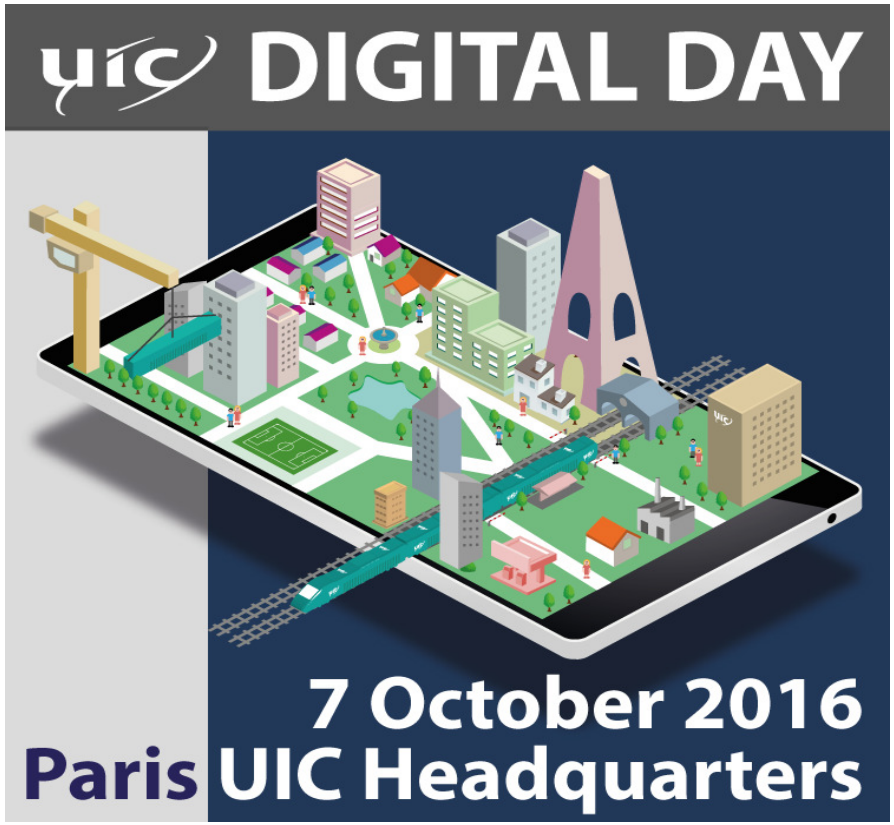
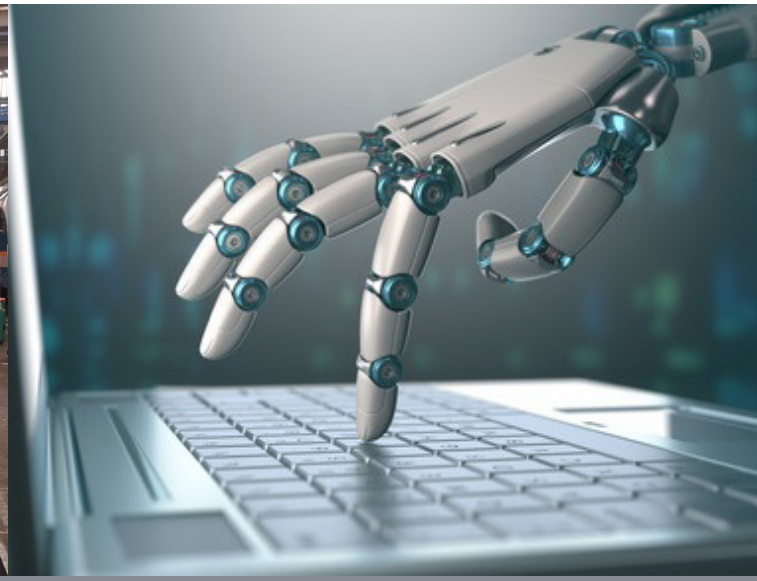


UIC DIGITAL DAY
Paris, 7 October 2016

I'M A DIGITAL RAILWAY





Digitalisation at DB – What is in it for Rail Freight?

UIC Digital Day

Dr. Markus Ksoll | Deutsche Bahn AG | October 2016

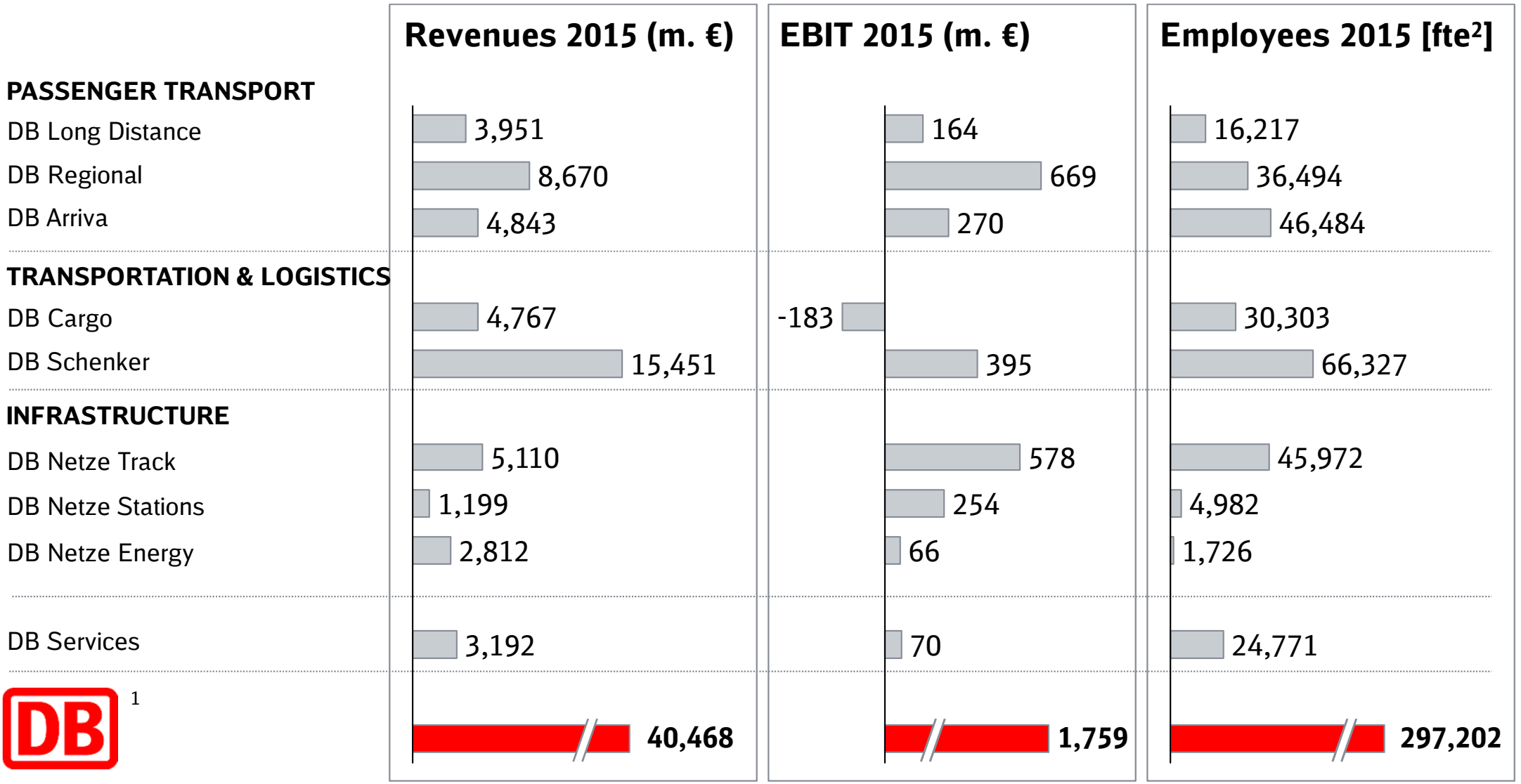
Agenda

Digitalisation at DB

Focus on Freight

Summary

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



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

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

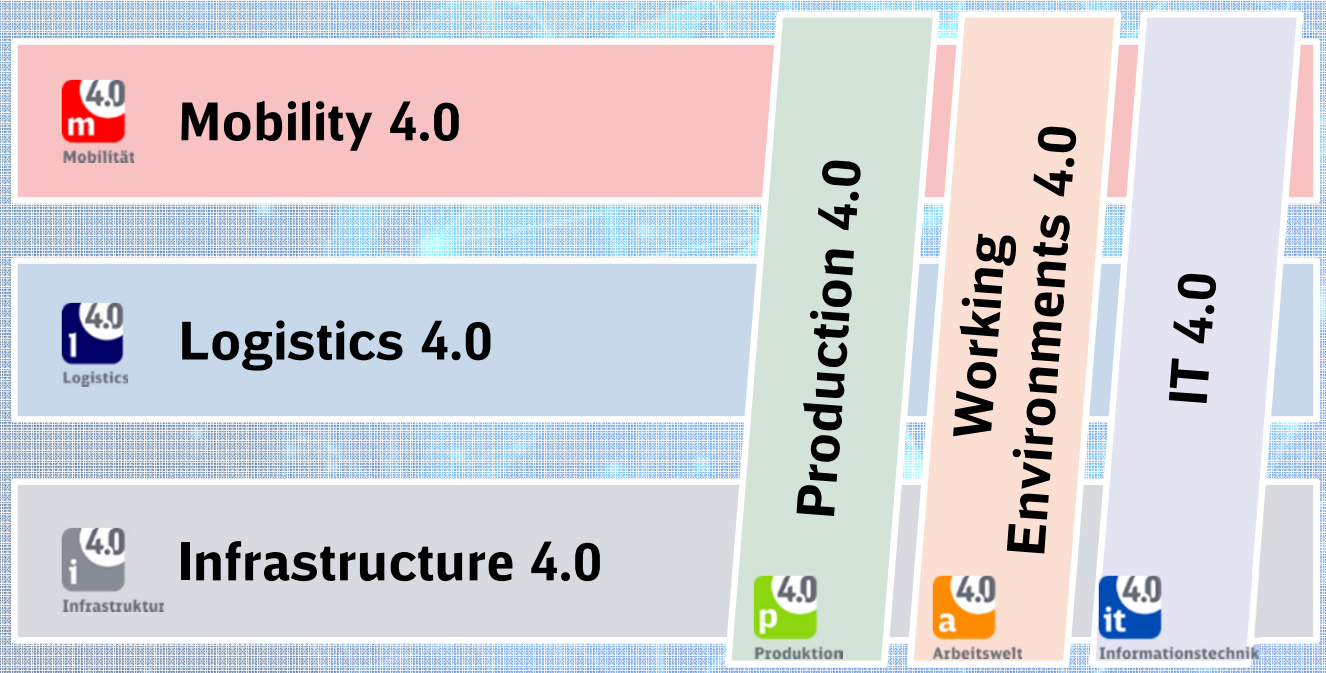
Volumes sold rail freight transport

Germany, in bn tonne kilometer

1 Own estimation, as of March 2016, 16


„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



- Six 4.0 initiatives form the foundation for the digital transformation at DB
- 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

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**

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**

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

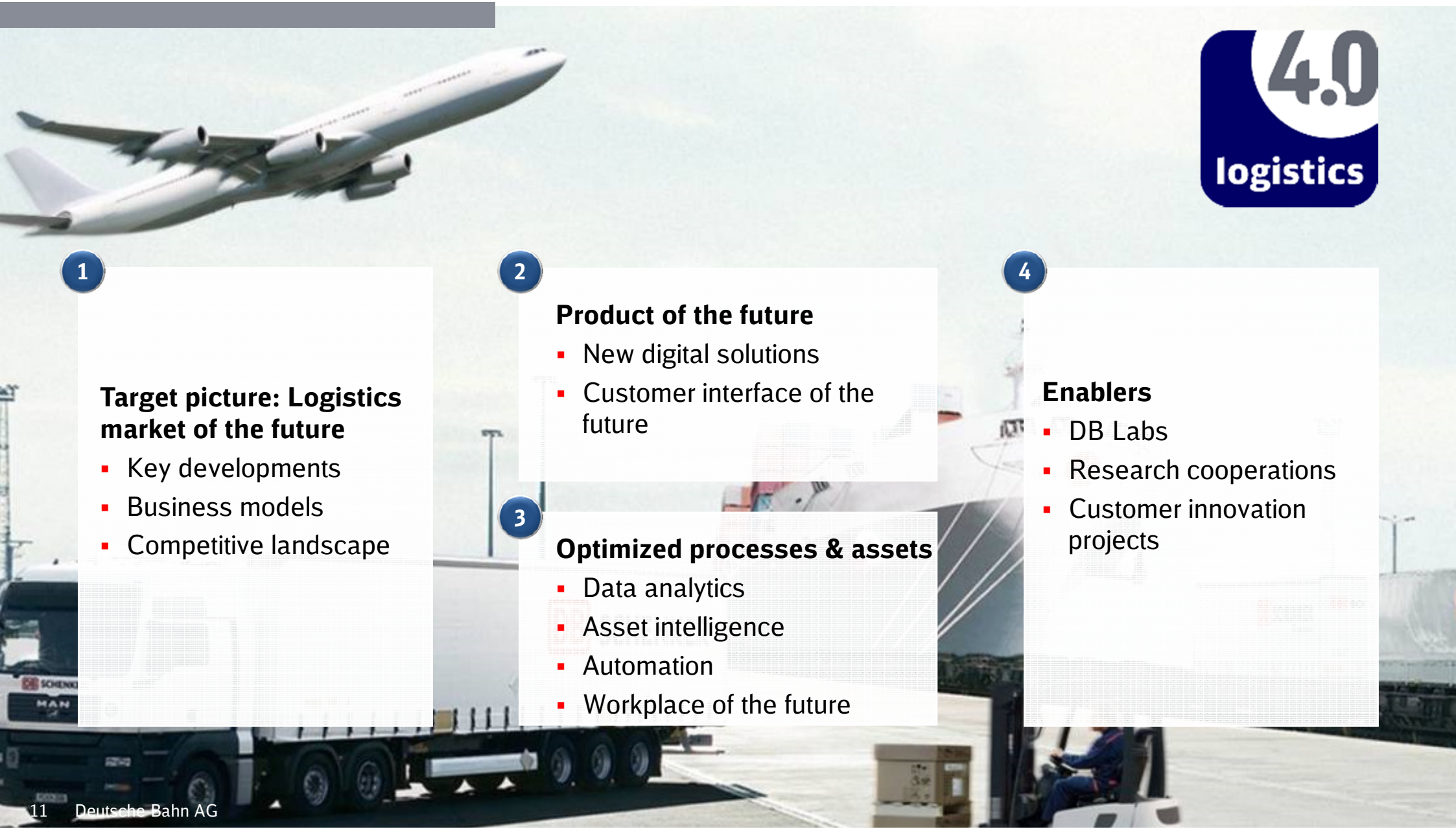
Overview

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

Logistics 4.0

Digital workflows

Paper based operations are replaced with digital workflows (e.g. in production processes)

Customer interaction

Customer interface will change due to increasing demand for transparency, visibility, real time information and convenience

Digital platforms

Online booking platforms will help to pool supply and demand and increase market transparency

E-commerce

Growth in e-commerce is offering opportunities in parcel / fulfillment business

(Big) data analytics

New technologies emerge to manage increasing volumes of heterogeneous data in short time

Asset intelligence

Assets are increasingly equipped with smart technologies / sensors which leads to permanent generation of data

Autonomization

Things will increasingly act and interact autonomously (e.g. automated vehicles, warehouses)

3D printing

3D printing (additive manufacturing) will change transport flows as well as sourcing of each sector

Focus in following examples

Agenda

Focus on Freight

Overview

Data Analytics and Asset Intelligence

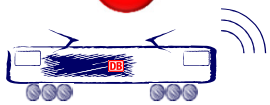
Automated Train Operations

3D Printing

Asset & Maintenance Digitization

Intelligent Locos (TechLok)
Equip locomotive fleet with sensors and connect assets to integrated database (status: 600 of 2.000 locos)

1



Digital Detection
Provides staff with real time damage information

2

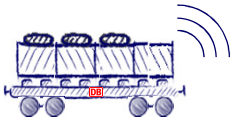
Asset Intelligence Center
Build integrated Asset Intelligence System (locos & wagons); harmonise data formats; align interfaces; generate knowledge base and provide intelligence to optimize all business processes

5

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

11

Asset Intelligence



3

4

Wagon Intelligence
Equip wagon fleet with sensors and connect assets to integrated database (status: 500 of 90.000 wagon)

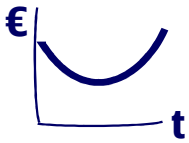
Semi automatic Damage Detection (SDW)
Provides staff with real time damage information

Live-Implementation

Digital Fleet Management
Bundles condition based requirements and matches it with maintence capacities

9

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



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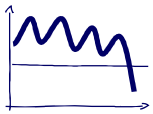
Data Analytics



7

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

8

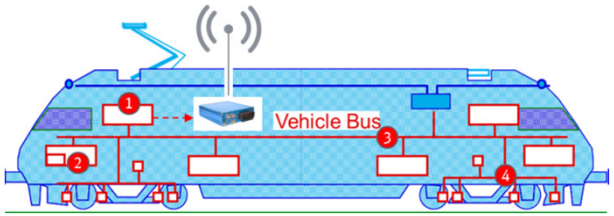
Regelwerk 4.0
Provide digital and flexible maintenance rules and CBM-knowledge in a data model with fast adoption; make speciffic information available on tablets in maintenance yards

10

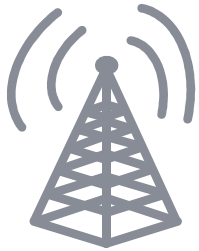
Workshop Management System
Digitization and automisation of orders and ressource logistics in maintence yards

Use case specific data is generated at the locomotive and handled for all fleets at DB Cargo Asset Control Tower

Generate Data → **Generate Business Value**

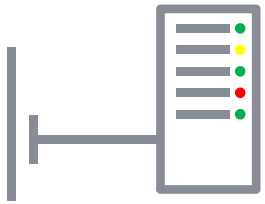


Data collection and off-boarding



Transfer/ Receiver

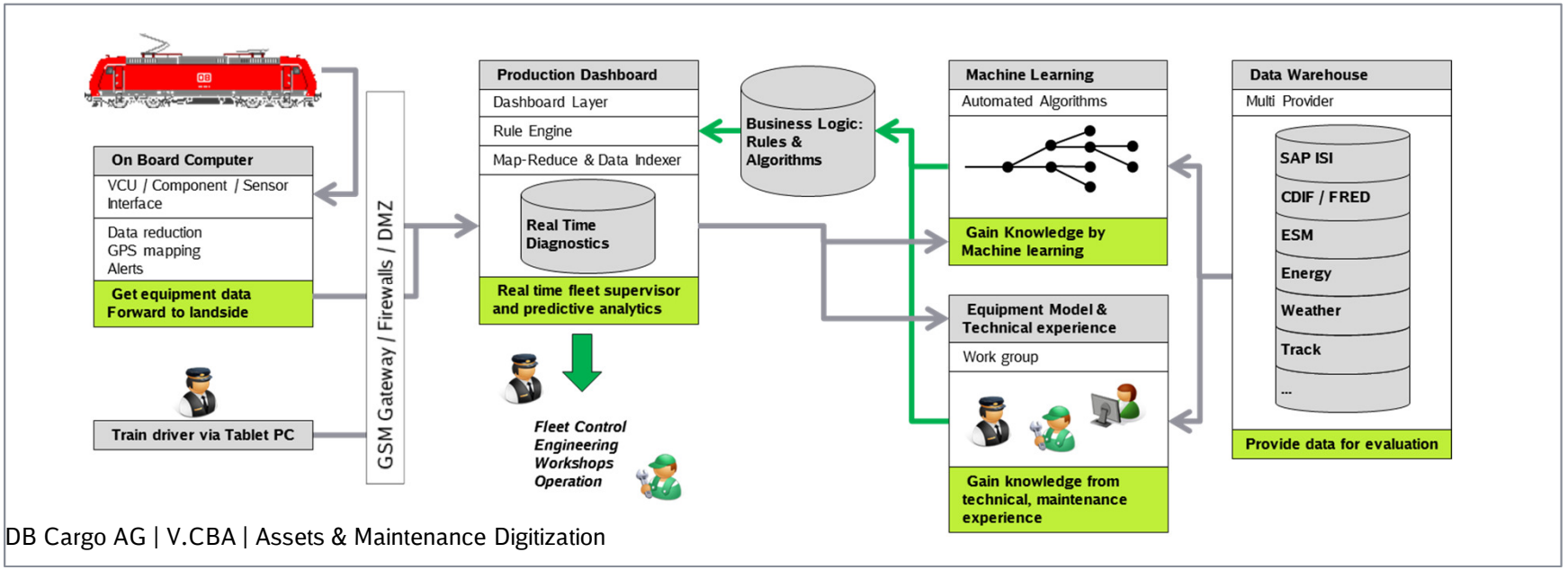
Storage



Analytics

Use Cases

Collect Data ← **Utilize Data**



DB Cargo AG | V.CBA | Assets & Maintenance Digitization

Agenda

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

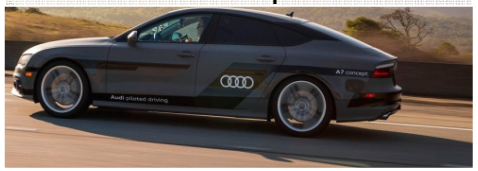
Various autonomous vehicle pilots on roads

Examples

Google „Self Driving Car

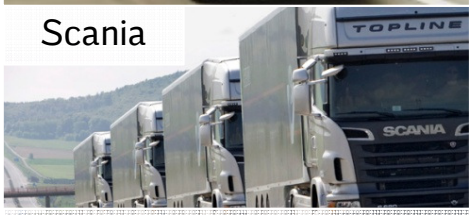
Mercedes-Benz *F 015* Luxury in Motion research car

A7 Sportback piloted driving concept



Mercedes-Benz Future Truck

Scania



Autonomous Truck Convoys

Volvo

Test track for autonomous driving vehicles

Automated train operations

Examples

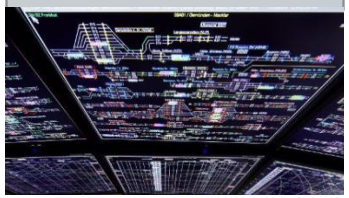
Automated metros running worldwide

"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 targetet

Key development areas

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

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

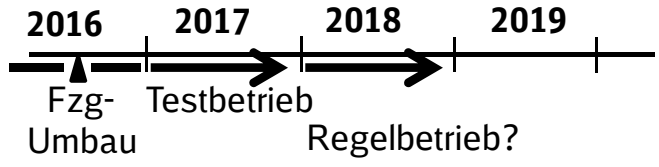
ATO currently in several pilots

Mainline ATO on LZB

Ziel der Stufe 1 des Projekte ist GoA2 (Autopilotfunktion) im produktiven Betrieb auf geeigneten Lokomotiven und Streckenabschnitten einzuführen

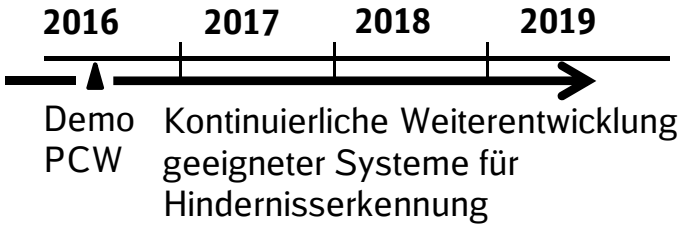
Assistence under PZB / Fassi 4.0

Pilotprojekt der Erzgebirgsbahn zur Signal- und Hinderniserkennung im Regionalverkehr



Obstacle Detection Technologies

Demonstrator ATO auf Vectron im Prüfcenter Wegberg-Wildenrath

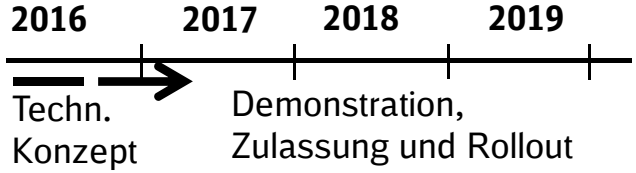


Next Slide

Automation Pilot DB Cargo

Example Automated Humploco

Automatisierter Rangierbetrieb, Rbf München Nord



Example: DB Cargo develops automated shunting yard with humploco in München Nord

Dieselloco Baureihe 290

Technology

- **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)

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

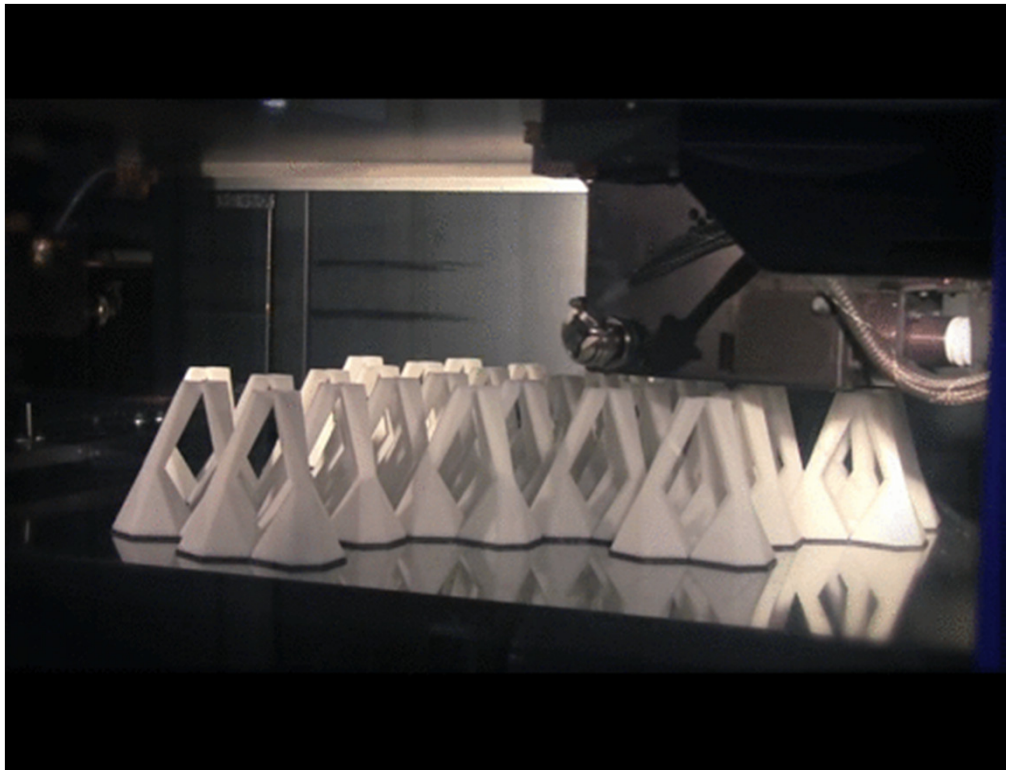
"3D printing has the potential to revolutionize the way we make almost everything"

(Barack Obama, US President, State of the Union 2013)

3d printing consists of more than 20 different technologies

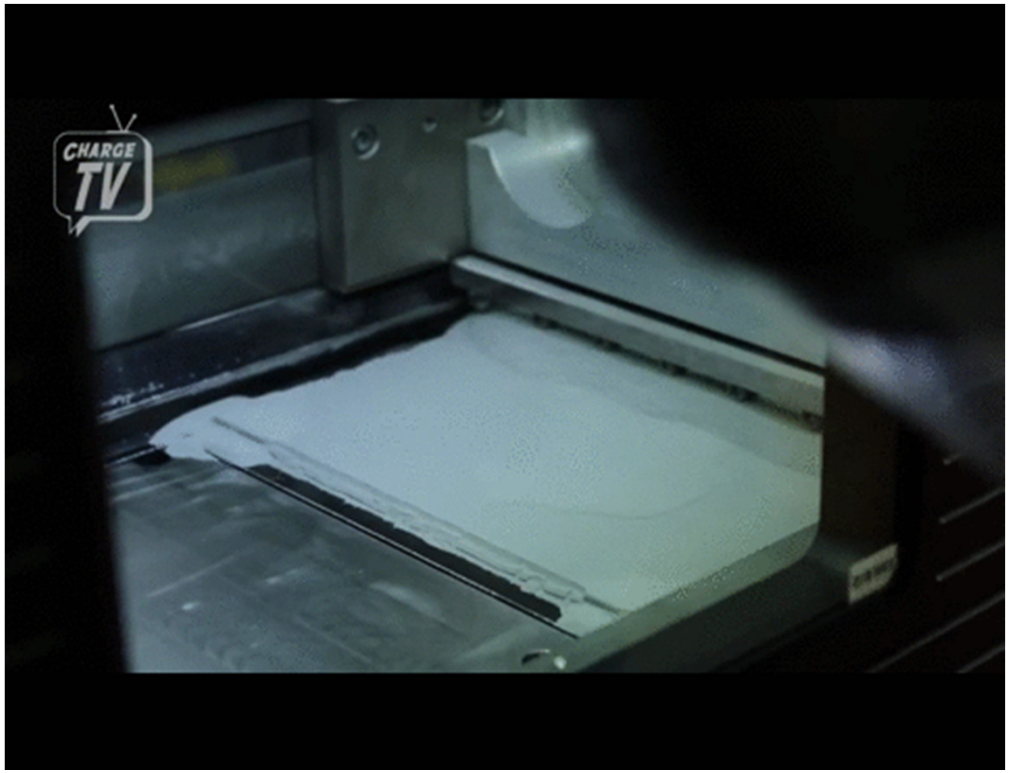
3D printing / Additive Manufacturing

Fused Deposition Modeling (FDM)



Quelle: i.materialise.com/

Selective Laser Melting (SLM)



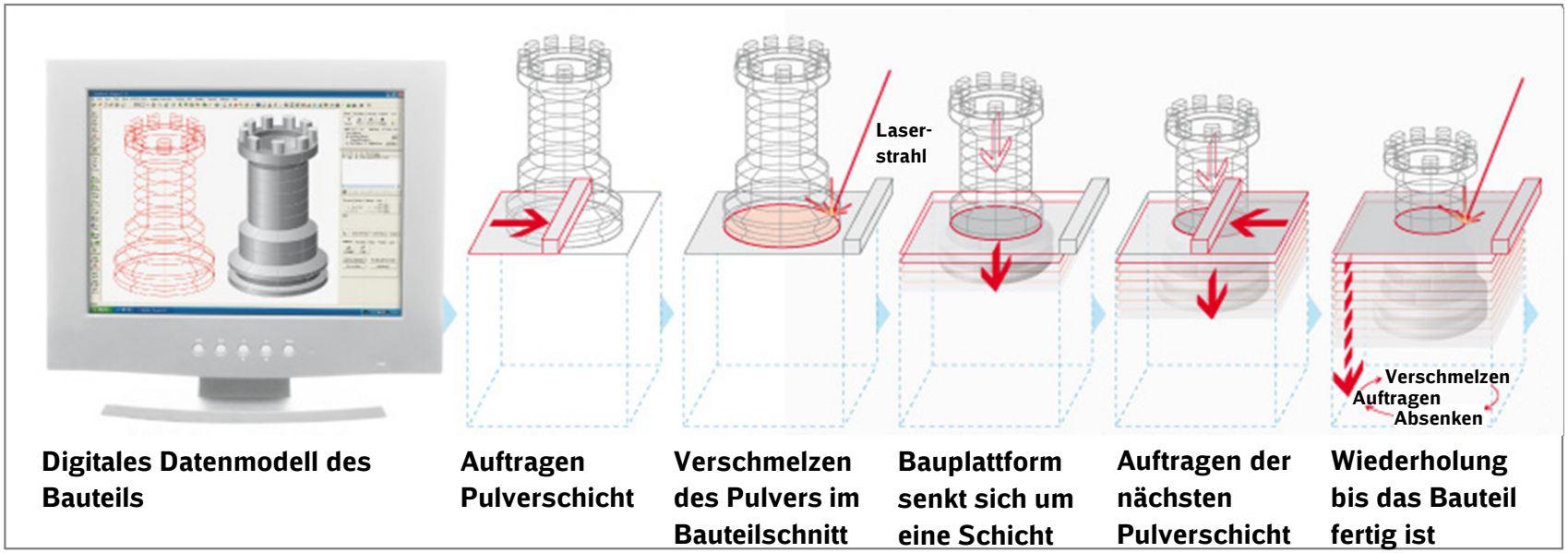
Quelle: EOS GmbH

How does it work?

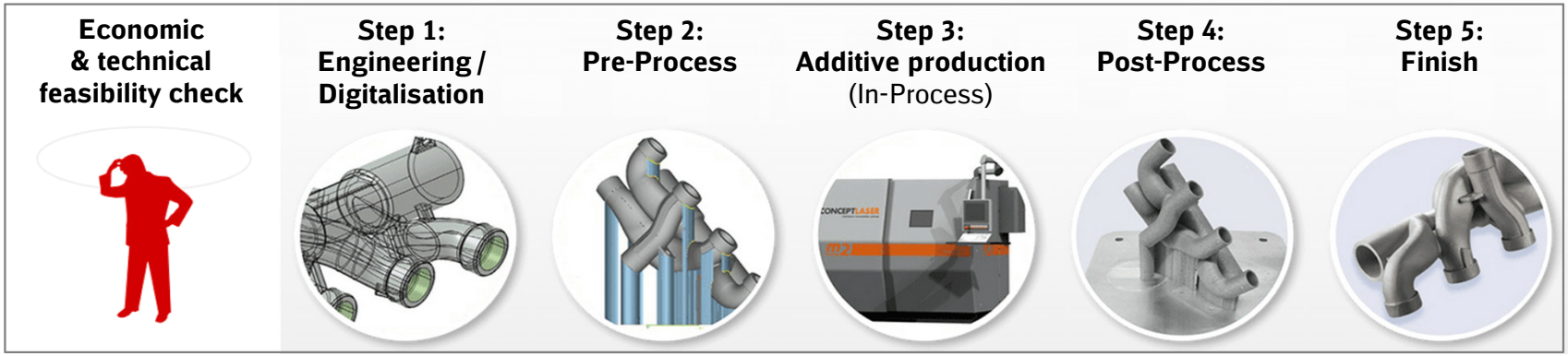
"A process of joining materials to make objects from 3D model data, usually layer upon layer […]"

Source: http://www.eos.info

Principle of Powderbed technology



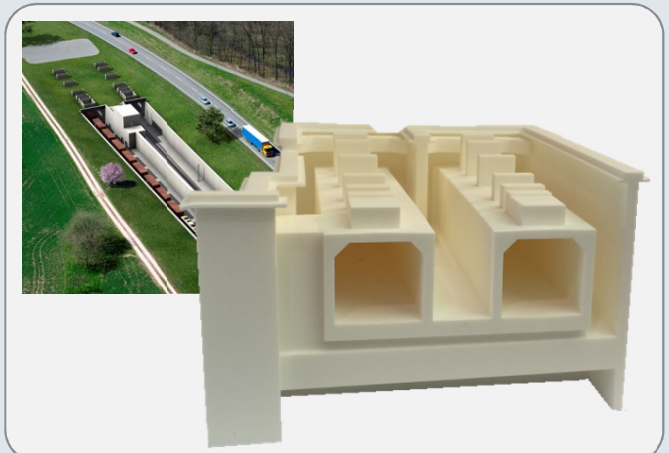
General Process



Source: http://www.3dprecision.ch

Wide range of applications - use cases

Rapid Prototyping



Tunnel model

Acceleration of

- Decision making
- Time to market

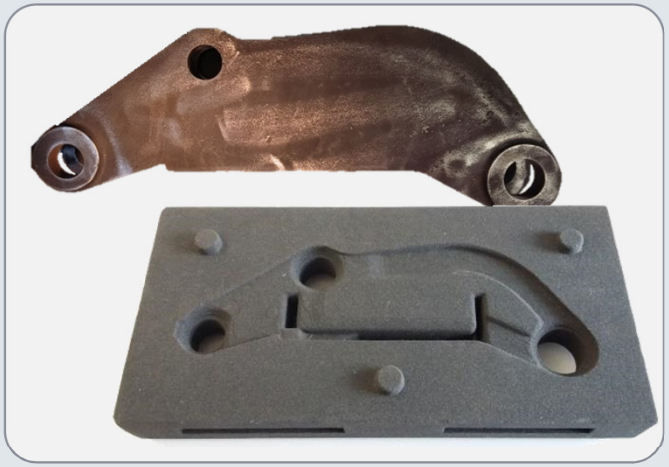
Rapid / Direct Manufacturing

Junction box

Improvement of

- Obsolescene 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

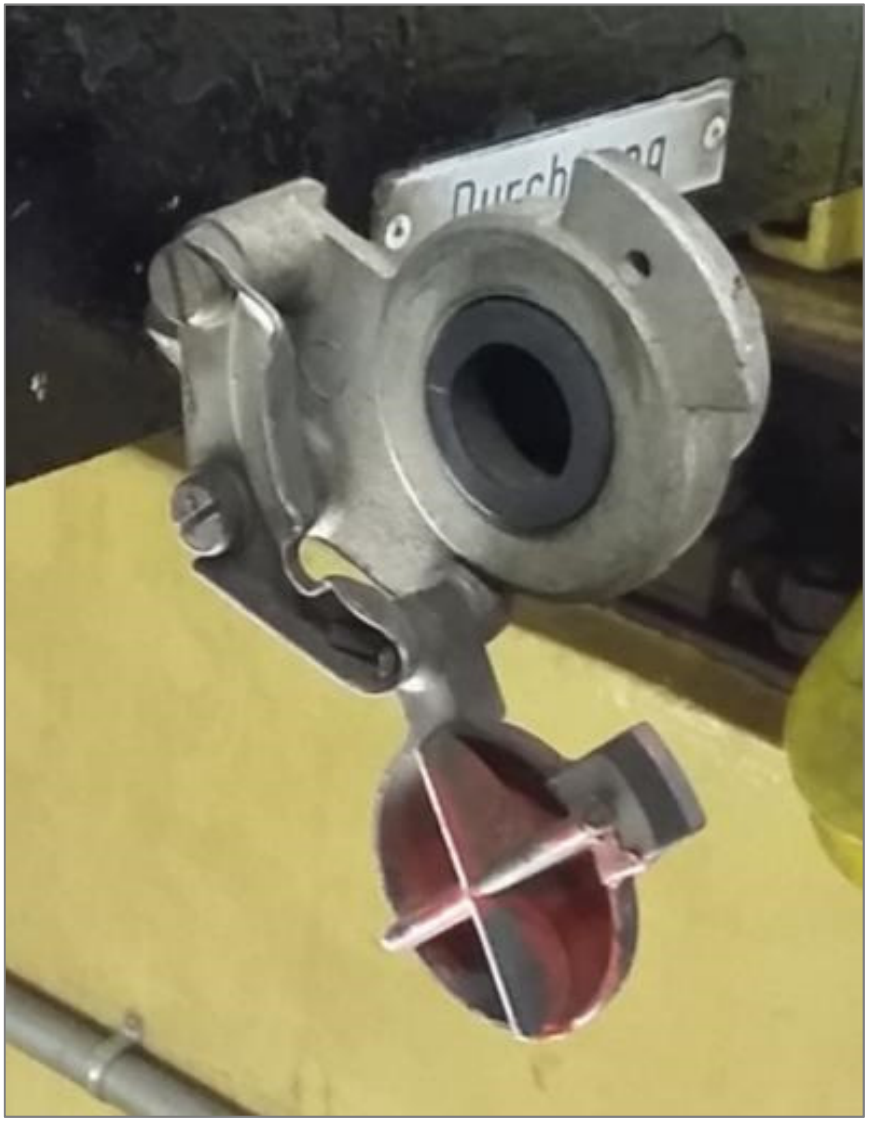
Framework

- Start: May 2016
- Targetgroup: maintenance service of all business units

ROADSHOW

It all started with a simple hook hanger…

Use case: Partial substitution of spare parts within a component



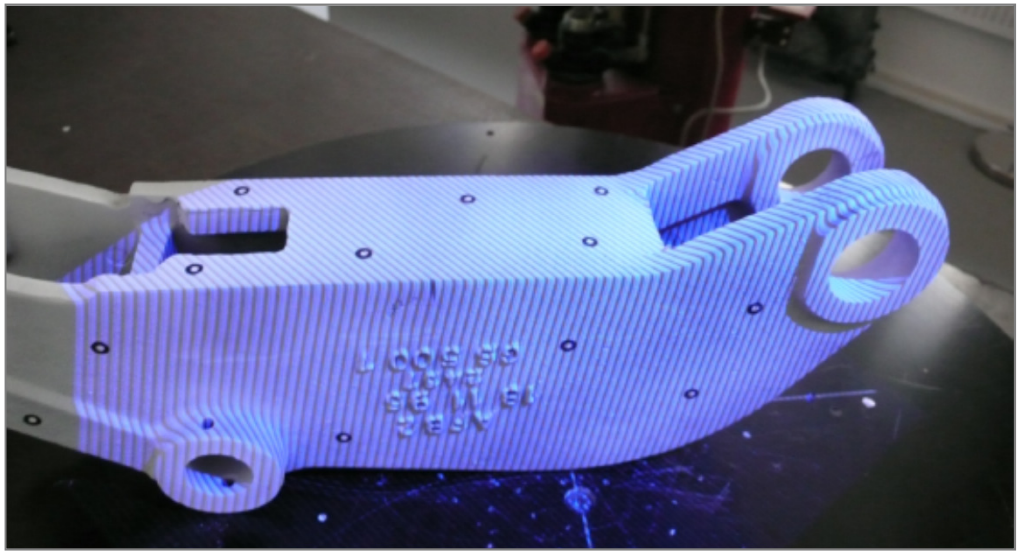
1:1 CAD-Modell

Optimised version

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 seperatly
  → 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

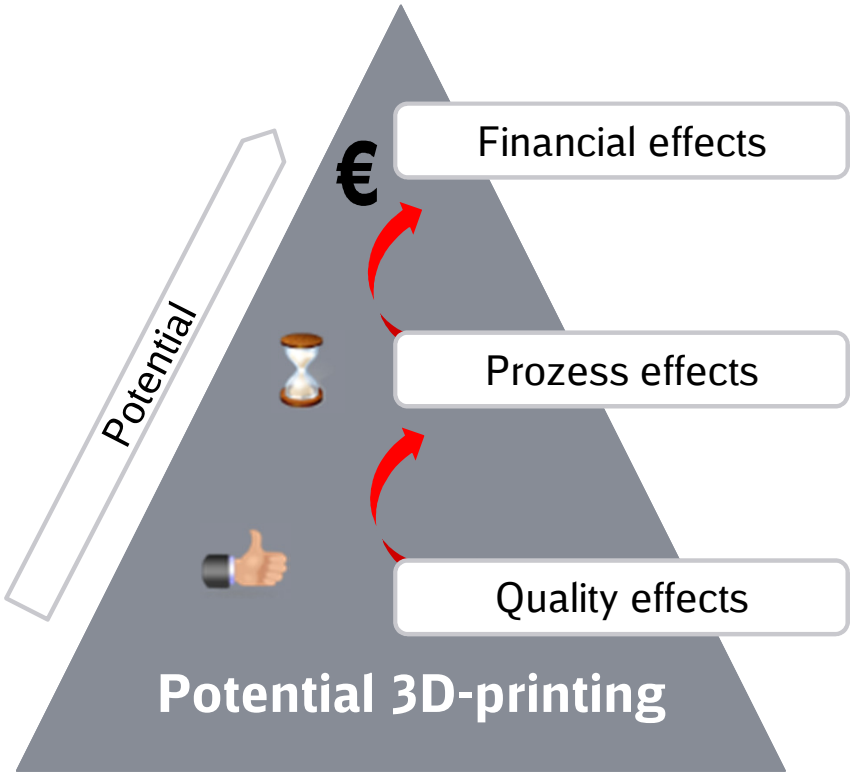


Lever
(ca. 50 x 10 x 20 cm)

- 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



Reduction component costs small quantities	Cost reduction via partial substitution	Improved procurement conditions	Reduction downtime costs
Shorten delivery time	Reduction Lead times	Faster post-accident repairs	Reduction standstill
Additional Sourcing for obsolete parts	Improve product characteristics	Stronger negotiation position	On-site production / Innovation strength

Quick-Wins — midterm — longterm

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

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

- 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

- 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

CUSTOMER

Optimize customer interface and increase customer value

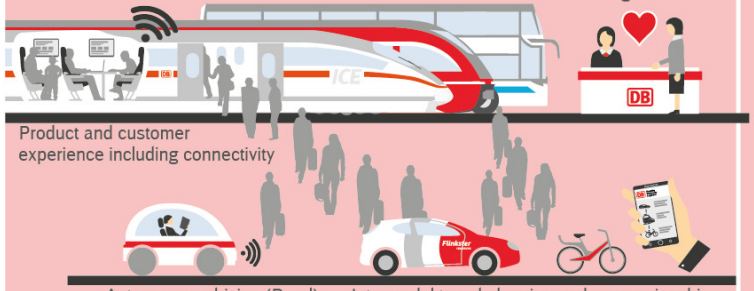
OPERATIONS

Optimize and develop production system

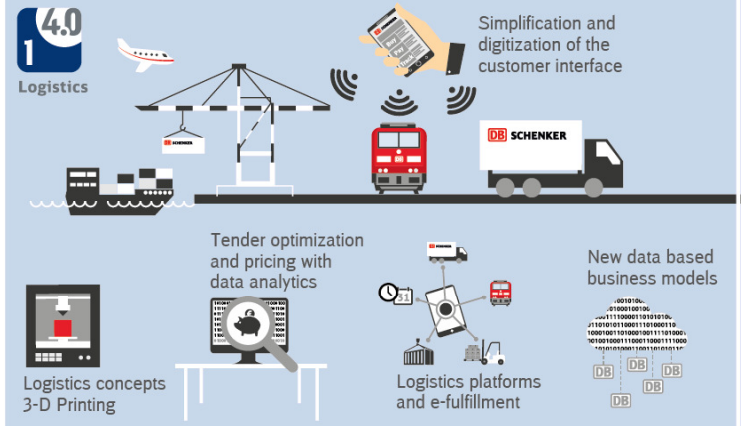
ENABLER

Provide comprehensive frameworks and conditions

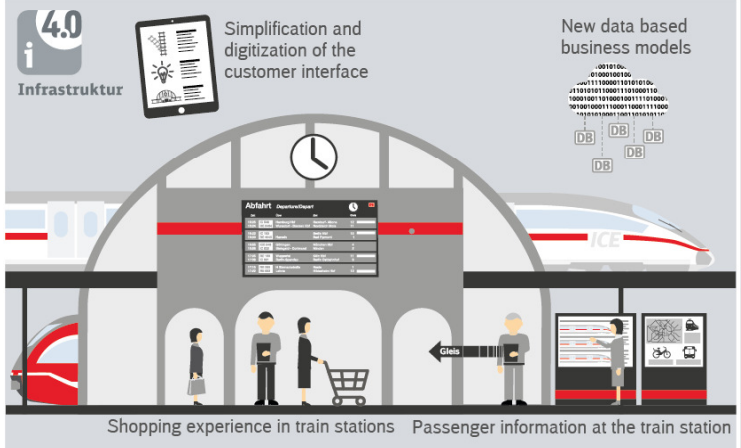
4.0 m Mobilität

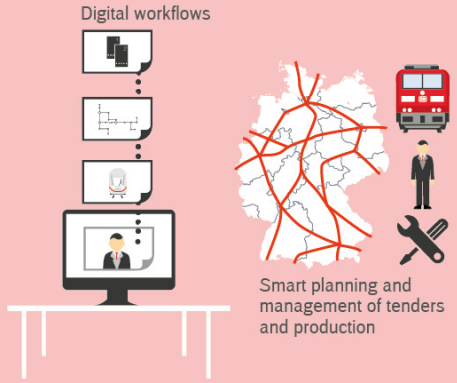


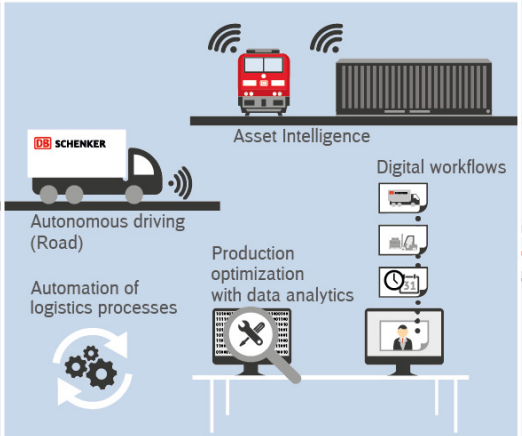
4.0 l Logistics

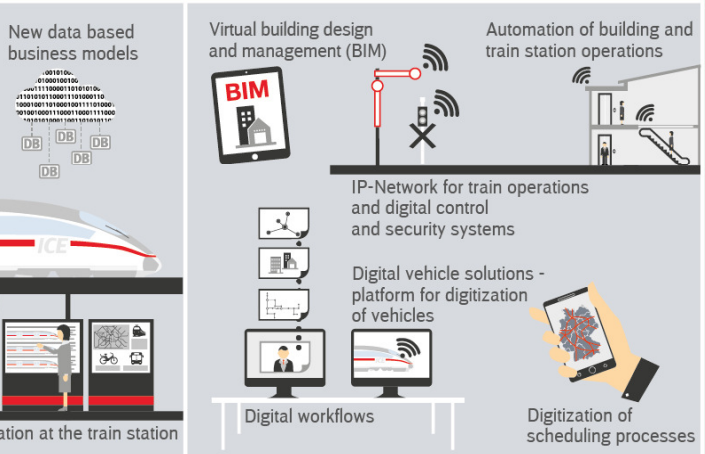


4.0 i Infrastruktur

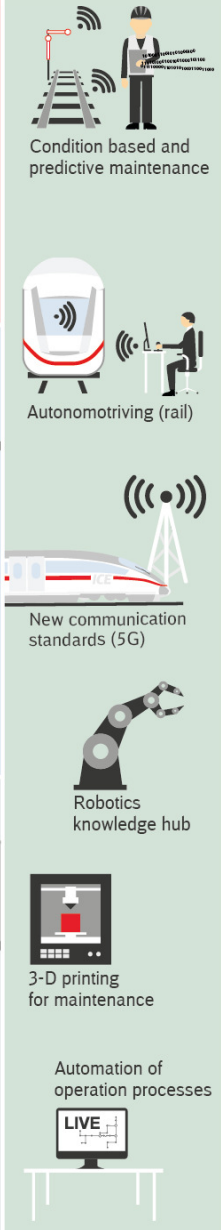




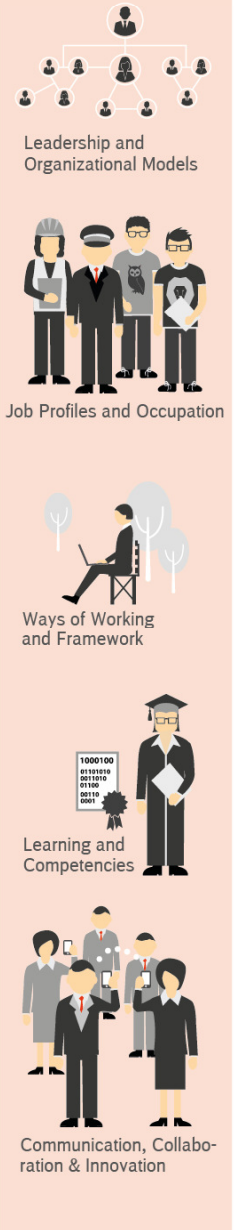




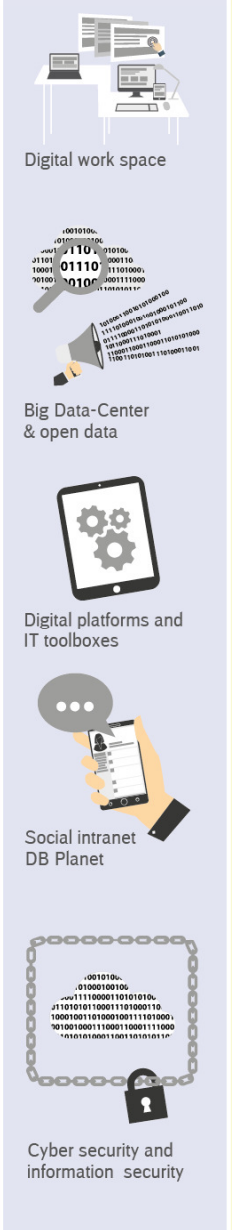
4.0 p Produktion

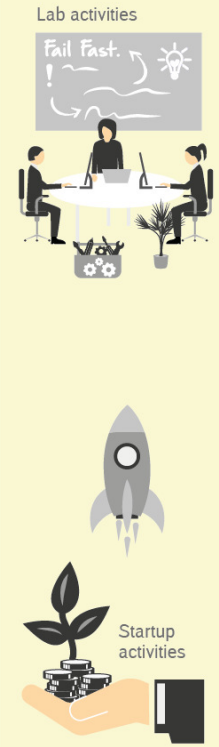


4.0 a Arbeitswelt



4.0 it Informationstechnik





DB Mobility Networks Logistics

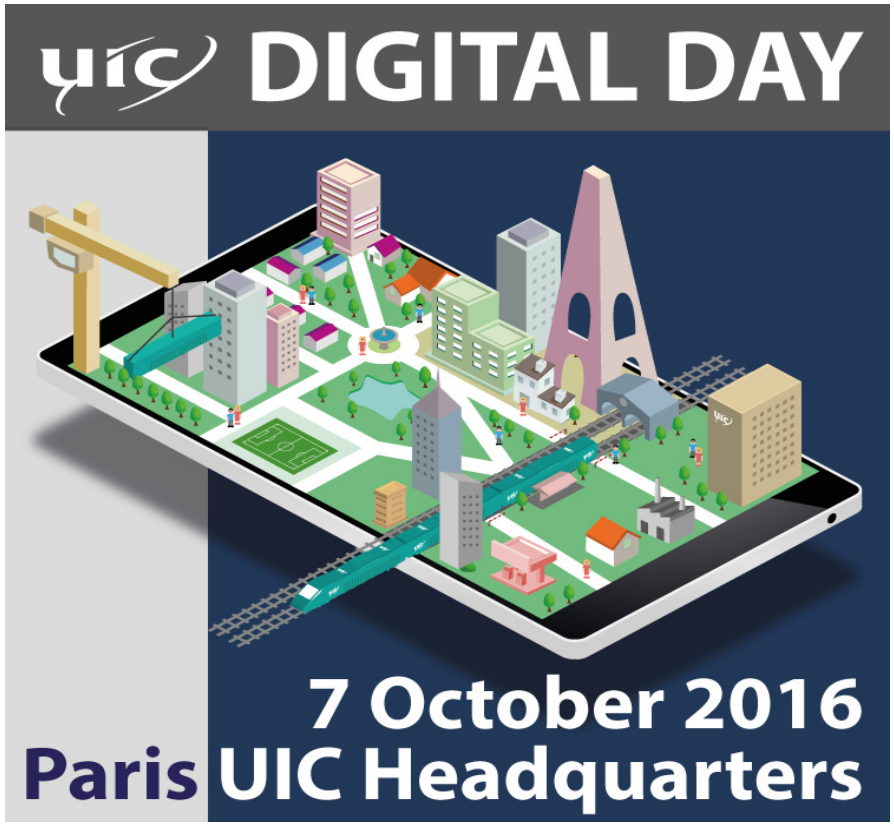
The digitization map shows the main topics of all 4.0 initiatives regarding digital transformation at Deutsche Bahn AG.

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



UIC DIGITAL DAY
Paris, 7 October 2016

I'M A DIGITAL RAILWAY