Transrapid Super Speed Maglev Technology

System Characteristics and Market Potential

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Content

Abstract

It is widely recognized in industrialized nations that only modern, fast, attractive, track– bound transportation is capable of alleviating the pressure on existing transportation networks. Ever increasing globalization and urbanization tendencies demand transportation solutions which are capable both of relieving traffic density between metropolitan areas and of reducing existing and potential environmental damage. The Magnetic Levitation rail technology developed by Transrapid International offers a solution to the manifold challenges presented by urban development and population sprawl.

- This report describes several aspects of the Marketing of the Transrapid Maglev system
- The Transrapid Maglev system and its technical and economic characteristics
- Implementation parameters and fields of application for the Transrapid
- Strategies for specific international markets under development to introduce the Transrapid Maglev
- Status reports on the projects in the US, China, Australia and in Europe

Mobility is the pulse of civilization. The foundation of this mobility is a satisfactory transportation system. In fact, an acceptable infrastructure is a prerequisite of economic growth. This is pertinent both for established industrialized nations and for those nations experiencing rapid economic and population growth such as in the Asian Pacific nations. The predicted population growth rate in Asia, for example, of 30% over 25 years will strain the existing infrastructure to breaking point. It is well documented that the present economic growth rate of up to 10% and more in these regions cannot be supported when the required levels of mobility demanded by such an economy is inhibited by oversubscribed road and rail networks. The steady increase in road and rail traffic is choking current global networks. Roads, bridges, highways - even the air is overloaded.

Developed to fill the transportation niche between conventional steel-on-rail trains and airplanes, Maglev System Transrapid can easily be operated at speeds of more than

300 km/h without increasing maintenance efforts. Levitating with a top speed of about 550 km/h Transrapid can successfully compete with air traffic at medium distances of 200 to 1.000 kilometers.

As an airport-to-city shuttle, an intercity link or for other regional transportation needs the maglev system can help to connect the outskirts of a metropolitan area to the city center by a dynamic and convenient commuter service.

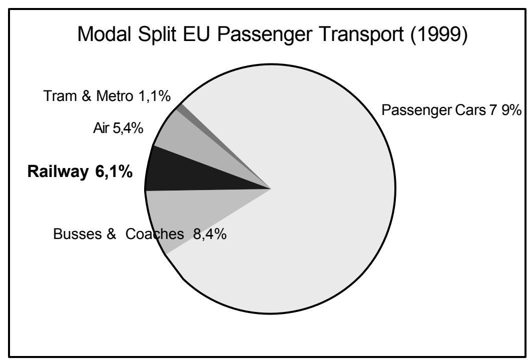
1. Situation of Transportation Markets in the Future

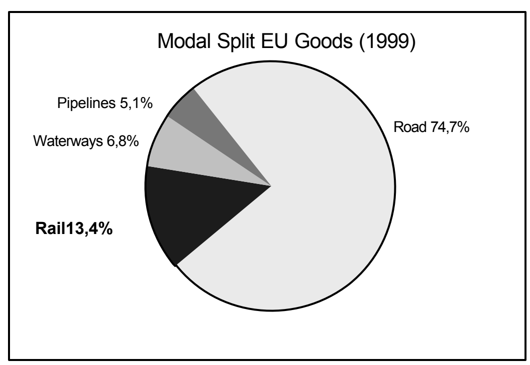
One only needs to look at the population figures to understand that an environmentally friendly solution to road and air traffic congestion must be found. It is estimated that by 2025 the population of the earth will have reached an unprecedented 8 billion. Looking at the level of pollution and congestion it is obvious that an increase in population by 2 billion people would lead to a disaster in many parts of the world as energy resources are increasingly drained and pollution levels soar.

1.1 Development of Modal Split

Over the past 40 years, air travel has replaced ground-based travel as the most convenient and comfortable means of covering both mid and long distances. Air travel has gained huge popularity among commuters as the fastest and most reliable means of travel. However with the numbers of travelers growing annually and with airports reaching breaking point, it has to be widely recognized that only modern, fast and attractive track bound transportation is capable of taking up the strain of competing with the airplane. This has already been acknowledged in Europe, where a veritable renaissance in the rail sector has come about for the following reasons: The increase in the gross domestic product (GDP) of the 15 member states of the European Union to 180% in 1996 (100% in 1970) was accompanied by a doubling of the volume of passenger and freight transportation over the same period. At the same time the number of passenger air-kilometres flown within Europe has increased sevenfold over a period of almost 30 years and road traffic (passenger cars) has increased by the factor 2.4. Freight traffic (lorries) has increased by as much as three times. In contrast to this, rail transportation figures have hardly shown any change at all over the past 30 years. The passenger transportation sector has shown a slight increase of around 30%. The European railways' freight sector even indicates a decrease of 16% in the number of ton-kilometers from 1970 to 1997.

A gradual diminishing of the railways' market share compared with road and air is apparent. Within the European Union the railways' market share of passenger transportation (modal split) has decreased from 10.1% in 1970 to 6.1% in 1999. Meanwhile the market share of air traffic in this sector has constantly increased from 1.5% (1970) to 5.4% (1999). This means the ratio of railways to air traffic has decreased from 6.7 to 1.3 during this period.





In the transportation of freight by rail sector this decline is even more pronounced. The modal split has fallen from 32.7% in 1970 to a mere 13.4% in 1999. The European Union has attempted to halt this downward trend. Both the member states and the European Union Commission continue to pursue their goal of reviving the railways, emphasising the important role they play in the maintaining of mobility in Europe. There are many reasons for this policy; they range from the continuously increasing volume of traffic, the environmental impact caused by road traffic, the difficulties encountered including bottlenecks in transit traffic across the Alps, the new chances and challenges arising from integration of Central and Eastern European countries into the European Union up to the efforts aimed at reducing CO_2-emission.

1.2 Future role of track guided transportation systems

As yet, not enough attention has been paid on the world transportation market to the fact that engineering in the form of completely new railway technologies can make a contribution to a real revival of the rail industry. This has been demonstrated by the development and successful introduction of high-speed passenger trains in Europe in the 1980s (TGV in France, TAV-ETR in Italy, ICE in Germany and AVE in Spain), without which the railways would have lost yet further market shares. The importance of technological innovations is also demonstrated by the rapid rise of air traffic over the past decades, which has been advanced by leaps in technological development.

Transportation experts and an increasing proportion of the general public therefore concur: the imminent crisis in personal mobility can only be averted with the development and implementation of attractive high-speed mass transportation. It is doubtful that conventional, existing railway systems can be categorized as attractive enough for long distance travel in the public eye. In order to gain a substantial share of the market, to divert car traffic and air traffic to rail, the systems offered must be very fast and convenient.

In other areas of the world, the USA, Australia, China and Asia in general, distances tend to be much larger than in Western Europe, with the effect that speeds must further increase in order to go head to head with airlines. That is why China has made the decision to focus on track guided transportation systems including Maglev as the backbone of its future transportation system. Transrapid Super Speed Maglev Technology is the answer to this challenge. Transrapid Technology offers a fast, attractive, comfortable, innovative solution to the transportation problems of the new era.

- Transrapid follows the general trend of replacing mechanical components which are subject to wear by electrical engineering and electronics. It makes use of non-contract technology and is therefore less subject to wear. This technology is ready to go into operation and has undergone large-scale testing at the Emsland facility.

2. Areas of application of the Transrapid Maglev System

The technological features of the system predestine the Transrapid for three specific fields of application:

- short-haul high-speed connections (e.g. airport links to cities)
- high-speed short-haul passenger transportation
- high-speed long-distance passenger and freight transportation.

2.1 Transrapid for high-speed short-haul transportation

Ideally Transrapid will be employed in high-speed short-haul operation covering a distance range of 25 km up to 150 km. The distance between the intermediate stations will be approximately between 10 km and 20 km. Depending on the particular route, the traveling speed will range from 200 km/h to 400 km/h.

Typical examples of Transrapid applications in this market segment include regional mass transit and airport shuttle, like the one under construction in Shanghai.

Large cities and conurbations throughout the world extend to diameters of 100 km and more. In order to get from A to B, extremely long traveling times are unavoidable even using urban railways (metropolitan railway, underground). Travel by road takes infinitely longer. Since Transrapid has short running times it offers distinct improvements here. As compared with conventional urban railways Transrapid will be able to reduce the traveling time by two to three times depending on the route. The greater Metropolitan area of L.A. or the Metrorapid in Germany's Ruhr Area are examples of this kind of application.

Throughout the world new major airports are being planned at increasingly greater distances from city centers due to the immense amount of land required and so as to cut down on high noise pollution. As a result of this, air passengers are forced to accept long traveling times ranging from one to two hours to reach city centers. Implementation of Transrapid as an airport shuttle could considerably reduce the amount of time spent traveling between airports and city centers by anything up to five times. A good example of this kind of application is the Munich Airport Connector, which is being planned.

Densely built-up and populated areas are the greatest obstacle to be overcome when considering the introduction of a new means of transportation for regional application. Here Transrapid offers advantages owing to its zero-emission and practically noiseless operation as compared to other modes of transportation. The favourable system parameters of the Transrapid guideway are of great benefit allowing flexibility in choice of route and low cost construction. Depending on local conditions the guideway can be built either at grade, on existing railway routes parallel to railway lines or elevated.

2.2 Transrapid for high-speed long-distance transportation

The classic field of application for the Transrapid is high-speed long-distance transportation. The distances involved in the individual projects range from 200 km to 1,000 km approx.

If a sufficient volume of traffic is provided, the distance between stations will range from 50 km to 100 km approx. The operational speed will range from approx. 300 km/h to 500 km/h and more.

In long-distance transportation the unequaled favorable running times of Transrapid are particularly evident. The Transrapid projects presented below clearly illustrate the advantages of Transrapid versus conventional means of transportation.

Due to these short traveling times all traffic forecasts concerning passenger transportation have shown that Transrapid is a serious alternative to cars and aircraft within the limits of short and medium-range transportation.

However, like all original technological advances, Transrapid technology must meet certain economic criteria in order to succeed. Engineers may be enthusiastic about the potential of this new product, but the marketplace is still dominated by cars and other means of transportation, all of which are established products competing with each other for a share of the market. With the experience of the first revenue application in Shanghai and others to come, substantial progress in cost cutting is needed and can be achieved.

3. System Characteristics

It is important to note that the Transrapid maglev is the first completely new mode of transportation to be developed since the invention of the aiplane. Since it has been designed, tested and improved in the current age, it is a mode that not only recognizes and embraces contemporary transportation values – safety, speed, environmental-friendliness and energy efficiency – but it is inherently more reliable and comfortable than any other transportation system.

The Transrapid maglev has been developed over a period of nearly 30 years and has been continually tested and improved upon through eight vehicle prototypes and several major infrastructure and operation control system improvements. This decades-long effort culminated with the Transrapid TR08 vehicle which is commercially available today and can be ridden at the full-scale Transrapid test facility in Lathen, Germany.

The Transrapid system eliminates contact between vehicle and infrastructure, which means no wear-and-tear on system components. Traditional steel wheel-on-rail systems experience steep increases in system maintenance costs for every mile per hour of increased speed. Unlike high-speed rail, Transrapid realizes considerable cost advantages due to its contact-free design, even with possible top speed of 500 km per hour.

Transrapid's contact-free system also eliminates typical wheel noise. The most audible signature from a maglev is the sound created from wind resistance. This is an important public-friendly aspect to note as we consider high-speed ground transportation for urbanized areas. Transrapid eliminates the noise considerations that other transportation projects face as a result of "NIMBY" objections. And, since a maglev system is relatively impervious to weather conditions and requires little maintenance, people could plan on reliable travel times based on published schedules.

The propulsion system for the Transrapid is attached to the guideway infrastructure rather than carried aboard the vehicle. As such, the guideway carries the power for the system, allowing for more accurate tailoring of the system's power requirements to the demands of the terrain. Only the section of guideway on which the train is traveling needs to be powered, allowing for lower energy consumption than other systems which require constant uninterrupted power for the entire route.

Not inconsequentially, the safety benefits of traveling on a Transrapid are second to none, because the maglev vehicle wraps around its guideway, virtually eliminating the possibility of derailments.

How much does a Transrapid system for a corridor cost? While apples-to-apples comparisons are hard to come by, it is important to note that approximately two-thirds of the cost of any project is in the infrastructure, i.e. the foundations, support pillars and guideway beams. The cost of those components is a function of the geotechnical issues one encounters along the alignment and the engineering design approaches utilized; for example, whether the guideway is elevated or at grade.

While investment costs for a Transrapid system generally approximate the costs for very high-speed rail systems, the life cycle costs for a Transrapid Maglev system, because of its inherently low maintenance characteristics, are much lower and more favorable to sustaining a self-supporting transportation system.

Transrapid System Advantages - Summary

- High cruising speeds of 300-500 km/h to cover long distances quickly
- Cruising speeds of up to 250 km/h in congested urban areas combined with very low noise levels
- Unbeatable overall trip times for distances up to 1000 km
- Unbeatable overall trip times for short haul shuttle operation between outlying airports and city centers or as a superimposed train system to give relief in large, densely populated urban agglomerations as an inter-regional mass transit system.
- Light and flexible guideway designs / parameters
- Low maintenance due to completely contact free operation and low energy consumption.

These characteristics clearly demonstrate that the Transrapid Maglev concept and the design of all its major subsystems and components was completed with economic parameters in mind and with continuous critical review of all technical solutions.

4. Projects for the Transrapid Superspeed Maglev

The projects included in this overview are being actively pursued by TRI. Depending on the individual project, the current status varies between initial contact, project development, detailed planning, paid feasibility studies, planning/engineering, construction, and maintenance management

4.1 People's Republic of China

The People's Republic of China is planning a high-speed ground transportation network of approx. 8000 km. As well as the Shanghai Project, various routes are under consideration in and connecting with Beijing, Shanghai, and Hong Kong.

Shanghai –Pudong International Airport

The contract for the first application of Transrapid technology worldwide was signed on January 23, 2001. The new Pudong International Airport is located 30 km outside the center of Shanghai and is not yet connected by any public transportation means. Construction began immediately after signing and the first demonstration runs are scheduled for January 2003. Commercial operation is scheduled to begin in 2004.

Potential extensions are foreseen from the Pudong Airport station to the city of Hangzhou, a distance of 240 km. From the Longyang Road station, the potential extension is to the city of Nanjing, a distance of 300 km. This latter extension would be the first segment of the high-speed line Beijing – Shanghai.

Route length	30 km/19 miles
Trip time	8 minutes
Headway	10 minutes
Stations	2
Vehicles	3 (5 sections each)
Ridership volume	10 – 36 million/year (year 2005-2020)
Commercial operation	2004

4.2 Germany

After the cancellation of the Berlin – Hamburg Project in February 2000, the Federal Government selected two projects in October 2000 for detailed planning within a feasibility study. The feasibility studies were completed in early 2002 and will form the basis for the realization of one or both projects

Metrorapid

In North-Rhine Westphalia (NRW), the route alignment of the first phase (initial route) connects the cities of Dortmund, Bochum, Essen, Duisburg, the Düsseldorf Airport, and the city of Düsseldorf. Later, the initial route could be extended from Düsseldorf via the cities of Wuppertal, Hagen, the Dortmund Airport, and back to Dortmund. The initial route with extension would encircle the Ruhr area with its population of approx. 12 million people. Another extension is considered from Düsseldorf via the Cologne Airport to the city of Cologne.

Route length	78 km/49 miles
Trip time (approx.)	34 minutes
Stations	7
Operating speed (max.)	300 km/h /185 mph

Munich – Munich International Airport

The Munich International Airport is the second largest airport in Germany with today over 20 million passengers per year. Although the airport is well connected to Munich by two suburban train lines and also a highway, these are at capacity and the trip time to the airport is not satisfying. The State of Bavaria, the city of Munich, and the airport desire a high speed connection to the airport to ease congestion on the existing modes. The short trip time of the Transrapid connection is not foreseen to hamper the economics of the suburban train lines, due to the strong growth rates of the Munich Airport.

Route length	37 km / 23 miles
Trip time (approx.)	10 minutes
Stations	2

4.3 The Netherlands

Rondje Randstadt

A high speed ring connection between the cities of Amsterdam, Utrecht, Rotterdam, Den Haag, and Schiphol Airport is being investigated. The goal of this initiative is to reduce automobile traffic with intermodal stations in each city/airport. The distribution of the passengers at the stations would be handled by the existing taxi, suburban rail, and subway services.

Route length	164 km / 103 miles

Amsterdam – Groningen

This route is foreseen to the northern portions of the Netherlands with the Amsterdam ring connection. Furthermore, this would allow airline passengers from northern Germany easy access to Schiphol Airport. With the Transrapid technology option, an extension of the route on to Bremen and Hamburg is also under consideration.

Route length	184 km / 115 miles

4.4 United States of America

Maglev Deployment Program

Included in the Transportation Equity Act for the 21st Century (TEA-21) of 1998 is the Maglev Deployment Program (MDP) which provides public funds for “Pre-construction Planning Activities” for several projects as well as for “Final Design, Engineering, and Construction Activities” for a single project chosen from those planned.

A total of US$ 55 million was available for Fiscal Years 1999 - 2001. Additional funding (up to US$ 950 million) for construction of a single maglev project will then be applied for as part of a public/private partnership financing concept.

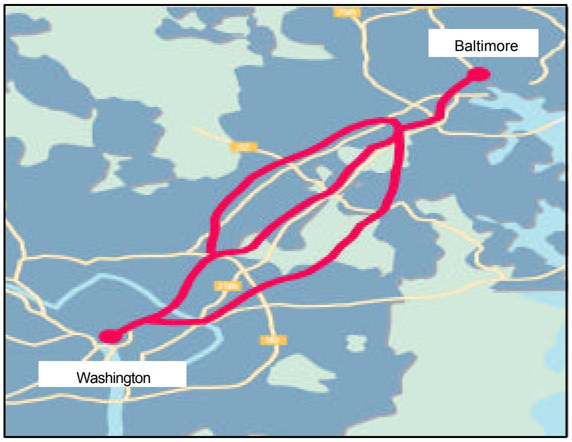
A total of 11 organizations submitted maglev planning applications to the Federal Railroad Administration (FRA) in February 1999 for funding under the Program. Seven of these projects were selected for funding in May 1999. Six of the seven projects have selected the Transrapid as the technology of choice.
The initial phase of planning activities extended from August 1999 – June 2000 and included system definition, environmental assessment, and financial viability. Two projects, Baltimore-Washington and Pennsylvania, were chosen in January 2001 for the next phase with increased funding for more detailed planning work (short list). This phase includes more detailed planning and engineering work and preparation of the Draft Environmental Impact Statement for each respective project.

All project activities in the US are conducted through TRI’s US subsidiary, Transrapid International-USA, Inc. (TRI-USA), located in Washington DC. In addition to project management and liaison work, TRI-USA actively lobbies and works with the public and private sectors at the national, regional, and local levels.

Short-listed Projects

Baltimore – Washington Maglev Project

This route travels from downtown Baltimore to the Baltimore-Washington International Airport and on to downtown Washington DC. It would carry commuters and allow BWI Airport to serve as a third airport for Washington DC. Long term, corridor extensions are foreseen to the north to Boston, MA and to the south to Charlotte, NC.



	Project	Corridor
Route length (approx.)	60 km / 37.5 miles	1280 km/ 800 miles
Trip time (approx.)	20 minutes	
Operating frequency (peak)	12 minutes	
Stations	3	
Vehicles	5 x 3 sections	
Annual ridership	12.9 million	
Investment cost (approx.)	$ 3.3 billion	

Pennsylvania High Speed Maglev Project (Pittsburgh Airport - Pittsburgh – Greensburg)

This route would serve Pittsburgh commuters and help alleviate congestion on the bridges leading into Pittsburgh. The „Magport" terminal at the Pittsburgh Airport would be truly intermodal with airplanes, maglev trains, buses, taxis, and cars as well as a shopping mall and passenger/commuter services. The route is the proposed initial segment of the Cleveland – Pittsburgh – Harrisburg – Philadelphia network.

	Project
Route length (approx.)	76 km / 47 miles
Trip time (approx.)	28 minutes
Operating frequency (peak)	7.5 minutes
Stations	4
Vehicles	8 x 5 sections
Annual ridership	33.5 million
Investment cost (approx.)	$ 2.7 billion

Remaining MDP Projects

Atlanta-Chattanooga Maglev Deployment Project (Atlanta – Cartersville – Dalton – Chattanooga)

This route shall connect Hartsfield Airport with Atlanta, Chartersville, Dalton, and the recently improved airport in Chattanooga, Tennessee. Hartsfield Airport is at capacity and further expansion would be difficult. A high speed connection to the Chattanooga airport would allow sharing of traffic and services.

	Project	Corridor
Route length (approx.)	52 km / 32 miles	188 km/ 118 miles
Trip time (approx.)	23 minutes	59 minutes
Operating frequency (peak)	15 minutes	30 minutes
Stations	4	5
Vehicles	5 x 3 sections	10 x 3 sections (incl. Proj. fleet)
Annual ridership	3.6 million	

California Maglev Deployment Project (Greater Los Angeles)

The California High-Speed Rail Authority, the Southern California Association of Governments (SCAG), and the State of California Business, Transportation and Housing Agency have proposed a regional high speed rail network for greater Los Angeles which will connect the major regional activity centers and significant inter/multi-modal transportation facilities in Los Angeles, Orange, Riverside, and San Bernardino Counties. This system as envisioned would also provide connection to the San Diego Region, interline with the proposed California North/South corridor and would provide for further corridor expansion into the high desert portion of Los Angeles and San Bernardino Counties as the region grows.

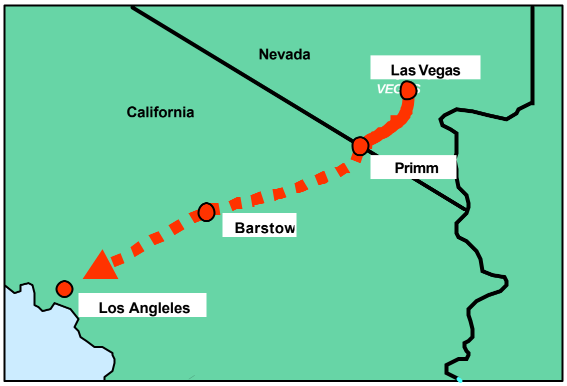
An initial segment, Los Angeles Airport – Union Station – Ontario Airport – March, has been selected for funding within the TEA-21 Maglev Deployment Program.

	Project	Corridor
Route length (approx.)	133 km / 83 miles	440 km/ 275 miles
Trip time (approx.)	58 minutes	
Operating frequency (peak)	20 minutes	
Stations	6	
Vehicles	8 x 8 sections	
Annual ridership	22.5 million	

California-Nevada Interstate Maglev Project (Las Vegas – Southern California)

This project is foreseen to ultimately connect Las Vegas with the southern California basin

(Ontario County) as well as to the California North/South route. The project is foreseen to be completed in phases, LV Airport - Primm (state border), LV Airport – LV Downtown, Primm - Barstow, CA, and Barstow - Southern California.



	Project	Corridor
Route length (approx.)	56 km / 35 miles	433 km/ 270 miles
Trip time (approx.)	11 minutes	
Operating frequency (peak)	20 minutes	
Stations	2	
Vehicles	3 x 8 sections	
Annual ridership	11.8 million	

5. Summary of Marketing Objectives and Strategies

Timing and choice of marketing strategies must be carefully harmonized with the particular features of the respective markets. This is normally only possible by bringing in local experts who are familiar with the political and economic situation as well as the approach to doing business in the particular region. The broad approaches to the international marketing of Maglev technology are based on the following key elements:

- International market survey and analyses with the purpose of better matching Maglev technology to the individual needs of the various markets and for allowing market trends to influence development work from the early stages.

- Initiation of the product adaptation process to satisfy country specific conditions and other requirements of the project country

- Branding of Transrapid Maglev technology in the market place – positioning the technology as a high speed, reliable, high quality means of transportation (to governments, operators, public).

- Developing and securing of market shares, evaluating potential application projects at an international level, completion of feasibility studies, including financial viability evaluations.

The following specifications of the market place have to be taken into consideration:

- existing transportation networks and their future development
- political structures and decisions process
- legal planning process
- financial resources and conditions.

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