

LeddarTech[®]
MASTERING LIDAR SENSOR TECHNOLOGY

LiDAR | Evolution in Advanced Driver-Assistance Systems – The Autonomous Shuttle Opportunity

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EPIC Meeting on LIDAR Technologies for Automotive, Eindhoven, Netherlands, October 30, 2019



LeddarTech Overview

LeidarEngine



LiDAR Modules



LCA3 Long Range Prototype



Leidar Pixell
180° X 16° Cocoon LiDAR



LCA3 Discrete Hybrid Flash Eval Kit



LCA2 3D Flash Architecture
60° X 16° Eval Kit



Leidar T16 Module



LeidarOne Module



Leidar Vu8 Modules



Leidar M16 Modules



Leidar IS16 Module



Leidar d-tec Traffic Sensors

Strong IP in signal acquisition and processing technology (72 patents / 52 granted)

14 Generations of solid-state LiDAR technology in volume production

- Leidar Modules and Sensors
- >35,000 units sold and 30+ million hours of 24/7 operation in outdoor environments

Open, scalable platform enabling various LiDAR solutions optimized for ADAS & AD applications

LeidarEngine LCA2 & LCA3 SoCs & Software

INDUSTRY-LEADING STRATEGIC INVESTORS

OSRAM

• APTIV •
DELPHI

MAGNETI
MARELLI

IDT™

> 180 Employees with >140 LiDAR & Automotive Engineers

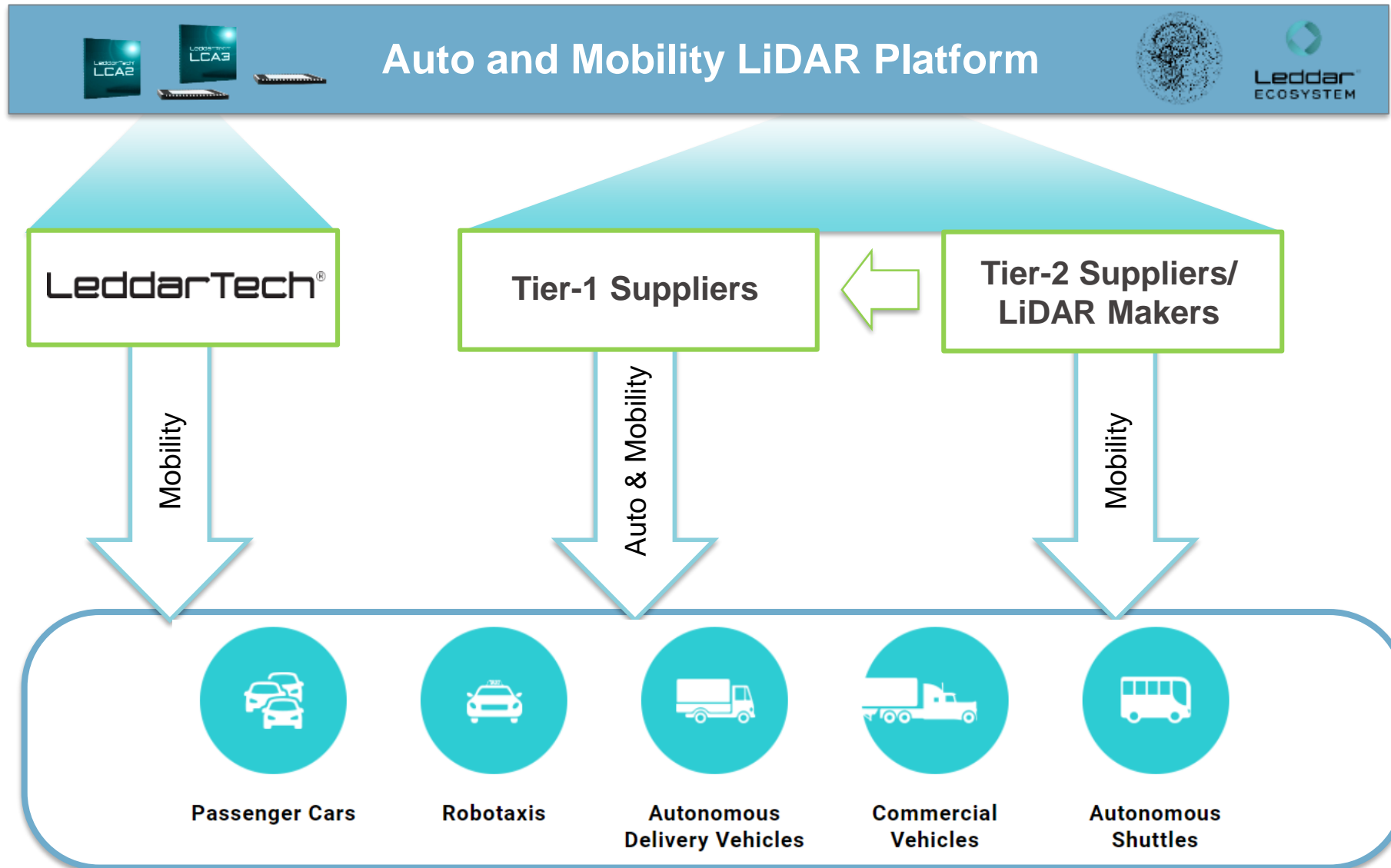


Auto and Mobility LiDAR Platform

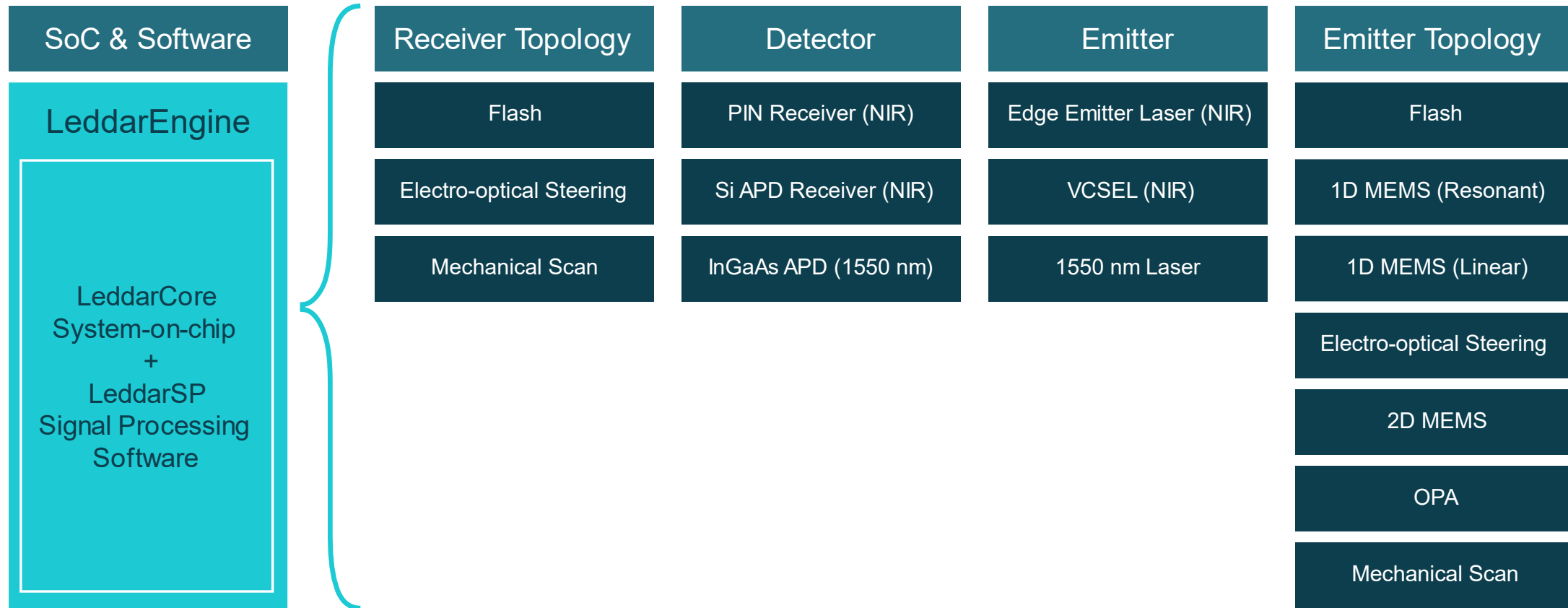


LeddarTech®
Engineering Services

Platform Go-to-Market Strategy Leverages the Supply Chain for Optimal Reach



Subsystems: Building Blocks Enabling Optimal LiDAR Products & Roadmap



Platform Approach: Key Benefits

- ✓ Flexible Architecture Addressing All Auto & Mobility Applications
- ✓ Software-based LiDAR Provides Higher Customization and Scalability vs. Hardware-based
- ✓ Cost & Time Effective Performance Scalability
- ✓ Enabling Technology to any ToF LiDAR
- ✓ Not Dependant on any Given Technology Winner
- ✓ Designed to Scale to Forthcoming Evolution and Commoditization Pressure

LiDAR Stakeholders Need to Collaborate

Develop Standards & Harmonize Specifications

Focus on Software Scalability & Architectural Compatibility

Emphasis on Performance Needed Instead of Specs

Sharing Cost & Risk In Developing the Key Components

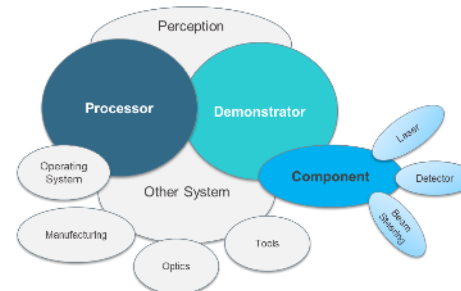
Leverage IP & Expertise from Technology & Industrial Leaders

Open Platform Model vs Vertical Integration (black box)

Supporting Development of Standard Components Versus Various



- **PROCESSOR** Partners
- **DEMONSTRATOR (EVALKIT)** Partners
- **COMPONENT** Partners
- **PERCEPTION** Partners
- **DESIGN** Partners
- **MANUFACTURING** Partners
- **OTHER SYSTEM** Partners



- **OEMs** -

Platform decisions

instead of *Product* decisions



Challenges in Urban Mobility



55% of the world's population lives in urban areas

➤ Projected to reach 68% by 2050!



The number of cars on the road worldwide is set to double by 2040

➤ Projected to reach the two billion mark!

Most cities were not designed to sustain such rapid growth!...

Key Urban Transportation Challenges:

Traffic Congestion

Vehicle Emissions

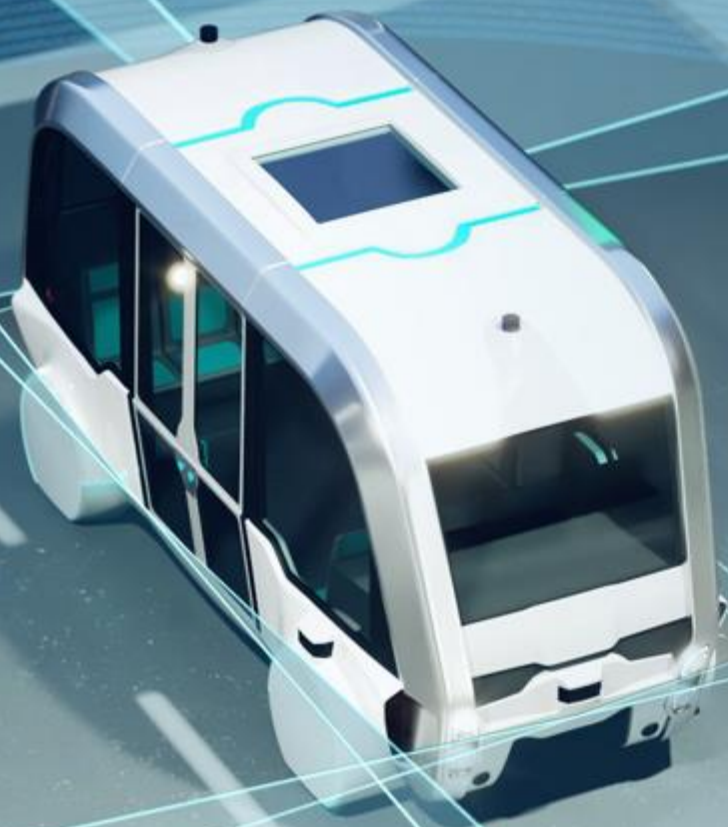
Road Accidents

Wasted Time/Productivity

Quality of Life

AUTONOMOUS SHUTTLES

A Solution to Urban Mobility Challenges



More than 2 million ride-sharing shuttles are expected to be deployed by 2025*

Operation

- Capacity to transport 4 to 15 people
- Autonomous navigation at sub-50km/h speeds
- Restricted to a specific area, using predetermined, learned paths

**Source: Press Articles, Forecast by Consultancy Firm Roland Berger*



“[Autonomous shuttles] will be the predominant market for highly automated vehicles for the next 5 to 10 years — and probably in perpetuity”

— Sam Abuelsamid, Senior Analyst, Navigant Research

AUTONEWS.COM





Why Autonomous Shuttles are Different

University Campuses



Airports



Ports



Retirement Communities



Business Parks



Industrial Parks



Resorts



Theme Parks

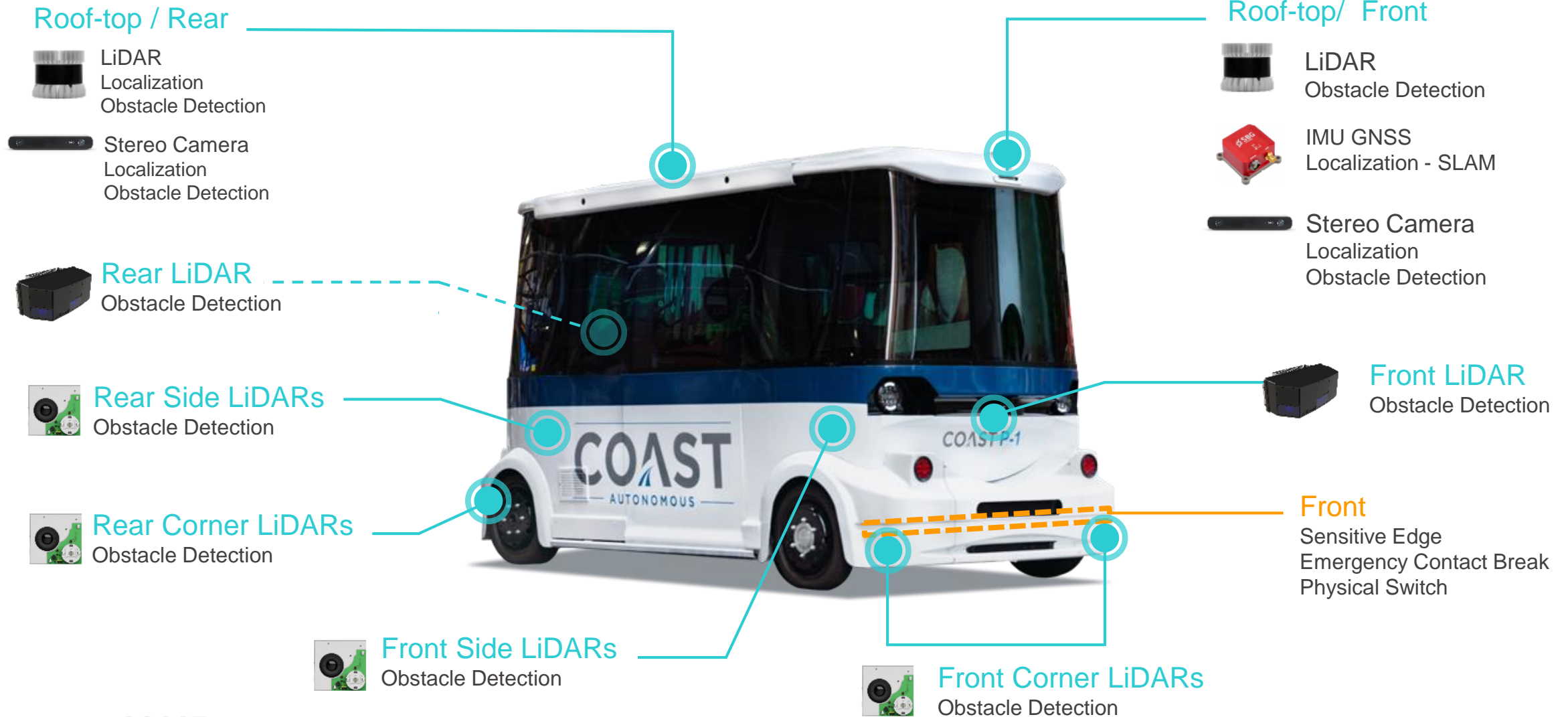


Railyards

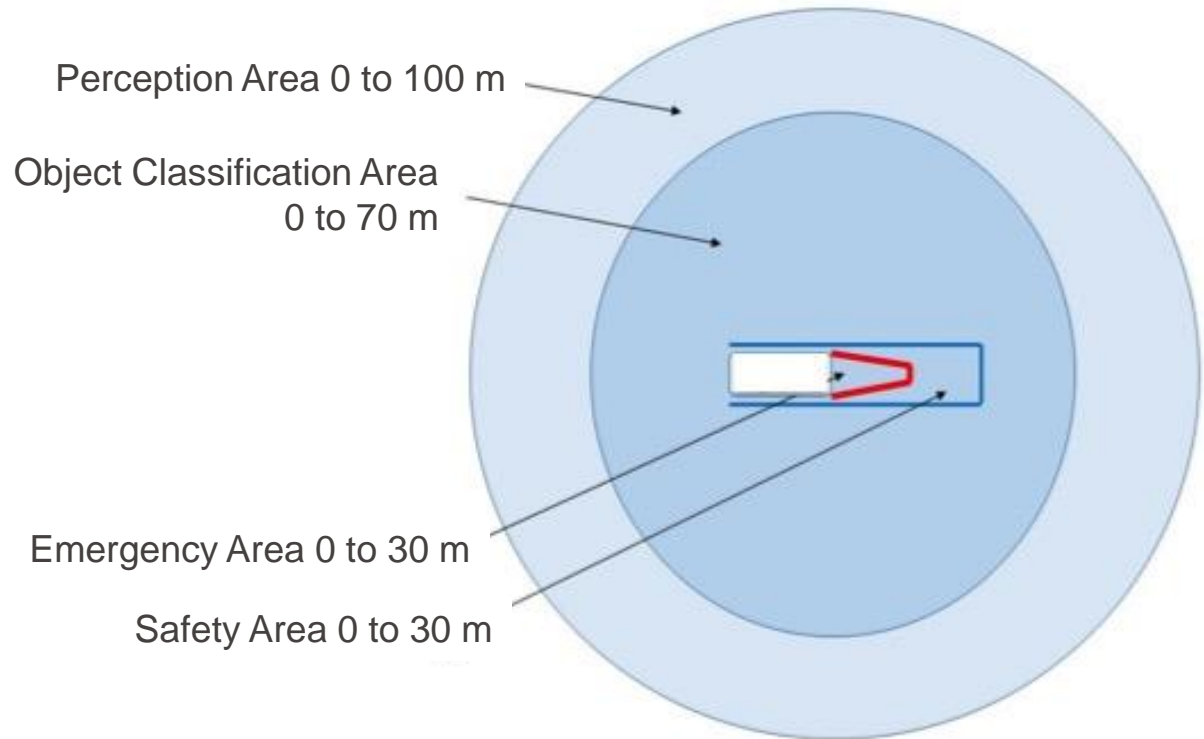


... **Technology** is also perfect for Campuses and Private Sites

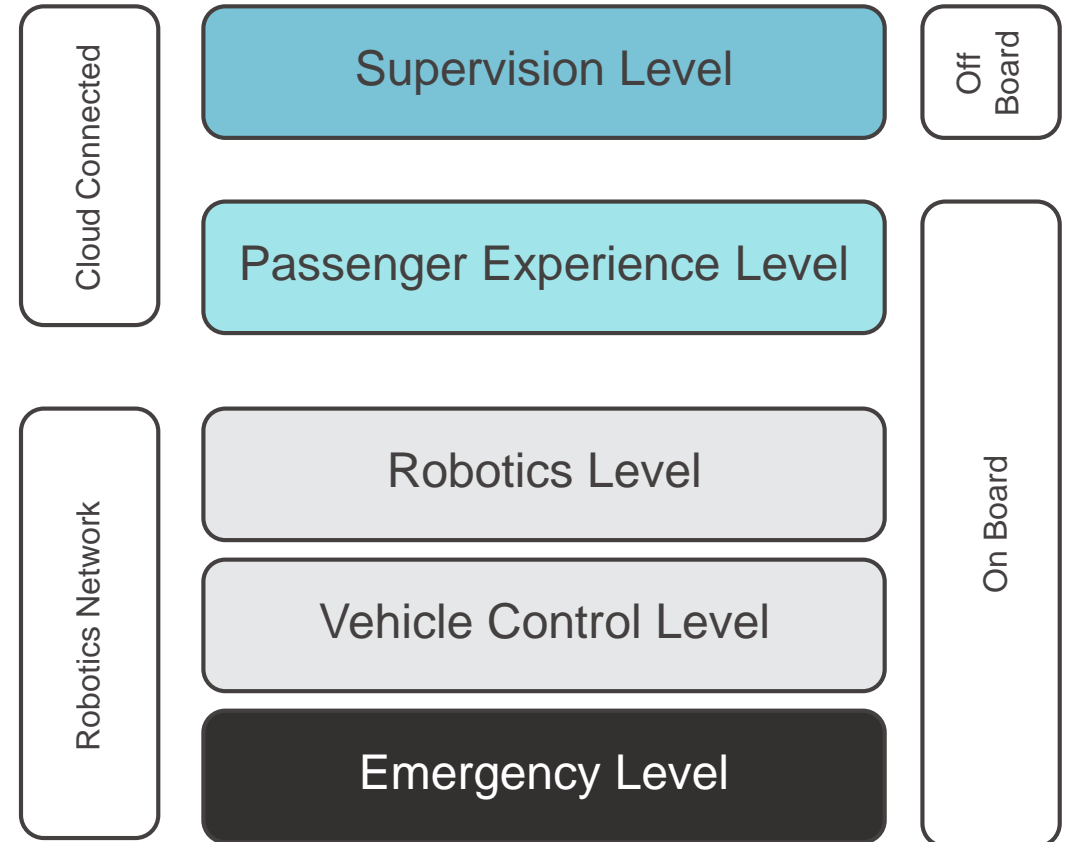
SENSOR STACK MUST BE EFFICIENT, REDUNDANT & **AFFORDABLE** ...



COAST VEHICLES INTEGRATE A REDUNDANCY OF SYSTEMS ...



COAST Vehicle System Levels



LEDDARTECH SOLVES THE SHORT-RANGE COCOONING ...



PIXELL
Short-Range perception
Obstacle detection
0 to 30 m




Robotics Level



M16
Safety cocoon at 25 cm from the floor
Obstacle detection
Emergency Stop
0 to 20 m

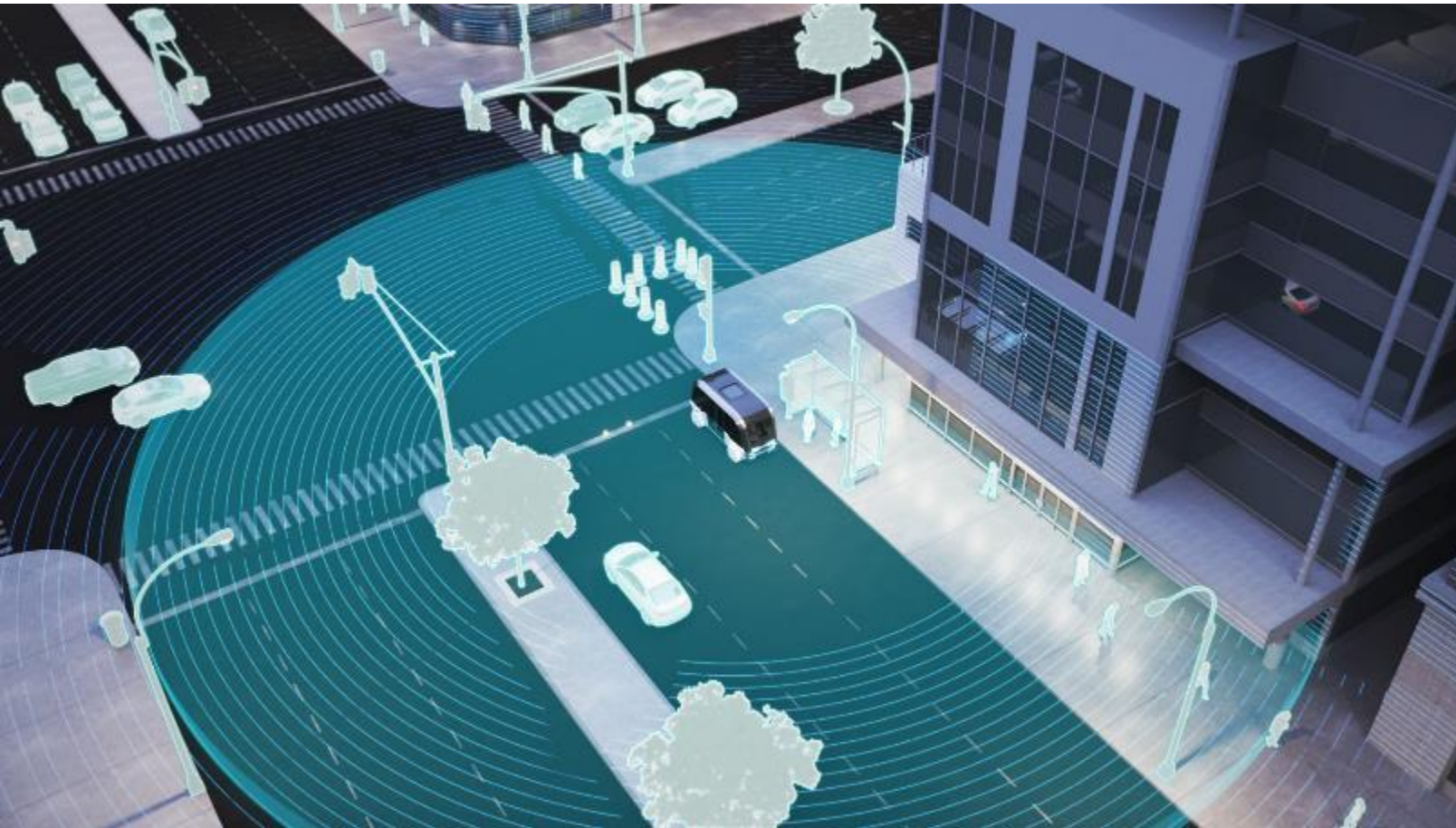


Emergency Level

A futuristic car interior with a circular LiDAR sensor and a digital dashboard. The scene is illuminated with a teal and blue color scheme, suggesting a high-tech, autonomous driving environment. The LiDAR sensor is a large, circular, metallic structure with a central lens and a ring of sensors. The dashboard is a sleek, digital display showing various metrics and icons. The overall aesthetic is clean, modern, and futuristic.

3D Solid-state LiDARs: A Powerful Enabler in VRU Safety (Vulnerable Road User)

Enabling the Safety Cocoon with 3D Flash LiDARs



Benefits of Flash LiDAR

- 3D flash illumination technology provides 100% scene coverage
- Various fields of view, up to 180°
- Uses significantly less data than point cloud methods, enabling highly efficient processing
- Zero proximity dead zone, with no blind spots in the entire field of view

Enabling the Safety Cocoon with 3D Flash LiDARs

3D Flash LiDARs are placed on the front, back, and sides of the vehicle

- Each sensor covers 180° field of view (FOV)
- Full 360° cocoon FOV coverage using only 4 sensors
- Redundancy on the 4 corners, enhancing perception robustness

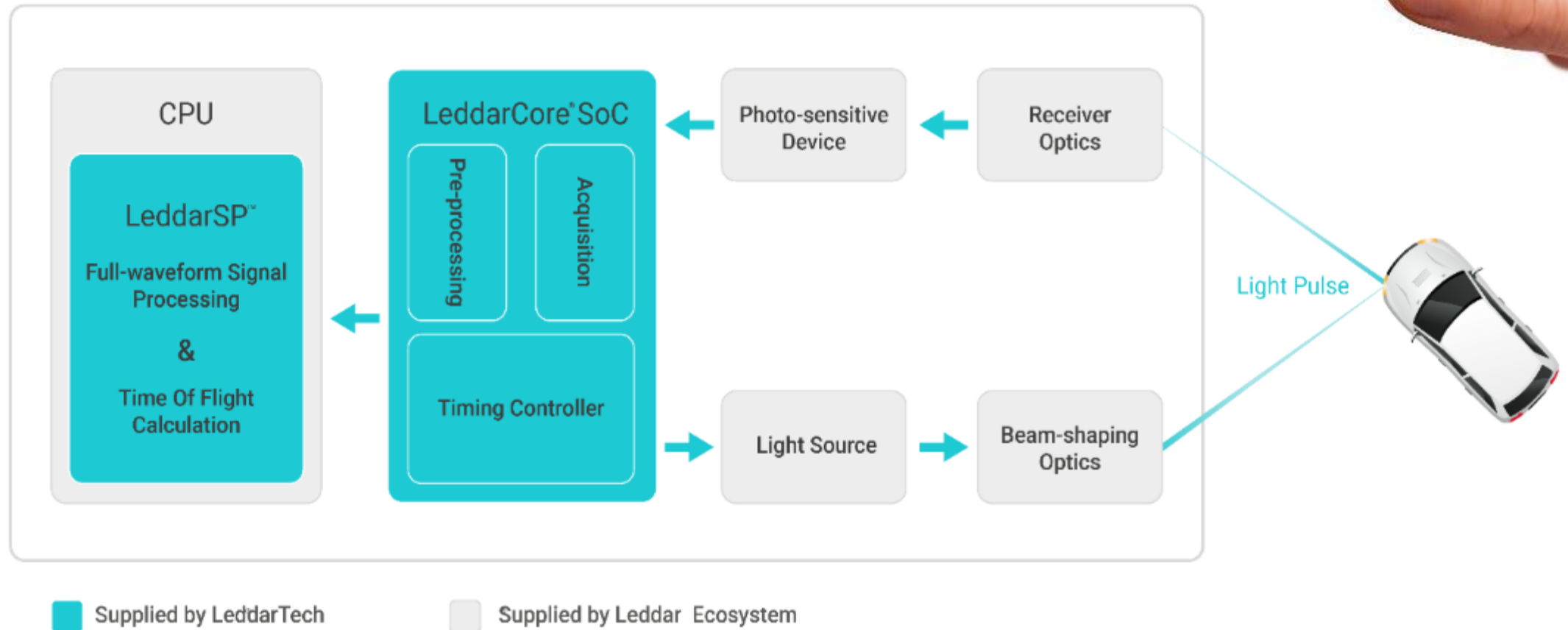


LiDAR Platform: Leveraging Best-in-Class Technologies

- Uses patented signal acquisition and processing at the core
- LeddarEngine™ = LeddarCore SoC + LeddarSP Library



LiDAR Block Diagram



Enabling the Safety Cocoon with 3D Flash LiDARs



100% Solid-state



Zero-Dead-Zone
Proximity Coverage



Road-ready design for
Superior durability



Adopted by Leading AV Providers

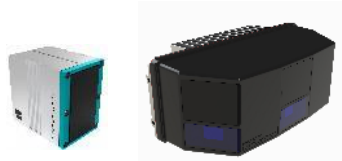


Leddar™ Pixell 3D Flash Cocoon LiDAR

- ✓ Dependable object and VRU detection over 180°
- ✓ 96 horizontal x 8 vertical segments = 768 independent surfaces with simultaneous data acquisition
- ✓ Road-ready design for superior durability
- ✓ Complementary to mechanical scanning LiDAR for a complete sensing solution

LeddarSense Development Kit – What is it?

LeddarTech Module / Eval Kit



Camera



Fixture



Calibration Checkerboard



Provided pre-assembled with LiDAR to camera alignment

Dev Kit Laptop (Linux)



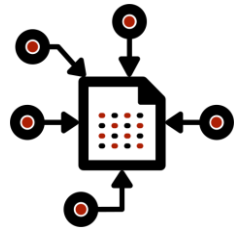
To help quick setup, provide a pre-configured laptop

Documentation



- Running the demo
- Sensor installation & calibration
- DAS API (sensor data acquisition & read dataset)
- Dataset file format
- PC setup / configuration
- Guide for developing a custom perception application based on Leddar Pixel cloud echoes and waveform data
- Getting started guide on pedestrian classification

Leddar Data Acq. Software (DAS)



RTMaps SW (by Intempora)



Leddar Pixel Cloud Dataset (Annotated)



Open Source Machine Learning Library



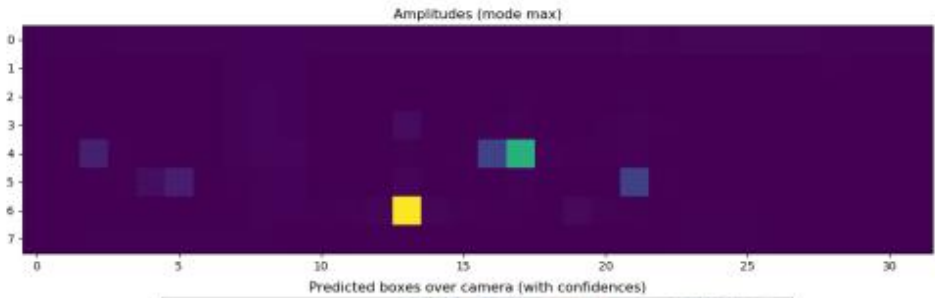
Leddar Demo App (pedestrian segmentation)



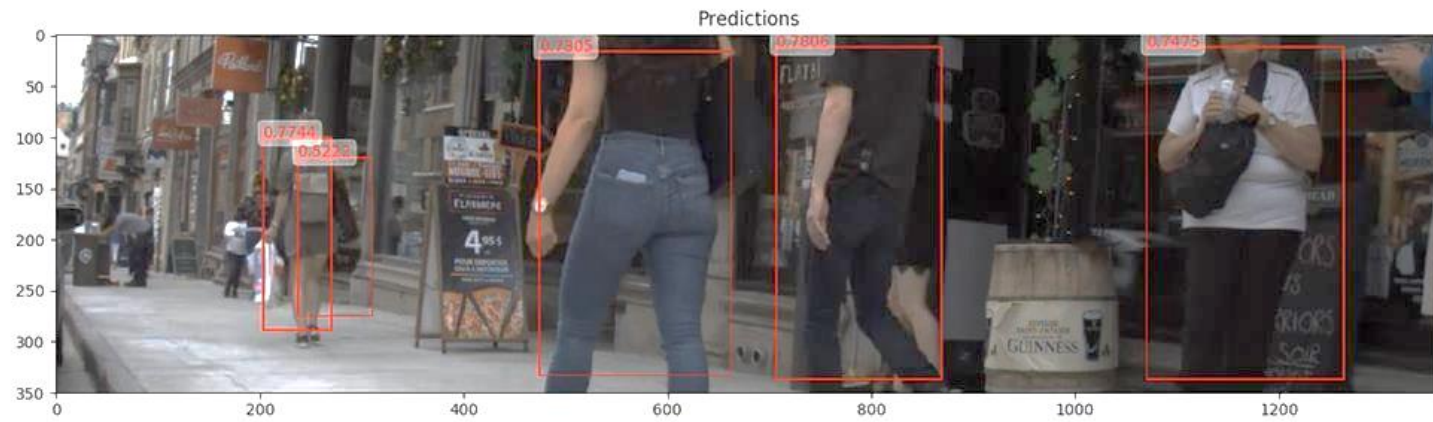
Demo software covering both learning of the CNN & execution of the segmentation demo



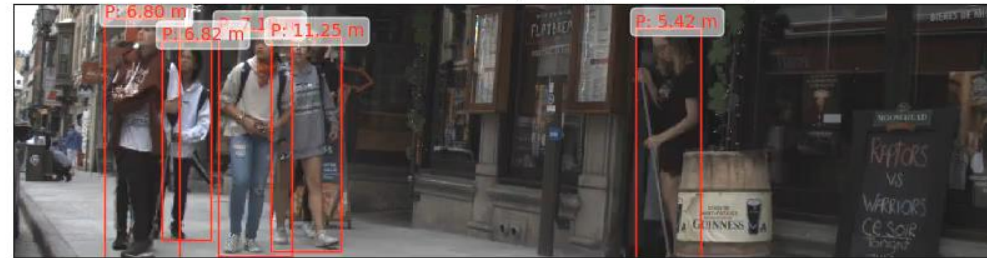
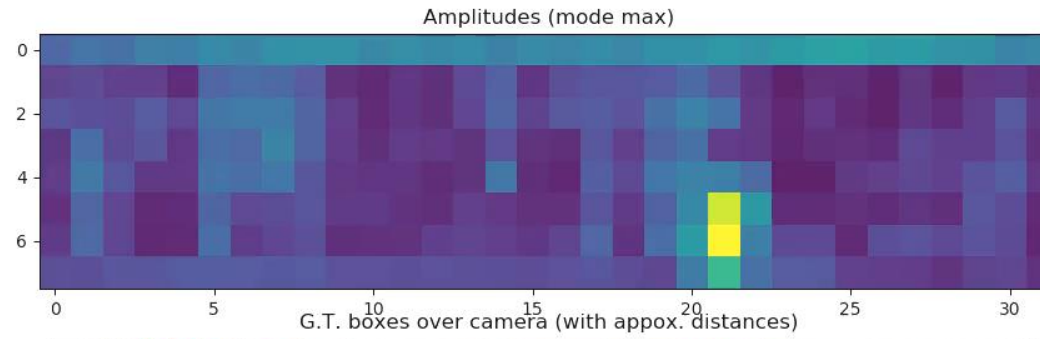
Using automated labeling from calibrated RGB camera image



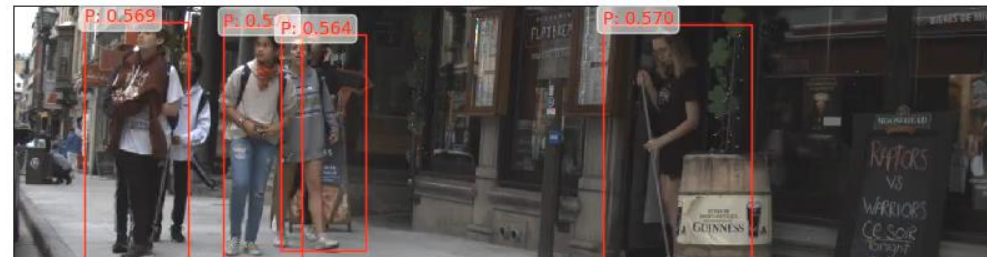
From LCA2 raw data, and 2D box obtained by maskRCNN in camera image



Predict 2d box
(class, center, H and v size, confidence)



Predicted boxes over camera (with confidences)



Metrics for P.: Recall=0.898; Accuracy=0.854.

3D Flash Cocoon LiDAR - Key Benefits

- True solid state
- High MTBF
- Full waveform LiDAR
- Fully supported perception development kit
- Available now

Benefits of Flash LiDAR

- 3D flash illumination technology provides 100% scene coverage
- Uses significantly less data than point cloud methods, enabling highly efficient processing
- Zero proximity dead zone, with no blind spots in the entire field of view

Representative Use Cases in Urban Environment



Use Case #1: Front Collision Avoidance, Cyclist or Running Pedestrian

- Vehicle speed of 60 km/h \rightarrow 16.7 m/s
- Reaction time of AEB System = 0.5 s
- Deceleration in $\text{m/s}^2 = 7 \text{ m/s}^2$



Cyclist crossing the road at 20 km/h

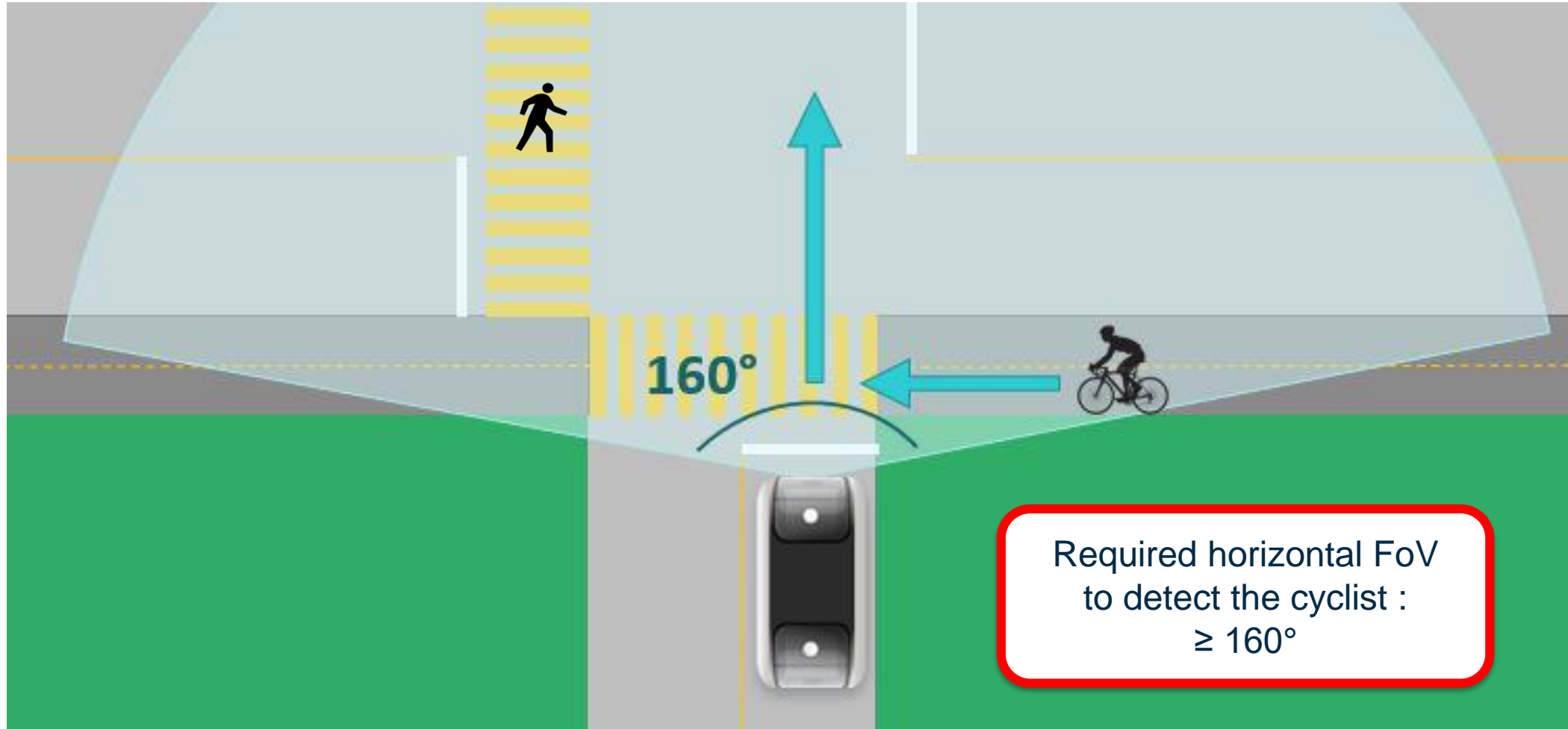
Range needed to avoid collision = 33 m



Running pedestrian crossing the road at 8 km/h

Range needed to avoid collision = 28 m

Use Case #2: Cyclist or Pedestrian Crossing the Road with Vehicle Stopped at an Intersection



Use Case #3: Cyclist Along the Road / Vehicle Making a Right Turn

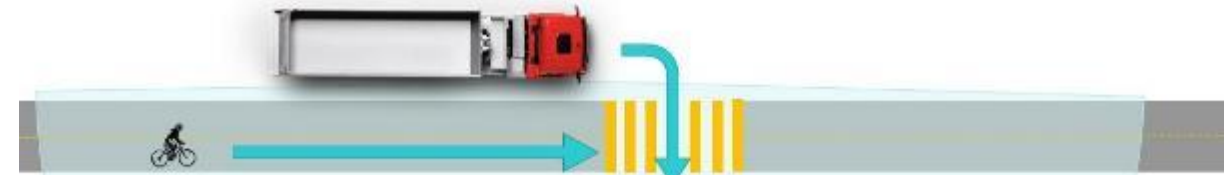
Application for Shuttles, Buses, Trucks

- Vehicle speed of ≤ 30 km/h
- Driver's reaction time of 1.4s
- Deceleration capability of 5 m/s^2



Use case 3A

Vehicle at high-speed (20 km/h) with cyclist at low-speed (10 km/h) in front of the vehicle

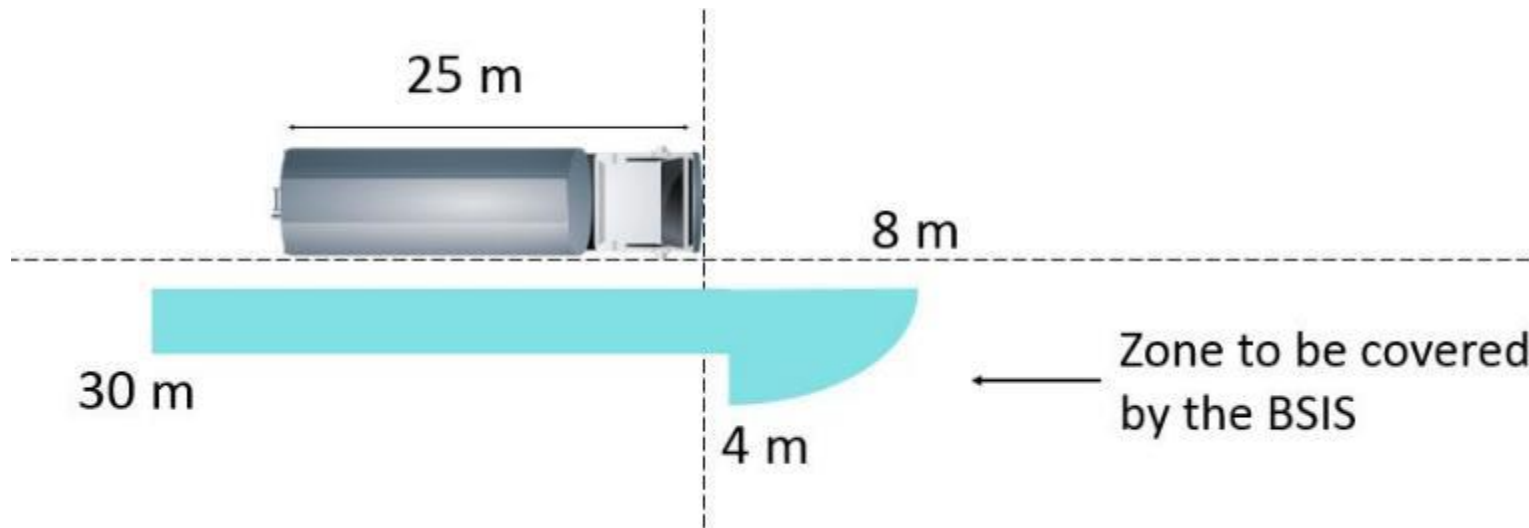


Use case 3B

Vehicle at low-speed (10 km/h) with cyclist at high-speed (20 km/h) coming from behind the vehicle

Use Case #4: Cyclist Along the Road / Vehicle Making a Right Turn

Application for Shuttles, Buses, Trucks



SYSTEM REQUIREMENTS:

Rear detection range: 30 m

Front: up to 8 m

Side: up to 4 m

Requires a full 180° side coverage to detect cyclists at the rear, side, or front



CONCLUSION AND QUESTION PERIOD

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<https://leddartech.com/lidar/leddar-pixell/>

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MASTERING LIDAR SENSOR TECHNOLOGY

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