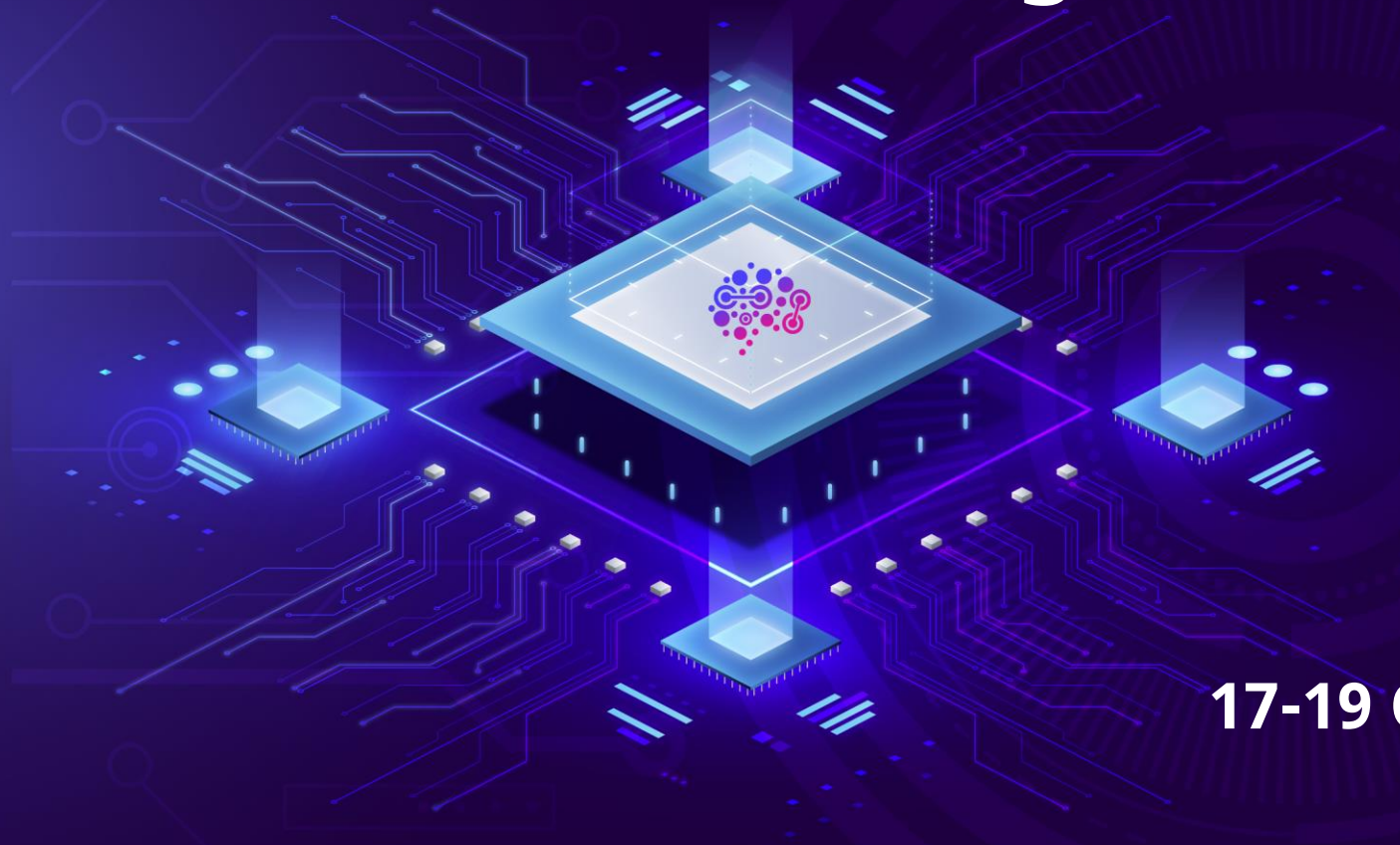
European Conference on EDGE AI Technologies and Applications - EEAI



Advancing emerging edge AI technologies and driving next generation intelligent applications.

17-19 October 2023, Athens, Greece

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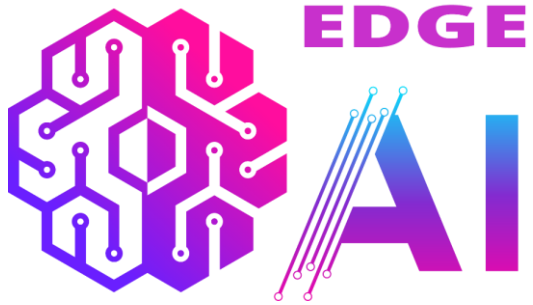

Embedding ROS and Edge AI-Based Perception Capabilities in AV Platforms

Ovidiu Vermesan, SINTEF, Norway

17-19 October 2023 Athens, Greece

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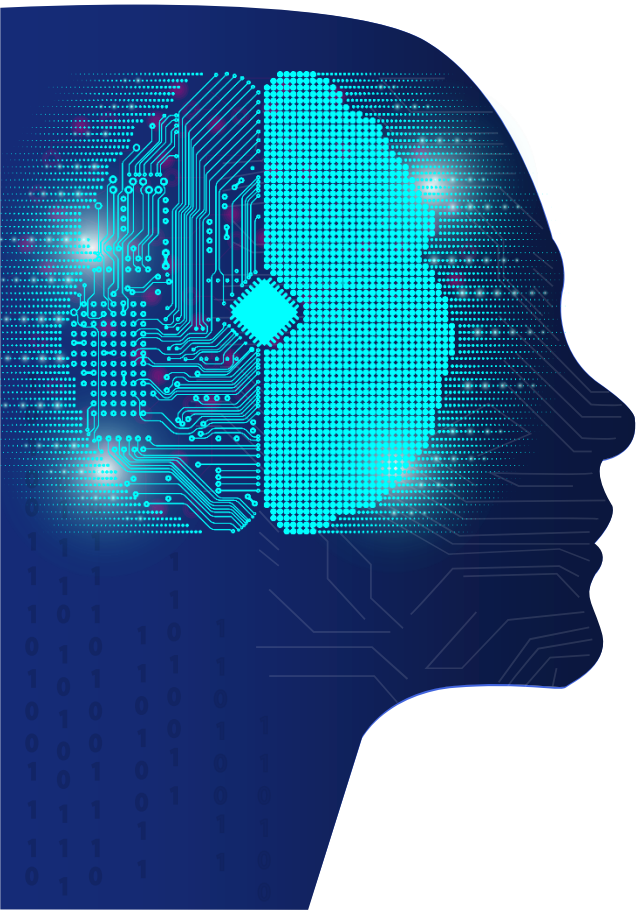
Presentation Outline



- Introduction
- Autonomous Systems
- Autonomous System Functions
- AV Domains
- Future Research
- Conclusion

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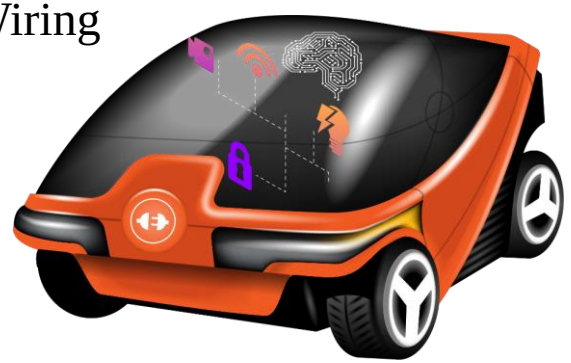
Introduction

- Autonomous systems.

Human		Autonomous System
Eyes	⟷	Sensors for 360° environment perception: camera, ultrasound, LiDAR, radar
Ears	⟷	V2X and V2E connectivity, sound detection, microphone sensors
Memory	⟷	Maps, environmental models, high-resolution 3D maps
Brain, decision making capabilities	⟷	Cognitive processing unit, AI, ML algorithms
Reflexes, coordination of movement	⟷	Actuators and actuators control, vehicle dynamics
Muscles propulsion	⟷	Propulsion engine, brakes, steering
Nerves	⟷	Wiring



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Autonomous System Functions

CONNECT

THINK

LOCATE

ACT

SENSE

COLLABORATE

COMPRENHED

LEARN

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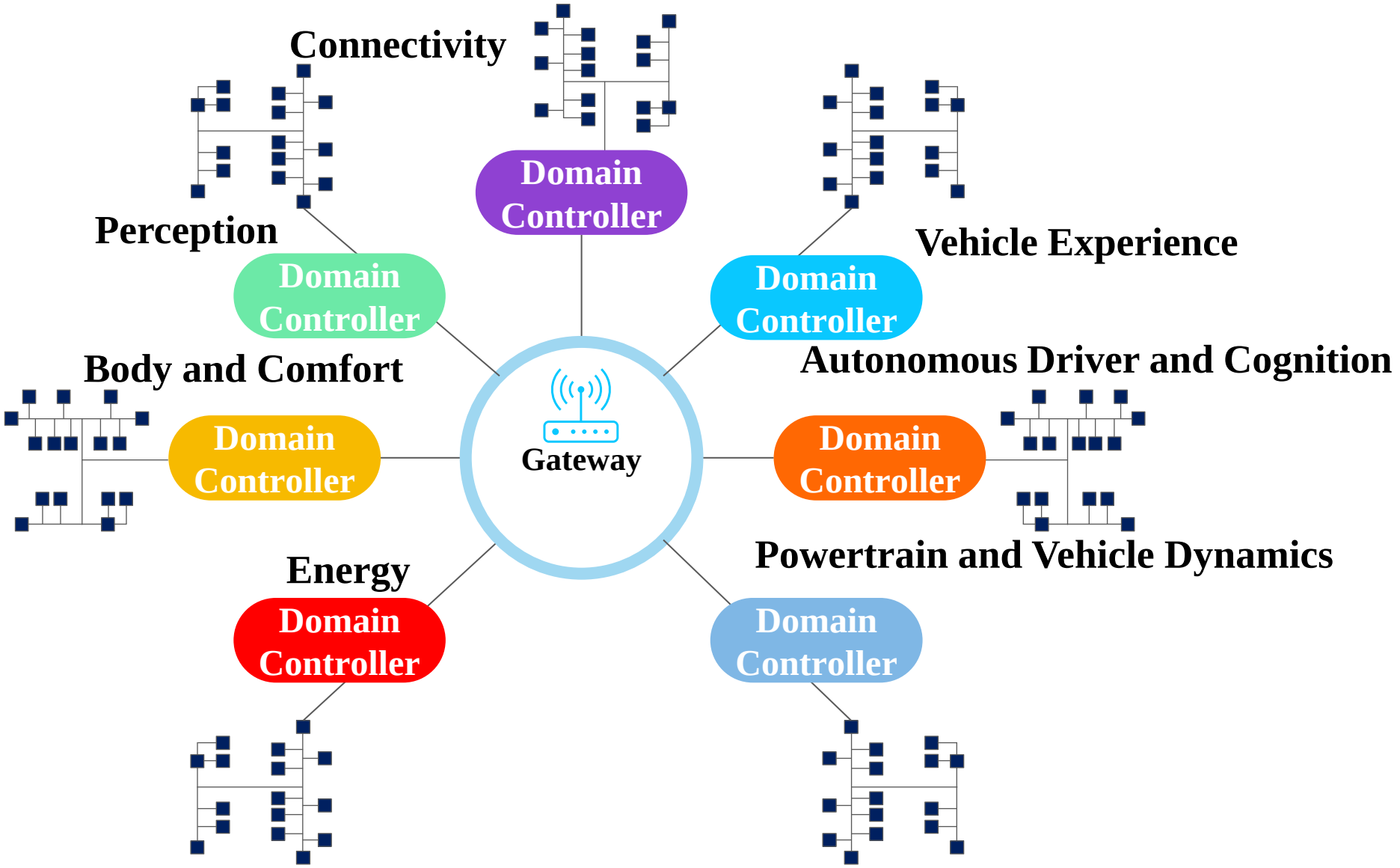
Autonomous Vehicle Domains



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Autonomous System Functional Architecture

- Refers to the logical decomposition of the system into sub-functions/sub-components and the data flows between them:
  - Sense: Process a variety of sensing modalities.
  - Map: Provide static and dynamic map data.
  - Localize: Calculate the vehicle's position, orientation, and motion.
  - Perceive: Calculate drivable areas and obstacle location and motion.
  - Predict: Estimate the future motion and movement of dynamic objects.
  - Plan: Calculate a desired trajectory for a vehicle.
  - Control: Execute the trajectory as steering, brake/acceleration, and throttle commands.

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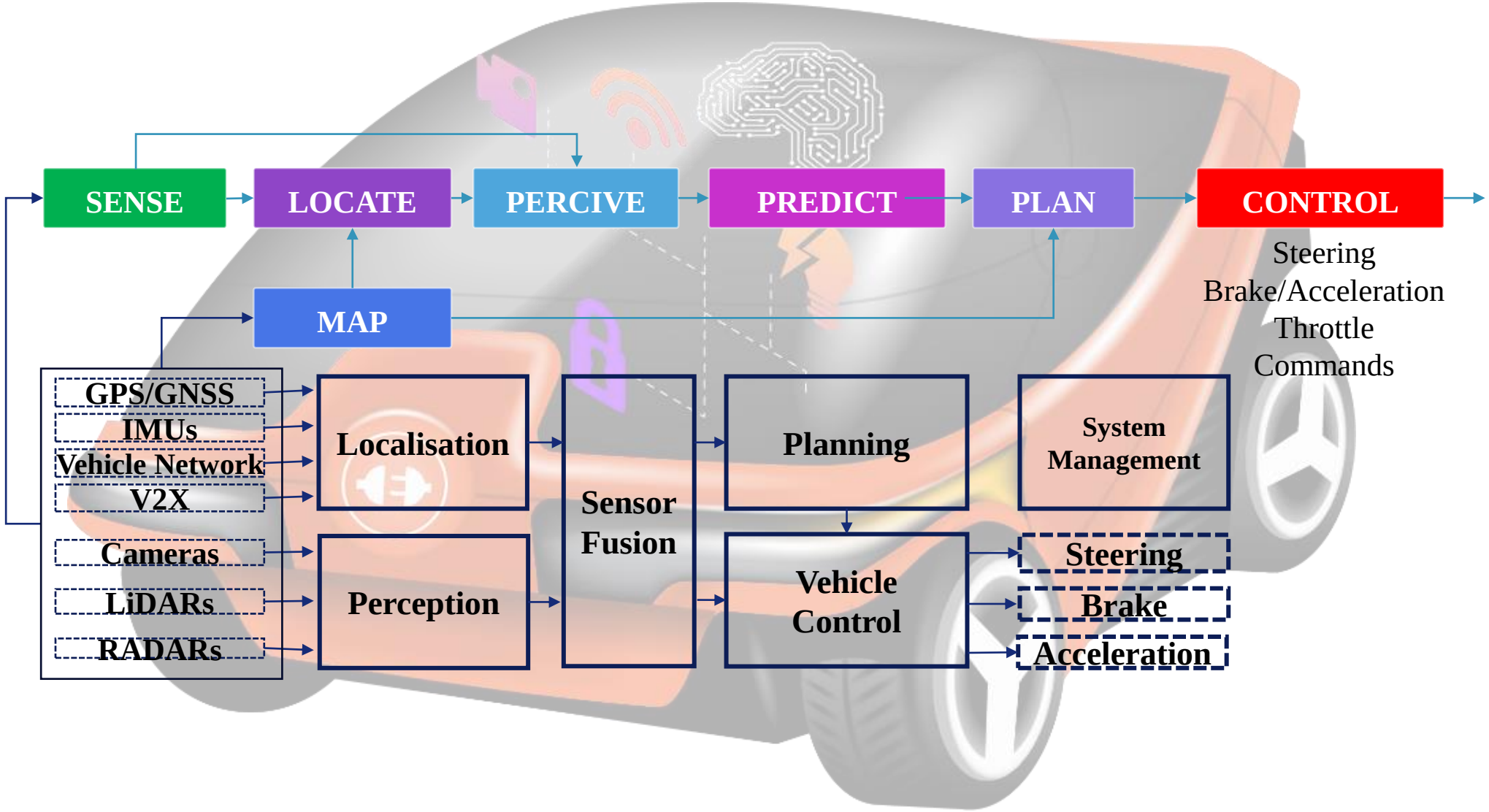
AV Functional Architecture



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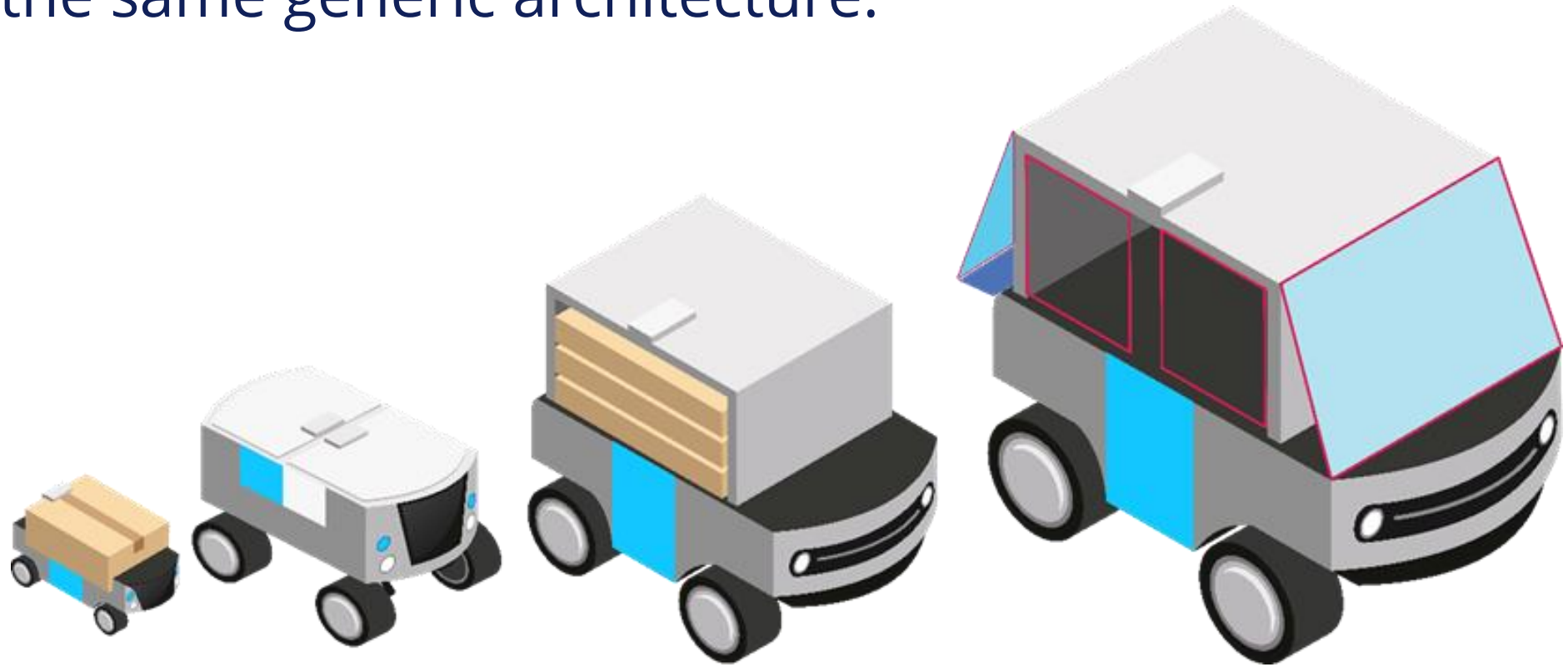
Computation Platforms for Autonomous Systems

- Autonomous vehicle for the transport of goods considers the use of scalable processing capabilities at the edge with AI-based functions implemented into the perception domain and covering the edge computing capabilities implemented into vehicles of different sizes (using the same generic architecture.



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Computation Platforms

	Micro	Mini	Midi	Meta
Computing platform	Jetson Nano	Jetson Xavier NX	Jetson AGX Xavier	Jetson AGX Orin
AI performance	472 GFLOPs	21 TOPs	32 TOPs	275 TOPS
GPU	128-core NVIDIA Maxwell™ GPU	384-core NVIDIA Volta™ GPU with 48 Tensor Cores	512-core NVIDIA Volta™ GPU with 64 Tensor Cores	2048-core NVIDIA Ampere GPU with 64 Tensor Cores
CPU	Quad-Core Arm® Cortex®-A57 MPCore processor	6-core NVIDIA Carmel Arm®v8.2 64-bit CPU 6MB L2 + 4MB L3	8-core NVIDIA Carmel Arm®v8.2 64-bit CPU 8MB L2 + 4MB L3	12-core NVIDIA Arm® Cortex A78AE v8.2 64-bit CPU 3MB L2 + 6MB L3
Power	5W - 10W	10W - 20W	10W - 30W	15W - 60W
DL accelerator	-	2x NVDLA v1.0	2x NVDLA v1.0	2x NVDLA v2.0
Vision accelerator	-	2x PVA v1.0	2x PVA v1.0	1 x PVA v2.0

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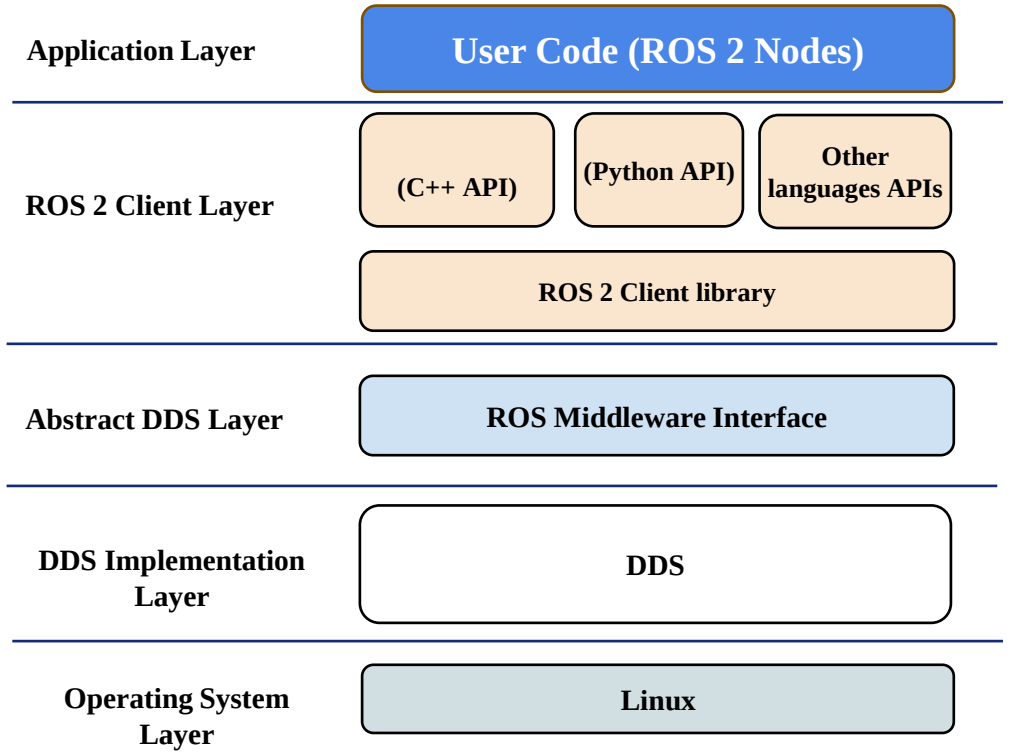
ROS Integration

The Robot Operating System (ROS) is a set of software libraries and tools for building robot and autonomous systems applications. From drivers and algorithms to developer tools, ROS has the open-source tools needed for autonomous systems developments.



DDS = Data Distribution Service is a decentralized, publish-subscribe communication protocol.
ROS Middleware Interface hides the details of the DDs implementations

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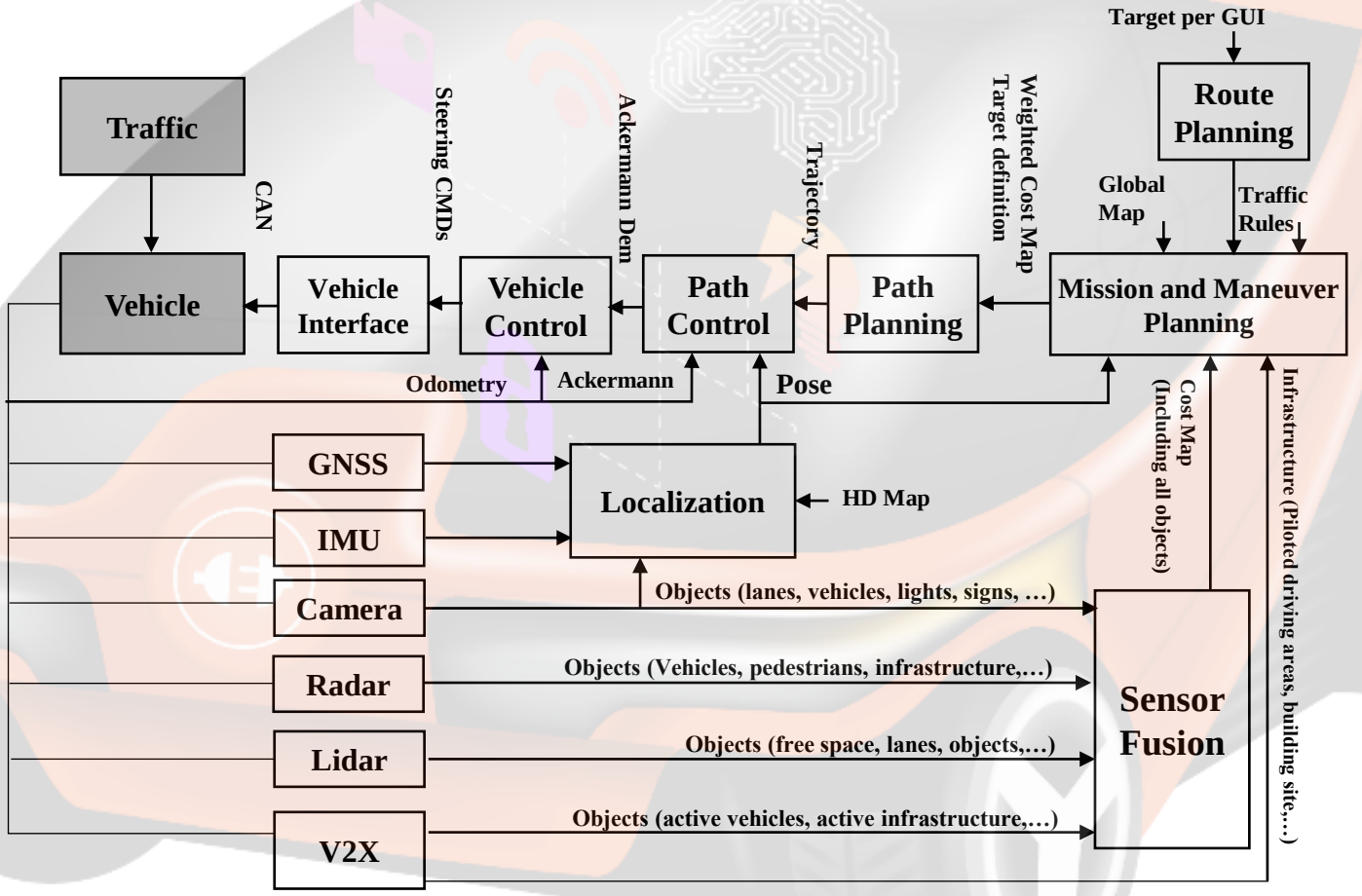
ROS Integration

Scalable commutation platforms with AI-capabilities are integrated into mobile systems that are able to navigate autonomously, detecting dynamic obstacles and following an optimal trajectory. The vehicles can recognize actions processing the images acquired by stereo cameras and LiDARs.
The processes are integrated into the ROS architecture that show potential for Avs applications.



The navigation system is based on the ROS navigation stack, that receives the inputs from a map provided by the map server, the odometry source from the wheels, the LiDAR information, and the estimated position, provided in our case by the Adaptive Monte Carlo localization package.

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Conclusion

- Autonomous systems are implemented using perception sensors for mapping the environment, HW/SW components for the acquisition, processing, aggregation, analysis, and interpretation of data, AI-based algorithms and methods for situation assessment, action planning, cognitive decision-making, and actuators for acting on the propulsion system.
- Scalable commuting platforms can be used for the implementation of processing and AI-base functions of different sizes vehicles combining ROS, different perception sensors and AI-based algorithms.
- Future work addresses the development 0f applications that will allow the platform to interact with people and static/dynamic objects as stand alone and a fleet of 2-3 vehicles.
- Integration with the Autoware platform.

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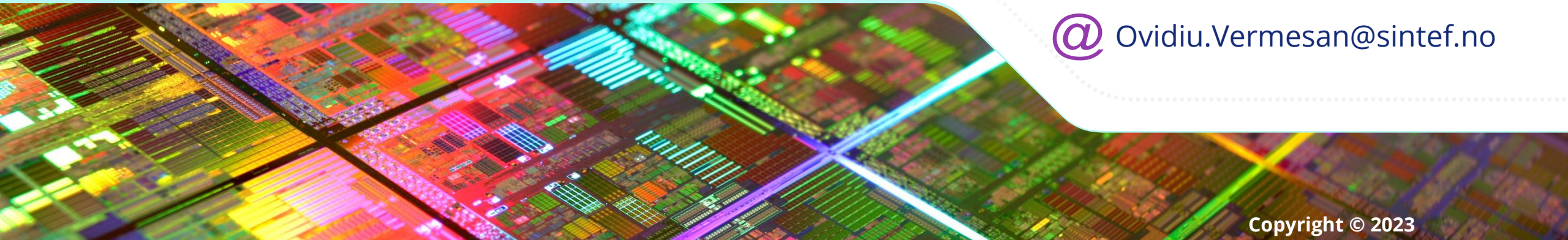
EDGE AI

Thank You

For your attention



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