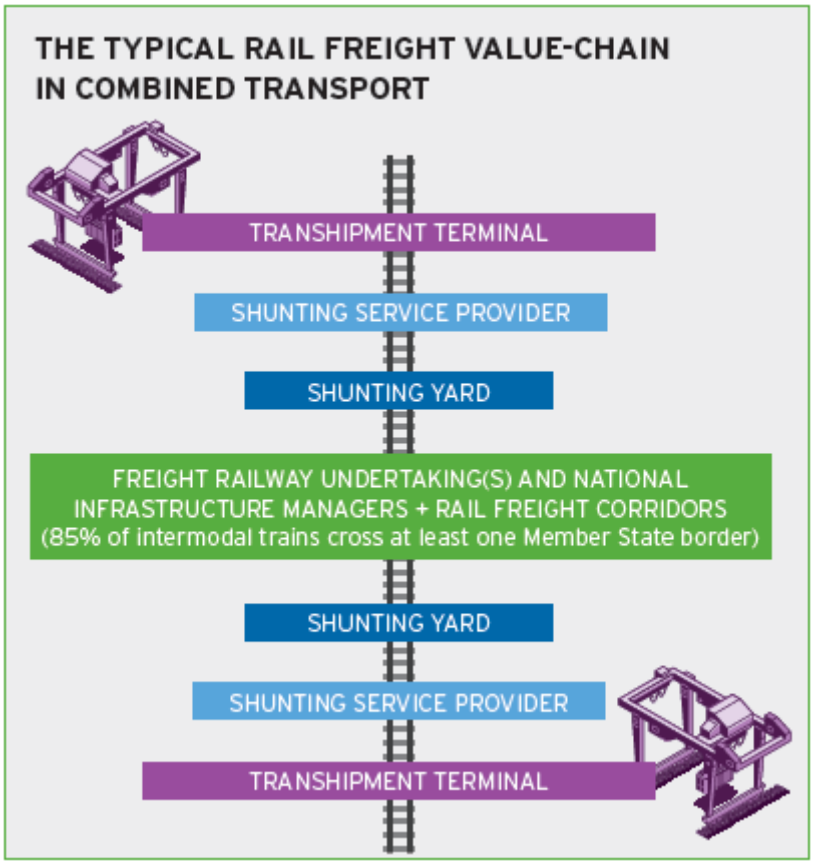


Illustration 54. Typical combined transport chain (source UIRR report European Road-rail combined services 2018-2019) - Unaccompanied combined transport services

So, several stakeholders are involved in the transport chain "door to door" and it can be enlarged also to road segments:

Transport chain	Stakeholders
Loading / unloading	At Client facilities, logistic centers or port by Companies in charge of loading unloading
Road transport	Road freight forwarder using trucks. In some case the first road segment for combined transport can be very

Transport chain	Stakeholders
	limited if, for instance, the truck or semi-trailer is delivered directly from the boat to train
Lo-Lo transshipment or Ro-Ro activities	In transshipment terminal or Ro-Ro terminals. Private operators in charge of Lift-On-Lift-Off, Roll-on-Roll-Off activity management
Shunting train in marshalling yards	In IM shunting yard. Usually managed by the infrastructure manager. Freight operator, in charge of shunting activities on behalf of the transshipment terminal operator
Rail section	Freight railway undertaking. It can be either the same company as the one in charge of transshipment terminal but also a freight operator providing rolling stock and assuming train driving.
Reverse transport chain segments described above (Shunting, Lo-Lo or Ro-Ro, road, etc.)	

Table 20. **Combined transport chain**

Multiple actors in the same chain can of course lead to cost increases, but multiple options, actors in competition can reduce costs for end customers and therefore increase attractiveness of modal shift.

A reduction or optimization of the number of actors is leading to a reduction of the transport costs in general with less complexity, and clear responsibilities.

Coherency and attractiveness of railway access charge added value

As stated before in this report, since track access charges are a significant portion of the fee payable for rail freight traction, when access charge will be set-up for RB, it is recommended to introduce "market segmentation" when determining mark-ups that will affect positively combined transport freight operators.

Market segmentation means that then path charge is not set-up only on the basis of 'freight train needing a path" but market oriented with a breakdown according to the category of trains (combined transport, container, oil, raw material, policy levers for encouraging modal shift.

Digitalisation added value

A proposal for an electronic freight transport document, promising to reduce the administrative burden of transport, has also been tabled by the European Commission. The European Commission's proposed new Regulation for Electronic Freight Transport Information (eFTI) is an initiative that has the potential to propel the entire European transport and logistics sector.

Main recommendation for RB is to be engaged in this global digitalisation process and in the implementation of this new regulation and to offer latest modern IT solution compatible with EU regulation. It is also important that intermodal solutions address integration with both maritime and air services but that is outside the scope of this Study.

Door-to-door added value

Logistic centers are concerned (origin or destination of the door-to-door transport chain). The current segmentation of the transport chain (with road services as the first and last segment of the chain) leads to have like a "break link" between the combined transport which is mainly considered starting from the transshipment (Ro-Ro or Lo-Lo).

Taking into account the "full door to door" transport chain and if at Origin or (and) at Destination goods are handled by logistic center(s), location of logistic centers shall also be considered to limit as possible the length of the road segment between logistic centers and transshipment yards.

Same conclusion can also be expressed for ports.

WP 3: Recommendations for Rail Baltica

WP 3.1 - Analysis of potential market size

This chapter aims to provide tentative forecast of potential market size and opportunities for modal shift 2025-2035, and 2035+.

Input data sources

The methodology for data gathering has been to collate information from published sources at EU and Member State level, including Eurostat, national statistical agencies and ports, along with in-house and third-party research reports and data. At European level only few sources of information regarding potential market size and modal shift are available:

- Analysis of the EU Combined transport report[32]. This report provides a comprehensive insight into the current economic and legal state of combined transport (CT) operations in the European Union (EU) including all CT sectors and combinations. The reference year for statistical data is 2011 but this report includes also forecast of CT rail/road by 2020 & 2030 against year 2011 and a relevant methodological approach by CT transport market segmentation.
- Port statistics[33] to identify mainly the current capacity in terms of rail-port shipment integration.
- "2018 Report on Combined Transport in Europe"[34], UIC (prepared by BSL Transportation Consultants).
- Eurostat statistics. Eurostat statistics are well recognized official source of data. Despite of this, it shall be considered that they are mainly collected on voluntary basis from the different countries.
- UIRR report[35]. Created in 1970, the International Union for Road-Rail Combined Transport (UIRR) is the industry association for the sector of Combined Transport in Brussels. Its members are Combined Transport Operators and Combined Transport Terminals. UIRR actively promotes Combined Transport,

3232 https://ec.europa.eu/transport/sites/transport/files/themes/strategies/studies/doc/2015-01-freight-logistics-lot2-combined-transport.pdf

33 Port statistics (from port owner/operator materials retrieved Q4 2019)
34 https://uic.org/IMG/pdf/2018_report_on_combined_transport_in_europe.pdf
35 http://www.uirr.com/en/media-centre/annual-reports/annual-reports/mediacentre/1188-uirr-annual-report-2018-19.html

primarily towards European decision-makers and facilitates the enhancement of the sector, while also supporting the daily functioning of this ecologically and economically sustainable mode of long(er) distance freight transport. Nevertheless, it shall be considered that UIRR data are including only records of UIRR Members.

Market analysis coverage

As specified in the ToR, the Consultant focuses on the following forecasts including but not limited to

- North-South axis, including integration with short-sea shipping;
- 1520-1435mm rail;
- Short-sea shipping.

Combined Transport classification

As clarified in the ToR, for avoidance of doubt, for the purposes of this pre-feasibility study "Piggyback transportation" **is defined as transportation of road transport units on the back of railway rolling stock.** Therefore, piggyback transportation is a specific market segment of Continental CT.

In terms of industry definitions and understanding of the CT market, until recently this has tended to be split into two broad segments with distinct equipment and service characteristics, namely:

- **Maritime CT,** primarily related to movement of ISO-standard shipping containers between sea ports and inland terminals, for inter-continental shipments starting or finishing within Europe (e.g. to and from the Far East);
- **Continental CT,** primarily related to movement of CEN-standard European swap bodies between inland terminals in European countries.

Whilst these segments can be used as one way of describing the current CT market structure, further segmentation is necessary, not only to reflect the available sources of statistics, but also to provide a more transparent analysis of the CT market. It is therefore used the following segmentation within this study:

By CT modal combination, i.e.:

- Rail/road (CT RR);
- Inland waterway/road (CT IWR);
- Short sea/road (CT SSR).

➢ ***Piggyback transportation is limited to the modal combination Rail-road (CT RR)***

By geographic coverage, i.e.:

- Intra-MS: transport of goods exclusively within one MS (domestic);

- Intra-EU: transport of goods between two or more MS, which may include transit through a non-EU country (e.g. Netherlands to Italy via Switzerland);
- International: transport of goods between a MS and a non-EU country (e.g. from Slovakia to Ukraine) or between several MS and a third country (e.g. from Germany via Poland to Russia).

➢ *In the context of this study, geographic coverage of piggyback transportation includes all above segments.*

By type of service, i.e.:

- **Unaccompanied (UCT)** – where the CT load unit moves by rail, inland waterway or sea without being accompanied by the road vehicle driver and/or tractor unit (e.g. a shipping container carried on a railway wagon or barge);
- **Accompanied (ACT)** - where the CT load unit moves by rail, inland waterway or sea and is accompanied by the road vehicle driver and/or tractor unit (e.g. an entire articulated lorry carried on a Roll-on, Roll-off rail service).

➢ *Piggyback transportation includes UCT and ACT services.*

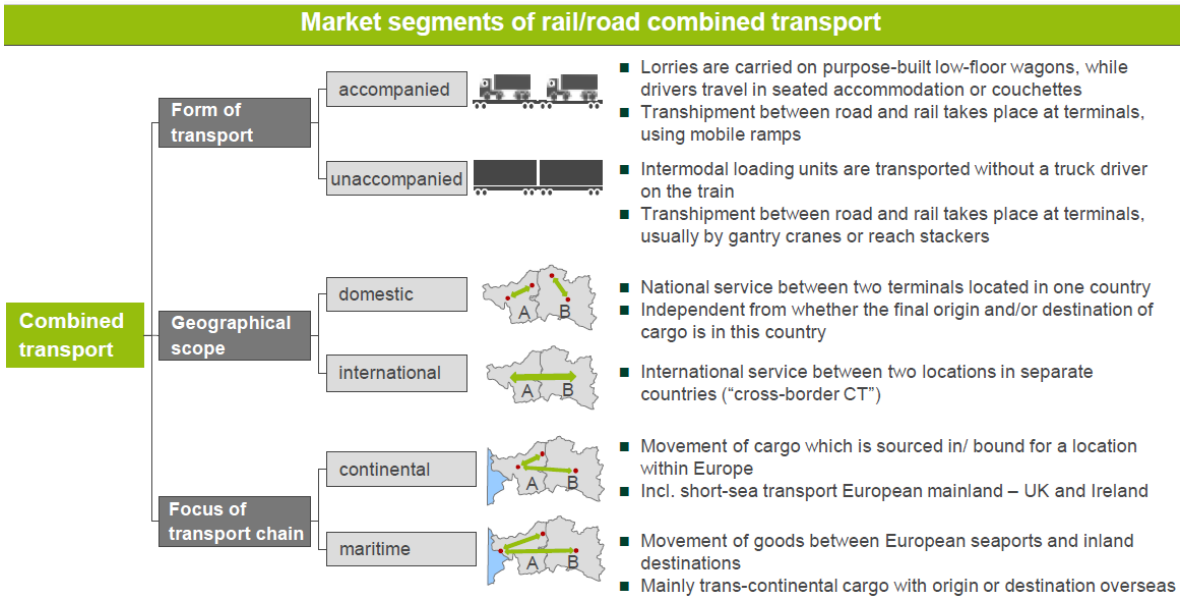


Illustration 55. Combined transport – Market classification (Source UIC report)

Standard units of available traffic statistics

It has been observed that CT volumes are in some cases expressed in terms of "lorry equivalent TEU" (Twenty-foot Equivalent Unit), a standard unit based on an ISO container of 20 feet length (6.10 m), used as a statistical measure of traffic flows or capacities. In these cases, a conversion factor either of 2.33 TEU or 2 TEU per semi-trailer or semi-

trailer with tractor is considered[36]. For the purpose of this study the value of 2 TEU equivalent has been considered by the Consultant.

It has been also observed that when data are expressed in tons (gross tons), it is generally considered by UIC and UIRR and average value of 11,5 tons per TEU for unaccompanied CT and 17,8 tons per TEU for accompanied CT. It gives the average values of 23 gross tons for a semi-trailer (2 TEU) and 35,6 gross tons for a semi-trailer with tractor (2 TEU).

It should be reminded also that, for combined transport, the weight of transported goods is measured as "gross-gross weight", i.e. including packaging *and* the tare weight (weight when empty) of the container or other ITU in which the goods are transported as the semi-trailer weight, tractor, etc.

Reliability of available data

During the analysis of the Consultant it has been observed significant discrepancies between Eurostat and UIC data.

In single cases, significant changes can be observed for the same country in the data, which make the volumes of previous years not fully comparable to the current figures. These variations are due to several reasons, mainly resulting from a revised methodology, changed approaches, and classifications of single market players' volume measurement. An overview of the most relevant explanations for these changes is provided in the following:

- Composition of CT services: In some cases, there has been only a slight variation of total CT volume, but a considerable change in its composition in domestic and international volume;
- New modi-operandi in the train system: For some rail connections, the modus operandi has been changed recently, e.g. routing all trains over a different route with impact on the statistics. This is the case for Belgium, where the re-opening of train services and a change in Antwerp port operations influenced rail and CT volumes;
- Methodology of data collection/ counting: furthermore, in Belgium, for example, a new national system was introduced regarding railway statistics with influence on the total CT volumes collected. As all trains leaving the country are now routed via Antwerp first (as domestic services), then heading further to their final destination abroad (as international services), there is a "double counting" of rail volumes, resulting in higher TEU and tonnage numbers;
- Data structure of single market participants: some companies introduced new or different controlling tools and methodologies, which lead to changes in the data structure on CT for these particular market players;
- Unaccompanied CT gathering piggyback semi-trailers, swap bodies and containers. No distinction done specifically for piggyback semi-trailers;

[36] Report "Analysis of combined transport" European Commission.

- Double counting of volumes especially in Eurostat data for international traffic counted twice in the origin country as well as in destination country;
- Data not systematically reported by countries (Eurostat);
- Double counting of volumes for trucks carrying containers but travelling by piggyback solution;
- UIC and UIRR data including only UIRR members (as example Eurotunnel excluded).

Conclusions: the general evolution trends and total aggregated by the Consultant can be considered to be correct but the analysis can only be achieved at macro level. Most of discrepancies are observed for unaccompanied transport in whole which are including also containers with a difference of about 30 % more in Eurostat data compared to UIC ones.

Previous study assessment - data assessment

In previous studies ("AECOM Rail Baltica" report, preparation of the Operational Plan of the railway prepared by ETCI) it is provided only few information and traffic forecasts regarding CT by piggyback solution.

- AECOM Rail Baltica: this study does not provide significant inputs regarding piggyback CT.
- Preparation of the operation Plan for the railway (ETC) Freight services for trucks and lorry transport (FRT2), conclusions are briefly summarized thereafter:
    - *Accompanied CT: it is considered that for accompanied transport, Rail Baltic that given the current road utilization in the Baltic States and the absence of truck restrictions for road transport transfer of trucks on rail by piggyback solution for the Baltic States would require a significant policy change in line with the targets formulated in EU White Paper on Transport.*

      One theoretical scenario would be the takeover of a significant share from Baltic Sea RoPax ferries by introducing new rolling motorway services by rail. These ferry services are running on long distances like Travemünde – Liepaja or Kiel – Klaipeda and are also utilised by a significant share of accompanied trucks. Typical size of a RoPax ferry will provide a loading length for trucks of 1,500 to 3,000 lm (loading metre), depending on the size of the vessel. This corresponds to approx. two to five intermodal trains depending on the allowed train length and size of the ship.

      The situation might change if FinEst link will be implemented providing a unique transport link with no road alternative. According to the results of the feasibility study truck and car shuttle services between Helsinki and Tallinn are foreseen. The feasibility study indicates that truck shuttles have a share of 70% of the total cargo tonnage to be transported through the tunnel. Loading and unloading of the shuttle trains on the Estonian side will take place in Tallinn area. According to the study the terminal site shall be situated at Soodevahe south east of Tallinn airport

- *Unaccompanied CT of semi-trailers: will have a significant share of intermodal freight transport and shall be facilitated to support modal shift to rail. In the Muuga freight terminal study the annual number of semi-trailers to be transhipped from and to Rail Baltica is estimated to grow from approx. 25,000 in 2025 to more than 100,000 in 2045. This corresponds to a share of approximately one third of total intermodal freight.*

Eurostat statistics - Analysis

Eurostat is the Statistical Office of the European Communities. Its mission is to provide the European Union with high-quality statistical information.

It has been observed that Eurostat statistics are far to be completed with "no data available" or with zero volume for a lot of countries. Therefore, this source of data has not been considered by the Consultant to be exhaustive despite being relevant. Only the global coherency with UIC and UIRR data has been checked.

General figures to be considered at European level:

General modal split (only year 2017 is available yet): the share of EU inland freight transported by road (76.7 %) was more than four times as high as the share transported by rail (17.3 %) in 2017. The remainder (6.0 %) of the freight transported in the EU was carried on inland waterways.

Rail played an important role for the inland freight transported in two Baltic Member States (in 2017, with shares of 66.7 % in Lithuania and 44.4 % in Estonia).

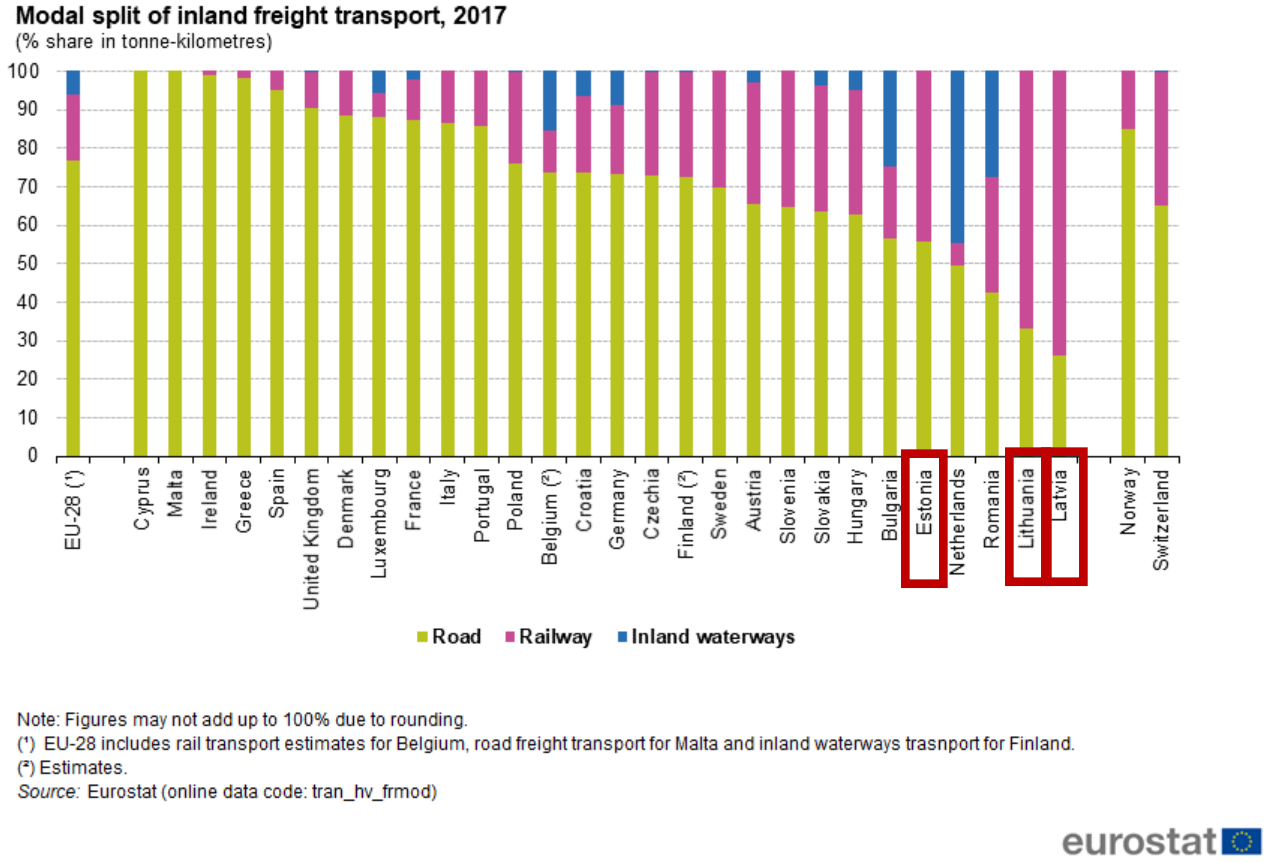
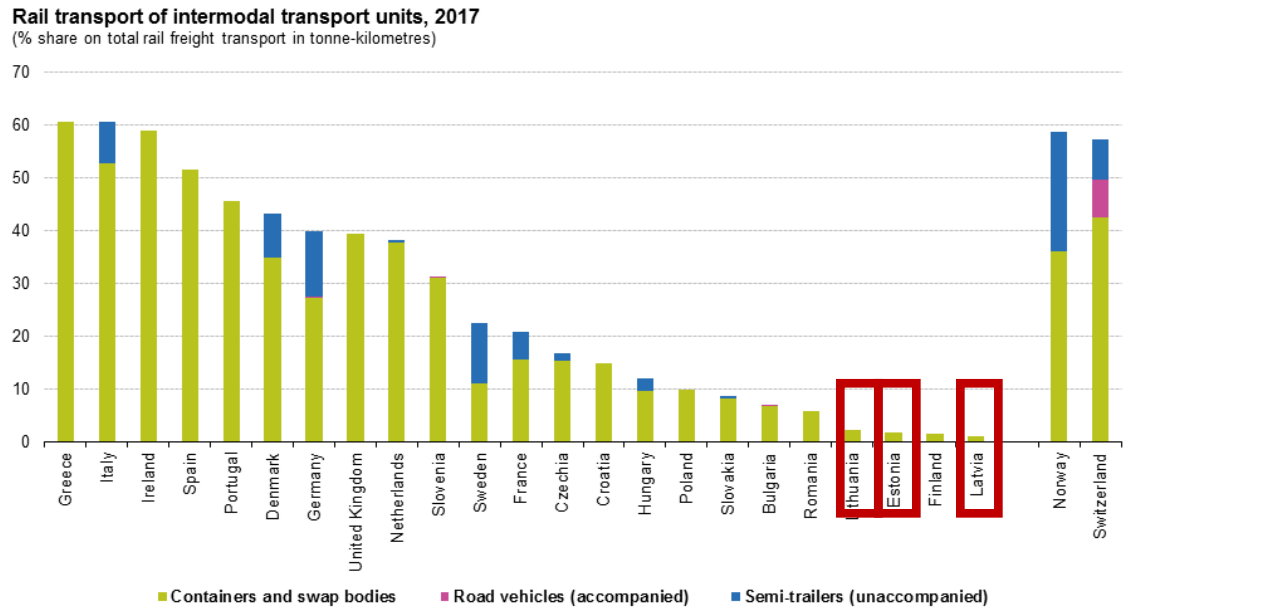


Illustration 56. Freight Modal share at European level, inland transportation (Source Eurostat)

Eurostat is also providing the following data regarding rail intermodal units in Europe and respective share.



Note: Based on gross-gross weight, including both the weight of packaging and the tare weight of the containers; Data for Belgium, Luxembourg and Austria are not available; Cyprus and Malta have no railways.

Source: Eurostat (online data code: tran_im_urail)

eurostat

Illustration 57. Eurostat data – year 2017 (tons km) – General figure (Source Eurostat)

The above figure shows that currently, for Baltic States, the railway percentage of share of intermodal transport unit is very low and mainly consists in containers and swap bodies. It should be noted that the very high rail share in inland freight in the Baltic states is mostly due to East-West bulk freight transit.

For information, in EU, compared to general freight volumes, railway and road, the following tables shows that the CT transport share for accompanied and unaccompanied is currently negligible:

Country	Railway freight	Accompanied CT (RoLa)	Unaccompanied CT (Semi-trailers)	% Accompanied CT on rail (RoLa)	% Unaccompanied on rail (semi-trailers)
Belgium	:	:	:	:	:
Bulgaria	14 226	11	0	0,08%	
Czechia	98 034	0	785		0,80%
Denmark	9 383	0	1 098		11,70%
Germany	363 512	3 183	23 316	0,88%	6,41%
Estonia	25 364	0	0		
Ireland	581	:	:	:	:
Greece	1 094	0	0		
Spain	26 504	0	0		
France	89 107	0	2 185		2,45%
Croatia	9 985	0	0		

Country	Railway freight	Accompanied CT (RoLa)	Unaccompanied CT (Semi-trailers)	% Accompanied CT on rail (RoLa)	% Unaccompanied on rail (semi-trailers)
Italy	92 949	:	9 960	:	10,72%
Cyprus	:	:	:	:	:
Latvia	47 819	0	0		
Lithuania	47 651	0	0		
Luxembourg	4 482	:	:	:	:
Hungary	50 047	0	1 362		2,72%
Malta	:	:	:	:	:
Netherlands	42 615	0	471		1,11%
Austria	102 835	:	:	:	:
Poland	222 523	12	103	0,01%	0,05%
Portugal	10 259	0	0		
Romania	52 618	0	0		
Slovenia	18 595	868	0	4,67%	
Slovakia	47 548	0	320		0,67%
Finland	36 162	0	0		
Sweden	67 479	0	4 010		5,94%
United Kingdom	78 549	0	0		
Norway	33 260	0	2 189		6,58%
Switzerland	67 846	3 559	3 380	5,25%	4,98%
Montenegro	1 395	0	0		
North Macedonia	1 358	0	0		
Turkey	24 546	0	0		
TOTAL	1 688 326	7 633	49 179	0,45%	2,91%

Table 21. **CT accompanied and unaccompanied – Share of railway transport (thousand tons) year 2017 (Source Eurostat);**

For railway, CT accompanied transport (RoLa) accounts on average for 0,45 % of the total freight volumes expressed in thousand tons. CT unaccompanied transport (Semi-trailers), accounts for 2,91 %. Maximum values observed are 5,25 % for accompanied CT (Switzerland) and 11,7 % for unaccompanied CT (Denmark).

Denmark should also be considered to be very specific because the traffic is mainly generated by the "beer train" from the Company Carlsberg.

The share of CT transport with road freight traffic is presented in the following table to provide a better overview of what are CT traffic representing currently in EU:

Country	Road freight	Accompanied CT (RoLa)	Unaccompanied CT (Semi-trailers)	% Accompanied CT	% Unaccompanied CT
Belgium	300 121	:	:	:	:
Bulgaria	151 479	11	0	0,01%	

Country	Road freight	Accompanied CT (RoLa)	Unaccompanied CT (Semi-trailers)	% Accompanied CT	% Unaccompanied CT
Czechia	459 433	0	785		0,17%
Denmark	179 062	0	1 098		0,61%
Germany	3 161 837	3 183	23 316	0,10%	0,74%
Estonia	28 969	0	0		
Ireland	146 543	:	:	:	:
Greece	388 898	0	0		
Spain	1 409 090	0	0		
France	1 714 292	0	2 185		0,13%
Croatia	72 343	0	0		
Italy	885 451	:	9 960	:	1,12%
Cyprus	25 595	:	:	:	:
Latvia	68 013	0	0		
Lithuania	76 980	0	0		
Luxembourg	56 594	:	:	:	:
Hungary	188 250	0	1 362		0,72%
Malta	:	:	:	:	:
Netherlands	666 069	0	471		0,07%
Austria	386 858	:	:	:	:
Poland	1 501 811	12	103		0,01%
Portugal	157 924	0	0		
Romania	226 345	0	0		
Slovenia	86 212	868	0	1,01%	
Slovakia	176 750	0	320		0,18%
Finland	280 744	0	0		
Sweden	455 480	0	4 010		0,88%
United Kingdom	1 417 482	0	0		
Norway	255 470	0	2 189		0,86%
Switzerland	291 346	3 559	3 380	1,22%	1,16%
Montenegro	:	0	0	:	:
North Macedonia	:	0	0	:	:
Turkey	:	0	0	:	:
TOTAL	15 215 441	7 633	49 179	0,05%	0,32%

Table 22. CT accompanied and unaccompanied (thousand tons) year 2017 (Source Eurostat)

For road transport, accompanied CT accounts only on average in EU for 0,05% and unaccompanied CT for 0,32 % of the road traffic.

Maximum values are 1,22 % for accompanied CT and 1,16 % for unaccompanied CT (both in Switzerland), in orange cells.

UIRR and UIC Data - Analysis

UIRR[37] and UIC[38] reports provide interesting and detailed data regarding CT combined transport. Both reports are showing similar data, figures and trends presented and commented thereafter. It is considered by the Consultant are the most reliable ones as the double checking / validation has already been performed by for previous studies and approved by UIC. In addition, interviews to local and private operators have been collected (UIRR report).

In UIC and UIRR reports, general figures are generally expressed in million TEU. It is observed that UIRR includes in unaccompanied CT, all traffics including swap bodies and container transportations and a specific care share has been taken to isolate and identify the piggyback part by the Consultant

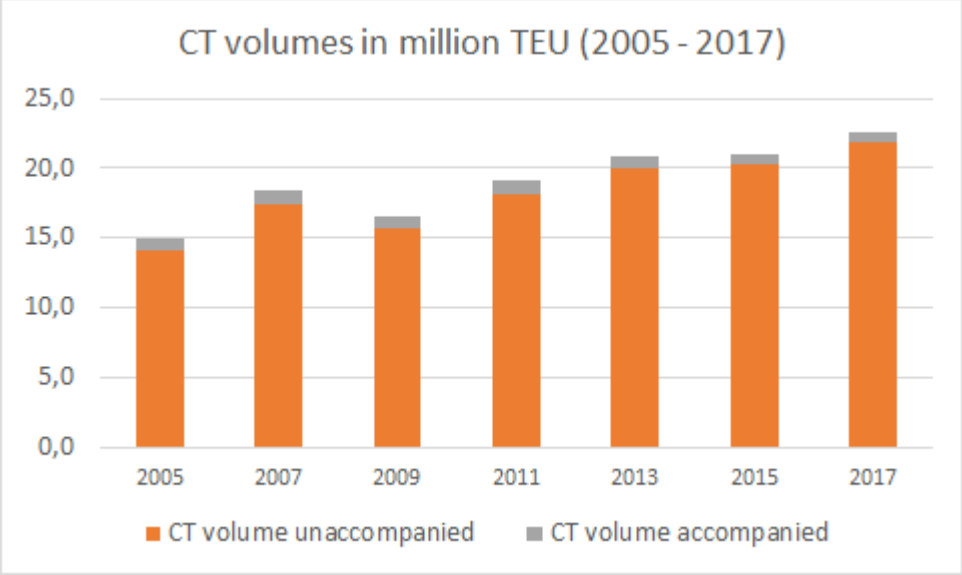
General share and evolution:

The UIC Growth Index shows that Combined Transport performance in total has increased by 52 % during the last 12 years mainly due from CT unaccompanied transports (4 % per year).

Whereas the unaccompanied transport market segment could witness increasing volumes, the trend in accompanied CT tonnage was slightly downward compared to 2005.

Segment	2005	2007	2009	2011	2013	2015	2017
CT volumes unaccompanied	14,1	17,4	15,6	18,1	20,0	20,3	21,9
CT volumes accompanied	0,8	1,0	1,0	1,0	0,8	0,7	0,7
TOTAL	14,9	18,4	16,6	19,1	20,8	21,0	22,6

Table 23. **CT transport – evolution- million TEU - years 2005 – 2017 (Source UIC)**



[37] http://www.uirr.com/en/media-centre/annual-reports/annual-reports/mediacentre/970-uirr-annual-report-2017-18.html
[38] https://uic.org/IMG/pdf/2018_report_on_combined_transport_in_europe.pdf

Illustration 58. CT market evolution (Source UIC report)

Accompanied CT:

Accompanied CT (RoLa) makes up the smaller share of the CT market, representing rather a niche market (3 % in the global CT transport including containers. Five companies are operated accompanied transport services in Europe with a focus on 3 major international trade relations across the Alps, RoLa solutions between:

- Germany and Italy;
- Austria and Slovenia;
- Austria and Italy.

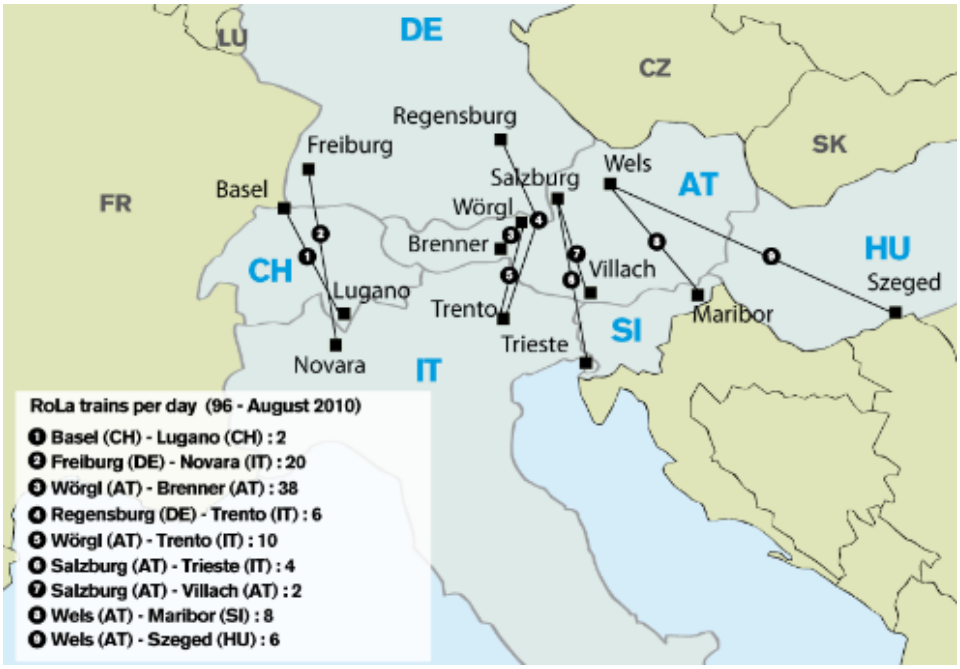


Illustration 59. RoLa solutions implemented in EU.

Additionally, a volume of 1,7 million trucks related to cross channel transport activities are reported in year 2018 between France and UK but are not considered in UIC and UIRR reports. More than likely, crossing the channel by train is more considered to be rather a “technical” solution than real combined transport according to the definition (road leg shall be shorter as possible) and also because Eurotunnel seems not to be Member of UIRR.

Main characteristics of the piggyback accompanied CT market segment according to industry are:

- CT modal combination: Rail/road (CT RR);
- Geographic area: Intra-EU;
- Type of services: accompanied (ACT).

It is observed that piggyback accompanied transport solutions are generally set-up to face "geographical constraints" as for example passing the Alps mountains or channel tunnel between France and UK. Domestic accompanied CT activities mainly focus on services in Austria and Switzerland.

The international market segment, in particular, lost volume in TEU compared to the years before, while the domestic market remained more or less stable. In year 2017, the share between international (border-crossing) and domestic accompanied CT transport is about 50 %.

Segment	TEU(*)			
	2013	2015	2017	Development (2015-2017)
Domestic CT	303 668	303 642	307 510	1%
International CT	498 883	438 591	347 348	-21%
TOTAL	802 551	742 233	654 858	-12%

Table 24. **Accompanied CT – evolution- in TEU- years 2013 – 2017 (Source UIC)**

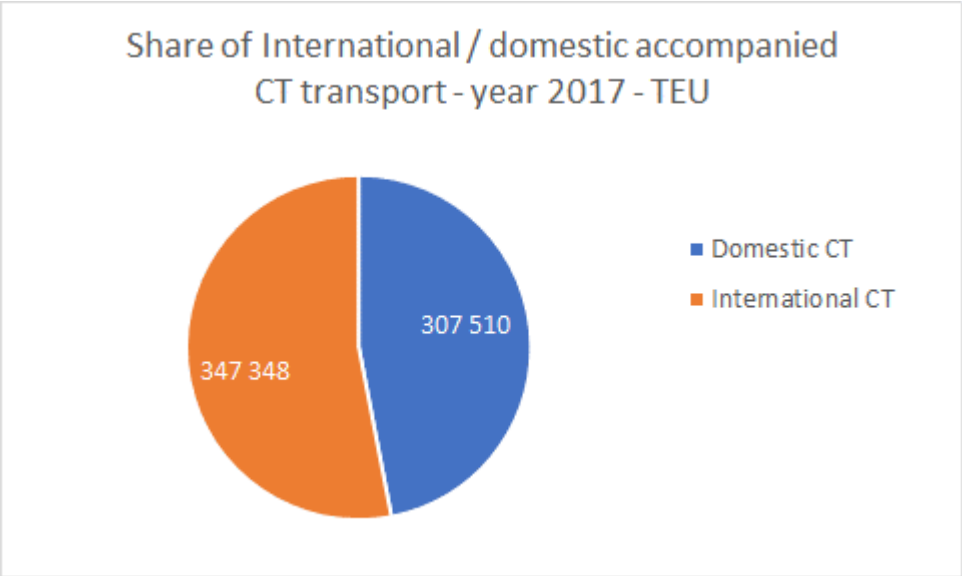


Illustration 60. Share of international / domestic accompanied CT transport - year 2017 – TEU (Source UIC).

Unaccompanied CT:

In general UIC figures are including containers in previous general figures, makes up the largest part of the total CT with a market share of more than 95%.

Nevertheless, in the context of this study dedicated to piggyback services, the semi-trailer part shall be isolated in UIC / UIRR data.

In view of the structure of loading units, domestic and international CT container 20- and 40-foot equivalent units are the most relevant types of loading units, representing about 61% in domestic and 44% in international CT. The percentage of semi-trailers carried is considerably larger in cross-border combined transport.

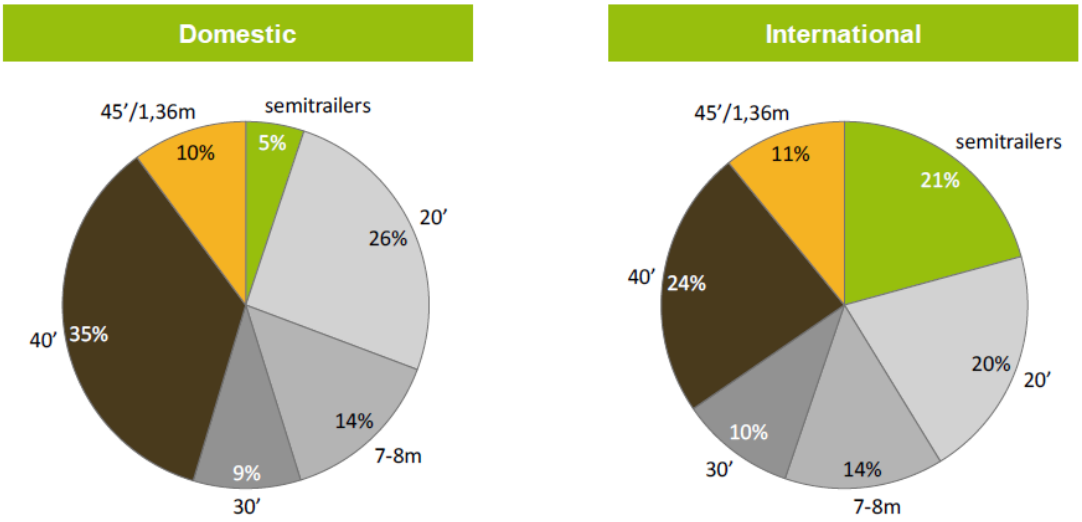


Illustration 61. Share of semi-trailers in unaccompanied CT (Source UIC)

Semi-trailers carried by piggyback trains represents only between 5 to 21 % of the total unaccompanied volumes expressed in TEU. For the year 2017, if the above share of piggyback service is considered, it shows the following expressed in TEU or semi-trailer units (*):

Segment	TEU including Swap bodies, containers and semi-trailers	% of semi-trailer	TEU Semi-trailer part	Semi-trailers units (*)	%
Domestic CT	12 056 516	5%	602 826	301 413	28,86%
International CT	7 074 697	21%	1 485 686	742 843	71,14%
TOTAL	19 131 213		2 088 512	1 044 256	100,00%

Table 25. **Semi-trailers volumes of unaccompanied CT (Source UIC)**

(*) 2 TEU = 1 semi-trailer

In average semi-trailer part including domestic and international CT segments represent about 11 % of the total CT market.

The percentage of semi-trailers carried is considerably larger in cross-border combined transport with more than 71 % of unaccompanied piggyback CT.

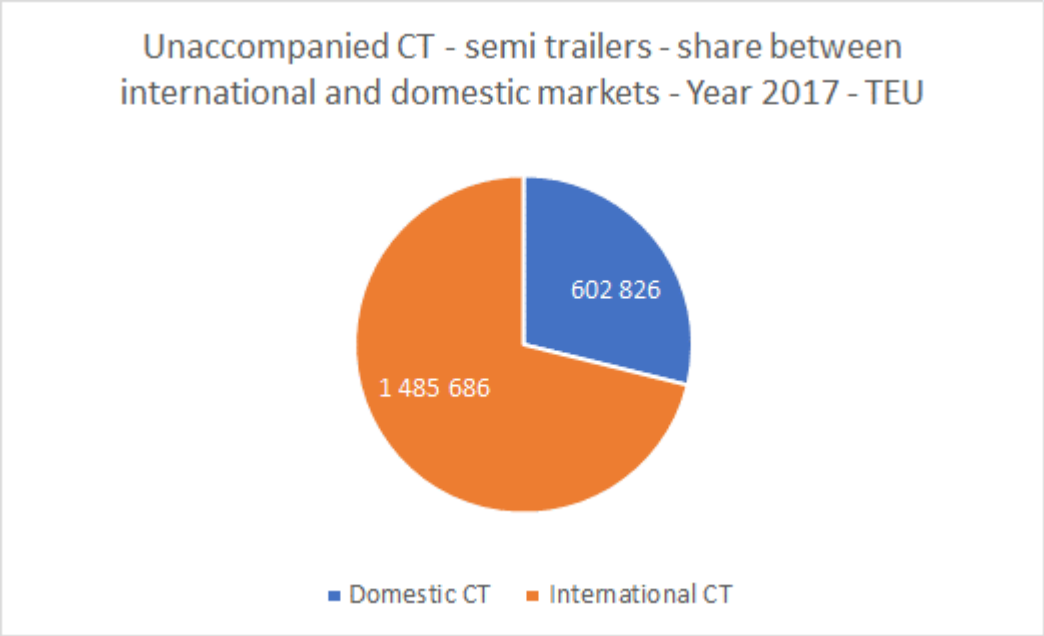


Illustration 62. Share of semi-trailers in unaccompanied CT – International and domestic part (Source UIC)

Details of domestic market for unaccompanied CT by Country and recent developments between years 2015-2017:

Unaccompanied CT domestic by country						
Country	TEU			Tons		
	2015	2017	development (2015-2017)	2015	2017	development (2015-2017)
Austria	400 993	455 234	13.5%	4 409 791	6 220 536	41.1%
Belgium	202 718	282 437	39.3%	1 273 904	2 668 353	>100%
Bosnia and Herzegovina	1 401	1 401	0.0%	14 015	14 015	0.0%
Bulgaria	32 834	5 224	-84.1%	330 059	52 501	-84.1%
Croatia	40 231	29 223	-27.4%	269 633	287 332	6.6%
Czech Republic	499 843	150 634	-69.9%	5 379 001	2 913 465	-45.8%
Denmark	287	12	-95.8%	2 837	182	-93.6%
Finland	10 717	10 717	0.0%	128 813	128 813	0.0%
France	663 419	710 053	7.0%	6 245 535	5 912 067	-5.3%
Germany	3 334 870	4 141 373	24.2%	35 629 640	41 377 684	16.1%
Greece	4 122	-		51 525	-	
Hungary	3 109	2 235	-28.1%	41 362	41 939	1.4%
Ireland	25 982	25 982	0.0%	311 790	311 790	0.0%
Italy	1 554 882	1 074 009	-30.9%	12 318 072	11 251 200	-8.7%

Unaccompanied CT domestic by country						
Country	TEU			Tons		
	2015	2017	development (2015-2017)	2015	2017	development (2015-2017)
Latvia	589	407	-30.9%	1 300	2 290	76.2%
Luxemburg	-	2		-	24	
Netherlands	326 639	325 420	-0.4%	3 958 563	3 326 335	-16.0%
Norway	322 815	339 672	5.2%	3 172 657	3 338 976	5.2%
Poland	719 079	1 001 615	39.3%	5 913 613	8 059 205	36.3%
Portugal	290 731	351 031	20.7%	2 896 420	3 648 915	26.0%
Romania	262 407	266 521	1.6%	3 163 094	3 154 527	-0.3%
Russia	32	1 024	>100%	136	8 032	>100%
Serbia	13 892	13 892	0.0%	138 922	138 922	0.0%
Slovakia	54 112	18 930	-65.0%	482 377	183 828	-61.9%
Slovenia	66 836	95 637	43.1%	508 756	1 028 293	>100%
Spain	503 697	492 502	-2.2%	5 194 814	4 752 335	-8.5%
Sweden	438 906	438 890	0.0%	4 635 490	4 635 338	0.0%
Switzerland	351 000	399 465	13.8%	4 430 744	4 340 684	-2.0%
United Kingdom	1 446 514	1 422 974	-1.6%	24 955 867	21 709 181	-13.0%

Table 26. Domestic market for unaccompanied CT by Country - in million TEU and tons- (Source UIC)

Only Latvia is recorded some negligible unaccompanied CT in UIC data with a significant positive trend for the 2 last years.

Details of major International European trade lanes for unaccompanied CT:

The segment of cross-border CT witnessed a considerable increase between 2015 and 2017. The major trade lanes concern the North-South connections, in particular to and from relevant seaports in the North Sea and Mediterranean. The following table includes also containers and swap bodies.

Trade lane between countries		TEU			Tons		
		2015	2017	develop-ment	2015	2017	develop-ment
Germany	Italy	1 488 080	1 553 328	4.4%	19 501 043	19 915 267	2.1%
Czech Republic	Germany	659 792	756 729	14.7%	6 000 182	7 649 439	27.5%
Belgium	Italy	580 173	714 694	23.2%	7 401 498	9 156 448	23.7%
Germany	Netherlands	667 378	581 379	-12.9%	6 215 813	6 686 219	7.6%
Italy	Netherlands	288 632	458 025	58.7%	3 394 024	6 118 486	80.3%

Trade lane between countries		TEU			Tons		
		2015	2017	develop-ment	2015	2017	develop-ment
Austria	Germany	268 860	358 729	33.4%	3 603 502	3 896 851	8.1%
Slovakia	Slovenia	258 921	319 922	23.6%	1 887 370	2 552 178	35.2%
Germany	Sweden	193 878	256 745	32.4%	2 067 542	2 813 600	36.1%
France	Italy	194 123	247 682	27.6%	2 371 238	3 259 281	37.5%
Hungary	Slovenia	179 215	217 777	21.5%	1 597 440	2 122 831	32.9%
Germany	Spain	174 381	214 299	22.9%	2 312 509	2 567 637	11.0%
Germany	Hungary	241 296	209 436	-13.2%	2 322 884	2 321 643	-0.1%
France	Luxemburg	178 766	205 037	14.7%	2 281 597	3 127 385	37.1%
Germany	Switzerland	148 188	168 742	13.9%	1 871 791	1 662 626	-11.2%
Germany	Poland	160 475	161 026	0.3%	1 274 739	1 284 398	0.8%
Belgium	France	131 878	152 626	15.7%	1 128 225	1 299 600	15.2%
Belgium	Spain	104 198	143 817	38.0%	1 432 094	1 891 514	32.1%
Austria	Italy	31 088	136 509	>100%	327 574	1 568 315	>100%
Czech Republic	Netherlands	80 865	116 105	43.6%	481 528	802 261	66.6%
Russia	Slovakia	58 984	102 090	73.1%	210 543	689 465	>100%

Table 27. **Major European trade lanes in international unaccompanied CT (in million TEU and tons)**

Baltic States are not identified in EU as being part of major international transport lanes for unaccompanied CT.

Summary of piggyback CT service modal share in EU:

The above figures are summarized for accompanied and unaccompanied CT services to provide specific overview of piggyback services excluding containers and swap bodies from UIC / UIRR statistics:

CT service	Accompanied CT (TEU)	Unaccompanied CT (TEU)	Total
Domestic CT	307 510	602 826	910 336
International CT	347 348	1 485 686	1 833 034
Total	654 858	2 088 512	2 743 370

Table 28. **Piggyback service, summary in TEU (Source UIC)**

CT service	Accompanied CT (TEU)	Unaccompanied CT (TEU)	Total
Domestic CT	11,21%	21,97%	33,18%
International CT	12,66%	54,16%	66,82%
Total	23,87%	76,13%	100,00%

Table 29. **Piggyback service, summary in % TEU (Source UIC)**

CT service	Accompanied CT (TEU)	Unaccompanied CT (tons*)	Total
Domestic CT	5 473 678	6 932 497	12 406 175
International CT	6 182 794	17 085 393	23 268 188
Total	11 656 472	24 017 890	35 674 362

Table 30. **Piggyback service, summary in tons (Source UIC)**

(*) average value of 11,5 tons per TEU for unaccompanied CT and 17,8 tons per TEU for accompanied CT are considered, following UIC rule. The above figures show a difference of about 30 % with Eurostat data (Please refer to chapter "reliability of data.

In EU, piggyback transport market volumes are mainly driven by:

- Unaccompanied CT transport (semi-trailers) with more than 76 % share;
- International cross-border transport with more than 66 % share.

The above shares will be considered to assess RB opportunities to offer relevant piggyback services attracting significant volumes.

Break Even distance considerations:

It is also observed that the CT market is also driven by distances travelled by CT goods. Unfortunately, available data of UIC, UIRR, Eurostat are not providing any detail regarding the specific part of piggyback services of accompanied CT services but general view including also containers and swap bodies.

For unaccompanied CT, the average rail distance travelled varies considerably between domestic and international CT. The average distance of the rail leg in domestic combined transport amounts to less than 400 km, while the average rail distance in international CT services is approximately twice the size.

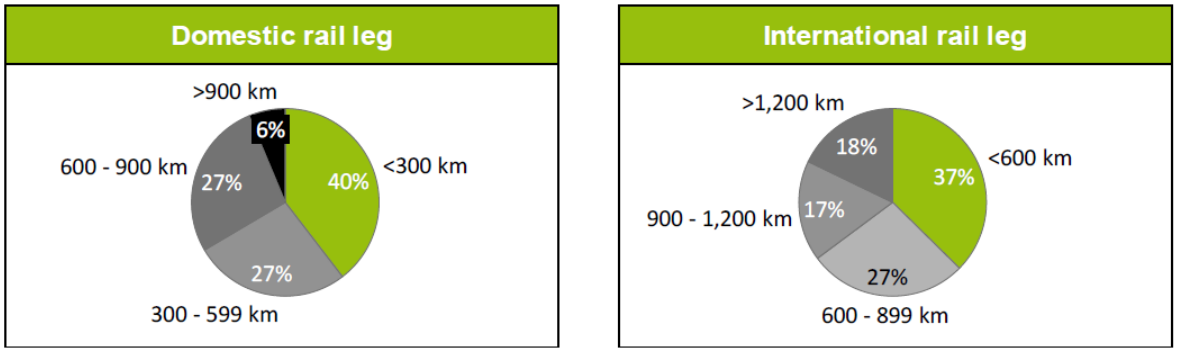


Illustration 63. Average distance segments of combined transport -rail leg (Source UIC)

According to UIRR data, the different share of CT volumes is considered, rail leg distances with more than 600 km (about 73 %) are the most relevant for international transport. If at least the total length of 795 km[39], RB rail leg is considered, it will be in the highest range of attractiveness of break-even distances for international CT market.

Short distances up to 600 km are more relevant for domestic CT market. If each Baltic country is considered individually for RB rail leg (265 km will be in Latvia, 213 km in Estonia and 392 km in Lithuania), distances are in the highest range of attractiveness for break-even distances for domestic CT market.

The Baltic States considered one by one are possibly too small to consider any domestic CT for each specific country, and if CT services should be only considered between main transport hubs where a CT terminal could be implemented, then Muuga, Salaspils, Kaunas and in Poland Elk (where routes to South and West are split). So, distance between possible terminals should be considered.

Distances between CT terminal are between about 190 to maximum 775 km. So, it is confirming the attractiveness for both CT market segments covering both "local" and also "international" rail legs distances.

Country		Estonia	Latvia	Lithuania	Poland
	CT terminal	Muuga	Salaspils	Kaunas	Elk
Estonia	Muuga		354	610	775
Latvia	Salaspils	354		260	440
Lithuania	Kaunas	610	260		190

[39] Distance Muuga – Elk. 870km is the total length of RB infrastructure in the Baltics, including Kaunas – Vilnius branch.

Poland	Elk	775	440	190	

Table 1. Baltic States – Distance between CT terminals (Source: approximate distance calculations)

For information, the average distance structure for the road leg unaccompanied CT is presented in the following figures. The typical road distance of unaccompanied CT adds up on average to about 50 km in domestic CT and over 100 km in international CT respectively.

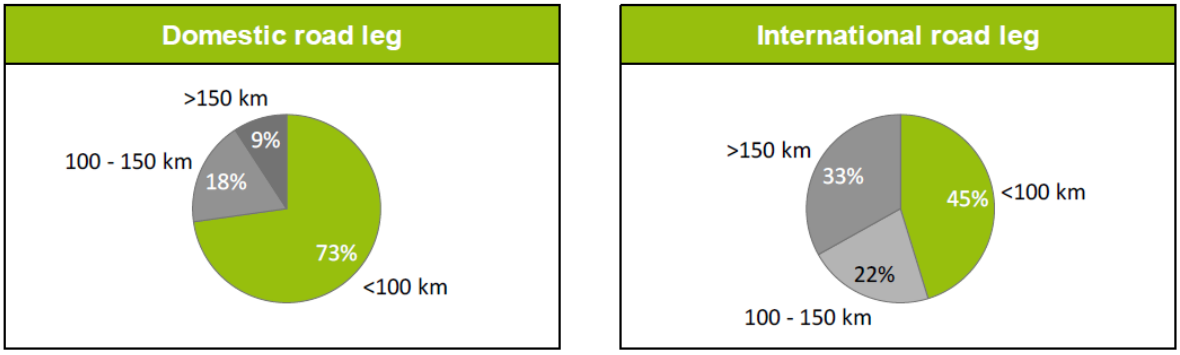


Illustration 64. Average distance segments of combined transport - road leg (Source UIC)

RB traffic forecasts

Global overview for Baltic States:

Current freight traffic in Baltic States (road and rail) for year 2018 have been collected from official web sites of statistics of the respective countries:

Country	Road	Railway	TOTAL	Road	Railway
Estonia	28 493	27 809	56 302	50,61%	49,39%
Latvia	76 703	49 260	125 964	60,89%	39,11%
Lithuania	89 105	56 776	145 881	61,08%	38,92%

Table 2. Baltic State – transport share – thousand tons (Source: official statistics of Baltic countries)

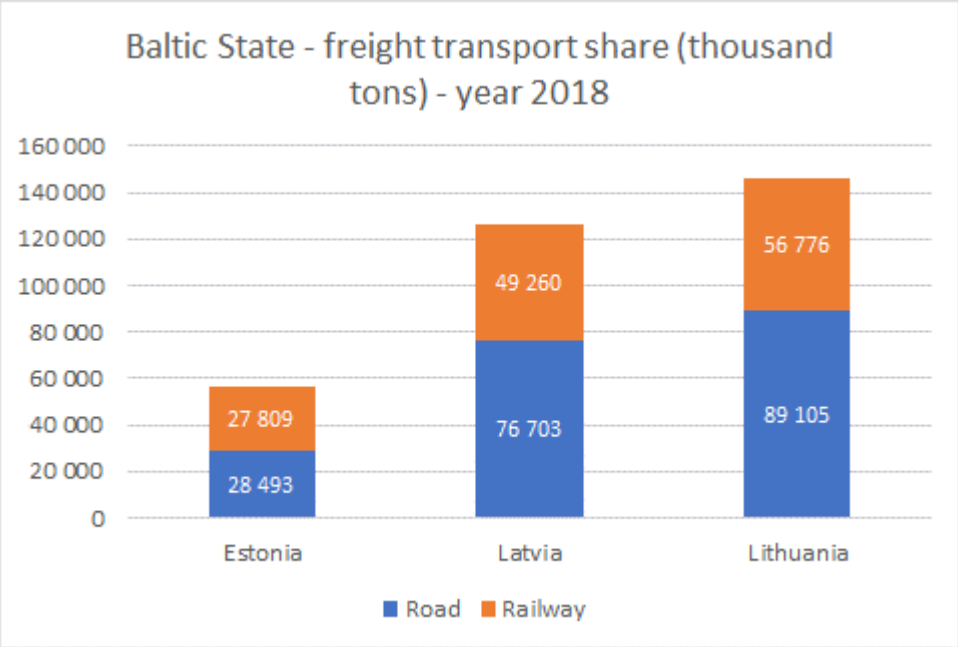


Illustration 65. Baltic State – transport share – thousand tons (Source: official statistics from Baltic countries)

The importance of rail transport in the Baltic States is still evident. For several years according to Eurostat data[40], the share of rail in the total transport performance was in the range 70 % - 85 % in the three Baltic countries. Nevertheless, compared to the average values in EU (17%), railway transport still plays and important role for inland transportation.

Regarding the freight market share between international (import – export – transit) and domestic markets, on average, freight traffics are generated by domestic needs (about 55 %), followed by import and transit (about 20 % each). Export generates only about 5 % of the traffic.

Country	Import	Export	Transit	Domestic	TOTAL
Estonia	2 938	1 343	11 777	40 243	56 302
Latvia	43 793	6 674	15 595	59 902	125 964
Lithuania	28 787	11 025	38 972	67 096	145 881
TOTAL	75 518	19 043	66 344	167 241	328 146

Table 3. **Baltic State – freight transport share between international and domestic markets – thousand tons (Source: official statistics from Ministries of Baltic States)**

[40] https://ec.europa.eu/eurostat/statistics-explained/index.php/Freight_transport_statistics_modal_split#Modal_split_in_the_EU

Country	Import	Export	Transit	Domestic
Estonia	5,22%	2,39%	20,92%	71,48%
Latvia	34,77%	5,30%	12,38%	47,55%
Lithuania	19,73%	7,56%	26,72%	45,99%
Total	23,01%	5,80%	20,22%	50,97%
Average	19,91%	5,08%	20,00%	55,01%

Table 4. **Baltic State – transport share international and domestic – % (Source: official statistics from Ministries of Baltic States)**

Data collected from official statistics shows slight difference especially for Estonia with a very low part of import market and high part for domestic market compared to Latvia and Lithuania.

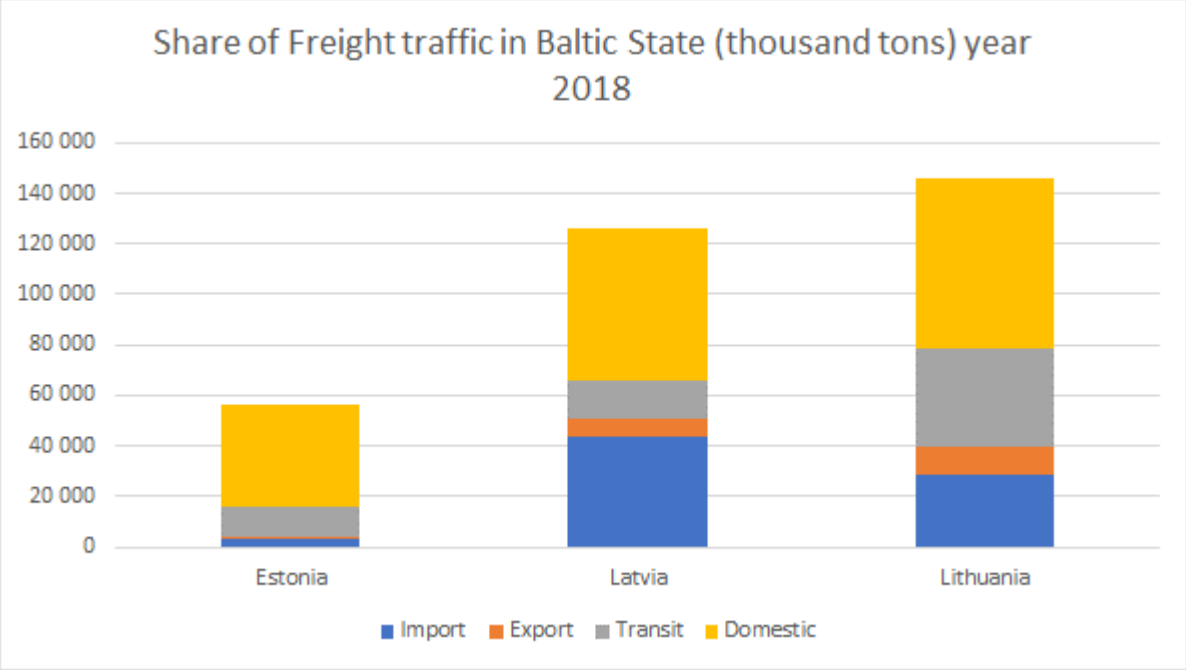


Illustration 66. Baltic State – freight transport share between international and domestic markets – thousand tons (Source: official statistics from Ministries)

Forecast of potential market size and opportunities for modal shift 2025-2035, and 2035+:

Only general traffic forecasts are available from E&Y report (2017) and not providing any details regarding specific piggyback transportation segment.

E&Y's forecasts indicate that the Baltic States trade with Poland and Germany makes up 10-15% of the total Rail Baltica freight volumes (in terms of volume in tons), which is roughly similar to the share of Finland transit. Consequently, in the terms of tons the largest share of Rail Baltica freight will be formed by the transit flows of Poland, Germany and rest of the EU with the largest countries of the CIS (linking the 1435mm gauge system with the 1520mm gauge system).

The forecasts indicate that usage of Rail Baltica infrastructure for freight shipments will be roughly split in proportion 57-43 % in favor of transit freight servicing as compared to the imports/exports of the Baltic States. Compared to official statistics, transit share seems to be in some way overestimated (currently only on average 20 %).

		2026	2035	2045	2055	Average share
Base Case	Estonia export/import	1.4	1.6	1.8	2.0	10%
	Latvia export/import	1.5	1.7	1.9	2.1	10%
	Lithuania export/import	3.4	3.9	4.2	4.6	23%
	Transit	8.7	9.7	10.5	11.4	57%
Low Case	Estonia export/import	1.1	1.3	1.4	1.6	10%
	Latvia export/import	1.2	1.4	1.5	1.7	10%
	Lithuania export/import	2.7	3.1	3.4	3.7	23%
	Transit	7.0	7.8	8.5	9.1	57%
High Case	Estonia export/import	1.6	1.9	2.2	2.5	10%
	Latvia export/import	1.7	2.0	2.3	2.7	10%
	Lithuania export/import	4.0	4.6	5.2	5.7	23%
	Transit	10.5	11.8	13.1	14.4	58%

Table 5. **Freight split by flow type, million tons (Source: E&Y 2017)**

It should be reminded that the above table includes CT transport in general including also containers. In 2026 it is considered that for the 3 countries cumulated the low case scenario will be about 12 million tons, the base case about 15 million tons and the high case about 17,8 million tons.

For the specific segment of CT piggyback market in Baltic countries, due to the lack of accurate data collected from surveys and previous studies, the Consultant has estimated the potential market by analogy with the existing piggy back CT freight share in EU (Eurostat data).

Average and maximum share values observed in EU are reminded thereafter (please refer to "General figures to be considered at European level" chapter, table 5).

For CT piggyback transport in EU the share of freight volumes expressed in thousand tons is the following :

- On average accompanied CT accounts on average for 0,05% and unaccompanied CT for 0,32 % of the road traffic;
- Maximum values are 1,22 % for accompanied CT and 1,16 % for unaccompanied CT (Switzerland), in orange cells.

It is observed that with significant differences exist between countries mainly linked to geographical constraints (mountains for accompanied CT) and voluntarist position combining taxes and incentives for Unaccompanied CT.

It should therefore be considered a voluntarist position of RB (or Baltic States) regarding the potential attractiveness of CT transport) with 2 different scenario: passive one and voluntarist one:

If applied to the current freight volumes in Baltic States (table 15) it gives the following:

Country	Freight volumes - thousand tons				Total average (passive scenario)	Total Max (voluntarist scenario)
	Accompanied CT		Unaccompanied CT			
	Average (passive scenario)	Max (voluntarist scenario)	Average (passive scenario)	Max (voluntarist scenario)		
Modal shift % in EU	**0,05%**	**1,22%**	**0,32%**	**1,16%**		
Estonia	14,25	347,61	91,18	330,52	105,42	678,13
Latvia	38,35	935,78	245,45	889,76	283,80	1 825,54
Lithuania	44,55	1 087,08	285,14	1 033,61	329,69	2 120,69
TOTAL thousand tons)	97,15	2 370,48	621,77	2 253,90	718,91	4 624,36
TOTAL million tons	0,10	2,37	0,62	2,25	0,72	4,62

Table 6. **Piggyback CT transport solutions – Thousand and million tons (Source: Consultant)**

In total for the most optimistic case, piggyback segment for the maximum cumulated of accompanied and unaccompanied CT piggyback transport values will reach 4,62 million tons per year with about between 1,4 % of Baltic Country freight market.

It should be reminded that, in average semi-trailer part including domestic and international CT segments in EU represent about 11 % of the total CT market. Compared to E&Y traffic forecasts (from 12 to 17,8 million for total CT market), the maximum value of 4,62 million tons ranks about from 26 to 38 % of E&Y values and can therefore be considered to be optimistic.

Expressed in number of units (truck for ACT and semi-trailer for UCT) it gives the approximate number of units per years. Average figures of 23 tons for a semi-trailer and 35,6 tons for a semi-trailer with tractor are considered in the calculations.

Country	Number of units (vehicles)			
	Accompanied CT		Unaccompanied CT	
	Average (passive scenario)	Max (voluntarist scenario)	Average (passive scenario)	Max (voluntarist scenario)
Estonia	400	9 764	3 964	14 370
Latvia	1 077	26 286	10 672	38 685
Lithuania	1 251	30 536	12 397	44 940

Table 7. Piggyback CT transport – number of units per year (Source: Consultant))

Expressed in number of trains per year (average 50 vehicles per trains, maximum train composition identified in the interim report):

Country	Number of trains per year			
	Accompanied CT		Unaccompanied CT	
	Average (passive scenario)	Max (voluntarist scenario)	Average (passive scenario)	Max (voluntarist scenario)
Estonia	8	195	79	287
Latvia	22	526	213	774
Lithuania	25	611	248	899

Table 8. Piggyback CT transport – number of trains per year (Source: Consultant))

And expressed in number of trains per day (365 days per year):

Country	Number of trains per day			
	Accompanied CT		Unaccompanied CT	
	Average (passive scenario)	Max (voluntarist scenario)	Average (passive scenario)	Max (voluntarist scenario)
Estonia	0,02	0,54	0,22	0,79
Latvia	0,06	1,44	0,58	2,12
Lithuania	0,07 (2 trains per month)	1,67	0,68 (3 trains a week)	2,46

Table 9. Piggyback CT transport – number of trains per day (Source: Consultant)

It is observed in the above table that there is a big gap between maximum of the "voluntarist scenario" and average values of the "passive scenario" (from 2 CT train per month to 1,67 CT train per day for ACT -23 times more) and from 3 trains a week to 2,5 trains per day for UCT - 3 times more).

It is mainly due to the fact that a significant rate for accompanied CT are generated in EU only by few countries and are on EU average very low.

Traffic of unaccompanied CT is more widely developed in EU in more countries and the difference between maximum and average value remains acceptable.

It is also taken as assumption that the share between domestic, import, export and transit CT trains should follow the same breakdown as the current freight market share:

Country	Import	Export	Transit	Domestic
Estonia	5,22%	2,39%	20,92%	71,48%
Latvia	34,77%	5,30%	12,38%	47,55%

Lithuania	19,73%	7,56%	26,72%	45,99%
Total	23,01%	5,80%	20,22%	50,97%
Average	**19,91%**	**5,08%**	**20,00%**	**55,01%**

Table 10. **Baltic State – transport share international and domestic – % (Source: official statistics from Ministries of Baltic States)**

It should be remembered also that in the previous tables, transit traffic will be mainly crossing the 3 countries (North Baltic corridor) and will be in total a sole a unique transit traffic for RB (about 20 % for each country). There is also scope for potential development of piggyback traffic originating from 1520mm railways with onward shipment on Rail Baltica.

Evolution:

According to UIC / UIRR reports, piggyback solutions for unaccompanied CT is showing a regular increase of 4 % per year but all figures available include also container and swap body traffic.

Port statistics – considerations:

"Ro-Ro" maritime definition:

"Ro-Ro" for the maritime transport and shipment should not be confused with "Ro-Ro" considerations in railway transport. In maritime, definition is the following:

> "*A Ro-Ro port is a terminal or reloading station equipped for the loading or unloading of road vehicles, rail vehicles and intermodal transport units onto or from a ship*" or "*Ro-Ro is a special kind of transport where the intermodal transport units are loaded and unloaded horizontally from and to a vessel*".

According to EU Commission Decision 2005/366/EC, in statistics some distinction is done between Ro-Ro "self-propelled" units (passenger buses, cars, vans, trucks, semi-trailers with tractor, motorcycles) or "non-self-propelled" units (goods placed on handling equipment with wheels, unaccompanied semi-trailers, wagons, caravans). For non-self-propelled units, manpower, towing equipment and storage areas within the port are all required in their handling.

It means that Ro-Ro maritime definition differs and is covering a larger spectrum of vehicles "self-propelled" than only trucks or semi-trailer with tractors in railway definition. It should also be pointed out that some Ro-Ro self-propelled vehicles in maritime data are also carrying also containers or swaps body.

Short-sea shipping:

According to Eurostat definition, short sea shipping (abbreviated as SSS) is the maritime transport of goods over relatively sea short distances, as opposed to the intercontinental cross-ocean deep sea shipping. In the present case, it is considered that it is defined as maritime transport of goods between ports in the area of Baltic countries[41] for short distance.

Taking into account the current RB railway corridor, short-sea shipping mainly concerns the 3 main ports of Baltic countries (one in each country): the port of Tallinn (Muuga), the freeport of Riga and Klaipeda port.

[41] https://ec.europa.eu/eurostat/statistics-explained/index.php/Glossary:Short_sea_shipping_(SSS)

Illustration 67. RB railway corridor.

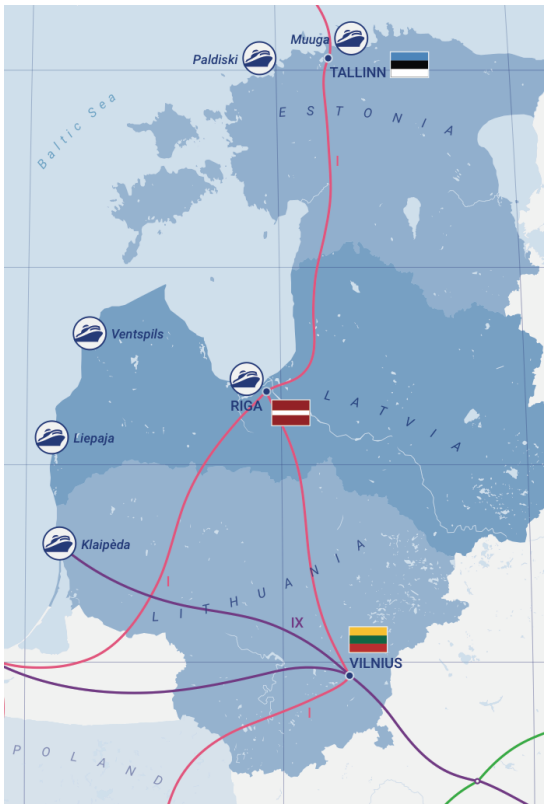


Illustration 68. Baltic sea-ports.

Muuga Port (Estonia):

Muuga port in Estonia is in the northernmost of the Baltic States. The strategic location at the crossroads of land routes and its access to the sea mean that within 72 hours it can be reached from the largest European ports in Germany, United Kingdom or the Netherlands. An important advantage of this port is also the proximity of large economic centres in the Scandinavian countries. The immediate catchment area for Muuga is Sweden, Finland, Latvia, Lithuania and Northwest Russia, which altogether constitute 65 % of Muuga Harbour inbound freight flows. Muuga is currently connected to the 1520 mm rail network and in the future will also be connected to the 1435 mm Rail Baltica network.

The Ro-Ro regular services operating between some Western European and Scandinavian ports are processed at Paldiski South Harbour, while Muuga Harbour and Old City Harbour have connections with Finnish and Swedish ports.

Regarding Paldiski South Harbour, options for improved connectivity to the port at Paldiski (possibly enabled by 1520/1435 transshipment) should be addressed in the future. Paldiski port is approximately 50km from Tallinn, and there is a 1520mm rail link which goes into Tallinn from the south rather than around the city towards Muuga or eastern railways. One option for the future to be considered could be a 1520-1435mm dry port to the south of

Tallinn, with a connecting line from the existing Tallinn-Keila-Paldiski route to the Rail Baltica corridor without going into (or closer to) the city.

As Muuga terminal is mainly seen as a gateway to Finland, a Ro-Ro terminal is a must as a prerequisite for the multimodal Muuga terminal but it should also be considered that the potential opening of the Helsinki-Tallinn tunnel in 2050 will lead to a decrease in Ro-Ro volumes, as they will bypass Muuga port. The construction of this possible tunnel implies therefore some uncertainties.

Muuga port is handling 5 million "Ro-Ro" tons per year representing about **450,000 units**.

Freeport of Riga:

The second largest Baltic Sea port, **the Freeport of Riga** is located in Riga (Latvia). In 2018, it handled 36,4 million tonnes of goods and Up to 75**%** of the Freeport of Riga cargo turnover is made up of transit cargo forwarded to or received from the CIS countries.

Riga is the closest of the Baltic States' ports to Moscow, which, taking into account the same railway infrastructure parameters (1520 mm rail gauge) allows for easy transportation of goods from the port of Riga to the Russian capital. Although only 60% of the Riga port's transshipment capacity is used, the decision makers are planning further investments to accelerate its development. The Freeport of Riga is effectively connected to the TEN-T road and rail network, as well as to the Motorways of the Sea, which provides an effective use of different transportation modes within the freight traffic chain. Unfortunately, at this stage of RB project development, it is not planned yet to have a direct connection in 1435mm track gauge to the freeport.

In year 2019, Riga freeport handled 492,5 thousand tons[42] of Ro-Ro goods including 355,1 thousand tons of "self-propelled" vehicles which represents only about 1 % of the total cargo volumes of the port.

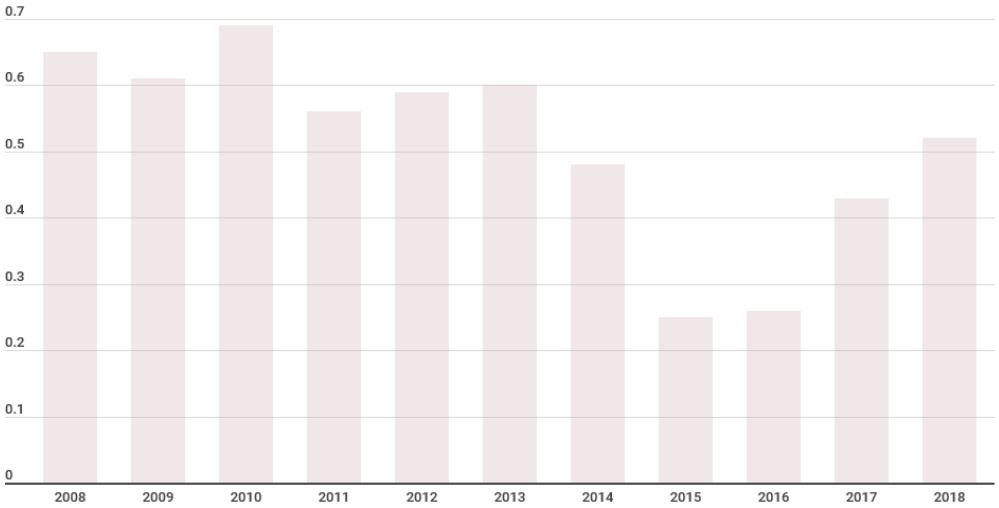


Illustration 69. Riga Freeport – Ro-Ro thousand tons years 2008 – 2018 (Source Riga freeport)

[42] http://rop.lv/en/about-port/statistics.html

Klaipeda port :

In terms of the load handled, the third largest port at the Baltic Sea and the largest among the Baltic States is located in Klaipeda (Lithuania). **Klaipeda State Seaport** is the most important and biggest Lithuanian transport hub, connecting sea, land and railway routes from East to West. In 2018, the port has handled 46,58 million tons of cargo, including 750 000 TEU containers. Lithuania, similarly to Latvia and Estonia, is located near the Scandinavian countries, Russia and Belarus, the latter being landlocked, and it collects 14 million tons of goods through the port of Klaipeda. Klaipeda port is connected only to the current 1520 mm track gauge railway network in Lithuania.

Currently, Ro-Ro combined transport is regularly increasing with about **288 thousand units** in year 2018 and about 11 % of the cargo volumes of the port. As for Muuga port under "Ro-Ro" definition, the port is considering all trucks handled by the ships, mainly reaching the port by road.

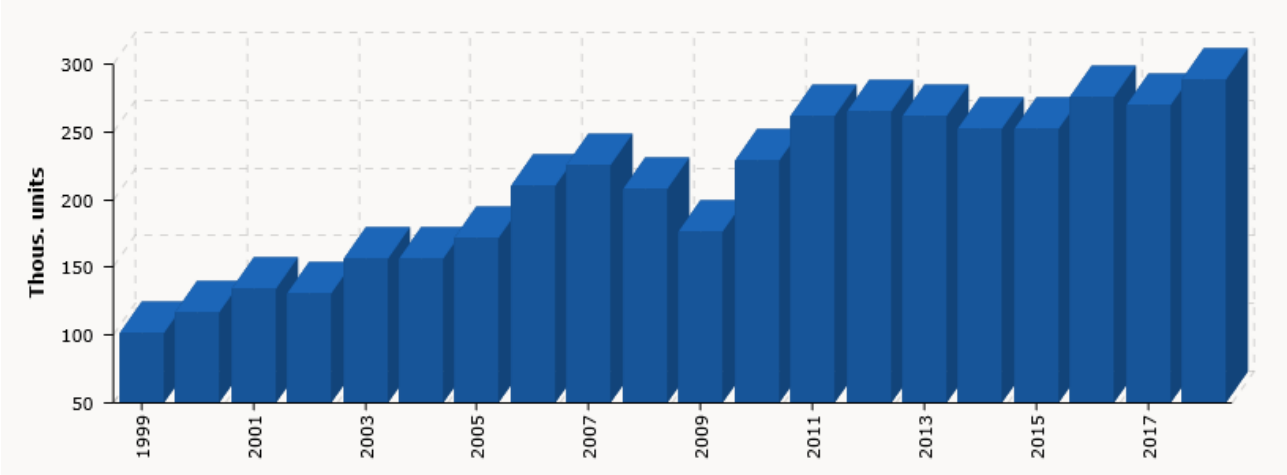


Illustration 70. Klaipeda port – Ro-Ro thousand units years 1999 – 2018 (Source Klaipeda port)

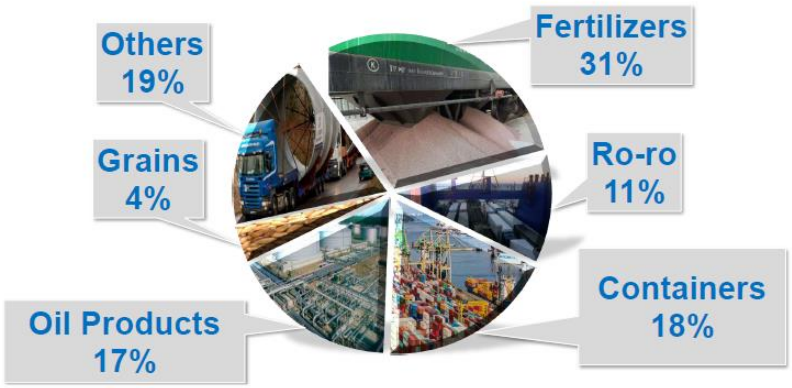


Illustration 71. Klaipeda port – Type of cargo (Source Klaipeda port)

Port statistics, analysis and conclusions:

In general, statistics for main Baltic Sea ports are not providing significant inputs for the market analysis. Main reasons are due to maritime "Ro-Ro" classification which including a wide range of road vehicles mainly counted on the format of "units".

It is therefore not possible to extract significant traffic data regarding cargo specifically transported by semi-trailers or semi-trailer with tractors.

Main inputs for the market analysis are related to the current predisposition of Baltic ports to accommodate piggyback services of RB with short -sea shipping.

North Sea-Baltic Core network corridor considerations:

The North Sea-Baltic Corridor consists of 5 947 km of railways, 4 029 km of roads, and 2 186 km of inland waterways and connects the ports of the eastern shore of the Baltic Sea with ports of the North Sea, situated in Northern Germany, Belgium and the Netherlands.

The corridor's most significant project is Rail Baltica European standard gauge railway connecting Estonia, Latvia and Lithuania to Poland. The corridor has branches to Ventspils in Latvia, and to Klaipeda, and Vilnius in Lithuania and to Terespol on the Polish/Belarussian border.

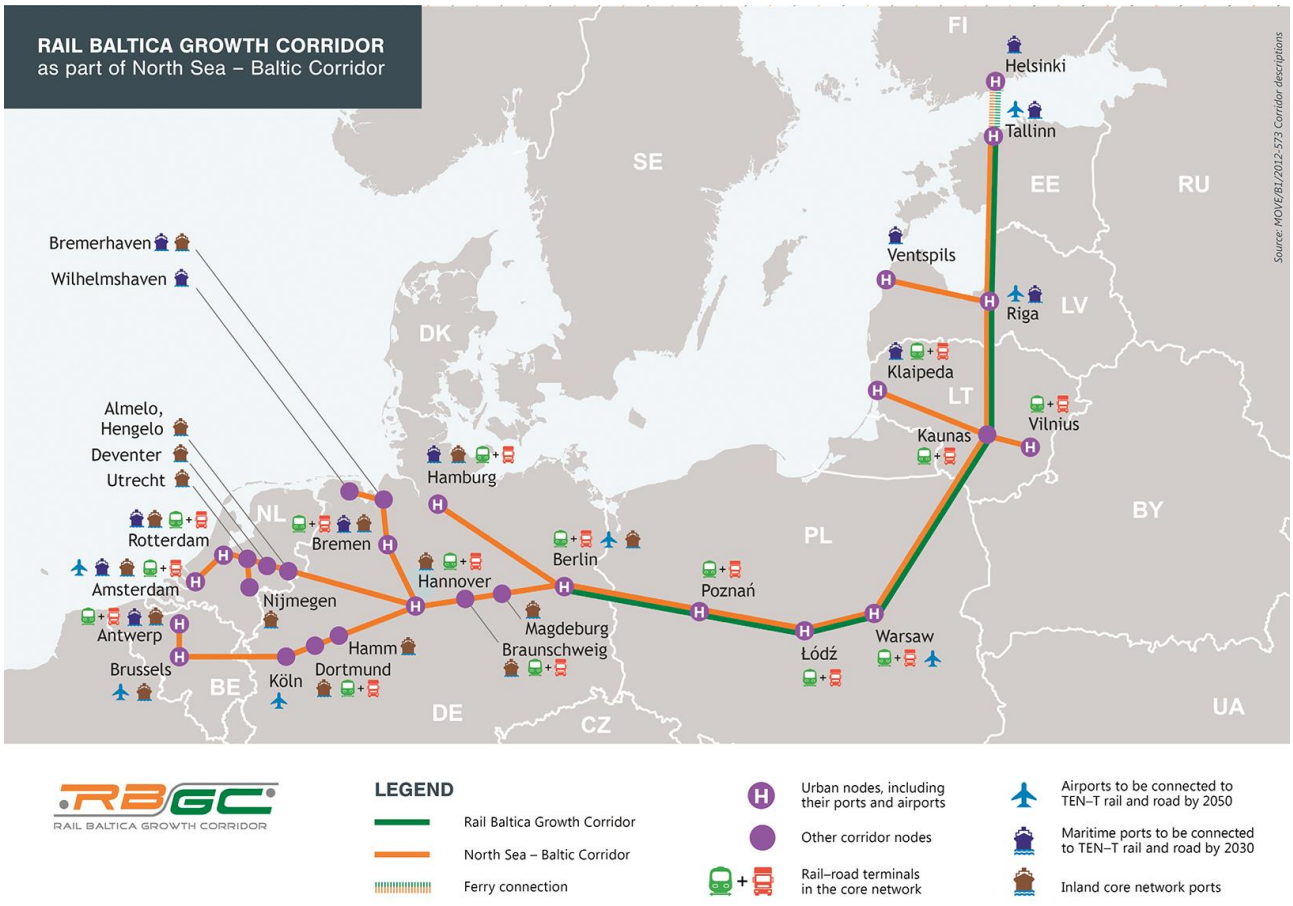


Illustration 72. North Sea-Baltic core network (RB-GC)

The RBGC partnership promotes transport policies for the development of multimodal logistics and modern railway infrastructure in Eastern Baltic Sea Region. The main focus is set on improving passenger mobility and freight transportation along Rail Baltica route. Furthermore, the project is organizing multilevel dialogue about transport policies of Baltic countries.

According to "North Sea Baltic" workplan 2018[43], while there is a strong traffic in the western end of the Corridor from the four largest ports in Europe (Rotterdam, Antwerp, Hamburg and Amsterdam) to the hinterland of the low countries and Germany up to Berlin, the flow then lessens from Berlin to Warsaw and, for rail at least, the connection with the Baltic States to the North from Poland is underdeveloped, although, the maritime connection between Helsinki and Tallinn works efficiently.

Another challenge is to create new traffic flows in a North/South direction on the eastern shore of the Baltic Sea and connect them to the well-established West/East flows between the North Sea ports, Berlin and Warsaw. The Rail Baltica project is a missing link to ensure that there is no gauge break between different Member States, and that these flows can be captured in a sustainable way

[43] https://ec.europa.eu/transport/sites/transport/files/3rd_nsb_wp_28032018web_june2018.pdf

1 435 – 1 520 mm track gauge considerations:

This corridor shall also be considered regarding the existing "historical" railway network 1 520 mm track gauge crossing or following RB corridor in several locations (Vilnius, Kaunas, Riga, Tallinn, etc.)

Baltic States are considered as a whole domestic market.

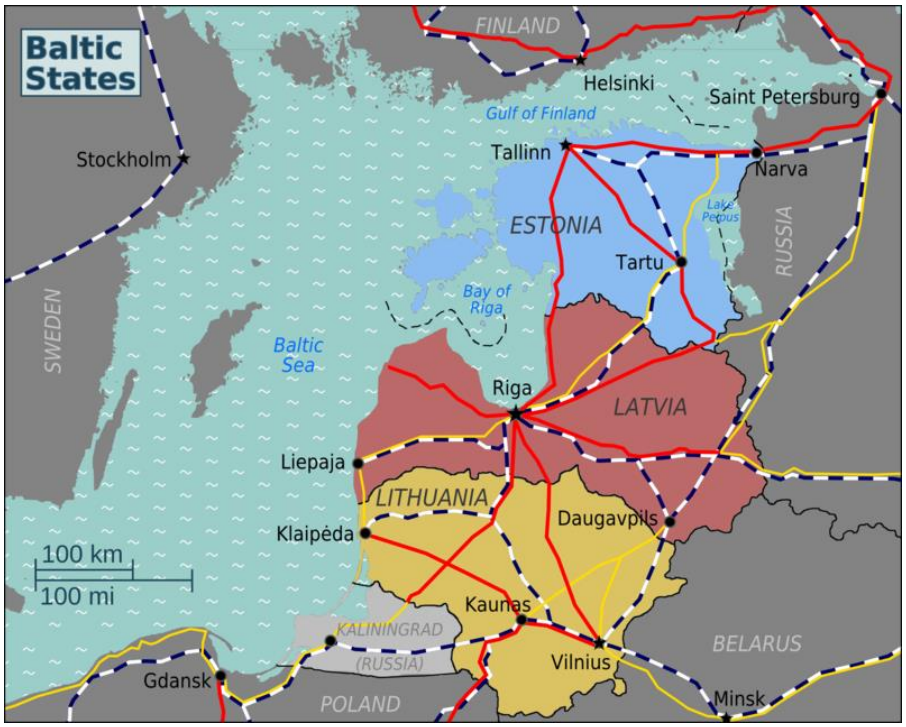


Illustration 73. Current 1520 mm track gauge network in Baltic countries (1435 mm elsewhere)

1520 intermodal trains running in Baltic States:

In Lithuania several intermodal national or international trains are running but dedicated for containers: also Amber trains, is an intermodal train which runs on the route Šeštokai/Kaunas – Riga – Tallinn (Muuga).

- **The Containerships Train** is the joint project of the Lithuanian, Belarusian and Ukrainian railways intended for the transportation of containers from Klaipėda to Kiev and back
- **Mercury Train** is designed to deliver 20', 40', 45' feet universal and specialized containers on route Klaipeda/Kaliningrad - Minsk - Moscow and return.
- **The container train Sun Train** (Saulė) connects Europe and China.
- **Container train Sestokai Express** connects partners from Western and Eastern Europe, Lithuania, Russia and Kazakhstan.
- **Riga Express is a weekly container block service connecting Riga with Moscow and other locations in Russia**
- **Viking Train** is a joint project of Lithuania, Belarus and Ukraine railways, stevedoring companies in Klaipeda, Odessa and Ilyichevsk seaports. All sizes of universal and special-purpose containers and trucks with semitrailers (contrailers) are carried by the Viking Train. The containers and trucks are transported from Scandinavia and Western European countries by sea transport to the seaport of Klaipeda, as well as via Mukran-Klaipeda ferry.
- **Container train Vilnius Shuttle** provides services for local market. Vilnius Shuttle, containers from Klaipeda port safely reach Vilnius railway station two times per week
- **Nemunas piggyback trains** between Lithuania and Belarus. The Nemunas piggyback train started running on the Kolyadichi-Vilnius/Kaunas-Kolyadichi route in November 2013 and is a piggyback train which can transport trucks with trailers.

  One of the obstacles of arranging road freight between Lithuania and Belarus are long queues and heavy traffic flows at the border. To solve this issue, Lithuanian Railways, jointly with its partners, offers a new service – the piggyback train Nemunas. One of the advantages of Nemunas train transportation is fast border crossing and customs clearance

  The route of the Nemunas piggyback train might be extended to Klaipeda and Kaliningrad. The time of travelling (including border crossing) is 11 hours. Train is running between Kaunas (Palemonas) – Vilnius (Paneriai) – Minsk (Koliadichi)

  It is believed that this train is not regular and is scheduled “on request”.

Illustration 74. Nemunas piggyback train (Source: LG)

In Latvia intermodal transport by railway concerns mainly also containers

- **"Baltika Transit":** Rail transportations from the Baltic states (Latvia - Riga and Ventspils; Estonia - Tallinn, Muuga, Paldiski; Lithuania - Klaipeda) to Kazakhstan, Central Asia states, Afghanistan and China using container block train.
- **"Riga–Moscow":** from/to stations at the Port of Riga to/from Moscow and the neighbouring stations
- **"ZUBR":** Estonia–Latvia–Belarus–Ukraine (back and forth), currently the possible freight amounts are being studied that would allow to extend the route through Ukraine to the Black Sea and, in the future, to Turkey
- **Express train "Riga–Minsk"** ensures cargo transportation from/to Riga to/from Mins (containers)

It has not been identified any relevant and robust source of complementarity, source of additional traffics between 1 435 and 1 520 mm track gauge for piggyback services. Piggyback traffics are currently limited to "Nemunas" trains, not scheduled on regular basis and Viking trains including truck and semi-trailer as a possibility in addition to containers.

In addition, 1 520 mm track traffic is more oriented for West – East relations, than purely oriented to the North (Muuga).

Short sea shipping considerations:

General overview:

- Tallinn has two ports, which form the combined Port of Tallinn. One of them is the Tallinn Old Port (Vanasadam), which serves mainly the passenger traffic and RoPax ferries, and has also some freight capacity. The Old Port does not have any rail or tram connection at the moment but the NSB project list includes a project for tram connection to the Old Port. The other port is the Muuga freight port, located to the east of the city. Muuga is currently connected to the 1520 mm rail network and in the future shall also be connected to the 1435 mm Rail Baltica network.
- The Freeport of Riga in Latvia is the largest port in the Baltic States and is connected to the rail network. Another Latvian port on the Corridor is the ice-free Freeport of Ventspils, which has convenient road and 1520 mm rail access.
- In Lithuania, the ice-free Klaipeda State Port is the biggest Lithuanian transport node with well-developed hinterland connections on rail.
- Germany has four core seaports on the Corridor: Hamburg, Bremerhaven, Bremen and Wilhelmshaven and all ports have rail connections.
- Ports in Belgium and The Netherlands: Amsterdam, Rotterdam and Antwerp have direct rail access.

At the national level, rail transport takes the biggest share in the Baltic States and shortsea-shipping is important for Finland, the Baltic States, Belgium and the Netherlands.

Illustration 75. Short-sea shipping links.

According to the CBA results (E&Y), it is assessed that sea transport is the cheapest option for the O/D pairs that are easily and conveniently reachable by sea from Finland and the Baltic States. For example, the shipping rate for one TEU from Rotterdam to Helsinki by sea may cost approximately EUR 500, while the land transport cost maybe three times higher. Considering that the Rail Baltica infrastructure would form maximum one third of the total end-to-end

journey of the freight for most O/D pairs, it would mean that even offering the Rail Baltica section for very low price, the overall shipment, for instance, from Rotterdam to Helsinki would cost considerably more by train than by sea. Nevertheless, seamless and efficient rail freight may attract transfers.

In view of these considerations the freight flows captured by Rail Baltica have been determined to shift predominantly from the road traffic.

Logistic platforms considerations:

There were two stand-alone RRTs completed in Lithuania – Vilnius and Kaunas intermodal terminals, others are developed in Klaipeda seaport.

There are no RRTs in Latvia, but they are planned to be constructed jointly with Rail Baltic project.

In Estonia, rail-road terminals (RRTs) exist in ports, but not on a stand-alone basis without the port, except a project idea to develop a dry port (RRT) at the outskirts of Tallinn. Rail Baltica project includes a potential new multi-modal Ülemiste RRT in Tallinn (Soodevahe/Rae).

WP 3.2 - Assessment of Feasibility of Piggybacking intermodal facility solutions

Assessment of feasibility of piggybacking solutions, technologies and options at intermodal facilities have been identified in WP2.2

General overview regarding intermodal facilities for RB

Most relevant solutions for RB according to market segments are presented in the following chapters. Costs of investments and operation costs are mainly sourced by "Data base and comparative analysis of CT and transshipment technologies for CT" prepared by the AlpInnoCT studies under Interreg[44].

Lift-On-Lift-Off solution:

Considering the current traffic forecasts of unaccompanied CT (please refer to chapter "forecast of potential market share"), between 2 400 (average) and 5 000 (maximum) reinforced semi-trailers should be transhipped per year in all Baltic States for all intermodal facilities.

It gives the figure of about 6 to 12 reinforced semi-trailers per day no more. Considering this low value especially because it concerns all facilities, it is assessed that in any case, investments for the implementation of such facilities should not be financially sustainable especially using crane solution.

It shall be limited only to some reachstacker device or sharing common lifting devices used also for swap bodies or containers.

The following investments and operation costs can be considered for the development of this transshipment solution:

- Approximately 130 m^2 is required for one loading / unloading area.
- A classical pocket wagon costs about 90 000 € (one parking place);
- Maintenance cost is about 8 cent/km per wagon;
- Reachstacker device price is in the range of 250 000 € (between 100 000 to 500 000 €);
- Approximate cost of transshipment is about 25-30 € per unit

Horizontal loading (CargoBeamer) solution:

This solution is mainly for small and medium terminals as big terminals normally do not have only ACT platforms, but also cranes etc. A network is required. This system is to be operated in origin/destination terminals, so at least it has to be installed in two terminals.

- A space of average 117 m2 is required for each transshipment unit;

[44] https://www.alpine-space.eu/projects/alpinnoct/outputs/deliverable-d.t1.2.1.pdf

- Terminal investment for one transshipment unit is 67 000 €.
- A Cargobeamer wagon costs 360 000 € for 2 parking spaces.
- According to Cargobeamer, the maintenance and repair costs correspond "*to those of a conventional pocket wagon*". Taken into account the complexity of the wagons, at least the same cost as a Modalohr wagon should be considered (about 50 cents/km per wagon);
- Costs of handling per loading unit are 75 €.

Roll-on-Roll-off transshipment solution:

To avoid gantry cranes and to attract any type of semi-trailer (reinforced or not), the Roll-On-roll-Off solution has been implemented typically for the RoLa, Modalohr, Megaswing and Eurotunnel solutions. Roll-On-Roll-Off are more dedicated for accompanied CT (ACT) but could also make use of automated vehicles for loading/unloading.

RoLa solutions:

RoLA solutions cover different technology and solution. The Type of transshipment technology is horizontal, there is no crane necessary. The truck (tractor unit + semi-trailer) is loaded as a full unit in RoLa "small wheels" wagons and Eurotunnel and uncoupled for Modalhor or Megaswing solutions.

Modalohr, Megaswing and Flexiwaggon railway system solutions are based on the principle "open the pocket of the wagon". The semi-trailer is uncoupled from the tractor unit which is loaded or not loaded on the same train.

RoLa solution with "small wheel" wagons:

The Type of transshipment technology is horizontally, there is no crane necessary. The loading unit is ACT (whole truck with driver).

The only required equipment facilities or specific terminal feature are a straight railway track with truck-drivable ends, parking space, turning options for trucks, and service facilities for passenger coaches. No real network is required because transshipment facilities are very simple.

- The loading ramp requires an area of approx. 80 $m^2$for one transshipment unit and at least 700 m of a straight railway track for loading and unloading;
- Costs approx. 100 000 € for one transshipment unit;
- A RoLa-Wagon costs about 180 000 € (1 parking place);
- Maintenance costs of RoLa-Wagons are about 15 cent/km per wagon;
- Costs of handling per loading unit is not identified (self-propelled unit);
- Transport of a full truck on the route Novara - Freiburg (437 km) is about 500 € (1,14 €/km)

Eurotunnel solution:

This solution can be adapted for RB although without adaptation its gauge (height 5 500mm) is exceeding GC and even SEc Swedish gauge. However it has been demonstrated elsewhere in this report that this solution could be combined with work such as FERRMED TOFW and this should be studied.

Roll-On-Roll-Off solution, based on truck transport (tractor unit + semi-trailers) on flat standard floor wagons with standard wheel diameter, serves Accompanied Combined Transport. With automation or the use of terminal tractors this could be adapted for Unaccompanied Combined Transport, with no requirement for crane or other large infrastructure elements.

As for RoLa with small wheel wagons, terminal facilities are very simple but in this case the loading / unloading of vehicles is achieved all along then train by "loader" wagons (3). So, a long platform is required, having at least the length of the part of the train to be loaded.

No public information is available regarding unit costs but it can be estimated that:

- The loading platform requires at least the length of relevant part of the train on straight railway track;
- Investment price for a transshipment unit: not available but it shall be considered for the full platform length;
- Maintenance costs of these shuttle wagons are about 35 cent/km per wagon (*estimation*);
- Costs of handling per loading unit is not identified (self-propelled unit);
- Transport of a full truck by the channel (55 km) is *sold for* approximately 300 € (5,45 € per km).

Modalohr solution:

The Type of transshipment technology is horizontally, there is no crane necessary. The loading unit is ACT (whole truck with driver).

Mainly for small and medium terminals as big terminals normally do not have only ACT platforms, but also cranes etc. It needs at least a pair of two terminals (O/D), but it can be more efficient within a network of terminals.

The Type of transshipment technology is horizontal, the trucks drive on and off the rail-racks. Due to the flexible structure of the wagons vertical transshipment is also possible

For Modalohr, investment costs for a terminal is about 6,7 million Euro.

- A space of average 156 m2 is required for each transshipment unit;
- Investment cost for a transshipment unit about 74 000 €
- A Modalohr wagon costs about 400 000 € with 2 parking places
- Maintenance costs for a Modalohr wagon is about 50 cent/km per wagon;

- Costs of handling per loading unit are 80 €;
- Terminal costs about 7 million Euro (Calais 2015);
- Semitrailer + Handling + Wagon + Rail traction Cologne – Milan (630 km) costs 759 € (1,2 € per km)

Megaswing solution:

The Type of transshipment technology is horizontally, there is no crane necessary. The loading unit is ACT (whole truck with driver).

Mainly for small and medium terminals as big terminals normally do also have cranes, installed infrastructure etc. The advantage is its flexibility at small terminals. There is no special network needed. The system can easily be integrated into existing trains and terminals and can potentially be used for the extension of maritime RO-RO connections

- A space of average 120 m^2 for is required, there is no special terminal needed. A drivable path along the railway track is sufficient. It is easy to operate within existing intermodal terminals as it allows horizontal and vertical handling.
- The Investment per track is approximately 30 000€.
- A Megaswing wagon costs about 300 000 € with 2 parking places (source AlpInnoCT "Database and Comparative Analysis of CT and Transshipment Technologies for CT);
- Maintenance costs for a megaswing wagon is about 50 cent/km per wagon (estimation by the Consultant, similar as for Modalohr);
- Costs of handling per loading unit are 80 € (estimation by the Consultant, similar as for Modalohr).

Life cycle cost – Unit prices - Summary

The following table summarized the above information for each transshipment solution

Solution	Lift-On- Lift-Off (ISU Innovativer Sattelauflieger", the "NiKRASA	Horizontal loading as Cargobeamer	RoLA small wheel wagons	RoLa- Eurotunnel	RoLa - Modalohr	RoLa - Megaswing
Sizing to be considered	130 m² for a transshipment unit	117 m² for each transshipment unit	80 m² for each transshipment unit + 700 m of straight track (or total length of the train)	Platform at least the length of the train and straight railway track for loading and unloading	156 m²	120 m²
Unit price for transshipment unit	Reachstacker price 250 000 € or more	67 000 €	100 000 €	Not relevant (no transshipment unit required)	74 000 €	30 000 €
Unit price for a wagon	90 000 € (1 parking place)	360 000 € (2 parking places)	180 000 € (1 parking place)	380 000[45] € (1 parking place) including loader wagons	400 000 € (2 parking places)	300 000 € (2 parking places)
Maintenance cost of a wagon	8 cents/km	50 cents/km	15 cents/km	35 cents/km	50 cents/km	50 cents/km
Handling unit cost	25 to 30 €	75 €	Not relevant (no handling unit required)	Not relevant (no handling unit required)	80 €	80 €

Table 11. Life Cycle Unit costs to be considered (Source: Analysis of EU combined transport report)

[45] Consultant estimate; it should also be recalled that this includes rolling stock requirements specific to the Eurotunnel environment

WP 3.4 - High-level Considerations for piggybacking solutions

Traffic forecast considerations

If the maximum value of modal shift from road to piggyback solution observed in EU are applied for the current road freight traffic in Baltic States, the number of CT piggyback trains per day should be **maximum 2 trains per day for accompanied CT and less than 3 trains per day for unaccompanied CT (50 units per train)**. Main piggyback traffic expected should be generated by unaccompanied CT and for what could be considered to be domestic gathering intra-domestic, export and import for each respective Baltic country (80 % of the traffic).

If the EU average road shift transfer to CT are considered, traffic forecast shows very low values as 2 trains per month for accompanied traffic up to 3 CT trains a week.

It was observed during the development of traffic forecasts that there is a big gap between maximum and average values (from 2 CT train per month to 1,67 CT train per day for ACT (23 time more) and from 3 trains a week to 2,5 trains per day for UCT (3 time more).

It shows in fact that a significant rate for accompanied CT are generated in EU only by few countries where a voluntarist position has been adopted with regulatory / incentives in force with in addition for ACT to geographical constraints (mountains) but for other countries, this rate is on EU average very low (passive scenario).

Traffic of unaccompanied CT is more widely developed in EU in more countries and the difference between maximum and average value remains acceptable. Voluntarist position is also a key issue affecting traffic volumes with some countries as Germany, Italy, Switzerland, Denmark having the highest CT modal share compared to other countries.

First expectation of the Consultant was that transit traffic for the North Baltic corridor, attracting also current short-sea shipment, could become a potential CT market for RB it is not reflected by factual approach and data collected.

Moreover, the above maximum traffic forecasts values are considered to be optimistic by the Consultant for the following reasons:

- The situation in accompanied CT rail/road differs completely from unaccompanied CT operations. Accompanied CT services mainly enable road hauliers to overcome administrative, regulatory or topographic barriers. Like ferry services, they aggregate transport flows originating from a very broad geographic area. The rail distances are comparatively short, between 100 and 500 km. Rail Baltica corridor does not include specific natural barriers, mountains, tunnel, channel, etc. where accompanied CT are generally implemented. More than likely, most of the traffic (or the traffic to be targeted) should be for unaccompanied CT.

- Most of the current Baltic State road traffic (80%) is generated by **import, export and domestic traffic for each respective Baltic State,** transit traffic ranking the less (20 %).

  If domestic market is considered for each respective country, around RB corridor, an average RB "Rail leg" distance of 265 km will be in Latvia, 213 km in Estonia and 392 km in Lithuania should be considered. According to UIC data, this rail leg distance for domestic market is representing only 50 % of CT domestic rail leg market in EU.

  For international traffic, the total rail leg length of RB with about 795 km is relevant but, in this case, traffic should be mainly generated by transit flow. Road transit represents currently only about 20 % of the current road traffic in Baltic States. It could be shifted to CT piggyback solution and this traffic should be purely North -South or South – North oriented.

- Short-sea traffic transfer to road is not considered (E&Y) to be relevant considering the higher price for rail transport compared to sea by vessels (3 times more). So, no additional traffic is generated by this shift. However for some potential shippers the time saving could be of significance.

- Specific attention should be paid to collecting robust traffic data, developing an intermodal demand model to analyze potential demand coming from upgraded integration with 1520mm.

- Maximum percentage value of potential road transfer shift in EU collected are those from Switzerland where incentive regulatory initiatives are implemented in favor of CT transport.

- Compared to E&Y value, maximum CT piggyback share are rather optimistic.

To summarize, results from this analysis suggest that RB piggyback CT traffic will be generated by unaccompanied CT with 1 or 2 trains per day for import / export / domestic market.

Optimum CT piggyback solution for RB

Several technical solutions have been presented and compared. Taking into account the traffic forecast results and Ct market segment (unaccompanied piggyback, short range of rail leg distance)

Solution	Solution description	Analysis
RoLa solution	Roll-On-Roll-Off solution, based on truck transport (tractor unit + semi-trailers on flat low floor wagons with small wheel diameter. Accompanied transport	RB corridor does not present any specific geographical barriers (tunnel, mountains, channel) and this specific technical solution is therefore not recommended. However an "improved" variant has been proposed for further study.
UTC solution (HUPAC)	Lift-On-Lift- Off solution for the transport of semi-trailer on pocket wagons with low floors but with standard wheel diameter. Unaccompanied transport	As it only concerns a very low percentage of semi-trailer with reinforced body, this solution is not recommended.
Eurotunnel solution (or classical flat wagons)	Roll-On-Roll-Off solution, based on truck transport (tractor unit + semi-trailers on flat standard floor wagons with standard wheel diameter. Accompanied transport	Due to the fact that SEc loading gauge will be implemented on RB corridor, the solution to carry 4m height truck on flat wagons (floor 830mm) will be possible or 4,5m height truck with pocket wagon: please refer to earlier treatment). It can be assessed that for RB for 4m height truck, a similar solution as Eurotunnel can be implemented in terms of loading / unloading with lateral platforms. Such a solution could also be implemented on the 1520mm railways providing common requirements for hauliers. The loading issue of unaccompanied CT (semi-trailer alone) must be explored because the loading principle is mainly developed on self-propelled vehicle (trucks or semi-trailer with tractors). Loading gauge interoperability with neighbouring countries (Poland, Germany, etc.) is a potential issue.
Modalohr / Megaswing / CargoBeamer solutions	Roll-On-Roll-Off solution, based on semi-trailer transport on specific very low floor pocket, wagons (open pocket system). with	All these solutions are compatible with RB needs to face piggyback unaccompanied CT traffic. However many of these solutions restrict choice of supplier

Solution	Solution description	Analysis
	standard wheel diameter. Unaccompanied transport	or equipment in the future and thus represent a significant risk.

Table 12. **Compatibility of existing solution with RB GC loading gauge**

WP 3.5 - Use of policy tools for the promotion of modal shift

General

The analyses of best practices of such countries as Austria, Switzerland and Germany (confirm that the reduction of road transport and the development of combined transport requires regulatory measures, including charging for access to road infrastructure in main transit corridors as well as public coordination of rail-road terminals development. For example, public aid scheme to promote the shift of freight traffic from road to rail has been implemented in Germany.

The scheme has a yearly budget of EUR 350 million between 2018 and 2023. Under the scheme, rail freight operators will be compensated for up to 45% of their track access charges (EC, 2018c).

National Regulatory Frameworks

Volume of rail-road traffic observed and prices are mainly influenced by Public sector which can contributes with incentive to either increase the price of road transport, to impose strict rules of circulation, load, taxes.

According to CargoBeamer assessment[46], emissions compared to road transport are reduced by 73% (CO2) and by 81% (NOx).). Internalization of environmental externalities through road tolls (and their potential effects on the road freight transport demand) should be considered in Baltic States in order to promote a voluntarist position.

The national legislation in most Member States of the European Union provides for restrictions on road.

Typical example, Austria:

in 1999, 217.500 complete trucks had crossed the Austria by the ROLA. The figures later showed an evolution in five phases: rapid growth (+ 75%) from 1999 to 2002, **a steep fall until 2005 (-58%),** growth from 2005 to 2010 (+ 181%), again a fall until 2012 (-38%) and a phase of stagnation since then. This evolution "sawtooth" can be explained largely by measures of policy transport (limitation of transit through Austria until 2003 by the transit contract ("ecopoints"), the introduction of a new toll system Electronics in 2004 and the sectoral ban on circulation between 2008 and 2011).

Examples of Promotions by governments

- AUSTRIA Prohibited traffic of freight vehicles with a trailer, if the gross weight of the vehicle or the trailer exceeds 3.5 tons, also freight vehicles and trucks with semi-trailers of gross weight exceeding 7.5 tons: • on Saturdays from 3:00 p.m. to 12 midnight • on Sundays and public holidays – from 12 midnight to 10:00 p.m. In the period from June 1 to August 31, on Saturdays from 8:00 a.m. to 3:00 p.m. – prohibition of transport on the routes busiest on week-end for vehicles of gross weight exceeding 7.5 tons;

[46] https://www.cargobeamer.eu/CargoBeamer-Overview-pdf-851136.pdf

- ITALY Prohibitions for freight transport: from 08:00 a.m. to 10:00 p.m. on Sundays from January to April and from October to December • from 07:00 a.m. to 12:00 midnight on Sundays and national holidays from May to September;
- GERMANY Prohibition of traffic of freight transport on the entire network of roads from 12:00 midnight to 10:00 p.m. on Saturdays, Sundays and national holidays. There are some restrictions on transportation at night-time on selected sections of highways that are marked with specific road signs; Combined rail/road transportation carries out transportation from a port to the closest railway loading point, or from a railway unloading point to the consignee at a distance not exceeding 200 km; Transportation of fresh milk, dairy products, fresh meat and its products, fresh and live fish and its products, fruit and vegetables; Unfilled road vehicles;
- SWITZERLAND Prohibition of traffic on the entire territory of the country on Sundays and national holidays from 12:00 midnight to 12:00 midnight At night-time the prohibition on traffic is imposed from 10:00 p.m. to 05:00 a.m.

Plans to help CT transport at EU level

Combined transport is an important pillar for reaching the EU policy goals towards more eco-friendly, sustainable and efficient freight transport in Europe. In addition to cross-border initiatives at EU level, different national measures have been created in the past.

To get the complete picture of national CT measures in Europe is challenging, since the current status of combined transport, types of measures, political objectives, funding volumes, responsible bodies and authorities as well as requirements and periods of validity, but also the publication and marketing of the different initiatives differ significantly.

It is currently 18 countries with current national programs (in 2018 in force) to support combined transport activities, while six countries reported that there is currently no national funding. This is illustrated in the figure below:

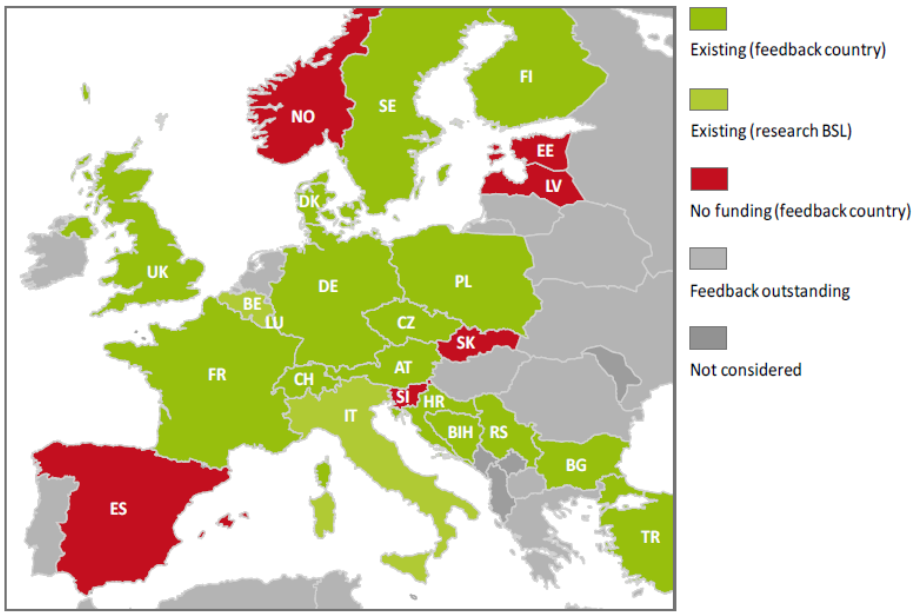


Illustration 76. Overview of countries with current national CT funding measures (Source UIRR report)

In the following table National funding programs identified according to the funding sector:

- Operational measures (support of operation and traction) with focus on:
  - Funding per km;
  - Support of Processes;
  - Technology support;
- Infrastructure measures with focus on support of:
  - rail track infrastructure;
  - terminal infrastructure;
- Support regarding rolling stock (intermodal wagons);
- Support regarding intermodal loading units (ILUs);
  - Research on combined transport (support of studies and development activities);
  - Fiscal support (Tax exemptions, reduced charges for CT etc.).

Country	National Funding measures or programs for Combined Transport										
	No. of funding measures	Operational Operational (Funding (Processes) per km)		Operational (Technology)	Infra-structure (Rail)	Infra-structure (Terminal)	Wagons	Intermodal loading units	Research	RoLa / Rolling motorway2)	Fiscal support1)
Austria	5	x	x	x	x	x	x	x	x	x	x
Belgium	1	x					x	x			x
Bosnia and Herzegovina	2 in 1	x			x	x					
Bulgaria	2	x			x	x					
Croatia	3 in 1	x									x
Czech Republic	2			x		x		x			
Denmark	1	x									
Finland	1	x								x	x
France	6 in 3	x	x	x	x	x		x	x	x	
Germany	3		x	x	x	x		x	x		
Italy	2	x								x	
Luxembourg	1	x									
Poland	1				x		x	x			
Serbia	2			x		x	x	x			
Sweden	1	x									
Switzerland	5	x	x		x	x				x	x
Turkey	2 in 1		x		x	x					x
United Kingdom	1	x								x	

Table 13. Analysis of existing national CT funding programs by funding sector (Source: UIRR report)

Baltic country cases:

In the above table and illustration it is observed that Baltic countries are currently part of countries where there is not yet any CT funding program.

But currently at EU level the "COMBINE"[47] project program is developed under Interreg which can also be fixed the ground for the development of CT transport and national funding program development in Baltic states: it should be noted that RB Rail is involved in this project.

COMBINE aims at enhancing the share of Combined Transport in the Baltic Sea Region (BSR) in order to make transport more efficient & environmentally friendly.

The COMBINE project started in January 2019 and runs till June 2021, the first midterm project results are expected in summer 2019.

In the Baltic States due to rural structures (spatially scattered transport volumes/long last mile), comparatively low transport volumes (especially CT-capable volumes) and a long tradition of pure road transport, CT can hardly compete with road transport & thus the share of CT is low. This results in inexperience & insufficient knowledge about CT amongst policy and industry & thus low exploitation of the CT potential.

The project will be attended by fourteen partners from eight European countries – Belgium, Denmark, Finland, Germany, **Lithuania, Latvia**, Poland and Sweden. UIRR is the work package leader of WP5 on framework conditions.

Scope of "Combine" project includes:

- Combined transport in the Baltic Sea region: challenges and opportunities:
  - Overview on the combined transport market in the Baltic State Region;
  - Concept for setting up national and international combined transport chains within the Baltic State Region;
  - Potential analysis of transport innovations for the Baltic State Region;
- Optimize combined transport operation in terminals:
  - Benchmark analysis of terminal operation in the Baltic State Region;
  - Increasing awareness, knowledge and acceptance of terminal handling and operation innovations;
  - Combined terminal strategy for the Baltic State Region;
  - Pilot case: Special truck regulation zone near terminals to booster CT;
- Capacity building for sustainable last mile transport:

[47] https://www.combine-project.com/en

- Overview on innovative last mile solutions to strengthen combined transport;
- Test-field development for platooning on Helsinki-Tampere highway;
- Feasibility of cross-border operation of innovative technologies;
- Last-mile concept for the multimodal platform;
- Round table with national transport ministries;

- Framework conditions for combined transport (regulatory / support programs):
  - Benchmarking of existing combined transport funding schemes;
  - Non-financial support to boost combined transport in Baltic State Region;
  - Dialogue with national politicians and European Commission;
  - Recommendations for adoption of rules and regulations for better consideration of BSR specifics such as rural structure, low transport volumes and long last mile;
  - Recommendations for Baltic State region specific support schemes

Unfortunately results of "Combine" project are not currently available (or made public) at the time of writing.

WP 3.6 - Requirements for an optimal / viable freight service

Lead-time, certainty and predictability of shipment/delivery

Standard logistics concept for long-distance hauls starts with a road vehicle loading goods in the afternoon of day A. The cargo can be delivered early on day B within a typical single driver shift on national and cross-border trade lanes between 600 and 900km, depending on topography, speed restrictions and other factors. Day C morning deliveries are performed on routes of up to about 1,500km.

CT trains might easily match the average lorry speed but the critical factors for CT operators to supply a competitive service are as follows:

- Road operators seek to register at the place of unloading early in the morning at 6-7 AM in order to be able to take up a return load on the same day. Therefore, CT trains must arrive well before then at the receiving terminals, to allow hauliers to pick up the load unit and carry it to its destination;
- To operate cost-efficient services trains must aggregate a diverse range of shipments and can only leave late afternoon or in the evening. This can challenge an early time of availability next morning. On longer distances an early morning day C or day D arrival may be impeded when favorable train paths are allocated to passenger trains, to the detriment of CT services.

For the time being, CT services are mainly used where schedules absolutely fulfill the requirements of the Logistic Service Provider providing the door-to-door transport, or logistics solutions have been designed to efficiently fit into their operations and serve shippers properly.

Door to door solution or "last mile services" are generally included or at least proposed as an option by the different CT providers.

Traceability and tracking of consignments

The CT rail/road sector in the EU lacks an "open data" ICT platform for exchanging booking, operational and tracking and tracing data between relevant companies involved in the CT supply chain. "Open data" means that the system has standardized interfaces and is not determined or controlled by a single actor.

It could be considered that it is a general problem outside from RB field of influence but for the processes to be efficient systems should be set-up not only from the RB IM perspective but in keeping with general requirements from operators, customers and other stakeholders.

This is best done during project delivery to ensure smooth transition with operational capabilities demonstrated to maximize opportunities and to attract potential customers. While many issues are rolling stock specific, there are enough common requirements to enable these to be taken into account (for example, train/vehicle tracking, consist, connectivity for condition monitoring, etc.).

Currently the CESAR system[48], the intermodal tracking and tracing system developed with European Union is in force for more than 15 years. At time of writing, significant parts of this site are non-functional and Rail Baltica must be careful to ensure that any similar system is managed and maintained, ideally open to all market actors on a fair and non-discrimantory basis provided they undertake to keep systems current.

CESAR stands for Co-operative European System for Advanced information Redistribution. Cesar-online.com is a common European website for transport related information exchange between intermodal operators and their customers. The objective is to attract more logistics companies to use intermodal traffic through offering one standardized sector interface, created and maintained in co-operation, regardless whether the intermodal services the operators offer are produced in competition or collaboration.

The current work and involvement of UIRR for traceability of consignment includes:

- Currently UIRR also operates several databases and issues various codes to enable the operation of IT systems. The "EDIGES" data exchange standard, developed and disseminated as an industry best practice, is also managed by the association.
- The ILU-Code (code of Intermodal Loading Units) owner identification marker: UIRR is not only the Administrator of the ILU-Code, responsible for issuing ILU-Code owner-keys and maintaining the Register of ILU- Code owner-key registrants, but is also engaged in developing a Register of Intermodal Loading Units based on the individual ILU-Codes, as well as other services that will deliver value to the intermodal operators and terminal managers.

Timetabling, scheduling and related areas

If a door-to-door CT time is considered in a wide approach, compared to road hauls, where price is typically derived from a rate per km or ton-km, the costs of pre- and end-haulage road legs are usually determined by the hours consumed for the initial or final leg between a loading place and a CT terminal, or vice versa. The cost of road section hauling charged to the Client is proportional to the time required to make the road journey.

The time is not only coupled with the distance of the haul, but is also influenced by the traffic density in the area, the condition of the infrastructure, the time of the day, and especially the waiting times at CT terminals for transshipment activities.

Against this background we can distinguish the following typical cases according to the road and railway leg distances:

- CT services with rail distances between 500 and 600 km: The origins and destinations of the goods carried by CT load units are likely to be close to the CT terminals on both ends, typically up to about 30 km. If waiting times are not excessive and local roads are not congested, the truck can execute the trip to the CT

[48] https://www.cesar-online.com/index.htm

terminal and execute the transshipment within about 2-3 hours. Typically, the rail journey time should be around 4 to 5 hours and again the trip from the CT terminal including unloading in the range of 2 hours. It gives a total time door to door between 8 to 10 hours

- CT services with rail distances between 600 and 900 km: Origins and destinations of the goods are likely to be located up to 75 km from the CT terminals. The truck or semi-trailer will likely need 3-4 hours for the trip to the CT terminal and execute the transshipment. The rail journey time should be around 5 to 7,5 hours and again the trip from the CT terminal including unloading in the range of 3 hours. It gives a total time door to door between 11 to 14,5 hours.
- CT services with rail distances between 1 000 and 1 300 km: Origins and destinations of the goods are likely to be located up to 120 km from the CT terminals. The truck or semi-trailer will need between 4-6 hours for the trip to the CT terminal and execute the transshipment. The rail journey time should be around 8 to 11 hours and again the trip from the CT terminal including unloading in the range of 4 hours. It gives a total time door to door between 16 to 21 hours.

If it is considered the following RB traffic forecasts expressed in trains per day (please refer to traffic forecast chapter):

Country	Number of piggy back CT trains per day			
	Accompanied CT		Unaccompanied CT	
	Average	Max	Average	Max
Estonia	0,02	0,54	0,22	0,79
Latvia	0,06	1,44	0,58	2,12
Lithuania	0,07 (2 trains per month)	1,67	0,68 (3 trains a week)	2,46

Table 14. **Number of piggyback CT trains per day (Source: Consultant)**

Among these trains, about 20 % should be transit ones, one train every 2 days with a minimum of 795 km railway journey and average door to door trip time of 13 to 14,5 hours. Considering this trip time, a single shuttle train should be required (day 1 terminal A to B, day 2 terminal B to A).

Regarding other traffic, domestic, export or import for each country (about 80 % of the traffic), it can be considered that on average the railway journey distance should be maximum in the range of 300 km. It gives an average door to door trip time of 6,5 to 7,5 hours and some kind of shuttle service can be offered (2 departure per day).

Short-haul / drayage or "last mile" considerations

Combined Transport is affected both through the potential effects this will have on first and last mile road haulage – an important component of an intermodal transport chain – as well as through the changes to transport prices that may increase as a consequence.

Amendment of Directive 92/106/EEC:

The Combined Transport Directive (92/106/EEC) is currently the only EU legal instrument that directly supports multimodal transport. Its aim is to increase the competitiveness of combined transport vis-à-vis the road only transport and through that reduce the negative externalities of transport sector.

The evaluation concluded in 2016 as well as the previous public consultation identified the following shortcomings with the current Directive:

- Problematic definition: The definition of combined transport is complex and somewhat ambiguous creating problems with the implementation. Furthermore, the definition is limited in scope.
- Non effective incentives: The economic incentives **(reimbursement of or exemption from road vehicle tax) foreseen are not effective**.
- Problems with implementation and monitoring:
    - The provisions relating to transport documents are outdated making it difficult for industry to prove and authorities to control eligibility.
    - No effective market monitoring exists (no EU wide common terminology based statistics gathering nor reporting of all national measures) making it difficult to ensure appropriate systematic assessment on the need of the economic support.

The need for national support measures for combined transport is underlined in the amendment of Directive 92/106/EEC[49] on the establishment of common rules for certain types of combined transport of goods between Member States. Main issues covered by this amendment -January 2019- are linked to the definition of CT transport and the definition of "Nearest terminal":

- 150 km and 20% limits of the road leg. According to the European Commission's proposal from 8 November 2017, the road leg in CT operations should not exceed the longest of the following two distance limits on EU territory:
    - 150 km as the crow flies between the CT terminal and the point of loading or unloading;
    - or 20% of the total door-to-door distance of a goods transport as the crow flies both for the initial and the final leg.

The Council of the European Union whilst backing the 150 km limit suggests to removing the 20% provision because an implementation of the 20% limit would imply a bureaucratic and costly system of evidences due to compromise the efficiency of CT operations.

The Commission has proposed a further rule on determining the length of an eligible road leg. The initial and/or final road haulages may be executed over even longer distances to the geographically nearest terminal in case of a

[49] https://ec.europa.eu/transport/themes/urban/consultations/2017-CTD_en

facility fulfilling certain eligibility criteria such as handling capacity, opening times or appropriate services cannot be reached within the 150 km and 20% limits.

There are numerous regions that currently do not provide for a terminal and/or rail infrastructure, which would enable users to reach an appropriate facility within a 150 km distance mainly due to the fact that the loading gauge (railway) cannot face semi-trailers on conventional flat wagons.

Business model of CT operators

The typical business model for continental CT rail/road still sees the CT operators as the brokers between demand and supply side. The main customer groups are forwarders, road operators, and other logistic service providers that design and carry out the door-to-door logistics services for shippers, use their own or rented CT equipment and also care for the pre-and on-carriage of the CT load units by road.

The key value proposition of CT operators is to deliver cost-efficient CT services to enable their customers to compete successfully for door-to-door logistics on the market (customer value). Based on customer requirements, the CT operators define the service level of CT services and implement them on their behalf. This concept corresponds to the principal terminal-to-terminal business model comprising the following components:

- Rail transport of the clients' load units including the provision of wagons;
- Terminal handling of load units at both ends of the rail journey;
- Administrative clearance of pick-up and delivery lorries (check-in/check-out) and the technical and safety check of load units at both terminals.

The CT operators commonly buy block trains (the full capacity of a train), from RUs and thus take on the economic risk of selling the train capacity. The contracts typically are concluded on an annual basis.

Changing these factors (block trains, annual contract) could encourage the modal shift: specific business model should be developed taking into consideration lot of additional factors as the management of "individual" CT wagon included in general freight trains (taking into account any shunting activities), cost and tariff calculations, loading and unloading times and related aspects, etc. In addition, the specific potential for block trains in the Rail Baltica environment should be considered, whether for "block train-style" shipments to/from Finland (or 1520/1435 transshipment), or for sector-specific needs such as automotive. The scope for integrating CT business models and this traffic remains to be seen.

APPENDIX: Coupler Capacity

Issue of coupler capacity according to typical RB CT train load is thereafter presented according to the above table and 8°/°° maximum gradient.

For RoLa solution:

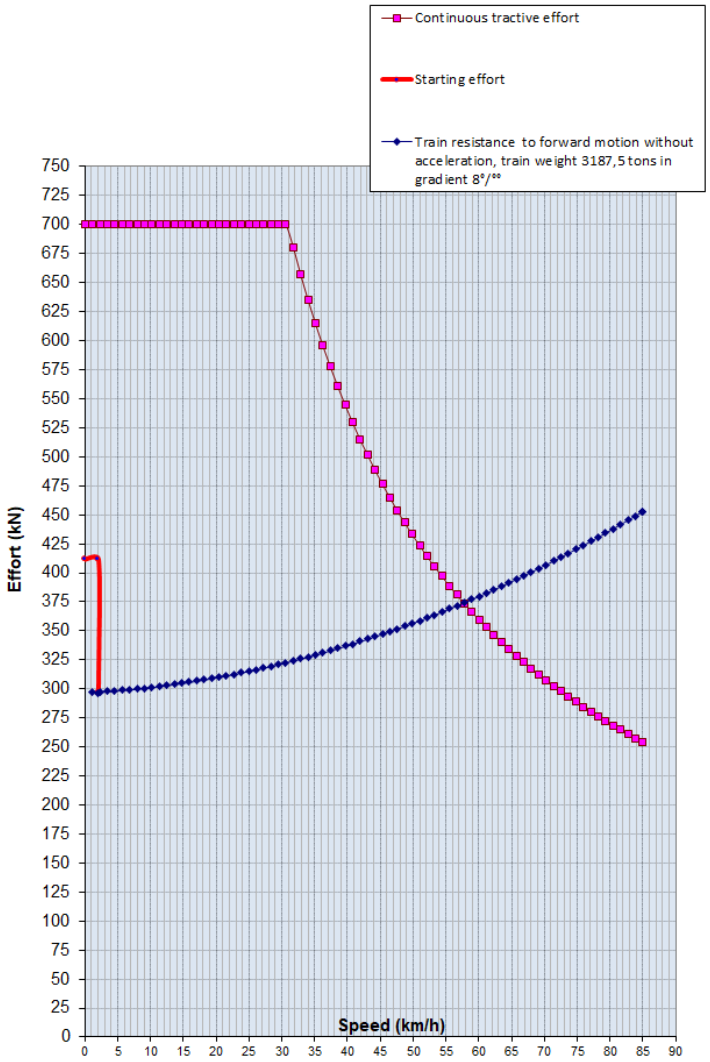


Illustration 77. Tractive effort curves in ramp 8°/°° for a RB RoLa train

The above figure shows that the maximum starting effort in ramp 8 of °/°° is in the range of 411 kN.

The UIC coupler 850 kN is weak with a safety coefficient of 2,06. With last recent UIC coupler 1 000 KN, the safety coefficient is 2,42 and is acceptable.

For UCT solution:

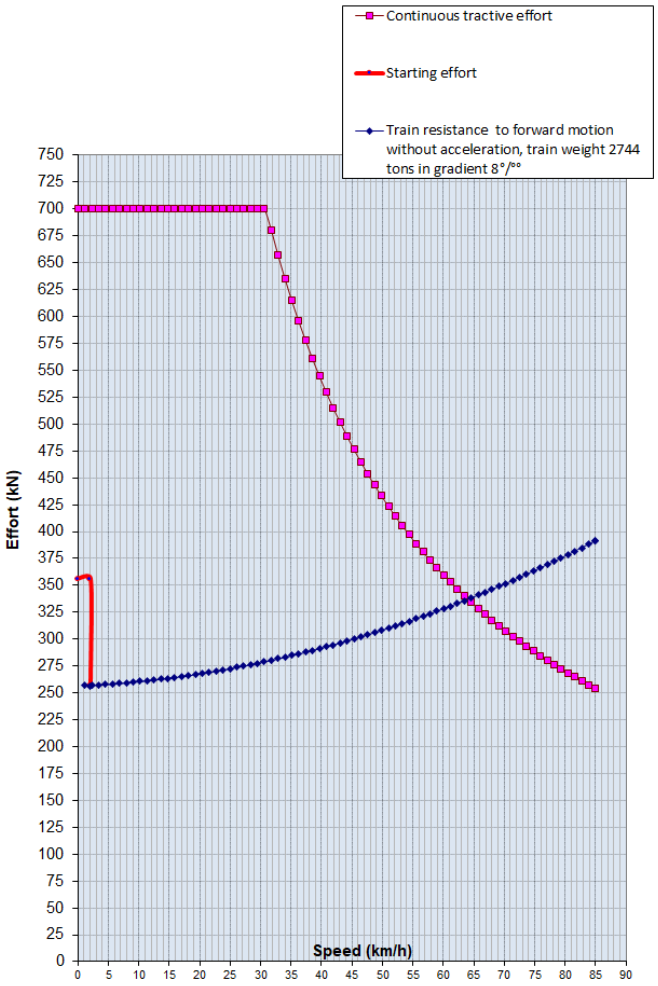


Illustration 78. Tractive effort curves in ramp 8°/°° for a RB UCT train

The above figure shows that the maximum starting effort in ramp 8 of °/°° is in the range of 368 kN.

The UIC coupler 850 kN is suitable with a safety coefficient being 2,30. With last recent UIC coupler 1 000 KN, the safety coefficient is 2,72 and oversized.

For Modalohr solution:

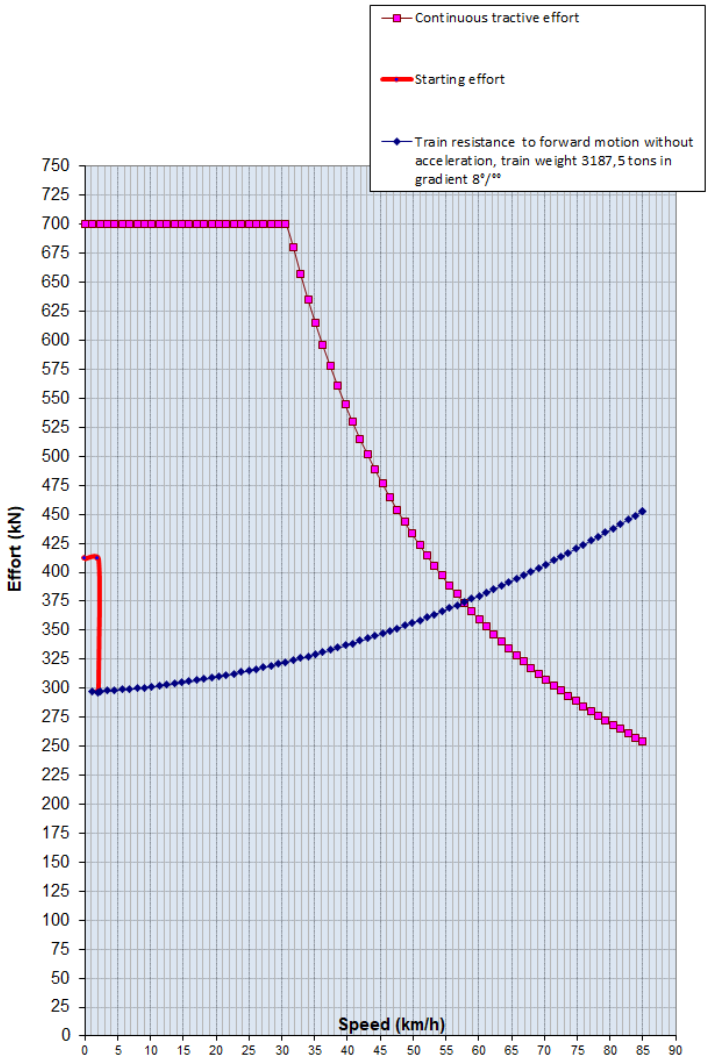


Illustration 79. Tractive effort curves in ramp 8°/°° for a RB Modalohr train

The above figure shows that the maximum starting effort in ramp 8 of °/°° is in the range of 433 kN.

The UIC coupler 850 kN is weak with a safety coefficient of 1,96. With last recent UIC coupler 1 000 KN, the safety coefficient is 2,30 and is acceptable.

For Eurotunnel solution:

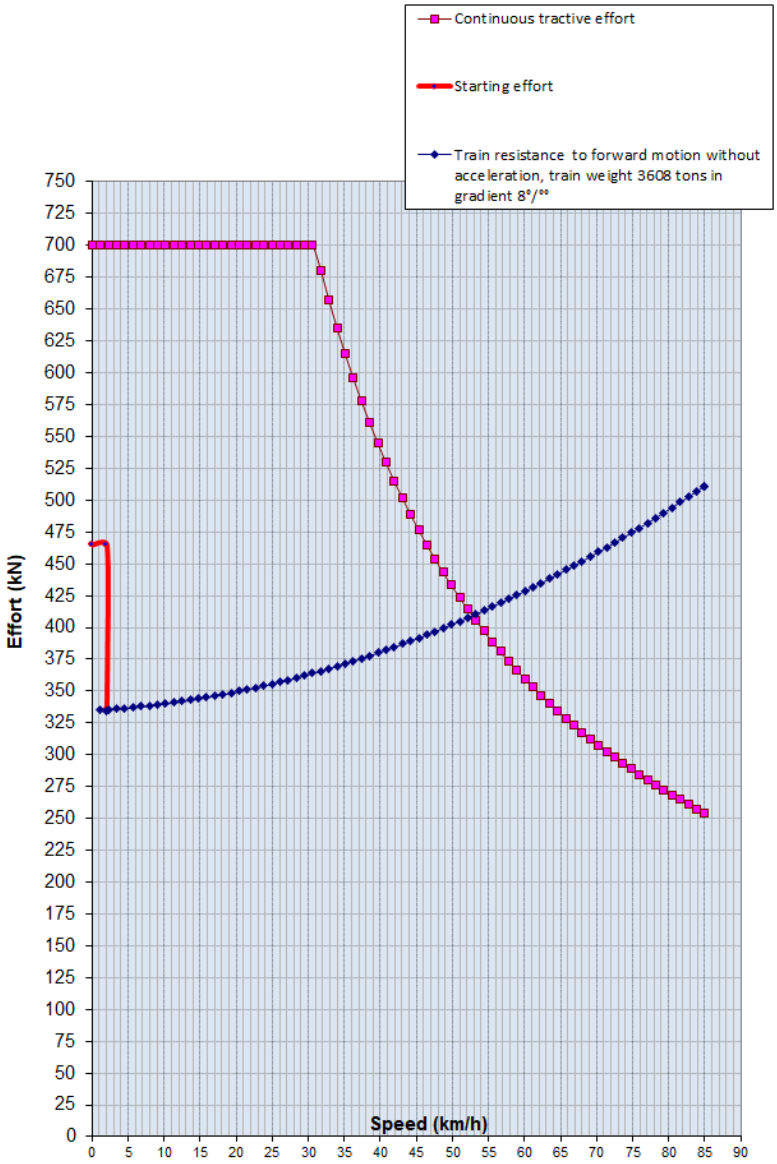


Illustration 80. Tractive effort curves in ramp 8°/°° for a RB Eurotunnel train

The above figure shows that the maximum starting effort in ramp 8 of °/°° is in the range of 464 kN.

The UIC coupler 850 kN is weak with a safety coefficient of 1,82. With last recent UIC coupler 1 000 KN, the safety coefficient is 2,10 and is acceptable.