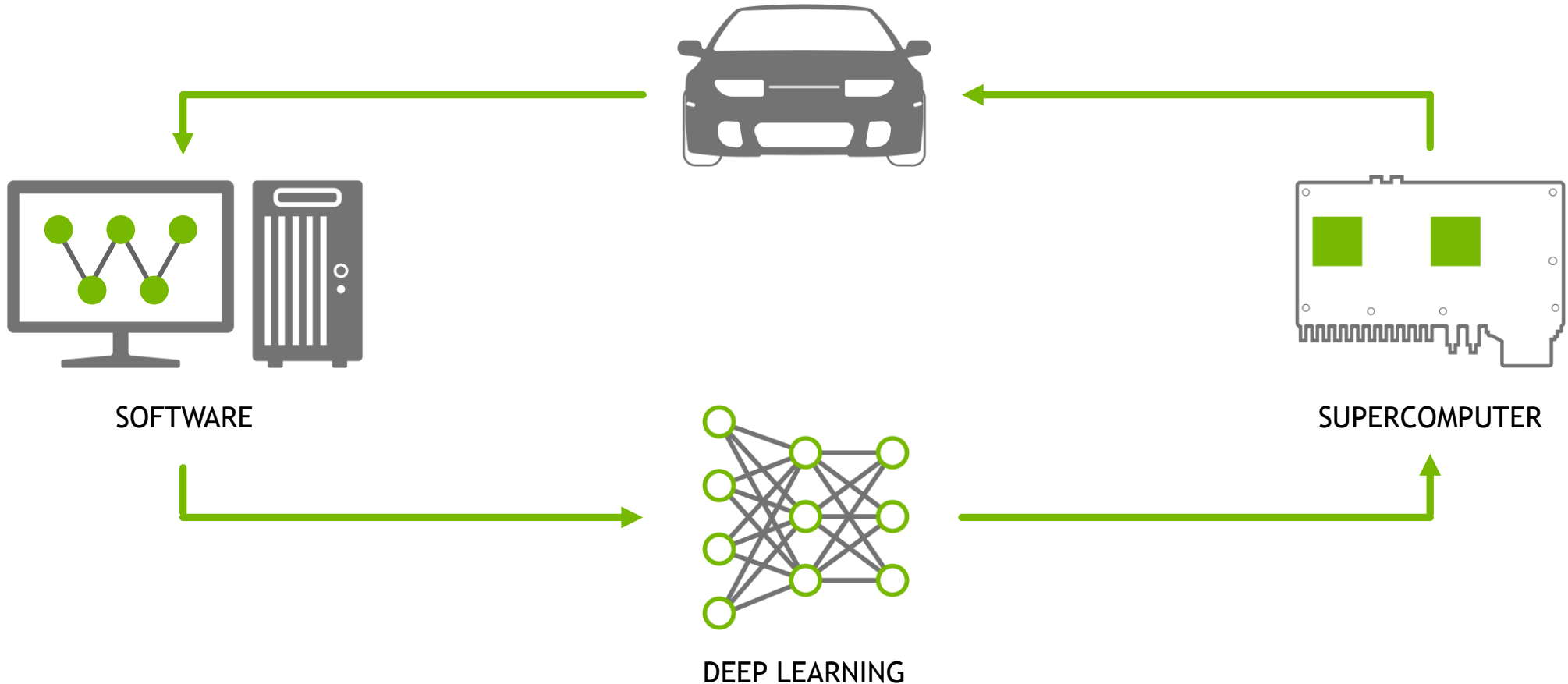




ACCELERATING THE RACE TO SELF-DRIVING CARS

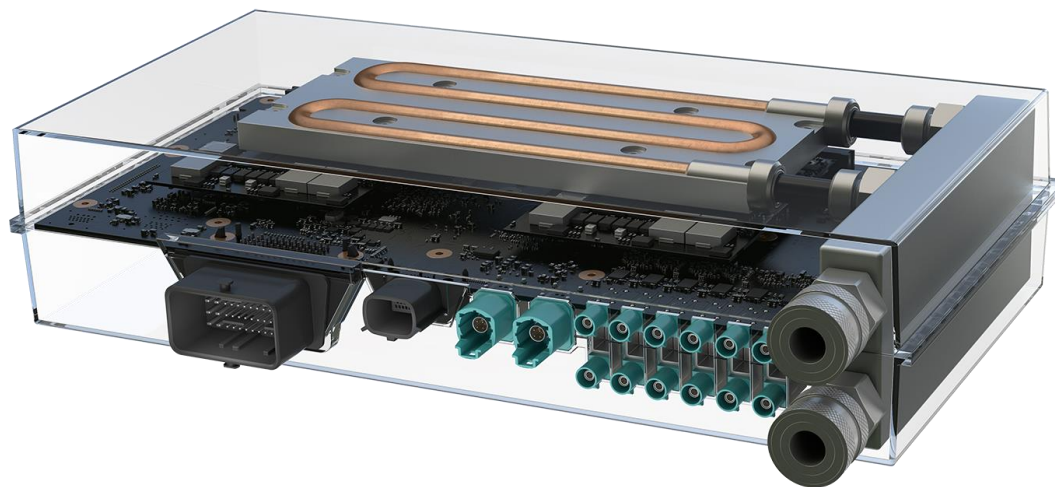
Jen-Hsun Huang, Co-Founder & CEO, NVIDIA | Jan. 4, 2016

SELF-DRIVING IS A MAJOR COMPUTER SCIENCE CHALLENGE



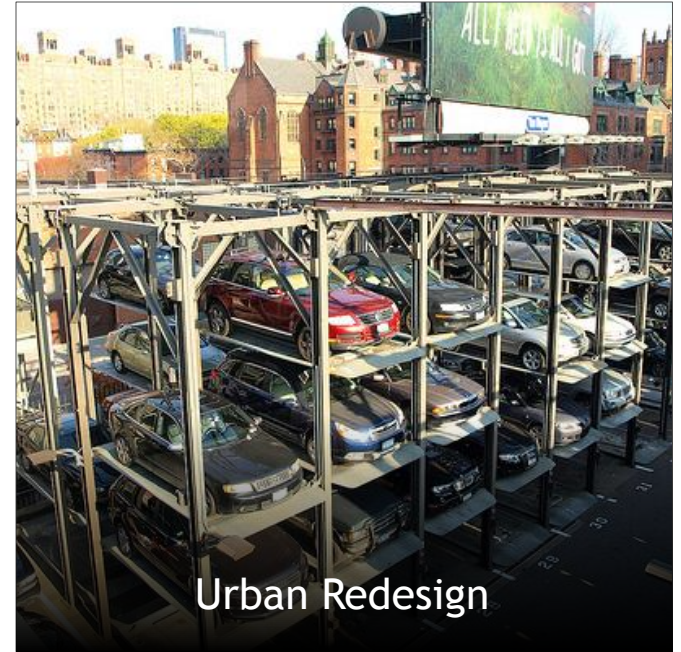
NVIDIA DRIVE PX 2

12 CPU cores | Pascal GPU | 8 TFLOPS | 24 DL TOPS | 16nm FF | 250W | Liquid Cooled



World's First AI Supercomputer for Self-Driving Cars

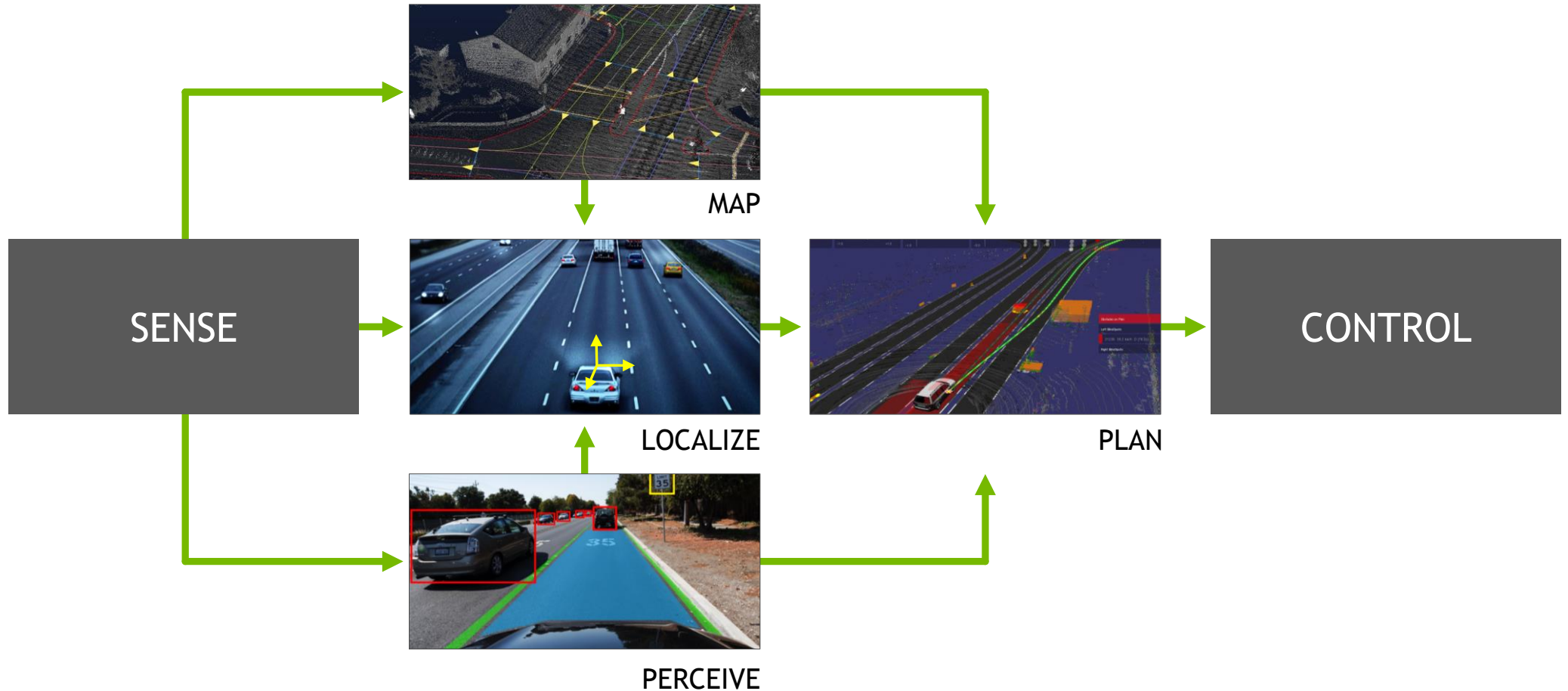
THE SELF-DRIVING REVOLUTION



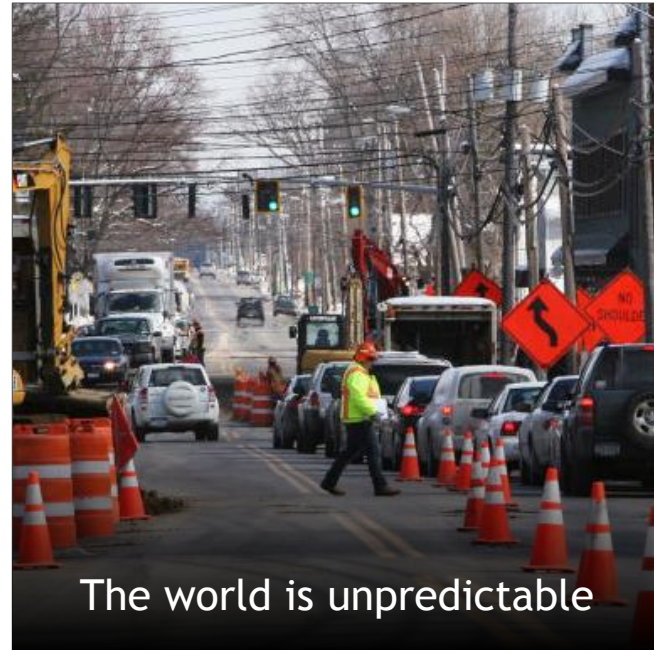
TWO VISIONS



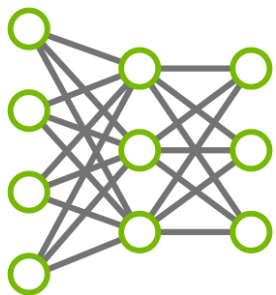
THE BASIC SELF-DRIVING LOOP



SELF-DRIVING IS HARD



DEEP LEARNING TO THE RESCUE



DNN



BIG DATA

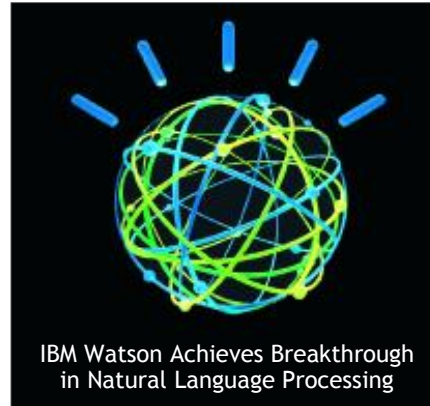
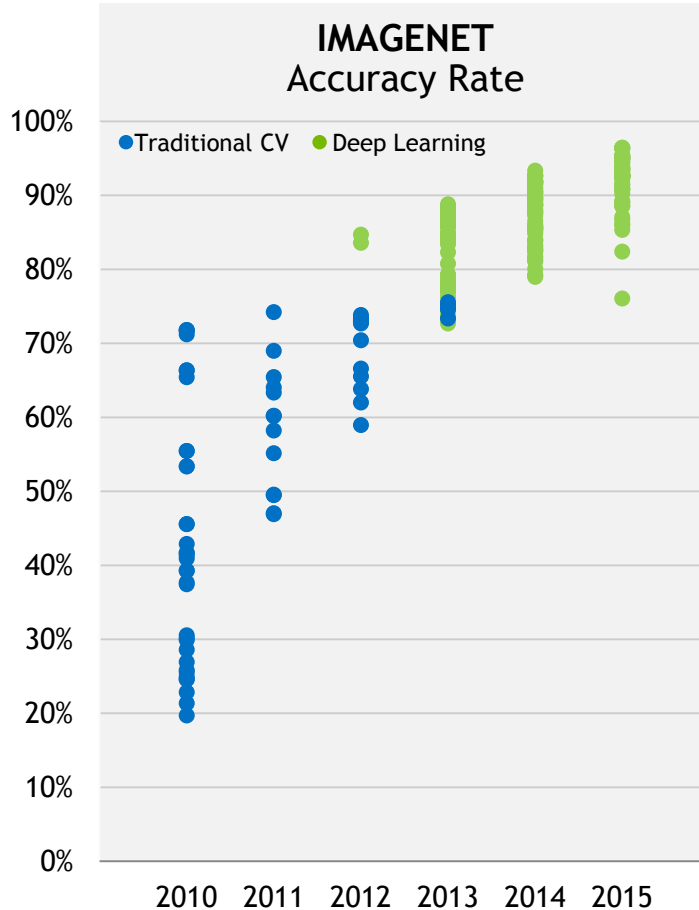


GPU

“The GPU is the workhorse of modern A.I.”

POPULAR
SCIENCE

THE AI RACE IS ON



THE ENGINE OF MODERN AI

EDUCATION

TORCH



CAFFE



THEANO



MATCONVNET



MOCHA.JL



PURINE



MINERVA



MXNET*



BIG SUR



TENSORFLOW



WATSON



CNTK



START-UPS

CHAINER



DL4J



KERAS



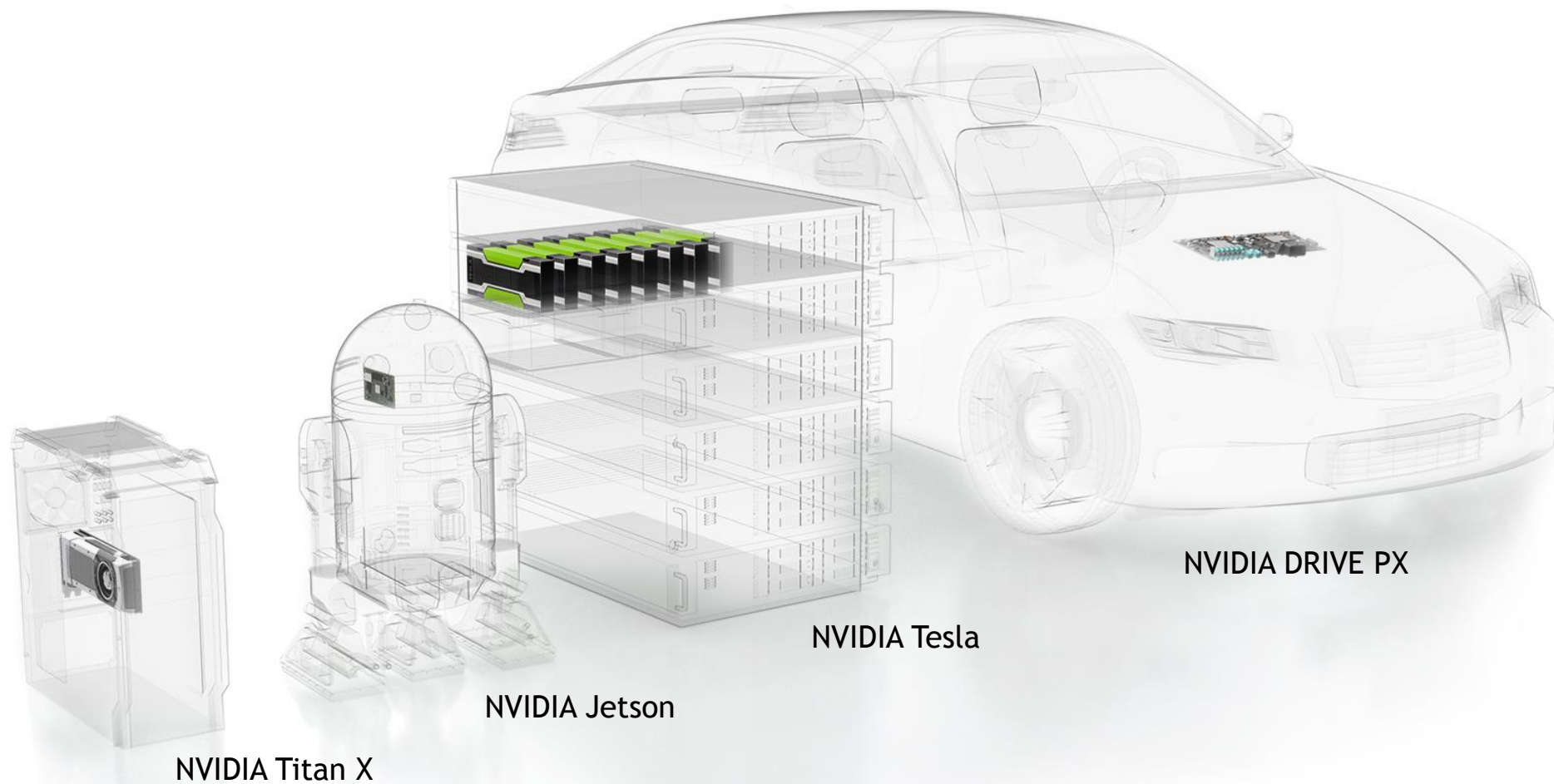
OPENDEEP



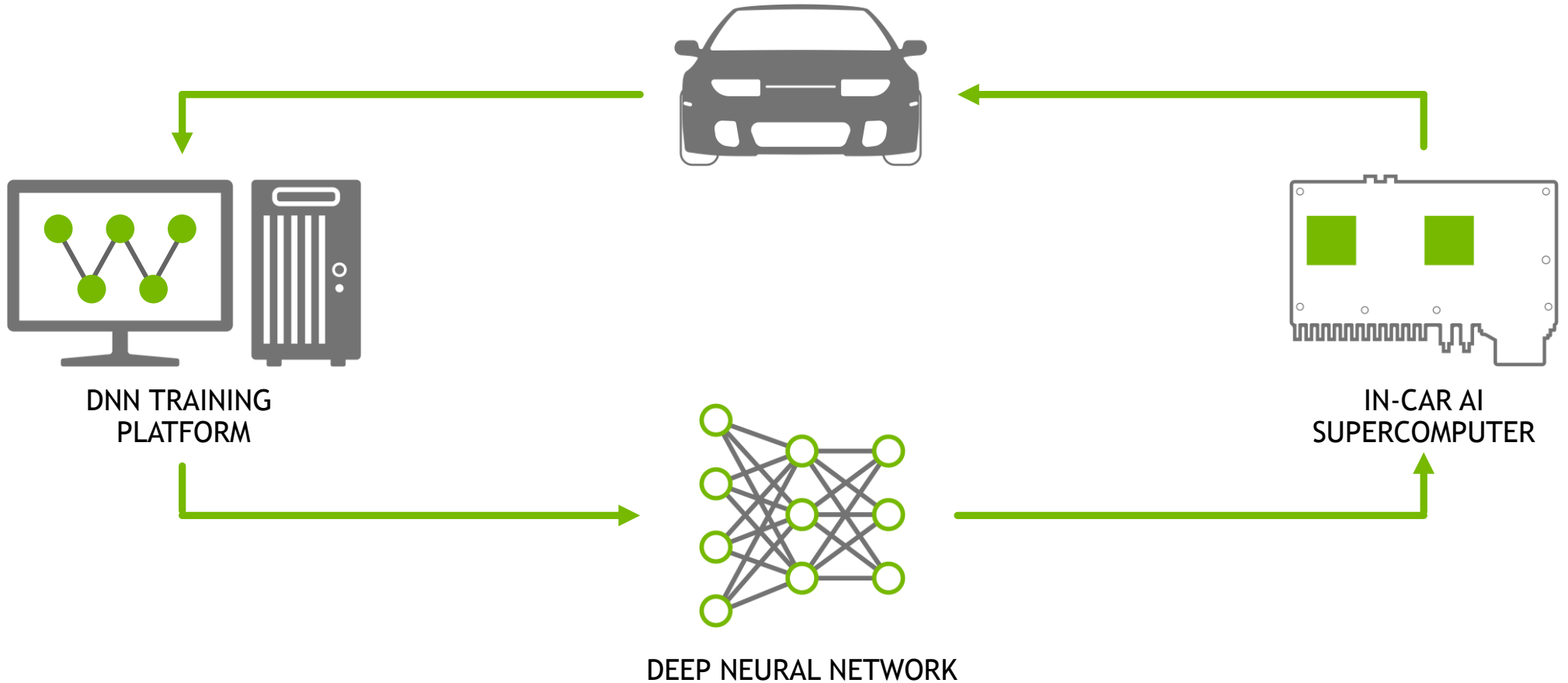
NVIDIA GPU PLATFORM

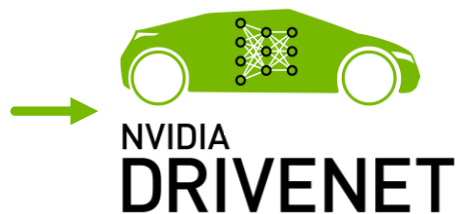
*U. Washington, CMU, Stanford, TuSimple, NYU, Microsoft, U. Alberta, MIT, NYU Shanghai

DEEP LEARNING EVERYWHERE



END-TO-END DEEP LEARNING PLATFORM FOR SELF-DRIVING CARS

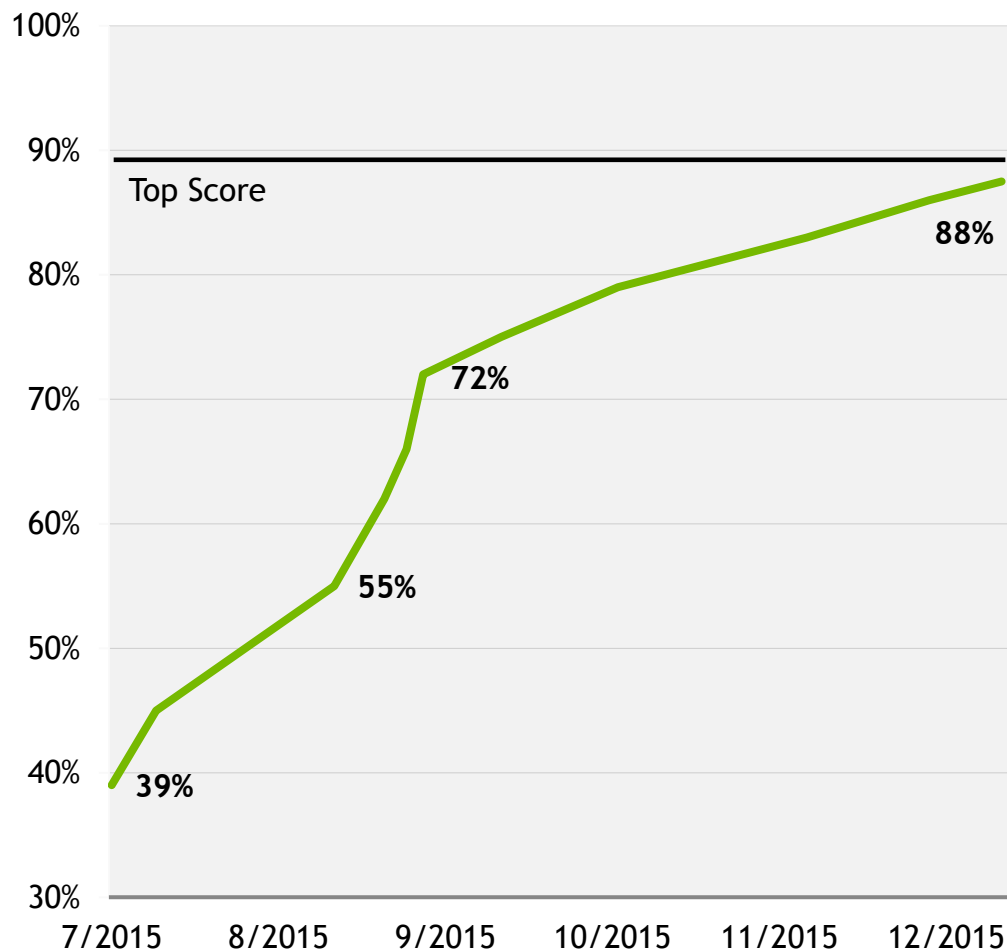


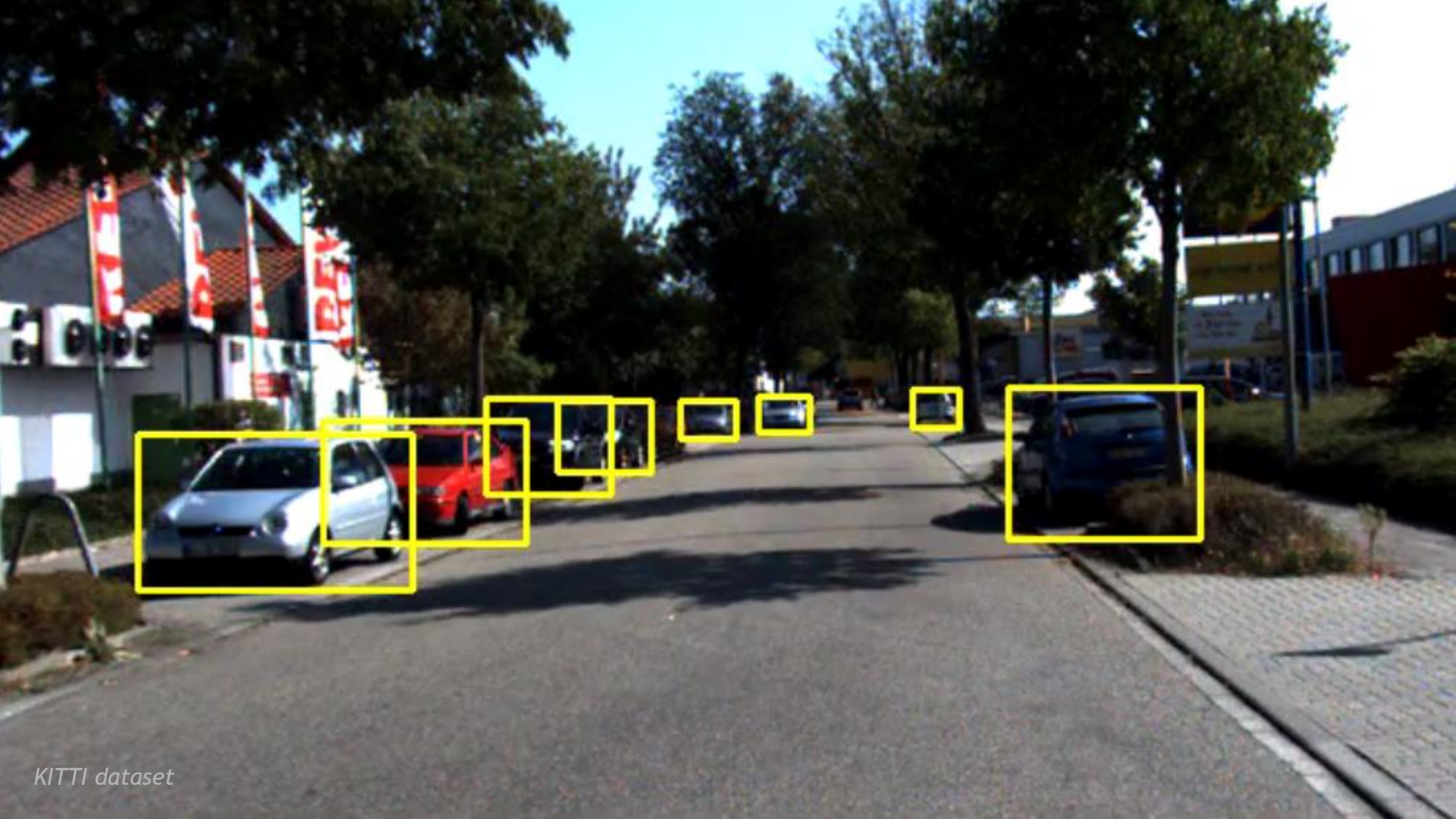


9 inception layers
3 convolutional layers
37M neurons
40B operations
Single and multi-class detection
Segmentation

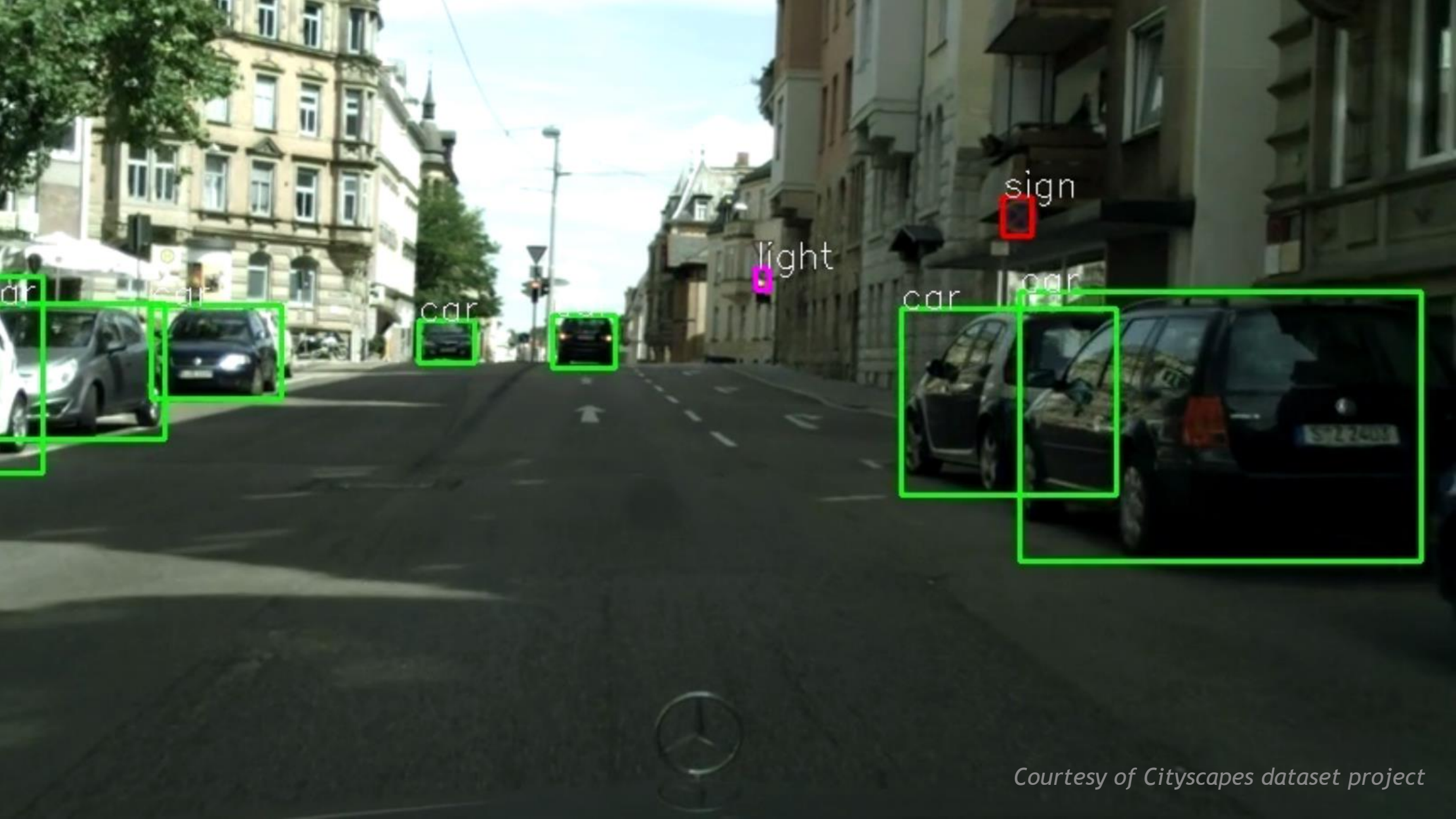
KITTI Dataset: Object Detection

— NVIDIA DRIVENet

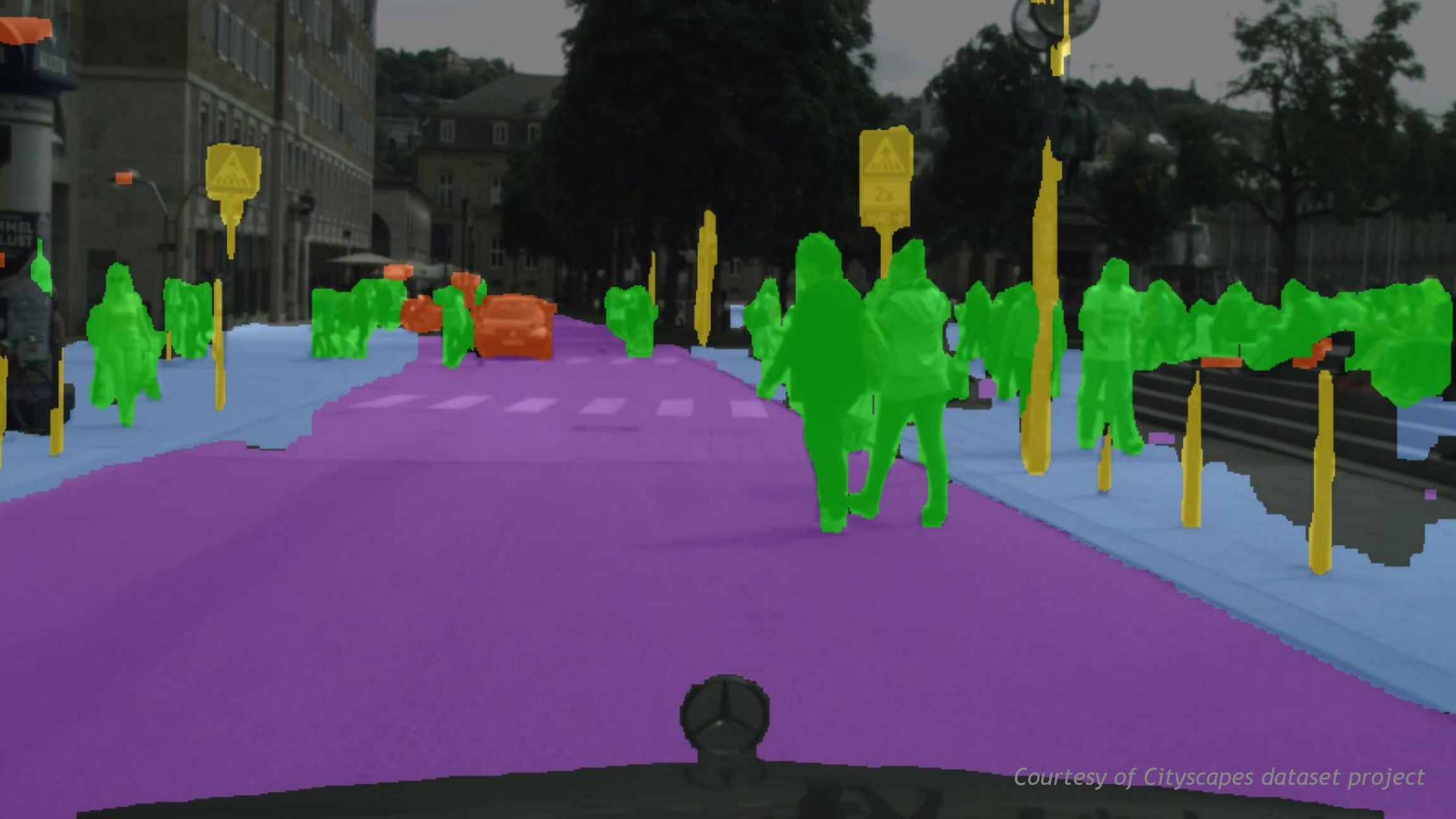




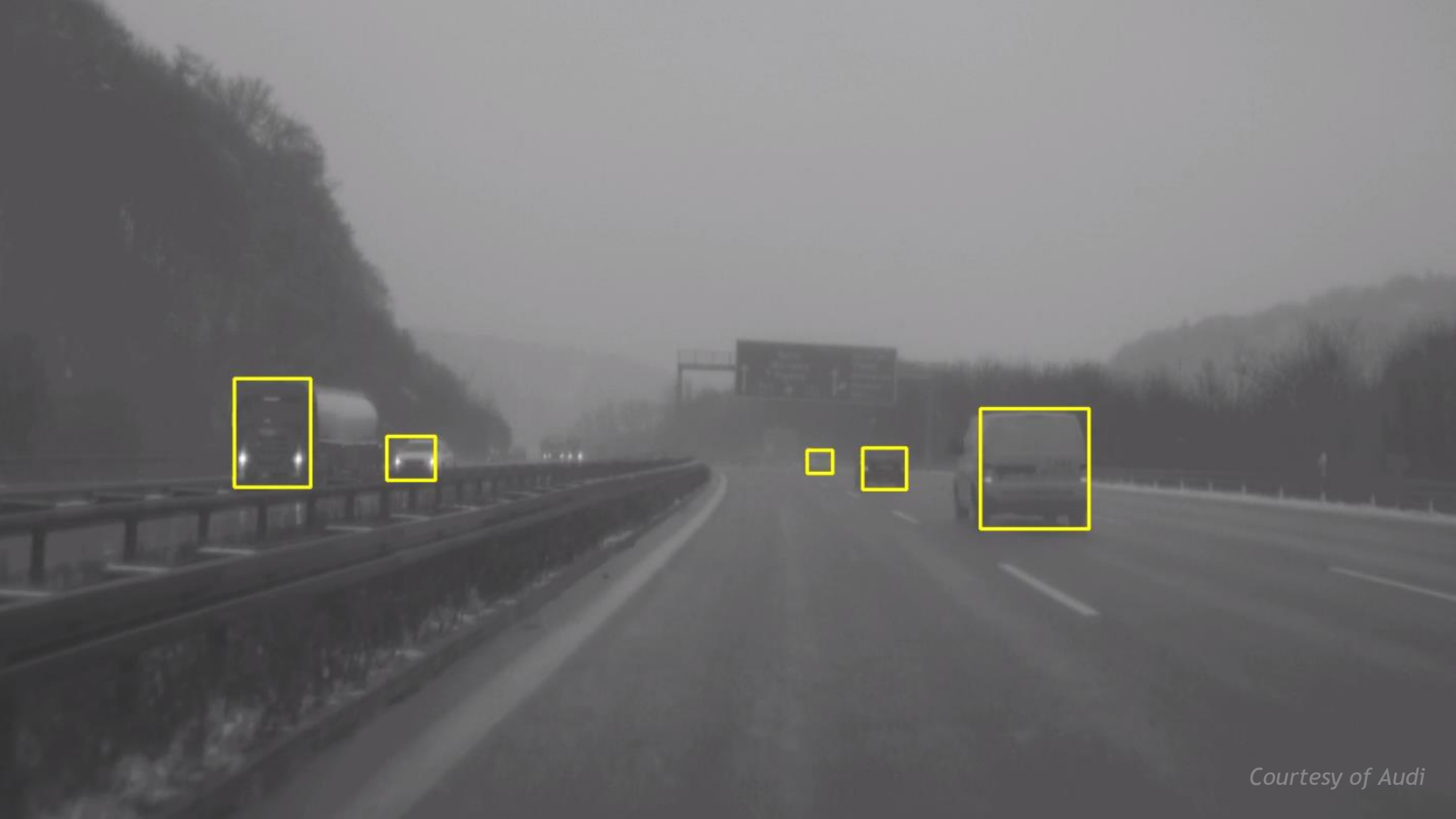
KITTI dataset



Courtesy of Cityscapes dataset project



Courtesy of Cityscapes dataset project



Courtesy of Audi

“Using NVIDIA DIGITS deep learning platform, in less than four hours we achieved over 96% accuracy using Ruhr University Bochum’s traffic sign database. While others invested years of development to achieve similar levels of perception with classical computer vision algorithms, we have been able to do it at the speed of light.”

*Matthias Rudolph, Director of Architecture,
Driver Assistance Systems, Audi*



Audi

NVIDIA DRIVE

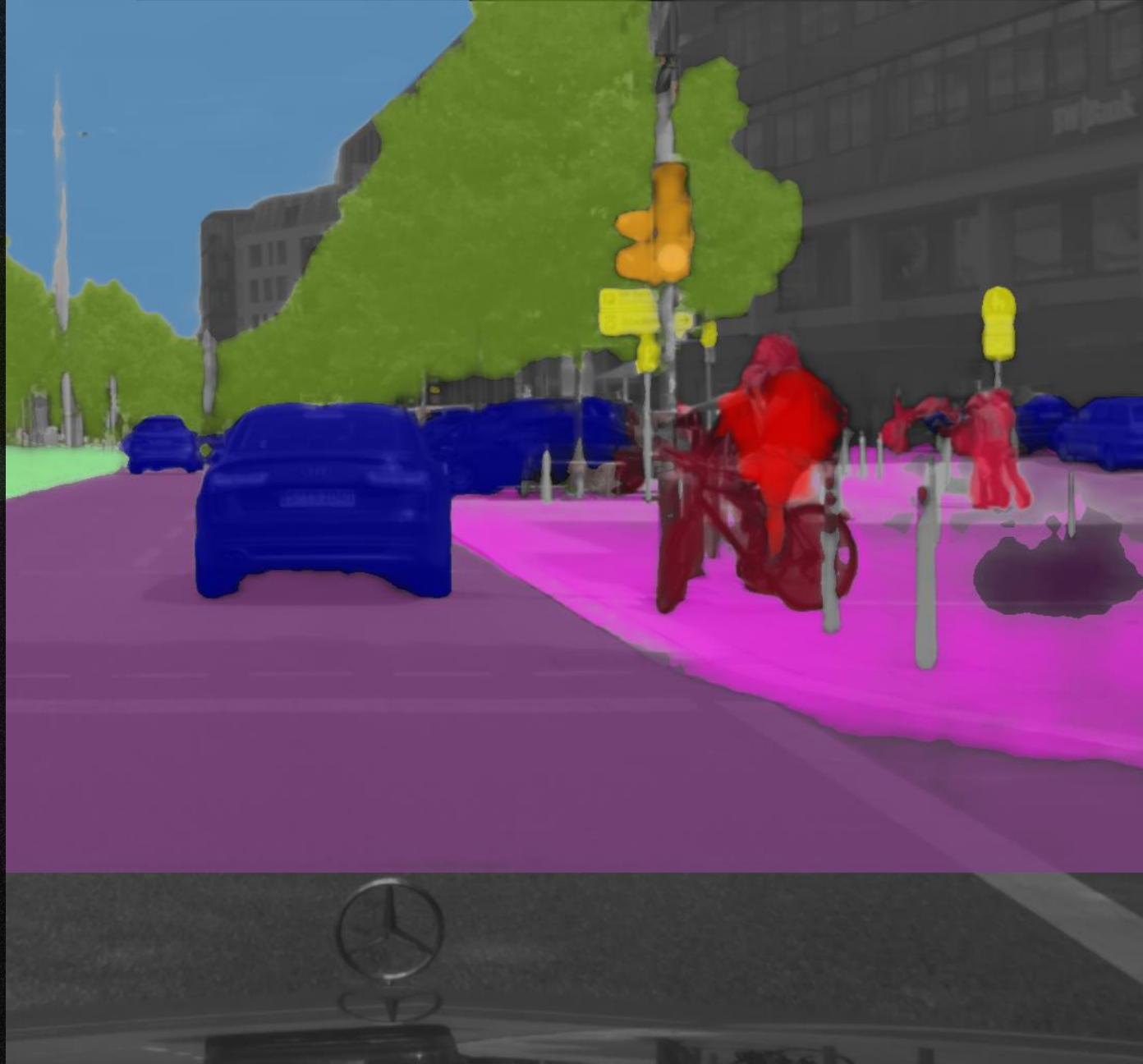


*“Due to deep learning,
we brought the vehicle’s
environment perception a
significant step closer to human
performance and exceeded the
performance of classic computer
vision.”*

*Ralf G. Herrtwich
Director of Vehicle Automation, Daimler*



NVIDIA DRIVE

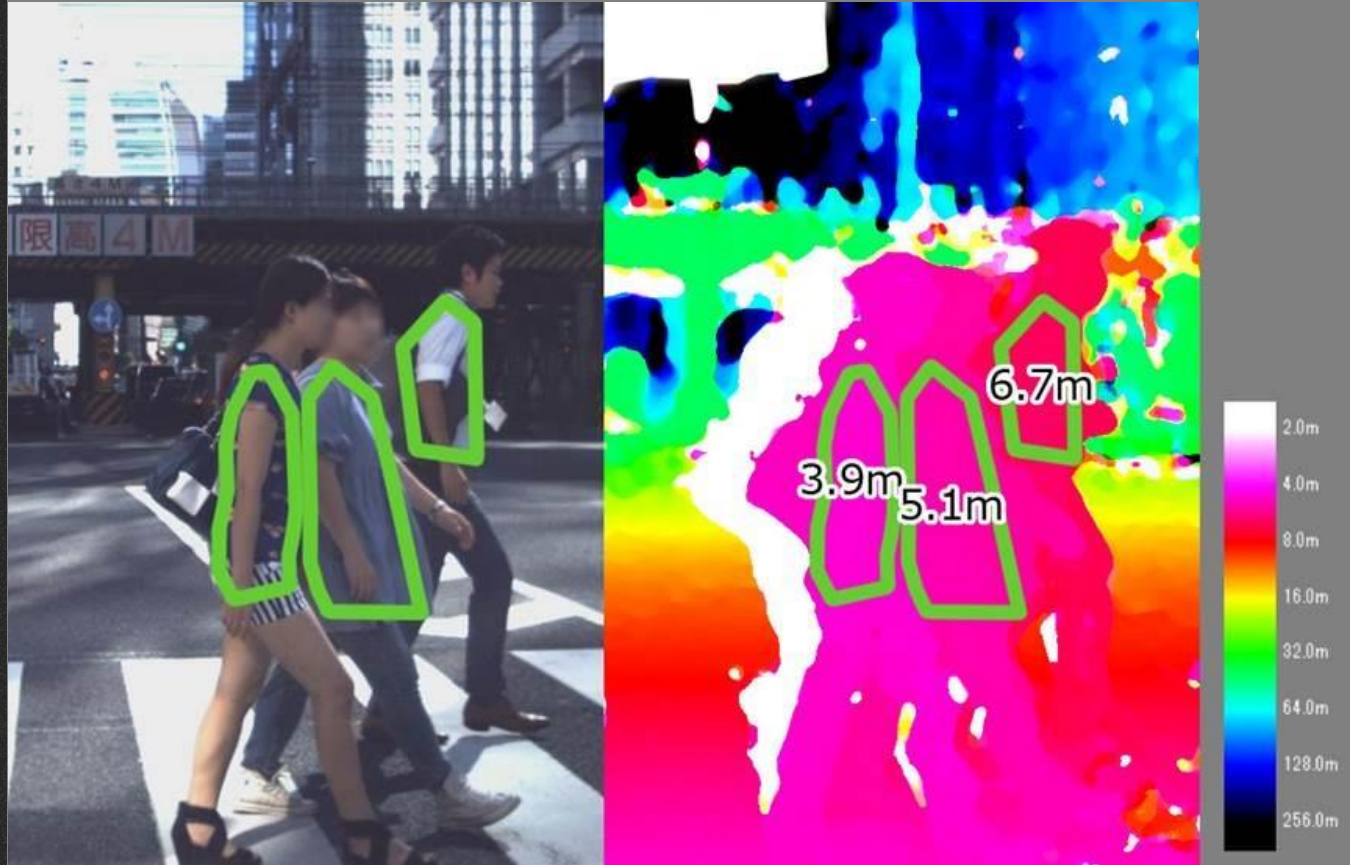


“Deep learning technology can dramatically improve accuracy of detection and decision-making algorithms for autonomous driving. ZMP is achieving remarkable results using deep neural networks on NVIDIA GPUs for pedestrian detection. We will expand our use of deep learning on NVIDIA GPUs to realize our driverless Robot Taxi service.”

Hisashi Taniguchi
CEO, ZMP Inc.



NVIDIA DRIVE



“BMW is exploring the use of deep learning for a wide range of automotive use cases, from autonomous driving to quality inspection in manufacturing. The ability to rapidly train deep neural networks on vast amounts of data is critical. Using an NVIDIA GPU cluster with NVIDIA DIGITS, we are achieving excellent results.”

Uwe Higgen
Head of BMW Group Technology Office (USA)



NVIDIA DRIVE

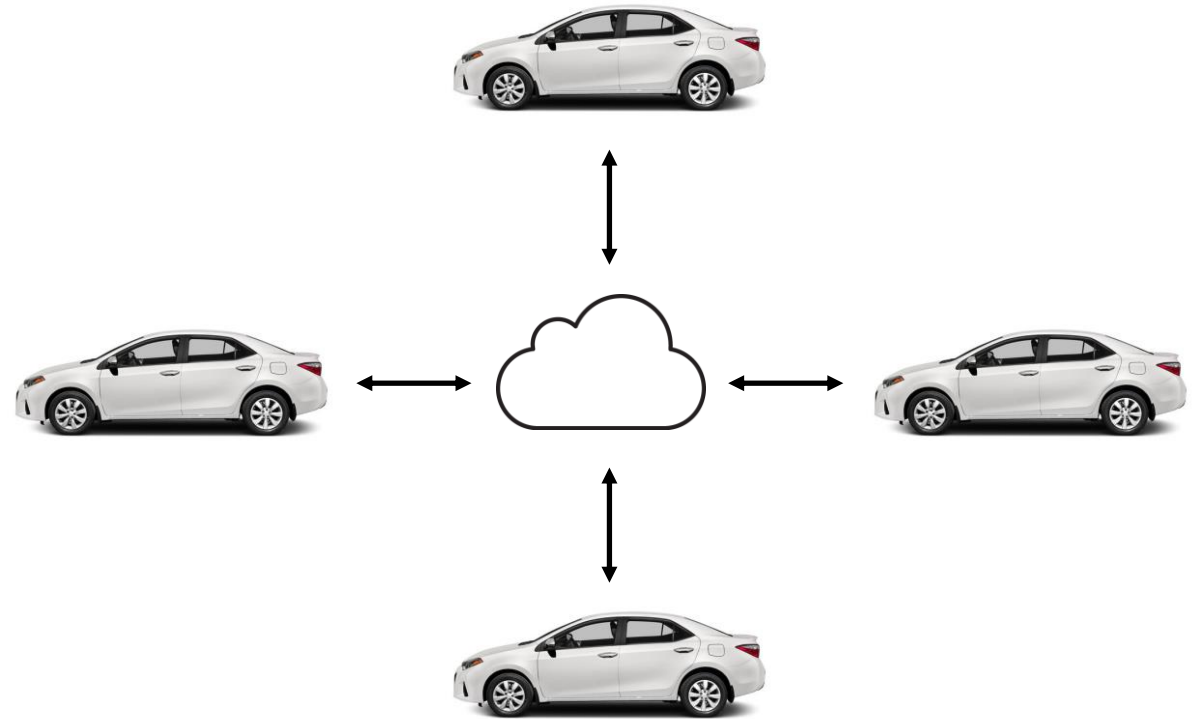


“With the NVIDIA deep learning platform, we have greatly improved performance on a variety of image recognition applications for cars, surveillance cameras and robotics. The remarkable thing is that we did it all with a single NVIDIA GPU-powered deep neural network, in a very short time.”

*Daisuke Okanohara
Founder & SVP, Preferred Networks*



NVIDIA DRIVE



Distributed Cooperative Deep Learning

“Deep learning on NVIDIA DIGITS has allowed for a 30x enhancement in training pedestrian detection algorithms, which are being further tested and developed as we move them onto the NVIDIA DRIVE PX.”

*Dragos Maciuca, Technical Director,
Ford Research and Innovation Center*



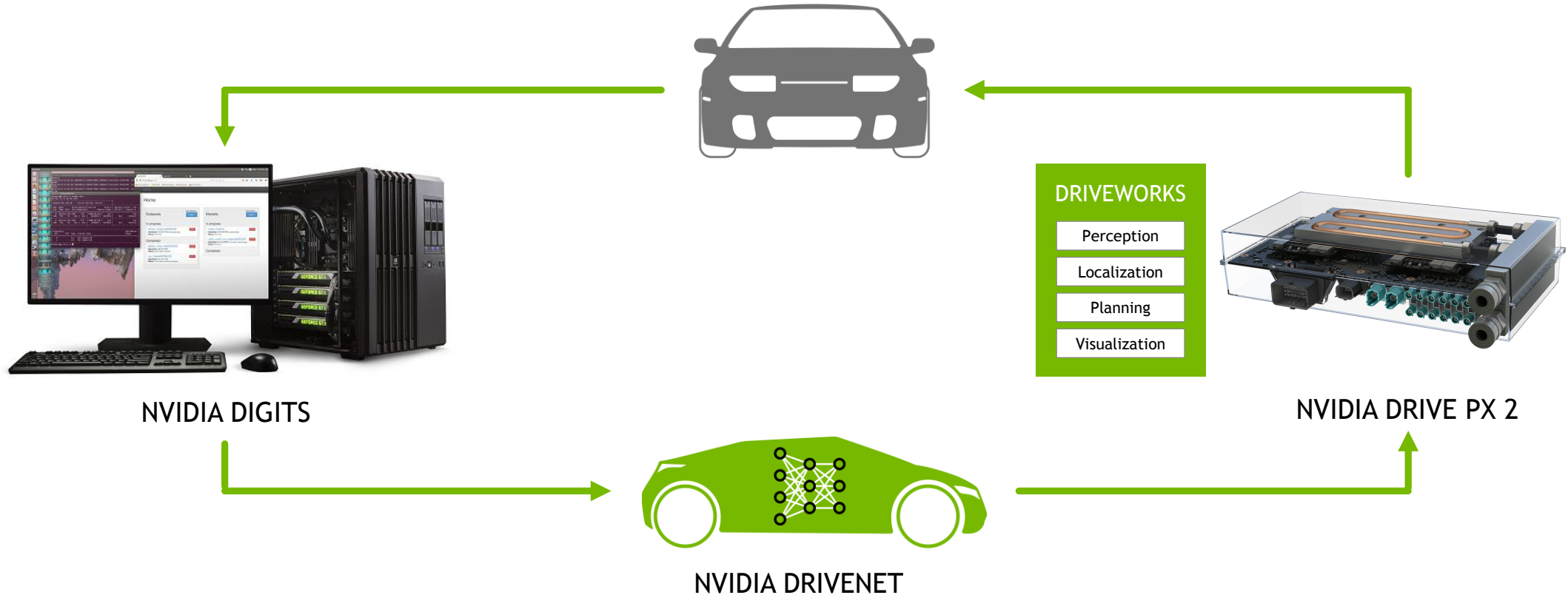
NVIDIA DRIVE



MANY THINGS TO LEARN



END-TO-END DEEP LEARNING PLATFORM FOR SELF-DRIVING CARS



Vehicle configuration

CAN + GPS



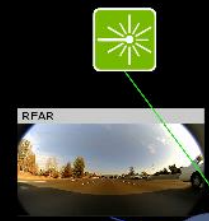
64 MPH

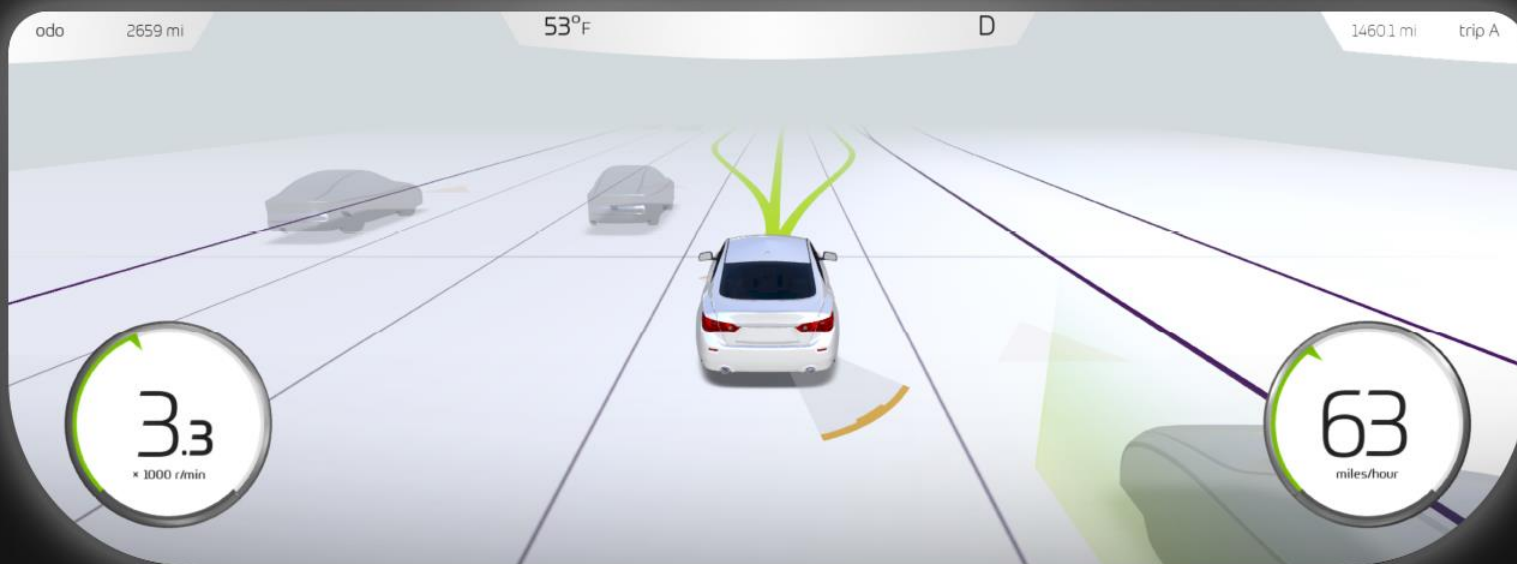


0 Deg

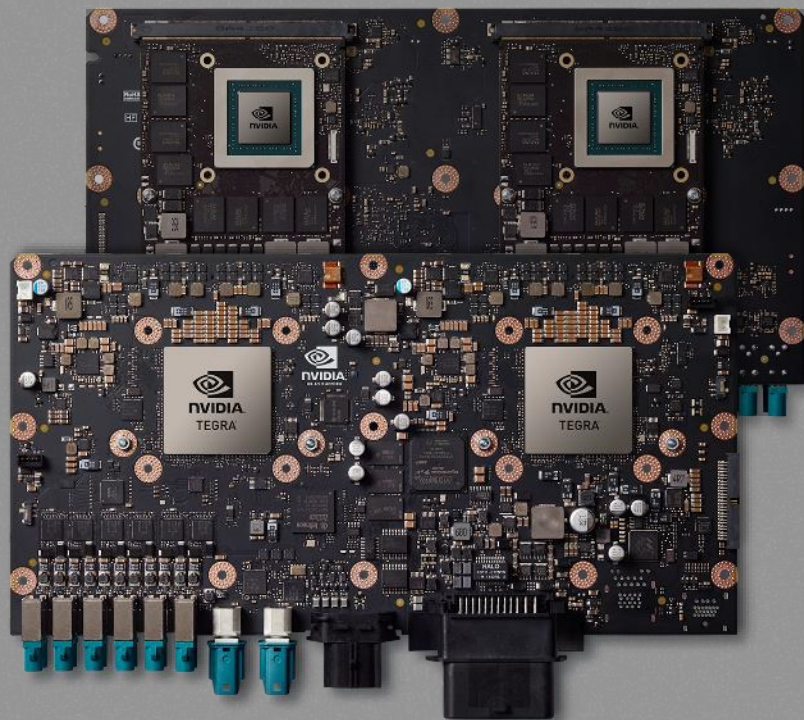


Lat 37.42
Lon -122.09



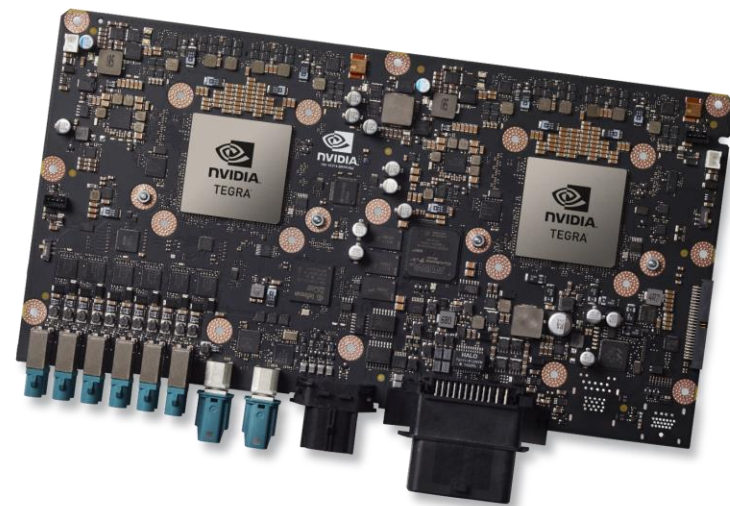


NVIDIA DRIVE PX 2



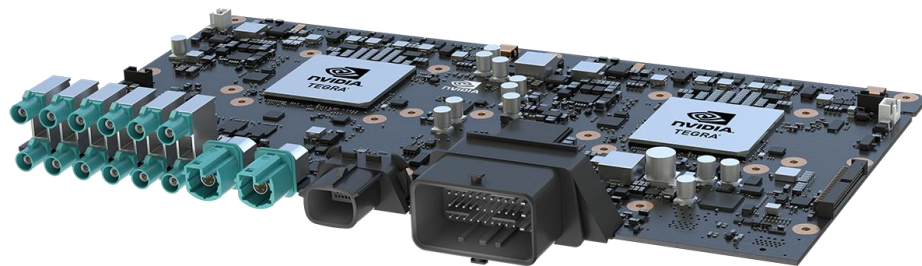
	TITAN X	DRIVE PX 2
Process	28nm	16nm FinFET
CPU	—	12 CPU cores 8-core A57 + 4-core Denver
GPU	Maxwell	Pascal
TFLOPS	7	8
DL TOPS	7	24
AlexNet	450 images / sec	2,800 images / sec

150 MACBOOK PROS IN YOUR TRUNK

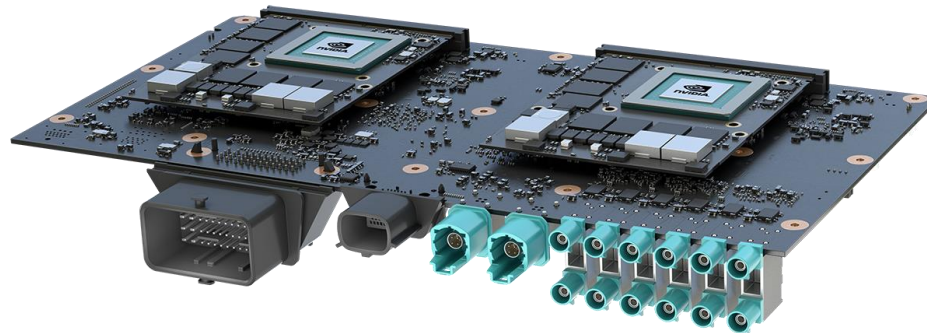


6 TITAN X = 42 TFLOPS, Core i7 = 280 GFLOPS, $42 / 0.28 = 150$ MacBook Pros

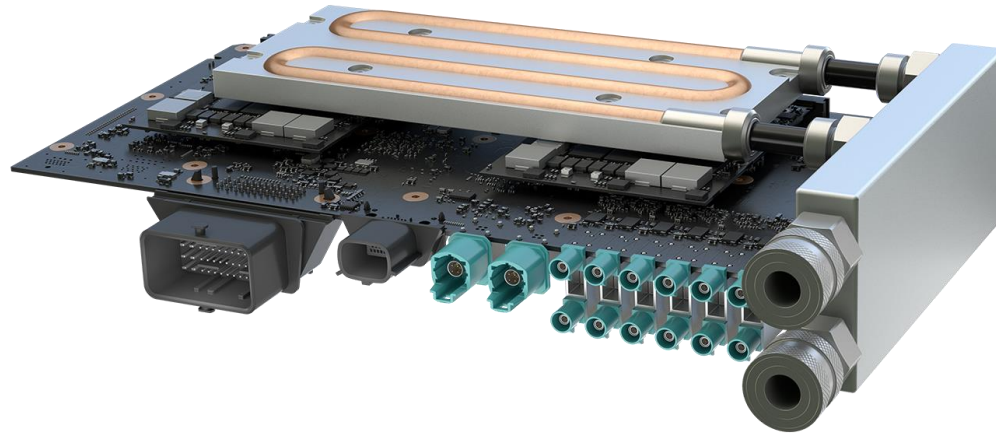
2 NEXT-GEN TEGRA PROCESSORS



2 NEXT-GEN PASCAL GPUS

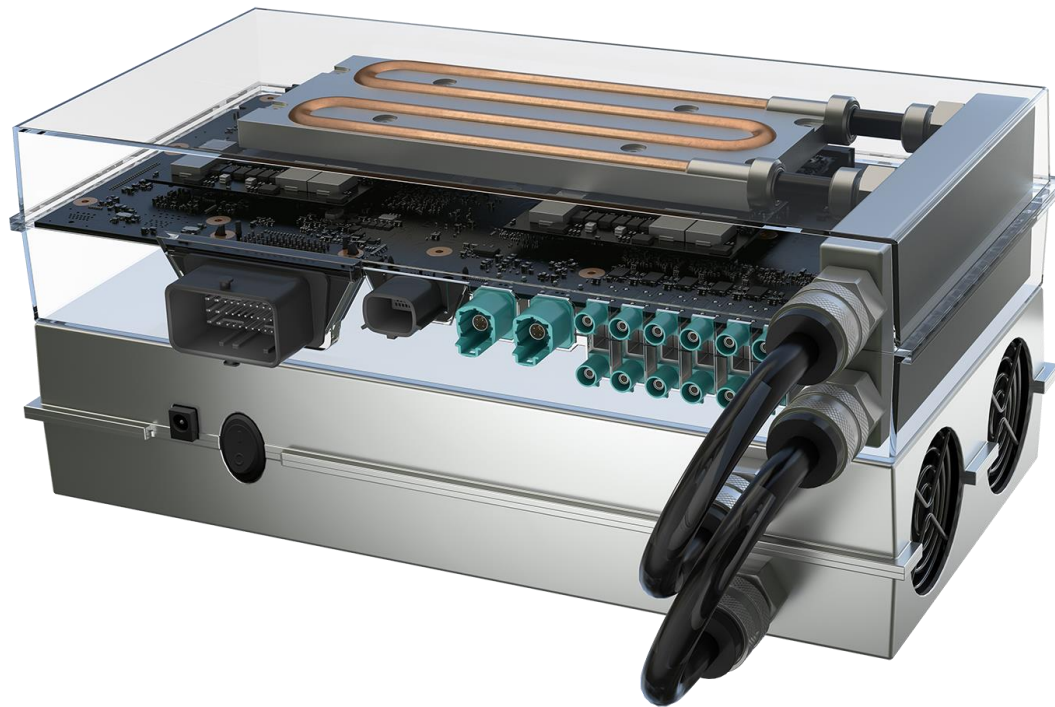


LIQUID COOLING



250W | Operation up to 80C (175F) ambient | 256 cubic inches

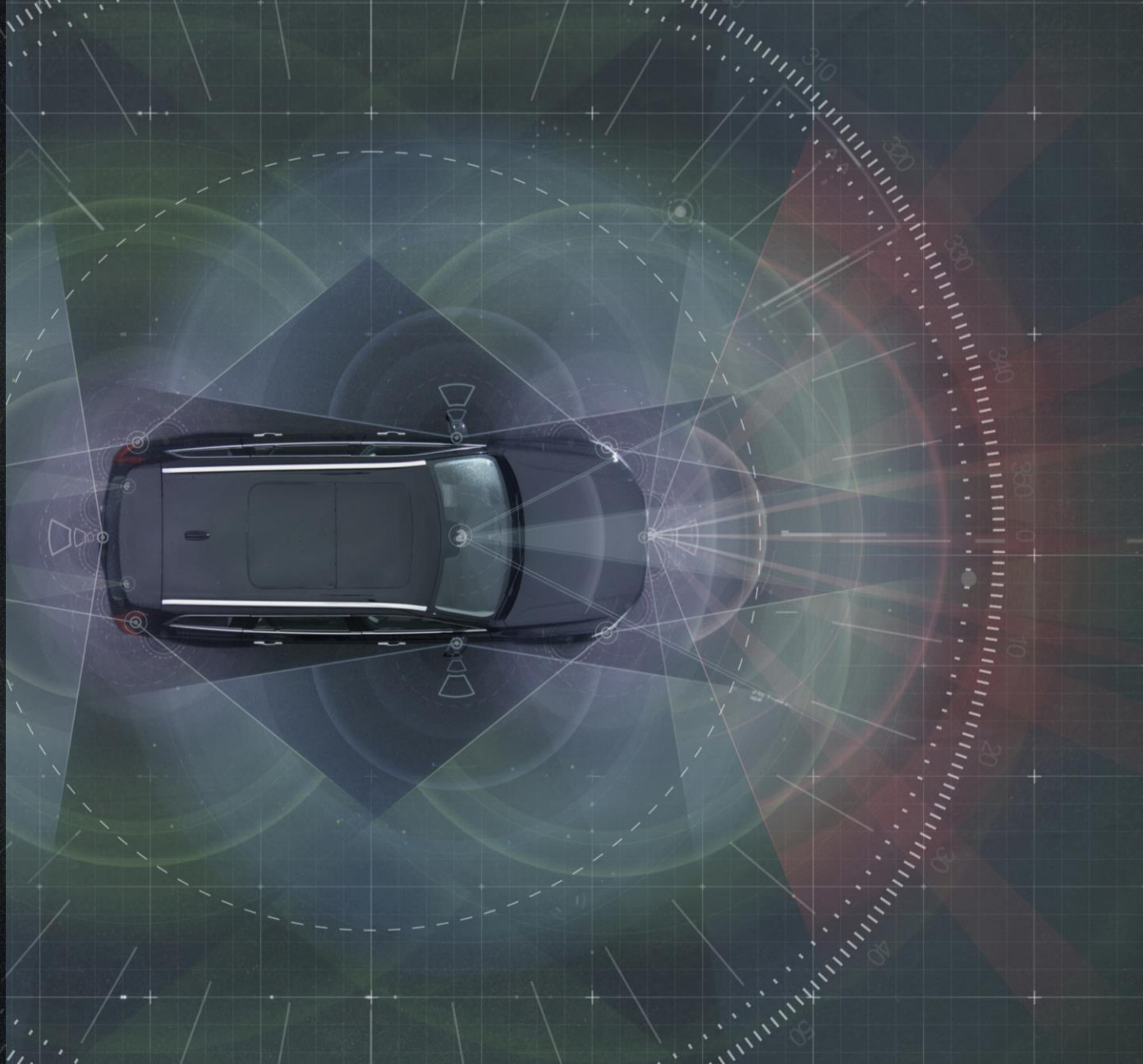
NVIDIA DRIVE PX 2



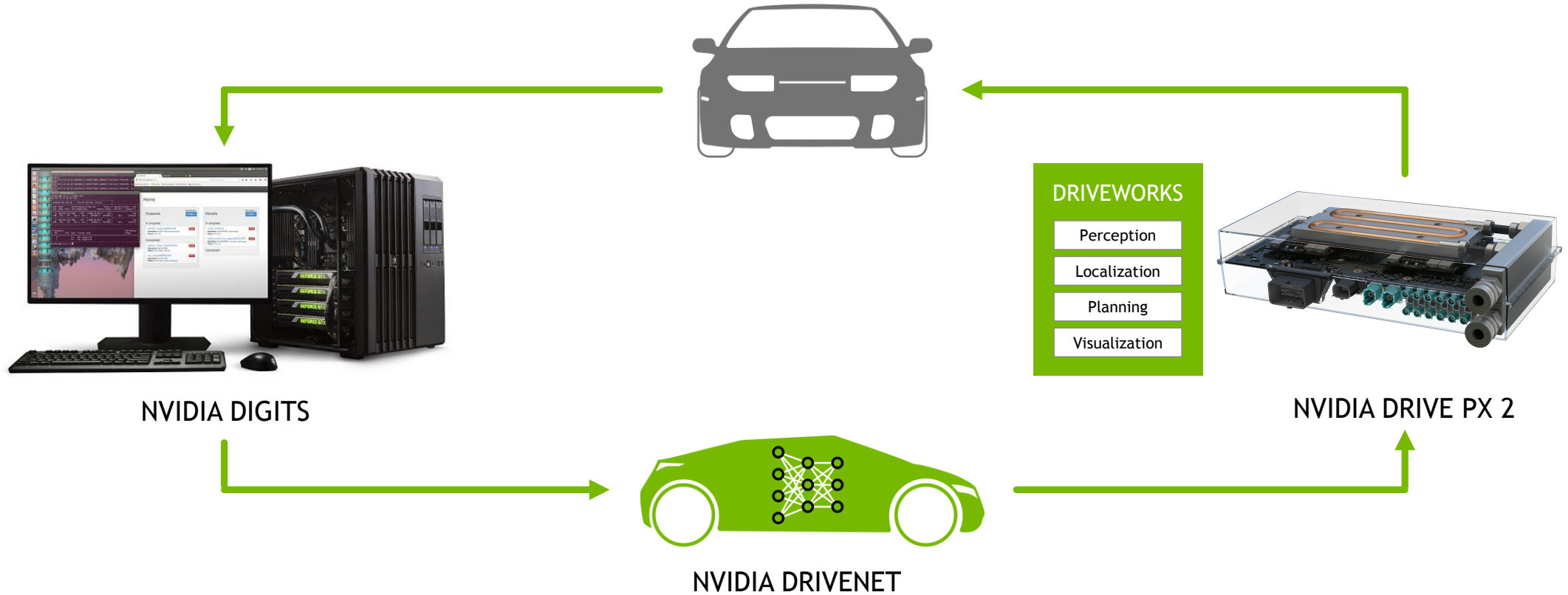
NVIDIA's Deep Learning Car Computer Selected by Volvo on Journey Towards a Crash-Free Future

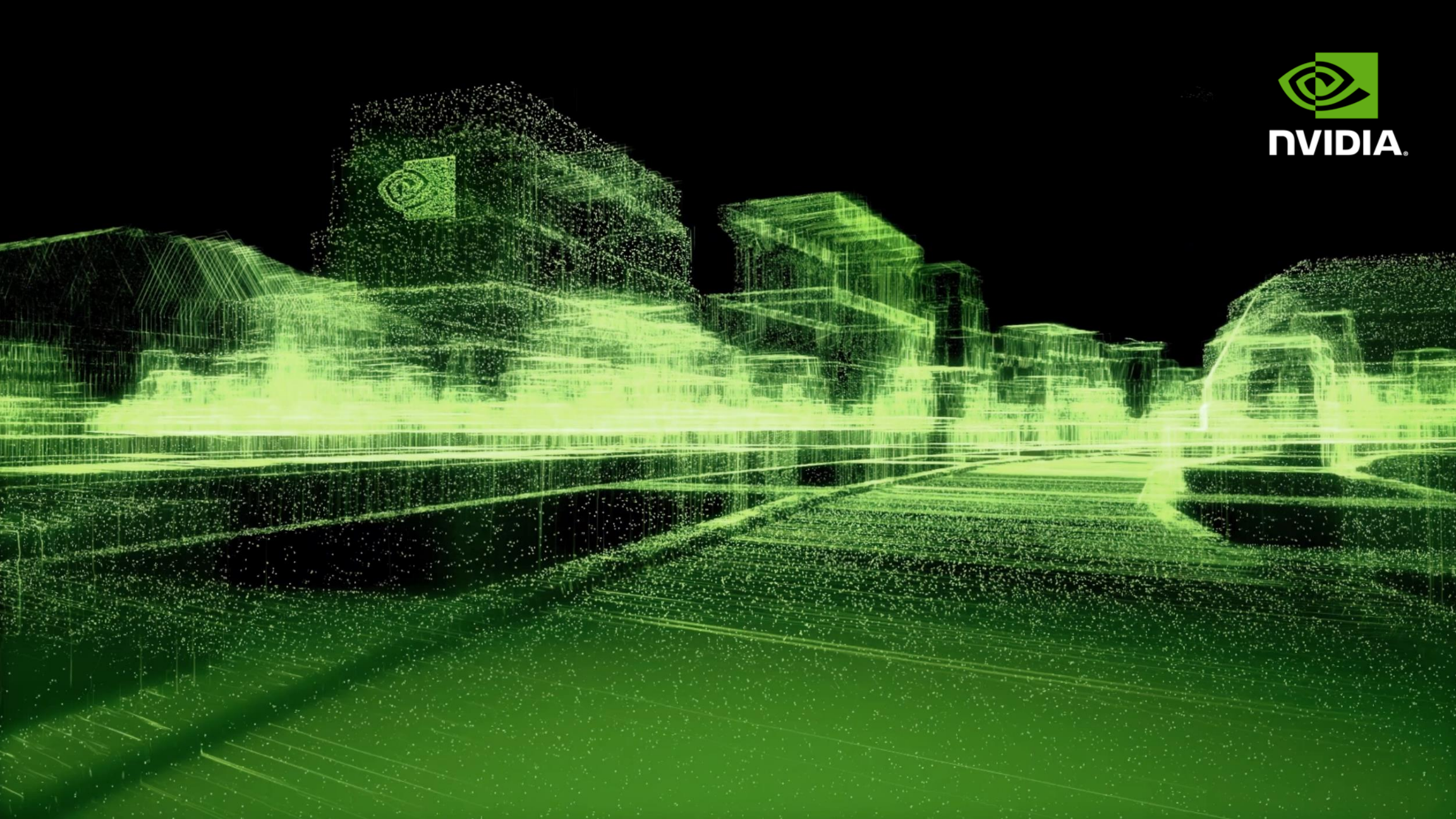


NVIDIA DRIVE



NVIDIA DRIVE PX SELF-DRIVING CAR PLATFORM





nvidia.