The Technical Impossibilities of Autonomous Driving

Mark Nitzberg

caruma

Berkeley AI Research Lab

IEEE Consultants' Network of Silicon Valley (IEEE-CNSV)
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Mark J. Nitzberg, PhD

Consulting CTO
Caruma Technologies, Inc.

Executive Director
UC Berkeley Center for Human Compatible AI

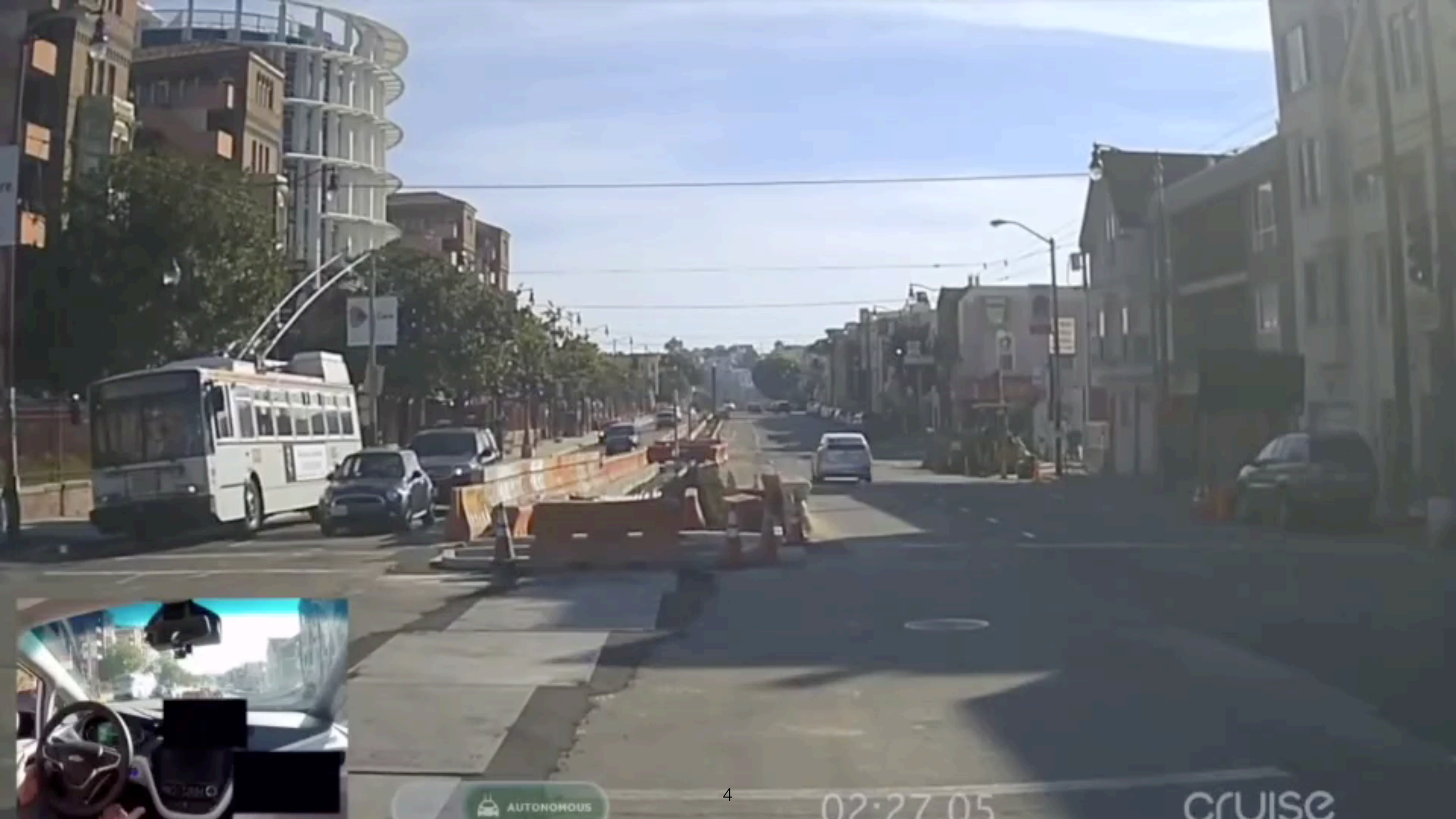
Prior to his roles at Caruma and Cal, Mark was Director, Computer Vision Products at A9 (Amazon), following their acquisition of The Blindsight Corporation, maker of assistive technologies for low vision and active aging, where he was founding CEO.

Mark has built companies and products in the areas of computer vision, machine learning, financial portfolio optimization, workflow efficiencies, online commerce, development aid data capture and analytics, and film and theatre.

He holds a Ph.D. in Computer Vision from Harvard University.

Agenda

- Autonomous vehicles primer
- What it takes to build one
- “Technical impossibilities”
- Bridge solutions / collateral benefits
- Skills needed


AUTONOMOUS
02:27.05
cruise

Levels of Automation

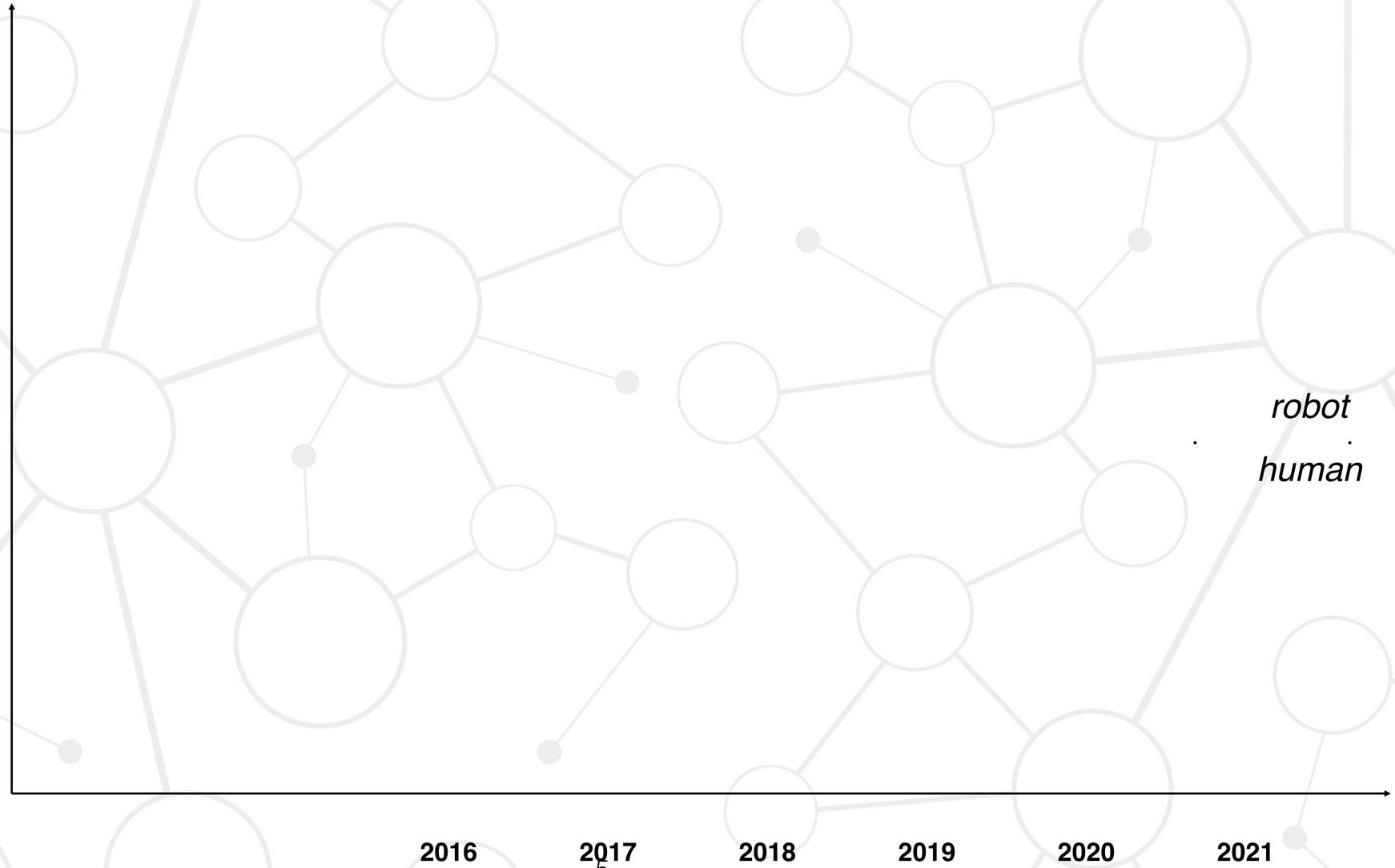
5 Full

4 High

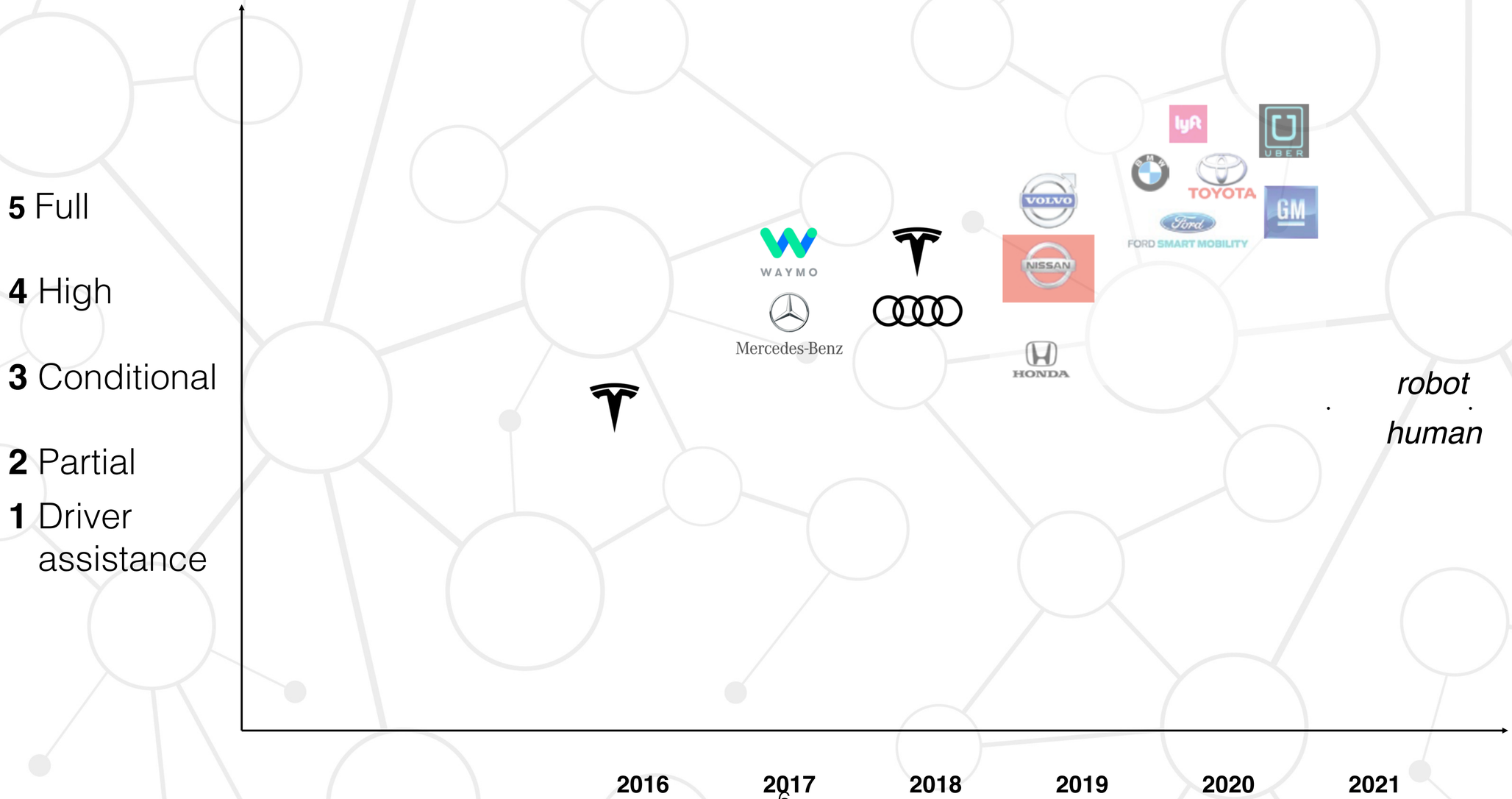
3 Conditional

2 Partial

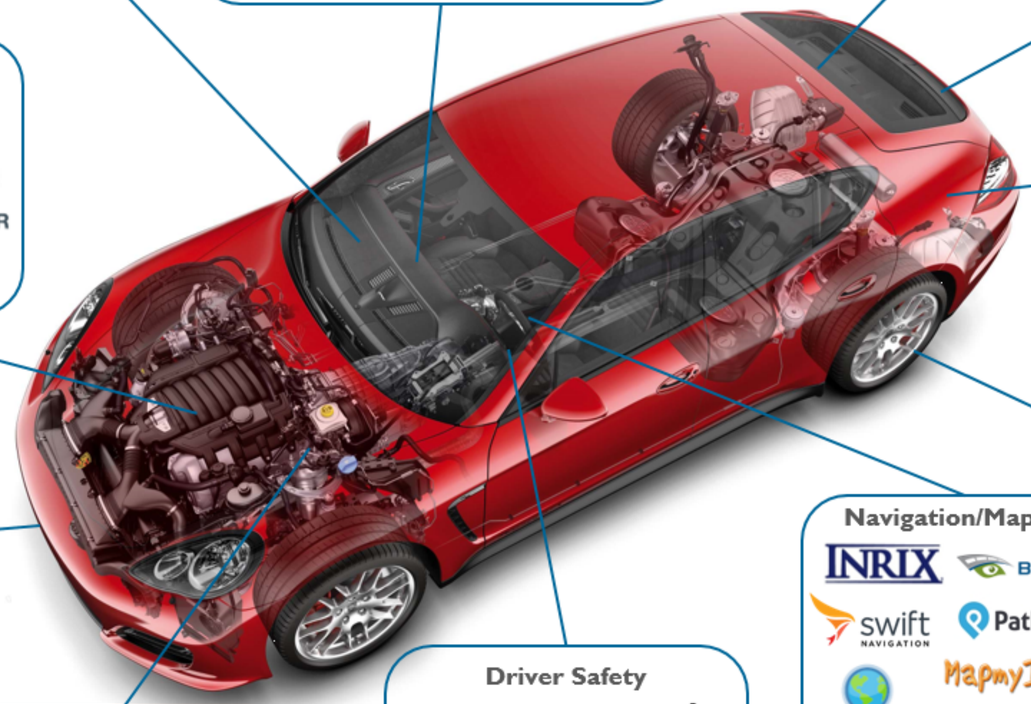
1 Driver assistance



Forecast


5 Full
4 High
3 Conditional
2 Partial
1 Driver assistance
WAYMO
Mercedes-Benz
VOLVO
NISSAN
HONDA
lyft
UBER
TOYOTA
GM
FORD SMART MOBILITY
robot
human
2016
2017
2018
2019
2020
2021

Transportation Tech is Exploding



Vehicle Cybersecurity
ARGUS CYBER SECURITY
Karamba Security
VisualThreat

Connected Car
dash
REMOTO
Airbiquity
Metromile
AutoBot
Automile
TRUVOLO
cariQ
carvi
AUTOMATIC
Zubie
mojio

V2V/V2X Communication
VENIAM
Savari
TTTech
RoboCV
KYMETA
CohdaWireless
Autotalks

ADAS/ Car Automation
nuTonomy
NAUTO
drive.ai
AdasWorks
Robot of Everything
ZMP
ZMX
OXBOTICA
(Comma.ai)

Engine Efficiency
ePower engine systems
YAN ENGINES
ACAT global
Pinnacle Engines
achatesPOWER
Agility fuel systems
EM

Auto Repair
CarZ
Your Safety. Our Passion.
YourMechanic
FAYETTE FABRICATION
ClickMechanic
HONK
openbay
URGENT.LY
REPAIR PAL
autobutler.dk
PITSTOP

Sensor Hardware
QUANERGY
LeddarTech
TRILUMINA
PHANTOM INTELLIGENCE

Tires
LDL TECHNOLOGY
Aperia TECHNOLOGIES
DMACK

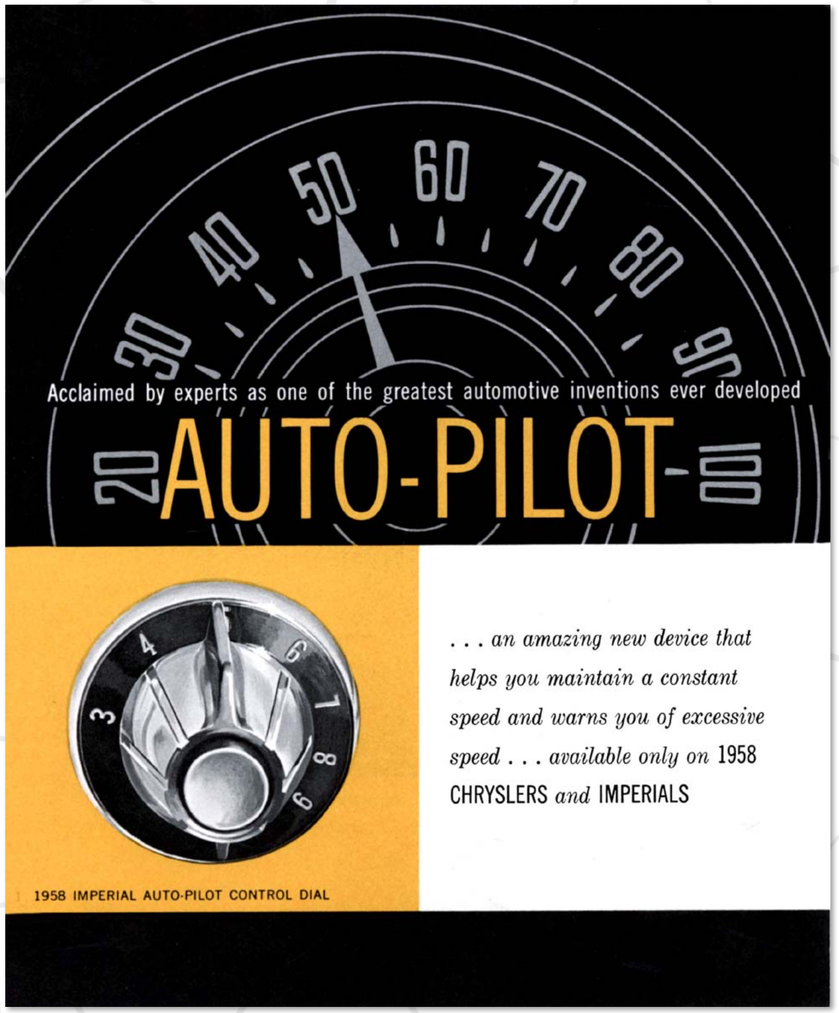
Navigation/Mapping
INRIX
BirdsEye
swift NAVIGATION
PathSense
navmii
MapmyIndia
MAPKIN

Battery Storage
Boston POWER
QuantumScape
solid energy
envia

Driver Safety
Zendrive
navdy
SMARTDRIVE
caruma
AUGARY
exploride

Created by
CB INSIGHTS
www.cbinsights.com

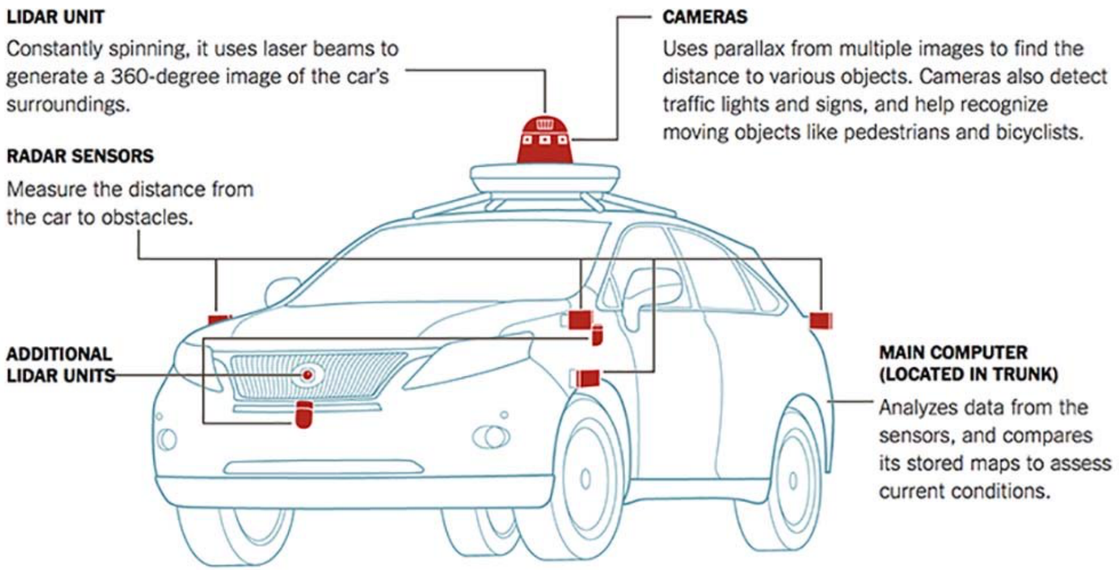
History: 1958



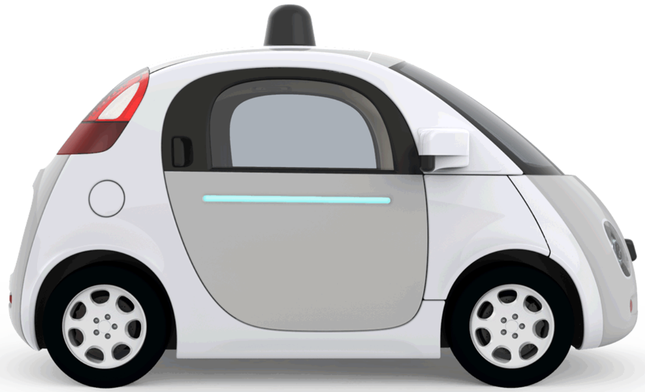
1912	Cadillac Self-Starter - crankless cranking
1939	Oldsmobile Hydra-Matic Drive AT
1951	Chrysler Hydra-Guide steering
1958	Chrysler cruise control
1970	Chrysler Imperial: sure-break ABS
1997	Toyota radar adaptive cruise
2003	Mercedes Pre-Safe brakes for moose
2004	Infiniti lane-departure warning
2005	Volvo blind-spot warning
2006	Lexus parallel-park assist
2007	CMU Tartan wins DARPA GC
2008	Mercedes Attn Assist - drowsy? warning
2009	Volvo pedestrian-detection
2010	Google AV's on CA roads

1986

Today



By Guilbert Gates | Source: Google | Note: Car is a Lexus model modified by Google.



Harder than it Looks

CNNMoney (New York)
April 4, 2016

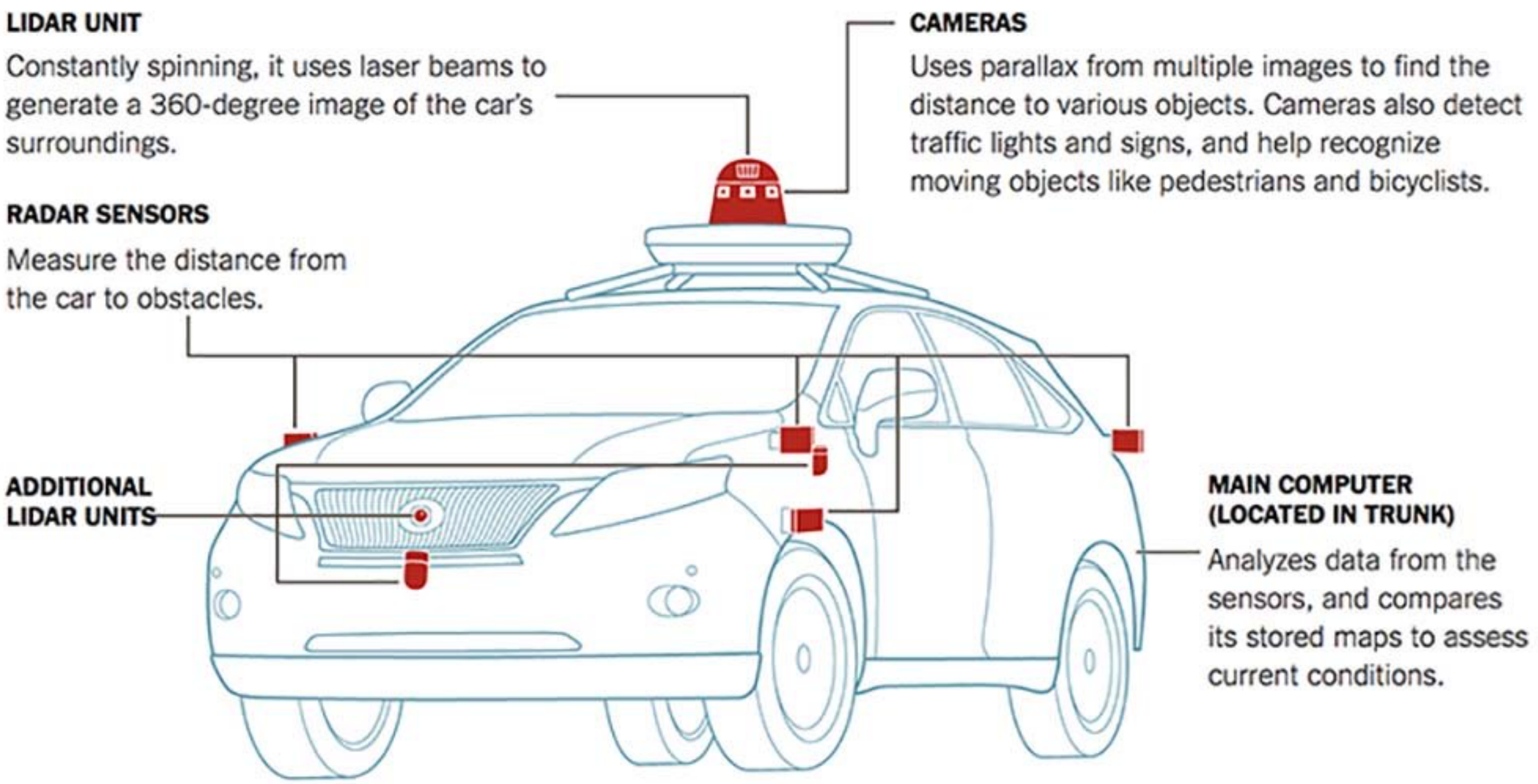
George Hotz
"How hard can it be?”

Bare Minimum

Good driver:

- Safety
- Speed
- Comfort
- Courtesy

More than a Mobile Phone



By Guilbert Gates | Source: Google | Note: Car is a Lexus model modified by Google.

Perception & Localization

- Perception:
  Cameras
  RaDAR
  LiDAR*
  ultrasound

- Localization:
  GPS+
  IMU
  odometry

- Supercomputer
  new options

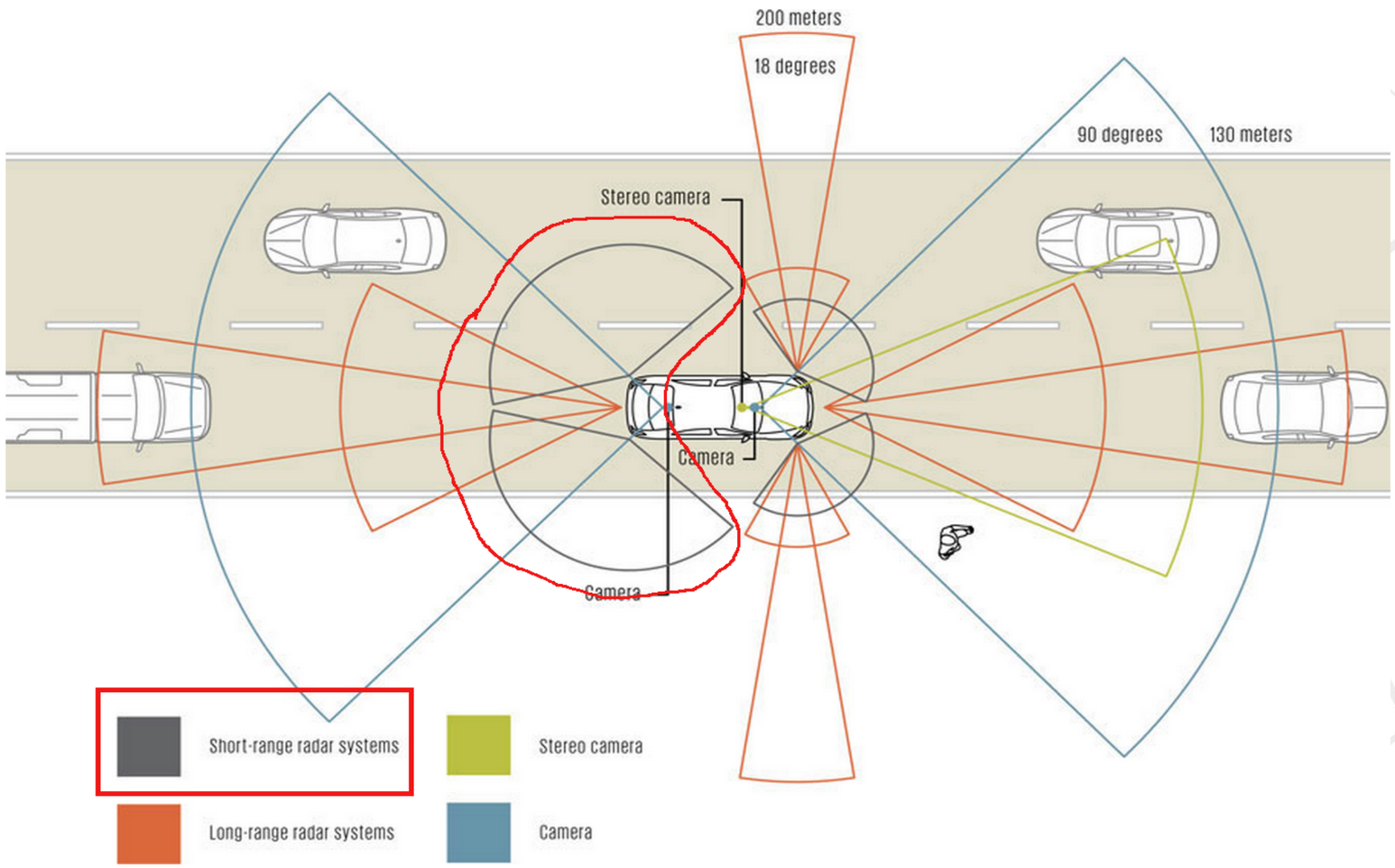


Illustration: John MacNeill

Sensors of different capabilities cover 360 degrees, with overlapping fields of view.

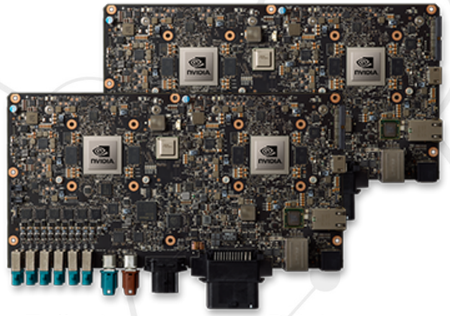
Source: Seeking alpha 10/22/2015

AV Supercomputer

- nVidia Drive
  PX 2 series

Autocruise

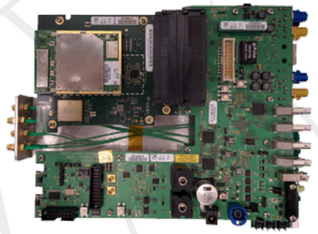
Chauffeur



Fully Autonomous Driving

- Intel GO platform
  Atom, Xeon & Arria 10 FPGAs

- Qualcomm
  Snapdragon
  820 Automotive
  processor



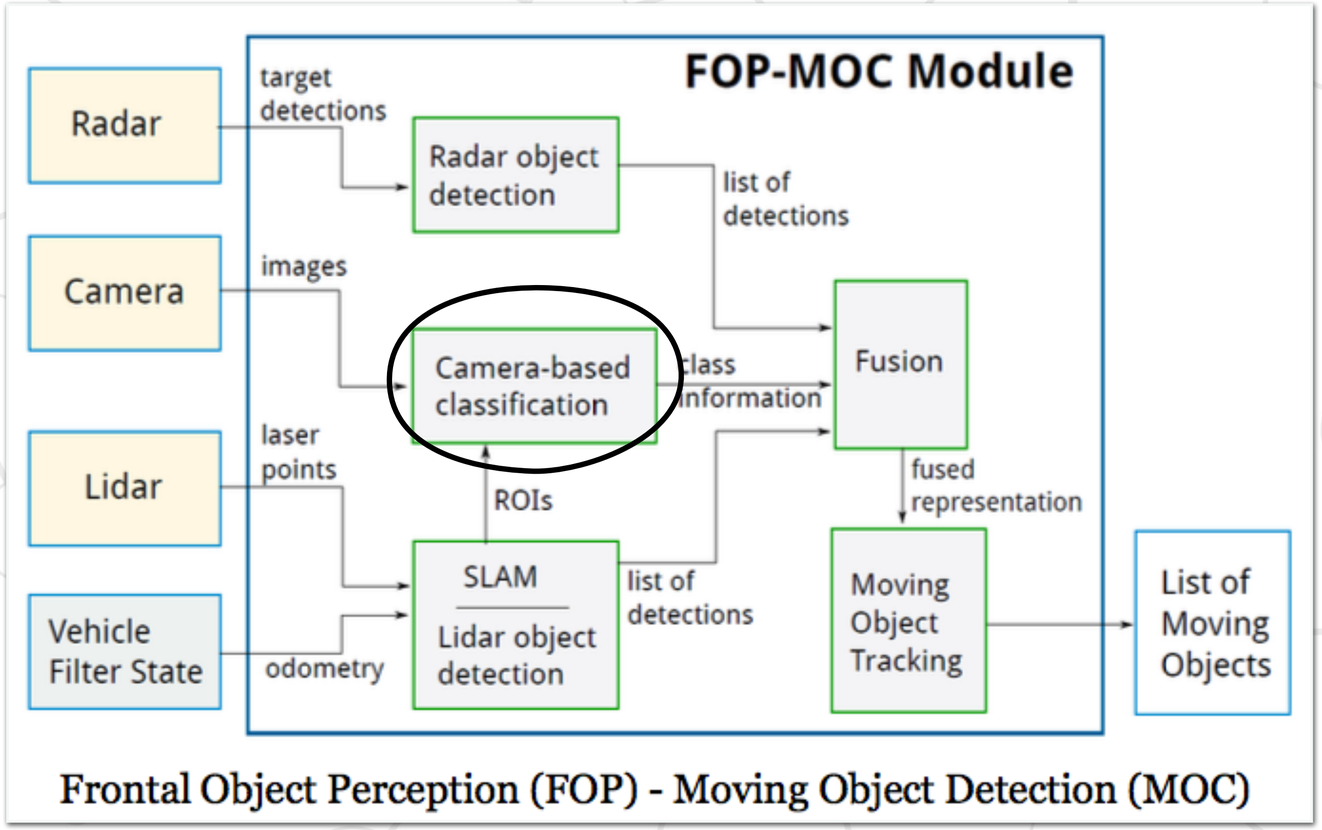
http://www.nvidia.com/object/drive-px.html 2/1/2017
http://www.intel.com/content/www/us/en/automotive/go-automated-driving.html 2/1/2017

Detection & Tracking

Find, ID & track multiple objects:

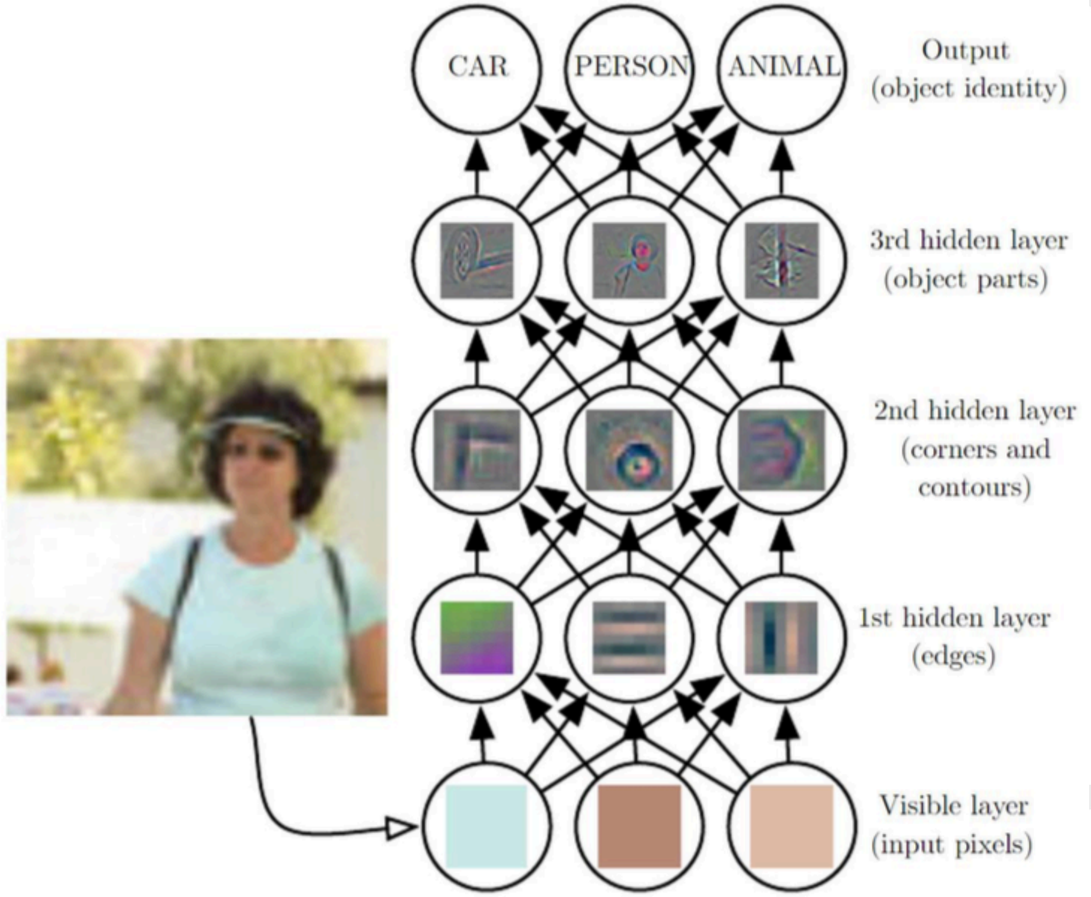
- Deep nets trained on hand-labelled datasets
- Pedestrians, cyclists, vehicles, signs, trees, sidewalks, painted lines.
- Output: boxes or pixel-by-pixel labels.

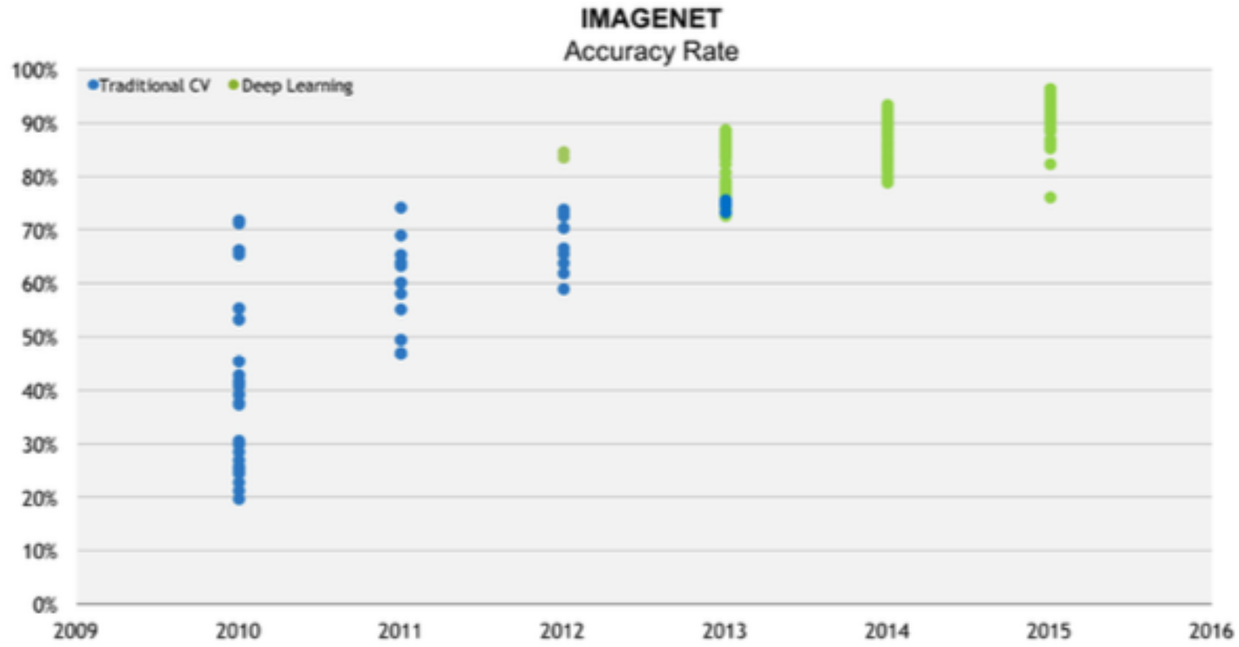
Impossible: complete training



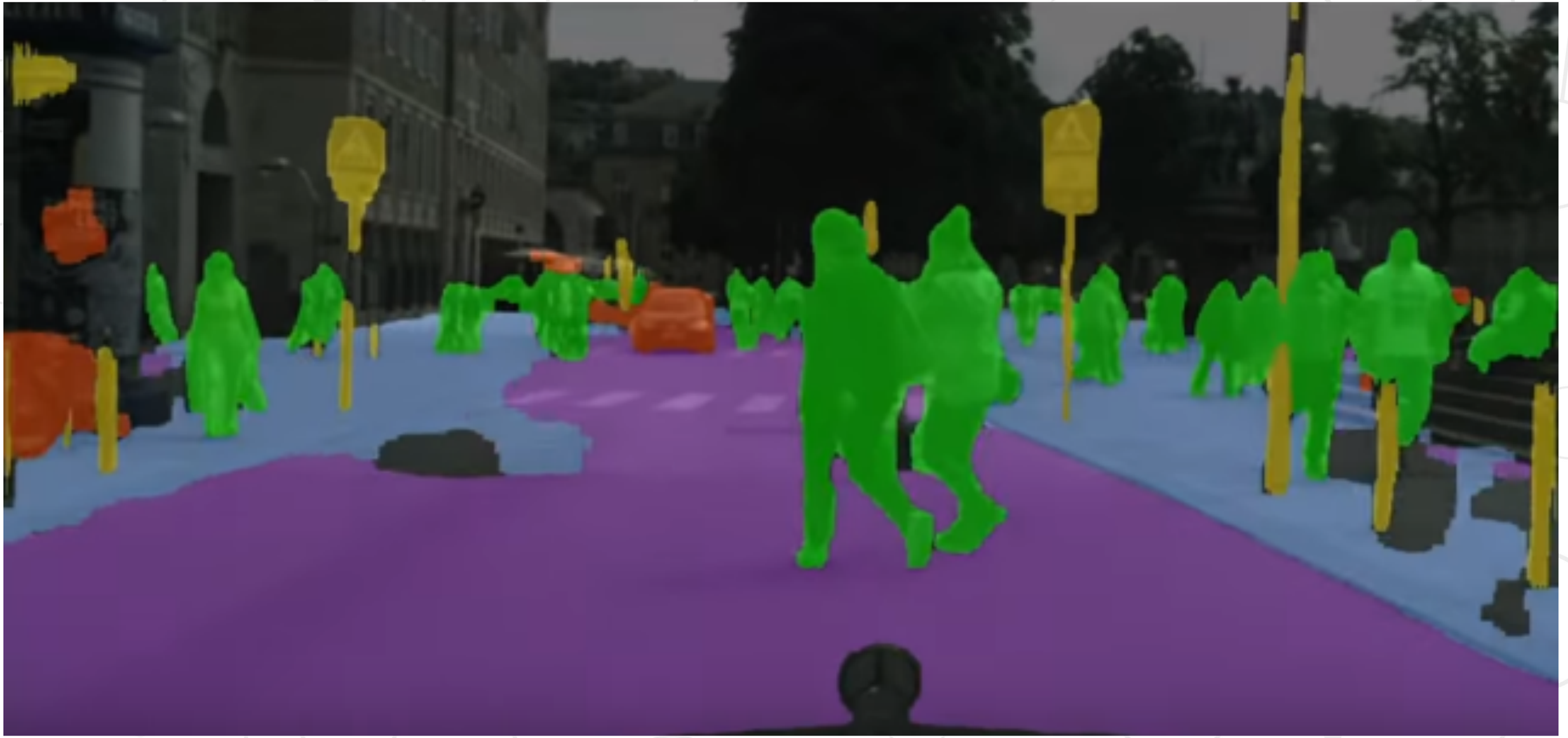
Source: Yu Huang, Baidu

Deep Networks





Deep Networks



Source: NVidia

Challenges

- **Technical**
- Legal / regulatory
- Privacy

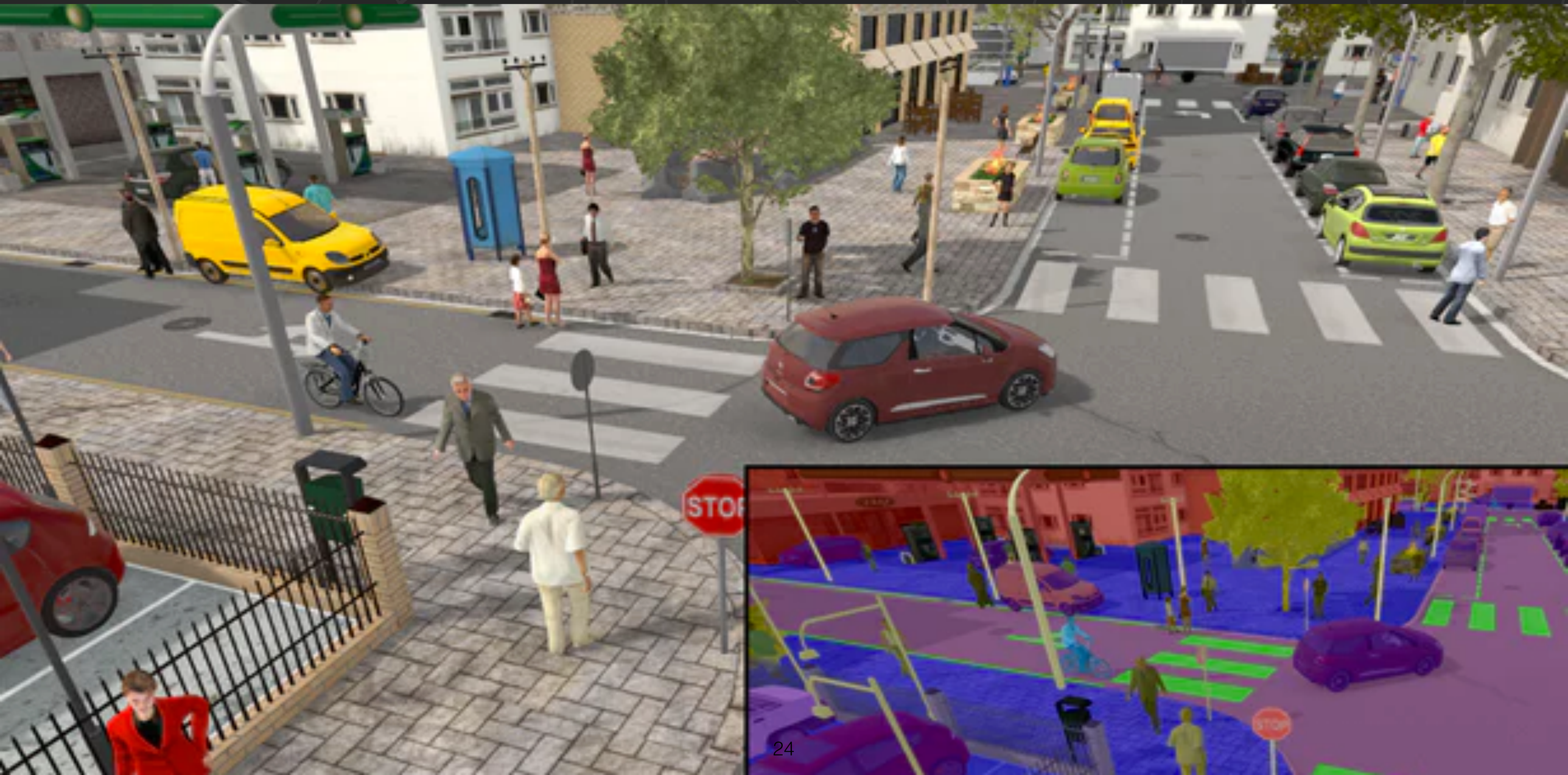
Challenges

The Unpredictable

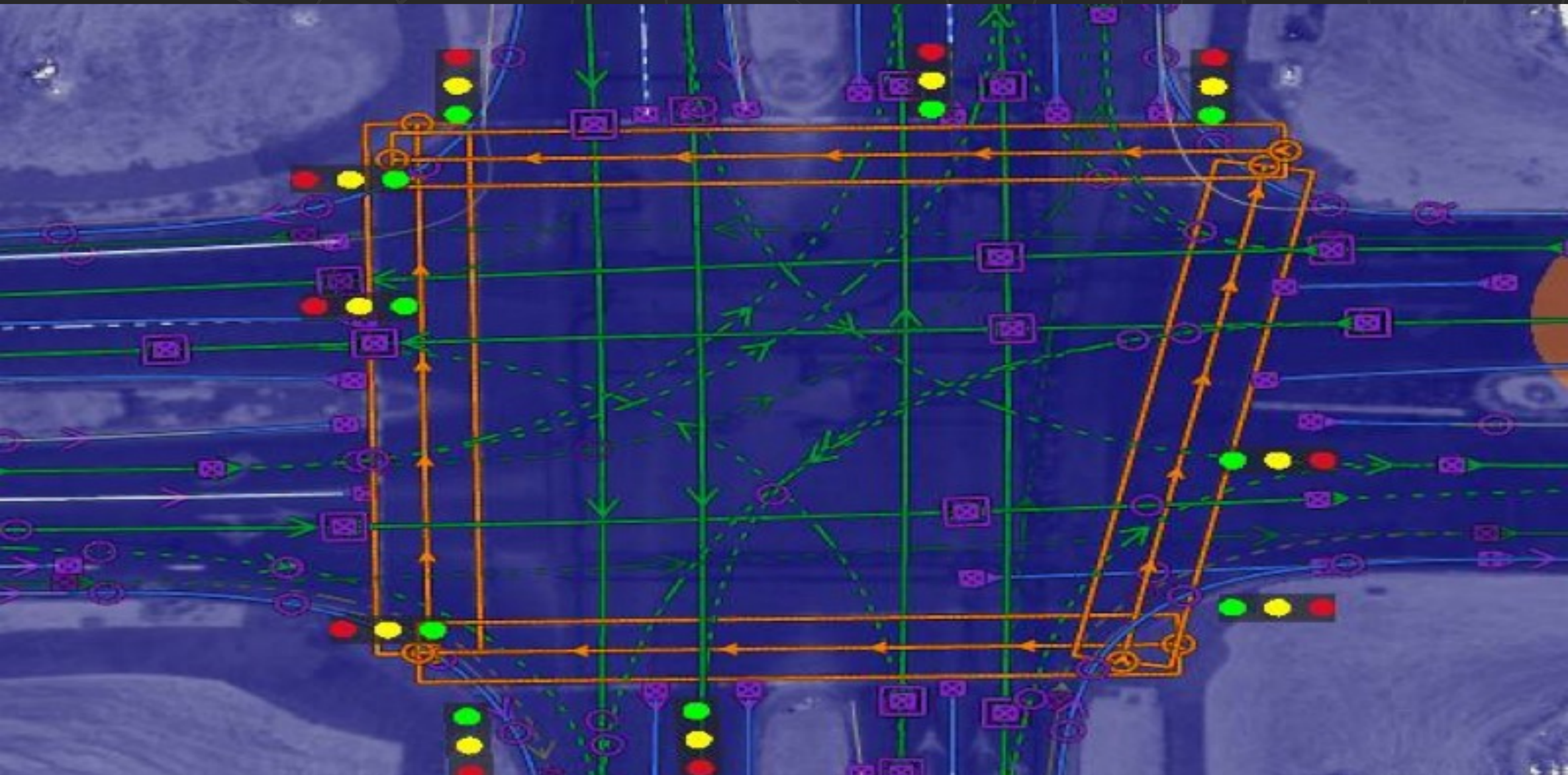

FALLING
ROCK

Source: sfcitizen.com 3/2012

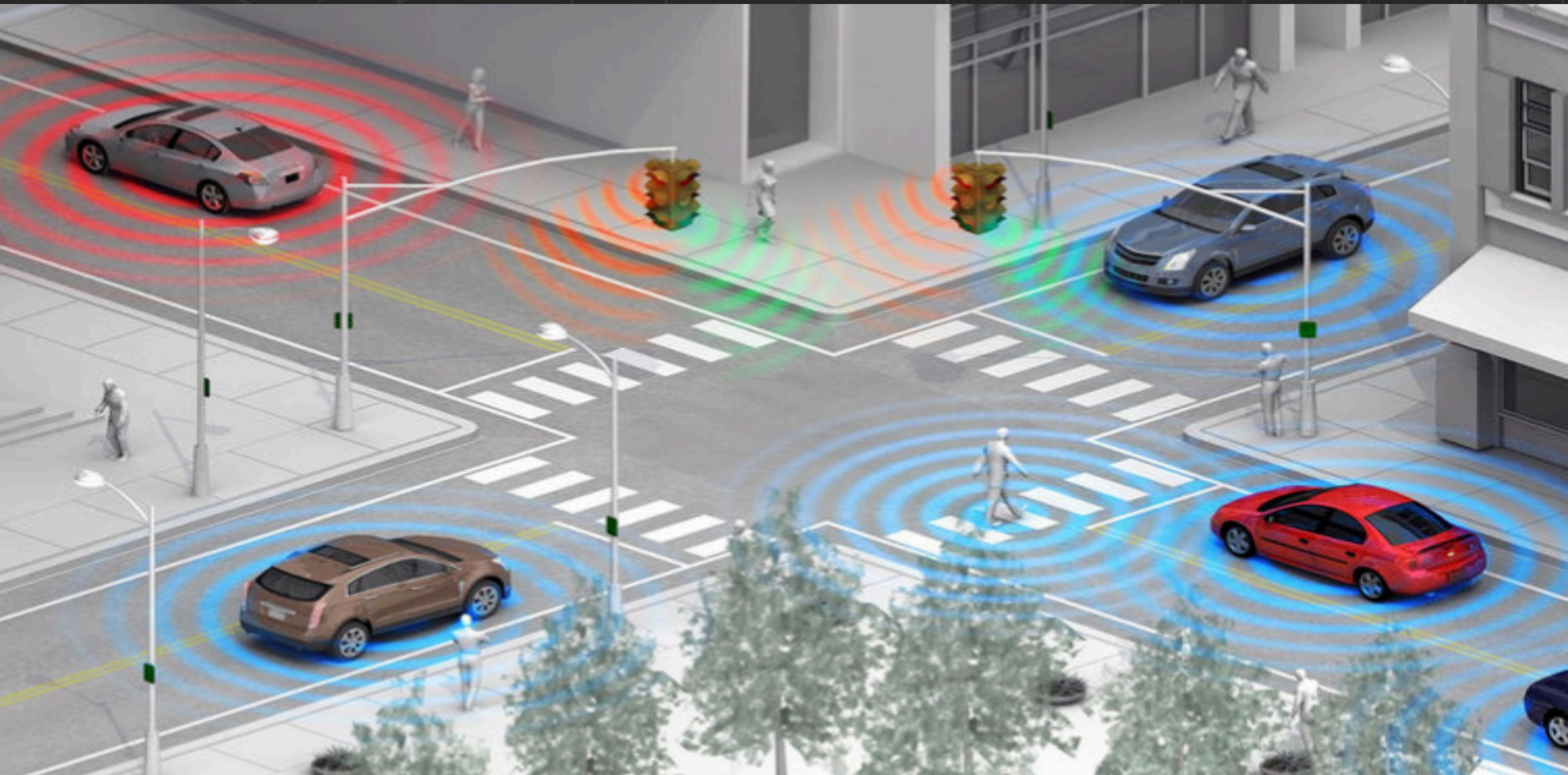
Potential Solutions: Simulation



Partial Solution: HD Maps



Partial Solution: V2x



Challenges

Rules of the Road

Official Signal: Context

Official Signal: Context

Source: The Greek Streets, June 30, 2011

Connected Car Platform

Safety

Tragically, nearly **1.3 million** people around the world are killed in traffic accidents every year.

94%

Collisions are caused by human decisions

66%

Collisions are caused by distracted driving

56%

Fatalities involve aggressive driving

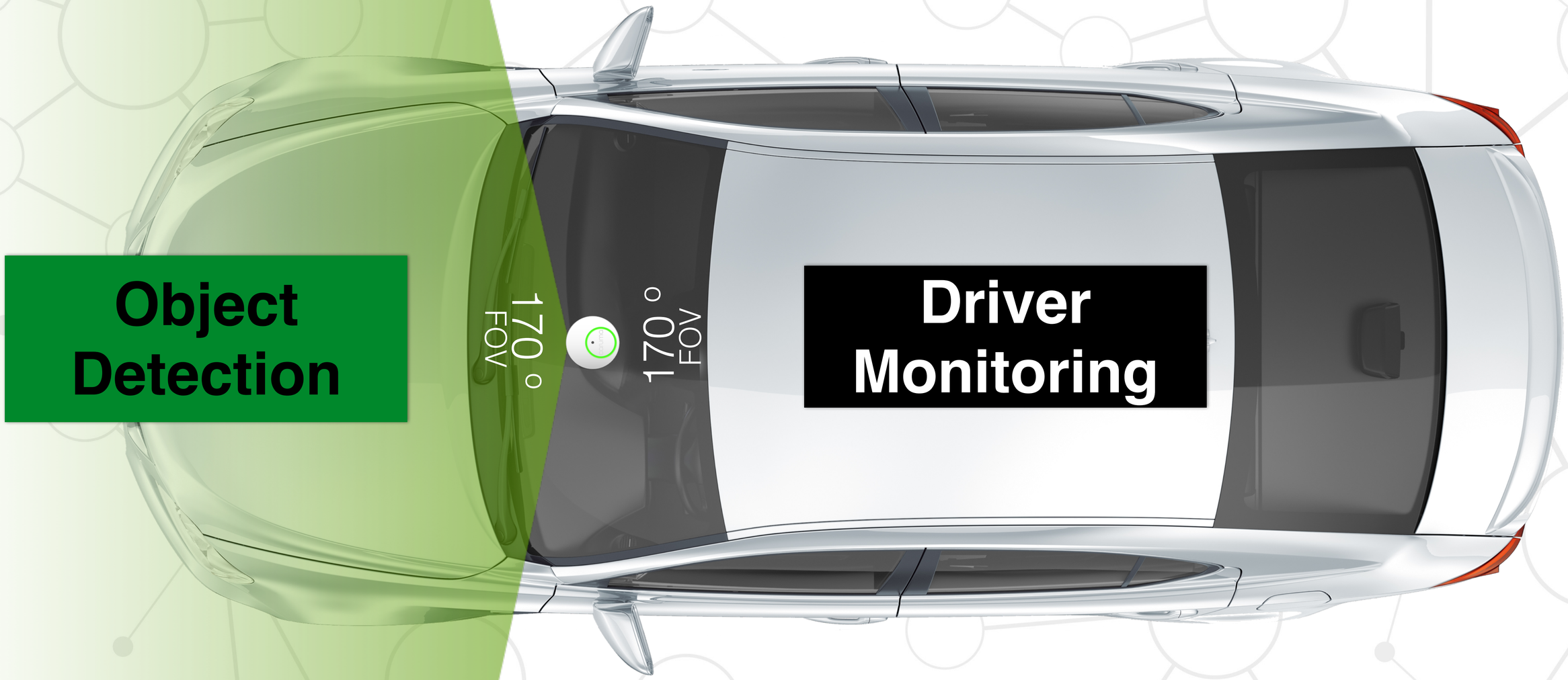
16%

Collisions are caused by drowsy driving

Source: Association For Safe International Road Travel (ASIRT) 2016

Caruma

State-of-the-art driver assistance with computer vision technology



Caruma

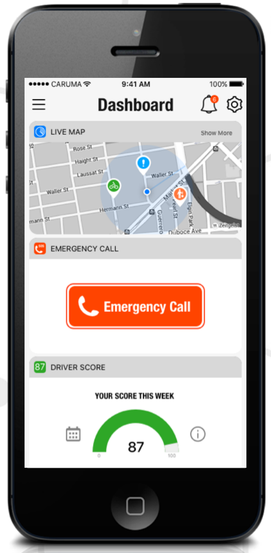
Caruma Technologies is about to change that with our initial technology offering that combines Big Data analytics, Cloud computing, High-Definition video and advanced mobile connectivity into a powerful vision-based connected car platform.

Caruma Cloud

a smart cloud system where video and data are stored and converted into actionable information.

Caruma App

Free web and mobile app.



Caruma Cam

an intelligent connected device that easily mounts inside any vehicle.

Skills Needed for AV

Deep Learning

Computer Vision

Sensor Fusion

Mapping

Analytics

Q&A