Autonomous driving and road markings

IRF & UNECE ITS Event
"Governance and Infrastructure for smart and autonomous mobility"

Eva Ambrosius I 4 December 2018 I Geneva, Switzerland

Agenda

1. Importance of road markings for autonomous driving

2. Challenges for camera sensors and road marking solutions

3. Summary

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1. Importance of road markings for autonomous driving

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Road markings are important to ensure safe and reliable navigation of autonomous vehicles through the roadway

"We really need better lane markings in California."
Elon Musk, CEO Tesla

"But like the human eye,
the technology cannot work effectively if it cannot
see the road markings and traffic signs if they are
worn out or hidden, or if they are confusing."
**EuroRAP, EuroNCAP**

"It can't find the lane markings! You need to paint
the bloody roads here!"
Lex Kerssemakers, CEO Volvo North America

"Now, we need to increase the durability, weather
range, time, and distance that a machine or camera
could 'see' the pavement markings even further."
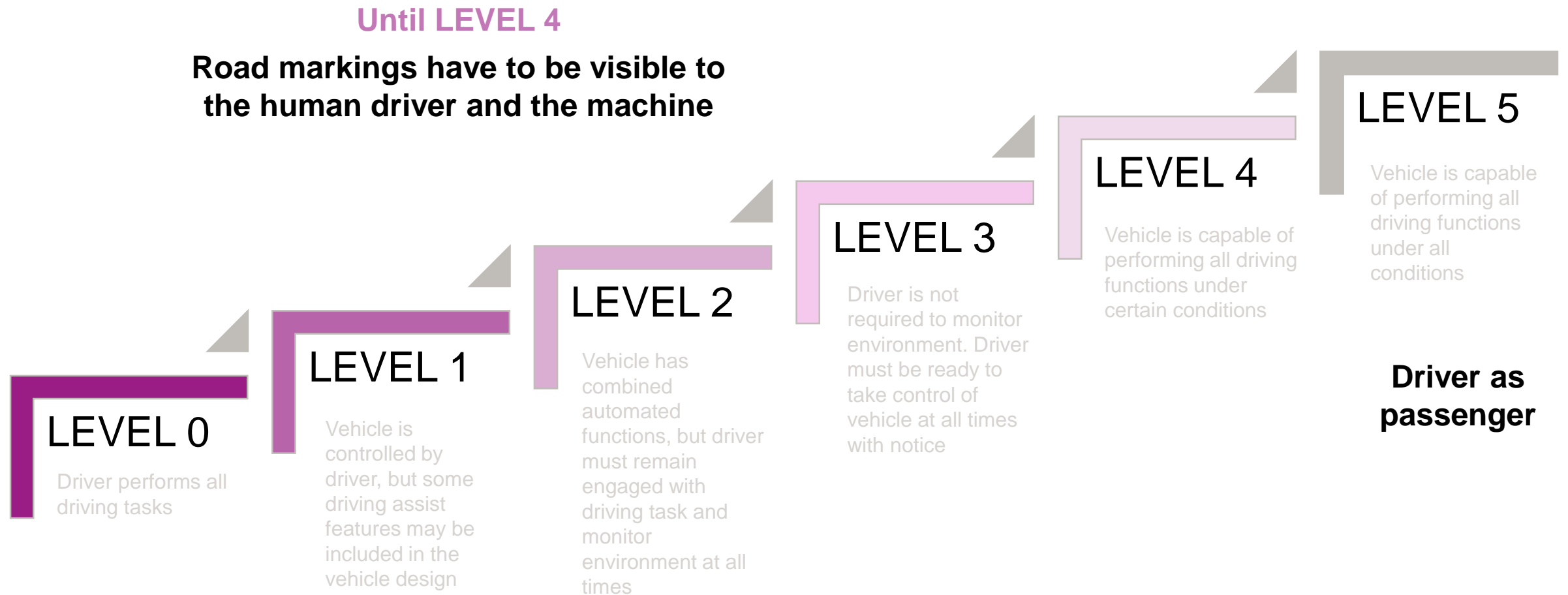**Tom Headblom, 3M scientist**

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Clearly visible road markings support the human driver and the machine in navigating through the roadway today and in future.

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Camera sensors are an integral component of advanced driving assistant systems using lane marking to ensure that the vehicle stays on course

- Today, only road marking functionality within the visual range is specified by current standards

- Innovative road markings could provide signals outside the visual range, but specifications would need to be derived

- Road infrastructure and corresponding standards can only be adapted to the digital age in an evolutionary process

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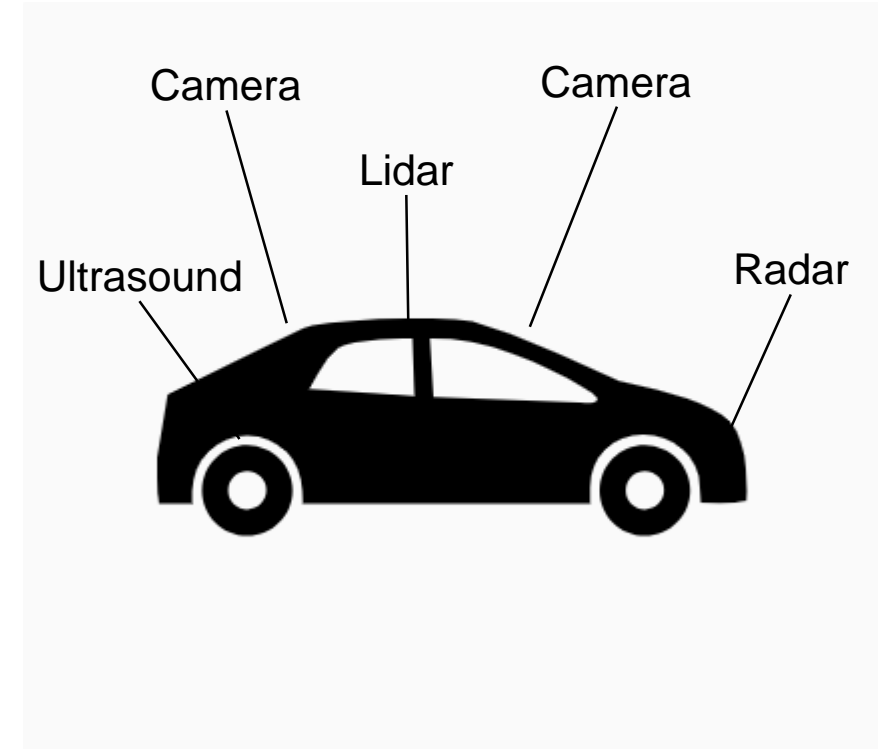
As the human driver will be able to take control of the vehicle until Level 4, road markings represent an important infrastructure element

Until LEVEL 4

Road markings have to be visible to the human driver and the machine

LEVEL 0

Driver performs all driving tasks

LEVEL 1

Vehicle is controlled by driver, but some driving assist features may be included in the vehicle design

LEVEL 2

Vehicle has combined automated functions, but driver must remain engaged with driving task and monitor environment at all times

LEVEL 3

Driver is not required to monitor environment. Driver must be ready to take control of vehicle at all times with notice

LEVEL 4

Vehicle is capable of performing all driving functions under certain conditions

LEVEL 5

Vehicle is capable of performing all driving functions under all conditions

Driver as passenger

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Fail-safe detection of lane markings is critical for advanced driving assistant systems to ensure road safety

- Camera technology is used to identify lane markings - safety is dependent on the visibility of road markings

- The quality of the lane markings' optical properties is important for safety and will be even more critical in future

- Adverse weather conditions and worn-out road markings still pose great challenges to camera sensors
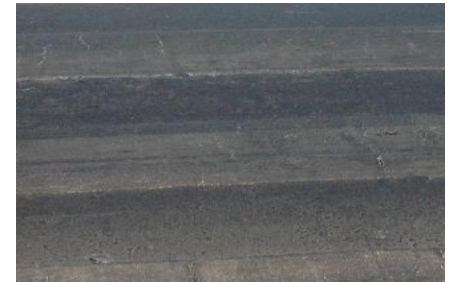
Rain	Snow	Fog	Sun	Dirt

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High-quality road marking systems can help meeting the challenges of camera technology and offer potential for innovation

Available marking solutions

High-quality road markings based on cold plastic with high visibility

Innovation opportunities

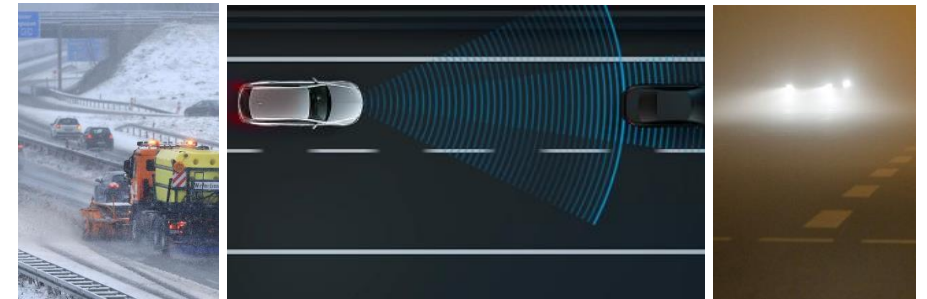e.g. radar-reflective road markings based on cold plastic

Rain
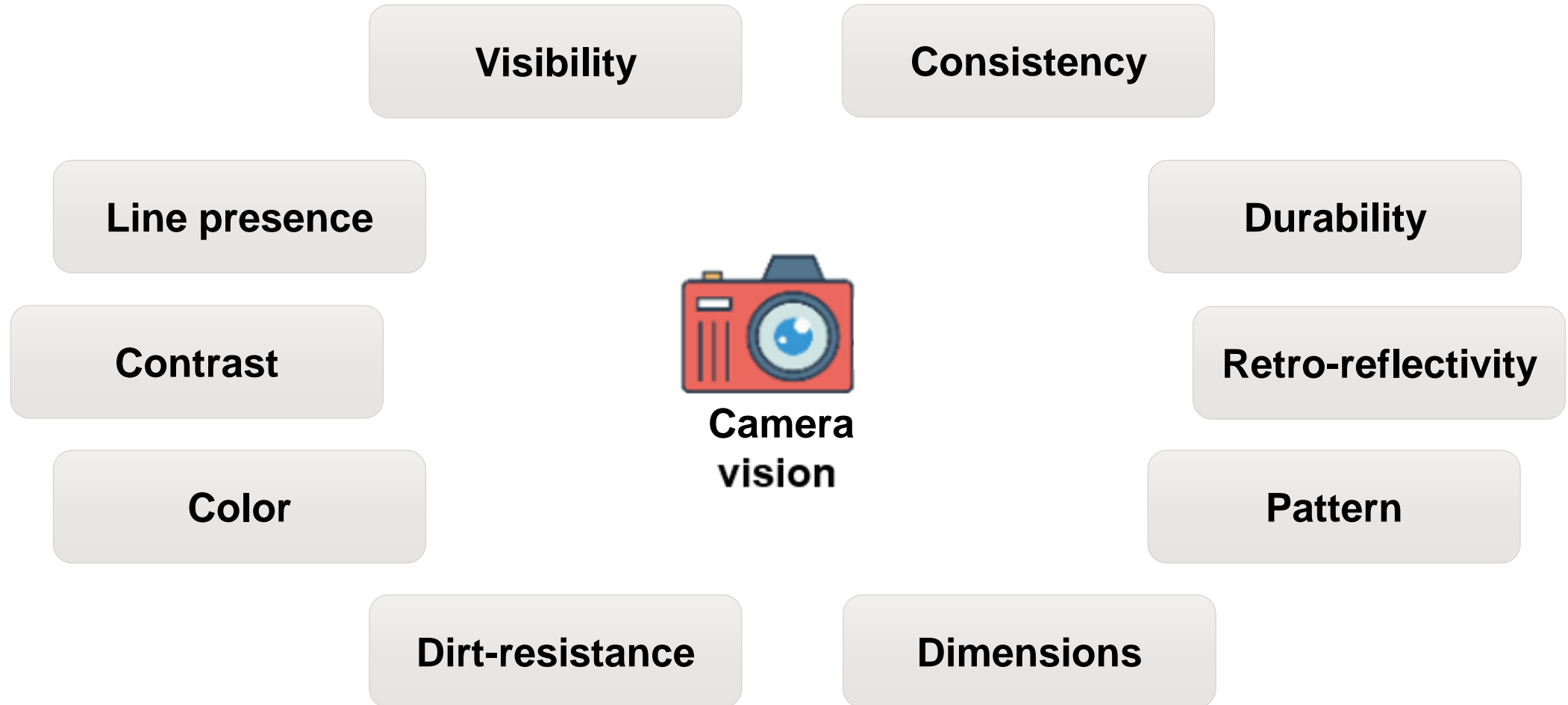

Type II markings
(wet-night visibility)

Dirt

Dirt-resistant markings
(anti-blackening effect)

Snow / Fog

Detection outside the visual range
(redundancy)

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Requirements and conditions of lane markings for camera vision are under investigation

Visibility

Consistency

Line presence

Durability

Contrast

Retro-reflectivity

Camera vision

Color

Pattern

Dirt-resistance

Dimensions

Discussions on performance levels for road markings and standards for autonomous driving have been started

- C-ITS Platform suggests a decent quality and visibility of lane markings to facilitate the control of automated driving

- ERF recommends retro-reflective markings that provide a night visibility of minimum 150 mcd/lx/m^2 under dry and minimum 35 mcd/lx/m^2 under rainy conditions, minimum 150 mm line width

- EuroRAP and Euro NCAP suggest line markings that are clearly visible in all-weather conditions

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Road markings contribute to improving road safety for human drivers and autonomous vehicles

- Available road marking solutions can support fail-safe detection of camera sensors
  - clear visibility at day and night, in all weather conditions, high quality and durability, anti-blackening effect
- Autonomous driving provides the road marking industry with new opportunities
  - support the change to digital systems with redundant solutions and improve road safety
- Harmonized regulations and standards to enable the evolution of road infrastructure into the digital age

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