BMW GROUP TECHNOLOGY WORKSHOPS
AUTOMATED DRIVING-DIGITALIZATION
MOBILITY SERVICES

December 2016
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AUTOMATED DRIVING. CHANGING FRAMEWORK LEADS TO NEW DEFINITION OF FUTURE MOBILITY.
DEVELOPMENT STAGES OF AUTOMATED DRIVING.

<table>
<thead>
<tr>
<th>Human</th>
<th>Transition of responsibility</th>
<th>Machine</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 – Driver Only</td>
<td>No active assistance system</td>
<td>No driver</td>
</tr>
<tr>
<td>1 – Assistance</td>
<td>Early warning systems such as cruise control/ speed assistant (&quot;Feet-off&quot;)</td>
<td>Take over request (&quot;Eyes-off&quot;)</td>
</tr>
<tr>
<td>2 – Semi-Automation</td>
<td>Traffic control (e.g. congestion assistant) (&quot;Hands-off&quot;)</td>
<td>General awareness</td>
</tr>
<tr>
<td>3 – High-Automation</td>
<td>Awareness for take over</td>
<td>No take over request (&quot;Mind-off&quot;)</td>
</tr>
<tr>
<td>4 – Full-Automation</td>
<td>TODAY</td>
<td></td>
</tr>
<tr>
<td>5 – automated</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

- **TODAY**
  - Human Machine Transition of responsibility}

"Eyes-off")
FIRST IDEAS BEING IMPLEMENTED TEN YEARS AGO.

- BMW Track Trainer (2006).
- Emergency stop assistant (2009).
- Highly automated driving on the motorway (Gen1: 2011; Gen2: 2014)
- Highly automated driving at the limits of vehicle dynamics (2014).
- Fully automated remote valet parking (2015).
THE NEW BMW 5 SERIES DRIVER ASSISTANCE PROVIDES COMFORT AND SAFETY AT THE HIGHEST LEVEL.

- Cross road assist
- Lane keeping assistant with active side collision protection
- Active cruise control with Stop&Go function
- Rear collision prevention
- Night Vision
- Lateral parking aid
- Distance information
- Lane departure warning
- Speed Limit Assist
- Wrong Way Assist
- Lane change warning
- Approach control warning with braking function
- Top View Remote
- 3D View
- Top View
- Parking assistant
- Active Park Distance Control
- BMW Selective Beam
- Remote Control Parking
- Panorama View
- Speed Limit Device
ARCHITECTURE FOR AUTOMATED DRIVING. END-TO-END WITH ALL KEY-TECHNOLOGIES.
HD-MAP, SENSORS, AI/ENVIRONMENT MODEL AND MOTION CONTROL PLAY A KEY ROLE IN THE ARCHITECTURE OF AUTOMATED DRIVING.

HD-MAP BACKEND
- centimeter precision
- real-time capable
- highly available and reliable

OEM-Cooperation

SENSORS
- camera
- radar
- lidar
- ultra-sonic
- inertial sensor

Trilateral Cooperation

AI / ENVIRONMENT MODEL
- object fusion
- free space detection
- road model
- prediction
- driving strategy / planning

VEHICLE INTEGRATION
- motion control
- safe vehicle management up to the limits
- fail operational architecture

BMW Group Technology Workshops – Automated Driving
HAD SENSOR SETUP – FOCUS ON LARGE-DISTANCE AREA COVERAGE.

<table>
<thead>
<tr>
<th>Redundant Sensor Coverage Per View</th>
<th>Lidar</th>
<th>Radar</th>
<th>Camera</th>
<th>Ultra-Sound</th>
</tr>
</thead>
</table>

Far Forward Looking

Far Rear Looking

Near Range Coverage

Mid Range Coverage
FAD SENSOR SETUP – FOCUS ON 360° COVERAGE.

Redundant Sensor Coverage Per View

- Lidar
- Radar
- Camera
- Ultra-Sound
HIGHLY ACCURATE MAPS AND BACKEND CONNECTIVITY – TWO CORNERSTONES FOR HIGHLY AUTOMATED DRIVING.
BESIDES THE MERE TECHNICAL SENSING OF THE ENVIRONMENT, THE CONTEXTUAL UNDERSTANDING IS CRITICAL FOR AUTOMATED DRIVING APPLICATIONS.

ENVIRONMENT MODEL + PREDICTIVE SITUATION UNDERSTANDING

360° REPRESENTATION

Object-based models

Occupancy maps/free space

Road models
"PLAYGROUND“ AUTOMATION. ROLL-OUT LIMITED BY SCENARIO COMPLEXITY AND DRIVING SPEED.

- **Inner City Comfort & Safety**
- **Rural Flow & Safety**
- **Highway Traveling Comfort & Safety**

**New Mobility-Concepts, L5**

**L4**

**L2**

**L2/L3**

**L3/L4**

**Driving Speed**

**Commuting**

**Complexity Traffic Scenario**

**BMW Group Technology Workshops – Automated Driving**

Page 14
ON THE WAY TO AUTOMATED DRIVING.

PAD (L2)
- Partial automated driving incl. Steering, breaking, acceleration on all roads, worldwide, up to 210 km/h. automated lane changing on highway.
- Hands-off up to 30 sec., no Eyes-off

HAD (L3)
- Hands- and Eyes-off on highway (EU, US, CN)
- Active lane changing and thread

FAD (L4) pilot project
- Hands- and Eyes-off on highway or highway-like (EU, US)
- Pilot project Mind-off on pre-defined routes
DIGITALIZATION AT BMW GROUP.
We leverage innovative technologies, digitalization and sustainability to deliver unique customer experiences.

We embrace the opportunities that the transformation of our industry offers. We are committed to expanding our technological competence in the years to come, to enhancing the interaction of individuals, vehicles and services and to driving progress in sustainable mobility. This will secure our success and set new standards amongst our competitors.
AUTOMATED DRIVING ENABLES NEW (DIGITAL) BUSINESS OPPORTUNITIES.

Increasing penetration of option and service business

Monetization of free time

New mobility concepts

Scalable platform available for third parties.
MOBILITY SERVICES – THE URBAN REVOLUTION.
MAJOR TRENDS AND NEW TECHNOLOGICAL POSSIBILITIES ARE CHANGING THE RULES OF THE GAME.
BMW GROUP’S CORPORATE STRATEGY NUMBER ONE NEXT IS THE ANSWER TO THE CHALLENGES OF SUSTAINABLE MOBILITY AND CHANGING MARKET CONDITIONS.

“We inspire people on the move: We shape tomorrow’s individual premium mobility.”

…already TODAY!
DRIVE NOW. PREMIUM, FREE FLOATING CAR SHARING SERVICE FROM BMW GROUP & SIXT.

DriveNow Customers are BMW Group´s youngest & most modern target group

750,000 customers in 11 cities

5,000+ cars in the fleets

DriveNow Customers are BMW Group´s youngest & most modern target group.
DRIVE NOW OPENS THE WAY FOR E-MOBILITY AND THE BMW i3.

200,000+ first electric rides with DriveNow

6 Mio.+ emission-free kilometers with BMW i3

20% of the DriveNow fleet is electric
REACH NOW. ON DEMAND MOBILITY SERVICES IN THE US.

Launch in April 2016 in Seattle
Followed by Portland and Brooklyn (NY)

1.000.000+ kilometers
32,000+ members

Piloting additional features
ON DEMAND MOBILITY ON A NEW LEVEL. REACH NOW TO INTRODUCE UNIQUE FEATURES FOR THE CUSTOMERS.

New features, as piloted in US from end 2016:

Ride: Car with driver

Reserve: For long period use of vehicles and delivery of car

Share: Renting out your own car

Fleet Solutions:
Individualized CarSharing offering for residential areas
CHARGE NOW.
THE SERVICE THAT MAKES CHARGING CONVENIENT AND EASY.

65,000+ charging points in 29 countries
PARK NOW.
OFFERING PREMIUM ON- AND OFF-STREET PARKING SERVICES.

On- and off-street parking

Time & cost efficient

Launch in 2016 in Austria, Germany & France

car integration starting with all new BMW 5 Series

On- and off-street parking integration starting with all new BMW 5 Series
CENTER OF COMPETENCE URBAN MOBILITY: IMPLEMENTING SUSTAINABLE URBAN MOBILITY – TOGETHER WITH ALL STAKEHOLDERS.

Before…

…After
DIGITALIZATION AT BMW GROUP.
MAXIMS FOR THE BMW GROUP IN THE CONTEXT OF DIGITALIZATION.

Responsible data handling for Personalization & convenience – Data security & privacy first, business follows

Permanent updatability / disconnect between hardware and software
Constantly connected vehicle

Robust, scalable IT & software architecture

Speed through software development skills and core in-house competence

Merger in the perception of product and service

X-functional collaboration
BMW WILL DRIVE DIGITALIZATION FORWARD ACROSS THE COMPANY.

We will lead the digital transformation of the automotive industry

- Connected / Autonomous Vehicle & Mobility Services
- Digital Customer Experiences
- Business Processes