Veoneer Vision Technical Solution Introduction

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Vision product Roadmap

Vision Roadmap – ADAS and HAD Sensing

2018 Mono Vision AEB (3rd Generation)

- Mono Camera with Vision
- Cost effective solution to meet NCAP 2018 (Lane, AEB, TSR)

➢ **Launched on new A-Class, Volvo， Geely**

2020 Mono and Stereo Vision (4th Generation)

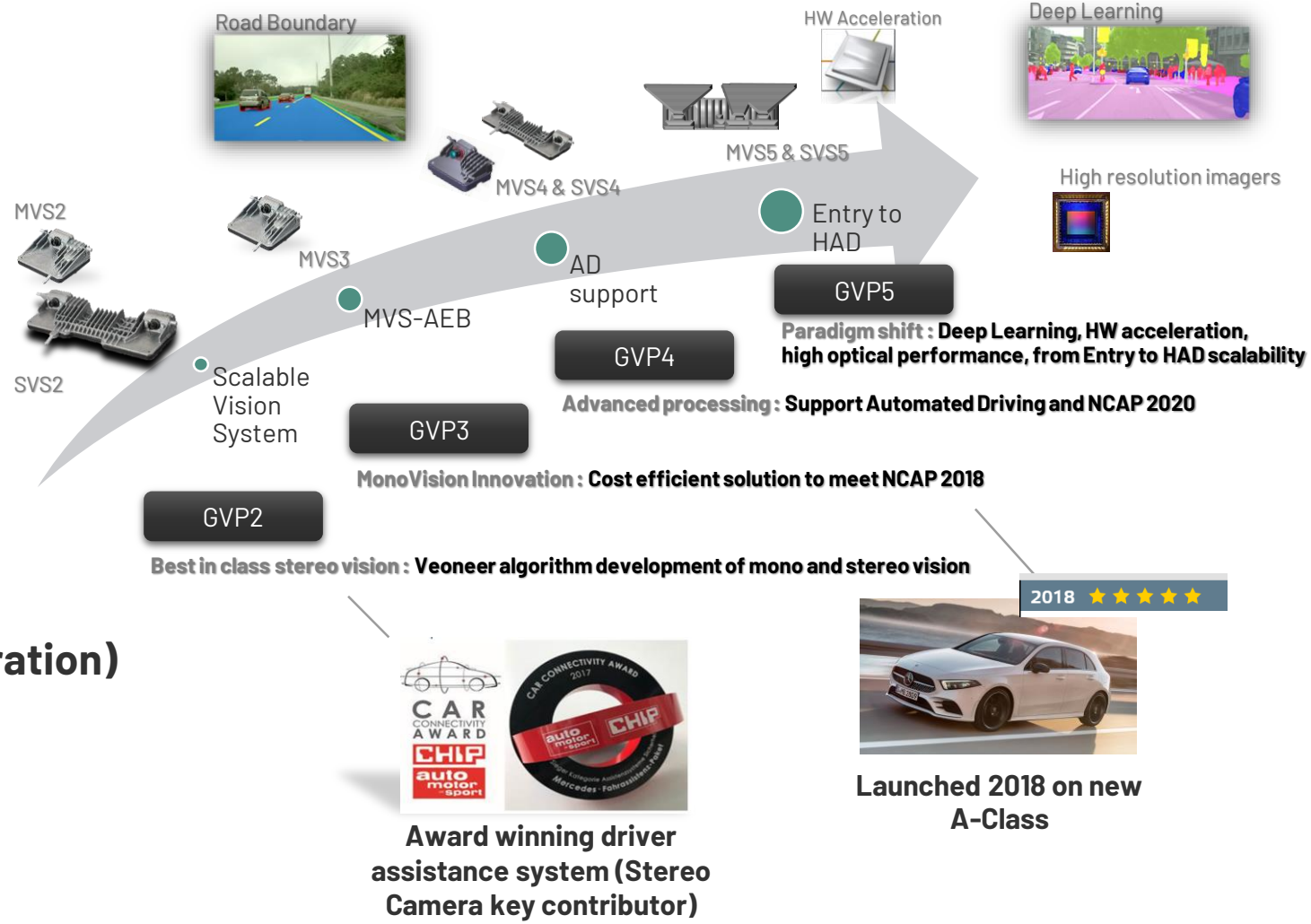
- Next generation Stereo and Mono cameras
- Support Automated Driving and NCAP 2020

➢ **Confirmed SOPs with 6 OEMs**

2022+ Next generation Vision systems (5th Generation)

- High resolution imagers
- Advanced algorithms and processing
- Multiple camera support

➢ **In RFQ/RFI with multiple OEMs**



Award winning driver assistance system (Stereo Camera key contributor)

Launched 2018 on new A-Class

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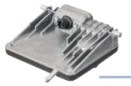
Product

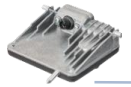
Stereo Vision 2
2x 1.2 Mp / 50°



Mono Vision 2
1.2 Mp / 50°

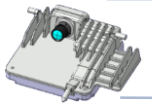
Mono Vision 3
1.2 Mp / 50°

Stereo Vision 4
2x 1.7 Mp / 100°



Mono Vision 4
1.7 Mp / 100°

Stereo Vision 5
2x 8 Mp / 120°
8 Mp / 40°



Mono Vision 5
8 Mp / 120°

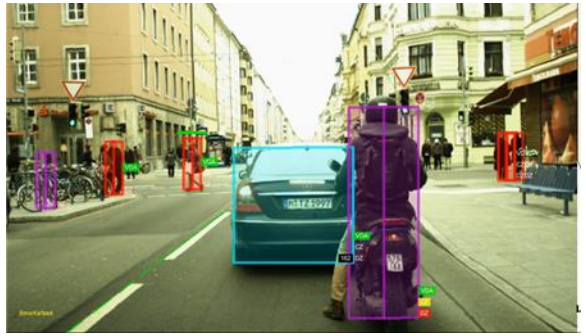
2016 2018 2020 2022

Feature

MVS2:
Lane Departure Warning
Lane Departure Prevention
Lane Keep Assist
High Beam Automation
Adaptive High Beam
Traffic Sign Assist (Fused with Navi System)
Cross Walk Alert/Wrong Way Alert

SVS2:
MVS2 features +
3D Object Detection for ACC S&G/TJA, Automatic Lane Change Assist, Collision Warning and AEB by fusion
General Object Detection
3D Lane Detection
Road Surface Preview
Support Object enhanced Map

MVS3:
NCAP 2018MVS2 Features +
Object Detection (Vehicle/Pedestrian/Cyclist) for ACC S&G and AEB by Fusion
Road Boundary Light
Traffic Sign Recognition (without Map information



MVS4:
2nd Generation Object Detection
2nd Generation Lane Detection & Road Boundary
Free Space Detection
Traffic Light Detection
Support Object Enhanced Map
NCAP 2020

SVS4:
2nd Generation 3D Object Detection
Parking Assist
Small Object Detection

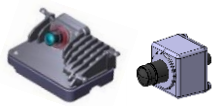
MVS5 Base:
3rd Generation Object Detection (DNN)
3rd Generation Lane Detection & Road Boundary (DNN)

MVS5 Mid:
Enhanced detection range Objects

SVS5 / CVS5:
3rd Generation 3D Object Detection
2nd Generation Small Object Detection

Veoneer Vision Roadmap – ADAS and HAD Sensing targets

ADAS



HAD

Camera Function	MVS 4 & SVS 4 PPAP Q4 2019	MVS 5 Base PPAP Q2 2022	MVS 5 Mid PPAP Q2 2022	SVS 5 PPAP Q1 2023
Image Sensor	1.7MP		8MP	3 x 8MP
Horizontal Field-of-View	100° MVS (67° SVS4)		120°	2 x 120° + 40°
Vision Processor	Xilinx ZU3	New Vision Processor for GVP5		
FuSa level	ASIL-B			TBC (≥ ASIL-B)
Vehicle Detection	150m	150m	250m	300m
Pedestrian and cyclist Detection	80m	80m	150m	200m
PTW Detection	80m	80m	200m	300m
General Object Detection	Veh and ped size objects @50m	Veh and ped size objects @50m	0.2x0.2 @ 100m	0.2x0.2 @ 150m
Lane and Road Boundary Detection	Lane: 100m Road Boundary: 60m	Lane: 150m Road Boundary: 60m	Lane: 200m Road Boundary: 80m	Lane: 300m Road Boundary: 100m
Traffic Signs	Range: 50m FP: 1/500km	Range: 50m FP: 1/500km	Range: 100m FP: 1/1000km	Range: 150m FP: 1/2000km
Traffic Lights	60m	60m	100m	300m
Light Sources (HBA)	1000m oncoming	1000m oncoming	1000m oncoming	1000m oncoming

视觉产品路线图

摄像头产品路线- ADAS 和 HAD 传感器

2018 单目摄像头 AEB (3代摄像头)

- 单目摄像头带图像处理
- 满足NCAP 2018要求的最具性价比方案 (Lane, AEB, TSR)

➢ **已经在A-Class, Volvo，Geely的项目中使用**

2020 单目和双目摄像头(4代摄像头）

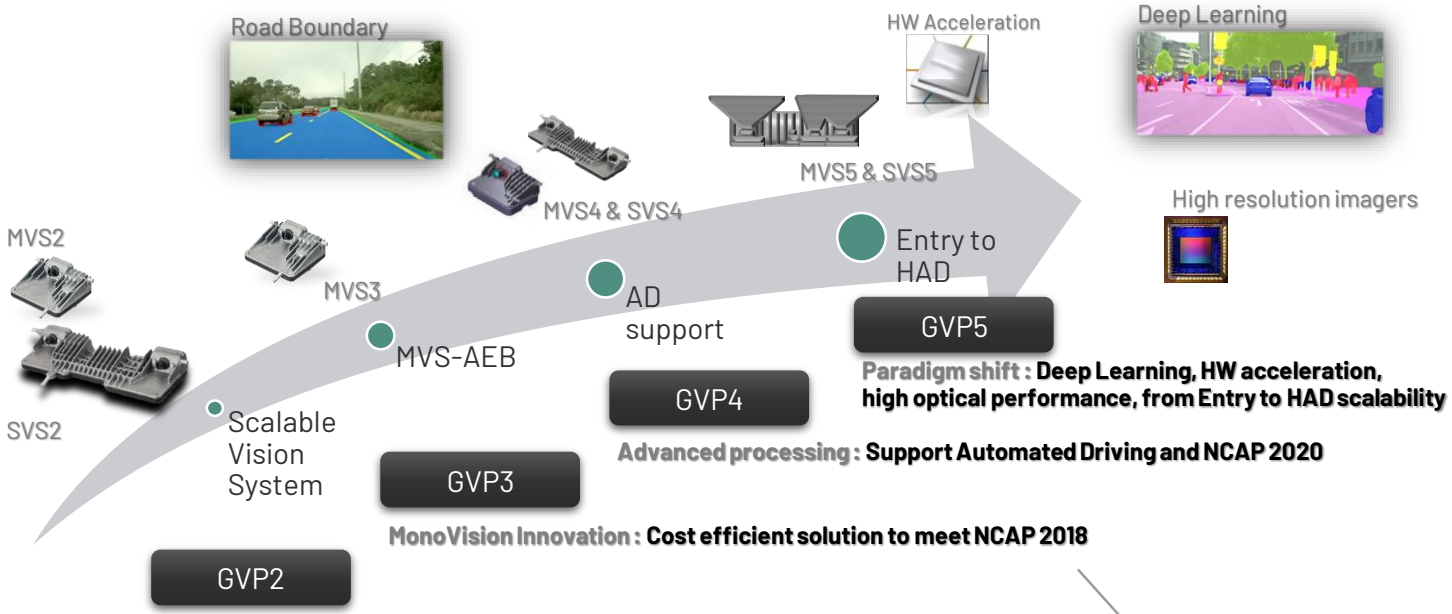
- 下一代单目和双目摄像头产品
- 支持自动驾驶和NCAP 2020

➢ **已经有6个OEM确认在量产车型中使用该产品**

2022+ 下一代摄像头系统(5代摄像头)

- 高精度图像
- 更先进的图像处理算法
- 多摄像头支持

➢ **跟多个OEM客户处在项目获取阶段**



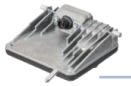
Award winning driver assistance system (Stereo Camera key contributor)

Launched 2018 on new A-Class

veoneer

Product

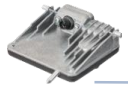
Stereo Vision 2
2x 1.2 Mp / 50°



Mono Vision 2
1.2 Mp / 50°

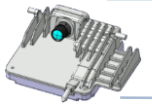
Mono Vision 3
1.2 Mp / 50°

Stereo Vision 4
2x 1.7 Mp / 100°



Mono Vision 4
1.7 Mp / 100°

Stereo Vision 5
2x 8 Mp / 120°
8 Mp / 40°



Mono Vision 5
8 Mp / 120°

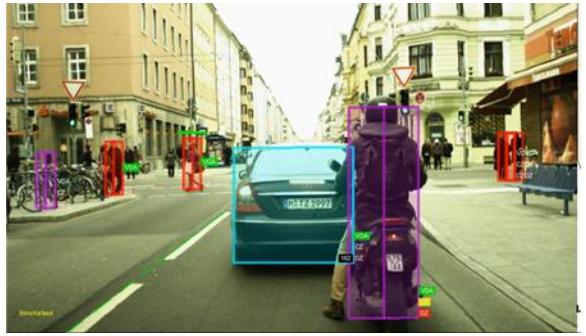
2016 2018 2020 2022

Feature

MVS2:
车道偏离报警
车道偏离保护
车道偏离辅助
自动大灯
自适应大灯
交通标识辅助(跟导航系统融合)
Cross Walk Alert/Wrong Way Alert

SVS2:
MVS2 功能 +
3D 物体检测 用于ACC S&G/TJA,
自动变道辅助
碰撞报警和基于融合的AEB
通用物体检测
3D 车道检测
路面预测
支持目标增强地图

MVS3:
NCAP 2018MVS2 功能 +
物体检测
(车辆/行人/自行车识别)用于 ACC S&G
和基于融合的AEB
道路边界灯
交通牌识别（不基于地图）



MVS4:
第二代物体检测
第二代车道和路边延识别
空地检测
交通灯识别
支持物体增强地图NCAP 2020

SVS4:
第二代3D 物体检测
停车辅助
小物体检测

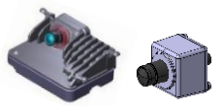
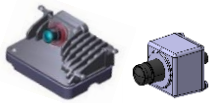
MVS5 Base:
三代物体检测(DNN)
三代车道线和路边缘检测（DNN）

MVS5 Mid:
增强物体识别范围

SVS5 / CVS5:
第三代3D 物体检测
第二代小物体检测

Veoneer 视觉系统路线图– ADAS 和 HAD Sensing targets

ADAS

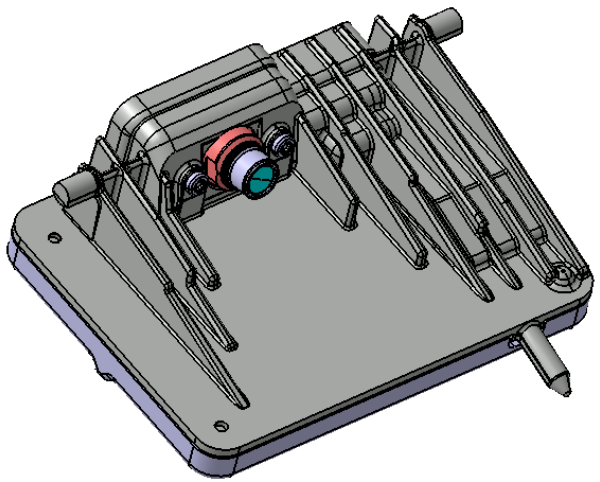





HAD

摄像头功能	MVS 4 & SVS 4 PPAP Q4 2019	MVS 5 Base PPAP Q2 2022	MVS 5 Mid PPAP Q2 2022	SVS 5 PPAP Q1 2023
图像传感器	1.7MP		8MP	3 x 8MP
水平视角	100° MVS（67° SVS4）		120°	2 x 120° + 40°
图像处理	Xilinx ZU3	New Vision Processor for GVP5		
FuSa 等级	ASIL-B			TBC (≥ ASIL-B)
车辆检测	150m	150m	250m	300m
行人和自行车检测	80m	80m	150m	200m
PTW 检测n	80m	80m	200m	300m
通用目标检测	Veh and ped size objects @50m	Veh and ped size objects @50m	0.2x0.2 @ 100m	0.2x0.2 @ 150m
道路和路边沿检测	Lane: 100m Road Boundary: 60m	Lane: 150m Road Boundary: 60m	Lane: 200m Road Boundary: 80m	Lane: 300m Road Boundary: 100m
交通标志	Range: 50m FP: 1/500km	Range: 50m FP: 1/500km	Range: 100m FP: 1/1000km	Range: 150m FP: 1/2000km
交通灯	60m	60m	100m	300m
灯源 (HBA)	1000m oncoming	1000m oncoming	1000m oncoming	1000m oncoming

MVS3

MVS - Mono Vision Camera Generation 3



MVS3G

MVS3G Dimensions:

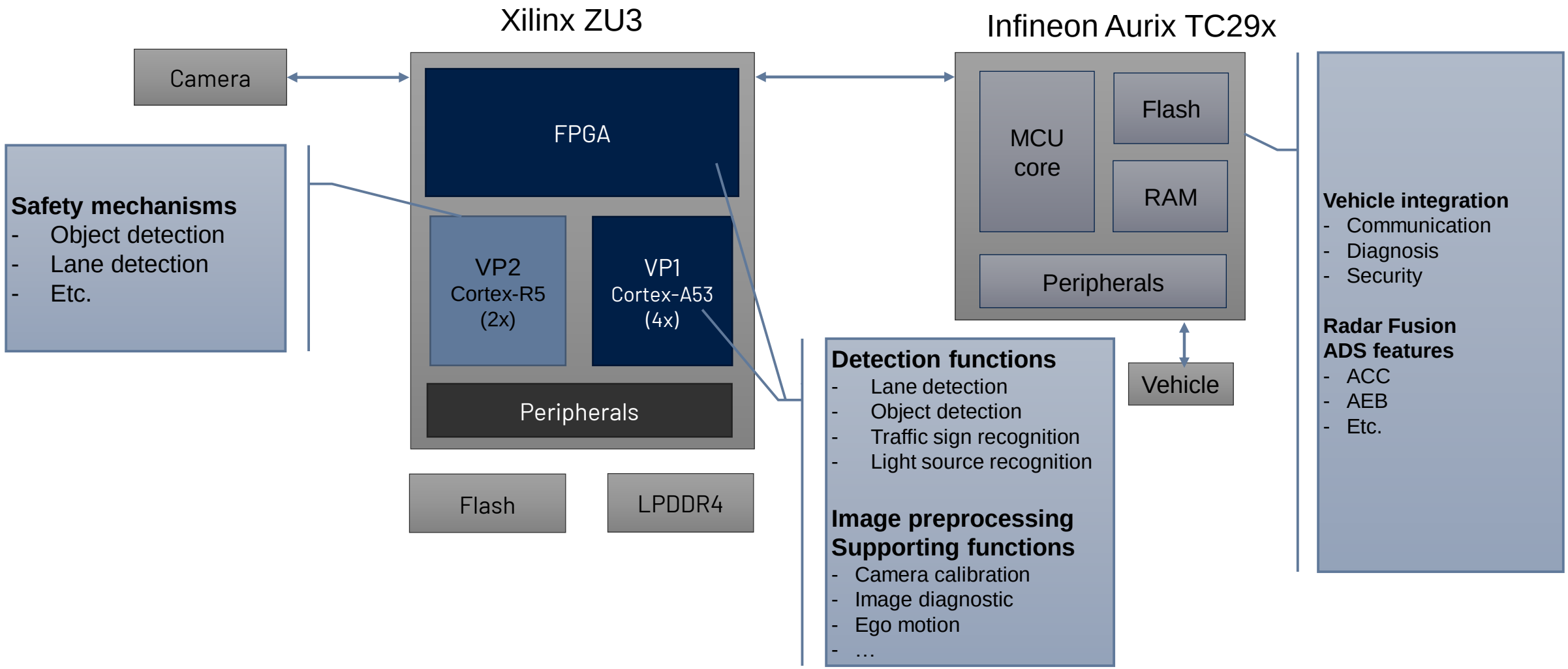
Width	~99 mm
Depth	~77 mm
Height	~33 mm

- Light traps integrated in bracket or attached to camera housing

  遮光罩安装再支架或外壳上
- Static calibration EOL optional. Dynamic calibration during driving
- EOL静态标定，驾驶过程中动态标定
- MVS3G uses extra CAN bus and larger micro-controller

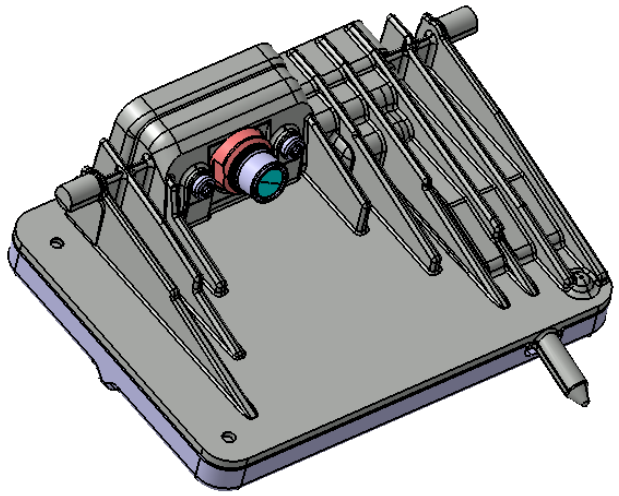
Key Item	MVS3G
图像传感器Imager	1.2MP Sensor ON Semi
FOV Field-of-View (水平)	52°
色彩Color	RGB
摄像头配置Camera Configuration	Mono
刷新率Camera update rate	22Hz (45ms)
图像处理器Vision Processor (VP)	Xilinx - Zynq Ultrascale ZU3
RAM / Flash @ VP	LPDDR4 / Flash
Micro controller (MCU)	Infineon Aurix 29
通信Vehicle communication	CAN + CAN
连接器Connector	Tyco
功能安全等级FuSa Level	ASIL - B

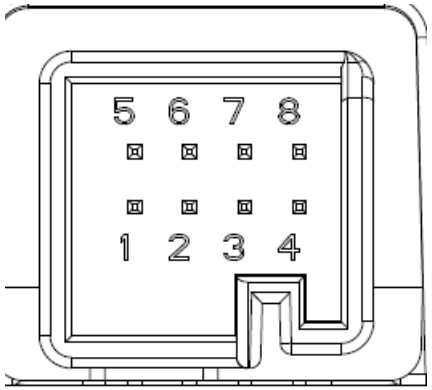
软件架构Mono vision Software Architecture



PIN脚定义PIN definition

Parameter/参数	CVM
Power consumption /能耗 (nominal)	~6 W
Weight (preliminary)/净重	~192 g
Camera dimensions/摄像头尺寸 (W x D x H)	Generic Design 99x77x33mm
Operating Temperature* (Unlimited Operation) /工作温度（不限工况）	-40 to +85ºC
Operating Temperature* (Network & Diagnostics Operation only) /工作温度（只有网络通讯和诊断工作）	+85 to +105ºC

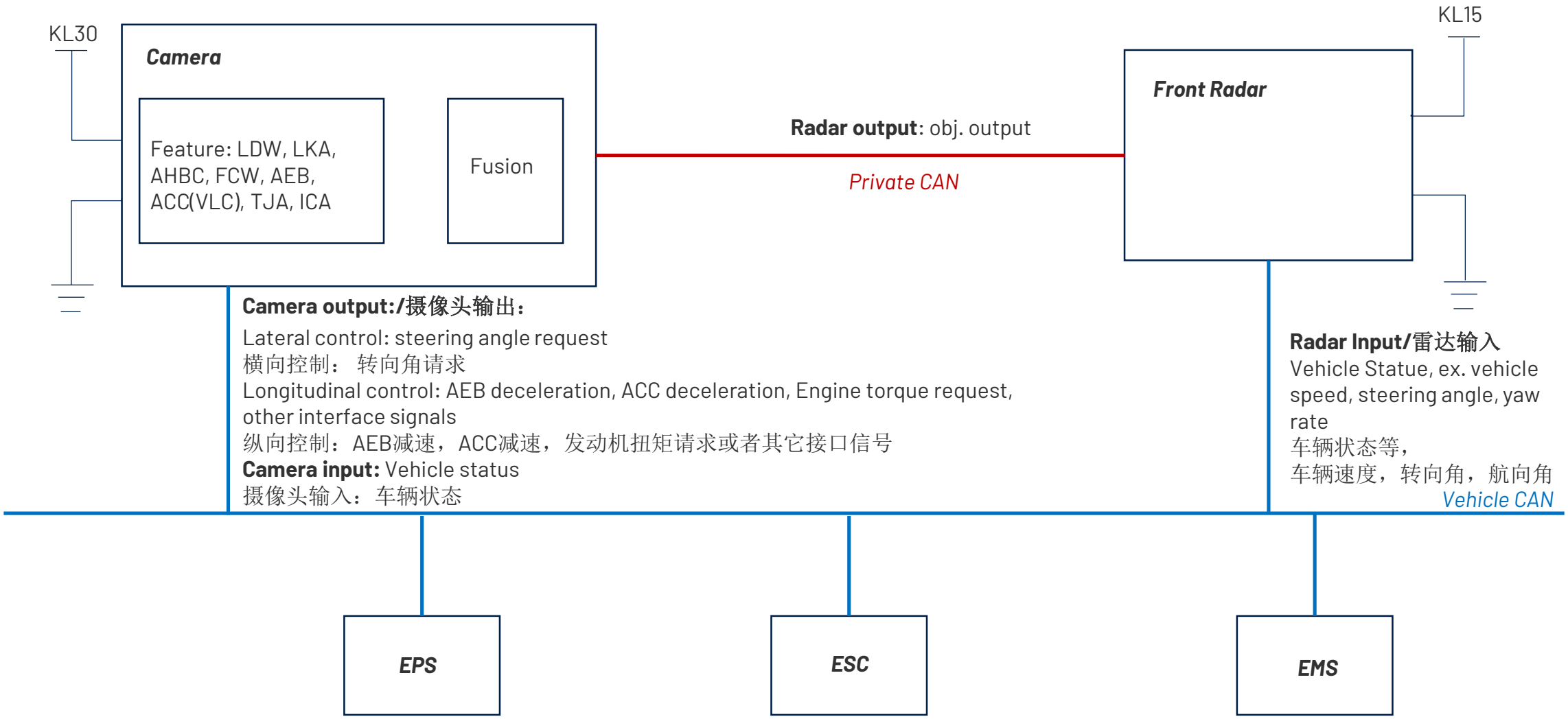




PIN脚	功能
1	GND
2	CAN1_L
3	CAN1_H
4	KL30
5	Reserved
6	Reserved
7	CAN2_L(private)
8	CAN2_H(private)

System Architecture
系统架构

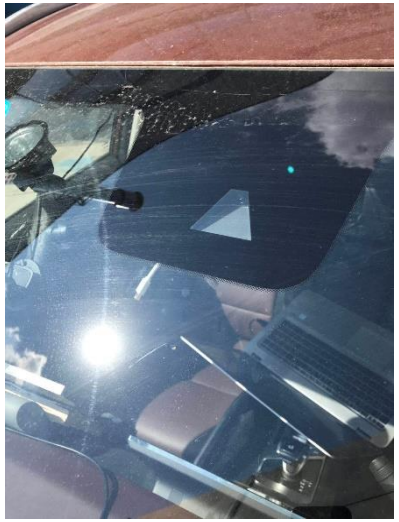
System Architecture-系统架构

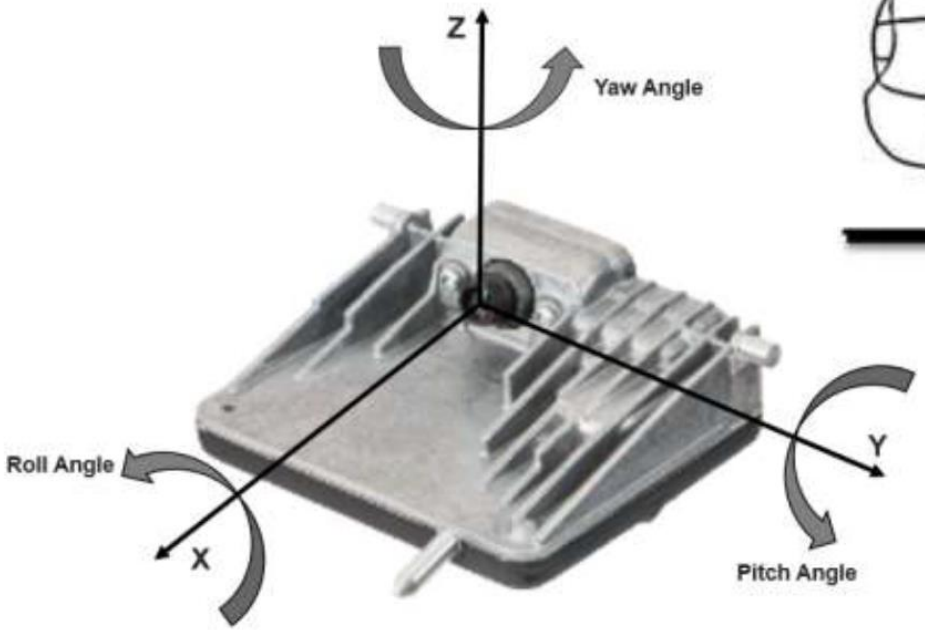


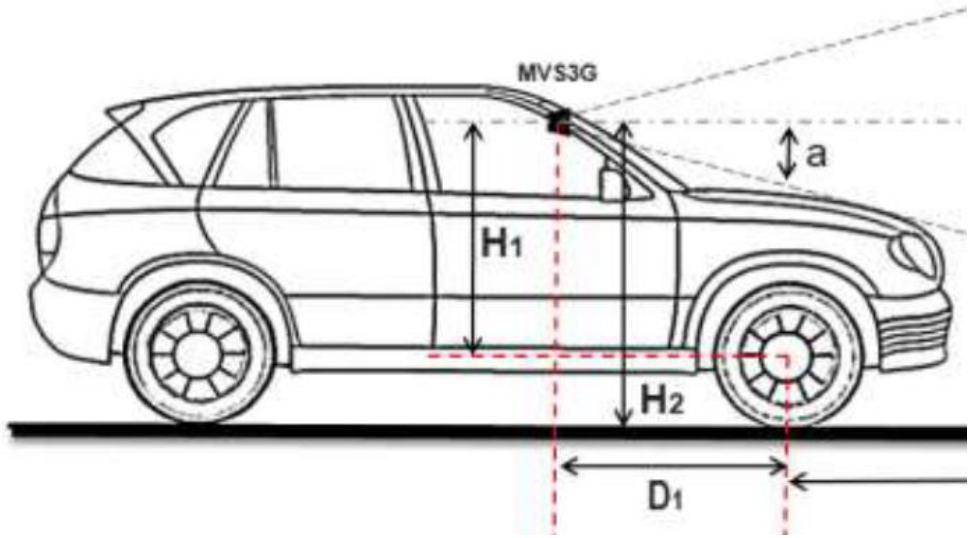
Camera Installation-
摄像头安装

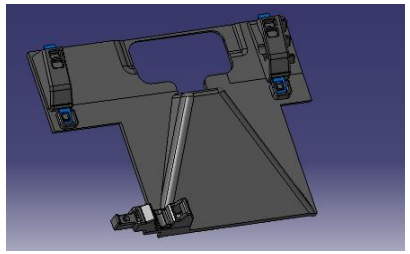
Installation Position-安装位置

- Height: H2=1422





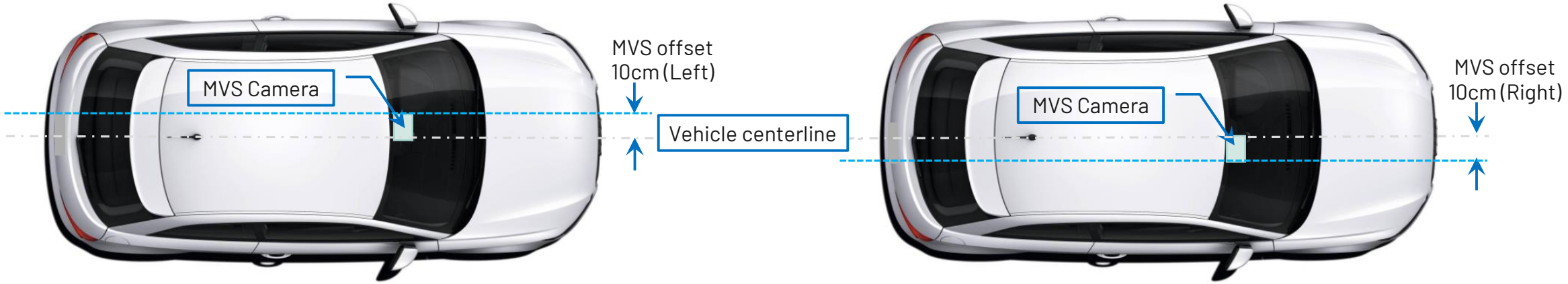




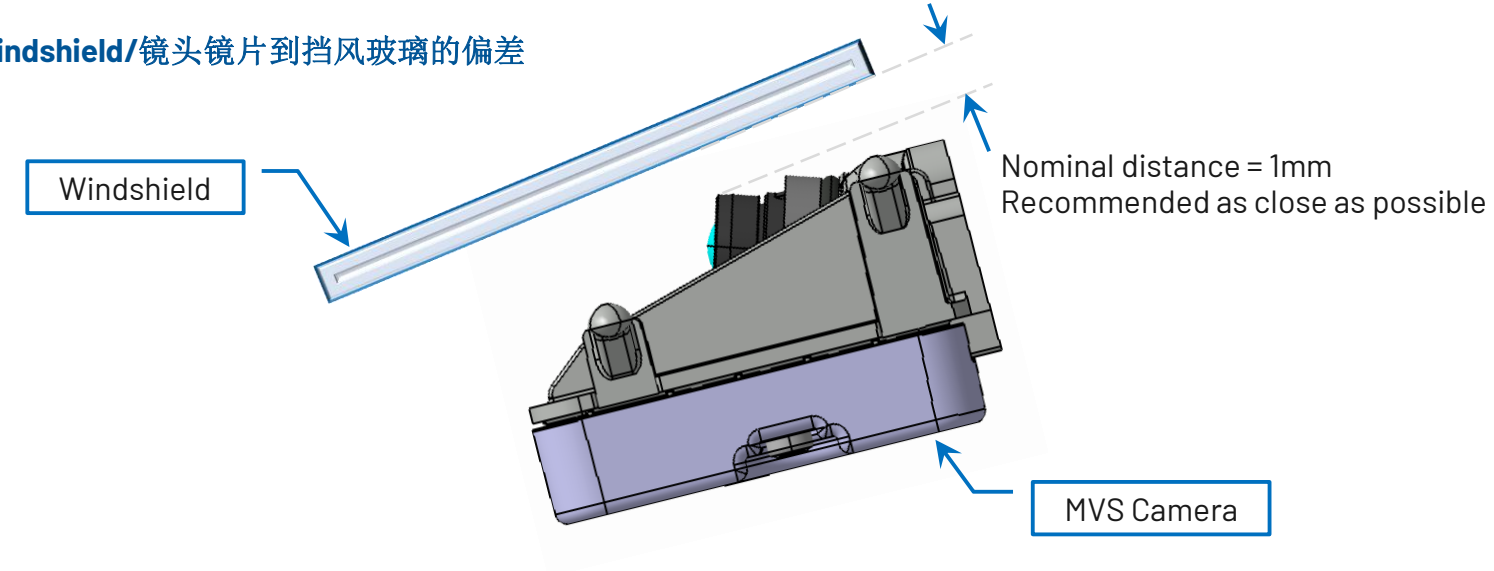
Angles	Pitch Angle	Yaw Angle	Roll Angle
Tolerance	±3°	±3°	±2.5°

Vehicle Camera Installation-车辆摄像头安装

Offset from vehicle center line/与车辆中心线的偏差



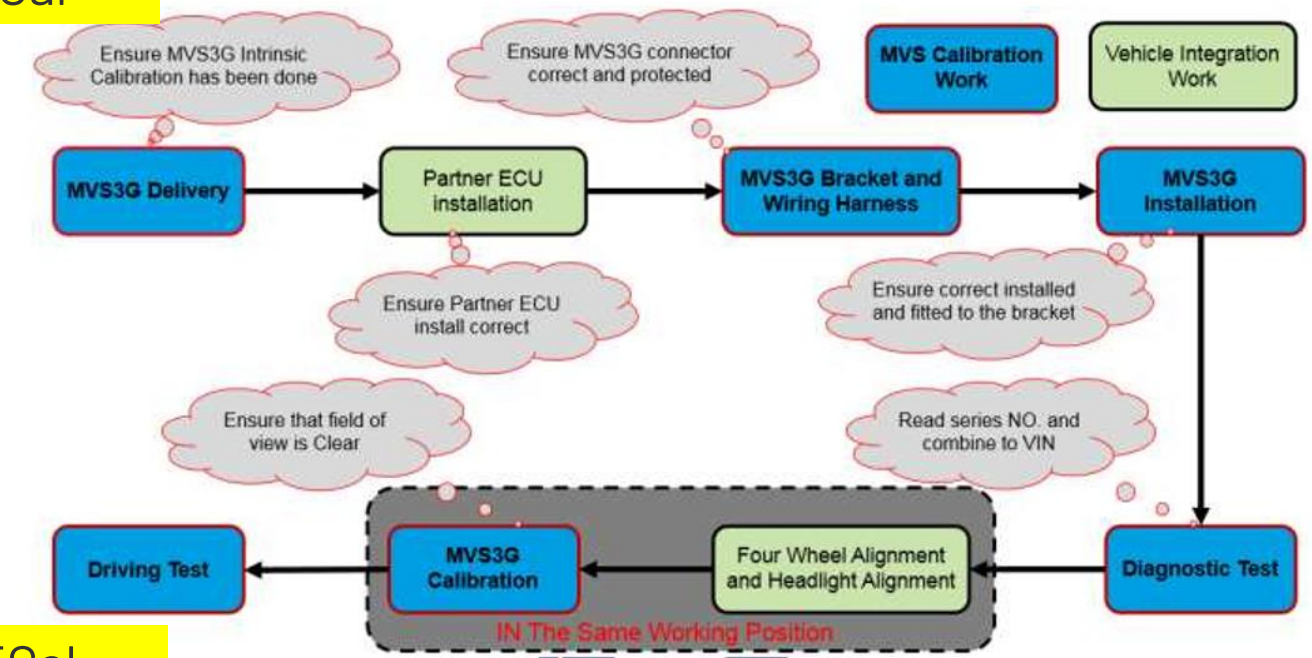
Lens clearance to windshield/镜头镜片到挡风玻璃的偏差



Camera Calibration-
摄像头标定

EOL静态-动态标定EOL – SECal and DECal

- SECal



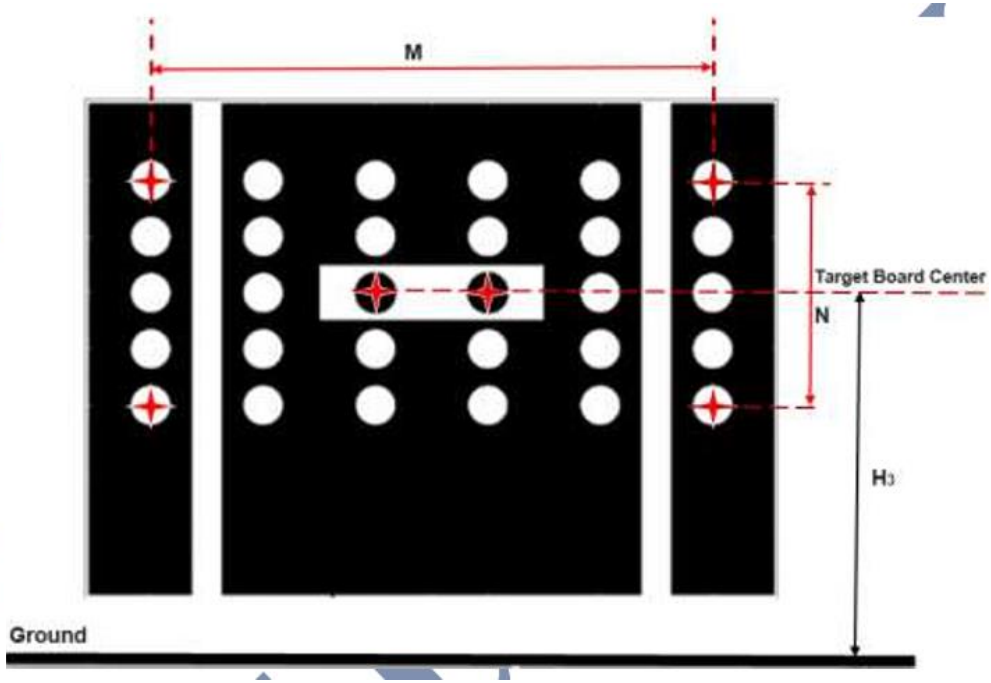
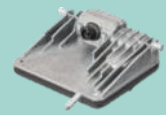


Figure: EOL Process

- DECal
  - As SECal calibration is done, take a drive for 20 minutes with the camera on. This will activate and run dynamic calibration algorithms in the camera. The drive should include different types of roads, traffic and objects. E.g. city, highway, cars, trucks and pedestrians. DECal does not require anything from OEM.
  - 当SECal校准完成后，开车20分钟，这将激活并运行摄像机中的动态标定算法。标定过程应包括不同类型的道路、交通和物体：城市，高速公路，汽车，卡车和行人。动态标定不需要OEM做任何额外的工作。

Object Detection-
目标探测



目标探测Object Detection

Key KPIs:

- True Positives
  - 车辆Vehicle – Car, Truck/bus
    - All 95%
    - Collision relevant (NCAP scenarios) 100%
    - Detection Distance 120 m
  - 行人,自行车Pedestrians(adult/children), bicyclists
    - All 80%
    - Collision relevant (NCAP scenarios) 100%
    - Detection Distance 80/50 m(child)
- False Positives collision relevant
  - Vehicle – Car, Truck/bus
    - 1 / 10 000 h
  - Pedestrian(adult/children)
    - 1 / 5000 h

目标探测Object Detection

- Highway scenario, classification of cars and trucks/高速场景，对乘用车和卡车进行分类

Mono: Object Detection, current status Gen 3 development/单目：物体检测，当前三代的水平

目标探测Object Detection

- City scenario, classification pedestrians, cyclists, two-wheelers and cars/城市场景，可以对行车，自行车，两轮车和乘用车进行分类识别

Mono: Object Detection, current status Gen 3 development 单目，当前三代的水平

Lane Detection-
车道线探测

Line Detection-车道线检测

Key KPIs:

- Availability/能力
  - Highway/高速
    - Good weather, lighting and marking quality 98%
      天气好，光线好和车道线标记清晰
  - Highway and rural/高速和乡村
    - Reduced weather or marking quality 91%
      相对好的天气，或者车道线标记下
      光线好
  - All road types/ 所有道路类型
    - Bad weather or marking quality 67%
      Reduced or bad lighting conditions
      坏天气或者车道线标识质量差
      相对差或者差的光线下

- Detection distance/检测距离
  - Lane solid*: 60 m
    实线
  - Lane dashed*: 35 m
    虚线

Lane Detection Example-车道线检测案例

- Robust support for Lane Departure Warning + Lane Centering
  对车道偏离报警和车道路中保持功能的强大支持

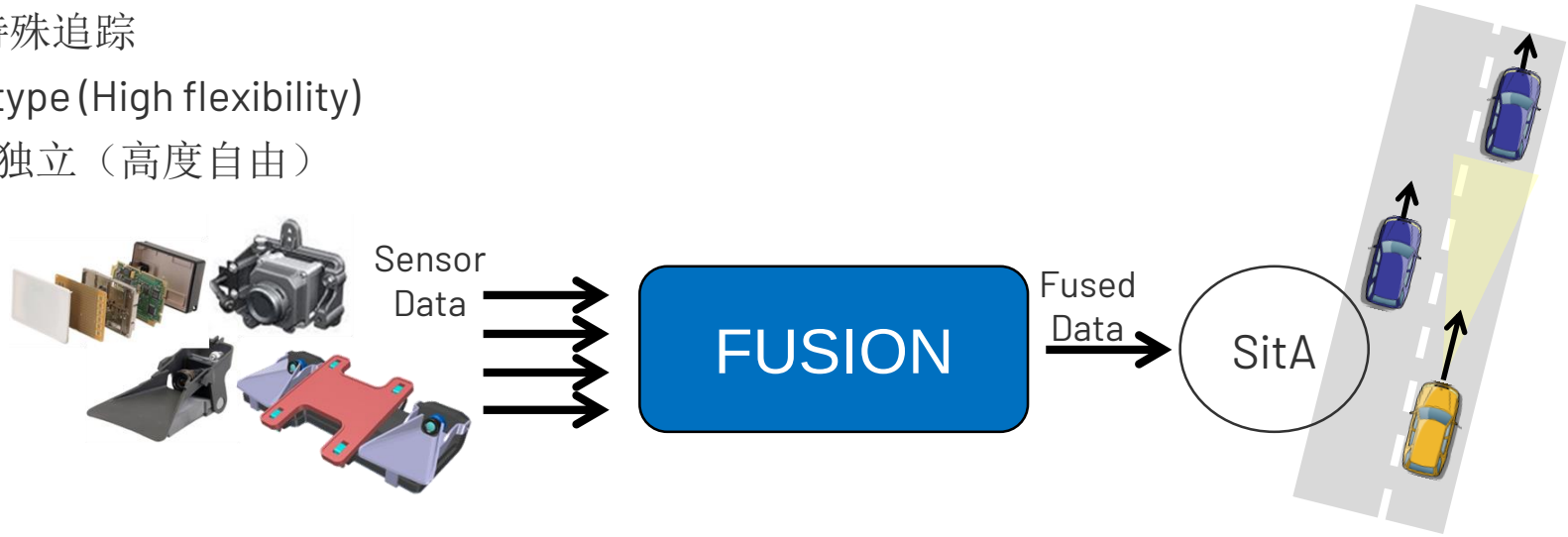
Object Fusion
融合

目标融合Object Fusion

- Object Fusion processes ALL incoming sensor objects in an intelligent way

  目标融合处理，智能化处理所有的输入感知信号

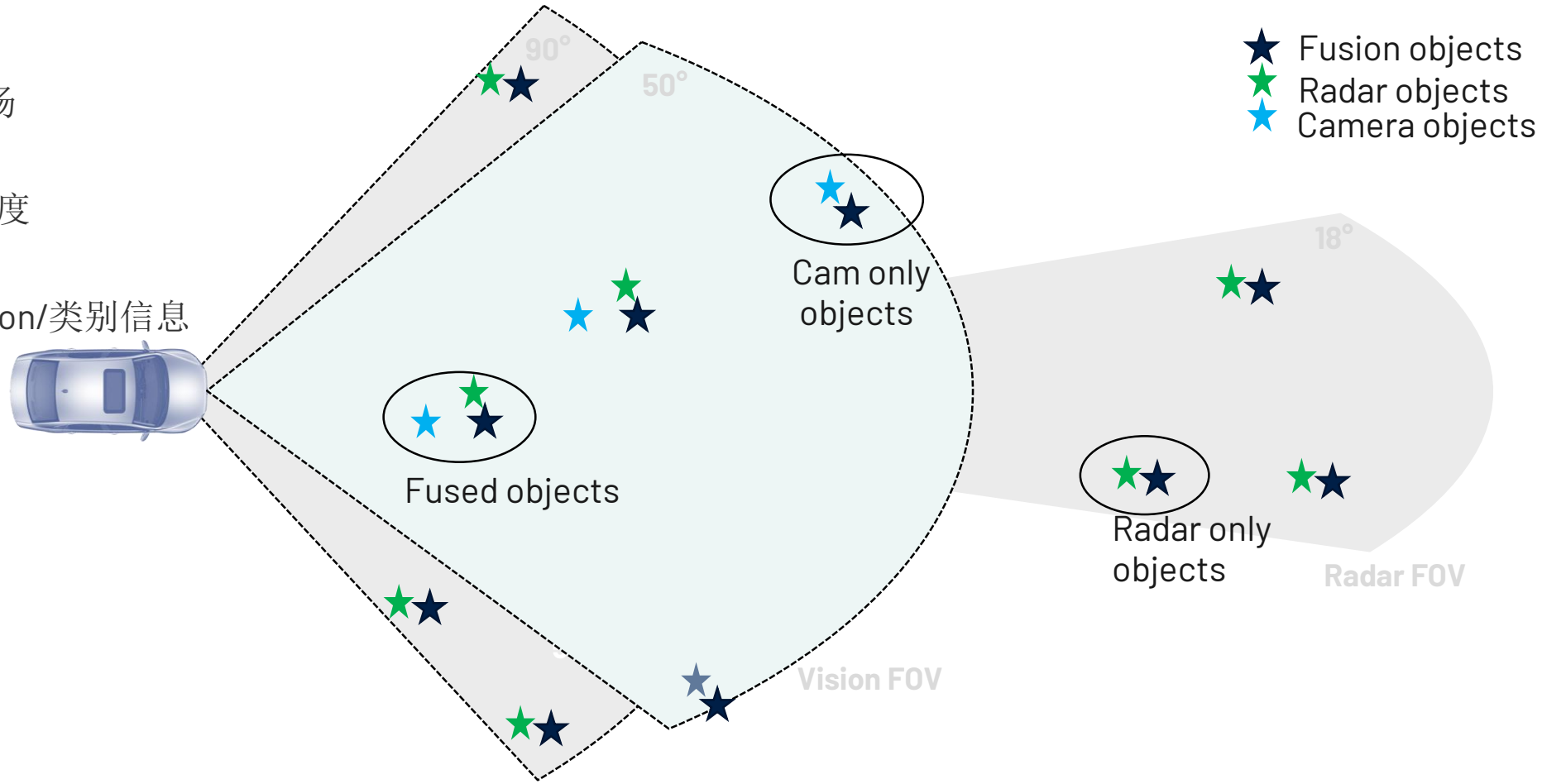
  - Functionaly support Veoneer
    Veoneer 提供功能支持
  - Describe environment surrounding the ego vehicle
    描述自车周围环境
  - Sensor-specific tracking executed by sensor technologies
    感知-传感技术执行的特殊追踪
  - Independent of sensor type (High flexibility)
    各传感器类型之间保持独立（高度自由）



目标融合Object Fusion

- Object Fusion improves:

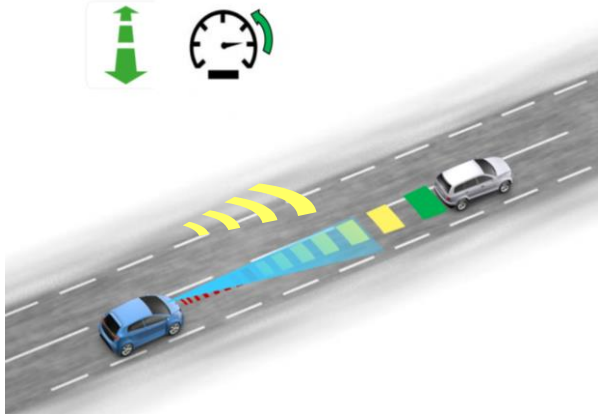
  目标融合提高了
  - Field of view/ 视场
  - Accuracy/精度
  - Confidence/可信度
  - Stability/稳定性
  - Type of information/类别信息



Feature list-
ADAS功能

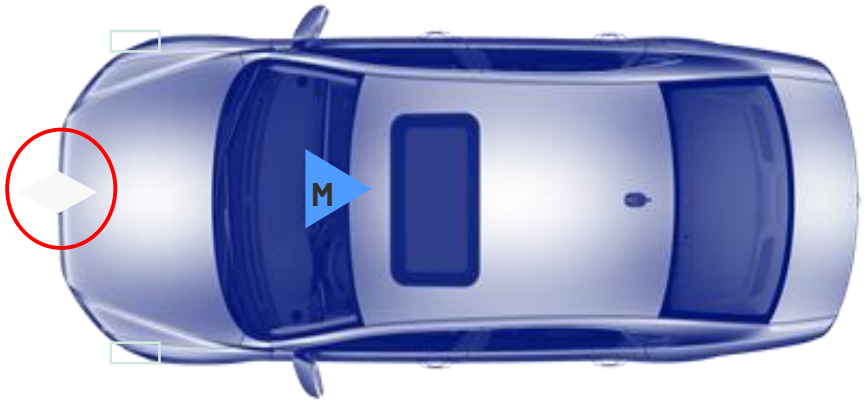
ACC

Overview 综述



ACC Plus is a comfort system to be used when following the traffic flow. It will automatic adjust the speed of the ego vehicle when the traffic rhythm is changing in order to keep the driver-selected time gap to the lead vehicle. ACC legal only performs a longitudinal control of the vehicle, lateral controlling of the ego vehicle is up to the driver. Stop and go.

ACC Plus是一种用于跟随交通流的舒适系统，它将根据交通流节奏自动调整自车的速度，与前车保持一定的距离。ACC只对车辆进行纵向控制，自车的横向控制取决于驾驶员。可跟随前车起停。

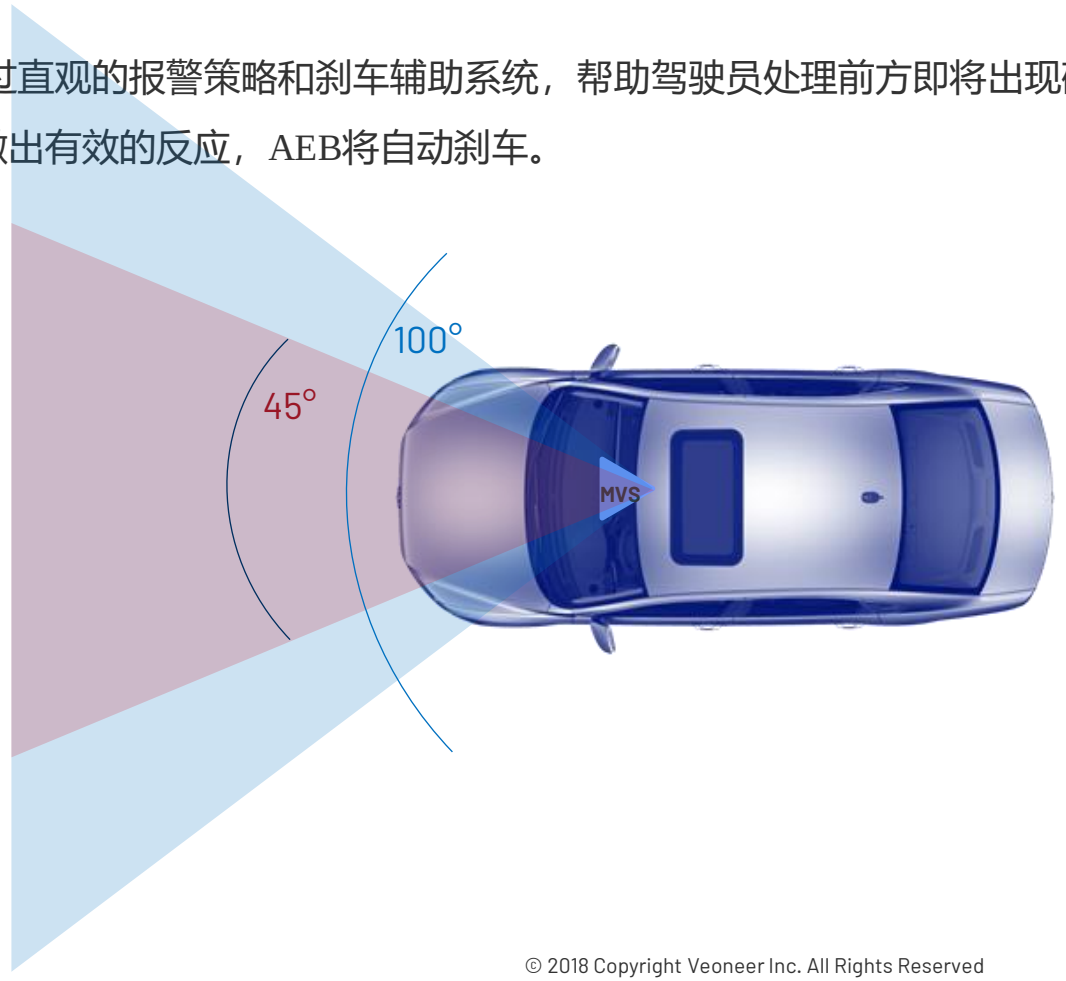


Parameter 参数	Value 数值
Detection range 检测距离	0.5 – 160 m
Activation Range (Ego Vehicle Speed)激活范围	0 – 150 kph
Time headway时间	0,8 – 2,2 s
Maximal Braking / Jerk 最大减速度和最大减速度率	3.5 m/s² (average 2s) 2.5 m/s³ (average 1s) According ISO
Maximal Acceleration 最大加速度	2.0 m/s² (20 m/s for 2 s) 4.0 m/s² (< 5 m/s for 2 s)
Minimal Target 最小的检测目标	Two wheeler 两轮交通工具
Road type/environment 道路类型/环境	highway, dual carriage road, and well-marked country roads city road

AEB

Overview 综述

- The purpose of AEB is to assist the driver in the case of an imminent front collision with another vehicle and VRU by an intuitive warning strategy and a brake support system. If a collision is unavoidable, AEB provides autonomous braking when the driver fails to respond to the imminent threat.
- AEB通过直观的报警策略和刹车辅助系统，帮助驾驶员处理前方即将出现碰撞的紧急情况 。如果碰撞是不可避免的且驾驶员没能对突如其来的威胁做出有效的反应，AEB将自动刹车。

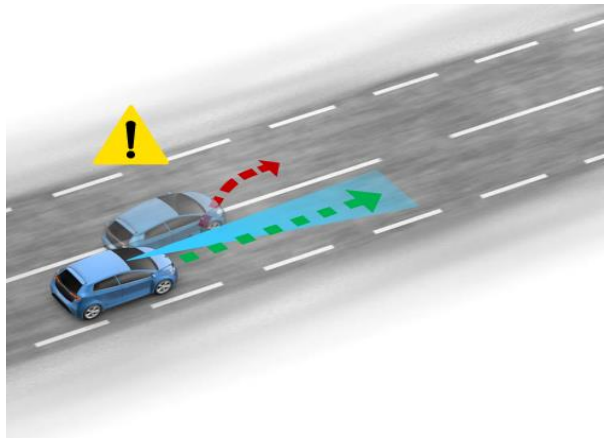


Parameter 参数	Value 数值
Detection range 检测距离	100 m Vehicle. 60 m bicycle, 50 m adult, 30 m child
Activation Range 激活范围 (Ego Vehicle Speed)	5-120 kph
Warning 预警	Up to 1s TTB
Maximal Braking 最大制动力	1G Customer demand
Maximal braking time 最大制动时间	1.4 s (Customer demand)
Minimal Target 最小目标物	Passenger car / Child

AEB Test Video

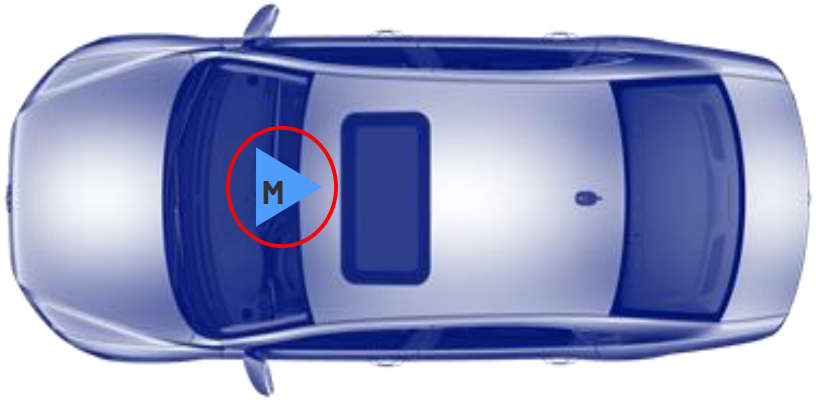
Lane Keeping Assist

Overview



The principle task of Lane Departure Prevention is to help the driver to stay in lane by warning the driver and applying an additional steering wheel torque on the steering column when the vehicle is about to leave the lane shortly. Thus, Lane Departure Prevention is a safety system that aims at reducing critical situations caused by unintentional lane departures.

车道保持辅助系统帮助驾驶员把车辆维持在车道线内行驶，当车辆即将偏离车道线时，系统会给驾驶员报警并增加额外的方向盘扭矩 。因此，车道保持系统是一个安全系统，它旨在减少非驾驶员意愿的偏离车道导致的危险。



Architecture

Parameter 参数	Value 数值
Activation Range (Ego Vehicle Speed) 可激活范围	60-130 kph
Lane marking type 车道线的种类	All lane markings
Lane angle 车道线的角度	<3 degrees
Curve radius outer circle 外圆曲率中心	> 500 m
Curve radius inner circle 内圆的曲率中心	> 150 m
Driver steering angle 方向盘转角	< 20 degrees
Driver steering torque 转向扭矩	< 2,5 Nm
Relevant lane marking verified 相关车道标志验证	> 0,3 x ego vehicle speed
Road type/environment 车道线类型/环境	highway/dual carriage road well-marked country roads with zero to moderate curvature.

Traffic Jam Assist (Part Of ICC)

Overview

Traffic Jam Assist provides with lateral and longitudinal guidance at low speeds. It follows to stop a target vehicle if no lane markings are available. Provides auto start. In case a lane can be detected, the lateral guidance is based on the lane marking. Driver supervision (i.e., hands on the steering wheel) is requested.

交通拥挤辅助系统在低速工况对车辆进行横向和纵向的控制。当没有车道线或者车道线识别困难时，系统会控制车辆横向和纵向上均跟随前车行驶，可以实现跟停和跟起。如果有车道线，纵向控制上保持不变，横向控制会基于车道线进行控制。同时系统会对驾驶员的驾驶行为进行监督。比如监测驾驶员是否手扶方向盘。

Architecture

Parameter 参数	Value 数值
Detection range **检测距离**	0,5 – 150 m
Activation Range (Ego Vehicle Speed) **可激活范围（自车速度）**	0 – 30 kph
Time headway时间间隔	**ACC**
Maximal Braking / Jerk **最大减速度和最大减速度率**	**ACC**
Driver steering angle **方向盘转角范围**	< 20 degrees
Minimal Target **最小的检测目标**	Minimum allowed vehicle size on city road可检测车辆的最小尺寸
Road type/environment **道路类型/环境**	Lane marking required 需要车道线

Intelligence Cruise Assist (Part of ICC)

Overview

Intelligence Cruise Assist provides with lateral and longitudinal guidance at high speeds. It follows to stop a target vehicle if no lane markings are available. Provides auto start. In case a lane can be detected, the lateral guidance is based on the lane marking. Driver supervision (i.e., hands on the steering wheel) is requested.

智能巡航系统可以在车辆高速工况下提供对车辆横向和纵向控制的辅助。当没有车道线或者车道线识别困难时，系统会控制车辆纵向上跟随前车行驶，可以实现跟停和跟起。如果有车道线，纵向控制上保持不变，横向控制会基于车道线进行控制。同时系统会对驾驶员的驾驶行为进行监督。比如监测驾驶员是否手扶方向盘。

Architecture

Parameter	Value
Detection range	0,5 – 150 m
Activation Range (Ego Vehicle Speed)	40 – 130 kph
Time headway	ACC
Maximal Braking / Jerk	ACC
Driver steering angle	< 20 degrees
Driver steering torque	< 2,5 Nm
Minimal Target	Minimum allowed vehicle size on city road
Road type/environment	highway/dual carriage road well-marked country roads with zero to moderate curvature.

Automatic High Beam Control (AHBC)自动远光灯控制

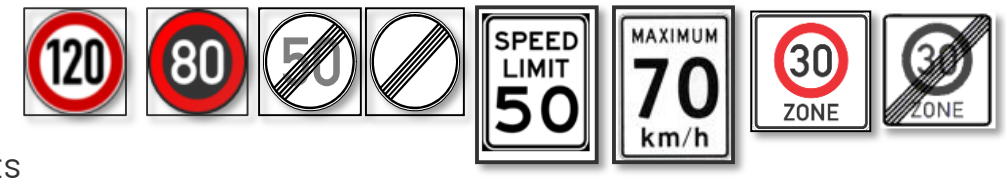
Available Functionality MVS Generation 3

- Light source recognition 灯光识别
  - Detection and classification of the light source
  - 检测和分类灯光
- Situation Detection 路况监测
  - City detection, left-/right- hand side traffic, motorway, self-glare from traffic signs
  - 城市环境检测，左右交通环境检测，高速公路，交通标志自眩光
- High Beam Control/Marking Light
- 远光灯控制

Road Sign Detection (RSD) 交通标志检测

Available Functionality MVS Generation 3 MVS Generation3

- Examples of detected signs 可检测交通标志牌
  - Speed Limit
  - 速度显示



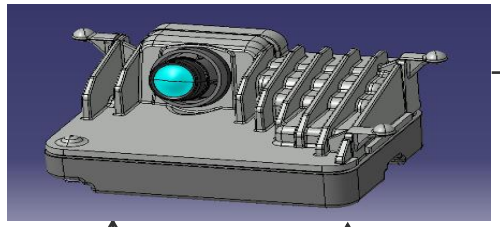
  - Implicit Speed Limits
  - 速度限制
  - Supplementary Signs
  - 补充标志

- KPI
  - Number of detections:14 signs simultaneously
  - Correct rate:95%
  - FP rate: Appr 1/500km

Project Team Organization and task
项目团队与分工

Vehicle setup

HiL



Debug data

Video data

Vehicle bus

Break out Box

Ethernet

Results data (ADTF)

HIL Player

Video + car communications data

Reference data (ADTF)

Statistics tool - WeStat

Post processing of statistics report

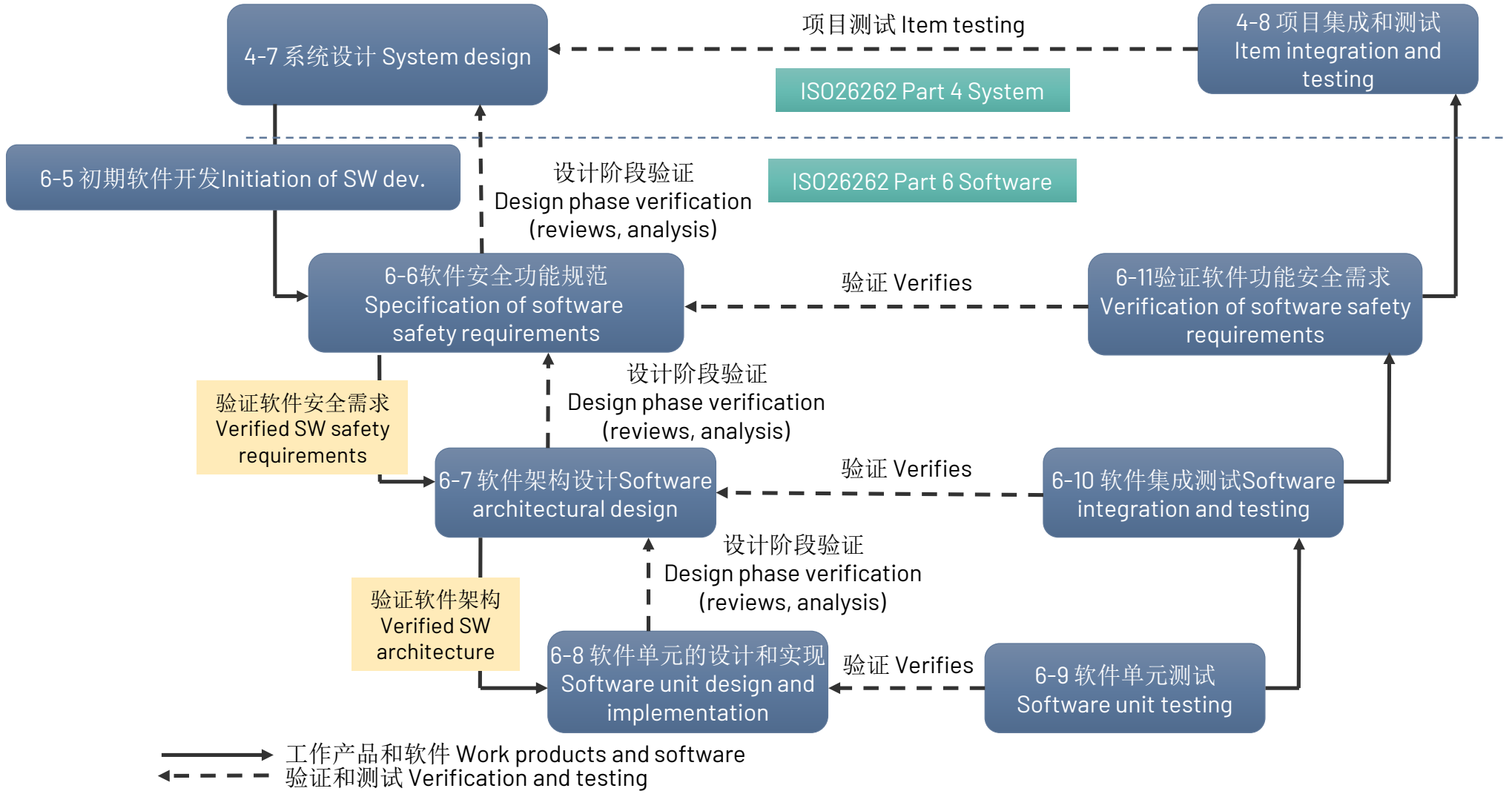
KPI reports

- 视频/总线数据BOB同步Synchronization video data / vehicle bus using BOB
- 记录ECU收发消息添加到ADTF文件Vehicle messages to/from the ECU is recorded and added to the result ADTF file
- 记录调试数据添加到同样的ADTF文件Debug data recorded and added to the same ADTF result file

- 比较参考数据与HiL数据Reference data is compared to output from HIL (result data)
- 统计工具生成报告The statistics tool generates statistics report which is used to extract the pass/fail information and KPI reports
- 测试结果上传DOORSTest results stored in Doors

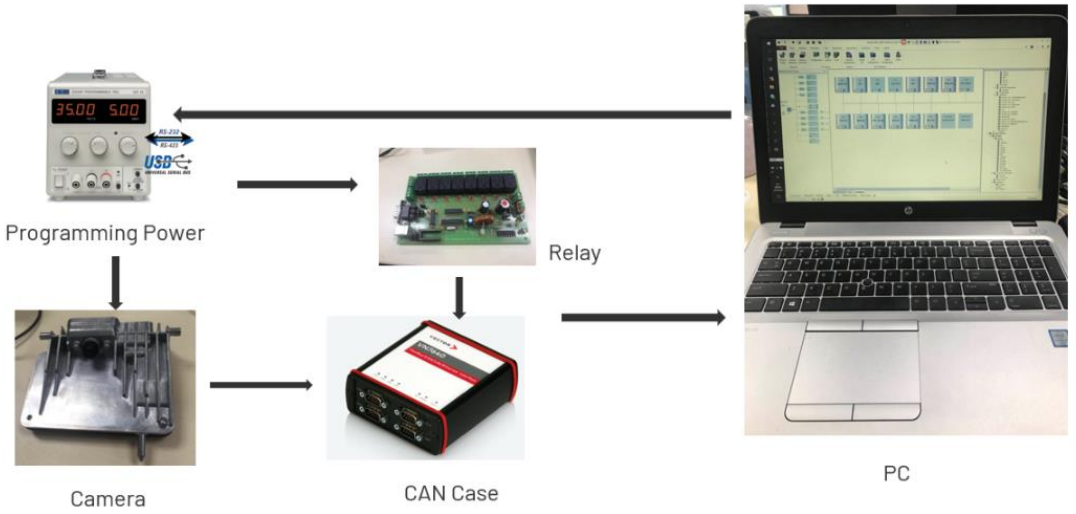
VS151 Software Development

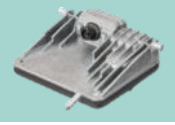
VS151 is fully follow ISO26262 & CMMI Maturity Level 3



系统测试System test

- 通信协议Communication protocols
  - Vehicle bus communication testing (DLC, Signal check, Message timeouts, bus load tests, etc);
- 诊断测试Diagnostics testing
  - UDS standards testing (Diagnostic session transition, services positive / negative response, NRCs, timings, FlowControl checks…);
- ECU刷写ECU Flashing (SW Application, Bootloader)
- 故障检查Error checking (DTCs)
  - Internal / peripheral diagnostic, CAN/FlexRay Messages timeouts, default / invalid values checking
- 数据存储，配置，安全性检查Data storage, Configurations, Security Check (so-called "Coding" related testing, checking different system configuration setups
  - e.g. different car models, camera authentication
- 系统状态机System States / transitions
- 客户需求Customer specific functions
  - BAP protocol, User personalization
- 鲁棒性/压力测试Robustness / stress testing (long time tests startup tests, power cranking, climate chamber tests)
- 功能安全需求测试FuSa requirements testing

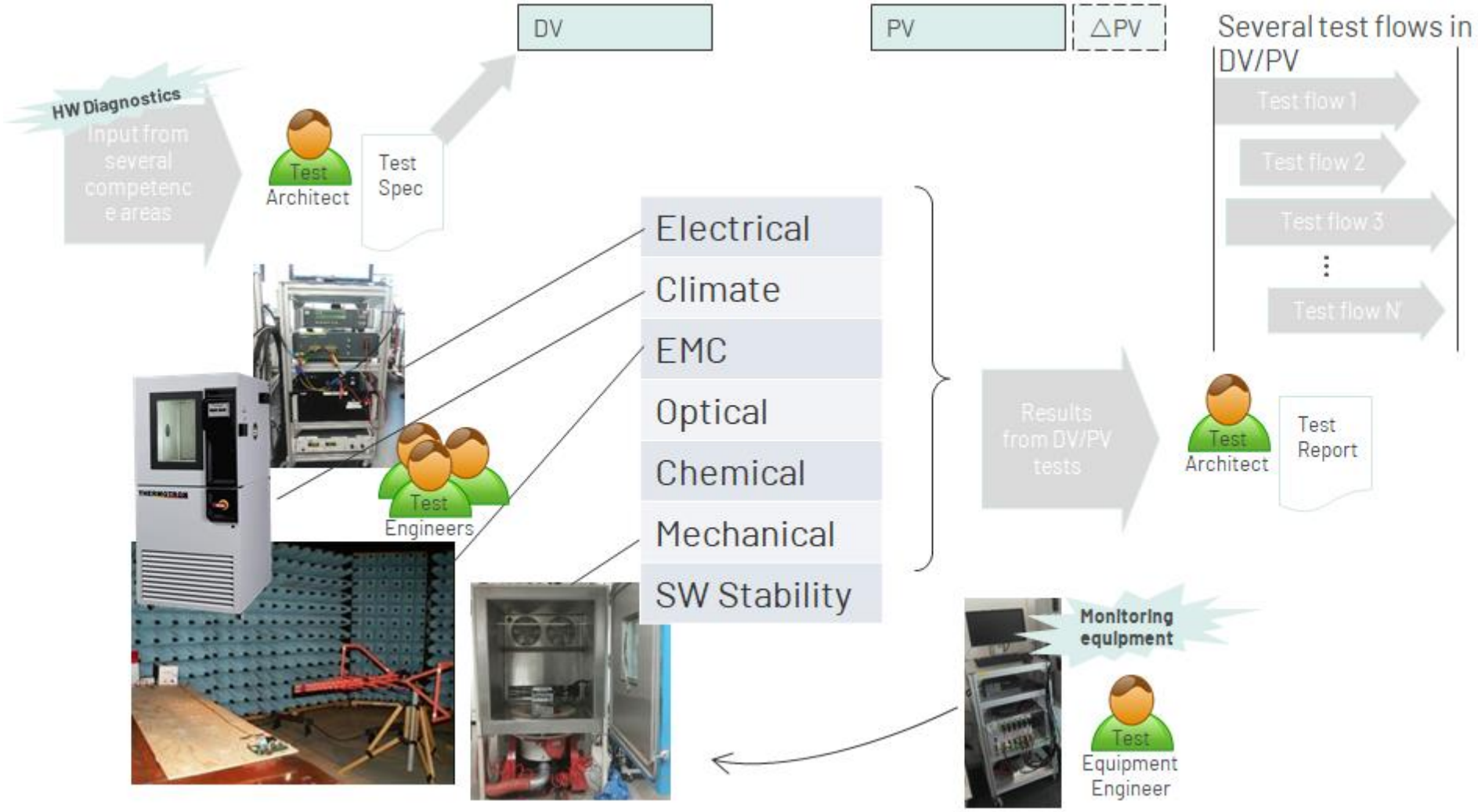




整车测试Vehicle test

- 实车环境验证Validates that the system is operational in a vehicle environment
- 探索性测试Exploratory testing.
  - 基于Hil完成完整的测试. Complement to the scripted tests performed in HIL. (Feature test)
  - 基于之前的结果，用演绎法持续改进.Use of deductive reasoning based on the results of previous tests to guide the future testing continuously.
  - 集中测试以往问题相关点Main focus on penetrating areas where we identify issues.
  - 根据测试重点制定测试路线与场景Pre-defined test routes are complemented with additional traffic scenarios depending on test focus.
  - 全面测试Not considered as approving tests.
- 典型用户场景性能评估Evaluation of perceived performance in some typical customer scenarios.
- Temporary additional tests to better understand product limitations.
  - 基本功能测试Basic functional tests
  - 车辆接口信号验证Verification of selected vehicle interface signals

DV/PV



MVS4/SVS4

Object Detection
目标探测

目标探测Object Detection

- Vehicle and VRU object detection
  - 目标分类Classification of
    - Car
    - Truck/Bus
    - Two-wheeler
    - Pedestrian
    - Cyclist
- 长距离探测Long detection range, 150 m for vehicles, 80 m for pedestrians
- 车辆侧面目标分类（横穿及并行车辆）Vehicle side view classification (both crossing and parallel vehicles)
- 更高的遮挡处理水平（横穿自行车及部分出现在FOV的车辆）Higher occlusion level (crossing bicycles and vehicles that are only partially in field of view)
- 单一主目标检测及动物探测Mono general object detection, including animal detection
- 刹车灯及转向灯探测Brake and turn light detection

目标检测Object Detection

Key KPI:s

Feature		MVS Generation 3 (current performance)	MVS Generation 4 Targets	
			All	*EuroNCAP etc.*
TP				
	Vehicle – Car, Truck	~95% (of all vehicles up to 80 m)	98%	100%
	Pedestrian	~80% (of all pedestrian up to 50 m)	95%	100%
	Bicyclist	~80% (of all pedestrian up to 50 m)	95%	100%
	Two wheeler – MC		90%	100%
	Vehicle crossing		98%	100%
Detection distance*				
	Vehicle – Car, Truck	100 m	150 m*	
	Pedestrian	50 m	80 m*	
	Two wheeler – Cyclist, MC	50 m	80 m*	
	Vehicle crossing	N/A	80 m*	

* Detection distance for MVS4 varies over FoV. Provided numbers valid for ~+/- 10 degrees

MVS4 OD: Video Examples

Lane Detection
车道线探测

车道线识别Lane Detection

- 车道检测和标记类型的分类Lane detection and classification of marking types
- 颜色:白色、黄色、蓝色、红色Painted markings: white, yellow, blue, red
- 路钉Botts' Dots
- 检测人行横道和施工现场Detection of crosswalk and construction site
- 道路边界检测（可穿越与不可穿越）草、砾石、路缘、

防撞护栏、护栏等Road Boundary

Detection (traversable and non-traversable)

  - Grass, gravel, curbs, crash barriers, guardrails, etc.

Road Boundary Detection Overview
路边沿检测概要

- Functionality功能
  - Traversable road boundaries (< 20 cm tall)
    可翻越的路边沿（低于20cm ）
  - Non-traversable road boundaries (> 20 cm tall)
    不可翻越路边沿（高于20 cm）
- Performance 性能(Generation 4, 2018)
  - Detection distance: ~ 70 m
    检测距离
  - Min road radius: ~ 100 m
- 最小道路曲率

车道识别Lane Detection

Key KPI

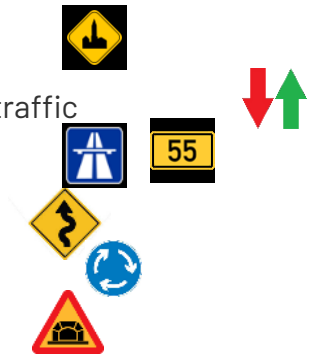
Feature	Description	KPI
Availability Lane (Distance based) 能力（基于距离）	**Good conditions优良条件** All road types Good weather, marking quality and lighting conditions 全部道路类型 好的天气，清晰的标识，和好的光照下	99%
	Adverse conditions不利条件 All road types Reduced weather or marking quality Good lighting conditions 所有道路类型 一般天气或者标记质量，好的光照条件	97%
	Bad conditions坏天气 All road types Bad weather or marking quality Reduced or bad lighting conditions 所有道路类型 坏天气或者标记质量差 一般或者差的光照条件	75-90%
Detection distance 检测距离	Lane solid 实线	100+m
	Lane dashed 虚线	100+m
	Road boundary 路边沿	70 m
Horizontal curvature 水平曲率		>100 m
Lane merge, split events 车道和合并，车道分离	Detection distance (opening/closing fork, marking type change) 检测距离，	20 m

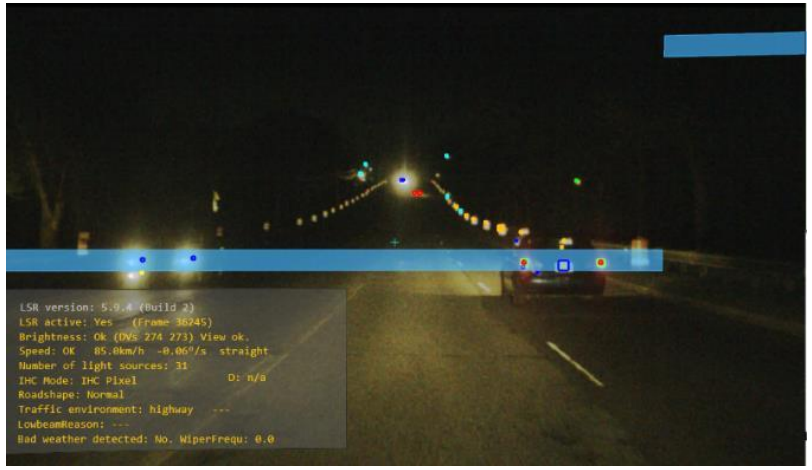
MVS4 Lane and Road Boundary Detection Examples
MVS4 车道和路边沿检测实例

Light Source Recognition
光源识别

光源识别Light Source Recognition

- 光源检测与分类Detection and classification of light sources
- 光源类型Light source types
  - 头灯、尾灯、led尾灯、运动中(卡车附加光源)、网灯、反射器、街道反射器、静态物体(标志)Headlamp, taillight, LED-taillight, running (additional light sources on trucks), net lamp, reflector, reflector on street, static object (sign)
- 场景检测Situation detection
  - 城市City detection
  - 左/右交通Left-/right- hand side traffic
  - 告诉公路Motorway
  - 连续弯路Serpentine road
  - 环路Roundabout
  - 隧道Tunnel detection





Detection and classification of light sources

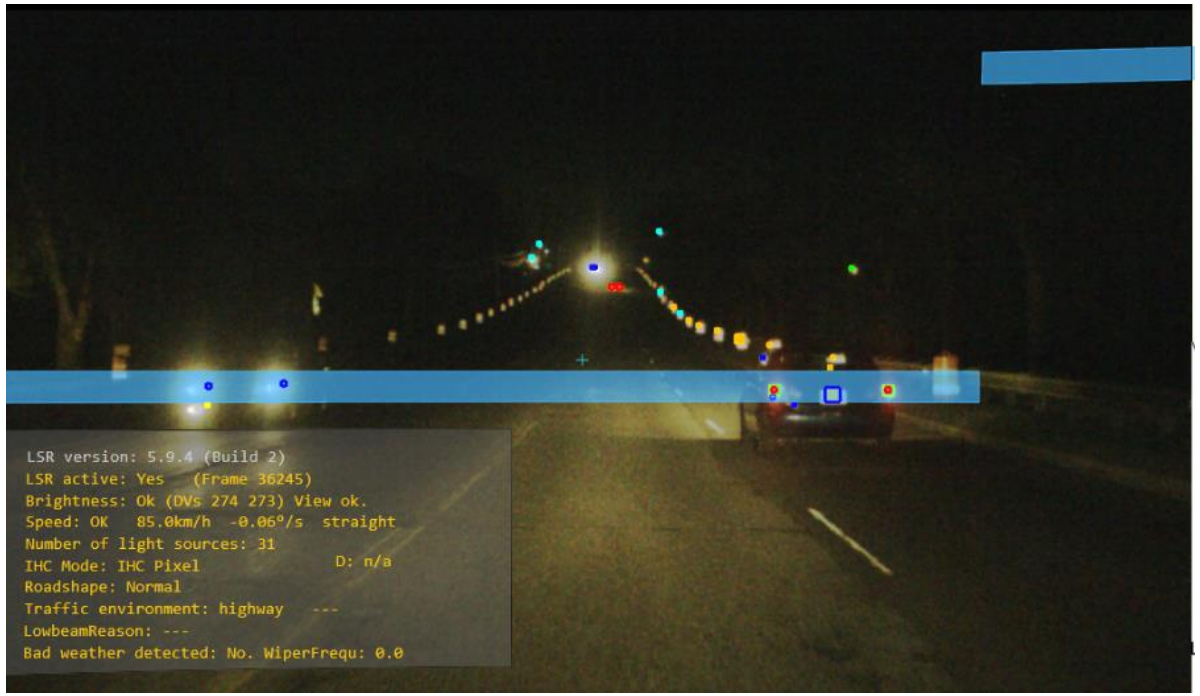
Detection of Position lights on trucks

Detection of cross-traffic

Light source recognition-光源识别

The purpose of Light source recognition is to find light sources as input to light steering.

光源识别的目的是找到光源以用于灯光转向



KPI	MVS3 (Current performance)	MVS4 (Target)
FP (HBA)	~ 8 FP / 100 km	~ 2 FP / 100 km
Detection range 探测距离	Oncoming: 600m Preceding: 500m	Oncoming: 800m Preceding: 700m
Reaction time oncoming two-track vehicles 对于迎面行驶过来的二轮车的反应时间	< 2000 ms 97%	< 900 ms 99%
Reaction time preceding two-track vehicles 对于前方正向行驶的二轮车的反应时间	< 3000 ms 90%	< 1400 ms 99%
Accuracy 精度	< [-15% 0] up to 400 m	< [-15% 0] up to 400 m

Traffic Sign Recognition
交通标志识别

交通标志识别Traffic Sign Recognition

- Traffic Sign Recognition 交通标志识别
  - Detection and classification of a wide range of traffic signs
    可以对大范围的交通标志进行检测和分类
  - Supports features like RSA
    可以支持RSA功能

- Traffic Light Recognition 交通灯识别
  - Detection of traffic lights
    红绿灯检测
  - Detection range 75 m
    探测距离75米
  - Determination of Light mode:
    - Red, Amber, Green

    可区分红/黄/绿灯模式

- Examples of detected signs
  - 限速Speed Limit
  - 隐含限速Implicit Speed Limits
  - 禁止超车No overtaking signs
  - 限制补充Restricting Supplementary Signs
  - 警告Warning Signs
  - 停止Stop Sign
  - **禁止驶入**，环路No Entry, Roundabout
  - 人行道Crosswalk Sign
  - 减速弯道Chicane announcement signs
  - 收费站Toll station signs
  - 菱形警告Diamond shaped warning signs, US

交通标志识别Traffic Sign Recognition

Key KPI

KPI	MVS3 (Current Performance, DE)	MVS4 (Target, DE)
Traffic Sign Recognition	95%	99%
Speed Limit Assist	95%	98%
No Overtaking Assist	97%	98%

MVS5/SVS5

Generation 4 & 5 Camera

Functional Overview

✓ Supported by product variant but could be a scalable option depending on customer requirements.

这些功能由各种产品支持，但可以根据客户的需求进行定制

		MVS4 MVS5 Base	MVS5-Mid	SVS5
Lanes/镜头	Lane Marking Detection/车道线检测	✓	✓	✓
	Road Boundary/路边沿检测	✓	✓	✓
	Free Space Detection/自由空间检测	➲	✓	✓
	Construction Sites/道路维护	✓	✓	✓
	Crosswalk Detection/人行道检测		✓	✓
	On-Road Symbols (see also TSR)/路面标识	✓	✓	✓
	Holistic Path Planning/全路径计划		✓	✓
Objects/目标	Vehicle Longitudinal/自车纵向	✓	✓	✓
	Vehicle Crossing/交叉车辆	✓	✓	✓
	Vehicle 3D/3D车辆	✓	✓	✓
	Vehicle Front/前方车辆	✓	✓	✓
	Two-Wheeler Detection/两轮检测	✓	✓	✓
	Pedestrian Detection/行人检测	✓	✓	✓
	Bicycle Detection/自行车检测	✓	✓	✓
	General Object Detection/通用目标检测	✓	✓	✓
	Animal Detection/动物检测		✓	✓
	Debris Detection/杂物检测		✓	✓
	Pothole Detection/凹坑检测		✓	✓
	Long Range Object Recognition/超长目标识别			✓
	Police/fire/rescue veh detection/警车/消防车/救护车检测		✓	✓
	VRU behavior prediction (Head Direction & Gestures)/行人行为预测			✓
Lights/灯	Light Control/ 灯光控制	✓	✓	✓
	Intelligent Light Ranging/智能灯光范围	✓	✓	✓
	Indicators, Police/Rescue flash, hazard lights/指示灯，警车/救护车闪灯，危险报警灯		✓	✓
	Running Daylights/日行灯	✓	✓	✓
	Glare Free Matrix Beam/矩阵式防眩目灯	✓	✓	✓
Traffic Signs/交通标识	Speed Signs, complementary signs/速度牌	✓	✓	✓
	Indirect speed regulations (city limit…)/间接限速	✓	✓	✓
	Painted speed information (on lane)/画出来的限值	✓	✓	✓
	Policemen regulation traffic/交警规定限速			✓
	Traffic Light Recognition/ 交通灯识别	✓	✓	✓
Other Functions/其它功能	Road Condition Preview (ice, water etc)/ 道路情况预览		✓	✓
	Weather Condition/Quality of Sight/天气情况/视野质量	✓	✓	✓
	Road Surface Preview/路面预览		✓	✓
Mapping/Roadscape Support 地图/道路景观支持	Signs & Lanes/标识 &车道	✓	✓	✓
	Visual Landmarks /虚拟车标志	✓	✓	✓

Veoneer Vision Product Roadmap-产品路线图

Mono Vision Cameras up to Gen 5 单目摄像头最高达到5代

2018				2019				2020				2021				2022				2023			
Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4

Mono Vision

B Sample & Vehicle Demo

C Sample

PPAP

Mono Vision Gen 4 (MVS 4)

- New 100 deg FOV lens w/1.7MP Image Sensor
- All new algorithms with 50% improved performance over previous generation
- Roadscape interoperability (map data fusion)
- Smaller form factor (MVS)
- EUNCAP 2020

PPAP

Mono Vision Gen 5 MVS 5 – Base & Mid

- Introduction of new Gen 5 vision processor
- New, advanced CNN algorithms
- Capacity for more ADAS functionality
- High resolution optical components
- Increased detection range and accuracy
- EUNCAP 2022

Legend

Gen 4

Gen 5

Veoneer Vision Product Roadmap

Stereo Vision Cameras up to Gen 5 - 双目摄像头最高达到5代

2018				2019				2020				2021				2022				2023			
Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4

Stereo & Bi-Focal

◆ B Sample & Vehicle Demo

◆ C Sample

◆ PPAP

Stereo Vision Gen 4 (SVS 4)

- New 67 deg and 100 deg lens w/1.7MP Image Sensor
- All new algorithms with 50% improved performance over previous generation
- Roadscape interoperability (map data fusion)

◆ PPAP

Stereo Vision Gen 5

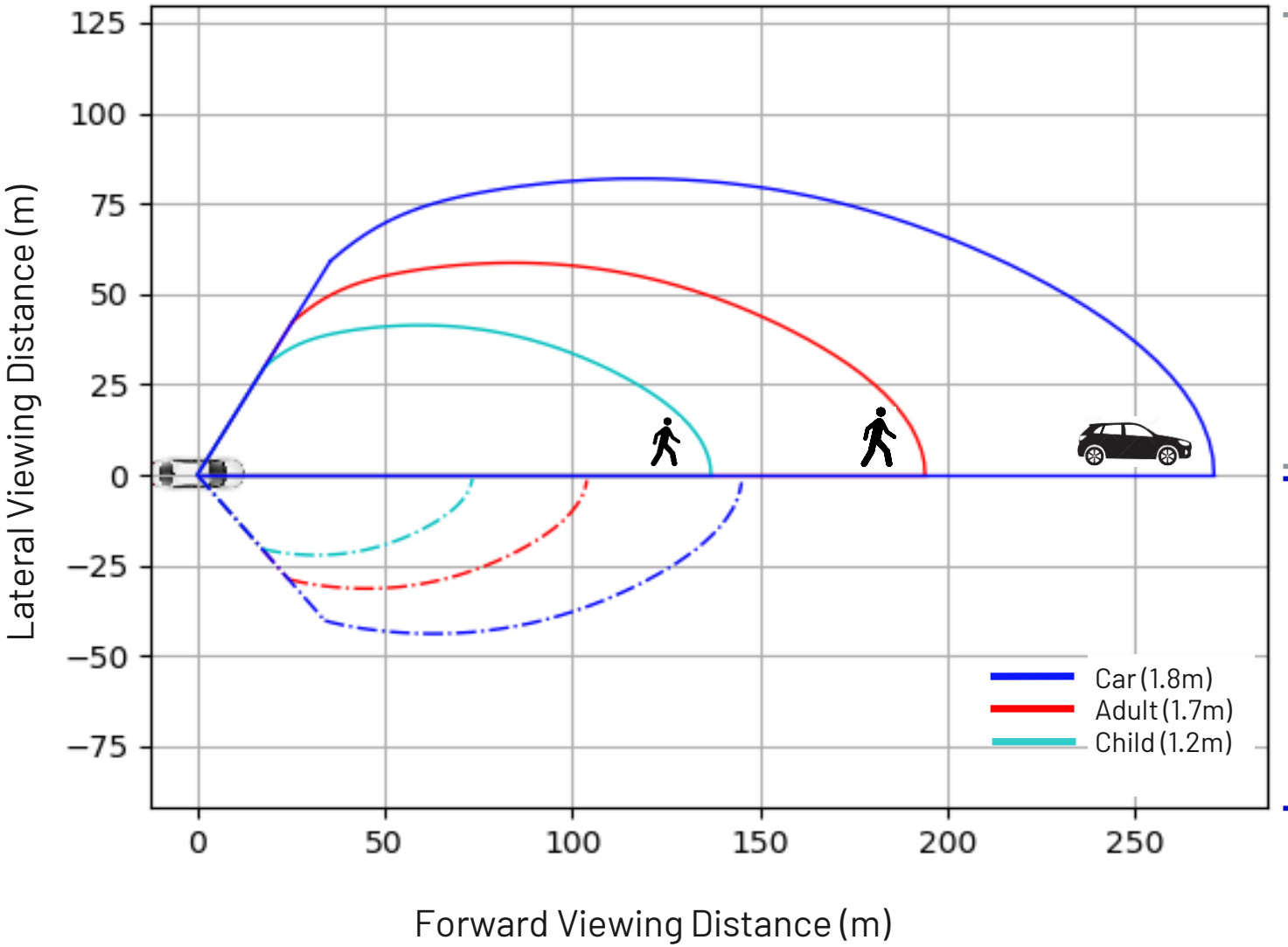
- Introduction of new Gen 5 vision processor
- New, advanced CNN algorithms
- Capacity for HAD support
- High resolution optical components
- Increased detection range and accuracy
- Stereo Vision for increased accuracy

Legend

Gen 4

Gen 5

GVP5 vs GVP4 Detection Distance Overview – optical potential



Gen 5 – 8MP, 120 deg HFOV

Gen 4 – 1.7MP, 100deg HFOV

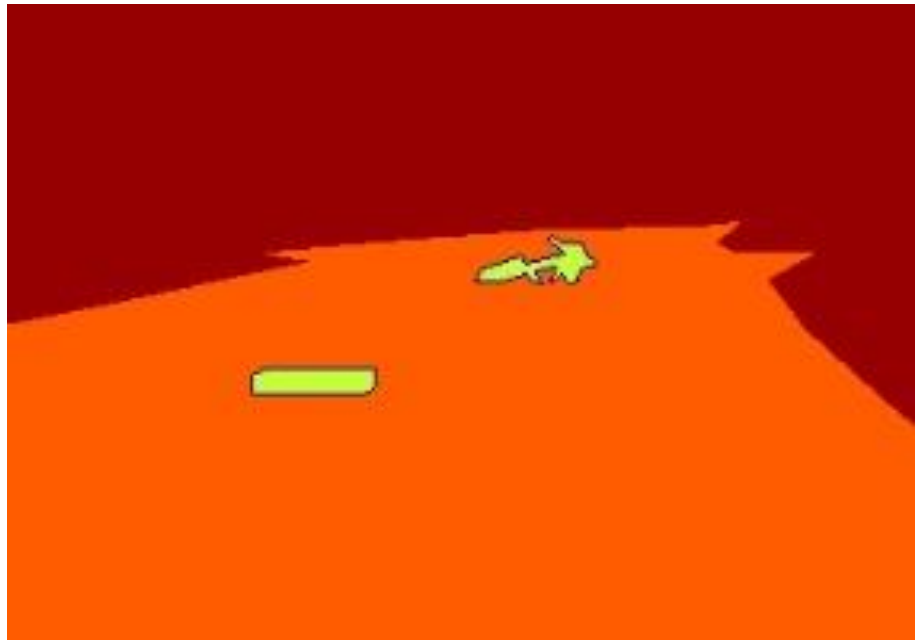
Mono vision trained system-单目视觉训练系统

Road classification data/道路分类信息

Debris data/杂物信息

Mono vision trained system-单目视觉训练系统

Debris markings-杂物



Thank You!