Motivation and Problem Definition

A frequent problem in the field of autonomous driving is the lack of trust mechanisms between the partners of a data exchange as well as the high demands on the computing power to perform complex analyses or simulations with large amounts of data. This problem can be addressed with the help of suitable trust mechanisms and the availability of adequate compute resources as needed.

Moreover, both data providers, who provide driving recordings from vehicles, providers of data processing applications, such as simulation software, as well as operators of data centers, and the consumers of the simulation results, benefit significantly by reducing the manual effort for the cooperation and trough implementing trust mechanisms "by design".

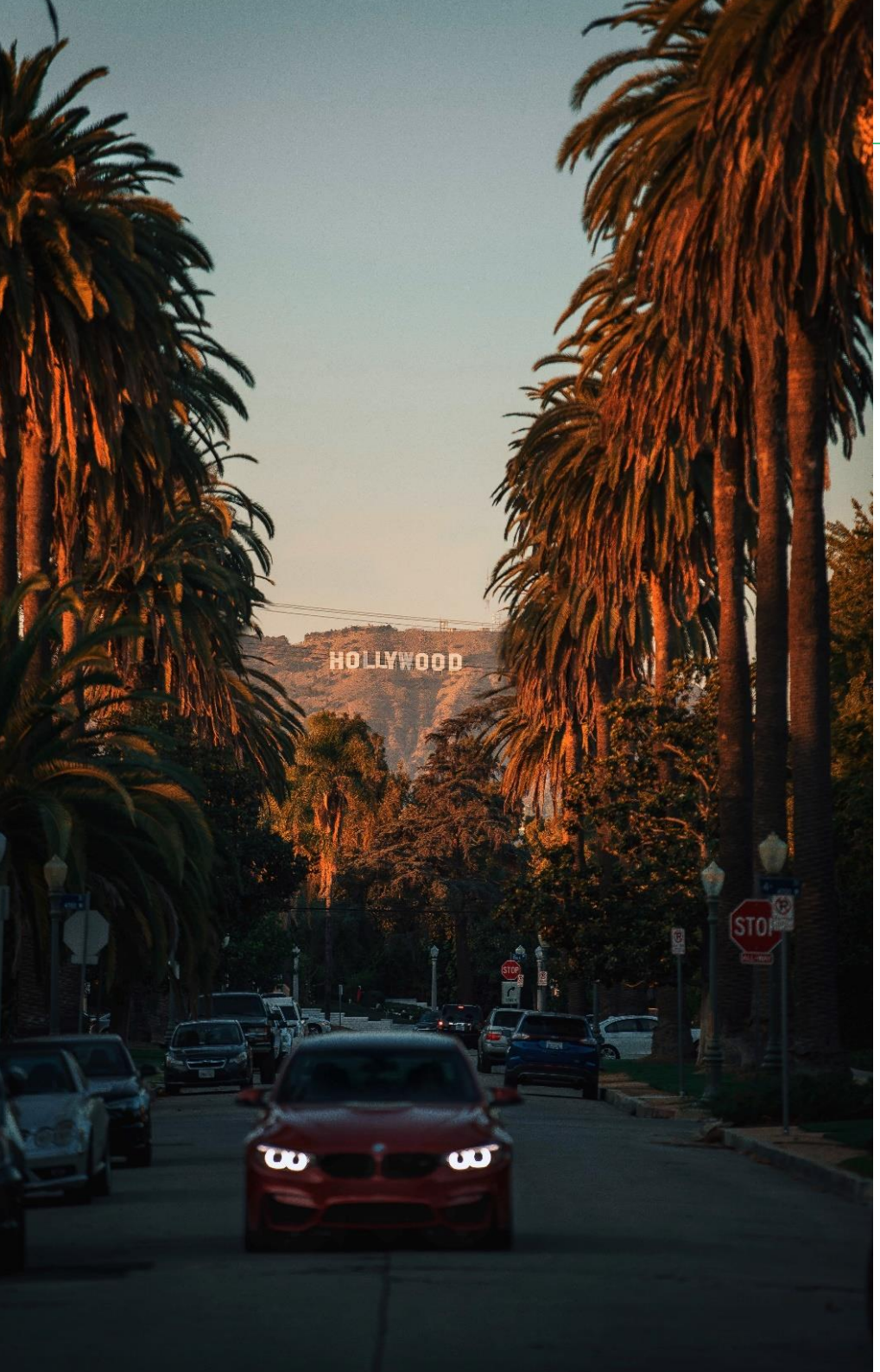
The Gaia-X framework consists of various compliance policies, trust mechanisms and open-source implementation options and thus offers a wide range of alternatives for implementing sovereign data and service environments. At the same time, the high complexity and abstraction level of Gaia-X also brings the challenge of presenting an implementation in a specific domain in a tangible and understandable way.

The GAIA-X 4 KI Use Cases master this challenge and show in a practical way in which the vision of Gaia-X can become reality. Following a compact presentation of the minimal example CARLA.

GAIA-X 4 KI

Ein Projekt der GAIA-X 4 Future Mobility Projektfamilie

Minimal Example CARLA



Objectives and Methodology

The overall goal of the minimal example CARLA in the GAIA-X 4 KI project is to implement a specialized application from autonomous driving that processes sensitive data in a (data-) sovereign infrastructure together with data-space technologies. A specific use case can be implemented in a very short time to address higher-level Gaia-X goals in a reduced scenario. Furthermore, the consortium can built up valuable competences and comprehensive knowledge which are required to tackle the complex applications. In the project, we are able to find a common entry point and prepare the implementation phase of a large-scale specialized application landscape as a data space.

For this purpose, a first workflow, which already exists in a non-Gaia-X independent AWS solution, will be implemented and connected to a sovereign, EDC-based (Eclipse Data Space Components) data space to enable stakeholders to make sovereign, self-determined decisions about sharing and processing their data. A data space enables on-demand, flexible collaboration between different partners and provides trust mechanisms. This allows the use case to be flexibly expanded or replaced in the future by the partner companies.

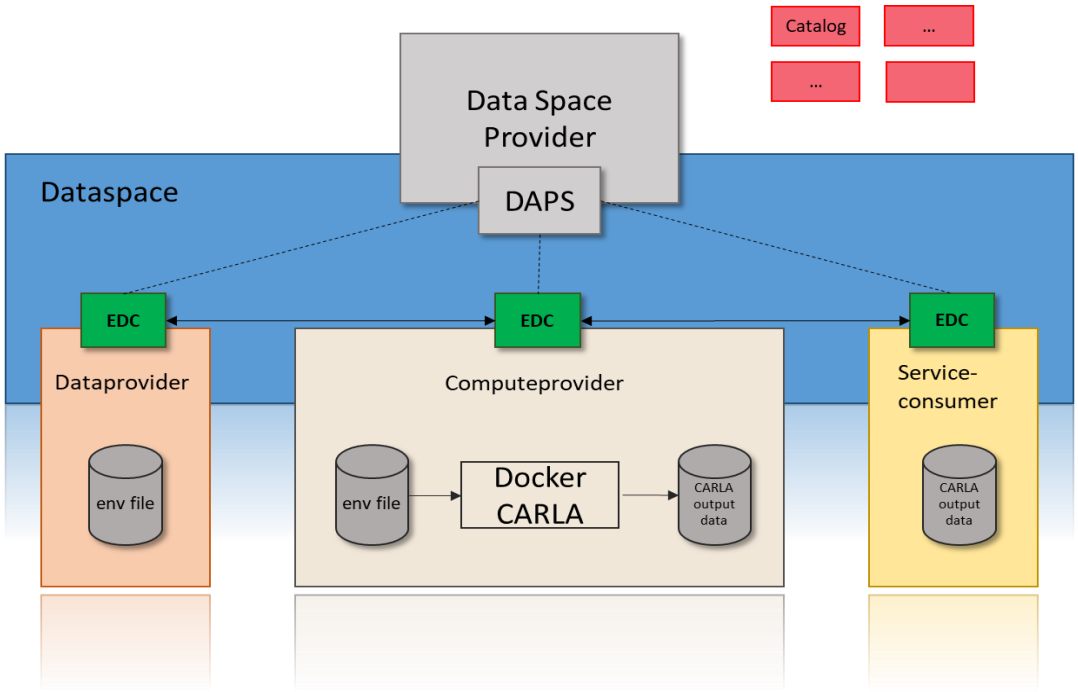
We are using the open source simulation framework CARLA for the explained purpose. CARLA is used in the sub use cases "location spoofing" and "simulative verification and validation of automated distributed driving" as well as in the joint research project GAIA-X 4 AMS.

Technical Conception

The application is provided to participants of the GAIA-X 4 AI data room as a container (Docker) with the software stack of the open simulation environment for autonomous driving CARLA on the IMLA Cloud System. The IMLA Cloud System is a computing environment built specifically for GAIA-X 4 KI. The computing environment is entirely built on hardware at the IMLA site and represents a provider of secure high-performance cloud environment located in Germany. GAIA-X 4 KI users can automatically run and use this data center after authentication and specification of hardware requirements by the orchestrator.

The requested data and the results are processed in a controlled manner using the Eclipse Data Space Components and stored in the final step on an S3 storage. The EDC connector functionality makes it possible to act as an interface component or gateway and to implement data sovereignty and trusted multi cloud federations. For this purpose, the EDC framework provides the possibility to record policies in a machine readable way and to process them accordingly. Various identity and trust mechanisms as well as Gaia-X services in particular can also be connected. Through various configuration options and extensions, the EDC Framework allows a connection to Gaia-X, but also a communication with various other data spaces.

This will create a prototype of a use case, which is linking big data with complex software services to demonstrate a cross-vendor service in a Gaia-X enabled environment.



Current Status of Implementation*

The first part of the implementation involves making the application and the computing resources available.

In the first step, a Docker container is developed with the simulation framework CARLA, which can store the simulation results as a Rosbag file locally and on AWS S3. Subsequently, a software stack is set up on the project's own cloud system. This allows to simulate typical workflows at cloud hyperscalers (such as AWS). Afterwards the Docker container is stored in a container store with the CARLA runtime environment and executed via RANCHER on a Kubernetes cluster. The results are stored in the S3-compatible MinIO storage system.

- Develop Docker Containers with the CARLA Simulation Framework for AWS
- Migration of the AWS version to the IMLA Cloud system
- Connection of the EDC for Gaia-X compliant data exchange from and to local S3 storages. Connection to a Data Space.
- Achieve full Gaia-X compliance

The second part of the implementation addresses the EDC connection to implement Gaia-X data exchange requirements.

For this purpose, the EDC Data and Control Plane were implemented and tested. In order to integrate an identity solution, the EDC Extension was initially used for the DAPS, which can be replaced by other solutions and trust models in the future. To preserve the minimal character of the use case, no further extensions are used for the time being. After setting up a simple workflow, an extension of this demonstrator to more complex processes is planned, e.g. scheduling of distributed target systems. Further adaptation and connection to the services and mechanisms required by Gaia-X will also be addressed in subsequent steps using the capabilities of the EDC.

*September 2022

Why does Gaia-X add Value to the Use Case?

Gaia-X makes it possible to establish distributed trust mechanisms and interoperability across different ecosystems. Due to the data diversity required in autonomous driving and possible participation in different eco systems and value network, Gaia-X is also considered in the minimal example CARLA. The distributed approach of Gaia-X is suitable to create extreme scalability, domain-agnostic application, as well as implementation- and technology-independent standardization of trust mechanisms, which is also relevant for processing sensor data from vehicles. Participants in Gaia-X-based ecosystems can thus decide for themselves, based on uniform self-descriptions and self-sovereign trust mechanisms, which offers they choose without subsequently becoming dependent on individual providers.

This allows especially small, specialized providers, like the project's own cloud provider in the minimal example CARLA, to gain visibility and interoperability in order to realize different compositions of services and data and thus to achieve e.g. meaningful simulation results.

More about Gaia-X: https://gaia-x4ki.eu/en

Why is the EDC the Appropriate Choice?

The EDC framework is a scalable and operational solution to realize data rooms and multi-cloud federations. The modularity of the EDC framework enables communication and interoperability with different data spaces and technologies, including the integration of different identification mechanisms. It is a modular, Java based framework that can be deployed in a variety of ways (e.g., as a gatekeeper) or integrated with existing enterprise systems. This flexibility makes it usable for both large enterprises and small and medium sized businesses, and it can be configured to be both lightweight but also comprehensive, depending on the use case. In the minimal example, this flexibility allows for a phased build and also to be able to respond to future developments in initiatives such as Gaia-X.

The EDC is also used in other data spaces and ecosystems, e.g. in Catena-X.

More on EDC:

https://www.youtube.com/channel/UCYmjEHtMSzycheBB4AelTHg

https://github.com/eclipse-dataspaceconnector

Why is the Use of CARLA the Appropriate Choice?

CARLA facilitates the entry into the development of parts of the processing chain in the vehicle automation. However, the software is also suitable up to the "full stack software in the loop" development of a digital twin for an autonomous driving vehicle, from sensor processing to trajectory planning and complex decision-making.

Due to the open business-compatible license of CARLA, the software is very well suited as a prototype of a complex service in the automotive sector. As a simulation frame work, CARLA is primarily aimed at researchers, but is nevertheless also of interest to commercial enterprises, as can be seen from the well-known sponsors from the automotive industry.

More about CARLA at: http://carla.org/

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You want to know more about GAIA-X 4 KI and our mission?

Come and visit us on our homepage www.gaia-x4ki.de or contact us by mail via gaia-x4ki@ks-pm.de.

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