

Automotive Calibration Standards

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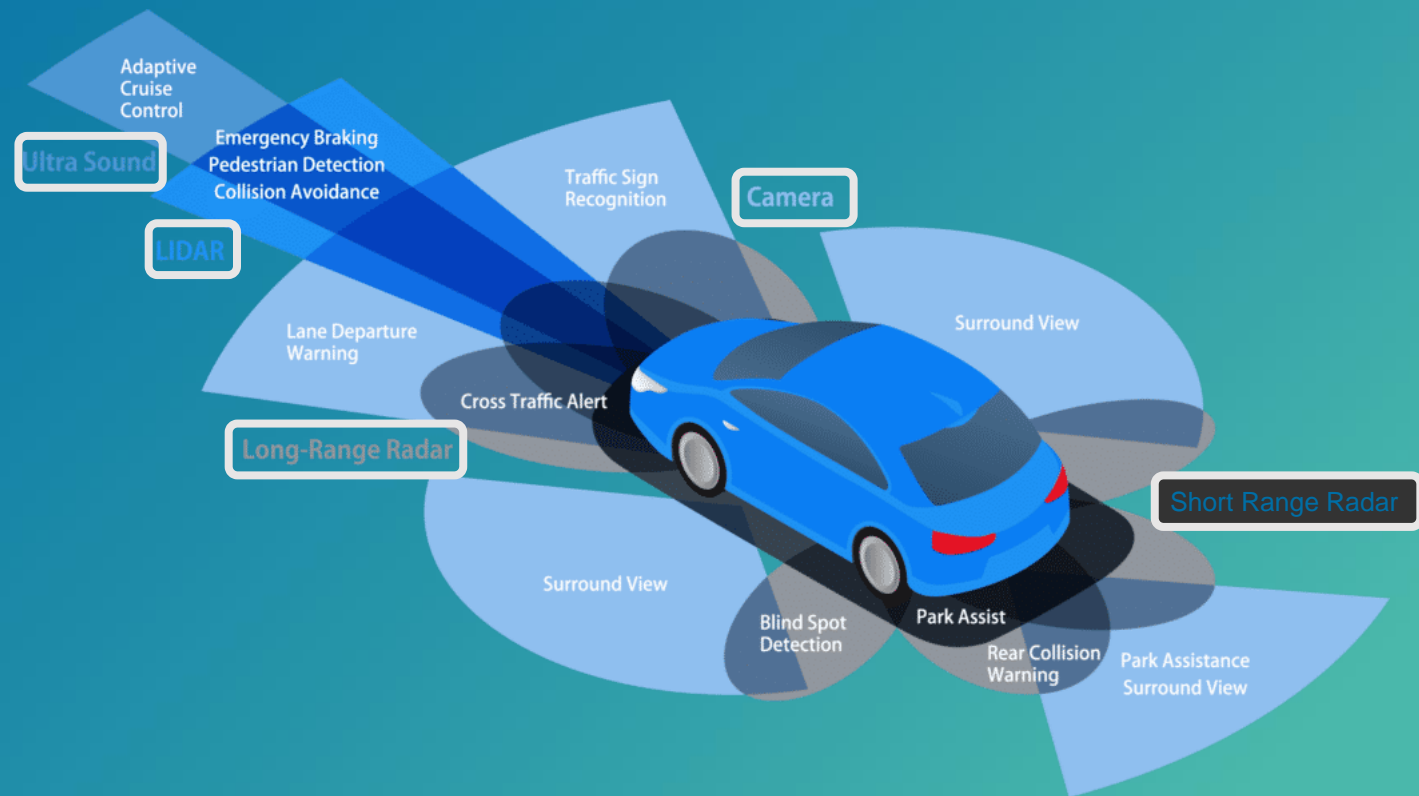


The future of mobility is enabled by sensors

Advanced Driver Assistance Systems (ADAS) sensors are needed to detect everything the driver can see and what the driver hasn't noticed or can't even see.

Automakers have slowed down on self-driving but are booming on ADAS and new sensors.

We will show why Deepen is already getting revenue here and will grow on top of that.



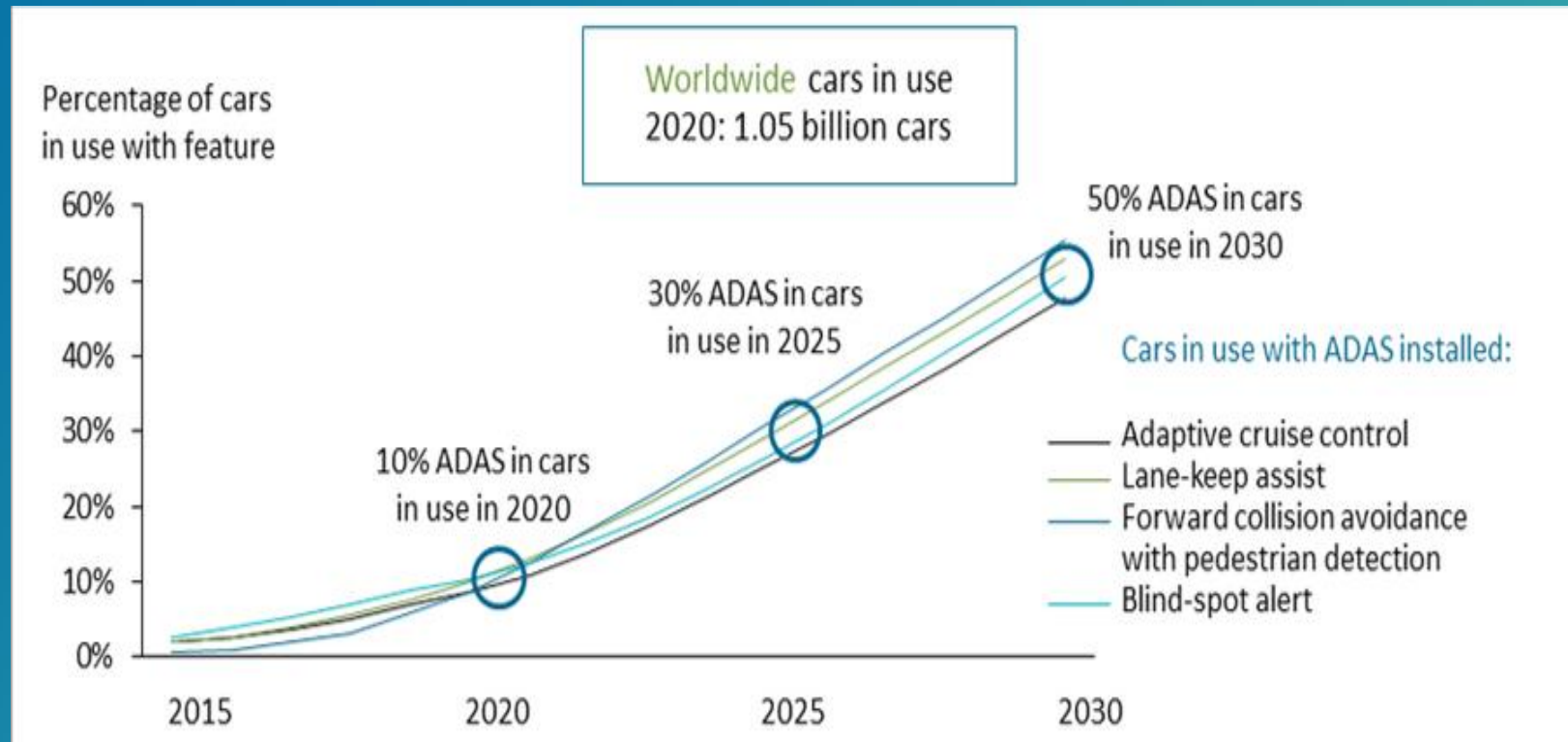
ADAS is no longer an option for OEMs

Regulation mandates adding ADAS capabilities in the US & EU

~400m ADAS enabled cars will be in use in 2025

Full L4+ AV will take a long time to be a big market.

ADAS is top of mind for automotive and automation is top of mind for industrial use cases.



Canalys currently predicts that around 30% of cars in use will have ADAS features in 2025 and around 50% in 2030

The use of sensors is skyrocketing

A regular passenger vehicle with minimum ADAS features has at least 5 sensors (cameras & radars)

USE CASES	SONARS	RADARS	LIDARS	CAMERAS	IMU / GPS
• Advanced Emergency Brake		1-2	1	1	
• Adaptive Cruise Control		1	1	1	
• Traffic Jam Assist		1	1	1	
• ACC Stop & Go	4	1-3	1	1	
• Lane Keeping Assist		2		2	1
• Blind Spot Detection		2		2	
• Intelligent Parking Assist	4	4	1	2	
• Highway Automated Driving	8	5	2	2	

Table of the average number and type of sensors used in ADAS systems provided by most of the car manufacturers. *Courtesy of Alain Servel*

Calibration has many use cases & permutations

Research &
Development
Calibration

Factory Calibration

Realtime
Calibration

Service Center
Calibration

Different use cases require different accuracy criteria

Every company is developing in-house capabilities and has many vendor options

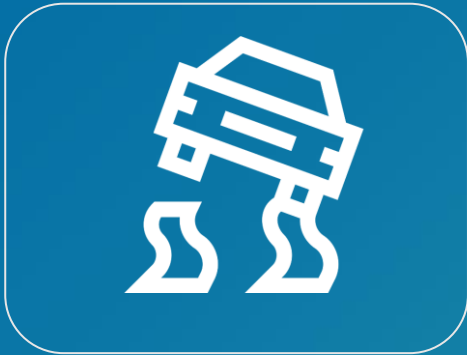
Many calibration permutations:

- Camera / Vehicle calibration
- Camera / Camera calibration
- Camera / IMU calibration
- Radar / Vehicle calibration
- Radar / Camera calibration
- LiDAR / Vehicle calibration
- LiDAR / Camera calibration
- LiDAR / LiDAR calibration
- LiDAR / Radar calibration
- Intrinsic Camera calibration
- Intrinsic IMU calibration
- Intrinsic LiDAR calibration
- Camera / IMU calibration
- LiDAR / IMU calibration
-etc

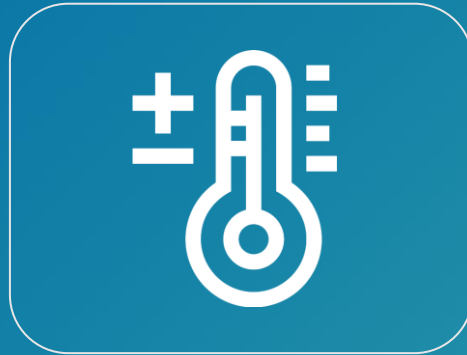
Industry needs sensors. Sensors need calibration

When vehicles become highly automated, data & sensor suite accuracy becomes critically important

Sensors can go out of calibration due to a multitude of reasons:



Regular wear and tear



Temperature changes



Vibrations



Accidents

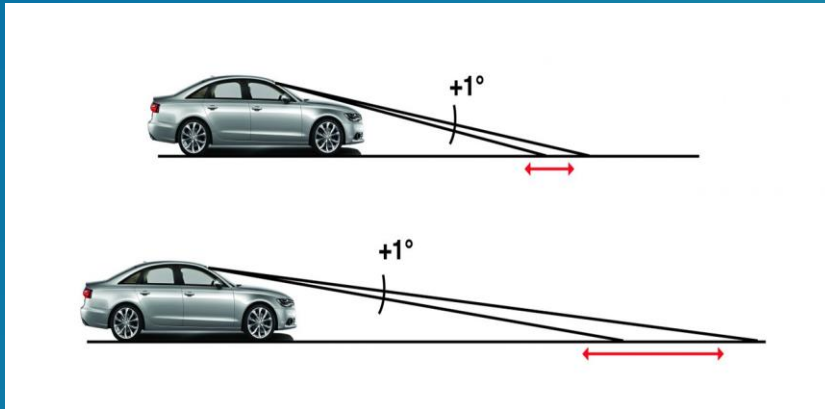
Calibration ensures sensors remain accurate and work together as a unit.

Dangers of inaccurate sensor calibration

Cameras are often mounted to the windscreen to enable ADAS systems such as emergency braking and lane departure warnings to function correctly.

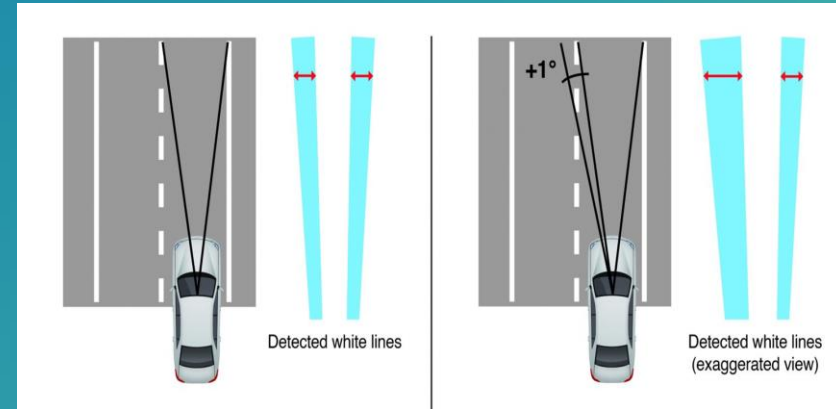
A camera that is miscalibrated by even one degree can have devastating consequences.

Small Error in Camera Pitch Angle



Result: Significant error in braking distance calculation

Small error in Camera Yaw Angle



Result: Significant error in white line detection

Calibration is safety critical for ADAS & AV

Despite that Calibration now is key to safe ADAS & AV, there are no standards.

We propose creating a new standard for multi sensor calibration for automotive and other related industries.

The standard should combine both quantitative and qualitative accuracy baselines for each calibration pair.

NEXT STEP:

Scoping session first week of April