

# Global Trends in Transport Routes and Goods Transport:

## Influence on Future International Loading Units

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# Introduction

The present is affected by discussions on the future transport system – and its constraints in terms of transportation time, price, quality and social as well as ecological impact. In technical terms this comes down to the question of weights, dimensions and modes of transport and IT support systems. Triggered by mega-trends such as globalisation, the growth of transport and the increasing environmental awareness of European society, science and industry are seeking to identify solutions for sustainable freight transport. In addition, policy makers in Europe are identifying a legislative framework to support a sustainable road map for the anticipated growth of freight transport. A current initiative of the European Commission is the publication of the White Paper entitled «*Roadmap to a Single European Transport Area – Towards a competitive and resource efficient transport system*» [EU 2011a]. Within this White Paper the European Commission specifies a roadmap of 40 concrete initiatives for policy decisions in the next decade. Aim is a competitive European transport system [ibidem].

Transport of goods is a prerequisite for a prospering economy. As the economy across Europe becomes increasingly global, the transport system has to meet global standards and the need of a free flow of goods on the global supply chains. For an efficient flow through these supply chains smaller logistic units (e.g. loose goods, small cargo, article units etc.) have to be bundled [Gudehus, Kotzab 2009]. Mobile load units provide such functionality as they “can be moved, transported and dispatched without restrictions” [ibidem]. Current transport units used for this purpose include containers or semi-trailers.

Due to their functionality such units are hereinafter referred to as loading units. The harmonisation of loading units is, however, complicated by framework conditions like different legislative limits for transport equipment (from loading unit size to the size of vehicles for the different transport modes) in different countries and different measurement standards. Thus, discussions on an international loading unit are currently led by the search for a common denominator. The European Commission proposed a new Directive in 2003 which dealt with the standardisation and harmonisation of intermodal loading units. This had the objective of reducing inefficiencies in intermodal transport resulting from the variable sizes of containers circulating in Europe. It is essential, however, to identify the types of goods that will be transported, as well as the main routes on which these goods will be transported in the future to understand the framework that defines the future international loading unit. In addition, it has to be revealed whether the consent to a common denominator hinders technological innovations or benefits the global transport system. The ideal loading unit has to fit most requirements in terms of loading capacity rather than fitting only at any existing system.

This report stimulates debate on the future of transport policy, providing a basis for discussion on how transport and transportation will evolve up until 2030. Each section discusses a range of challenges and issues surrounding present and future trends in transport.

# 1 Transport System Forecast – what is being transported on which routes?

## Initial status

The two main questions of a freight transport system forecast which have to be answered when it comes to the development of new international loading units are:

1. What types of goods have to be transported in the future?
2. On which routes will they be transported?

The answers on those questions are significantly influenced by socio-economic trends such as the legislative framework, the oil price, environmental awareness, etc. The economic development within the next ten years will lead to five economic areas of different size: Americas (North and South), India, China, Japan and Europe together with Russia (cf. Figure 1). Due to the importance of these emerging markets, transport chains will be re-charted and trade

volumes will shift towards these markets. The upward trend of the emerging markets is accompanied by structural adjustments, e.g. privatisation or free trade zones. These changing regulations will have a major impact on the transport system.

Prior to answering what goods on what routes will be transported in the future, it is necessary to take a look at the current situation. The development of the Asian market intensifies the high trade volume and therefore the utilisation of current trade corridors between the EU, Asia and North America. Figure 2 provides an overview of the amounts of foreign trade for these regions in 2009. Within the next few years this picture will shift and the BRICS (Brazil, Russia, India, China and South Africa) states will become more visible.

But how are foreign trade goods transported? Container ship transport accounts for the largest share of international trade transportation. The latest trends show that international maritime transport carries up to 90% of world trade [IMO 2010]. This transport means is the backbone of international trade. To provide an example, the figures for

FIGURE 1: ECONOMIC AREAS OF 2020

SOURCE Henning et al. 2009

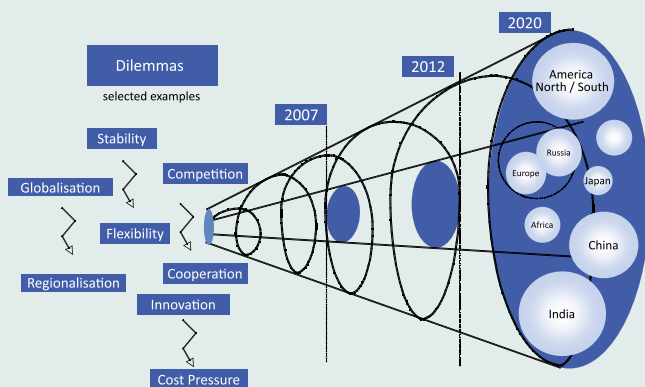


FIGURE 2: TRADE VOLUME BETWEEN THE MAIN ECONOMIES IN 2009

SOURCE U.S. Census Bureau 2011



the European Union are presented in detail. The distribution of all surface freight transport across all transport modes with and without extra-EU transport is given in Figure 3. In terms of transport service in tonnekilometre (tkm), air transport holds a share of less than 1 % [EU 2011b].

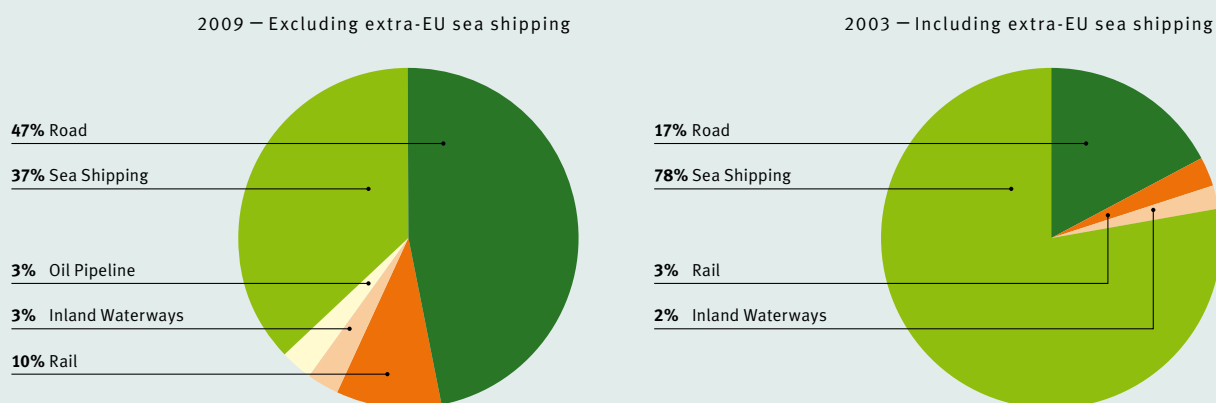
Compared to this and the dominance of the container vessels in extra-EU transport, the situation for inland transport is different. Here, the road is the dominant transport mode. With regards to tkm, road holds a 73.8 % share as of 2009 whereas the rail holds a 15.8 % share and the inland waterways 5.2 % [EUROSTAT 2011]. These figures indicate a bottleneck for the transport system. Huge quantities of goods are transported between the major ports across Europe in high capacity vessels of 15.000 TEUs (Twenty-foot Equivalent Unit). These large volumes require an efficient logistical support system as well as the acknowledged approach of hubs and spokes to tackle the transport task. Shifting transport from road to rail is, in terms of environmentally-friendly inland transport, favourable. It is simply impossible to reduce the share of road transport in the short-

run because it is responsible for approx. 80 % of inland transport. The rail network in Europe is facing capacity challenges today and there are several conditions, such as the constraints of rail freight transport schedules on passenger transportation or different track measures across European countries, that can hinder the efficient use of rail transport [Thunen 2010].

The above scenario is the situation in freight transport today, but what is the transport development forecast? The expected permanent growth of freight transport within the next few years will lead to more capacity constraints. For overall freight transport, the European Commission predicts 50 % growth in the EU25 countries from the year 2000 until the year 2020 [EU 2006]. Thus, the framework conditions will become more challenging and the discussed constraints will threaten transport flow. Taking this in account, it is obvious that efficiency-boosting measures, both technical and legislative, are necessary.

FIGURE 3: DISTRIBUTION OF SURFACE FREIGHT TRANSPORT ACROSS MODES IN EUROPE

SOURCE EU 2011b



## Socio-economic trends influencing the transport system of the future

The transport system of the future will have to contend with several fundamental socio-economic trends which will define the future quality of goods and the routes on which they will be transported. The trends discussed in this report according to PricewaterhouseCoopers [PWC 2009] are:

1. legislative frameworks and infrastructure constraints,
2. oil price and supply as a proponent of transport costs,
3. environmental awareness of society and changes in consumer behaviour and
4. re-regionalisation of production.

### Legislative framework and infrastructure constraints

Optimised supply chains should adequately take into account the externality costs arising from transport emissions. These costs should fall on the emission producer. The reduction of emissions from transport has become a greater challenge than the supply of energy for the transport itself. Particulate matter and emissions are a further concern in the environmental zones of bigger cities. Only less emitting commercial vehicles are allowed to enter into these eco-zones. Together with congestion charging zones these measures will induce changes in how goods and services are delivered.

Transport modes and their sustainability have become the subject of debates between policy makers, lobbyists, science and industry. The current transport White Paper, “*Roadmap to a Single European Transport Area – Towards a competitive and resource efficient transport system*”, gives a clear statement for multimodal logistic chains. Long distance freight transport is specifically addressed and the European Commission has set a target of a

shift of 30 % of road freight transport over 300 km to other modes, such as rail or waterborne transport, by 2030 and more than a 50 % shift by 2050 [EU 2011a].

In addition, the dimensions of transport means are the subject of heated discussions. The maximisation of cargo capacity of transport means is one key issue (besides the frequency of service and the distance from the end user) for compensating rising transport costs and for more efficiency in terms of economy of scale. Road freight transport is likely to continue to dominate in terms of market share in the EU. Accordingly, the European Commission is committed to “Adapting the legislation on weight and dimension to new circumstances, technologies and needs [...] and to make sure it facilitates intermodal transport and the reduction of overall energy consumption and emissions.” [EU 2011a]

In addition, infrastructure constraints limit the dimensions of transport means, e.g. the road network across Europe is not able to allow for 60 t commercial vehicles on all of its roads, and the width of Panama or Suez Canal sets a strict limit for container vessel dimensions. Without investments or at least a more efficient use of the existing infrastructure, today’s railway network across Europe will not be able to cope with the European objectives of road transport shift to rail. Parts of the railway network are overloaded whilst others are ignored or not subject to competition nor sold or leased to competitors. Another constraint arises from the demise of single wagonload services. Even though, the demand for full trainloads from bulk shippers is shrinking, there are still industries relying on rail freight (e.g. steel, automotive, paper and chemical industry).

This is one direction in which infrastructure influences transport. Another infrastructure constraint is set through the predictable and timely flow of transport means via a transport mode. As soon as an efficient transport flow of a transport



mode is hampered by congestion, logistic providers seek either alternative transport modes or more efficient use of the given infrastructure. The latter can be achieved by more efficient transport means and a better utilisation of the limited space. The former is more complex to achieve. “Modes of transport are broadly specialised in specific and separate area of advantage, and they are more complementary than rival.” [Savy 2009] Thus, the measure modal shift alone to overcome infrastructure constraints due to the foreseen growth of transportation is not feasible.

#### **Oil price and oil supply**

Oil price and oil supply still continue to define the future of the transport industry, and oil price volatility is a major risk. PricewaterhouseCoopers (PWC) has undertaken a Delphi survey in which they conclude that the oil price will not rise by such an amount that it will threaten conventional transport. Pessimistic projections of the US Energy Information Administration predict an oil price of \$200/barrel in the year 2030 [EIA 2008]. The permanent rise, however, will foster significant investments into alternative energy sources. PWC states that: “Should the oil price soar to a four digit figure, regionalisation of supply chains and relocation of production sites would be the consequence. If oil prices stay in the three digit figure range, global sourcing and transportation are still expected to provide reasonable cost advantages.” [PWC 2009] Thus, the oil price also has an impact on the entire production system, like the just-in-time approach which benefits from favourable transport costs. There will be a substantial growth in renewable energy sources by 2030. However, the costs for such energy are not clearly predictable [ibidem].

#### **Environmental awareness of society and changes in consumer behaviour**

Increasing societal environmental awareness is an overarching trend. ‘Sustainability’ is no longer only a marketing slogan. Following events in the Gulf of Mexico in 2010 (explosion on and sinking of the Deepwater Horizon oil platform and the ensuing marine contamination) and in Japan in 2011 (tsunami and partial meltdown of the nuclear power plant Fukushima), society expects the development of alternative energy sources. This development has begun to be reflected in the purchasing patterns of customers. For instance, smaller and more efficient cars are being requested by US customers (the registration figures in the US for small and medium-sized cars have grown significantly compared to those for bigger cars in the first quarter of 2011 [MotorIntelligence 2011]) and in Germany a trend towards green electricity can be observed: in 2010 the share of green electricity was four times bigger than in the 1990s [Destatis 2011].

Today, the global sourcing of grocery (produce) has become commonplace. The consumption behaviour of a growing number of people, however, has begun to change towards environmentally-friendly products [GfK 2008]. On the one hand, such products are produced in an environmentally friendly manner, i.e. the production is resource-efficient and undertaken either by a necessary choice of corresponding raw materials or because of a need to engage in resource saving production. On the other hand, the transport of the goods should be carried out in an energy-efficient way and consumers are increasingly paying attention to the ecological behaviour of their vendors. Another minor facet of changed consumer behaviour is the wish for personal influence on logistic processes in terms of delivery dates, short delivery times and high flexibility [PWC 2009]. These dimensions are the key indicators for logistics in general. The innovation is

that final consumers look at these criteria, too. This combines with customers taking an interest in the eco-friendliness of the supply chain and in consumer pressure on businesses to produce a low amount of carbon dioxide when transporting goods.

### **Re-regionalisation of production**

Another trend heading in the same direction is the re-regionalisation of production back from Asia, e.g. since 2008 some western companies started to question their reliance on outsourcing because of the long lead-times and the effects thereof upon cost competitiveness. This trend is caused by two developments, and the effects can be notable. For instance, in the German industry, the percentage of production abroad fell from 25% in 2003 to 9% in 2010 [DVZ 2011a]. In the automotive industry, it has become more and more popular to build entire production locations instead of assembly plants. Such production locations can then be supplied by local industry. Lower taxes and personnel costs, as well as subsidies, will be supplanted by quality and delivery security. Longer supply chains increase vulnerability and induce risks. This marks the first causation for a re-regionalisation. The second cause is determined by the nature of the products themselves. Locally manufactured products are getting more attention [PWC 2009, DVZ 2011a]. For groceries, there is a clear trend towards farmer's markets; in the US, the number of such markets has tripled from 1994 to 2008. According to PWC, it is conceivable that this trend spreads over to other consumables like clothing, furniture or toys [PWC 2009]. A concrete figure for the share of this group of consumers in the future is hard to predict. This trend is balanced by the share of consumers which do not possess purchasing power for such products. The trend to locally manufactured products, however, influences future transport chains.

### **What types of goods will need to be transported in the future?**

A summary of the world merchandise transport trade volume by major product groups (manufactures, mining products and agricultural products) is presented in Figure 4 [WTO 2011]. Manufactures consist of chemicals and related products, manufactured goods classified chiefly by material, machinery and transport equipment and of miscellaneous manufactured articles. Mining products consist of mineral fuels, lubricants and related materials. Agricultural products consist of food and live animals, beverages and tobacco, crude materials and inedible substances excluding fuels, and of animal and vegetable oils, fats and waxes.

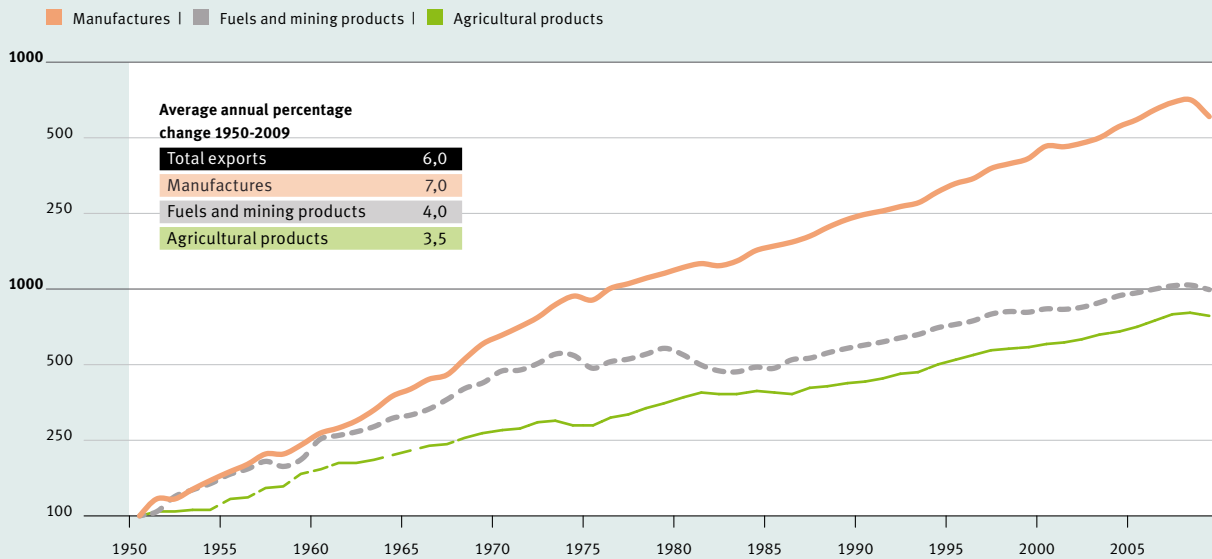
A robust global scientific forecast for goods to be transported in the future is not feasible in detail. The complexity of the market itself reduces the predictability of future trends. An example is the Chinese boom and its consequences. The boom has caused a shortage of shipping, port capacity with consequent delays in ports, on the roads and rail links serving these ports. The interaction between global and regional economic development, the demographic situation and consumers' buying behaviour is hard to assess. A complete change in the structure of transported goods (e.g. Standard International Trade Classification [WTO 2011]) cannot be assumed today. There are, however, several trends regarding future types of goods which may influence the future transport system. These trends include but are not limited to [PWC 2009]:

1. more locally manufactured goods
2. more high quality goods and finished products
3. more "ethical" products (e.g. fair trade or controlled organic products)



FIGURE 4: WORLD MERCHANDISE TRADE VOLUME BY MAJOR PRODUCT GROUPS, 1950-2009

SOURCE WTO 2011



### Locally manufactured goods

[PWC 2009, DVZ 2011a] identify a clear trend towards more locally manufactured goods. There are two reasons for the trend towards such goods. The first is greater awareness of sustainability issues in changing consumer behaviour, and this is reflected in purchasing patterns. To know the farmer your groceries are from will become increasingly important. The second reason is an increasing need for delivery security and product quality. This can only be guaranteed when all parts of the manufacturing process can be observed and thus, they need to be closely linked.

### High quality goods

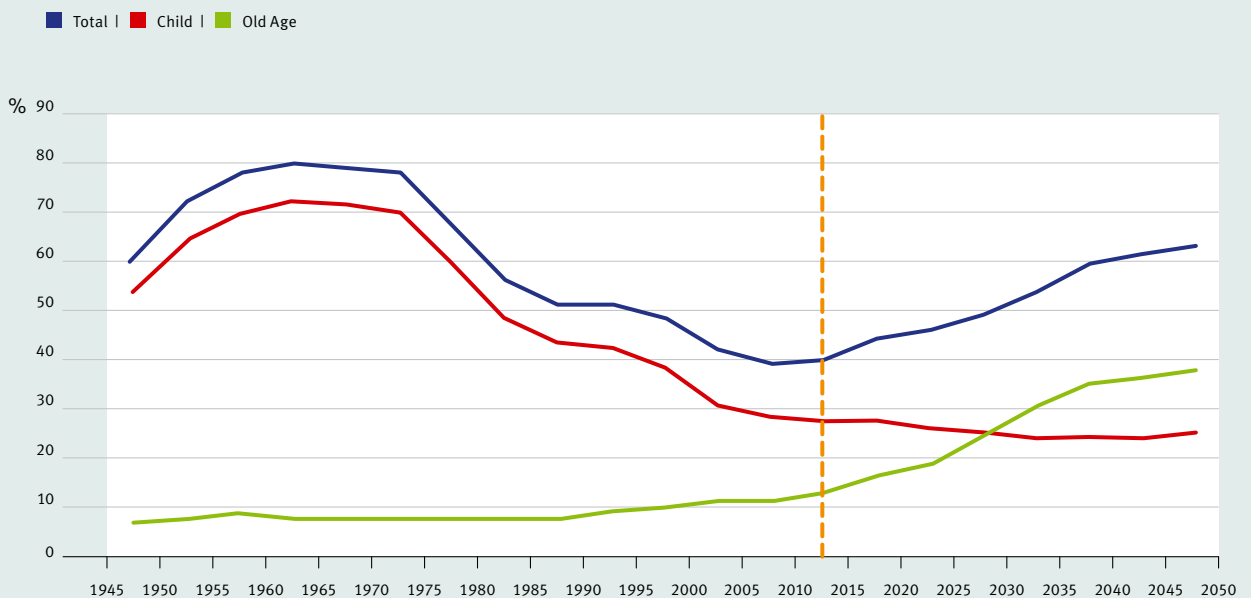
Demographic development plays an important role in the prediction of future economic trends [PWC 2009]. In this context, stagnation and eventually a decrease of the population in the industrial countries in Europe and Japan is forecasted (China will follow this trend, cf. Figure 5). The trend for the EU predicts stagnation for the year 2060 at

506 million inhabitants. The stagnation is accompanied by a shifting of the age distribution towards elderly and old people. In the EU the percentage of over 65-year-old people will increase from 17.1 % to 30.0 % and the percentage of the population over 80 years of age will rise from 4.4 % to 12.1 % [ibidem]. This shifting will not only have an impact on the market potential in terms of higher purchasing power and a higher standard of living but also may change purchasing behaviour.

Population development in the emerging BRICS markets is in sharp contrast to the situation in industrialised countries. The result is that emerging economies have a large and growing market size in which will further accelerate economic growth within these regions. China, for example, had an economic growth rate (in terms of GDP) of nearly 10 % in 2010, outperforming most other major economies. These developments are not limited to Asia. Similar trends can be observed in Brazil (7.5 %) or Russia (3.8 %) and other developing countries [CIA 2010]. The future demographic development of China, however,

FIGURE 5: DEPENDENCY RATIOS FOR CHINA

SOURCE United Nations 2011



is closer to that of developed countries. Chinese inhabitants aged 60 + will count for a share of 24 % in 2030 [United Nations 2011]. In addition, by 2015 the Chinese workforce will start to shrink in absolute terms. Figure 5 presents the dependency ratios for China in percent, i.e. the ratio from children (under the age of 19) or the elderly (more than 65 years old) to the working population. The dependency ratio from both, children and the elderly, to the working population is presented by the total in the graph [ibidem].

As a consequence, the emerging markets will not only experience the development of new transport corridors (road, rail, water, air) and new industrialised economies, but also a changed purchasing behaviour due to regional preferences and different customer structures. Due to the previously described population development, strong and sustainable growth is expected in emerging markets for the transport and logistics sector. Due to the requirement to have flexible and transparent supply chains, an

“internet of things” will become key to sustaining the growth in the transportation industry [DHL 2009]. Forecasts propose a trend towards products that “will communicate and navigate independently and will be networked with each other” for 2020. Not only will the total networking of the production create new business models and require new logistics centres, but it will also change the traditional structure of the transport and logistics sector. The need for a faster and semi-autonomous transport will dominate in the future, where “products will be able to determine their own optimal transport path” [ibidem].

The logistics and transport companies will have to develop customised transport solutions as well as individualised and flexible production processes. The need for flexibility and individualisation is the result of partially contradictory customer demands. Logistics companies can tackle these challenges with greater flexibility and it is likely “that logistic hubs will be designated to operate for a much shorter time frame” [DHL 2009]. In the last couple of years,

transported goods have become lighter and of higher quality, while their lot sizes have become smaller. In addition to this development, the packaging became lighter but more voluminous [Shell 2009]. The above discussed trends may influence future loading units in terms of needed dimensions but also in terms of needed cargo security.

### “Ethical Products”

A potential future trend for goods to be transported will result from consumers’ evolving purchasing behaviour, which depends on social framework conditions and consumer demand. Over the past decade, the public debate about the interaction between human and nature has steadily gained traction. Several laws and regulations have reinforced this trend towards an environmentally-friendlier way of life. For example, the high standard of European emissions legislation has led to significant pollutant reduction from motorised vehicles. In this context, “ethical” products, such as environmentally-friendly produced goods or goods consisting of sustainable resources, will

become more important for final consumers and require a transparent logistics system [GfK NOP 2011]. Customers “will want to be assured that everything they buy conforms to their ethical and moral standards” [DHL 2009]. The transparency of the goods should not only include transparent and ethical transportation, but also an equivalently “ethical” method of production. While the price will remain a decisive factor, ethical and environmental considerations will become more important. [ibidem].

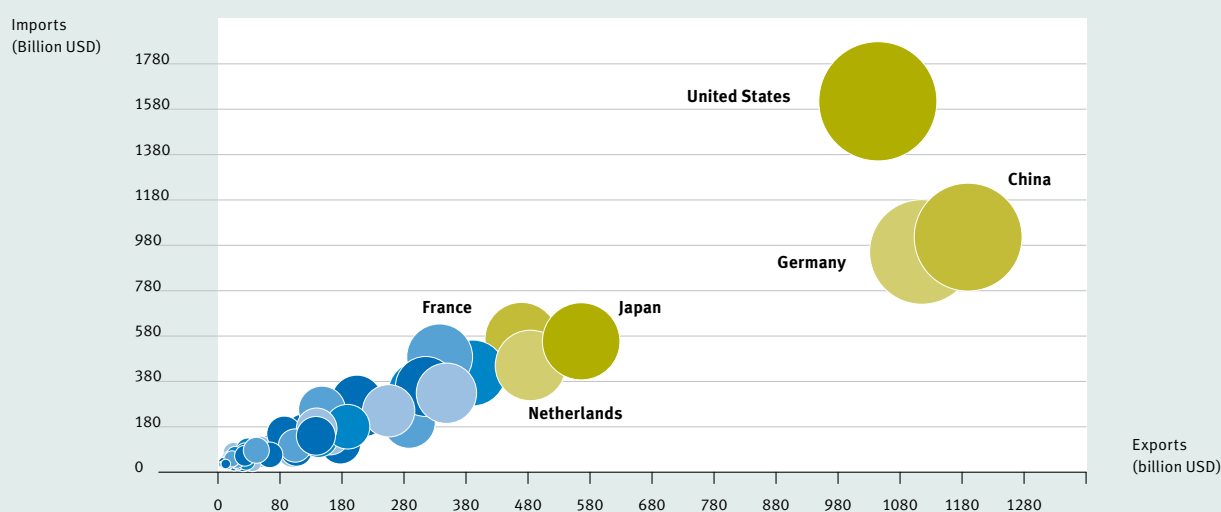
### From where to where will the goods be transported in the future?

The three main exporting economies: China, Germany and the USA are responsible for 27.1 % of global export volume and for 28 % of global import volume. These figures show the importance of the trade corridors between the largest trading countries (cf. Figure 6).

The flow within these traditional trading routes is not expected to decrease, but instead to grow even further along with the shifting of economic

FIGURE 6: LARGEST COUNTRIES BY WORLD TRADE

SOURCE WTO 2011



significance towards the Asian and in particular towards China [WTO 2011]. As a result, logistics companies' trade corridors from and to Asia will experience an utilisation of capacity right on the edge of a manageable level. The traditional trade routes between developed economies are growing relatively slowly, at between 6 – 10% annually, whereas the growth rates of the trade corridors between emerging economies is reaching between 20 – 40% [PWC 2009].



















The transportation and logistics sector is highly dependent on the state of the global economy. As a result, the financial crisis had a strongly negative impact on the sector. After decades of global

economic growth and strong increase in world merchandise trade, the year 2009 marked a turning point for the global economy and especially the logistics industry. Further, industrialised economies experienced a deeper slump and a subsequently slower economic recovery than the newly industrialised countries.

While national GDP growth rates were moderate for the industrialised countries before the crisis (e.g. Germany 3.6 %), the emerging nations experienced high growth rates (e.g. China 10.3 %). This can be further illustrated by a comparison of the figures of the largest European and Chinese seaports. While the largest European port, Rotterdam, grew by 2 % in

TABLE 1: TOP-20 WORLD PORTS, 2008 – 2010. UNIT: GROSS WEIGHT X 1 MILLION METRIC TONS

SOURCE *Port of Rotterdam 2011*

PORT	COUNTRY	2010	2009	2008
Shanghai	 CHINA	650.0	590.0	582.0
Ningbo & Zhoushan	 CHINA	627.0	570.0	520.1
Singapore	 SINGAPORE	502.5	472.3	215.4
Rotterdam	 NETHERLANDS	429.9	387.0	421.1
Tianjin	 CHINA	408.0	380.0	355.9
Guangzhou	 CHINA	400.0	375.0	344.3
Qingdao	 CHINA	350.1	315.5	300.3
Dalian	 CHINA	300.8	203.7	185.2
Hong Kong	 CHINA	267.8	243.0	259.4
Busan	 SOUTH KOREA	262.1	226.2	241.7
Qinhuangdao	 CHINA	257.0	243.8	252.2
South Louisiana	 UNITED STATES OF AMERICA	246.2	215.6	233.7
Houston	 UNITED STATES OF AMERICA	225.0	155.5	227.0
Shenzhen	 CHINA	221.0	194.0	211.2
Rizhao	 CHINA	221.0	181.3	151.0
Los Angeles	 UNITED STATES OF AMERICA	187.8	157.5	170.0
Nagoya	 JAPAN	185.7	165.1	218.1
Port Hedland	 AUSTRALIA	178.6	159.4	130.7
Antwerp	 BELGIUM	178.2	157.6	189.4
Chiba	 JAPAN	165.0	150.0	170.0

the period between 2008 to 2010, the world's biggest port, Shanghai, experienced an increase of 11 %. China benefitted from access to a huge Asian market and therefore developed partly independently from the overall world market (cf. Table 1). Additionally, the fact that China's trade partners are globally spread makes the economy less volatile and less dependent on global trends. The country has established global business relationships with all world regions including least developed countries in Africa [PWC 2009].

The figures reveal another trend in the logistics sector: the emerging markets are becoming increasingly important. Ten Chinese seaports are ranked in the worldwide top 20 (table above) and China has an advantage in terms of its infrastructure quality and quantity in comparison to other emerging markets. The World Bank ranked the overall logistic performance of China as number 27 in a worldwide comparison [The World Bank 2010]. In order to take a deeper look in these developments and the importance of these emerging markets for the future transport, the next sections provide information and forecasts for Brazil, Russia and the Commonwealth of Independent states, as well as for India and China and the Asian region.

### **Brazil**

Many of the new trade flows will bypass the developed countries of Europe and North America and will concentrate inside new trade corridors. A developing country with high potential is Brazil, which has one of the biggest economies in the world and is ranked as number 8 in terms of national GDP. An additional advantage of Brazil is its high wealth in resources [CIA 2010]. Important factors for the bright perspectives of Brazil are major investments of mainly European companies into the Brazilian industrial sector. It is therefore possible that Brazil will become a buyer's market for merchandising

exports, but that it will also develop into a major exporting economy. The strategic advantage of Brazil as a gate to the South American market will amplify this process. Brazil is already China's largest trading partner and outlines the evolution and importance of new trading corridors between the emerging markets.

### **Russia and the Commonwealth of Independent States (CIS)**

The Commonwealth of Independent States (CIS) of the former Soviet republics will strengthen its position as the largest transit region for the European-Asian trade corridor. The EurAsEC Integration Committee expects a trade volume six times greater by 2020 through the territories of the CIS than in the year 2000. The Committee considers Russia and Kazakhstan as the most important countries for future transport transit from Asia to Europe [Eurasian Development Bank 2009]. The trade volume between the CIS and the EU is strongly increasing and is expected to grow even further [PWC 2009]. Moreover, the CIS market itself has also developed into a highly interesting buyer's market with annual growth rates of over 40 % for trade volume from South and Central America and Asia to the CIS.

Russia in particular is expected to be able to use its resource base to develop successfully and experience rapid growth until 2020 [DHL 2009]. First developments in this direction can already be seen by an annual GDP growth rate of around 4 % over the last three years [CIA 2010].

The total growth of cargo transit in Russia is expected to nearly triple between the years 2010 to 2030, from a total of 34.2 million tons to 100 million tons. Rail transport will account for 76 % of the total freight transport and be the main transportation mode. Today as much as 90 % of Russian revenues in railway cargo transport are generated by

TABLE 2: CARGO TRANSIT IN MILLION TONS IN RUSSIA [EURASIAN DEVELOPMENT BANK 2009]

SOURCE WTO 2011

MODE OF TRANSPORT	2000	2005	2007	2010	2015	2020	2030
Railways	20	17.4	27.2	33.1	40.3	53	76
Motor Transport	0.5	0.5	0.5	1	2	2.5	3
Inland Water Transport	1.3	0.1	0.1	0.1	0.4	4.5	21
<b>TOTAL</b>	<b>21.8</b>	<b>18</b>	<b>27.9</b>	<b>34.2</b>	<b>42.7</b>	<b>60</b>	<b>100</b>

international shipments. This trend is expected to stay at a high level and become a decisive factor in the growth of the Russian transport and logistics sector [Eurasian Development Bank 2009].

Trade volumes from Asia to CIS measured in billion US\$ rose annually by 42% between the year 2000 and 2008. South and Central America also have increased exports to the CIS in this period, with a flow of goods up by 49% [WTO 2011].

### India

Apart from China, the Indian economy is expected to experience the highest growth rates and move up as number three in the world economy [ibidem]. Although India had a GDP growth rate of 8% in 2010 [CIA 2010] and has a huge market potential with the fastest growing population and 1.3 billion inhabitants [PWC 2009], the potential is expected to be limited by the economic and political framework. Substantial social inequalities (estimated 25% of the population live below the poverty line [CIA 2010]) will limit the perspective and development potential in comparison to the other emerging markets [DHL 2009]. Nevertheless, India has had annual growth rates of 7% to 8% over the period of three years from 2008 to 2010 [CIA 2010], while its merchandise imports and exports contribute to 4.3% of world trade volume in 2010 [WTO 2011].

The most important trade corridors for India are those to Arabian countries (United Arab Emirates and Saudi Arabia), the USA, the EU and China [Indian Government, Ministry of Commerce & Industry 2011]. The sustainable growth rates in terms of trade volume, particularly with the Arabic countries, show a new trend for the future development in the transport and logistics sector: a strongly increasing trade volume within the emerging markets and to the least developed countries. The trade volume between India and the EU increased by 30% within a period of only three years between 2006 and 2009, and which is expected to grow further [Germany Trade & Invest 2009]. Although the prognoses for further development of the Indian market are not so clearly positive, the market potential remains at a high level.

### China and the Asian region

The importance of China as one of the largest trading markets in the world will increase over the next few years as the country develops into the world's largest exporting economy. The great importance of the Asian market is reinforced by presence of the economically powerful Japan and South Korea. These two economies are two of the world's largest and were ranked 4th and 13th by national GDP in 2010 [CIA 2010]. Intra-Asian trade

will become an increasingly important factor in world trade. Today, China is the largest trading partner for several Asian countries including Japan, North and South Korea, Vietnam and Taiwan [ibidem]. Forecasts anticipate that this trend will continue, and that trade volume in this economic region will expand significantly. By 2028, the Asian region is expected to contribute nearly 40 % of global trade volume and to overtake the European region, which had a share of 41.2 % for world's goods exports and 41.6 % of world merchandise imports in 2010 [PWC 2009, WTO 2011]. DHL sees Asia as the undisputed winner of globalisation and the most important market for the logistics and transport sector.

The development of the Asian market intensifies high trade volume and therefore the utilisation of current trade corridors between the EU, Asia and North America. Forecasts see a constant growth of the trade volume from North America to the EU of annually 6% and from Asia to the EU by 13% per annum [PWC 2009]. The three regions were not only responsible for 83.8 % of global export volume in 2009, but also for 86.5 % of global import volume in the same year [WTO 2011]. This underlines the crucial importance of these markets for global trade. The trade volume in between these regions remains at a high level, at over 80 % of the total trade volume for each region and is expected to grow moderately over the next few years [PWC 2009].

China is not only very successful in the traditional markets and in the Asian region, it has also developed into one of Brazil and several African countries' biggest trading partners. China's major African trading partners are Angola and Sudan [CIA 2010]. A resource hungry country, China has established new trade flows with these countries in order to ensure the supply of fuels and raw material [PWC 2009]. It is already the 2nd largest trading nation globally and will become the largest national economy by 2050 [HSBC 2009]. As a result, the trade

corridors between China and its partner emerging countries in Asia, Africa and South America will gain greater importance over the next decade.

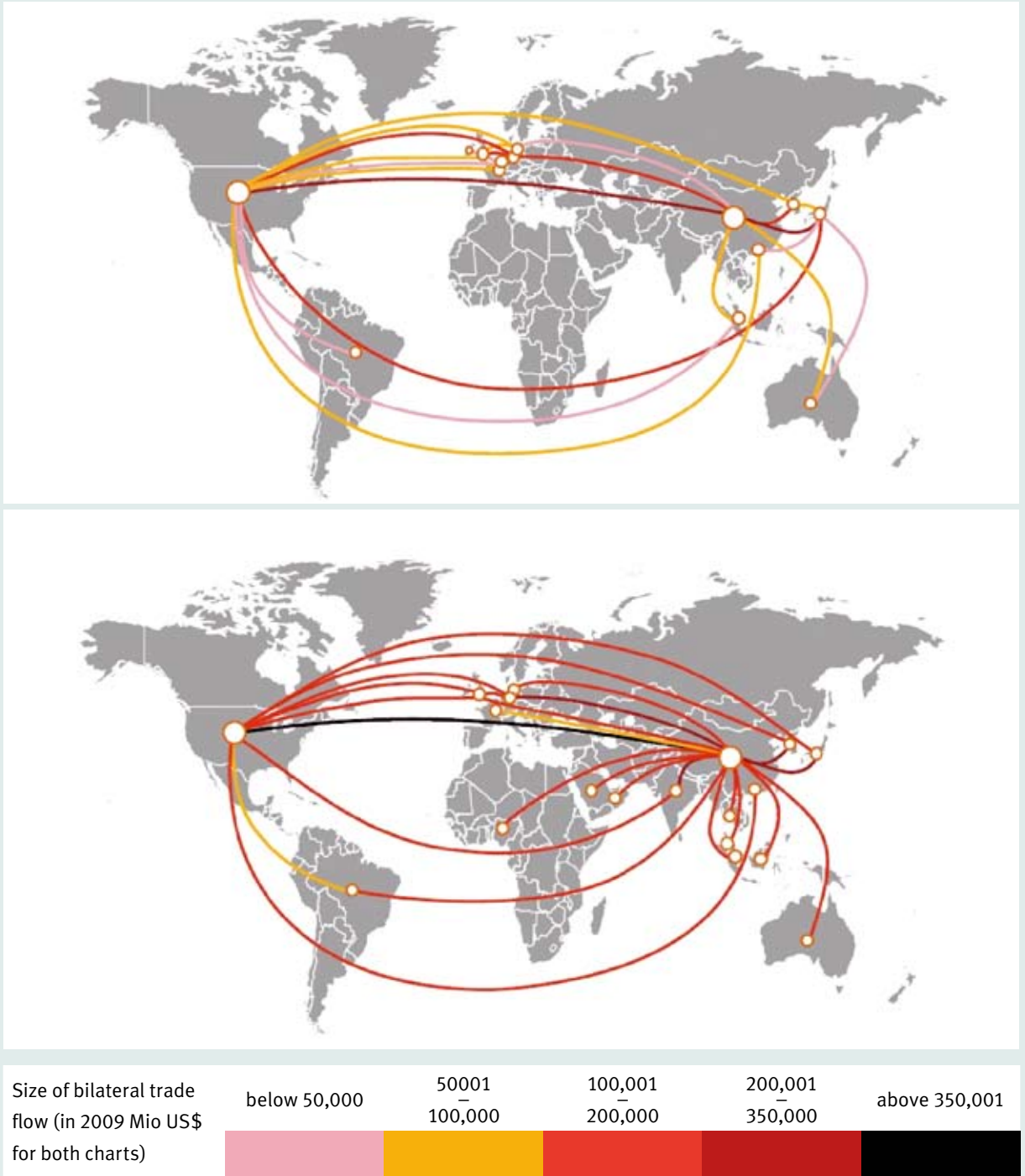
#### **Consequences for future transport routes**

According to [PWC 2011], the “development of new trade corridors is already underway” due to the increasing trade flows between Asia and other regions such as Africa and Central and South America. It is expected that the main trade corridors will relocate to the growth regions for transportation and logistics operators from Asia to Africa, from South America to Asia, and on the Asian continent. As a result of these developments, new trade corridors between Asia and Africa, Asia and South America and within Asia will re-chart global supply chains. Trade volumes will shift towards emerging markets, and least developed countries will take their first steps into the global marketplace. In 2030 it is expected that global trade flows will have shifted in such a way that new transportation corridors between emerging countries and least developed countries will have been established. Traditional trading routes will have lost relative importance in terms of trade volume. Intra-Asian trade will grow the most, attaining a share of world trade volume of up to 40 %. These trends are illustrated in the following figure:



FIGURE 7: DEVELOPMENT OF BILATERAL TRADE FLOW FROM 2009 TO 2030

SOURCE PWC 2011





## 2 International Loading Units

### Current Loading Units

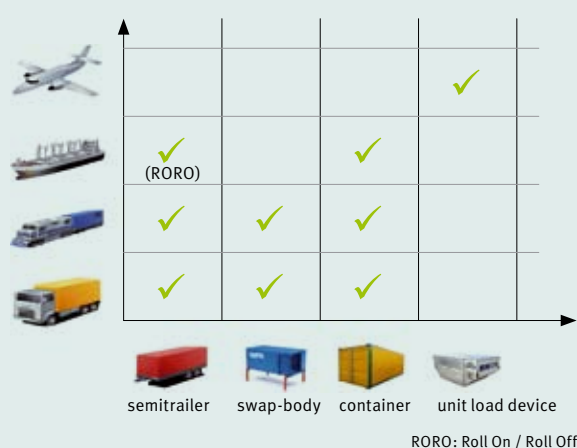
Today, the transport sector has to face various challenges in terms of safety, traffic congestion, loading processes, and interoperability of available transport modes. The discussion above has revealed several essential requirements with respect to this development. Especially, the impact of transport on environment is addressed in the new transport White Paper of the European Commission [EU 2011a]. One major goal is an optimisation of the performance of multimodal logistic chains, e.g. by making greater use of more energy-efficient modes. Thus, the intermodal freight transport will be promoted over the next years. This will affect the design of future international loading units in terms of interfaces to different carriers (e.g. road chassis or railway waggons) of the different transport modes. Concepts for future loading units have to respect these requirements.

optimised transport efficiency can be achieved by efficient loading units and by more efficient use of infrastructure and the transport means.

This section provides a brief overview of the commonly used current loading units, including semitrailers, swap-bodies, containers and unit load devices. Some of these loading units are applicable to only one mode of transport whilst others can be used intermodally. Figure 8 presents the introduced loading units and clusters them to their modes of transport.

The three most dominant concepts - containers, swap-bodies and semitrailers - have been further developed for certain purposes and markets. Containers and swap-bodies hold a share of 75 % in combined transport across Europe, and semitrailers hold a share of 10 % [UIRR 2010]. A general tendency in the enhancement of loading units concerns the maximization of the cargo volume and the facilitation

FIGURE 8: CURRENT LOADING UNITS



of loading and transshipment processes [Walter 2005]. These loading units differ from others in aspects such as dimensions and stability as well as usability regarding handling, transport and loading processes.

#### Semitrailers

Semitrailers are predominantly used in road transport (cf. Figure 9). They are road vehicles for goods transport with no front axle/axle assembly. They are designed “in such a way that part of the vehicle and a substantial part of its loaded weight rests on a road tractor [EUROSTAT 2009a]”. In road haulage, semitrailers are preferred because of their flexibility not only in terms of manoeuvrability but also concerning the easy coupling and uncoupling process. Within the last few years, greater sized semitrailers, called “Mega-Trailers” or “Jumbos”, have become more common. Because of their length and internal height (about 3m), the maximum cargo volume provides important economic advantages leading to more cost effective transportation [Buscher 1998]. Compared to containers and swap-bodies however, semitrailers are only partially applicable in intermodal transport chains because

FIGURE 9: SEMITRAILERS



they are not stackable and require special equipment for handling. In general, less than 3% of semitrailers are equipped to be used in intermodal transport [EUROSTAT 2006].

For different cargo haulage operations different semitrailers have been designed. The following list presents a selection of the most common types:

- Box trailer – also called van trailer is equipped with fixed walls.
- Car-carrying trailer – this trailer is able to carry multiple cars, predominantly used by car manufacturers to distribute their products to the resellers.

- Curtain sider – this concept is similar to the box trailer concept. However, the walls of this trailer are made of tarpaulin / reinforced fabric and thus they are movable for easy access. The purpose is to combine the advantages of box trailers in terms of security and weather resistance and of flatbeds in terms of ease of loading.
- Flatbed trailer – consisting of a loading floor and protective devices, such as removable side rails, and a bulkhead in the front for the purpose is easy loading of all types of goods that can be strapped down.
- Reefer trailer – equipped with a heating/cooling unit to haul all products which require a defined cargo condition (e.g. perishables or food)
- Dry bulk / tipping trailer – these trailers are used to haul dry (powder) materials e.g. in the construction logistic.
- Tanker trailer – are designed to haul all types of liquids from oil/gasoline to beverages.

#### Swap-Bodies

Swap-bodies are loading units optimised to road vehicle dimensions and are equipped with handling devices for easy transfer between transport modes (road/rail). They are predominantly used in intra-continental freight transport between the European member states (cf. Figure 10). They are adjusted to road transport restrictions and the transport of standardised euro pallets. Swap-bodies are demountable from the chassis but more lightly constructed than containers, so that most of them cannot be stacked or top-handled. Some swap-bodies are equipped with folding legs. They are able to stand alone whilst not actually attached to a vehicle. The increasing use of curtain-sided and volume-optimised swap-bodies meets the loaders requirements for wide openings on both sides and a maximised cargo area [Stackelberg 1998]. For example, the swap-body “Arcus 100” from Ewals

Cargo Care B.V. offers a cargo volume of 100m<sup>3</sup> and has curtains on both sides. These commonly used curtain-sided swap-bodies, however, only resist low horizontal forces in short sea shipping. Also, curtain-sided swap-bodies cannot be certified for TIR and therefore are not able to be transhipped to Russia. Hence, in general swap-bodies are not suitable for intermodal transport including all modes (road, rail and waterborne). While European standards in terms of dimensions and general requirements [EN 284, EN 452], securing of cargo [EN 12640] and the coding, identification and marking of swap-bodies [EN 13044] have been published in the last 15 years, there are still notable differences in dimensions, fitting and

lifting points and other properties concerning the loading and transshipment operations.

Swap-bodies are mainly designed in three different body types: as curtain sided, as box concept or as reefer. Most frequently used swap-bodies are of class A [EN 452], specially designed for the use on semitrailers with a length of up to 13.67 m or of class C [EN 284], specially designed for the use on truck-trailer combinations with a length of 7.15 m to 7.82 m.

### Containers

[EUROSTAT 2009a] defines containers as “special box(es) to carry freight, strengthened and stackable, and allowing horizontal or vertical transfers”. Containers are loading units which can be carried on all transport modes and for that reason, they offer many advantages for their use in intermodal transport (cf. Figure 11). During the last 50 years, maritime containers complied strictly with the ISO standards and were optimised with the introduction of the 40 ft standard containers. Advantages of standard containers are related to efficient terminal handlings and cost-effective intermodal operations. Intermodal transport focuses on the use of containers, as they prove to be functional in intermodal transport chains. The stability and stackability of these carriers ensure an efficient transport and loading process. However, when it comes to road transport, containers represent a very small percentage of the total tonnage per freight vehicle. With the introduction of pallet wide containers, the disadvantage of inefficient cargo area utilisation when hauling palletized goods has been stamped out.

FIGURE 10: SWAP-BODIES



FIGURE 11: CONTAINERS



For different cargo haulage operations, different containers are designed. The following list presents a selection of the most common types according to the ISO Standards Handbook on Freight Containers:

- General purpose containers – these containers, also called dry freight container, are most frequently used.
- Specific purpose containers – among these containers are closed ventilated containers (e.g. for organic products requiring ventilation), open top containers (e.g. for bulk materials) and different kinds of platform containers (for barrels/drums, cable drums, out of gauge cargo, machinery etc.).

- Specific cargo containers – this group of containers consists of thermal containers, insulated containers and refrigerated containers providing special (and controlled) cargo conditions, e.g. for perishables. Tank containers (a tank in an outer frame with standard container dimensions in terms of e.g. corner casting position), dry bulk containers or named cargo containers (such as automobile, livestock etc.) are also part of specific cargo containers.

#### Unit load devices

In air freight transport so-called unit load devices (ULD) are commonly used (cf. Figure 12). ULDs are introduced to bundle large quantities of goods for a more efficient ground handling. There are two types of ULDs, pallets and containers. The pallets are made of aluminum sheets and they are equipped with rims that fit to the eyelets of the cargo net. The dimensions vary from 1.53 m x 2.44 m (LD8) to 2.44 m x 3.18 m (LD7). ULD containers are made of aluminum or a combination of aluminum and synthetics. Their shape is designed to fit into the aircraft body. These containers can be refrigerated, too. Their volume varies from 3.4 m<sup>3</sup> (LD2) to 8.95 m<sup>3</sup> (LD6).

FIGURE 12: UNIT LOAD DEVICES





## Future International Loading Units

### Derived Requirements for the Future

#### International Loading Unit

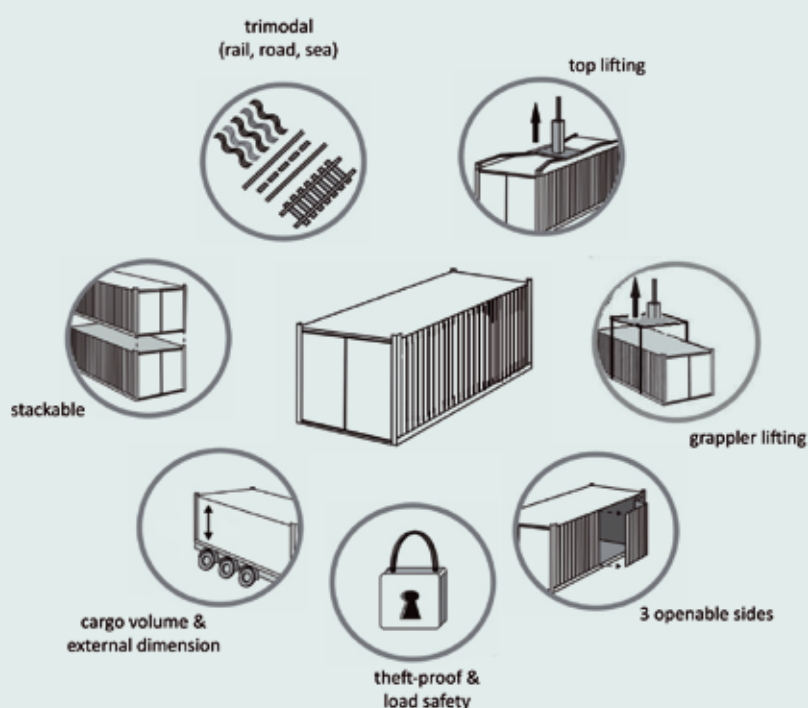
The discussion on the modal share of carriers above has revealed that as regards to tkm, the major share of world wide freight transport is performed by container vessels, followed by road transport. Distance rail and inland waterways follow far behind in significance. Air transport plays a minor role, in terms of tkm, with a share of less than 1 %. With respect to the value of transported goods, air transport is responsible for 40 % [Merge Global Inc. 2011].

The requirements of air transport differ from other transport modes, particularly in terms of external dimensions, weight and the costs per loading unit. In addition, there is an increased interest of importers in sea-air-solutions. Sea-air solutions have the benefit of combining the fuel-efficient transportation

abilities of slow-moving container ships with the ability of air transport to cover large distances rapidly. This means that for particularly high value items that are required rapidly, air transport can be used, whereas large, bulky and relatively inexpensive goods can be conveyed by ship transport. Using both methods ensures that production cycles can be maintained and goods can continue to be delivered, which is important for situations in which delays cannot be tolerated [DVZ 2011b].

Optimising costs, transport time and transport quality are basic requirements for global transport. The future international loading unit has to be compatible with improved means of transport and newly designed transport chains. Figure 13 provides a brief overview of the discussed general requirements for a new international loading unit as they were identified in the TelliBox research project [TelliBox 2008].

FIGURE 13: REQUIREMENTS FOR THE FUTURE INTERNATIONAL LOADING UNIT AT A GLANCE



Due to the supremacy of container vessel transport, the international loading unit must essentially be applicable to intermodal transport via road, rail and sea. Thus, the international loading unit has to be stackable, unloadable and loadable according to (UIC 592-2), (UIC 592-4), and [UIC 2005] respectively, and needs standard interfaces for the different transport modes.

When it comes to external dimensions and cargo volume, it is essential that the international loading unit fit to the different dimensions of transport means. Railway waggons have a maximum length of 90 feet and container vessels are equipped with distinct spacing. The interface dimensions of the international loading unit should be compatible with existing ISO containers (DIN ISO 668) in terms of e.g. corner casting position and dimensions. The exactness of cargo volume is of utmost importance in order to utilise the infrastructure as efficiently as possible. Given this principle, the international loading unit should ‘cube out’ before it ‘weighs out’ – i.e. it should be filled up before it becomes too heavy. However, the greater idle weight of the loading unit is also of crucial importance. The greater the idle weight carried by any means of transport, the greater the waste in energy and carrying capacity. One ton equipment carried by sea costs the equivalent of three tons of equipment carried by road and the equivalent of six tons by air.

The international loading unit should be able to be handled in terminals by the following basic methods:

- by spreader lifting by top fittings – in this case the international loading unit has to be equipped with four intermediate or corner top fittings (40 ft or 45 ft) and
- by grab-lifting appliances (grapplers) – in this case the international loading unit has to be

provided with grooves on the underside of the bottom of the frame.

Accordingly, an international loading unit has to be equipped with top and bottom corner and intermediate fittings. During transportation on railway waggons for intermodal transport as well as by road transport chassis, the international loading unit must be also equipped with bottom corner fittings (UIC 592-2 or 592-4) [UIC 2005]. This point is also important for fixation of the international loading unit during inland and short sea shipping by bottom and top corner castings. The international loading unit needs intermediate fitting on the bottom at the 40 ft. position and corner fittings in the bottom at 45 ft. position.

The international loading unit should have three openable sides for loading/unloading to assure flexibility and loading efficiency. In addition, it has to be ensured that the maximum inner loading height can be fully used. Robust and lockable side walls are required and the sides must be closed to avoid theft, and must be sealable to be TIR certifiable. It should be possible to verify that a container has not been opened during a check by the responsible departments. An integrated tie down eases the stabilisation of the container when it is being secured. In addition, the requirements of EN 12642 (Securing of cargo on road vehicles – body structure of commercial vehicles – minimum requirements) have to be fulfilled.

The international loading unit must be designed with respect to easy maintenance – used materials must therefore be easily repairable due to a high probability of international loading unit structure damage during transportation. Metal parts should ensure good weldability, non-metal parts should either be easily replaceable or repairable through the use of adhesives. In addition, the international loading unit must be producible by known tools and

methods, and therefore be buildable by existing manufactures.

The international loading unit has to be designed with ease of operation in mind. It must be operable by one person and should be usable without prior given instruction. In addition, there should be no risk of injury. In general, the ideal international loading unit should be modular in its design to be able to meet the different needs of customers. As it is impossible to meet all requirements of the vast variety of logistic provider needs, the design should be flexible enough (modular design) to allow for derivatives. For example, if a customer does not want openable side walls or an extended inner height, this should not affect the constructive principles of the international loading unit.

### Efficient Loading Units

When comparing the above listed requirements with loading units on the market, a comparison matrix of technical parameters for an international loading unit can be created. For example, swap-

bodies exist with an internal height of 3 m, but none of them can be used for shipping or equipped with side doors. In the following table (Table 3) the most important demands on an international loading unit for envisaged usage are summed-up and refer to established transport solutions already on the market. At present, there is no international loading unit on the market which meets all demands. The relatively new pallet-wide container is the closest solution on the market with an extended external width of 2.5 m.

### TelliBox – a new MegaSwapBox for Intermodal Transport

To overcome the absence of such a new international loading unit, the European Commission granted the TelliBox - Intelligent MegaSwapBoxes project for Advanced Intermodal Freight Transport under its seventh research framework programme [Jursch et al. 2010]. The project was launched due to the increasing demands from politics and society to counteract the trend towards increasing

TABLE 3: COMPARISON OF TECHNICAL PARAMETERS OF ESTABLISHED INTERNATIONAL LOADING UNITS

■ Standard | ● Purpose-built | ▲ None

	CONTAINER ISO 1A	SWAP-BODY (SERIES A)	SEMITRAILER (JUMBO)
Trimodal	■	●	●
Stackable	■	▲	●
Handling from top (corner fittings)	■	●	●
Cargo volume 100m <sup>3</sup> / pallet wide	●	■	■
3m internal height	●	■	▲
Loading facilities from three sides	■ on demand	▲	■
Safety of cargo (pilferage / theft)	■	▲	▲
Liftable top	■ on demand	▲	▲ (only tilt version)

freight transport on roads. The development of a new all-purpose loading unit is a market response to Europe's policy objectives of developing an integrated, seamless and competitive transport system (Figure 14). The TelliBox project aims to improve the efficiency of intermodal freight transport flow across Europe and Russia. The aims and contributions of freight forwarders, shippers, rolling stock manufacturers and scientists have been taken into account by the consortium in developing a new intermodal loading unit.

FIGURE 14: THE TELLIBOX AT A GLANCE



The TelliBox project has focused on the development of a 45-foot intermodal transport unit, applicable to transport by road, rail, inland and short sea shipping. Additionally, it has to meet special requirements like stackability, applicable for handling from the top, optimised cargo volume of 100m<sup>3</sup> with an internal height of 3m and completely openable doors on three sides. At the same time, improved safety features against theft have to be ensured.

After a successful certification for the application to freight transport (UIC, CSC and DIN EN 12642 Code XL), the MegaSwapBox was also successfully tested on an over 5000 km long trimodal demonstration circuit. Within two demonstration phases, the MegaSwapBox and its chassis covered typical routes on which goods of the automotive industry are presently transported. Currently, these transports

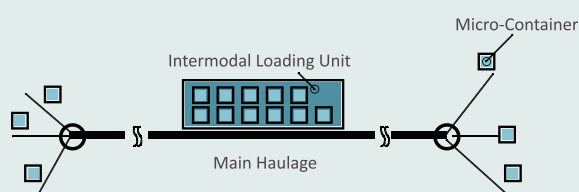
can only be made on road, inland and short-sea shipping without exchanging the carrier. The project ended in March 2011. At the moment, the involved partners are working on a market introduction of the MegaSwapBox to ensure a sustainable utilisation of the project results. One technical issue to overcome in the future is the need for better stackability. At the moment, the TelliBox is not appropriate for overseas transport as it is only two times stackable. This is enough for inland waterway barges across Europe and the short sea transport but not for bigger vessels. In addition, despite all the advantages of the TelliBox, it has the disadvantages of, at the moment, being more expensive to manufacture and of having a higher tare weight. Thus, its use is somewhat a trade-off when compared to the use of standard loading containers.

#### Micro-Containers

Loading units for intermodal transport have been introduced above. Due to their design and their dimensions, they are not appropriate for to be transport by airfreight. The analysis of future supply chains above has revealed that this means of transport will become more prominent, especially for high-value goods. To cope with this development the introduction of micro-containers could be a solution [Hackenberg 2009]. Such micro-containers are able to store different types of goods and should have standardised dimensions which fit into commercial delivery vehicles and/or the cargo compartment of aircraft. The external dimensions of micro-containers have to be adapted to the internal dimensions of intermodal loading units (cf. Figure 15). Following this approach, extensive transshipment of individual goods between different loading units for different transport modes (e.g. from hanging garment containers for overseas shipping to transport compartments for road transport) can be avoided. Further advantages of micro-containers are



FIGURE 15: MICRO-CONTAINER APPROACH



that they are applicable for goods which cannot be transported on pallets, and they are stackable, which pallets are not.

### **Efficient Use of Infrastructure/ Means of Transport**

#### Larger means of transport

Increasing the size of the transportation means is one approach that can be used to help move larger quantities of goods. The concepts regarding larger means of transport include the following examples (cf. Figure 16):

- longer and heavier trucks (e.g. Krone Gigaliner),
- longer freight trains (e.g. GZ 1000) and
- larger freight vessels (e.g. Maersk Line Triple-E class container vessels)

A new class of container vessel is being developed for overseas transport by the industry. Rail freight transport would benefit from longer trains, and in Europe recent research projects are analysing the maximum length of trains with respect to the

infrastructure. In road transportation, longer and heavier trucks are the object of heated discussions. In Canada, Australia and some countries in Europe, they are allowed to circulate whereas in the US and for circulating across borders in Europe, trucks are limited to 40 t (44 t in intermodal transport). The concept for longer but only slightly heavier trucks has been proved in field trials and scientific studies [Klingender et al. 2009].

#### Electronically coupled commercial vehicle convoys

A future freight transport system will benefit from automated/autonomous transportation. In the scientific community as well as in industry, a variety of solutions for the different transport modes is being discussed. One road freight transport concept is the electronic coupling of commercial vehicles to convoys. Projects in the US (Path), in Germany (KONVOI, cf. Figure 17) [Kunze et al. 2010] and Japan (Energy-ITS) have proven the advantages of such automated highway systems.

The first trials with convoys in real traffic have been performed in Germany. With the aid of Advanced Driver Assistance Systems, it is possible to couple trucks electronically. With the technology, trucks can maintain short distances between vehicles of approx. 10 meters at a speed of 80 kilometres per hour, and operate as “platoons” on the motorway. Electronically coupled truck platoons offer various

FIGURE 16: LARGER CONTAINER VESSELS AND LONGER TRUCKS [GZ 1000, MAERSK AND KRONE]



FIGURE 17: ELECTRONICALLY COUPLED TRUCKS ON A GERMAN MOTORWAY WITHIN THE PROJECT KONVOI



solutions to the road freight transportation problem, such as improved vehicle occupancy, freed-up road space, optimisation of traffic flow, reduction of fuel consumption due to slipstream driving, relief for professional drivers and finally, an increase in safety due to longitudinal and lateral guidance.

#### CargoCap

On a factory/facility level, different automated systems are well established (e.g. automated high-bay warehouses or autonomous delivery of vendor parts to the assembly line). Such systems are also under development for transport between factories, logistics centres and the final consumer. Autonomous transport systems need to be used in isolation due to the complexity of the environment detection and the task planning etc. One solution for such transport systems in isolation is CargoCap [INNOTRANS 2010]. The system was developed to overcome congested urban areas via underground freight transport on a local and long-distance transport up to 150 km (cf. Figure 18).

These so-called ‘Caps’ are run 24 hours a day in an extensive underground pipe transportation network. At their final destination, one or more Caps arrange themselves automatically into the station to be un- or re-loaded. These stations mark the link to the surface transport system. The caps themselves have a storage capacity of two CCG1 euro-pallettes, thus the system is compatible with existing supply chains. Trailing wheels take on the load-bearing function while lateral guide rollers keep the Caps on their tracks. Individual Cap propulsion is provided electrically. The production of the pipe network is based on competitive jacking pipes, of which there is much practical laying experience. The CargoCap system is developed and has been proven on a test and demonstration track. However, it is not a short-term solution, and it is unlikely to be introduced soon. At least, if such system were to be implemented in the future, it would require no new loading units as Euro-pallettes are standardised freight carriers and they have proven their practicality over many years.

FIGURE 18: CARGOCAP STATION AND CARGOCAP ITSELF [CARGOCAP 2011]



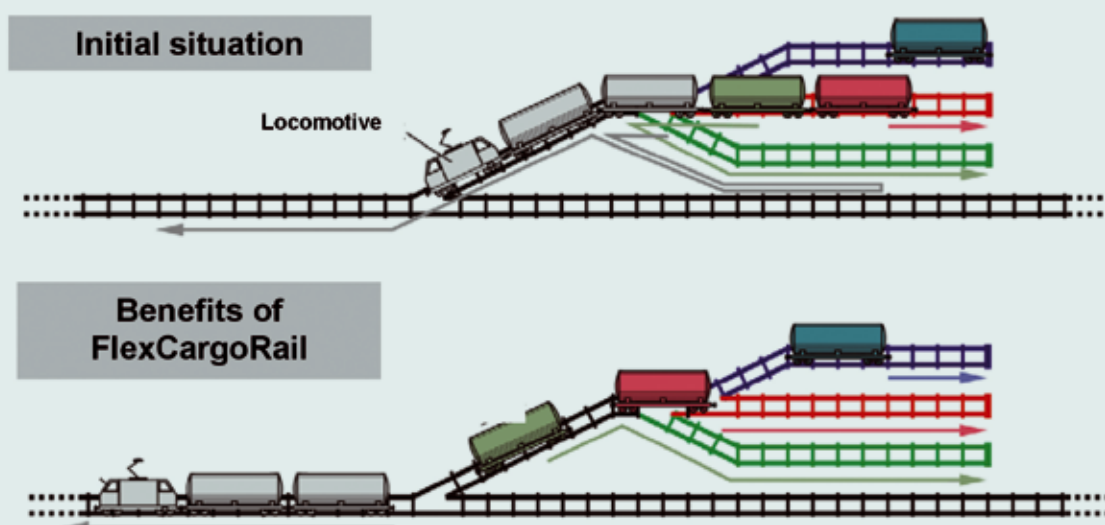
### FlexCargoRail

There are several reasons not to fully load a train. These vary from the required volumes to be transported to legislative constraints when it comes to the loading/unloading of dangerous goods. Single waggon-load services provide an alternative for such use cases. However, the demands of shippers in terms of transport speed and flexibility cannot be met in many cases.

FlexCargoRail [Dickenbrock et al. 2009] aims to increase the efficiency of single waggon-load traffic, especially at the first/last mile and during shunting operations. Therefore, the single waggons are self-electrically propelled and are operated via radio remote control by personnel in the yard. FlexCargoRail is not an autonomously driven and self-organising rail freight waggon system. The idea is to accelerate the shunting processes and to bring in more flexibility. As each FlexCargoRail waggon is equipped with an electric drivetrain and a battery, distributed traction for freight trains - as already

applied to modern passenger trains – could be a future extension of the system. Unlike the initial situation in which all waggons have to be pulled by a locomotive, the main advantage of FlexCargoRail is that every single payload carrier equipped with FlexCargoRail technology can be moved independently from the switcher/locomotive during shunting (Figure 19). The FlexCargoRail project was initiated and granted by the German Ministry for Economics.

FIGURE 19: BENEFITS OF FLEXCARGORAIL [DICKENBROCK ET AL. 2009]



## Conclusion

Several solutions for future international loading units are on their way. The transport initiative of the European Commission is for a single European transport area with harmonised (and adapted) legislation. This legislation on weights and dimensions of road freight transport will benefit transport development. It is, however, impossible to provide and recommend a single one-fits-all international loading unit which covers all requirements, as the transport sector is highly fragmented and consists of innumerable businesses moving goods widely varying in size and weight. The market introduction of the 45 ft palletwide container provides a feasible approach to overcoming these challenges. To benefit from this development, however, the concept has to become an international standard.

This report has investigated the goods transported in the future and their routes. Based on the findings of different studies, it can be stated that there will be a slight shift to more locally produced and more “ethical” goods. Locally produced goods arise from increased societal environmental awareness and from the trend to more concentrated production locations due to the quality of products and delivery security. It is, however, indisputable that freight volume across the world will rise significantly. The routes on which goods will be transported, however, will focus more on the emerging markets.

The BRICS states Brazil, Russia, India, China and South-Africa in particular will become increasingly dominant. Europe’s relative importance will shrink in global transportation in the future. In general, socio-economic trends such as the oil price and supply, environmental awareness of society and changes in consumer behaviour, re-regionalisation, legislative frameworks (such as regulations on the dimensions of transport means) and infrastructure constraints define the requirements for future international loading units.

The report provides first solutions on how to tackle these framework conditions and thereby introduces different concepts for optimised transport both for efficient loading units and for the efficient use of infrastructure/means of transport. The Tellibox is one solution for more efficiency on road, rail and waterborne transport, whereas micro-containers overcome extensive transshipments of goods between loading units for single modes in global supply chains. For the efficient use of infrastructure/means of transport, solutions could arise from automated/autonomous systems for use in global supply chains. Electronically coupled commercial vehicle convoys and CargoCap, a system for underground freight transport, can be more widely introduced. Such systems are more (convoys) or less (CargoCap) on their way to application. Regarding larger means of transport, longer and heavier vehicles

are subject of heated debates across Europe.

The figures on modality split shares when they include the oversea transport. Figure 3 reveals that the load spacing of the container vessels determines the external length of loading units, due to the majority of freight transported (78 %) on that specific transport means. Thus, the transport means distributing the loading units from the overseas harbours to their final destinations are dependent on the constructive framework of the container vessels, particularly if a seamless transport chain is envisaged. These requirements call for a transport industry-wide consensus on the right dimensions of loading units together with the support of policy makers to ensure the efficiency of future transport flow. The initiative of the European Commission to adapt the legislation on weights and dimensions for road freight transport for new circumstances, technologies and necessities is already a step in the right direction. Such a systematic approach, combining the requirements and needs of all transport modes is, in this context, the only way to facilitate intermodal transport and thus to support a sustainable reduction of the overall energy consumption and emissions of global freight transport.

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