# VON DER FAHRERASSISTENZ ZUM AUTONOMEN FAHREN

**BRAUCHEN WIR DIE INTELLIGENZ IN DEN FAHRZEUGEN ODER IN DER INFRASTRUKTUR ?**

**ÖVG SYMPOSIUM WIEN**

**15.11.2018**

**DR. PETER SCHOEGGL**
**AVL LIST GMBH**
**GRAZ, AUSTRIA**

# Content

- **Introduction of AVL**

- **The future of road mobility**

- **ADAS & AD trends**

- **System architecture L2, L3, L4**

- **Where is the intelligence ?**

- **How safe must AD be ?**

- **The challenges perceived safety, testing and validation**

- **Conclusion, discussion**

# AVL List GmbH

**FORSCHUNG 10%**
des Umsatzes in Eigen-F&E
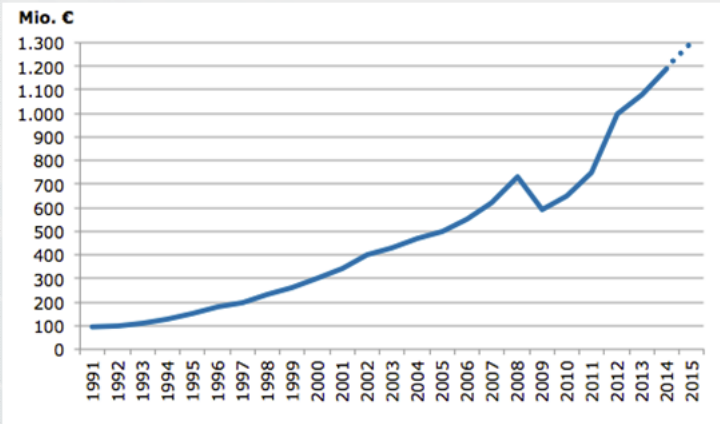
**INNOVATION 1500**
erteilte Patente

**MITARBEITER**
➢ **9.500** Mitarbeiter

➢ **65%** Ingenieure & Wissenschaftler

**GLOBALE AUFSTELLUNG**
**30** Entwicklungsstandorte
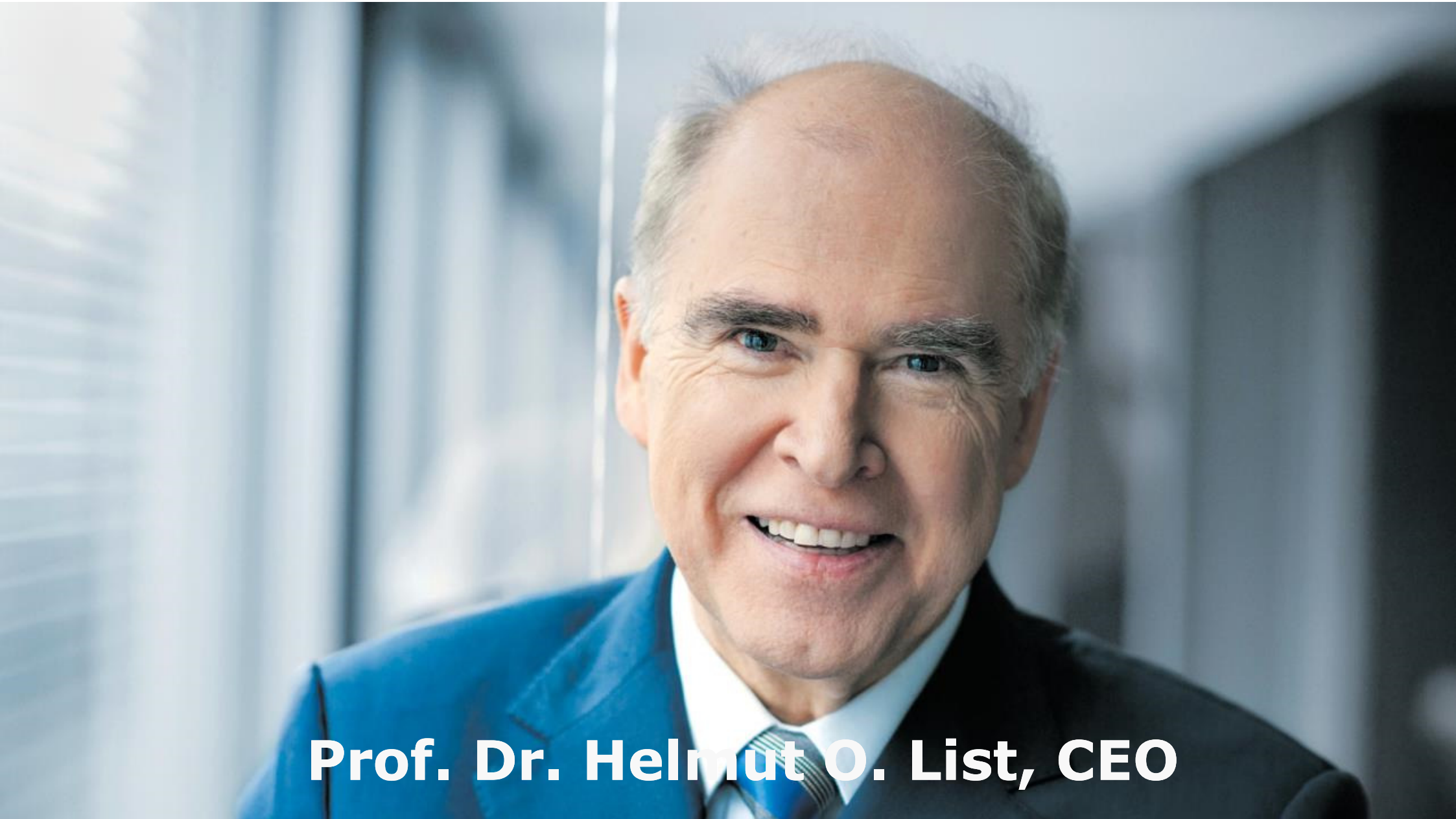
Globales Netzwerk zur lokalen Kundenunterstützung

## Wachstum



**Umsatz**
- 1991:
  **0.1 Mrd €**

- 2017:
  > **1.6 Mrd €**

- Plan 2018
  > **1.7 Mrd €**

**Erfahrung**
**> 65** Jahre !

Antriebs-strang und Fahrzeug Business

**One partner**

Prof. Dr. Helmut O. List, CEO

# AVL Business Fields


Passenger Cars


2-Wheelers


Racing


Construction


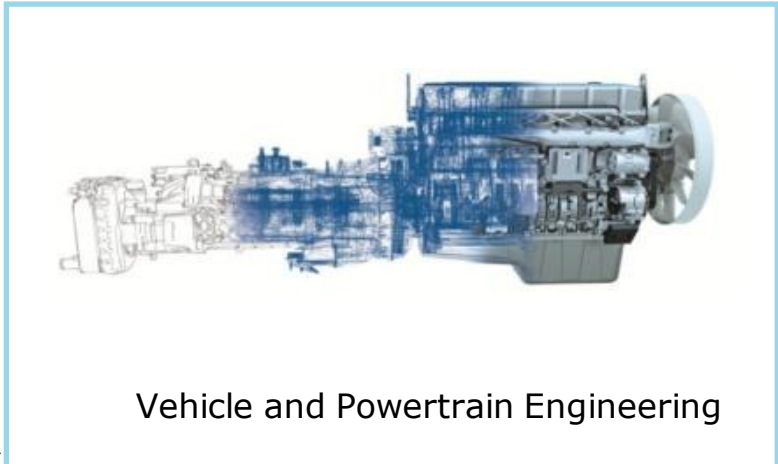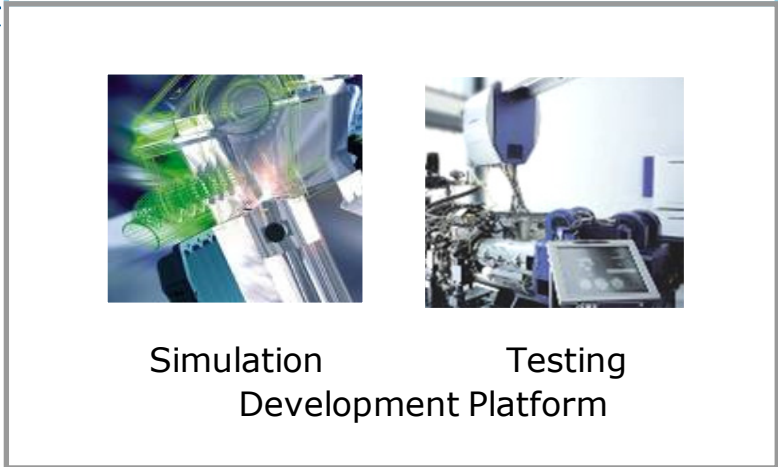Agriculture


Commercial Vehicle


Locomotive


Marine


Power Plants

Vehicle and Powertrain Engineering

Simulation                Testing
Development Platform

# AVL in ADAS and Autonomous Driving



**System Design**
system engineering,
use & test cases, architecture,
component & function
specification

**Specific Control
& SW Development**
concept & series
development, modification/
adaptation

**Advanced
Predictive Functions**
improving vehicle attributes
e.g. energy or fuel efficiency

**Calibration, Testing
& Validation**
simulation, integration,
optimization,  assessment
using lab, XiL and road

**For new levels of vehicle comfort, safety & efficiency**

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# Future of Road Mobility

**Connected**

New dimension in Comfort, safety and entertainment

**Autonomous**

From assisted driving to accident free Autonomous driving

**Shared**

Mobility on demand Digital transport services

**Electric**

Local emission free BEF and FCEV

# Future of Road Mobility

## Connected

New dimension in
Comfort, safety and
entertainment

## Autonomous

From assisted driving
to accident free
Autonomous driving

## Shared

Mobility on demand
Digital transport services

## Electric

Local emission free
BEF and FCEV

# Predicting Future Trends



**View from 1850 to 1900:**

- **C**onnected
- **A**utonomous
- ~~**S**afe~~
- ~~**E**lectrified~~

**View from 1900 to 1950:**

- ~~**S**afe~~
- **E**lectrified

**View from 1950 to 2000:**

- **C**onnected
- **A**utonomous
- **S**afe
- **E**lectrified

**View from 2018 to 2050:**

- **C**onnected
- **A**utonomous
- **S**afe
- **E**lectrified

1850          1900          1950          2020     2050
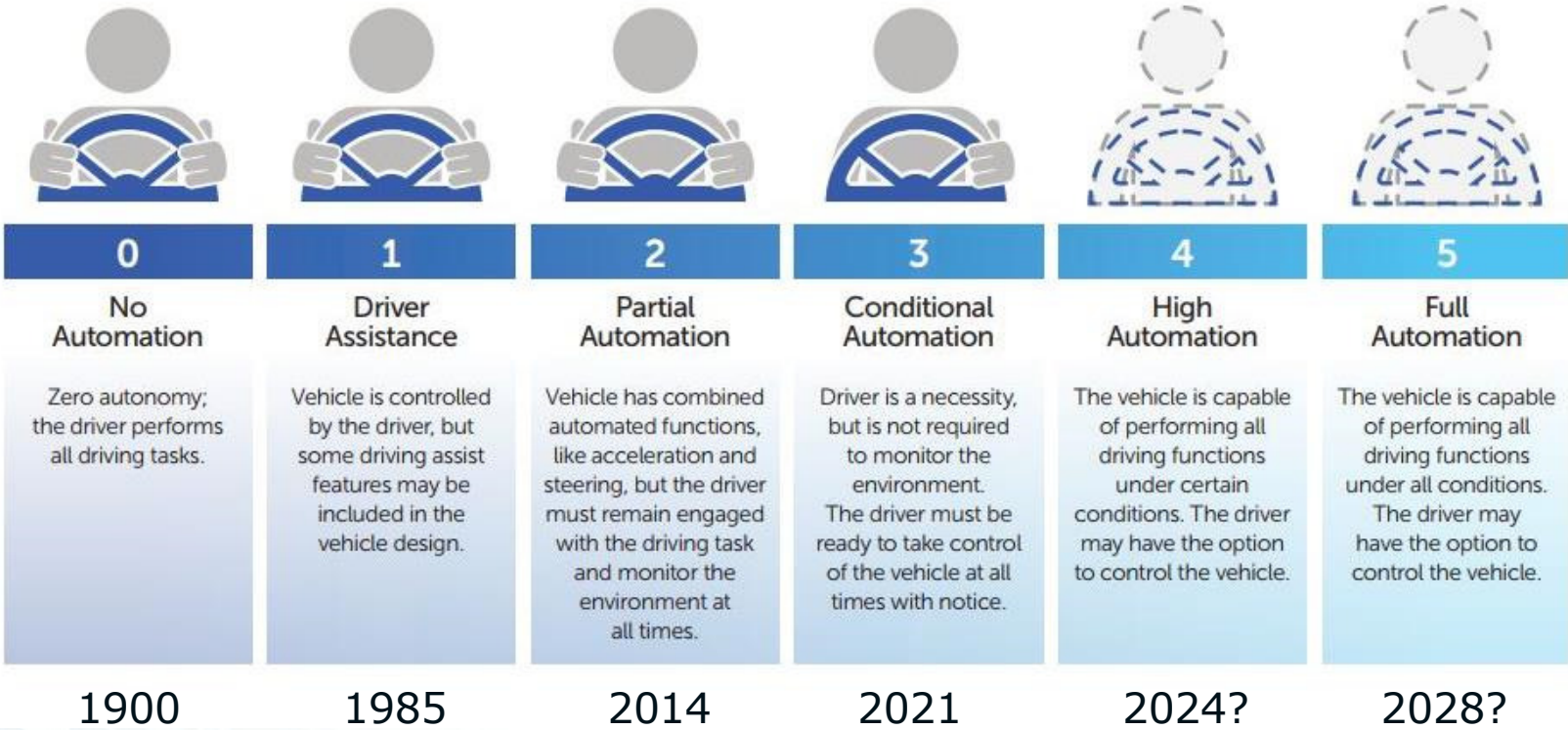
**Predicting the future is a target since long time !**

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# ADAS and AD Trends, Source SAE

| 0 | 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|
| No Automation | Driver Assistance | Partial Automation | Conditional Automation | High Automation | Full Automation |
| Zero autonomy; the driver performs all driving tasks. | Vehicle is controlled by the driver, but some driving assist features may be included in the vehicle design. | Vehicle has combined automated functions, like acceleration and steering, but the driver must remain engaged with the driving task and monitor the environment at all times. | Driver is a necessity, but is not required to monitor the environment. The driver must be ready to take control of the vehicle at all times with notice. | The vehicle is capable of performing all driving functions under certain conditions. The driver may have the option to control the vehicle. | The vehicle is capable of performing all driving functions under all conditions. The driver may have the option to control the vehicle. |

**Introduction:** 1900    1985    2014    2021    2024?    2028?

**Motivation:**

Safety, comfort, energy consumption

Give the customer time, e.g. to work/make profit

# The Future of Road Transport



## 2018 with L0-L2

- From A to B
- Fun





## 2030 with AD Level 4/5

- From A to B
- Fun
- Work in the car
- Sleep
- Eat
- Purchase in vehicle

# The Future of Transport

## 2018 with L0-L2

**People transport**

- From A to B
- Fun

## 2030 with AD Level 4/5

- From A to B
- Fun
- Work in the car
- Sleep
- Eat
- Purchase in vehicle

**Goods transport**

2018 with L0-L2
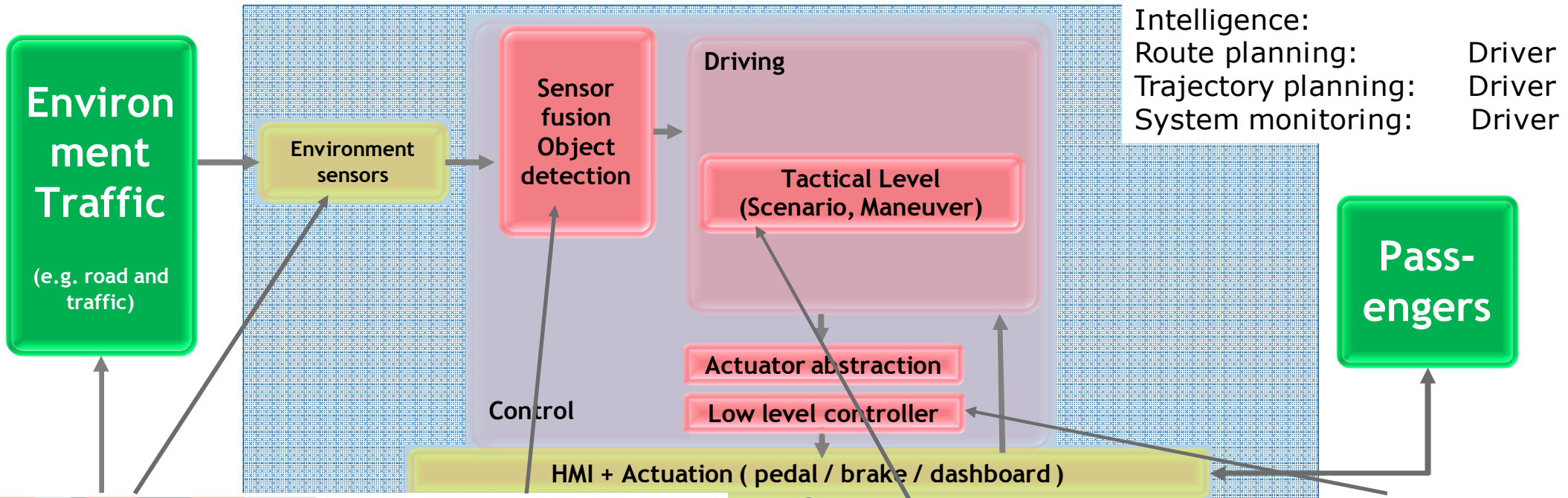
- From A to B

2030 with AD Level 4/5
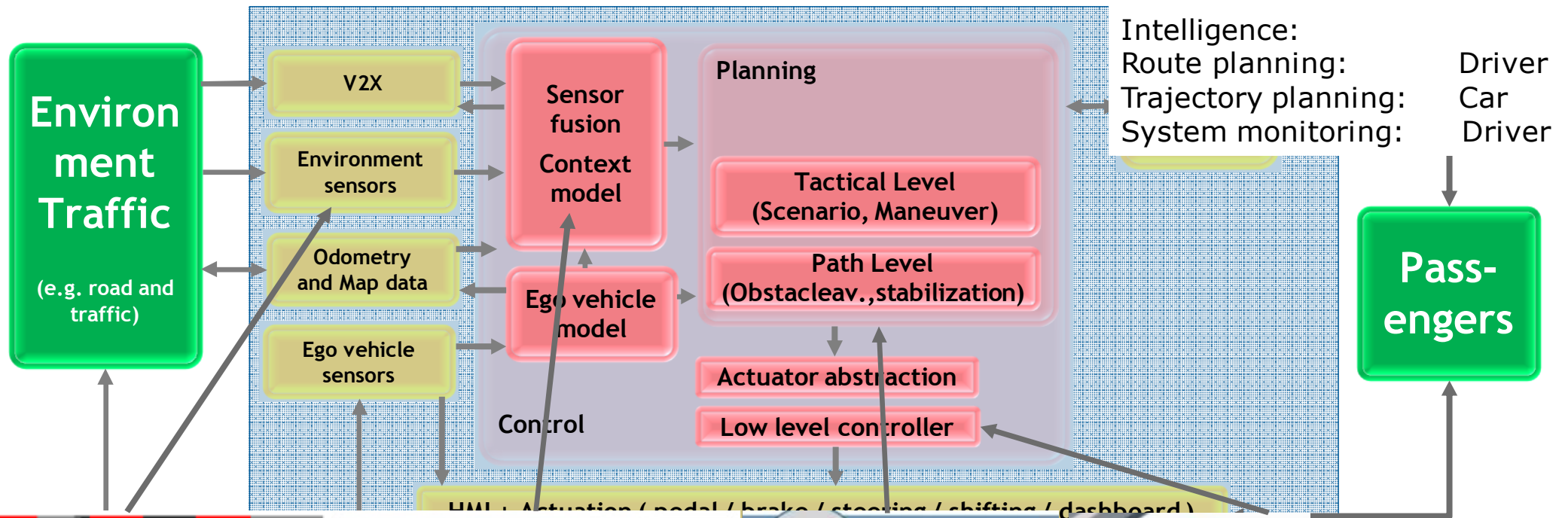
- From A to B
- Dangerous areas

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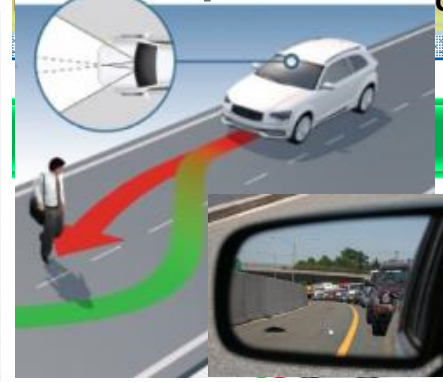- **Conclusion, discussion**

# L2 SYSTEM STRUCTURE, SIMPLIFIED



Environment Traffic (e.g. road and traffic)

Environment sensors

Sensor fusion Object detection

Driving

Tactical Level (Scenario, Maneuver)

Control

Actuator abstraction

Low level controller

HMI + Actuation ( pedal / brake / dashboard )

Pass-engers

Intelligence:
Route planning:        Driver
Trajectory planning:   Driver
System monitoring:     Driver

# L3 SYSTEM STRUCTURE, SIMPLIFIED

# Level 3 System in Operation



Brain, intelligence:

Route planning: Driver

Trajectories:     Car

Monitoring:     Driver

# Level 3 System in Operation
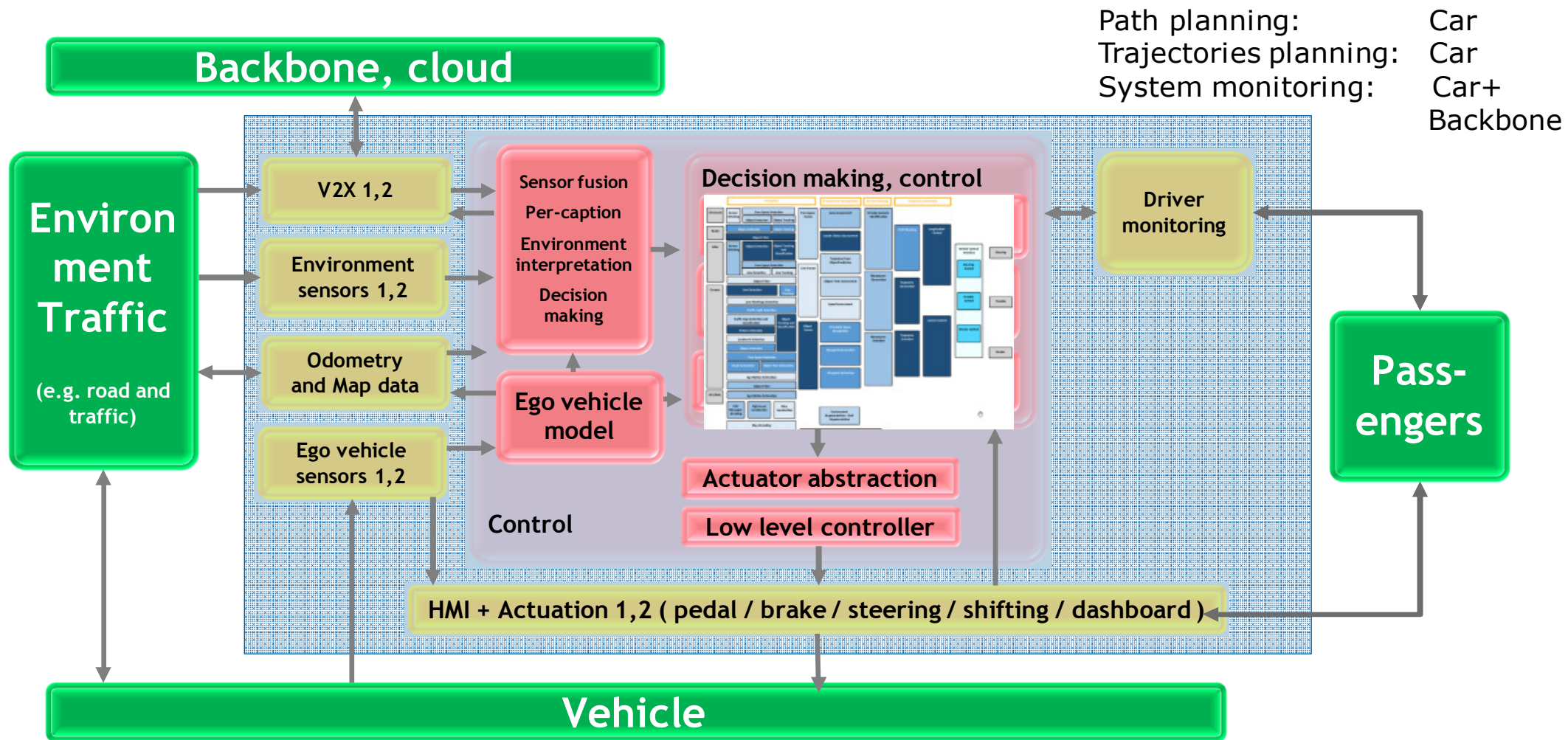
Brain, intelligence:

Path planning: Driver

Trajectories:    Car

Monitoring:      Driver

# L4 SYSTEM STRUCTURE, SIMPLIFIED

**AVL RACING**

Path planning:          Car
Trajectories planning:  Car
System monitoring:      Car+
                        Backbone

**Backbone, cloud**

**Environ ment Traffic**

(e.g. road and traffic)

V2X 1,2

Environment sensors 1,2

Odometry and Map data

Ego vehicle sensors 1,2

Sensor fusion
Per-caption
Environment interpretation
Decision making

Ego vehicle model

**Decision making, control**



Control

Actuator abstraction

Low level controller

Driver monitoring

**Pass-engers**

HMI + Actuation 1,2 ( pedal / brake / steering / shifting / dashboard )

**Vehicle**

# Level 4 System

Intelligence:

Path planning: Car

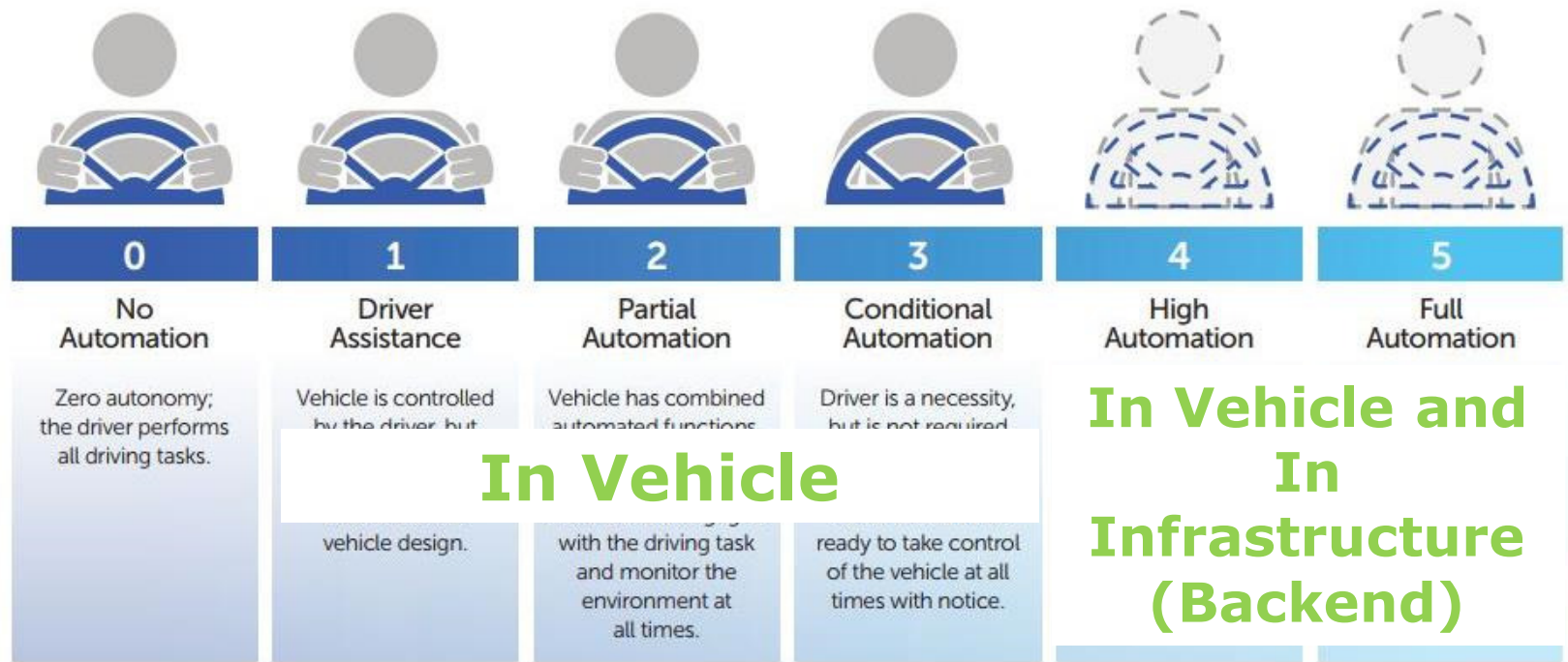Trajectories:    Car

Monitoring:      Car&
                 Environment

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# Do we need the Intelligence in the vehicles or in the infrastructure ?



| | 0 | 1 | 2 | 3 | 4 | 5 |
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| | Zero autonomy; the driver performs all driving tasks. | Vehicle is controlled by the driver, but ... vehicle design. | Vehicle has combined automated functions ... with the driving task and monitor the environment at all times. | Driver is a necessity, but is not required ... ready to take control of the vehicle at all times with notice. | | |

**In Vehicle**

**In Vehicle and In Infrastructure (Backend)**

| | 0 | 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|---|
| Introduction: | 1900 | 1985 | 2014 | 2021 | 2024? | 2028? |
| Route: | Driver | Driver | Driver | Driver | Car/Env. | Car/Env. |
| Driving tasks: | Driver | Driver/Car | Driver/Car | Car | Car | Car |
| Monitoring: | Driver | Driver | Driver | Driver | Car/Env. | Car/Env. |
| Fail safe: | Driver | Driver | Driver | Driver | Env. | Env. |

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# ADAS/AD - THE CHALLENGE SAFETY

2017 – Human Driving + L1,L2

AD drives x times better than humans

| | 1x | 10x | 100x | 1.000x | 10.000x | |
|---|---|---|---|---|---|---|
| | | | | | | |
| | 130.000 | 13.000 | 1.300 | 130 | | fatals /year |
| | 5 Mio. | 500.000 | 50.000 | 5.000 | | injured/ year |

Our guess

Road safety – the vital statistics

**1.3 million** people die each year as a result of road traffic accidents

**50 million** people are injured globally as a result of road traffic accidents

**90%+** of accidents are caused by human error.

Source: United Nations

Graphic: Allianz Global Corporate & Specialty

-> How much better must autonomous driving be to be accepted by the public ?

-> How many AD caused accidents are acceptable ?

-> AD must drive 1000 times better than humans

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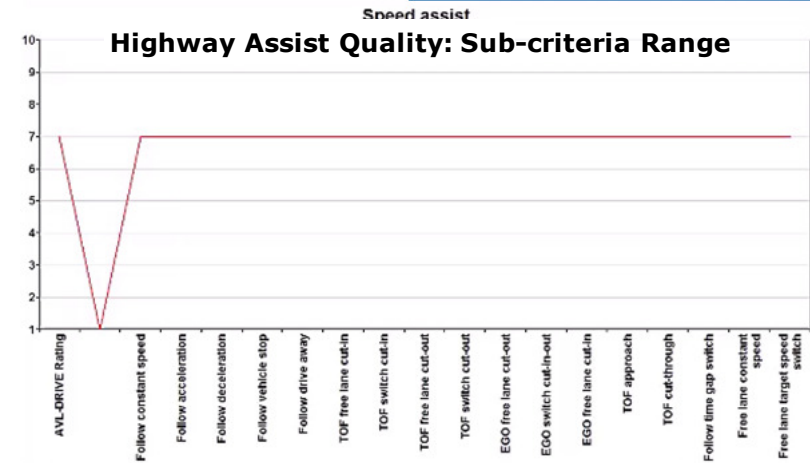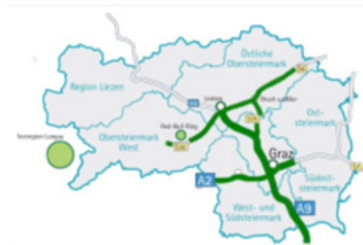MOVIE How safe would you feel in this situation?

# HUMAN STRESS FROM PLATOONING



Would you feel good here ?

Source:
cdn2.hubspot.net

# EVALUATION OF PERCEIVED SAFETY

**Infrastructure:** Styria Test Region, Alp.Lab, AVL test track **Tool**: AVL-DRIVE™ ADAS



**Highway Assist Quality: Sub-criteria Range**



Automated events detection

**Highway Assist Perceived Safety**
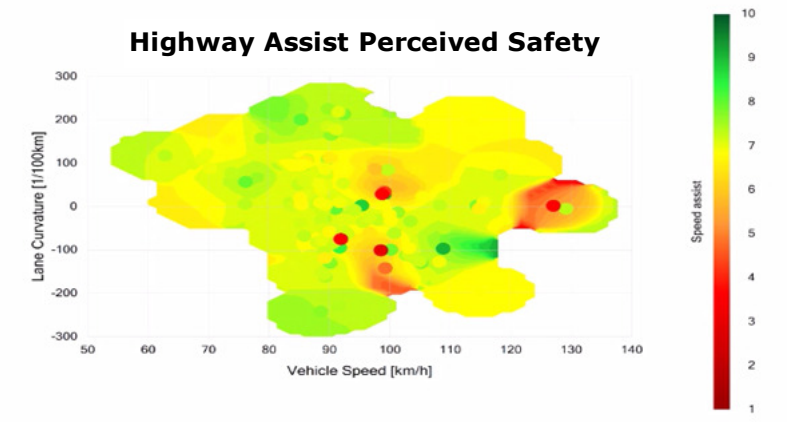


Perceived safety assessment

# THE CHALLENGE TESTING AND VALIDATION

2018 – people drive

AD drives n times better

| | 10x | 100x | 1000x | 10.000x | |
|---|---|---|---|---|---|
| | | | | | |
| 1.3 million people die each year as a result of road traffic accidents | 130.000 | 13.000 | 1.300 | 130 | died people |
| 50 million people are injured globally as a result of road traffic accidents | 5 Mio. | 500.000 | 50.000 | 5.000 | injured |

Human drivers drive very safe, statistically 1 died person per 12 Mio. km in Germany

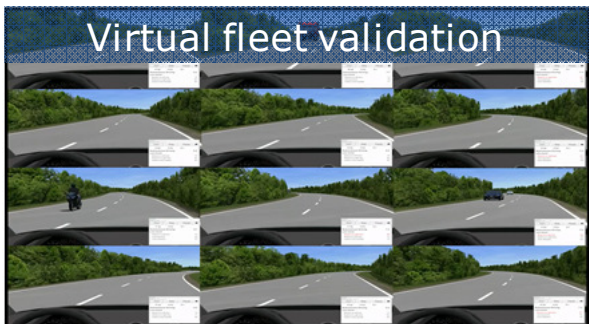| Necessary AD testing | 120 Mio. | 1,2 Bio. | 12 Bio. | 120 Bio.km | |
|---|---|---|---|---|---|
| Testing duration: 100 cars, $1*10^5$ km/car/year: | 12 | 120 | 1.200 | 12.000 years | |

-> New solutions required !

Our guess

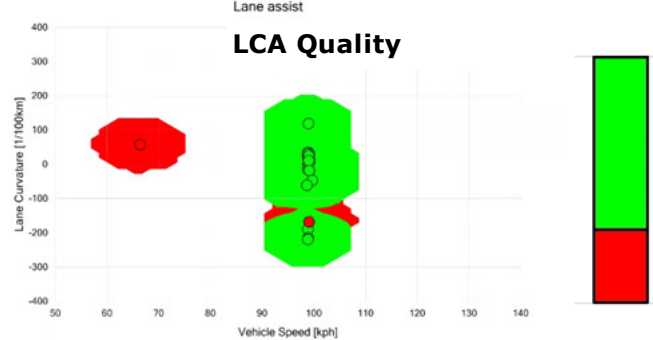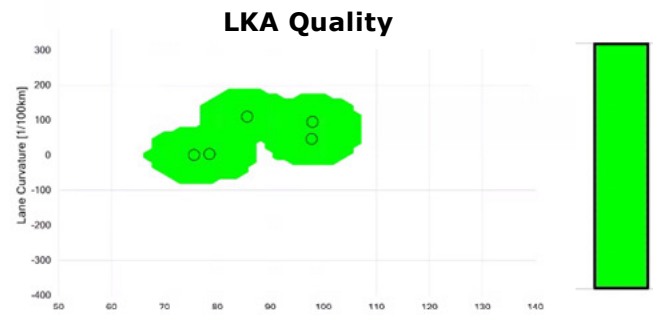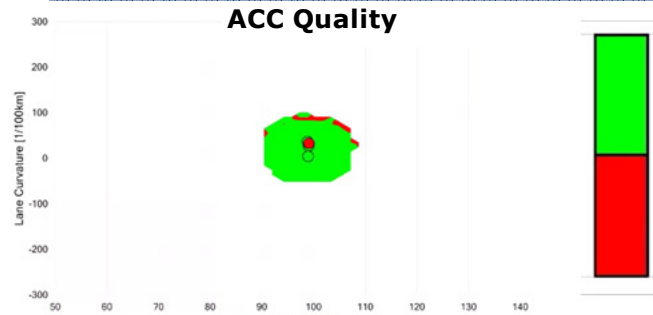# AD VALIDATION WORKFLOW IN AVL ADAS DEVELOPMENT CENTER



AVL

Driver simulator

Road / test track vehicle tests

Test master Scenario catalog

- Synthetic
- Euro-NCAP
- Real life

Attributes evaluation

Simulation/ cloud master

Vehicle model

Quality validation

5000 cores

AD function

Environment/ Traffic model

50 Mio. virtual validated km/week in 2018

Human tests

Driving cube

Vehicle tests

Relevant use cases
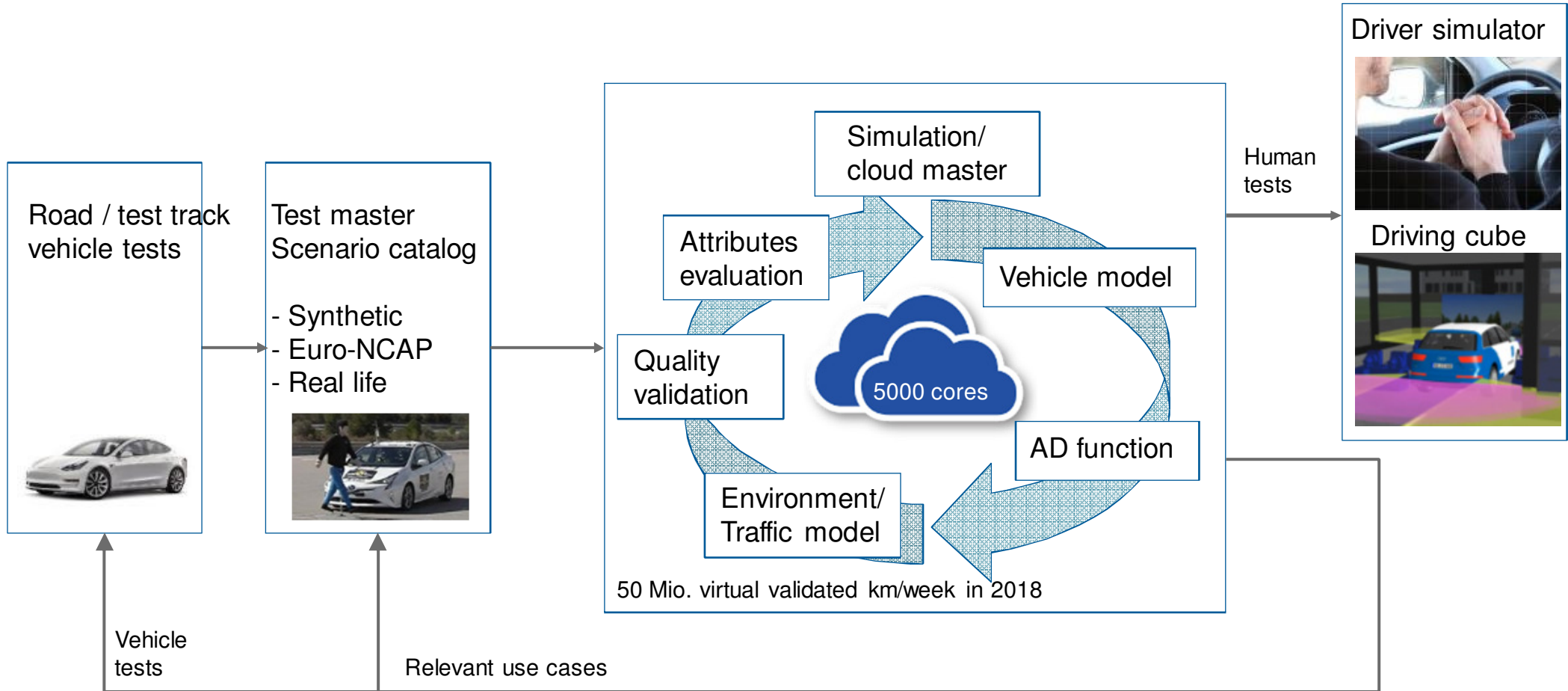
# ADAS/AD VALIDATION
## FROM ROAD TO CLOUD SIMULATION



Road validation

Virtual validation

Virtual fleet validation

1000-5000 cores

Automated Validation

**ACC Quality**

**LKA Quality**

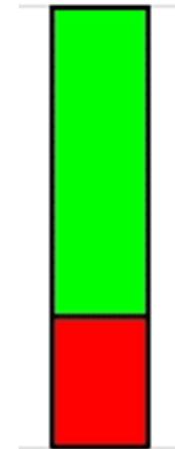**LCA Quality**

Overall Validation Status

Virtual validated testing:
2017: 5 Mio.km/week
2018: 50 Mio.km/week

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# CONCLUSION

- ADAS & AD introduction: L3 in 2021, L4 in 2024, L5 in 2028

- Main introduction reasons are safety, comfort, additional time to be spend !!

- The intelligence is in the car (L1-L5) and in the backbone (L4-L5)

- Multiply challenges to be solved:

  - System safety must be significant higher than today

  - Perceived safety is key for customer satisfaction

  - New development processes to achieve acceptable development time

Thank you for your attention !

**ÖVG Forum: Rail & Road Traffic Management**

# Technologie für Straße und Schiene
# Standortbestimmung und wo geht die Reise hin

**15.11.2018**

**Quartier Belvedere Central**

Gertrude Fröhlich Sandner Straße 3, 1100 Wien

09:00     *Registrierung*

09:30     **Begrüßung**
             Dipl.-Ing. Peter KLUGAR (Präsident der ÖVG)

09:40     **Keynote: Von der Fahrerassistenz bis zum autonomen Fahren. Brauchen wir die Intelligenz in den Fahrzeugen oder in der Infrastruktur?**
             Dr. Peter SCHÖGGL (Vizepräsident AVL List)

**10:10** **Roundtable der Arbeitsgruppenleiter „Rail & Road Traffic Management und Technologie"**
Dipl.-Ing .Dr. BIESTER (Siemens Mobility GmbH), Ing. Gottfried SCHUSTER (Schuster&Schuster Traffic Infrastructure Consulting GmbH), Ing. Wolfgang WERNHART, (Thales Austria GmbH), GF Dipl.-Ing. (FH) Martin MÜLLNER (ASFINAG), Albert KALTENBRUNNER, MSc (ÖBB Infrastruktur AG), Dipl.-Ing. Markus RACZ (Siemens Mobility GmbH)

**11:10** *Kaffeepause*

**11:30** **Open Rail Lab**
GF Dipl.-Ing. Dr. Ulrich PUZ, MBA (SCHIG)

**11:55** **Wissensmanagement und Wissenstransfer**
Dr. Veronika ZÜGEL (ÖBB Holding), FH-Prof. Dipl.-Ing. Otfried KNOLL, EURAIL-Ing

**12:30** *Mittagspause*

**13:30** **Automatisiertes Fahren aus Sicht des Straßenbetreibers**
GF Ing. Mag. Bernd DATLER (ASFINAG Maut Service GmbH)

**13:55** **Autonomes Fahren auf der Straße in der Stadt – Projekt „auto Bus-Seestadt"**
Dipl.-Ing. Peter WIESINGER

**Rail & Road Traffic Management**

ÖVG-Forum

Datum: **15. November 2018**
Ort: **Quartier Belvedere Central,  Wien**

Anfahrtsplan   Programm
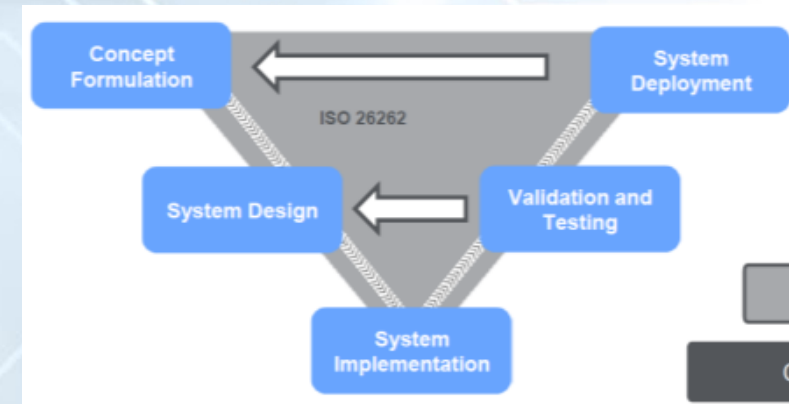
Weitere Informationen

# CHALLENGES

Sensor quality

Security and safety

Validation







- Weather
- Dirt
- Ageing

- Hacker
- Data mis-use

- 55.000 years with standard methods
- 1.2 Mrd. km testing and validation

VIELEN DANK

**AVL**

www.avl.com