THE WAY TO HIGHLY AUTOMATED DRIVING.

DR. WERNER HUBER, HEAD OF DRIVER ASSISTANCE AND PERCEPTION AT BMW GROUP RESEARCH AND TECHNOLOGY.
AUTOMATION IS AN ESSENTIAL FEATURE OF THE INTELLIGENT CAR OF THE FUTURE.

Improved traffic and driving safety.
- Always safe, with and without automation.
- Active safety as the next big stroke in vehicle safety.

Increased driving comfort.
- Automation of annoying tasks.
- Gaining valuable time in boring situations.

Expanded offer of mobility services and increased driving efficiency.
- Mobility offers e.g. for older or disabled people.
- Optimized utilization of the infrastructure.
AUTOMATED DRIVING IS CONSEQUENTLY ORIENTED TOWARDS THE NEEDS OF OUR CUSTOMERS.

Dr. Werner Huber, BMW Group Research and Technology, 15th December 2014.
ROLES OF THE AUTOMATED CAR IN THE FUTURE.

Valet Parking

Emergency Stop Assistant

Driving instructor

Neighborhood taxi ($v_{\text{max}}$ 40km/h) within new mobility concepts

Long-distances chauffeur up to 130km/h

Guardian angel

Dr. Werner Huber, BMW Group Research and Technology, 15th December 2014.
THE TRANSITION BETWEEN PARTIALLY AND HIGHLY AUTOMATED DRIVING REPRESENTS A MAJOR STEP. FULLY AUTOMATION IS THE SUPREME DISCIPLINE.

Driver performs longitudinal AND lateral control at all times.

Driver performs longitudinal OR lateral control at all times.

Driver must permanently monitor the system.

Driver no longer needs to monitor the system permanently.

Longitudinal and lateral control tasks are performed entirely by the vehicle, within specific applications. The driver does not need to monitor the system.

Regulated by law and introduced into the market.

Not regulated by law and under research.

(e.g. Fully automated remote valet parking)

(e.g. Highly automated driving on the motorway)

(e.g. Traffic Jam Assistant)

(e.g. Parking Assistant)

(e.g. Speed Limit Info)

No assistance systems active.

The other (longitudinal or lateral) control task is performed by the vehicle.

Longitudinal and lateral control tasks are performed by the vehicle (for a certain period of time and/or in specific situations).

Degree of automation

Driver only

Assisted

Partially automated

Highly automated

Fully automated

(Source: BAST Working Group 2012)
HIGHLY AUTOMATED DRIVING NEEDS AN HOLISTIC APPROACH.

Driver no longer needs to monitor the system permanently.

Driver gains valuable time.

Driver has to take over the driving task within an appropriate time.

Technology:
- Redundancy architecture
- Overall environmental model
- Connectivity/Foresight
- Vehicle control

Interior Design:
- Human Machine Interface
- Displays, Operating elements
- Infotainment / Office functions
- User experience: Self driving, relaxing, working

Driver State:
- Driver’s condition
- Take over or warning time
- Ensuring state of minimal risk

Validation & verification of the overall system.

Dr. Werner Huber, BMW Group Research and Technology, 15th December 2014.
LONG-TIME EXPERIENCE IN DRIVER ASSISTANCE SYSTEMS OFFERS THE BASIS FOR HIGHLY AUTOMATED DRIVING.

Active Cruise Control (S&G)
Lane Departure Warning
Speed Limit Info
BMW TrackTrainer
Emergency Stop Assistant
Remote Controlled Parking
Collision Warning with braking function
Traffic Jam Assistant
Highly Automated Driving on the motorway
Enhanced safety and precision at the vehicle's limit with highly automated driving.


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Research
Series Production

Dr. Werner Huber, BMW Group Research and Technology, 15th December 2014.
MASTERING THE BASIC TECHNOLOGIES IS THE FIRST STEP TOWARDS HIGHLY AUTOMATED DRIVING.
ENHANCED SAFETY AND PRECISION AT THE VEHICLE’S LIMIT WITH HIGHLY AUTOMATED DRIVING.

FUNCTION.

- The research prototype can follow a predefined path to the vehicle’s limit robustly, reliably and with high accuracy.

- Also in ambitious traffic situations where the car tends to oversteer or to understeer the system is able to stabilize the car with precise steering and braking intervention.

- The function is the basis for an exact tracking of optimized trajectories in a highly automated driving mode.

- Safety systems will also benefit.

⇒ In the future, BMW Group’s highly automated cars will handle every driving situation up to the vehicle’s limits with maximum safety and comfort.

⇒ For the BMW Group, in emergency situations precise and reliable vehicle control at the physical limit is the next important step to offer a continuous and emotional highly automated driving experience.
MODIFICATIONS IN REGULATORY LAW AND ROAD TRAFFIC REGULATIONS ARE NECESSARY.

### REGULATORY LAW
- Currently, highly automated driving systems are not admissible in many countries due to conflicts with regulatory requirements.
- For example, corresponding systems are not in line with ECE-R 79 (Steering Equipment) and ECE-R 48 (Lighting).

### ROAD TRAFFIC REGULATIONS
- Highly automated driving seems to contradict regulations of Vienna Convention on Road Traffic of 1968:
  - Art. 5: Every vehicle shall have a [human] driver who shall at all times be able to control his vehicle.
  - Art. 13: Every [human] driver shall in all circumstances have his vehicle under control.
- Newly inserted paragraph now denies conflict with the above mentioned regulations "when … systems can be overridden or switched off".
- The scope of this new paragraph and its impact on automated driving still needs clarification.

### PRODUCT LIABILITY
- Highly automated driving will be evaluated under existing product liability laws. No special liability law for automated driving expected.
- Higher liability risk for manufacturer which „intrudes“ into traditional driver's area of responsibility.
- Period of legal uncertainty until judgments of higher courts dealing with highly automated driving systems have been rendered.

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Discussions about changes of regulatory law and road traffic regulations are ongoing on national and international level (e.g. German Ministry of Transport, UN ECE).

Dr. Werner Huber, BMW Group Research and Technology, 15th December 2014
FIRST STUDIES SHOW THAT HIGHLY AUTOMATED DRIVING WILL BE ACCEPTED BY THE CUSTOMER BUT WE ALSO HAVE TO CONVINCE THE SOCIETY.

“The industry is developing autonomous vehicles. Could you imagine driving such a car if you were able to intervene in the case of an emergency?”

Results of a survey of 1,000 customers with a German driver’s license:

- Absolutely not: 41
- Yes, perhaps: 25
- Yes: 18
- No, that’s unlikely: 12
- I am not sure: 4

>> For two thirds of the drivers an autonomous car would be an option.

(Source: Ernst & Young GmbH, Study „Autonomous Driving“, 2013, provided by research partner Continental AG)

The society’s hopes and concerns:

- Sustainable and individual mobility
  - Technology has better reaction time
  - Car sharing
  - Solution for increasing traffic volume
  - Cooperative behavior
- Robotics taking ethical decisions
  - Swarm accidents
  - Loss of driving competence
  - Mobility for all
- Data security
  - Innovative strength of the economy
  - More efficiency - less emissions
  - Liabilities
- Relaxed traffic flow
  - Technology has less wasted space for parking
  - Rise of productivity via efficient traffic
- Increased safety
  - Compliant to traffic rules
  - Unemployment

(Source: BMW Group Research and Technology, Online-Media Analysis „Social perception of highly automated driving“)

Dr. Werner Huber, BMW Group Research and Technology, 15th December 2014.
HIGHLY AUTOMATED DRIVING NEEDS A JOINT COLLABORATION AND CLEAR ROLE OF ALL KEY PLAYERS.

- Establish integrated service offerings (maintenance, SW-updates, insurance, …)
- Establish market potentials and standards
- Reduce costs
- Consider holistic solution for in-car-technology, connectivity, data processing, security, …
- Assess potentials and risks
- Define specific insurance models
- Create network plans considering Autom. Veh. requirements
- Design and implement policy and legislation, certification, license requirements and training
- Conduct research programs and analysis
- Use new business models, innovative finance progr., targeting fleet customers
- Prove effectiveness with regard to safety
- Inform the car drivers and society
- Clarify joint positions

Dr. Werner Huber, BMW Group Research and Technology, 15th December 2014.
SUMMARY.

- With highly automated driving we can shape the future of accident-free and sustainable individual mobility.
- For the rollout of the industrialization a controllable technology is necessary, the whole package must be profitable and the suppliers must be capacitated.
- The society has to be informed and prepared.
- Regulations are needed and the common political procedure has to be continued.
- A joint collaboration of all key players is necessary.