



We are the link  
between the real and  
the digital world.

# Accurate AI-models with limited edge hardware for automotive applications

Infineon's virtual show 2020

TERAKI™



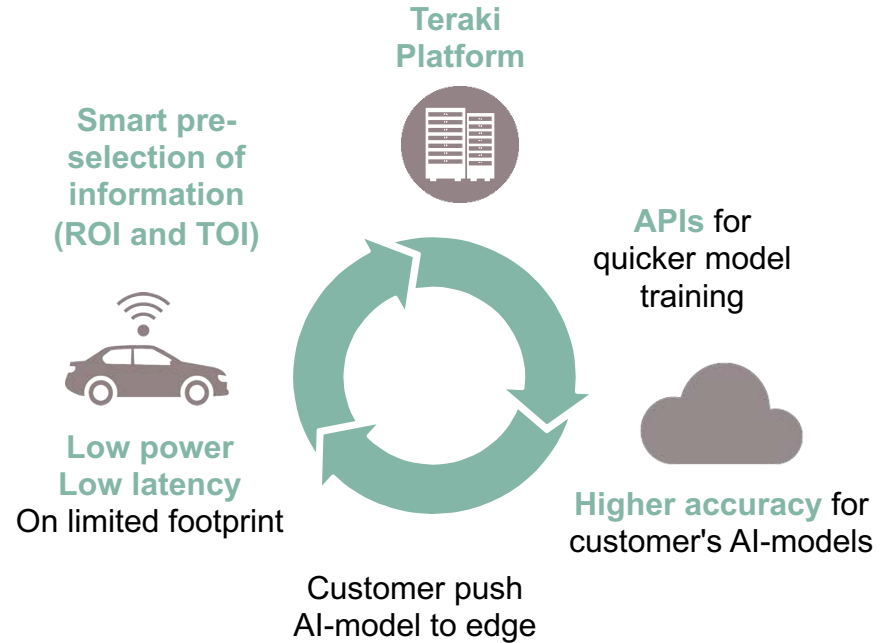
# The edge AI lifecycle: how to train and run AI-models

## AI models are the foundation for:

- › New functionalities
- › Better products
- › New services
- › Safer operations

## Leading to a demand for smarter processing of sensor data at the edge:

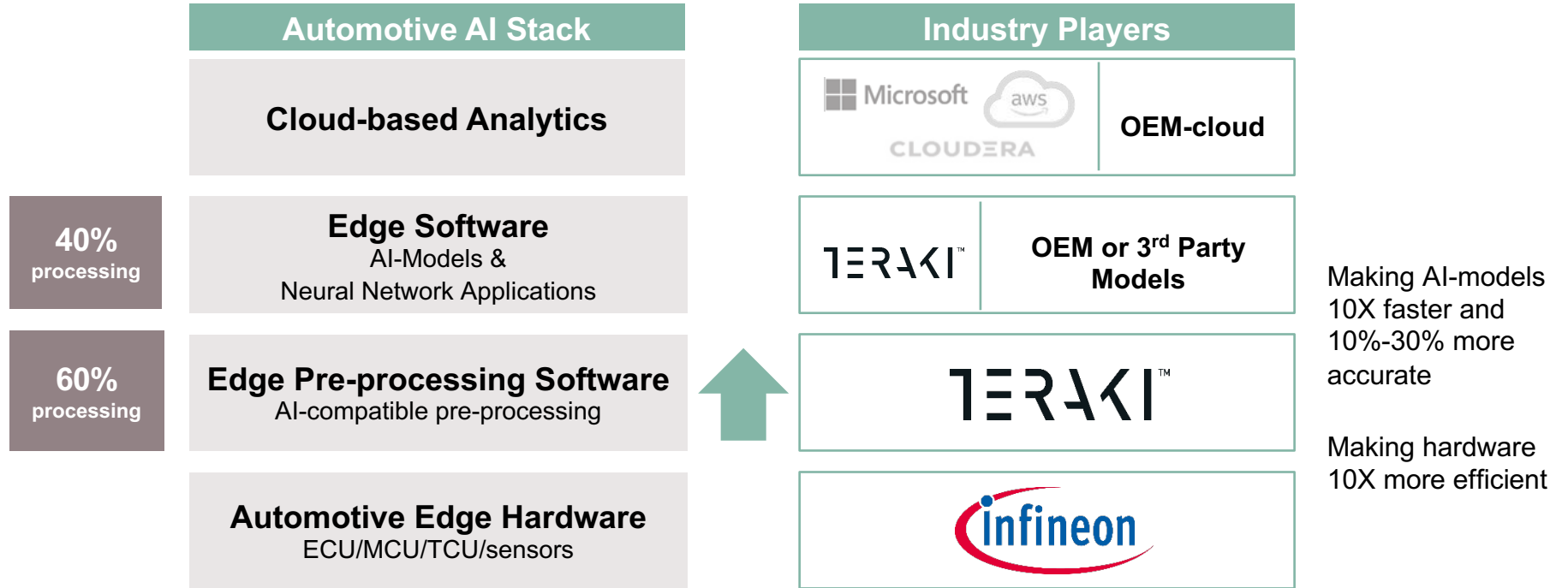
- › Sensor data is the fuel for AI models
- › The more sensors and the higher the resolution, the better AI-models get.
- › This data "flood" creates various bottlenecks and requires a solution



Green = Teraki deliverable

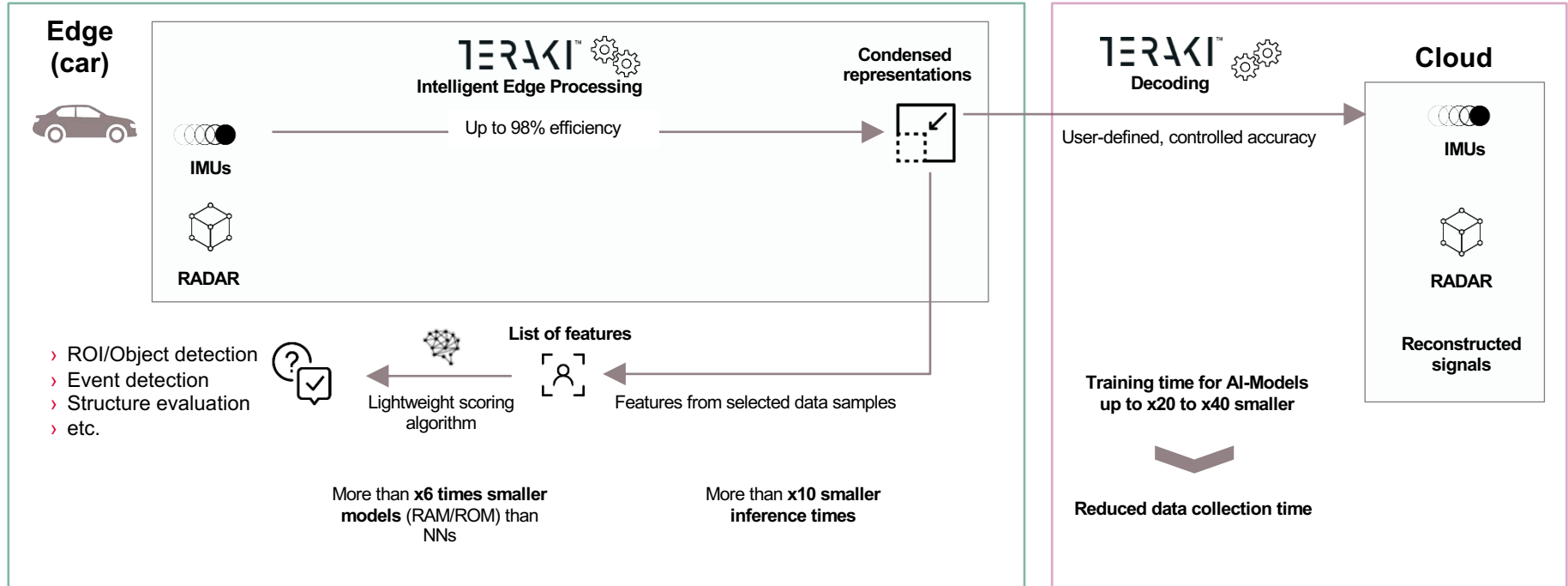
**Coping with sensor data at the edge is key to deliver to the increasing customer demands for AI-models**

# Where is edge pre-processing in the automotive IT-stack?



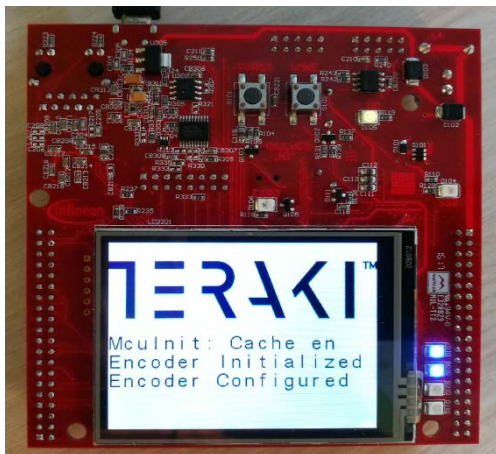
**Teraki edge AI software runs on edge hardware and inputs to AI-models**

# Intelligent signal processing by Teraki at the edge



**Reducing raw data and extracting the relevant information**

# Real benchmarks on AURIX™ TC2 and TC3 implementations



Infineon AURIX™

**ROM:**

Total: 7,974 bytes

**RAM:**

Working buffer (internal memory): 7,312 bytes

## Evaluation

Signal group 1 (50 signals, frame\_buffer = 20):

State	Min	Max	Avg	Avg / Sig
Encode	11.95 ms	20.4 ms	14.96 ms	299.27 us

Signal group 2 (7 signals, frame\_buffer = 20):

State	Min	Max	Avg	Avg / Sig
Encode	363.98 us	542.26 us	400.51 us	57.21 us

50 signals simultaneously processed **in 15ms** with **7KB RAM** and ROM.

Average CPU usage 7% for 10Hz signals.

**No spikes** in CPU-usage.

**Teraki demonstrates 10x higher speeds without compromising quality and hardware resources**

# Reality: Pre-processing in action on the AURIX™ TC3XX

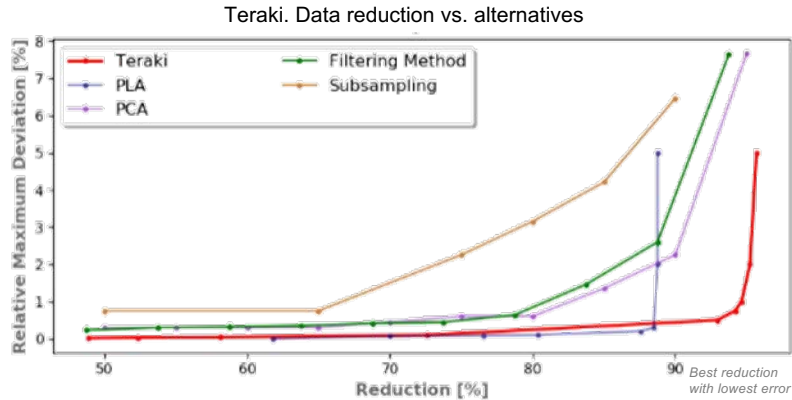
# TERAKI™



**Teraki successfully demonstrated working implementations on AURIX™ chipsets**

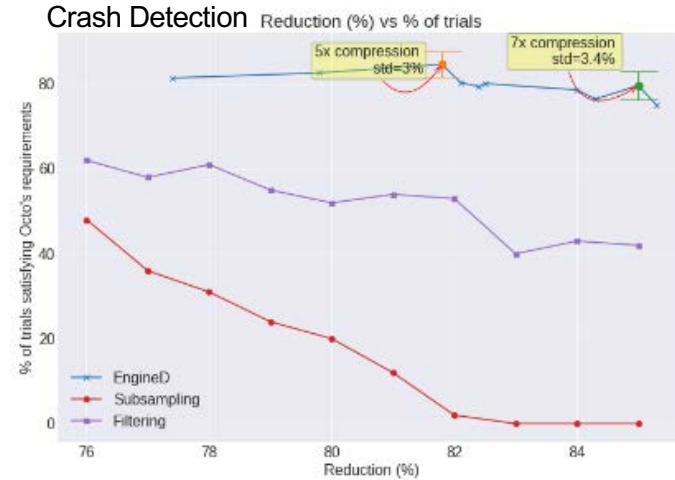
# Delivering higher AI-accuracy

Only Teraki delivers high accuracy (<1% deviation) while reducing with factor 20X



Alternatives start failing in preserving accuracy at acceptable x5 increased rates and x10 lower latency

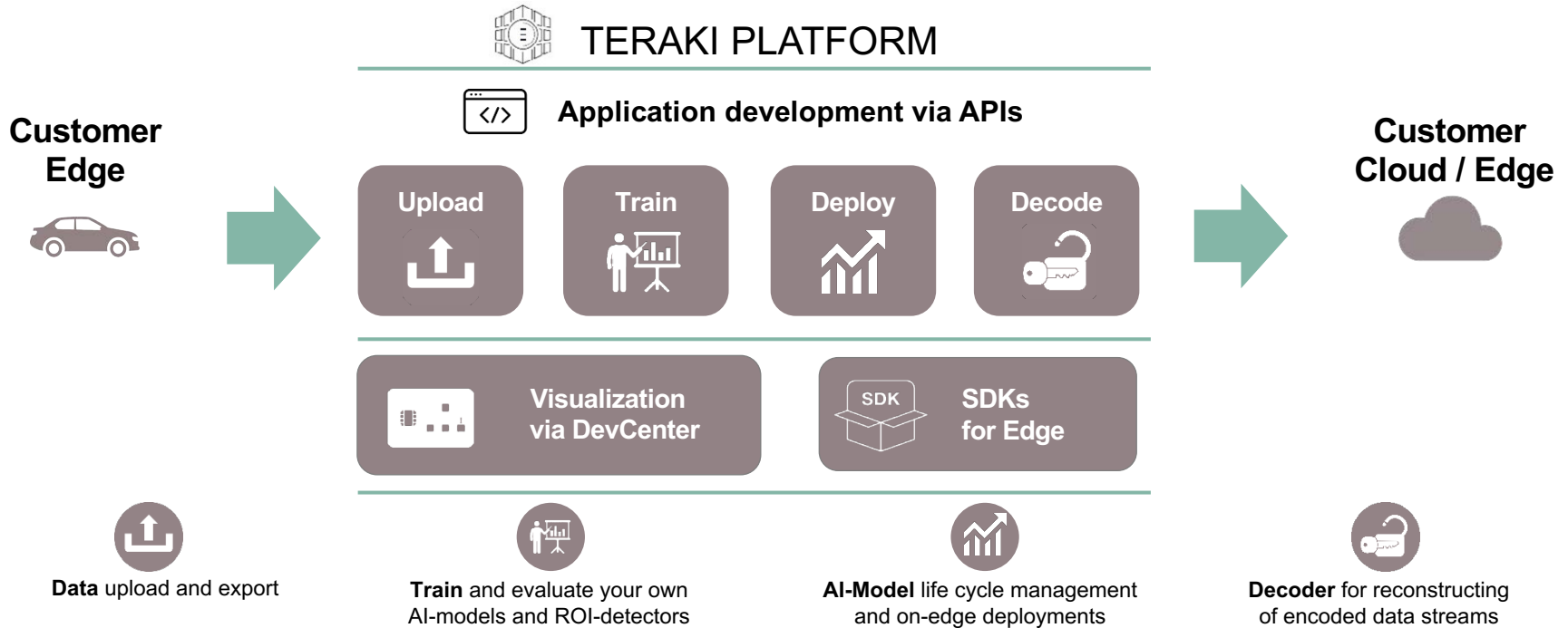
Detection accuracies 30% higher compared with other processing



With Teraki, the accuracy of the AI-model's result does not degrade and can be even improved vs. raw data

**Teraki delivers 10% - 30% higher accuracy outcomes than alternative methods**

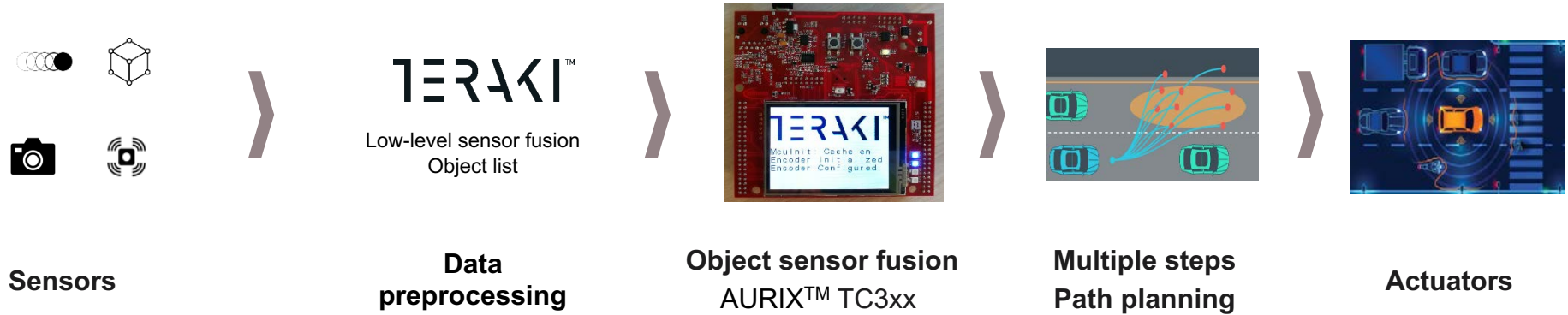
# Faster training of AI-models – automated via Teraki Platform



**Build and deploy the best algorithms for any targeted use case and scale to high volumes**



# Low level sensor fusion: the step prior to AURIX™ decision making

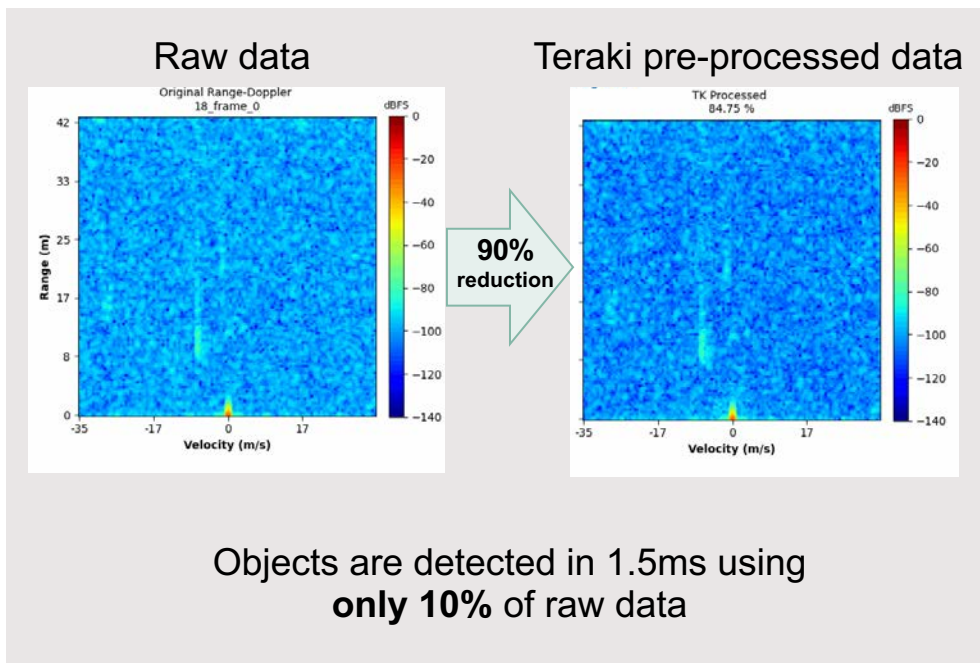


"With TERAKI, the Safety SoC can process more sensor data at higher resolutions, leading to better real-time decisions."

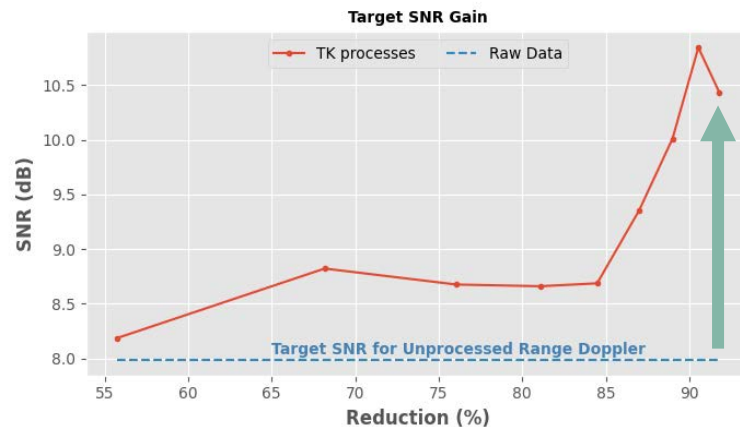
Raw vs Pre-processed data:  
 2D Camera: 40x faster transmission (10x Codec, 4x ROI)  
 3D Lidar: 80x faster transmission (20x Codec, 4xROI)  
 3D Radar: 10x faster transmission

**Efficiently combining powerful sensor information in low-powered chipsets**

# Example 1: Radar pre-processing for improved SN-ratio



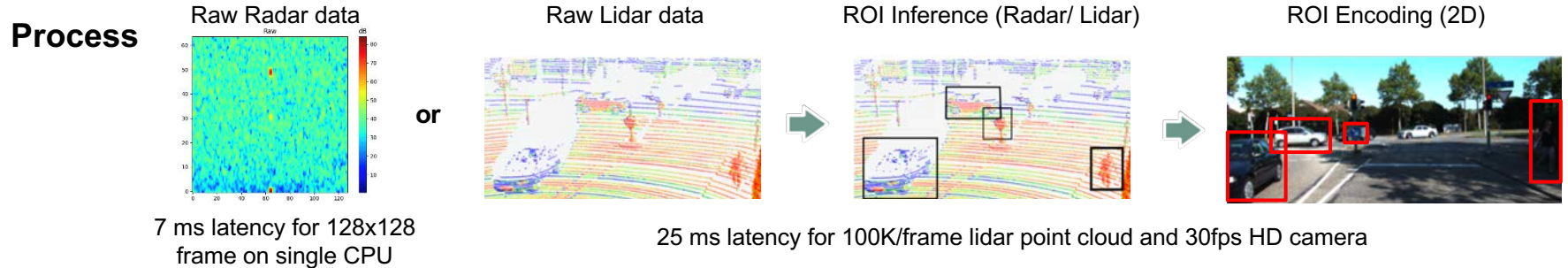
**31% SNR improvement**  
by applying Teraki pre-processing  
(on target at 90% reduction)



**Teraki software improves Signal to Noise ratio by 31% in 1.5ms**

# Example 2: Low level sensor fusion of radar / lidar & camera

Sensor Fusion		Value
Sensor Fusion: > Lidar & camera > Radar & camera > IMUs & camera		> Lower CPU and energy > Lower latencies > Accurate info for planning, etc  > Making Sensor Fusion efficient and scalable > Production-grade ADAS functionalities > Accurate, real-time fusion done on one single core



Benefits			
	Production-scale automotive hardware (single core)	Real-time, local processing of large data streams	Powerfull combination of complementary sensors

**Enabling ADAS with high precision and low latency on existing production hardware**

# Low level sensor fusion: 1) IMU + Camera

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Lane Change detections

**IMU + Video.mp4 (in wetransfer)**

**Real-life, automotive-grade & accurate sensor fusion (IMU & camera) to detect events**

## Low level sensor fusion: 2) Lidar + Camera

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People and car detections

**LIDAR + Camera.mp4 (in wetransfer)**

**Real-life, automotive-grade & accurate sensor fusion (lidar + camera) to detect objects**

# More accurate AI-models in high volume series production



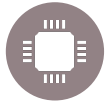
10% - 30% higher accuracy rates of AI-model



Reduction performance between 90% - 97%



Deterministic – hence certifiable and for safety related functions



Embedded on low powered ECU's – constant CPU-usage (7% for 50 signals at 100Hz)



Faster training and continuous improvements of customer AI-models via Teraki's Platform



Enabling low-level sensor fusion outputs towards path planning or decision making in AURIX™

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