UIC DIGITAL DAY
Paris, 7 October 2016
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Digitalisation at DB – What is in it for Rail Freight?
UIC Digital Day

Dr. Markus Ksoll | Deutsche Bahn AG | October 2016
Agenda

Digitalisation at DB

Focus on Freight

Summary
## Overview of revenues, EBIT and employees of DB and its business units 2015

### Revenues 2015 (m. €)

<table>
<thead>
<tr>
<th>Business Unit</th>
<th>Revenues 2015 (m. €)</th>
</tr>
</thead>
<tbody>
<tr>
<td>DB Long Distance</td>
<td>3,951</td>
</tr>
<tr>
<td>DB Regional</td>
<td>8,670</td>
</tr>
<tr>
<td>DB Arriva</td>
<td>4,843</td>
</tr>
<tr>
<td>DB Cargo</td>
<td>4,767</td>
</tr>
<tr>
<td>DB Schenker</td>
<td>15,451</td>
</tr>
<tr>
<td>DB Netze Track</td>
<td>5,110</td>
</tr>
<tr>
<td>DB Netze Stations</td>
<td>1,199</td>
</tr>
<tr>
<td>DB Netze Energy</td>
<td>2,812</td>
</tr>
<tr>
<td>DB Services</td>
<td>3,192</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>40,468</strong></td>
</tr>
</tbody>
</table>

### EBIT 2015 (m. €)

<table>
<thead>
<tr>
<th>Business Unit</th>
<th>EBIT 2015 (m. €)</th>
</tr>
</thead>
<tbody>
<tr>
<td>DB Long Distance</td>
<td>164</td>
</tr>
<tr>
<td>DB Regional</td>
<td>669</td>
</tr>
<tr>
<td>DB Arriva</td>
<td>270</td>
</tr>
<tr>
<td>DB Cargo</td>
<td>-183</td>
</tr>
<tr>
<td>DB Schenker</td>
<td>395</td>
</tr>
<tr>
<td>DB Netze Track</td>
<td>578</td>
</tr>
<tr>
<td>DB Netze Stations</td>
<td>254</td>
</tr>
<tr>
<td>DB Netze Energy</td>
<td>66</td>
</tr>
<tr>
<td>DB Services</td>
<td>70</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>1,759</strong></td>
</tr>
</tbody>
</table>

### Employees 2015 [fte²]

<table>
<thead>
<tr>
<th>Business Unit</th>
<th>Employees 2015 [fte²]</th>
</tr>
</thead>
<tbody>
<tr>
<td>DB Long Distance</td>
<td>16,217</td>
</tr>
<tr>
<td>DB Regional</td>
<td>36,494</td>
</tr>
<tr>
<td>DB Arriva</td>
<td>46,484</td>
</tr>
<tr>
<td>DB Cargo</td>
<td>30,303</td>
</tr>
<tr>
<td>DB Schenker</td>
<td>66,327</td>
</tr>
<tr>
<td>DB Netze Track</td>
<td>45,972</td>
</tr>
<tr>
<td>DB Netze Stations</td>
<td>4,982</td>
</tr>
<tr>
<td>DB Netze Energy</td>
<td>1,726</td>
</tr>
<tr>
<td>DB Services</td>
<td>24,771</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>297,202</strong></td>
</tr>
</tbody>
</table>

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1 As of December 31, 2015; 1 Difference between total for divisions and DB Group due to other activities/consolidation (revenues, EBIT) and other (employees); 2 full time equivalent

Deutsche Bahn AG
Since 1994 German rail freight has seen strong growth - however, with less dynamics in latest years.

**Volumes sold rail passenger transport**
Germany, in bn passenger kilometers

<table>
<thead>
<tr>
<th>Year</th>
<th>1994</th>
<th>1995</th>
<th>1996</th>
<th>2013</th>
<th>2014 (^1)</th>
<th>2015 (^1)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Values</td>
<td>65.2</td>
<td>71.0</td>
<td>71.7</td>
<td>89.6</td>
<td>89.6</td>
<td>89.6</td>
</tr>
</tbody>
</table>

**Volumes sold rail freight transport**
Germany, in bn tonne kilometer

<table>
<thead>
<tr>
<th>Year</th>
<th>1994</th>
<th>1995</th>
<th>1996</th>
<th>2013</th>
<th>2014 (^1)</th>
<th>2015 (^1)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Values</td>
<td>70.6</td>
<td>69.6</td>
<td>68.1</td>
<td>112.6</td>
<td>112.6</td>
<td>114.3</td>
</tr>
</tbody>
</table>

1 Own estimation, as of March 2016, 16
5 Deutsche Bahn AG
„We are facing the most radical CHANGE since Rail Reform.“

Rüdiger Grube
In order to best exploit the benefits of digital transformation, DB has introduced six 4.0 initiatives and a competence center. The initiatives currently span 260 digitalization projects. Major objectives are: Customer centricity and operational excellence. New innovation culture serves as an enabler. 

Digitalization Competence Center
Central platform under the auspices of the CEO to coordinate the initiatives and facilitate dialogue among them.
Among these digitalization activities, logistics 4.0 is specifically dedicated to freight – others also provide positive spill-overs.

**Mobility 4.0**

This initiative works to design new products with a focus on **customer centricity**, based on different scenarios for developments on the digital mobility markets. It also works to establish a strong **culture of innovation** as a foundation.

**Logistics 4.0**

This initiative uses **big data** and **smart assets** to develop a product portfolio for the future, **digital customer interfaces** and **web-based production processes**.

**Working Environments 4.0**

This initiative centers on overarching topics involved in **working, communicating and learning**. Potential future scenarios are drawn up for **job profiles**.

**Production 4.0**

This initiative focuses on the **automation** and digitalization of rail operations and maintenance.

**Infrastructure 4.0**

This initiative focuses on digitalization in infrastructure: end-to-end **connectivity with customers**, digital **process improvements** and the creation of new **business models**.

**IT 4.0**

This initiative works to develop a **smart, agile, effective, efficient** and **reliable IT landscape** for DB.
Agenda

Digitalisation at DB

Focus on Freight

Summary
Agenda

Focus on Freight

Overview

Data Analytics and Asset Intelligence

Automated Train Operations

3D Printing
Digital transformation through Logistics 4.0

1. Target picture: Logistics market of the future
   - Key developments
   - Business models
   - Competitive landscape

2. Product of the future
   - New digital solutions
   - Customer interface of the future

3. Optimized processes & assets
   - Data analytics
   - Asset intelligence
   - Automation
   - Workplace of the future

4. Enablers
   - DB Labs
   - Research cooperations
   - Customer innovation projects
Eight key developments in digitization will shape the future of transportation and logistics

<table>
<thead>
<tr>
<th>Logistics 4.0</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Digital workflows</strong></td>
</tr>
<tr>
<td>Paper based operations are replaced with digital workflows (e.g. in production processes)</td>
</tr>
<tr>
<td><strong>(Big) data analytics</strong></td>
</tr>
<tr>
<td>New technologies emerge to manage increasing volumes of heterogeneous data in short time</td>
</tr>
</tbody>
</table>

Focus in following examples
Agenda

Focus on Freight

Overview

Data Analytics and Asset Intelligence

Automated Train Operations

3D Printing
Intelligent Locos (TechLok)
Equip locomotive fleet with sensors and connect assets to integrated database (status: 600 of 2,000 locos)

Digital Detection
Provides staff with real-time damage information

Asset Intelligence Center
Build integrated Asset Intelligence System (locos & wagons); harmonise data formats; align interfaces; generate knowledge base and provide intelligence to optimize all business processes

Optimisation and automation of processes
TechLOK and Wagon Intelligence provide signals in operative systems across the entire value chain (e.g., operations and sales)

Wagon Intelligence
Equip wagon fleet with sensors and connect assets to integrated database (status: 500 of 90,000 wagon)

Semi automatic Damage Detection (SDW)
Provides staff with real-time damage information

Digital Detecton
Provides staff with real-time damage information

Asset Intelligence

RAM-LCC Analysis
Continuously detects optimisation potential with LCC-mapping for fleet-planning and technical improvements

Condition Based Maintenance
Optimise maintenance rules, knowledge, processes and timing

Regelwerk 4.0
Provide digital and flexible maintenance rules and CBM-knowledge in a data model with fast adoption; make specific information available on tablets in maintenance yards

Workshop Management System
Digitisation and automation of orders and resource logistics in maintenance yards

Optimisation and automation of processes
TechLOK and Wagon Intelligence provide signals in operative systems across the entire value chain (e.g., operations and sales)

Digital Fleet Management
Bundles condition-based requirements and matches it with maintenance capacities
Use case specific data is generated at the locomotive and handled for all fleets at DB Cargo Asset Control Tower.

Data collection and off-boarding

Generate Data

Transfer/Receiver

Storage

Generate Business Value

Analytics

Use Cases

Collect Data

Utilize Data

On Board Computer
VCU / Component / Sensor Interface
Data reduction
GPS mapping
Alerts
Get equipment data Forward to landside

Production Dashboard
Dashboard Layer
Rule Engine
Map-Reduce & Data Indexer
Real Time Diagnostics
Real time fleet supervisor and predictive analytics

Business Logic: Rules & Algorithms

Machine Learning
Automated Algorithms

Gain Knowledge by Machine learning

Equipment Model & Technical experience

Work group

Gain knowledge from technical, maintenance experience

Data Warehouse
Multi Provider

SAP ISI
CIF / FRED
ESM
Energy
Weather
Track

Provide data for evaluation

Train driver via Tablet PC

GSM Gateway / Firewall / DMZ

Fleet Control Engineering Workshops Operation

TechLOK

Deutsche Bahn AG | V.CBA | Assets & Maintenance Digitization
Focus on Freight

Overview

Data Analytics and Asset Intelligence

Automated Train Operations

3D Printing
The European rail freight sector is lagging behind in the development of automated operations.

Various autonomous vehicle pilots on roads

- Google “Self Driving Car”
- Mercedes-Benz F 015 Luxury in Motion research car
- A7 Sportback piloted driving concept
- Scania
- Autonomous Truck Convoys
- Volvo

Automated train operations

- Automated metros running worldwide
  - “It’s not a lack of technology that’s keeping trains from going driverless.”
- In 2015, AutoHaul creates the world’s first fully-autonomous heavy haul, long-distance railway for iron ore transports in Australia
Automation is a major element of DB Cargo’s technology & innovation strategy - three development areas are targeted.

Key development areas

<table>
<thead>
<tr>
<th>Technologies</th>
<th>Functions</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Auto Control</strong></td>
<td>Access to control by an advanced auto-pilot plus remote control, harmonized with existing train control and monitoring systems</td>
</tr>
<tr>
<td><strong>Obstacle detection</strong></td>
<td>Detection of potential obstacles ahead of locomotive, through advanced signal technologies in order to comply with safety standards</td>
</tr>
<tr>
<td><strong>Self-diagnosis</strong></td>
<td>On-board monitoring of critical components plus additional system surveillance in order to guarantee reliable system functioning</td>
</tr>
</tbody>
</table>

**Integrated ATO allows for safe and reliable…**

- Efficiency increase by higher capacity utilization, energy savings and availability of resources
- Short-term adjustments and flexibility towards changing customers’ requirements
- Creation of attractive job profiles and new opportunities in dealing with labor market trends

**Testing of ATO functions will take place in three-stage approach:**

1. Test of basic auto control functions on separate test ring and shunting yard (humploco)
2. Test of auto control and obstacle detection on German network with mainline loco
3. Test auf full ATO system requirements on international freight corridor
ATO currently in several pilots

**Mainline ATO on LZB**
Ziel der Stufe 1 des Projektes ist GoA2 (Autopilotfunktion) im produktiven Betrieb auf geeigneten Lokomotiven und Streckenabschnitten einzuführen.

- **2016**: Demo, PCW
- **2017**: Entwicklung
- **2018**: Zulassung
- **2019**: Probebetrieb

**Obstacle Detection Technologies**
Demonstrator ATO auf Vectron im Prüfcenter Wegberg-Wildenrath

- **2016**: Demo, PCW
- **2017**: Kontinuierliche Weiterentwicklung geeigneter Systeme für Hinderniserkennung
- **2018**: 2019

**Assistance under PZB / Fassi 4.0**
Pilotprojekt der Erzgebirgsbahn zur Signal- und Hinderniserkennung im Regionalverkehr

- **2016**: Fzg-Umbau
- **2017**: Testbetrieb
- **2018**: Regelbetrieb?

**Automation Pilot DB Cargo**
*Example Automated Humploco*
Automatisierter Rangierbetrieb, Rbf München Nord

- **2016**: Techn. Konzept
- **2017**: Demonstration, Zulassung und Rollout
- **2018**: 2019
Example: DB Cargo develops automated shunting yard with humploco in München Nord

Dieselloco Baureihe 290

- **Command of Loco via Onboard Computer** enables fully automated operation
- Equipment of Loco and/or infrastructure with sensors to detect obstacles in near field (radar, camera)

**Technology**

**Approach**

- **Step 1, 2017**: Fully automated humploco with obstacle detection (demonstration)
- **Step 2, 2018/19**: Pilot operations and licencing
- **Stufe 3, 2019/20**: Rollout in further/ all shunting yards
Agenda

Focus on Freight

Overview

Data Analytics and Asset Intelligence

Automatic Train Operations

3D Printing
"3D printing has the potential to revolutionize the way we make almost everything"
(Barack Obama, US President, State of the Union 2013)
3d printing consists of more than 20 different technologies

3D printing / Additive Manufacturing

*Fused Deposition Modeling (FDM)*

*Selective Laser Melting (SLM)*

Quelle: i.materialise.com/  
Quelle: EOS GmbH
How does it work?
“A process of joining materials to make objects from 3D model data, usually layer upon layer […]“
Wide range of applications - use cases

**Rapid Prototyping**
- Tunnel model
- Acceleration of:
  - Decision making
  - Time to market

**Rapid / Direct Manufacturing**
- Junction box
- Improvement of:
  - Obsolescence management
  - Availability
  - Downtime

**Rapid Tooling**
- Sandform / sand mould
- Reduction of:
  - Tooling costs
  - Process times
Target of DB project: 1,000 3D printed parts in 2016

Targets
- Sharing of knowledge and information
- Identification of use cases
- Enhancement of competences

Framework
- Start: May 2016
- Target group: maintenance service of all business units
It all started with a simple hook hanger...
Use case: Partial substitution of spare parts within a component

Dust protection cap
(ca. 7 x 7 x 2 cm)

- Red cap: For closing brake lines on various vehicles for track works
- Cap often breaks in operations and cannot be purchased seperately
  → in the past: the whole coupling head had been exchanged
    (incl. Brake test, lake test)
- Constructive optimization of part, field tests coordinated
  → in future: exchanging caps without additional amount of work
Use case: Faster procurement process by printing casting moulds

**Lever**  
(ca. 50 x 10 x 20 cm)

- Heavy-duty brakes automation for freight wagons  
- Castings for cost reduction  
- Testing 3d-printing technology of sand moulds (Rapid Tooling)  
- Conventional cast in original alloy, additional machining/ lack of original data
3 kinds of effects on business model of 3D-printing

Overview of effects

Potential 3D-printing

- Financial effects
  - Reduction component costs
    - small quantities
- Prozess effects
  - Shorten delivery time
- Quality effects
  - Additional Sourcing for obsolete parts
  - Improve product characteristics
  - Stronger negotiation position

Potential

Quick-Wins        midterm        longterm

Reduction downtime costs
- Cost reduction via partial substitution
- Improved procurement conditions
- Faster post-accident repairs
- Reduction standstill

Innovation strength
On-site production
Criteria for 3D printable spare parts

1. Cases of application
   - Obsolete components
   - Low Volume with high costs (incl. Non-recurring costs)
   - Accident repair
   - Prototype

2. Requirements to the component
   - Regardless of the security relevance
   - Simple or complex geometry
   - Conventional production is cost intensive

3. Availability
   - Reduce system failure (train, locomotive, etc.)
   - Replace components with long delivery times

4. Specification for production
   - According to manufactures specifications
   - Including reverse engineering
   - Optimized parts

5. Materials
   - Tool & stainless steels, aluminum (Titanium, Inconel, CoCr)
   - Polyamide, ABS, PEEK, Ultem (flame-retardent)

6. Maximum component size
   - 914 x 610 x 914 mm plastic
   - 630 x 400 x 500 mm aluminum
   - 250 x 250 x 300 mm steel
DB initiated network for 3D printing of spare parts, called “Mobility goes Additive”

- First Meeting of founders (app. 15)
  - Objectives: get to know each other, network-staffing
  - Topics: strategic orientation and organization
  - Where: Bahntower, Berlin, Germany

- Press conference with founding members

- 1. conference of all network members (at the moment) and potential members, print-providers
  - Objectives: increase their recognition, acquisition of new members, networking, sharing expertise
  - Up to 150 participants of the industry, policy, research
  - Panel discussion, speeches, startup pitches, exhibition
  - Where: Kaiserbahnhof, Potsdam, Germany

- Objectives
  - Contacts and best practises
  - Standardisation and approval
  - Setting legal frameworks (IP rights, liability, warranty)
  - Generating R&D funds

- 1st working Session „Mobility goes Additive“
  - Specific collaboration on network main topics
  - Where: Red Dot Design Museum, Essen, Germany
  - Invitation by materialise
Currently, more than 40 partners are on board, if you like to join …

... please contact:
Stefanie Brickwede
Head of 3Dprinting@db and „Mobility goes Additive“
Stefanie.Brickwede@deutschebahn.com
Agenda

Digitalisation at DB

Focus on Freight

Summary
3 Key Messages

- Digitalisation is of high relevance to railfreight markets and production - DB is taking it as a great opportunity

- Customer centricity and operational excellence are major objectives - culture and speed of innovation are crucial factors

- Major fields of action in railfreight are data analytics/ asset intelligence and automation in mainline/ shunting operations - many projects already launched
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