GEMINI

GREENING EUROPEAN MOBILITY
through cascading innovation INITIATIVES

D4.2: AI-enabled automation in fleet health monitoring

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Summary Sheet

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About this deliverable	This deliverable presents the development of AI-enabled tools for automated fleet health monitoring, including real-time vehicle insights, predictive maintenance, and data-driven fleet analytics. It summarises the identified use cases, the AAOS in-vehicle app, and the GEMINI Fleetboard with AI-enabled Fleet Assistant, and outlines next steps for scaling and real-world implementation.
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LIST OF ABBREVIATIONS

Acronym	**Full meaning**
AAOS	Android Automotive Operating System
AI	Artificial Intelligence
API	Application Programming Interface

Acronym	Full meaning
AWS	Amazon Web Services
B2B	Business to Business
CAV	Connected and Automated Vehicles
EU	European Union
GDPR	General Data Protection Regulation
GEMINI	Greening European Mobility through cascading innovation INItiatives
GPS	Global Positioning System
IT	Information Technology
LLM	Large Language Model
MaaC	Mobility as a Commons
MaaS	Mobility as a Service
MLL	Mobility Living Lab
NMS	New and Shared Mobility Services
POC	Proof of concept
SES	Simple Email Service
SNS	Simple Notification Service
SQS	Simple Queue Service
TMLL	Twining Mobility Living Lab
VIF	Virtual Vehicle Research
VIN	Vehicle Identification Number

EXECUTIVE SUMMARY

Work Package 4 (WP4) designs and develops the technological core of the project, providing digital enablers and tools that accelerate the introduction and transferability of new mobility services. Task 4.1 (T4.1) specifically focuses on developing data-driven technologies for vehicle state-of-health monitoring, predictive maintenance, and real-time vehicle usage analytics, supporting increased automation in fleet health monitoring and improving the safety of NMS. The results from WP4 enable data-based decision-making for cities and AI-supported vehicle fleet monitoring, while promoting technology transfer between the MLLs and strengthening the transferability of innovations.

In cooperation with the MLLs, 11 use cases were identified across four MLLs—MLL Amsterdam, MLL Copenhagen, TMLL Paris-Saclay, and TMLL Helsinki—for the operation and monitoring of vehicle fleets, including Connected and Automated Vehicles (CAV). These use cases informed an overall concept for real-time insights into vehicle utilization and fleet status, summarized in a feasibility study.

A key outcome of WP4 is a data-driven service enabling vehicle condition monitoring and predictive maintenance, providing detailed insights into vehicle utilization through an intuitive dashboard. Leveraging the Android Automotive Operating System (AAOS), an in-vehicle application was developed to deliver vehicle condition information and facilitate easier vehicle use.

Another core contribution is the GEMINI Fleetboard with its AI-enabled Fleet Assistant, which implements a secure, consent-based data platform for fleet management. It includes a proof-of-concept dashboard for vehicle analytics and an AI chatbot designed to make digital fleet management accessible to small and medium fleets. Key features include a modular architecture integrating real-time connected vehicle data, intuitive natural language interfaces, and robust GDPR compliance via B2B contractual frameworks. Internal evaluations have shown strong usability, quick data insights, and low technical entry barriers, demonstrating practical value even for non-expert users.

The next phase of the project will focus on targeted development of the AAOS app and refinement of the identified use cases, with particular attention to enhancing user-friendliness and operational functionality, including carsharing management and community-based vehicle maintenance. The use cases will be collaboratively evaluated with the MLLs to ensure relevance, transferability, and adaptability, while data protection and security remain central priorities through careful review and risk analyses.

The GEMINI Fleetboard with AI-enabled Fleet Assistant is being tested with small fleets and has shown scalable potential for medium and large fleets. Future development will expand data sources for richer real-time insights, apply predictive analytics for proactive maintenance, enhance AI capabilities including conversational and voice interfaces, and enable modular add-on services such as sustainability dashboards, compliance tools, and technical vehicle information.

Both the AAOS app and the CARUSO Fleetboard have been successfully implemented as proof-of-concept prototypes, demonstrating feasibility, usability, technical stability, and operational relevance. Looking ahead, the project will focus on implementation testing within the MLLs, integrating the systems with local fleets, and refining them based on operational feedback, thereby reinforcing the practical applicability, innovation potential, and scalability of GEMINI's digital NMS enablers for future mobility solutions.

1 INTRODUCTION

The Greening European Mobility through cascading innovation INItiatives (GEMINI) project is a 3.5-year Innovation Action project funded by the Horizon Europe Framework Programme running over the timeframe 2023-2026. It designs, implements and evaluates new and shared mobility services (NMS; e.g. car-sharing, bike-sharing, ride-hailing) in 8 mission cities[1]. These cities are the 4 GEMINI lead Mobility Living Labs (MLLs): Amsterdam, Copenhagen, Munich and Turin, and the 4 GEMINI twinning MLLs: Helsinki, Ljubljana, Paris and Porto (see Figure 1). The twinning MLLs will begin operations later than the lead MLLs, enabling them to replicate positive experiences of the lead MLLs.

Figure 1: The 8 GEMINI Mobility Living Labs

The aim of this project is to accelerate progress towards climate neutrality by strengthening a modal shift through demonstration and application of NMS, active transport modes, micromobility and their integration with public transport in Mobility as a Service (MaaS). The project puts a specific emphasis on developing sustainable business models for NMS and integrating social and behavioural strategies for NMS adoption.

The GEMINI MLLs will demonstrate their contribution to an increased share of NMS in the modal distribution and integration with public transport, and to a reduction of congestion, CO_2 emissions, air pollution and road risk, whilst fostering accessibility and social inclusion.

1.1 Description of Work Package 4 and Task 4.1

T4.1 as a Task in WP4 promised to develop data-driven technologies for vehicle state-of-health, predictive maintenance, and real-time vehicle usage analytics to increased automation in fleet health monitoring, thus improving safety of NMS.

Task 4.1 is divided into two subtasks:

Subtask ST4.1 identifies use cases for fleet health monitoring including CAV (VIF - MLLs) and architect an overall concept for real-time vehicle usage insights and fleet health monitoring via connected cars. ST4.1 specifies mock-ups of an innovative data-driven-service for vehicle-state-of health and predictive maintenance as well as a corresponding dashboard for vehicle usage insights and develops a proof-of-concept of a data-driven service for vehicle-state-of health and predictive maintenance (On-board / in-vehicle app (e.g., Android Automotive OS-based).

Subtask ST4.2 develops a data pipeline and a proof-of-concept dashboard for vehicle usage analytics (CARUSO). Enable (interested) MLLs to evaluate data-driven services and participate in vehicle usage analytics, e.g., by providing proof-of-concept and guidelines for MLLs about the

[1] 100 cities from European Union member states, along with 12 cities from associated countries, have been chosen to participate in the EU Mission for 100 climate-neutral and smart cities by 2030, also know as the Cities Mission. The designated cities aim to become climate neutral by 2030 while pioneering innovative approaches and engaging citizens and stakeholders. https://research-and-innovation.ec.europa.eu/funding/funding-opportunities/funding-programmes-and-open-calls/horizon-europe/eu-missions-horizon-europe/climate-neutral-and-smart-cities_en

boundary conditions for experimentation. Analyse usage patterns of connected car vehicle data collected in MLLs and derive data-driven insights.

1.2 Content

This deliverable D4.2 presents the outcomes of Task 4.1 as part of Work Package 4 – Mobility Data Labs: Digital NMS Enablers.

Chapter 2 describes how the results in Task 4.1 were achieved, taking into account both the approach outlined in the grant agreement and the actual situation in the Living Labs.

Chapter 3 provides in-depth insights into the Feasibility Study, which informed the development of the use cases and proof-of-concepts presented in Chapters 4 and 5.

Chapter 4 presents the AAOS In-Car App and its proof-of-concept (POC). The chapter includes a detailed description of the use cases addressed, the challenges identified, the conceptual design, implementation details, and evaluation results.

Chapter 5 is dedicated to realizing the second requirement of Work Package 4: developing a data pipeline and a proof-of-concept (POC) dashboard for vehicle usage analytics (CARUSO). This chapter provides a detailed overview of the POC, including system diagrams, security and GDPR compliance, basic data analytics processes, potential enhancements, and exploitation opportunities.

Chapter 6 offers an outlook and conclusion on the project’s remaining phase, summarizing evaluation insights and future plans.

2 PROCEDURE & PLANNING

To support the development activities foreseen in Task 4.1, a requirements analysis was conducted with a clear emphasis on identifying vehicle-related operational needs and technical prerequisites relevant to fleet monitoring and analytics.

Since not all MLLs operate shared vehicle fleets or consider them a priority in their use cases, the involvement across sites varied intentionally. Participation was concentrated on those Living Labs where vehicle health monitoring, data integration, and fleet automation are relevant and actionable within their operational environments. Table 1 summarises where active vehicle fleets are present and therefore where alignment with Task 4.1 activities was strongest.

Table 1: List of MLLs and TMLLs operating vehicles

No.	Name	Operate Vehicles
MLL 1	Amsterdam	x
MLL 2	Copenhagen	x
MLL 3	Munich	
MLL 4	Turin	
TMLL 1	Paris-Saclay	x
TMLL 2	Ljubljana	x
TMLL 3	Porto	
TMLL 4	Helsinki	x

The requirements analysis was conducted through a combination of workshops and semi-structured interviews. These involved both Living Lab partners and external operators of shared mobility fleets, who were engaged as domain experts due to their practical experience in fleet operation, maintenance cycles, and safety-critical service management. Their contributions were essential for identifying technical prerequisites, data availability constraints, maintenance workflows, and potential application scenarios for predictive and real-time vehicle analytics.

Originally, use cases were intended to be developed jointly with the MLLs and later shared with the TMLLs. However, during the analysis phase it became evident that a broader participation model was more effective and inclusive. Consequently, all Living Labs were invited to contribute use case ideas, regardless of whether they currently manage fleets. Conversely, all MLLs and TMLLs are offered access to the prototypes developed under Task 4.1 and may evaluate and adapt them within their own environments in later stages.

This process provided a well-grounded understanding of operational needs and vehicle health-related data streams, laying the foundation for the WP4 technological developments that enable predictive maintenance and automated fleet safety monitoring.

A visual representation of this planning is included in the project Gantt chart (Figure 2). The present deliverable is submitted at Month 30, by which stage proof-of-concept solution approaches have been established based on the collected requirements and expert insights. Task 4.1 continues until Month 38, allowing for further development, refinement and validation of these approaches in collaboration with the participating Living Labs.

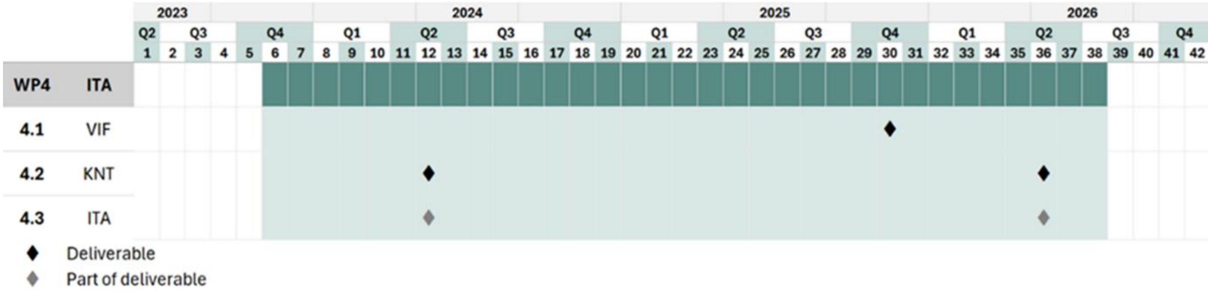

Figure 2: Gantt Chart of WP4

3 FEASIBILITY STUDY

A feasibility study was conducted to identify and define potential use cases across the eight Mobility Living Labs. The study's main objective was to explore feasible solutions that address specific mobility challenges in each Living Lab. To achieve this, workshops were held with the responsible stakeholders of each lab to identify overlaps between the technical objectives of the labs and the planned solutions outlined in Task 4.1.

Each use case developed during the study included:

- A description of the current challenge,
- The desired target situation,
- A proposed solution approach, and
- The expected benefits and opportunities resulting from its implementation.

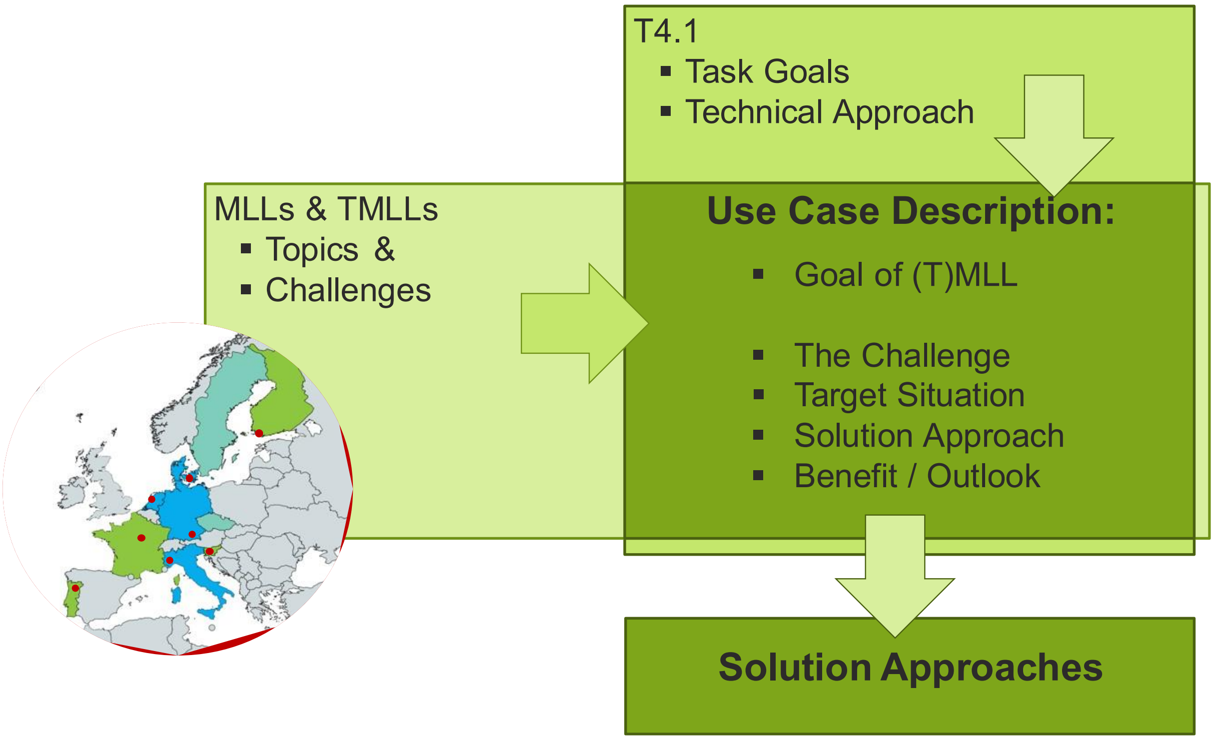

Figure 3: Mapping of topics and challenges of MLLs to Task 4.1

3.1 Identified use cases

The following use cases were identified across four Mobility Living Labs. For the remaining MLLs, no concrete use cases could be defined that overlap with the objectives in Task 4.1.

3.1.1 MLL Amsterdam

Amsterdam MLL is actively reducing private car use by promoting shared vehicle fleets managed by local communities under its "Mobility as a Commons" initiative. These community-operated fleets are based on shared values and mutual trust, allowing residents to collectively manage and share vehicles sustainably.

To support this, Amsterdam leverages tools like GoodMoovs[2], a white-label software platform that helps communities efficiently coordinate reservations, track maintenance and damages, and manage services like cleaning. While GoodMoovs does not operate the vehicles, its platform ensures that the city's vision of community-driven, sustainable mobility is effectively facilitated.

- **Use Case 1.1 – Predictive Maintenance**: Vehicle telemetry is sent to GoodMoovs, which calculates the optimal time for servicing to lower costs and prevent breakdowns.
- **Use Case 1.2 – Damage Reporting & Immediate Maintenance**: Drivers report damages via an app with guided support. The platform informs the community, organizes repairs, and proposes garage appointments.

Benefits:

- **Lower operating costs:** Predictive maintenance and coordinated repairs reduce breakdowns and emergency expenses.
- **Optimized vehicle usage:** Real-time scheduling ensures vehicles are available and actively used.
- **Transparency and trust:** Damage reporting and repair tracking keep maintenance processes visible to all users.
- **Higher reliability:** Fewer breakdowns and faster repairs improve fleet availability and user satisfaction.

3.1.2 MLL Copenhagen

The MLL Copenhagen explores how new mobility services (NMS) can expand or improve access to public transport (PT) in peri-urban areas. Its main goals are to reduce car use and congestion, shift traffic toward public transport and shared mobility, increase cycling, lower CO_2 emissions, free up parking space, and enhance regional liveability and accessibility.

To achieve this, six multimodal mobility hubs featuring at least three shared mobility options (e-bikes and two types of car sharing) will be implemented in Rudersdal for 12 months.

- **UC 2.1 – Predictive Maintenance**: Vehicle telemetry is used to determine actual wear and plan maintenance only when needed, reducing costs and enabling long-term maintenance planning.
- **UC 2.2 – Immediate Maintenance**: A fleet management dashboard displays faults (e.g., low fluids, broken bulbs) in real time, allowing quick "just-in-time" maintenance to prevent further damage.
- **UC 2.3 – Accident Report**: Digital tools support drivers in reporting accidents and ensure that vehicle status updates are available early, improving communication and reducing downtime.

Benefits:

- **Improved fleet efficiency:** Predictive and just-in-time maintenance (UC 2.1 & 2.2) keeps vehicles in service longer and prevents downtime.
- **Lower operating costs:** Maintenance is performed only when necessary, avoiding unnecessary expenses and reducing repair costs.

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[2] https://www.goodmoovs.com/

- **Better service continuity:** Real-time fault monitoring and accident reporting (UC 2.2 & 2.3) minimize disruptions and ensure vehicles remain available.
- **Enhanced user experience:** Faster repairs, reliable vehicle availability, and transparent communication increase trust and satisfaction among users.

3.1.3 TMLL Paris – Saclay

The Paris-Saclay TMLL aims to enhance sustainability and quality of life by introducing Clem' e-car sharing with an electric charging network. The project seeks to reduce private combustion vehicles, lower greenhouse gas emissions, and decrease street congestion and parking pressure, thereby improving the local environment and livability while increasing the long-term profitability of Clem's system.

- **UC 3.1 – Optimising Vehicle Location and Usage**: Data-driven analysis of customer demand helps position vehicles efficiently, improving availability, reducing idle times, cutting costs, and enhancing customer satisfaction.
- **UC 3.2 – Optimising Interaction between Car Sharing and Public Transport**: By analysing mobility data and CO_2 emissions of different transport modes, cities can make informed decisions to reduce emissions, while car sharing complements rather than replaces public transport.

Benefits:

- **Cleaner environment:** Reduced private car use and optimized integration with public transport lower CO_2 emissions and congestion.
- **More efficient fleet use:** Data-driven vehicle positioning increases availability, reduces idle time, and lowers operating costs.
- **Better integration with public transport:** Analysing mobility patterns ensures car sharing complements, rather than competes with, existing transit, improving overall regional mobility.

3.1.4 TMLL Helsinki

The Helsinki TMLL investigates mobility behaviour between Helsinki and the nearby rural towns Raasepori and Karkkila (70–90 km away). The concrete implementation design will begin in January 2025. Led by Forum Virium Helsinki, a city-owned innovation company, the project focuses on improving fleet management for Helsinki's 1,200 shared city vehicles used by around 12,000 employees. The fleet is managed mainly by Helsinki City Construction Services (Stara) and consists of petrol, diesel, and electric cars and vans.

- **UC 4.1 – Predictive Maintenance**: Automatic alerts for technical issues (e.g., low batteries, uncleaned DPFs) and driving recommendations to maintain vehicle health.
- **UC 4.2 – Optimising Vehicle Use**: Monitoring vehicle usage and costs to reduce underused vehicles and improve sharing efficiency, leading to city cost savings.
- **UC 4.3 – Vehicle Status Monitoring**: Automated detection of technical issues, tire wear, and damages without relying on user reports, improving fleet condition and reducing repair costs.
- **UC 4.4 – Monitoring Vehicle Usage**: Automated driving logs for better insights into vehicle use and fleet management.

Benefits:

- **Better maintenance:** Predictive alerts and automated status monitoring (UC 4.1 & 4.3) prevent breakdowns and reduce repair costs.
- **Improved fleet utilization:** Usage monitoring (UC 4.2 & 4.4) identifies underused vehicles and optimizes sharing, increasing efficiency.
- **Cost savings:** Reduced downtime and better allocation of resources lower overall fleet expenses.
- **Enhanced transparency:** Automated reporting and logs provide clear insights into vehicle condition and usage for management and employees.

3.2 Developed Solution Approaches

To implement the defined use cases in line with Task 4.1 goals, two complementary solution approaches were developed. Each approach defines the technical and organizational measures needed to achieve improvements in the Mobility Living Labs and is described in its respective chapter. A clear focus on car sharing was identified during the definition of use cases, which was particularly considered in the development of the solutions.

To address the identified needs, the following two solution approaches were developed:

- **AAOS In-Car App** – developed by **VIF.** This app enables real-time monitoring of vehicle state-of-health, predictive maintenance, and usage analytics, providing drivers and fleet operators with actionable insights. A proof-of-concept (POC) was developed using an AAOS-based app. The AAOS App is described in detail in Chapter 4.

- **Data Platform** – developed by CARUSO. This platform collects, processes, and analyses vehicle data to support fleet health monitoring and enhance automation in predictive maintenance. It analyses connected car usage patterns to derive actionable insights. The developed GEMINI Fleetboard with its AI-enabled Fleet Assistant is described in detail in Chapter 5.

Together, these approaches provide a comprehensive framework for fleet health monitoring and vehicle usage analytics, validated through POCs and ready for further experimentation and deployment in the Mobility Living Labs.

4 GEMINI AAOS APP

4.1 Introduction

Android Automotive Operating System (AAOS) is a complete operating system that runs directly on a vehicle's hardware, providing a full-featured infotainment platform. It comes pre-installed with essential in-vehicle applications and also supports first-, second-, and third-party Android apps. Built on the same Android codebase as phones and tablets, AAOS is fully open-source, customizable, and scalable, enabling car manufacturers to tailor the system while leveraging the extensive Android ecosystem. AAOS is already being used in various implementations by most major OEMs.

AAOS is not a separate fork; it is fully integrated into the Android ecosystem, using the same codebase, repositories, and developer tools as mobile Android. It extends Android with automotive-specific features and requirements, creating a full-stack infotainment platform while maintaining Android's security model, APIs, and frameworks. This allows developers to reuse existing Android expertise and applications, benefiting from over a decade of platform maturity.

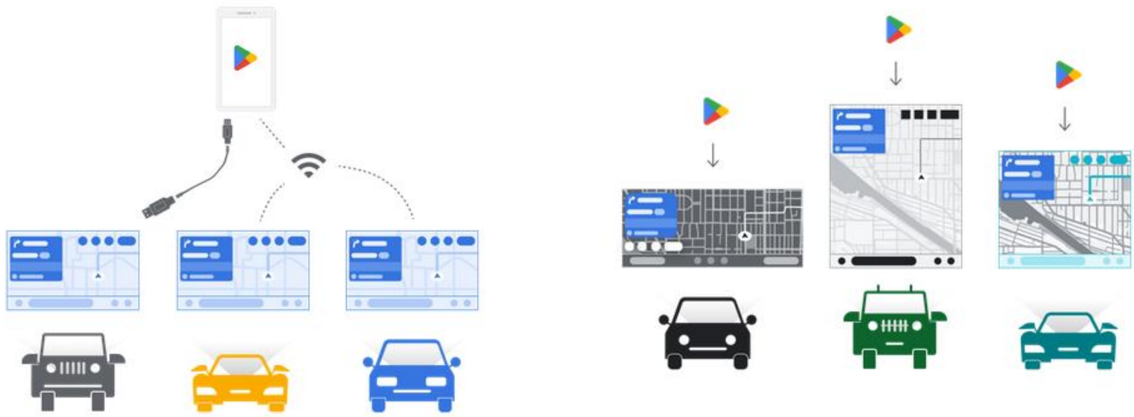

Figure 4: Android Auto vs. AAOS

In contrast to Android Auto, which runs on a user's smartphone and mirrors its interface on the car display, AAOS runs directly on the vehicle hardware as a standalone operating system. It supports both native apps and Android Auto apps, whereas Android Auto only runs apps from the phone. AAOS delivers a fully integrated infotainment experience, while Android Auto is essentially a projection of the smartphone interface.

Advantages of AAOS:

- **Openness:** Free, open-source code enables transparency and development efficiency.
- **Customizability:** Car manufacturers can tailor the system to their brand and design preferences.
- **Scalability:** Shared frameworks, APIs, and programming languages allow reuse of expertise and integration of existing Android apps.
- **Robustness and Security:** Leverages Android's mature platform, security model, and developer tools.
- **Full-stack solution:** Provides a turnkey infotainment platform similar to Android on mobile devices.

- **Direct vehicle data access:** Enables deep integration with car systems and features for enhanced functionality.

Due to its direct access to vehicle data and high adaptability, AAOS is ideally suited for carsharing platforms and vehicle fleet health monitoring, allowing seamless integration of vehicle status, usage data, and fleet management systems.

4.2 Use Cases, Challenges & Benefits

An AAOS-based app for carsharing provides a comprehensive solution to enhance the user experience for shared mobility, optimize fleet management, and support fleet health and proactive maintenance. In the context of carsharing, the app can improve both the convenience for users and the operational efficiency for fleet operators.

- A key use case is supporting an integrated driving assistant, offering real-time navigation, safety alerts, and guidance directly through the vehicle's infotainment system.
- The app also allows personalization of shared vehicles by automatically applying user-specific settings, such as seat positions, climate controls, infotainment preferences, and connected services, ensuring comfort and familiarity even when using a vehicle from a shared fleet.
- Another important use case is providing up-to-date vehicle status, including fuel or battery level, mileage, and maintenance alerts, as well as a comprehensive overview of available driver assistance systems and their current activation status. This gives users full transparency about active safety and convenience features, such as adaptive cruise control, lane keeping assistance, or parking assistance, helping them understand which systems are ready to use and how they can support the driving experience.
- The app can introduce features and functionalities to carsharing users who operate different vehicles, helping them quickly understand each vehicle's capabilities, from multimedia systems and autopilot functions to connectivity options, even if the vehicle model differs from one they have previously used.
- Furthermore, the AAOS app supports vehicle health monitoring by accessing data that is normally only requested during scheduled car servicing. This enables early detection of potential issues, monitoring of key components, and proactive maintenance management, ensuring vehicles remain safe, reliable, and available for users while improving overall fleet health.

Implementing such a system presents several challenges. Carsharing fleets often consist of different vehicle models, each with distinct hardware and configurations, requiring the app to maintain a consistent and intuitive user experience. Users typically interact with shared vehicles only occasionally, making fast onboarding and ease of use critical. Providing accurate real-time vehicle information, such as condition, range, and access permissions, is essential to ensure reliability and trust. Seamless interaction between the AAOS app, the carsharing platform, and the vehicle systems is also necessary to manage sensors, actuators, and system feedback across diverse platforms.

Despite these challenges, an AAOS-based carsharing app delivers clear benefits. It increases user trust through accurate vehicle data and smooth interaction, reduces planning and preparation effort via easy access to personalized settings and vehicle information, and enhances overall mobility experiences by integrating mobile devices with the vehicle system. By enabling detailed fleet health monitoring and proactive maintenance, it ensures fleet reliability and safety while providing a connected, efficient, and user-friendly carsharing service across heterogeneous fleets.

4.3 Concept

The concept of the GEMINI AAOS app for carsharing aims to provide a seamless and intelligent interaction between the driver and the vehicle, enhancing usability, comfort, and operational efficiency in NMS.

When a user unlocks a shared vehicle, the app automatically retrieves relevant data from the carsharing platform. The driver is greeted with a personalized welcome screen providing key information such as the estimated range, parking authorizations, and highway access permissions, ensuring that all necessary operational details are immediately available before departure.

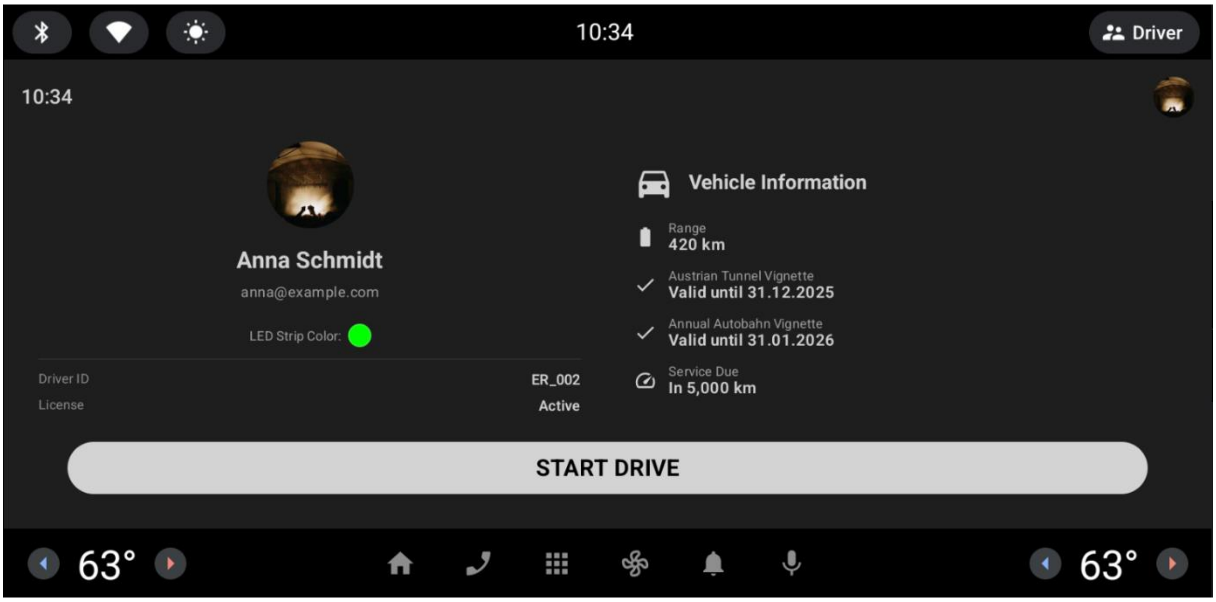

Figure 5: AAOS app Overview

Subsequently, the app downloads the driver's personal profile and applies it to the vehicle configuration. This process automatically adjusts seat and mirror positions, climate settings, and infotainment preferences, creating a familiar and comfortable driving environment even in a shared car. In this way, the app ensures a consistent and personalized experience across different vehicles within the fleet.

For users operating a vehicle model for the first time, the app displays a short interactive introduction to familiarize them with essential controls and key vehicle functions, including infotainment navigation, driving modes, and available driver assistance systems. This onboarding process reduces uncertainty and supports safe and efficient use of diverse vehicle types.

The app also features a Vehicle Information page, providing real-time data on available and active driver assistance systems, tire condition, energy or fuel level, and reported issues, ensuring transparency and driver awareness.

Figure 6: AAOS app Vehicle Information and Maintenance

In addition, a Maintenance page enables users to report problems directly through the app, such as malfunctioning windshield wipers, warning lights, or other irregularities noticed during operation. These reports are automatically transmitted to the fleet management system, supporting timely maintenance and improving overall fleet health. Furthermore, data collected from in-vehicle networks is continuously recorded and analysed, enabling predictive maintenance by identifying patterns and early indicators of component wear or system malfunctions.

Through this concept, the AAOS app acts as a bridge between personalization, operational transparency, and proactive maintenance. It enhances user comfort and trust while enabling efficient vehicle management and sustained fleet reliability in carsharing operations.

4.4 Implementation

ViF can act as a demo OEM[3], leveraging its research facilities to emulate an OEM environment and enabling the app's features to be tested directly in real vehicles under authentic conditions. The GEMINI AAOS app is developed in Kotlin[4], a modern, statically-typed programming language officially supported by Android and well-suited for developing robust, maintainable, and high-performance mobile applications. It is deployed as a Device Manufacturer App directly on AAOS in an Audi A4 – B8. The software architecture of the application, shown in Figure 7, illustrates its integration with the underlying AAOS platform and demonstrates how the app interacts with vehicle systems to deliver its full functionality.

[3] Original Equipment Manufacturer**:** The company that originally manufactures a vehicle or its components, in contrast to third-party or aftermarket suppliers.
[4] https://kotlinlang.org/

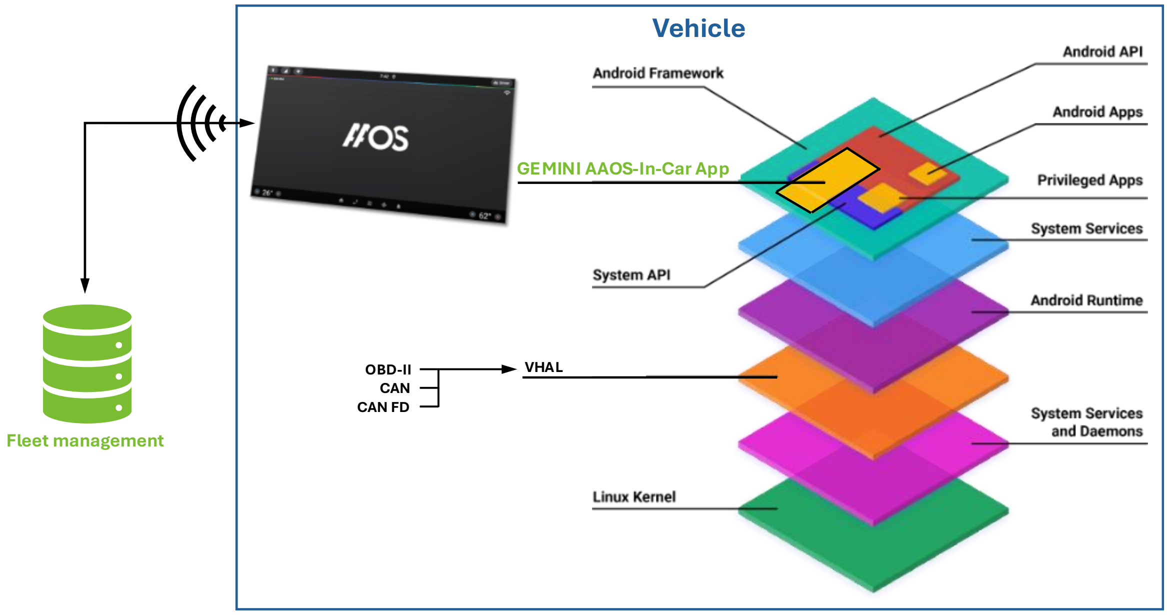

Figure 7: GEMINI AAOS app software architecture

The app accesses vehicle data from in-vehicle networks (OBD-II[5] and CAN[6],) through the Vehicle Hardware Abstraction Layer (VHAL) in AAOS. The data obtained in this setup are presented in Table 2. It should be noted that more recent vehicle models also support CAN FD[7] and offer a substantially larger set of accessible data.

Table 2: Data retrieved from Audi A4-B8 over in-vehicle networks

Speed	km/h	~50Hz	0.00-655.32 (0.01)
RPM	1/min	~100Hz	0.00-16383.00 (0.25)
Gear	Enum	~50Hz	0.0-15 (1.0)
Steering wheel angle	°	~100Hz	0.0-800.0 (0.1)
Coolant temp	°C	~2Hz	-48.00-141.75 (0.75)
Oil temp	°C	~2Hz	-60-192 (1)
Odometer	Km	~1Hz	0-1048573 (1)
Fuel level	l	~1Hz	0|126 (1)

The app additionally retrieves driver login and profile data from the Fleet Management Platform to provide personalized services and functionalities. The Fleet Management Platform consists of a backend developed in Python and a frontend in React, which enables the management of both driver and vehicle data. Vehicle data can be stored in the platform for maintenance task analysis, but storage is independent of driver data to ensure data privacy.

[5] On-Board Diagnostics , version II: A standardized system used in vehicles to monitor and report engine and vehicle health data.
[6] Controller Area Network: A vehicle network protocol that allows microcontrollers and devices within the car to communicate with each other without a central computer.
[7] CAN with Flexible Data-Rate: An enhanced version of the CAN protocol that allows for faster data transfer and larger payloads, enabling access to more detailed vehicle information.

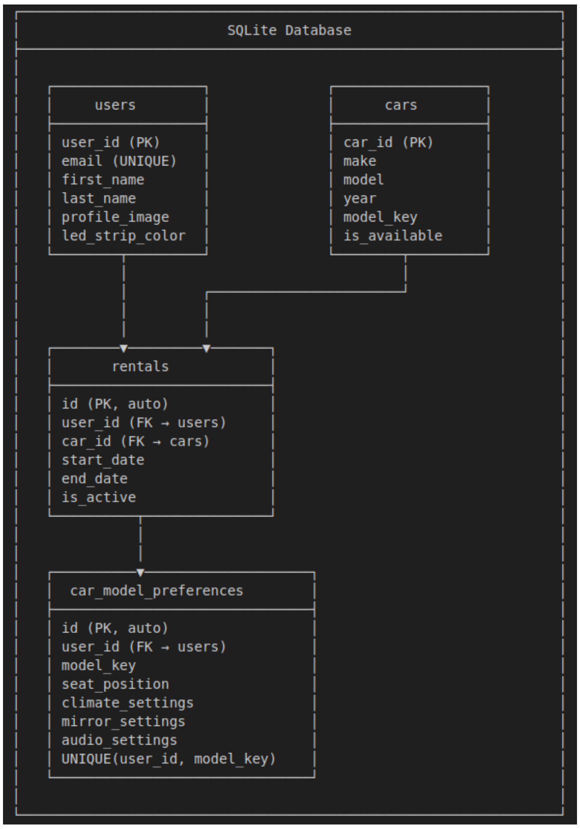

Figure 8: Database schema of Fleet Management Platform

While the Audi A4 – B8 does not inherently support automated adjustment of seats, mirrors, or climate settings, the concept of personalized vehicle adaptation is demonstrated through the integration of an LED strip, as shown in Figure 9. Upon driver authentication, the LED strip visualizes the driver's preferred colour, as stored in their profile. This approach exemplifies the potential for implementing automated, profile-based personalization of in-vehicle settings in future vehicle generations.

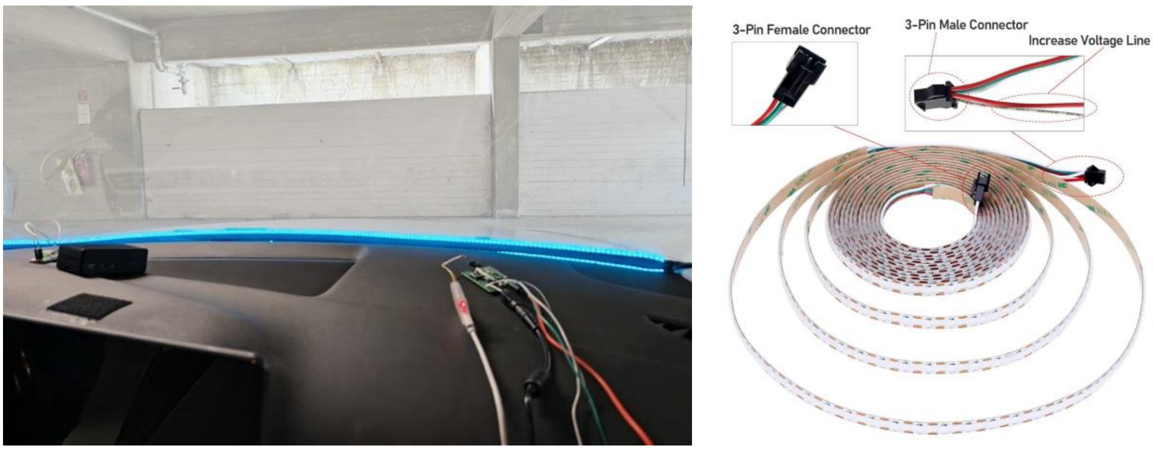

Figure 9: LED strip in Audi A4-B8

This architecture allows seamless integration between the vehicle, the app, and the backend, enabling real-time processing of vehicle data and efficient use of driver profiles.

4.5 Evaluation

4.5.1 Initial Situation, Research Questions, and Evaluation Method

Based on the analysis of the solution approaches and insights gained from the consortium visit to Shellingwoude (Amsterdam) in January 2025, the Neighbourhood Carsharing concept was identified as a central focus within the GEMINI project. Its key characteristics include:

- Collective organization of vehicle availability and service quality.
- Optimization of individual mobility costs in the long term.

Supported by an AAOS application, the concept is explored along two dimensions:

1. **User perspective:** Focusing on intuitive, digitally supported processes similar to established rental models.
2. **Community maintenance:** Vehicle maintenance is performed by local users in a do-it-yourself approach, reducing operating costs and promoting community responsibility.

Interim results include:

- Development of an AAOS app mock-up for interaction visualization.
- Implementation of a functional prototype demonstrator.

The study investigates whether the developed app meets user expectations and effectively supports the Neighbourhood Carsharing model, focusing on usability and functional suitability. Key research questions address:

- User satisfaction in terms of comfort, clarity, and experience.
- The app's potential to foster shared use, coordination, and efficient maintenance.
- Usability in key application areas such as booking and maintenance processes.

4.5.2 Evaluation Workshop

A workshop-based evaluation was selected as an appropriate method to capture qualitative and context-specific user experiences. Unlike standardized surveys, this participatory approach enables direct interaction with the application and immediate feedback. Six participants were invited following an open call for interest and submission of relevant information.

After an introduction and explanation of objectives, participants actively contributed their experiences and suggestions. The topics discussed were structured and categorized on a whiteboard. Although data protection issues could not be addressed in detail, participants were able to prioritize the most relevant use cases.

The AAOS app was deployed in a test vehicle at VIF, allowing participants to try out the application directly in the vehicle environment. This hands-on testing provided valuable practical feedback on usability and functionality under real conditions.

Figure 10: Workshop participants trying out the AAOS app

Participants (anonymized): Six individuals (ages 29–50; 4 male, 2 female; 4 car owners; annual mileage 2,000–12,000 km).

Results:
The identified use cases were grouped under Carsharing User Interface and Maintenance. The main findings include:

- **AAOS App / Demonstrator:** Improve interface layout (e.g., reposition personal settings icon); integrate vehicle-specific instructions (fuel cap, parking brake).
- **Maintenance:** Introduce user scoring for responsibility and driving behavior; enable damage detection, feedback on error messages, and documentation of minor maintenance tasks.
- **Carsharing:** Identify special usage (e.g., animal transport); ensure fair and transparent vehicle allocation.
- **Driver Profiles:** Allow transfer of preferences, guest driver functionality, and automatic deletion of outdated profiles.
- **Driver Support:** Provide centralized management for tolls, permits, and documents; integrate a voice assistant and vehicle feature explanations.
- **User Communication:** Implement vehicle handover notifications and app-based alarm forwarding.

Figure 11: Outcome of evaluation workshop

5 GEMINI FLEETBOARD AND AI-ENABLED FLEET ASSISTANT

CARUSO Dataplace is a company offering mobility data from connected vehicles. The platform connects data providers and users in a secure, scalable, and interoperable ecosystem. Through the data platform, vehicle identification number (VIN) based mobility data from various automotive manufacturers can be retrieved in a consistent and standardized way. As of now, the company's coverage of Europe's connected car parc has reached 90%. This coverage accounts for over 90 million vehicles in the European Union that can share data. Their real-time data can lead to valuable insights for different stakeholder groups.

Next to Insurances, Roadside Assistance, and Workshops, Fleet companies are one of the companies targeted customer clusters. Through the power of connected vehicle data, safer, more efficient, and sustainable fleet operations can be realized. Traditional fleet management can value significantly by real-time insights across car brands that have the potential to transform the management of vehicles to streamlined digital solutions. CARUSO's solution enables fleets, whether small or large scale, to depart from traditional, hardware-heavy telematics units, such as OBD-II dongle solutions, to a fully digital ecosystem.

With the developed proof-of-concept (POC) of the GEMINI Fleetboard, Fleets can not only benefit from mere connected-vehicle data, but from a consolidated, interactive dashboard that enables data-driven and artificial intelligence (AI)-enabled decision processes. By offering multi-brand, standardized, and instantly accessible connected car data, fleet managers and other potential users are enabled to monitor vehicle health and are motivated to derive actions, such as route optimization and cost reductions.

5.1 Requirements and Ideation

Subtask 2 in Task 4.2 focused on developing a data pipeline and a proof-of-concept (POC) dashboard for vehicle usage analytics (CARUSO). This work was closely integrated with the feasibility study and co-creation activities carried out earlier in the project. During requirements gathering and ideation, insights and needs identified through collaboration with project partners. As a result, the data pipeline and dashboard were tailored to support real-world fleet analytics scenarios, ensuring alignment with both the project's technical objectives and the operational needs of stakeholders.

Table 3: Requirements and Solution Overview

Requirement	Specifics	Solution
R1 Proposal	Enable MLLs to evaluate data-driven services and participate in vehicle usage analytics.	Allow access to CARUSO's real-time, multi-brand connected car data offering, delivering standardized data for user analytics and evaluation of fleet behavior.
R2 Proposal	Provide POC and guidelines for MLLs about the boundary conditions for experimentation.	Supply clear documentation, dashboards, and practical technical instructions. To specify system requirements, data access needs, and legal boundaries. This way MLL partners can independently trial, evaluate, and give feedback on the GEMINI Fleetboard in their own environments.
R3 Proposal	Analysis of usage patterns for connected car vehicle collected in MLLs and derive data-driven insights.	No vehicles from MLLs onboarded to GEMINI Fleetboard. Analysis started with internal vehicle fleet.

R4 Collected	Deliver AI-enabled fleet health monitoring and predictive maintenance for connected vehicles.	Deploy the AI-enabled Fleetboard to deliver actionable insights for users and fleet owners and provide alerts for predictive maintenance based on live data.
R5 Collected	Provide tools for the demonstration and adoption of advanced digital Novel Mobility Services (NMS) across urban and commercial fleets.	Fleetboard together with CARUSO dataplace APIs.
R6 Collected	Ensure transferability, interoperability, and strong compliance with GDPR and EU regulations.	Maintain standardized APIs, compatibility with various IT environments, and GDPR-compliant consent/data protection processes across all services.

These requirements led to the idea of developing a fleet management dashboard with an integrated AI assistant that can be used as an interactive chatbot.

The developed solution reflects a departure from traditional fleet management devices and processes and transfers the required functionalities based on real-time connected car data as well as AI-enabled natural communication interaction. The Fleetboard and the AI-enabled Fleet Assistant deliver processes that help keep an eye on the vehicle fleet with minimal effort.

It ensures intuitive, seamless user interactions, allowing fleet managers and drivers to access important data quickly and easily, whether through the dashboard or the AI chatbot. Fleet monitoring and smart assistance is offered by automated insights and predictive alerts.

5.2 GEMINI Fleetboard Overview

The GEMINI Fleetboard is a fleet management solution that enables users full overview of their vehicle fleets and the specifics of each vehicle.

Figure 12 shows the homepage of the dashboard. On the left side of the dashboard, a navigation pane shows the different functions of the application. "Vehicles" give an overview of the entire fleet. This list can be filtered by vehicle brand, the mileage of the vehicles, or by telematics capability. Additionally, vehicles can be searched by the input of free text, such as the license plate.

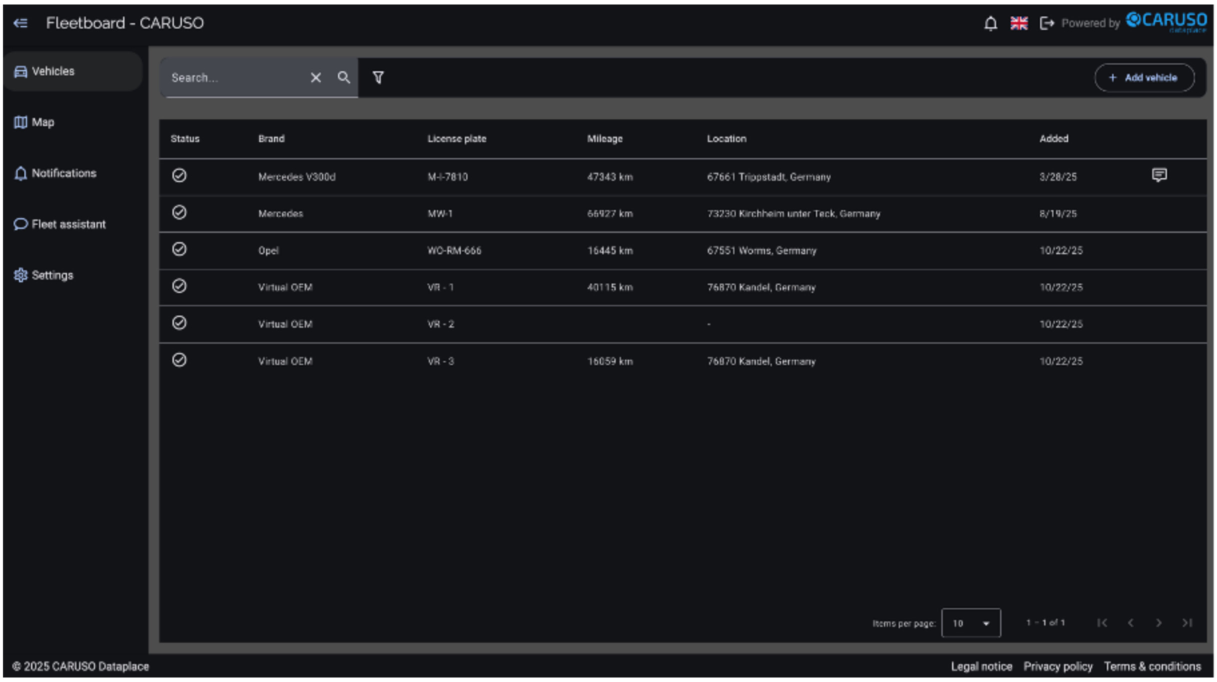

Figure 12: Overview homepage, GEMINI Fleetboard.

To add vehicles to the existing fleet, "Add vehicle" allows the user to insert the VIN and brand of the vehicle, as shown in Figure 13. Optional details, such as model or colour of the car, can be added voluntarily. Is a vehicle added to the fleet, the system performs a capability check that will determine if the vehicle is able to share telematics data in general and if data can be retrieved via the CARUSO platform. For this, an active subscription to the respective vehicle manufacturer needs to be active.

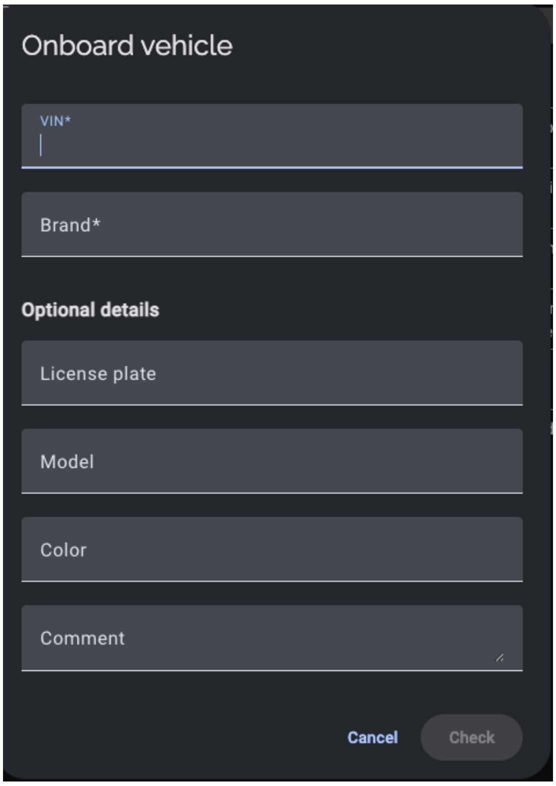

Figure 13: Onboard vehicle.

To see all available data for respective vehicles, in the vehicle overview single vehicles can be chosen and inspected in detail. As seen in Figure 14, the inspected vehicle is a Mercedes V300d. This frame shows all available details about the vehicle itself and on the right side the telematics data that is being streamed from the vehicle. This information includes general information (e.g., mileage, ignition status, or vehicle speed), maintenance information (e.g., next service distance and next service date), indicators and errors (e.g., the status of indicator lights), information about the tires, the status of the windows and doors, information about fuel and charging (e.g., the battery voltage or fuel level), crash information, and trip information.

Additionally, the precise location of the vehicle is available visualized in the location, the coordinates, and in the OpenStreetMap.

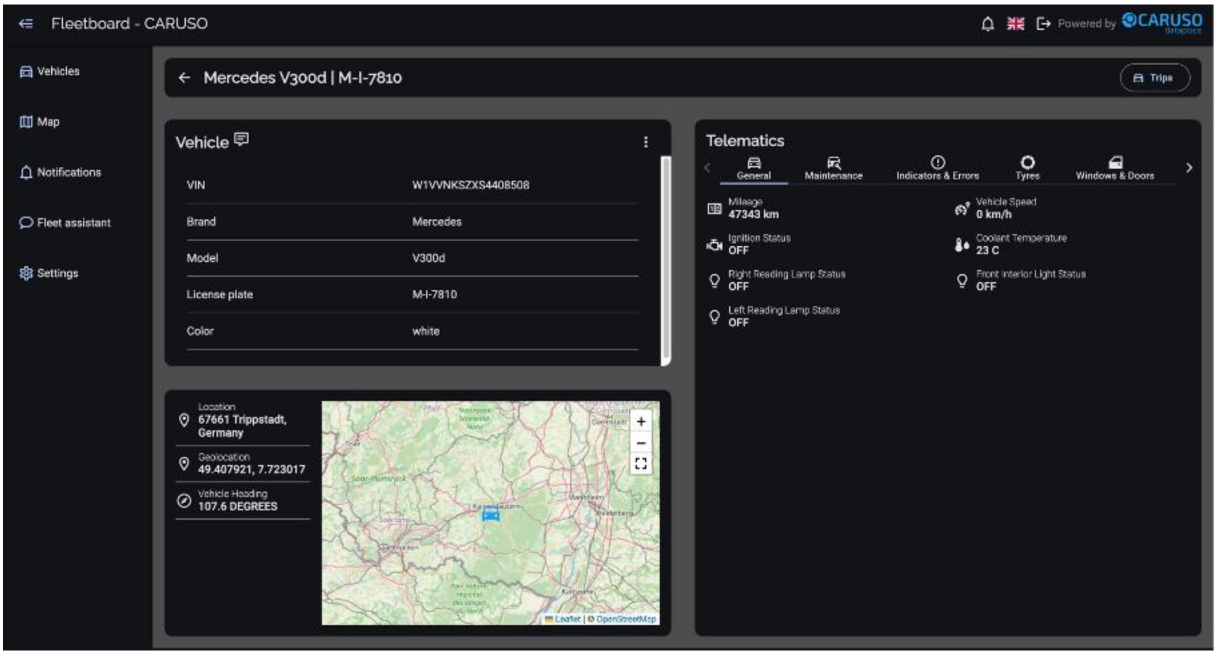

Figure 14: Vehicle in-detail overview.

Further, in this frame, the button “Trips” shows an overview of aggregated data items accumulated to a trip. This trip can show users where the vehicles have been, and which routes they took. For this, the GPS positions create location points that are delivered in a regular frequency (subject to each vehicle manufacturer). These are combined to create a route. Additional data that was delivered by the vehicle is shown as well as it can be seen in

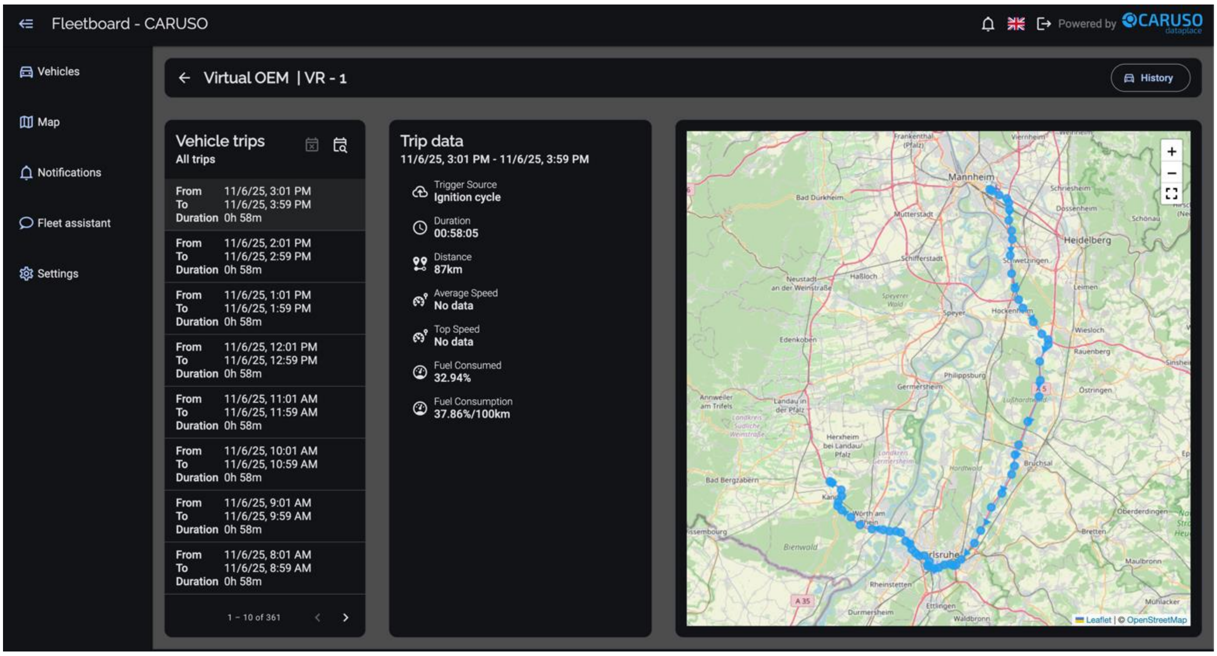

Figure 15: Trip overview.

The next tab in the panel leads to the “Map”, refer to Figure 16. Using an implementation of OpenStreetMap and the delivered location data of each vehicle, the cars can be mapped to their current location in a visually attractive way. This ensures a simple overview for the user to see all their vehicles' location at once. Hovering over a vehicle shows relevant details, such as the brand, the licence plate, as well as the VIN.

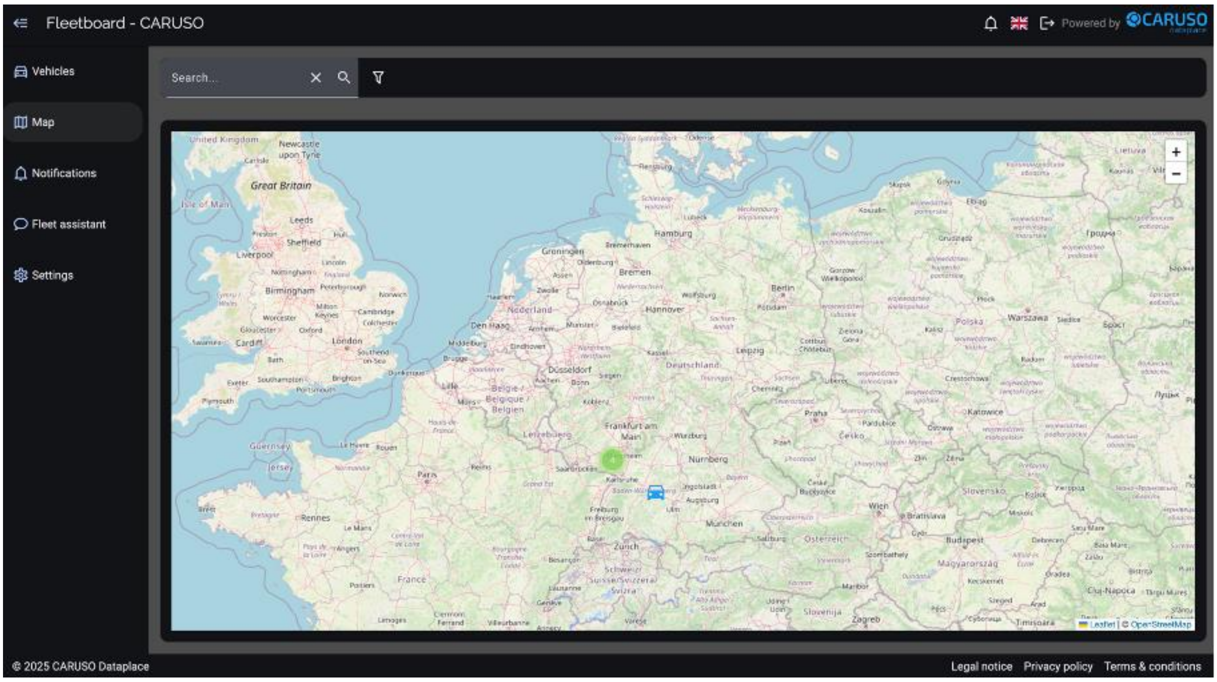

Figure 16: Map function.

To stay informed about any alerts concerning the fleet, notifications can be accessed directly in the fleetboard (Figure 17). These can additionally be pushed directly to the user to ensure a transparent communication and allow flexibility for any needed action.

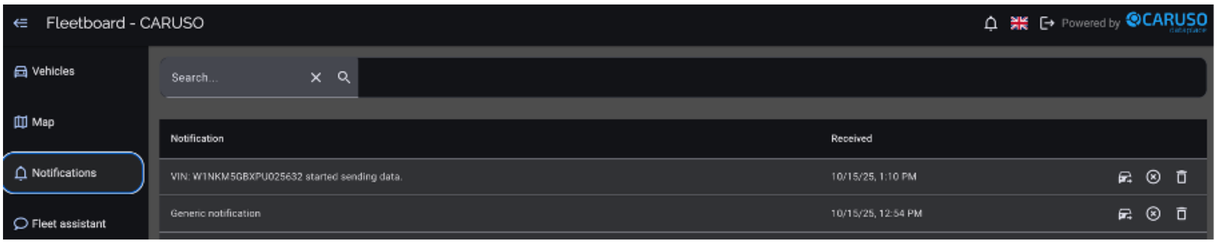

Figure 17: Notifications.

Lastly, the "Settings" menu option can be used to alter the configuration of the fleetboard. Here, notification contacts can be stored, and an overview of the board's active subscriptions is available to see for which vehicle brands, real-time data can be received.

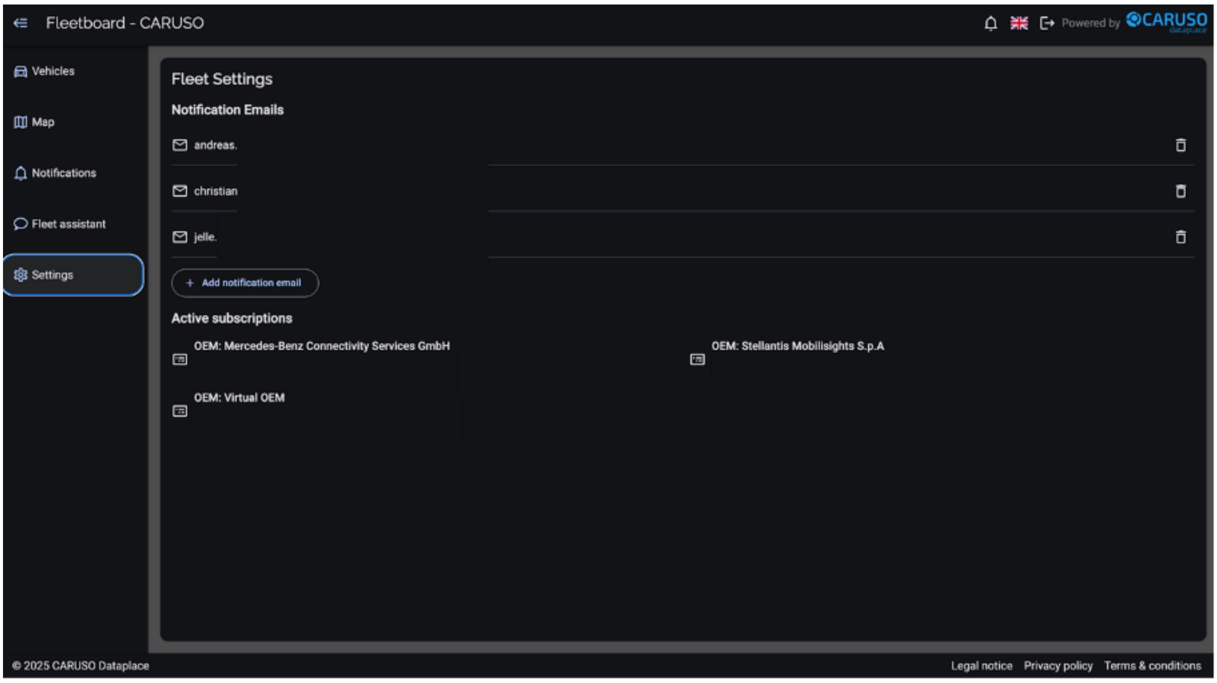

Figure 18: Settings.

5.3 AI-enabled Fleet Assistant

The AI-enabled Fleet Assistant as part of the GEMINI Fleetboard enables users to interact with a chatbot and their fleet's data. As a POC, the chatbot can access all available data of the onboarded vehicles and can disclose information about specific vehicles or the entire list of cars. The Fleet Assistant is available in multiple languages and can compute pre-written prompts of self-invented queries.

Pre-written prompts include test scenarios that were internally collected, such as:

- Can you give me all vehicles with a mileage above 100,000 km?
- Can you give me the latest data for all vehicles?
- When is the next service for vehicle ...?
- What country is the vehicle ... located in?

Self-invented queries can be as creative as the user can be. The only limitation is that the system is only able to answer the request if the context of the question can be answered with available data in the GEMINI Fleetboard. Examples for self-invented queries could be:

- Show me all vehicles with current warning lights or fault codes.

- List all trips today below 100 kilometres.
- Show only electric vehicles in my fleet and their charge status.

The core of the AI-enabled Fleet Assistant is built around three essential pillars: natural language interaction, direct access to advanced data analytics, and automated, context-driven responses. Users can communicate with the assistant using everyday language, no technical terms required, which makes the system highly intuitive and accessible for operators across diverse fleets.

Figure 19: AI-enabled Fleet Assistant.

The setup of the Fleet Assistant is shown in Figure 20 and visually introduces the component. Multiple elements allow guidance for an interactive user experience. The layout highlights ease of use: users can either click on suggested prompts for quick insights or type their own questions directly into a dedicated text field.

- 1 Greeting: The assistant greets the user in a friendly way, promoting them to make use of their assistance.
- 2 Example prompts: Offering a selection of useful prompts, such as requesting vehicle's fuel levels or filtering vehicles by specific criteria, e.g., vehicles <100.000km mileage.
- 3 Discarding the chat: Getting rid of all former interactions, the chatbot discards all saved information and will forget the connections made between answers.
    - 4 Text field for inserting prompts: Users can freely write prompts into the text field, allowing for flexible requests.

The screen is organized to guide new users, showing them where to click and which steps are possible to take.

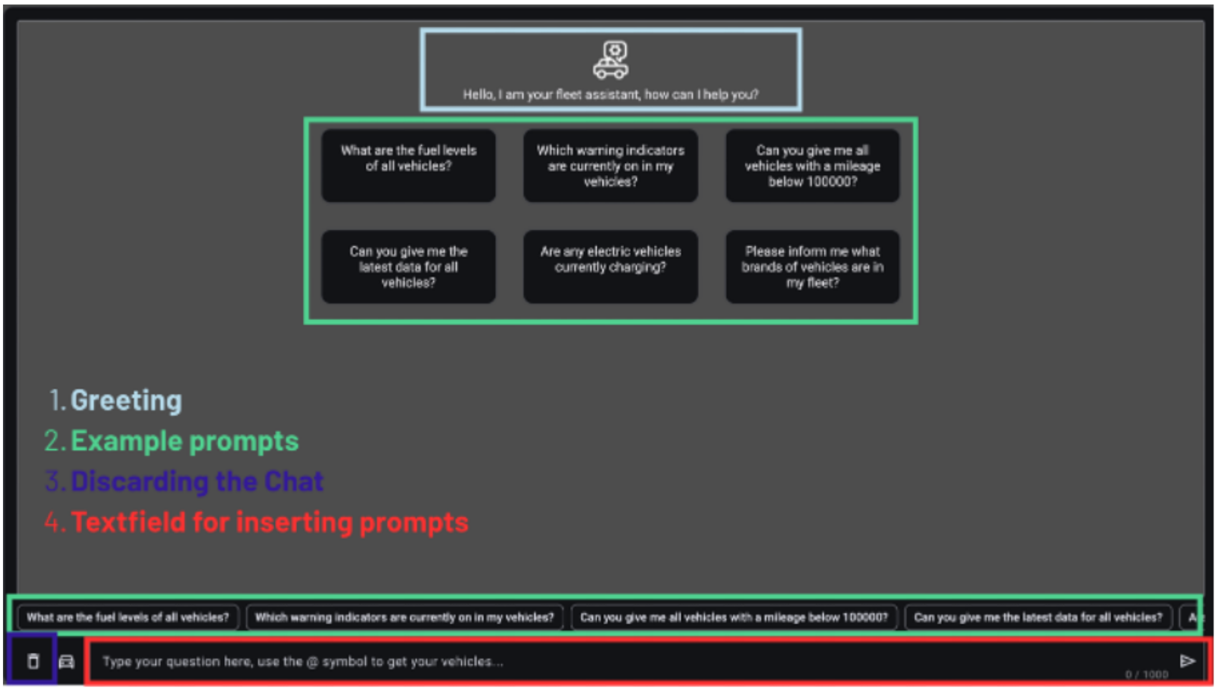

Figure 20: AI-enabled Fleet Assistant setup.

Next to the text field, the user can filter and search for specific vehicles that are of interest. Either the list function with the car button as seen in Figure 21 can be used or the list of cars can be retrieved by recalling the list typing the "@".

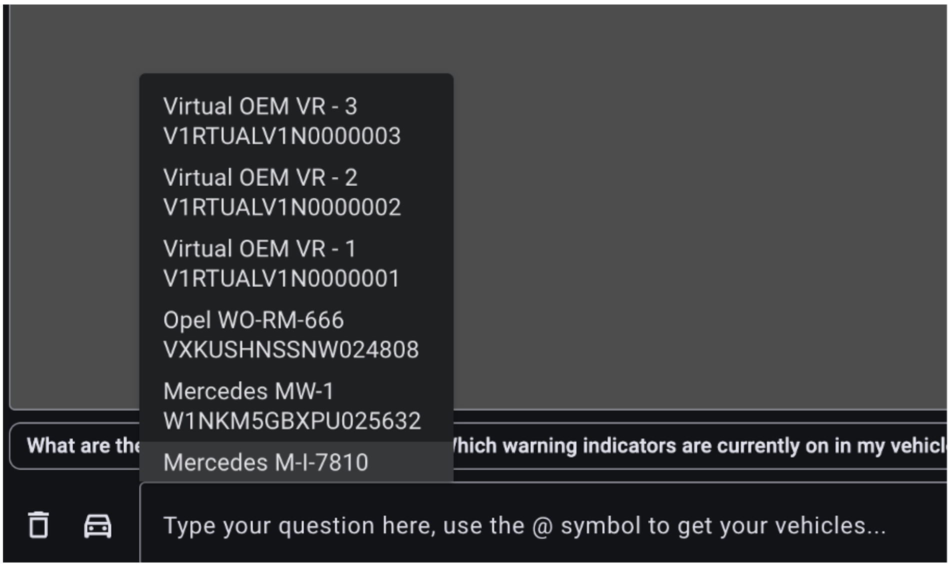

Figure 21: List of vehicles.

In the figures below, example prompts are shown. The AI-enabled Fleet Assistant can only access available data in the Fleetboard solution. It does not make use of external information. While this limits the detail for response, it ensures full GDPR compliance and protection of personal data. With the responses, the user can interpret basic information to derive actions necessary for their fleet or respective vehicles.

Below, Figure 22 shows exemplary prompts. Here, the user first asked about the fuel levels of all available vehicles. The AI takes a moment to "think" and checks all available data for each vehicle to find fuel levels. Then, it delivers the answer for each VIN and each value. Depending on the vehicle manufacturer and their delivered data item content, the fuel level is displayed in liters or as a percentage. The second prompt queries for the maintenance schedules of the fleet to be able to plan workshop appointments accordingly. After compiling the answer, the Fleet Assistant provides its answer again naming each vehicle by VIN and the first digits of the license plate, the next service date, and the distance to the next service.

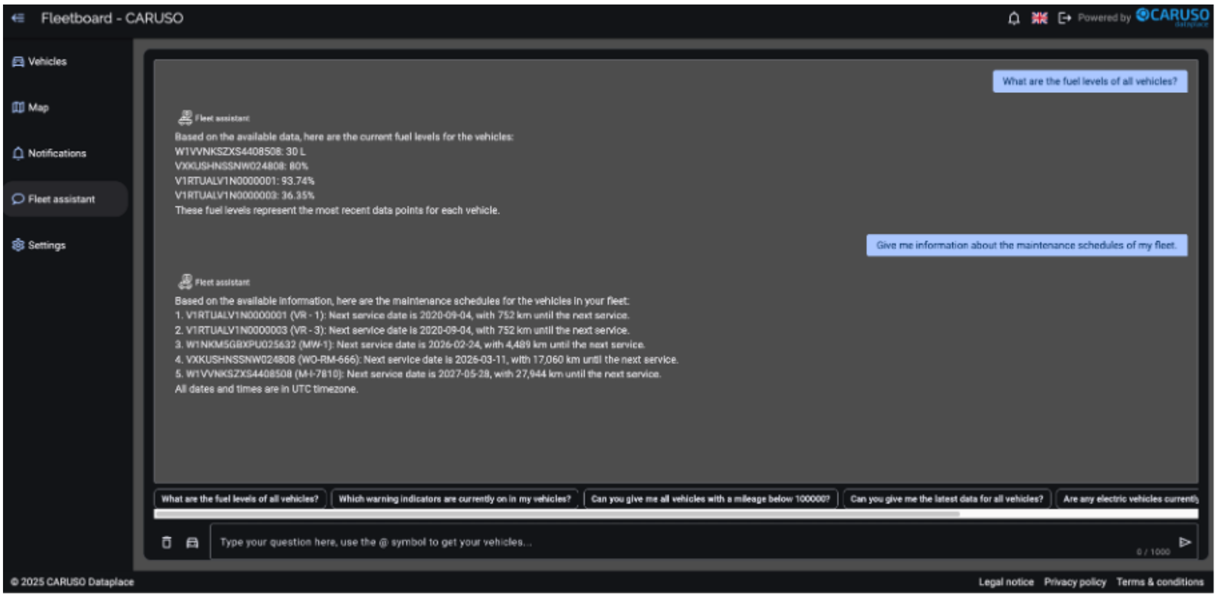

Figure 22: Example prompts.

As Figure 23 shows, the Fleet Assistant is able to translate queries and answer in other languages than English. The system processes the prompt and answers in the given language. Here, the first prompt asks which vehicle would need a maintenance service next. The system collects the information and provides the specific vehicle and the information available. The second prompt mentions a specific vehicle and asks for the next service date in a colloquial way. The chatbot is also available to provide the information for this request.

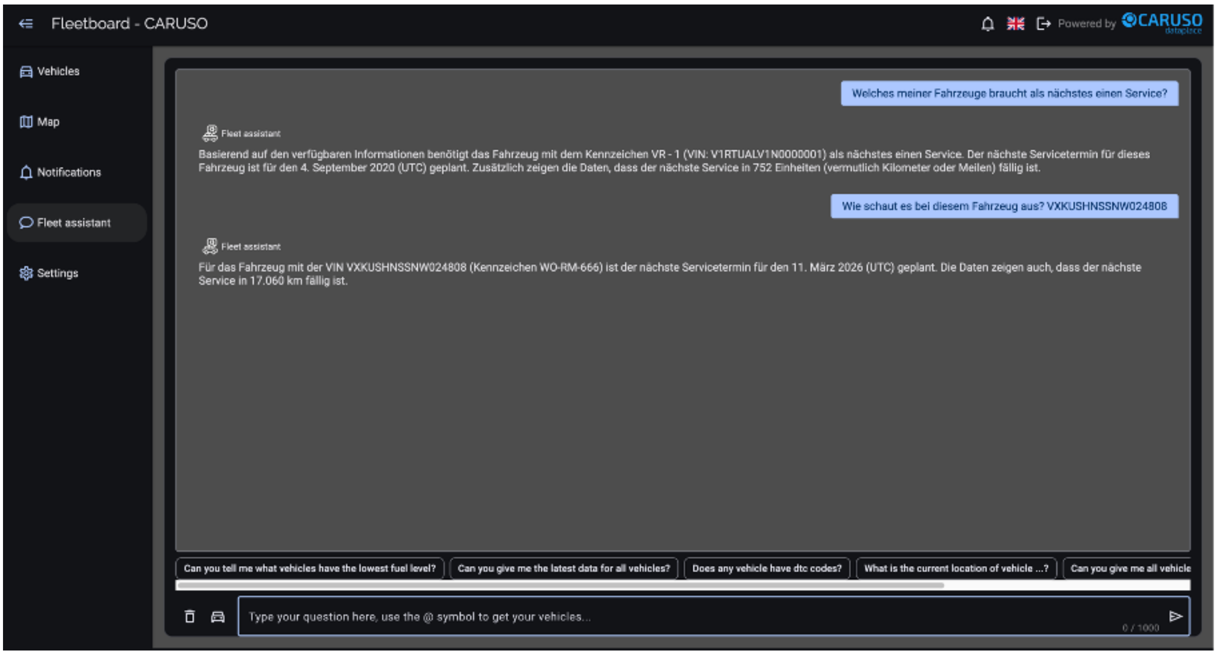

Figure 23: Foreign language compatibility.

5.4 GEMINI Fleetboard Architecture

The GEMINI Fleetboard Architecture can be seen in Figure 24. It provides a high-level technical overview of the system, illustrating how data flows between various backend components, APIs, and the frontend user interface.

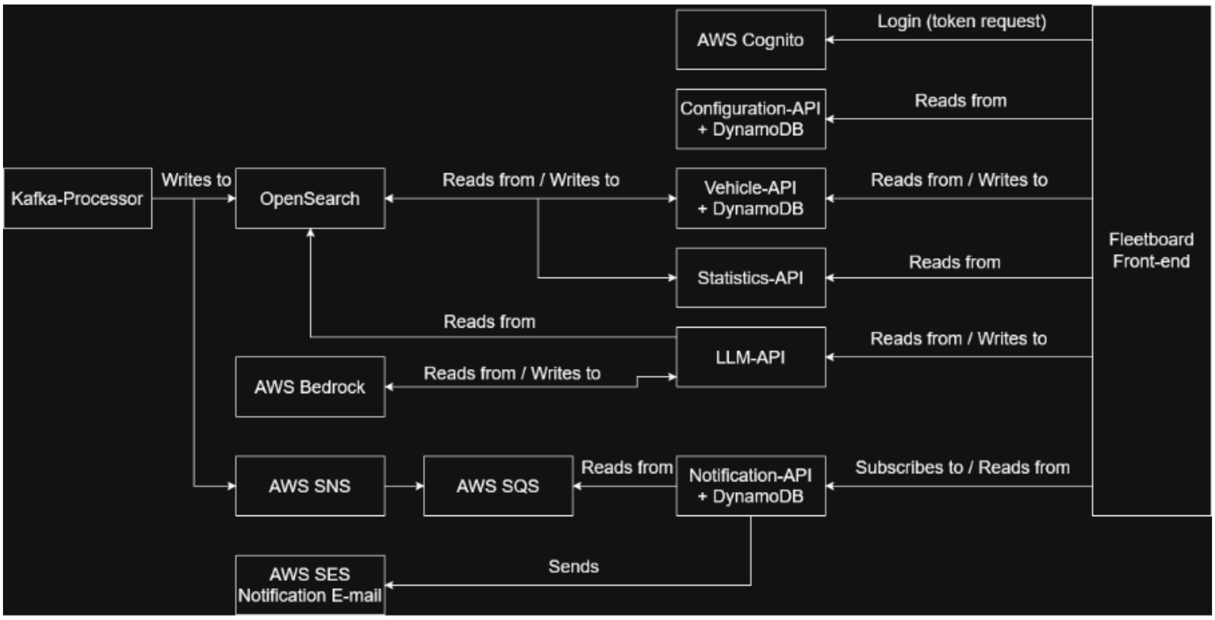

Figure 24: GEMINI Fleetboard architecture diagram.

From the perspective of the Fleetboard Frontend the first action for any user is the login. The login is enabled via user management and fleet association in AWS Cognito. During the login, Cognito returns all necessary information required to access the backend components that are collectively exposed via an AWS API Gateway which checks each request for the token content of the authenticated user.

The Backend itself contains various components that are illustrated in Figure 18, such as the Configuration-API, the Vehicle-API, the Statistics-API, the LLM-API and the Notification API.

The backend data flow begins with an instance of the Kafka-Processor, which handles the incoming standardized platform in-vehicle data ingestion into OpenSearch, which is the primary Data source for Vehicle Data for the Fleetboard. For each fleet, a Kafka-Processor instance can be created which allows for horizontal scalability of the architecture.

The Configuration-API allows fleet-based look and feel customization and flags to enable or disable certain Fleetboard features.

The Vehicle-API is responsible for handling vehicle specific Platform integrations such as checking for the capability of VINs, onboarding and offboarding vehicles as well as accessing OpenSearch, which allows for reading and updating of static vehicle data and vehicle filters for easier search in larger fleets.

The Statistics-API periodically reads the ingested data from the telematics-index in OpenSearch to analyze it and restructure it into Trip Data which in turn is written to a separate trips-index in OpenSearch. The Statistics-API also provides an interface for the Fleetboard to read the trip statistics and routes for each specific vehicle.

The Notification-API is a component that is accessed by the frontend and indirectly the Kafka-Processor. While ingesting the in-vehicle data, the Kafka-Processor also looks for specified data-items that trigger notification events into AWS SNS (Simple Notification Service) such as first data delivery for a vehicle. These notification events are forwarded to AWS SQS (Simple Queue Service) where they then await a read acknowledgement from the Notification-API component. This acknowledgement signals that the notification was successfully read in the Notification-API. The Notification-APIs itself serves three purposes. One is providing live notification events through WebSocket connections that can be initiated by the Fleetboard Frontend. The second is storing past notifications and their read state for future access and for when a user is not logged in. The last is sending notification emails to specified recipients through AWS SES (Simple Email Service) for important notifications. These emails provide links directly to the affected vehicle in the Fleetboard Frontend.

Lastly, the LLM-API is a wrapper around any large language model hosted in an EU Region of AWS Bedrock. It contains the different system prompts and can fetch OpenSearch mapping information for the vehicle, telematics, and trip indices. With the user-provided prompt, the LLM-API can determine the context of the user's request and on its on either answer the request outright or fetch the requested data from the OpenSearch indices by generating Query DSL compliant JSON requests. These requests are parsed into JSON objects and checked if they are valid. Whenever the Model doesn't return valid syntax, the generated request is put into a query fixing parser that asks the Model to try and fix the request once. When the request syntax is correct, the request is modified to only fetch data for the fleetId of the user. Afterward the request is sent to OpenSearch and the results are processed by the model which then answers the original question with the received data. When the request could not be fixed, the user will receive an error message. In order to increase the probability that the Fleet Assistant answers questions correctly, there are integration tests in place that test certain predefined user questions on predefined data. The answers then scored by how semantically similar they are to predefined answers for each question. When an answer is too dissimilar, the test for that question fails and adjustments are made.

5.5 AI-enabled Fleet Assistant architecture

Considering the technical background of the AI-enabled Fleet Assistant, several components need to be considered.Figure 25 shows the technical overview and explains how the AI-enabled Fleet Assistant understands and answers user questions, combining AI, a search engine for in-vehicle data, and flexible integration tools.

- When a user asks a question, the assistant first determines the context.
    - If it is an off-topic question not related to the fleet, the system doesn't answer it, since it doesn't access external off-topic data.
- If the question is relevant and the answer is immediately available, the system answers it with previous knowledge of the chat or the context.
- If the question is relevant and additional data from the database is needed, the system generates an OpenSearch query fitting the question (it translates the natural language prompt into technical database queries). If the answer cannot be found within the first try, the query will be once repeated and the answer will be given based on available knowledge and the knowledge of the database results.

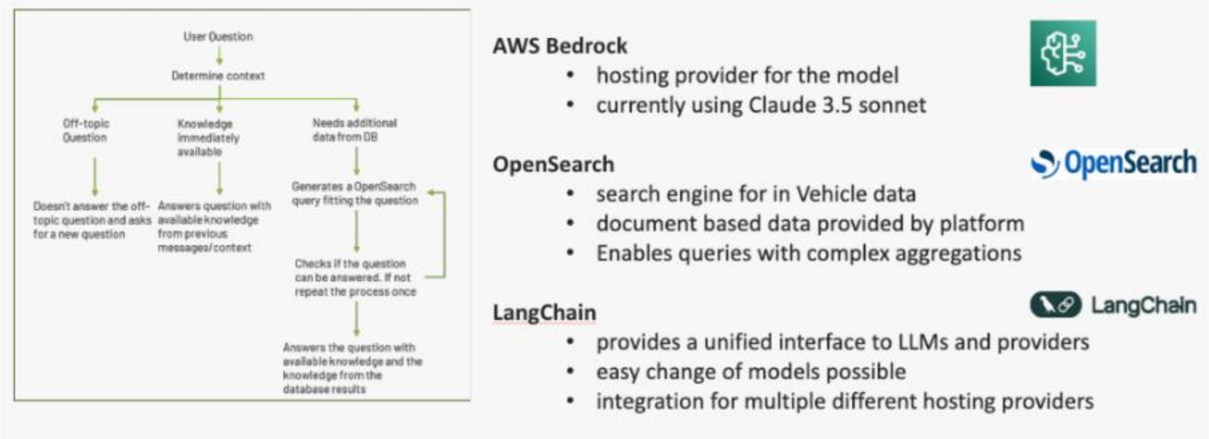

Figure 25: AI-enabled Fleet Assistant technology overview.

The system relies on AWS Bedrock to host the AI language model (currently using Claude 3.5 sonnet), OpenSearch to store and retrieve vehicle data for complex questions, and LangChain to be able to use a unified interface and potentially be able to switch between different models or hosting providers.

Altogether, this architecture ensures that the Fleet Assistant can flexibly handle a wide range of user questions. It also makes it possible that the assistant can answer common queries immediately, searching real vehicle data when needed, and always being ready to help.

5.6 Security and GDPR compliance measures

The GEMINI Fleetboard and its AI-enabled Fleet Assistant adhere strictly to standard GDPR guidelines and internal guidelines for the usage of AI ensuring the highest standards of data protection.

All information that flows within the system is consent-based and supported by contractual frameworks in a B2B context. Data sharing is only enabled with the explicit consent of the vehicle owner. Every data flow is governed by binding agreements between the vehicle manufacturer, CARUSO as the provider of the data harmonization and environment, and the fleet owner or user. This guarantees that vehicle data is accessed and processed in compliance with European privacy regulations and that all stakeholders retain control and transparency over their information.

In line with internal company policy, the use of AI is subject to clear governance, ethical standards, and privacy-by-design principles. AI applications are powered by approved AI engines, such as Claude 3.5. No personal or sensitive data is handled by AI tools unless covered by legally binding data processing agreements; all data exchanges are logged and monitored for traceability and auditing, minimizing risk of unauthorized usage.

This approach ensures that every element of CARUSO's AI-enabled fleet services, from contract formation through daily operation, prioritizes data security, user privacy, regulatory compliance, and ethical innovation.

The owners of the displayed personal information in this report, such as VIN or vehicle license plates, have consented that this information does not have to be censored. In a productive user environment, e.g., the MLLs or external users, this information naturally would not be shared beyond the parties involved.

5.7 Use Cases supported by the AI-enabled Fleet Assistant

The current AI-enabled Fleet Assistant is designed to make the management of fleets easy and accessible by supporting simple, conversational interactions that don't require deep technical expertise from the users. While the current system mainly delivers an overview without deep automated interpretation, it already unlocks practical value for small to medium fleets, especially for users that want quick answers without having to search within the entire vehicle fleet.

Use Cases supported by the AI-enabled system:

- Real-Time Data Querying and Reporting

  Users can quickly access current fleet status, vehicle locations, or mileage without navigating in the dashboard. A simple question like "Which vehicles are overdue for inspection?" brings up actionable answers, helping users to stay proactive.

- Simple Predictive Maintenance Insights (potential for future expansion)

  The assistant can flag vehicles approaching service intervals or showing signs of wear (such as accumulated mileage), supporting advance planning and reducing downtime.

- Incident and Fuel Efficiency Reporting

  The assistant provides an overview of statistics for incidents, like accidents or unusual events, and monitors fuel consumption. This gives power to users to create safer, more economic fleets by easily identifying trends or anomalies.

- Scenario 1: Daily Operations Check

  Fleet Managers can ask for a snapshot of all active vehicles, helping them track daily activities and ensure that operations run smoothly.

- Scenario 2: Maintenance Overview

  With a simple query, users see which vehicles are nearing service deadlines, streamlining scheduling and minimizing operational disruptions.

- Scenario 3: Incident Follow-Up

  If a crash happens, the dashboard notifies the users and they can start the necessary process steps.

The conversational interface lowers barriers, speeds up decision-making, and provides all users with a user-friendly way to interact with complex fleet data. This ensures efficiency and transparency with minimal necessary user training.

5.8 GEMINI Fleetboard and AI-enabled Fleet Assistant Evaluation

The AI-enabled Fleet Assistant has been designed and developed based on the project goals and requirements. Based on numerous conversations with MLL representatives, this solution is of great interest. However, an immediate usage and implementation into existing solutions was not prioritized by MLL's. Nonetheless, the tool has been extensively tested internally within the project consortium.

These internal tests have demonstrated robust system performance, responsive natural language interaction, and ease of use for non-technical users. These tests enabled the team to identify specific areas for improvement. Feedback gathered during this evaluation has informed a prioritized roadmap for incremental enhancements.

Moving forward, the project team aims to re-engage the MLLs for another evaluation of testing needs. This can lead to a second round of testing and evaluation, offering another chance to integrate MLLs' vehicle fleets. This way, the solution remains relevant and adaptable for real-world MLL fleet contexts, accommodating local operational needs and user feedback.

The project's outlook therefore includes ongoing dialogue with MLL partners about practical implementation scenarios, such as integrating the AI-enabled Fleet Assistant into daily fleet workflows, connecting it to existing data systems, or using it as a first step towards digital fleet management.

Continuous stakeholder engagement is essential not only to validate usability, functionality, and practical impact on fleet management processes but also to encourage MLL engagement and inform future rollouts. This iterative cycle of deployment, feedback, and refinement aims to deliver a mature AI-enabled Fleet Assistant well aligned with end-user requirements and operational realities.

PS: The board can be accessed with a user account requiring e-mail address and password. **If any GEMINI project partner wishes to access the board, please feel free to reach out to one of our CARUSO colleagues Rebekka Rank rebekka.rank@caruso-dataplace.com, Christian Webel christian.webel@caruso-dataplace.com, or Micha Weißer micha.weisser@caruso-dataplace.com.**

6 OUTLOOK AND CONCLUSION

The next phase of the project will focus on the targeted development of the AAOS app and the conceptual refinement of the identified use cases, with particular attention to enhancing user-friendliness and operational functionality. Key areas of improvement include carsharing management and community-based vehicle maintenance, ensuring that the app meets the practical needs of users in real-world settings. The use cases will be discussed collaboratively with the MLLs to evaluate their relevance, transferability, and potential for adaptation, providing an opportunity to refine the conceptual framework and align it with operational requirements.

Data protection and security remain central priorities. All use cases will be carefully reviewed to guarantee that only necessary personal or sensitive data are processed. Risk analyses will identify potential vulnerabilities, and tailored implementation concepts will be developed to secure data while enabling efficient use of the app in neighbourhood carsharing contexts.

The GEMINI Fleetboard with its AI-enabled Fleet Assistant is currently being tested with small fleets and has demonstrated a realistic potential for scaling to medium and large fleets. Its cloud-native architecture and robust GDPR compliance provide both legal security and commercial feasibility. Future development plans include integrating expanded data sources for richer real-time insights into vehicle health and usage, applying predictive analytics for proactive maintenance and operational forecasting, enhancing conversational AI capabilities such as voice interaction, and enabling modular add-on services such as sustainability dashboards, compliance tools, and technical vehicle information. These steps aim to deliver a stable, user-focused, and data-compliant system that can be effectively integrated into practical testing environments and scaled for wider mobility ecosystems.

The AAOS App and the CARUSO Fleetboard with AI-enabled Fleet Assistant have been successfully implemented as proof-of-concept prototypes, demonstrating the feasibility and practical value of data-driven digital mobility solutions for shared vehicle fleets. Internal tests and workshop evaluations confirmed the systems' usability, technical stability, and operational relevance, while identifying areas for refinement in interface design, user guidance, maintenance workflows, and AI functionalities. The findings indicate that both systems are transferable and scalable for small and medium fleets, providing a solid foundation for broader integration into real-world mobility scenarios.

Looking ahead, the project will focus on implementation testing within the MLLs, integrating the systems with local fleets, and continuously refining them based on operational feedback. Overall, the work completed so far highlights the innovation potential, practical applicability, and readiness for further development of GEMINI's digital NMS enablers, paving the way for their effective deployment in future mobility solutions.

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