
Embedded AI Processors for Autonomous

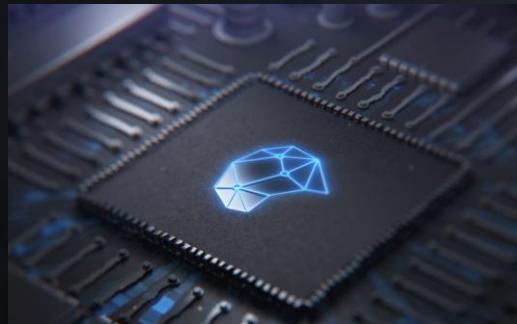
Harvey Lv
Director of International Business Development, Horizon Robotics

Our Mission



Embedded AI for autonomous,
to make human life more safe, convenient and joyful

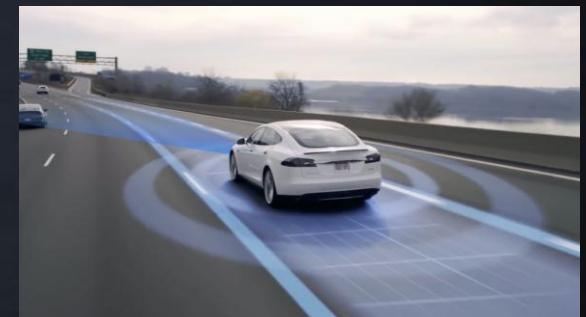
Tape out our first generation ASIC



Enable 100 million smart cameras & other IoT devices



30 million autonomous cars using our AI processors



2017, the second year



2020, the fifth year



2025, the tenth year

The paradigm shift of AI computing



Horizon
Robotics



CPU

2011 Google DistBelief

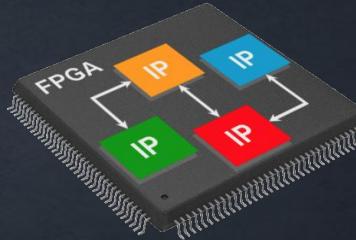
Good for training



GPU

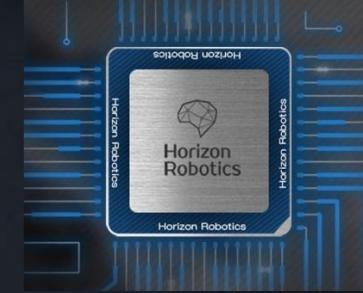
2012 Baidu

Good for inference



FPGA

2014 Baidu,
Microsoft



TPU, BPU

In 2015 BPU (Brain Processing Unit) architecture was proposed by Horizon Robotics for inference acceleration;

In 2016 TPU (Tensor Processing Unit) was announced by Google

With Unique Thinking, Horizon being the Leader of China AI Technology



= China Top AI
Algorithm Company +

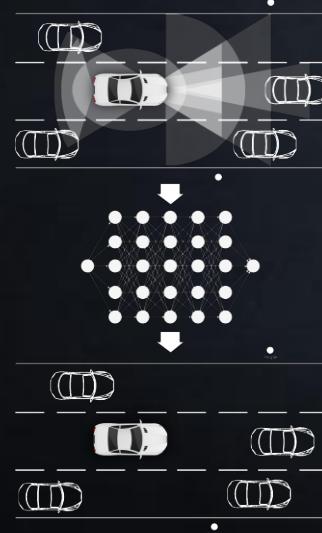


A large number of Chinese companies compete homogeneously in the algorithmic area, including four unicorn companies in China

Market capitalization of 130 billion US dollars, global leader in artificial intelligence processors

The roadmap of our software platform Hugo

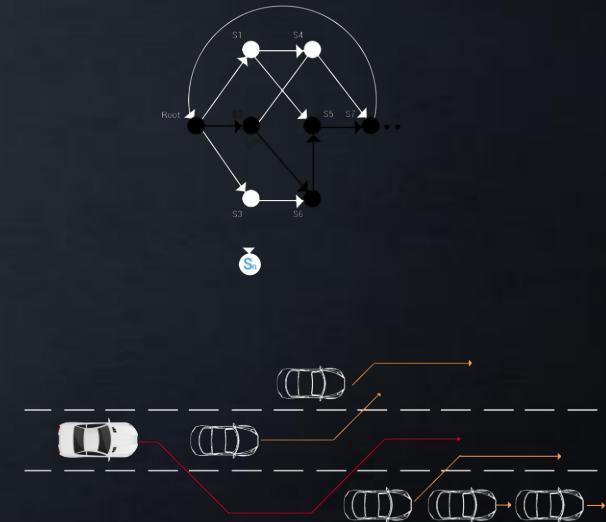
2017 : Perception



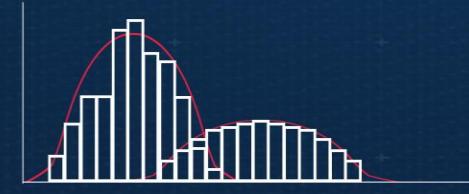
2018 : Modeling



2019 : Decision Making



The Roadmap of BPU Architecture for both FPGA and ASICs



Gauss Architecture

Spec: (L1-L2)

1080p@30fps object detection, recognition

Detect & recognize 250 objects per frame

Detect up to 8 categories of objects

17Q1

17Q2

17Q3

17Q4

18Q1

18Q2

18Q3

18Q4



Bernoulli Architecture

Spec: (L3-L4)

Sparse & binary neural networks

1080p@30fps x 6 cameras

Detection, prediction, scene parsing

Multi-sensor fusion

$$\mathcal{P}(\mathcal{A}|\mathcal{B}) = \frac{\mathcal{P}(\mathcal{B}|\mathcal{A}) * \mathcal{P}(\mathcal{A})}{\mathcal{P}(\mathcal{B})}$$

Bayes Architecture

Spec: (L4-L5)

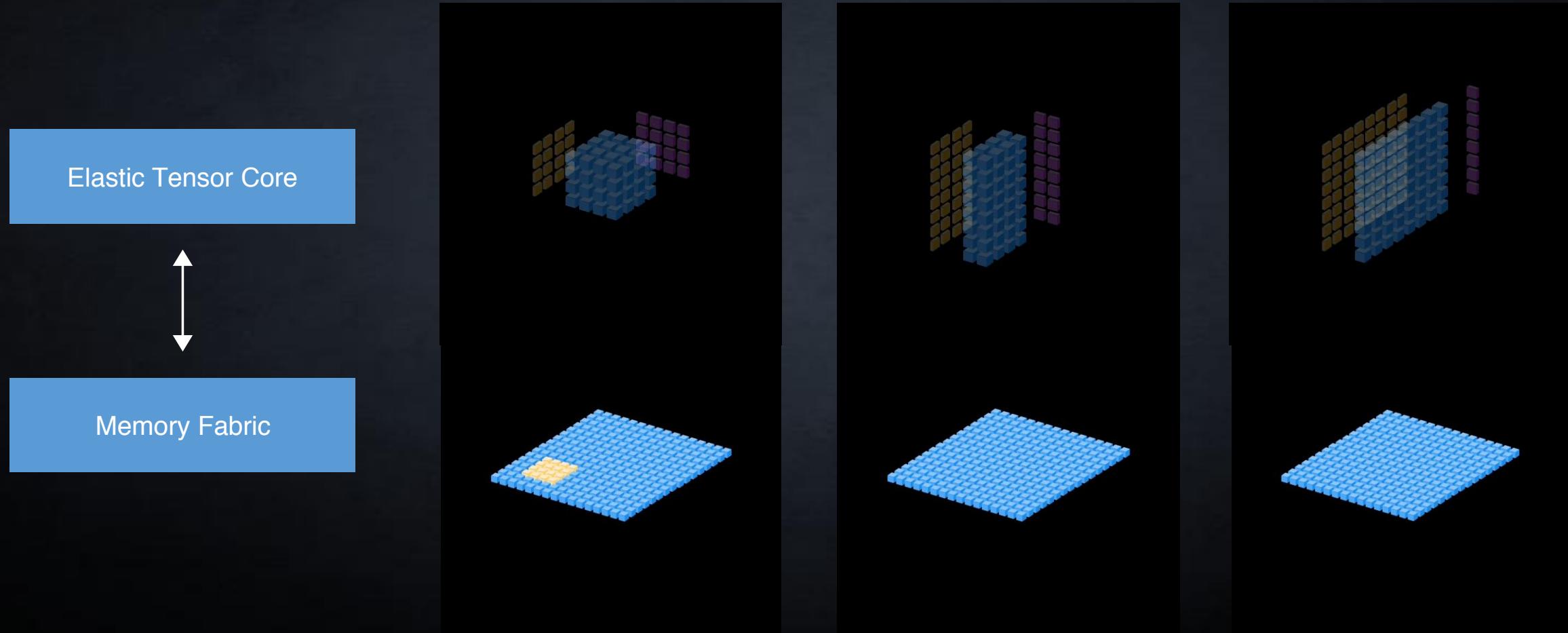
CNN , RNN, Bayes network inference

4K@30fps x 12 cameras

Semantic 3D scene model

Trajectory planning

Elastic tensor core – optimize the NN computation



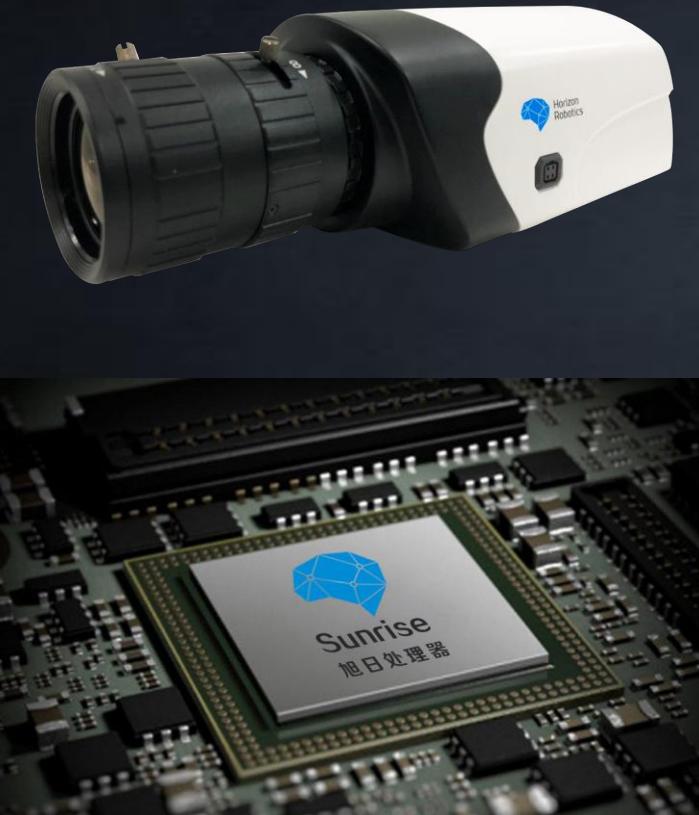
On Dec. 20th 2017, we launch the first-generation ASIC

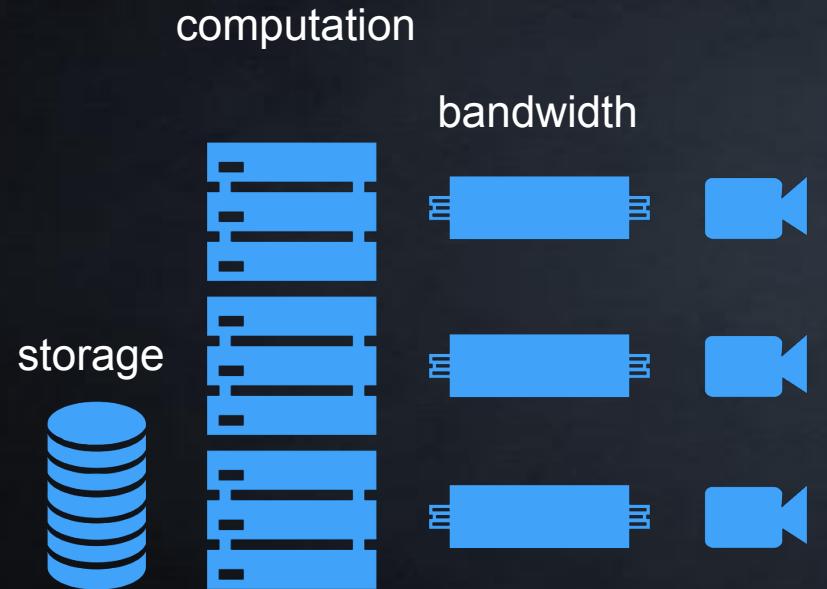


A screenshot of the official website of the Chinese Central Government (www.gov.cn). The header includes the Chinese National Emblem, the text "中华人民共和国中央人民政府", the website address "www.gov.cn", and various navigation icons. A blue horizontal menu bar below the header contains links for "国务院" (State Council), "总理" (Premier), "新闻" (News), "政策" (Policies), "互动" (Interaction), "服务" (Services), "数据" (Data), and "国情" (National Conditions). The main content area shows a news article titled "我国首款嵌入式人工智能视觉芯片发布" (The launch of China's first embedded AI visual chip). The article is dated December 21, 2017, at 07:56, and is attributed to Xinhua News Agency. The text of the article discusses the development of the "Zengcheng 1.0" processor for intelligent driving and the "Xirui 1.0" processor for intelligent cameras by the Didi Chuxing Research Institute. It highlights the chip's ability to process 200 visual targets per frame and its low power consumption and low latency.

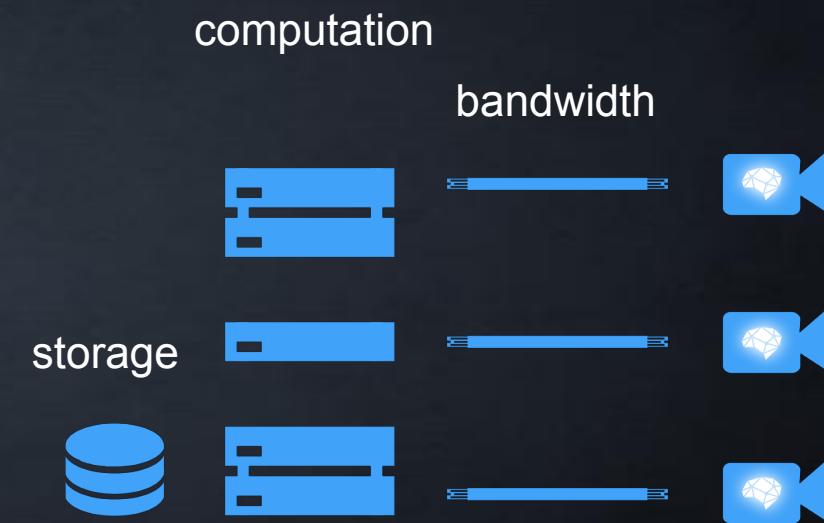
The News was featured on China Central Government official website.

Sunrise 1.0 ASIC processor for smart IP cameras





traditional approach:
AI computation on servers



new approach:
AI computation on cameras



- Using Nvidia TX1, power consumption 20w, 12 frames per second, detecting 30 objects simultaneously
- Using Horizon Sunrise 1.0 processor , power consumption **1.5w**, **30 frames** per second, detecting **200 objects** simultaneously



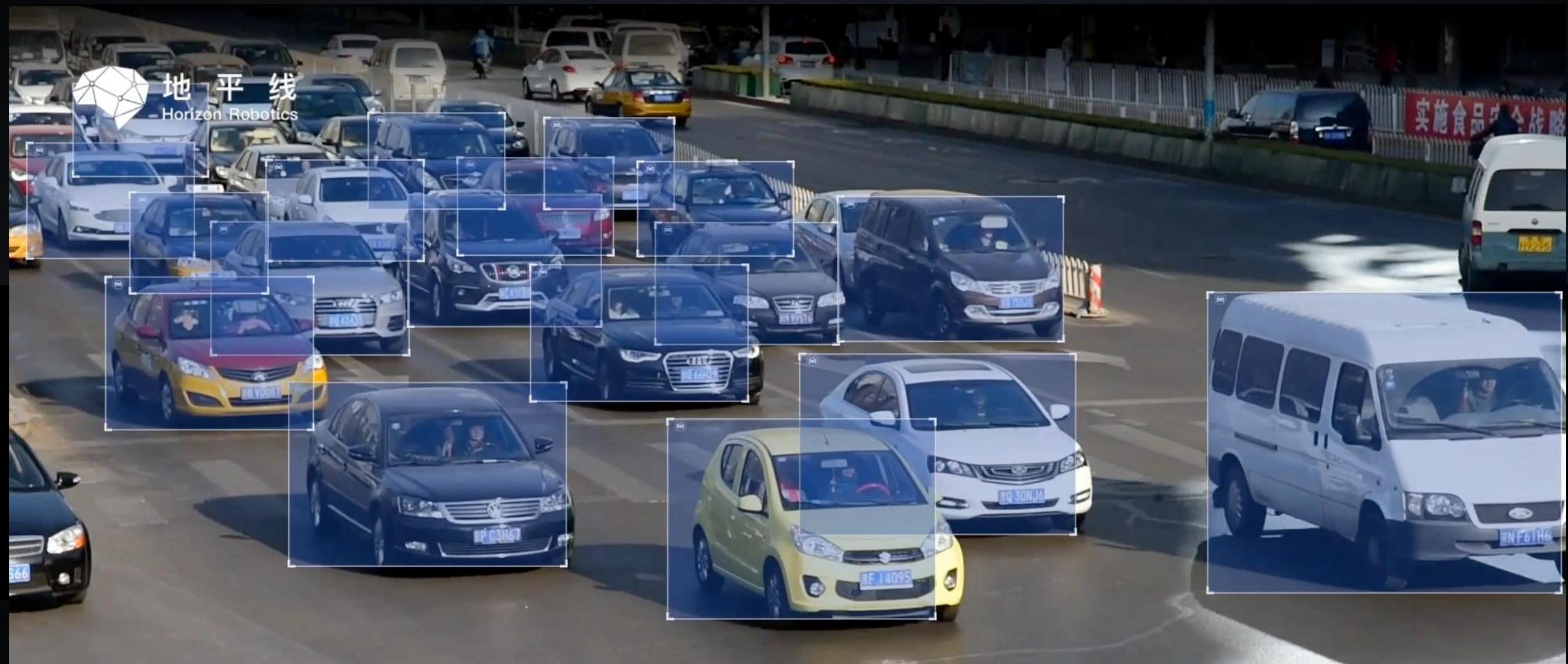
地平线
Horizon Robotics



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| 女性 青年 | 男性 青年 | 男性 青年 | 男性 青年 | 男性 青年 | 男性 青年 | 男性 青年 | 女性 青年 | 男性 青年 | 男性 青年 |
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地平线
Horizon Robotics



机动车总量 **901** 辆

非机动车总量 **331** 辆

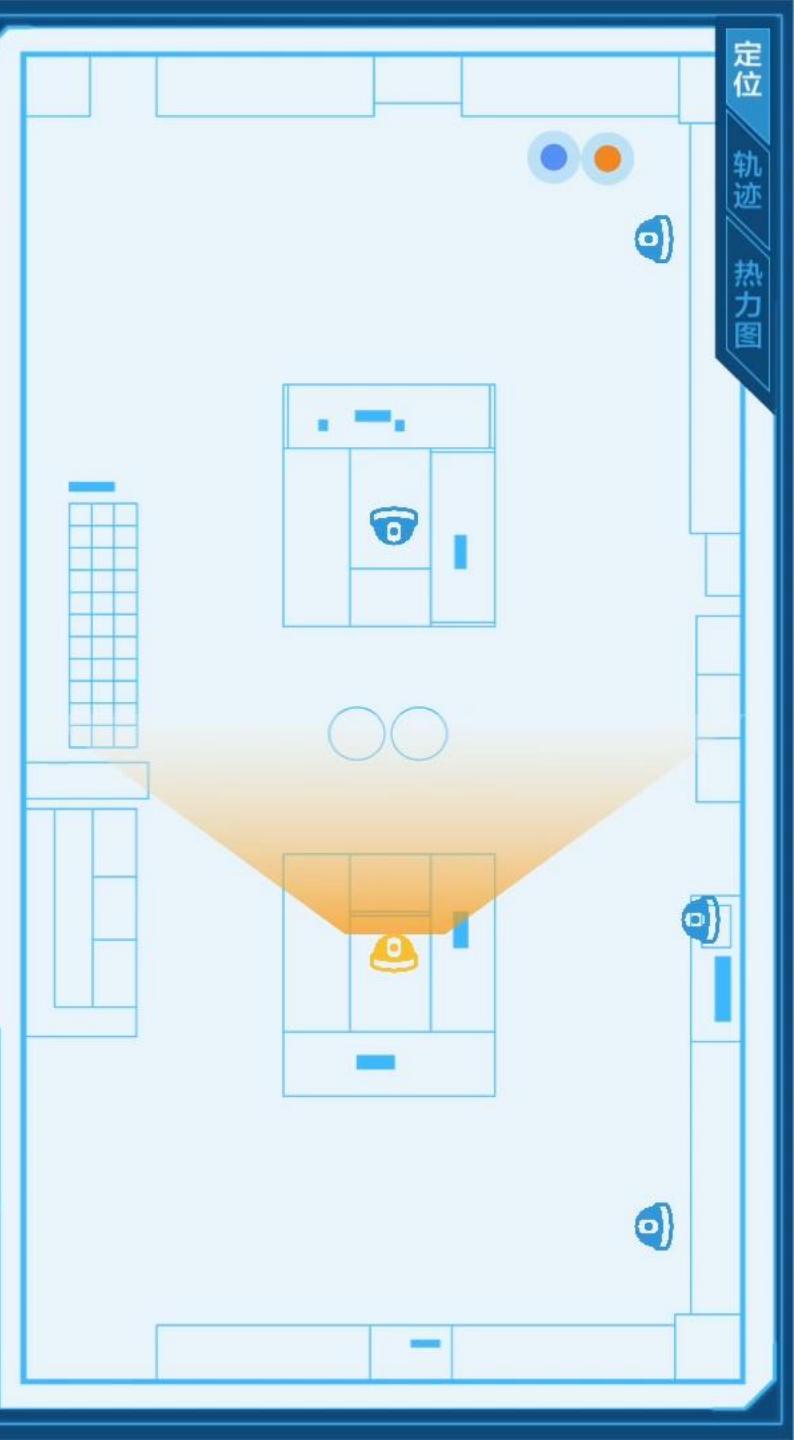
行人

机动车

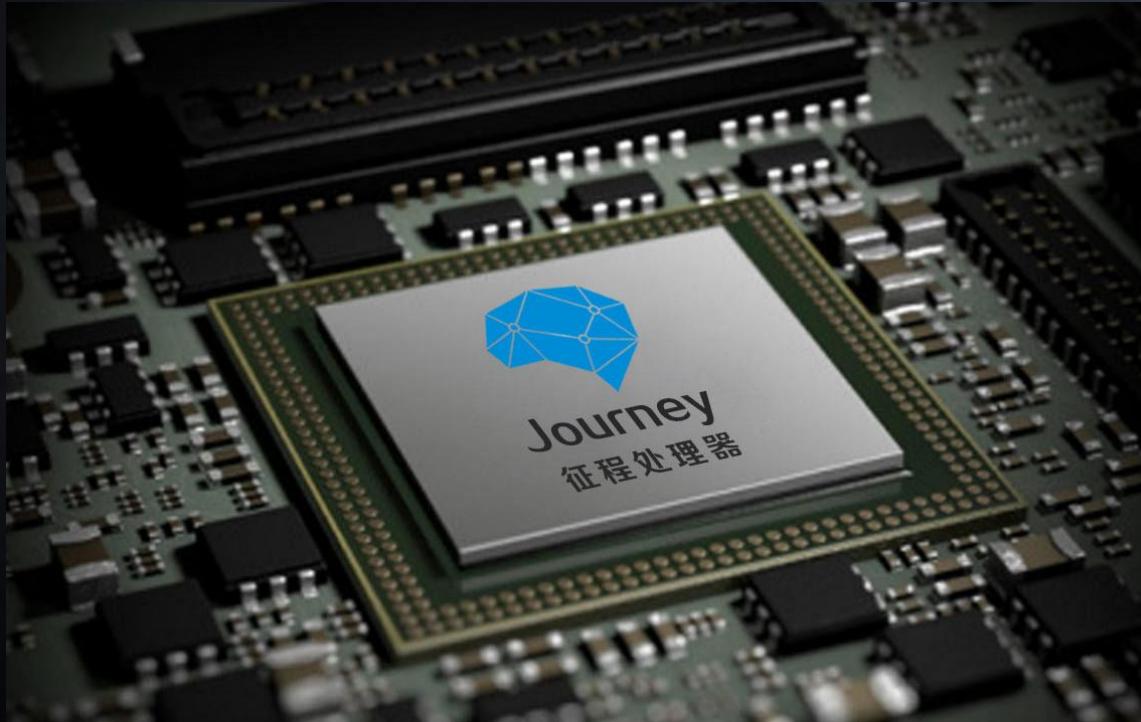
非机动车

行人总量 **379** 人





Journey 1.0 ASIC processor for ADAS



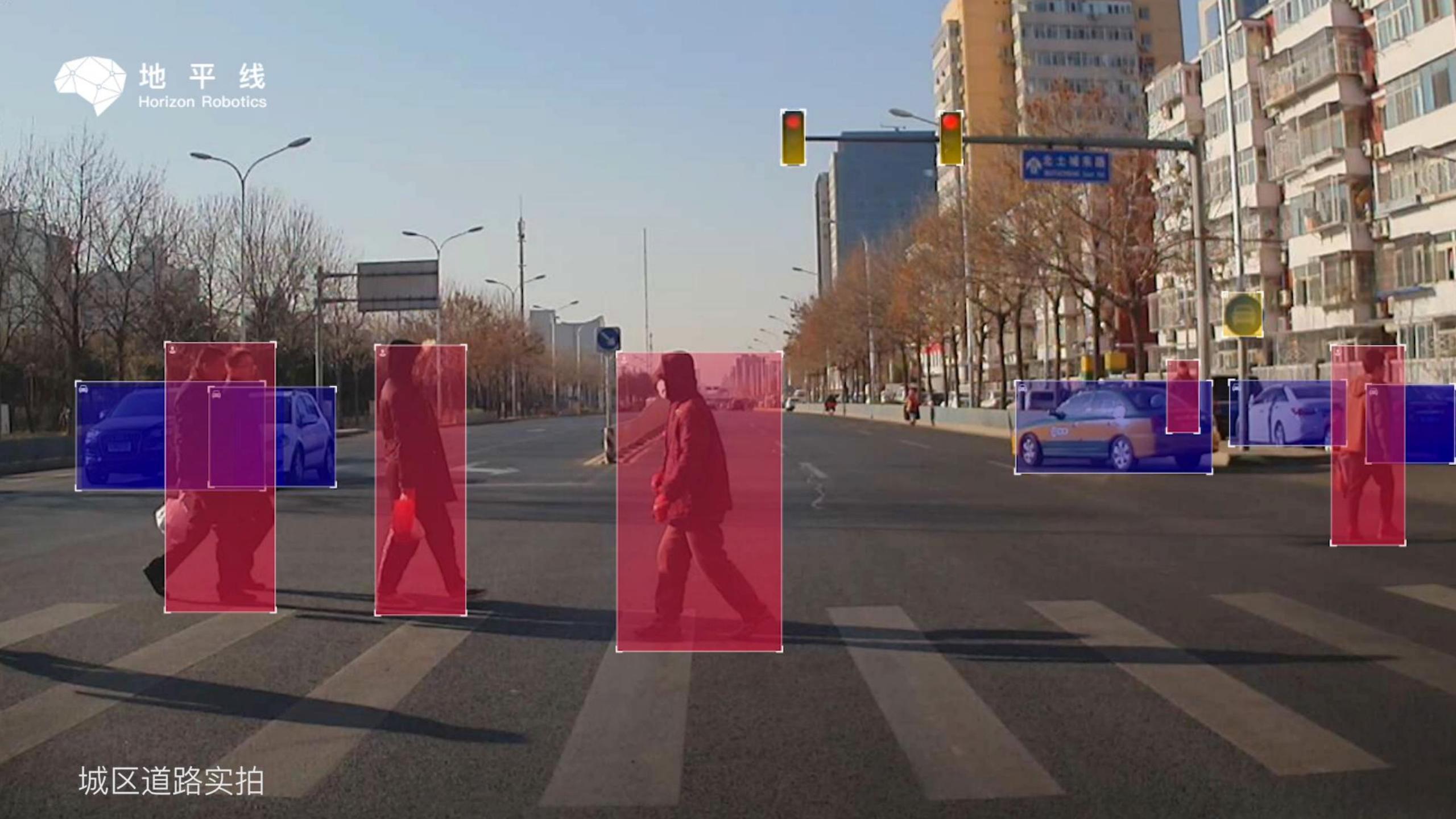
- Tape out with TSMC
- 1Tops, only 1.5w
- 1080p @ 30 fps
- Recognize 200 objects/frame

ADAS system using Journey 1.0



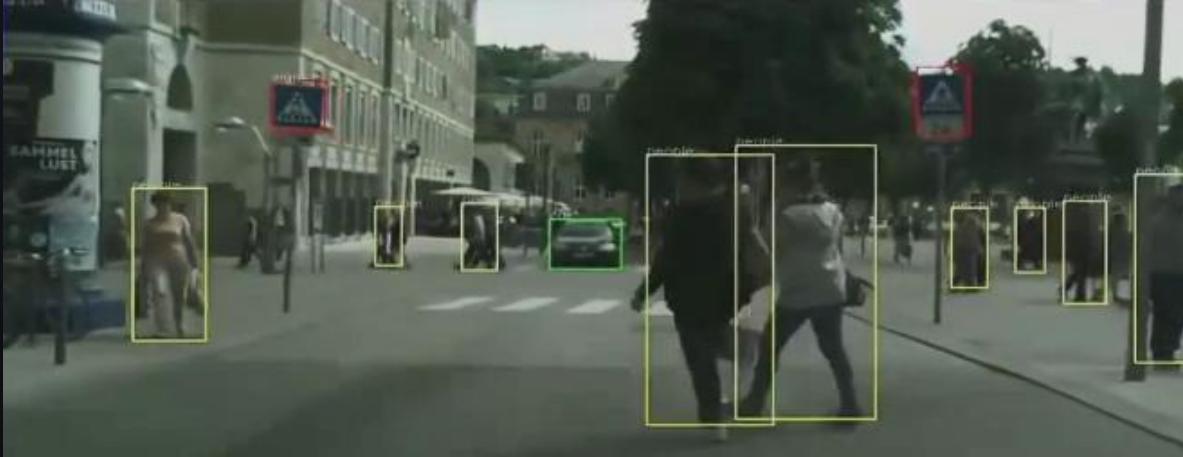


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城区道路实拍

Journey 2.0 architecture on Intel FPGA



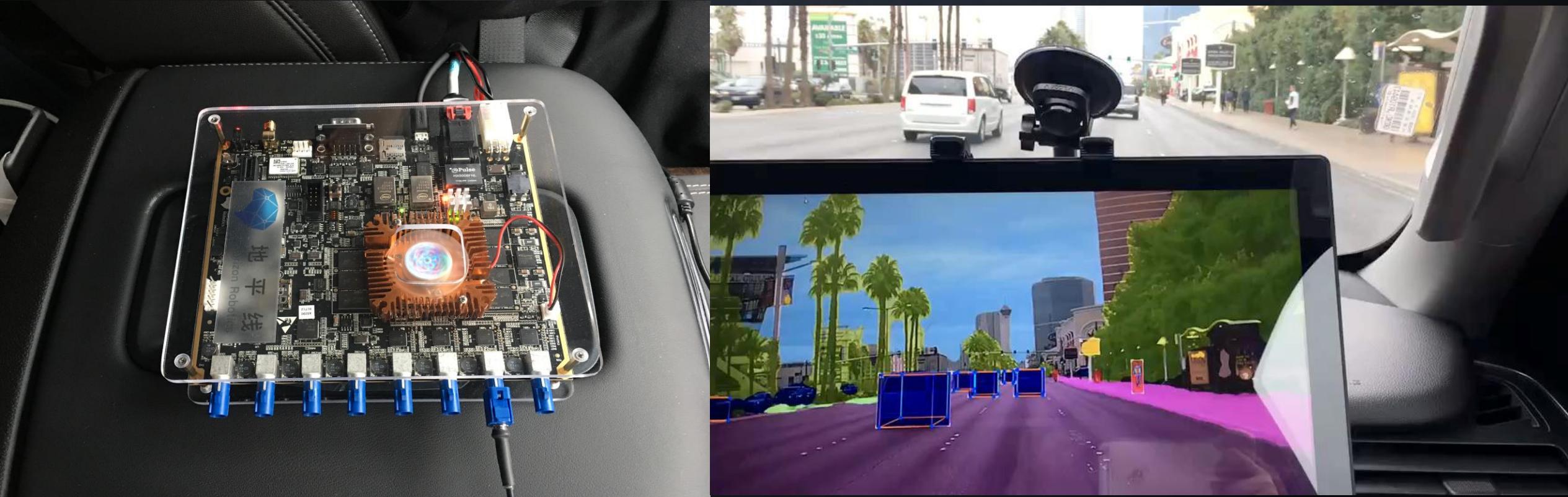
Boundingbox based detection



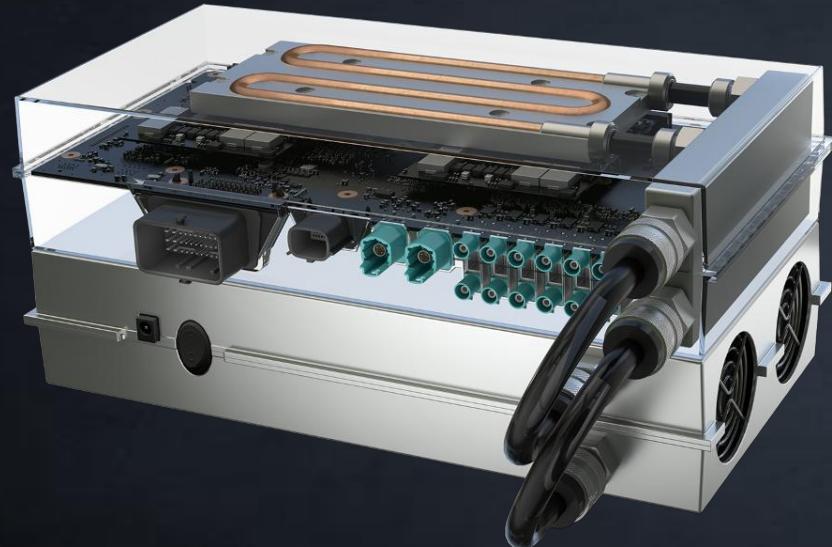
vs.

Pixel-wise segmentation

Matrix: autonomous driving computing platform using Journey 2.0 processor



Drive PX2 vs. Journey 2.0



110 Watts
7-8 FPS*
20+ TOPS



31 Watts
30 FPS
10 TOPS

* with space for further optimization

Thank you!