State of the art ISA, LKAS & AEB

Yoni Epstein

ADAS Program Manager
Advanced Development

Mobileye, an Intel Company: The world leader in Advanced Driver Assistance Systems (ADAS)

An Intel Company

In 1999, Prof. Amnon Shashua and Mr. Ziv Aviram founded Mobileye and harness the power of computer vision for automotive safety

2007: First Camera-Radar Fusion

2008: First bundling of LDW, IHC, TSR

2010-11: First camera-only FCW

First Pedestrian AEB

2013: First camera-only ACC & TJA

First camera-only AEB (partial braking)

2015-2016: First camera-only full AEB

First camera-only full speed ACC on Nissan Pro-Pilot

2017: Mobileye, an Intel Company

2017-2018: First camera-fusion L3 system on Audi A8

REM™ mapping launch

2021: BMW Group and Mobileye Team Up to Commercialize Fully Autonomous Driving

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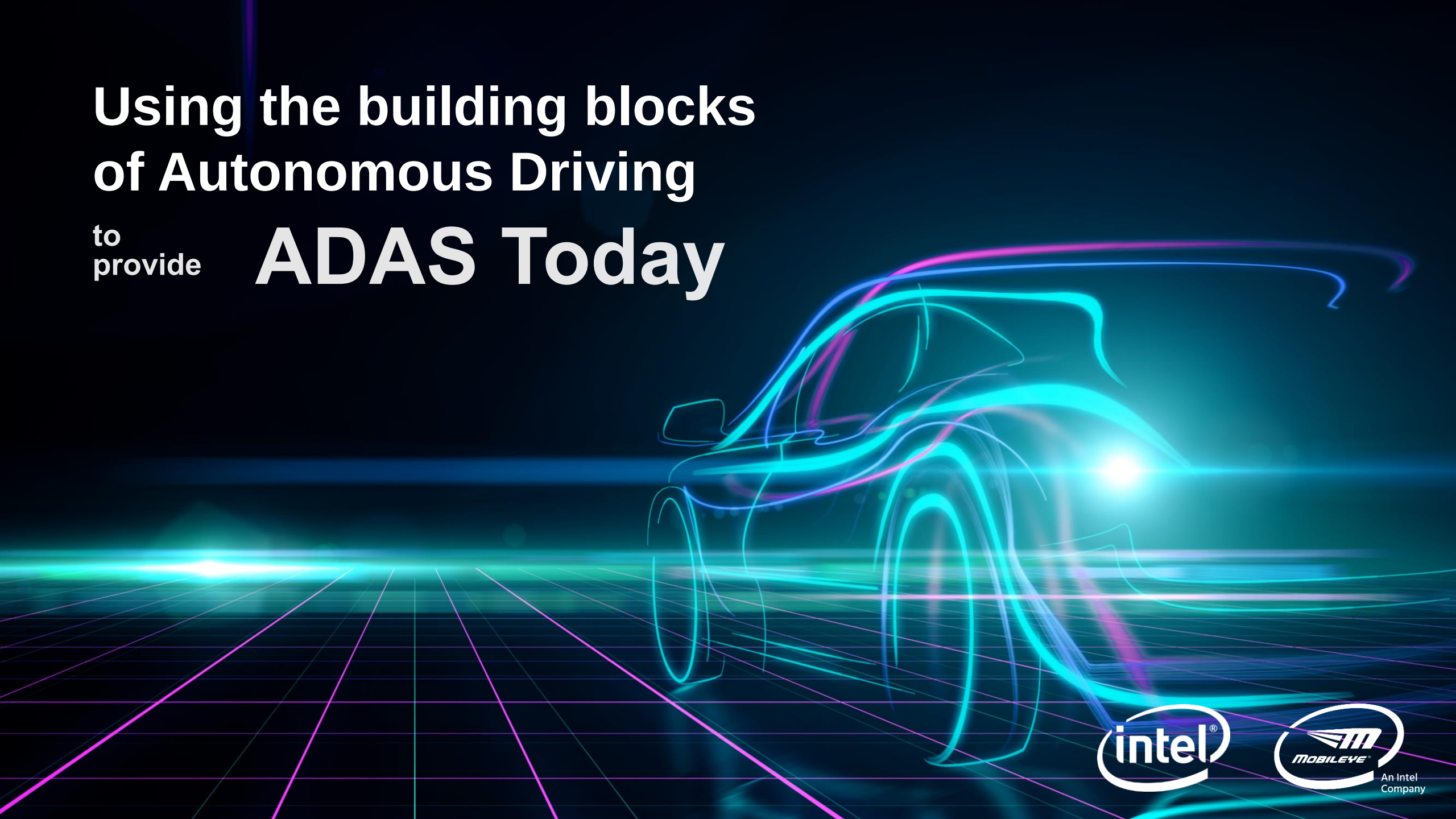
Using the building blocks of Autonomous Driving

to provide **ADAS Today**



EyeQ4 Vision Technologies

- 3D Vehicles
- Pedestrians
- Lane Marks
- Road Edges
- Path Prediction
- Traffic Signs
- Traffic Lights
- Road Markings
- Semantic Freespace
- Road Profile
- General Objects
- Hazards
- Animals

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Traffic Sign Recognition

Explicit Speed Limit detection across EU28 average ~95%.

High system awareness to inclement weather and limited visibility, during which systems can be temporarily shut-off (tunable by OEM).

Decreasing false-rates as a algorithms become more robust, and development database across EU28 increases.

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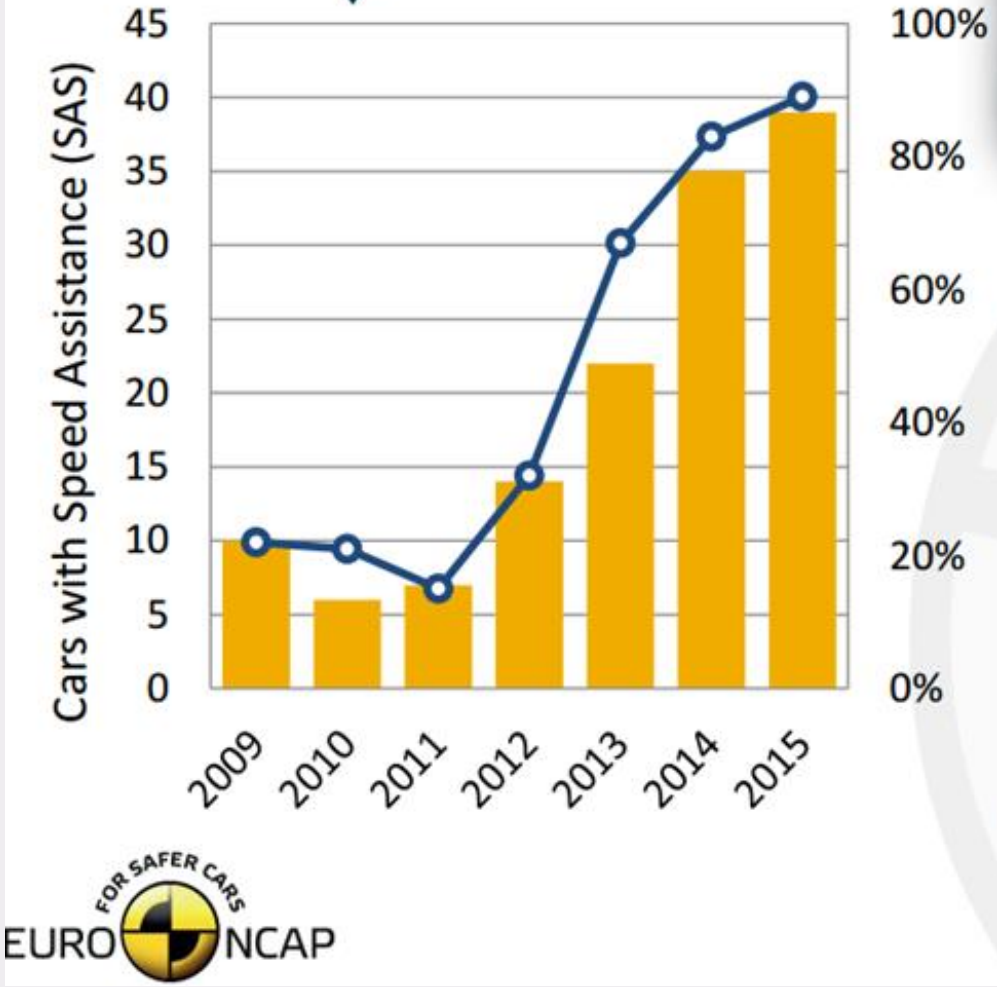
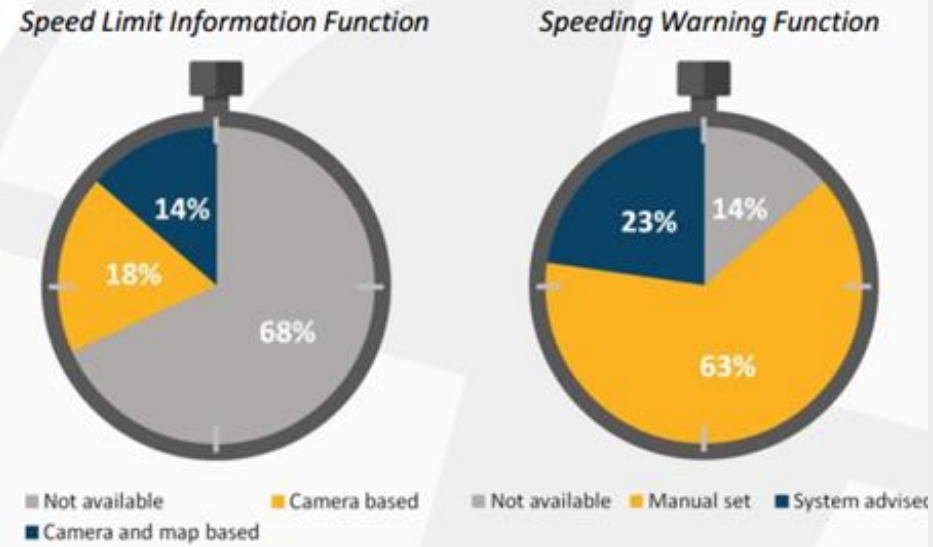
ISA Availability

SAS entered the mainstream but has not yet reached its full potential



SAS functionality in 2015 rated models (N=44)



FOR SAFER CARS EURO NCAP

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FCW/AEB

FCW & AEB Pedestrians, Cyclists, Vehicles & Motorbikes has been in production for over 5 years.

Current-Gen Object Detection provides 3D modelling for motorized vehicles and low detection latencies for VRUs, resulting in extremely high performance w.r.t. collision-critical objects.

- Audi A6 state-of-the-art results of Euro NCAP 2018
  - 3.9 / 4 AEB City
  - 2.9 / 3 AEB Inter-urban
  - 5.4 / 6 AEB Pedestrians
  - 4.9 / 6 AEB Cyclists

- Other camera-only solutions reached similar scores in Euro NCAP 2016 Ratings

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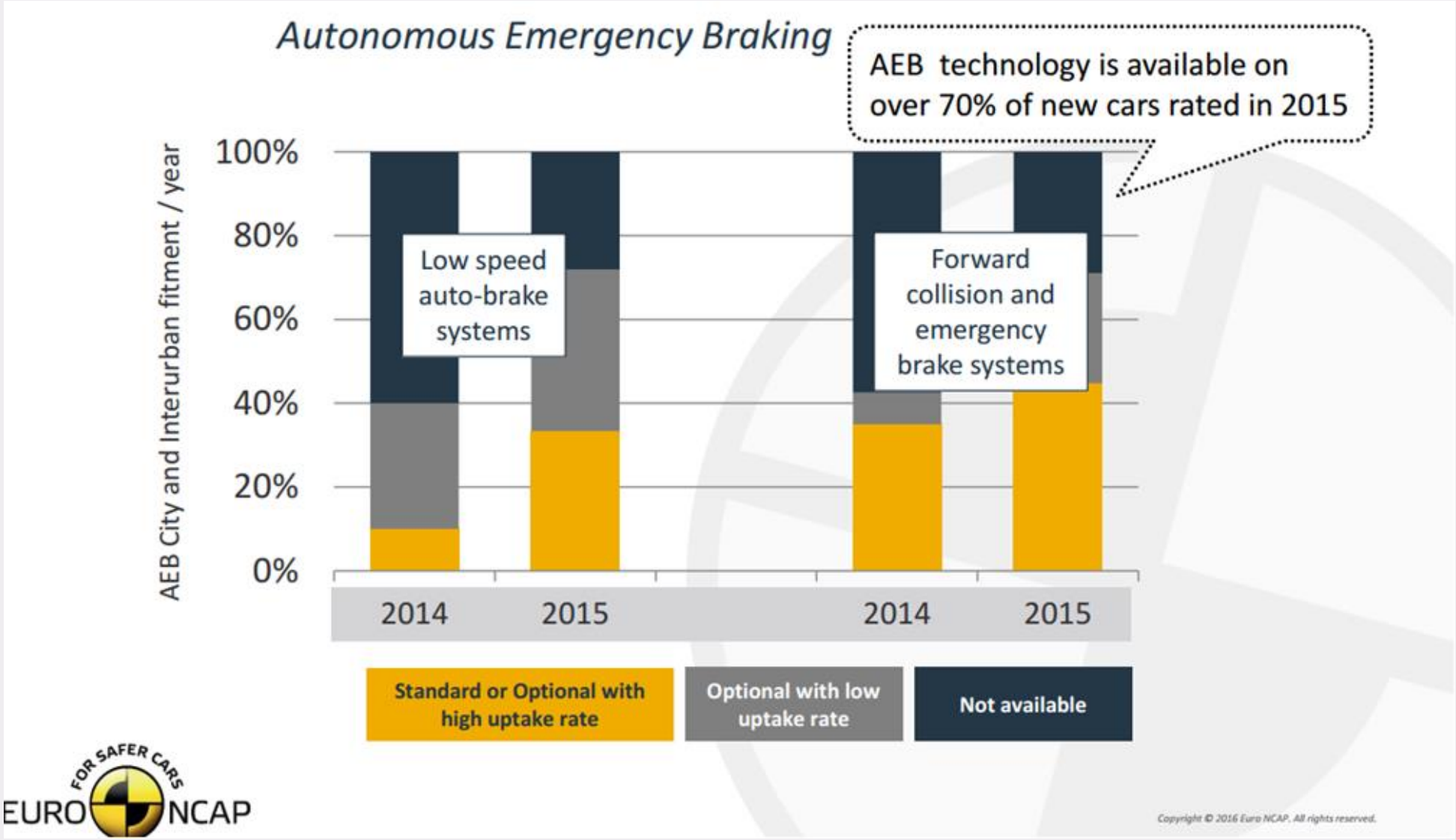
AEB Availability



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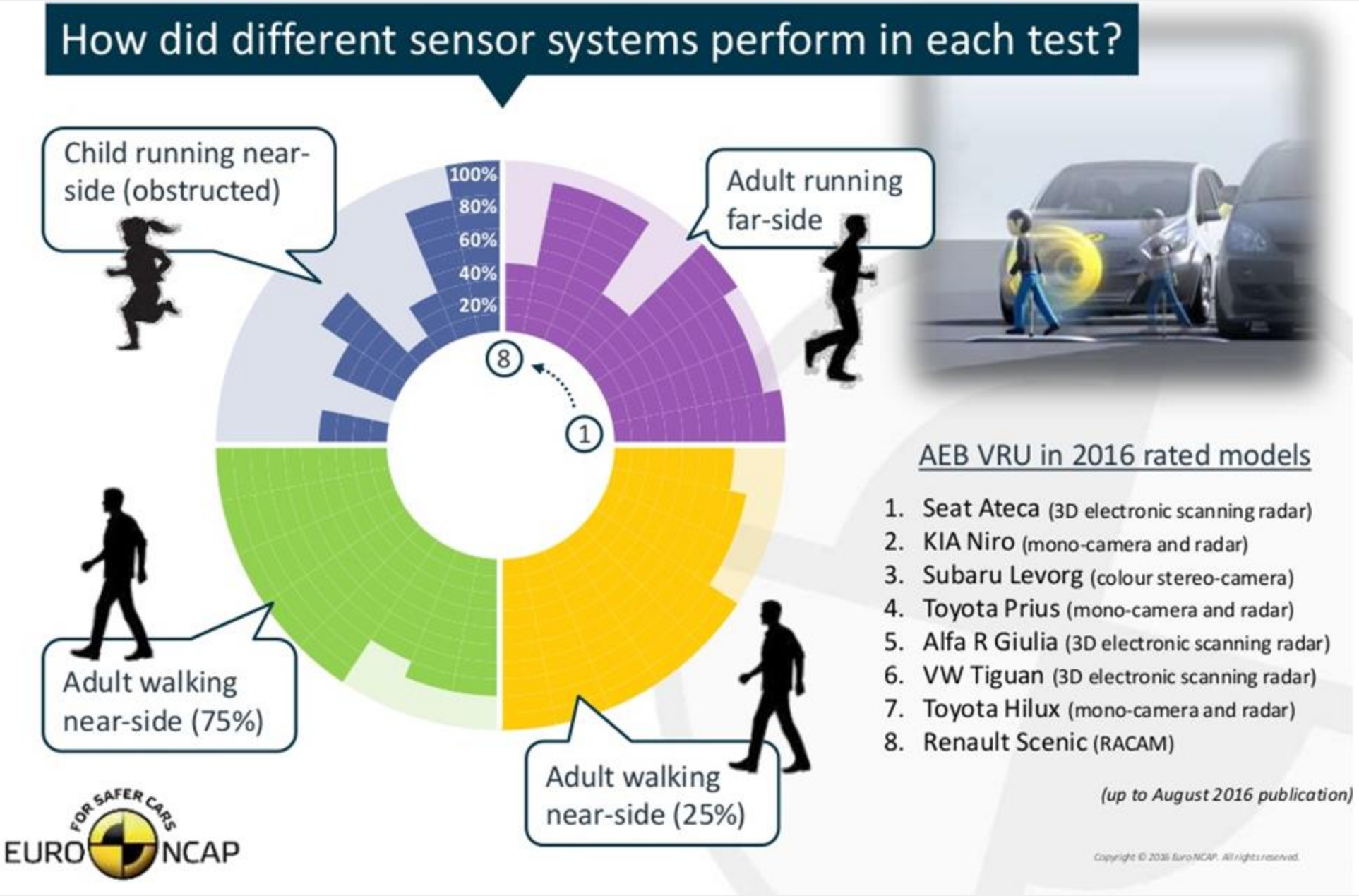
2016 AEB Pedestrian Performance

How did different sensor systems perform in each test?



AEB VRU in 2016 rated models

1. Seat Ateca (3D electronic scanning radar)
2. KIA Niro (mono-camera and radar)
3. Subaru Levorg (colour stereo-camera)
4. Toyota Prius (mono-camera and radar)
5. Alfa R Giulia (3D electronic scanning radar)
6. VW Tiguan (3D electronic scanning radar)
7. Toyota Hilux (mono-camera and radar)
8. Renault Scenic (RACAM)

(up to August 2016 publication)

EURO NCAP FOR SAFER CARS

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Lane & Road Edge Detection

Current-Gen Algorithms providing highly availably & accurate lane detection over 100m ahead.

Enables: LDW, LKA, Auto Lane-Change, AES

Another layer of algorithm can detect the road condition, such a wet roads or snow on the road surface.

In extreme weather with limited visibility, ADAS functions are disabled.

Advanced DNN technologies provide Path Prediction (trajectory for driving path) enabling more advanced Lane Centering applications.

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CV Challenges

Challenges

- Poor road infrastructure maintenance
- Lack of standardization

Mitigation Factors

- Next-gen processors, enabling more powerful algorithms
- Standardization efforts & best-practice design for CV (CEN, UNECE, etc) & infrastructure improvements
- OTA – Over the Air Updates: enabling continuous improvements
- Real-time HD Maps

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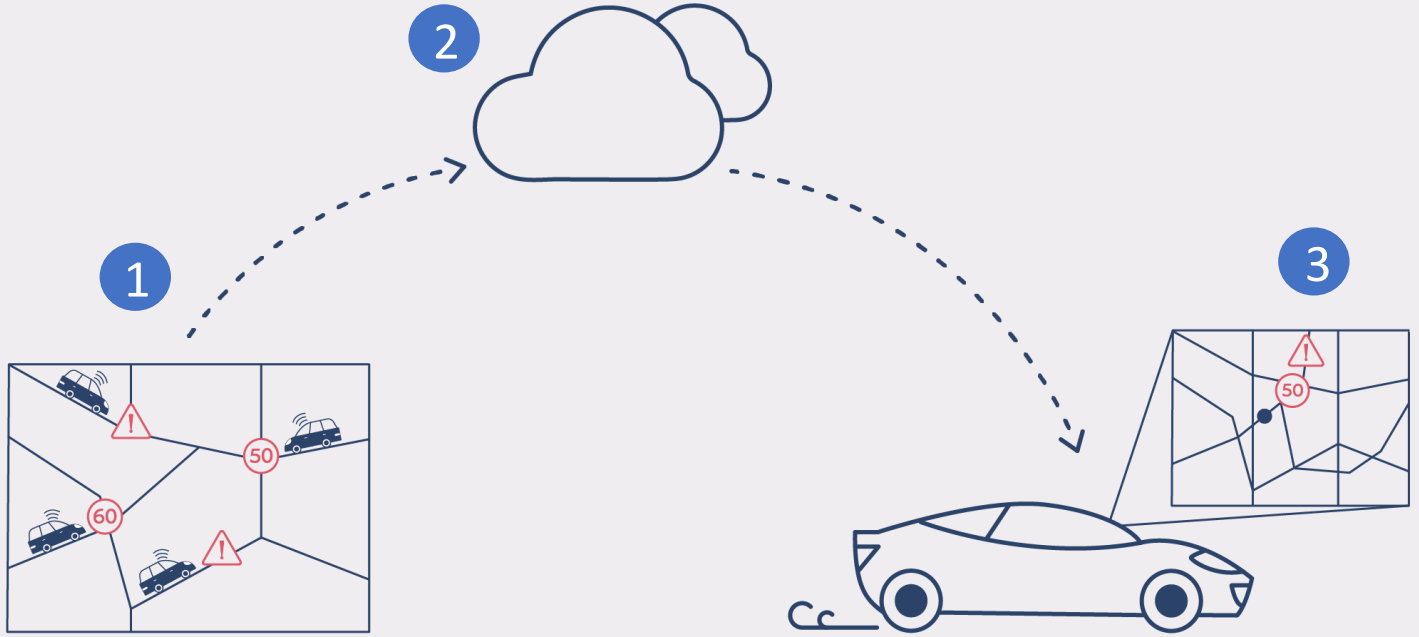
REM: Road Experience Management

1. Collecting static road landmarks through Mobileye ADAS & Aftermarket Systems
2. Anonymizing & encrypting RoadBook data sent to the cloud
3. Generating high definition crowdsourced maps for ADAS & AD



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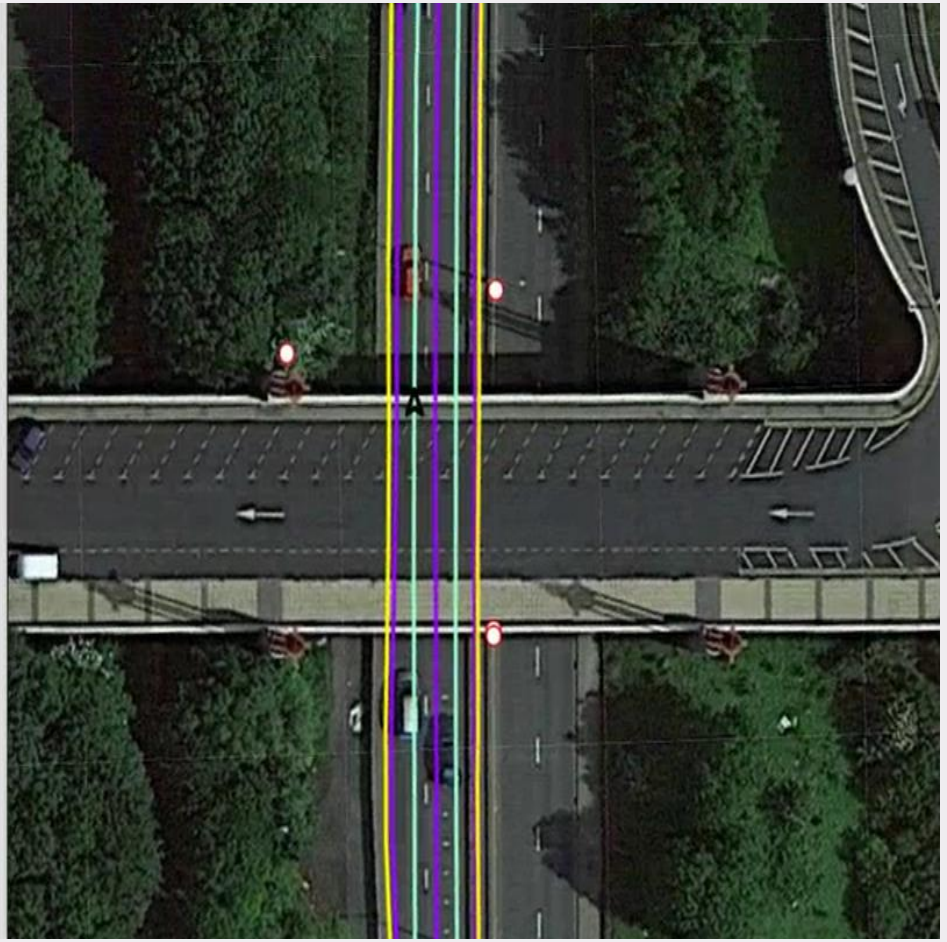
REM Roadbook Localization for L2+ to L4

RoadBook projected onto image space:
Road edge, lane marks, lane center, landmarks



RoadBook projected onto Google Earth

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State of the art ADAS

AEB, LKA & ISA systems have on the road for years, with increasing market penetration.

State of the art ADAS solutions perform with optimal accuracies. Examples of recent launches: Nissan ProPilot, Audi A8 zFAS, BMW X5, and more to come.

In extreme weather with limited visibility, systems are temporarily disabled to reduce the risk of miss or false detections and ensure driver awareness.

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State of the art ADAS

The technology roadmap in the coming years will optimize overall robustness, focus on availability in bad weather and performance in remaining corner-cases by adopting smarter deep network analysis, and by harvesting higher image resolution enabled by the latest generation of vision processors.

This will ensure very high performance is achieved by the time the ADAS mandate takes effect, and it is our job as the industry to continually improve these products to ensure customer acceptance.

As ADAS evolves as the cornerstone of AD, an increasing portion of OEMS will enhance performance of ISA by fusion with a GPS-MAP, and LKA with an HD Map, such as REM.

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A formal definition of Safety

I. **Sound**: Completeness with societal agreement on safety

II. **Useful:** Sufficiently agile to ensure traffic flow and natural driving alongside human drivers

III. **Technology Neutral**: can be applied to all AVs, without cost-burden for entry

IV. **Safe by Design:** Efficiently verifiable – ensuring every AV will follow a common interpretation of the law

V. **Observable:** Transparent model, applicable both pre and post-deployment

Responsibility Sensitive Safety (RSS): a safety model formalizing the interpretation of the law applicable to AVs.

Whitepaper:
https://arxiv.org/pdf/1708.06374.pdf

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THANK YOU

Drive Safe!