Automated driving by rail

Positive impact of rail market transformation
Exponential growth of digitalization will change rail and road transportation enormously – and has already begun!
Positive impact of rail market transformation

Challenges in mainline, regional line and freight traffic

Potential for optimization through automatic train operation

“ATO over ETCS”

Outlook
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Outlook
Current challenges of different railway operators and their expectations of automation solutions between the priorities of different requirements

**High Density mainline**
- Capacity increase on existing infrastructure
- Mixed traffic
- Interoperability
- High availability of the overall system
- High safety/security requirements

**Low Density mainline**
- Low operating costs
- Reduction of equipment
- High safety/security requirements

**Freight**
- Energy savings
- Interoperability
- Equipment on the train
- Driverless train operation
- High safety/security requirements

**Mining**
- Precise stopping
- Robust high-end solutions
- Driverless train operation
- High availability requirements
- Lower safety/security requirements
Siemens is global market leader with EUR > 3.0 bn order intake in the last five years for highly and fully automated mass transit solutions.

**Highly automated (GoA 2)**

- Beijing Linie 10 (2008)
- Budapest Linie 2 (2008)
- Guangzhou Linie 4+5 (2008/10)
- Paris Linien 3, 5, 9, 10, 12 (2009)
- Algiers Linie 1 (2010)
- Nanjing Linien 2+1 (2009/10)

**Fully automated (GoA 3-4)**

- Istanbul Linie 1 (2010/12)
- Suzhou Linie 1 (2012)
- Guangzhou Guang-Fo (2010/12)
- Chongqing Linie 1 (2011/12)
- Beijing Olympia Linie 8 (2012/13)
- New York PATH (2017)
- Metro Nuremberg (2006)
- Barcelona, Linie 9 (2009)
- Metro Paris Linie 1 (2011)
- Sao Paulo Linie 4 (2012)
- Budapest Linie 4 (2014)
- Metro Riad (2018)

**Solutions for GoA 2-4**

- CBTC/Trainguard MT, Controlguide, Sicas, Westrace, Airlink

**New orders 2014/2015 (extract)**

- Buenos Aires Linie C, Queens Boulevard New York City, Xian Linie 3 (China), Fuzhou Linie 1 (China), Sosa Wonsi (Korea)

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1) Siemens Mobility Products/Systems/Solutions for Rail Automation

Year = "Commissioning/Start of Operation". GoA = Grade of Automation, ATO = Automated Train Operation, CBTC = Communications-Based Train Control.
Opportunities for railway operators by increasing the grade of automation

- The preconditions for additional solutions in today's railway systems are excellent

- High potential for economic optimization
  - Energy saving
  - Increase in track capacity
  - Increase in operational flexibility
  - Increase of punctuality
  - Precise stopping

Grade of automation

- Performance capability
- Costs of operation
- Initial investment
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Outlook
Automation functions from mass transit can be adapted successfully for mainline

GoA – Grades of Automation according to IEC/EN 62290-1

<table>
<thead>
<tr>
<th>Partially automated</th>
<th>Highly automated</th>
<th>Fully automated</th>
</tr>
</thead>
<tbody>
<tr>
<td>Supervised by driver</td>
<td>Reduced driver supervision</td>
<td>System is responsible</td>
</tr>
</tbody>
</table>

1. **Driver in cab**
   - Ensure safe movement of train

2. **Driver in cab**
   - Drive train

3. **Train attendant on-board**
   - Supervise track
   - Supervise passenger transfer, train status, incidents and emergencies

4. **No staff on-board**
   - Driverless and Unattended Train Operation DTO/UTO

Solutions:
- **Automatic Train Protection** e.g. ETCS
- **Driver Advisory Systems** DAS
- **Automatic Train Operation** ATO
- **Driverless and Unattended Train Operation** DTO/UTO
ETCS has become the worldwide standard for automatic train control systems and is the fundament for a sustainable development of railways

Trainguard solutions for ETCS Level 2

GSM-R or other radio system (e.g. TETRA)

Train

- GSM-R or other radio antenna
- Driver-machine interface
- Interlocking
- RBC

Train components:
- Balise antenna
- Odometer
- Radar
- Eurorail position calibration
- EVC = European vital computer
- EMD = Event movement detection
- ATC = Automatic Train Control
- RBC = Radio block center
- ADC = Automatic track operation

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Market tendencies

- Assistance solutions in low density and freight traffic segments are in high demand
- ATO over ETCS is in demand in the United Kingdom, Netherlands and Germany
- Fully automated driving (driverless/unattended)
  - Complex layout of tracks
  - It is not possible to completely isolate the network from any outside influences (e.g. with fences, over- and underpasses etc.)
- In addition to the technical challenges, the systems in Europe have to be harmonized
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Outlook
ETCS and ATO in the railway system

Operational tier
- Operator
- Driver
- Interlocking control
- Communication/operational rules

Technical tier
- Route
- Vehicle
- Train control
- Vehicle control

ETCS

ATO

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Overall system concept

**TMS**
Traffic Management System
Coordinates train movements

**ETCS trackside**
European Train Control System
radio block centre and eurobalises
Provides safe movement authorities

**Track – train communications**
ATS – ATO communications
via ETCS and GSM-R radio

**ETCS on-board**
European Train Control System
on-board equipment
Ensures safe train movements

**ATO**
Automatic Train Operation
on-board equipment
Ensures optimum train movements
ATO allows an optimal utilization of capacity through a shortened headway due to a consistent mode of operation

- ATO ensures an exact realization of the speed profile at any time (minimal energy consumption at a fixed timetable)
- ATO stops more precisely
- Some notifications and warnings are suppressed by ATO to avoid confusion
ATO can reduce energy consumption by 15 to 20 percent

- The energy-optimal driving curve is calculated in realtime by the ATO and comprises four different types of driving: full acceleration, cruising, coasting and full braking
- The driving curve is optimized for every train run and is not based on a limited amount of profiles
- On top of that, ATO reduces wear and tear of brakes and CO₂ emissions
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Outlook
Further developments are happening on the basis of ETCS

Within the scope of the EU initiative Shift2Rail, more aspects are developed further

**European committee work**

- Standardization of ATO over ETCS
- Same requirements for interoperability as with ETCS
  - Option 1: With ETCS as an integrated ATO
  - Option 2: ATO as a standalone product
Thank you for your kind attention