WARSAW UNIVERSITY OF TECHNOLOGY
FACULTY OF TRANSPORT
DEPARTMENT OF TRANSPORT SYSTEMS ENGINEERING AND LOGISTICS

Advances in global intermodal transport

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Agenda:

- Basic definitions
- Container transport statistics
- Marine intermodal terminal handling equipment advances
- Rail-road technologies
- Advances in rail-road technologies

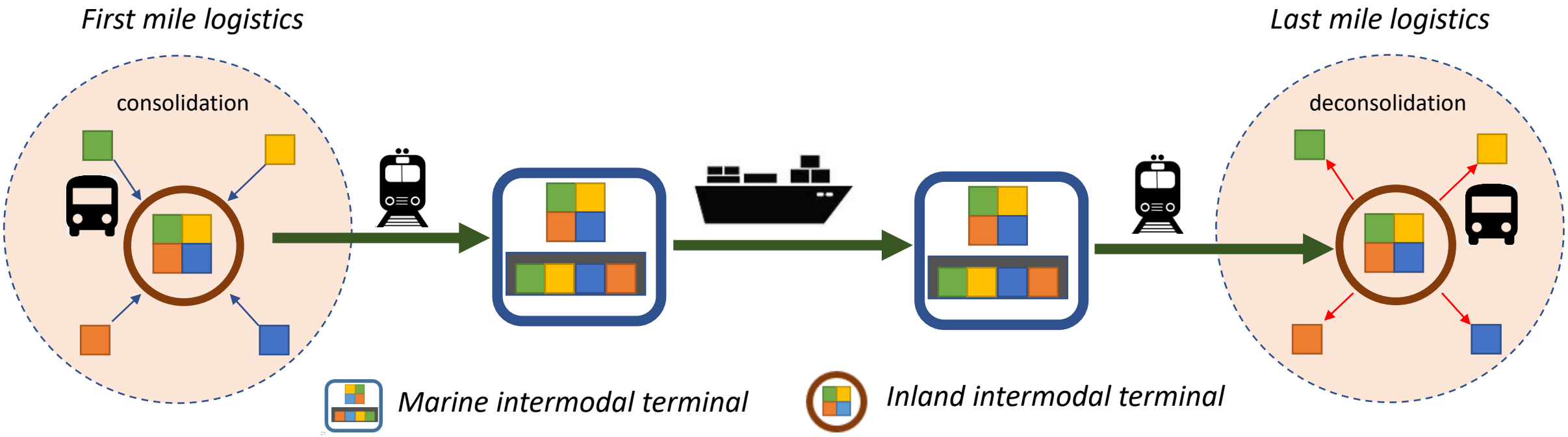
Basic definitions

Multimodal transport - transportation of goods under a single contract, but performed with at least two different means of transport.

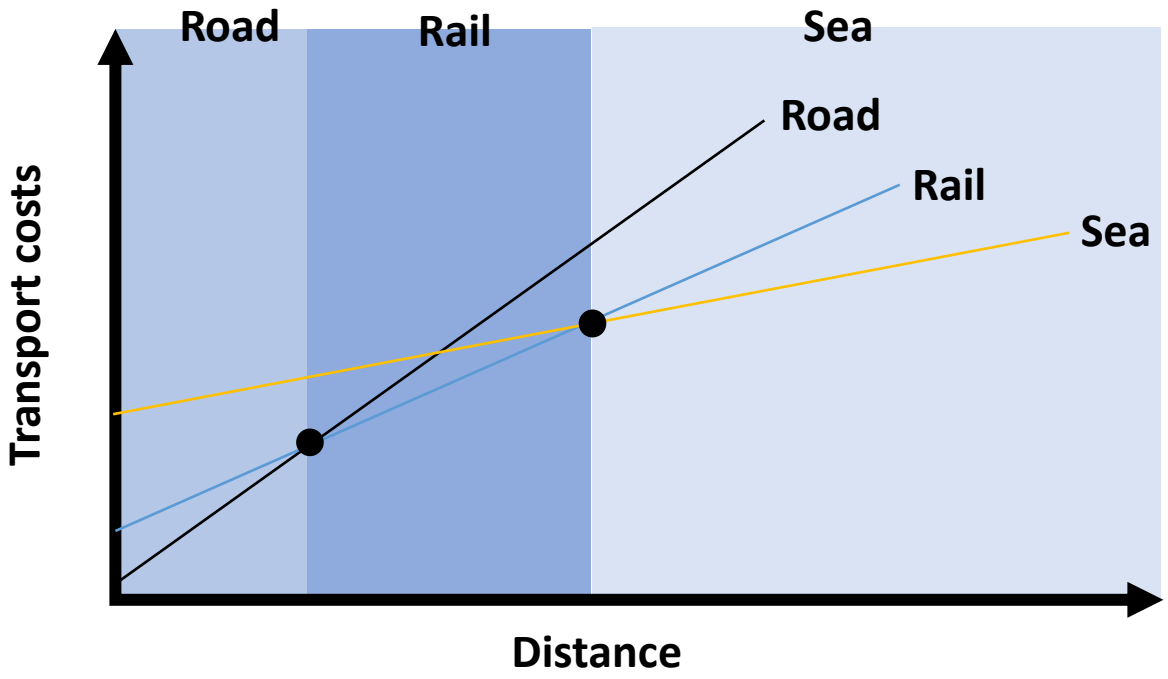
- the carrier is responsible for the entire carriage, even though it is performed by several different modes of transport. The carrier responsible for the entire carriage is referred to as a multimodal transport operator (MTO).

Intermodal transport involves the transportation of freight in an intermodal container or vehicle, using multiple modes of transportation, without any handling of the freight itself when changing modes.

Combined transport - a form of intermodal transport, where goods are moved in one and the same loading unit or road vehicle, using successively two or more modes of transport without handling the goods themselves while changing modes of transport. Combined transport is a kind of an intermodal transport where the major part of the journey is performed by rail, inland waterways or sea, and any initial and/or final routes are carried out by road transport. The road transport should be as short as possible

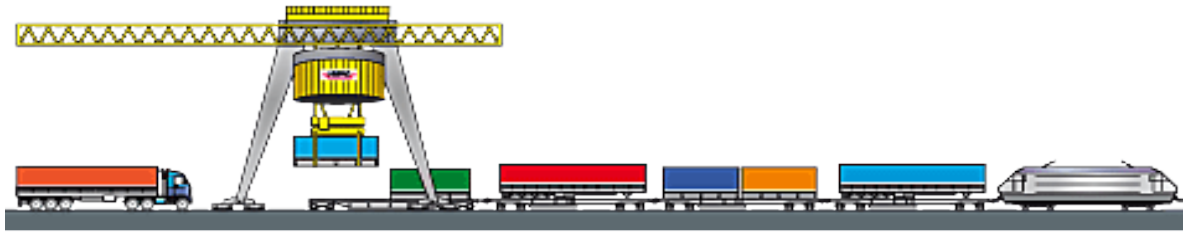


Why is the intermodal transport so popular



INTERMODAL TRANSPORT

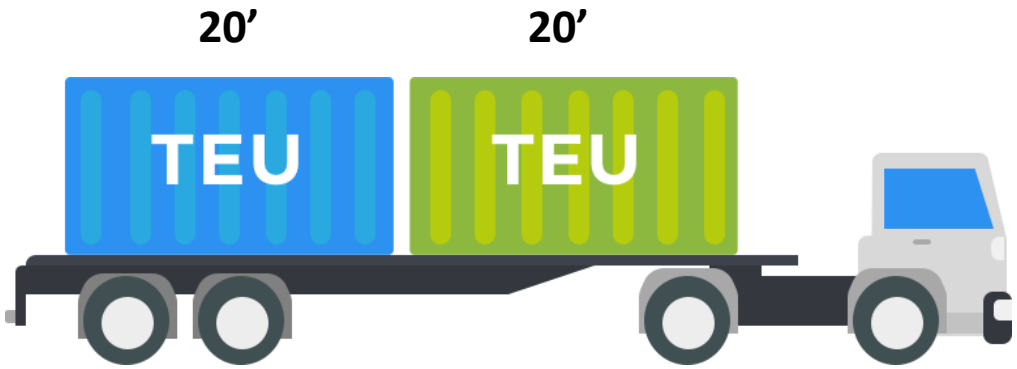
- technologically efficient, pro-ecological and effective form of cargo movement



1 liter of fuel allows to move up to 97 tonnes of freight by rail, while only 50 tonnes by truck

Intermodal transport elements

- Infrastructure: roads, rail roads, transshipment terminals, transshipmen equipment;
- Transportation vehicles and intermodal transport units;
- Intermodal market participants: transportation companies, freight forwarders, customers, transshipment terminals



UTI – French: (*Unite de transport Intermodal*)

ITU – English: (*Intermodal Transport Unit*)

TEU – (*Twenty-feet Equivalent Unit*) – calculation unit of a 20’ container size

FEU – (Forty-feet Equivalent Unit) – calculation unit of a 40’ container size (2xTEU)

Intermodal transport units

a) Container,
b) Semitrailer,
c) Swap body,
d) Truck,
e) Tractor + semitrailer,
f) Truck + trailer.

a

b

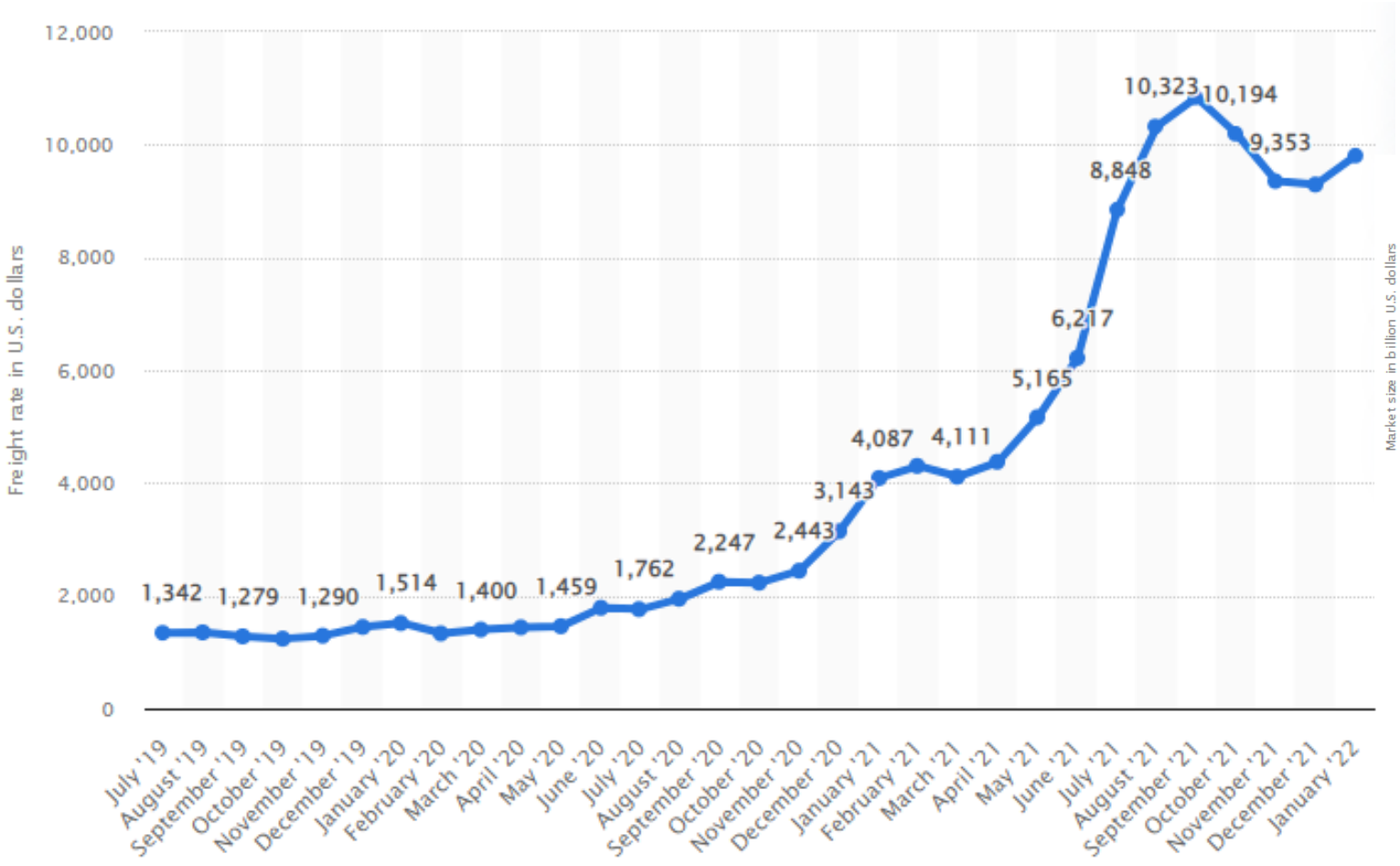
c

d

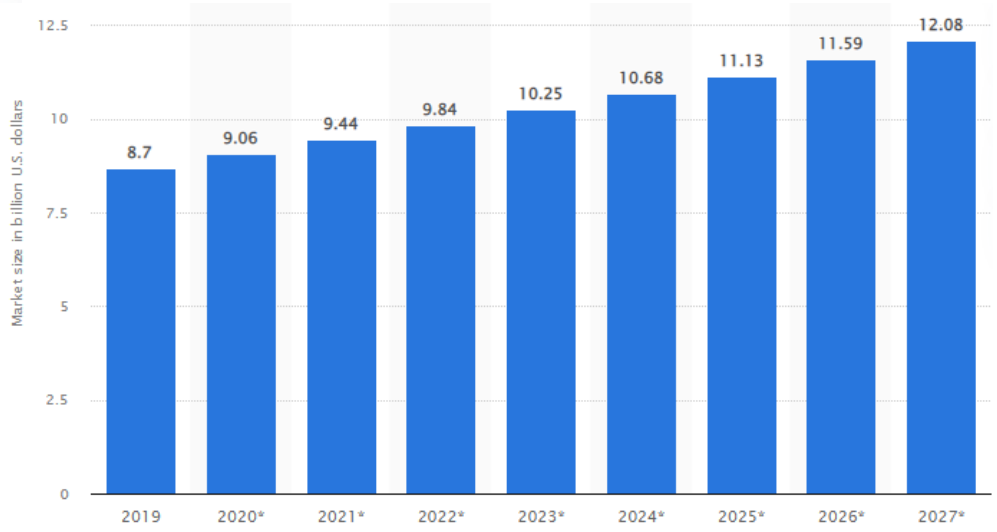
e

f

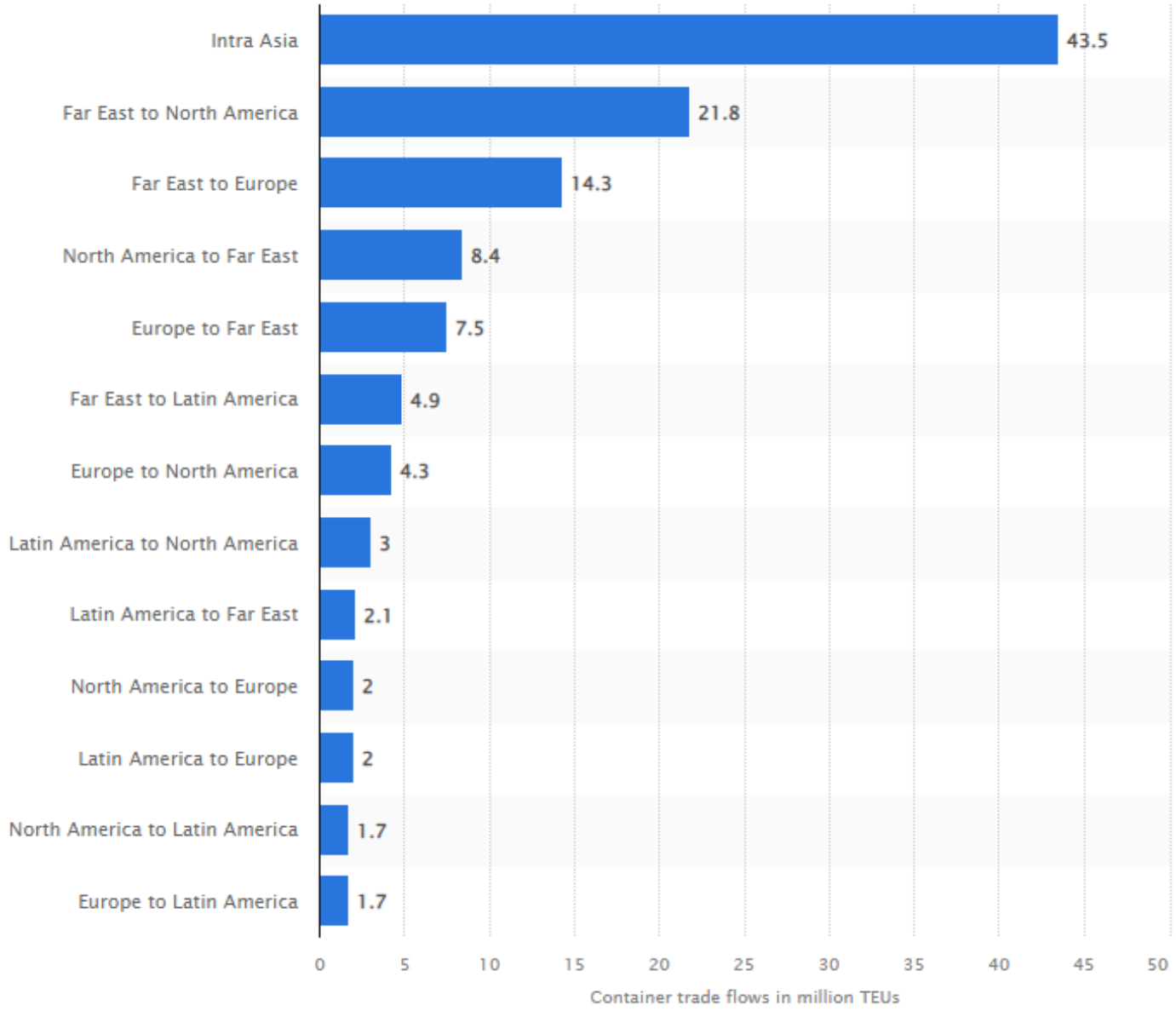
Global container freight rate index from July 2019 to January 2022



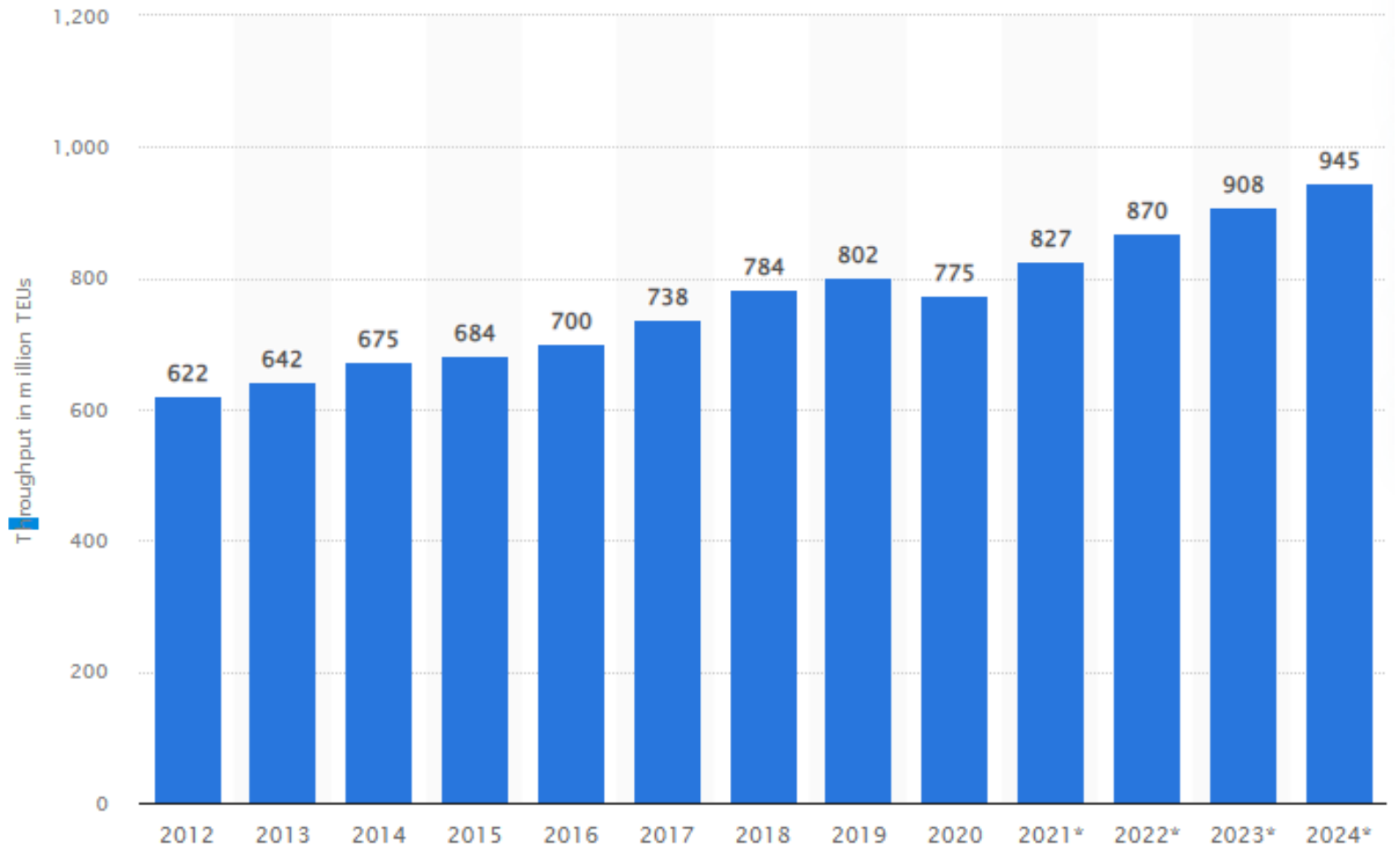
Projected size of the global shipping container market between 2019 and 2027



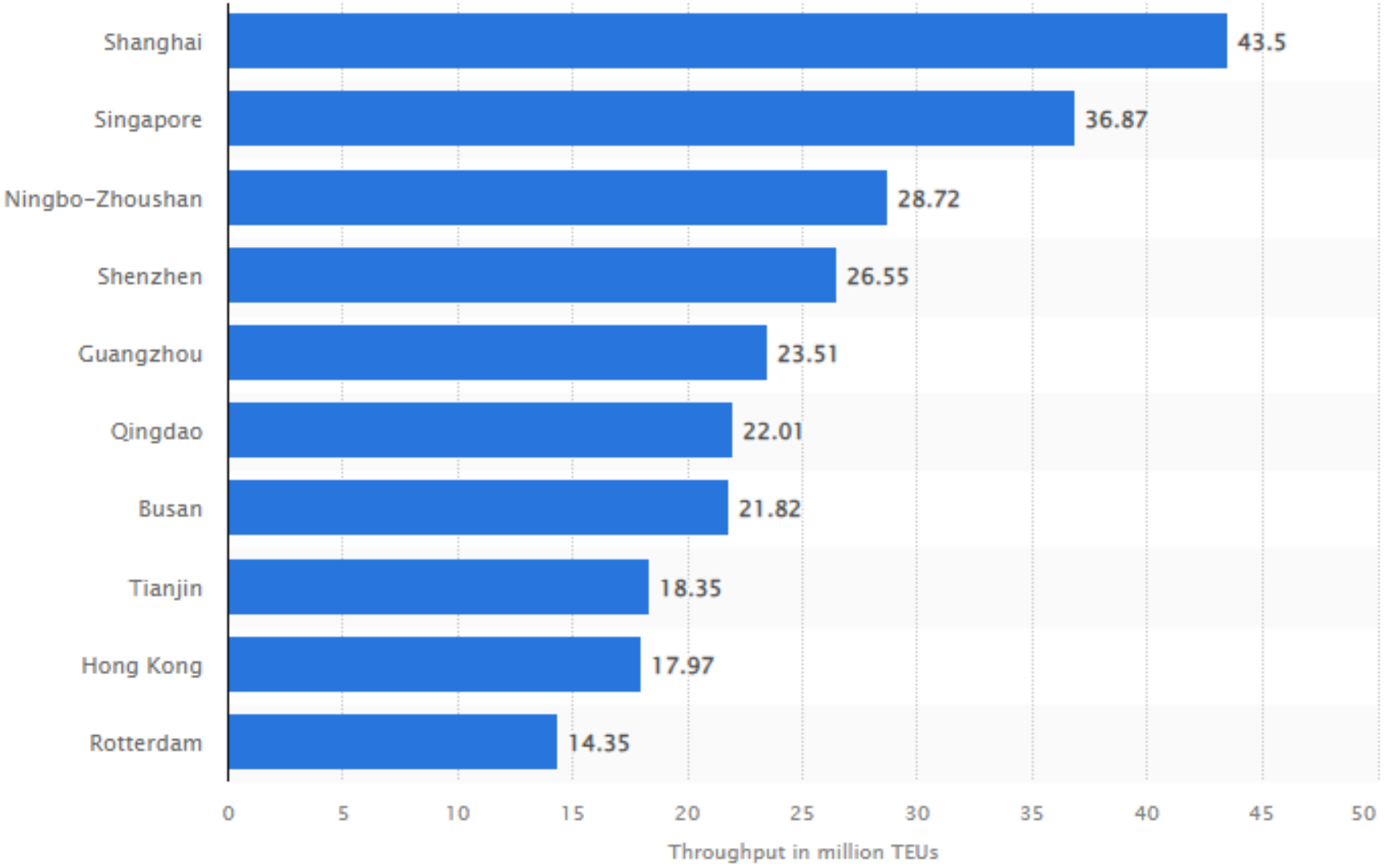
Projected global container trade between 2021 and 2025, by trade lane



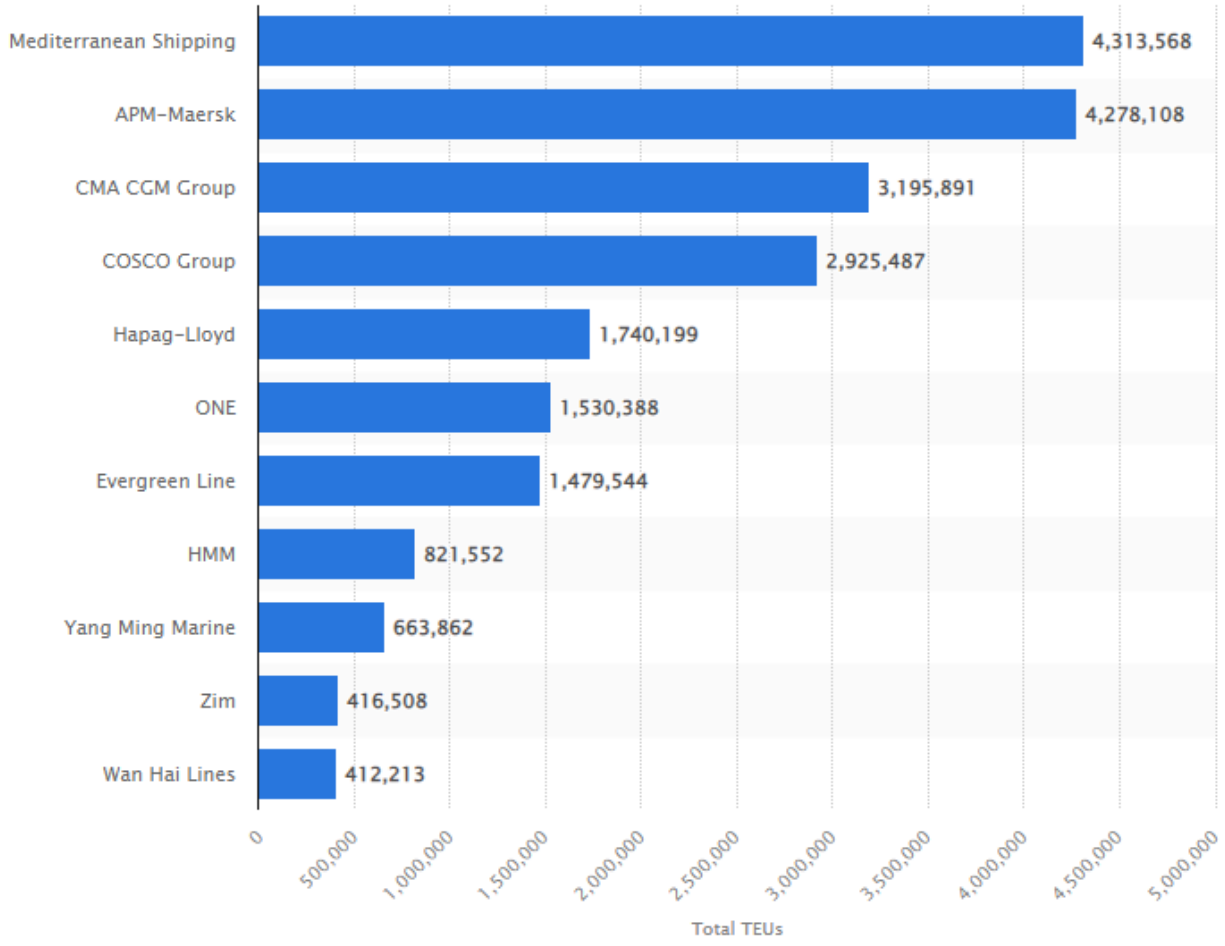
Container throughput at ports worldwide from 2012 to 2020 with a forecast for 2021 until 2024

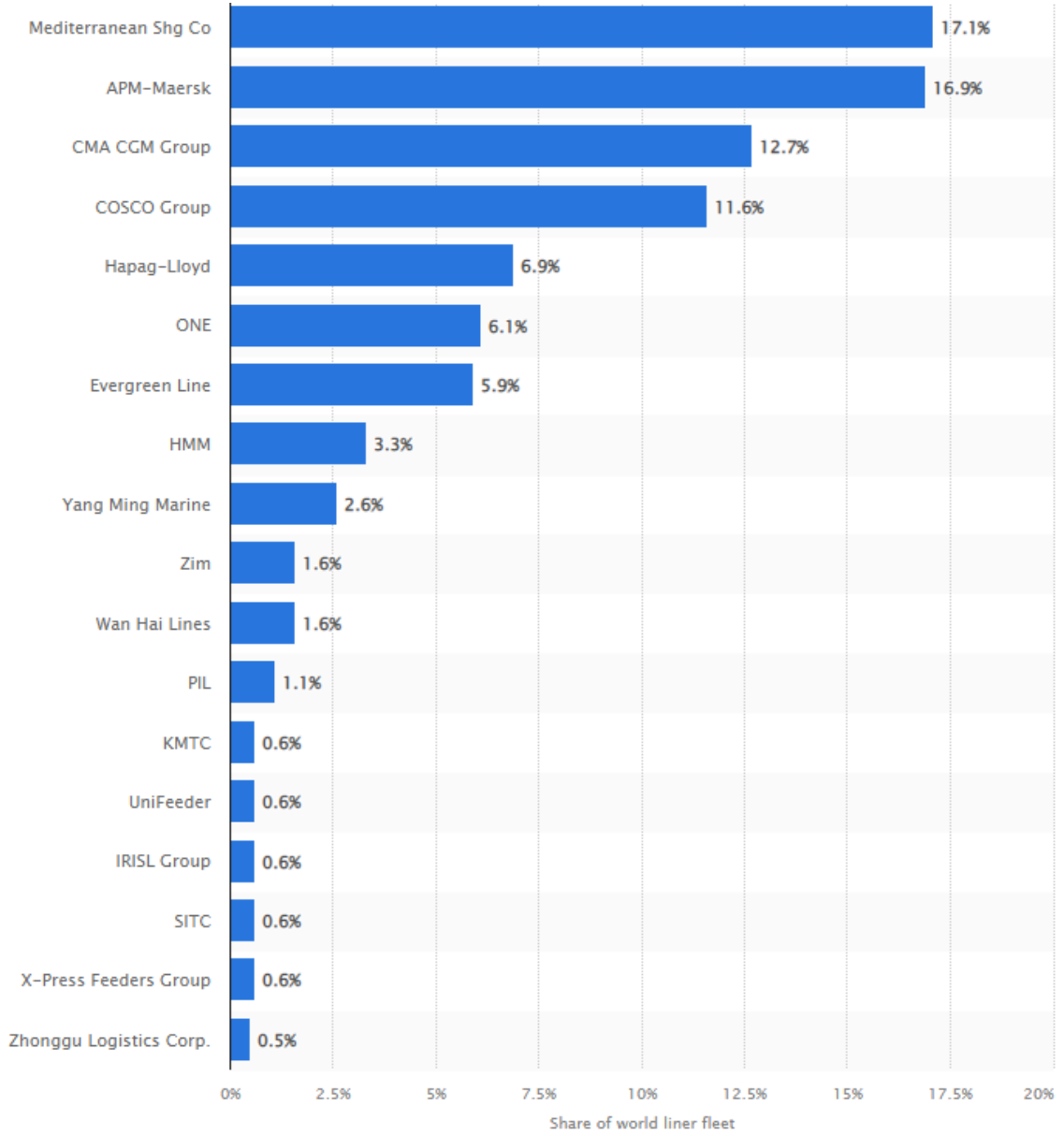


The largest container ports worldwide in 2020, based on throughput

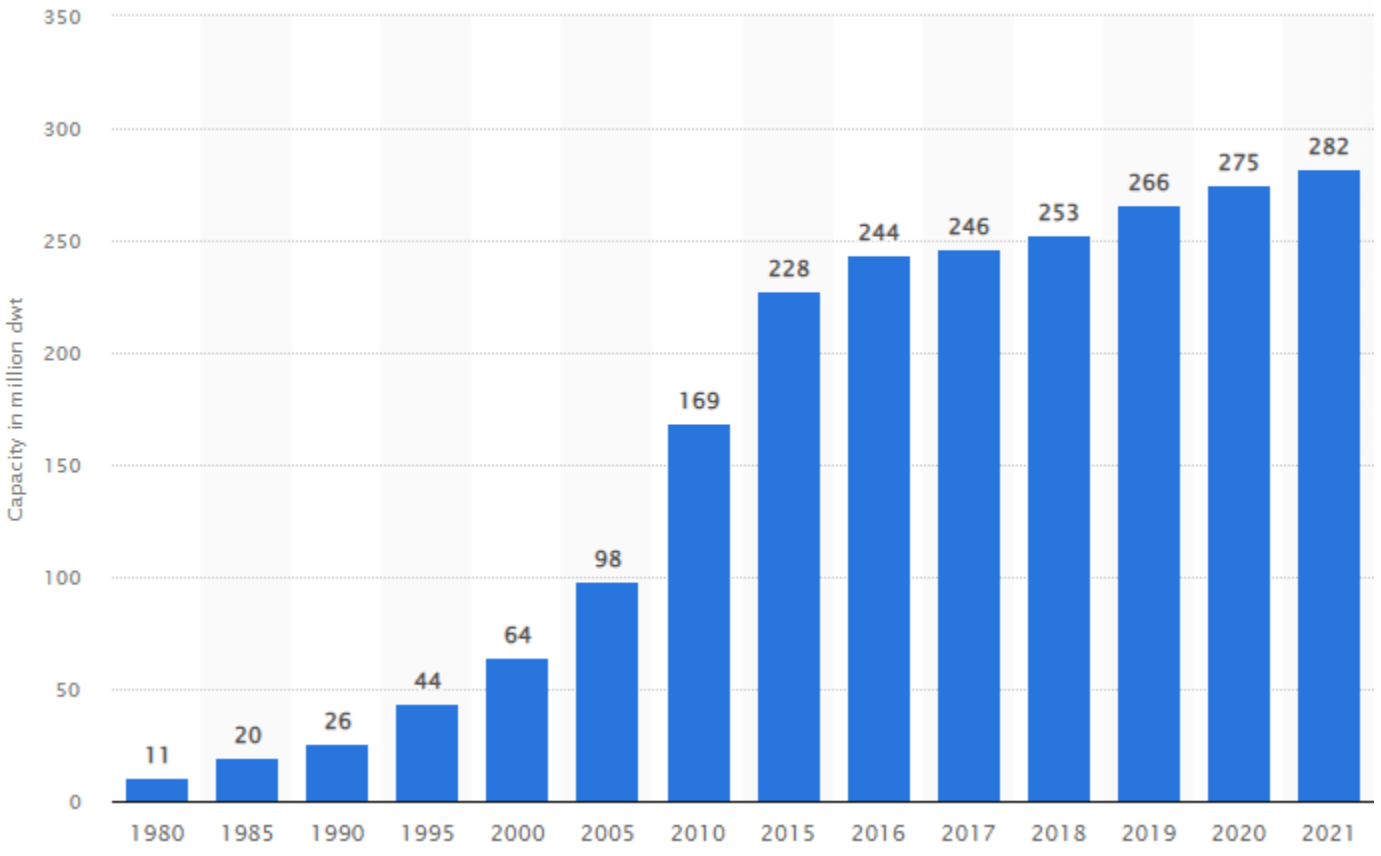


The world's leading container ship operators in 2022, based on TEU capacity

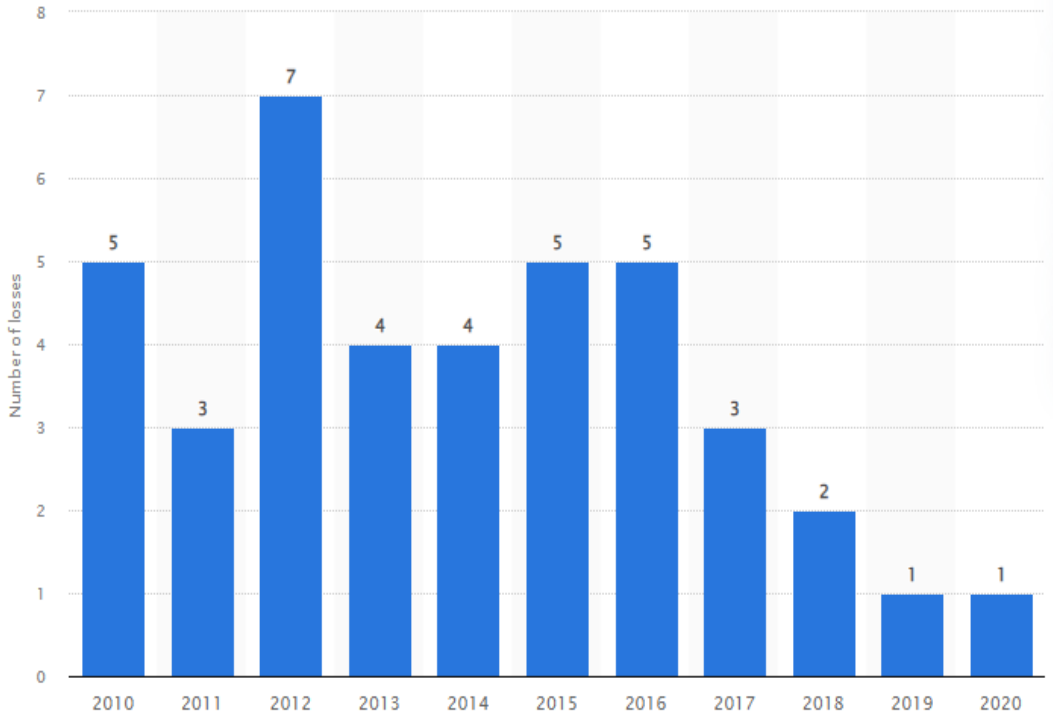




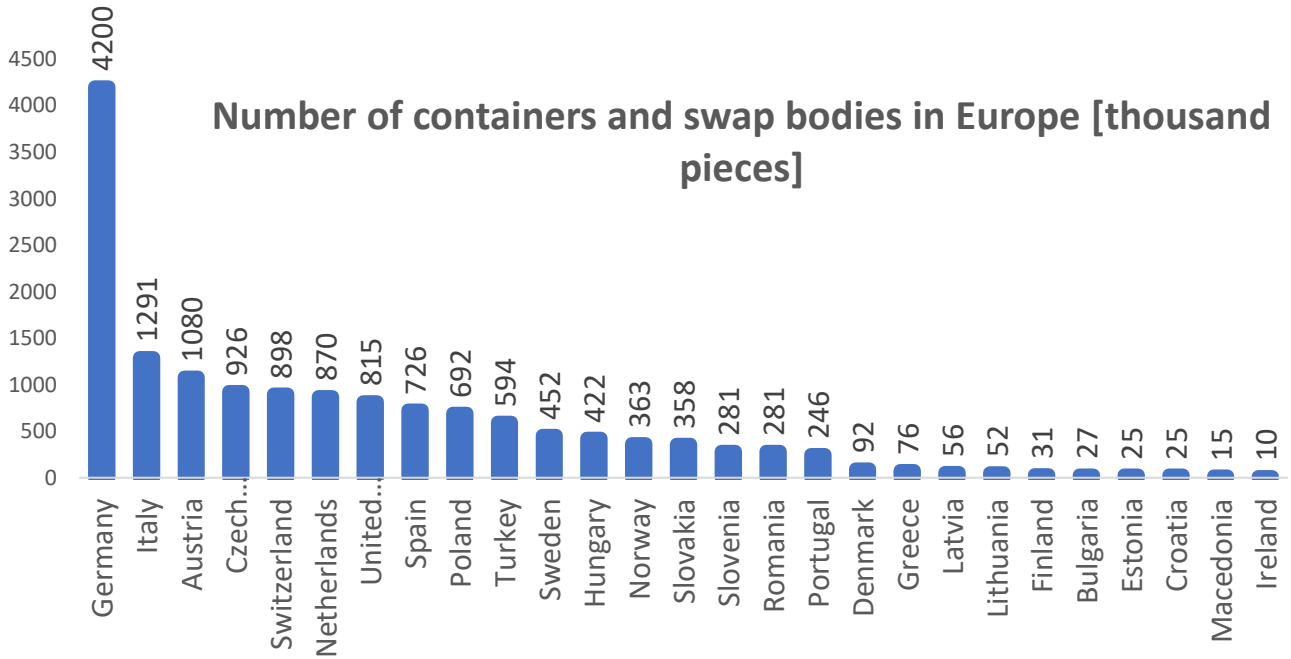
Capacity of container ships in seaborne trade from 1980 to 2021

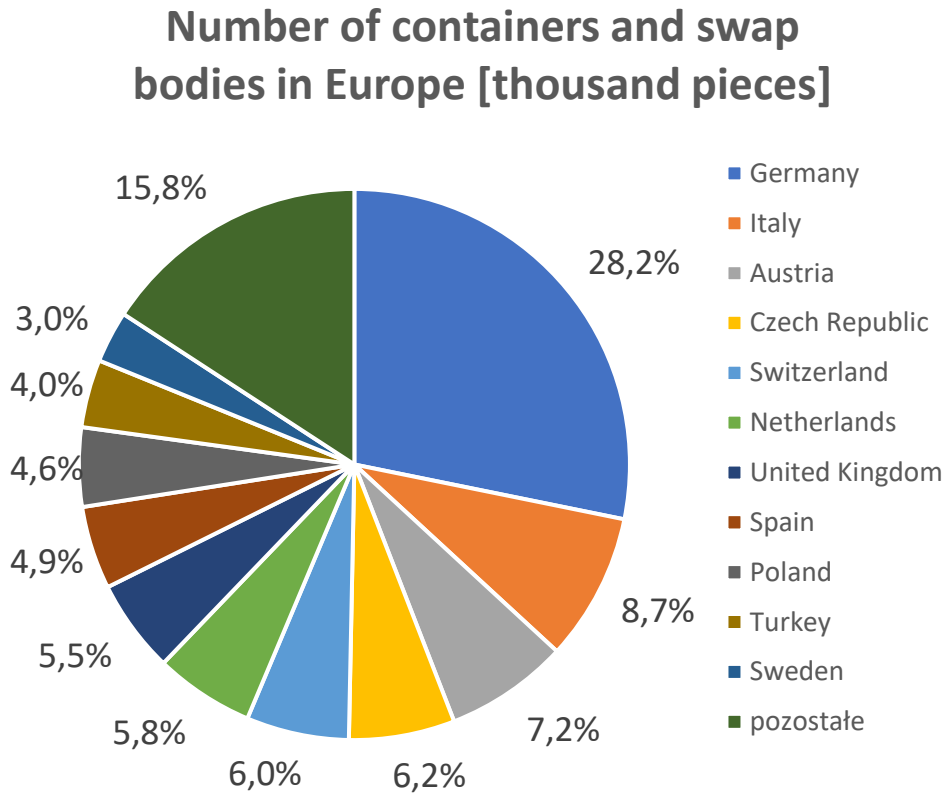


Number of container ships lost worldwide



Intermodal transport in Europe



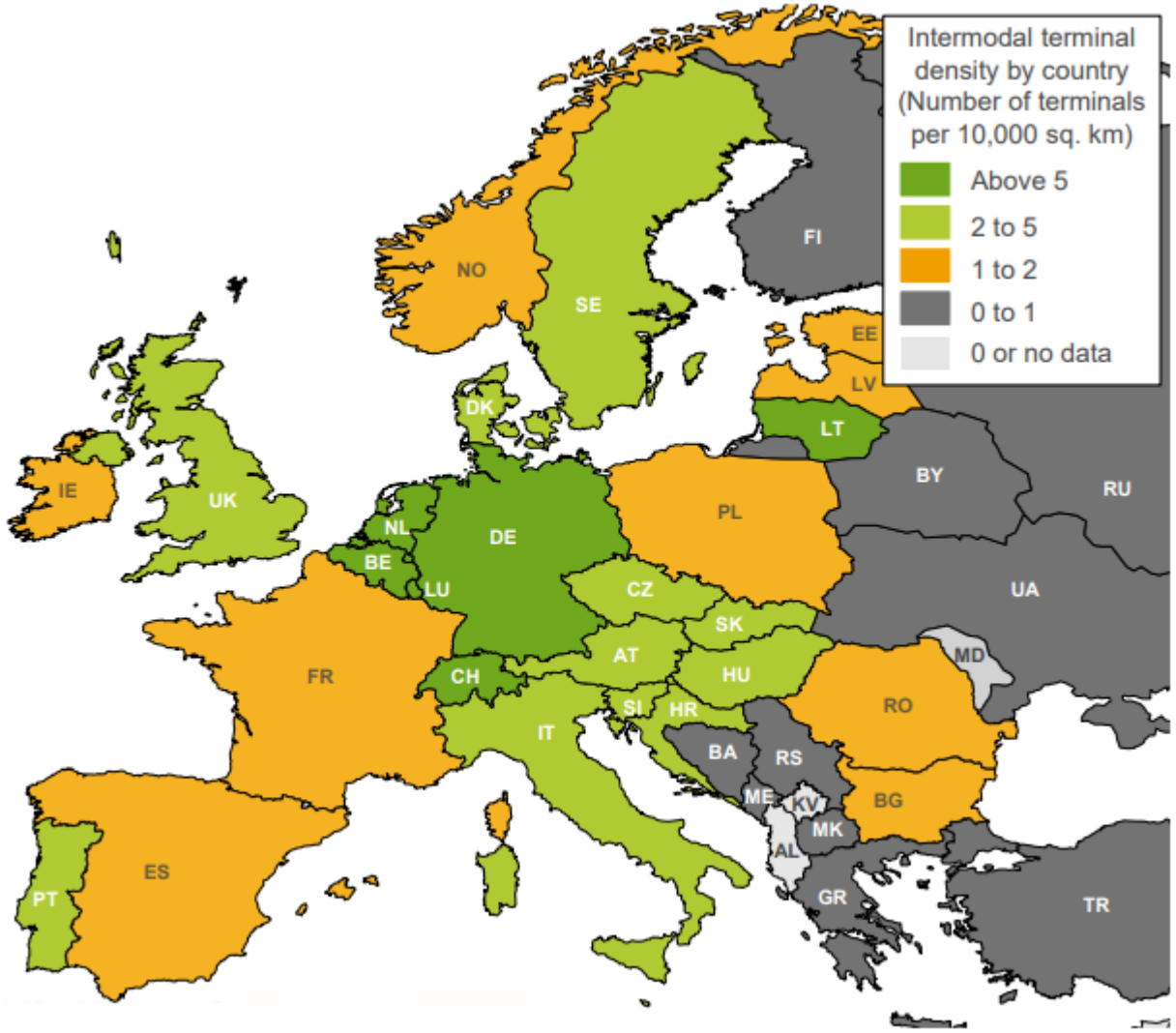


Intermodal transport is strongly promoted within the framework of the sustainable transport development policy in the EU:

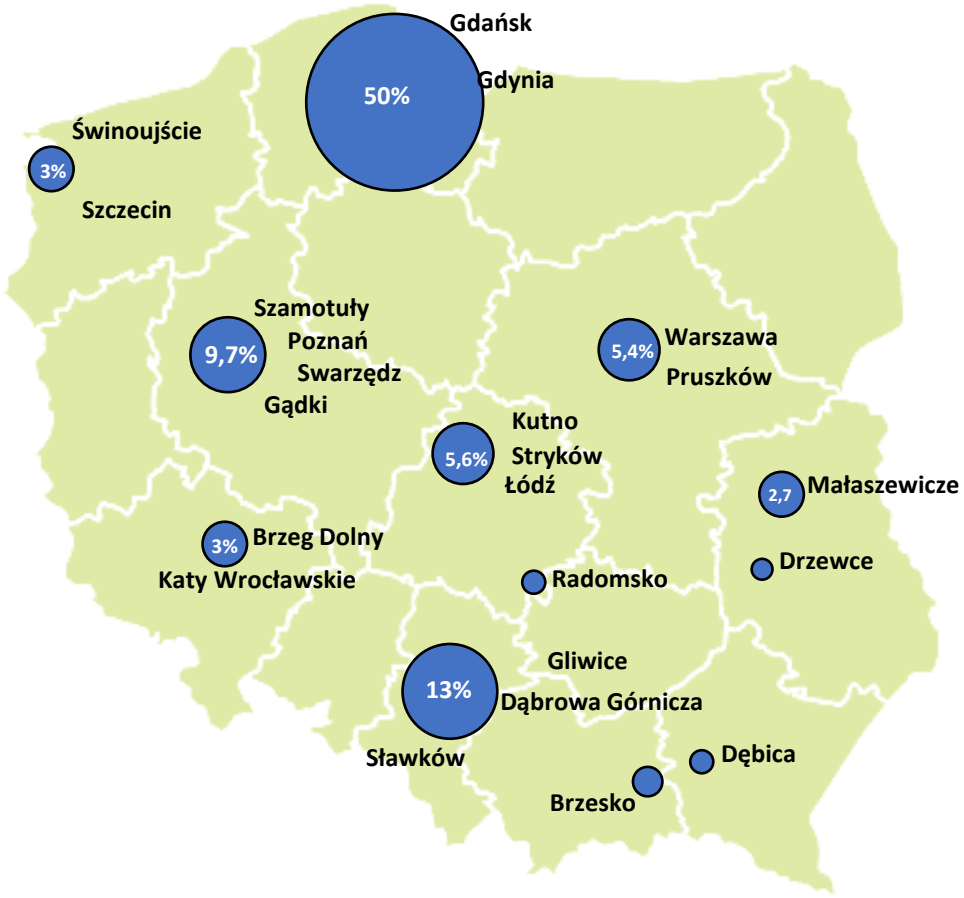
WHITE BOOK– ***Roadmap to a Single European Transport Area - Towards a competitive and resource-efficient transport system:***

- ❑ Reduction in the transport sector of pollutant emissions by 60% by 2050;
- ❑ The use of rail transport in long-distance transport

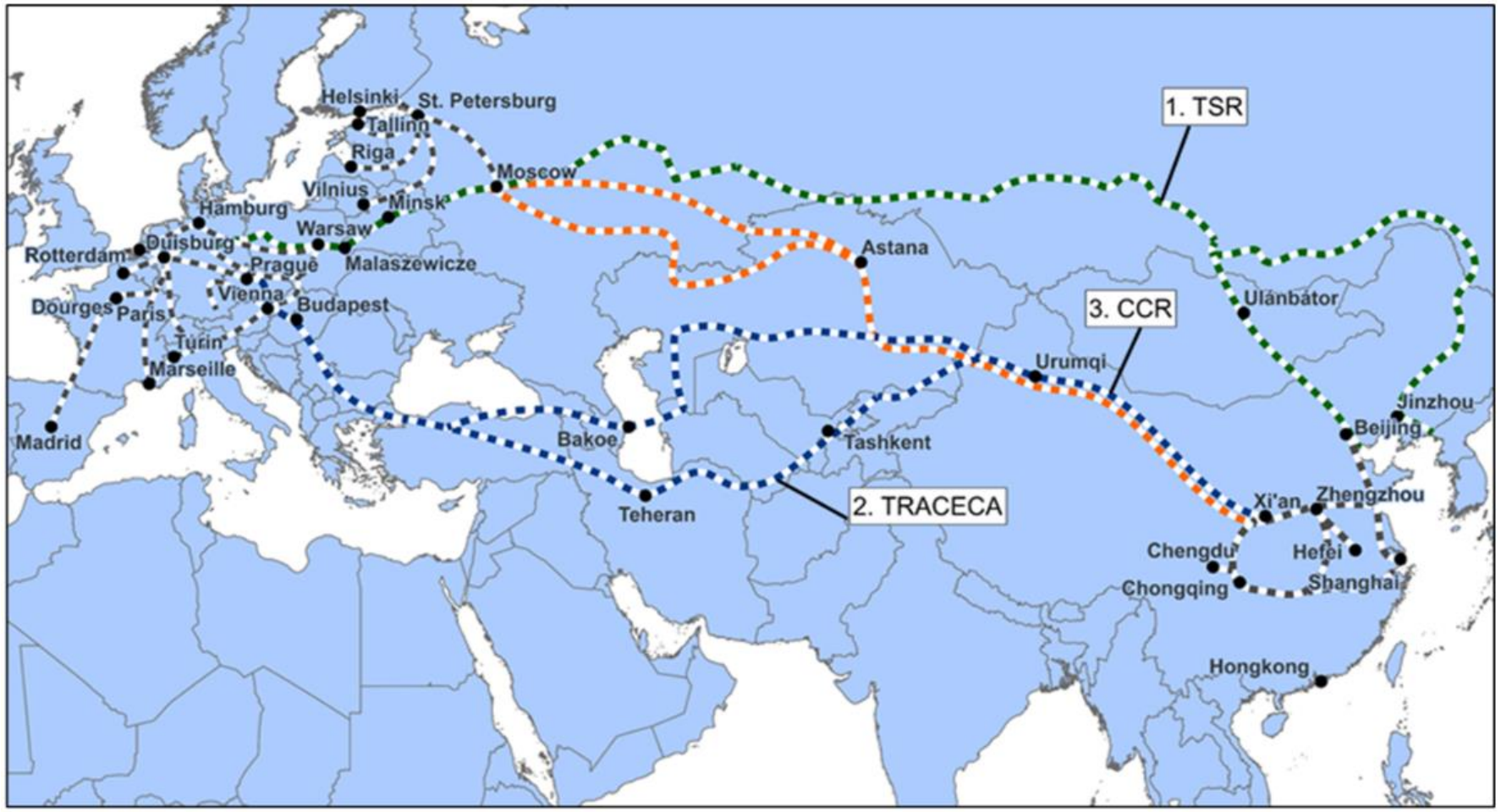
Intermodal terminals density in Europe



Intermodal terminals in Poland



New Silk Railway



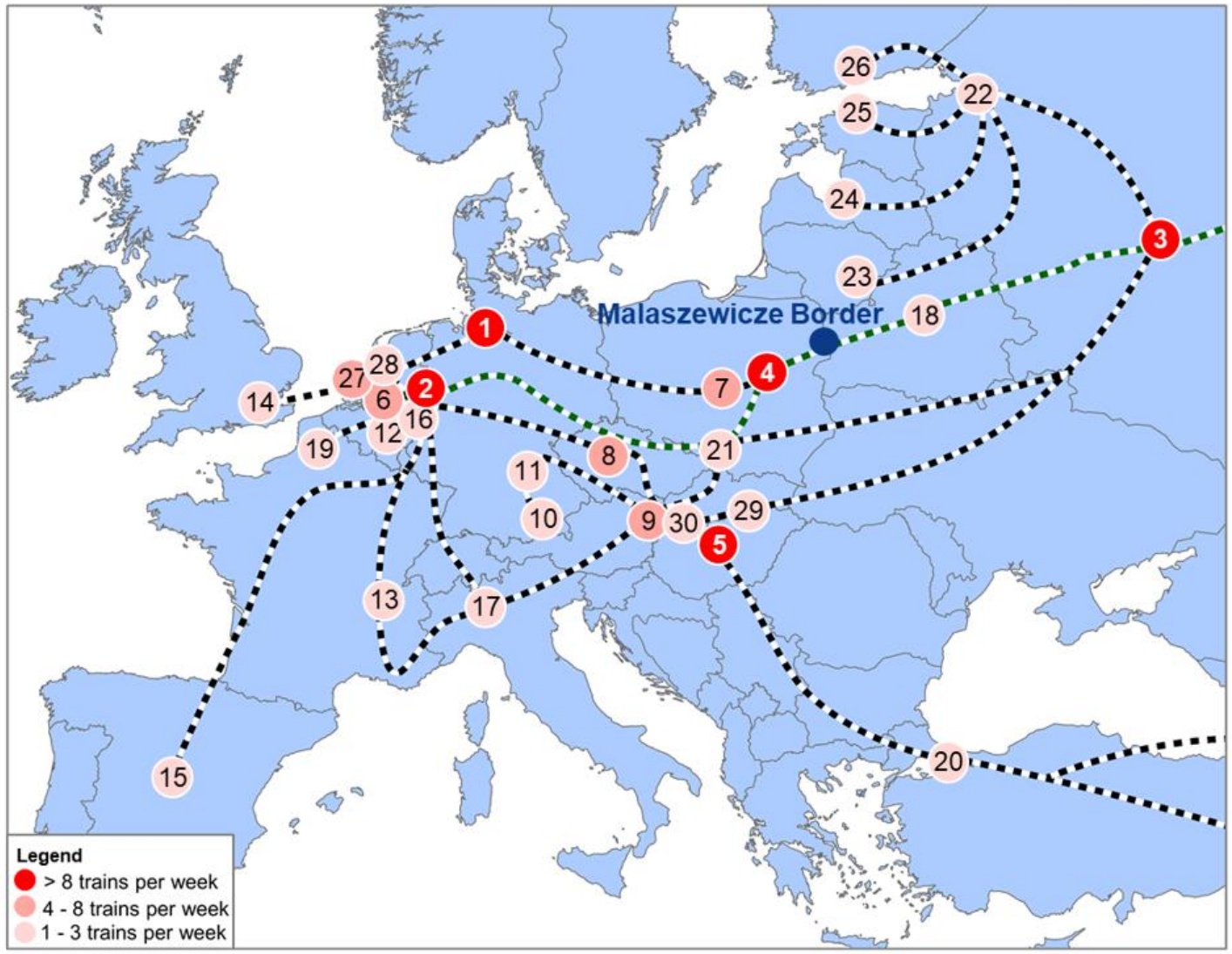
1 Trans-Siberian Route (TSR): connecting Northern China, Mongolia, Russia the Baltics and Scandinavia

2 TRACECA: connecting Western Europe via Turkey and countries around the Black Sea and the Caspian Sea

3 Central Corridor Route (CCR): connecting Western Europe via Belarus-Poland and Ukraine-Slovakia

- The new Silk Rail Routes between China and Europe have shown a fast growth with an increase of 50% in volume and 100% in value in the last five years.
- Currently, about 150 trains per week run between 30 European location and 16 regions in China

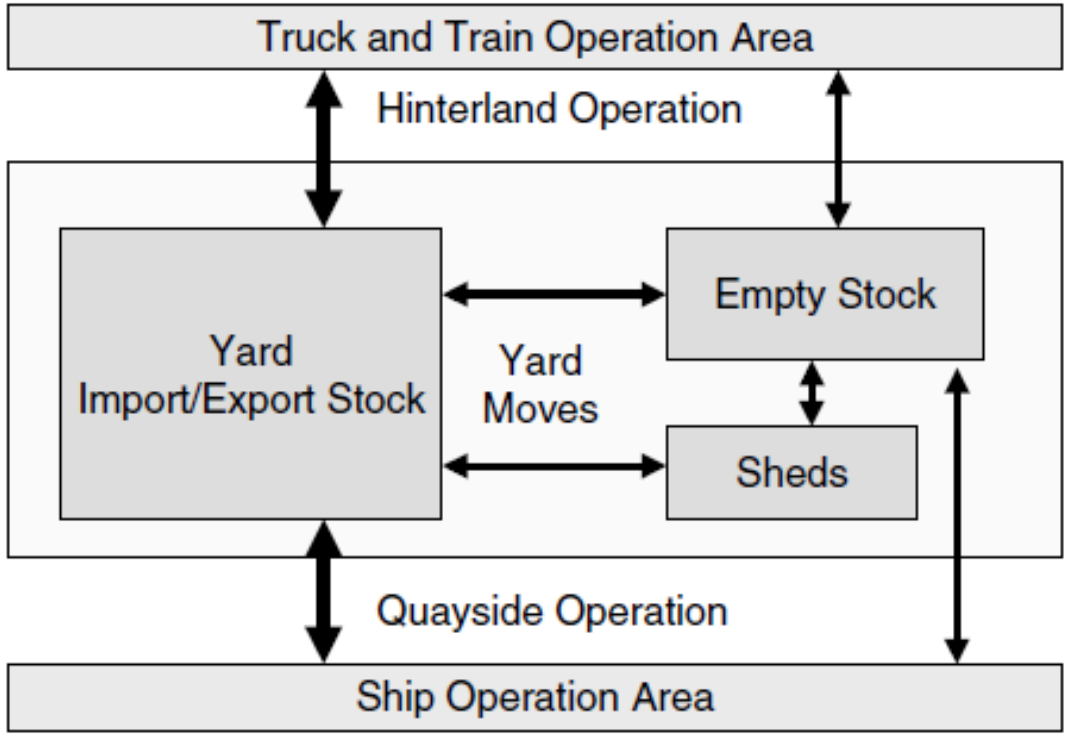
New Silk Railway

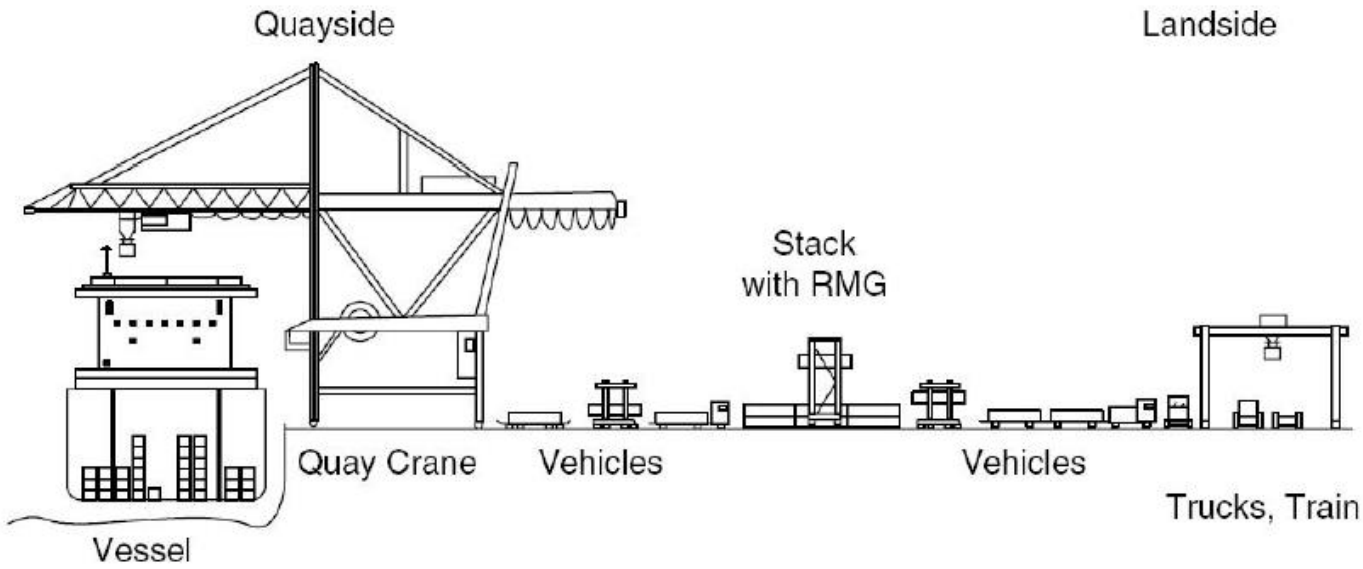


1 Hamburg
2 Duisburg
3 Moscow
4 Warsaw
5 Budapest
6 Tilburg
7 Lodz
8 Prague
9 Vienna
10 Munich
11 Nuremberg
12 Liege
13 Lyon
14 London
15 Madrid
16 Neuss
17 Milan
18 Minsk
19 Dourges
20 Istanbul
21 Slawkow
22 St. Petersburg
23 Vilnius
24 Riga
25 Tallinn
26 Helsinki
27 Rotterdam
28 Amsterdam
29 Dobra
30 Danuiska Streda

- Transition times -12-18 days in comparison with 35-42 days over sea)
-
- Rail transport costs are higher than sea transport

Marine intermodal transport terminal operations



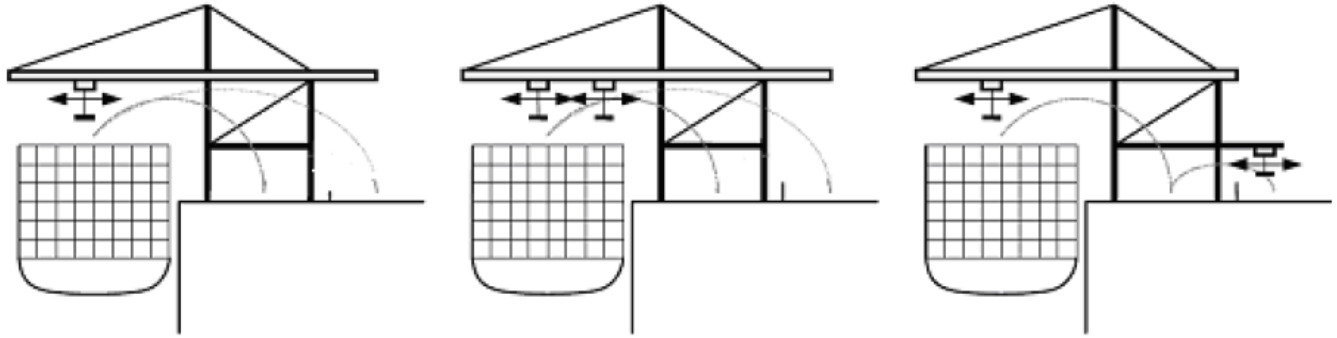


Intermodal handling equipment

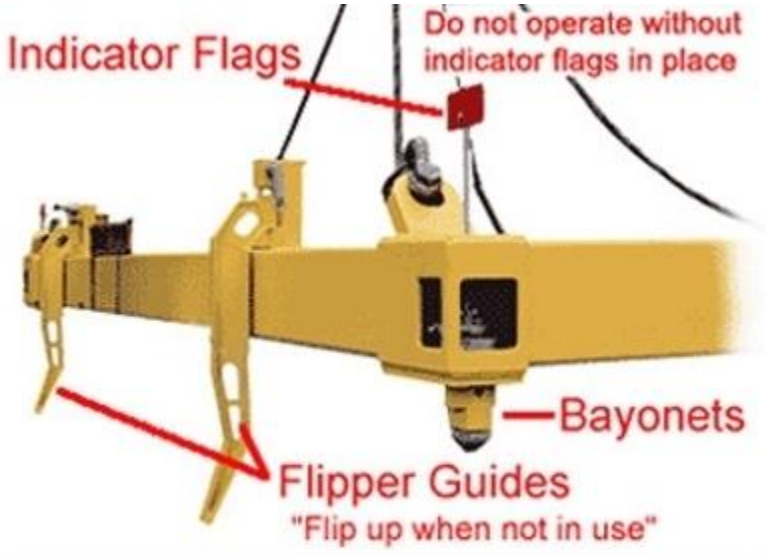
STS (Ship to Shore) Cranes

- **Single trolley**
- **Double trolley**

Practical efficiency 22-30 contaier operations/hour



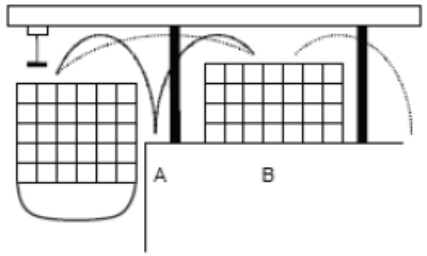
single trolley, twin trolley and dual trolley crane

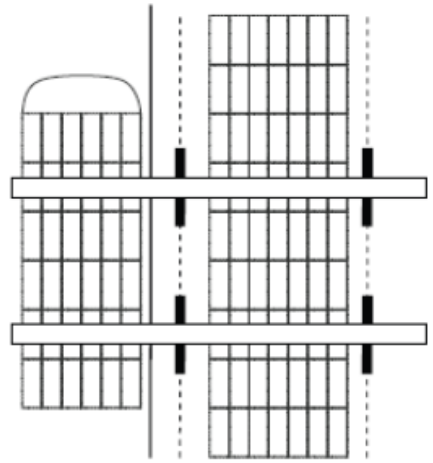


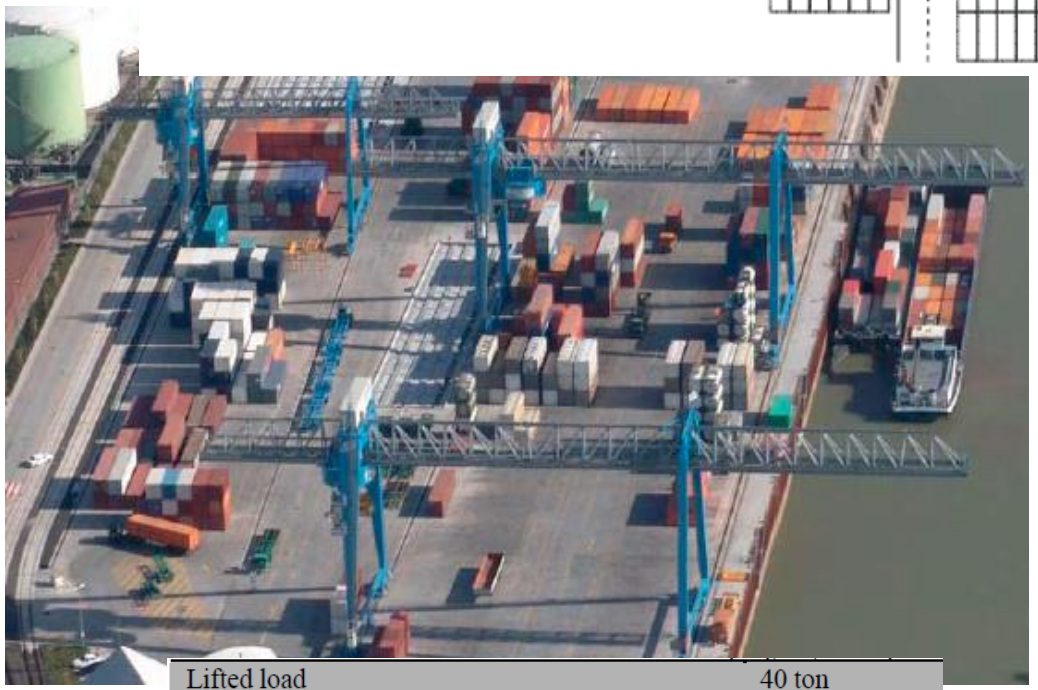
Intermodal handling equipment

WSC (Wide-span Crane)

- **They are used in small and medium-sized marine terminals, where the container storage capacity is limited**
- **They enable the storage of containers also under the gantry**







STS CRANE

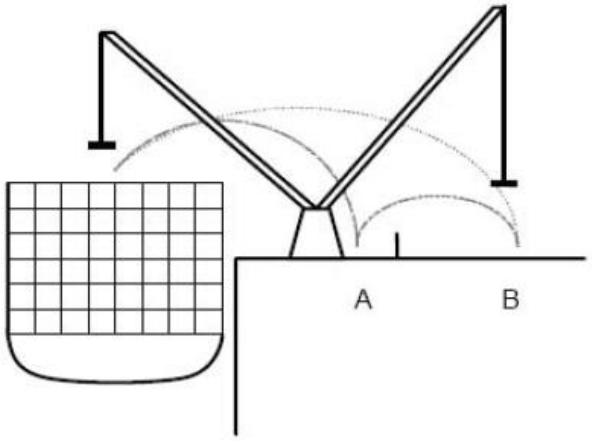
Outreach	47	m
Rail span	30.48	m
Back reach	15	m
Hoisting height of spreader above top of rail	32.3	m
Hoisting height of spreader beneath top of rail	32.3	m
Max. hoisting/lowering speed with 50 tons on ropes	60	m/min
Max. hoisting/lowering speed with 15 tons on ropes	120	m/min
Max. trolley travelling speed	60	m/min
Max. gantry travelling speed	5	m/min

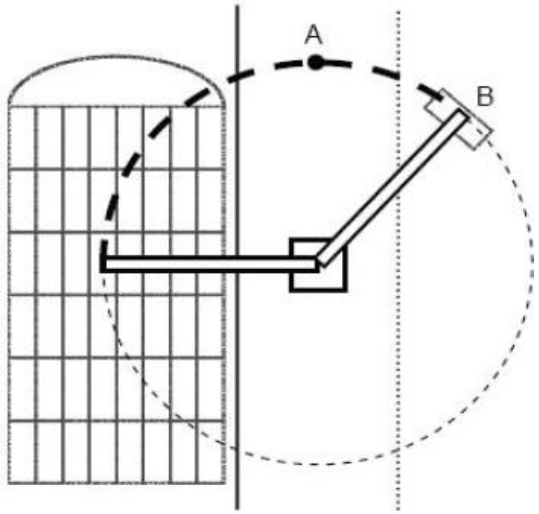
Lifted load	40 ton
Outreach	30 m
Rail span	48 m
Back reach	16 m
Hoisting speed	40/100 m/min
Trolley speed	180 m/min
Gantry speed	120 m/min
Handling capacity per crane per year	100,000 TEU/yr

Intermodal handling equipment

MHC (Mobile Harbour Crane)

- **Theoretical efficiency for containers handling is around 15-20 container operations/hour**
- **Tapacity – do 200t**
- **Rail mounted *or* rubber tyred**





Capacity heavy lift	100 ton
Standard lift	45 ton
Hoisting/lowering	85 m/min
Traveling	80 m/min
Hoisting height	
Above ground level	36 m
Below ground level	12 m
Dimensions	
Propping base	12.5 m × 12 m
Crane in travel mode	17.2 m × 8.7 m
Crane productivity	15 move/hr

Intermodal handling equipment

RMG (Rail mounted gantry)

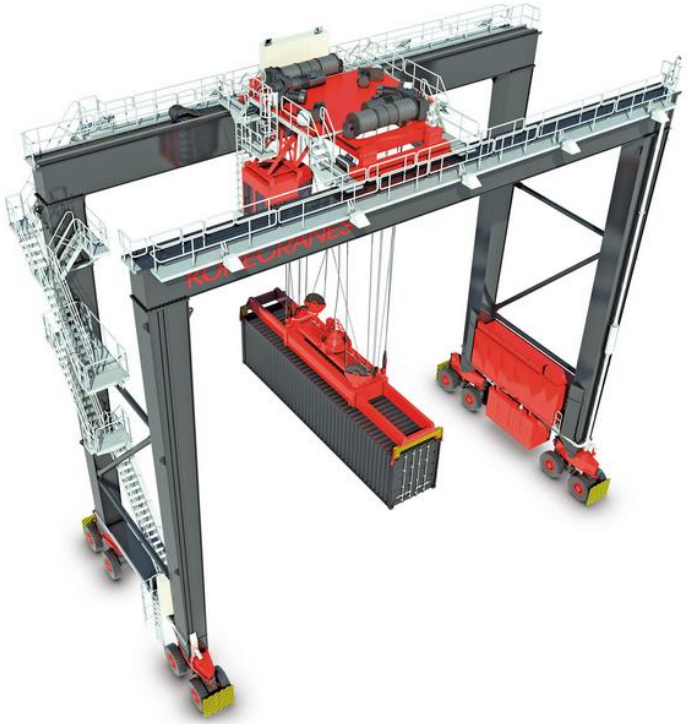
- **Theoretical efficiency - 20 container operations/hour**

RMG

Double RMG

RTG (Rubber Tyred Gantry)

- **Theoretical efficiency for containers handling is around 20 container operations/hour**
- **Ability to change the working area,**
- **GPS positioning, laser**



Intermodal handling equipment

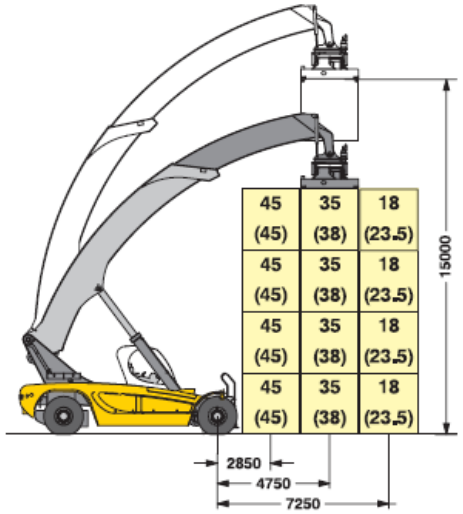
Straddle carrier

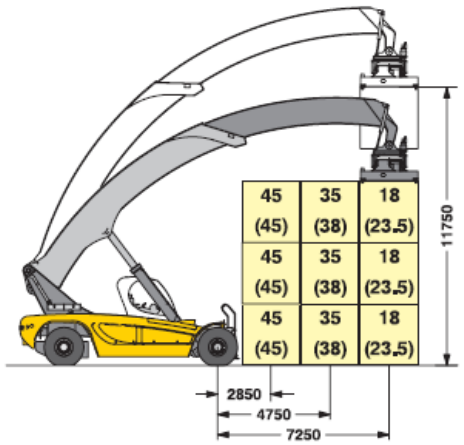
- They can manipulate such as: loading, unloading, stacking and transporting containers
- Lifting containers (30-60cm)
- Stacking containers up to 4 layers.
- Can be automatic (ALV – automated loading vehicle)

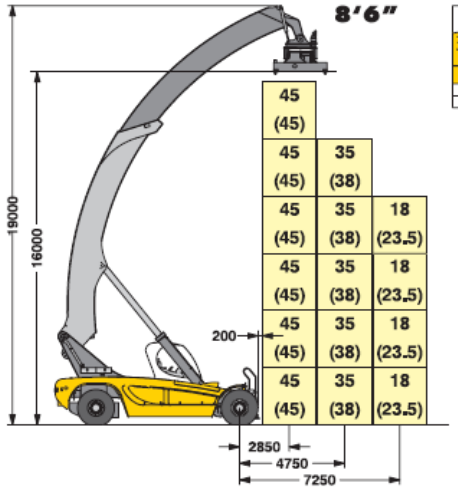
Intermodal handling equipment

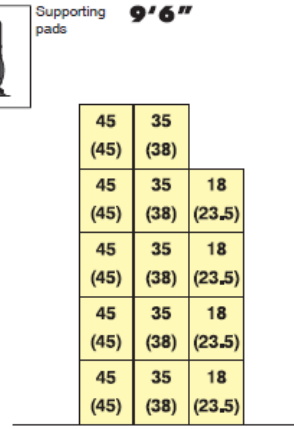
Reach stacker

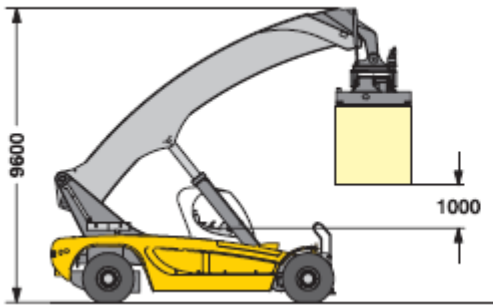
- the ability to stack up to 9 layers of containers
- equipped with a counterweight and in some cases with supports to reduce pressure on the front axle

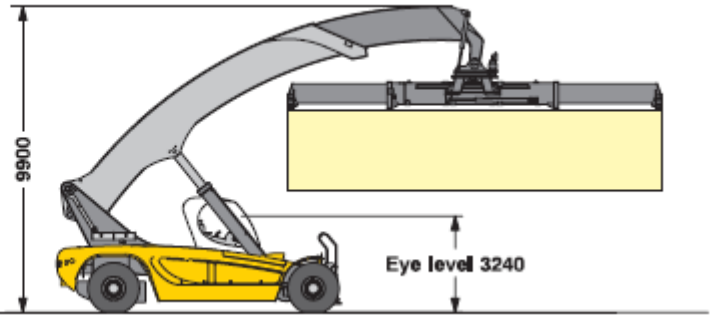


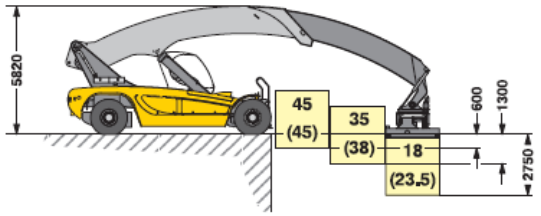


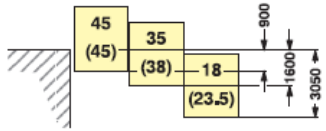












Intermodal handling equipment

Forklift Truck

- They can be equipped with forks and gripping frames
- Possibility of lifting 2 containers at the same time

Intermodal handling equipment

Side Forklift Truck

- They can be equipped with forks and gripping frames
- Possibility of containers stacking in 2 layers

Intermodal handling equipment

Terminal Tractor

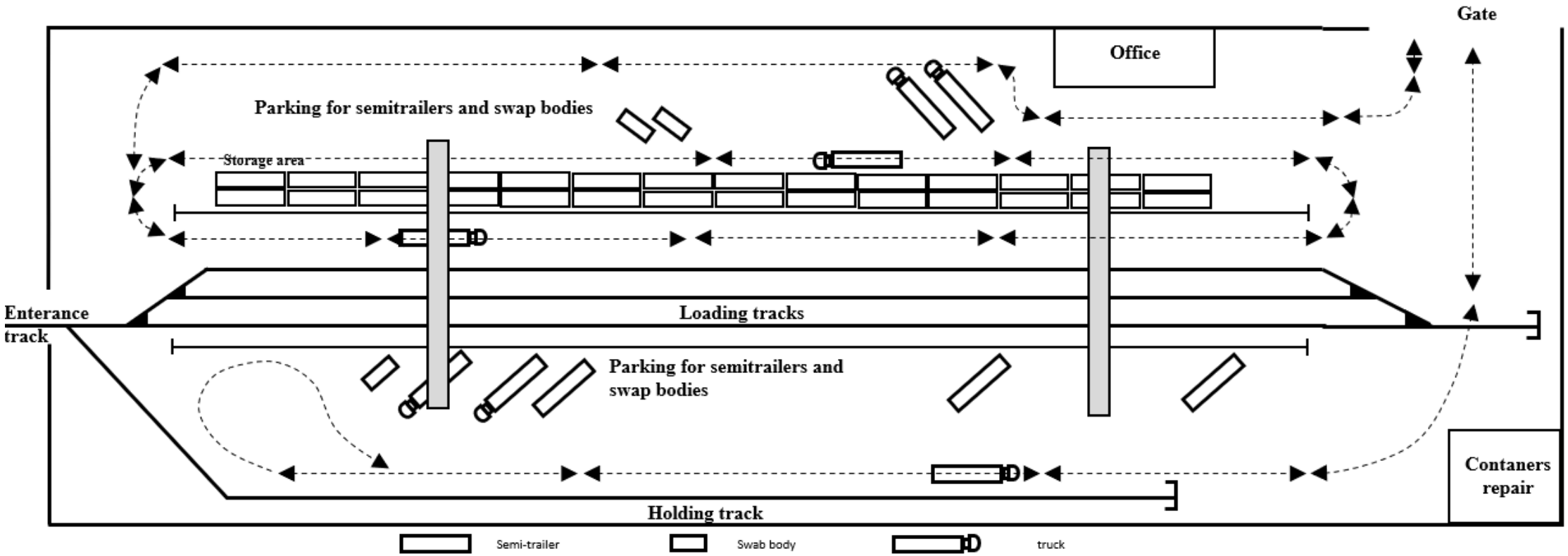
Speed up to 35 km/h
Possibility of pulling many trailers

Intermodal handling equipment

AGV Vehicles

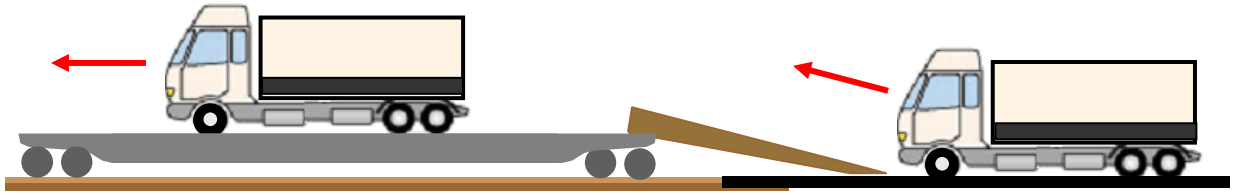
- automatically controlled on designated paths and induction loops placed in the terminal floor or using GPS
- They support containers up to 45 ,
- Movement speed - 6 m / s
- Load capacity up to 70t
- Possibility of lifting the container

Inland intermodal terminal



Rail-road technologies

Rolling Highway - **vehicle loading and unloading only horizontal transhipment is possible with the use of ramps**



Loading (Rolling Highway)

Rolling Highway **disadvantages:**

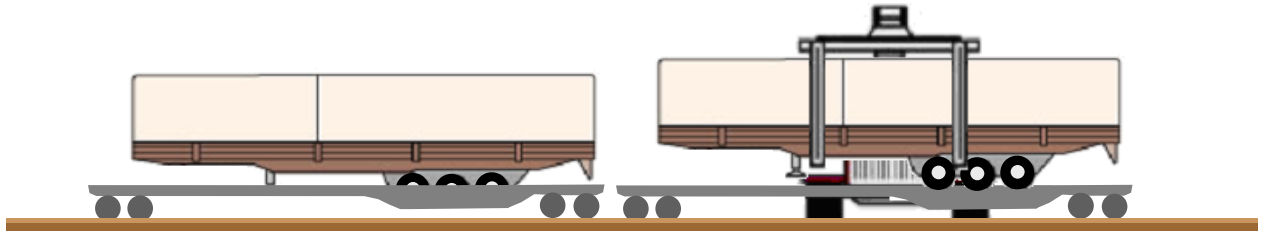
- **Expensive low floor rail cars**
- **Driver and tractor excluded from work**
- **High gross mass of a train**

Rolling Highway **advantages:**

- **Easy loading and unloading**
- **Short loading and unloading**
- **No need of special loading equipment**
- **Driver performes loading himself**

Rail-road technologies

***Piggy Back* – the most popular intermodal technology**



Loading (*Piggy back*)

- ☐ **Semitrailers and swap bodies are transported on rail cars with special pockets for semitrailer's wheels.**
- ☐ **Trucks deliver intermodal units to transshipment facilities (intermodal terminals)**
- ☐ **Loading/unloading performer with Lo Lo technology**

***Piggy back* disadvantages:**

- **Special loading equipment**
- **Long loadin/unloading time**
- **Intermodal semitrailers**

***Piggy back* advantages:**

- **Comparing to Rolling Highway?**

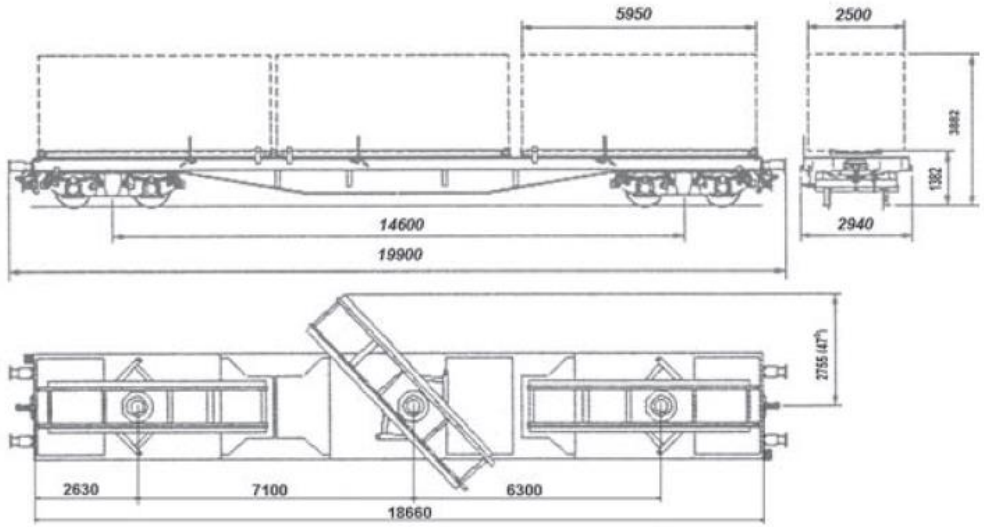
Rail-road technologies

ACTS System **– rolling container system.**

ACTS **advantages**

- ☐ **the transshipment terminal does not have to be specially equipped (hardened floor at least 11 m wide);**
- ☐ **loading/unloading performer by a driver;**

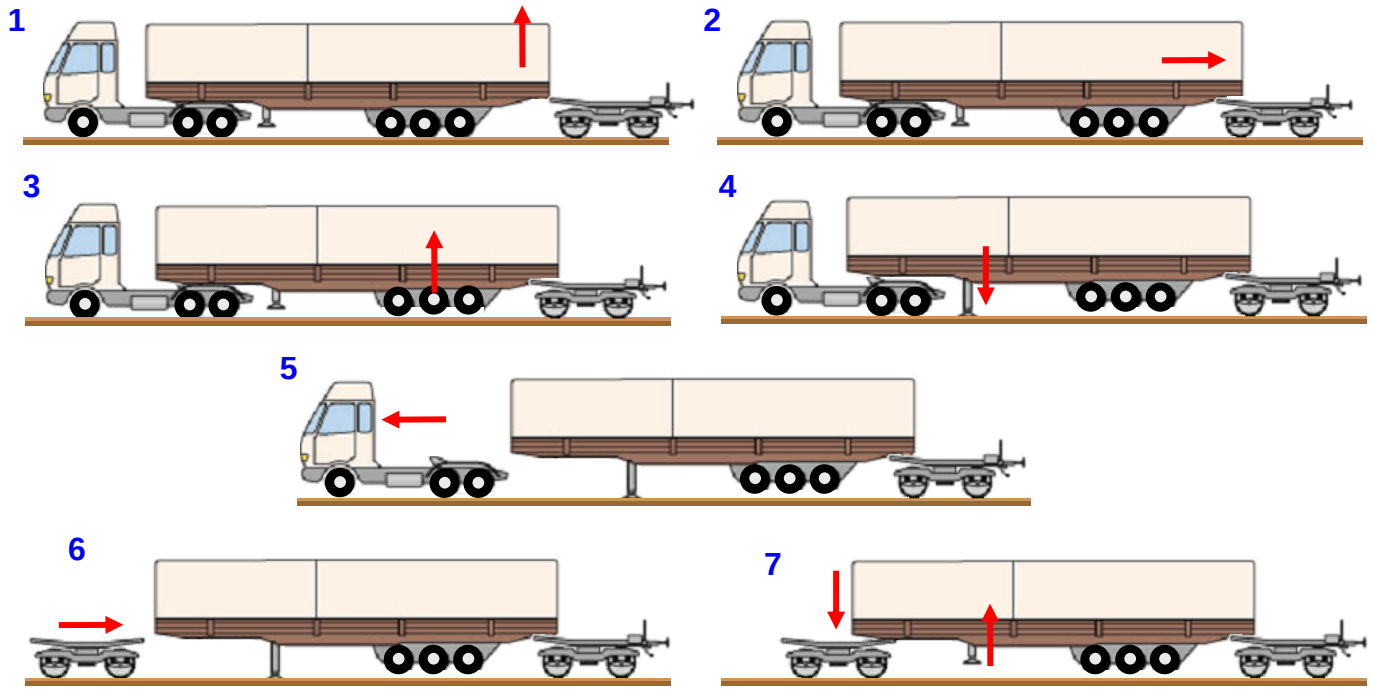
ACTS **disadvantages: ?????**



Rail-road technologies

Bimodal System - it **is a variation of rail-road transport, in which special semi-trailers are mounted directly on two typical 4-wheeled railway bogies with spherical pivots**

1. **lifting the rear of the semi-trailer**
2. **approaching the back of a railway bogie**
3. **lift of the semi-trailer wheels**
4. **lowering the supports of the front semi-trailers**
5. **tractor's departure**
6. **rolling the railway bogie under the front of the trailer**
7. **lifting the supports and placing the trailer on the railway bogie**



Rail-road technologies

Bimodal **advantages:**

- **relatively low implementation costs**
- **the smallest (from all variants) gross shipment weight**
- **simplicity of loading and unloading operations**

Bimodal **disadvantages:**

- **operational problems (loads steram should be symmetrical)**
- **the need to adapt semitrailers**

Advances in Rail-road technologies

INNOFREIGHT system **– posibility to transport various bulk materials. Its use allows the organization of effective rail transport and unloading of bulk materials. The containers used in the system are higher than standard ones, which increases their capacity by 30-50%.**

System elements:

- **specialized containers;**
- **HardTop container cover (optional)**
- **forklift equipped with a turntable for unloading containers**

Advances in Rail-road technologies

Innofreight **advantages:**

- **Winter reliability - The unique method of unloading containers by rotating them 360 degrees with the possibility of shaking the frozen container of the raw material works well even in arctic conditions. The reliability of this system in winter conditions contributes to the rapid dissemination of this technology in the Scandinavian countries.**

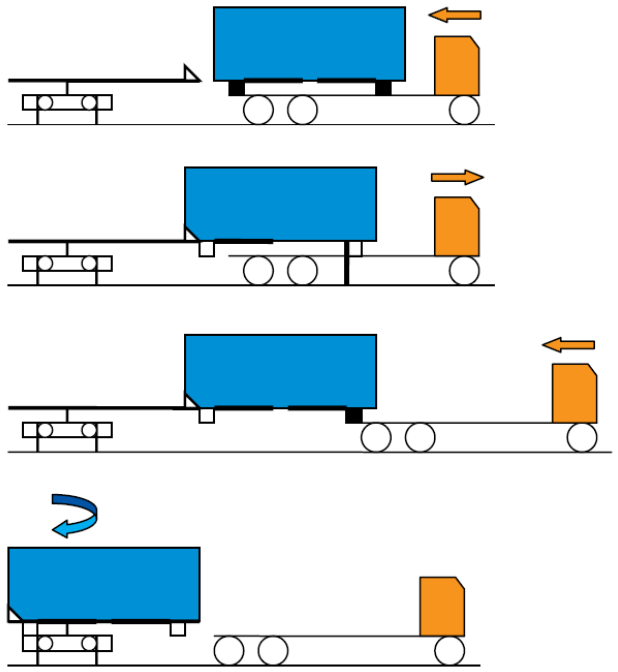
- **Security**
  - **Unloading in the Innofreight system involves only one employee and one machine - forklift.**
  - **All operations take place without direct human intervention, the operator remains in the machine's cabin all the time;**
  - **There is no need to clean containers after unloading**

Advances in Rail-road technologies

Kombilifter System **– transport concept based on a special wagon equipped with a lifting system (pneumatic system, hydraulic jacks, scissor lift) for swap bodies and containers equipped with supports**

Kombilifter System **– loading stages:**

- **Alignment of the body in one line**
- **The entrance of a special car for interchangeable bodies**
- **Lift the wagon body and lift the swap bodies to fold the supports**
- **Pulling down and blocking the body on the wagon**



Advances in Rail-road technologies

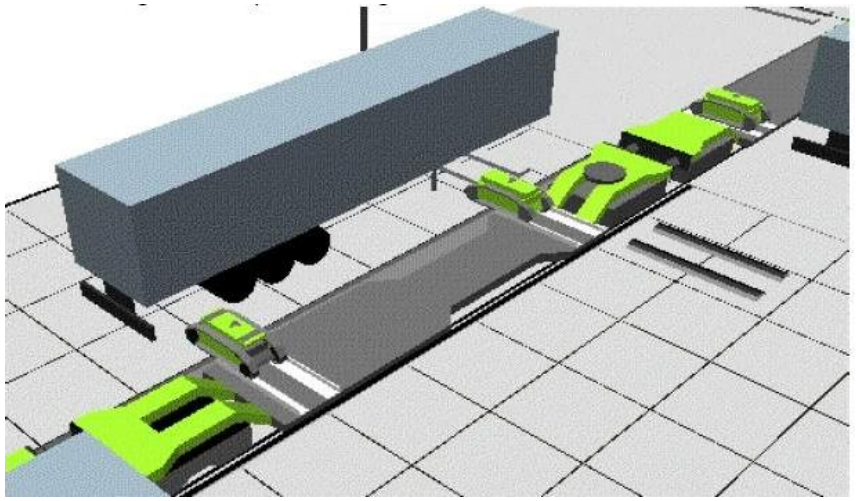
CargoSpeed System **– system consisting of a pop-up mechanism (separation / lifting-rotation mechanism) and a rail car equipped with moving floor. It is used for horizontal reloading. Unloading is carried out by the vehicle drivers themselves**

- **Transport of semi-trailers up to 13.6m in length**
- **Lifting mechanism max 45 t**
- **Rail cars on standard trolleys with wheels of normal diameters**
- **Platforms rotated by 36% or 144%**

CargoSpeed **disadvantages and advantages ??**

Advances in Rail-road technologies

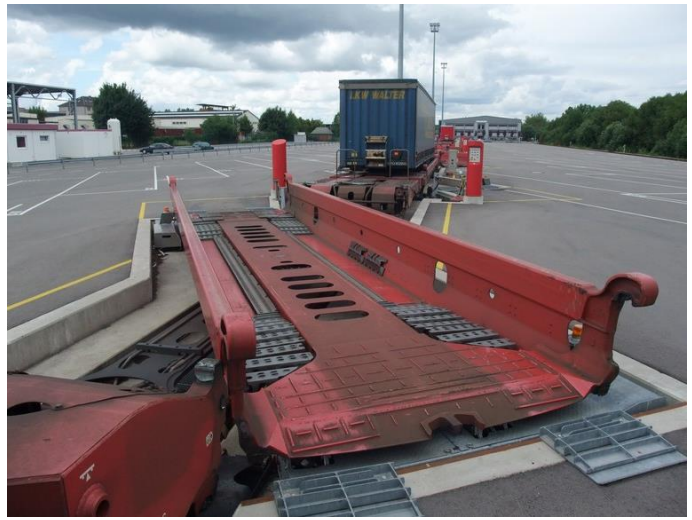
CargoRoo System **– system built on the basis of platform wagons equipped with transhipment devices on the wagon (mobile robots, 2 for each wagon)**



CargoRoo **disadvantages and advantages ??**

Advances in Rail-road technologies

MODALOHR System **– horizontal loading system of semi-trailers. This system for proper operation requires special wagons equipped with a rotating platform, on which the vehicle with the trailer enters. Then the trailer is disconnected and the platform together with the trailer rotates and sets parallel to the wagon axle.**



Modalohr **advantages:**

- **short loading and unloading time**
- **possibility of handling many wagons at the same time**
- **no need to use lifts**

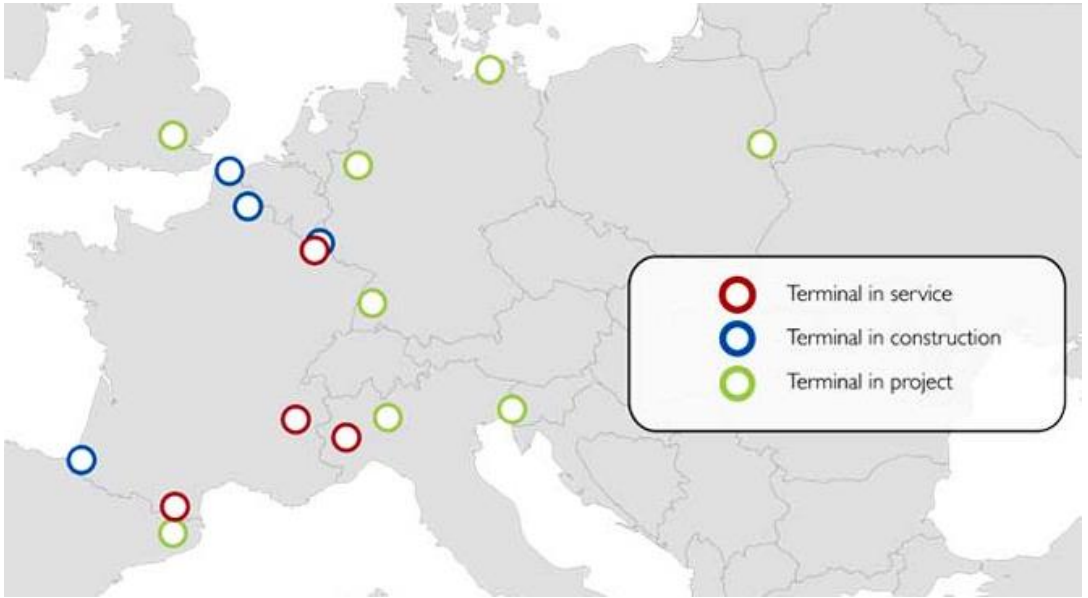
Modalohr **disadvantages: ???**

The MODALOHR terminal can be installed on an existing combined transport station.

Advances in Rail-road technologies

System MODALOHR **– loading stages**

- ❑ **arrival of the train and precise positioning of the wagons**
- ❑ **turning the platform of the wagon**
- ❑ **the tractor's entry with the trailer on the rotated platform**
- ❑ **turning the platform of the wagon**



Advances in Rail-road technologies

CARGOBEAMER System **– fully automated, horizontal system of intermodal rail traffic service. It was designed primarily for the transport of semi-trailers and containers.**

System contains of 3 main elements:

- **Cargojet (specialized rail car),**
- **Jet (the type of platform on which the tractor with the trailer enters)**
- **Cargogate (specialized terminal).**

Advances in Rail-road technologies

CARGOBEAMER System **– loading stages**

- **arrival of the train with rail cars (wagons) and arrival of the road vehicle to the terminal**
- **precise positioning of rail cars**
- **lowering the wagon's safety boards**
- **displacement of the inner part of the wagon (platform) towards the road**
- **platform setting**
- **entering the truck and unhooking the trailer**
- **moving the platform to the wagon and blocking it in the wagon**
- **raising the safety sides**
- **forming and sending a train**

CargoBeamer **advantages and disadvantages…..**

Advances in Rail-road technologies

FLEXIWAGGON System **– horizontal load handling system. In contrast to the Modalohr system, it is possible to load entire vehicle + trailer. It increases mobility and does not enforce additional vehicles.**

A significant *advantage* is the fact that loading and unloading can take place wherever a hardened floor occurs. This is associated with large savings, as it is not required to build specialized terminals.

Advances in Rail-road technologies

FLEXIWAGGON System

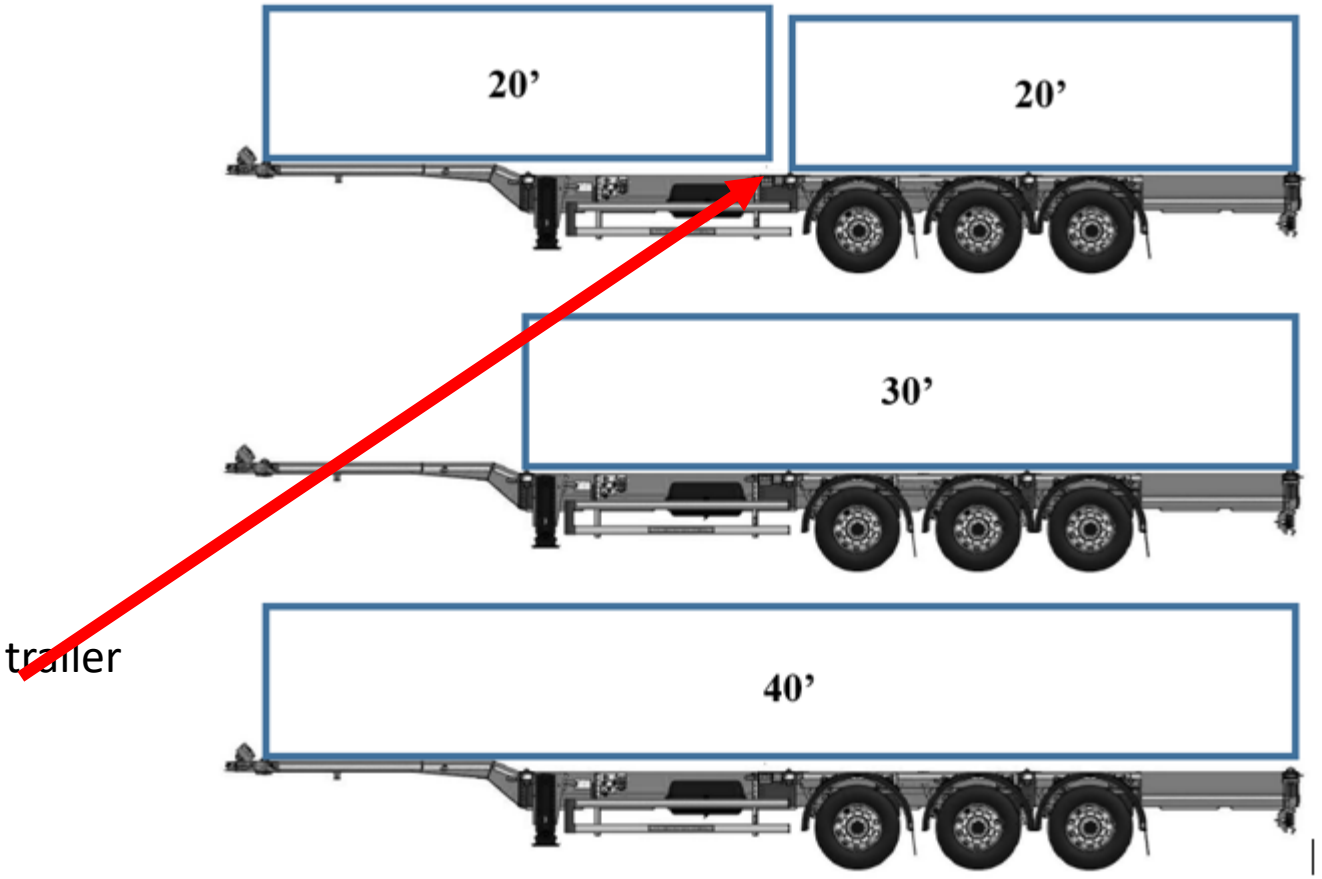
Special platform placed on the wagon rotates relative to the wagon axis, then the driveway is lowered to the ground. After that vehicle + semi-trailer enters the wagon and the platform rotates to a position parallel to the axis

Intermodal handling equipment

Container semi-trailers

- **for 20 ', 30', 40 'containers,**
- **sliding semi-trailers at the rear,**
- **sliding semi-trailers at the front and rear,**
- **two-module sliding semi-trailers in the middle,**
- **self-dumping trailers**

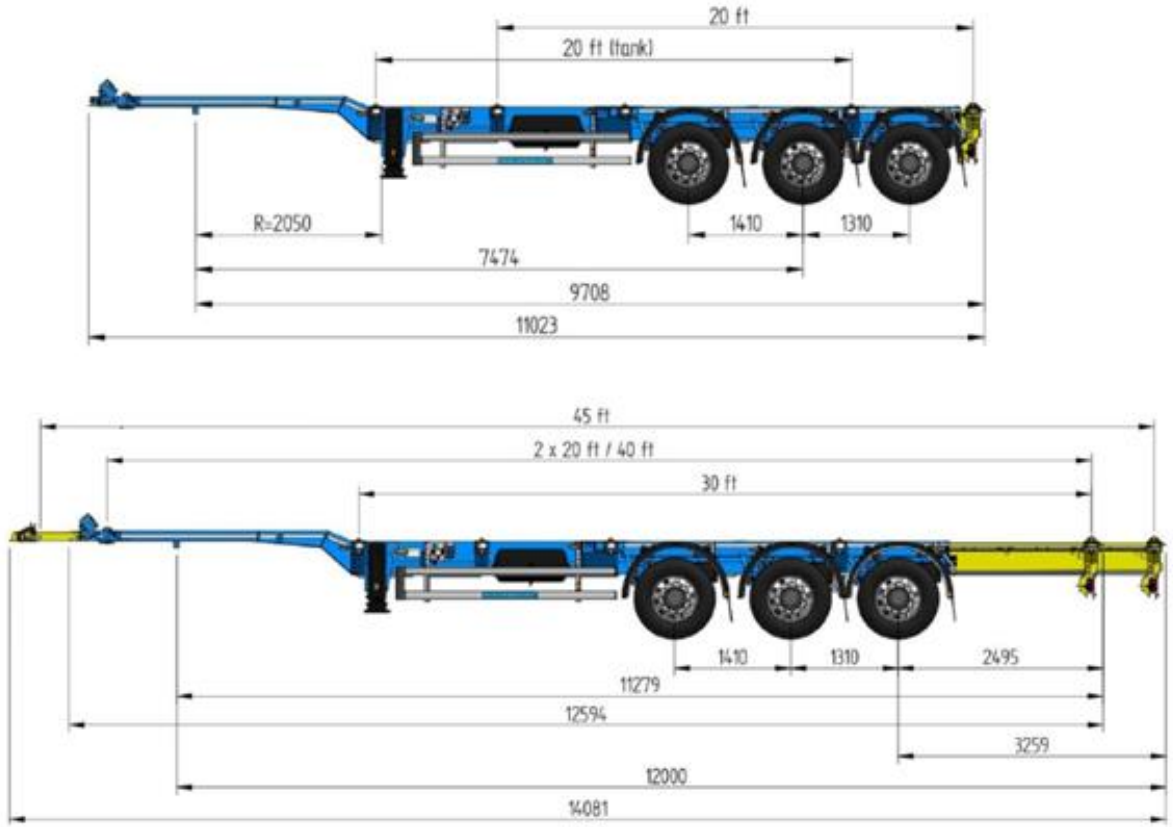
spacers in the middle of the trailer



Intermodal handling equipment

Container semi-trailers

Container trailer extended at rear

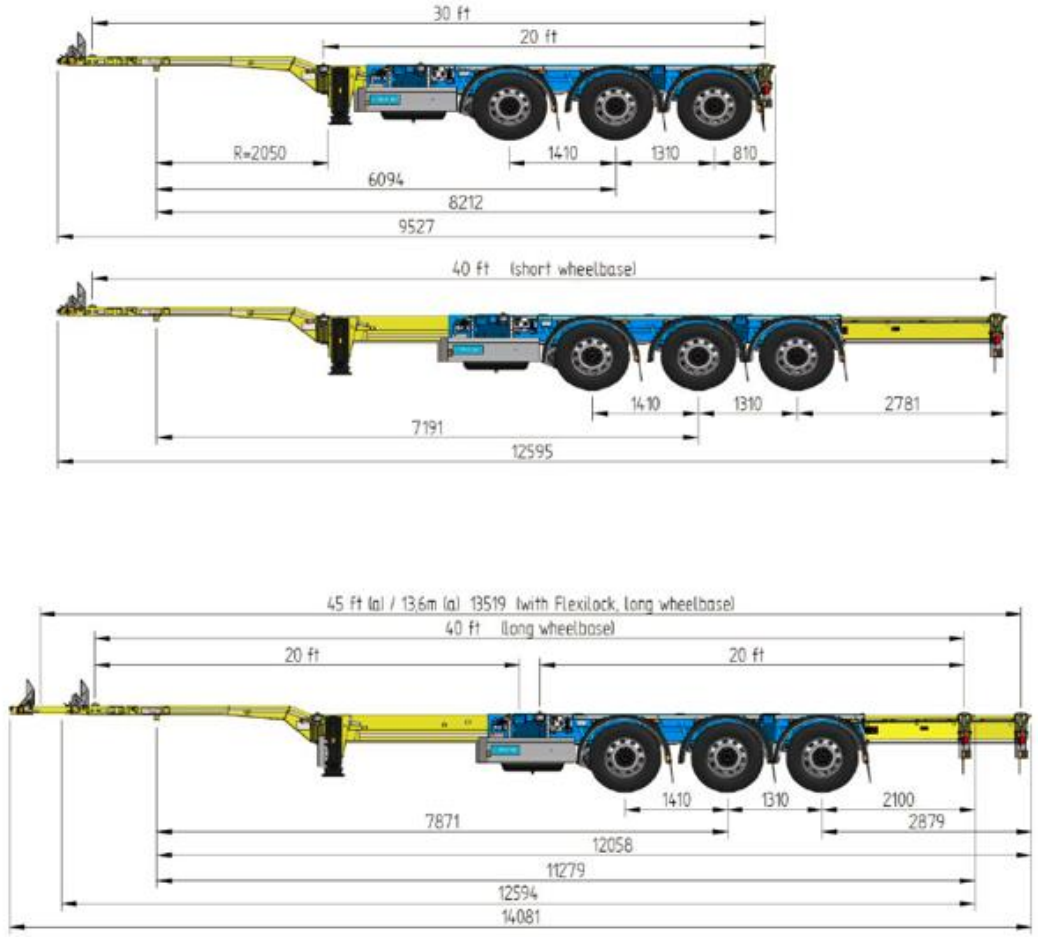


Intermodal handling equipment

Container semi-trailers

Container trailer extended at rear and front

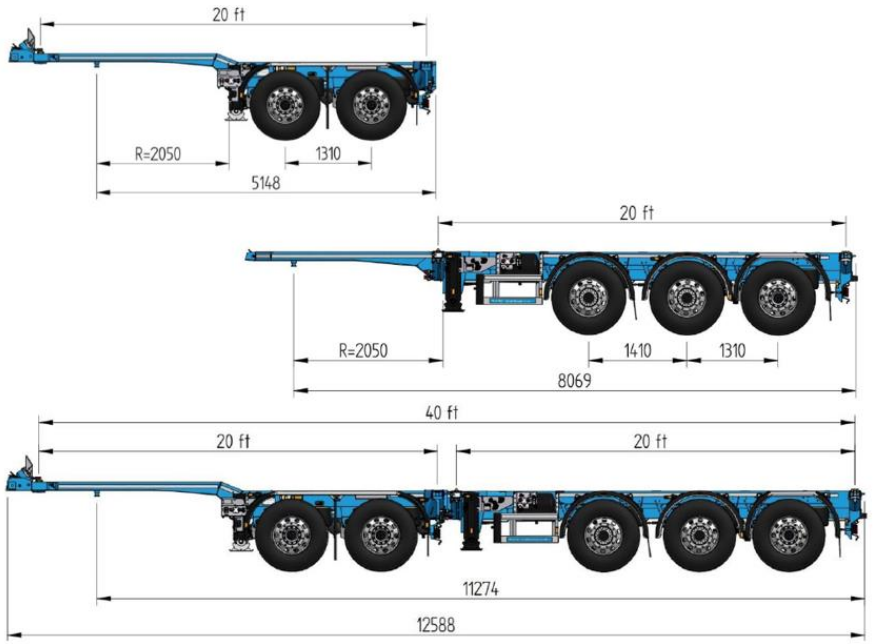
- enables the carriage of one or two 20-foot containers, a 40 or 45-foot standard container, a 25 or 23-foot container with a 20-foot container
- the possibility of sliding the semi-trailer both at the front and rear.



Intermodal handling equipment

Container semi-trailers

Two-module semi-trailer



Naczepa samowyładowcza

The axles of the front semi-trailer module are torsion axles

Intermodal handling equipment

Swap body trailers

Przyczepa centralnoosiowa

Using a truck adapted to transport swap bodies and a center-axle trailer, it is possible to transport two swap bodies at the same time

Intermodal handling equipment

Container Vessels