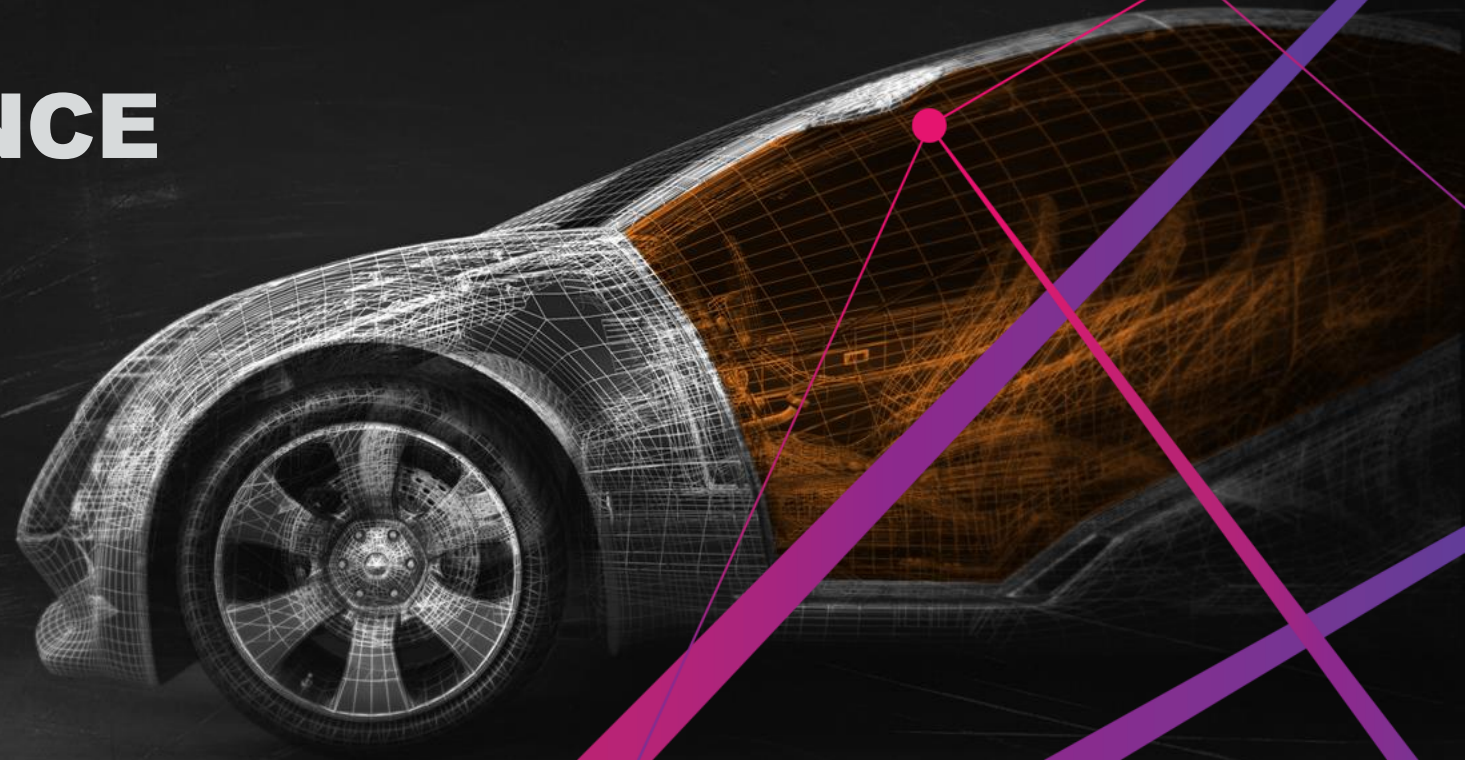




THE FUTURE OF IN-CABIN EXPERIENCE

Dr. Petronel Bigioi
CTO, Products
January 2021



THERE IS NO PLACE
LIKE MY **CAR**

XPERI



XPERI - COMPANY OVERVIEW

40+ OFFICES WORLDWIDE

headquartered in San Jose, CA

\$1.5B+ MARKET CAP

public company, trading under XPER

2,000+ EMPLOYEES

1200+ engineers

10,000+ PATENT ASSETS

strong focus on innovation

100B+ DEVICES WORLDWIDE

DTS, HD Radio, Invensas, TiVo



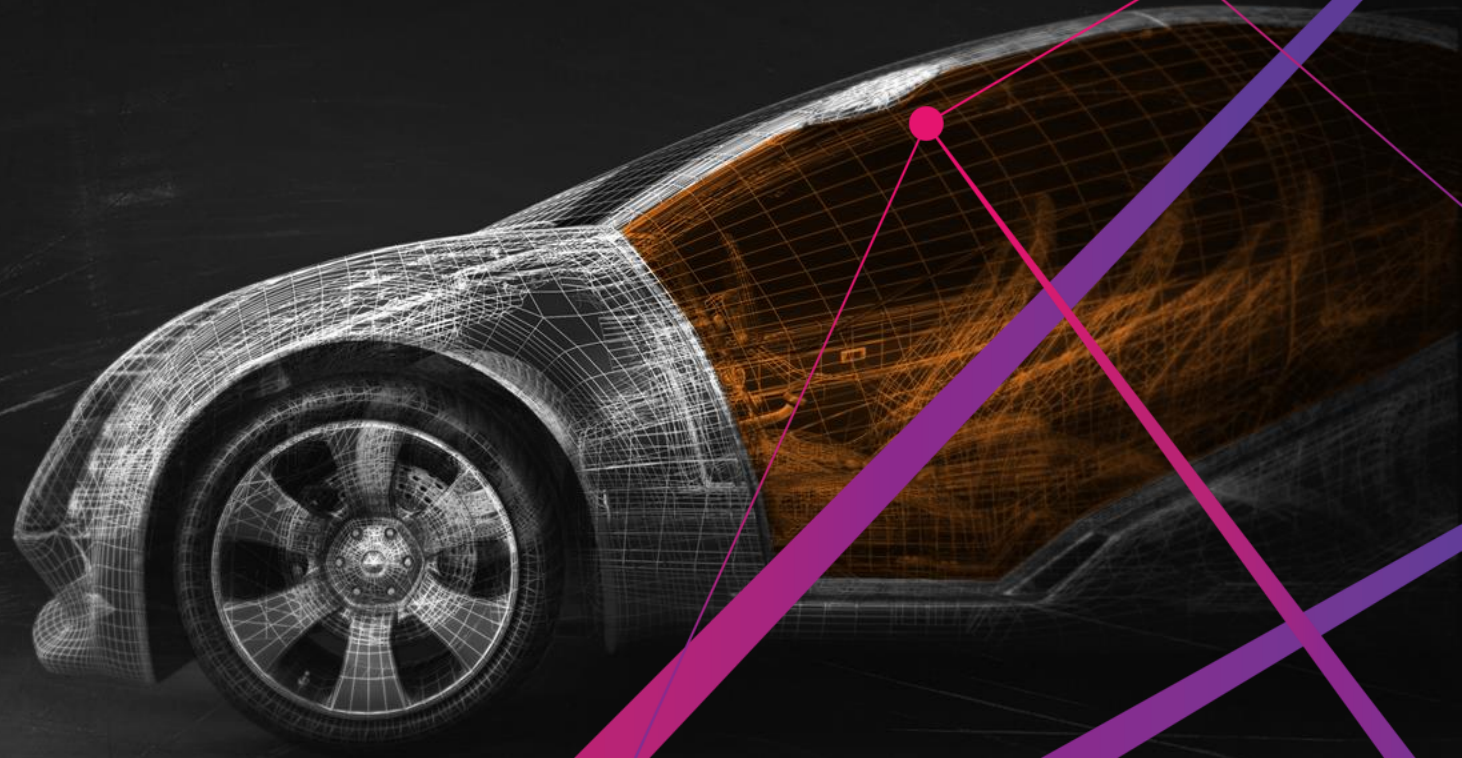


IN-CABIN MONITORING

... what is it and why it's important

THERE IS NO PLACE
LIKE MY **CAR**

XPERI



FRONT PASSENGER

NAME: RACHEL
EXPRESSION: SMILING
BODY POSE: NORMAL
ACTIVITY: TEXTING
SEATBELT: ON
HEART RATE: 70 BPM
RESPIRATION: NORMAL
SKIN TONE: NORMAL

BACK LEFT PASSENGER

NAME: BOB
EXPRESSION: SMILING
BODY POSE: NORMAL
SEATBELT: ON
HEART RATE: 64 BPM
RESPIRATION: NORMAL
SKIN TONE: NORMAL

**PET DETECTED
DOG**

DRIVER

NAME: DAVID
EXPRESSION: NEUTRAL
ALERTNESS LEVEL: ATTENTIVE
DROWSINESS STATUS: NOT DROWSY
ACTIVITY: DRIVING
OBSTRUCTIONS: NO
SEATBELT: ON
BODY POSE: HANDS ON WHEEL
HEART RATE: 68 BPM
RESPIRATION: NORMAL
SKIN TONE: NORMAL
UNDER THE INFLUENCE: NO

BACK RIGHT PASSENGER

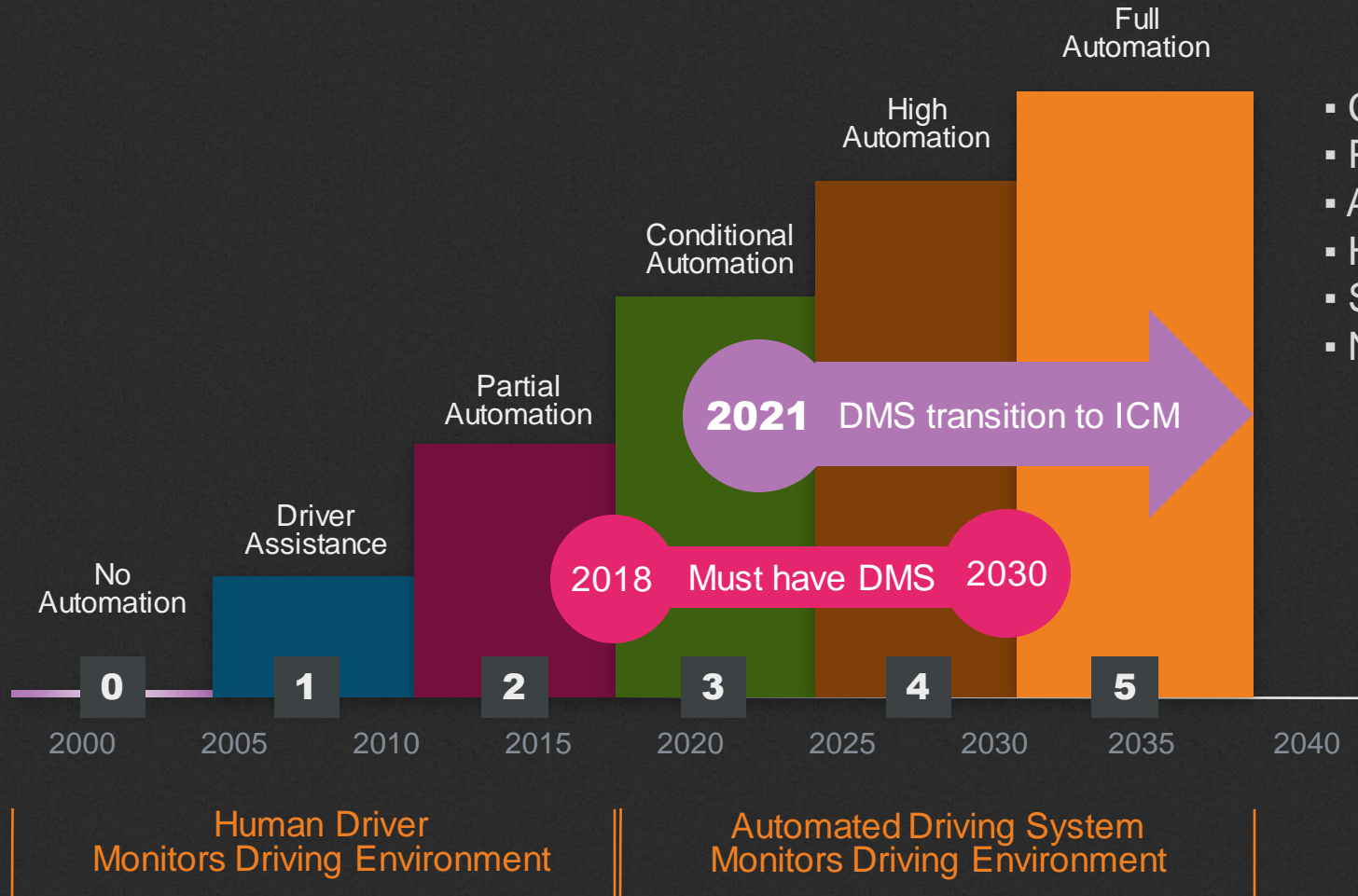
CHILD DETECTED
CHILD SEAT: **PRESENT**
HEART RATE: 76 BPM
RESPIRATION: NORMAL
SKIN TONE: NORMAL

**OBJECT DETECTED
PHONE**

HOLISTIC IN-CABIN MONITORING



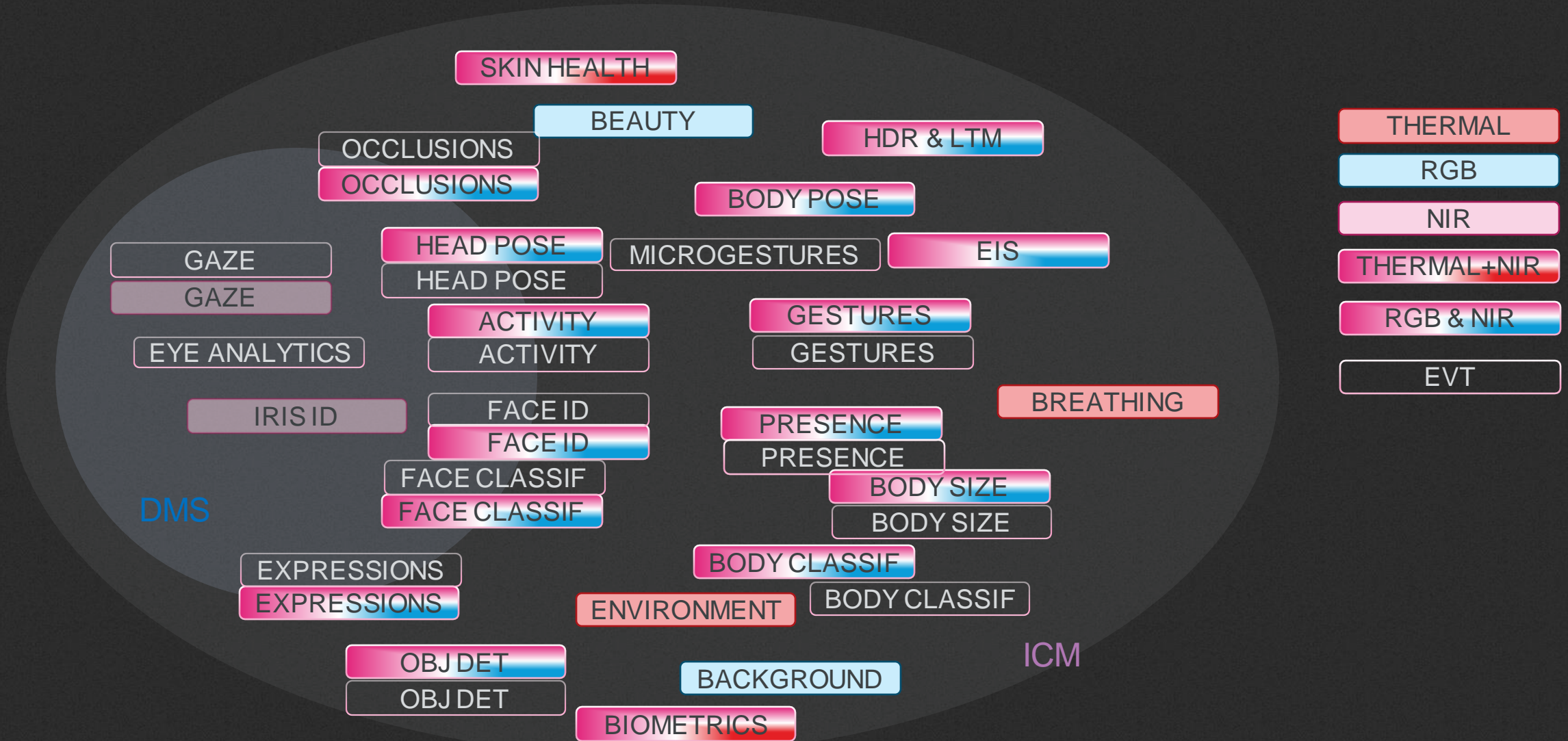
X DMS TRANSITION TO ICM - NEW EXPERIENCES ENABLER



- Continuous health & safety monitoring
- Personalized experience
- Authentication
- Human machine interface
- Social and work Interaction
- Next Gen Entertainment



ICM - POSSIBILITIES AND COMBINATIONS





ICM - QUESTIONS

MONITORING FEATURES

PD, HP, Gaze (what precision)? Identity (how strong)? Fatigue (how many levels?), Biometrics (what type)? Health monitoring (what)?



EXPERIENCE FEATURES

HMI, Video conferencing, Beautification, Background replacement, personalized sweet spot sound;



ENTERTAINMENT FEAT.

Movies (back seat or main windshield), active noise cancellation



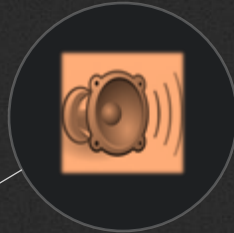
IMAGING SYSTEM

How many cameras? What type? What FOV? What resolution?



SOUND

How many speakers? What configuration? What types?



PROCESSING

Centralized vs Decentralized? TOPS? Memory? ISPs?



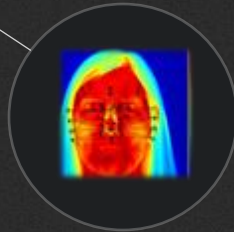
SAFETY

ASIL Levels? Redundancy? For which systems/features?



SENSORS

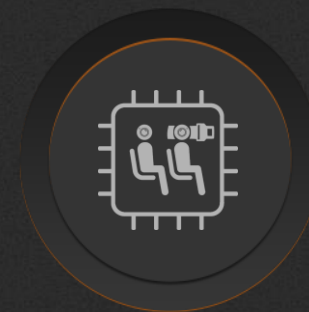
What sensors? How to fuse? What for?





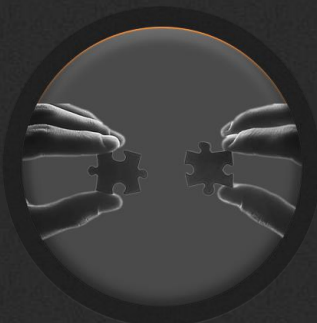
× TOTAL FLEXIBILITY · IS REQUIRED

In-cabin monitoring, and personalized experience use-cases are diverse,



and need to be powered by ultimate flexible platform (XILINX) with built in domain expertise (XPERI)

 XILINX[®]



 XPERI

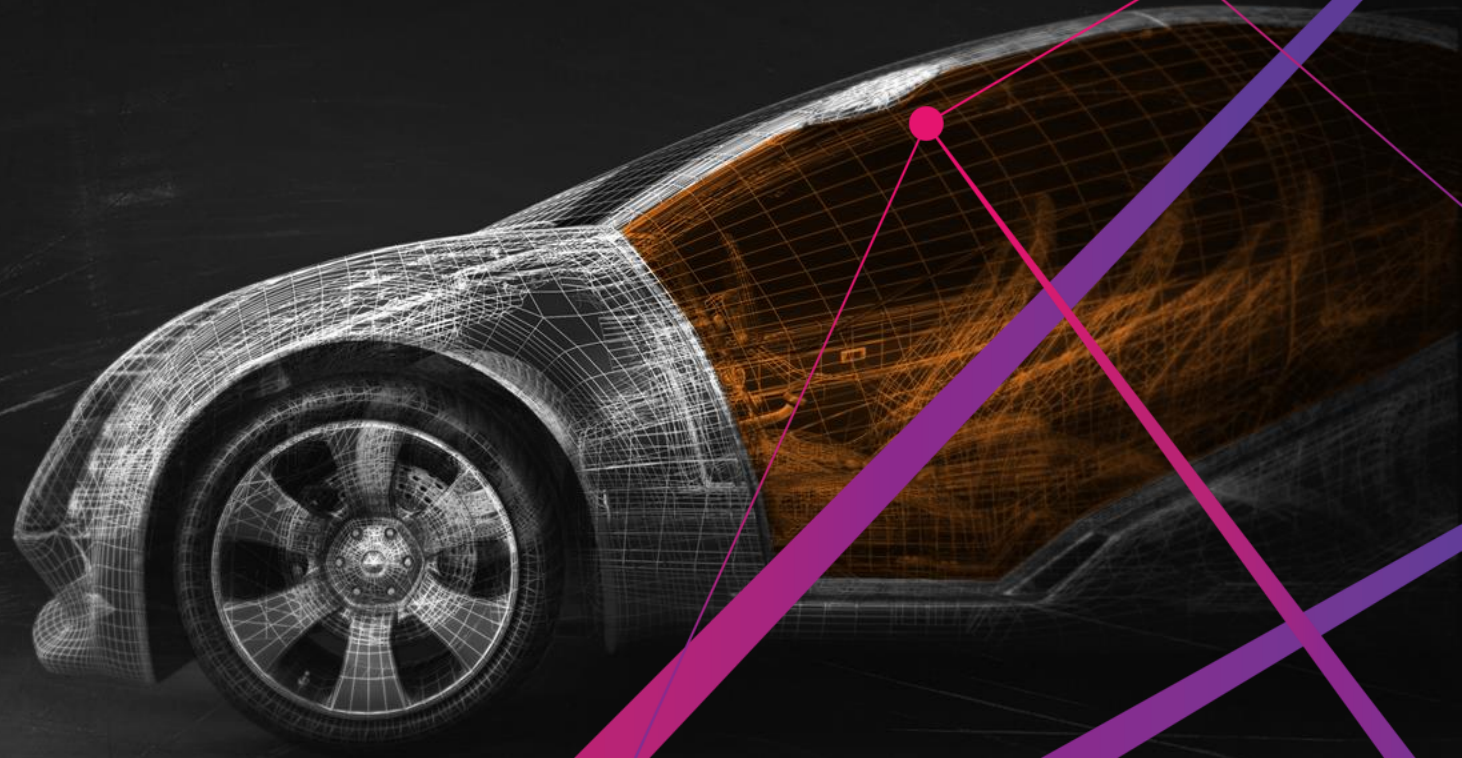


OCCUPANCY MONITORING

The first step to ICM.
Solution presentation.

THERE IS NO PLACE
LIKE MY **CAR**

XPERI





X OMS - IS DESIGNED FOR

OCCUPANTS SAFETY

37,133

lost lives
in accidents¹

47%

wore no
seat belt¹

14,955

estimated saved
lives by seat belt¹

2,549

lives that could
have been saved¹

CONTINUOUS MONITORING FOR HMI AND HEALTH

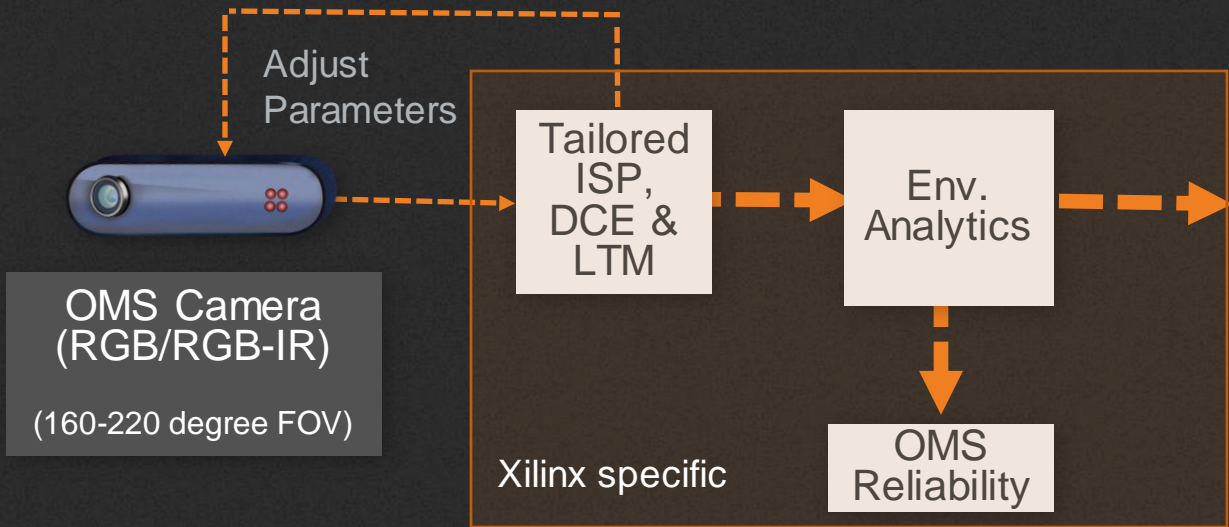
Understand **where** and **what** occupants do at any moment in time

BETER EXPERIENCE

Identify **who** the occupants are and tailor comfort settings such as seat position and entertainment content.

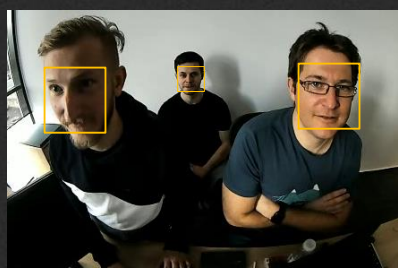


OMS - SOLUTION WORKFLOW



Face Detection

Face ROI



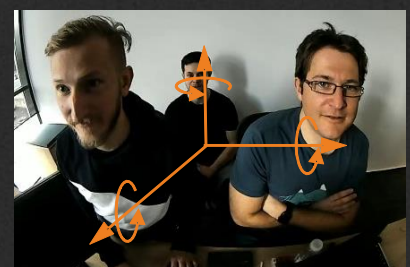
Body Detection

Body ROI



Hand Detection

Hand ROI



Face Direction & Position

Direction



Continuous Driver ID

Identification



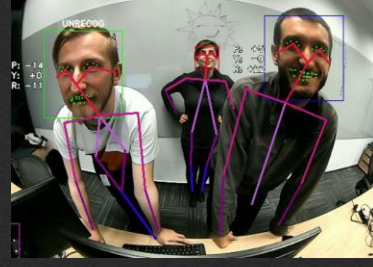
Face Feature Points

Face Features



Emotions & Face Classification

Emotions, Gender
Ethnicity, Age



Body Pose

Body Points



Hand Skeleton

Finger Points



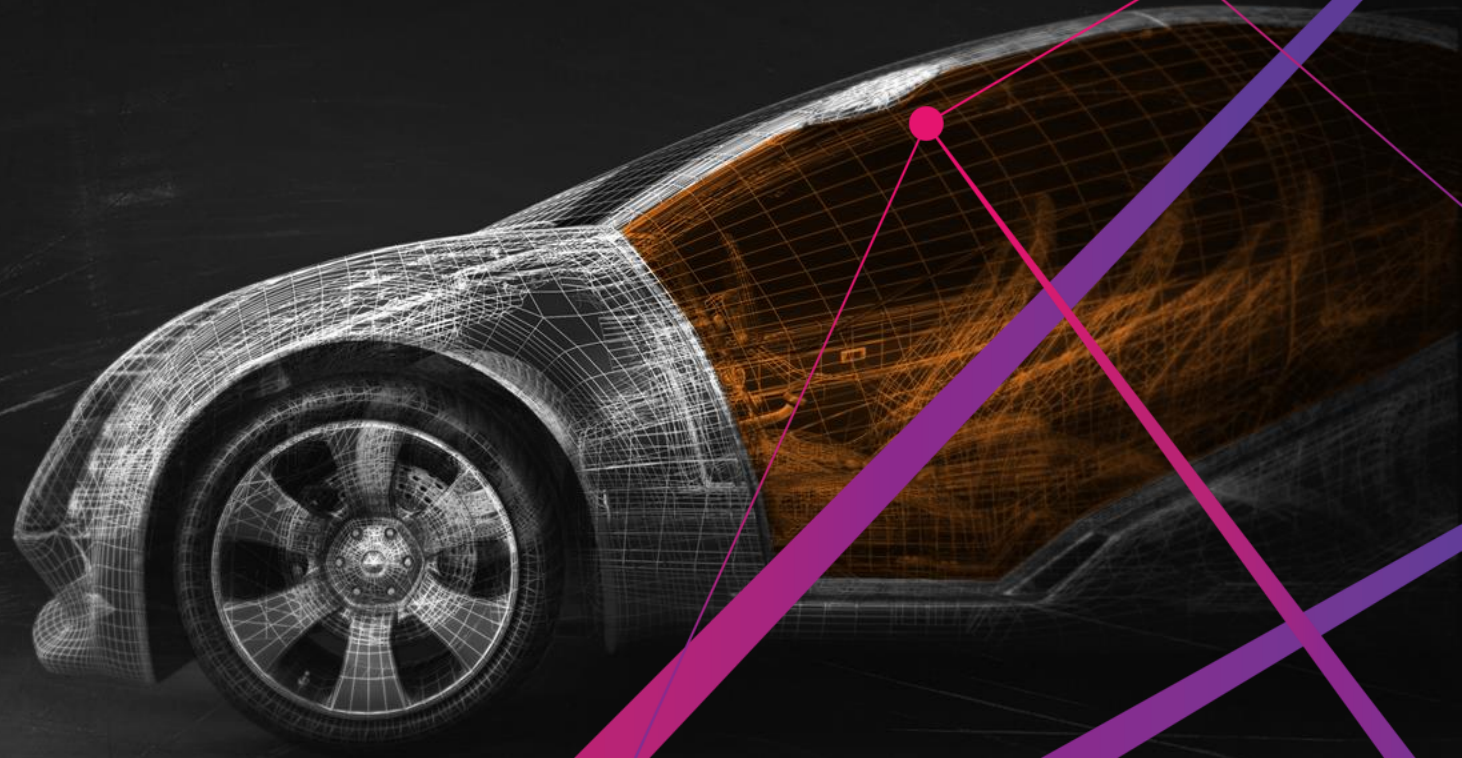


IN-CABIN MONITORING FUTURE

Vision

THERE IS NO PLACE
LIKE MY **CAR**

XPERI





× ICM - LONG TERM VISION



- ✓ DMS FOR DROWSINESS OR INATTENTION
- ✓ HD-RADIO

- ✓ DMS FOR SEMI-AUTO DRIVING
- ✓ DTS AUTOSTAGE

- ✓ IN-CABIN MONITORING FOR SAFETY AND PERSONALIZED EXPERIENCE



DTS AUTOSTAGE **HD RADIO** **IMAX ENHANCED**

WE BELIEVE THAT
ALL THE VEHICLES OF TOMORROW
WILL HAVE IN-CABIN SENSING, IMAGING AND
PERSONALIZED ENTERTAINMENT AT THEIR CORE

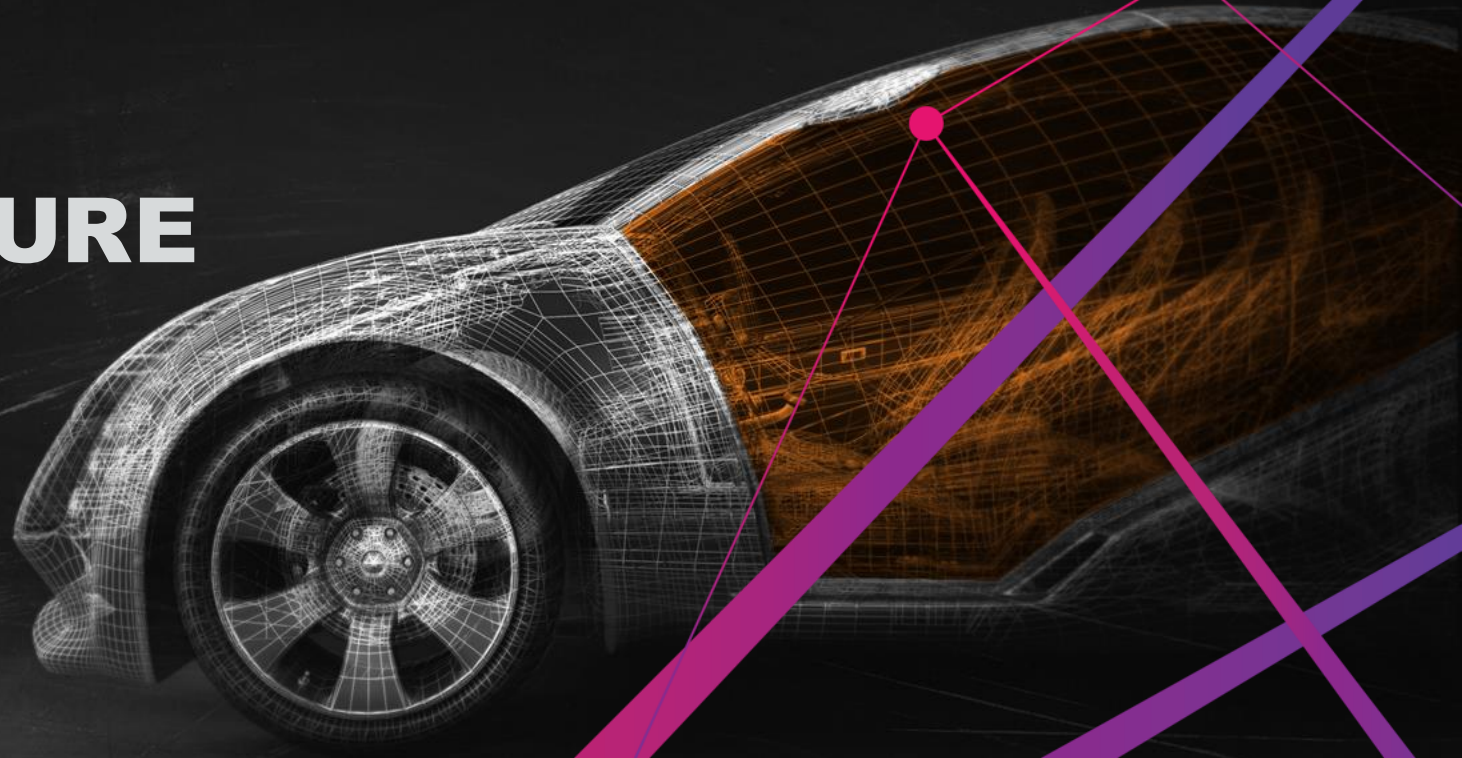


ENABLING TECHNOLOGIES AND INFRASTRUCTURE

We have many technologies & infrastructure to significantly contribute to the future of automotive in cabin experience

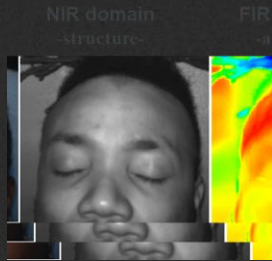
THERE IS NO PLACE
LIKE MY **CAR**

XPERI





ENABLING TECHNOLOGIES



MULTI-SPECTRAL SENSING

Visible + NIR + LWIR Analytics



IMAGE ENHANCEMENT

EIS with RS correction, LTM, portrait enhancement, De-fogger and de-warping



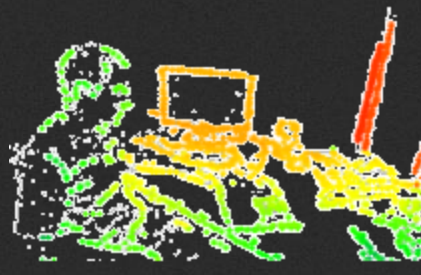
BIOMETRICS

Production ready biometrics all the way from 2D FR on visible or NIR, 3D-FR with iTOF/SL/Stereo to IRIS recognition



DEPTH SENSING

Neural network based stereo depth engine



TIME EVENT

Analytics based on time event sensors to capture information never seen before



Dual Camera Sensing

WFOV RGB-IR + AF PT NFOV NIR tightly connected to provide better features for ICM (DMS + OMS)



TESTING · INFRASTRUCTURE

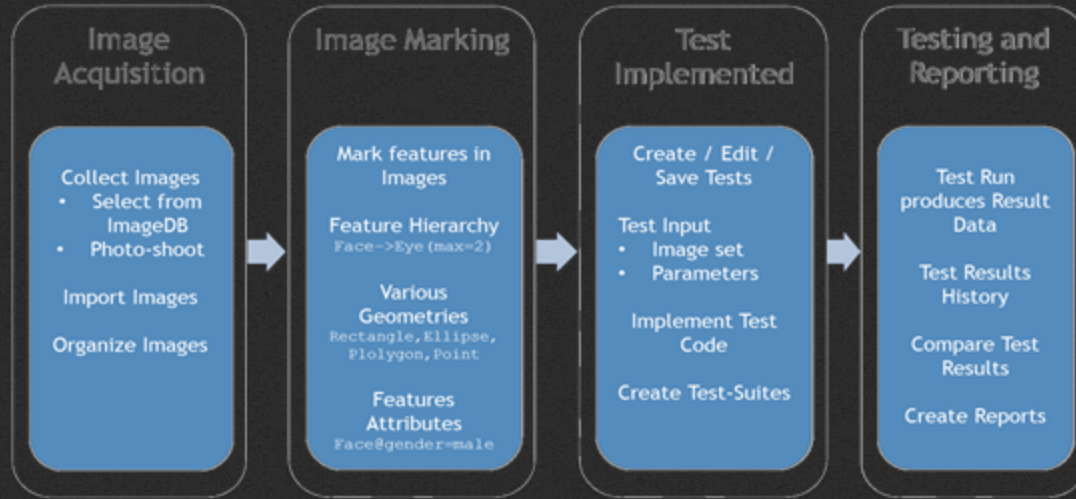


IMAGE DATABASE MANAGEMENT

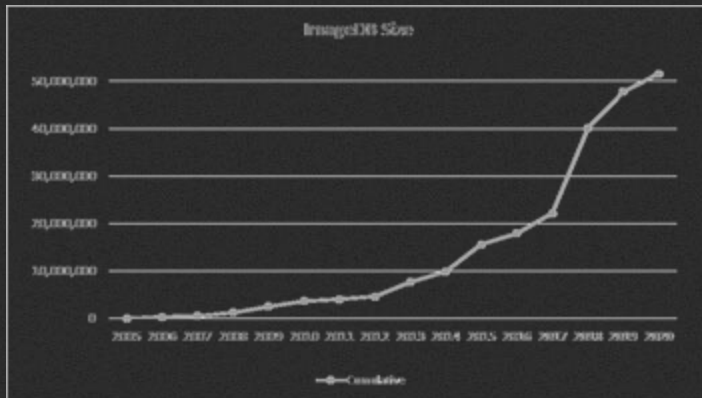
Storage and versioning of video data and associated metadata (annotations, acquisition information)

TESTING FRAMEWORK

Fully automated testing of algorithm KPI's
Tests execution distributed across the Xperi intranet. Automatic generation of reports.

TEST IMAGE DATABASE HIGHLIGHTS

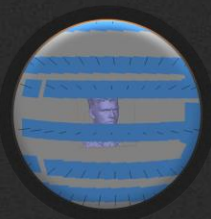
Over 50 million **annotated** frames, keeps increasing each year. Combination of data acquired in the wild and in controlled environment. Multiple light conditions, camera positions, thermal noise, etc.





X INFRASTRUCTURE - COMPUTER VISION BASED

ACQUISITION - 3D IMAGES



MESH >

TEXTURE (vis) >

TEXTURE (nir) >



SETUP (VISIBLE «& NIR») ▪ PHOTOGRAMMETRY ▪ 3D MODEL

GENERATING MARKED 2D RENDERS



MARKED 2D
SAMPLES

RENDERING
LENS/SENSOR/ISP MODEL



AUTO MARKING - 3D MODEL



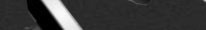
3D
MODEL



CUSTOM
BACKGROUNDS



3D
ACCESSORIES



CUSTOM
LIGHTING



× EXAMPLES - OF SYNTHETIC DATA GENERATION

DMS VIEWPOINT



OMS ROOFTOP VIEWPOINT



Example of synthetic data generation for specific camera lens type and positions
Enables very fast algorithm training, validation and testing & last mile optimizations (for target camera)



× IN CAR - ACQUISITION SETUP

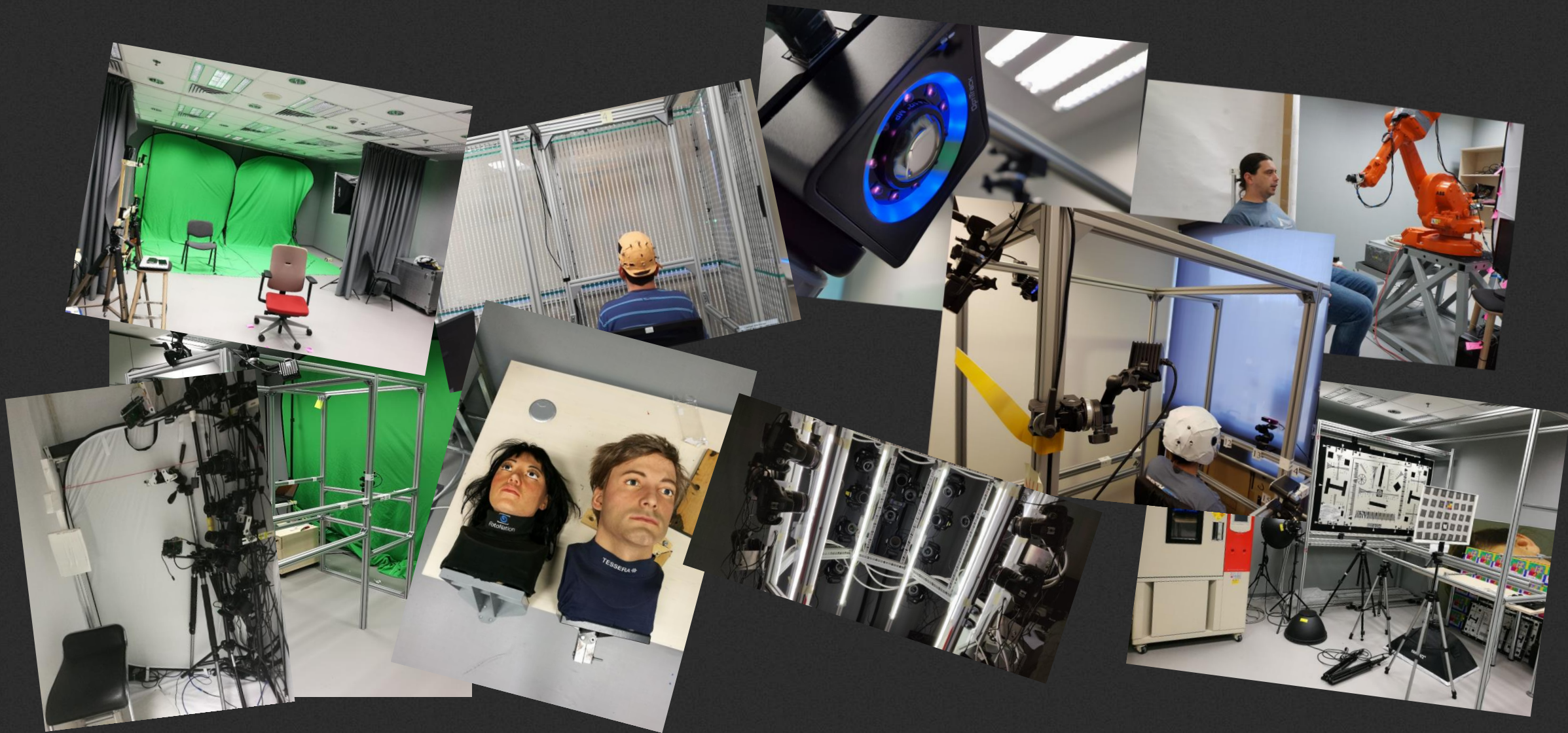


In-car driving scenarios strong value comes from ensuring ground truth real testing data is available.





× MORE - INFRASTRUCTURE



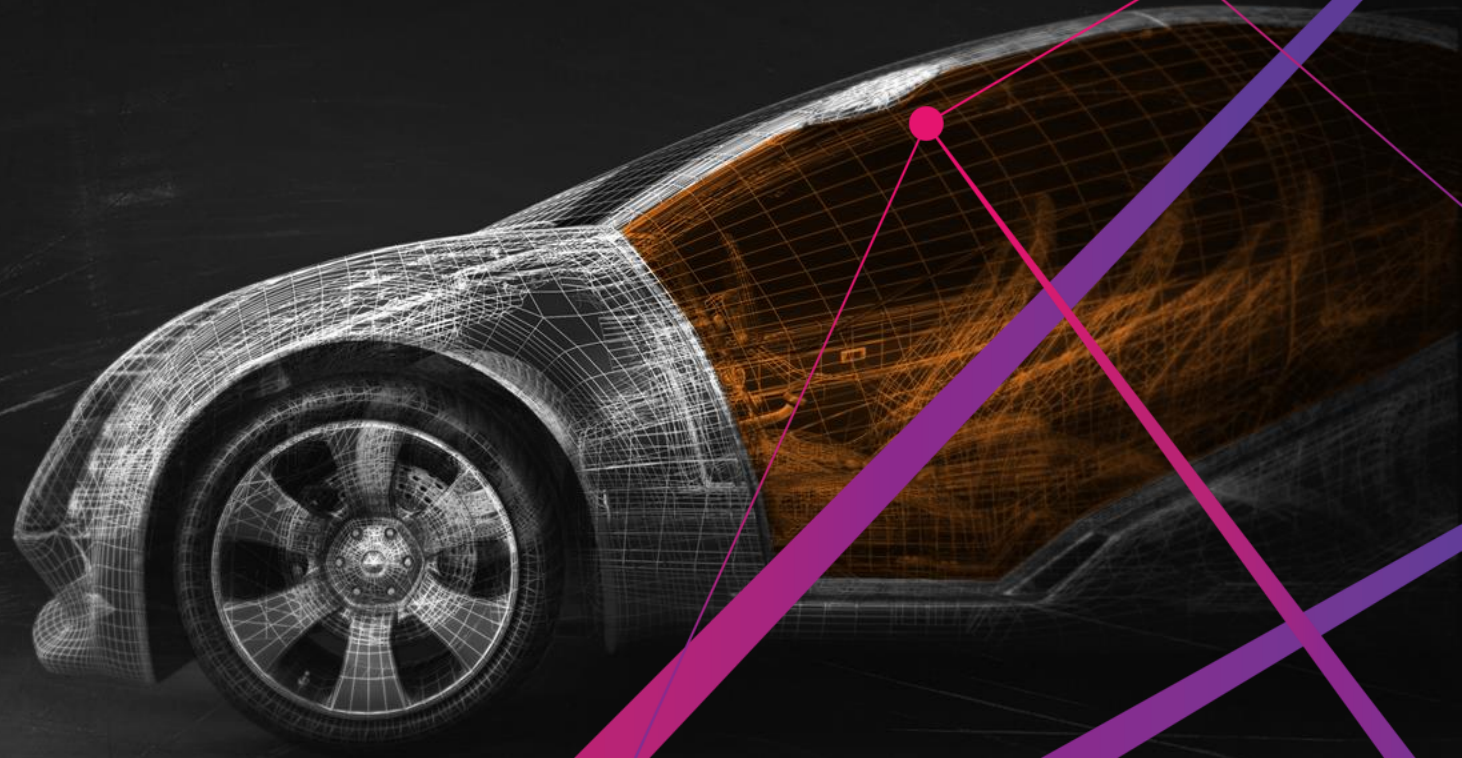


CONCLUSIONS

XPERI is your right partner for smart
Cars & best in cabin experience

THERE IS NO PLACE
LIKE MY **CAR**

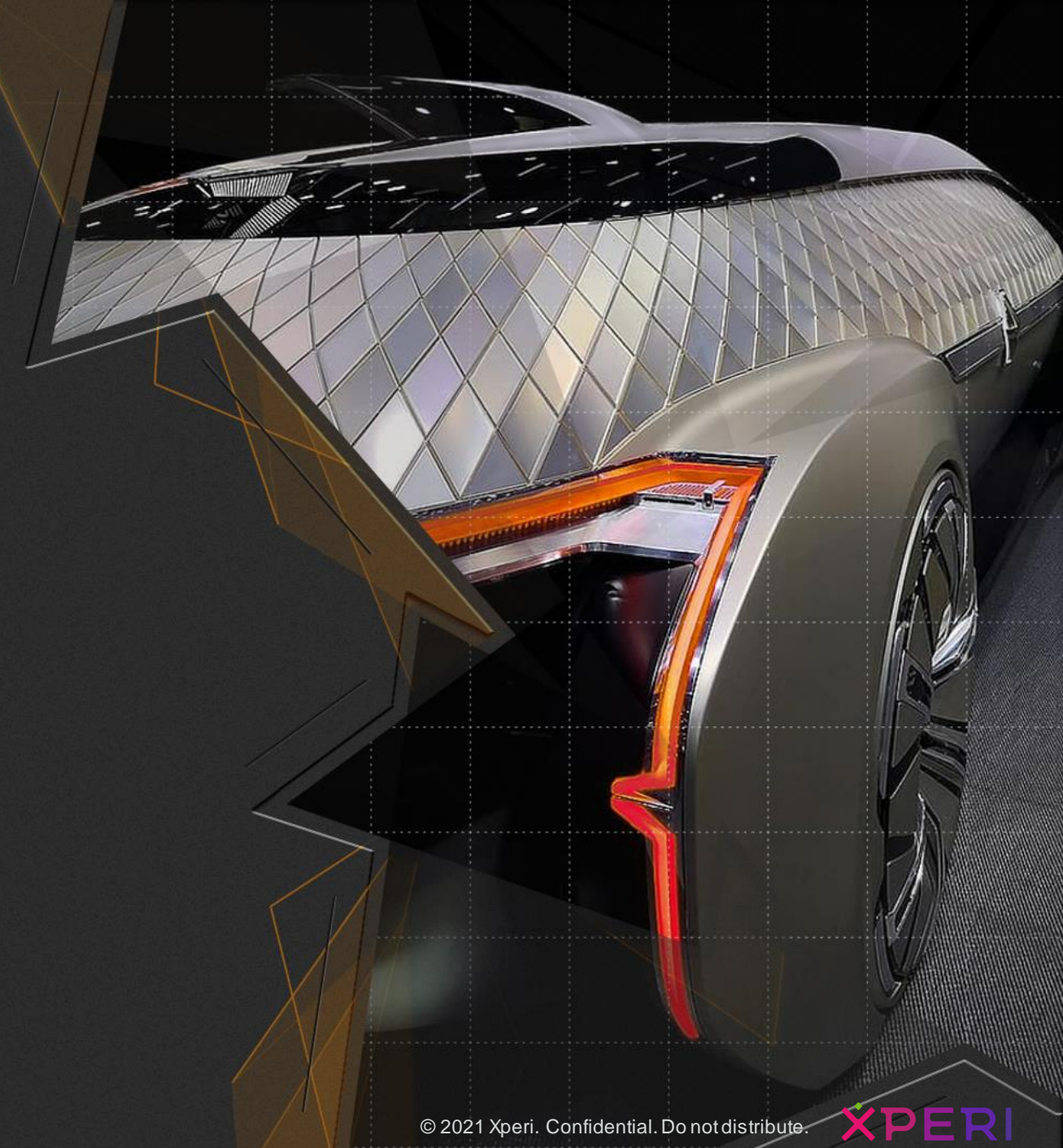
XPERI





× FUTURE · HIGHLIGHTS

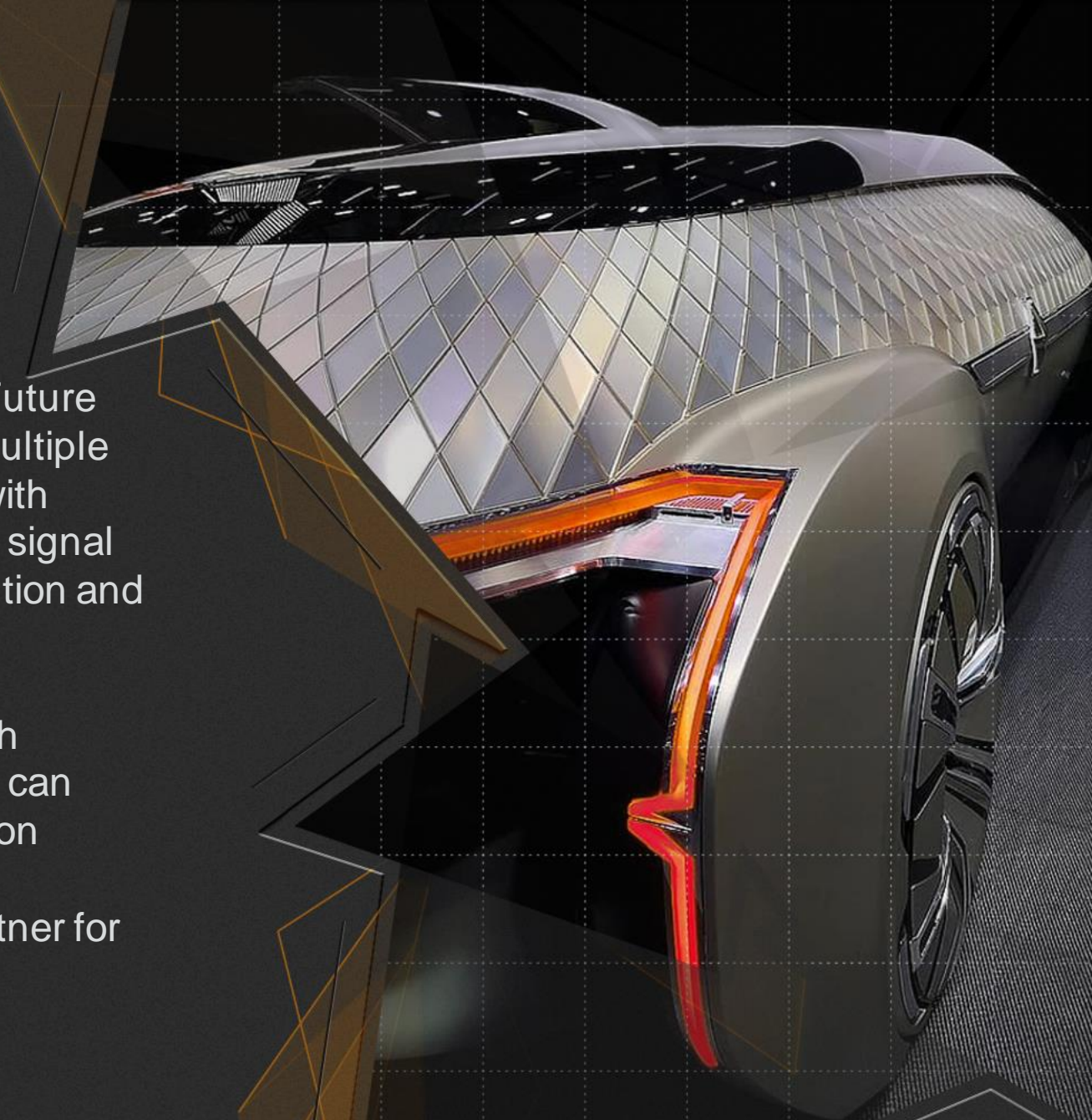
- Intelligent sensing is required by next generation In-cabin experience, but the exact method is not yet set-in stone ...
- Flexible and reusable architecture for many use-cases where intelligent sensors are required is a must ...
- XPERI has proven & accepted algorithms by two major car OEMs as 'best in the world'; all thanks to its novel data preparation, testing and validation methods as well as delivery mechanisms (standard SoCs and/or FPGAs);





× FUTURE · HIGHLIGHTS

- XPERI provides the intelligence forward to reach required power efficiency, latency, and performance for automotive in cabin sensing; Future in-cabin sensing and entertainment will bring multiple sensors and cameras opportunities in the car with multiple challenges to SoC providers related to signal processing, processing power, power consumption and latency
- Dedicated and proven hard-cores coupled with specific proven algorithms for ICM from XPERI can enhance XILINX future parts flexibility & adoption
- Xilinx can be the driving force and trusted partner for XPERI's innovative solutions in automotive



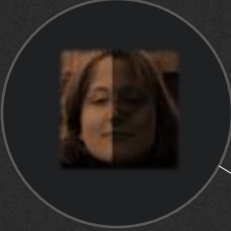


TRUSTED PARTNER - FOR ICM AND ENTERTAINMENT



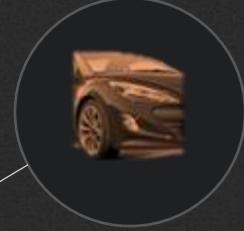
SIGNAL (PRE)PROCESSING

On the fly input signal processing for optimum analytics



AUTOMOTIVE PROVEN

Shipping DMS, HD Radio & Connected radio technologies



ANALYTICS, ENHANCEMENT & STRONG BIOMETRICS

Core proven facial, people analytics, recognition, scene understanding and enhancement technologies



R&D INFRASTRUCTURE

Testing and computer vision infrastructure for effective training, validation and testing our algorithms



HARDWARE IP CORES

Dedicated IP cores for extreme performance and programmable inference IP Cores for flexibility



CORE ENTERTAINMENT

DTS & IMAX ENHANCED for ultimate living room experience on wheels



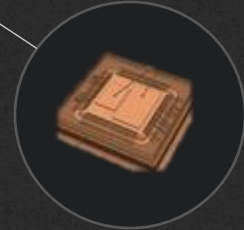
DBI® DIRECT BOND INTERCONNECT

3D ASIC Enabler for massive ultra-low power AI on the Edge



PACKAGING & MINIATURIZED

High performance, high-integration low-cost intelligent camera modules & sensors





THANK YOU

THERE IS NO PLACE
LIKE MY CAR

XPERI

