ADASTEC

Automated, Shared, Connected

May 2020

About ADASTEC

Focus

Main focus of ADASTEC TEC-DRIVE Platform

Controlled Area

Pre-defined and dedicated roads, limited access traffic areas in cities, (university or hotel campus areas, etc.)

Level 4 Automated

Level 4 : Automated in Controlled Area.

Cloud Services

Dynamic Data like traffic, parking space, etc.

Location Based Marketing ecosystem.

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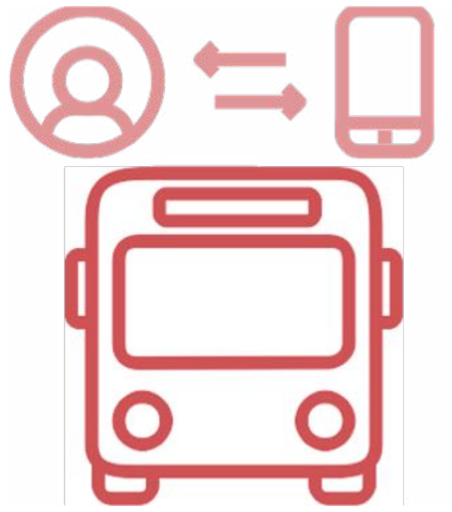


Shared Fleet Operations

Scheduling, Route planning, etc.

Production

What are we currently working on?

OEM Agreement: Karsan

- Manufacturing buses for public transportation and semi-trailers for logistics.
- L4 Automated Bus Project for Electric Atak powered by BMW

Sustainable BUS

HOME NEWS E-MOBILITY ALTERNATIVE FUEL COACH SMART MOBILITY PARTS EVENTS INTERVIEW

Karsan autonomous bus. Work in progress to implement the Atak Electric

Home / Electric Bus, News / Karsan autonomous bus. Work in progress to implement the Atak Electric

Karsan is developing an autonomous version of its 8-meter city **electric bus** Atak Electric. The Turkish manufacturer announces it will bring SAE **Level-4 Autonomous driving skills in the electric vehicle.** Prototype is scheduled to be completed by August 2020, Karsan's CEO states. Technological system for driverless operations is provided by California-based company **Adastec**.

In March 2020 Karsan stated that **orders for 20 electric Atak have been secured so far**. The key features of Karsan range of battery-electric buses (the 6-meter **Jest Electric** and **Atak Electric**) is that they are equipped with BMW battery system.

Karsan autonomous bus, work in progress

The project to be carried out by Karsan's R&D team aims to provide Atak Electric with Level-4 Autonomous driving skills. For the project the company collaborates with **Adastec**, which has past experiences in autonomous vehicles, and expects to complete the first prototype for the autonomous Atak Electric vehicle in August.

Atak Electric will feature autonomous driving skills following the integration of Level-4 Autonomous software programs (according to **SAE's chart**) developed by Adastec into Atak Electric's electrical and electronic architecture and electric vehicle software. Testing and validation works on Karsan autonomous bus will continue until the end of the year.

Search...

SOLARIS DIRECTION › E-mobility

Popular Recent

Sustainable Bus Award 2019: the prize gets more European at IAA
April 1st, 2018

Masabi and Uber in team for multimodal journeys
April 5th, 2018

Smart buses in the crosshairs of Scania and Haylion Technologies
April 11th, 2018

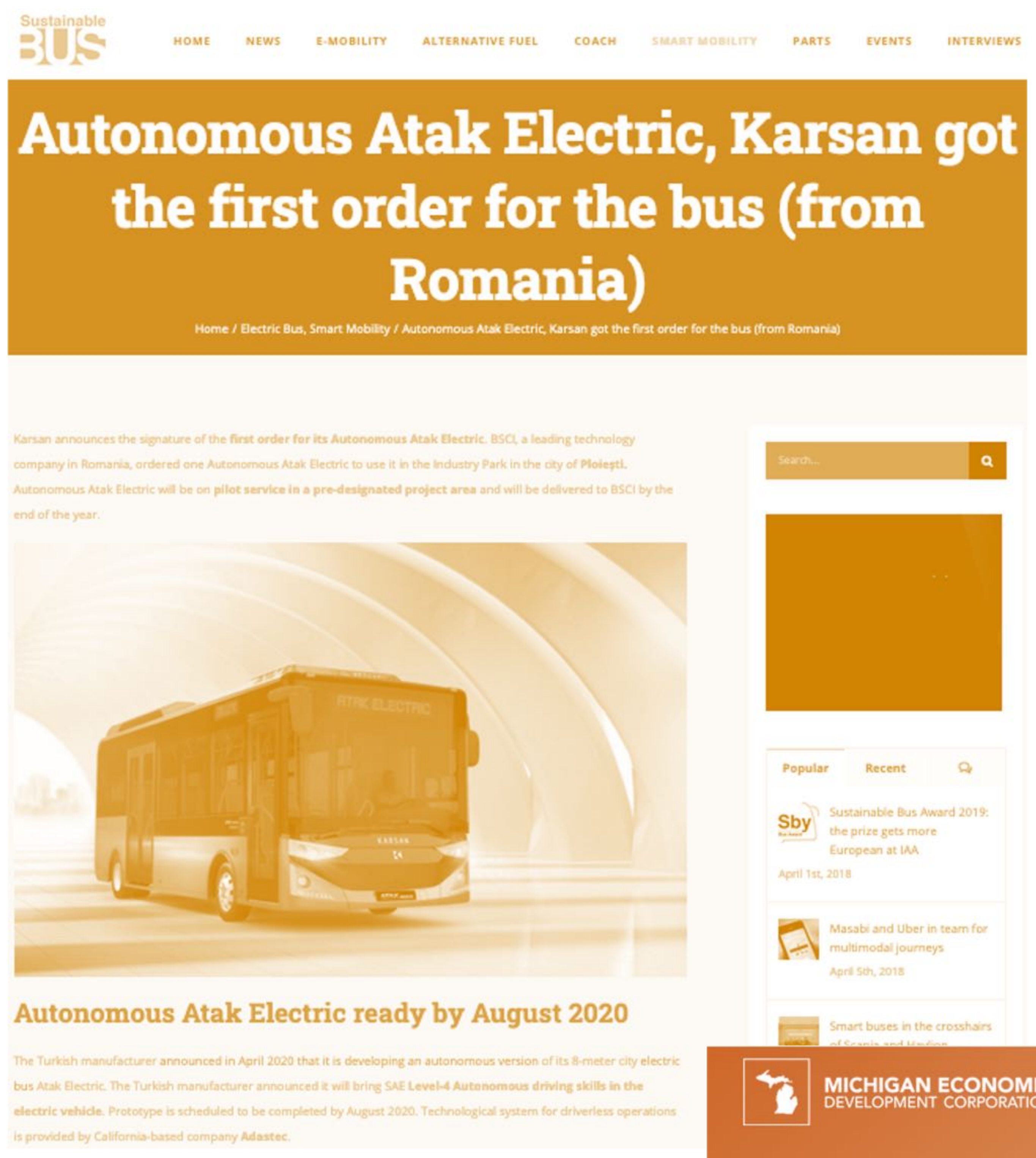
CAETANO Imagine your city with us

Deployments

What are we currently working on?

Bucharest - Romania

- Autonomous Shuttle Bus Project in Bucharest, Romania with the partnership of the bus producer KARSAN.
- RFI responded > March 2019
- Contract awarded October 2019
- Scheduled demo > 2020 Q4



Sustainable BUS

HOME NEWS E-MOBILITY ALTERNATIVE FUEL COACH SMART MOBILITY PARTS EVENTS INTERVIEWS

Autonomous Atak Electric, Karsan got the first order for the bus (from Romania)

Home / Electric Bus, Smart Mobility / Autonomous Atak Electric, Karsan got the first order for the bus (from Romania)

Karsan announces the signature of the **first order for its Autonomous Atak Electric**. BSCI, a leading technology company in Romania, ordered one Autonomous Atak Electric to use it in the Industry Park in the city of **Ploieşti.** Autonomous Atak Electric will be on **pilot service in a pre-designated project area** and will be delivered to BSCI by the end of the year.

Autonomous Atak Electric ready by August 2020

The Turkish manufacturer announced in April 2020 that it is developing an autonomous version of its 8-meter city electric bus Atak Electric. The Turkish manufacturer announced it will bring SAE **Level-4 Autonomous driving skills in the electric vehicle.** Prototype is scheduled to be completed by August 2020. Technological system for driverless operations is provided by California-based company **Adastec**.

Search...

Popular Recent

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April 1st, 2018

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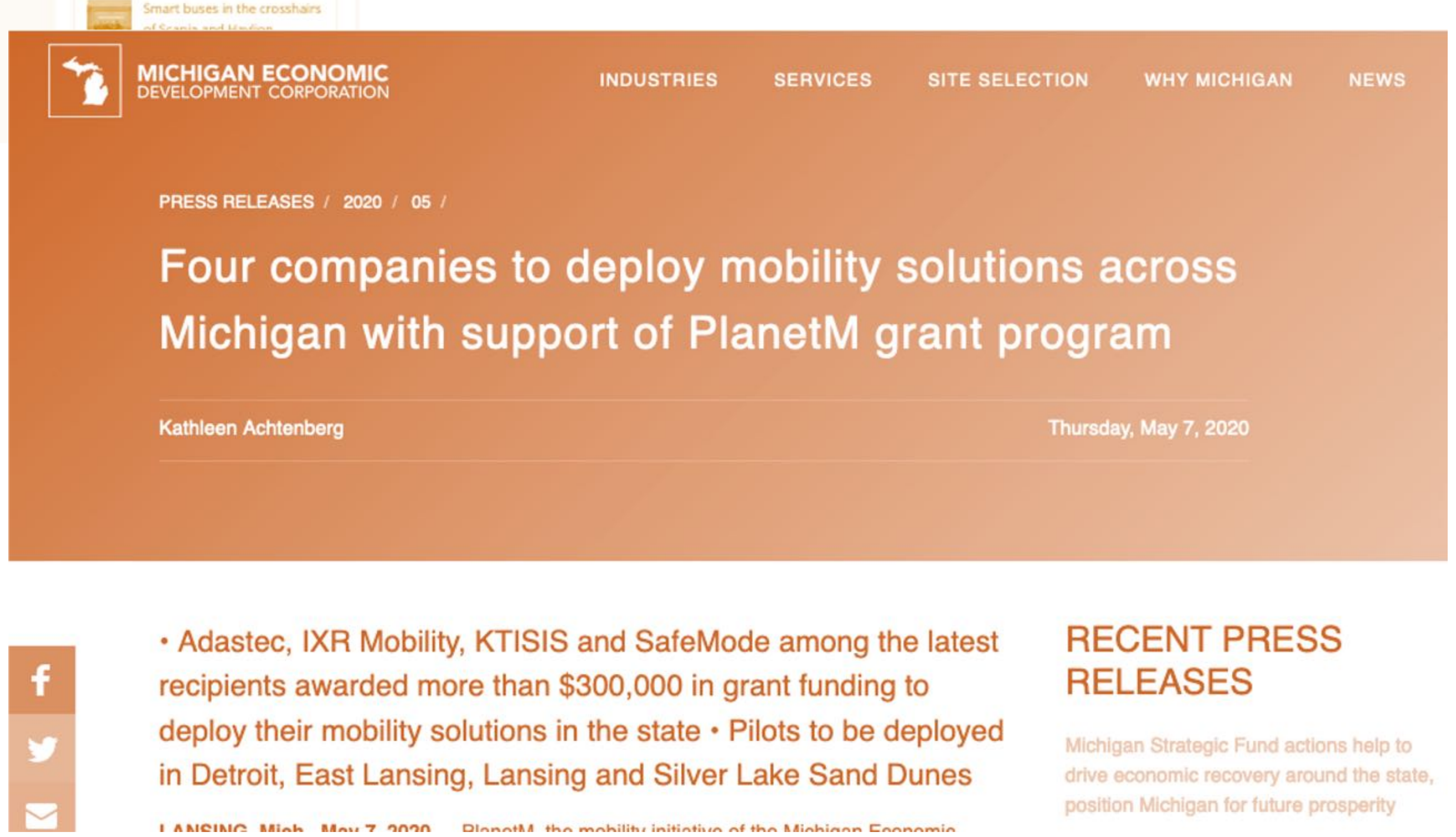
April 5th, 2018

Smart buses in the crosshairs

Michigan State University - US

- A real-life pilot of a full-size, electric, Level 4 automated bus within the MSU campus
- Automated shuttle services along the Farm Lane between Mount Hope Road and the Auditorium
- First full size automated L4 bus demo
- Crucial use-cases specific to public transportation



MICHIGAN ECONOMIC DEVELOPMENT CORPORATION

INDUSTRIES SERVICES SITE SELECTION WHY MICHIGAN NEWS

PRESS RELEASES / 2020 / 05 /

Four companies to deploy mobility solutions across Michigan with support of PlanetM grant program

Kathleen Achtenberg Thursday, May 7, 2020

• Adastec, IXR Mobility, KTISIS and SafeMode among the latest recipients awarded more than $300,000 in grant funding to deploy their mobility solutions in the state • Pilots to be deployed in Detroit, East Lansing, Lansing and Silver Lake Sand Dunes

RECENT PRESS RELEASES

Michigan Strategic Fund actions help to drive economic recovery around the state, position Michigan for future prosperity

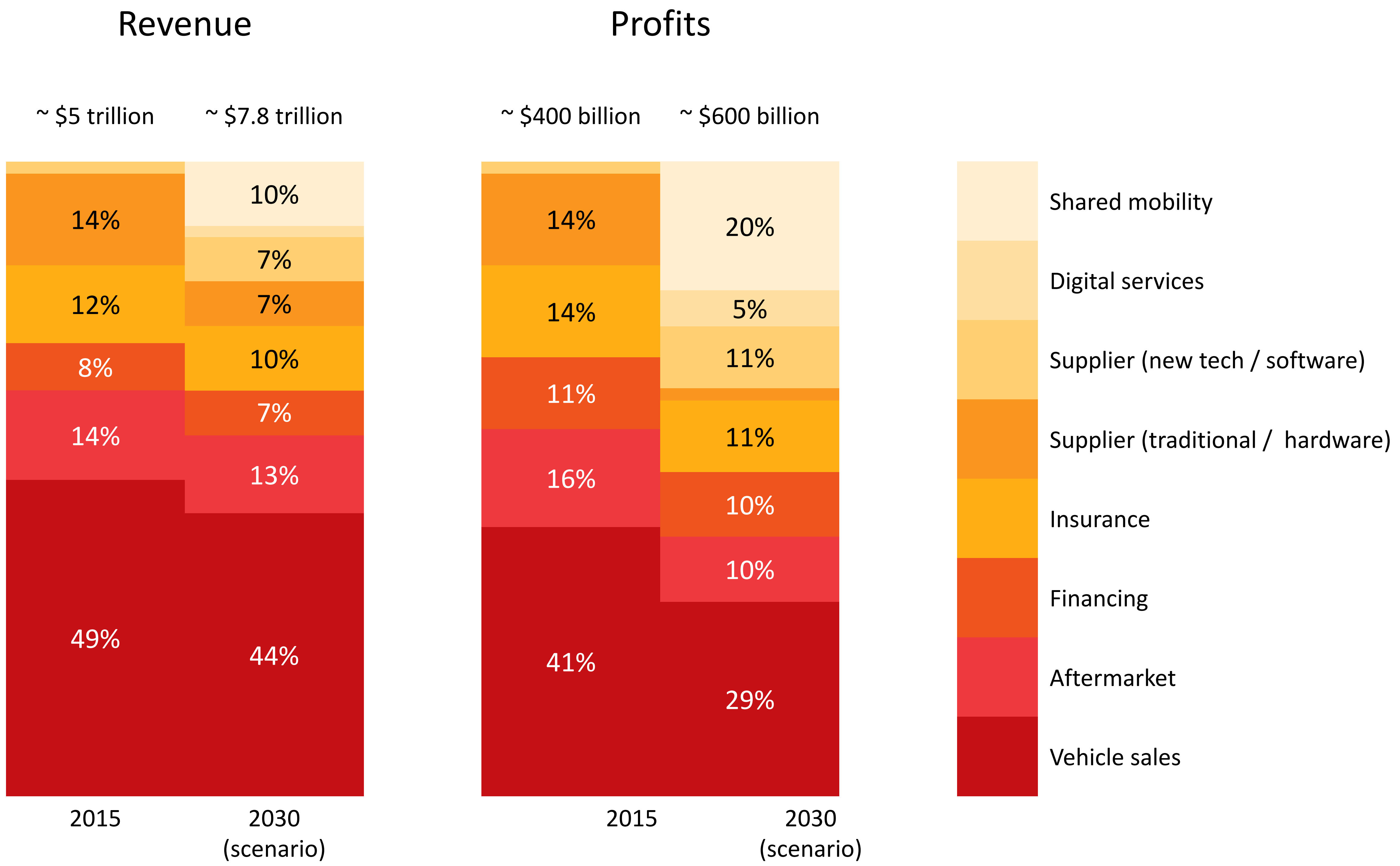
Automation and Public Transportation, Why? When?

Value Shift in the Auto Industry, 2030

How will be the value in automotive industry distributed by 2030?

	From Now	To 2030
Revenues increasing	$5 trillion	As much as $7,8 trillion
Profits increasing	$400 billion	As much as $600 billion
Supplier revenues will shift	Engines, interiors and chassis	Electronics, Software and Cloud Services
Profits will shift	New cars sales (*)	Shared mobility and digital services

(*) : profits from new cars will decline as the industry shifts to less differentiated, low-cost vehicles such as robo-taxis, as robo-fleets put pricing pressure on the automakers and as the cost of the technology in cars rises.



Connected Car Report – 2016 - pwc

Autonomous > Product vs Service

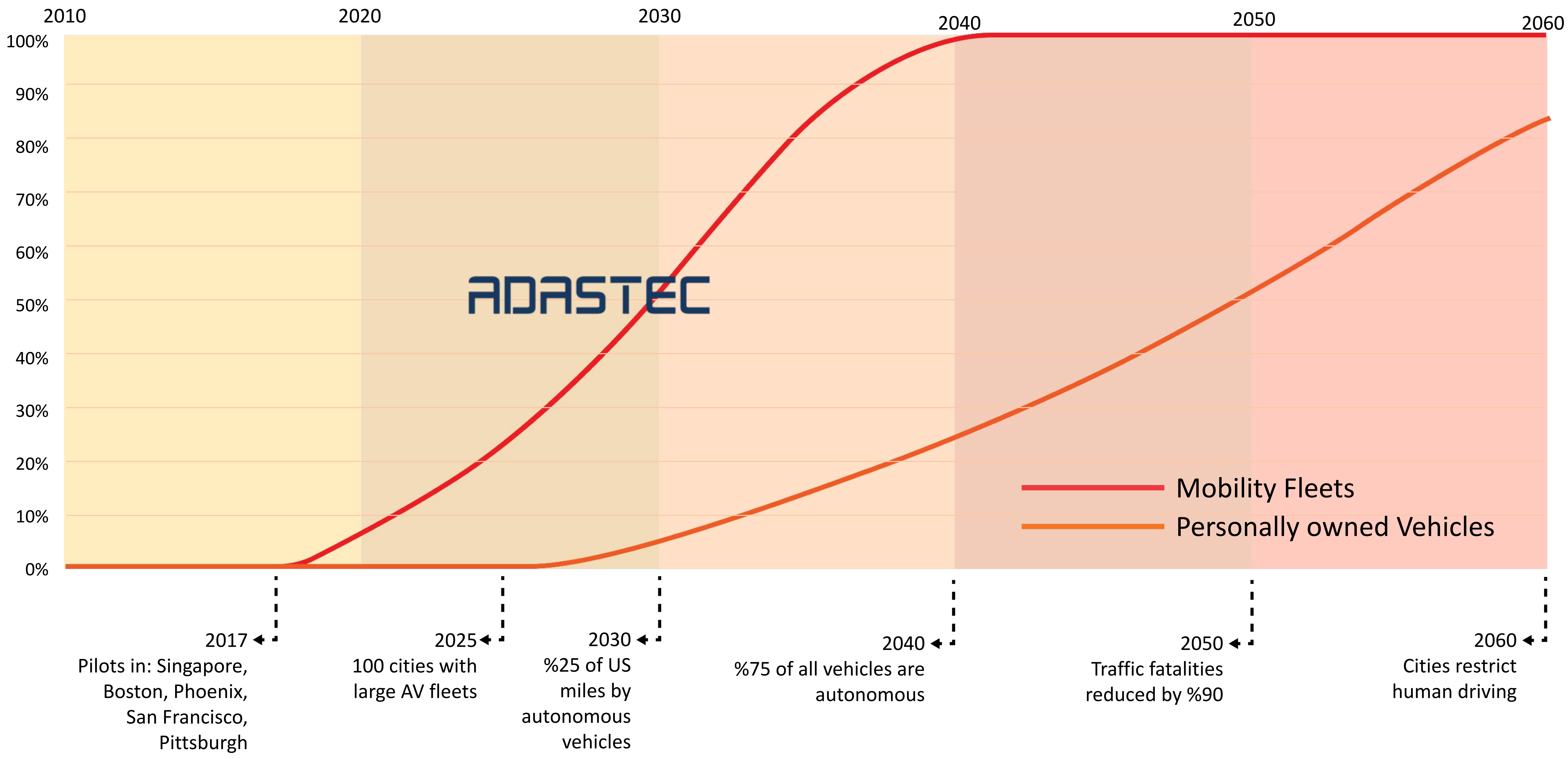
A brief comparison of automated vehicle as a product vs as a service

Description	Autonomous Vehicle as a Consumer Product	Autonomous Vehicle as a Service
Scope Where and when the AV capabilities must function	Everywhere, all the time	Geo-, time-, weather-fenced operation
Financials Cost Constraints	Comparable to the cost of the vehicle and/or driver's time. NPV of the driver's time: ~$23,000 for a 10-year lifetime	Comparable to the cost of hiring a driver > $100.000 USD per year
Infrastructure Maps, dealers, service	Global scale, immediately	Scale (sub)linearly with the user base
Servicing and Maintenance	Most high-tech sensors etc. not user serviceable yet	Servicing/maintenance crews already on roster

ADASTEC

What Type of Autonomous & When?

A forecast of the autonomous landscape



Why Automated Public Transportation

Automated cars are not the solution

L-4 Automated Electric Bus

ADASTEC Products: L-4 Automated Bus

We provide full stack solution for automated full-size L-4 bus

DRIVE-BY-WIRE CONVERSION	SENSOR KIT	SIMULATION & HD MAPPING	AUTOMATED DRIVING SOFTWARE STACK
Lateral/Longitudinal Control HW	LIDAR	HD Map Creation	Localization
Vehicle CAN Interface	Camera	3D Map Creation	Perception
Central Compute	GNSS Receiver	Simulation Content Generation	Prediction
Power Kit	Radar	Simulator Setup	Path Planning
Wireless Connection	IMU/INS	Simulation SW	Control

ADASTEC L-4 Automated Bus Specifications

How our bus work?

ROUTES

- Dedicated Bus Routes
- Predetermined
- Campuses
- Mixed Traffic Conditions (2020 Q4)

OPERATING CONDITIONS

- Full Autonomous in the route
- Day/Night working capability
- Operation in Rain / Hazy conditions
- Controllable Maximum Speed (35 miles/h Max)
- No Safety Driver in the route (2021 Q4)

CENTRAL CONTROL

- Operation Management
- Mission Management
- Communication
- Data sharing

AUTONOMOUS DRIVING

- Bus stop handling
- Intersection handling
- Traffic light
- Crosswalk handling
- Safe road edge
- Traffic participants handling

The Bus

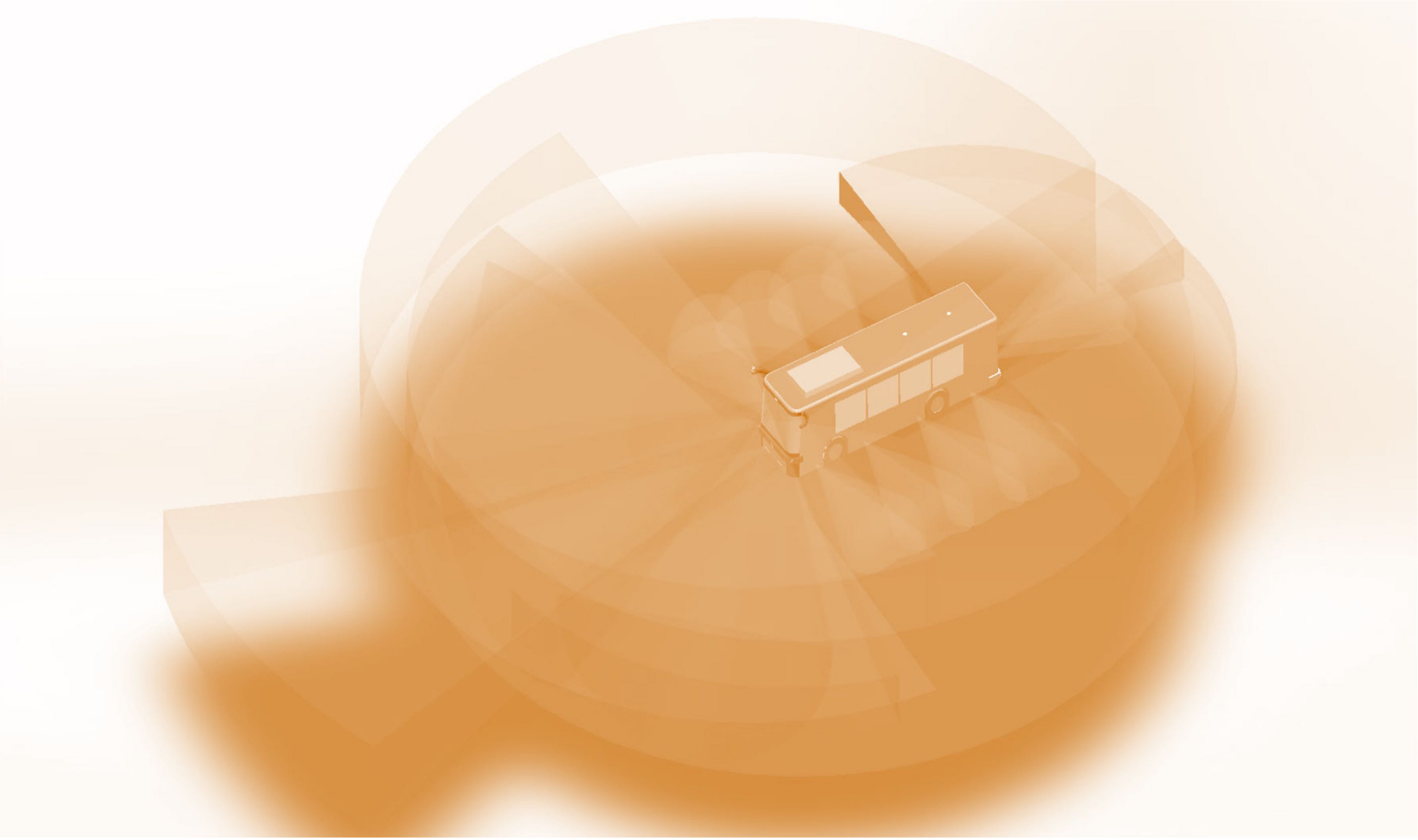
Full size, long range, high capacity automated bus

Specifications

- Powered by BMW
- 26 feet, Low Floor Electric Bus
- Up to 200 Mile range
- Carbon Steel: Space frame steel tube structure
- 21 Seated, 25 Standing, 1 Wheelchair, 47 Total
- Sensors :
    - 1 X 64-Channel LiDAR
    - 4 x 16-Channel LiDARs
    - RADAR
    - High Precision GNSS
    - 6 x Cameras
    - 2 x Thermal Cameras
    - IMU

Fault Tolerant Sensor Configuration

Sensor fusion to increase perception performance and reliability



Partners

Who we work with?

- Bus : Karsan
- Cloud : Amazon, Oracle
- Hardware : Ouster, Nvidia, AutonomousStuff
- Simulation : LGSVL
- Platform: Autoware, Apex.AI
- Organizations: PlanetM, UITP

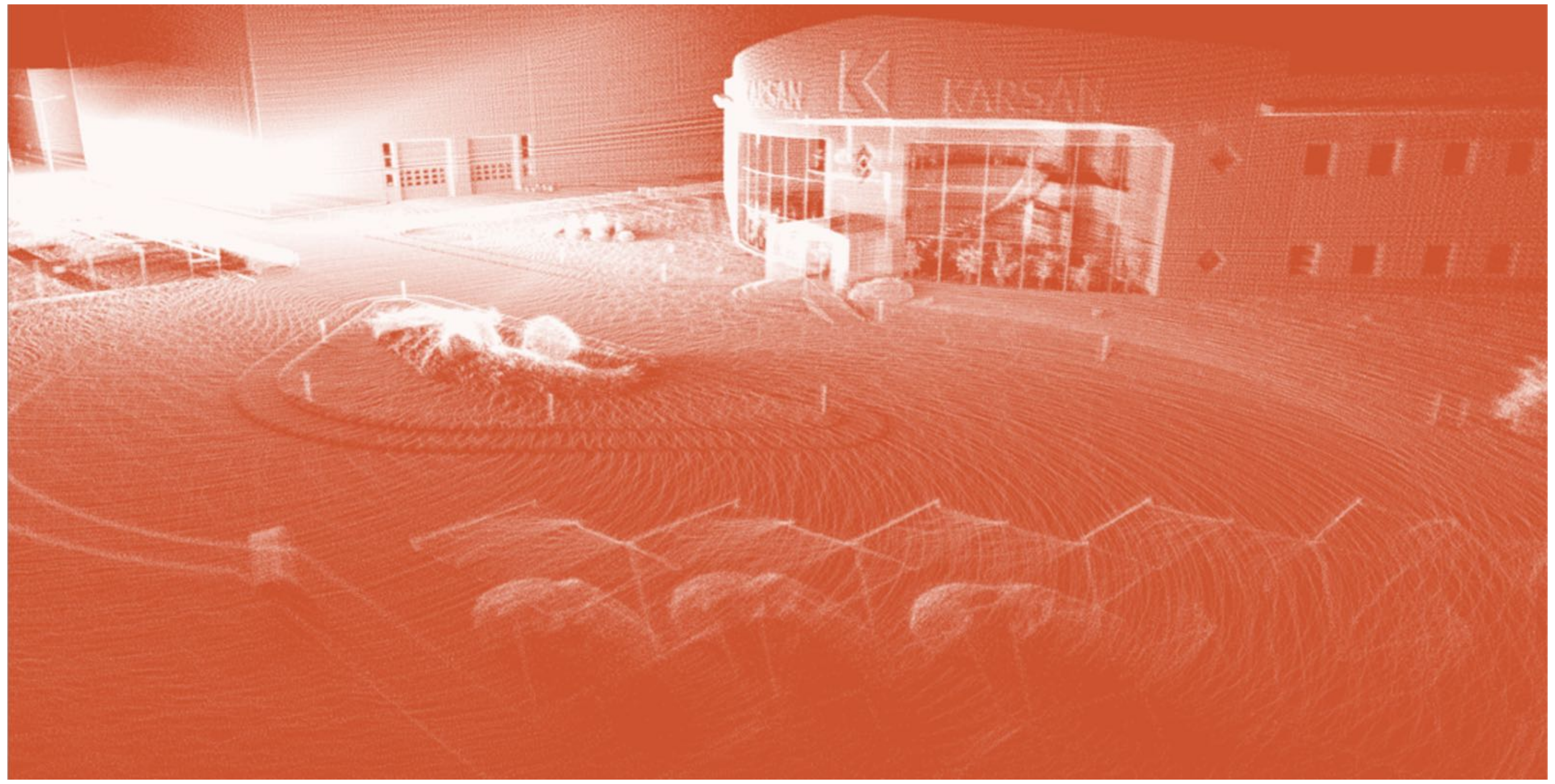
Simulation

Simulation

Photo realistic content for testing and AI training

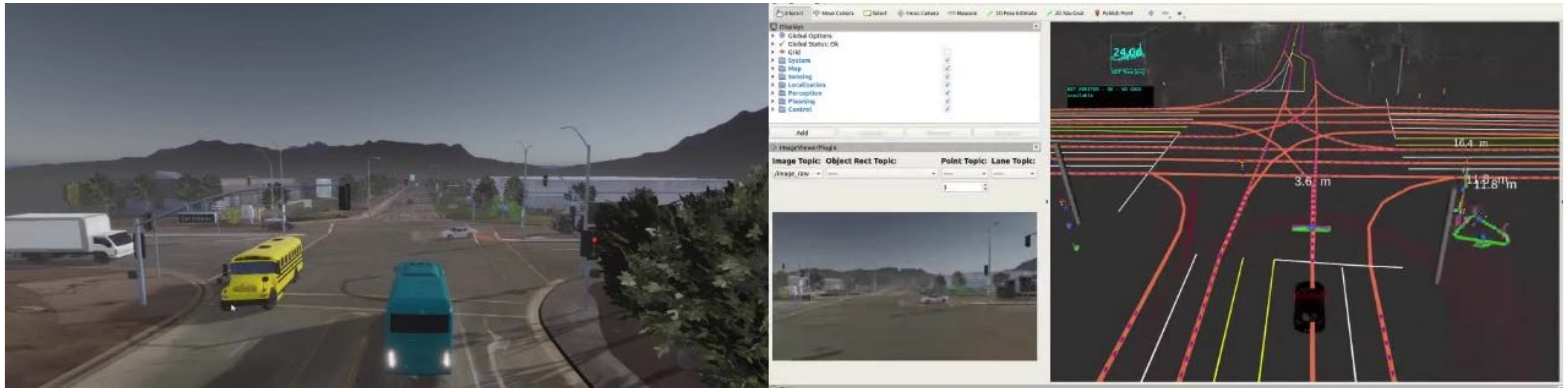
Advantages

- Safe
- Cost Effective
- Edge cases
    - Accidents
    - Sudden road changes
    - Ambient conditions : snow, fog, etc.
- Simulated sensors
    - HD – Map Integration
    - Lidar
    - Camera
    - Sensor placement options
- Localization



Demo Videos

Photo realistic content for testing and AI training



Sensor Fusion

Sensors

Modality	Affected by Illumination	Affected by Weather	Color	Depth	Range	Accuracy	Size	Cost
LiDAR	-	✓	-	✓	medium (< 200m)	high	large*	high*
Radar	-	-	-	✓	high	medium	small	medium
Ultrasonic	-	-	-	✓	short	low	small	low
Visual Camera	✓	✓	✓	-	-	-	smallest	lowest
Stereo Camera	✓	✓	✓	✓	medium (< 100m)	low	medium	low
Thermal Camera	-	✓	-	-	-	-	smallest	low

Outlook

AD Market Outlook: Competition Landscape, Global, 2017–2023

	Audi	BMW	Mercedes-Benz	Volvo	Tesla	Ford	Toyota	GM	FCA
Present	**L2**	**L2**	**L2**	**L2**	**Between L2 & L3**	**Driver Assistance**	**Driver Assistance**	**Driver Assistance & L2**	**Active Safety**
Future-Targeted Applications	Highway Pilot, City Pilot, Automated Parking	Focused primarily on L3, L4 for fleet by 2021	L4 automation on cars by 2020	No L3. L4 by 2020	Mind off highway autopilot by 2018-19, L4 by 2021	No L3. Shared Mobility Fleet (L4) by 2021	Level 4 Highway teammate post 2020	SuperCruise L3 with lane change. Shared mobility by 2019	L4 by 2020 with Waymo
Expected Sensor Fusion Strategy	1x LiDAR + 5x radars + 5x cameras including forward-facing stereo camera + Ultrasonic sensors + GPS	6 radar sensors + 8 cameras + 5 LiDAR	1x LiDAR + Stereo camera + Radars + GPS + FLIR	1 Stereo/ trifocal camera + 1 LiDAR + 7 Radars + 4 Cameras + 12 ultrasonic sensors + HAD Maps	1 Radar + 8 Cameras + 12 ultrasonic sensors + HAD Maps	Stereo / trifocal camera + 2 LiDARs (for L4 only) + Radars + Camera + HAD Maps	4 long range LiDARs + Radars + Camera + HAD Maps	2/4 x LiDAR sensors + 14 cameras + 8 static long-range radar units + 10 ultra-short-range radar sensors	5x LiDARs+ Radars + Cameras + Ultrasonic Sensors + GPS
Key Partnerships	Valeo, Mobileye, Conti,Bosch Nvidia	Mobileye, Intel, Bosch, Conti	Nvidia, Conti, Autoliv, Bosch	Nvidia,Autoliv,Delphi, Valeo	Nvidia, Conti, Delphi	Magna, Conti, Delphi, Valeo, Velodyne	Denso, Conti, Nvidia	Conti, Takata, Denso, Autoliv, ZF, Gentex	Waymo, Mobileye, BMW, Intel

Source: Frost & Sullivan

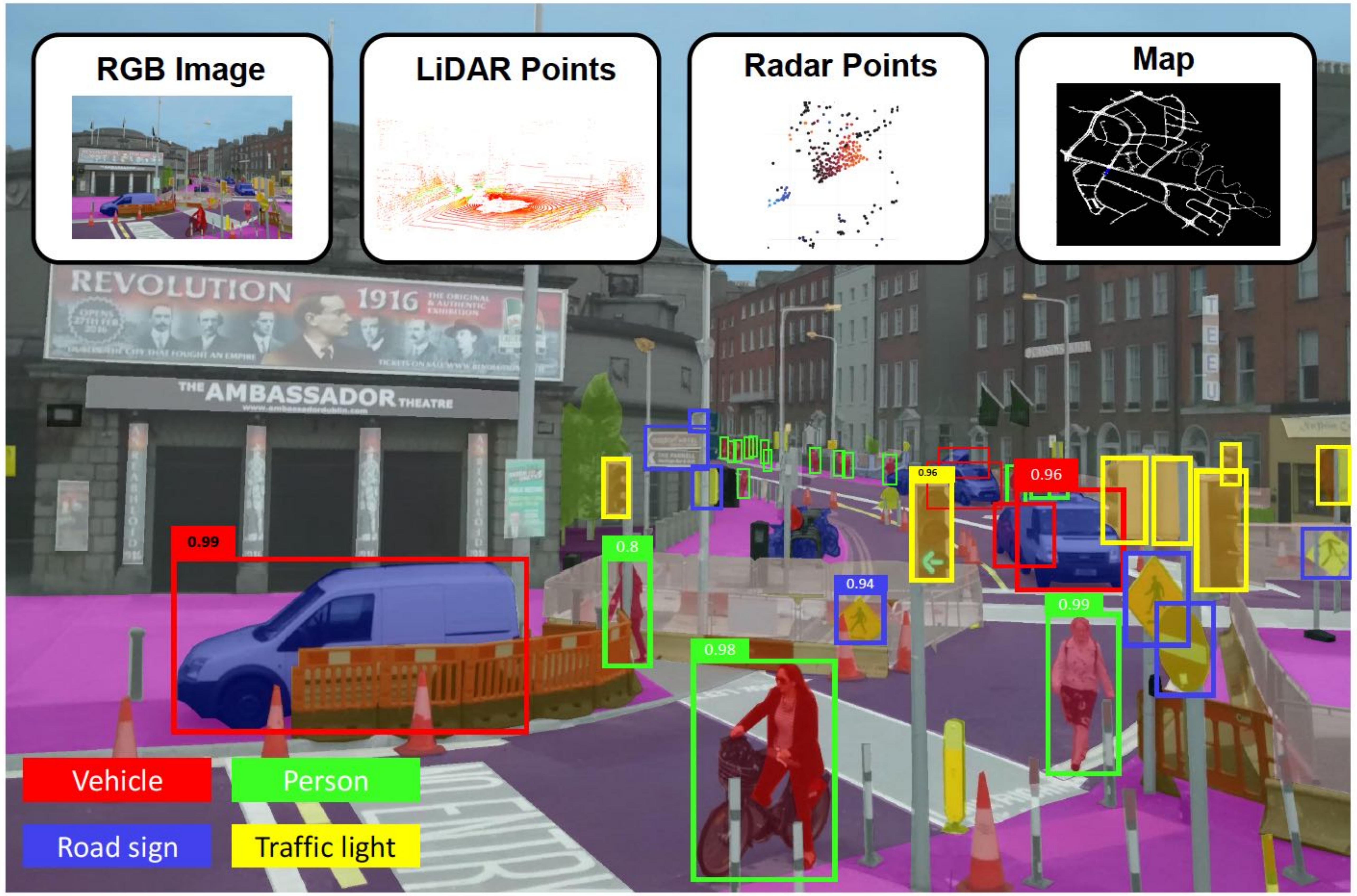
Outlook

AD Market Outlook: Competition Landscape, Global, 2017–2023

	Volkswagen	mazda	HYUNDAI	NISSAN	RENAULT	PORSCHE	PSA
Present	**Active Safety and Driver Assistance**	**Active Safety and Driver Assistance**	**Active Safety and Driver Assistance**	**Active Safety and Driver Assistance, Infiniti - Level 2**	**Driver Assistance**	**Driver Assistance**	**Driver Assistance**
Future-Targeted Applications	L2 vehicles by 2019	Autonomous driving technology on Mazda vehicles by 2025	L4 autonomous vehicles by 2021-22	L2 autonomous by 2019	L4 Vehicles by 2022	Optional autonomous drive mode operational on driver's demand	First L2 vehicle by 2018
Expected Sensor Fusion Strategy	5x radars + 5x cameras including forward-facing stereo camera + GPS	2 LiDARs + 4 Radars + 3 Cameras	2 LiDARs + 4 Radars + 3 Cameras + ultrasonic sensors + GPS	6 LiDAR + 9 Radars + 12 camera + 12 ultrasonic sensors + HAD Maps	Ultrasonic sensors + Vehicular antennas + Radar + LiDAR+ cameras + HAD Maps	Stereo/trifocal camera + LiDAR (for L4 only) + radars + camera + HAD Maps	Up to 7 Radars + 5 Cameras + HAD Maps
Key Partnerships	Aurora, Intel, NVIDIA	Mobileye, Intel, Bosch, Conti	Aurora, Hyundai Mobis, LG	Microsoft, NASA, Intel	Embotech, Tom Tom, LG, Ubisoft, IAV, Sanef	Magna, Conti, Delphi, Valeo	nuTonomy, Almotive

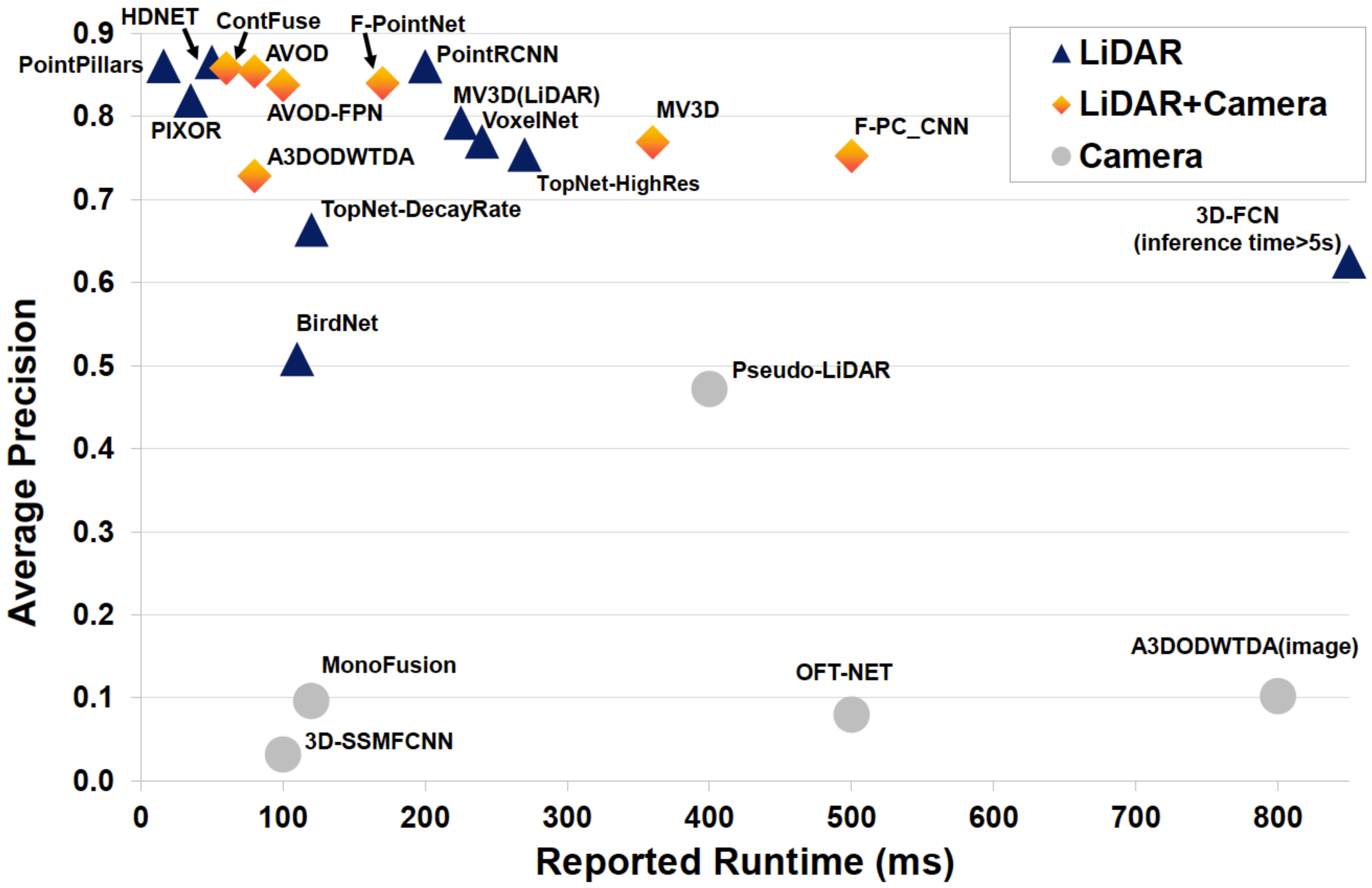
Multi-modal Perception

- A **complex urban scenario** for autonomous driving. The driverless car uses **multi-modal signals for perception**, such as RGB camera images, LiDAR points, Radar points, and map information. It needs to perceive all relevant traffic participants and objects **accurately**, **robustly**, and **in real-time**.



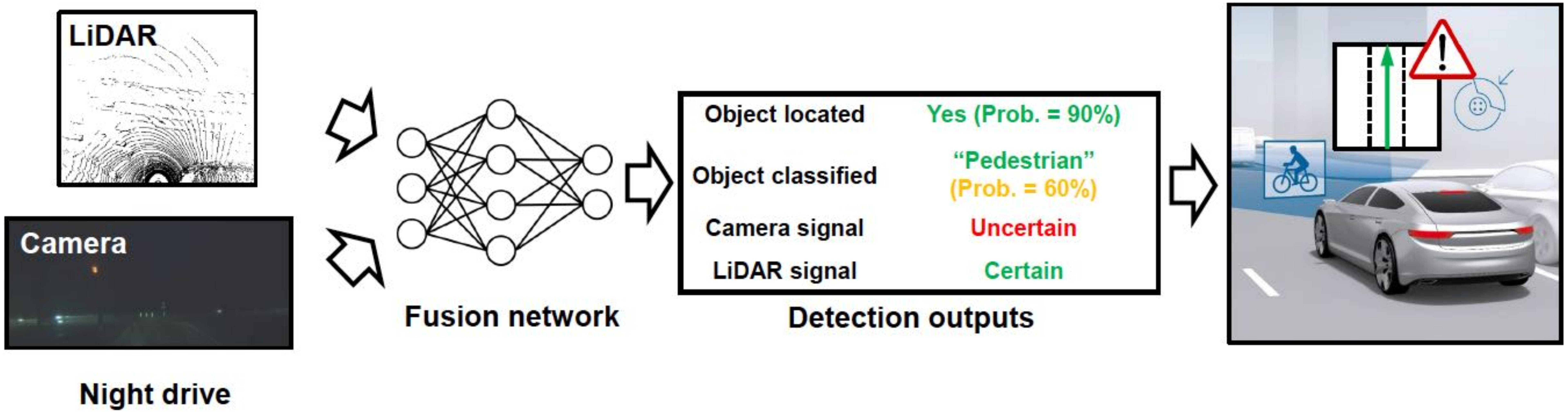
Deep Learning Approaches

- **Average precision (AP) vs. runtime**. Visualized are **deep learning approaches** that use **LiDAR**, **camera**, or **both** as inputs for car detection on the KITTI bird's eye view test dataset. The results are mainly based on the **KITTI leader-board** (Apr. 2019).



Multi-Modal Object Detection Network

- Ideally, the network should produce reliable prediction probabilities (object classification and localization). It should e.g. depict high uncertainty for camera signals during a night drive.



Challenges and Open Questions

Topics		Challenges	Open Questions
Multi-modal data preparation	**Data diversity**	• Relative small size of training dataset • Limited driving scenarios and conditions, limited sensor varity, object class imbalance	• Develop more realistic virtual datasets • Finding optimal way to combine real and virtual data • Increasing labeling efficiency through cross-modal labeling, active learning, transfer learning, semi-supervised learning etc. Leveraging lifelong learning to update networks with continual data collection.
	Data quality	• Labelling errors • Spatial and temporal misalignment	• Teaching network robustness with erroneous and noisy labels • Integrating prior knowledge in networks • Developing methods (e.g. using deep learning) to automatically register sensors
Fusion Methodology	**“What to fuse”**	• Too few sensing modalities are fused • Lack of studies for different feature representations	• Fusing multiple sensors with the same modality. • Fusing more sensing modalities, e.g. Radar, Ultrasonic, V2X communication • Fusing with physical models and prior knowledge, also possible in the multi-task learning scheme • Comparing different feature representation w.r.t. informativeness and computational costs.
	“How to fuse”	• Lack of uncertainty quantification for each sensor channel • Too simple fusion operations	• Uncertanity estimation via e.g. Bayesian Neural Networks (BNN). • Propagating uncertanities to other modules, such as tracking and motion planning • Anomaly detection by generative models • Developing fusion operations that are suitable for network pruning and compression.
	“When to fuse”	• Fusion architecture is often designed by empirical results. No guideline for optimal fusion architecture design • Lack of study for accuracy/speed or memory/robustness trade-offs	• Optimal fusion architecture search • Incorporating requirements of computation time or memory as regularization term • Using visual analytics tool to find optimal fusion architecture
Others	**Evaluation metrics**	• Current metrics focus on comparing networks’ accuracy	• Metrics to quantify the networks’ robustness should be developed and adapted to multi-modal perception problems.
	More network architectures	• Current networks lack temporal cues and cannot guarantee prediction consistency over-time. • They are designed mainly for modular autonomous driving	• Using Recurrent Neural Network (RNN) for sequential perception. • Multi-modal end-to-end learning or multi-modal direct perception

Fusion Methodology

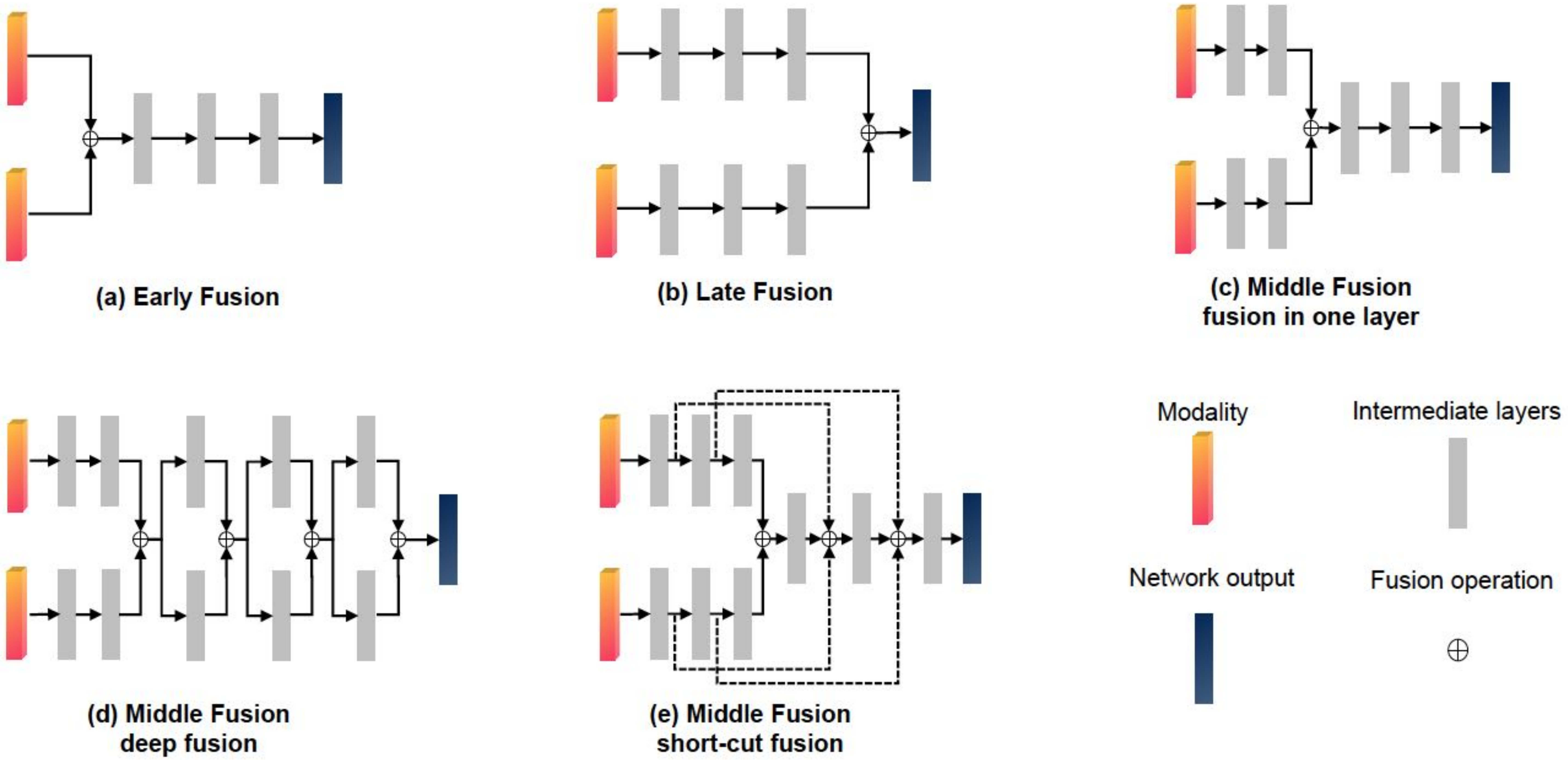
• **What to Fuse?**	**What sensing modalities** should be fused?
• **How to Fuse?**	**What fusion operations** should be utilized?
• **When to Fuse?**	**at which stage of feature representation** in a neural network should the sensing modalities be combined?

When to Fuse?

• **Early Fusion**	This method fuses the **raw** or **pre-processed sensor data**.
• **Late Fusion**	This fusion scheme **combines decision outputs of each domain specific network** of a sensing modality.
• **Middle Fusion**	It combines the feature representations from different sensing modalities **at intermediate layers**.

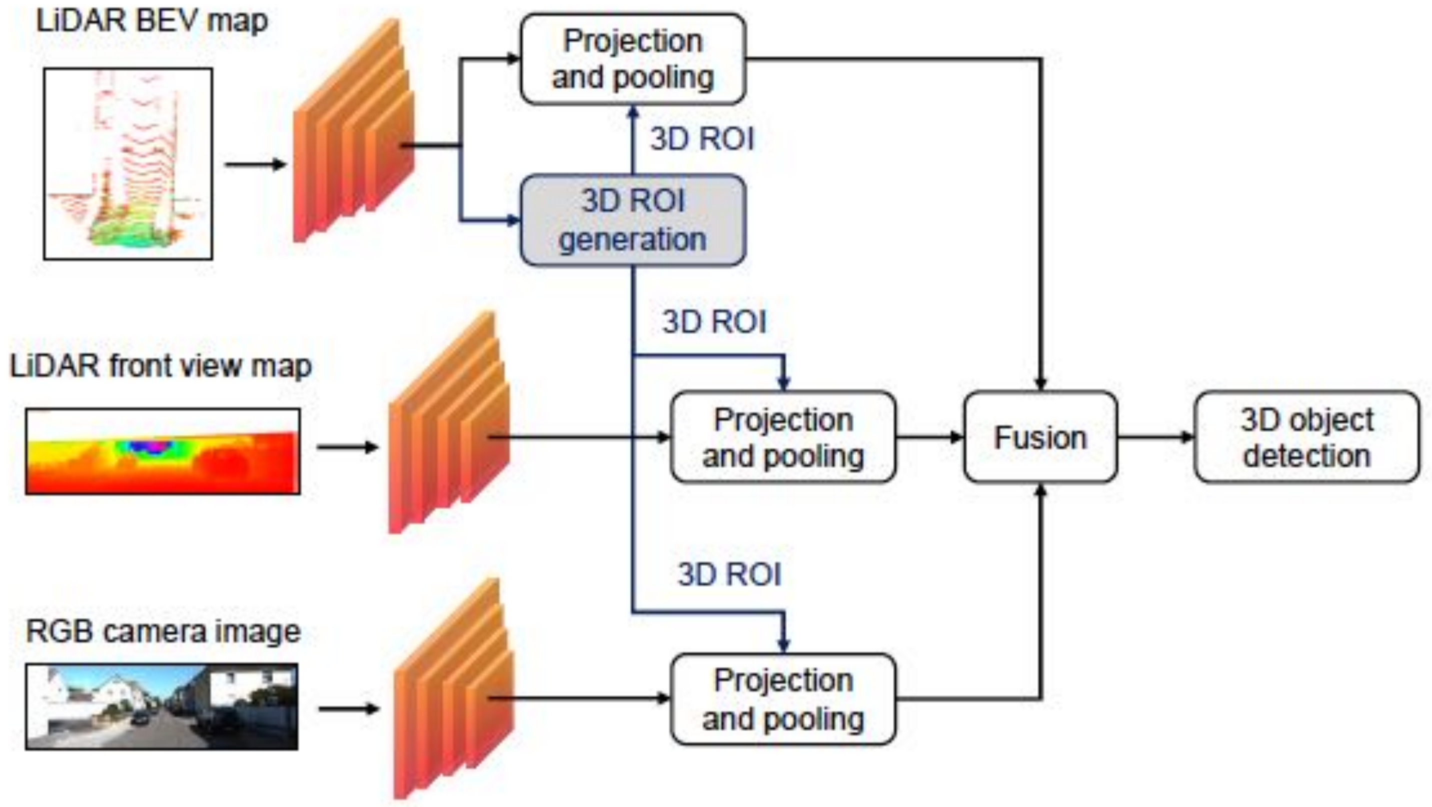
When to Fuse?

An illustration of **early fusion**, **late fusion**, and several **middle fusion** methods

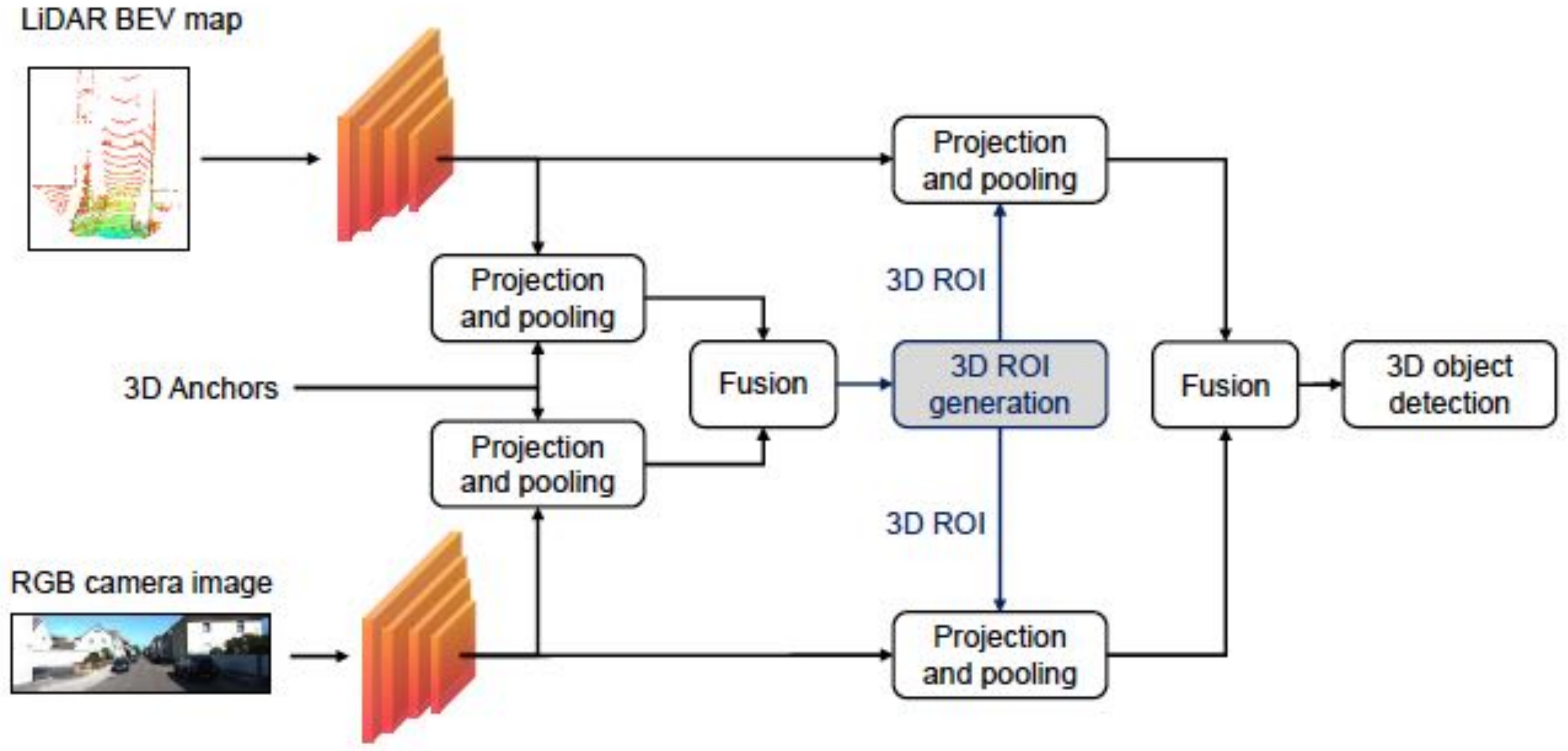


How to Fuse?

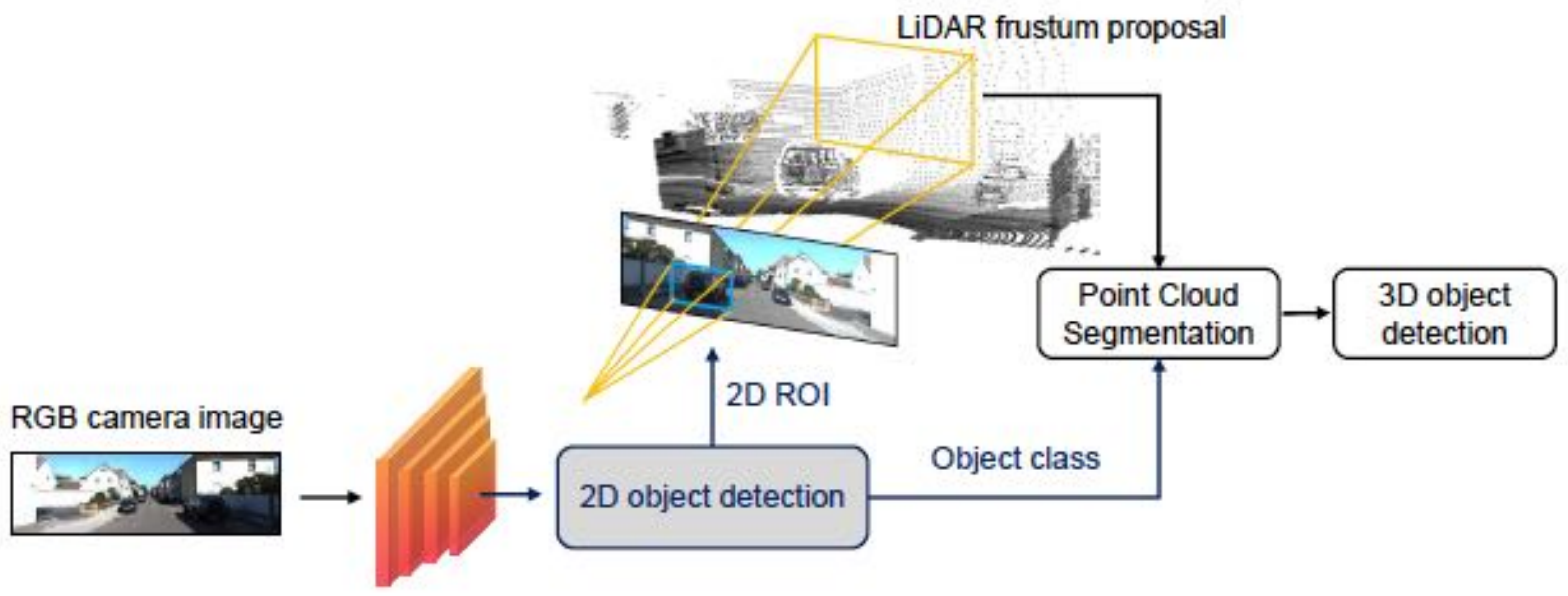
Exemplary **fusion architectures** for **two-stage object detection networks**. (a) MV3D (b) AVOD (c) Frustum PointNet (d) Ensemble Proposals.



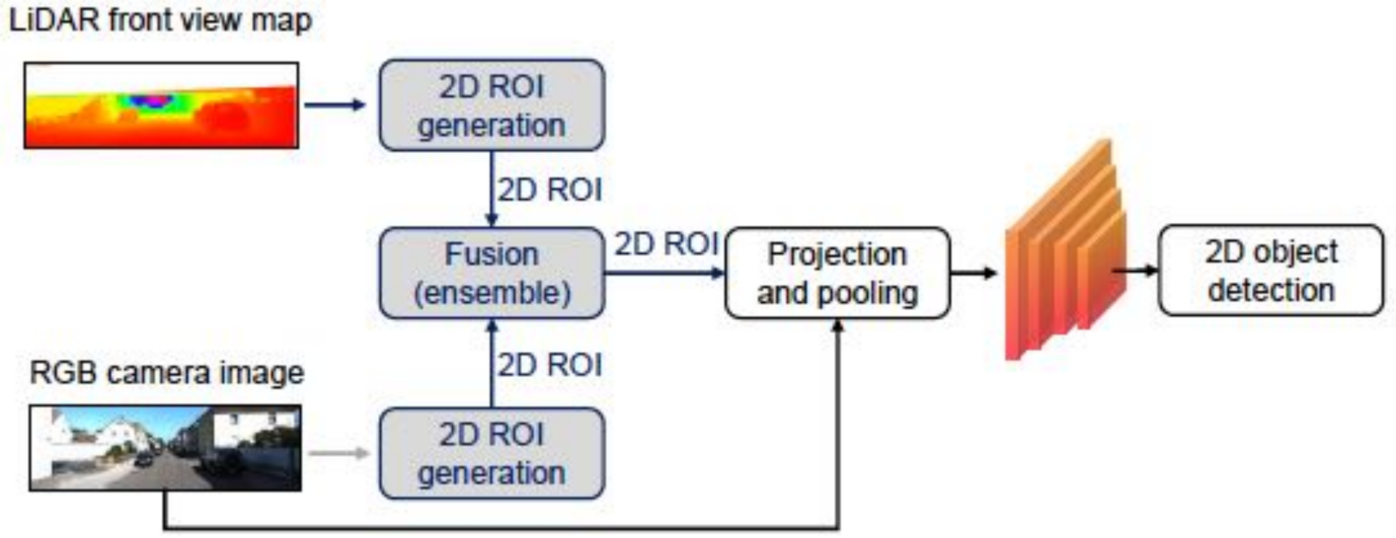
(a) MV3D



(b) AVOD



(c) Frustum PointNet



(d) Ensemble Proposals

COVID – 19 Impact

Safer Public Transport

How we help with COVID-19 and future requirements for enhanced passenger and operator safety

STOP

Direct Benefits

Driver Protection
– limited to delivery of empty vehicle to route

Less People / More Buses / Less Operational Costs
- **Improved QoS with less labor / cheaper energy**

Flexible waiting time in bus stops
No waiting time with accurate arrival information

6'

Social distancing aware interior design

Contactless Payment

Future Enhancements

Automatic social distancing warnings

UV-C

Automated, intelligent and safe disinfection

007

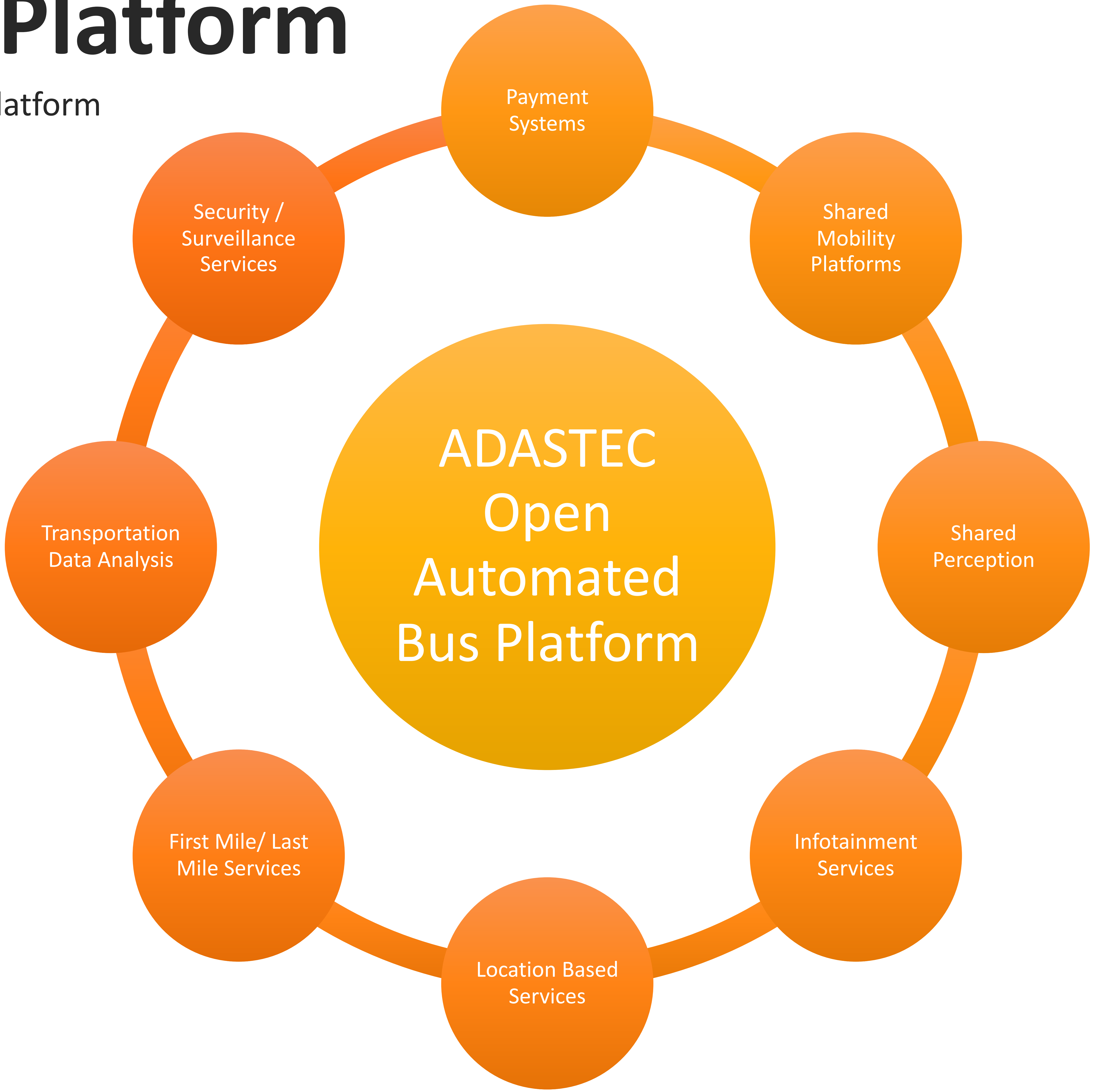
Passenger counting

Flexible bus stops on the route – Demand Response Transit

Other Services

The Open Platform

Open automated mobility platform



Thank You For Watching

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