The Transrapid Superspeed Maglev Technology – System Characteristics and Market Potential

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Abstract

This article outlines the developments taking place within the international transportation sector which in past decades have been to the detriment of the rail sector. The relatively late introduction of modern rail systems is partly to blame for this situation. The article also shows that appropriate measures can bring about a renaissance in rail traffic as seen in Western Europe and Japan. Particularly in China and USA there is a great demand for ultra modern rail systems such as the Transrapid.

1 Sales Strategy

The international introduction of the Transrapid as a new, particularly high quality transport system is based on a long-term sales strategy of the German Transrapid system industry. The very different boundary conditions in the respective markets and countries must be taken into account in the acquisition. Transrapid International (TRI), concentrates its acquisition efforts on those countries in which the relevant political and economic boundary conditions exist and/or which have already proven to be receptive to new, high-quality transport systems in the past.
At the moment there are three countries in the world in which Transrapid projects are actively being planned, respectively have a Transrapid system in operation. These so-called "A-level countries" are:

- China
- Germany
- USA

B-level countries are all other countries in which Transrapid International is developing different projects together with local authorities and partners or possible investors. The status of those projects range from pre-feasibility studies to announced public tender. "B-level countries" are:

- Australia
- Brazil
- Canada
- Korea
- Malaysia / Singapore
- Middle- and Eastern Europe
- Netherlands
- Russia
- Thailand
- United Arab Emirates
- United Kingdom

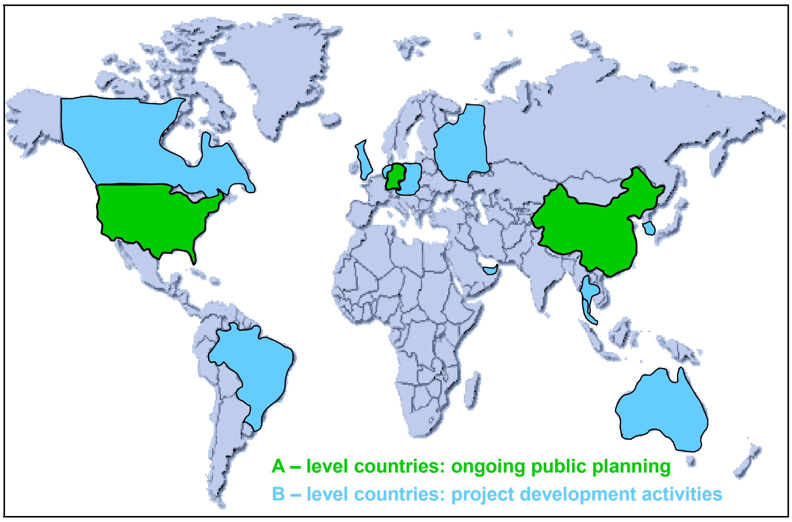


Figure 1: *Worldwide Transrapid Activities*

The sales strategy is specifically oriented to the respective national conditions with respect to

- transport networks and markets and their future development
- political structures and decision-making paths
- public planning law and
- financing conditions.

Due to the very different circumstances and political boundary conditions in various countries, a detailed and flexible adjustment of the individual steps is necessary.

Together with its parent companies, Siemens and ThyssenKrupp, TRI has offices or representatives both in A- and B-level countries, in order to advise customers. This enables the following goals or individual steps to be pursued:

- Introduction of the Transrapid high-speed maglev system as a future transport system for passengers and goods for short-distance, regional and long-haul transport (to governments, operators and the public, e.g. within the scope of public legal transport planning),
- Specific introduction of the Transrapid within the scope of planning for future transport networks,
- Securing the supply share for the German Transrapid systems industry in the respective projects and markets, taking into consideration any localization measures required,
- Participation in planning and design work and studies on the realization of the objectives and
- Providing Transrapid technology, systems, and project planning advice to the client.

2 Situation of Future Transport Markets

A glance at the current transport situation in many countries and the population growth figures shows that an environmentally friendly solution to the overfilled roads and air space is long overdue. It is estimated that by 2025 the world population will have reached the 8 billion mark. We are currently experiencing an annual population growth of approx. 80 million. If we consider the degree of environmental pollution and the numerous traffic jams, it quickly becomes clear that a further population growth of 2 billion must lead to gridlock in many parts of the earth. Ever scarcer resources and increasing environmental pollution are the result of growing individual and air traffic.

2.1 Development of the modal split

During the past 40 years, air traffic has established itself as more practical and convenient for medium and long distance travel than other types of transport. Flying is also becoming increasingly popular

with commuters, not only as the fastest but also as the most reliable and - especially since the emergence of low-cost airlines - as often cheapest means of transport.
However, a look, e.g. at the overloading of European airports, makes it clear that an environmentally friendly alternative to flying must be found. As **Figure 2** shows, during the past 30 years the number of passengers in Europe's 20 largest airports has increased by almost 500%. The most significant increase occurred during the 1990's.
With the further expansion of airports becoming increasingly difficult, it is necessary to use existing airport capacities more efficiently. Short haul travellers should be encouraged to change to other means of transport. The resulting vacant slots at the airports would then be available for the growing demand for long-haul connections.

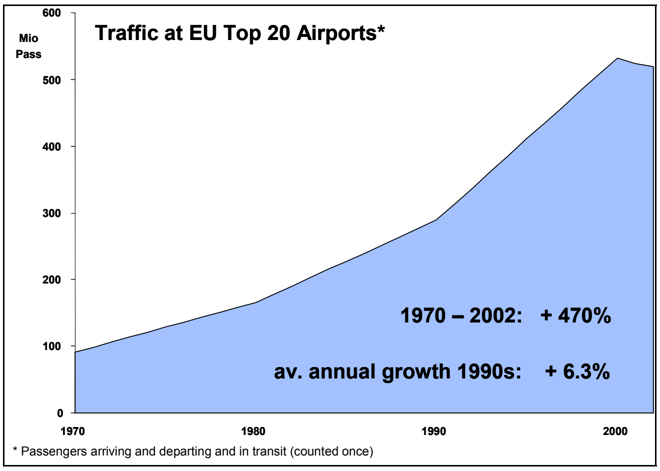


Figure 2: *Traffic at EU Top 20 Airports*

This increase is not only apparent in air traffic. **Figure 3** shows that during the past 30 years, passenger traffic has more than doubled, and the largest increase is due to individual automobile traffic.
During the past three decades, the number of passenger kilometres travelled by automobile has risen on average by 3% per year. During the same year, the number of passenger kilometres flown rose more than sevenfold.
In contrast to this, the figures for conventional rail traffic have hardly grown during the past 30 years. The passenger transport sector rose slightly by approx. 40%.
This shows the gradual reduction in the railway's market share, compared to road and air traffic. Within the EU states, the railway's market share of passenger transport fell from 10% in 1970 to 6% in 2001. The share of air traffic in this sector constantly grew from 1.5% (1979) to almost 6% (2001). This means that during this period the ratio of rail traffic to air traffic fell from 6.7 to 1.07.

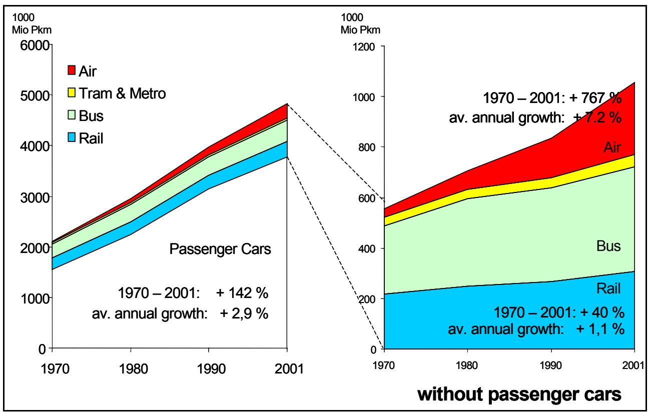


Figure 3: *Modal split in EU passenger transport*

In view of the annually increasing passenger figures and airports which are verging on the limits of their capacity, it must be clearly recognized that only the most modern, fastest and attractive track bound systems will be capable of competing against the airplane or automobile. In Europe, this has already been recognized, where the use of high-speed trains has caused a real renaissance in the rail transport sector. As **Figure 4** shows, in only ten years its share of passenger kilometres in Europe has risen from 5.6% to 20%. This growth was mainly achieved by consistent development of the high-speed rail network.
The aforementioned countries are important target markets, in which rail transport needs to be completely restructured and developed from scratch. Especially in the USA, there are no significant handicaps to be taken into account due to an underdeveloped wheel/rail infrastructure network, which is why high-speed maglev system applications have excellent prospects.

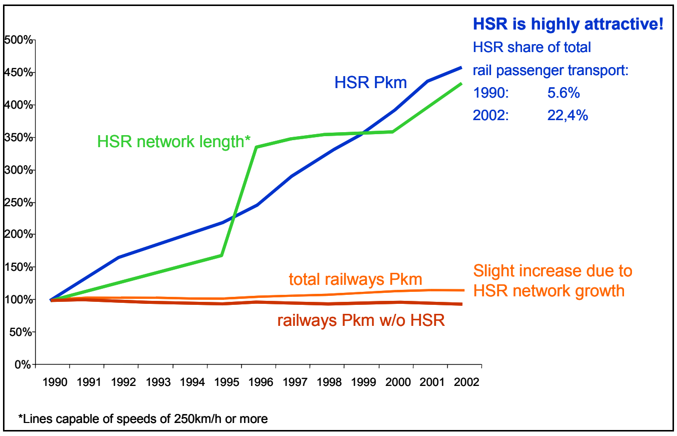


Figure 4: *Development of high-speed railway transport in the EU*

2.2 Future role of rail transport systems

In Europe, recent decades have shown that modern railway systems such as the TGV or ICE can revitalize rail transport.
This development was proven by the successful introduction of high-speed trains in Europe during the 1980s and 1990s (TGV in France, TAV-ETR in Italy, ICE in Germany and AVE in Spain), without which the railways would have lost further market shares. By comparison, in this context reference is made to the rapid, innovative development in aircraft construction, e.g. large capacity jets, which were also prerequisite for the major air traffic successes.
Transport experts and an increasing part of the broad public therefore agree: the mobility crisis can only be averted by developing and using attractive high-speed rail systems. However, it is doubtful whether conventional railway systems can be categorized worldwide as sufficiently attractive for long-haul transport. In order to win back a considerable share of the market and to divert large parts of individual traffic and air traffic on to the railway, new rail systems must be very fast, convenient and comfortable. The conventional wheel/rail system is limited here, as daily operational experience shows. In other parts of the world such as the USA, China, Asia in general, South America and Australia, the distances are much larger than in Western Europe. Therefore, it is necessary to increase the speed in order to compete against the airplane. For this reason, China has decided to incorporate modern wheel/rail systems and the high-speed maglev system in the overall transport concept.
In the USA, in practical terms the classic railway is no longer important. Public opinion considers it to have been left behind. De facto in the future, the wheel/rail system will not be able to play a significant role in the competition with the airplane, the only relevant long-haul transport provider in the USA, because of the large distances between the conurbations.
The Transrapid high-speed maglev system is therefore an important contribution for the worldwide requirements of future transport markets. This technology offers a particularly fast, attractive, comfortable and environmentally friendly alternative to the known means of transport.

The Transrapid philosophy is to replace mechanical structures and subassemblies subject to wear with contact-free, low-wear, electronic or electromagnetically based components. After many years' testing, the Transrapid is now ready for worldwide application and has already completed its market launch with the Shanghai airport link.

3 Areas of Application of the High-Speed Transrapid Maglev System

The technological properties of the system predestine the Transrapid for use in the following areas

- long-haul,
- short-haul and
- a combination of both.

The essential system characteristics of the high-speed maglev system for these areas of use are:

- its contact-free, friction independent and wear-free support, guidance and propulsion technology,
- its high degree of safety and high level of ride comfort, both in fast short-distance transport up to 400 km/h (250 mph) and in high-speed long-haul transport up to 500 km/h (310 mph),
- the high acceleration and braking capacity,
- the flexible alignment of the guideway due to small curve radii and high climbing capability (10%),
- the standard, space-saving solutions for both at-grade and elevated guideway (track) as well as
- the low specific energy consumption and low overall operating costs.

3.1 Use of Transrapid in short-distance transport

The Transrapid is sensibly used for high-speed short distance operation for distances between 30 and 150 km (18 - 95 miles). The distances between the stations are approx. 15 to 20 km (9 to 13 miles). The travel speed fluctuates between 300 to 450 km/h (185 - 280 mph), depending on the respective route.

Regional transport systems and airport links like in Shanghai are typical examples of Transrapid applications in this market segment.

Worldwide, new major airports are planned at increasing distances from city centres due to the enormous land requirement and the need to limit noise effects. In order to reach the city centre, passengers have to accept long travel times of 1 to 2 hours. The application of Transrapid as an airport link considerably reduces the travel time between the airport and city centre. A good example of this application is the Munich airport link, currently being planned.

Large cities and conurbations in the whole world now have diameters of 100 km (60 miles) and more (e.g. USA, China). To travel from A to B by urban rail involves unavoidably long travel times. Even longer times have to be considered for road traffic. The Transrapid offers a considerable improvement. Compared to conventional urban and suburban rail systems, the total travel time is reduced by half or two-thirds, depending on the route. Greater Los Angeles and its high-speed maglev system project is an outstanding example of this application.

Densely built-up and populated areas also represent the greatest obstacle to the introduction of a new means of transport for regional application. The Transrapid offers advantages here thanks to its exhaust free and low noise operation. The favourable system parameters of the Transrapid guideway also allow flexibility when choosing the route and allow cost effective construction. Depending on the local conditions, the guideway can be installed at-grade or elevated and collocate with existing traffic corridors (road, rail).

3.2 Transrapid as a long-haul transport system

The classic Transrapid area of application is high-speed long-haul transport. The distances in the individual projects range from approx. 150 to approx. 1 000 km (95 - 600 miles).

If the traffic volume is sufficient, the distance between the stations is approx. 50 to 100 km (30 to 60 miles). The operating speed ranges from approx. 300 to 500 km/h (185 to 310 mph).
The extremely favourable travel times are worth highlighting for long-haul with Transrapid. Thanks to the short travel times, all passenger transport traffic forecasts show that the Transrapid offers a serious alternative to the automobile or airplane.
Nevertheless, as with each technological advance, Transrapid must fulfil certain economic criteria in order to be successful on the market. Even though engineers are enthusiastic about the potential of this new transport system, the market is still dominated by automobiles and other means of transport, all of which compete with each other to secure their market share. In that this competition is often a public process, overall investment cost plays a significant role in the decision-making process, as to which projects can be realized. Experience gained from the first commercially operated Transrapid application route in Shanghai clearly shows that considerable cost savings are not only necessary for future application projects but are also achievable. With lower investment costs, Transrapid will become even more attractive to both transport planners and decision makes as well as the travelling public.

4 International Transrapid Projects

The projects contained in the following overview are actively being pursued by TRI. The status of the individual projects varies greatly and ranges from initial project development, feasibility studies, detailed planning and design, financed planning/engineering/construction through to initial commercial operation.

4.1 People's Republic of China

The People's Republic of China is planning a high-speed network with a total length of approx. 8 000 km (5 000 miles), which is to be realized in the next few decades (**Figure 5**). Apart from the Shanghai project, which is in commercial operation since the end of 2003, there are promising routes extending from Peking, Shanghai and Guangzhou.

***Figure 5**:* *High-speed network in China*

Shanghai-Pudong International Airport and Future Projects
The contract for the worldwide first application of the Transrapid technology was signed on 23 January 2001. The new international airport in Pudong is located 30 km (19 miles) outside Shanghai's

centre and does not yet have a short-distance public transport service. **Figure 6** shows an overview of the route and the most important project data.

Construction started immediately after the contract was signed and on 31 December 2002, the so-called VIP run took place in the presence of the Chinese Premier, Zhu Rongji, and the German Chancellor, Gerhard Schröder. Commercial operation began in January 2004 and final acceptance for the project was achieved in April of this year.

Longyang Road to Int. Airport

Route length	30 km / 19 miles	Vehicles	3 (5 sections each)
Stations	2	Commercial Operation	2004
Trip time	8 minutes		

Figure 6: *Shanghai Project*

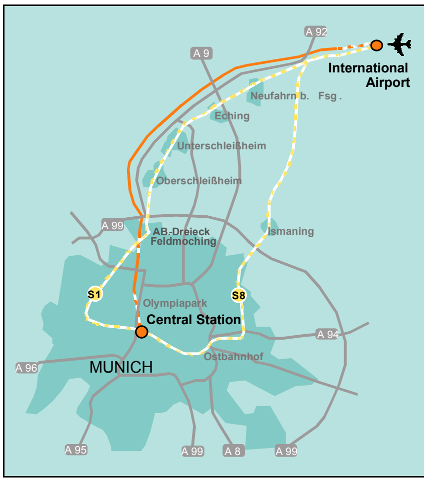
The route to the south to Hangzhou with a distance of around 163 km (101 miles) is a most probable extension of the world's first maglev application project. (Figure 7).

Shanghai – Hangzhou

length	163 km / 101 miles
trip time	39 minutes

Figure 7: *Extension to Hangzhou*

4.2 Germany



Central Station - Airport

Route length	37 km / 23 miles
Stations	2
Trip time	10 minutes
Vehicles	5 (3 sections)
Construction	2006 – 2009
Begin operation	2010

Figure 8*:* *Munich Project*

Munich airport is the second-largest in Germany with annual passenger figures of more than 20 million and a future capacity of up to 50 million. Although the airport actually has a good connection with Munich with two urban rail lines and a motorway, the capacity limit has been reached and the travel times leave much to be desired. The State of Bavaria, the city of Munich and the airport would like a high-speed link to the airport, in order to help to relieve the overloading of the current connections, especially as the airport continues to grow. Thanks to the large growth rates of Munich airport, it is improbable that the Transrapid link with its short travel times will compete against the urban rail service as this has many stops and primarily provides a regional connection. The project is now entering the official legal planning process for the Right of Way (ROW) in 2005. Construction is expected to begin in mid/late 2006 and commercial operation in early 2010.

4.3 United States of America

Maglev Deployment Program

The Maglev Deployment Program (MDP) was included in the Transportation Equity Act for the 21st century (TEA-21) of 1998. This made public funds available for the first time for both the planning activities of several maglev projects as well as for the final design, engineering and construction activities of a single selected project.

55 million US dollars were available for the fiscal years 1999 to 2001 for initial planning and additional funds (up to 950 million US dollars) for the construction of a single maglev project as part of a public-private partnership. Although two projects were selected in 2001 for the legal planning process (Environmental Impact Statement (EIS)), neither of these has progressed yet to the start of construction. The US Congress is currently renewing the overall law, including the MDP, as part of the new Transportation Equity Act (TEA 3). It is expected that additional planning/engineering as well as construction funds will be included in the final version.

All project activities in the United States are handled via Transrapid International USA, Inc. (TRI-USA), a subsidiary of TRI based in Washington DC.

In July 2003, a Teaming Agreement was concluded with the American firm Lockheed Martin to strengthen the position of the Transrapid industry in the USA and above all to prepare the Americanization of the technology for the realization phase. Cooperation with national firms is indispensable for all projects abroad as public funds are always involved and thus the client requires a certain mandatory local content, be it for studies or the realization. On the other hand, it is also necessary to work with partners who know the local specifications, practices and customers and e.g. have the necessary contacts within the Government and the scope of public law approvals for transport systems.

The following 3 projects are being developed in the Maglev Deployment Program and are currently in legal planning process (EIS).

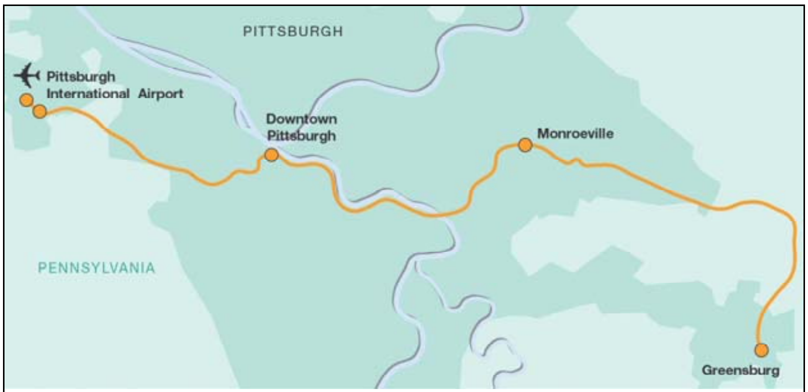
Baltimore-Washington Maglev Project
This line connects Baltimore's city centre with Baltimore-Washington International Airport (BWI) and the city centre of Washington, D.C. The route is primarily intended for commuters; furthermore it would Washington D.C. with fast access to a third airport, BWI. In the longer term, corridor extensions are planned in the north to Boston, MA. and in the south to Charlotte NC. **Figure 9** shows a project overview.

Baltimore-Washington Project

Route length		63 km / 39 miles
Trip time		18.5 minutes
Headway		10 minutes
Operating speed (max.)		430 km/h
Stations		3
Commercial operation		2011
Extensions:	Baltimore -	Boston, MA
	Wash. DC -	Charlotte, NC

***Figure 9**: Baltimore – Washington Project*

Pennsylvania High-Speed Maglev Project
This project will connect Pittsburgh International Airport with the Pittsburgh city centre and the eastern suburbs of Monroeville and Greensburg. This route is intended primarily for commuters and would relieve severe overloading on the bridges and tunnels leading to Pittsburgh (**Figure 10**). It also has as a unique feature, the "Magport" terminal at Pittsburgh airport with connections to aircraft, Transrapid trains, buses, taxis, and automobiles and furthermore with its shopping centre and passenger/commuter services, it would be truly "intermodal". This route is the planned as the initial section of the Cleveland-Pittsburgh-Harrisburg-Philadelphia network.



Pennsylvania Project

Route length	87 km / 54 miles
Trip time	35 minutes
Headway	7.5 minutes
Operating speed (max.)	430 km/h
Stations	5
Commercial operation	2011
Extensions:	Mid-western cities

Figure 10: *Pennsylvania Project*

California-Nevada Interstate Maglev Project

This project ultimately plans to connect Las Vegas (LV) both with the southern Californian basin (Ontario County) and with the Californian north/south high-speed rail route (Los Angeles - San Francisco). The project will be developed in phases: LV airport – Primm (state border), Anaheim – Ontario, California, and finally in parallel, Ontario - Barstow / Barstow - Primm / LV airport - LV city centre. **Figure 11** shows a project overview.

The route from Las Vegas to Primm offers good prerequisites for a pilot project due to the high visibility of Las Vegas as a tourist magnet, the high speed capability and ease of construction due to the low population density outside of LV, and the relative ease of financing due to the low overall project investment cost.

Las Vegas - Primm (initial segment)

Route length	56 km / 35 miles
Trip time	11 minutes
Headway	20 minutes
Operating speed (max.)	500 km/h
Stations	2
Commercial operation	2009
Extensions:	Los Angeles

Figure 11: *California-Nevada Project*

4.4 The Netherlands

The route, which starts from Schiphol airport and passes via Amsterdam and further stations to Groningen is planned to develop the north of Holland and to provide a link with the economically stronger south. Above all, it is significant for regional development and air passengers from North Germany would also have more convenient access to Schiphol airport. A possible extension to Bremen and Hamburg is also being considered for the Transrapid option. **Figure 12** shows an overview of the route. At the end of April this year, the Dutch government started the official public tendering process with an international competition. Although the tender will include both maglev and high-speed rail, the preference of the involved regions and cities is maglev.

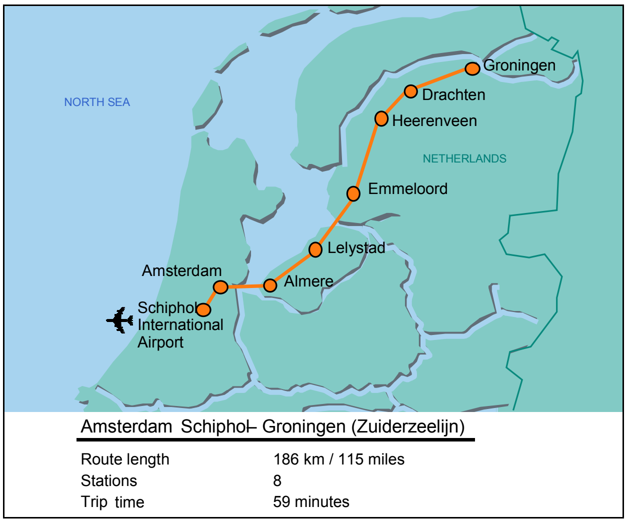


Figure 12: *Zuiderzeelijn*

5 Summary and Outlook

Due to the rapid development in international transportation, the large opportunities for the highly developed transport systems of Western Europe in the international transport markets and the strong market position of the European rail industry, the active market efforts should be further increased in the future. The coordination with regard to time and selection of the marketing strategies must be carefully matched with the special distinctive features of the individual markets. Normally, local experts will be involved, who are familiar with the political and economic situation as well as the way of doing business in the respective area. The international marketing of Transrapid is based on the following focal points:

- International market observation and analyses for the purposes of better adjustment of the Transrapid technology to the requirements of the individual markets and, in order to consider market trends in the development at an early stage.
- Initiation of the product adaptation process in order to incorporate specific national requirements and specifications of the project country.
- Positioning the Transrapid technology in the markets as a high quality, attractive, reliable, high-speed system (with governments, operators and the public), as well as
- Developing and securing market shares (local content), evaluating possible application projects at an international level, completing feasibility studies taking into consideration whether projects are fundable and their financing conditions.

References:

1. European Union: Directorate-General Energy & Transport: Figures and Main Facts, Statistical pocket book 2003.