Financing Rail Projects in Germany
Creating Modern Infrastructure

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Introduction

A fundamental reform of the government-owned railways Deutsche Bundesbahn DB (West Germany) and Deutsche Reichsbahn DR (East Germany) was initiated in 1994. The main features of this reform are[1]:

- Founding of Deutsche Bahn AG (DBAG) as a private-sector company from the two former government-owned railways, DB and DR.
- Separation of infrastructure and transport, achieved at present by splitting DBAG into four subdivisions (tracks, long-distance passenger transport, short-distance passenger transport, freight transport), which are to become public limited companies in their own right within 5 years.
- Opening up of the rail network to third parties against payment of track charges.
- Establishing Federal responsibility for rail infrastructure.
- Financial refloating by the State.
- Regionalization of suburban passenger transport from 1996.

This reform provides the preconditions for DBAG to run on a commercial basis and to offer more attractive services. However, in addition to a more customer-oriented philosophy and better services, the improvement of the track network is the important factors in regaining passengers and cargo.

Germany had a large rail network in 1995. It amounted to about 45,000 km of tracks, 41,700 km of which were operated by DBAG. Compared to other countries, the German rail network is characterized by a high density both in respect to land area and population (Table 1). However, this positive picture has to be put into perspective. First, the network utilization (daily passenger density) is lower than in countries like France and Japan. To a large extent, this results from the very dense network in East Germany which has serious utilization problems in some areas. Second, the old East German lines are in poor condition and the proportion of multi-tracked and electrified lines is below average. Furthermore, Germany as a whole has fewer high-speed lines (an important factor in attracting passengers) than France or Japan.

Based on these problems, two factors characterize German investment policy. On one hand, the old-fashioned tracks in former East Germany must be modernized and gaps in the network caused by 40 years of a divided Germany must be closed. On the other hand, DBAG is now rethinking the general network configuration. Keywords in this context are:

- Separation of passenger and freight lines
- Harmonization of train speeds to increase track capacity and cut track costs
- Speeding-up of lines
- Closing of unprofitable lines

In addition to these main features, the *Transrapid* maglev project—although not track-bound—must be mentioned.

Table 1 Characteristics of Rail Transport in Some Countries - 1992[1]

		UK	France	Germany	Sweden[5]	Japan[5]
Land area (1,000 sq km)		244	552	357	450	378
Population (million)		57	56	81	9	123
Network length (km)		16,600	32,300	41,700	10,000	20,200
Out	multi-tracked	11,800[4]	15,800[4,5]	17,600	1,300	5,960
of	electrified	5,000[6]	13,600[6]	18,200	7,300	9,680
these:	high-speed sections[2]	720	770	430	390	1,800
Network density						
	km/1,000 sq km	68	58	117	22	53
	km/million inhabitants	291	577	515	1,111	164
Performance						
	Million passenger-km	28,700	58,700	62,941	5,234	249,606
	Million tonne-km	13,000[7]	48,800[7]	69,437	51,115	55,663
Daily passenger density[3]		4,737	4,979	4,135	1,434	33,854

1 As per 31 December—only national railways
2 UK: 170 km/h, France: 240 km/h, Germany: 190 km/h, Sweden: 170 km/h, Japan: 230 km/h
3 Passenger-km/network length/365
4 As per 1991
5 As per 1992
6 As per 1993
7 Train load freight

Sources: Eurostat, UIC, DBAG

Financing Railways in Germany

According to the German constitution, the highways and other trunk roads, the rail network and the main waterways are owned by the State. The state is responsible for financing investment in this infrastructure and must bear—with the exception of railways—the operation and maintenance costs. To define future investment, a Master Plan is compiled for the government-owned infrastructure every 5 years. The current Master Plan (BVWP 1992) dates from 1992 with a time line up to 2010.

The railway reform led to some special features for railway financing compared to other government-owned infrastructure.

Master Plan features

The rail network's assets were transferred to Track Network, which is a subdivision of DBAG at present. Like DBAG, Track Network is still owned by the State. In contrast to the other DBAG subdivisions which are allowed to be fully privatized in 2002 as the earliest possible date, the amended German constitution obliges the Federal government to retain the majority of shares in Track Network.

Track Network must run the lines on commercial principles. In accordance with the terms of the European Directive 91/440 EEC, other companies offering railway services (including foreign companies) will be granted equal access to the rail network. All users of the network—including the transport companies belonging to DBAG—will pay charges to Track Network for using the railway facilities.

The Federal government will finance investment (construction, expansion and replacement) of DBAG's railway lines and will assume liability for interest payments. Track Network will make annual depreciation payments to the State. To select projects, a special Master Plan for the rail infrastructure is set up every 3 years. If there will be projects in this plan that are either not, or are only partially in DBAG's interest, the company will make depreciation payments only on part of the invested sum, or will receive a corresponding subsidy from the State. Furthermore, DBAG itself can raise loans to finance projects it is interested in[2]. Additionally, third parties (e.g., regional governments, banks) can contribute to rail investment.

In contrast to the other government-owned infrastructure, Track Network bears the costs for operating and maintaining the infrastructure.

Transrapid at Lingen (Emsland) Test Line *(Author)*

Track charges

To cover operation and maintenance costs and the depreciation payments, Track Network levies charges both for use of tracks and other facilities (stations, etc.). The track charges depend on the line (speed, signalling and communication equipment, economic importance) on one hand, and on the train (weight, speed, special requirements regarding bends and gradients) on the other hand. These basic prices can be modified according to special customer requirements (reliability, train weight, etc.). Furthermore, the price system includes discounts for ordering a certain amount of track capacity (train-kilometers) and for ordering longer in advance. The charges for stations depend mainly on usage frequency.

In this article it is not possible to describe the usage charges in detail[3]. However, it is of special interest whether the usage charges cover the track costs, or in other words, whether the financing principles outlined above do work in practice. Due to poor available data, it is hard to answer this question.

Undervalued assets

In 1994 and 1995, the annual receipts of Track Network from track charges amounted to about DM7.8 billion. According to my calculations, the annual costs in 1994 for operation and maintenance (one cost component to be covered by the track charges) amounted to about DM8 billion (excluding stations and other facilities).

The level of annual depreciation as the second cost component is heavily discussed. The reason lies in the balance-sheet adjustment achieved within the refloating measures of the railway reform. DBAG's opening balance at 1 January 1994 shows a balance of DM30 billion with fixed assets of DM20 billion. By contrast, DB's and DR's combined balance sheet for 1993 showed a total of DM110 billion, with fixed assets of DM100 billion[4]. As a result of this asset value reduction, the profit-and-loss accounts for 1994 and 1995 show almost no depreciation costs.

So far, no information has been available on the share of the DM20 billion allotted to lines. However, in view of investments made in recent years—DM15

billion alone for the new Hanover-Wurzburg and Mannheim-Stuttgart lines—the valuation of all fixed assets at DM20 billion is very questionable. Therefore, there is great doubt that the track charges are sufficient to cover both the current operation and maintenance costs, and the annual depreciation costs, which will increase in the future in view of planned investment. As a result of the undervaluation, Track Network can calculate the track charges on the basis of the low value for the existing network at least for the first years. However, in the long term, the depreciation costs of at least all post-reform investments in the track network must be covered by receipts[5].

To summarize, the consistency and achievability of the new financing principles are questionable. Experts already assume that the government will have to finance a larger amount of investment than actually planned, either by construction subsidies or by redefinition of projects not in the full business interest of DBAG. However, due to the shortage of public cash, it is feared that necessary investments in new lines as well as in modernization and replacement of the existing network will either not be made, or will be delayed[6]. Hence, it is necessary to establish priorities for projects both in respect of efficiency and environmental aspects. Additionally, new forms of project financing and management of infrastructure (private financing, public private partnership) must be investigated and realized.

Development Trends

Network 21

To regain market share in the fierce intermodal competition, an important task of Track Network is to reduce the high level of infrastructure costs. This objective cannot be achieved by continuation of the present rationalization measures alone. The problem of all railways in general lies in the high level of network assets compared with other carriers. Approximately 30% of the total costs of railway services are infrastructure costs. This high share is first caused by the nature of railways as a combination of infrastructure and transport operations. Furthermore, different types of traffic e.g., slow heavy freight trains and high-speed passenger trains, operate on the same routes. They have different requirements regarding maximum speeds, bends, gradients, passing tracks, switches, etc., and result in costly infrastructure. Adding to this problem is the unequal utilization of the networks; while a number of corridors present serious bottlenecks, a large part of networks is underutilized. About half of all transport performance is generated from only one third of DBAG's network.

In view of these problems, Track Network developed a new network philosophy, called *Network 21*, which sets the framework for the future infrastructure. It can be characterized as a strategy of separating traffic and harmonizing train speeds in transport corridors. As the first step in elaborating this strategy, passenger and freight flows were analyzed and forecast. Thereafter, future corridors where the volume of certain traffic types is high enough for creation of a specialized corridor were identified. In the next step, the required standards for these specialized lines were defined. Of course, creation of specialized transport corridors does not preclude use of the lines by other types of rail traffic, but these have secondary-user status and must adjust to the requirements of the primary user. The *Network 21* strategy contains the following five types of routes with specific construction standards:

- High-speed network for long-distance passenger transport (H Network, about 3500 km)
- High-performance network for freight transport (G Network, about 4500 km)
- Network for exclusive use by suburban rapid transit trains (S-Bahn Network, about 2000 km)
- Supplement network with mixed traffic (M Network, about 10,000 km)
- Regional network, partly with short-line characteristics (R Network, about 21,000 km)

In particular, the H Network and G Net-

German high-speed ICE at Enztal Bridge (Mannheim-Stuttgart) *(Author)*

Table 2 German Rail Network[1]

		Eastern Germany		Western Germany	
		1990	1995	1990	1995
Land area (1000 sq km)		108	108	249	249
Population (thousands)		16,247	15,531	63,800	66,007
Network length (km)		14,031	13,900[6]	26,900	26,400[6]
Out	multi-tracked	4,226	4,400[6]	12,300	12,600[6]
of	electrified	4,025	4,600[6]	11,700	11,800[6]
these:	high-speed sections	–	–	•	430[6]
Network density					
	km/1,000 sq km	130	129	108	106
	km/million inhabitants	864	895	422	400
Level crossings		9,485	5,030	20,267	19,165
Out of these:	without safety equipment	5,449	3,650	10,185	9,803
Performance[2]					
	Million passenger-km	18,000	9963[6]	43,560	47,576[6]
	Million tonne-km	40,900	13,041[6]	61,418	51,762[6]
Daily transport density[3]					
	Passenger	2,180	2,149	5,710	6,267
	Freight	8,179	2,608	6,398	5,540
Infrastructure investments					
	1991–1995[4,5] (DM billion)	23		19	
Value of infrastructure[4] (DM billion)					
	Gross	37	52	191	189
	Net	18	32	111	111

1 As per 31 December; only national railway (1990: DR, DB; 1995: DB AG)
2 Domestic traffic; freight: excluding railway internal freight
3 Passenger-km/network length/365, tonne-km/network length/365
4 Excluding real estate
5 Gross investment, including replacement
6 As per 1993

Sources: DB, DR, DBAG

work must be fitted into the Trans European Network (TEN) and the European Rail Freight Network (EUFRANET). Obviously, compromises must be made in the meantime, because the necessary investments in the network configuration have to be interpreted as long-term targets.

Step-by-step realization of this concept should lower construction costs because the corridors will not have to meet the infrastructure requirements for all train types. Furthermore, the concept aims to create higher route-capacity by harmonizing the train speeds in order to eliminate bottlenecks.

Network 21 is clearly the right way to create a modern network with lower costs and higher capacity. It also reflects developments in France and Japan, where dedicated high-speed passenger lines are operating successfully. Nevertheless, there are some problems in realizing this concept. For example, the investment plan is based on the 1992 Master Plan meaning projects planned before the railway reform and before the creation of *Network 21*. Hence, modification according to the *Network 21* concept is necessary. But while some parts of routes are already designed following the new concept (e.g., the Berlin-Oebisfelde section which belongs to Project 4 in the list of German Unification Rail Investment Projects. See Table 4 and Figure 1), the whole Nuremberg-Berlin project (Project 8) is designed as an all-round route.

Modernization of Rail Infrastructure in Former East Germany

Initial situation

In 1990, the rail network of the former DR covered about 14,000 km. The East German network had a higher density than the network in West Germany, both in respect to land area and population (Table 2). However, it was distinguished by an inferior network structure (no high-speed lines) and lower construction standards (less electrified and multi-tracked lines, lower average speed, obsolete signalling equipment, large number of level crossings without safety equipment). Although DR was the main means of transport in the former East Germany, the performance of lines was poor and maintenance was neglected. The resulting poor condition led to a large number of speed and weight limits and reduced the general functionality. At the end of 1990, the gross infrastructure assets of DR were valued at DM37 billion; the net value amounted to about DM18 billion. Compared with DB assets in West Germany, the DR facilities had an unfavorable age structure; 30% originated from pre-war investments compared to only 15% for DB's assets. A study by the German Institute for Economic Research (DIW) for the Federal Ministry of Transportation estimated that about DM57 billion would be required from 1991 until 2010 to replace lines and catch-up to the level of West German lines (excluding stations and other facilities).

Apart from the desolate condition of the

Table 3 Investment Programme to Close East-West Rail Gaps

Route	Measures	Opening date	Estimated investment (DM million)
Hamburg-Büchen -Berlin	Double-tracking, electrification	1997	2,760
Helmstedt -Magdeburg	Speeding-up to 160 km/h, electrification	1995	1,535
Bad Harzburg -Stapelburg	Reconstruction as single-track line	1992	41
Eichenberg -Leinefelde	Double-tracking, electrification	1994	264
Bebra -Neudietendorf	• Double-tracking of former route via Wartha, electrification • Re-opening of Blankenheim -Fassdorf (Bebra) section • Construction of Honebach Tunnel • Reconstruction of Gotha Viaduct	1995	682
Rentwertshausen -Mellrichstadt	Reconstruction as single-track line	1991	29
Neustadt (Coburg) -Sonneberg	Reconstruction as single-track line, electrification	1991	21
Hochstadt-Marktzeuln -Camburg	Double-tracking, electrification	1995	931
Hof-Plauen	Double-tracking	1993	137

Source: Federal Ministry of Transportation

former East German rail infrastructure, re-establishing the interrupted east-west routes and adjusting the exclusively north-south oriented former East German network to the new transport flow direction requires huge investments.

In mid-1990, an investment programme was established to close the gaps in the former east-west routes. This programme included 9 projects with total investment costs of about DM7 billion at 1990 prices (Table 3). These projects were necessary but still insufficient to improve the East German lines. Therefore, in 1991, the so-called German Unification Transport Projects (GUTP) containing 9 railway lines, 7 road projects and 1 waterway project were legislated. These projects total about DM57 billion and are planned for completion before 2000; they have been incorporated into the 1992 Master Plan for government-owned infrastructure. The 7 rail projects (Table 4, Figure 1) total about 1960 km and are expected to cost about DM29 billion (1991 prices). Apart from these investments, the Master Plan includes rail projects for DB remaining from the former Master Plan (1985) which have not been completed yet, as well as international projects defined in bilateral negotiations with the relevant countries.

Projects realized in 1995

From 1991 to 1995, about DM23 billion was invested in the former East German rail infrastructure. This amount exceeded all rail investments in former West Germany for the same period. The measures included electrification of about 1200 km of tracks, replacement of more than 9000 switches, replacement of damaged concrete sleepers over 3200 km and reduction of speed-limited tracks from 2200 to 900 km. Almost half (about DM10 billion) of the total was spent on rail projects falling under the GUTP and meeting about 30% of the planned sum until 2010. So far, Projects 5 (Helmstedt-Berlin), 6 (Eichenberg-Halle) and 7 (Bebra-Erfurt) have been completed. Projects 2 (Hamburg-Berlin) and 4 (Hanover-Berlin) are in the construction phase. However, Project 8 (Nuremberg-Berlin), which is the most extensive and costly, is behind schedule. Project 1 is part of the Berlin-Verona corridor of TEN, and entered partly the construction phase in 1996. Financial problems, delays in the planning process and uncertainty concerning the route selection in Berlin due to a late decision on the new Berlin-Brandenburg International Airport at Schönefeld stalled the project. Further delays are feared in view of the reduced Federal transportation budget.

The huge investments enabled considerable reductions in travel time, more frequent services and more customer-friendly stations. One example is the reduced travel time between Erfurt and Frankfurt am Main from 4 hours and 30 minutes (1990) to 2 hours and 20 minutes (1996). Another example is the frequency of services from and to Potsdam, the capital of the Brandenburg Federal state; 16 ICEs and 15 Intercity/Eurocity trains now serve this station daily.

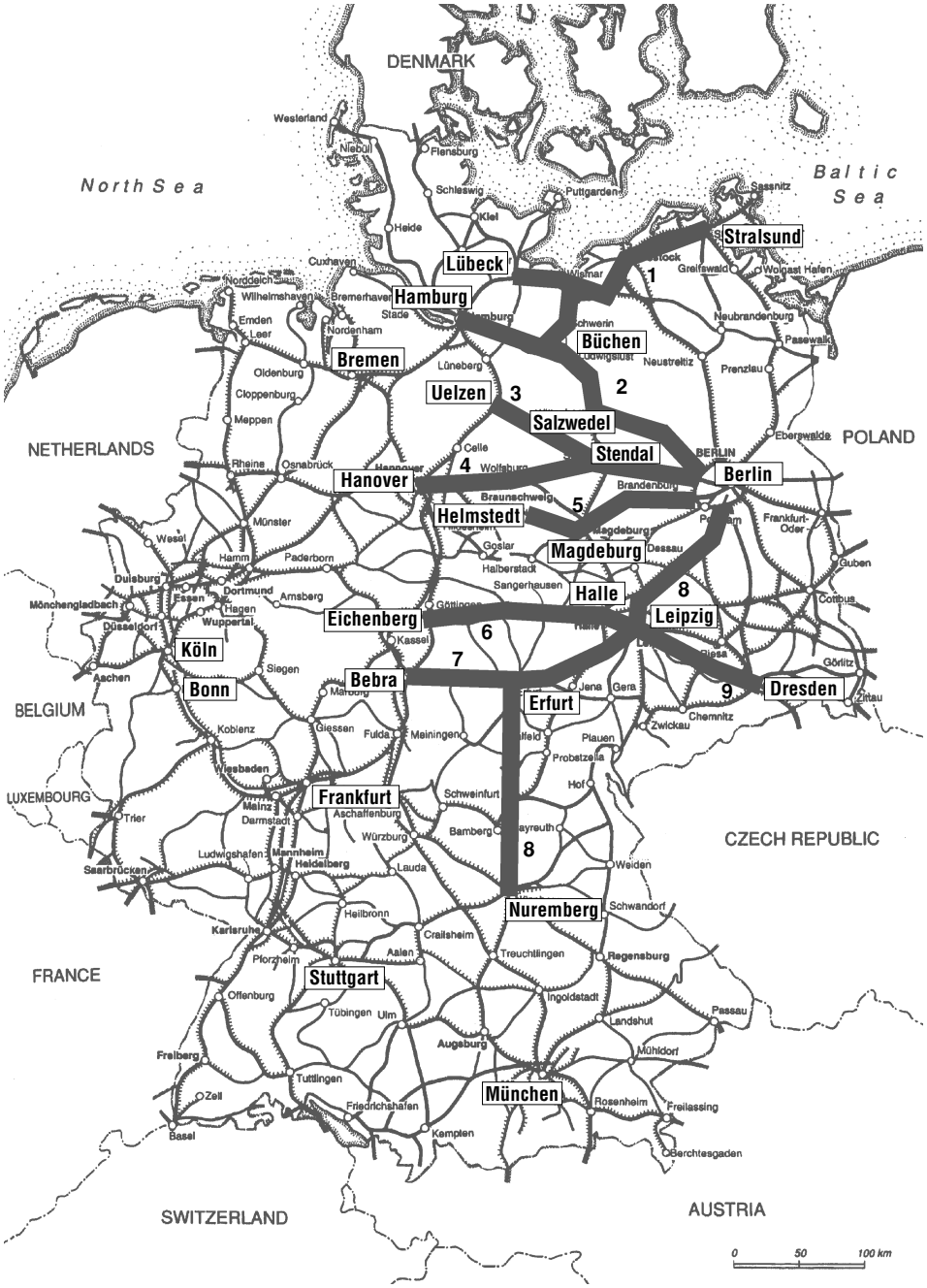
The modernization of lines in former East Germany also offers the chance to apply new technological developments. One example is the construction of the new electronic signal box in Magdeburg as

Table 4 Rail Projects in German Unification Transport Projects

Project no.	Route	Route-length (km)	Aim	Measures	Estimated costs (DM million)	Status
1	Lübeck/ Hageno w–Rostock –Stralsund	251	• Extension of East-West rail corridor in North • Linking of Schwerin (capital of Mecklenburg-Vorpommern federal state) and ports of Wismar, Rostock and Stralsund • Improved performance of services with Scandinavia and Eastern Europe • Improved rail accessibility of East German coastal area and in Schwerin-region, particularly for tourism • Higher frequency and reliability of regional transport	• Improvement of superstructure • Electrification of sections • Speeding-up to 120 km/h, partly to 160 km/h • New signalling/communication equipment	1,100	In progress
2	Hamburg –Büchen –Berlin	270	• Extension of Berlin-Hamburg rail corridor, links between Wittenberge, Ludwigslust etc. • Link between Eastern Europe and North-Sea ports • Part of European Infrastructure Master Plan (TEN) • Regional importance for areas concerned • Higher frequency and reliability of regional and suburban transport	• Electrification and double-tracking • Speeding-up to 160 km/h, partly 200 km/h • Construction of electronic signal boxes in Hamburg and Aumuhle • Four-track configuration of Hamburg S-Bahn to separate short- and long-distance passenger transport • Construction of passing tracks at four stations	3,600	In progress
3	Uelzen –Salzwedel –Stendal	110	• Improved rail-link between Hamburg and Berlin • New links between middle Germany and North-Sea ports • Improved short- and long-distance transport on route • Reduction of bottlenecks • Reduction of travel time between Berlin and Hamburg to about 2 hours	• Extension/partly new construction of line • Electrification and double-tracking • Speeding-up to 200 km/h • Construction and extension of passing tracks • Construction of stations and platforms without level crossing • New signalling/communication equipment	1,850	In progress
4	Hanover –Stendal Berlin	246	• Part of Trans-European High-speed network Paris/London-Brussels-Aachen-Cologne-Hanover-Berlin-Warsaw-Moscow • Part of agreement on general corridors for international rail transport (AGC) • Improved link between cities of Hanover and Berlin and other cities lying along the east-west route (particularly linking Rhine/Ruhr and Saxony-Anhalt/Brandenburg/Berlin) • Reduced travel time to 1.75 hours	• Extension, electrification and speeding-up to 200 km/h of Lehrte-Oebisfelde section • Construction of Oebisfelde-Staaken section for 250 km/h • Electrification of Staaken-Berlin section	4,780	In progress
5	Helmstedt –Magdeburg –Berlin	163	• Part of European Infrastructure Master Plan (TEN) • Part of agreement on general corridors for international rail transport • Improved link between Hanover, Braunschweig, Magdeburg, Potsdam and Berlin • Reduction of bottlenecks and travel time	• Electrification of whole line • Speeding-up to 160 km/h • New signalling/communication equipment	1,850	Completed
6	Eichenberg –Halle	170	• Improved link between east and west Germany, linking cities of Kassel, Nordhausen and Halle • Reduction of bottlenecks and travel time	• Double-tracking and electrification	280	Completed
7	Bebra –Erfurt	100	• Part of European Infrastructure Master Plan (TEN) • Part of agreement on general corridors for international rail transport (AGC) • Improved link between east and west Germany, especially between Kassel/Bebra and Eisenach/ Erfurt • Reduction of bottlenecks and travel time	• Reconstruction of Blankenheim-Fassdorf line • Reconstruction of Eisenach-Wartha line • Gerstungen; double-tracking, electrification and speeding-up to 160 km/h • Construction of Gotha Viaduct • New signalling/communication equipment • Construction of stations and platforms without level crossing	730	Completed
8	Nuremberg –Erfurt –Halle/ Leipzig –Berlin	540	• Part of European Infrastructure Master Plan (TEN-Project 1 Berlin-Verona) • Part of agreement on main corridors for international rail transport (AGC) • Meeting increasing importance of corridor between south/southwest Germany, and industrial areas of middle Germany and Berlin • Reduction of bottlenecks at Leipzig-Erfurt section and Leipzig junction • Reduction of travel time to about 3.5 hours	• Double-tracking of Nuremberg-Lichtenfels section and speeding-up to 200 km/h • Construction of new Lichtenfels-Erfurt-Weissenfels-Leipzig route for 250 km/h • Speeding-up of Weissenfels-Halle section to 200 km/h • Reconstruction of Bitterfeld-Berlin section, speeding-up to 200 km/h	12,400	Planning completed, construction started in 1996
9	Leipzig –Dresden	106	• Part of European Infrastructure Master Plan • Improved link between Saxony and Ruhr, Rhine/ Main and Bavaria • Inclusion of Dresden in high-speed network • Improved regional and suburban transport by reducing bottlenecks • Reduction of travel time	• Reconstruction and extension of existing Leipzig-Wurzen and Cossebaude-Dresden lines • Construction of new line between Wurzen and Cossebaude	2,680	In progress

Source: Federal Ministry of Transportation

Figure 1 German Unification Rail Investment Projects



Projects			Source: Federal Ministry of Transportation
1. Lübeck/Hagenow–Rostock–Stralsund	4. Hanover–Stendal–Berlin	7. Bebra–Erfurt	
2. Hamburg–Büchen–Berlin	5. Helmstedt–Magdeburg–Berlin	8. Nuremberg–Erfurt–Halle/Leipzig–Berlin	
3. Uelzen–Salzwedel–Stendal	6. Eichenberg–Halle	9. Leipzig–Dresden	

Map: Railway Gazette International

part of Project 5 (Helmstedt-Berlin) to replace 37 conventional signal boxes. Another example is the construction of so-called fixed lines where tracks are fastened to concrete slabs. This procedure is expected to lead to lower maintenance costs.

The gross value of infrastructure assets of the former East German lines amounted to about DM52 billion at the end of 1995 while the net value was DM32 billion. Nevertheless, there is still a remarkable difference in the quality compared to former West Germany. There are still more level crossings and more non-electrified sections and the percentage of high-speed lines is lower, showing that the modernization of the East German infrastructure has not been completed yet.

Transrapid Project

Project background

Germany has been developing the *Transrapid* magnetically-levitated high-speed train system for more than 25 years. The *Transrapid* concept is based on the pioneering work of Hermann Kemper during the 1920s, and uses a combination of superconducting magnets and linear motor technology. R&D has been subsidized mainly by the Federal Ministry of Education and Research to about DM2 billion. Originally, the project aimed to close the speed gap between the traditional wheel-and-rail technology (250 km/h) and the airplane (800 km/h). *Transrapid* is designed as a system for passenger transport over middle to long distances (1000 to 1200 km). It will have special container-sections for transporting high-value express goods. It is not meant for short-distance passenger transport but could be used for rapid regional transport like linking airports.

There has been long discussion about the advantages and disadvantages of *Transrapid* mainly focused on comparison with high-speed trains based on conventional wheel-and-rail technology, as well as on the question of whether there is a demand for this new system in general and for the prototype line between Berlin and Hamburg, in particular.

Advocates of *Transrapid* put forward the following arguments.

- The system enables more flexible fitting of the guideway to the landscape. Tighter bends, higher gradients (up to 10% compared to 4% for ICEs) and higher cants are possible.
- *Transrapid* allows higher speeds (400 to 500 km/h) and better acceleration than ICEs.
- The guideway uses less land and the landscape is cut less than by conventional lines.
- At equal speeds, *Transrapid* uses less energy and produces less noise than ICEs.
- The construction costs for new ICE routes and for *Transrapid* are very similar. In mountainous areas, *Transrapid* is cheaper; on flat land, high-speed lines are less costly.
- Due to the planned 10–15 minute frequency, *Transrapid* will be more attractive than traditional train services.

Critics argue:

- The technical development of conventional wheel-and-rail technology has made further progress. High-speed trains can run at 300 km/h. The speed-gap between conventional trains and *Transrapid* is diminishing.
- A high service frequency can also be achieved with conventional trains.
- Further R&D will reduce energy consumption and noise emissions of wheel-and-rail systems. Apart from this, both systems should be compared not at equal speeds but at envisaged operating speeds (400 to 500 km/h for *Transrapid*, 250 to 300 km/h for ICEs). At such a comparison, the *Transrapid* energy consumption and noise emission increase and the advantages are smaller.
- *Transrapid* uses less land area but this is offset by serious problems in getting it into the inner cities. It requires new corridors because it cannot run on existing tracks.
- The *Transrapid* guideways are difficult to link with railway lines.
- The infrastructure planning of the EU is strongly influenced by France which has shifted its R&D priorities to improvement of traditional wheel-and-rail technology and high-speed railway lines. Therefore, practical use of *Transrapid* within Europe is very limited or even impossible.

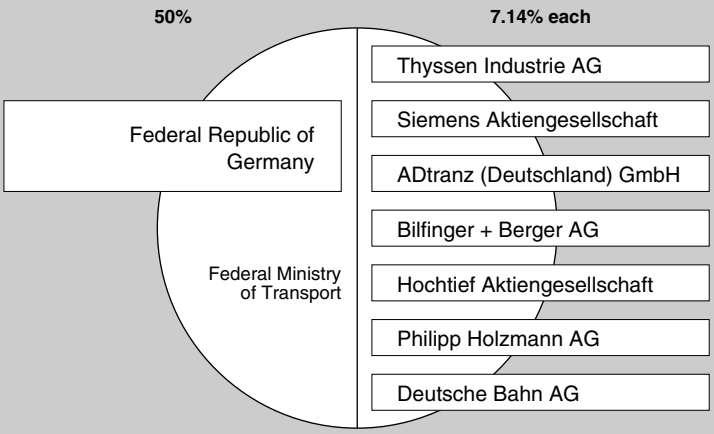
I shall not comment on the industrial-economic aspects of *Transrapid* in this article. However, it should be mentioned that in 1989 the European Commission asked for a greater financial contribution to *Transrapid* R&D from industry. Furthermore, the envisaged export of *Transrapid* developed using huge government subsidies includes the danger of trade conflict with countries offering competitive, non-subsidized, transport systems. In the context of industrial policy and export of *Transrapid*, the advocates voted for construction of a prototype route. The *pros* and *cons* of this line are discussed below from the aspects of transport demand and economy.

Hamburg-Berlin *Transrapid*

By late 1991, the Federal Railway Board certified the technical applicability of *Transrapid* technology. Thereafter, construction of a prototype route between Berlin and Hamburg was included in the 1992 Master Plan. In 1994, the legislation was passed and in the same year the *Transrapid* Planning Corporation was established (Fig. 2).

International studies on the applicability of the technology had already been carried out in the 1970s. The investigations on possible guideways included the Cologne-Brussels-Amsterdam-Paris and

Figure 2 *Transrapid* Planning Corporation (June 1996)



Frankfurt-Kaiserslautern-Nancy-Paris corridors. Subsequently, France, which had contributed to the research, committed itself to the TGV and withdrew from research. In the late 1980s, the TEN corridors were decided on the basis of conventional wheel-and-rail technology and discussion on European magnetic-levitation guideways ended. Numerous corridors were investigated in Germany (Hamburg-Bremen-Ruhr-Cologne/Bonn-Frankfurt/Main, and Essen-Düsseldorf-Cologne/Bonn). All routes were later rejected either because they contradicted the planned European high-speed network or because they did not match the requirements of unified Germany to establish east-west links. After German unification, a route between Hamburg and Berlin was chosen. This route is summarized in Fig. 3.

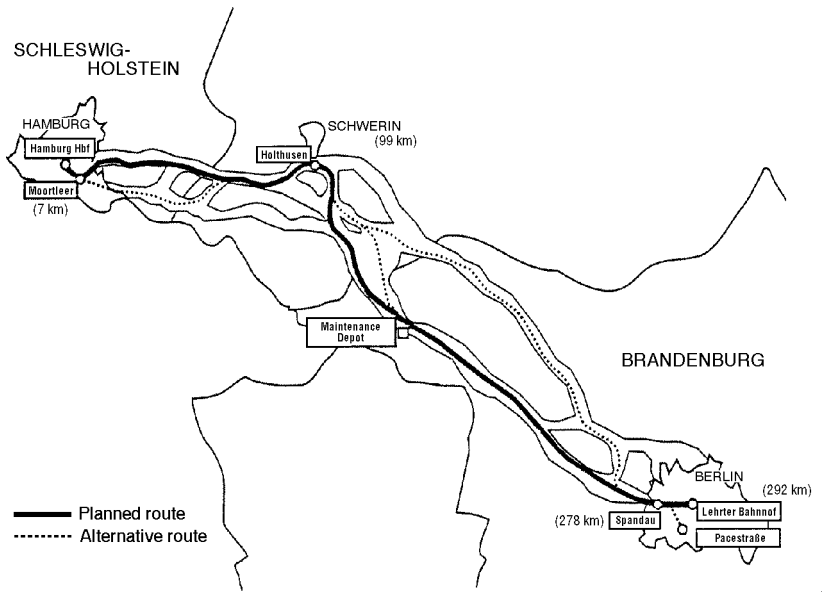
Financing

The project was included in the 1992 Master Plan under the condition of private financing. The financing concept, passed within the legislation and praised by the government as very progressive, envisages separation of infrastructure and transport. The Federal government will finance construction of the guideway which is estimated to cost about DM5.6 billion. The operating company will run *Transrapid* without subsidies and will bear part of the investment costs for buildings, energy facilities, signalling and vehicles, which are estimated at about DM3.3 billion, as well as the operation and maintenance costs. About DM2.4 billion of the total government investment will be financed by loans. The operating company will make payments to the Federal government as follows:

- Charges for use of guideway (similar to track charges that users of DBAG's tracks pay to Track Network). These annual charges are fixed to meet the depreciation of the guideway and amount to about DM138 million.
- Additional annual charge of about DM173 million based on business success

Payment of the additional annual charge (DM173 million) should repay the government credit costs (DM2.4 billion). Therefore, it is argued, the government budget is only burdened with costs of DM3.2 billion (DM3.8 billion considering inflation).

Figure 3 Planned *Transrapid* Guideway from Berlin to Hamburg



Length: 292 km
Land area: 571 ha
Travel time: 55 minutes
Rush-hour frequency: 10 to 15 minutes
Max. speed: conurbations: 200 km/h,
otherwise: 400 km/h
Service: 72 trains each way / 6 carriages
Estimated fare revenues: DM0.28 per passenger-km[7]
Passenger forecast: 14.5 million from 2010
Estimated construction cost: DM8.98 million

The operating company will consist of the following partners[8]:

- DBAG and Lufthansa (capital: DM300 million)
- Banks and insurance companies (holding group, capital: DM200 million)
- Businesses and utilities (holding group, capital: DM500 million)
- Other shareholders (capital: DM500 million)

Project valuation

The basic components of the financing concept are the estimated investment costs, the passenger forecast, and the expected revenues. As usual for projects of this dimension and novelty, there are serious financial risks. The first lies in the estimated investment cost which, based on previous experience with Munich Airport, etc., is probably underestimated. According to the financing concept, these risks must be borne by the State. Further risks concern the optimistic rentability forecasts. There is doubt about the passenger forecast of 14.5 million (4.1 billion passenger-km annually) from 2010. According to the forecasts underpinning the 1992 Master Plan, in 2010, about 10 million passengers will travel between Hamburg and Berlin. Obviously, the sphere of influence of the line as well as the induced traffic were optimistic estimates, otherwise the estimate of 14.5 million passengers is not possible. Meanwhile, experts expect only 11 to 13.7 million passengers. Apart from revised passenger forecasts, planners are thinking about reducing the train frequency (from 10 to 15 minutes to 15 to 20 minutes) in order to decrease operating costs. However, in this case, the estimated induced traffic and the modal shift from other transport must be revised downwards too.

The figure of 14.5 million passengers is based on ideal-case assumptions. Meanwhile, the underlying optimistic economic and demographic prospects have been rendered void by actual developments. Additionally, the assumed project characteristics do not correspond with those now planned. The passenger forecast is based on a ticket-price of DM0.27 per passenger-km at maximum, while the financing concept proceeds from DM0.28 per passenger-km. Furthermore, the assumption that there will be no competing transport on this route is problematic. DBAG has indeed stated that it will not speed-up the existing line, because it is one firm within the operating company. It also is a matter of fact that Lufthansa will cease its service between Hamburg and Berlin. However, other railway companies (perhaps from abroad) will be able to claim access to the existing line and may offer cheaper services than *Transrapid*. Considering these risks, there is much doubt about the profitability of the route.

One *pro* argument is that the prototype route will demonstrate the new transport system in normal operation, which is a prerequisite for marketability. This may be partly true, but on the other hand, low profitability might fatally damage the system's image.

To summarize, the original reason for *Transrapid*—closing the speed-gap between train and airplane and releasing trunk routes—has disappeared. The financial risks are high. On the other hand, if the hidden costs can be reduced to an extent comparable to those of competing transport modes, there might be a good chance for international applicability and marketability. ■

References

1 For a more detailed description see, Link, H., German Railway Reform—Chances and Risks. *Japan Railway & Transport Review*, June 1994, and Link, H., Structural Reform of Germany's Railways—Could Japan Serve as a Model? *Economic Bulletin* of DIW, Vol. 31, No. 11, 1994.

2 Due to cuts in the envisaged DM36 billion rail investments from 1996 to 1999, DBAG decided to finance part (about DM7 billion) of this sum by raising loans. It is expected that this will debit the profit-loss account by about DM350 million per annum.

3 For a description see, Link, H., Railway Reform in Germany—Chances, Risks and First Experiences. Fourth International Conference on Competition and Ownership in Land Passenger Transport, Rotorua, NZ, July 1995.

4 Data provided at DBAG's press conference on 26 May 1994

5 These include replacement investment for the existing network in addition to investment in new routes.

6 The delayed start of construction on the new Nuremberg-Berlin line and the announced extension of the construction phase confirm this fear.

7 This rate lies in the range of other transport modes.

8 Deutscher Bundestag, 12. Wahlperiode, *Bericht über das Finanzierungskonzept der Magnetschnellbahn Berlin-Hamburg* (*Transrapid*), Drucksache 12/6964, 1994.

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