

Knorr-Bremse at railML – a short introduction

Looking for active Use Case Groups for Driver Advisory
Systems



Agenda

- **Knorr-Bremse AG and Rail Vehicle Systems (RVS)**
- Driver Advisory Systems in Europe
 - Organizational background at KB
 - Market study DAS in Europe in 2020
- Use Case Group involvement

Driven to create the best solutions

Rail Vehicle Systems

- High-speed trains
- Regional & commuter trains
- Metros
- LRVs
- Monorails
- Locomotives
- Passenger cars
- Freight cars
- Off-train

Commercial Vehicle Systems

- Trucks
- Trailers
- Buses
- Engines
- Special vehicles



Knorr-Bremse is based in 30 countries/regions around the world at more than 100 locations, some 80 of which are manufacturing facilities



* FTE at 31.12.2020

FY20: excellent performance in an extraordinary year

REVENUES OF **€ 6.16bn**
(-11.2% yoy)

18.0% EBITDA MARGIN
(PY: rep.19.2% / op. 18.8%)



€ 3.34bn



€ 2.82bn



22.9%



13.5%

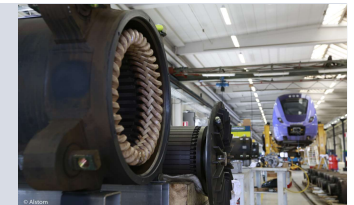


€ 729m FREE CASHFLOW
(yoy: -15.3% incl. SLB / +9.2% excl. SLB)¹

137% CCR²

ORDER INTAKE **€ 6.44bn**
(-8.8% yoy)

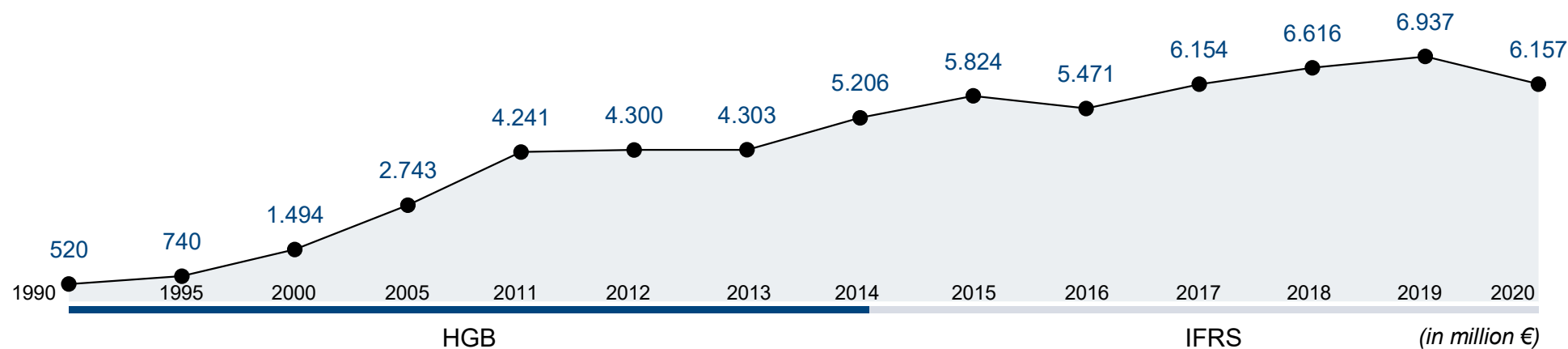
ORDER BOOK **€ 4.98bn**
(+6.1% yoy)



1) SLB = Sale and Lease Back

2) CCR = Cash Conversion Rate

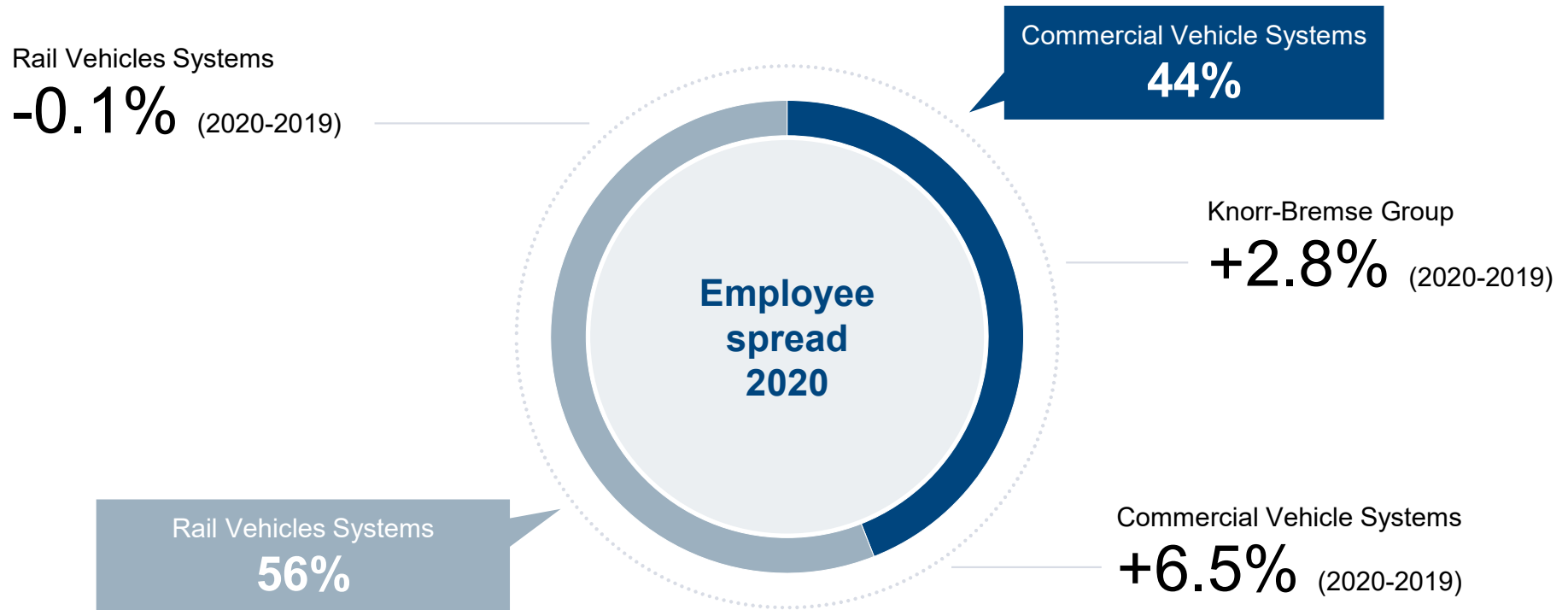
Development of sales



| | 2019 | 2020 | Δ |
|--|----------------|----------------|----------|
| Sales | 6,936.5 Mio. € | 6,156.7 Mio. € | -11.2 % |
| EBITDA | 1,328.7 Mio. € | 1,106.9 Mio. € | -16.7 % |
| Return on sales | 19.2 % | 18.0 % | -1.2%-P. |
| Capital expenditure | 331.8 Mio. €* | 341.7 Mio. € | +3.0 % |
| R&D | 396.9 Mio. € | 396.4 Mio. € | -0.1 % |
| Employees (incl. leasing; as of Dec. 31) | 28,905 | 29,714 | +2.8 % |

* 2019 adjusted for northern terrain SLB (€ 33,2 Mio.)

Employees by division (Stand: 31.12.; incl. leasing)



Rail Vehicle Systems (RVS) - The product portfolio includes braking systems, on-train and off-train products and service solutions over the entire vehicle life cycle



Braking systems
Windscreen wiper and wash systems
Sanitary systems
Couplers
Test rigs



Brake control systems



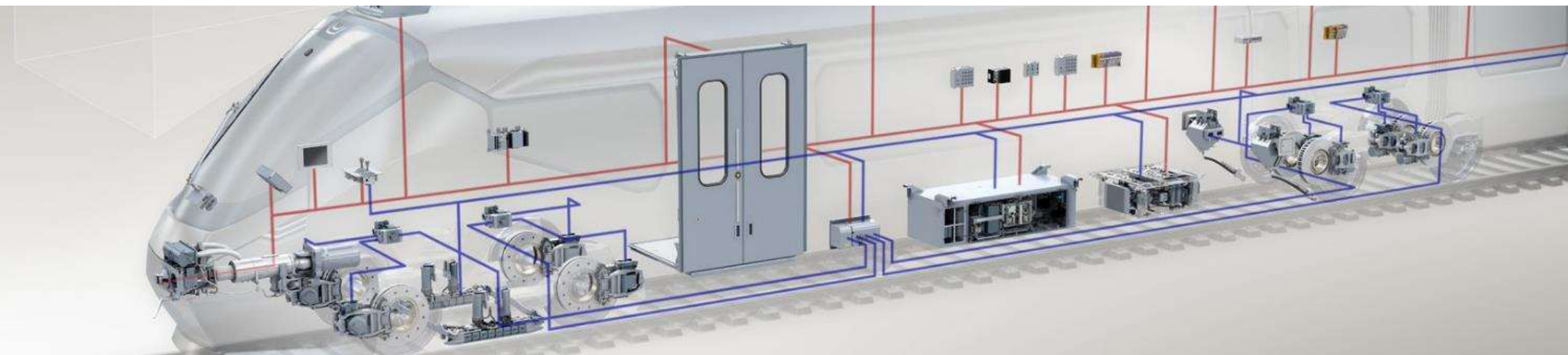
Entrance systems



Climate control systems (HVAC)



Power electrics



Train control and management systems (TCMS)



Electrical systems
Traction
Auxiliary power supply
System integration



After-sales service

Off-Train



Signalling systems

Agenda

- Knorr-Bremse AG and Rail Vehicle Systems (RVS)
- **Driver Advisory Systems in Europe**
 - **Organizational background at KB**
 - Market study DAS in Europe in 2020
- Use Case Group involvement

Driver Advisory Systems for Energy Savings provide driving recommendations to train drivers based on buffers in the timetable, on the gradients of topography and – if possible - on live traffic information from the TMS of the infrastructure provider

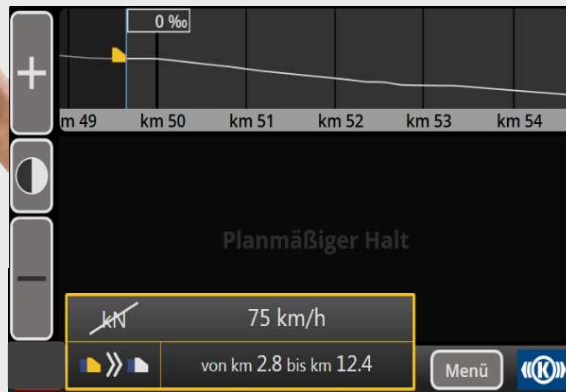
Locomotive Cab



Train Driver



Panel-PC /
Tablet



KB Backoffice
Server

Central TMS / DB
Netz (Germany)

Input data:

Topography + Timetable + Live traffic information (e.g. „Green Functions“)

DAS are addressing important mega trends in the KB innovation roadmap - operationally driven by KB RailServices and KB Digital Products and Services

Mega Trends

Urbanization



Sustainability



Digitalization



Mobility



Rail Industry Trends



Transport Capacity

We pave the railway for more travelers

- Shorter headways via driver assistance technology & smooth passenger flow
- Increased vehicle availability



Eco Friendliness

We make sustainable transportation a priority

- Cleaner, eco-friendly products for a greener railway
- Energy efficiency
- Passenger health & comfort for higher attractiveness of railway transportation



Availability

We stand for smart reliability

- Smart products and services ensure reliable connectivity
- Extensive cyber-security solutions for 360° virtual protection

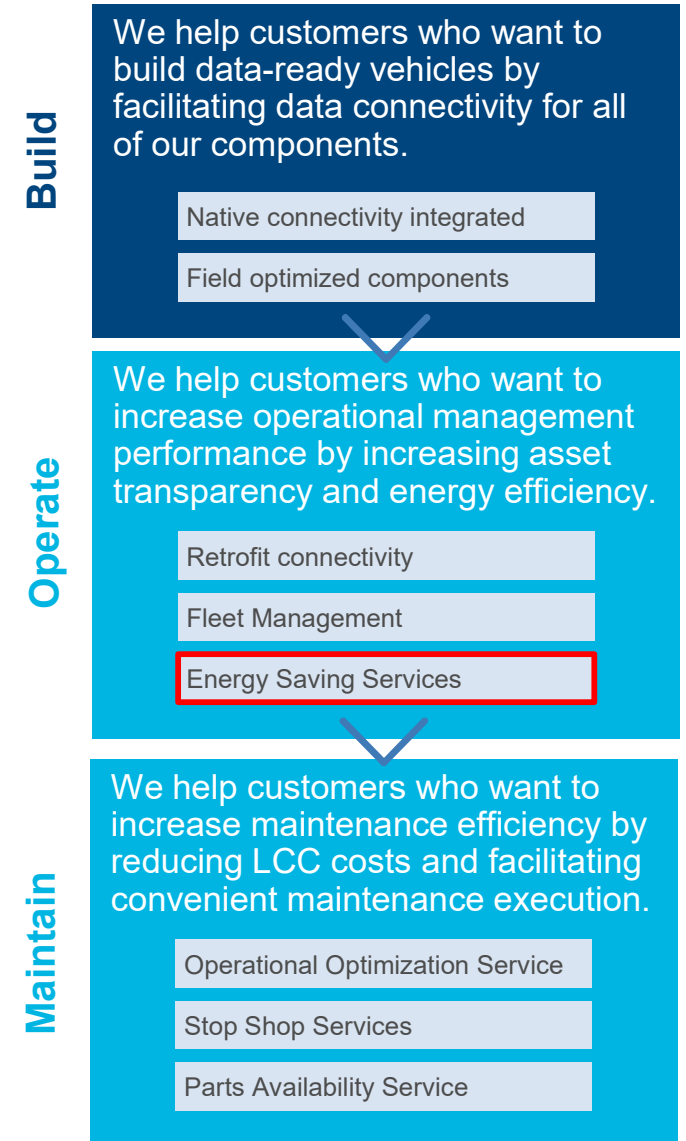
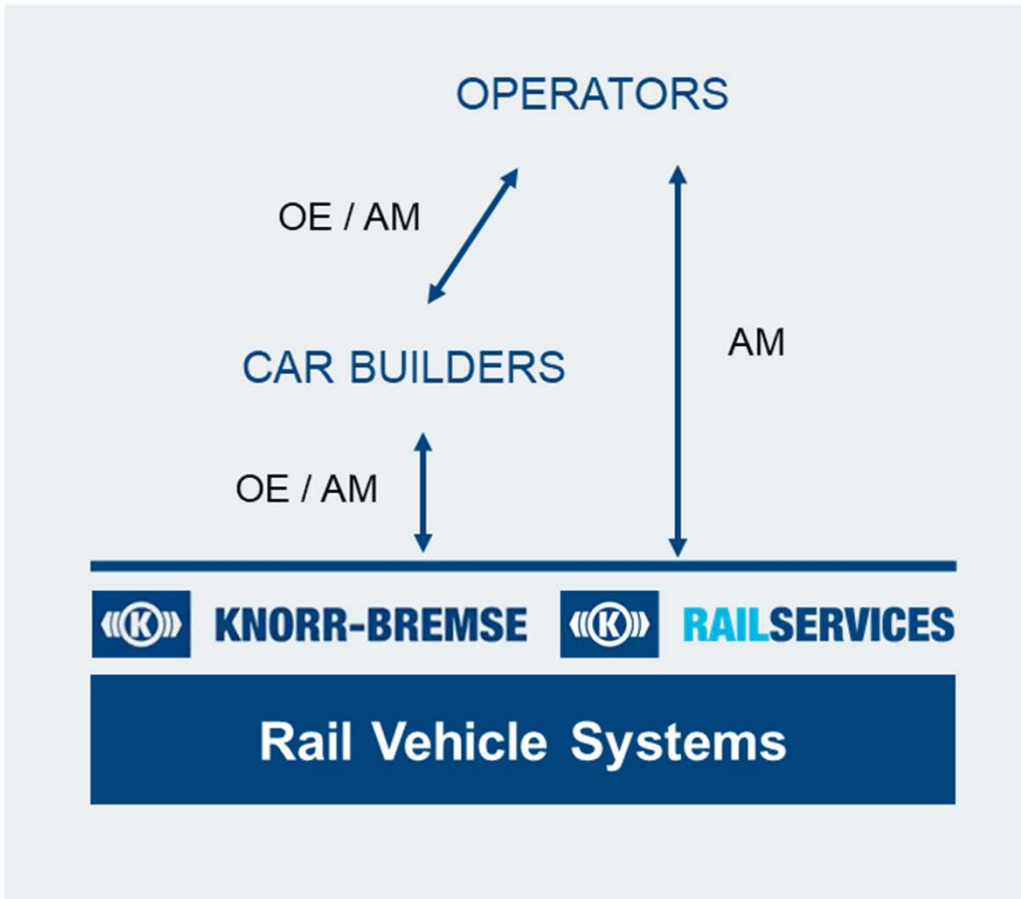


Life Cycle Management

We provide cost-optimized products & services

- Intelligent maintenance services for near-to-zero downtime
- Minimized operation energy and reduced total costs of ownership

KB RailServices uses data as enabler and risk mitigator to provide a continuous flow of customer value across the entire lifecycle.



Knorr-Bremse RVS Digital Products and Services (“DP”) has been established as a new global Business Unit



Develop and deliver own products and services, e.g.,

- Driver Advisory
- Environmental Observation

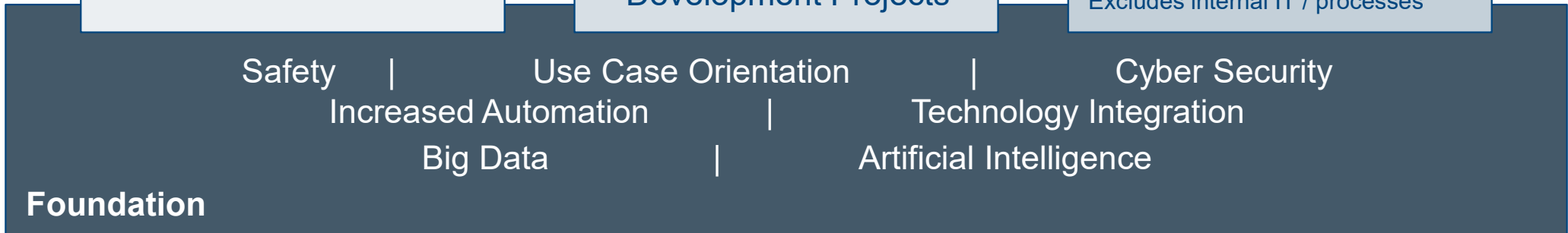
Provide digital products and services within the RVS ecosystem, e.g.,

- SW Applications
- Cloud Environment and related Services
- Digital Lab and Joint Development Projects

Ensure digital standardization across all RVS units, e.g.,

- Architecture
- Methods and Tools
- Data exchange formats
- Business models

Excludes internal IT / processes








Agenda

- Knorr-Bremse AG and Rail Vehicle Systems (RVS)
- **Driver Advisory Systems in Europe**
 - Organizational background at KB
 - **Market study DAS in Europe in 2020**
- Use Case Group involvement

Market Study about DAS in Europe in summer 2020 to better understand the market
























Interview candidates – RU and lessors

| Base year: 2018 | Freight | | Passenger long-distance | | Passenger short-distance | | Locomotive leasing | |
|--|---|--|--|---|---|---|---|----------|
| | Active operators | bn tkm | Active operators | bn pkm | Active operators | bn pkm | Lessor ³⁾ | Fleet sz |
|  Belgium | 1. Lineas 2. DB Cargo Belgium ¹⁾ 3. Railtraxx ²⁾ 4. Crossrail Benelux ²⁾ 5. CFL Cargo ²⁾ Total market | 5,4 (72 %) 0,6 (8 %) 0,5 (7 %) 0,4 (5 %) 0,4 (5 %) 7,5 | 1. SNCB 2. Eurostar International 3. Thalys International 4. DB Fernverkehr 5. SNCF Total market | n/a n/a n/a n/a n/a 1,3 | 1. SNCB Total market | 11,7 (100 %) 11,7 | Total fleet size – market study focuses on freight fleet 1. Alpha Trains 800 2. Akiem 600 3. Railpool 460 4. Beacon Rail Leasing 340 5. Mitsui Rail Capital Europe 300 Without lessors operating only in the UK | |
|  France | 1. Fret SNCF 2. Euro Cargo Rail ¹⁾ 3. VFLI 4. Europorte 5. Naviland Cargo Total market | 18,6 (58 %) 4,3 (13 %) 3,5 (11 %) 1,9 (6 %) 1,0 (3 %) 32,0 | 1. SNCF 2. Eurostar International 3. Thalys International 4. SBB 5. Trenitalia Total market | >54,2 (>88 %) n/a n/a n/a n/a 61,5 | 1. SNCF Total market | 27,5 (100 %) 27,5 | | |
|  Germany | 1. DB Cargo Deutschland 2. TX Logistik 3. SBB Cargo International 4. Captrain Deutschland 5. HSL Logistik 6. Metrans Total market | 64,2 (49 %) 9,1 (7 %) 7,9 (6 %) 6,6 (5 %) 5,3 (4 %) 4,5 (3 %) 131,8 | 1. DB Fernverkehr 2. Flixbmobility 3. ÖBB 4. SBB 5. SNCF Total market | 42,8 (99 %) n/a n/a n/a n/a 43,0 | 1. DB Regio 2. Transdev 3. Netinera 4. Abellio 5. BeNEX Total market | 41,9 (74 %) 2,7 (5 %) 2,3 (4 %) 2,2 (4 %) 1,4 (2 %) 57,0 | | |
|  Italy | 1. Mercitalia 2. Captrain Italia 3. Rail Traction Company ²⁾ 4. SBB Cargo Italia ²⁾ 5. DB Cargo Italia ¹⁾ Total market | 11,7 (51 %) 5,0 (22 %) 2,2 (10 %) 1,7 (7 %) 1,1 (5 %) 23,0 | 1. Trenitalia 2. Italo – NTV ²⁾ 3. SNCF 4. SBB 5. ÖBB Total market | 20,6 (<80 %) 5,3 (<20 %) n/a n/a n/a >25,9 | 1. Trenord 2. Trasporto Passeggeri ER 3. Ente Autonomo Volturno 4. Ferrovie del Sud Est 5. Ferrovie della Calabria Total market | 18,9 (>67 %) n/a n/a n/a n/a <28,1 | | |
|  Netherlands | 1. DB Cargo Nederland ¹⁾ 2. Captrain Benelux 3. Crossrail Benelux ²⁾ 4. ERS railways ²⁾ 5. HSL Total market | 3,7 (54 %) 1,2 (18 %) 0,3 (4 %) 0,3 (4 %) n/a 6,9 | 1. NS 2. Eurostar International 3. Thalys International 4. DB Fernverkehr 5. SNCF Total market | 14,8 (<100 %) n/a n/a n/a n/a >14,8 | 1. NS 2. Arriva Netherlands 3. Connexxion 4. Keolis 5. Abellio Netherlands Total market | 3,8 (>74 %) ~0,9 (<19 %) ~0,1 (<1 %) ~0,1 (<1 %) ~0,02 (<1 %) <4,8 | | |

1) FY 2019 2) FY 2017 3) Fleet sizes for all segment leasing, differing from freight fleet sizes mentioned in the interview

In addition, the network manager, the infrastructure manager and the most important power supplier(s) of each respective market were considered for interviews

Interview candidates – network managers, power infrastructure managers and suppliers

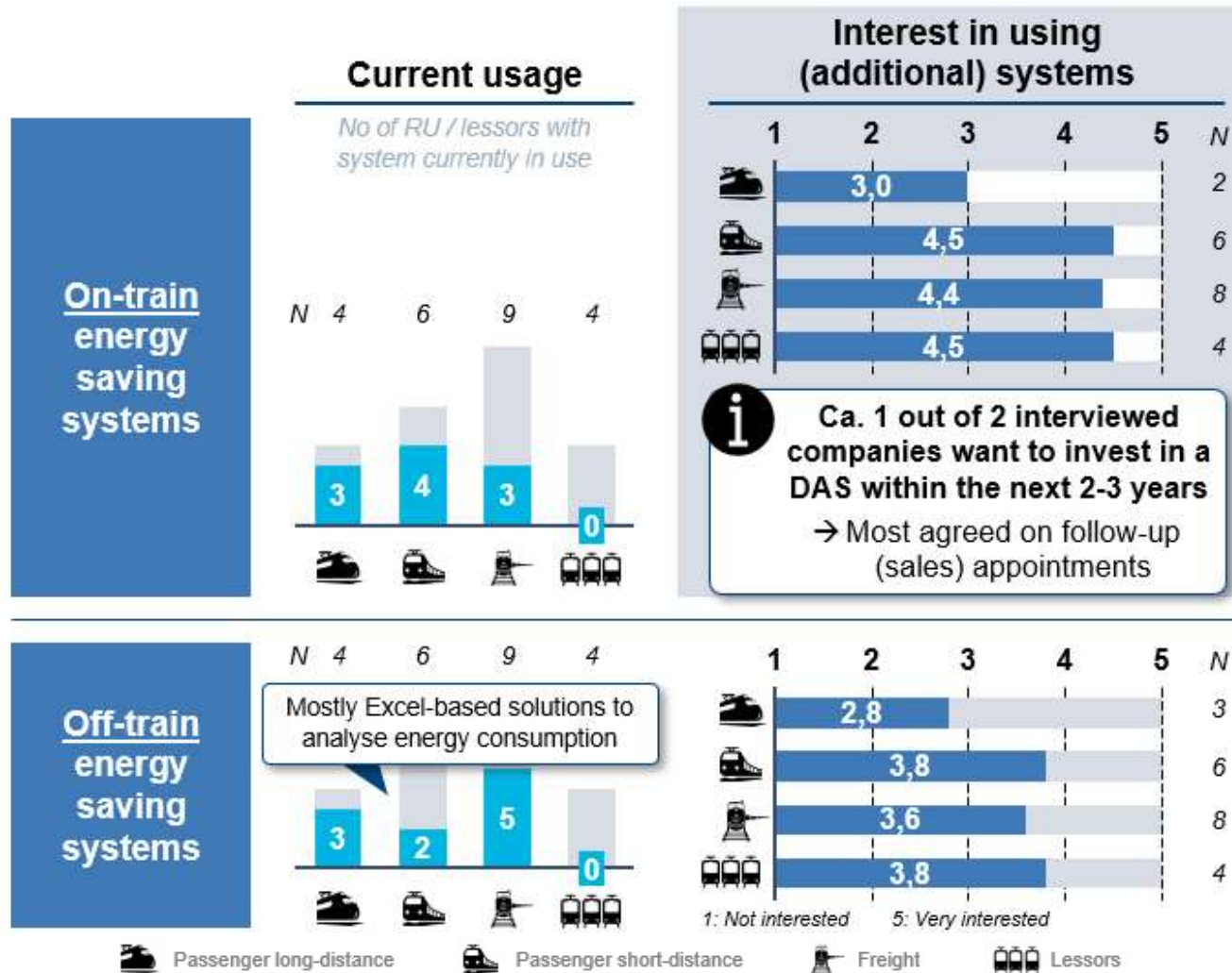
| |  Network manager |  Power infrastructure manager |  Power supplier ¹⁾ |
|--|---|--|--|
|  Belgium |  |  |  |
|  France |  |  |  |
|  Germany |  |  |  |
|  Italy |  |  |  |
|  Netherlands |  |  |  |

1) Traction current supplier of the incumbent in the respective country

2) Supply for the Betuweroute

RU and lessors both recorded high interest in DAS technology during the interviews with short-term window of opportunity, ATO being still at least a decade away

Usage of / interest in energy saving systems



Key Challenges for the DAS market: availability and quality of input data

Availability of input data, especially also topography data

- “**Live traffic and topography data are not available in all countries.** However, if available, only a marginal number of RU make use of these data types.”
- KB is getting involved both in the topic of gathering and providing topographic data as well as influencing the format of the required input data
- SFERA – a parallel stream?
 - Knorr-Bremse is also involved in the SFERA User Group
 - The SFERA-approach of standardizing input data for DAS is not sufficiently addressing the requirements of a DAS optimization.
 - SFERA User Group meeting April 15, 2020:
 - The implementation of SFERA is basically put on hold in 2021. Implementation will probably start in 2022 only.
 - SFERA is planning to merge with subset126 (ATO over ETCS), timing not known; mapping between SFERA and railML urgent.
- railML - is addressing the requirements of DAS in a better way.
 - Knorr-Bremse would like to (re)initiate or join a **Use Case group at railML (3.x)** working on the (topography) **input data of DAS**
 - Maybe in future even also other Use Case groups in the direction of topics like **reproducible brake management?**



Agenda

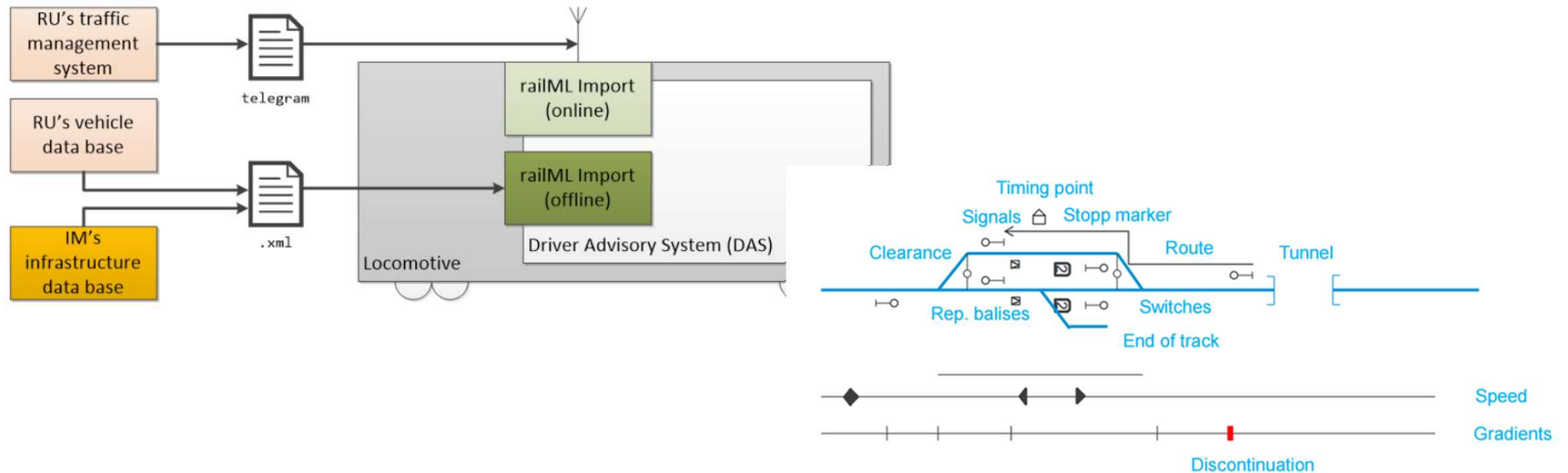
- Knorr-Bremse AG and Rail Vehicle Systems (RVS)
- **Driver Advisory Systems in Europe**
 - Organizational background at KB
 - Market study DAS in Europe in 2020
- **Use Case Group involvement**

KB is interested in Use Case activities around the field of DAS within railML (3.x)

Why?

- Many different solutions quickly evolving within the field of technologies for increasing energy efficiency
- High dynamics in the market for DAS, digitalization is allowing for more integrated solutions
- The stakeholders need to collaborate to create future-proof solutions
- Create the data ecosystem needed together

First steps already available from the Use Cases “DriverAdvisorySystem” and “Schematic Track Plan”, Subschema Infrastructure (release 2.0) – can we join/re-vive these activities?





RAILSERVICES

Knorr Bremse Contact (sales & commercials):

Eva Lohmeier

Knorr-Bremse Systeme für Schienenfahrzeuge GmbH
Moosacher Straße 80 , D-80809 München
Direkt: +49 89 3547 182645
Mobile: +49 151 11 90 3517
mailto: eva.lohmeier@knorr-bremse.com
<http://www.knorr-bremse.com>

Knorr Bremse Contact (product management DAS):

Andor Szabo

Knorr-Bremse Systeme für Schienenfahrzeuge GmbH
Moosacher Straße 80 , D-80809 München
Direkt: +49 89 3547 186147
mailto: andor.szabo@knorr-bremse.com
<http://www.knorr-bremse.com>