



Cooperation-Network for logistics and nautical education focusing on inland waterway transport in the Danube corridor supported by innovative solutions

# LOGISTICS COURSE

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## 1. Definition of target group(s)

The main target group for the logistics course are students at universities with appropriate logistics topics in their curriculum. The duration of the course offered is 16 lecture units in a one term course. The material provided will be a power point presentation as well as a handout in script-style, including all relevant information. The presentation, which is to be given in lectures, covers the main topics and contains key-information.

According to the ELA Certification for Logistics Professionals a classification of the learning material at hand is made.

### Supervisory/Operational level

At this level students will fulfil the following points according to ELA:

- Comply with relevant legislation and regulations
- Contribute to the implementation of a change initiative
- Make recommendations for the improvement of operational effectiveness

At the senior level in the transport management section the following points will be achieved:

- Evaluate the impact of environmental factors on transport activity
- Plan the coordination of multi-modal operations
- Develop transport plans and proposals evaluating costs and added value

On the supply chain flow and network management level the following compulsory points will be met:

- Model supply chain networks as a holistic, flow-oriented system.

## 2. Definition of transnational learning targets and learning content

The overall learning target of the logistics course is to provide comprehensive information and material about inland waterways and logistics respectively in order that they are recognized as basic and substantial traffic carriers.

Inland waterways will be discovered as a competitive, ecologically friendly and save transport mode. In this context the consignor's perspective will be focused.

## 3. Content

The content prepared is separated in a transnational as well as national / regional section.

Geo. scope	Approach	Content	Work allocations
Transnational (NELI project)	Generic content (e.g. What is a port, important European ports)	Transnational / generic	75%
National / regional	Specific content (e.g. Danube ports in	National	25%

(obligatory)	Austria, business contacts, best practises...)	specific	
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### 3.1. General characteristics

*Students are acquainted with the advantages and disadvantages of inland waterways as traffic carrier and get to know about basic figures concerning transport volumes on inland waterways.*

*According to ELA<sup>1</sup> standards students should be able to contribute to the evaluation of transport environment (operational level).*

#### 3.1.1. Basic data about European waterways

##### Overview and basic information<sup>2</sup>

The total length of navigable inland waterways suited for inland waterway transport in the 27 member states of the European Union accounts for approximately 35,500 km – classified as waterways class I to VII. This implies an inland waterway density of 8,2 km per 1,000 km<sup>2</sup>.<sup>3</sup>

Waterways may consist of different sections such as

- free flowing sections,
- sections regulated by dams,
- canals,
- sections through lakes.

Inland waterway systems offer a restricted network size in comparison to railways and roads. The railway network amounts to over 210,000 km and the road network (motorways and major national roads) to more than 410,000 km. The navigability (=capacity) of a waterway is largely determined by its fairway depth. A fairway is a navigable deep-water channel in a river, a harbour or along a coastline. The available fairway depth determines the maximum possible draught of ships and their loads, i.e. the maximum depth below water's surface of the lowest part of a ship. Draft is usually determined for a fully-laden vessel.

The main infrastructure of inland waterway transport has a direct impact on the performance. The following key rules are essential for the specific operational performance:

- The larger the draught, the more cargo can be transported and its unit costs per ton are reduced.
- Free-flowing rivers have high water fluctuation, which are often not sufficiently predictable.<sup>4</sup>

<sup>1</sup> ELA – European Logistics Association.

<sup>2</sup> Cf. <http://ines.plweb.at/start.php> [May 2010].

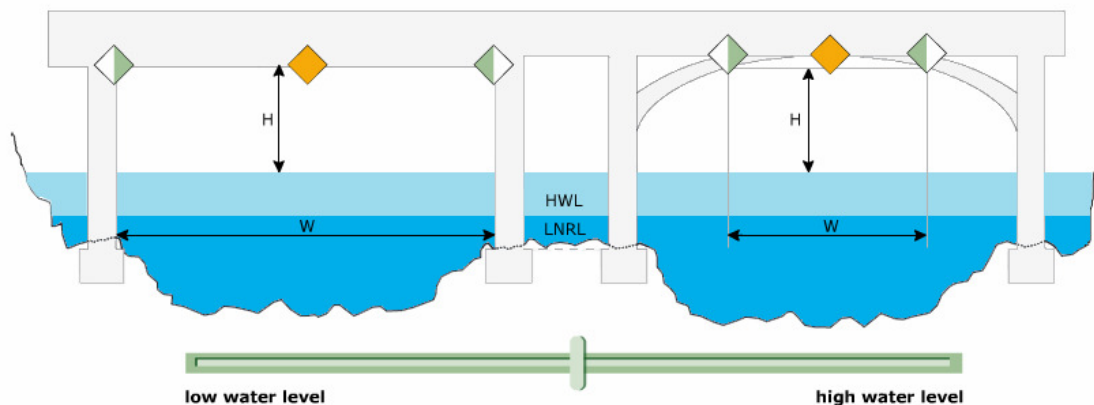
<sup>3</sup> Cf. [http://www.ines-danube.info/ilias.php?ref\\_id=405&obj\\_id=921&cmd=layout&cmdClass=ilImpresentationgui&cmdNode=b3&baseClass=ilMPresentationGUI](http://www.ines-danube.info/ilias.php?ref_id=405&obj_id=921&cmd=layout&cmdClass=ilImpresentationgui&cmdNode=b3&baseClass=ilMPresentationGUI) [March 2011].

<sup>4</sup> Especially in international traffic corridors with long transit times, the predictability of fairway depths becomes an issue of major importance: When the maximum possible draught cannot be predicted reliably

- Canalised sections have generally less fluctuations and larger guaranteed fairway depths.

**Locks** can be found on waterways due to hydro power stations, which would otherwise block rivers. Locks act as shipper's stairway. The Danube, for example, may have a difference in height between upper water (from the lock upstream) and the tail water (from the lock downstream) of more than 10 metres. Therefore vessels have to "climb stairs", which is enabled by locks.

The **bridge clearance** implies the distance from any nominated point on the underside of a bridge to the water level (=bridge clearance height) as well as the distance between two piers of a bridge.



Picture 1: Parameters for bridge clearance in inland navigation<sup>5</sup>

<b>H</b>	Bridge clearance height at the highest navigable water level
<b>W</b>	Bridge clearance width at the highest navigable water level
<b>HWL</b>	High water level
<b>LNRL</b>	Low navigation and regulation level.

## Waterway systems<sup>6</sup>

Within Europe there are **four waterway systems** which are – besides autonomous inland waterway systems<sup>7</sup> – of key importance:

**Rhine waterway:** The Rhine is the busiest inland waterway in the world in terms of commercial navigation. The Rhine waterway system consists of the Rhine river and its tributaries (the Moselle, the Neckar, the Main) as well as the Wesel-Datteln and the Rhine-Herne canals. It links

over a period of a few days, vessel operators will have to minimize risks and load their vessel according to the expected minimum fairway depths, which leads to more expensive shipments than the actual fairway depths would have allowed.

<sup>5</sup> <http://ines.plweb.at/start.php> [March 2011].

<sup>6</sup> Cf. <http://ines.plweb.at/start.php> [May 2010].

<sup>7</sup> Autonomous inland waterway systems can be found in Italy, Spain, Portugal, Finland, Great Britain, Ukraine and Russia.

the seaports in Belgium and the Netherlands to the Ruhrgebiet region, the industrial areas surrounding Basel, the Alsace and the regions surrounding the cities of Stuttgart, Karlsruhe, Mannheim as well as Cologne.

*North-South Corridor:* The North-South Corridor comprises the areas around the IJsselmeer in the northern Netherlands, the rivers Meuse and Schelde, as well as a host of canals in Belgium, the Netherlands and northern France. Furthermore, connecting the Seine with France's north-west waterway network (also referred to as "Seine-Nord") has been defined as a top priority in the framework of the revision of the Trans-European Transport Networks (TEN-T).

*East-West Corridor:* The main transit routes for the East-West Corridor include the Mittelland canal, the Dortmund-Ems canal, as well as the Elbe and the Weser rivers as connectors to northern German sea ports, Poland and the Czech Republic.

*South-East Corridor:* The Main river, the Main-Danube Canal and the Danube river form the South-East Corridor. The opening of the Main-Danube Canal in 1992 created a continuous and competitive waterway, stretching from the North Sea to the Black Sea.

The Rhine is Europe's most important waterway transport link. Navigation is possible by even the largest vessels from Antwerp and/or Rotterdam to Basel and it has tributaries connecting with major economic centers around Metz, Frankfurt and Stuttgart. Many inland barge terminals are scattered along the full length of the Rhine and its tributaries.

In terms of container transport demand, domestic traffic in the Netherlands and Belgium is second in importance. The traffic is handled on the Meuse and Scheldt as well as on the well-developed canal system and in the Rheine Delta. In these countries a lot of inland barge terminals were established in the last decade in order to create a very dense network of terminals.

The Danube is the longest navigable river in Europe. It connects the South of Germany with the Black Sea via Austria, Slovakia, Hungary, Croatia, Serbia, Bulgaria and Romania. The Danube basin is linked to the Rhine basin by the Main-Danube Canal. The Danube can accommodate the largest motor vessels and push convoys. Until now container traffic development has been modest due to limited demand.

In the North and West of Germany, the rivers Elbe and Weser as well as the Mittelland canal system connect Hamburg, Bremen and the Rhine basin with Northern and Eastern Germany and the Czech Republic. In the hinterland of Hamburg the Elbe represents a route with high potential demand, but with substantial water level difficulties. The seaport of Bremen has connections with its hinterland via the Weser and the Mittelland Canal. The German canal system also links Benelux seaports with Eastern Germany.

Container traffic from French seaports is still small. There are two inland barge terminals on the Seine near Paris and three along the Rhone in France. Between Paris and Le Havre and Rouen

the Seine twists and turns to an extent making distances and travel times significantly higher than by road and rail. The Rhone is well-suited for container traffic and is used by daily container services.

In the future the Seine and Rhine-Scheldt basins will be connected by the Seine North link ("Seine-Nord"). This will connect Paris with Antwerp and Rotterdam and is expected to absorb substantial container traffic currently handled via roads.<sup>8</sup>

Waterway maps of the Danube as well as further information are available under the following link:

[http://www.donauschiffahrt.info/en/facts\\_figures/the\\_danube\\_as\\_a\\_major\\_route\\_of\\_transport/waterway\\_maps/](http://www.donauschiffahrt.info/en/facts_figures/the_danube_as_a_major_route_of_transport/waterway_maps/)

### Infrastructural bottlenecks<sup>9</sup>

The UN/ECE Working Party on Inland Water Transport defines three infrastructural bottlenecks for inland waterways. These are missing links, strategic bottlenecks and basic bottlenecks.

Missing links are those parts of the designed inland waterway network which do not exist at all or where the quality of the link is by far below the standards of waterways which have to be mutually interlinked. One example is the missing link between the Mittelland canal and the Elbe-Havel canal ("Magdeburg Waterways Crossroads", E 70).

Strategic bottlenecks are sections which satisfy the basic requirements of at least UN/ECE class IV but ought to be upgraded in order to improve the structure of the entire network or to increase the economic viability of inland navigation. One example for a strategic bottleneck can be found on the Elbe (E 20), where low fairway depths at dry seasons (1,40 m) upstream from Lauenburg to the German-Czech border occur.

Basic bottlenecks are waterway stretches whose nautical parameters are at present time not conform to requirements applicable to inland waterways of international importance (class I, II and III waterways). An example is the Havel-Oder waterway (E 70), where an upgrading to class Va is necessary.

As part of the European transport policy, the concept of **Trans-European Transport Networks (TEN-T)** was introduced in the beginning of the 1990s. The TEN-T programme aims at creating a modern, interconnected, and compatible transport network in Europe in order to support the development of the economy of the European Union. Within TEN-T, 30 priority projects have been identified (status 2005), which contribute most to promoting transnational traffic (for example by eliminating bottlenecks) on the major trans-European axes. These projects are liable for funding by the European Community.

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<sup>8</sup> Vrenken, H./Macharis, C./Wolters, P. (2005): Intermodal Transport in Europe, Belgium.

<sup>9</sup> Cf. <http://ines.plweb.at/start.php> [May 2010].



## **Advantages**

Advantages of inland waterway transport are numerous. The following environmental advantages shall be mentioned:

- Compared to road and rail transport, inland navigation requires the lowest energy input and consumption to carry one ton of cargo over a distance of 1000 kilometers, therefore it covers the greatest transport distances with the same energy consumption.
- Compared to road transport, waterway transport has lower CO<sub>2</sub> emissions in relation to its energy input and emits considerably less hydrocarbons and carbon monoxide.
- Compared to road and rail transport, waterway navigation has the lowest capital expenditure requirements for the maintenance and improvement of the infrastructure. Moving 1000 ton-kilometers requires an investment of 1 € in waterway transport, 1.83 € in road transport and 6.57 € in rail transport.
- Waterways offer excellent safety levels and cause the lowest accident costs.
- Provided that a minimum water depth can be guaranteed throughout the whole year inland navigation constitutes a very reliable transport mode incurring low transport costs.
- And so forth.

Projects concerning fairway improvements and the elimination will contribute to a modal shift of freight traffic from the road to the waterway. As a result of this modal shift, lower external and societal costs can be expected.

## **Disadvantages**

Besides all advantages one disadvantage is worth mentioning:

- An important weakness of this transport mode (particularly relevant to Danube navigation) is the fact that waterway transport depends on water levels. The water level determines the unloading depth and the rate of capacity utilization of the vessels – and hence also the efficiency of the transports.
- A comparatively low transport speed has to be taken into account.
- In comparison there is a low network density, which comes along with the obligatory pre and end haulage.

Altogether a slow image transformation from a mass volume transport route to a high quality logistics service provider takes place.

## **Transport on inland waterways – Transnational**

Inland waterway transport progressed by 17 % in nearly three decades. It should be noted that the efficiency of this transport mode made a big step forward since the transport performance was done with a considerably reduced vessel fleet. For some countries, like the Netherlands, it is the second mode of transport after road, and for other countries, it still has a major share of

the market.<sup>10</sup> The following table shows the inland freight transport shares of the traffic carriers in Europe:

	(million t-km)			(t-km per inhabitant)			National air freight and mail transport (tonnes) (3)
	Road (1)	Rail (2)	Inland water-ways	Road (1)	Rail (2)	Inland water-ways	
EU-27	...	...	145 680	...	...	293	659 223
Belgium	38 356	9 258	8 746	3 596	875	820	721
Bulgaria	15 322	5 241	2 890	2 005	682	378	29
Czech Republic	50 877	16 304	28	4 901	1 585	3	1 934
Denmark	19 480	1 779	-	3 580	327	-	2 403
Germany	341 532	114 615	64 056	4 154	1 392	779	141 139
Estonia	7 354	8 430	-	5 484	6 280	-	0
Ireland	17 402	129	-	3 954	30	-	9 827
Greece	27 791	835	-	2 488	75	-	15 023
Spain	242 983	11 064	-	5 366	249	-	102 265
France	206 304	41 190	8 896	3 224	654	139	141 920
Italy	179 411	25 285	-	3 034	428	-	62 195
Cyprus	1 308	-	-	1 657	-	-	566
Latvia	12 344	18 313	-	5 436	8 027	-	0
Lithuania	20 419	14 373	-	6 066	4 246	-	7
Luxembourg	10 273	427	367	21 234	897	759	0
Hungary	35 759	10 048	2 250	3 560	998	224	0
Malta	-	-	-	-	-	-	-
Netherlands	81 457	7 216	46 024	4 965	441	2 805	0
Austria	34 327	21 371	2 359	4 127	2 575	284	854
Poland	164 930	54 253	277	4 327	1 423	7	6 914
Portugal	39 091	2 586	-	3 682	244	-	20 599
Romania	56 386	15 757	8 687	2 619	731	404	291
Slovenia	16 261	3 603	-	8 089	1 792	-	0
Slovakia	29 276	9 647	1 101	5 420	1 789	204	1
Finland	29 856	10 434	-	5 633	1 977	-	3 628
Sweden	29 075	23 250	-	3 166	2 551	-	19 314
United Kingdom	171 477	26 384	-	2 820	434	-	129 593
Croatia	11 042	3 574	79	2 489	805	18	1 590
Turkey	-	9 755	-	-	140	-	-
Iceland	-	-	-	-	-	-	-
Liechtenstein	-	18	-	-	512	-	-
Norway	20 595	3 456	-	4 348	738	-	17 095
Switzerland	11 321	-	-	1 491	-	-	4 685

(1) Greece, Italy and the United Kingdom, 2007; road transport is based on movements all over the world of vehicles registered in the reporting country.

(2) All data refer to 2007, except France, 2006.

(3) Data based on departures; Denmark does not include data for Copenhagen/Kastrup airport; France underestimated as freight transport at Paris Charles-de-Gaulle and Paris Orly is incomplete.

Source: Eurostat (road\_go\_ta\_totl, rail\_go\_typeall, tt000007, tps00001 and avia\_gooe) and Directorate-General for Energy and Transport

Figure 1: Inland freight transport 2008<sup>11</sup>

## Transport on inland waterways – National

Waterway transport on the Danube accounts for approximately 2,2 % (12 million tons) of the overall transport quantity (594,9 million tons) in Austria.

Transport modes		
Inland waterway	11,7 Mio. tons	2,2 %
Road	425,5 Mio. tons	80,6 %
Rail	90,7 Mio. tons	17,2 %

Table 1: Transport quantity in Austria<sup>12</sup>

<sup>10</sup>

[http://epp.eurostat.ec.europa.eu/portal/page/portal/product\\_details/dataset?p\\_product\\_code=TTR00007](http://epp.eurostat.ec.europa.eu/portal/page/portal/product_details/dataset?p_product_code=TTR00007) [29.06.2010].

<sup>11</sup> Source:

[http://epp.eurostat.ec.europa.eu/statistics\\_explained/index.php?title=File:Inland\\_freight\\_transport\\_2008.PNG&filetimestamp=20100406093956](http://epp.eurostat.ec.europa.eu/statistics_explained/index.php?title=File:Inland_freight_transport_2008.PNG&filetimestamp=20100406093956) [29.06.2010].

<sup>12</sup> Cf. Käfer A. et al. (2006): Statistik Austria. in: Herry M. et al. (2007): Verkehr in Zahlen – Ausgabe 2007. bmvit, Wien.

When considering traffic performance (distance \* tons), inland waterway transport on the Danube accounts for approximately 5 % (2,6 billion tons) of the total number.

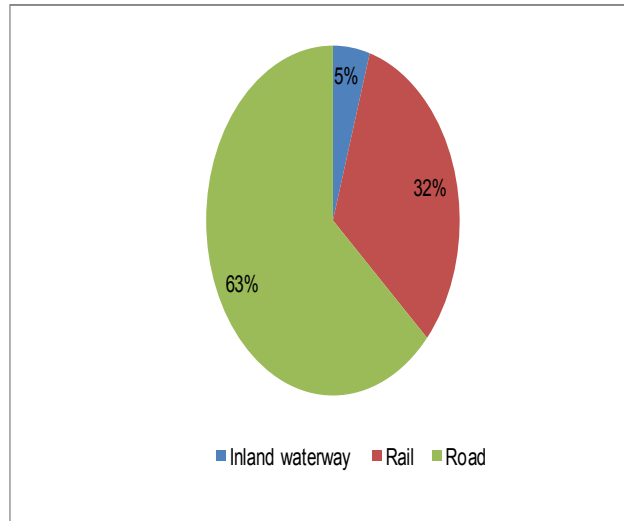


Figure 2: Inland freight transport in Austria (in billion-tons)<sup>13</sup>

Between 1999 and 2005 a yearly growth in the transport quantity of 2,2 % was listed in Austria. In the course of the economic crisis a significant decline of transport numbers among all modes was obvious. For the first time negative alternation rates were observed.

### 3.2. *Intermodal Transport*

General target: Students are acquainted with transport processes as well as basic information concerning measuring and loading units, vehicles etc. Furthermore, advantages and disadvantages of intermodal transport chains are known.

According to ELA standards, students should be able

- to select modes of transport (operational level),
- to agree transport performance objectives (operational level),
- to plan the coordination of multi-modal operations (senior level),
- to evaluate the impact of environmental factors on transport activities (senior level).

#### 3.2.1. General information

Logistics is about planning, execution and control of the movement and placement of people and/or goods and of the supporting activities related to such movement and placement, within a system organized to achieve specific objectives.<sup>14</sup> In the context of inland waterway transportation, intermodality comprises the set of tools to fulfil all logistics tasks as mentioned before. Therefore, an extensive description of this logistical form of organization will be given in the composition at hand.

<sup>13</sup> Herry, M. et al. (2007): Verkehr in Zahlen – Ausgabe 2007, BMVIT, Wien.

<sup>14</sup> Cf. European Logistics Association.

Demand for freight transport in Europe has been rising constantly during the last decades. The increase, which has been most significant in the road transport segment, is expected to continue. Forecasts point to 50 % growth in international road transport within the next years. This percentage may also be taken as an indication of likely intermodal transport growth, since road transport is the demand segment closest to intermodal.<sup>15</sup>

In Europe (European Union) the major part of the infrastructure necessary for transport activities is administered under national laws and hence is planned, financed and developed by the governments of the member states of the EU. Additionally EU-wide initiatives in the field of transport infrastructure planning exist. These initiatives do not only focus on road, rail and inland waterway transport, but include transport modes such as aviation, deep sea and short sea shipping. These initiatives are

- Pan-European Transport Corridors and the
- Trans-European Transport Network (TEN-T, see also 0).

#### Pan-European Transport Corridors

The Pan-European transport corridors formed the basis for linking the Western European Trans-European transport network (EU-15) with the Central and Eastern European countries. They were defined as a result of co-ordination efforts among the EU Commission, EFTA countries, the CEMT<sup>16</sup>, the UNECE<sup>17</sup>, international financial institutions and the Central and Eastern European Countries at the Pan-European Transport Conference in Crete 1994 and in Helsinki 1997.

The realization of individual measures or projects within the Pan-European transport corridors primarily depends on the financial resources of the countries involved in the relevant corridor section. A total of ten corridors have been defined in Europe with a width of 100 to 200 km, leading up to Europe's borders with Asia and the Middle-East. The transport corridors are multimodal, which means that they are based on road or rail networks or a combination of both. Corridor VII is the waterway corridor, the Danube. Capitals of European countries or other metropolitan areas constitute points of intersections between the individual transport corridors. At the nodes, new logistics centres emerge, where flows of goods are broken up or consolidated. The following illustration shows the course of the pan-European transport corridor VII and its connections with the other road and rail corridors in the Danube region. The triangles indicate potential future logistics centres, the circles mark important ports. In addition, areas with high freight transport volumes have been marked with ellipses.

#### Trans-European Network (TEN-T)

In the fields of transport, energy and communication the Trans-European Network forms the basis for EU's single market and help to improve economic and social cohesion within the Community. The TEN-T comprises of basic transport infrastructure as well as traffic guidance, navigation and positioning systems. In 1996, the European Parliament and the European Council adopted Community Guidelines for the Development of the Trans-European Transport

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<sup>15</sup> Vrenken, H./Macharis, C./Wolters, P.: Intermodal transport in Europe, 2005, p. 17.

<sup>16</sup> European Conference of Transport Ministers.

<sup>17</sup> United Nations Economic Commission for Europe.

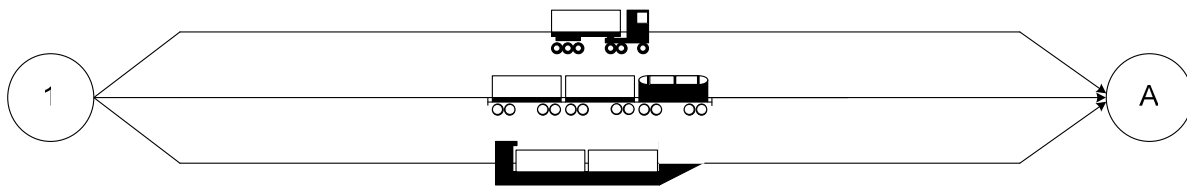
Network (Decision No. 1692/96/EC). These Guidelines not only constitute a reference framework for the realization of the TEN-T, but also identify important projects of common interest. The aim is to integrate the EU Member States' national transport infrastructures and all existing transport modes into one Pan-European scheme. The revision of the TEN-T Guidelines in 2004 provided an occasion to define 30 priority transport infrastructure projects of Community interest. The realization of sub-projects along these significant transport axes is co-financed from European funds. The trans-European transport network consists of roads, railways, inland and coastal waterways, deep sea and inland ports, airports and other nodal points of the system. Moreover, additional infrastructure, such as information and communication systems play an important role in increasing the transport network's efficiency.

### 3.2.2. Systematization of transport processes

#### **Monomial transport**

In monomial transport chains the point of loading and unloading are connected without changing the means of transport (e.g. truck, train, vessel) and therefore without changing the traffic carrier. The term unimodal transport is also frequently used.

Direct traffic comprises transports chains where no changing of the modes of transport takes place.



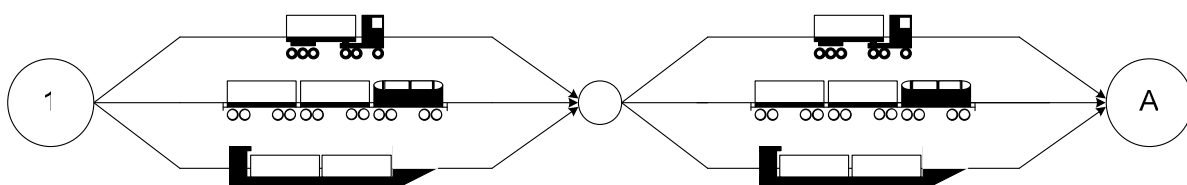
**Figure 1: Direct traffic (unimodal)**

Example: Vessel transports broken stones from the place of excavation to the dumping ground.

#### **Multi-chain transport**

In multi-chain traffic a change of the modes of transport takes place and transshipment is carried out.

Multi-chain unimodal transport means that goods are transported with more than one means of transport but only on one traffic carrier (e.g. two trucks with transshipment).



**Figure 2: Multi-chain transport (unimodal)**

Example: Goods are transported in an articulated vehicle from a freezer warehouse to a transshipment point. The onward transport processes are carried out with light goods vehicles.

### Multimodal transport

The transport of goods with two or more different traffic carriers is called multimodal traffic. These transports take primarily place on long and less time-sensitive routes, since every transshipment process comes along with extra costs and time loss.

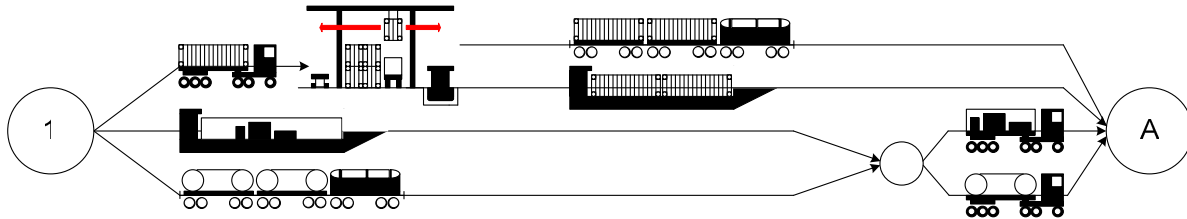


Figure 3: Multimodal traffic

So called bi- and trimodal traffic are subforms of multimodal traffic, which means that two or three traffic carriers are involved in a transport process.

Example (for trimodal traffic): loading units are transported via a railroad siding (road) to the next port. The main leg is then carried out on the inland waterway and on the final leg goods are transported with trucks on the road (see picture below for bi- and trimodal transports).

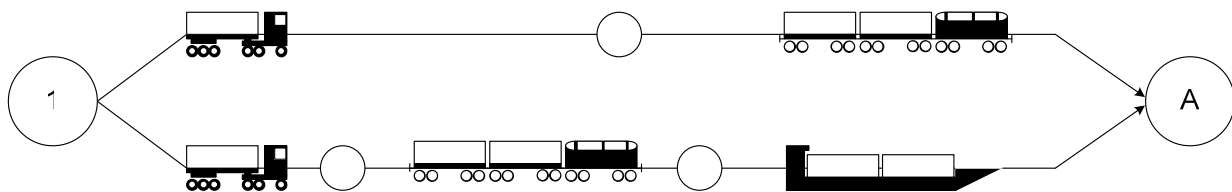


Figure 4: Bi- and trimodal transport

### Interrupted transport

The transport of goods with two or more modes of transport on one (unimodal) or more (multimodal) traffic carrier(s) is called interrupted transport.

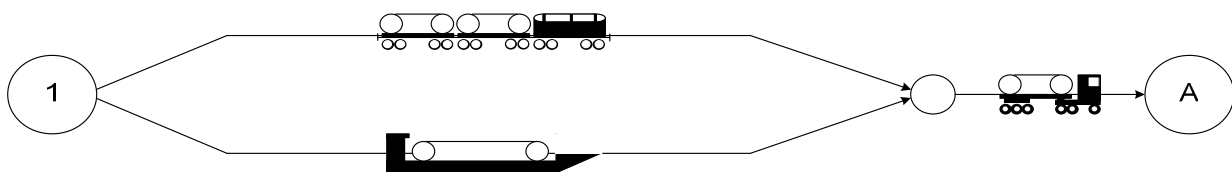
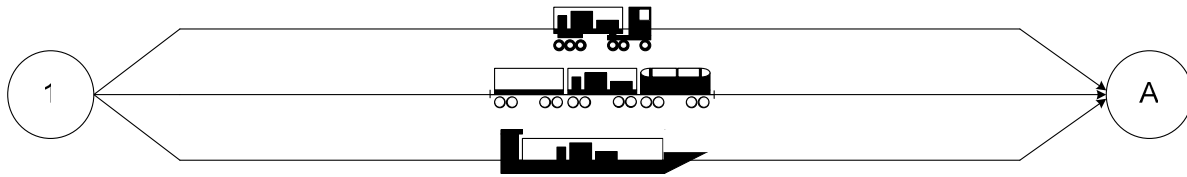


Figure 5: Interrupted bimodal mass transportation

Example: a tankship proceeds from a refinery to a special transshipment point where the intertank transfer to a tank truck takes place.

### Part-load transport

The transportation of individualized, distinguishable goods, which can be handled separately in pieces or bundles, is called part-load traffic. In general all individually packed goods can be transported in one piece in trucks, containers or planes, and it's insignificant whether a good is to be transported as small package or on a pallet.



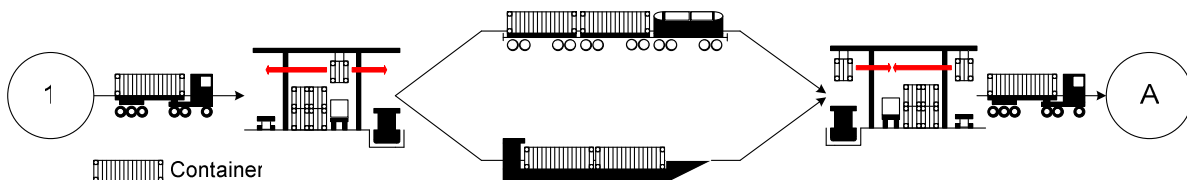
**Figure 6: Part-load traffic**

*Example: CEP<sup>18</sup> service provider or hub-and-spoke groupage freight with the main leg on the road.*

Frequently the terms multimodal transport, intermodal transport and combined transport are used synonymous with the term interrupted transport.

### **Intermodal transport**

Intermodal transport is 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 in changing modes.



**Figure 7: Intermodal transport**

### **Combined transport**

Combined transport is 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 as short as possible.<sup>19</sup> Combined transport is therefore a special form of intermodal transport.

### **3.2.3. Types of intermodal transport**

Intermodal transport activities can be differentiated in the following way:

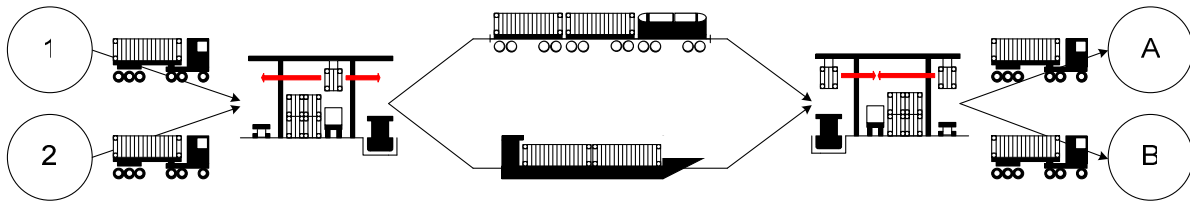
- Unaccompanied combined transport
- Accompanied combined transport

#### **Unaccompanied combined transport**

In unaccompanied combined transports loading units are handled from one traffic carrier to another. The tractive unit and the driver do not accompany the transport. Therefore appropriate trucks have to be made available at the destination of the train or vessel. Loading units have to be appropriate for transshipment, standardized and – normally – craneable.

<sup>18</sup> Courier-, express-, parcel service provider.

<sup>19</sup> Terminology on combined transport, UN/ECE, ECMT, United Nations New York and Geneva, 2001.



**Figure 8: Unaccompanied combined transport**

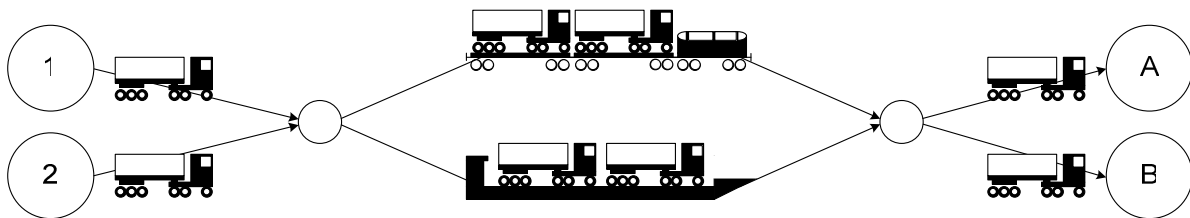
### **Roll-on-Roll-off (RoRo)**

RoRo means loading and unloading of a road vehicle, a wagon or ITU<sup>20</sup> on or off a ship on its own wheels or wheels attached to it for that purpose. In the case of rolling road<sup>21</sup> only road vehicles are driven on and off train.

Lift-on-Lift-off (LoLo) means loading and unloading of ITU using lifting equipment.

### **Accompanied combined transport**

This means the transport of complete road vehicles, using roll-on-roll-off techniques, on trains comprising low-floor wagons throughout. The driver of the road vehicles accompanies the transport on the other mode of transport (primarily train, also ferry) in a couchette coach. Due to safety reasons it is not allowed to stay in the road vehicle.



**Figure 9: Accompanied combined transport**

<sup>20</sup> Intermodal transport unit.

<sup>21</sup> Transport of complete road vehicles, using roll-on-roll-off techniques, on trains comprising low-floor wagons throughout.



### 3.2.4. Measuring units

Measuring units in intermodal transport are most frequently specified in feet and inch respectively. The following table displays the most important conversion factors:

Foot (')	Inch (")	Meter (m)	Centimeter (cm)	TEU <sup>22</sup>
1,0000	12,000	0,3048	30,4800	
0,0833	1,000	0,0254	2,5400	
3,2808	39,3701	1,0000	100,0000	
0,0328	0,3937	0,0100	1,0000	
20	240	6,10	609,6	1
22	264	6,71	670,6	
23	276	7,01	701,0	
24	288	7,32	731,5	
25	300	7,62	762,0	
30	360	9,14	914,4	
35	420	10,67	1.066,8	
40	480	12,19	1.219,2	2
45	540	13,72	1.371,6	
48	576	14,63	1.463,0	

**Table 2: Measuring units in intermodal transport**

Furthermore freight traffic is divided into transport performance and transport volume tons.

**Transport volume:** in tons

The unit transport volume describes the quantitative volume of goods transported within in a period of time, the mileage is not considered.

**Transport performance:** in ton kilometres (distance \* tons)

The unit transport performance incorporates the mileage as well as the quantitative volume of goods.

**Intermodal transport unit (ITU):** ITU defines containers, swap bodies and semitrailers which are suitable for intermodal transport.

**Consignment:** Freight sent under a single contract of carriage. In combined transport, this term may be used for statistical purposes, to measure loading units or road vehicles. The grouping together of several consignments into a full load is called consolidation or groupage.

<sup>22</sup> TEU – Twenty Foot Equivalent Unit.

**Twenty-foot Equivalent Unit (TEU):** is a standard unit based on an ISO container of 20 feet length (6,1 m), used as a statistical measure of traffic flows or capacities. One standard 40' ISO series 1 container equals 2 TEUs.

**Gross tonne:** this unit accumulates the total mass which has to be moved for the transport of a certain good. This means that – besides the good itself – the packaging or container as well as the dead load of the transport vehicle (e.g. wagon, lighter) but not the tractive unit are summed up.

**Net tonne:** Net tonnes indicate the weight of the cargo or the ITU in intermodal transport respectively. In this case, the dead load of the ITU is also included.

**Net-net-tonne:** in order to make a comparison of transport performances possible, net-net-tonne have to be applied, which means that only the weight of the cargo without the dead load of the transport vehicle is taken into account.

### 3.2.5. Transport chains

Intermodal transport holds advantages in regard to costs, quality, time and geographic reason in comparison to unimodal transport. Various circumstances or customer requirements may even necessitate the involvement of different modes of transport and transport systems respectively. From an economic point of view there are two approaches:

- Due to geographic circumstances is the transport organization only possible by integrating different modes of transport.
- Basically the transport could be unimodal (with only one traffic carrier), nevertheless combined transport is more cost-effective.

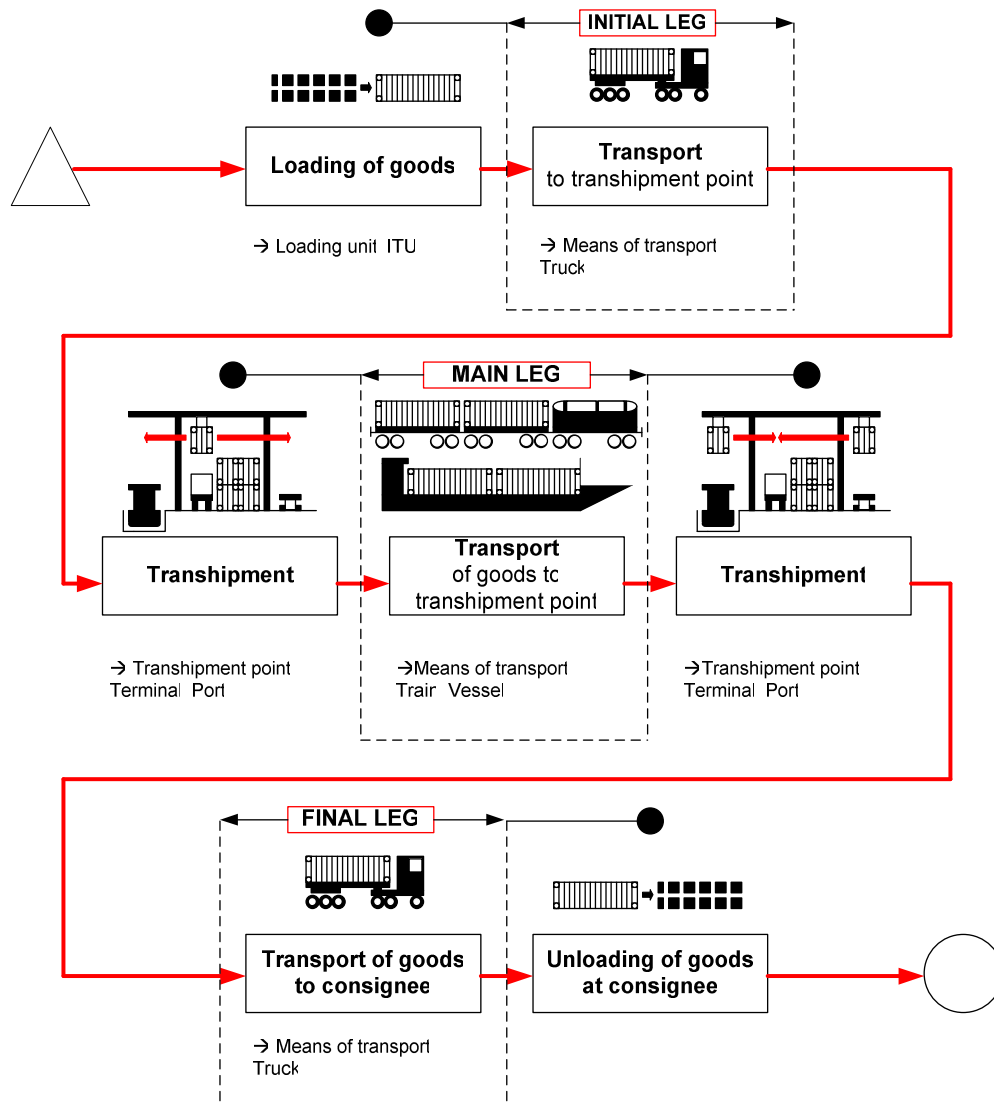
For a cost-efficient and economic realization of combined transport activities the following elements have to be realized:

- Efficient handling processes in transshipment points
- Reduction of costs for initial and final leg
- Compensation of additional costs due to bundling in the main leg
- Offering of additional services.

When considering these prerequisites in combination with a necessary minimum transport distance, combined transports can be a cost-efficient alternative to unimodal transports. Additional costs have to be compensated by means of cost cuts on the main leg and a higher productivity of the two traffic carriers railway and inland waterway. Depending on the transport network, a cost-efficient transport distance for combined transports varies between 300 and 500 kilometres. With appropriate short initial and final legs as well as high and consistent transport volumes (matched transports) combined transports can also be cost-efficient on shorter transport distances.

## Elements and processes of intermodal transport chains

Intermodal transport chains comprise of the elements initial leg, transshipment, main leg and final leg. The following figure illustrates an intermodal transport chain:



**Figure 10: Intermodal transport chain**

In the first step the intermodal loading unit of the consignor is transported (on the road via truck) to a transshipment point (terminal, port) by a freight forwarder or carrier. In the next step the loading unit is handled to another traffic carrier (railway, inland waterway). At this point the main leg on the railway or inland waterway between the shipping and receiving point takes place. The loading unit is again handled and transported to the consignee with a truck on the final leg. Intermodal transport is also given, when either the consignor or the consignee have a railway siding at disposal or are located next to a port and either the initial or the final leg are omitted. The fact decisive for intermodal transport is that at least two traffic carriers are involved in the transport process.

### Initial/first leg

The initial/first leg is the first part of the goods' or loading units' transport from one or more consignors to a transshipment point (hub). The term "initial leg" is valid for road transportation as well as railway, inland waterway and air transportation. The loading units of the consignor are most often transported with trucks to a specific transshipment point.

### **Transshipment**

Moving ITUs from one means of transport to another is called transshipment. Intermodal transport chains are always interconnected with transshipments and the deployment of different means of transport. The transshipment takes place in transshipment points such as terminals. Depending on the equipment necessary for the transshipment, horizontal and vertical transshipment can be differentiated.

Vertical transshipment: is the conventional way of transshipment where the loading unit or semi-trailer are handled with equipment such as cranes or reach stackers.

Horizontal transshipment: is another way of transshipment, where handling units or semi-trailers are not lifted (in contrast to vertical transshipment). Advantage of this transshipment is that no terminal infrastructure or terminal equipment has to be available. The transshipment can take place with special equipment outside of terminals or ports.

### **Main leg**

The main leg covers the transport from the transshipment point of the consignor to the transshipment point of the consignee. The term "main leg" is valid for road transportation as well as railway, inland waterway and air transportation.

### **Final leg**

The term final leg describes the transport from the receiving transshipment point to the consignee. Loading units or goods (which were transported bundled in the main leg) are transported separately to the consignees. On the final leg the transport usually takes place with trucks.

## **3.2.6. Players in intermodal transport**

In this chapter the participating players in the organization of intermodal transport processes are introduced.

### **Consignor/Shipper**

A consignor is 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. The consignor can carry out these deliveries on his own (transport on own account). In the majority of cases and especially in combined transport processes consignors will fall back on agents organizing the transport chain. This organization will primarily be carried out by a forwarding agent / freight forwarder or a multimodal transport operator. A contract of carriage has to be concluded among consignor and contractor.

## **Consignee**

A consignee is the person entitled to take delivery of the goods. Subject to the contract of carriage, the consignee is allowed to assert certain rights: he is allowed to demand the delivery of goods from the carrier and give appropriate instructions.

## **Forwarding agent/Freight forwarder**

The forwarding agent is the intermediary who arranges for the carriage of goods and / or associated services on behalf of a shipper.

The area of operations of a forwarding agent comprises the following duties and responsibilities:

- Conclusion of the contract of carriage.
- Management of the national and international goods' transfer.
- Consultancy concerning and selection of traffic carriers, modes of transport, transportation route and transshipment points.
- Completion and dispatch of freight documents.
- Inspection of goods at delivery.
- Carrying out of customs formalities.
- Cooperation and consultancy concerning all logistics aspects and questions.
- Preparation of modern logistics concepts for customer.
- Handling of data traffic.
- Etc.

## **Transport operator / Carrier**

The transport operator is the person responsible for the carriage of goods, either directly or using a third party. As against forwarding agents – who usually only organize transports with carriers – they actually provide modes of transport, irrespective of the traffic carriers, which means that they in fact provide modes of transport for road, inland waterway and railway as well as for air and seaway. According to the traffic carrier road, transport operators act as sub-contractor of forwarding agents and only uncommonly accept direct orders from end customers. The party bringing the ITU to the terminal is called “sender”, the one picking up “collector”.

## **Multimodal transport operator**

A multimodal transport operator is any person who concludes a multimodal transport contract and assumes the whole responsibility for the performance thereof as a carrier or a transport operator.

Most of the customers access intermodal transport via multimodal transport operators which offer connections to the most important commercial centres in Europe. The operating fields of multimodal transport operators are determined by maritime and continental combined traffic. Multimodal transport operators offer the following services:

- Service from terminal to terminal.

- Offering of the complete “transport chain” from door-to-door: which means from the shipper to the end customer. This service furthermore incorporates the initial/first and final leg on road from and to the terminals.

## **Terminal operator**

The transshipment of loading units and goods calls for appropriate buildings, installations and equipment. In Europe a terminal network was implemented step-by-step, with the growing importance of intermodal transport the previous makeshift terminals were gradually expanded and new were built. Size and location of the terminals vary regarding the market served. A good connection to the high-ranking road network and to the business premises of consignors/consignees as well as rails in appropriate length are prerequisites for successful transshipment. Most of the terminals are located close to the big European seaports, industrial areas and areas of high population density respectively. Besides capacious terminals a number of small transshipment points exist.

## **Railway undertaking**

Railway undertakings are companies which offer railway transport services on the infrastructure of railway infrastructure companies. Prior the actual transport takes place, railway undertakings have to bring forward technical and organizational admittance, and furthermore a reservation of a train path has to be made.

## **Regular services in inland waterway transportation**

Traditional transportation of bulk cargo varies according to supply and demand. This means that either contracts (repeated transportation on the basis of a contract closed for a certain period of time) or the spot market (contracts on short notice for single shipments) are used. Transportation on inland waterways shows the following characteristics:

- Transportation of freight from 1.000 to 7.000 tons with self-propelled vessels or pushing units.
- Broad time slots regarding departure and arrivals.
- Shipment of goods from port of loading to the port of discharge.
- Involvement of a shipper and a consignee.

Therefore logistics services need to guarantee timeliness and reliability concerning departure and arrival times while the size of shipments declines but the number of customers continuously increases. Traditional inland waterway transportation is not yet able to meet all these demands in a completely satisfying way. Regular intermodal services help to increase the service level for customers. Thus inland water vessels call at a port, according to passenger liners, following a regular timetable, where the cargo is transhipped to trucks or rail car for the further transport.

Regular intermodal services represent the main leg of modern logistics chains between purchasing and business market on the inland waterway (=long distance). The so-called “first mile” (initial leg, first part of the transportation route) from the consignor to the port of loading and the “last mile” (final leg) from the port of discharge to the consignee take place on railway or street – depending on the infrastructure given.

Major advantages for customers are

- regular departure and arrival times,
- transportation of part load,
- maintenance of sailing lists in spite of nautical obstacle, for example by transportation on road or railway as substitute,
- year-round service,
- services open to the public.

### Shipping companies / ocean carriers

Shipping companies commercially organize the completion of transports. Therefore own or external ships can come into operation. In all cases several ships are disposed. Shipping companies arrange transports on shore.

Shipping agencies usually represent more shipping companies and act as commercial agents on behalf of them but trade on own account. Their service comprises the acquisition of cargo, the issue of documents, invoice processing, retraction of freight, claims management etc.

### 3.2.7. Infrastructural aspects

In this chapter basic information about the infrastructure given and necessary will be offered.

#### Road infrastructure

Concerning the transport performance is the road the most important modes of transport. In 2008 around 78 % of the overall transport performance was carried out on the road. The EU possesses one of the world’s most dense transport networks. This density reflects a number of factors, including of course relative population density and transportation demand. Transportation demand in urban, industrial and other densely populated areas is especially high. The infrastructure in these areas can be expressed as a ratio between their length and the area of the territorial unit on which they are built. The following table shows the European regions with feature the highest motorway densities:<sup>23</sup>

Region	Motorway density km / 1000 km <sup>2</sup>
Lisboa	220

<sup>23</sup> [http://epp.eurostat.ec.europa.eu/cache/ITY\\_OFFPUB/KS-SF-08-028/EN/KS-SF-08-028-EN.PDF](http://epp.eurostat.ec.europa.eu/cache/ITY_OFFPUB/KS-SF-08-028/EN/KS-SF-08-028-EN.PDF)  
[03.08.2010].

Bremen	176
Greater Manchester	140
Utrecht	122
Düsseldorf	118
Hamburg	107
Zuid-Holland	104
Wien	101
Merseyside	100
Noord-Brabant	95

**Table 3: Highest motorway density in Europe<sup>24</sup>**

In the next table, the overall length of the road network in the European Union is displayed:

Country	km	km / 100.000 inhabitants	km / 1.000 km <sup>2</sup>
Bulgaria	331	4	3
Czech Republic	564	6	7
Denmark	1.032	19	24
Germany	12.363	15	35
Estonia	99	7	2
Ireland	247	6	4
Spain	11.432	27	23
France	10.801	17	17
Italy	6.542	11	22
Cyprus	276	37	30
Latvia	-	-	-
Lithuania	417	12	6
Luxembourg	117	32	57
Hungary	636	6	7
Netherlands	2.602	16	63
Austria	1.677	20	20
Poland	522	1	2
Portugal	2.341	22	25
Romania	228	1	1
Slovenia	569	28	28
Slovakia	334	6	7
Finland	693	13	2
Sweden	1.685	19	4
United Kingdom	3.638	6	15
EU	59.205	14	18

**Table 4: Road network in the EU<sup>25</sup>**

## Railway infrastructure

<sup>24</sup> Source: [http://epp.eurostat.ec.europa.eu/cache/ITY\\_OFFPUB/KS-SF-08-028/EN/KS-SF-08-028-EN.PDF](http://epp.eurostat.ec.europa.eu/cache/ITY_OFFPUB/KS-SF-08-028/EN/KS-SF-08-028-EN.PDF).

<sup>25</sup> Source: [http://epp.eurostat.ec.europa.eu/cache/ITY\\_OFFPUB/KS-SF-08-028/EN/KS-SF-08-028-EN.PDF](http://epp.eurostat.ec.europa.eu/cache/ITY_OFFPUB/KS-SF-08-028/EN/KS-SF-08-028-EN.PDF).



All countries of the European Union separate the operation of the railway infrastructure and railway service. This is one of the imperative exertions of the EU-directive 91/440 for the development of railway companies. Goal of this separation is to offer all interested railway undertakings a transparent and neutral admittance to the sections.

Germany and France possess the longest rail networks with 38.206 km and 30.832 km. Related to the population, this amounts to approximately 50 km of rail network per 100.000 inhabitants. In the Netherlands, the ratio is as low as 17 km per 100.000 inhabitants. To a certain extent, this ratio illustrates the complexity of rail traffic management: a low ratio means that many people, hence many trains, have to share the local network. However, the latter statement is only true when the rail network is fairly evenly spread over the territory. Greece for instance offers a similar ratio (22 km per 100.000 inhabitants), but its rail network is uneven due to the geographical characteristics of the country (numerous islands and extensive mountain regions).<sup>26</sup> The following table shows the length of the railway network in the year 2005:

	km	% electrified	km / 100.000 inhabitants	Km / 1.000 km <sup>2</sup>
BE	3.544	84 %	34	116
BG	4.154	69 %	54	37
CZ	9.614	30 %	94	122
DK	2.644	24 %	49	61
DE	38.206	52 %	46	107
EE	959	14 %	71	22
IE	1.912	5 %	46	27
EL	2.449	3 %	22	19
ES	12.839	59 %	30	25
FR	30.832	48 %	49	49
IT	16.166	70 %	28	54
LV	2.413	11 %	105	37
LT	1.771	7 %	52	27
LU	275	95 %	60	106
HU	7.498	34 %	74	81
NL	2.809	70 %	17	68
AT	5.690	Data not available	69	68
PL	20.253	59 %	53	65
PT	2.839	51 %	27	31
RO	10.948	37 %	51	46
SI	1.228	41 %	61	61
SK	3.658	43 %	68	75
FI	5.732	46 %	109	17
SE	11.050	70 %	122	25
UK	16.237	32 %	27	67
EU	215.720	44 %	57	57

<sup>26</sup> [http://epp.eurostat.ec.europa.eu/cache/ITY\\_OFFPUB/KS-SF-08-028/EN/KS-SF-08-028-EN.PDF](http://epp.eurostat.ec.europa.eu/cache/ITY_OFFPUB/KS-SF-08-028/EN/KS-SF-08-028-EN.PDF).

Table 5: Length of railway network 2005<sup>27</sup>

## Inland waterway infrastructure

The operator of inland waterway infrastructure is in Austria for example via donau. The detailed scope of its responsibility is defined in the Waterways Act and includes the following areas:

- Regulation, maintenance and enlargement of waters,
- flood protection,
- protection of waters, monitoring the status of waters,
- landscaping of riverbanks,
- federal ports and jetties,
- etc.<sup>28</sup>

**Goods transport by inland waterways - [ttr00007]; Millions of Tonne-kilometre**  
2009

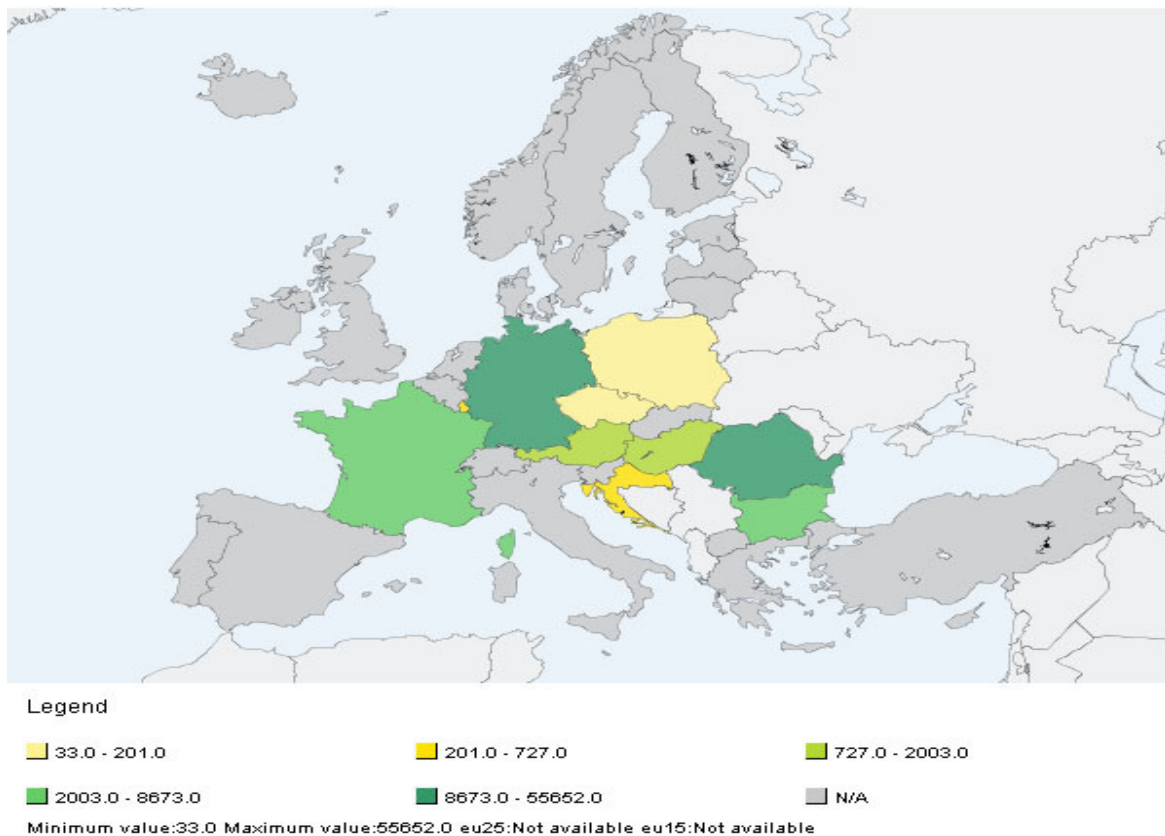


Figure 11: Goods transport by inland waterways (millions of tonne-kilometres)<sup>29</sup>

## Important associations and institutions in intermodal transport

<sup>27</sup> [http://epp.eurostat.ec.europa.eu/cache/ITY\\_OFFPUB/KS-SF-08-028/EN/KS-SF-08-028-EN.PDF](http://epp.eurostat.ec.europa.eu/cache/ITY_OFFPUB/KS-SF-08-028/EN/KS-SF-08-028-EN.PDF).

<sup>28</sup> [http://www.via-donau.org/en/waterway/brief\\_overview/](http://www.via-donau.org/en/waterway/brief_overview/).

<sup>29</sup> Source:

[http://epp.eurostat.ec.europa.eu/portal/page/portal/product\\_details/dataset?p\\_product\\_code=TTR00007](http://epp.eurostat.ec.europa.eu/portal/page/portal/product_details/dataset?p_product_code=TTR00007).

The following institutions are all concerned with intermodal transport and its improvisation and serve as examples.

### ***United Nations Economic Commission for Europe – UNECE Transport***

The work of the transport division is guided by the mandates and work programmes of the UNECE Inland Transport Committee (ITC) and its Subsidiary Bodies. The transport Division also provides the secretariat to the ECOSOC Committee of Experts on the Transport of Dangerous Goods and on the Global Classification and Labelling of Chemicals as well as to the Administrative Committees of a number of UNECE legal instruments on transport. The Division also contributes to the implementation of the Pan-European Programme on Transport, Environment and Health (THE PEP).

The Transport Division provides the secretariat to the Inland Transport Committee (ITC). The ITC is the Sectoral Committee of the UNECE for cooperation in the field of inland transport. Transport is an activity of priority concern to all UNECE governments. The strategic importance of this area of work stems from the fact that economic development and integration of UNECE countries require international transport and therefore intergovernmental cooperation. The overall objective of this cooperation is to facilitate and develop international transport while improving its safety and environmental performance. Pursuing this objective is a complex task, which involves a large number and a great variety of issues, including those pertaining to the specific infrastructures, vehicles and operational procedures of three different modes of transport, namely road, rail and inland waterways transport, as well as of multi-modal and combined transport. They also include specific issues of passenger transport and of goods transport, as well as those of the transport of special cargoes, such as dangerous goods or perishable foodstuffs. The transport of dangerous goods requires specific, particularly stringent, safety regulations. The transport of perishable foodstuffs requires special regulations in order to preserve the quality of these products and therefore the health of populations. Although not all of these components, modes and cargoes are dealt with by the ITC with the same emphasis, a variety of specific efficiency, safety and environmental issues are involved in all of them. Last but not least, a variety of border crossing problems and procedures has to be addressed.<sup>30</sup>

### ***Directorate-General for Mobility and Transport – DG MOVE***

The Directorate-General is in charge of developing transport policies for the European Union. Its remit is to ensure mobility in a single European transport area, integrating citizens' needs, environmental policies, and competitiveness. It does so by:

- Completing the European internal market: ensuring seamless integration of all modes of transport into a single competitive system capable of providing better services for citizens and companies at affordable costs, while safeguarding safety and security and improving the rights of passengers.
- Developing an agenda for innovation: promoting the development and roll-out of a new generation of sustainable transport technologies in particular for integrated traffic management systems and low carbon vehicles.

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<sup>30</sup> <http://www.unece.org/trans/presentTransDiv.html>.

- Building the EU's core trans-European infrastructure network as the backbone of a multimodal sustainable transport system capable of delivering fast, affordable and reliable transport solutions to serve Europe's transcontinental corridors as well as the needs of its urban centres.
- Projecting the EU's mobility and transport objectives and defending EU political and industrial interests on the world stage, within international organisations and with strategic partners.<sup>31</sup>

### ***International Union of combined Road-Rail transport companies – UIRR***

All the tasks carried out by the UIRR are geared towards the development of road-rail combined transport in Europe at the same time as defence of the interests of its member companies, which in their respective market take care of the organisation and marketing of this intelligent system of routing goods.

### ***European Intermodal Association***

The European Intermodal Association is an European association open to all transport modes (rail, road, waterborne, air). Its aim is to improve the co-operation of the different modes of transport as the logistics chain still has lots of shortcomings in infrastructural, technical, organisational and legal respect.

Therefore this neutral organisation with more than 90 members discusses controversial subjects and proposes solutions in line with and to improve the EU transport policy. In this sense EIA offers its services to the EU institutions in order to help shaping the appropriate measures.<sup>32</sup>

## **3.2.8. Loading units in intermodal transport**

Transport of goods in standardized loading units offers numerous advantages, which are for example economic transshipment, simple handling, better utilization of storage and shipping space, easier capture of information, statistics etc.

### **Container**

Containers first gained importance in the 1950s during the Korean War. The American origin is reflected in the indicated dimension (feet, '). Advantages of containers are first of all their standardization and robustness which are a prerequisite for their stack ability and the space-saving storage. The primary disadvantage of containers is their lacking compatibility with euro-pallets as well as the necessity to deposit containers on the basement (rarely on ramps) which makes loading and unloading more difficult.

### **ISO-Container**

The ISO<sup>33</sup>-container is the most popular and successful loading unit for intermodal transport with seagoing vessels and ground transportation. 96 % of all containers are 20' or 40'

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<sup>31</sup> [http://ec.europa.eu/dgs/transport/doc/2010\\_05\\_move\\_mission\\_statements.pdf](http://ec.europa.eu/dgs/transport/doc/2010_05_move_mission_statements.pdf).

<sup>32</sup> <http://www.eia-ngo.com/> [09.08.2010].

containers. The exact dimensions, corner fittings as well as the multiple stack ability are orientated on seagoing-vessels. The following tables indicate the dimensions of ISO-containers:

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<sup>33</sup> ISO – International Standardisation Organisation.

ISO-Container / 20 Feet (Ct 20)			
Inside length	Width	Height	Loading weight
20' = 5.919 mm	8' = 2.340 mm	8' = 2.380 mm	22.100 kg

ISO-Container / 40 Fuß (Ct 40)			
Inside length	Width	Height	Loading weight
40' = 12.051 mm	8' = 2.340 mm	8' = 2.380 mm	27.397 kg

The dimensions (inside length and width) make an optimal usage of shipping space with europallets impossible. The inside area can only be used up to 78 % (20') and 84,8 % (40').

### Land container (UIC norm)

Land containers, according to the UIC norm, fit to the European dimensions. With a width of 2,55 m they fit to the maximal allowed width in road traffic as well as to the railway loading gauge in railroad traffic. Therefore they better match to the European infrastructure and are – as opposed to maritime containers – better suitable for the loading of euro pallets due to their width of 2.400 mm.

These containers can be stacked six fold but are most of the time stacked three- or fourfold.

### Special forms of containers

Besides the mentioned standard types of containers exists a variety of special forms for all kinds of transport assignments. The dimensions of these containers are primarily oriented on the allowed length and width in road traffic and vary from a length of 7,15 m, 7,45 m, 7,82 m, 13,60 m and a width of 2,55 m and 2,60 m.

Examples for special containers are roll-off containers, bulk containers, flat containers, high cube containers, reefer/refrigerated containers, open-top containers and tank containers.

### Swap containers

A swap body is 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 (see 0) to be used on rail. Some swap bodies are equipped with folding legs on which the unit stands when not on the vehicle.<sup>34</sup> Swap bodies are used in intercontinental transport, but very rarely in inland waterway transportation. Furthermore swap bodies with EN and UIC standardization are in use.

<sup>34</sup> Terminology on Combined Transport, UN/ECE, ECMT, EC, New York and Geneva, 2001, p. 49.

### *Boxes with special design*

Special techniques are applied for boxes with a length of 13,60 m in order to realize an internal height of three meters. These boxes need special trailer chassis in road transport and in rail transport special rail cars have to be applied.

## **Semi-trailers**

Semi-trailers are non-powered vehicles for the carriage of goods, intended to be coupled to a motor vehicle in such a way that a substantial part of its weight and of its load is borne by the motor vehicle. Semi-trailers may have to be specially adapted for use in combined transport<sup>35</sup>. The width of semi-trailers is 2,55 m (except reefers with a width of 2,6 m), height is 4 m and length 12-13 m. Loading height amounts to 2,7 m. For intermodal transports semi-trailers need to have a chassis clearance of 170 mm.

Semi-trailers can be craneable or not craneable. So called grappler pockets at craneable semi-trailers, which are four jacking positions on the bottom side of the strengthened outer frame of the semi-trailer, make their handling/transshipment in intermodal transport processes possible. Semi-trailers, which are not equipped with grappler pockets, are primarily applied in accompanied intermodal transport processes (see 0, rolling road).

### **3.2.9. Vehicles in intermodal transport**

The following road vehicles are used in intermodal transport:

#### **Load train and tractor-trailer**

Complete load trains and tractor-trailers can be transported with low-loader wagons. Load trains generally fit to rolling-road transport if the following measurements are not exceeded:

<b>Length</b>	18.75 m	
<b>Width</b>	2.60 m	
<b>Height</b>	max. 4.00 m	
<b>Total weight</b>	40 t	
<b>Chassis clearance</b>	17 cm	
<b>Load per axle</b>	The sum of the load per axle may not exceed the following values when considering the appropriate wheel base	
	For trucks:	
	Less than 1 m:	11,500 kg
	1 m to 1,3 m:	16,000 kg
	1.3 m to 1.8 m:	18,000 kg
	For trailers and semi-trailers:	
	Less than 1 m	11,000 kg
	1 m to 1.3 m	16.000 kg

<sup>35</sup> Terminology on Combined Transport, UN/ECE, ECMT, EC, New York and Geneva, 2001, p. 37.



	1.3 m to 1.8 m	18,000 kg
	1.8 m and above	20,000 kg
	The sum of the load per axle of a triple axis of trailers and semi-trailers may not exceed the following values when considering the appropriate wheel base	
	1.3 m or less	21,000 kg
	More than 1.3 m, up to 1.4 m	24,000 kg

**Table 6: Loading per axle**

### Truck parameters

The initial/first leg from the consignor and the final leg to the consignee on the road can take place with or without handling equipment:

- With handling equipment at the final customer/consignee: In this case tractor-trailers, comprising a towing vehicle and a chassis are used. A chassis is a carrier which is connected with the towing vehicle via a fifth-wheel plate. Modern chassis carry swap bodies as well as containers with various dimensions.
- Without handling equipment at the final customer / consignee: Containers can be transported with side loaders which also allow stabling and grabbing. Side loaders comprise the towing vehicle, chassis and telescopic parts of a crane (payload up to 37 tons), which allow a sideways unloading of containers from the chassis. Swap bodies are placed on their extended supporting legs by means of the pneumatic suspension of the truck.

### Railway vehicles

This part covers the most important topics and regulations concerning the deployment of railway vehicles.

- Railway car parameters: In unaccompanied intermodal transport processes predominantly container cars are used. For craneable semitrailers pocket wagons are used.



**Picture 2: Pocket wagon**

- Load limit: These limits are displayed directly on the railway car. The decisive limit is dependent on the speed as well as on the lowest track class on the transport way



connection and must not be exceeded. The following picture is an example for a load limit:

	A	B1	B2	C2	C3	C4
90	35,0	37,5	49,0	54,0	59,0	
S	35,0	37,5	49,0	54,0	57,0	

**Picture 3: Load limit**<sup>36</sup>

- A/B<sub>1</sub>/B<sub>2</sub>/C<sub>2</sub> etc. indicate the track class for which the load limit is valid,
- S in the first column indicates a maximum speed of 100 km/h,
- SS in the first column indicates a maximum speed of 120 km/h,
- Any other number indicates the particular maximum speed.
- Load distribution: The payload has to be distributed evenly, which means that the maximum permissible wheel load must not be exceeded. For every railway wagon special schemes for loading have to be applied in order to guarantee an even load distribution.
- Railway loading gauge: A loading gauge defines the maximum height and width for railway vehicles and their loads to ensure safe passage through bridges, tunnels and other structures. Classification systems vary between different countries and gauges may vary across a network, even if the track gauge remains constant.<sup>37</sup>
- Train parameters: Train parameters are the length and weight of a train. Both parameters are displayed without the railway traction vehicle. The length of a train is limited to passing and intersection tracks. The average length of trains is about 650 m, on some test tracks 1,000 m long trains are transported.

### Inland waterway vessels

For the transport of goods on inland waterways so called inland waterway vessels are applied. These vessels differ from seagoing-vessels regarding their construction design. In this section a brief overview over the most common vessels will be given.

- Dry cargo vessels: These vessels are used for transporting a wide variety of goods, such as long wood, coils, grain and ore. They can be used for nearly everything, reducing the number of empty voyages.  
In the Danube region approximately 100 dry cargo vessels travel on international transport routes. This category can carry between 1,000 to 2,000 tons.
- Container vessels: According to the Central Commission for Navigation on the Rhine (CCNR), more than one million TEU are transported annually on the Rhine river to the sea ports using the river for pre- and end-haulage, whereby vessels constructed for this purpose are predominantly used for transporting containers.
- Tanker shipping: special tankers transport various kinds of goods in liquid form, including

<sup>36</sup> Source: [http://www.railcargo.at/de/Kundenservice/Tarife\\_&\\_Co/Beladetarife/2\\_Band\\_1\\_Grundsaeetze\\_01\\_01\\_2008\\_Nachtrag\\_8.pdf](http://www.railcargo.at/de/Kundenservice/Tarife_&_Co/Beladetarife/2_Band_1_Grundsaeetze_01_01_2008_Nachtrag_8.pdf).

<sup>37</sup> [http://en.wikipedia.org/wiki/Loading\\_gauge](http://en.wikipedia.org/wiki/Loading_gauge).

- Mineral oil and its derivatives (petrol, diesel and light heating oils etc.)
- Chemical products (acids, bases, benzene, styrene, methanol, etc.)
- Liquid gases
- Roll-On/Roll-off vessels: the term roll-on/roll-off means that objects are transported which are loaded and unloaded via port or vessel ramps. The most important types of goods that are transported in this way are
  - Tractor trailers and semi-trailers ("floating motorway"),
  - Passenger vehicles,
  - Construction machinery, farm machinery, motor tractors,
  - Heavy cargo and over-sized goods.

Most roll-on/roll-off transports are carried out using specially constructed vessels. In this context, catamarans have to be mentioned. Catamarans are vessels made up of a double hull held together by a single deck which forms a large loading surface.



Picture 4: Roll-on/Roll-off catamaran<sup>38</sup>

### 3.2.10. Advantages/disadvantages/barriers in intermodal transport

The dynamic development of goods traffic, which is the concept of increasing prosperity, is accompanied by negative impact on living space, environment and road safety for example. First and foremost trucks or rather road transportation contributes to this negative development. On the other hand modern logistics and goods traffic are unimaginable to do without road transportation due to its fast supply of wide distances. Rail transportation and inland waterway navigation have an advantage against road transportation especially on long distances, where heavy and big bulk cargo can be transported more cost-effective.

Intermodal transport can be advantageous due to cost, quality, time and or geographical reasons as well as due to evident reasons regarding environmental and efficiency reasons in comparison to unimodal transport. Given factors of some customers necessitate the incorporation of different modes of transport and transport systems. The following approaches can be cited:

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<sup>38</sup> Source: via donau, 2009.

- Due to geographic reasons transportation can only be carried out when applying different modes of transport.
- Basically transportation could be carried out unimodal; nevertheless combined transport is more economic than unimodal transport.

While combined transport obviously marks an efficient alternative regarding geographic reasons, an adequate economic efficiency is difficult to attain when non-stop unimodal transport chains simultaneously exist. Reasons therefore are a multitude of players involved in the initial, main and final leg as well as costs emerging in transshipment activities because of an increased coordination effort. Hence combined transport cannot compete with unimodal transport on short distances since additional costs cannot be compensated via savings on the main leg. For an efficient performance of intermodal transport processes the following criteria is essential:

- Efficient design of transshipment processes in handling points.
- Reduction of the portion of costs for the initial and final leg.
- Compensation of additional costs by bundling in the main leg.
- Offering of additional services.

When considering the listed factors and a given minimum distance combined transport can be an economic alternative to unimodal transport. According to this additional costs have to be counterbalanced with cost savings on the long leg and a higher productivity at the transportation by rail or inland waterway. Depending on the conditions of the transport network, an economic minimum distance varies between 300 and 500 kilometres. Short initial/first and final legs in combination with a correspondent constant volume (matched transports) in both directions enable an economic transport already on shorter distances or rather political regulations may presuppose intermodal transport.

### **3.3. Port technology – Terminals**

*Students are familiar with ports and the technology implemented and necessary to handle cargo. Students get to know how goods are handled from a consignor's point of view.*

*According to ELA standards, students should be able*

- *to plan transport transshipment operations to meet objectives (operational level),*
- *to manage transport loading and unloading operations (operational level),*
- *to contribute to the evaluation of the transport environments (operational level).*

Terminals depict a structured (regular) access to goods traffic on rail and/or inland waterway. Terminals are public accessible transshipment points in combined transport, which are equipped with special infrastructure and transshipment technology for the handling of intermodal loading units between modes of transport for ground (truck, freight train) and water transportation (container, Roll-on/Roll-off vessels). Transshipment can take place with or without

an intermediate storage. Besides conventional terminals, in which vertical transshipment processes take place, special forms of terminals exist. These terminals are either integrated in existing facilities or exist as self-contained transshipment point. The main difference is the horizontal transshipment. Terminals are both transshipment points for changing modes of transport as well as point of intersection of transport roads for combined transport where the transshipment of containers, semi-trailers and swap containers takes place. They take over the business of bundling, storage and distribution of intermodal loading units. Besides public, general and non-discriminating accessible terminals private terminals exist.

### 3.3.1. Terminal functions

Generally terminals can be characterised according to the subsequently displayed functional groups:

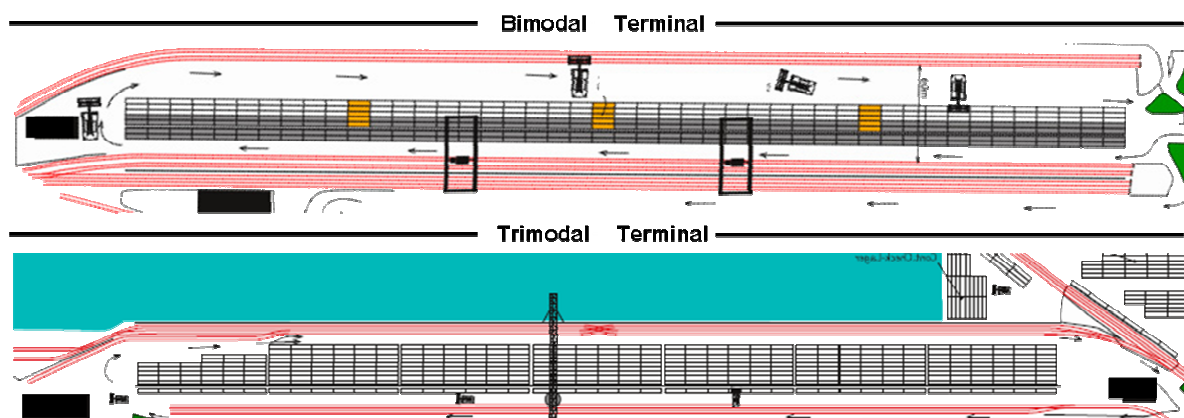
Terminal functions					
Transport function		Logistics function			Customer function
<i>Transport connection</i>	<i>Train services</i>	<i>Network</i>	<i>Local</i>	<i>Business segment</i>	
Bimodal Trimodal	Single wagon Block train Shuttle train Company train	Gateway Loco	Import Export	Maritime Continental	Transshipment Storage Additional services

**Table 7: Terminal functions**

The displayed classification is oriented towards the basic terminal functions and the attended benefits.

#### Transport function

The transport function of a terminal describes the type of connection to various modes of transport and the primarily offered train services. Depending on the number of connections to modes of transport so-called bi- and trimodal terminals can be differentiated:

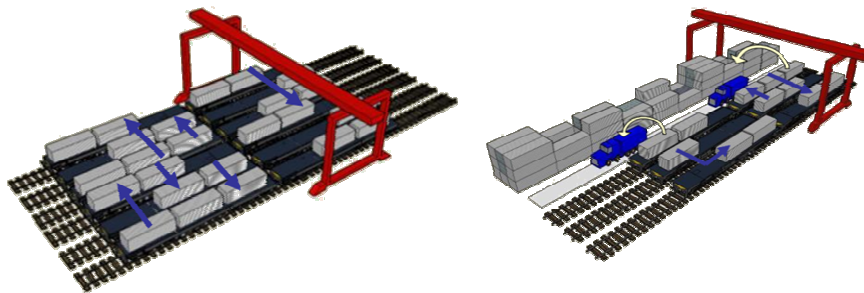


**Picture 5: Bi- and Trimodal Terminal**

The transport function is additionally described by the offered/handled train services. The predominant train services are of importance due to their influence on transshipment processes. Train services can be divided into single wagons, block trains, shuttle trains and company trains.

## Logistics function

The offered logistics functions in a terminal form another distinguishing feature. A differentiation regarding the function of the terminal in a network, the local function and the characteristics of the operated business segments can be made. The function in the network describes the intended purpose of the primarily carried out transshipment. In this context the so-called Gateway and Loco-terminals exist:



**Picture 6: Terminal functions Gateway and Loco**

Gateway terminals act as connection- and transshipment point for the railway. The majority of the loading units is transhipped directly between trains and subsequently transported to other destinations. This means that trains almost isochronously run-in to the terminal and swap loading units among them, pick new loading units up and proceed to their respective target terminals.

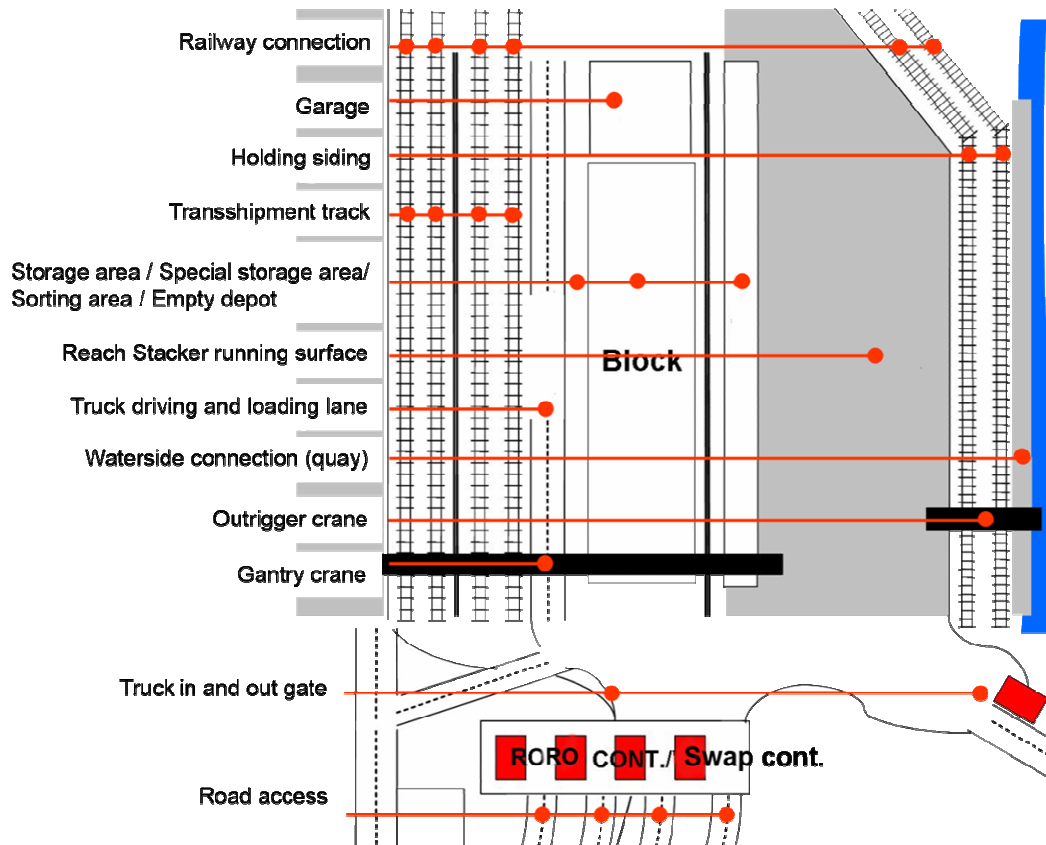
Loco terminals on the other hand act as local distribution centres, where the majority of loading units is delivered with trucks and transported onward by train and vice versa. Principally a mixture of both terminal types can be found.

## Customer function

The customer function describes the nature and amount of offered service features. Terminals can offer several services in addition to transshipment tasks. Correspondingly an added value for customers can be offered, which should enhance the attractiveness of intermodal transport. A differentiation according to transshipment, storage and additional services can be made. Different lead and follow-up times on the road, time tables of the railway and run-times on the inland waterway call for retributive arrangement of loading units in the time elapsed. The storage space in terminals can therefore be seen as buffer which allows for the temporal compensation. As a consequence, the different modes of transport involved do not have to wait for each other. A systematic planning and management considers an optimal loading of vessels and the loading of trains to the greatest possible extent as fast as possible in order to minimize holding times and subsequently reduce costs for customers.

### 3.3.2. Functional area

The infrastructure of terminals is divided into different functional areas whereupon they may vary. The following picture provides an overview over different functional areas in a terminal:



**Picture 7: Terminal functional areas**

The picture shows a potential configuration of a terminal infrastructure. The infrastructure can be divided into the following functional areas:

- Railway connection to the railroad network.
- Garage for repairing damaged loading units.
- Holding track for temporal removal from service.
- Transshipment tracks with a craneable track length for trains with a length up to 700 metres.
- Storage: areas with parking areas (ranks) for multiple stacking of loading units (stacking tiers) under the gantry crane.
- Running surface for gantry cranes for rerouting of loading units between landside and waterside connection.
- Running surface for trucks for delivery and pick-up of loading units on the road.
- Gantry crane above transshipment tracks and storage area with a crane runway width of approximately 40 metres.
- Waterside connection via quay wall and outrigger crane for loading and unloading of vessels.
- Truck in- and out gate.



- Road connection and parking lots.

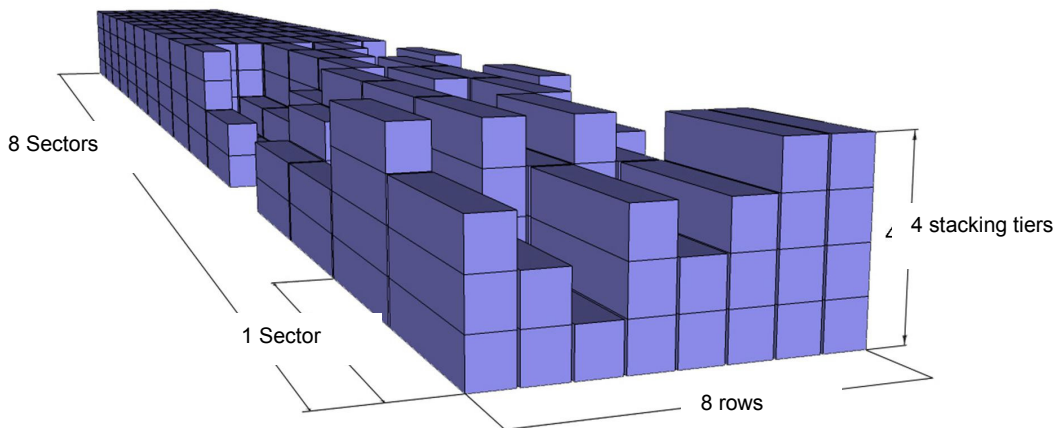
In general a classification in landside connection, storage area as well as waterside connection can be made. These areas will be explained in detail on the following pages.

## **Landside connection / Landside operation**

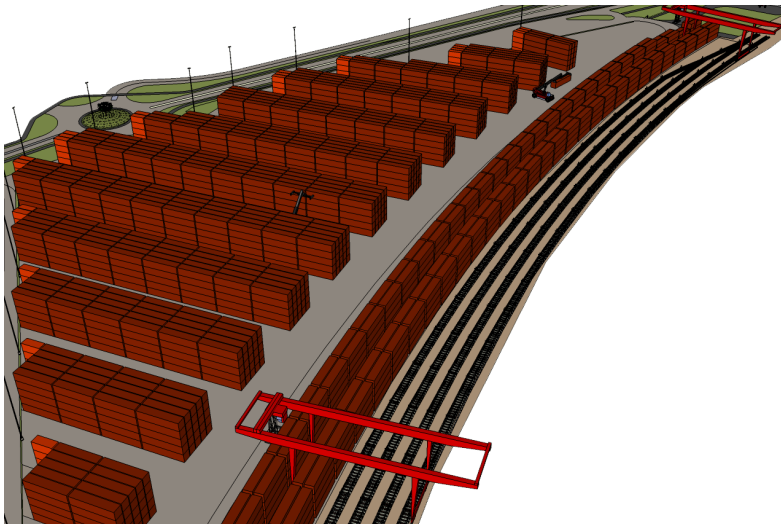
Landside operation or connection respectively is related to the connection to rail and road. At the road side a terminal comes with registration counters where the truck processing is carried out. Inside the terminal marked driving lanes for delivery and collection as well as arrival and departure exist. This division prevents from collisions. The truck gate is the interface between terminal and landside operation. Basically there are two types of gates. In one case trucks directly enter the gate and deposit the cargo documents or announce the loading units to be connected. In the other case truck drivers head to a central parking lot and proceed to a check-in counter in order to carry out all the formalities and enter the terminal afterwards. The transshipment of the loading units takes place in the truck driving lanes or in designated delivery positions. In the majority of cases driving (loading) lanes for trucks are located next to the regular driving lanes in order to not disturb the traffic flow within a terminal. The dispatch rate of trucks is closely tied to the number and capacity utilization of transshipment facilities available. Connecting the railway a terminal has transshipment rail tracks available for loading and unloading of trains. Between landside and waterside connection a storage area in which loading units are transhipped and stored intermediately can be found.

## **Storage area**

The storage area is divided in different blocks according to the size of the terminal facilities. In inland terminals a classification of the storage areas according to the length of the sectors, in the width according to rows and height according to the stacking tiers is made. A block typically consists of more lanes whereof one or two lanes are provided for loading and unloading as well as approach and departure. Blocks are divided in several sectors where one block has a total length of up to 650 meters, which comes up to the length of a block train. The length of the sectors (measured in feet, typical length varies between 80 and 125 feet for one sector) varies and is adjusted to the storage area available and the various lengths of the loading units handled. The height of a block is displayed with the stacking height, which accounts for the height of one loading unit. The following picture shows a typical picture:



**Picture 8: Container block**



**Picture 9: Storage area**

Stocking, stock removal and moving the stacks within the storage area is carried out with terminal transshipment facilities. Loading units are most of the time stored in mixed blocks, which means that loading units with different lengths (20, 22, 23, 24, 25, 30, 35, 40 and 45 feet) are mixed. In inland terminals solely a separation between containers, swap bodies and semi-trailers is made. A further breakdown of storage areas can be made according to different functional areas such as separate storage of empty containers, special loading units (e.g. hazardous goods) and sorting areas.

## Waterside connection

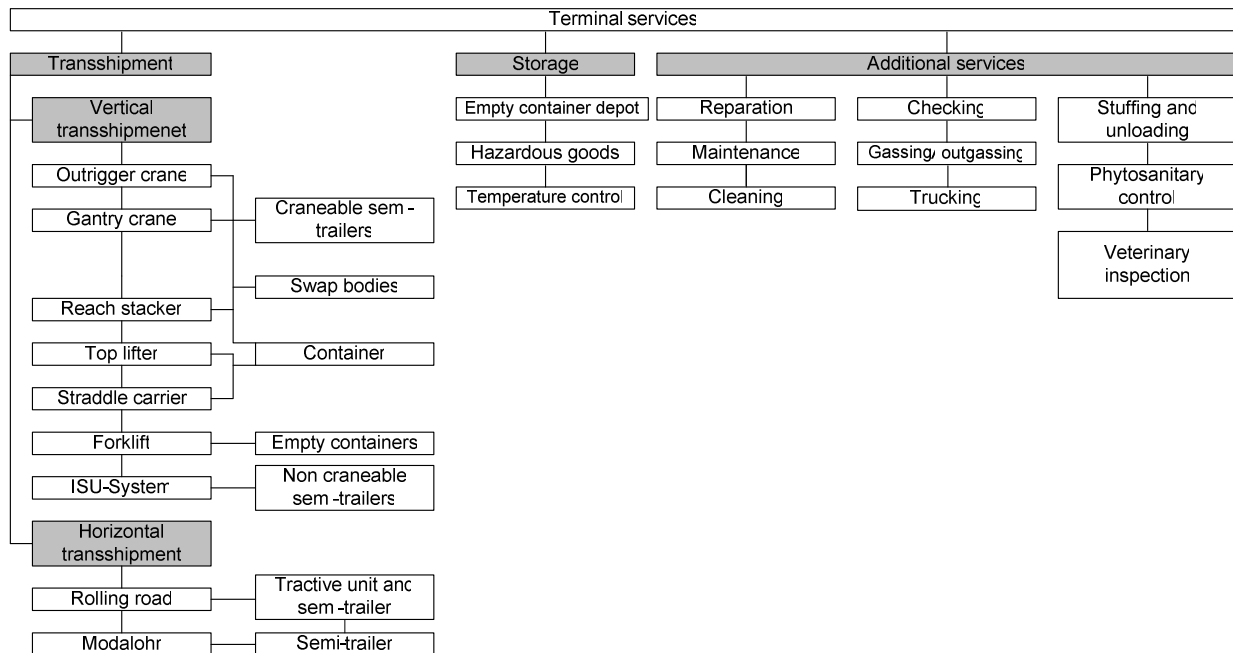
The waterside connection of a terminal takes place via a quay and a quay wall respectively which is the interface between terminal and container vessels. Alongside the quay wall so called berths are situated where the mooring of vessels for loading and unloading takes place. Outrigger cranes are placed on the quay walls which undertake the loading processes.



According to the composition of the terminal loading units can be transported directly with trucks or trains or indirectly with reach stackers, forklifts, terminal tractors, straddle carriers or automated guided vehicles to the quay cranes.

### 3.3.3. Terminal services

Terminal services comprise transshipment, storage and additional services which are offered for customers. The following picture provides an overview over terminal services:



**Picture 10: Terminal services**

The services offered vary extensively according to the particular terminal and depend on the customers as well as on the demand. Furthermore the space available, the geographical location and the transport connection of the terminal have an effect on the services. The particular services will be described in the following chapters.

## Transshipment

Transshipment describes changing modes from one mode of transport to another. A basic differentiation between horizontal and vertical transshipment can be made. In terminals primarily vertical transshipment takes place. This method is the classical style while horizontal transshipment is a younger method which makes transshipment without any special terminal facilities possible.

When applying horizontal transshipment the loading units are only lifted slightly. In the majority of cases special loading units and/or special transport equipment have to be applied. Furthermore innovative transshipment facilities (technologies) can be applied but are frequently not yet widely employed.

Moreover a distinction between a commercial upstroke and so called dispo-upstroke is made. The commercial hub refers to the transshipment of a loading unit from one means of transport to

another and vice versa. The hub connected to the transshipment is charged and is therefore called commercial hub. The so-called dispo-hub is not charged and refers to transshipment processes when managing and handling the storage area. Oftentimes loading units are not directly accessible and have to be laid open. The upstrokes necessary for accessing a unit load are called dispo-hubs. To that effect terminals seek to minimize such dispo-hubs.

## **Storage**

Storage and empty are services which affect the physical storage of loaded or unloaded units. Storage and intermediate storage serve as a bridgeover for the time span which arises due to asynchronisms between delivery and pick-up. The number and extent of additional services in a terminal vary according to the location, equipment and area available. Therefore a terminal can offer a storage function for a producing company by offering parts necessary for the production just-in-time. Another variety is that customers store their empties intermediately. In this case the terminal is called empty depot. Customers (and shipping companies) bundle their containers (empties) in a terminal and call them up on demand in regular intervals. The terminal takes over the administration and organisation.

**Dangerous goods** are handled / stored differently in many terminals. Dependent on the infrastructure dangerous goods may only be stored on rail cars, up to 21 days or longer than 21 days. For an intermediate deposit on the ground special infrastructure such as accidental basin and interceptor have to be available.

**Temperature control** – which means to hold a certain temperature within specified boundaries – is also a service offered by terminals for special loading units. Loading units can be differentiated between isolation containers (porthole containers) which have to be connected to an on-board electrical system and integral reefer containers (integral unit) which possess their own aggregate. The service comprises the provision of electric power and temperature records.

## **Additional services**

Reparation, maintenance and cleaning of loading units are integral parts of terminal services. Most of the terminals have special garages available in which these services take place. Since loading units are often exposed to heavy forces maintenance actions have to be carried out after some time. Checking is to control loading units when entering a terminal regarding various damages. Gassing and degassing of loading units are services which serve for the protection of packaging materials and handling aids made of wood, of fruits or vegetables against attacks by pests. Some terminals offer trucking which is about the organisation of the first and final leg on the road. Loading (stuffing) and unloading (stripping) can also be done in terminals and is about optimal loading (space saving, secured). Phytosanitary and veterinarian control should minimize the risk of a carry-over of any pest organisms. Certain plants, herbal products have to be controlled when importing in a customs area.

### 3.3.4. Transshipment equipment in terminals

Transshipment equipment are vehicles and instruments (tools) respectively which support transshipment activities, stacking and transportation of loading units, swap bodies and semi-trailers in combined traffic. Generally a differentiation between rail-mounted and non-rail-mounted industrial tracks as well as driverless transport vehicles can be made. According to the size and flow-capacity of the several terminals each of the device models has its advantages and disadvantages and has to be analysed against the background of all relevant parameters. The following categories can be differentiated:

- Rail-mounted industrial tracks: are means of transport on built-in slide racks, which serve for the conveyance, pulling and pushing of loading units. When they are equipped lifting devices they are able to pick up and unload, lift and stack loading units. They are powered with petrol, diesel, electricity or hybrid systems.
- Non-rail-mounted (rubber-tyred) industrial tracks: are means of transport on steerable wheels. Their functionality is similar to rail-mounted industrial tracks. The essential difference is given by the fact that they are not fixed.
- Driverless transport vehicles: are also called automated guided vehicles (AGV). These means of transport navigate without any driver along real or virtual guidance. The vehicles are steered, scheduled and administered by a superior processor.

The following table gives a brief overview over the principle functions of the different types of terminal equipment:

Equipment-Type	Funtion							Work area	Control mode			Cargo gear			Loading units						Movements (hubs; per hour							
	Transshipment	Vertical	Horizontal	Transport	Internal	External	Variable	Fixed	Manually	Semi-automatic	Fully automatic	Gripping piers	Spreader	Fork	ISU deployment	Container (loading)	Empty	Swap bodies	Semi-trailers	Craneable	Semi-trailers	Non-craneable	Transport container	Stacking	Loading and unloading of train	Loading and unloading of truck	Carrying capacity (t)	
Rail-mounted industrial tracks																												
Outrigger crane	●	●						●	●	●		●	●		●	●	●	●	●	●			r a	r a	r a	4'		
RMG Rail Mounted Gantry	●	●						●	●	●		●	●		●	●	●	●	●	●			r a	2C-3C	r a	4'		
Non-rail-mounted industrial tracks																												
Cranes																												
RTG Rubber Tyred Gantry	●	●					●		●	●		●	●		●	●	●	●	●	●			r a	2C-3C	r a	4C		
Container stapler																												
Reach Stacker	●	●		●	●		●		●			●	●		●	●	●	●	●	●			15	2C-3C	10	42-45		
Top Lifter	●	●		●	●		●		●			●	●			●	●						N a	N a	N a	36-45		
Straddle Carrier	●	●		●	●		●		●	●			●			●	●						N a	N a	N a	4C-11C		
Empty stapler																												
Reach stacker	●	●		●	●		●		●				●		●		●	●	●	●	●		15	2C-3C	10	12		
Forklift	●	●		●	●		●		●					●			●						N a	N a	N a	5-18		
Frontlift	●	●		●	●		●		●				●				●						N a	N a	N a	7-10		
Terminal Tractor				●	●		●		●							●	●	●	●	●	●		-	N a	N a	25-32		
Truck (With or without chassis,				●	●	●	●		●							●	●	●	●	●	●		-	N a	N a	25		
Driverless transport vehicles																												
Automated guided vehicle				●	●		●			●						●	●	●					-	N a	N a	6C		

**Table 8: Terminal equipment functions**

Transshipment equipment can be divided according to their possible application in transshipment and transport of loading units. The operation can be manually or automated whereupon outrigger cranes can be operated semi-automatic. In doing so one of the two crabs is computer-operated. Due to their configuration outrigger cranes or rail mounted gantries only have a preassigned application area. Reach stackers and forklifts on the contrary are flexible and can be deployed variably. According to the technical fitting not all kinds of loading units can be manipulated and transported respectively. Thus adequate additional equipment or various transshipment equipment are necessary in order to allow for an optimal transshipment as well as a systematic management of storage areas.

In the following section a transparent overview over the various equipment types is given:

### Outrigger crane

An outrigger crane is a conventional hoisting crane which uplifts loading with a cable via a pivot mounted arm. Outrigger cranes are the direct connection between vessel and quayside. Usually these cranes are also rail-mounted.

Outrigger crane	Function						Working area		Control		Cargo gear		Loading units					Hubs / Movements per hour							
	Transshipment	Vertical	Horizontal	Transport	Internal	External	Variable	Fixed	Manually	Semi-automatic	Fully automatic	Gripping pliers	Spreader	Fork	ISU deployment	Container	Empty	Swap bodies	Semi-trailers craneable	Semi-trailer non craneable	Transport container	Stacking	Loading / Unloading train	Loading / Unloading truck	Carrying capacity
	●	●						●	●	●		●	●		●	●	●	●	●	●		k A	k A	k A	4 t

Table 9: Outrigger crane

**Gantry cranes** are lifting equipment for the vertical transshipment. This lifting equipment bridges loading lanes with a portal fixed on sidewise shoring. Loading units can be moved in the three dimensions of height, breadth and length.

### Rail mounted gantry

Rail mounted gantries possess two pillars and drive on two parallel racks along a block. These cranes can only drive lengthwise between two neighbouring blocks. Due to their span width they can serve several blocks with more rows. The cranes can drive over up to 13 rows and have a span width of up to 60 metres. Under a rail mounted gantry loading units can be stacked in six to ten layers (depending on the building class) whereat one layer has to be kept free for the length- and crosswise transport of loading units.


Rail mounted gantry		Functior						Working area	Contro			Cargo gear			Loading units					Hubs / Movements per hour						
	Transshipment	Vertical	Horizontal	Transport	Internal	External	Variable	Fixed	Manually	Semi-automatic	Fully automatic	Gripping pliers	Spreader	Fork	ISU deployment	Container	Empty	Swap bodies	Semi-trailers craneable	Semi-trailer non craneable	Transport container	Stacking	Loading / Unloading train	Loading / Unloading truck	Carrying capacity	
	●	●						●	●	●		●	●		●	●	●	●	●	●		Na	2C-3C	Na	4'	
RMG																										

Table 10: Rail mounted gantry

### Rubber tyred gantry

A rubber tyred gantry is a lifting equipment for the vertical transshipment which bridges loading lanes with a portal fixed on sidewise pillars.


Rubber tyred gantry		Functior						Working area	Contro			Cargo gear			Loading units					Hubs / Movements per hour					
	Transshipment	Vertical	Horizontal	Transport	Internal	External	Variable	Fixed	Manually	Semi-automatic	Fully automatic	Gripping pliers	Spreader	Fork	ISU deployment	Container	Empty	Swap bodies	Semi-trailers craneable	Semi-trailer non craneable	Transport container	Stacking	Loading / Unloading train	Loading / Unloading truck	Carrying capacity (t)
	RTG	●	●					●		●	●		●	●		●	●	●	●	●		N a	2C-3C	N a	4C

Table 11: Rubber tyred gantry

Rubber tyred gantries can be equipped with four, eight or sixteen wheels (depending on the building class) and have a span width which allows for bridging several rows. A separation between rubber tyred gantries with five rows plus driving lane up to nine rows plus driving lane for vehicles can be made. Tyres can be turned 90° and enable flexibility.

### Reach stacker

A reach stacker is a tractor vehicle with front equipment for lifting, stacking or moving ITU.


Reach Stacker	Functior						Working area	Contro			Cargo gear			Loading units					Hubs / Movements per hour						
	Transshipment	Vertical	Horizontal	Transport	Internal	External	Variable	Fixed	Manually	Semi-automatic	Fully automatic	Gripping pliers	Spreader	Fork	ISU Einsatz	Container	Empty	Swap bodies	Semi-trailers craneable	Semi-trailer non craneable	Transport container	Stacking	Loading / Unloading train	Loading / Unloading truck	Carrying capacity (t)
	●	●		●	●		●		●			●	●		●	●	●	●	●		15	2C-3C	10	42-45	
	●	●		●	●		●		●				●		●	●	●	●	●		15	2C-3C	10	12	
Container	●	●		●	●		●		●			●	●		●	●	●	●	●			15	2C-3C	10	42-45
Empty	●	●		●	●		●		●				●		●	●	●	●	●			15	2C-3C	10	12

Table 12: Reach stacker

Reach stackers can be used both for transshipment and stacking as well as for the internal transport of containers, swap bodies and semi-trailers. Reach stackers are typical for inland

terminals. These tractor vehicles have a lifting capacity of up to 50 tons and a dead weight of approximately 100 tons. They can stack loading units up to five layers.

### Top lifter

Top lifters are equipped with spreaders which hoist loading units at the upper corner fittings. These vehicles can only pick up loading units in the front row.


Top Lifter		Function						Working area	Contro		Cargo gear			Loading units						Hubs / Movements per hour						
	Transshipment																									
	Vertical	●	●						●				●			●	●					Na	Na	Na	36-45	
	Horizontal																									
	Transport	●																								
	Internal	●																								
	External																									
	Variable	●																								
	Fixed																									
	Manually	●																								
	Semi automatic																									
Fully automatic																										
Gripping pliers																										
Spreader	●																									
Fork																										
ISU deployment																										
Container	●																									
Empty	●																									
Swap bodies																										
Semi trailers craneable																										
Semi trailers non craneable																										
Transport container																										
Stacking	Na																									
Loading / unloading train	Na																									
Loading / Unloading truck	Na																									
Carrying capacity (t)	36-45																									

Table 13: Top lifter

This forklift is suitable for pilling up loading units as well as empties and is applied for block and line storage since loading units can only be picked up crosswise to the direction of motion. Stacking up to five rows is possible.

### Straddle carrier

A straddle carrier is a rubber tyred overhead lifting vehicle for moving or stacking containers on a level reinforced surface.


Straddle carrier		Function		Working area		Contro		Cargo gear		Loading units				Hubs / Movements per hour												
	Transshipment	Vertical	Horizontal	Transport	Internal	External	Variable	Fixed	Manually	Semi automatic	Fully automatic	Gripping pliers	Spreader	Fork	ISU deployment	Container	Empty	Swap bodies	Semi trailers craneable	Semi trailers non craneable	Transport container	Stacking	Loading / unloading train	Loading / Unloading truck	Carrying capacity (t)	
	●	●		●	●		●		●	●			●			●	●					Na	Na	Na	40-110	


Table 14: Straddle carrier

Straddle carriers consist of a frame and an in between hoisting gear with a spreader which is slewable as well as crosswise slidable for an exact positioning above containers. This vehicle is used for transporting and stacking (three to four rows).

### Fork lift truck

A fork lift truck is a vehicle equipped with power-driven horizontal forks, which allow it to lift, move or stack pallets, containers or swap bodies. The latter two are usually empty. These operations can only be performed on the front row of stack.




Fork lift truck	Funtionr						Working area	Control		Cargo gear			Loading units					Hubs / Movements per hour							
	Transshipment	Vertical	Horizontal	Transport	Internal	External	Variable	Fixed	Manually	Semi-automatic	Fully automatic	Gripping pliers	Spreader	Fork	ISU deployment	Container	Empty	Swap bodies	Semi-trailers craneable	Semi-trailers non craneable	Transport container	Stacking	Loading / unloading train	Loading / Unloading truck	Carrying capacity (t)
	●	●		●	●		●		●					●			●					Na	Na	Na	5-18

**Table 15: Fork lift truck**

These vehicles are equipped with a conventional fork which can only be deployed for stacking empties. Depending on the construction the stacking height can be nine layers while in inland terminals usually four rows are built.

### Front lift truck

The difference between this front lift truck and the top lifter presented before is the cargo gear. Front lift trucks pick up containers at the face side (side pick) with a spreader.


Front lift truck		Funtion						Working area	Contro		Cargo gear			Loading units						Hubs / Movements per hour						
	Transshipment																									
	Vertical	●	●																							
	Horizontal																									
	Transport	●																								
	Internal	●																								
	External																									
	Variable	●																								
	Fixed																									
	Manually	●																								
	Semi-automatic																									
Fully automatic																										
Gripping pliers																										
Spreader	●																									
Fork																										
ISU deployment																										
Container																										
Empty	●																									
Swap bodies																										
Semi-trailers craneable																										
Semi-trailers non craneable																										
Transport container																										
Stacking	Na																									
Loading / unloading train	Na																									
Loading / Unloading truck	Na																									
Carrying capacity (t)	7-10																									

**Table 16: Front lift truck**

Special constructions with raised driver's seat can stack empties in four or six layers. As against reach stackers these vehicles can only pick up containers in the first row. Usually front lift trucks are used for empties.

### Terminal tractor

A terminal tractor is a terminal internal towing vehicle used for the transport of loading units within terminals.

Terminal Tractor		Function						Working area	Contro		Cargo gear			Loading units					Hubs / Movements per hour						
	Transshipment																								
	Vertical																								
	Horizontal																								
	Transport			●																					
	Internal			●																					
	External																								
	Variable						●																		
	Fixed																								
	Manually								●																
	Semi automatic																								
Fully automatic																									
Gripping pliers																									
Spreader																									
Fork																									
ISU deployment																									
Container																●									
Empty																●									
Swap bodies																●									
Semi trailers craneable																●									
Semi trailers non craneable																●									
Transport container																									
Stacking																					Na				
Loading / unloading train																					Na				
Loading / Unloading truck																					Na				
Carrying capacity (t)																								25-32	

**Table 17: Terminal tractor**

This vehicle is – depending on the construction – equipped with a height adjustable fifth-wheel plate and can transport containers as well as swap bodies on chassis. Furthermore semi-trailers can be directly coupled to the tractor in order to complete internal transport activities.

### Truck (with our without chassis)

Trucks and tractor-trailers respectively are used for internal transports between different terminal areas as well as for pickup and delivery services for customers.


Trucks (with our without chassis)	Funtionr						Working area	Contro			Cargo gear			Loading units					Hubs / Movements per hour								
	Transshipment		Vertical	Horizontal	Transport	Internal		External	Variable	Fixed	Manually	Semi-automatic	Fully automatic	Gripping pliers	Spreader	Fork	ISU deployment	Container	Empty	Swap bodies	Semi-trailers craneable	Semi-trailers non craneable	Transport container	Stacking	Loading / unloading train	Loading / Unloading truck	Carrying capacity
				●	●	●	●			●							●	●	●	●	●		-	Na	Na	25	

Table 18: Trucks

Trucks can carry loaded and empty containers, swap bodies and semi-trailers. Containers and swap bodies have to be loaded on special chassis for the transport.

### Driverless transport vehicles

Automated guided vehicles are driverless means of transportation, which are guided via leader cable or transponder in the ground throughout the network of streets in a terminal.


Automated guided vehicle		Function						Working area		Contro			Cargo gear			Loading units					Hubs , Movements per hour					
		Transshipment	Vertical	Horizontal	Transport	Internal	External	Variable	Fixed	Manually	Semi-automatic	Fully automatic	Gripping pliers	Spreader	Fork	ISU deployment	Container	Empty	Swap bodies	Semi-trailers craneable	Semi-trailers non craneable	Transport container	Stacking	Loading / unloading train	Loading / Unloading truck	Carrying capacity (t)
					●	●			●			●					●	●	●				Na	Na	Na	6C

Table 19: Automated guided vehicle

Automated guided vehicles can either carry one 40 or two 20 feet container(s). Preferred they are deployed at the quayside in order to serve outrigger cranes, rail mounted gantry cranes and straddle carriers with containers.

### 3.3.5. Special forms of containers

Special forms of containers are the so called Rolling road and so-called “Modalohr” terminals. In both transshipment methods semi trailers are handled horizontally. Modalohr necessitates special infrastructure, in rolling road terminals trucks are loaded with mobile chutes.<sup>39</sup>

<sup>39</sup> <http://www.modalohr.com/>.



### 3.4. Market & Organization

*Students are familiar with general market conditions and frameworks concerning inland waterway transport. Furthermore, relevant policies and laws, essential for organizing intermodal transport are known.*

*According to ELA standards, students should be able to*

- *make recommendations for the improvement of operational effectiveness (operational level),*
- *to contribute to the*
- *to develop transport plans and proposals evaluating costs and added value (senior level),*
- *to plan the coordination of multi-modal operations (senior level),*
- *to evaluate the impact of environmental factors on transport activity (senior level).*

#### 3.4.1. Documents in intermodal transport

Appropriate documents in intermodal transport are up to the selected type of intermodal transport. Container traffic is carried out with waybills or so-called Intercontainer (ICF-Basel) transfer notes. In this case the majority are railway transports. Trailer shipments are in the majority of cases road transports, therefore CMR bills of lading have to be used. In combined transport so called “combined bills of lading” are applied. It is necessary to consider the fact that forwarding agents/freight forwarders are able to sign FIATA combined transport bills of lading. In this case forwarding agents act as overall carrier. These documents can either be transferable or non transferable and therefore have the character of master’s receipt. Furthermore it is worth mentioning, that a FIATA FCT (Forwarders Certificate of Transport) is a non transferable instrument and doesn’t evict the forwarding agent as shipper.

#### Bill of lading

The bill of lading is a transport paper which administers the legal position of the consignor and the carrier:

Type of document	Bill of lading
International	Yes
Function	Documentation, function of the bill of lading
European Union	Yes
National	Yes
Issuer	Consignor/carrier
Addressee	Consignor/carrier/consignee
Authority	None
Person responsible (signature)	Consignor/carrier
Title	Carrier/consignor

Part load	Yes
Barge	N.a.
Normal goods	Yes
Dangerous goods	Yes
Empty	No

**Table 20: Characteristics of the bill of lading**

The bill of lading is a demonstration document concerning the completion and content of the of the freight contract. The bill of lading has no “traditional function”, which means that the ownership of the bill of lading does not imply the legal power of disposition for the goods. Its issuing is not required for an effective signing of a freight contract. A properly issued bill of lading verifies the completion and content of the freight contract as well as the acceptance of the goods by the carrier. It is the basis for the assumption that the goods and its packaging were in a proper condition and the number of packages matches with the information specified in the bill of lading. Copies of the bill of lading are in principle handed out to the consignor, carrier and consignee. As the outlook of the bill of lading may vary, the following information has to be given:

Per good, description	Description/Content	Information category
Consignor	Name, Address	Freight
Consignee	Name, Address	Freight
Identification number	Number of shipping note	Public authority
Promoter	Carrier	Freight
Place of loading/unloading	Port	Port data
Goods	Description and kind of packaging	Freight
Goods	Size and dimension	Freight
Postage	General crossing	Freight
Subject matter of contract	Terms of delivery	-

**Table 21: Information in the bill of lading**

## Customs documents

For goods traffic within the European Union customs documents are only necessary for non community goods. The commercial invoice is a bill issued in a proper manner which serves as proof for the fulfilment of a contract when making foreign business. It serves as base for the issuance of further documents and contains information about the identification of the packaging as well as goods, freight and insurance costs, name and address of the exporter and importer, date of issue, exact description of the goods (form, amount, weight etc.), price per unit after discount, all round price, delivery conditions, conditions of payment and legally binding signature and stamp. The commercial invoice is furthermore an important document in connection with the customs and foreign exchange laws of the country of importation. For goods traffic within and outside the EU the accompanying document T1 or Carnet TIR matters.

## e-Customs

e-customs is meant to replace all paper-based customs procedures with electronic procedures. In addition to the customs clearance in the customs procedure, a fully automated risk-analysis-module is integrated, which either suggests the checking of goods within a certain period or releases goods within a certain period (usually ten minutes). The final decision is always made by the particular customer team of the responsible customs office. The trader gets the adequate documents, supplemented with the electronic customs certificate.

## **Assignments for dangerous goods**

Dangerous goods are all kinds of

- materials, which can be dangerous for human beings, animals or the environment due to their physical, chemical or biological characteristics,
- all items, which contains such materials.

Their transportation is therefore specifically regulated in international agreements. The following regulations are valid for the European ground transport (in the relative version):

- ADR = Accord européen relatif au transport international des marchandises dangereuses par route, European Agreement concerning the International Carriage of Dangerous Goods by Road,
- RID = Règlement concernant le transport international ferroviaire de marchandises dangereuses, Agreement for the International Carriage of Dangerous Goods by Rail,
- ADN = Accord européen relatif au transport international des marchandises dangereuses par voie de navigation intérieure, Agreement for the International Carriage of Dangerous Goods on Inland Waterways,

which have to be applied according to the Directive 2008/68/EG (applicable for both national and international transportation).

### **3.4.2. Legal framework in intermodal transport**

For combined transport the particular agreements and regulations for the particular modes of transport (road, rail or inland waterway) have to be applied. In the following section a short overview over the most important international and national regulations is presented.

#### **National regulations**

The Austrian motor vehicles act, the road traffic regulation and the railway act are of essential relevance for combined transports. The legal information system RIS<sup>40</sup> is publicly accessible without any registration or identification in line with e-government and offers an online documentation of the Austrian legal system (<http://www.ris.bka.gv.at>).

#### **European regulations**

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<sup>40</sup> Rechtsinformationssystem der Republik Österreich.

Special regulations in the European legal system for combined transport are rare. The only special fundament of the European Union is the Directive 92/106/EWG, which provides for a liberalisation of the initial and final leg in combined transports as well as fiscal alleviations. The European act about the granting of financial support for the advancement of environmental friendliness of freight traffic can be seen as a promoting regulation for combined transport in a broader sense, due to its goal to support a modal shift to more eco-friendly modes of transport, which envelops combined transport as well.

The appropriate directives and regulations can be accessed via RIS (see above) or on the portal of European laws of the EU (EUR-lex<sup>41</sup>).

## Liability

A complete listing of regulations concerning the liability is impossible. The following listing contains the most important regulations.

National provision regarding liability: freight contracts are usually based on the “*Allgemeine Österreichische Spediteursbedingungen (AÖSp)*”, which are – according to § 2 lit. AÖSp – applicable for freight transportation as well as for airfreight and transportation abroad, as far as no other imperative regulations are opposed.

International provision regarding liability: international regulations for transports with the several traffic carriers. For each traffic carrier specific international regulations are brought to bear. In particular, the following regulations matter:

- CMR – Convention on the Contract for the international carriage of goods by road
- CIM – Uniform Rules concerning the Contract for international carriage of goods by rail
- Montreal Convention – formally the Convention for the Unification of certain rules for international carriage
- CMNI – Convention de Budapest relative au contract de transport de marchandises en navigation intérieure, valid for transportation on inland waterways
- Hague-Visby Rules – set of international rules for the carriage of goods by sea.

### Specific features of the international transport law

**International road transport- CMR:** The CMR convention is a United Nations convention signed in Geneva in 1956. It relates to various legal issues concerning the transport of cargo, particularly on the road, and has been ratified by the majority of European states. A standard waybill was developed, which is prepared in three languages. The standard liability within the CMR arranges for the compensation of 8,33 SDR<sup>42</sup>/kg.

**Montreal Convention:** is a treaty adopted by a diplomatic meeting of ICAO member states in 1999. Its rules relate to the international carriage of passengers, baggage and cargo.

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<sup>41</sup> <http://eur-lex.europa.eu>.

<sup>42</sup> SDR – Special Drawing Right.

**Convention concerning international carriage by rail – COTIF:** until the signature of the Protocol of June 1999 (Vilnius Protocol) for the modification of COTIF, the objective of this governmental organization was principally to develop the uniform systems of law which apply to the carriage of passengers and freight in international traffic by rail. These systems of law have been in existence for decades and are known as the CIV and CIM Uniform Rules.

## **Shipping procedure**

According to customs law the shipping procedure is especially relevant for the transport of bond goods in bond (non community goods). The shipping procedure is a customs procedure which is applied for the transport of goods under customs control within EU and EFTA<sup>43</sup> states. Besides certificates it is obligatory for non community goods in intra-community transport as well as for transport in third countries to carry accompanying documents. The decisive factor is the origin of the goods as well as the transport route.

## **Carnet TIR**

The so-called TIR procedure aims at facilitating the international transportation of goods on the road. It makes the formalities easier in transnational traffic. With Carnet TIR, goods can be transported through any number of regions of contracting parties. However, it is not applied when goods have to be transported solely within the European Union. Carnet TIR is applied when the transportation starts or ends in a member state of the EU and when the haulage goes through (at least one) third country. At the moment it is accepted in 68 contracting states. In contrast to the shipping procedure, the Carnet TIR includes the verification that a guarantee was accepted as a security for the dues payable for the goods transported. Since 1<sup>st</sup> January 2009 “NCTS-TIR” have to be applied obligatory in all EU member states, which means that TIR-data has to be transferred electronically. The Carnet-TIR in hardcopy form is still in use, due to its function as a surety bond.

## **Common/Community transit<sup>44</sup>**

This procedure is used for the transport of goods between the 27 EU member states and the EFTA countries. It is based on the Convention of 20<sup>th</sup> May 1987 on a common transit procedure. The rules are effectively identical to those of Community transit.

Community transit is used for customs transit operations between EU states (and Andorra and San Marino) and is in general applicable to the movement of non-Community goods for which duties and other charges at import are at stake, and for Community goods, which, between their point of departure and point of destination in the EU, have to pass through the territory of a third country.

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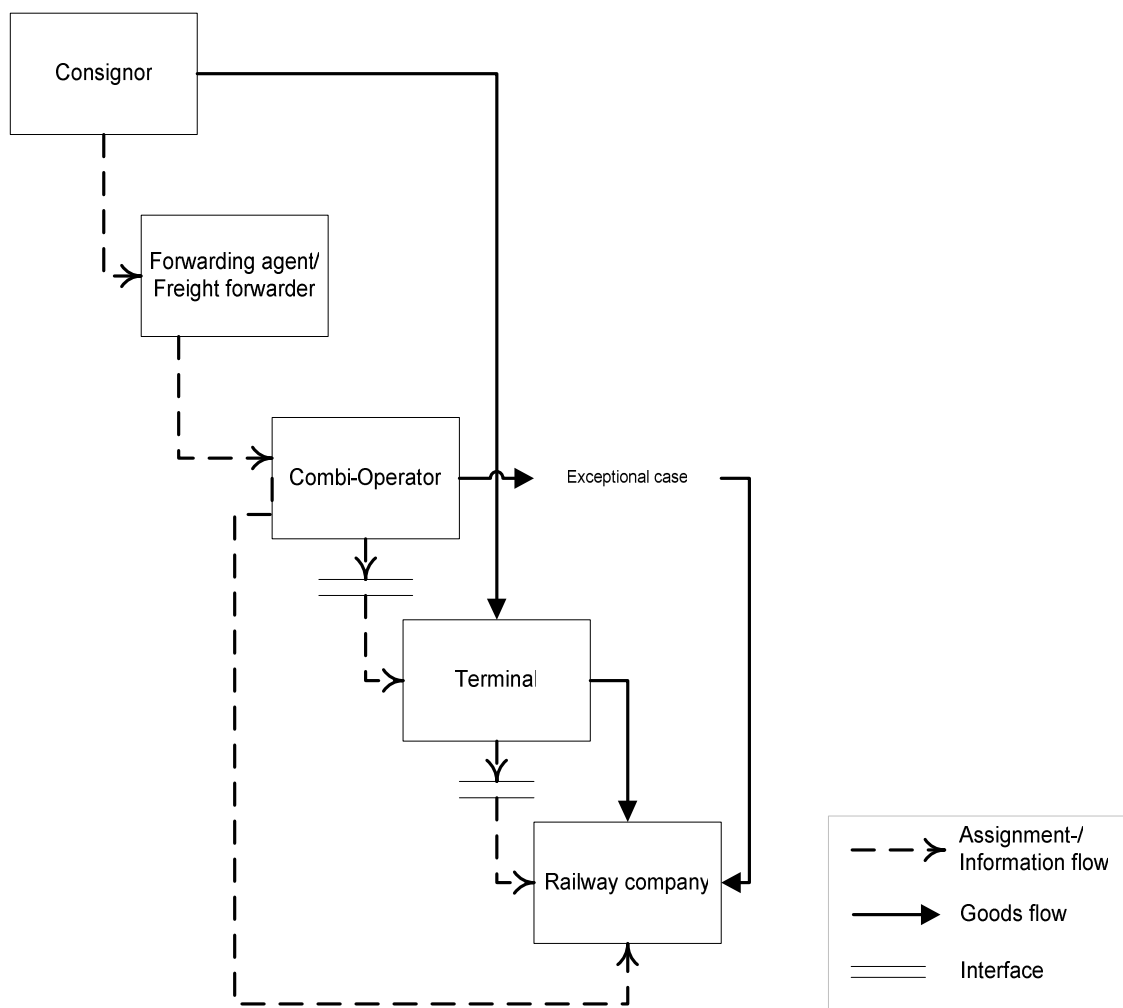
<sup>43</sup> EFTA countries: Iceland, Norway, Liechtenstein, Switzerland.

<sup>44</sup> [http://ec.europa.eu/taxation\\_customs/customs/procedural\\_aspects/transit/common\\_community/index\\_en.htm](http://ec.europa.eu/taxation_customs/customs/procedural_aspects/transit/common_community/index_en.htm).

### 3.4.3. Information and communication technology

Information and communication technology, often called ICT, is often used as an extended synonym for information technology. It consists of all technical means used to handle information and aid communication, including network and network hardware, communication hardware as well as necessary software.

In order to clarify the information and goods flow in an intermodal transport chain, the following picture is presented.



Picture 11: Information and goods flow

The assignment between combi-operator and terminal happens in the majority of cases electronically.

### Electronic booking

Internet based application concerning booking facilitate the preparation of electronic freight documents, which are transferred in a standardized way among participating parties. Advantage of this system is that documents cannot get lost and that they arrive earlier due to the electronic

submission. Additionally, the electronic processing of information makes it possible to trace and schedule goods along the whole supply chain.

#### e-waybill

An e-waybill allows for the simple and cost-efficient preparation of waybills for goods via internet. An application of the Austrian company Rail Cargo Austria offers standardized drafts for repeating transports, which contributes to an increase in quality and rationalization in the collection of data. Furthermore, a current overview about the processing status of the waybills is offered. The following advantages can be mentioned:

- No printing of waybills necessary.
- Reduction of administrative effort.
- Simple, electronic transfer of waybills.
- Simplification of data captures due to search and filter functions.
- Possibility of saving of templates.
- Abbreviation and simplification of the recording of waybills.

#### Tracking & tracing

In numerous transport processes information concerning the location and processing status are needed by the consignor and/or consignee. Logistics service providers, which take over the shipment, offer such kinds of value added services on the basis of modern, cross-linked communication systems. Due to the improved planning quality, cost savings and a better delivery service should be possible. It is a precondition that all packages are equipped with barcode-labels.

#### Dispatch

A dispatch is an electronic announcement of a delivery and the receipt of goods respectively. It is differentiated between a dispatch notification and a shipping notice. A dispatch notification is transferred from the consignor to the consignee before the goods are delivered. Therefore, the consignee can react on any unintended variations in the transportation process.

A shipping notice is a receipt about the goods and loading units which have to be delivered. It contains information about the order, goods description, and date of delivery and mode of shipment/transportation. A dispatch is an electronic document, which contains information about a forthcoming delivery and is transferred via Electronic Data Interchange (EDI). A dispatch notification is also called Advanced Shipping Notice. Furthermore, the announcement DESADV (Dispatch Advice Message) exists. EDIFACT<sup>45</sup> is an interbranch, international standard for electronic data in trading.

#### Intermodal transport as potential field of application for telematics

In the context of intermodal transport the term telematics stands for the integrated application of the technologies of telecommunication, automation and informatics. Telematics denotes the combination of these components in order to cope with specific traffic and transport duties. Communication comprises data between mobile and/or fixed devices in the necessary

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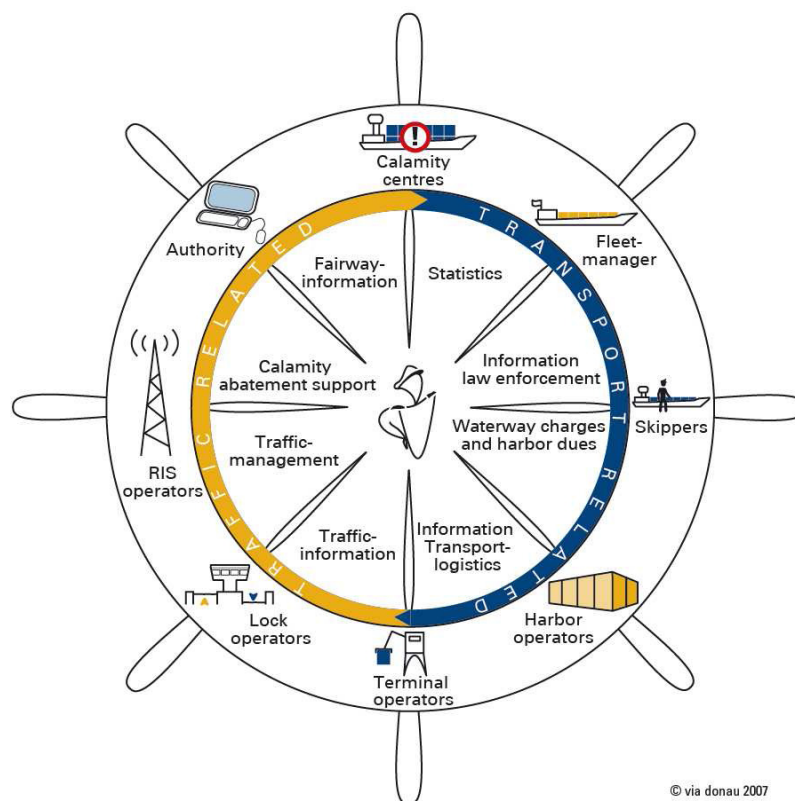
<sup>45</sup> EDIFACT: Electronic Data Interchange For Administration, Commerce and Transport.



bandwidth. Automation focuses on the automatic gathering of data and parameters as well as on digital display. Informatics has to combine and display information in an appropriate way. Basically telematics based on vehicles and telematics based on road have to be differentiated.

Concerning telematics in intermodal transport the postulation repeatedly comes into place that all traffic carriers have to be integrated and intelligently combined. Therefore, such systems could compensate for the basic disadvantages of interrupted transports by means of improved information management. By integrating all modes of transport in terms of information, telematics could bear up potentials in intermodal transport. To date technically and economically feasible concepts only exist rudimentary.

One field of application of telematics are the so-called RIS – River Information Services. With this service, a modernization of inland navigation is realized. Furthermore it increases safety and efficiency and provides numerous benefits for commercial users. The following picture displays the users and functions of RIS.



**Picture 12: Users and functions of RIS<sup>46</sup>**

The services for skippers are as follows:

- Electronic navigational charts (ENC)
- Information about actual waterway conditions (fairway, conditions, weather, water level)
- Information on traffic situation (traffic image)

<sup>46</sup> via donau, 2010.



- Emergency messaging with authority
- Electronic cargo reports
- Electronic announcements at locks and terminals.

Logistics users can make use of the following services:

- Access to ship position
- Calculation of estimated arrival times
- Notification of arrivals and departures (billing)
- Electronic customs procedures
- Data for voyage planning
  - Waterway data
  - Water level forecasts
  - Operational status of locks.

The legal basis for RIS is the Directive 2005/44/EC on harmonised River Information Services (RIS), which is in force since 20.10.2005. For further information please refer to the RIS course.

### **3.4.4. Organization of logistics processes / intermodal transports**

When organizing intermodal transports it has to be differentiated between sea shipping and inland waterway navigation as well as between railway and road transportation. Transport with inland waterway or sea vessels can be organized as carrier's haulage or merchant's haulage.

Carrier's haulage means that transport services door-to-door are offered. The loading units are therefore directly provided at the ramp of the consignor by the consignee or ship owning company and taken back by them after the transport. The transport operator/carrier organizes the transport on the inland waterway (main leg) as well as the transport to and from the transshipment point (first and final leg) and is liable for the whole transport organization door-to-door. This is also valid for those transport sections for which other transport operators (sub-contractors) are assigned.

In merchant's haulage processes on the contrary has the first and final leg to be organized by the consignor himself or by an authorized freight forwarder. The freight forwarder supplies the loading units at the ramp of the consignor and organizes the transport to the transshipment point and port respectively. There the loading units are handed over to the ship owning company, which organizes the transport on the inland waterway. At the place of destination the loading units are handed out to the freight forwarder who organizes the final leg to the consignee and delivers the empty loading units to the ship owner afterwards.

Carrier's haulage and merchant's haulage are general definitions in the maritime freight sector; in continental traffic these definitions are rather unknown. The main leg is in this context the overseas transport, whereat the carrier's haulage implies the organization of the initial and final by the carrier – primarily a ship owning company – while in merchant's haulage it is organized by a third party.

### Checklist for the organization of intermodal transports

- Are the goods to be conveyed applicable for intermodal transport?
  - Loading capability of containers, swap bodies, craneable semi-trailer
- Is there enough transport volume?
  - At least one shipment (2 containers up to 9,15 m and 16,5 t or a longer and heavier container per shipping)
- Who organizes the rail- and/or inland waterway transport?
  - Freight forwarder and/or combi-operator, own request
- Is there a possibility for the transshipment to rail or inland waterway nearby?
  - Railroad siding, terminal, port
- Are there any railroad or inland waterway connections to the designated destination?
- Are there any potential partners at the destination, who could care for the pick-up?
- Is the duration of the transport processes applicable for the logistics concepts?
- Are the prizes offered marketable?
- Does an intermodal transport fit into transport control concept?
- Are liabilities clear and acceptable?

### 3.4.5. Inland waterway transport solutions

Modern logistics systems are faced with more complex requirements than contract shipments. With the scope of delivery decreasing and the number of suppliers and recipients increasing, transport needs to be reliable and both arrive and depart punctually. One solution to this dilemma are new types of services such as **intermodal liner services**. Similar to passenger transport vessels or public buses, the cargo vessels of a liner service call at certain ports following a fixed timetable. In these ports the cargo is then transhipped for further road or rail transportation. The vessel formation and the possible arrangement of convoys enable the simultaneous transportation of all types of cargo (containers and roll-on/roll-off cargo) and thus help to compensate for imbalances of transport volumes on the travelled transport legs. An intermodal transport chain with the inland vessel in the main haulage requires at least two **transhipments** (in the loading and unloading ports) as well as a **pre- and/or end-haulage** to and from the transshipment points. The “first mile” from the consignor to the loading port and the “last mile” from the unloading port to the consignee are covered either by road or rail transport, depending on the infrastructural and economic conditions.

### 3.4.6. Best practice examples in intermodal transport

In this chapter some relevant best practice examples in inland waterway transport are displayed. First, some short reports on best practice examples from Holland are given:

#### Green goods deserve green transport<sup>47</sup>

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<sup>47</sup> [http://www.inlandnavigation.org/nl/why-use-waterways/all-freight-types/flora-holland\\_93.aspx](http://www.inlandnavigation.org/nl/why-use-waterways/all-freight-types/flora-holland_93.aspx). [16.02.2011].

Plant and flower transport make up about 10 % of all goods transported on Dutch roads. The usage of water transport contributes to a reduction of CO<sub>2</sub> and improves the accessibility and quality of life. In order to reduce the number of trucks on the road and to add to the virtue of sustainability of the product affected, FloraHolland and Port of Amsterdam executed a pilot project named Plantshuttle. The innovative and sustainable transport concept combines several actors in a co-modal cooperation. The participants, including sea and inland ports, road transport, inland waterway transport and container terminals, have transformed a regular supply chain into a regular one. The pilot was executed successfully between March and May 2010 and delivered positive results:

- The reliability of the transport chain was 95 %.
- The fragile cargo didn't suffer quality losses through shipment in containers on barges.
- A supportive IT-system kept partners updated.
- Inland navigation proved to be a clean, efficient, reliable and sustainable transport alternative for floricultural products.
- A partial shift of plant and flower transport from road to water is very feasible.

#### **Dissolving traffic jams with water<sup>48</sup>**

Mokum Maritim is an efficient, smart and environmentally friendly distribution system for the city centre of Amsterdam, which uses the existing infrastructure: the canals.

The Mokum Maritim ship, named "city supplier" is driven by a quiet and clean electric motor and can carry the load of full compact trucks (85 m<sup>3</sup>). It is equipped with electric power. The onboard electric crane, used for transshipments, is also powered by batteries. For transport from the quay to the customer (up to 150 m) an electric powered hand truck is available on board. For longer distances the combination with a freight bicycle or electric city truck could be made. The Mokum Maritim solution is holistically sustainable.

#### **New cars straight from the factory<sup>49</sup>**

With the help of innovative logistics solutions, cars can also be moved by inland waterway transport. Since 1998, new cars of Mitsubishi, Ford and Renault have been carried on the Danube from Kehlheim and Vienna to Budapest. On the way back, Suzuki cars are transported from Budapest to Kehlheim. With this strategy empty runs can be avoided and cost-efficiency increases can be realized. The service schedule depends on capacity utilization, so that there is no regular operation during the year. Runs may be added or cancelled at short notice, in order to be able to respond quickly and flexibly to sector specific fluctuations in demand.

Regular services are operated with the motor cargo vessel "Heilbronn". The ship has three decks with grid floors made for vehicles up to 2.000 kg each. The Heilbronn can load 205 to 270 cars, depending on the type. The vehicles are loaded on and unloaded from the ship via a bow ramp lowered on the concreted roll-on/roll-off ramp of the port.

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<sup>48</sup> [http://www.inlandnavigation.org/nl/why-use-waterways/all-freight-types/mokum-mariteam\\_95.aspx](http://www.inlandnavigation.org/nl/why-use-waterways/all-freight-types/mokum-mariteam_95.aspx). [16.02.2011].

<sup>49</sup> [http://www.donauschiffahrt.info/en/transport/success\\_stories/new\\_cars\\_straight\\_from\\_the\\_factory/](http://www.donauschiffahrt.info/en/transport/success_stories/new_cars_straight_from_the_factory/). [16.02.2011].

### **A new intermodal recipe for Kraft Foods<sup>50</sup>**

Kraft Foods, the second biggest food maker in the world, buys its European wide transport services centralized. Thereby all traffic carriers (road, rail and inland waterway) are applied. The majority of all transports from the production sites to the storage facilities is carried out via direct traffic with trucks. The plan of the company is to change this apportionment. Due to its sustainability goals the company wants to diminish transport emissions by integrating the traffic carries rail and inland waterway. By reflecting the existing transport processes potentials to consolidate should be detected and an overall optimization should be realized.

Concepts for truck traffic are present due to annual calls for tender. The so called SPC<sup>51</sup> assisted the company in their search for transport alternatives. First multimodal alternatives have to be considered. The goods are all palletized and have a total volume of 18.000 full truck loads. Aim of the analyses, conducted by SPC, is to minimize the truck leg to the shortest possible first and final legs distance within the transport processes.

Five alternatives for rail as well as five for inland waterway connections were identified. With this ten potential shifts approximately 5.000 full truck loads can be avoided, which amounts for about 30 % of all truck shipments. Primarily saving potentials can be realized by bundling single traffic processes. In these cases two existing truck relations can be transformed to a rail and two waterway relations. For a significant efficiency increase a rotation was conceived.

Relations with the highest loading volumes have been transferred to rail. Other identified relations will be brought to new multimodal calls for tenders. To sum up, the following advantages could be generated by including rail and inland waterway:

- Generation of new freight hold resources.
- Identification of round trips and consolidating of single shipments.
- Higher security of supply due to undisturbed transport flows.
- Optimization of the environmental balance.

### **3.4.7. Basic principles of cost calculation in inland waterway transport<sup>52</sup>**

In this section, basic information about the calculation of costs as well as pricing will be given.

#### **Calculation of costs in inland waterway transport**

In general, two types of costs incurred for inland waterway transport can be distinguished, depending on whether the costs are fixed (standby costs) or variable (operating costs). Both

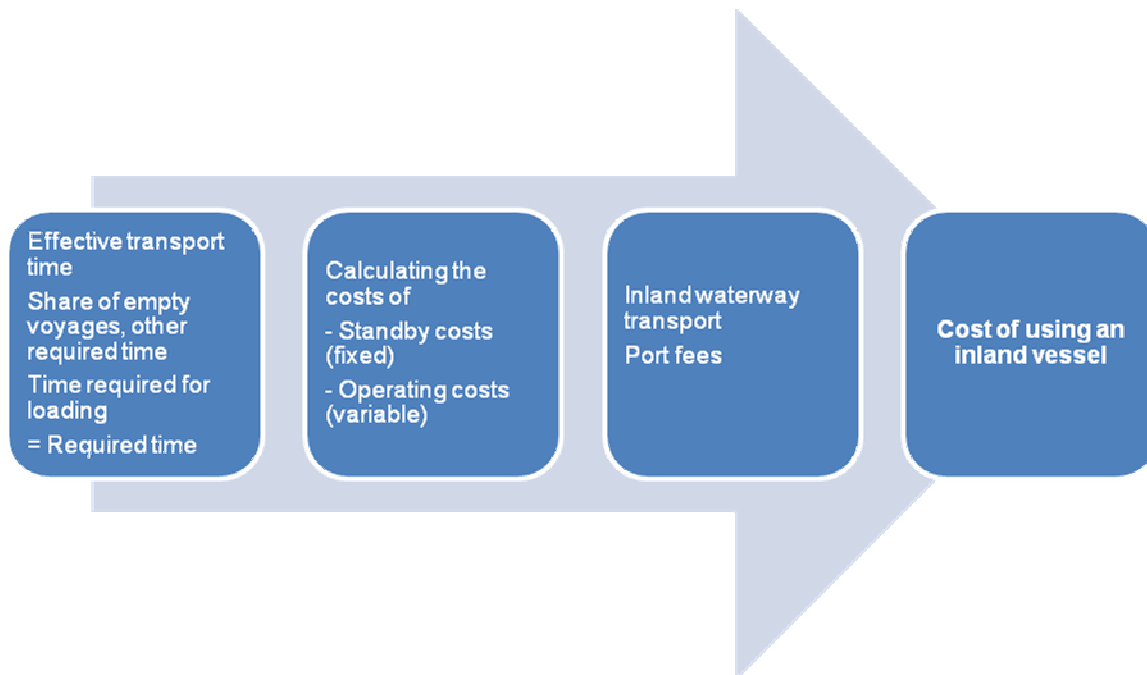
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<sup>50</sup> [http://www.shortseashipping.de/de/referenzen/pdf/SPC\\_Best\\_Practise\\_KraftFoods.pdf](http://www.shortseashipping.de/de/referenzen/pdf/SPC_Best_Practise_KraftFoods.pdf). [16.02.2011].

<sup>51</sup> Short Sea Shipping Inland Waterway Promotion Center.

<sup>52</sup> [http://www.ines-danube.info/ilias.php?ref\\_id=213&obj\\_id=439&cmd=layout&cmdClass=ilImpresentationgui&cmdNode=b3&baseClass=ilLMPresentationGUI](http://www.ines-danube.info/ilias.php?ref_id=213&obj_id=439&cmd=layout&cmdClass=ilImpresentationgui&cmdNode=b3&baseClass=ilLMPresentationGUI) [March 2011].

types of costs strongly depend on individual factors and basic conditions, such as bunker costs and maximum possible draught, and therefore have to be calculated on a timely basis. Further important criteria are the condition of the vessel fleet and the organisation behind it. The chart displayed illustrates the composition of inland waterway transport costs incurred between loading and unloading port excluding transshipment and cost for the first and final leg. When comparing whole transport chains, costs for the actual carriage by inland vessel have to be complemented by costs for transshipment in the port and for the first and final leg (i.e. transport from and to the port).



Picture 13: Inland waterway transportation costs<sup>53</sup>

**Effective transport time:** The time travelled is determined by the speed of the vessel, the flow rate of the river and the number and duration of lockings. Usually, the time required for locking is 45 minutes for vessels travelling from Vienna westbound and approx. 1,5 hours for vessels travelling eastbound.

**Empty voyages and other unproductive time:** Empty voyages are primarily caused by disparate traffic, i.e. when loads are carried only in one direction, upstream or downstream. However, they can also be caused by different transport flows between two regions. Another major reason for empty voyages consists in the long distance which frequently exists between the unloading and loading ports of the successive transport operations. Empty voyages vary depending on the different sections of the route and on the individual operator and are included as an additional percentage added to transport time.

Other unproductive times are caused by unexpected waiting times as a result of lightering operations (due to insufficient fairway depth the load of a vessel or lighter has to be distributed on several vessels or lighters) or by navigation closures due to ice or high water levels (approx. 5.5 days per year). The percentage added to the travel times is assumed on the basis of

<sup>53</sup> Source: via donau.

practical experience and depends on the relevant route and operation mode (shipping company or private ship owner).

**Loading and unloading time:** Loading and unloading times may vary strongly from voyage to voyage. They depend on the transshipment facilities used, their capacities and their current availability. The estimated waiting time in the different ports usually is one notification day per transport (i.e. half a day per port).

**Costs calculation:** The following vessel parameters should be included into the calculation of costs and should be calculated on a timely basis:

- Size and capacity of the vessel, draught and maximum possible draught
- Age and condition of the vessel used
- Flag under which the vessel is registered
- Operator structure (shipping company, private ship owner)
- Operation mode (period of 14, 18 or 24 hours/day)
- Crew (number of crew, qualifications, nationality)

**Standby costs:** Costs for maintaining a vessel ready for use, which do not take account of operating costs and are also incurred during stand-still times, e.g. crew wages, maintenance and repairs, depreciation on the vessel, interest and insurance. The most common vessel types used in the Danube region are:

- privately owned and operated vessels with 800–1,700 t in operation mode A (14 hours/day)
- privately owned and operated vessels with 1,500–2,000 t in operation mode C (24 hours/day)
- 2-unit pushed convoys (MCPV+PL) operated by a shipping company, operation mode C (24 hours/day) or 4-unit pushed convoys downstream from Passau (can be used without interruption),
- the section downstream from Bratislava can also be used by convoys with more than four pushed lighters, so-called large pushed convoys; depending on the relevant river section and water levels they are operated in different configurations with a maximum of 9 lighters; due to the wide range of options available, the related standby costs cannot be indicated.

**Operating costs:** Costs incurred by the operation of a vessel, depending on the number of kilometers or hours travelled, e.g. bunker and lubricant costs, commissions for contract brokerage, dues and fees. Inland vessels are usually propelled by combustion engines and use gasoil as a fuel. The average consumption depends on three factors: the capacity utilization of the vessels (due to cargo restrictions), the parity of traffic (empty voyages) and the available fairway depth (shallow water resistance). Nautical conditions (dammed sections, free-flowing sections, characteristic current speeds) influence fuel consumption in each individual transport operation. A global (macroscopic) analysis provides average values in kg/1,000 tkm. As an

alternative, the operator of a particular vessel is also provided with information on average consumption levels in liter/hour travelled. Fuel prices are tied to the oil price and may vary strongly, as can be seen from the following illustrations. Note that prices are indicated either per tonne or per 100 l. 1 l gasoil = 0.86 kg.

**Inland Waterway Transport Dues:** As has been mentioned in the Chapter “Waterway”, no inland waterway transport dues have to be paid on international waterways such as the Rhine and the Danube. The use of national waterways such as the Main, artificial canals such as the Main-Danube Canal or the Danube-Black Sea Canal and the maritime part of the Danube incurs dues.

### **Pricing in inland waterway transport**

Price policies form an integral part of the business decisions of inland navigation companies. In times where shipping companies were owned by the state, mandatory and state-controlled tariff systems were used, which essentially limited the economic options in inland waterway transport. The tariff models usually applied were based on fixed freight rates and margin prices. Under fixed freight rate models, price levels are fixed in advance, leaving no room for price competition. Under margin tariff schemes, only a price range, i.e. a maximum and minimum price, was fixed, within which prices could be agreed freely and which hence enabled limited competition in terms of quality and services. Since 1998, prices have been fully liberalised within the European Union. The free formation of prices as a result of supply and demand has increasingly placed quality factors at the centre of competition on the market. The quality characteristics of a particular transport and logistics service indicate the appropriateness of a price for a bundle of services within the price-performance ratio. The logistics effect is also increasingly reflected in inland waterway transport prices. The term logistics effect refers to the specific effects of the implementation of logistical concepts on individual transport modes. These effects substantially influence the demands shippers place on the quality of the physical transport service, the adherence to schedules and the flexible response to logistical requirements. They also involve communication services, such as electronic information systems (River Information Systems in inland waterway transport). The scope of the logistics services offered increasingly determines the selection of a particular means of transport.

When addressing the issues of prices or pricing in inland waterway transport, in most cases one comes across the synonymously used terms “freight rates”, “freight prices” or “freight tariffs”. As is the case in other business and transport sectors, these prices are influenced by different factors and basic conditions. In general, prices should cover costs and usually include a profit margin. Therefore, inland shipping companies operating on the free market basically align their policies with their internal cost structure. Pricing measures essentially take account of fixed costs (e.g. acquisition, maintenance, financing and insurance costs) and operational costs (e.g. wage and labor costs, fuel and operating costs). In addition to internal costs, pricing policies are also influenced by the market constellation, i.e. the interplay of supply and demand significantly influences the level of freight rates to be achieved. The following rule generally applies: If the



supply of shipping space exceeds the demand for freight transport, freight rates will decrease because of overcapacities. If, on the other hand, the transport demand exceeds the available shipping space, freight rates are increasing.

### **The inland waterway transport market**

The liberalisation and deregulation of the transport markets in the European Union is far advanced. In the Danube region the framework conditions for transportation policy are still relatively heterogeneous because of the recent or still outstanding accession of some Danube riparian countries to the EU. So far the majority of goods transported on the River Danube has come from only a small number of large-scale shippers working with a small number of contractors who are mostly organised in shipping companies. The traditional transport of bulk cargo on the Danube is, depending on supply and demand, mostly carried out in the form of contract shipments, i.e. in the course of several voyages on a contract basis for a certain period of time, or on the spot market, i.e. on the basis of a short-term contract for individual voyages or shiploads.

Often, contract shipments on the Danube are arranged for long-term periods in the form of **annual contracts**. These transports are characterised by the following aspects:

- Total annual volumes are arranged but the times and volumes of partial shipments are not fixed (to avoid the uneconomical cargo transport in low-water periods).
- Transport of full loads via self-propelled vessels (individual motorised cargo vessels) or pushed convoys.
- More generous time slots for arrivals and departures.
- Transport of cargo between a loading port and an unloading port.
- Involvement of only one consignor and one consignee.