Digitalization: The future of mobility

Innotrans 2016 | Pre-press conference | June 28, 2016 | Jochen Eickholt, CEO Mobility
Exponential growth of digitalization will change rail and road transportation enormously – and has already begun!
Siemens meets key transportation sector requirements

The needs of passengers and motorists

Operators and cities have to react

Siemens solutions provide

- Guaranteed availability
- Maximum throughput
- Enhanced passenger experience
Digitalization is key to fulfilling customer demand for availability, throughput and passenger experience

Guaranteed availability
- Smart data analytics for infrastructure and vehicle service
- High vehicle and infrastructure performance combined with best-in-class service and maintenance

Maximum throughput
- Integrated resource management
- Software for next-generation train control
- Next-generation, digitally enhanced interlockings

Enhanced passenger experience
- Passenger information and assistance systems
- Broadband and entertainment services
- Automated fare collection “be-in/be-out”
Grades of automation in the rail and automotive sectors: Autonomous systems for rail operation are more mature than those for road traffic

1 GoA = Grade of Automation, according to the International Electrotechnical Commission/Commission Électrotechnique Internationale, Internationaler Standard 62290-1
2 SAE Levels 0-5: Grades of automation defined by the Society of Automotive Engineers (SAE)
Automation / digitalization of mobility market are expected to grow rapidly

Share of networked people as % of world population

<table>
<thead>
<tr>
<th>Year</th>
<th>World Population in Billions</th>
<th>Networked</th>
<th>Not Networked</th>
</tr>
</thead>
<tbody>
<tr>
<td>1995</td>
<td>5.7</td>
<td>0.7%</td>
<td>99.3%</td>
</tr>
<tr>
<td>2005</td>
<td>6.5</td>
<td>15.0%</td>
<td>85.0%</td>
</tr>
<tr>
<td>2015</td>
<td>7.3</td>
<td>75.3%</td>
<td>24.7%</td>
</tr>
</tbody>
</table>

Rail and road market in billions of €

<table>
<thead>
<tr>
<th>Year</th>
<th>electrification</th>
<th>digitalization/automation</th>
</tr>
</thead>
<tbody>
<tr>
<td>1995</td>
<td>&lt; 50</td>
<td>&lt; 50</td>
</tr>
<tr>
<td>2015</td>
<td>67</td>
<td>&gt; 85</td>
</tr>
<tr>
<td>2025</td>
<td>&gt; 85</td>
<td></td>
</tr>
</tbody>
</table>

1 Industrie 4.0 Produktion, Automatisierung und Logistik. Publisher: T. Bauernhansl; M. ten Hompel; B. Vogel-Heuser. Springer Fachmedien Wiesbaden, Wiesbaden 2014
The market for highly and fully automated transportation is growing rapidly.

**Mainline and freight rail**

Rail control world market incl. industrial and mining in billions of €

- **2014**: 7.9 billion € (GoA 0-1)
- **2020**: 9.3 billion € (GoA 2)

**Partially automated**

Supervised by driver

**Mass transit**

Rail control world market in billions of €

- **2014**: 3.2 billion € (GoA 0-1)
- **2020**: 3.8 billion € (GoA 2-4)

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Siemens is global market leader for highly and fully automated mass transit systems (> €3 billion in orders in the last five years)

**Highly automated (GoA 2)**
- Beijing Line 10 (2008)
- Budapest Line 2 (2008)
- Guangzhou Lines 4+5 (2008/10)
- Paris Lines 3, 5, 9, 10, 12 (2009)
- Algiers Line 1 (2010)
- Nanjing Lines 2+1 (2009/10)

**Solutions for GoA 2-4**
- CBTC/Trainguard MT, Controlguide, Sicas, Westrace, Airlink

**Fully automated (GoA 3-4)**
- Istanbul Line 1 (2008)
- Suzhou Line 1 (2012)
- Guangzhou Guang-Fo (2010/12)
- Chongqing Line 1 (2011/12)
- Beijing Olympia Line 8 (2012/13)
- New York PATH (2017)
- Metro Nuremberg (2006)
- Metro Paris Line 1 (2011)
- Sao Paulo Line 4 (2012)
- Budapest Line 4 (2014)
- S-bane Copenhagen (2016)
- Metro Riyadh (2018)

**Orders in 2014-2016** (selection)
- Queens Boulevard New York City
- Xian Linie 3 (China)
- Fuzhou Line 1 (China)
- Sosa Wonsi (Korea)
- Paris Metro Line 4

Jahr = Vergabe/Betriebsstart

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GoA = Grade of Automation, ATO = Automated Train Operation, CBTC = Communications-Based Train Control

1 Siemens Mobility Products/systems/solutions for rail automation

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Paris Metro: Building up long-term and sustainable customer ties through competence in digital mobility

- 1998: Construction of Line 14 for fully automated operation
- Since 2004: Rail automation systems for Lines 3, 5 and 9
- 2006: Modernization of Line 1 for fully automated operation
- 2014: Extension of Line 14
- 2016: Expansion and modernization of Line 4 for fully automated operation
Riyadh’s fully automated metro system: transporting the equivalent of a small town’s entire population every hour

- World’s largest urban transport project with 7 metro lines, total length of 175 km
- Turnkey systems for Lines 1 and 2: Metro trains, electrification, signaling/communication, interlockings
- Signaling and train control technology ensure that trains can operate at 90-second intervals
- High operating frequency enables the system to handle 21,000 passengers per hour
S-bane Copenhagen: Partially automated controls with driver participation in operation since March 2016

- All the network’s lines are equipped with CBTC (Communication Based Train Control) for fully automated operation
- Train intervals in the inner city zone shortened from 120 seconds to 90 seconds
- Low maintenance costs due to elimination of trackside signals in the network
- Mixed transport with regional trains at the Hillerød terminal station
Thameslink London: A showcase for Siemens’ innovative strength in all areas of digital mobility

Guaranteed availability
- Smart predictive maintenance in the Thameslink depots
- Faults are spotted before they occur – ensuring full availability of the trains

Maximum throughput
- 24 trains per hour in London’s inner city
- Automated train operation with ERTMS (European Rail Traffic Management System), Level 2

Enhanced passenger experience
- “Always connected” – innovative passenger information system
Cooperation with DB Cargo: First demonstration project worldwide for automated driving in rail freight transport

- Successful tests for:
  - Sensor-controlled hazard detection
  - Automated coupling to freight train
  - Automated braking and acceleration to adjust to line speed limits
  - Tablet-controlled remote departure and precise stopping of the train

- Advantages:
  - Increased transport capacity and flexibility
  - Energy consumption reduced by around 20 percent
From product business via driver assistance systems and automated train operation to autonomous driving – what is required?

**Rail**
- Automated train operation
- Extended operations control center
- Radio block center
- Remote control
- Radio-operated approach indicator
- Hazard detection
- ETCS\(^1\) on-board unit
- Driver assistance system
- Rail2X\(^2\)
- ...

**Connected by**
- Management center
- Integrated mobility platform
- Vehicles and infrastructure communicate with each other

**Road**
- Magnetic sensors
- Traffic management
- Traffic controller with WLAN
- Video/radar detectors
- Loop detectors
- Traffic computer
- Fleet management
- eBus charging
- Car2X\(^2\)
- ...

**Key portfolio elements**
- Extended operation control system
- Hazard detection system
- Remote control system (in emergency)
- Driver assistance system
- Automated train operation
- Automated train protection systems
- Interconnected sensor network
- Traffic/fleet management

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1 ETCS: European Train Control System
2 Rail2X / Car2X: Autos bzw. Schienenfahrzeuge kommunizieren mit Infrastruktur und untereinander

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Vision 2050: The future of mobility will be exciting

- All vehicles will be autonomous (GoA 3\(^1\) or higher)
- Especially for low-density traffic, vehicles will connect/scale for longer distances (vehicle transporters or connected driving)
- Traffic flows will be supported by intelligent streets/roads and distributed control centers
- Safety levels will improve substantially for high- and low-density traffic
- Energy consumption will be reduced
- Capacities and flexibility will be increased dramatically
- Seamless intermodal travelling will be standard

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\(^1\) GoA = Grade of Automation according to International Electrotechnical Commission / Commission Électrotechnique Internationale, Internationaler Standard 62290-1
Highlight at Innotrans: Digital Service – Highest availability of our transport systems with the help of IT-based data analytics

- **Our basis:** Modern rail vehicles transmit over one billion data points a year
- **Our competence:** Analyzing this data with algorithms and deriving measures to prevent downtimes in operation
- **Our goal:** Support our customers by providing highest availability of vehicles and optimal maintenance
- **Our reference:** Data analytics used with the Velaro Spain for predictive maintenance and avoiding costly downtimes

Presentation: Mobility systems data analytics for optimized operations
Highlight at Innotrans: Automated train control – greater flexibility together with higher safety and reduced energy consumption

- **Our basis:** Demand for high and fully automated rail systems is growing rapidly in transportation markets.

- **Market leader:** Siemens is the market leader for high and fully automated rapid transit systems.

- **Future:** The next stage of development in automated train control will enable seamless travel between regional and rapid transit systems.

- **Reference:** Thameslink is the world’s first realization of an “ATO over ETCS” system.

Workshop: Automated driving on rail
Highlight at Innotrans: Integrated, intermodal and connected solutions for passengers

- **Always connected**: Integrated solutions for passenger assistance and entertainment during the journey

- **PIS+**: Passenger information and guidance systems in the train – depending on passengers location and traffic situation

- **SiMobility**: Solutions for information and transactions across transportation modes – incl. hands-free ticketing “Be-in/Be-out”

- **iCCTV**: Automated recognition solutions, incl. detection of empty seats and availability of wheelchair space

- **Train-IT**: Fully integrated IT backbone for flexible and future-proof train applications

Workshop: Enhanced passenger experience through digitalization
Highlight at Innotrans: Mireo – Intelligence on rail

- **Energy efficiency**: Lighter & LCC-optimized regional and light rail trainsets
- **Consequent development of train IT concept**: Separation of safety-relevant control network, operator network and passenger network
- **Always Connected**: Siemens solutions for networked regional trains
- **Predictive maintenance**: E.g. through real-time field data acquisition and analysis
- **Flexible train concept**: To meet capacity and infrastructure requirements
- **Infrastructure-protective bogies**
- **Financing from one hand**

Workshop: The new modular vehicle concept for regional trains
Highlight at Innotrans: Interoperability of the charging system for electric buses in Hamburg

- **Our goal:** Interoperability of Siemens’ charging system for electric buses from different manufacturers
- **Success:** Siemens is worldwide the first producer of fully automated charging systems that ensure compatibility of the charging infrastructure with vehicles from different manufacturers
- **Details:**
  - Beginning in summer 2016, 109 buses from Solaris and Volvo will be charged on the innovation line with the existing Siemens charging system
  - Reliable Siemens charging technology for transportation companies and bus manufacturers is based on the international standard IEC 61851-23
Highlight at Innotrans: Vehicles displayed outside

- Vectron Finland
- Desiro City SWT
- Desiro ML ÖBB cityjet
- Velaro Turkey
- Metro Riyadh
- Avenio QEC
Current news: Munich Metro gives limited authorization for the first Siemens C2 trains on a section of the U6 line

- Commissioning taking place on the section Kieferngarten – Garching Research Center
- Total order: 21 articulated trains
- Energy-saving LED interior and exterior lighting
- Dynamic braking nearly to a full stop; braking energy fed back into power system
- Transmission of video and diagnostics data during operation
- Video cameras and modern monitors for the passenger information system
Thank you!
Innotrans 2016 | Pre-press conference|
June 28, 2016 | Jochen Eickholt, CEO Mobility