Horizon Robotics

Advancing AI Processing Architecture for a New Era of Intelligent Vehicles

Deon Spicer, Director of Sales

Automotive BU, Horizon Robotics

January 2021

Agenda

- Horizon Robotics
- Perception Compute Platform, AI Algorithms, Processors and Toolchain
- MAPS (Mean Accuracy-guaranteed Processing Speed)

Horizon Robotics

July 2015
founded

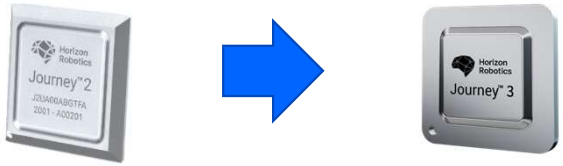
1,000+
employees

700+
patents

One of the world's leading **edge AI computing** companies.
Focused on **Smart Mobility**
Processors & solutions **optimized for deep learning**

Our mission: *"Establish the leading AI platform to make human life **safer** and **better**."*

China's First Auto-grade Processor



In production — Sampling now

Perception Compute System

Matrix

In production

Leading Partners

Audi, Continental, Honda, BOSCH, COAST AUTONOMOUS, SAIC MOTOR, faurecia clarion, CHANGAN, SK

Global Recognitions

2020 Vision Product of the Year Award
Best Automotive Solution: **Horizon Robotics Journey 2.0** AI Processor

2020 Tech.AD Runner-up
Most Outstanding Autonomous Vehicle Technology Innovation of the Year Award: **Horizon Matrix 2**

2019 Vision Product of the Year Award
Best Automotive Solution: Horizon Robotics, **Horizon Matrix**

2019 CES Innovation Award

Matrix won the CES Innovation Award in 2019 alongside Nvidia and Waymo

Global Deployment

Horizon Global Business Success

6 CY2020 Model launches

4 models for **Intelligent Cockpit**
2 models for **L2+ ADAS**

40 Design-in Contracts

Global OEM/Tier1s customers
150k+ shipment mark in 2020

60+ Ongoing Projects

Increasing momentum in ADAS, Automated driving, Robotics mobility and intelligent cabin

Growing Partnerships

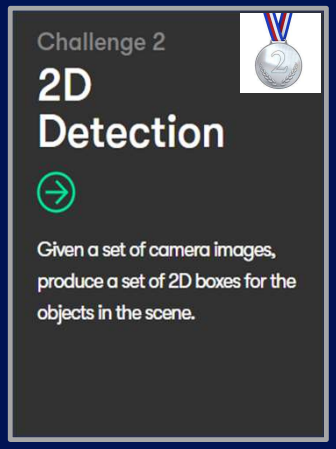
Audi, BMW, GM
APTIV, BOSCH, Continental
SK telecom, faurecia Clarion, SAIC MOTOR
INCEPTIO 赢彻科技, GEELY AUTO, GAC MOTOR
COAST AUTONOMOUS, CHANGAN, LI

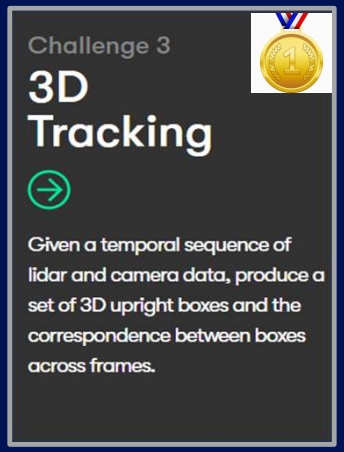
+ More ongoing

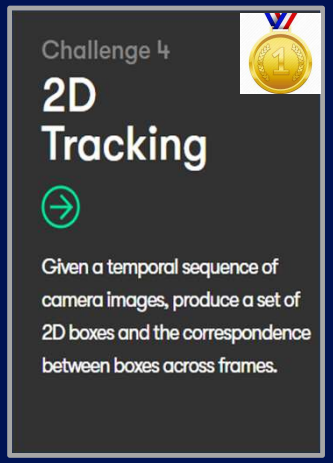
AI Algorithm Expertise

Horizon Robotics

Waymo Open Dataset Challenges







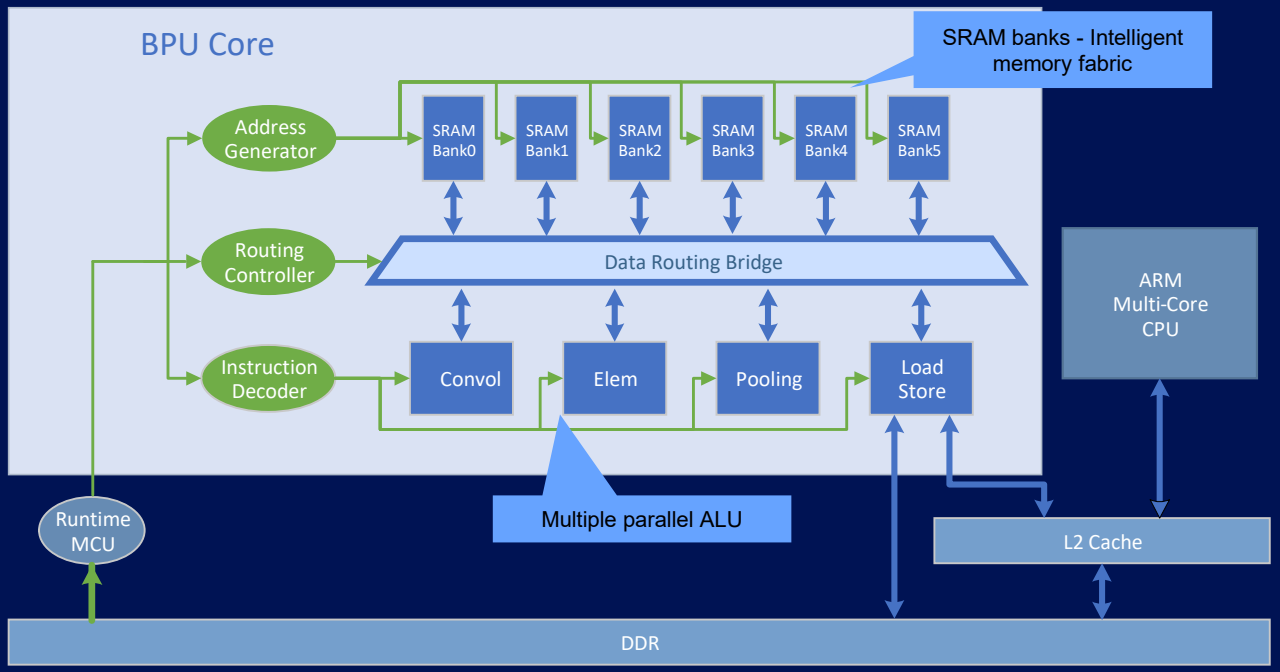
https://blog.waymo.com/2020/07/opendataset-challenge-winners.html

AI Compute Architectural Innovation

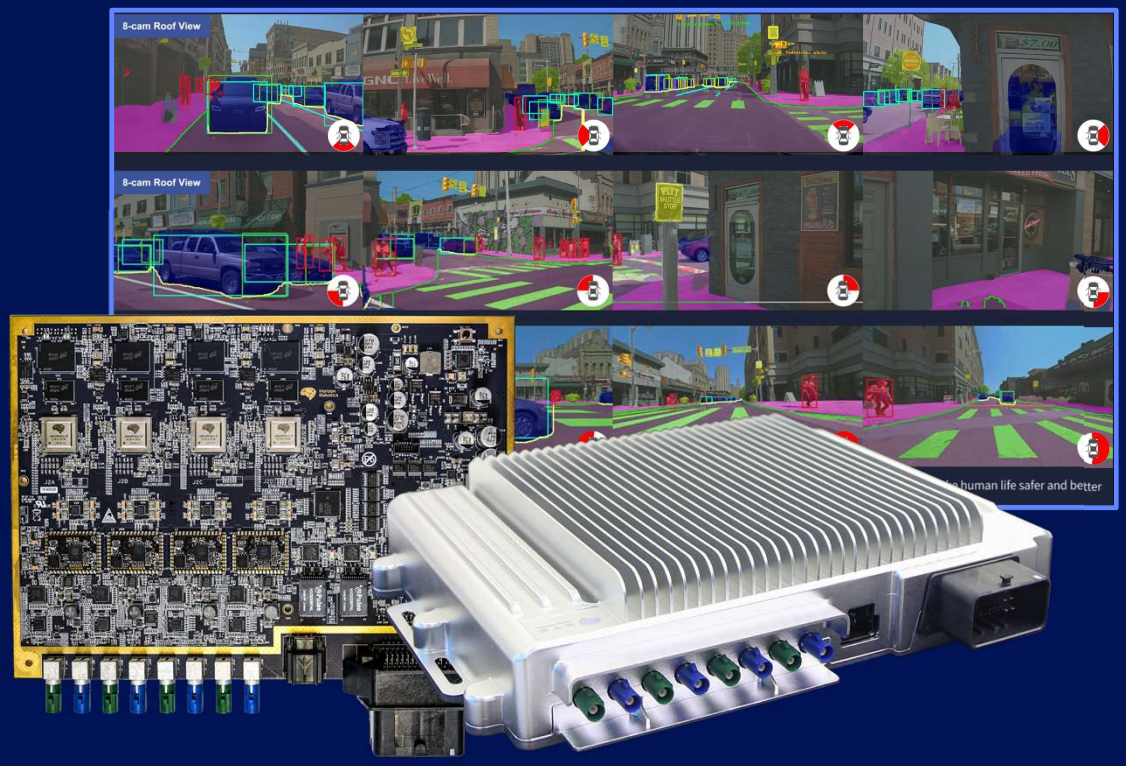
Horizon Robotics

Horizon BPU: The Bernoulli v2 Architecture

- Dual core BPU (Brain Processing Unit)
- Natively designed for deep learning
- MIMD
- Maximize memory reads/writes in BPU
- Parallel computation with multiple ALUs
- The Horizon Difference
  - VS Nvidia: Significantly higher efficiency
  - VS Mobileye: Native deep learning support
  - VS Tesla: Open Ecosystem
- Result: High performance with low latency



Perception Compute System Expertise



Matrix 2

Modalities
- Vision perception
- LiDAR perception
- Localization and Mapping

Hardware:
- 4x1080P camera input @30fps
- Passively cooled 22W system. Ready for in-vehicle operation
- Tested to ISO-16750 and Ip51 for ingress protection
- Low latency (end to end: 100ms)

Algorithms:
- Semantic segmentation of 23+ categories
- 3D detection of vehicles and pedestrians
- Traffic light, traffic sign, road sign recognition
- Lane and free space parsing
- Robustness functions

Integration Tools:
- Hardware-in-Loop Test Kit
- Raw data collection system (framegrabber)
- AI Training Toolchain for custom network deployment
- Multi-platform reference design

ISO 26262 ASIL D Process Certification

ASIL D certification for SOC development process – Sept 2020

Horizon is member of ISO 26262 standard working group (ISO-TC22SC32-WG8)

SGS TÜV SAAR

CERTIFICATE NO.: FS/71/220/20/0582 PAGE 1/1

LICENCE HOLDER

HORIZON (SHANGHAI) ARTIFICIAL INTELLIGENCE TECHNOLOGY CO., LTD.
BEIJING HORIZON ROBOTICS TECHNOLOGY RESEARCH AND DEVELOPMENT CO., LTD.
BUILDING C, NO. 888, WEST LAKE ROAD, NANHUI NEW TOWN, PUDONG NEW AREA, SHANGHAI, 200135
ROOM302, UNIT1, F3, BUILDING NO.2, IC PARK, NO.9 FENGHAO EAST ROAD, HAIDIAN DISTRICT, BEIJING
P.R. CHINA

Project-No/-ID	LICENSED TEST MARK	Report No.
R30P	SGS TÜV SAAR FUNKTIONALE SICHERHEIT GEPRÜFT FUNCTIONAL SAFETY APPROVED	R30P0001

Tested according to	ISO 26262:2018
Certified Product(s)	Development process V1.0 / 202008 for Functional Safety related components
Technical Data/Parameter	The audited development process complies with the ISO 26262 standard part requirements
	ISO 26262-2:2018, ISO 26262-4:2018, ISO 26262-5:2018, ISO 26262-6:2018, ISO 26262-7:2018, ISO 26262-8:2018, ISO 26262-9:2018
Specific Requirements	The certificate is created for the purpose of providing conformity of the development and support process in accordance with ISO 26262. Changes which are not covered in the Audit Report have to be reconsidered.

Certification Body for Functional Safety SGS-TÜV Saar GmbH

Munich, 11th September 2020

Marcus Rau

The test mark regulation is an integral part of this certificate.

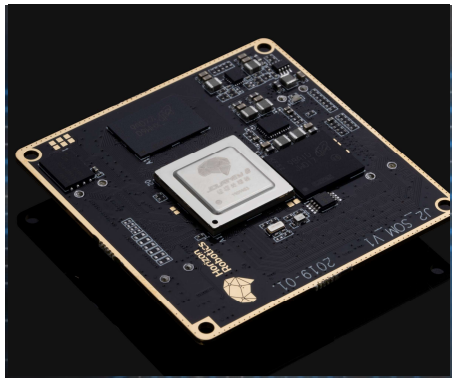
SGS-TÜV Saar GmbH, Technopark, 2D, D-81379 München, Deutschland / Germany.
Website: www.sgs-tuv-saar.com/fs E-Mail: fs@sgs.com

CERTIFICATE

Horizon Efficient AI Platform For Autonomous Machines

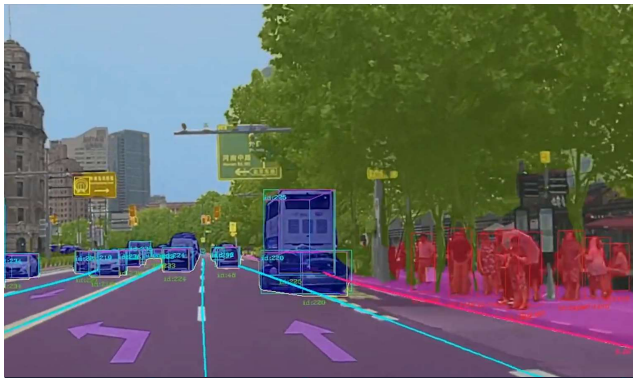
Horizon Robotics

Journey Auto grade, edge AI Processor, with domain specific Deep Learning dual core "BPU"*



Open AI toolkit for NNs training, quantization, optimization and deployment on the "BPU"

Vehicle-ready, scalable, passively cooled, with processor and algorithms: Matrix perception computer



Co-designed and co-optimized, state-of-the-art AI algorithms for camera and LiDAR perception + Mapping and localization

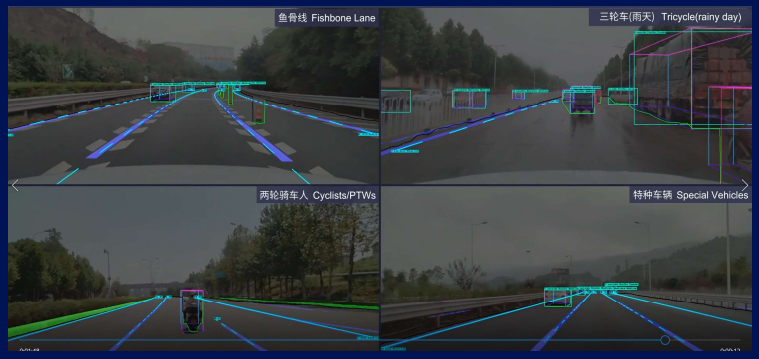
(*) BPU: Brain Processing Unit

Comprehensive Front Vision Perception

Horizon Robotics

Horizon AI technology enables more features, more flexibility and better overall perf. than classic CV

- One Journey AI processor
- Less than 3W
- Horizon Vision Perception:
  Detection/Classification/Semantic parsing
- 3D detection for vehicles/cyclist/motorbikes
- Less than 60ms latency
- Robustness features/ODDs
- Support Euro NCAP post-2020
- General cases. Corner cases. Special objects



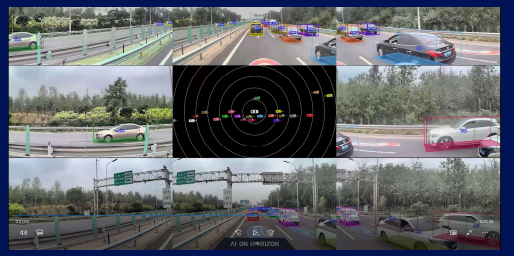
Comprehensive Deep Learning Based Perception

Horizon Robotics

Horizon AI technology enables more features, more flexibility and better overall perf. than classic CV

- 00 road
- 01 background
- 02 pole
- 03 traffic _sign
- 04 traffic_light
- 05 road sign
- 06 traffic_lane
- 07 pedestrian
- 08 two-wheel
- 09 vehicles
- 10 fence
- 11 sky
- 12 cone
- 13 barrel
- 14 crosswalk
- 15 traffic_arrow
- 16 safety_area
- 17 stop_line
- 18 yield mark
- 19 speed mark
- 20 diamond
- 21 bicycle_sign
- 22 speed_bumps

- L4 surround vision
- 8x narrow FOV + 4 fisheye
- Horizon perception:
  - Detection. Classification
  - Semantic parsing
- 3D vehicles/cyclist/motorbikes
  - Vehicles: 6 types, 150m
- Traffic sign: 376 types in US
- Traffic light: 3 colors + off + more
- Lane line: 4 types and 2 colors
- Pedestrians/Cyclists: 80m
- Latency < 100ms
- Multicam 3D detection and tracking
- Day and night scenes



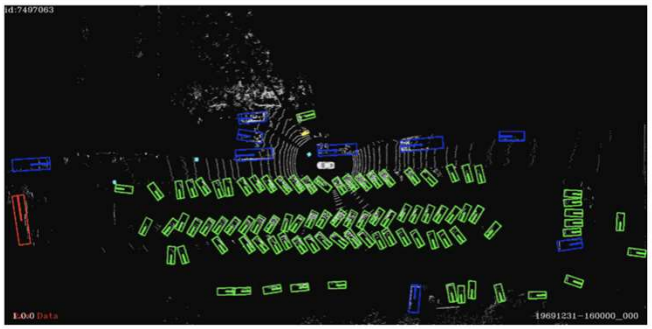
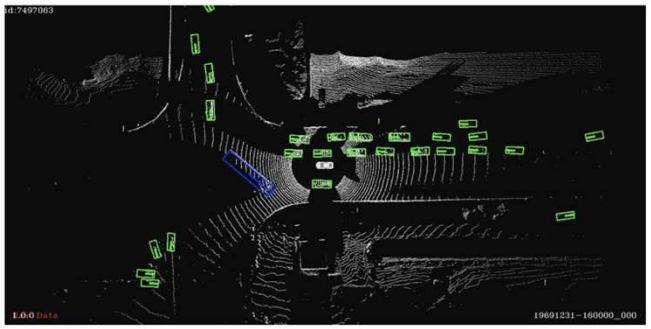
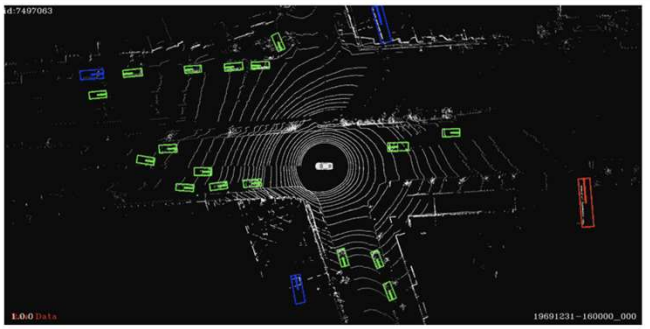
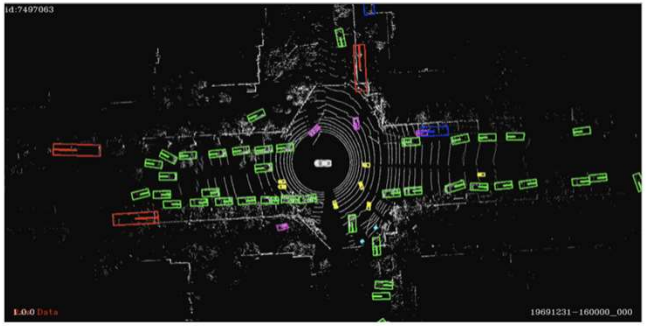
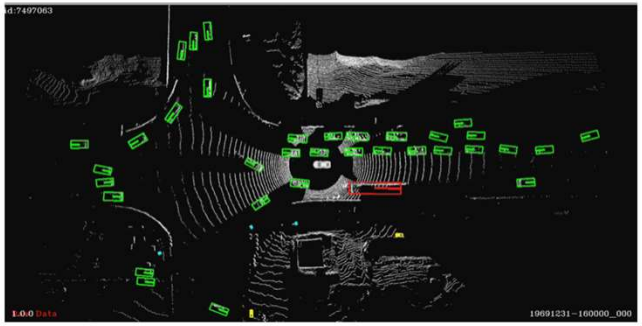
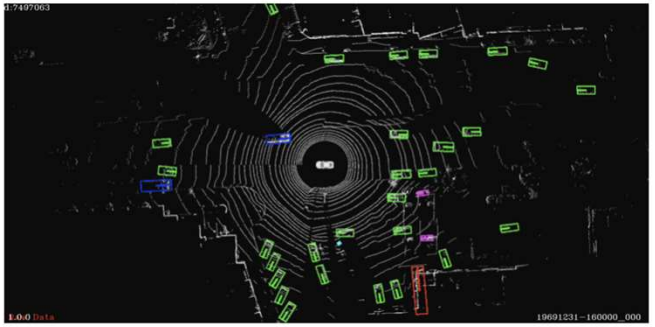
LiDAR and Camera Perception and Fusion

- LiDAR 3D object detection and tracking
- 1x Journey processor
  - CPU: ~40% Utilization
  - BPU: ~90% Utilization (one core)
  - Performance: up to 44 FPS
- Detection range:
  - Longitudinal [-100m, 100m]
  - Lateral [-50m, 50m]
- 6x Camera semantic parsing (mult. proc)
- Fused output. Improved perception robustness through multi-sensor fusion

Algorithm Generalization

Horizon Robotics

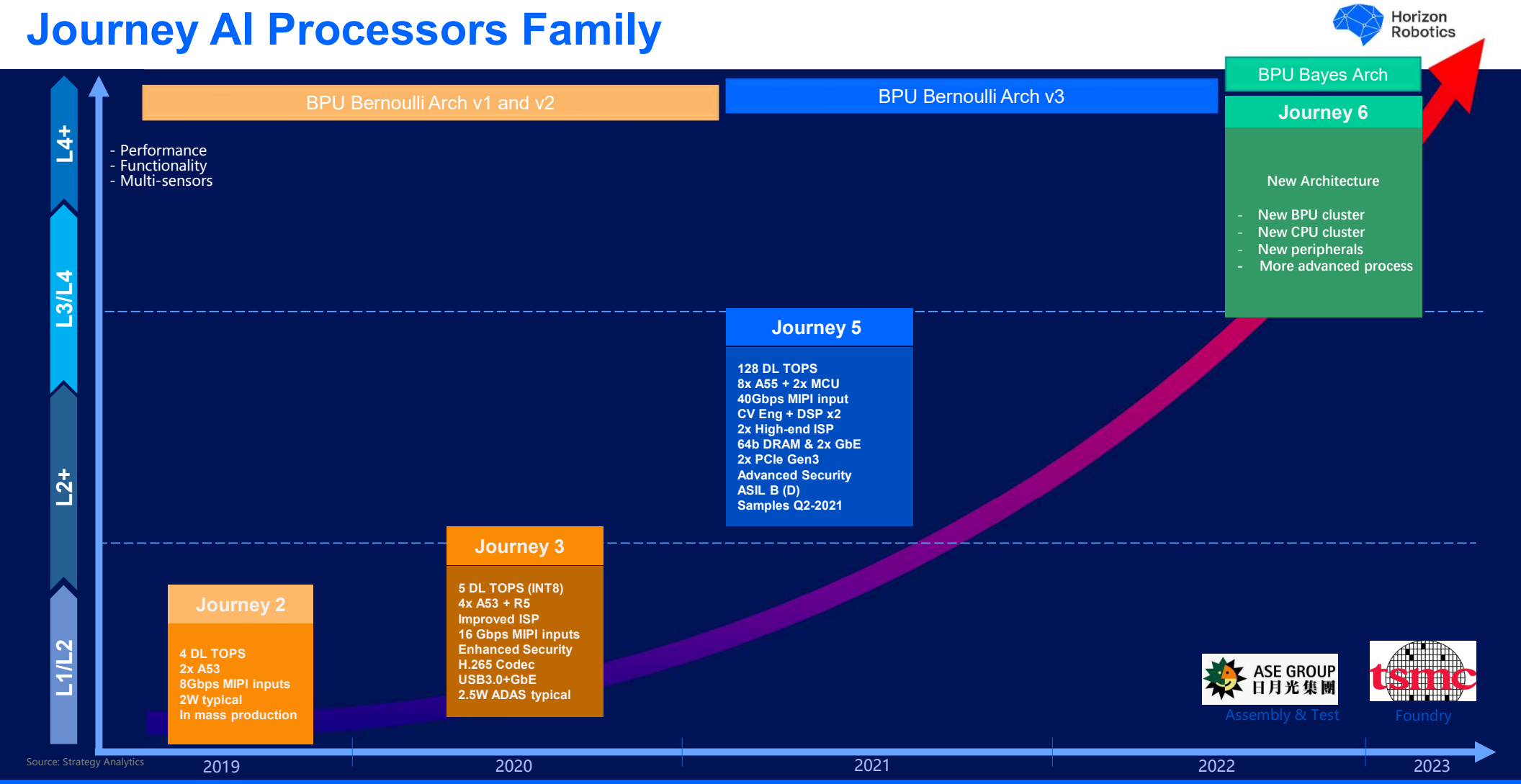
Detector trained on one LIDAR/Dataset can generalize to a different LIDAR/Dataset

Hesai Test	Waymo Test	Lyft Test
		
		

Multimodal Solutions For Smart Cockpit

- Horizon Halo™ Multimodal solutions
- Calling security alert
- Auto lower console volume
- Distraction alert
- Mild, moderate and heavy fatigue mitigations
- Smoking detection and mitigations
- Cockpit selfie

Journey AI Processors Family



Source: Strategy Analytics

Journey 3 New AI Processor

Computation Specs:

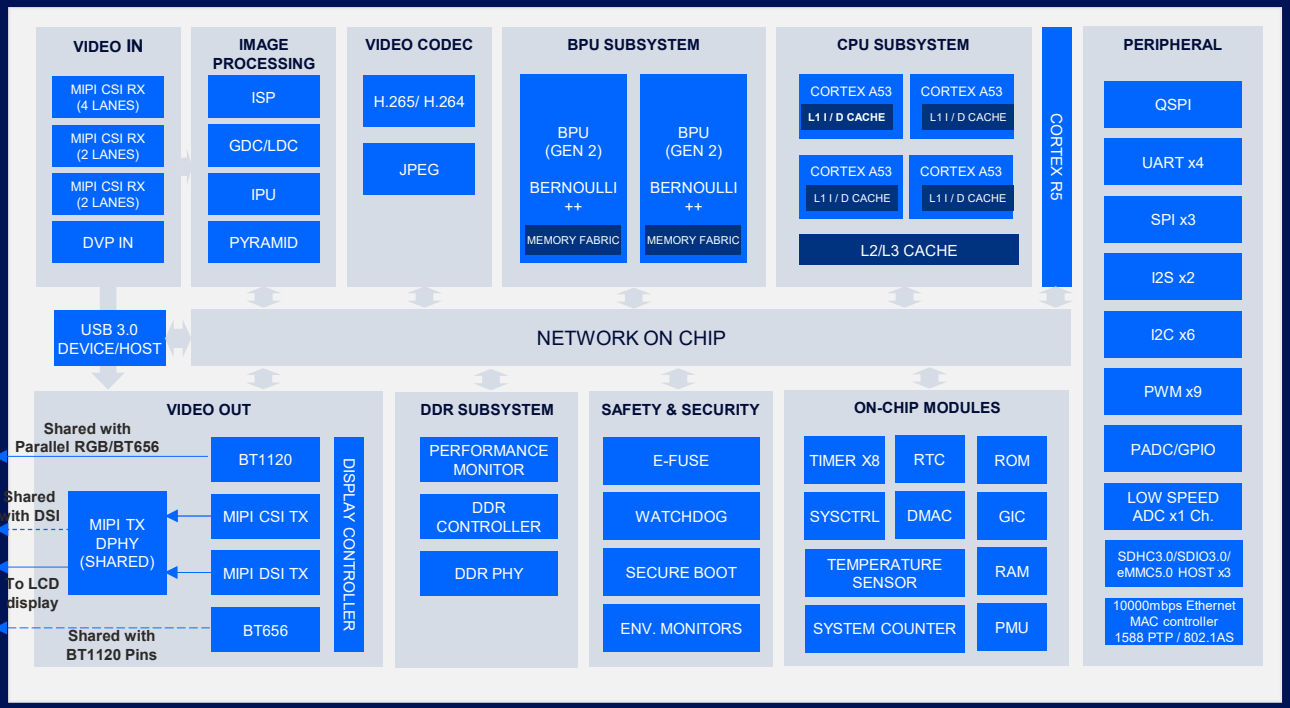
- Quad Cortex-A53
- Single Cortex-R5 assistant
- Dual BPU™ @ 5 DL TOPs
- On-chip ISP support HDR
- High perf. Video codec 4K60 (H.264/H.265, JPEG)
- DDR4/LPDDR4/LPDDR4X

Physical Specs:

- 2.5W Typical ADAS workload
- TSMC 16nm FinFET
- AEC-Q100 Grade 2
- 15x15mm, FCBGA484 Package

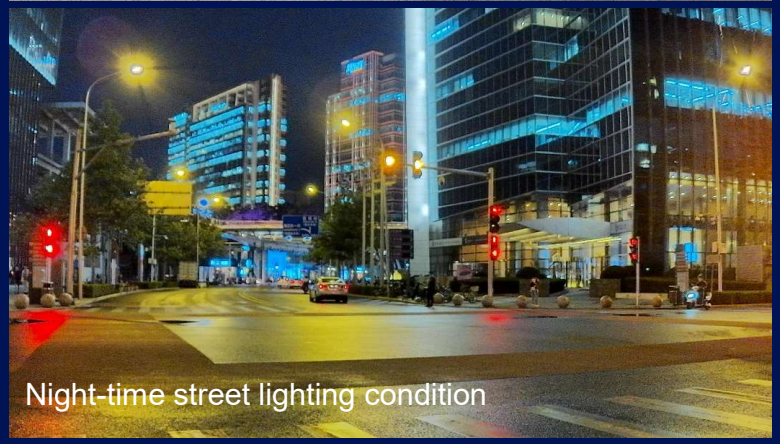
Other Features:

- MIPI CSI-2 – Up to 16 Gbps
- Gigabit Ethernet TSN
- USB 3.0
- HW Crypto/Secure Boot



Perception Starts with Great Image Quality

Journey 3 on-chip ISP delivers outstanding performance*



* For AR0820 RCCB (8MP)

Perception Starts with Great Image Quality

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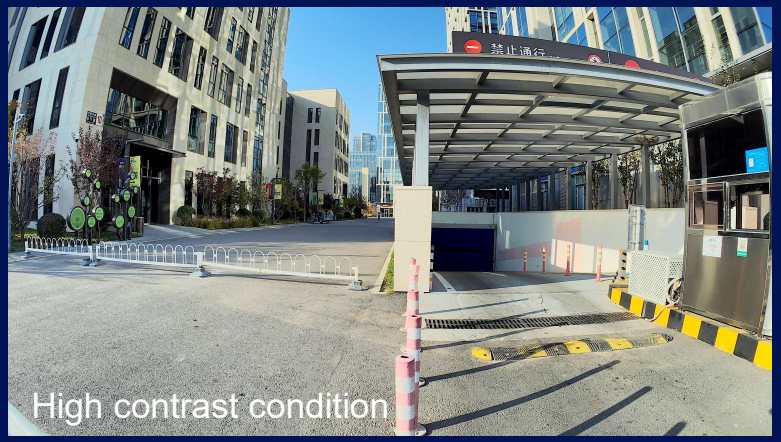
Journey 3 on-chip ISP delivers outstanding performance*


Outdoor scene front glare



High contrast condition


Night-time street lighting condition


Low light condition

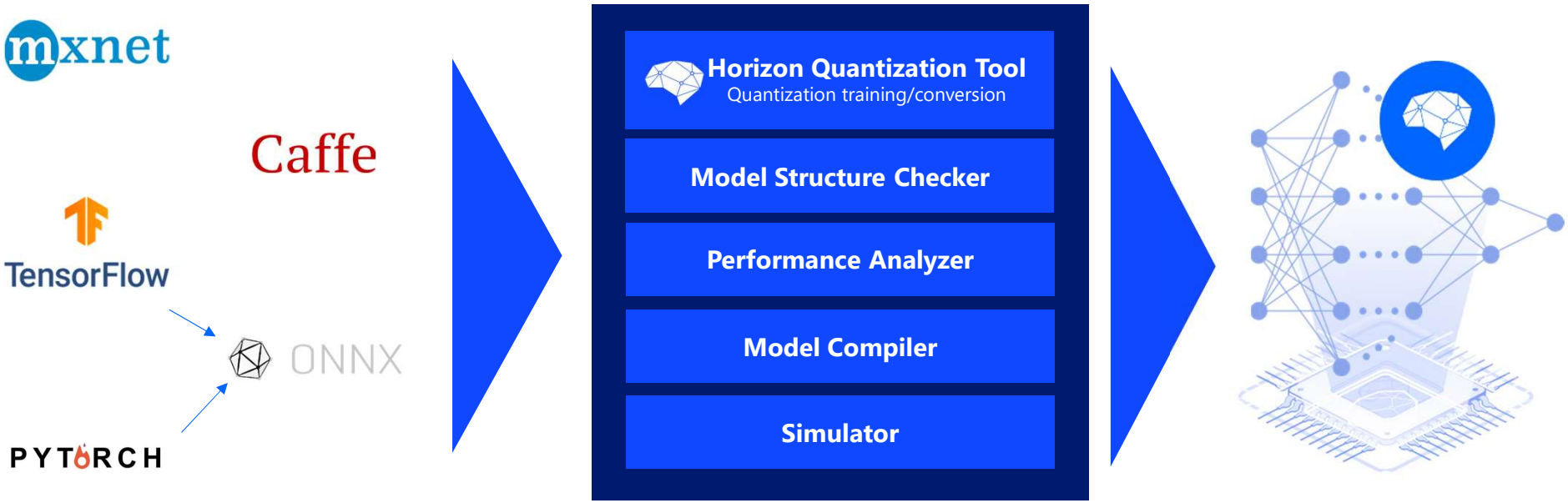
* For AR0820 RGGB (8 MP)

Easy-to-Use AI Toolkit for Developers

Horizon Robotics

OpenExplorer

Development platform provided for customers to train and deploy their existing algorithm models and create their algorithm differentiation



Powerful Tools, Simple APIs and Sample Code

Horizon Robotics

Model Conversion

Post-training Quantization:

- Flt. Pt to Fix pt. conversion
- No retraining required
- Fast and easy
- Minimum accuracy loss
- Caffe native. TF and PyTorch via ONNX

Quantization-aware Training

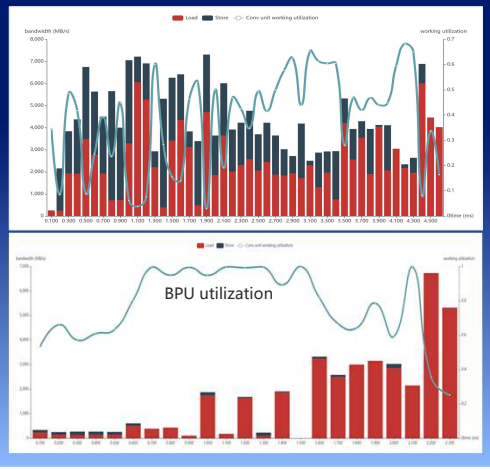
- MXNet and TF plugins. PyTorch planned
- Retraining required
- Flexible to adjust model structure
- Fully recovered accuracy

ONNX mxnet Caffe TensorFlow PYTORCH

Performance Optimization

Performance Compiler:

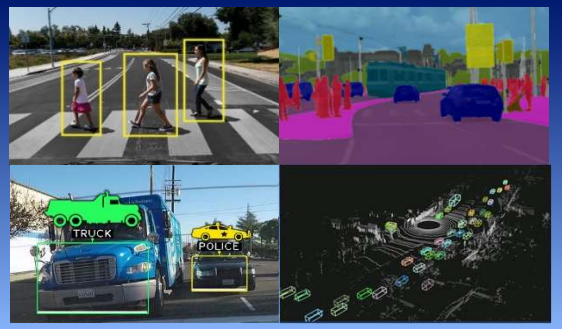
- Compiler automatic optimization
- Performance visualization
- Convolution-level operation details
- Diagnose tool of quantization loss
- Model deployment simulator



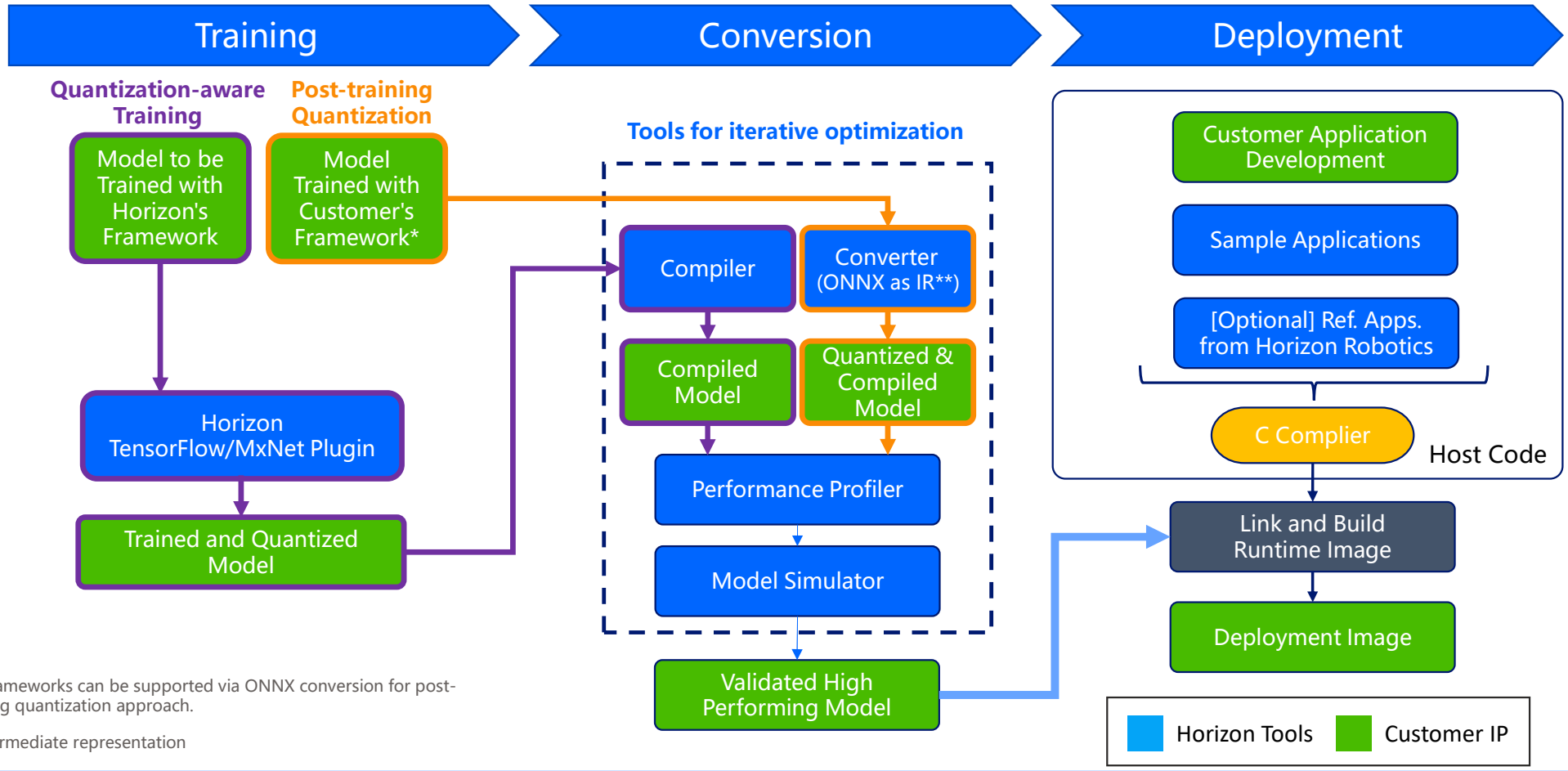
Deployment

Runtime SDK:

- High level API (BPU, ISP, Multimedia) for rapid development
- Low level APIs (Runtime, VIO, TaskMgr) for more flexibility
- Performance test tools
- Quick start guide and manuals
- Sample models and applications (detection, classification, segmentation, LiDAR)



Workflow



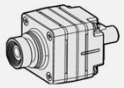
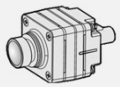
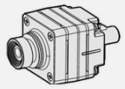
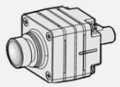
*All frameworks can be supported via ONNX conversion for post-training quantization approach.

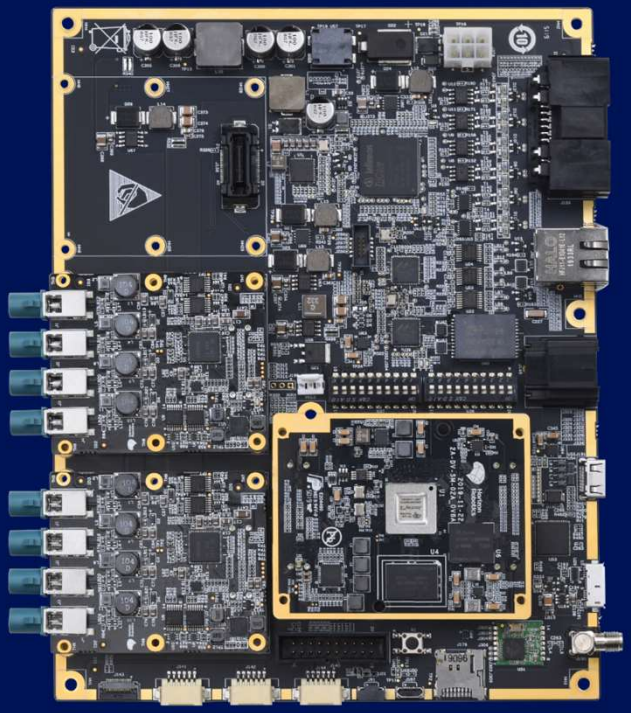
**Intermediate representation

Journey3: Start Now!

Journey 3 Development Board (J3-DVB)

- Quick access to the capabilities of Journey 3's powerful architecture.
- Hardware environment with rich peripherals & features.
- Powerful tools to easily develop applications on Journey 3.

Camera Type		Effective Focal Length	Lens View Angle	Image Size
	**OV10635 (Available via Horizon)**	5.47mm 1.33mm	H (59°) V (36°) H (192°) V (129°)	1280x800
	**AR0233 (Available via 3rd Party)**	3.43mm	H (103°) V (57°)	1920x1080
	**IMX390 (Available via 3rd Party)**	5.5mm 1.83mm	H (61°) V (34°) H (186°) V (105°)	1920x1080
	**AR0820 (Available via 3rd Party)**	Planned		



AI Processor Performance

Key Performance Indicators

Algorithm accuracy reflected on dedicated tasks

Direct association between AI performance and functions/tasks

Image Classification (ImageNet) : accuracy, TOP-1, TOP-5
Detection (COCO) : mAP

Latency

Throughput

FPS (Frame Per Second)

Cost

Power Consumption

MAPS: Mean Accuracy-guaranteed Processing Speed

Horizon Robotics

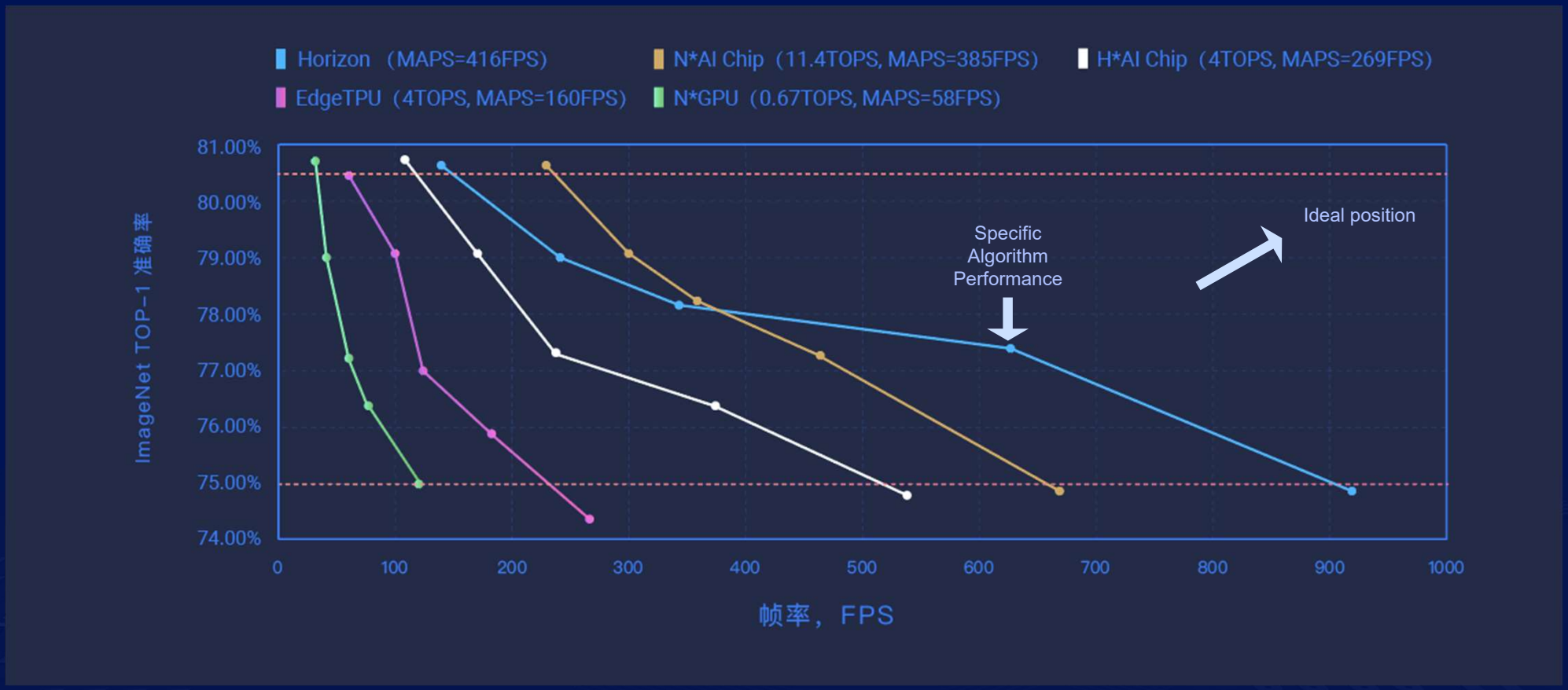
A New Metric for Fair Performance Evaluation

Comprehensive: Considers both accuracy and speed, from algorithm to processor.

Fair: Compares the best-supported models of each processor.

Application-oriented: Only cares about performance within acceptable accuracy range.

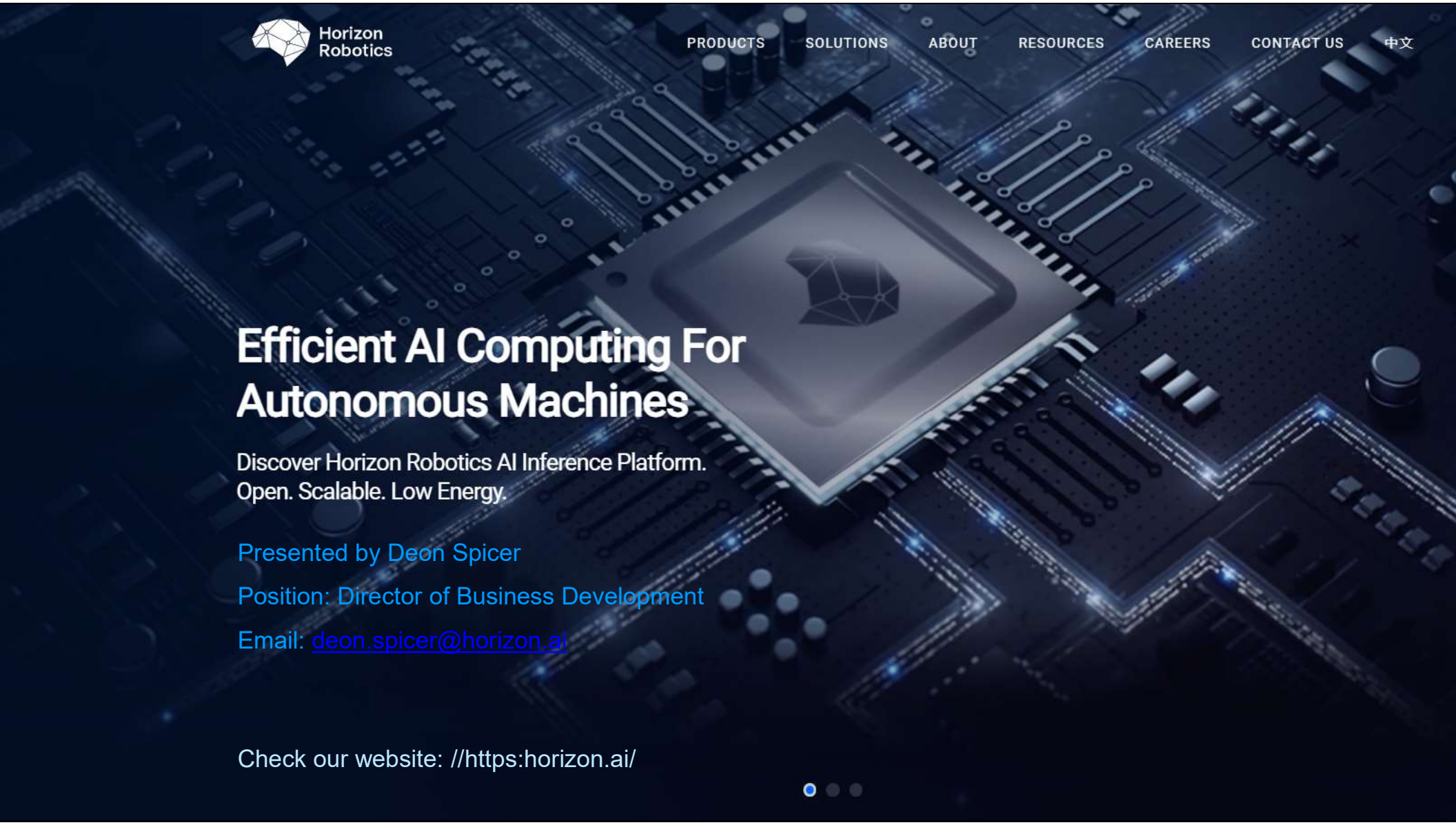
Machine Learning CV Task: ImageNet Classification MAPS



The New Formula to Effective AI

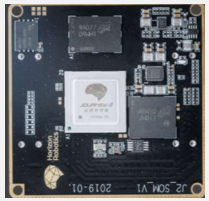
Horizon Robotics

A Fair Representation of all Key Metrics


Horizon Robotics
PRODUCTS
SOLUTIONS
ABOUT
RESOURCES
CAREERS
CONTACT US
中文
Efficient AI Computing For Autonomous Machines
Discover Horizon Robotics AI Inference Platform.
Open. Scalable. Low Energy.
Presented by Deon Spicer
Position: Director of Business Development
Email: deon.spicer@horizon.ai
Check our website: //https:horizon.ai/

Hardware Scalability for Mass Production

Horizon Robotics

Fast time to market	Module solution	Customer board design
		
Matrix Compute System	**Journey SOM**	**Journey SOC**
Robust Turnkey Solution	Balance of Scale & Ease of Design	Most Cost Effective
Immediate deployment	3 - 6 months design time	12 - 18 months design time
Modular, “Plug & Play”	Highly Flexible Architecture Design	Fully Flexible Architecture Design
No HW development needed	IPC integration via daughter card	Chip-down integration into PCB

Empowering Product Creators to Harness Edge AI and Vision

The Edge AI and Vision Alliance (www.edge-ai-vision.com) is a partnership of ~100 leading edge AI and vision technology and services suppliers, and solutions providers

Mission: To inspire and empower engineers to design products that perceive and understand.

The Alliance provides low-cost, high-quality technical educational resources for product developers

Register for updates at www.edge-ai-vision.com

The Alliance enables edge AI and vision technology providers to grow their businesses through leads, partnerships, and insights

For membership, email us: membership@edge-ai-vision.com

edge ai + vision ALLIANCE™

Join us at the Embedded Vision Summit

May 25-27, 2021—Online

The only industry event focused on practical techniques and technologies for system and application creators

- *"Awesome! I was very inspired!"*
- *"Fantastic. Learned a lot and met great people."*
- *"Wonderful speakers and informative exhibits!"*

2021 embedded VISION summit®
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Embedded Vision Summit 2021 highlights:

- **Inspiring keynotes** by leading innovators
- High-quality, practical **technical, business and product talks**
- Exciting **demos**, **tutorials** and **expert bars** of the latest applications and technologies

Visit www.EmbeddedVisionSummit.com to learn more and register (use promo code SUPEREARLYBIRD21 by 2/26 to receive your 25%-off Super Early Bird Discount!)