The German High Speed Rail System

DB International GmbH
Ottmar Grein
Bilbao, 24.02.2015
High Speed Rail Senior Consultant
Ottmar Grein

Personal Data

- **Professional Experience:** >30 Years
- **Position:** Senior Expert
- **Languages:** German, English

Core Competences and Projects

- **Core Competences**
  - Development of transportation concepts
  - High Speed Rail systems
  - Feasibility studies

- **Projects (excerpt)**
  - Commissioning of new railway lines in Germany
  - Management of the commissioning of Lötschberg-Basetunnel (Switzerland)
  - Feasibility study for a High Speed Rail system in Norway
  - Feasibility study for a High Speed Rail system in the Québec-Windsor Corridor (Canada)
  - High Speed Rail system consulting for the HS2 project (UK)

Education and Professional Experience

- **Education**
  - Civil Engineer (transportation) at Technical University of Darmstadt

- **Professional Experience**
  - Since 1981 project manager and consultant at DB International GmbH Frankfurt
The integration of ICE traffic into the long-haul network is mostly due to the polycentric settlement structure in Germany.

Characteristics of population structure in Germany:

- Several urban regions instead of one
- Few large and numerous medium- and small sized points of origin spread across the entire country
- Densely-populated urban areas prevent exclusive focus on point-to-point services
The settlement structure in Germany has immediate implications for long-haul rail traffic

High Speed Network in Germany 2014

A large number of access points for long distance network as a condition for sufficient utilisation of national travel demand potential
Our long distance train network for Germany – We serve the Country with high quality railway services

Legend:
- ICE Line every hour
- ICE Line every 2 hours
- ICE Line every 4 hours
- Single ICE Trains
- System Stops

ICE Lines:
- Linie 10
- Linie 11, 31
- Linie 12, 91
- Linie 20
- Linie 22, 90
- Linie 25, 79
- Linie 28, 43
- Linie 41, 83 (TGV)
- Linie 42
- Linie 45, 82, 90 (Railjet)
- Linie 49, 76
- Linie 50, 80 (THALYS)
- Linie 75, 78

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Shortened travel times are essential success factor of ICE; Attractive travel times allow high market shares

Travel times from Frankfurt to:

- Hannover: 02:19 (1990), 03:21 (2009)
- Stuttgart: 01:18 (1990), 02:11 (2009)
- München: 03:10 (1990), 04:30 (2009)
- Berlin: 04:06 (1990), 07:40 (2009)
- Köln: 01:10 (1990), 02:14 (2009)
- Brüssel: 03:06 (1990), 05:17 (2009)
- Amsterdam: 03:56 (1990), 05:08 (2009)

Rail market shares Passenger transport in Germany

- All O&Gs
- Frankfurt - Stuttgart
- Frankfurt - Hamburg
- Frankfurt - Munich
- Frankfurt - Berlin

*market share rail [market share all other modes]
Long Distance Service is the backbone of a passenger rail system – regions get interconnected by attractive feeder systems.

Integrated Feeder System

- Major City A
- City B
- City C
- Major City D

Feeder system:
- LDS Line
- City
- Feeder system

Service types:
- Regional Service
- High Speed Service

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Passenger Intermodality is the key for HSR networks

- Interchange Stations to link with Feeder Systems
- Direct connection of airline hubs by rail
- Park & Rail facilities for commuters
- Car Rental / Car sharing at station
- New ticket systems, e.g. Integrated City Transit & HSR tickets
In the beginning there was mixed traffic.

Mixed traffic in 1825
Mixed Traffic on High Speed Lines in Germany

History

Development of a High Speed Network

1970 First ideas for a nation-wide 300 km/h High Speed network including upgrading of existing lines for 200 km/h operation

1973 First transport master plan including the HSL Hannover-Würzburg and Mannheim-Stuttgart

1975 Priority for freight operation on new lines for economical and capacitive reasons. Operation with loco hauled passenger trains at 200 km/h and all kind of freight trains.

1984 Decision for High Speed: ICE trains at 250 km/h and freight trains at 80 km/h.
Mixed Traffic on High Speed Lines in Germany
German High Speed Network – Mode of Utilization

ABS 2004
$V_{\text{max}} = 230 \text{ km/h}$
Mixed Traffic

NBS 1998
$V_{\text{max}} = 250 \text{ km/h}$
Mixed Traffic

NBS 2006
$V_{\text{max}} = 300 \text{ km/h}$
Local and High Speed Passenger Trains
Optional Light Freight

NBS 2002
$V_{\text{max}} = 300 \text{ km/h}$
High Speed only

NBS 1991
$V_{\text{max}} = 250/280 \text{ km/h}$
Mixed Traffic
Day: High Speed
Night: Freight

NBS 2002
$V_{\text{max}} = 250 \text{ km/h}$
Mixed Traffic

Green: upgraded conventional lines (ABS)
$V_{\text{max}} = \text{up to 200 km/h}$
Mixed Traffic on High Speed Lines in Germany

InterCity Cargo Express, 160 km/h (1988)

LZB,
Axle load only 18 t

At present: PIC
Mixed Traffic on High Speed Lines in Germany
Dimensioning of Mixed Traffic Lines

NBS Hannover - Würzburg (1991): High Speed + Freight Trains

NBS Köln - Rhein/Main (2001): High Speed 300 km/h
Mixed Traffic on High Speed Lines in Germany Impacts On Infrastructure Cost

Construction cost of several High Speed Lines and the corresponding share of bridges and tunnels

![Graph showing the relationship between construction cost per km (m€) and the percentage of tunnels and bridges.](chart-image)
Mixed Traffic on High Speed Lines in Germany
Capacity as a Function of Different Speeds And Train Mixture
Mixed Traffic on High Speed Lines in Germany
Train Distribution on the Hannover – Würzburg Line

Göttingen – Kassel section, 2003

Red: High Speed trains
Dark blue: freight trains

Maintenance windows hours 4 to 5 and 5 to 6 respectively
Construction and operation of mixed traffic High Speed Lines show advantages but also disadvantages compared to passenger dedicated lines:

+ Higher capacity and shorter transport time for freight trains,
+ Better utilization of expensive infrastructure (higher revenues),
- Reduction of line capacity without segregation of fast and slow trains,
- Higher infrastructure cost in mountainous areas,
- Less time slots for maintenance.
Target: Finalized HST-network in 2025

Under construction:
- Nürnberg – Erfurt – Halle/Leipzig
- Karlsruhe – Basel
- Stuttgart 21
- Stuttgart – Ulm

Planned:
- Hamburg/Bremen – Hannover
- Frankfurt – Fulda
- Rhein/Main – Rhein/Neckar

200 to 230 km/h
250 km/h and more
VDE 8 NBS/ABS Nürnberg – Erfurt / NBS Erfurt – Halle/Leipzig
VDE 8.2 NBS Erfurt – Halle/Leipzig

Length of line 123 km
Design speed 300 km/h

Trackwork Slab track
Tunnels 3 (total length 15.4 km)
Bridges 6 (total length 14.4 km)

Commissioning 2015
(Gröberts-Leipzig since 2003)

Total costs 2.7 Bil. €

Running times
Erfurt – Halle 31 min (today 77 min)
Erfurt – Leipzig 39 min (today 66 min)
VDE 8.2 NBS Erfurt – Halle/Leipzig

[Diagram showing a section of a railway with tracks and tunnels, labeled 'Gleis Richtung Erfurt' and 'Gleis Richtung Leipzig/Halle'. The diagram includes a section view with a tunnel, labeled 'zwei parallel eingleisige Tunnelröhnen' (two parallel single-track tunnel sections) and 'Durchmesser 9,60 m' (diameter 9.60 m).]

[Images of construction sites and railway infrastructure, including a bridge and a railway track with overhead lines.]
VDE 8.2 NBS Erfurt – Halle/Leipzig
VDE 8.1 ABS/NBS Nürnberg – Erfurt

Length of line 190 km
Thereof NBS 107 km

Design speed NBS 300 km/h
ABS 230 km/h

Commissioning 2017

Total costs 5.3 Bil. €

Running times
Nürnberg-Erfurt 66 min
(today via Fulda 172 min)
NBS Erfurt – Halle/Leipzig

Reduction of Travel Times by VDE 8

<table>
<thead>
<tr>
<th>Route</th>
<th>Today</th>
<th>New</th>
</tr>
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<tbody>
<tr>
<td>Berlin – Munich</td>
<td>6:00</td>
<td>4:15</td>
</tr>
<tr>
<td>(Sprinter 3:45)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Leipzig – Frankfurt</td>
<td>3:30</td>
<td>3:00</td>
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</table>
The HST fleet of DB Fernverkehr was gradually developed according to the requirements

- Since 1991 the ICE fleet of currently 275 trains has constantly grown: another 130 trains are on order. The fleet is managed centrally.

- The fleet was designed according to the requirements and consists of train sets with concentrated traction and of train sets with distributed traction.

- The ICE fleet has the following key data:
  - 200 – 330 km/h max. speed
  - 100 – 375 m train length
  - 200 – 700 seats

<table>
<thead>
<tr>
<th>ICE 1</th>
<th>59 trains since 1991</th>
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<tbody>
<tr>
<td></td>
<td>358 m, 705 seats</td>
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<tr>
<td></td>
<td>280 km/h, 9,6 MW</td>
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<tr>
<th>ICE 2</th>
<th>44 trains since 1996</th>
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<tbody>
<tr>
<td></td>
<td>205 m, 368 seats</td>
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<tr>
<td></td>
<td>280 km/h, 4,8 MW</td>
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<thead>
<tr>
<th>ICE 3</th>
<th>59 trains since 2000</th>
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<tr>
<td></td>
<td>200 m, 430-440 seats</td>
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<tr>
<td></td>
<td>330 km/h, 8,0 MW</td>
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<tr>
<th>ICE T</th>
<th>17 trains since 2015</th>
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<tbody>
<tr>
<td></td>
<td>200 m, 460 seats</td>
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<tr>
<td></td>
<td>320 km/h, 8,0 MW</td>
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<table>
<thead>
<tr>
<th>ICE TD</th>
<th>59/11 trains since 1998</th>
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<tbody>
<tr>
<td></td>
<td>133/184 m, 250/357 seats</td>
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<tr>
<td></td>
<td>230 km/h, 3,0/4,0 MW</td>
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</table>

<table>
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<tr>
<th>ICx</th>
<th>19 trains since 2001</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>107 m, 195 seats</td>
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<tr>
<td></td>
<td>200 km/h, 2,0 MW</td>
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</table>

<table>
<thead>
<tr>
<th>ICE TD</th>
<th>45/85 trains from 2016</th>
</tr>
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<tbody>
<tr>
<td></td>
<td>200/343 m, 500/724 seats</td>
</tr>
<tr>
<td></td>
<td>200/250 km/h, 5,0/8,3 MW</td>
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</tbody>
</table>
Thank you

Dipl.-Ing. Ottmar Grein

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Back Up
The Berlin – Hamburg Line gives a good example for our focused Investment Strategy

Case Study: Berlin – Hamburg

- Upgrade of an existing Railway Line
- Mixed Operation
- Terrain: rather flat
- Length: 270 km
- Operational: Speed 230 km/h
- Travel Time: 90 min.

- Investments: 650 mio. €
- Costs per Km: 2.4 Mio. € per km
In flat terrain also High Speed Lines have reasonable costs

Case Study: Berlin – Hannover

- New Construction of a High Speed Line
- Mixed Operation
- Terrain: rather flat
- Length: 260 km
  (200 km new, 70 km upgrade)
- Operational Speed: up to 250 km/h
- Travel Time: 90 min.
- Costs per Km: 9.7 Mio. € per km
Hilly terrain is a challenging frame for High Speed Traffic and results in a higher construction effort

Case Study: Frankfurt – Köln

- New Construction of a High Speed Line
- Passenger Dedicated High Speed Line
- Terrain: hilly
- Length: 180 km
- Operational Speed: 300 km/h
- Travel Time: 75 min.
- Costs per Km: 28.3 Mio. € per km
### Improved international rail service on various corridors – on main lines product upgrade to ICE

**International services DB Fernverkehr**

- **Status:** schedule year of 2010
- **Figures:** number of daily connections in day traffic
- **Significant enhancements in past years**

#### Projects realized

**2007-2008**
- 2-hourly ICE T service Stuttgart-Zürich
- Extension of services to Switzerland via Basel
- ICE service to Denmark with direct link Berlin
- High-speed services to Paris by ICE/TGV
- 2-hourly ICE T service Frankfurt-Vienna

**2009-2010**
- 3 additional connections Berlin - Amsterdam
- Double frequencies Munich-Vienna, railjet launch
- New direct connections to Klagenfurt/Graz
- Acceleration of ICE services to Brussels
- 2-hourly IC bus Nuremberg – Praha
- Restructuring of Brenner services to Italy with ÖBB/FNM – including launch of marketing unit
Improved international rail service on various corridors