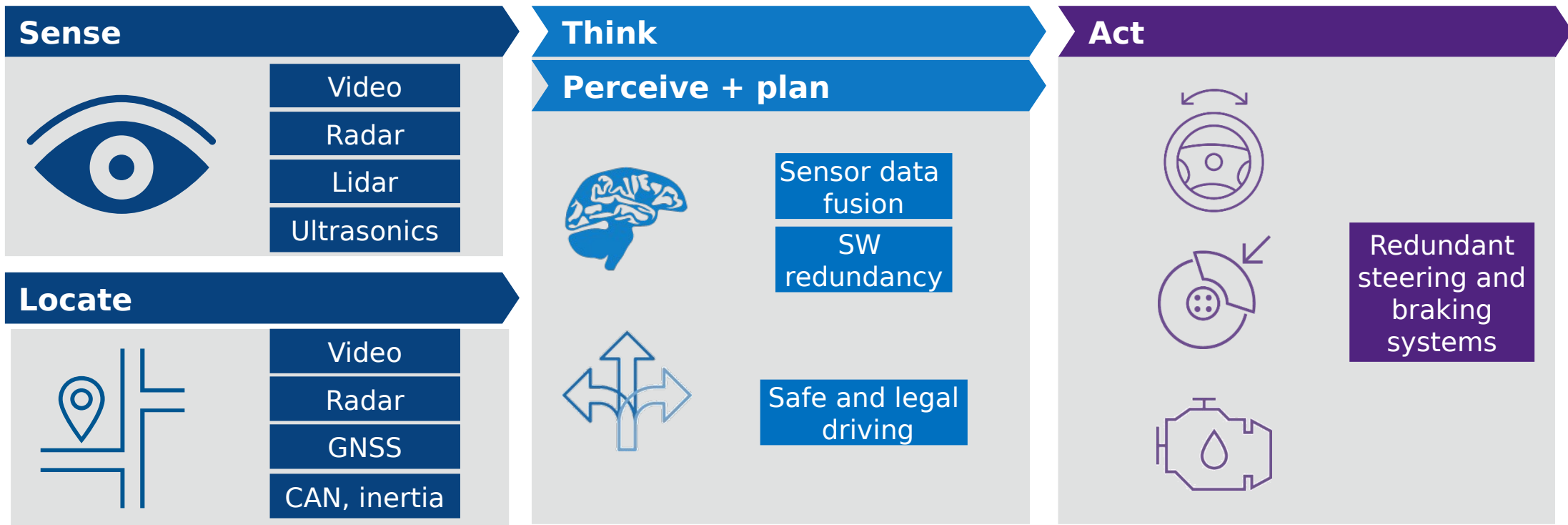


OpenADx – xcelerate your Autonomous Driving development

Autonomous Driving

The car has to mirror a driver's abilities to see, evaluate and act



The OpenADx community provides a platform which leverages...

...open source to increase efficiency and create standards

Reason Why

AD requires a multifaceted process incorporating a variety of software tools

But none of these tools were ever designed to work together

This costs the industry time and money

We are mitigating this problem by creating the leading automated driving ecosystem > **OpenADx**

RB launched OpenADx at BCW 2018 ...



... and established an Eclipse hosted community

▣ 30 entities

▣ 60+ active contributors

▣ Initial projects:

- Cloe (simulation kit for testing AD software components)
- Standardized AI labeling
- SiL standardization

Targets



- ▣ Accelerate time to market
- ▣ Share costs
- ▣ Free up resources to focus on customers

Approach

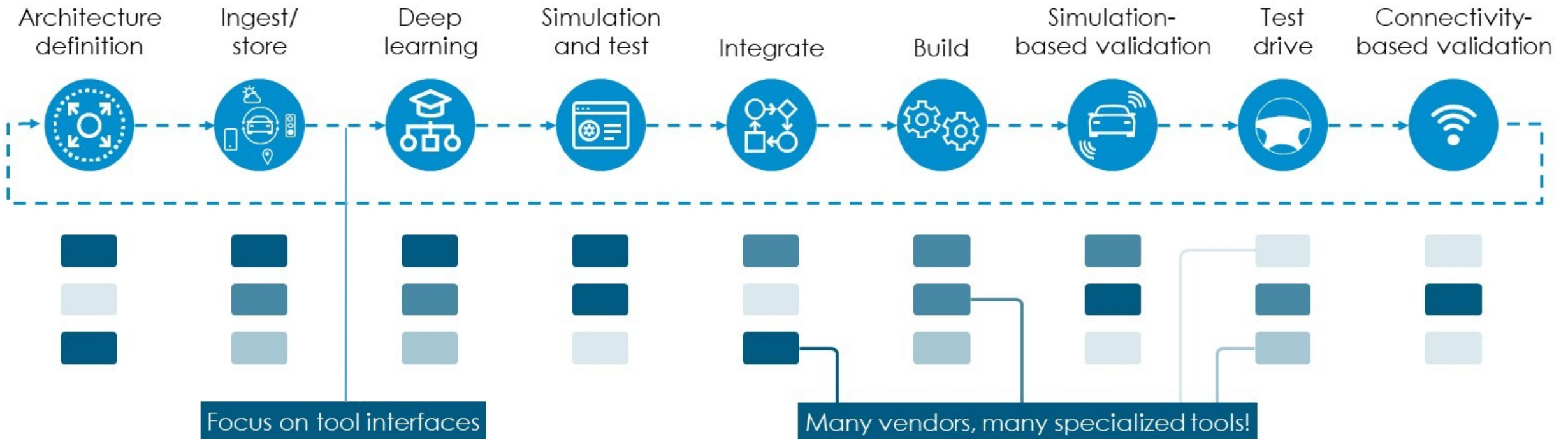


- ▣ Define Industry-wide AD toolchain
- ▣ Ensure high interoperability
- ▣ Provide easy access
- ▣ Establish basis for reference arch.



OpenADx

...with a wide-ranging tool landscape

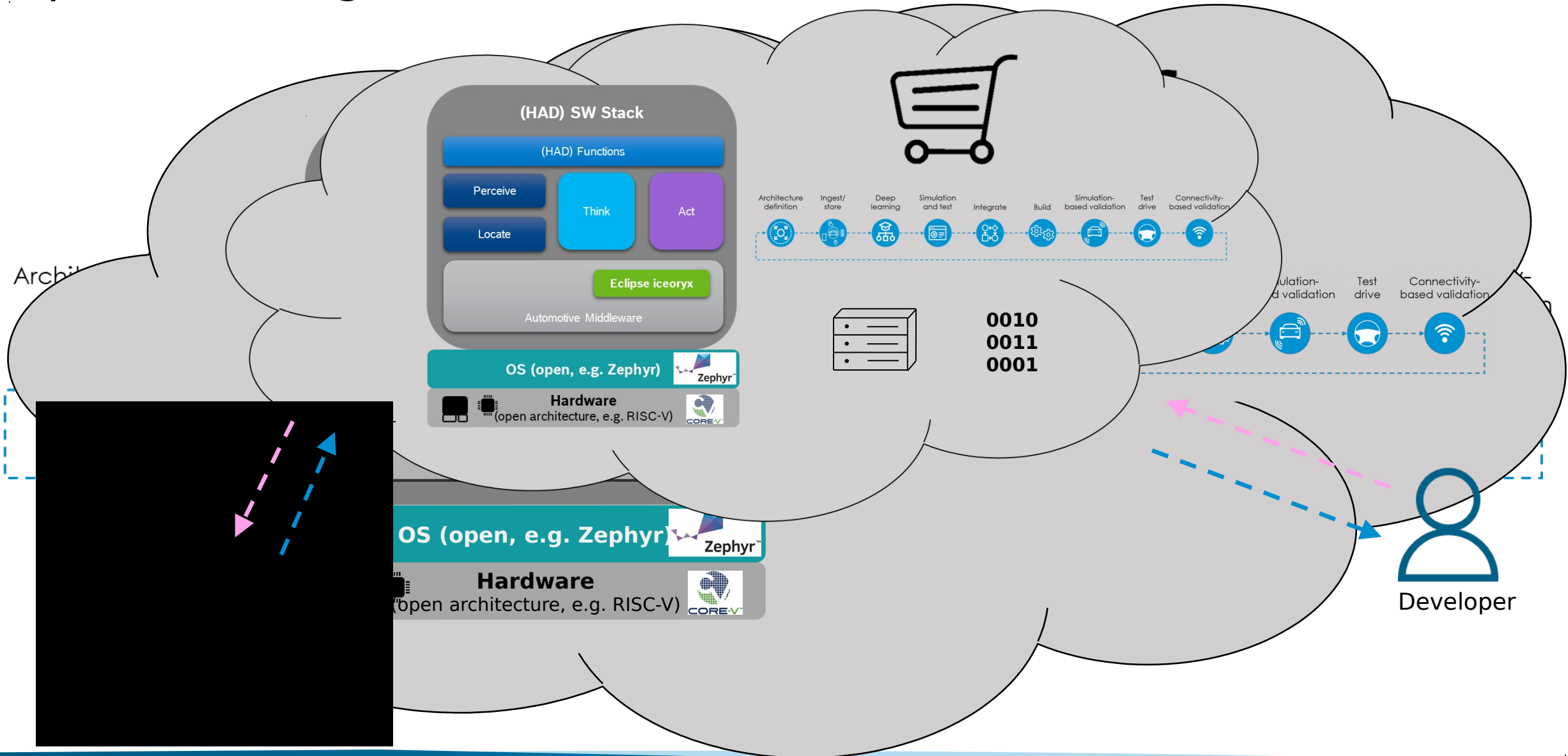


GOALS

- › Industry-wide accepted definition of the AD toolchain
- › Tool interface standardization
- › Ensure efficient implementation and interoperability
- › Foundation for reference architecture

Make a complex tool landscape more accessible for enterprise users

OpenADx - Big Picture - Vision



OpenADx as a Portal to Autonomous Driving

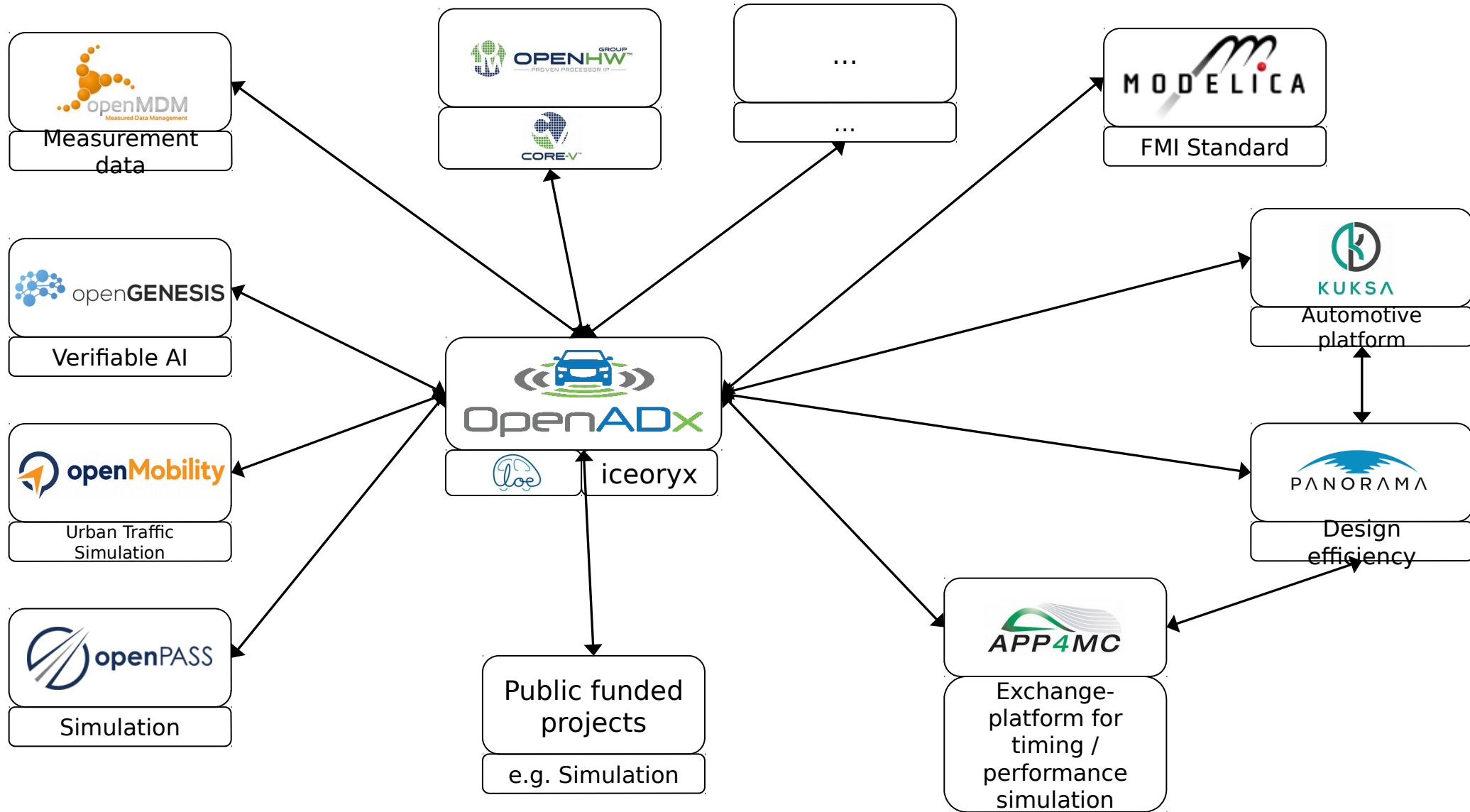
- › OpenADx embraces open solutions
- › The [OpenADx AD Portal](#)
 - › Internet portal to share information about Autonomous Driving
 - Toolchain proposals
 - Cookbooks
 - HowTos

- › OpenADx targets to realize open solutions
- › Eclipse based open projects

- › But: OpenADx integrates exciting solutions from anywhere
- › Any quality solution be it commercial or open independent of the license will be considered
- › Described in toolchain proposals and cookbooks for anyone to use as is or adapted as needed

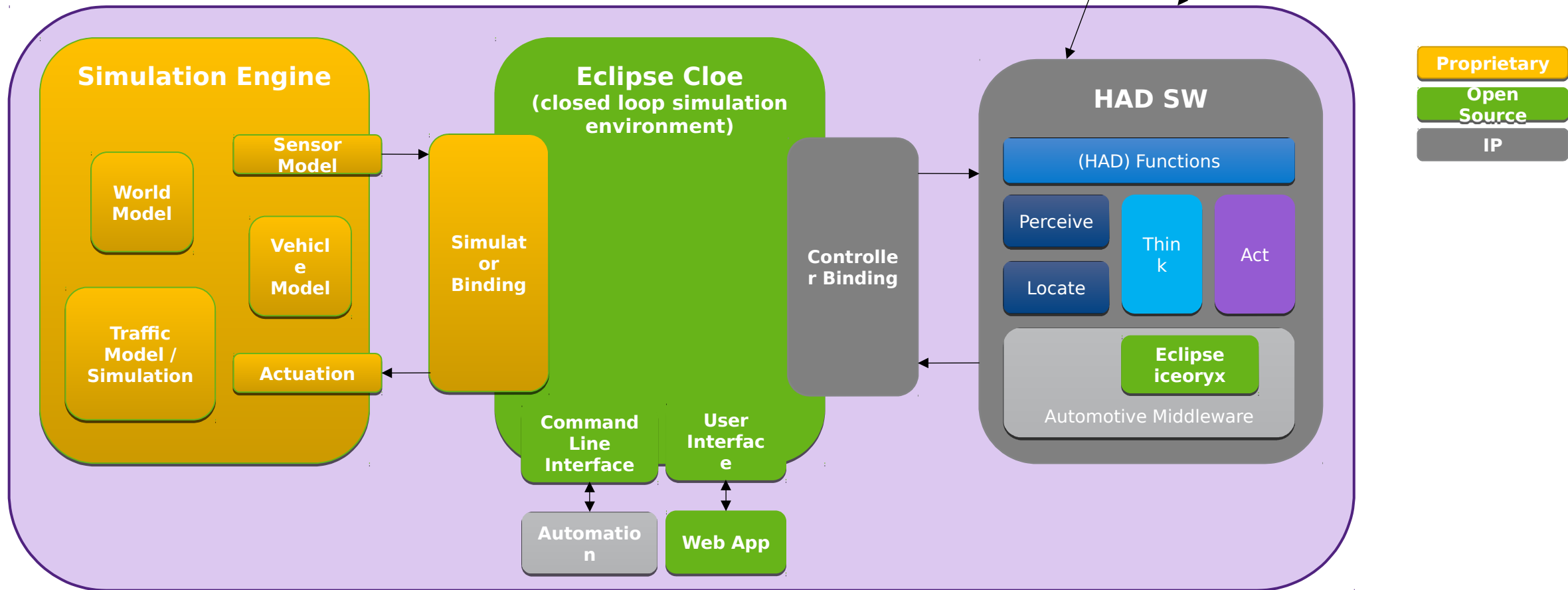
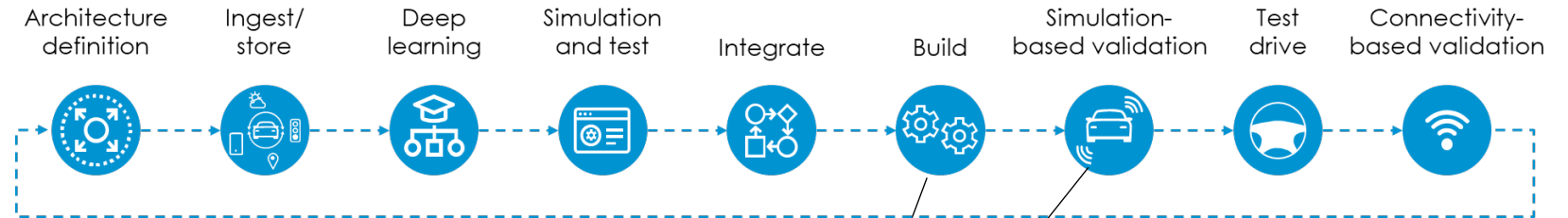
<https://openadx.eclipse.org/>

Cooperations and potential




Eclipse Cloe - Simulation Middleware

Eclipse iceoryx - Shared Memory



Simulation Middleware – Eclipse Cloe



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[Working Groups](#)
[Projects](#)
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Eclipse Cloe

Overview
Downloads
Who's Involved
Developer Resources
Governance
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Cloe is an enhanced middleware solution for closed-loop simulations, with a focus on functional software tests on system level. Cloe is used as a development tool for interactive and scripted workstation simulations, for code debugging, and for automated tests on servers. Cloe covers a central part of the verification and validation strategy, needed by all vendors in the field of Automated Driving.


- Cloe acts as closed-loop simulation master and middleware for all involved components, such as simulator engine, vehicle controller, and component models.
- Cloe provides a tool for orchestrating such closed-loop simulations in a variety of environments, e.g. on localhost or in a Kubernetes cluster.
- Cloe provides a lightweight web-based user-interface for visualizing the simulation state.
- Simulations are described through Cloe stack-files for reproducibility.

These core characteristics of Cloe allow it to (partially) fulfil the closed-loop simulation in the V&V strategy. Vehicle controllers and models can be easily integrated with Cloe and immediately have access to multiple simulator engines. Given M simulator engines and N vehicle controllers, Cloe allows the number of integrations to be reduced to M+N, rather than M×N that would otherwise be necessary. Multiple simulator engines are supported, proprietary as well as open source. This allows a user to mix-and-match engines to their system-under-test based on test requirements. Cloe provides generalized interfaces allowing ground truth and key-performance indicator extraction, as well as fault injection.

Orchestration features provided by Cloe allow faster scaling of simulation tests and evaluation. Through containerization and the simulation description files, development artifacts along with their tests can be easily archived and the results quickly reproduced.

Licenses:
[Apache License, Version 2.0](#)

Contribution Activity:
 Commits on this project (last 12 months).



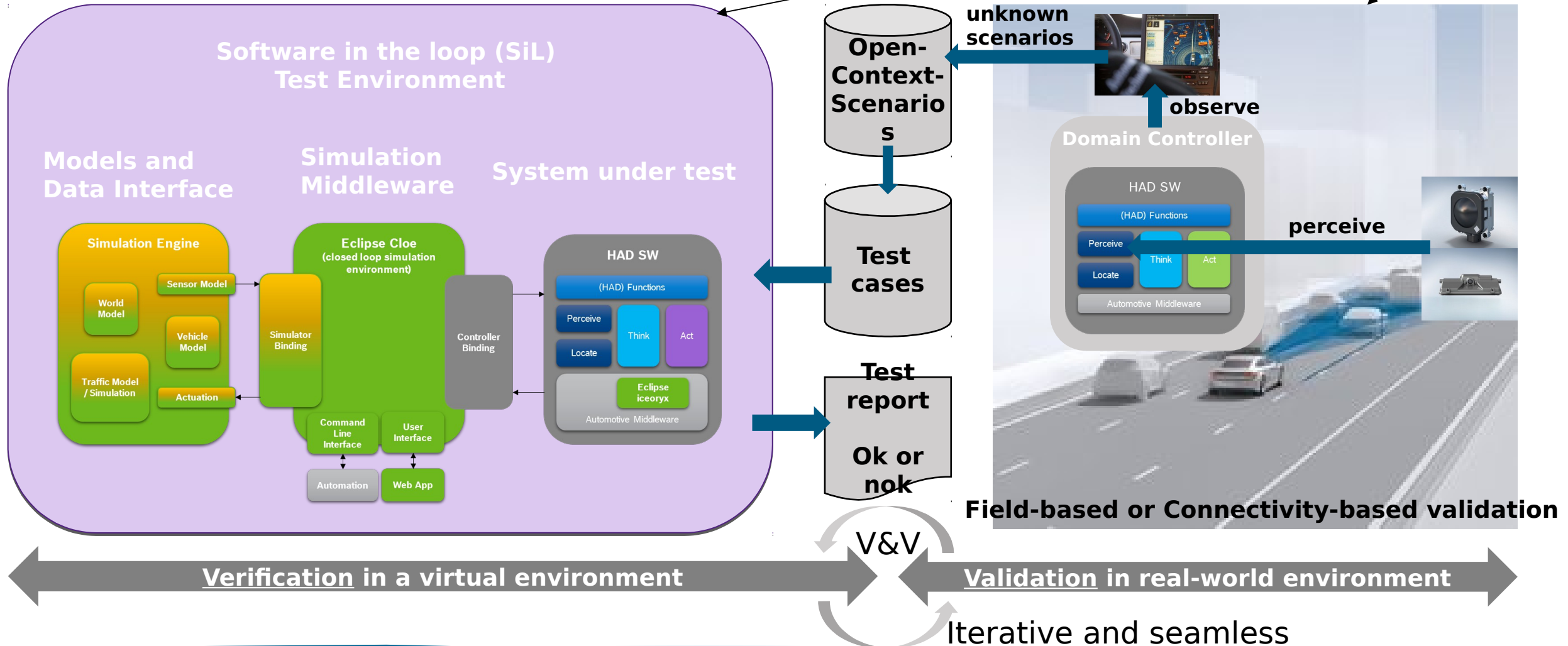
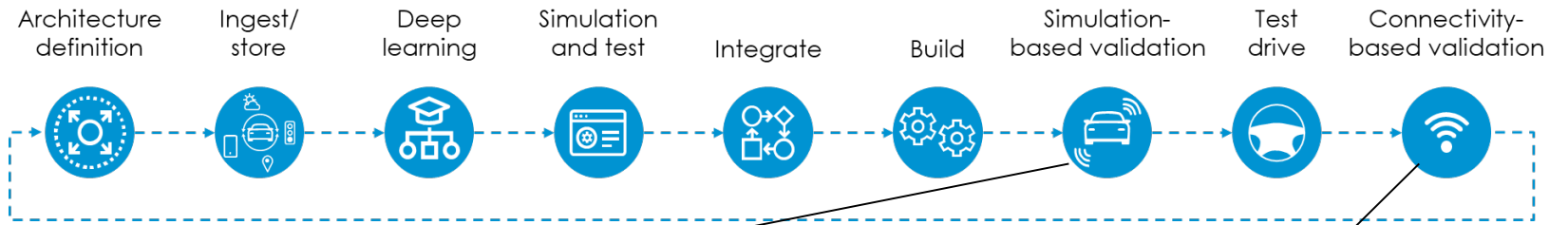
RELATED PROJECTS ▾

Project Hierarchy:

- » [Eclipse Technology](#)
- » [Eclipse Cloe](#)

<https://projects.eclipse.org/projects/technology.cloe>

Software in the loop Field-based Validation



Shared memory



NEW PROJECT ALERT

Eclipse iceoryx

Eclipse iceoryx is an IPC middleware for POSIX based operating systems with a zero-copy shared memory approach, optimized for the huge data inter-process-communication.

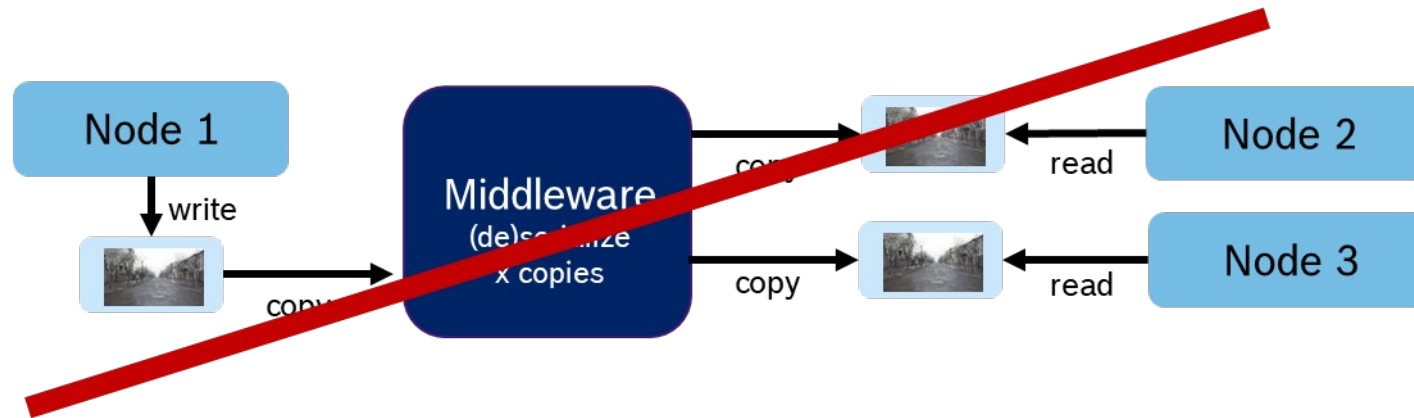
 ECLIPSE
FOUNDATION

<https://projects.eclipse.org/proposals/eclipse-iceoryx>

Eclipse iceoryx



A True Zero-Copy Inter-Process-Communication

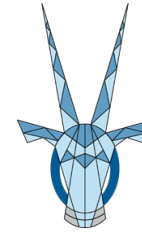


A typical middleware...

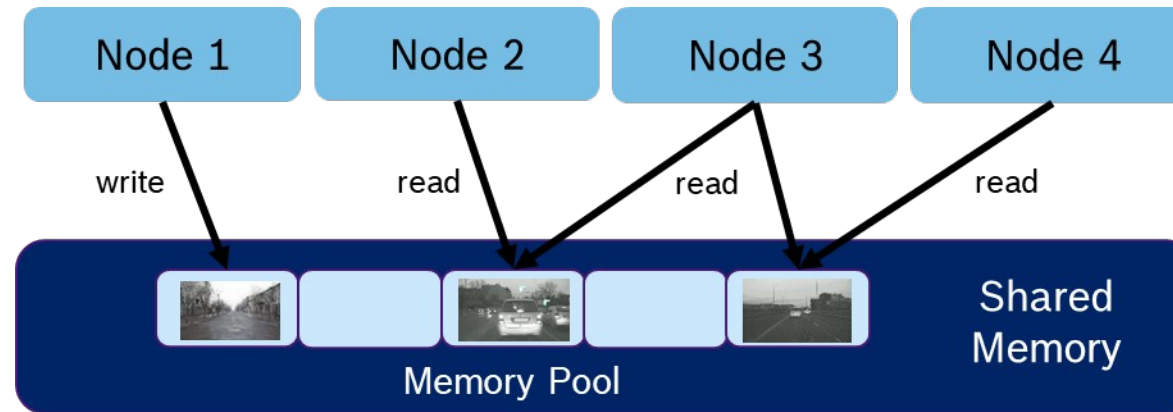
- > copies when passing messages from the publisher to the middleware
- > copies when passing messages from the middleware to the subscriber
- > does internally even more copies and/or serialization/deserialization
- > does at least $n+1$ copies for an inter-process-communication with n subscribers

No time for multi-GB/s data copying and serialization while driving!

Eclipse iceoryx



A True Zero-Copy Inter-Process-Communication



True zero-copy means...

- > it is an end-to-end zero-copy approach from publishers to subscribers, based on shared memory
- > the publisher directly writes to a chunk of memory provided by the middleware
- > the middleware passes message references to subscribers and manages their liveness

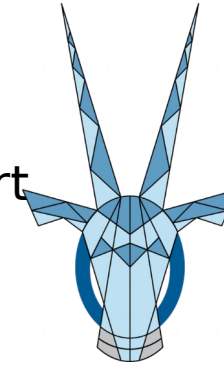
Zero-copy communication is a must-have for automated driving!

Eclipse iceoryx

A True Zero-Copy Inter-Process-Communication

Eclipse iceoryx

- › Shared memory inter-process-communication with zero-copy support
- › Written in modern C++ with support for Linux and QNX
- › Just launched as Eclipse incubation project with Apache 2.0 license



rmw_iceoryx – the iceoryx RMW implementation for ROS2

- › First version available that supports publish/subscribe, the ROS2 CLI and a bridge
- › Zero copy support for fixed size messages, slim serialization for dynamic messages



Summary

› **Open source software**

- › become more and more important in the automotive industry
- › minimizes dependency on suppliers -> Having alternatives to your software suppliers
- › increase quality by broad testing reviews, skilled attention, broad expertise
- › share risks: If something goes wrong ... you are at least in good company!
- › reduces costs: Share costs for commodity without losing influence
- › will be the answer to partnerships, consortia's ...

› **Future software toolchain for autonomous driving should**

- › support the integration of tools along defined development workflows
- › fill identified gaps along the development workflows

Summary and Outlook

- › OpenADx is an industry wide initiative to accelerate the development of Automated Driving
- › Collaboration is done in the form of testbeds as prototypes for potential open source projects
- › Currently the primary focus is to publish first solutions

We invite you!

Links

- › OpenADx
 - › Website: <https://openadx.eclipse.org/>
 - › Wiki: <https://wiki.eclipse.org/OpenADx>
 - › Mailing List: <https://accounts.eclipse.org/mailling-list/openadx>
 - › OpenADx in Blogs: <https://blog.bosch-si.com/developer/5-things-you-should-know-about-openadx>
 - › Eclipse iceoryx
 - <https://github.com/eclipse/iceoryx>
 - <https://projects.eclipse.org/proposals/eclipse-iceoryx>
 - › Eclipse Cloe: <https://projects.eclipse.org/proposals/eclipse-cloe>
 - › Eclipse APP4MC: <https://www.eclipse.org/app4mc/>
 - › Eclipse Kuksa: <https://www.eclipse.org/kuksa/>
 - › Panorama: <https://panorama-research.org/>
- › openMDM: <https://www.openmdm.org/>
- › openPASS: <https://wiki.eclipse.org/OpenPASS-WG>
- › openMobility: <https://openmobility.eclipse.org/>
- › openGENESIS: https://wiki.eclipse.org/OpenGENESIS_WG

Thank you!

Andreas Riexinger

Andreas.riexinger@de.bosch.com

Find out more and join us

<https://wiki.eclipse.org/OpenADx>

<https://openadx.eclipse.org>