

Context Aware Software Stacks for Mobility Composive.ai Overview

Naci Dai, Deniz Memis, Burak Saglam

Eteration

Istanbul, Turkey

{naci.dai, deniz.memis, burak.saglam}@eteration.com

Eclipse SAAM Mobility 2021
Security | AI | Architecture | Modelling

Supported by:

OULU
AUTOMOTIVE
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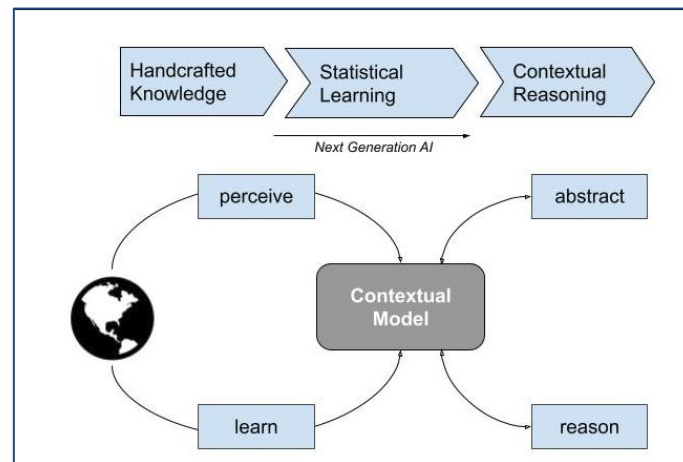
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Outline

- Background
 - AD software: System Design Approaches
 - Contextual AI & Explainable AI
- Context & Context Awareness for AD
- Composive.ai: Goals
- Model Driven Adaptive Software Stacks
- Roadmap

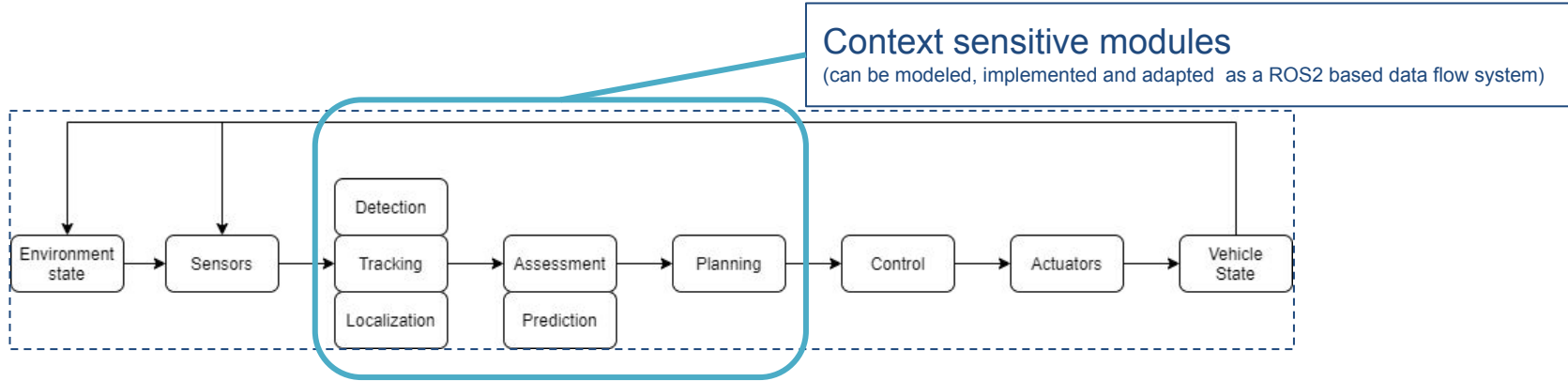
Background

- AD software performs well in a specific context.
 - Dependent on training data and models
 - Unexplainable bias.
 - Underperforms in corner cases.
- The AI Next Campaign (*DARPA*) is announced:
 - *A third wave that brings forth machines that **understand and reason in context.***

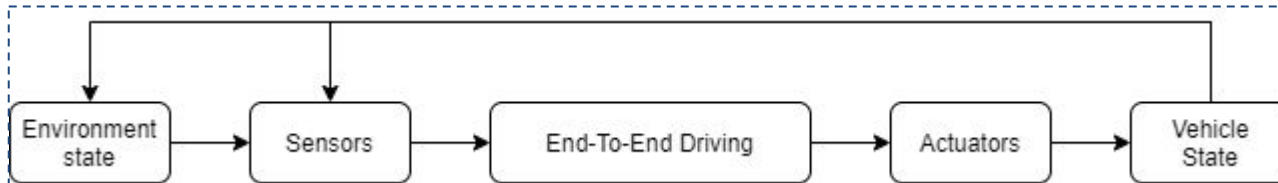


<https://www.darpa.mil/work-with-us/ai-next-campaign>

AD Software Information Flow

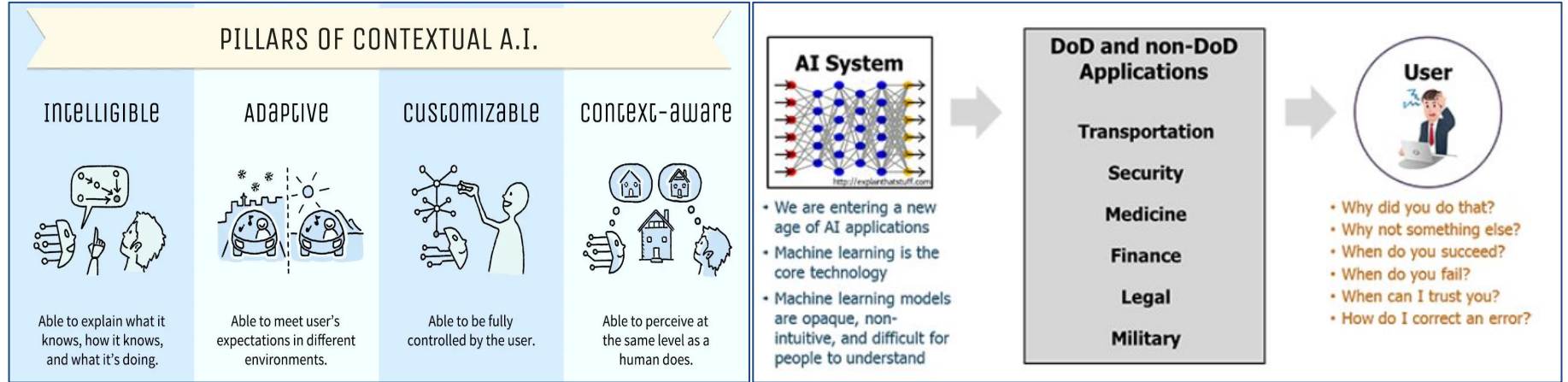


Modular vs End-to-end Systems



E. Yurtsever, J. Lambert, A. Carballo and K. Takeda, "A Survey of Autonomous Driving: Common Practices and Emerging Technologies," in IEEE Access, vol. 8, pp. 58443-58469, 2020, doi: 10.1109/ACCESS.2020.2983149.

Contextual AI & Explainable AI



Contextual AI: The Next Frontier of Artificial Intelligence. Oliver Brdiczka

Explainable Artificial Intelligence (XAI). Dr. Matt Turek

Relation to the structure of the models of the system

Context Variation Example

- Humans are pretty successful at understanding the context changes
- The design and capabilities (sensing, detecting, tracking, planning etc.) of AD software should match.



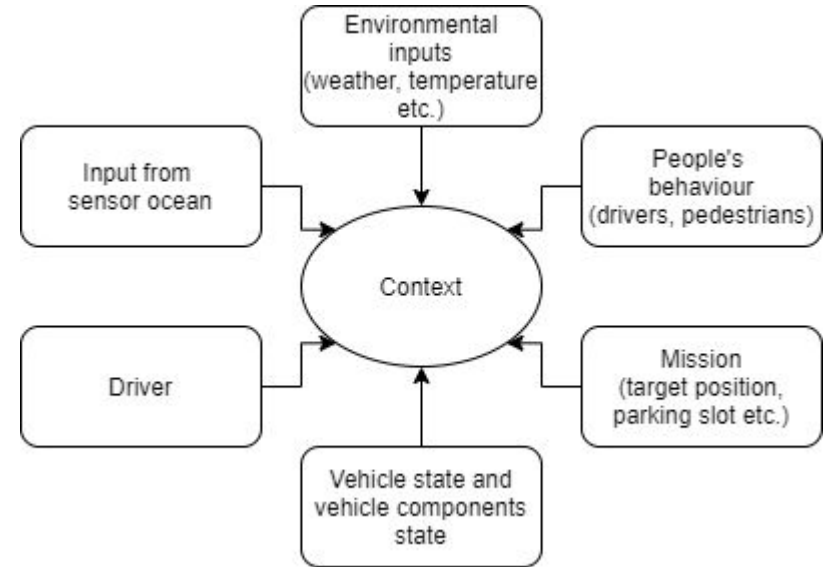
Urban Driving (Organized vs Unorganized)



Parking Lot Driving (Indoor vs Outdoor)

Context & Context Awareness for AD

- Sensory
 - Distance (Lidar)
 - Speed (Radar)
 - Object detection (Camera, image processing, ML)
 - Orientation (SLAM, 3D Maps)
- Behavior
 - Driver, Pedestrians, Other Drivers
- Environment
 - Traffic signs (Object detection, image processing)
- Mission
 - Purpose (park, cruise ..)
 - Destination
 - Planning



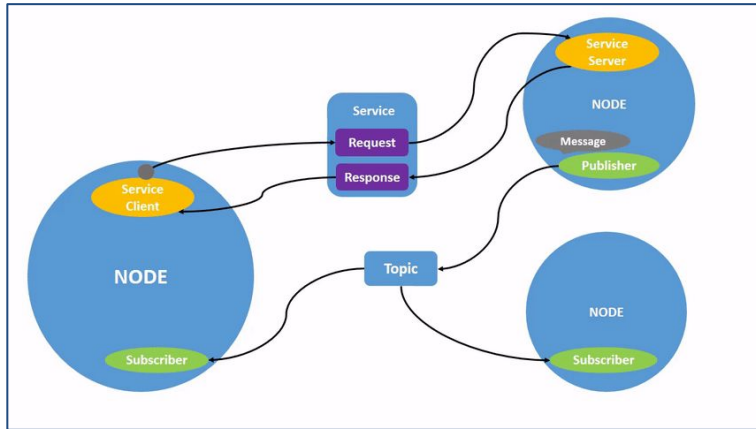
Composiv.ai Goals

- Change the **existing** state towards the **desired** state (i.e. from urban driving context to parking context).
- Ability to abstract **contextual** knowledge for AD.
- Ability to **modify** runtime code (vs. code-first black-box proprietary systems).

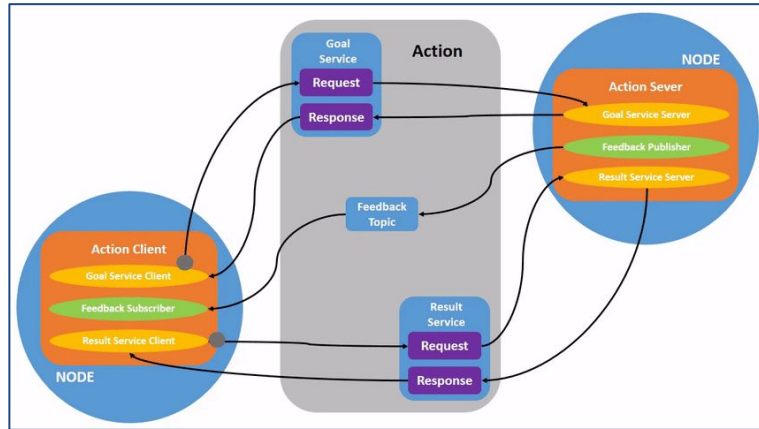
ROS2 System

ROS graph is a network

- ROS 2 elements (executables) and connections processing data together



<https://docs.ros.org/en/foxy/Tutorials/Understanding-ROS2-Nodes.html>



<https://docs.ros.org/en/foxy/Tutorials/Understanding-ROS2-Actions.html>

Model Based Robotics in ROS2 ecosystem



RobMoSys

RobMoSys:

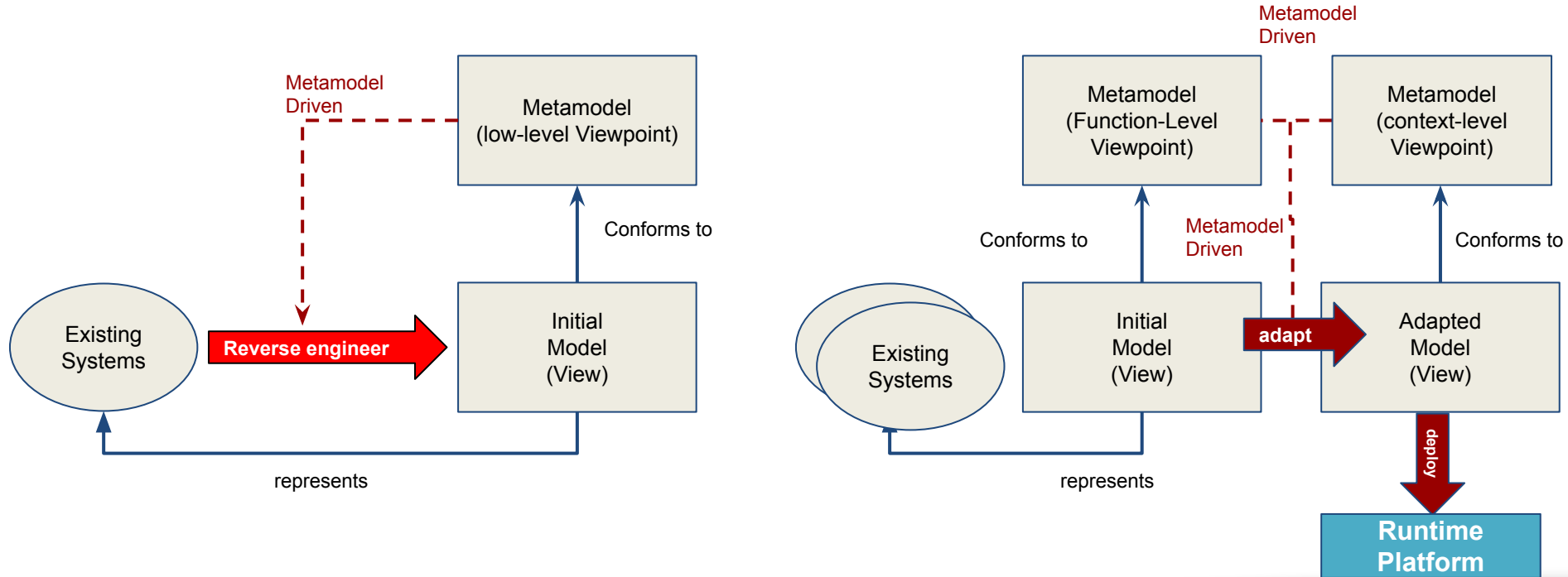
- Enables the **composition** of robotics applications with managed, assured, and maintained system-level properties via **model-driven** techniques.

• *MROS:*

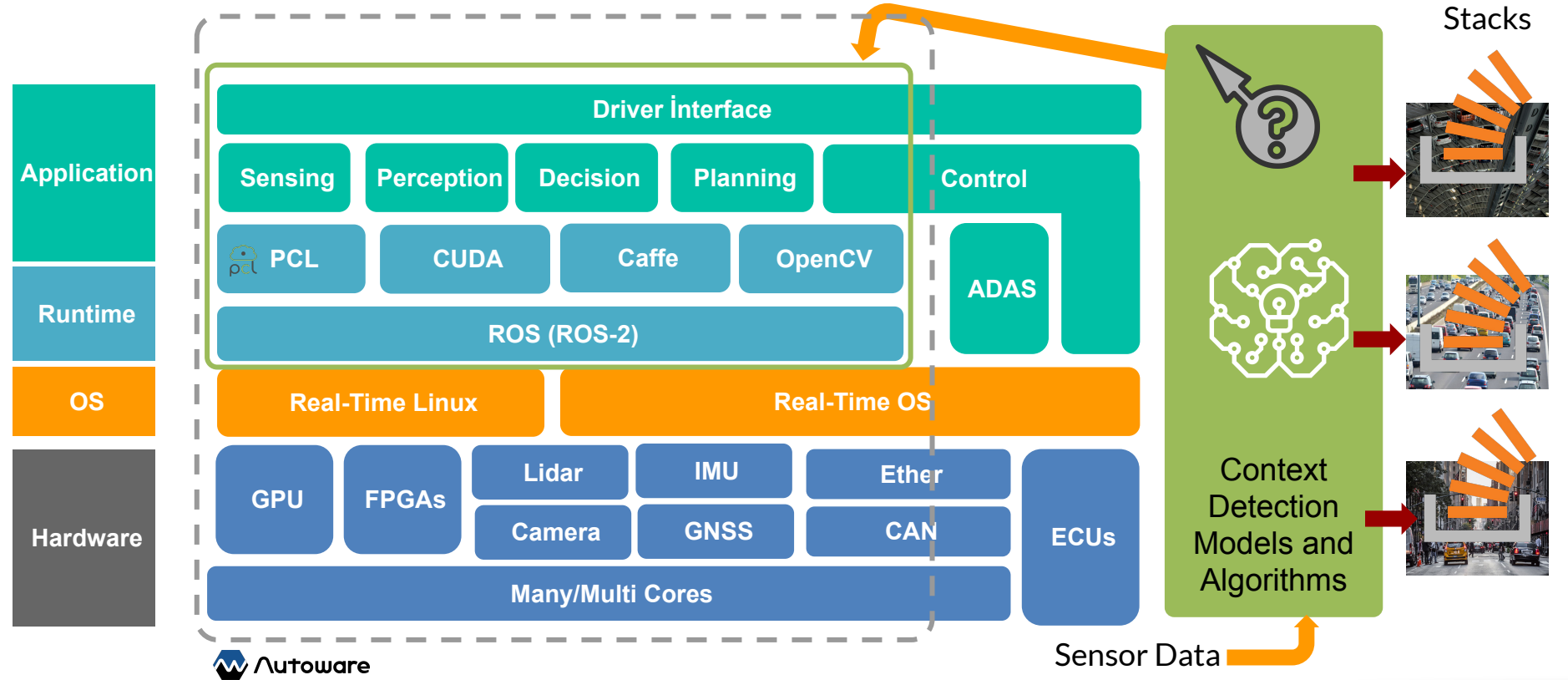
- The objective of MROS is to leverage the RobMoSys **model-based approach at runtime**, to provide a solution for ROS2 systems, based on architectural self- adaptation driven by **ontology reasoning** on the architecture models.

MROS

Model Driven Context Aware Stacks

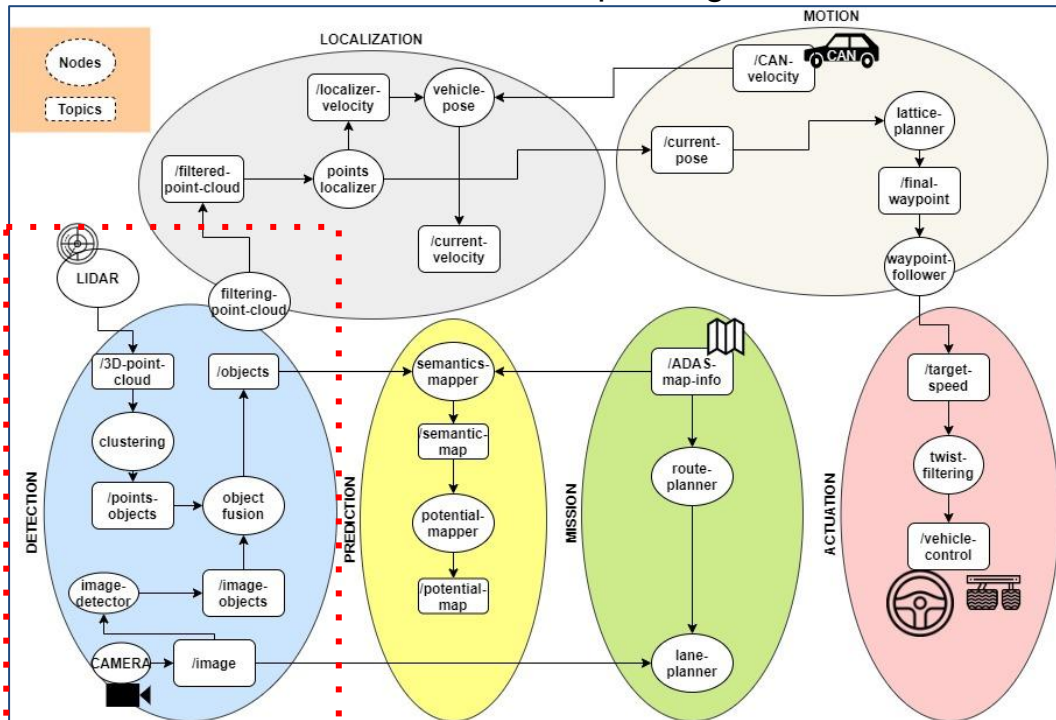


Model-driven Approach with open-source AD stack

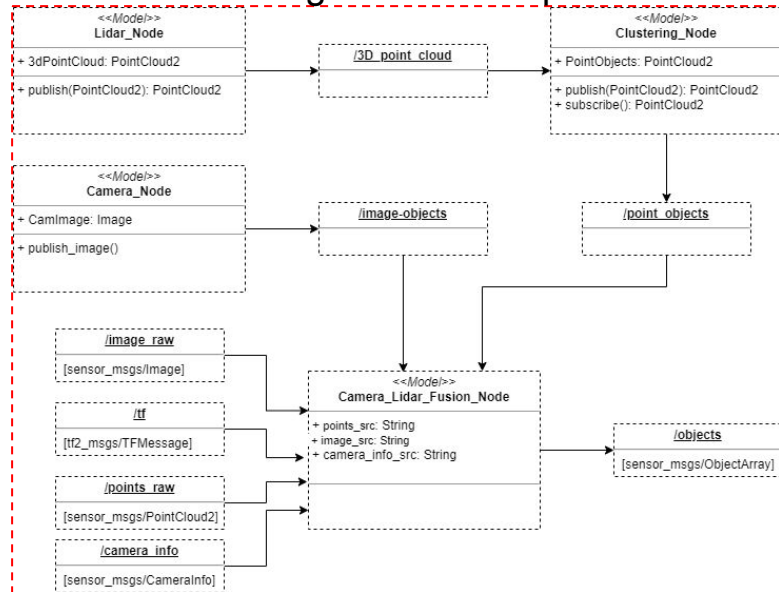


Modeling Existing AD Framework (Autoware)

Partial Autoware Node-Graph Diagram

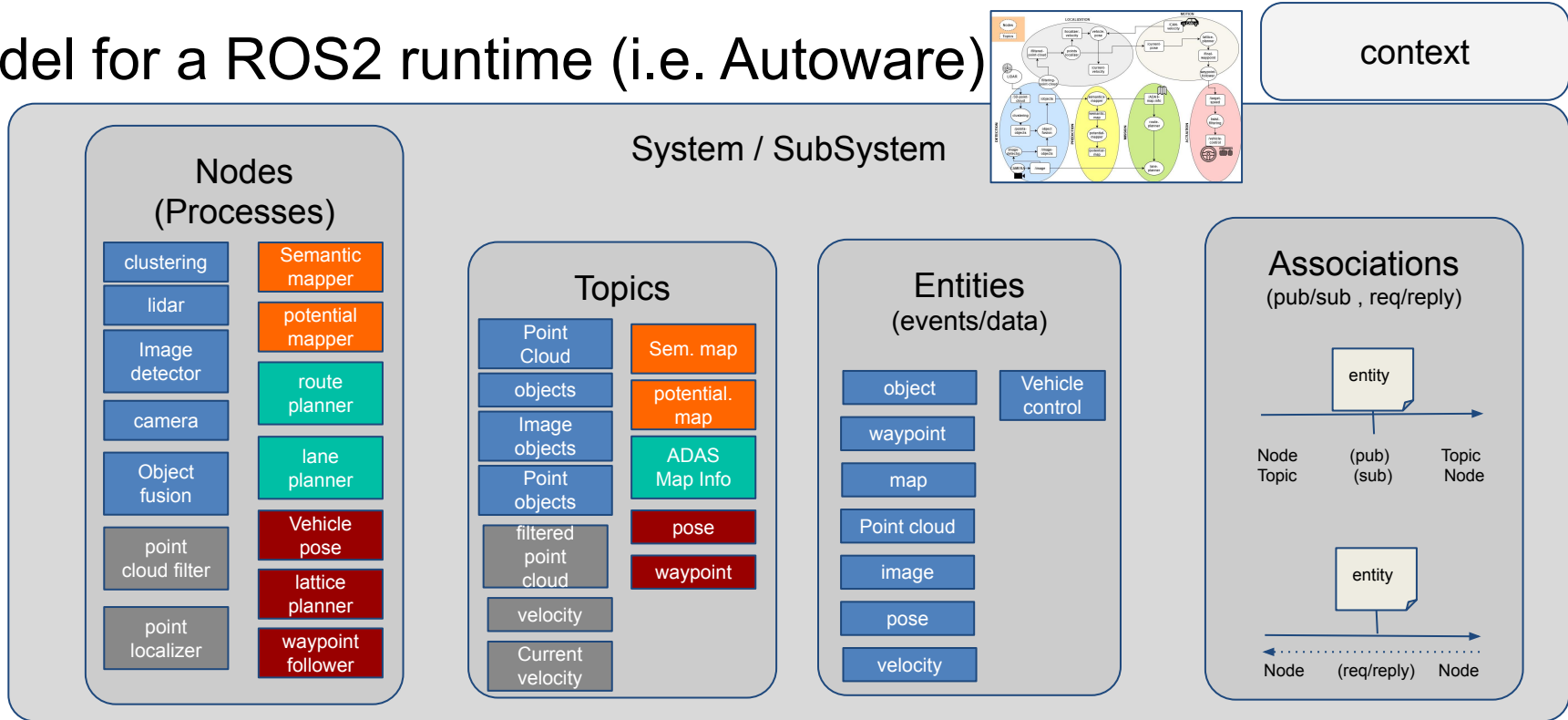


Modeling of Node-Graph



ROS2 Based AD Model Concept

Model for a ROS2 runtime (i.e. Autoware)






Composiv.ai Components


SDKs for Stack and Component Development

LiveUI
UI Stacks




Client Devices

LiveFlow
Flow Stacks




Cloud (MW) Platforms

LiveStream
Edge Stacks

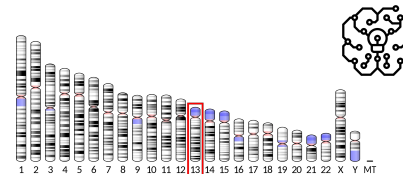


Edge Devices

Algorithm & Model Development



Feature Engineering



Sensor Ocean



Context Awareness

Model Driven Stacks

Stack (App & Service) Repositories

Stack Lifecycle and Trust Management

Roadmap

- Architectural Definitions & Requirements Analysis **(09/2021)**
 - Autonomous Vehicles
 - Autonomous Driving Software Stacks
- CASSM v1 **(01-03/2022)**
 - Models and algorithms
- CASSM Edge Runtime Platform v1 **(01-03/2022)**
 - LiveStreams (*Composive.ai*)
 - ROS2/DDS
- Micro user interfaces and flows SDK v1 **(01-03/2022)**
 - LiveUI (*Composive.ai*)
 - LiveFlow (*Composive.ai*)
- Case Studies
 - Case Study I: Modeling studies based on *open-source* modular AD software stack.
 - Case Study II: Testing on a 1/10th scale RC car conforming to *f1fenth.org* specs

Thank you for listening and for your attention.

We'd be glad to answer any questions...



*Naci M. Dai
Chief Scientist*



*Deniz Memis
Engineer*



*Burak Saglam
PM*