Autonomous Driving and Open Source – Is this a good idea?

EclipseCon 2020
October 19th – 22nd, 2020

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Product Manager Automated Driving
Who am I?

Andy Riexinger
Robert Bosch GmbH
Chassis System Control – Automated Driving

› Product Manager Automated Driving
› ~23 years at Bosch
› ~15 years experience in embedded software development
› Pushing Open Source development and business within Robert Bosch GmbH
› Interest in creating business with Open Source
Complexity of Autonomous Driving

The car has to mirror a driver’s abilities to see, evaluate and act.
Open Source has arrived in automotive

FEP — Functional Engineering Platform launched to face the upcoming complexity in function development, considering all relevant aspects in simulation (MiL, SiL, HiL) and testing.
Motivation for Open Source Software

How OSS works for companies …

<table>
<thead>
<tr>
<th>Product / Ecosystem Strategy</th>
<th>Differentiating</th>
<th>Commodity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Open Source SW</td>
<td>?</td>
<td>X</td>
</tr>
<tr>
<td>Proprietary SW</td>
<td>X</td>
<td>?</td>
</tr>
</tbody>
</table>

Identify differentiating vs commodity elements

Identify commodity over time

Shared development

Efficient technology development

- Gain speed
- Increase quality
- Increase security
  - > fast response time
- Reduce costs
- Share risks
- Modularity
  - > break up monoliths
- Cross-domain / -company expertise

Higher independence

- Minimize dependencies on suppliers
- Prevent / break proprietary monopoles
  - > answer to consortia

Accelerated market penetration

- Viral “marketing”
- Establish a new technology in the market
- Standardization

Competitive advantage

… and what they get from OSS
Autonomous driving accelerator “OpenADx” launched

Today at the Bosch ConnectedWorld conference in Berlin, a new open source autonomous driving accelerator was introduced. OpenADx focuses on the software development toolchain for autonomous driving, an enabling component in the landscape of highly autonomous driving.

OpenADx – accelerate your Autonomous Driving development
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.

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OpenADx targets reference architecture and ...

a wide ranging interoperable toolchain for PoV* and commercial applications

**GOALS**

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

*PoV – privately owned vehicle
OpenADx: A business enabling ecosystem ...

Use Case: Leverage OpenADx to build your own software development toolchain

(HAD) SW Stack

(HAD) Functions

Perceive
Locate
Think
Act

Eclipse iceoryx

Automotive Middleware
OpenADx: Enabling interorganization collaboration …

Use Case: Leverage OpenADx to bring your toolchain to the cloud
OpenADx: Leading to holistic functional approaches

Use Case: Leverage OpenADx to develop end-to-end solutions (with the community)
OpenADx lays the foundation for safety and standardization.

- Measurement data
- Verifiable AI
- Urban Traffic Simulation
- Simulation
- Public funded projects (e.g. Simulation)
- Exchange-platform for timing / performance simulation

Related tools and standards:
- openMDM
- openGENESIS
- openMobility
- openPASS
- MODELICA
- FMI Standard
- KUKSA
- PANORAMA
- APP4MC

Technology areas:
- Autonomous Driving
- Open Source

Date: 12.10.2020
OpenADx: e.g. two major initiatives to address requirements for simulation and data transfer in real time (Cloe and iceoryx)

1. **Simulation Engine**
   - **Eclipse Cloe** (closed loop simulation environment)
   - **Controller Binding**
   - **User Interface**

2. **Eclipse Cloe**
   - **Function**
   - **Functional Elements**
   - **Automotive Middleware**

3. **AD SW** (under test)

4. **OpenADx**
   - **Open Source**
   - **Proprietary**

5. **Links**
   - [https://projects.eclipse.org/projects/technology.cloe](https://projects.eclipse.org/projects/technology.cloe)
   - [https://projects.eclipse.org/projects/technology.iceoryx](https://projects.eclipse.org/projects/technology.iceoryx)
Eclipse Cloe – Simulation Middleware

Eclipse Cloe

Overview  Downloads  Who’s Involved  Developer Resources  Governance  Contact Us

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) fulfill 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.

License:
Apache License, Version 2.0

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

https://projects.eclipse.org/projects/technology.cloe
Eclipse iceoryx – Shared Memory

In domains like automotive, robotics or gaming, a huge amount of data must be transferred between different parts of the system. If these parts are actually different processes on a POSIX based operating system like Linux, this huge amount of data has to be transferred via an inter-process-communication (IPC) mechanism.

The mechanisms provided by the operating system, like message queues, normally require to copy the data and are subject to context switches between user and kernel space. In fact, it is often not only one but many copies of the transferred data between the sender and the receiver. If it comes to Gigabyte/s data exchange rates, avoiding these copies becomes a crucial factor.

iceoryx is a middleware with a zero-copy shared memory approach which is optimized for the huge data inter-process-communication.

**License:**
Apache License, Version 2.0

**Active Member Companies:**
Member companies supporting this project over the last three months.

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

https://projects.eclipse.org/projects/technology.iceoryx
Eclipse Cyclone DDS – platform independent device to device data share

› Cyclone DDS is a standards-based (OMG DDS Specification) data sharing technology for designed to secure platform neutral interoperability
› Cyclone DDS, originally IoT focused, is going automotive
› Cyclone DDS is widely used in diverse product initiatives

https://projects.eclipse.org/projects/iot.cyclonedds
Eclipse Cyclone DDS – Open Source DDS Implementation

Eclipse Cyclone DDS is an implementation of the OMG Data Distribution Service (DDS) specification (see http://www.omg.org/spec/DDS/) and the related specifications for interoperability (see http://www.omg.org/spec/DDS-RTOS/).

With "DATA being the currency of the IOT, having a proper data-sharing technology will be a key asset in any IOT-platform. The OMG DDS standard is recognized as a highly applicable standard for reliable and robust data-sharing in business- and mission-critical environments (see http://www.omg.org/standards/DDS.htm and http://www.omg.org/standards/DDS-RTOS.htm) and with that a great fit with the Eclipse-IOT ecosystem. Eclipse Cyclone DDS offers unique data-sharing capabilities compared to the already existing Eclipse solutions (like, for messaging).

Its data-centric architecture (where data has RDBMS-like structure and relations rather than 'blobs' as typically used in lower level messaging products) combined with the capability to 'annotate' the data models with fine-grained QoS properties (for reliability, urgency, persistency etc.) provide unparalleled functional and non-functional properties for time- and mission/business-critical IOT-systems.

With a history of proven applicability in the military C4I domain (that are not so much unlike upcoming large-scale IOT-systems where you can also distinguish between planning, awareness- and execution grids that all impose specific requirements w.r.t. Interoperability, high-volume data-sharing and deterministic/realt-time data-access) we are confident that starting from day-1 this offering will significantly reduce the complexity of many IOT-systems and with that reduce their integration efforts and risks.

Furthermore we are confident that the Eclipse-IOT ecosystem will benefit even more by active participation in the evolution of this technology and the OMG-standards it is based upon.

Licenses:
Eclipse Distribution License 1.0 (BSD)
Eclipse Public License 2.0

Latest Releases:
From March 1st, 2019 to August 6th, 2020

Name       Date      Review
0.7.0 (Coquette) 2020-08-06

https://projects.eclipse.org/projects/iot.cyclonedds
Summary

› **Open source software…**
  › Is gaining traction in the automotive industry
  › Minimizes dependency on suppliers
  › Increases quality through broad testing reviews, skilled attention, broad expertise
  › Enables risk sharing and cost reduction
  › Will be essential to the success of partnerships and consortia

› **Our open source-based software toolchain for autonomous driving will:**
  › Support the integration of tools along defined development workflows
  › Fill identified gaps along those development workflows

We invite you to publish further solutions and bring the blueprint to life!
Links

- OpenADx
  - Website: https://openadx.eclipse.org/
  - Wiki: https://wiki.eclipse.org/OpenADx
  - Mailing List: https://accounts.eclipse.org/mailing-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/projects/technology.iceoryx
- Eclipse Cloe: https://projects.eclipse.org/projects/technology.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!

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Find out more and join us
https://openadx.eclipse.org/
https://wiki.eclipse.org/OpenADx

https://wiki.eclipse.org/OpenADx